Mammals in Hawai'i

A Synopsis and Notational Bibliography

Second Edition

P. Quentin Tomich

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FRONTISPIECE.—"Arrival of the domestic goat on Hawai'i Island, *ca.* 1779." A composite from tracings of the petroglyphs at Puakō, South Kohala District. (Arranged by Marcia Tomich.)

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to Caroline

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Introduction to the Second Edition

MAMMALOGY IN REVIEW

The first edition of *Mammals in Hawaii* (Tomich, 1969a) included a lengthy introduction appropriate to a pioneer effort in organizing a scattered and nebulous literature on a fauna that is generally alien to Hawai'i. This fauna possesses few evolutionary roots in our remote archipelago and the entire list of ancient, naturally distributed, land-based mammals (Johnson, 1944) consists of a seal that arrived by swimming and a bat or probably two (Ziegler, 1982) that arrived by flying. The inquisitive reader is invited to examine those introductory pages. I abstract and paraphrase from them, use portions bodily, and add remarks prefatory to the present revision. It is necessary, in deference to the historical record of mammals and mammalogy in Hawai'i, to retain essentially all the bibliography of the first edition, and I have done that. Mammals and mammalogy remain important to the small, diverse land area of Hawai'i and its vast, surrounding seas. Although many researchers and natural resource managers among the islands continue to work with mammals, not more than six of some 4,000 professional mammalogists nationwide (American Society of Mammalogists, 1984a) reside in Hawai'i, up from one in 1960.

Polynesians occupied this northernmost of their "*Hawaiki*" possibly as early as the second century (Suggs, 1960) and there were at least 1,400 years of dynamic interaction between their cultures and Hawaiian ecosystems, with severe repressions of lowland biota (Kirch, 1982). Early settlement brought the pig, dog, and Polynesian rat. A second influx of alien mammals dates from rediscovery by James Cook in 1778. By 1815 feral herbivores ranged in uncontrolled hordes that further altered or destroyed original natural ecosystems. Cats and aggressive strains of dogs and pigs became numerous; additional rodents appeared and were destined to be of economic and public health significance.

A century after European contact there began a third invasion of free-ranging mammals with the rise of plantation agriculture, and later, of game management. A mongoose and at least two species of bats were brought in for

biological control of pests, and additional wild ungulates were imported to diversify sport hunting. Miscellaneous species released or escaped at various times included a deer, a wallaby, a rabbit, and a guinea pig, and these have added to the faunal list.

Mice, presumably *Mus domesticus*, are claimed to have been present when Cook arrived, or to have come with the Polynesians (Svihla, 1935; Tinker, 1938, p. 111), but these assertions lack documentation. Nonetheless, we cannot be sure that pre-Cook mammals, other than the pig, dog, and rat usually associated with Polynesian cultures, did not come by one means or another. There has been an undercurrent of speculation as to whether an occasional early Spanish ship did reach Hawai'i and bring humans, rodents, or metallic implements (Jarves, 1843; Dahlgren, 1917; Taylor, 1927; Restarick, 1927; McClellan, 1936; Cooke, 1949, p. 151). The matter was examined by Stokes (1939) and seemingly refuted as highly improbable on the basis of available evidence. However, with intensification of archaeological research it came forward once more (Emory, 1961; Kirch, 1985). In addition to the possibility that Spanish galleons were wrecked among the islands with few existing traces, there is one actual record of an Oriental fishing boat, with surviving crewmen aboard, that drifted to Hawai'i in the 1830s (Emerson, 1838). This may not have been the first such event.

The marine waters of Hawai'i are rich in various indigenous whales and dolphins, and these constitute a prominent segment of the mammalian fauna. The smaller of these cetaceans still enjoy a primeval existence only slightly modified in our region of the Pacific by interferences of man. In sum, Hawai'i presently claims in addition to one volant, two marine littoral, and at least 22 pelagic mammals (the naturally distributed forms), 19 free-ranging terrestrial species that arrived through human agency, for a total of 44 forms. The horse is no longer among the feral mammals in the state. Nomenclatural lists are now reasonably well up-to-date. We have progressed a long way from the initial attempt (Tinker, 1938) to gather and present information on all the mammals known in Hawai'i. Hypothetical species include two introduced bats that failed to colonize, and there may be several cetaceans that will qualify eventually for listing. With additions and deletions 22 whales and dolphins are accounted for. Three others remain unconfirmed. The Pacific white-sided dolphin (*Lagenorhynchus obliquidens* Gill), though reported (Nishiwaki, 1967, p. 38), is supported by no specific records. The same author (p. 34) ascribes also the common dolphin (*Delphinus delphis* Linnaeus) to Hawaiian waters. Again, there are no specific records, and I have dropped both from the list. Shallenberger (1981) has seen and photographed a bottlenose whale (*Hyperoodon* sp.) but prefers not to list the animal until a specimen is examined in hand or identified at sea by two or more experienced observers. In time, new

species probably will be added to the Hawai'i list of marine mammals under these cautious criteria. With vigilance, no additional land mammals will be acclimated.

Nomenclature of the well-known mammals in Hawai'i has remained generally stable. A notable exception is the immigrant mouse, which is now called *Mus domesticus* (European house mouse) rather than as formerly, *Mus musculus* (Linné's house mouse). Hence, designation of our mouse is undergoing an awkward transition in the literature.

STRATEGY

Passage of some 16 years since first publication of *Mammals in Hawaii* required a newer version of the book, though the original writings have stood largely against change. A primary task, then, was to continue the story and bring it once again up-to-date. The pattern of presentation is not changed. Where revision has been appropriate, I have not hesitated. Accumulation of vast new information on the cetaceans stimulated recasting of the entire species list and related narrative sections. The overall plan for presentation of bibliographic materials remains the same. All articles are listed in alphabetical sequence by authors' names. Each article is cited appropriately in the text, so the perusal of any particular section will bring forth all pertinent references. New entries are integrated with the old in a single list that now includes more than 1,500 discrete items. The ambitious investigator may wish to scan all entries in order to judge what may be useful to a present need. Notations of various sorts accompany each item, including brief abstracts or descriptions of the entire article, or of portions referring specifically to mammals. Some contain salient quotations.

The setting for research in the form of basic reference sources survives as a familiar friend. I cite the earlier collection here as a means of reference to it, and include later in these pages those of newer vintage. Among the old titles are sure to be fugitive materials that are too easily lost if cast aside, and if regained at all, done so at some risk of trauma. Hence, I retain them.

Basic library resources have been summarized in several ways at several times (Titcomb, 1961; Gregg M. Sinclair Library, 1963; Bernice P. Bishop Museum, 1964a; Hawaii Library Association, 1965; Conrad, 1967). However, the rapid deployment of computerized listings and search services since the 1970s tends to press some of them into the background. One newer aid is a subject index to leading Hawai'i newspapers, published annually. It can be found in even the smaller of public libraries (State of Hawaii, Department of Education, 1968—). Sources of knowledge about research facilities and published reports are contained in E. H. Bryan, Jr. (1936, 1961), Anon. (1947b), Bernice P. Bishop Museum (1967a, 1967b).

The physical and biological setting for field work, especially on ecology, has been examined in its many aspects. C. J. Lyons (1884) was among the early supporters of ecological research in Hawai'i. Geological works include those of Hinds (1930), Palmer (1927, 1930, 1936), and Wentworth (1925, 1926). A long series of reports on geology and groundwater resources is exemplified by Stearns and Macdonald (1946), and Cline (1955) has examined the soils. The United States Department of the Interior (1964) and E. H. Bryan, Jr. (1964) have provided maps. Wadsworth (1933), Wentworth (1947), Leopold and Stidd (1949), Chang (1961, 1963), and Blumenstock (1961) discuss climate, weather, and irrigation. Disruptive forces in nature (volcanic eruptions and so-called tidal waves) are reported by Finch (1947), Macdonald and Orr (1950), Macdonald (1962), Macdonald, Shepard, and Cox (1947), Wall (1960), and Anon. (1967f). Zimmerman (1948) and E. H. Bryan, Jr. (1954) have made masterly syntheses of most topics referred to in this paragraph, and have interwoven in them also the flora and fauna. Mayr (1943) discusses further the zoogeography of Hawai'i, and McKnight (1964) includes Hawai'i in the scope of his work on feral animals.

More general works dealing with the environment, and brief reviews of the mammals, include Alexander (1892), Affonso (1895), W. L. Hall (1904), Goodrich (1914), L. W. Bryan (1933), Christ (1958), Nelson and Wheeler (1963), Anon. (1927), Chun and Tinker (1940), Lennox (1951), E. H. Bryan, Jr., Wentworth and others (1957), Breese (1959), State of Hawaii, Department of Land and Natural Resources (1962), and R. L. Walker (1963).

Serious work on Hawaiian flora is based on Hillebrand (1888) and has been augmented particularly by Degener (1932–1980). Regional studies and those on endemic and alien groups have been reported by Rock (1913), Degener (1930), Christophersen and Caum (1931), Fagerlund (1947), Fagerlund and Mitchell (1947), Wagner (1950), Matsuura (1956), Anon. (1962a, 1963a), and Neal (1965). Hartt and Neal (1940) studied the ecology of plants in a specialized high altitude environment. Ripperton and Hosaka (1942) established a system of vegetation zones, and Schwartz and Schwartz (1949) applied this concept to a practical field problem dealing with game birds. Other important reports concerned with plants are those of Robyns and Lamb (1939), Krajina (1963), and Knapp (1965).

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Again I have relied on fellow professionals and kindred spirits, and they have responded generously when called upon. New faces and personalities have emerged. To name a few, Timothy A. Burr, Jon G. Giffin, Marie P. Morin, Timothy W. Sutterfield, Meyer Ueoka, and Thomas C. Telfer of the State Division of Forestry and Wildlife. David P. Fellows, Larry F. Pank, J. Michael

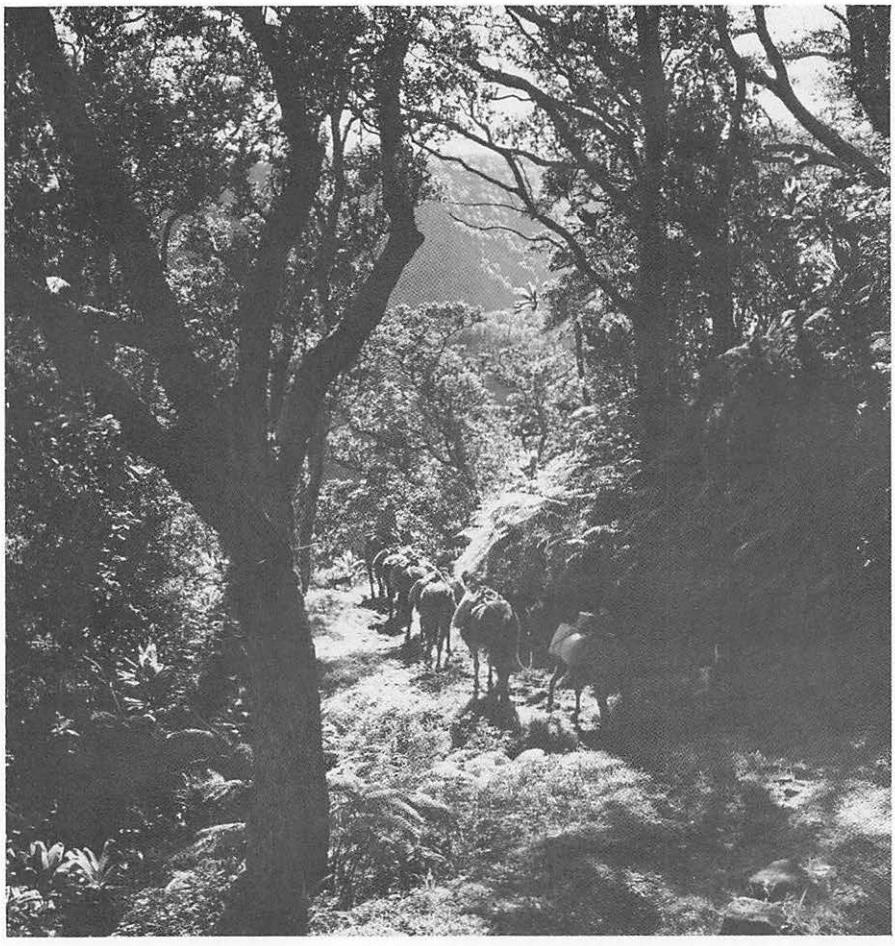

FIGURE 1.—A primeval forest of Kohala Mountain, on Hawai'i, forms an important watershed. Kohala Ditch Trail, shown here, provides a limited access to this region. (Hawaii Visitors Bureau photo.)

Scott, and Robert J. Shallenberger of the U. S. Fish and Wildlife Service; C. John Ralph and Paul G. Scowcroft of the U.S. Forest Service. Added to the list are Donald W. Reeser and J. Kenneth Baker of the National Park Service, and their successors, Dan Taylor and Charles P. Stone; Alan C. Ziegler of the Bishop Museum; and Jerome S. W. Marr, Director of the Honolulu Zoo. William Gilmartin, Louis M. Herman, Edward W. Shallenberger, Stephen Leatherwood, George H. Balazs, and Dale W. Rice have been generous with information about marine mammals.

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Stephen Leatherwood generously permitted publication of Figures 14–24, 26, 28–31, 33–35, and 37–40 from *Whales, Dolphins, and Porpoises of Eastern North Pacific and Adjacent Arctic Waters: A Guide to Their Identification*, Leatherwood, Reeves, Perrin and Evans (1982). Whales and dolphins on the end sheets, Figures 41–42, are the careful drawings of Marcia T. Rose.

Since 1970, formal attention was given the mammals of Hawai'i in works of Kramer (1971), Tomich (1973), Shallenberger (1981), and van Riper and van Riper (1982); and in pertinent reviews by Walker (1970) and Gagné (1972).

A BRIEF ESSAY ON CLASSIFICATION

Systematic naming of living organisms is provided for under the binomial system of nomenclature firmly established by the Swedish naturalist Carolus Linnaeus (1707–1778), and it is appropriate to dwell on this topic. The tenth edition of his *Systema Naturae*, published in 1758, is now considered the starting point of zoological nomenclature. Names change with increased understanding of taxonomic principles and of the organisms themselves, and lists are periodically in need of revision. Yet many names have stood the test of time and are as acceptable today as they were more than 200 years ago.

The scientific binomial of each animal consists of a capitalized generic term and a lower case specific epithet. All names are written in italicized Latin form, which is accepted as the universal standard by the International Rules of Zoological Nomenclature. The binomial is often followed in print by the name of the person who described the species. Thus the dog is called *Canis familiaris* Linnaeus, for its name stands today exactly as listed by the author in 1758. When a species (or subspecies) is allocated to a genus different from that in which it was first described, the original author's name is enclosed in parentheses. For example, the roof rat is now called *Rattus rattus* (Linnaeus) because the eminent Swede grouped it in his classification with the house mouse as *Mus rattus*, and the genus *Rattus* was later erected by Fischer in 1803 to accommodate many of the rats.

Biological science has also adopted an orderly use of trinomial nomenclature for designation of subspecies (geographic variants), which is essential to the understanding of differences among animals immediately below the species level. Discretion is ordinarily applied in scientific reports so as not to burden the literature unnecessarily with trinomials; these are used only when there is cogent need to distinguish between the local form and other subspecies. In a paper on the home range, for example, of the small Indian mongoose in Hawai'i, it would be of no use to embellish the report with the bulky trinomial *Herpestes auropunctatus auropunctatus*, because the binomial is perfectly adequate.

Application of trinomials to domesticated mammals sometimes has questionable value because artificial selection and transport by man have distorted the usual meaningful bases for subspecific designation. Nonetheless, such application may allow a better understanding of degree of kinship, and is therefore acceptable for certain polymorphic forms long in the service of mankind.

There are no international standards for vernacular names of mammals. Each language ordinarily has its own usages and these are seldom directly translatable into other tongues. Attempts on the national scale to standardize the common names for American wild species have met with reasonable success (Hoffmeister, 1953; Rodeck, 1954; E. R. Hall, 1965). In the United States a principle that is coming to be generally accepted is that the several subspecies of a single species shall be called by a single name. When subspecies are given separate names it tends to confuse persons with slight understanding of systematics by suggesting greater than actual differences within the species. There is no one test to distinguish species, but a usually acceptable criterion is the absence of interbreeding in nature between sympatric forms.

Subspecies, as populations, may intergrade over parts of their ranges, or they may be reproductively isolated by barriers of various sorts, water, for example.

To demonstrate relationships and differences among the Hawaiian mammals, alien and native, they are classified by order, family, genus, and species, and by subspecies when such are applicable. Genera and species are listed in phylogenetic sequence, from the more primitive to those more highly advanced in an evolutionary sense, following G. G. Simpson (1945) almost exclusively. His important work provides a concise treatment of all taxa above the species level, and treats relationships of a finer degree than is possible in this book.

TRENDS

The decade of the 1970s was a period of encouraging renewal and advance for environmental care and protection, with formulation of studies in Hawai'i especially under the International Biological Program (IBP). In addition to some 77 technical reports issued by the project, and many published papers, a

synthesis volume has appeared (Mueller-Dombois, Bridges, and Carson, 1981). The concept of endangered species was developed at the state and federal levels with consequent programs in the Hawaii Department of Land and Natural Resources, University of Hawaii, National Marine Fisheries Service, Bernice P. Bishop Museum, U. S. Fish and Wildlife Service, and the National Park Service, including cooperative ventures between various agencies.

Under provisions of the National Environmental Protection Act (NEPA) of 1969 there have evolved requirements for the Environmental Impact Statement (EIS) for all actions of development or land use change supported by federal funding (reviewed by Manta Corporation, 1979). Regulation is vested at the state level in the Department of Health under the Office of Environmental Quality Control (OEQC). Any number of EIS are now on file and provide valuable natural resource inventories of sites where actions for change are proposed. The law allows also for public input through a formal hearing process. Examples of reports generated by the EIS process are diverse: concerning a new management plan for a tiny islet (Manta Corporation, 1979); development of astronomy facilities on Mauna Kea (Group 70, 1980, 1983); proposed dams on Hawai'i and Kaua'i (Parsons, Brinckerhoff-Hirota Associates, 1974; Kennedy/Jenks Engineers, 1981); and the sticky challenges of producing geothermal energy (R. M. Towill Corporation, 1982).

As agency support has declined for programs directed primarily toward environmental studies on public lands, a private enterprise, The Nature Conservancy, has risen as a strong leader in purchase, lease, and management protection of privately owned habitats critical to survival of native species (see, for example, Nature Conservancy News, 1982).

A Natural Area Reserves System for state-owned lands in Hawai'i was established by statute in 1970 (Hawaii State Legislature, 1970). All these activities have implications for mammalogy, for the further definition and alleviation of damage wrought by exotics, and assessment of "what is left" of natural ecosystems.

Perhaps the most important product of the 1971–1976 era of the IBP and related projects in Hawai'i is a corps of well-trained students and emerging scholars who have launched professional careers in ecosystem sciences. A sampling of these includes Sheila Conant, Rangit G. Cooray, Carolyn A. Corn, Betsy H. Gagné, Wayne C. Gagné, Francis G. Howarth, James D. Jacobi, Kenneth Y. Kaneshiro, John I. Kjargaard, Steven L. Montgomery, Lani Stemmermann, Charles van Riper III, and Frederick Warshauer. The vacuum of the 1960s has been filled beyond all expectations.

New works have appeared on volcanology (Stearns, 1966; Macdonald and Abbott, 1970); origin and development of Hawaiian biota (Dalrymple, Silver, and Jackson, 1973; Sibley and Ahlquist, 1982); flora (St. John, 1973; Lamb,

1981; Haselwood and Motter, 1983); birdlife (Berger, 1972; Shallenberger, 1984; Banko, 1981); evolution of insects (Carson, 1970; Montgomery, 1975, 1983; Ashburner, Carson, and Thompson, 1982; and Hapgood, 1984); cave-adapted microfauna (Howarth, 1981); and biogeographical subjects (Carlquist, 1970, 1980, 1981; Armstrong, 1973; Juvik and Austring, 1979; Pimm and Pimm, 1982). Authentication of the concept that Polynesian settlers had, after all, drastic effects on native bird, plant, and associated organisms in lowland areas, is just now coming forth with the news that as many as 45 species of land birds alone became extinct in prehistory (Kirch, 1982; Olson and James, 1982a, 1982b; James and Olson, 1983). Apt students have probed the last frontiers of Hawaiian lands, as exemplified by Kjargaard (1972) and Peterson (1976), under the federally supported Student Originated Studies program. One such project resulted in discovery of what is possibly the last living bird species to be described in Hawai'i (Casey and Jacobi, 1974). A variety of interesting background on the flora, lands, and personalities is given in Anon. (1930), Doty and Mueller-Dombois (1966), Sutton (1974), Handy and Handy (1972), Pukui, Elbert, and Mookini (1974), Craig and King (1981), Frängsmyr (1983), and Motteler (1983). Imber and Cumberland (1977) should be consulted for highly instructive parallels in geographies of Hawai'i and New Zealand.

Compendia of mammals worldwide have some bearing on knowledge of their occurrence in Hawai'i, as Anderson and Jones (1967), Jones, Anderson, and Hoffman (1976), Corbet and Hill (1980), Hall (1981), Honacki, Kinman, and Koeppl (1981), Jones, Carter, and Genoways (1982), and Nowak and Paradiso (1983). Tinker (1980) provides a checklist of terrestrial quadrupeds in Hawai'i.

Because of the unrelenting impact of introduced mammals on native ecosystems, I call attention to the following resource inventories, treatises on feral species, assessments of invasion, and new views on the uses of wildlife species, some from distant locales: State of Hawaii, Department of Land and Natural Resources (1981a, 1984), J. S. King (1978), Tomich (1983), Hafez (1968), Rolls (1969), Geist and Walther (1974), Daniel (1976), Roots (1976), Case (1978), Scheffer (1980), Bull (1981), Wodzicki and Wright (1983), C. M. King (1984), Price (1984), and Walker (1984). Readers are referred to Miller and Botkin (1974), Martin (1975), Regenstein (1975), Meyers (1979), Cairns (1980), Ehrlich and Ehrlich (1981), and Nitecki (1984) for thoughtful arguments concerning extinctions and possible means of staving them off.

In spite of reasonably encouraging actions of the past two decades as documented in the foregoing pages, in the absence of a widely spread or long enduring stewardship ethic among those in Hawai'i who control large tracts of surviving natural ecosystems, the trends toward extinction continue. These trends could have been reversed long ago except that the overall sorry record for Hawai'i is linked to an ancient nature of man that appears to be immutable.

It goes beyond the imperative for survival and a moderated existence. The attractions to ease of living, aspirations to riches, and the drive to wring the final harvest from natural resources available for the taking are all part of the fabric of human societies, past and present. I trust that the following will be construed not as an angered diatribe, but as a fair rendition of this reality.

The scenes in Hawai'i of flightless geese clubbed to the last bird, their nests disrupted, several species driven to destruction; lowlands burned of their native plant cover far in excess of need for cultivation of sweet potatoes, taro, and other food crops; hoofed animals placed under royal *kapu* to assure firm establishment beyond restraint; the lag effect of cattle and other grazers on forest/pasture lands, which has doomed many plants, unknown insects, and perhaps the *'alalā* (Hawaiian crow) and other birds; a drive to plant the last acre in pineapple, sugar cane, or macadamia nuts at the expense of native vegetation, and its frequent proof as a futile economic exercise; replacement of fine natural forest with alien monocultures of minimal commercial worth; the insistence that sheep and other ungulates must be run as game animals at the cost of native plants and birds; the hollow claim that the education of Hawaiian children is well served by projects that destroy the forest heritage of those same children; and ruin of the last extensive lowland forest to feed insatiable furnaces for generating electric power because "a contract for biomass fuel must be fulfilled." All these are cumulative headstrong blunders that have made Hawaiian environments what they are today. It is a way of life that spells death to countless species found nowhere else on Earth. Extinction is indeed forever. When an unreasonable share of natural ecosystems is wantonly disrupted, can the demise of viable habitat for humans, or of humans ourselves, be far behind?

P. Quentin Tomich
Honoka'a, Hawai'i
June 3, 1985

A Checklist of Names and Origins

Class Mammalia

Mammals

Order MARSUPIALIA

Pouched Mammals

Family MACROPODIDAE—Rock-wallabies

Petrogale penicillata (Griffith, Smith, and Pidgeon, 1827). Brush-tailed rock-wallaby.
Escape.

Order CHIROPTERA

Bats

Family VESPERTILIONIDAE—Common Bats

Pipistrellus javanicus abramus (Temminck, 1840). Asiatic pipistrelle.
Hypothetical (introduced).

Lasiurus cinereus semotus (H. Allen, 1890). Hoary bat.
Endemic as a subspecies.

Family MOLOSSIDAE—Mastiff Bats

Tadarida brasiliensis mexicana (Saussure, 1860). Brazilian free-tailed bat.
Hypothetical (introduced).

Order LAGOMORPHA

Hares, Rabbits, and Pikas

Family LEPORIDAE—Hares and Rabbits

Oryctolagus cuniculus cuniculus (Linnaeus, 1758). European rabbit.
Introduced.

Order RODENTIA

Gnawers

Family MURIDAE—Old World Rats and Mice

Rattus rattus rattus (Linnaeus, 1758). Roof rat.
Immigrant.

Rattus norvegicus norvegicus (Berkenhout, 1769). Norway rat.
Immigrant.

Rattus exulans hawaiiensis Stone, 1917. Polynesian rat.
Immigrant or introduced (endemic as a subspecies).

Mus domesticus Rutty, 1772. European house mouse.
Immigrant.

Family CAVIIDAE—Cavies and Allies

Cavia porcellus (Linnaeus, 1758). Guinea pig.
Introduced.

Order MYSTICETI

Baleen Whales

Family BALAENOPTERIDAE—Fin-back Whales.

Balaenoptera acutorostrata Lacépède, 1804. Minke whale.
Indigenous.

Balaenoptera edeni Anderson, 1878. Bryde's whale.
Indigenous.

Balaenoptera physalus (Linnaeus, 1758). Fin whale.
Indigenous.

Balaenoptera musculus (Linnaeus, 1758). Blue whale.
Indigenous.

Megaptera novaeangliae (Borowski, 1781). Humpback whale.
Indigenous.

Family BALAENIDAE—Right Whales

Balaena glacialis Müller, 1776. Right whale.
Indigenous.

Order ODONTOCETI

Toothed Whales and Dolphins

Family DELPHINIDAE—Dolphins and Allies

Steno bredanensis (Lesson, 1828). Rough-toothed dolphin.
Indigenous.

Tursiops truncatus (Montagu, 1821). Bottlenose dolphin.
Indigenous.

Stenella longirostris (Gray, 1828). Spinner dolphin.
Indigenous.

Stenella attenuata (Gray, 1846). Spotted dolphin.
Indigenous.

Stenella coeruleoalba (Meyen, 1833). Striped dolphin.
Indigenous.

Grampus griseus (G. Cuvier, 1812). Risso's dolphin.
Indigenous.

Peponocephala electra (Gray, 1846). Melon-head whale.
Indigenous.

Feresa attenuata Gray, 1875. Pygmy killer whale.
Indigenous.

Pseudorca crassidens (Owen, 1846). False killer whale.
Indigenous.

Globicephala macrorhynchus Gray, 1846. Short-finned pilot whale.
Indigenous.

Orcinus orca (Linnaeus, 1758). Killer whale.
Indigenous.

Family PHYSETERIDAE—Sperm Whales

Physeter macrocephalus Linnaeus, 1758. Sperm whale.
Indigenous.

Kogia breviceps (de Blainville, 1838). Pygmy sperm whale.
Indigenous.

Kogia simus Owen, 1866. Dwarf sperm whale.
Indigenous.

Family ZIPHIIDAE—Beaked Whales

Ziphius cavirostris G. Cuvier, 1823. Cuvier's beaked whale.
Indigenous.

Mesoplodon densirostris (de Blainville, 1817). Blainville's beaked whale.
Indigenous.

Order CARNIVORA

Flesh Eaters

Family CANIDAE—Wolves, Jackals, and Allies

Canis familiaris familiaris Linnaeus, 1758. Domestic dog.
Introduced.

Family VIVERRIDAE—Civets and Allies

Herpestes auropunctatus auropunctatus (Hodgson, 1836). Small Indian mongoose.
Introduced.

Family FELIDAE—Cats

Felis catus Linnaeus, 1758. House cat.
Introduced.

Family PHOCIDAE—Hair Seals

Monachus schauinslandi Matschie, 1905. Hawaiian monk seal.
Endemic.

Mirounga angustirostris (Gill, 1866). Northern elephant seal.
Vagrant.

Order PERISSODACTYLA

Odd-toed Ungulates

Family EQUIDAE—Horses, Asses, and Zebras

Equus caballus caballus Linnaeus, 1758. Domestic horse.
Introduced.

Equus asinus asinus Linnaeus, 1758. Donkey.
Introduced.

Equus asinus X Equus caballus. Mule.
Sterile hybrid.

Order ARTIODACTYLA

Even-toed Ungulates

Family SUIDAE—Old World Swine

Sus scrofa scrofa Linnaeus, 1758. Pig.
Introduced.

Family CERVIDAE—Antlered Ruminants

Axis axis (Erxleben, 1777). Axis deer.
Introduced.

Odocoileus hemionus columbianus (Richardson, 1829). Mule deer.
Introduced.

Family ANTILOCAPRIDAE—American Antelope

Antilocapra americana americana (Ord, 1815). Pronghorn.
Introduced.

Family BOVIDAE—Hollow-horned Ruminants

Bubalus bubalis (Linnaeus, 1758). Water buffalo.
Introduced.

Bos taurus Linnaeus, 1758. Domestic cattle.
Introduced.

Capra hircus hircus Linnaeus, 1758. Domestic goat.
Introduced.

Ovis aries Linnaeus, 1758. Domestic sheep.
Introduced.

Ovis musimon Pallas, 1811. Mouflon.
Introduced.

Ovis musimon X Ovis aries. Mouflon—domestic sheep hybrid.
Fertile hybrid.

TABLE 1

Distribution of Wild or Feral Populations of Mammals Established on the Eight Principal Islands and on Seventeen Smaller Islands and Islets of the Hawaiian Chain

	Hawai'i	Maui	Molokini	Kaho'olawe	Lāna'i	Moloka'i	O'ahu	Ford	Manana	Popoi'a	Mokumanu	Mokuoloe	Mokolii	Moku'auia	Kaua'i	Ni'ihau	Lehua	Kaula	Nihoa	Tern	Laysan	Lisianski	Sand	Eastern	Green
Wallaby							x																		
Hoary bat*	x**	x			p**	p	x								x										
Rabbit			f**					f	x								x				f	f			
Roof rat†	x	x		x	x	x	x	x				x	x	x	x	x	p						x	x	
Norway rat	x	x			x	x	x	x							x	p									
Polynesian rat*	x	x		x	x	x	x			x	x				x	p		x							x
House mouse‡	x	x		x	x	x	x	x	x			x			x	p		x					x	x	
Guinea pig																					f				
Dog	x	x			x	x	x								x										
Mongoose	x	x				x	x	x				x													
Cat	x	x		x	x	x	x								x	x									
Monk seal*																			x	x	x	x	x	x	x
Horse	f	f													f										
Donkey	x					f									f									f	
Pig	x	x		f	f	x	x								x	x					f				
Axis deer		x			x	x	x																		
Mule deer															x										
Pronghorn					x																				
Water buffalo						f																			
Cattle	x	f				x	f								x										
Goat	x	x		x	f	x	x								x	f									
Sheep	x			f																					
Mouflon	x				x																				

*Endemic. **x—Currently existing; p—Probably existing; f—Formerly existing. †Also found on Kāohikaipu (near O'ahu). ‡Also known from Kekepa and Kapapa (near O'ahu).

Species Accounts

Petrogale penicillata. Brush-tailed rock-wallaby.

ORIGINAL DESCRIPTION: *Kangus penicillatus* Griffith, Smith and Pidgeon, Cuvier's Animal Kingdom 3 (Mammalia): Plate only, dated December 1, 1825. 1827 (see McMurtrie, 1834).

TYPE LOCALITY: New Hollandia (=Sydney, N.S.W., Australia).

NATIVE RANGE: Mountainous regions of eastern New South Wales; scarce except for scattered elements of earlier populations (Troughton, 1965, p. 178).

RANGE IN HAWAI'I: Restricted to sections of leeward O'ahu.

Tate (1948) lists four subspecies in the native range, but which, if any of these, occurs in Hawai'i is unknown. Origin of introduced parent stock was not recorded except as from Australia. A scattering of skeletal materials from Hawai'i includes a skull in the Bishop Museum and one and a portion of another in the possession of Raymond J. Kramer.

Arrival of this small wallaby on O'ahu in August 1916, and its escape shortly thereafter is described by Tinker (1938, p. 73). He informs me (pers. comm.) that he interviewed the owner of these animals about 1936. Other original sources are Anon. (1916a, 1916b). Two adults survived the accidental release of three wallabies when dogs tore open their cage (a tent) on 'Ālewa Heights in Honolulu. There are few well-documented early reports of them; however, Anon. (1921) attests to the rapid development of an independent population, and Anon. (1957a) records the accidental capture of one specimen.

Kramer, who studied these animals intensively in 1960, has indicated (pers. comm.) that the population once extended between Nu'uanu and Hālawa streams, for a distance of about 4.5 miles across a series of ridges and valleys of the lower Ko'olau Range. Distribution was as low as 300 feet, as at Moanalua, and perhaps seldom above 1,400 feet. This habitat is being increasingly dissected by land development, and the wallaby seems to have survived because of its adaptation to rocky slopes where there are many caves and

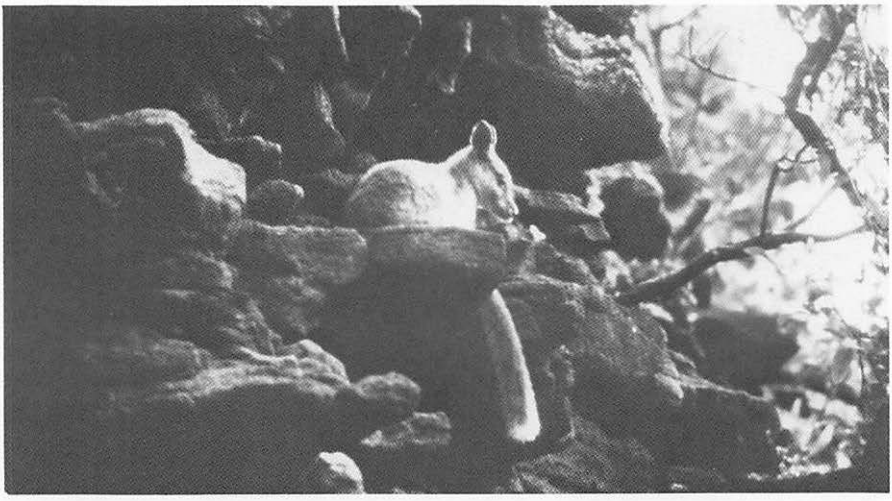


FIGURE 2.—Brush-tailed rock-wallaby at home in cliff-face habitat, Kalihi Valley, O'ahu. Conditions resemble those of native range in Australia. (Timothy Sutterfield photo.)

recesses (Fig. 2). The population appears to be concentrated on the northwest side of Kalihi Valley.

A wallaby was observed over a period of about three weeks in July 1963, behind a residence at 2552A Kalihi Street, Honolulu, across the valley from the principal colony. It readily accepted lettuce left for it, and allowed approach to within about 40 feet. I visited the site on August 15 and noted a scattering of droppings in and about a shed where the wallaby had climbed as much as six feet above ground on stacks of building materials, as if to rest. Here the land dropped abruptly off to Kalihi Stream below, so the wallaby had a ready retreat from disturbances. On February 27, 1964, I interviewed Manuel Cabral, occupant of an isolated residence at the foot of the main wallaby colony across Kalihi Valley (elev. 450 ft.). He reported seeing the animals regularly in the evenings on the rocky slope above his home, and had observed as many as 17 at one time during the past two years. At the top of this ridge at an elevation of 1,100 feet, tracks were present in fresh mud of a roadway on February 10, 1965, and droppings were found in this same area.

The Honolulu Zoo ordinarily displays a specimen (Fig. 3). Breeding in captivity has been unsuccessful because of agonistic behavior between the sexes, which has resulted in fatal wounds (P. L. Breese, pers. comm.). On February 27, 1964, I briefly observed the zoo animal bounding back and forth on a wooden ledge four inches wide and some nine feet above ground at the back of its pen, using only the hind feet and tail in this style of locomotion. It had gained the ledge from a stout hibiscus growing against the wall. On a

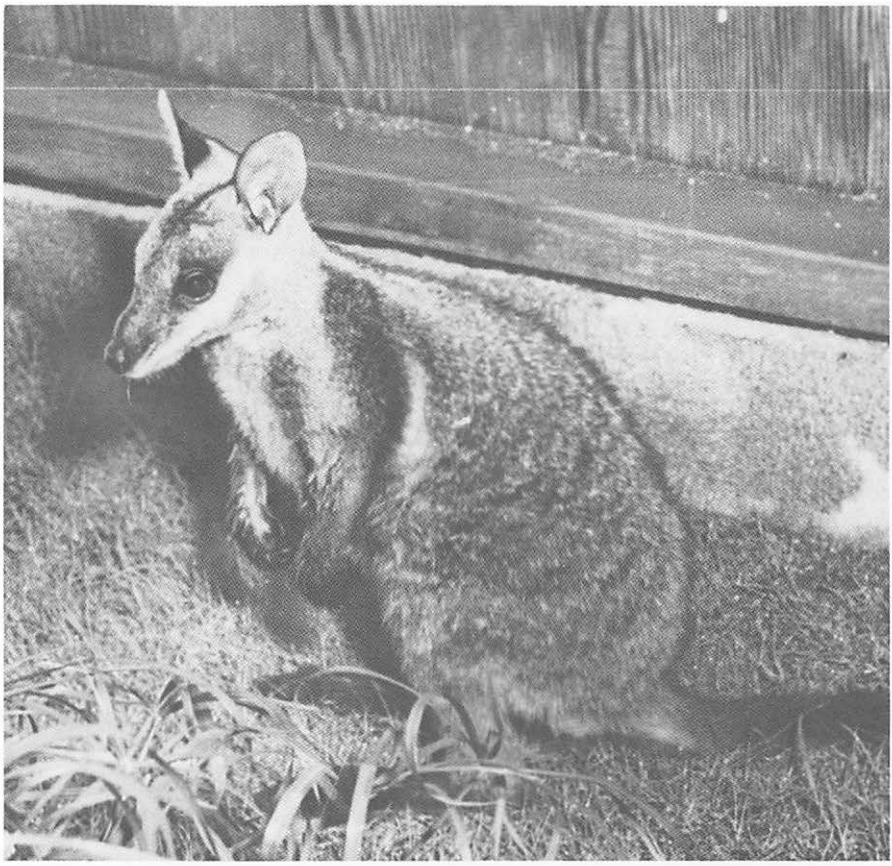


FIGURE 3.—Young female brush-tailed rock-wallaby (*Petrogale penicillata*) in the Honolulu Zoo soon after its capture on May 13, 1957. Licked fur of the forelimbs denotes stress, from an encounter with a cage mate. Penned separately, this specimen lived peacefully for nearly nine years, until it died on March 1, 1966. Adults are judged to weigh 8 to 13 pounds (3.6 to 5.9 kg). (*Honolulu Star-Bulletin* photo.)

previous occasion, only the long black tail of the wallaby was visible, extended vertically downward as the animal rested in the dense shrub.

While there was no firm basis for an estimate in the 1960s, the entire O'ahu population was thought to consist of only a few dozen individuals. The species had been unable to spread widely and for this reason was harmless to native vegetation. It apparently foraged mainly on steep open slopes. Kramer examined some 300 fecal pellets and found that the principal foods were grasses and *'ūlei (Osteomeles)*.

This wallaby should be preserved in Hawai'i because it may be an endangered species in its original range in Australia. Whether or not it should be

transplanted to other Hawaiian islands with the purpose of exploiting it as a game animal, as has been proposed (Riney, 1959), could not be determined from a limited knowledge of its characteristics. Wodzicki and Flux (1967) recorded its adaptation to conditions in New Zealand. Calaby (1966) provided information on the ecology of this species in Australia.

Encouraging interest is shown in the rock-wallaby since the above paragraphs were written in 1967. Kramer (1971) presented his data and added some historical vignettes which had escaped my attention. He noted the small size of the animal compared with size in Australia, and its predilection for dry ledge and cave habitat with southern exposure; considered the population as a "remnant" of perhaps 100 animals increasingly pressed by human disturbance; described its behavior at the colony from long hours of observation; and reviewed aspects of wallaby biology largely from the Australian literature. A scattering of evidence indicated that some animals left the known colony but did not permanently occupy distant habitat. No second colony was discovered. Aldrich, Beck and Curry (1975) report on a productive foray to the colony to obtain photographs, and Loftus (1976) reworks successfully the historical background in another popular article. See also Titchen, 1974.

Lauret (1982) explored known range and potential habitat and concluded that the population, though well-established, is unable to spread to neighboring valleys. J. D. Lazell and co-workers began formal research in 1979 (Lazell, 1980, 1981) and determined that the Hawai'i population is indeed strikingly different in appearance from any known in Australia, and that in preliminary tests of tissue, blood proteins, enzymes, and alloenzymes, the Hawaiian form emerges distinctly among these populations. Perhaps its parent stock in Australia is extinct, but there is also the intriguing possibility that rapid evolution of the founder stock under new conditions in Hawai'i may have produced a form not readily identifiable with its progenitors in Australia.

A key to understanding the rock-wallabies in Hawai'i and in Australia surely depends on more information gathered in both locales. Some work has been done, as reflected in the reports of Wakefield (1971), Johnson (1979), Short (1982), Sutterfield (1982), Lazell, Sutterfield and Giezentanner (1984), and Saito (1983, 1984). Fluctuation in numbers is evident (Hastings, 1985).

Pipistrellus javanicus. Asiatic pipistrelle.

ORIGINAL DESCRIPTION: *Scotophilus javanicus* Gray, Magazine of Zoology and Botany 2:498. 1838.

TYPE LOCALITY: Java.

NATIVE RANGE: Eastern Siberia, Japan, eastern China, Burma, Indo-China to Java (adapted from Ellerman and Morrison-Scott, 1951, p. 165).

RANGE IN HAWAI'I: As a probable introduction, O'ahu.

Bats were introduced from Japan in 1895 for control of sugar cane insects, but none survived to establish a population. A skin and skull of the Asiatic pipistrelle (Bishop Museum Acc. #9131) bearing the label, "? Honolulu, 1895±," suggests that this specimen was among those imported. On the basis of this slim evidence, *Pipistrellus javanicus* may be considered an interesting member of the hypothetical list. The Japanese populations of this bat are referable to *Pipistrellus javanicus abramus*. The Hawai'i specimen has been compared with materials at the U. S. National Museum but cannot be assigned with certainty to subspecies.

An active proponent of establishing bats in Hawai'i was Professor Albert Koebele (1852–1924), the pioneer in biological insect control for the islands (Swezey, 1925). Letters on file at the Experiment Station of the Hawaiian Sugar Planters' Association, and other sources, give us some evidence of the interest from 1895 to 1920 in foreign bats for pest control and of the attempts to get them established in Hawai'i.

Koebele traveled widely and arrived in Japan from Ceylon on February 23, 1895 (HSPA letter #136), and apparently left that country in December of the same year or in January 1896 (letter #144); letters #199 of April 30, #190 of October 28, and #209 of December 27 (all 1895) to Koebele from the Agricultural Commissioner in Honolulu encouraged him to send bats and to make arrangements for having large numbers of them sent in the future. It was during this period, and perhaps also in 1896, that bats were brought from Japan and released upon arrival in Honolulu. Koebele's own appraisal of the results is brief, and the details of these attempts are largely unknown, for he says simply (1897, p. 80), "Several trials with Japanese bats resulted in a failure." This subject is further discussed under *Tadarida*. *Pipistrellus javanicus* is a small, dainty bat found generally in small colonies about buildings and could easily have been collected in good numbers for transport to Hawai'i. Their poor condition on arrival and inability to adjust rapidly to a new environment might have been prominent factors in failure of establishment.

Lasiurus cinereus. Hoary bat.

ORIGINAL DESCRIPTION: *Vespertilio linereus* (=*cinereus*) Peale and Beauvois, Catalogue Raisonné du Musée de Peale. Philadelphia, p. 15, 1796.

TYPE LOCALITY: Philadelphia, Pennsylvania.

NATIVE RANGE: Temperate regions of North and South America; island groups such as the Bermudas and Galápagos (in migration), and Hawaiian Islands.

RANGE IN HAWAI'I: Specimens recorded from Kaua'i, O'ahu, Maui, and Hawai'i, but probably occurs on all main islands at least sporadically, and casually in flight over offshore islets.

The endemic bat of Hawai'i was thought in early times to be a distinct species, *L. semotus*, but its affinities with the American mainland populations of the hoary bat have been established (Sanborn and Crespo, 1957), and these authors were the first to use the combination *Lasiurus cinereus semotus* for the Hawaiian form.

Very first mention of a bat existing in Hawai'i is apparently by Peale (1848) of the U. S. Exploring Expedition which visited Hawai'i in 1840. He wrote (p. 24): "At Kaa-la-kea-kua on the island of Hawai'i, memorable as the place where the renowned circumnavigator perished, a species of bat, which we believe new to naturalists, was quite common. . . . " No specimens were taken and Peale's remarks in a preceding paragraph about having lost two species of bats shot, because they fell "amongst the bushes and grasses" refer in part to another bat seen and not collected, at Bay of Islands, New Zealand. This notation may have led R. C. L. Perkins (1903, p. 465) to suppose that possibly two species of bats were observed in Hawai'i by early naturalists. Others have alluded to this same concept but there is no evidence, presently or historically, of any living native bat in Hawai'i other than the endemic race of the hoary bat.

The first recorded museum specimens were taken in 1861 and sent to London. The brief report on them (Gray, 1862) identified the bat of Hawai'i with *Lasiurus grayi* Tomes collected at Juan de Fuca Island and in Chile (which was later regarded as a subspecies of *L. cinereus*). However, H. Allen (1890) proposed, on the basis of eight specimens in the U. S. National Museum from the islands of Kaua'i and Hawai'i, that the bat was a distinct new form and named it *Atalapha semota*, giving it the then current generic name of the hoary bats. No type specimen was designated. Lyon and Osgood (1909) formally selected the lectotype from the original series. In 1914, the generic name *Lasiurus* again replaced *Atalapha* (Hall and Jones, 1961, p. 95), so the Hawaiian bat became known as *Lasiurus semotus*. G. S. Miller (1939), in reviewing the problem, discovered a serious error of measurement or of typography in Allen's description. Allen had considered the bat, on the basis of forearm length, a close relative of *L. borealis*, the red bat, but Miller then noted that "in reality its relationship is entirely with the hoary bats. . . . " He went on to state: "Cranial and dental characters are like those of *Lasiurus cinereus*, but size of skull averages slightly less than in the continental animal."

The way was then clear for establishing the currently accepted subspecific name for the hoary bat population of Hawai'i, as was accomplished by Sanborn and Crespo (1957). In the somewhat sketchy Hawaiian literature the bat was soon recognized as an endemic subspecies isolated from its mainland relatives but closely allied to them (Altonn, 1960).

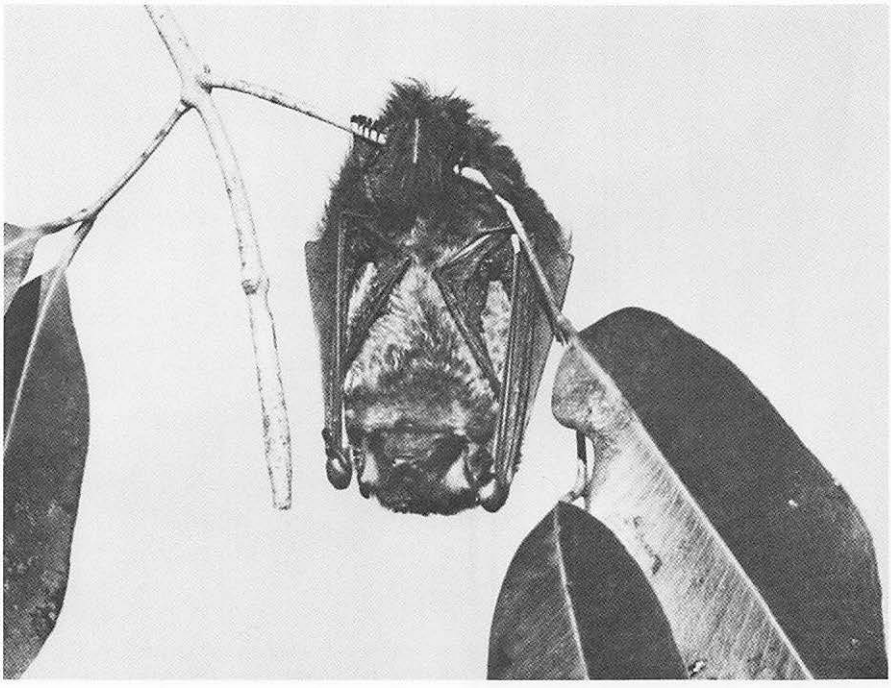


FIGURE 4.—Adult female hoary bat (*Lasiurus cinereus*) at rest on a branch of Java plum. Hind claws grip a twig for support. The tail is curled over the twig and serves to shed rain. (Sakata Art Studio.)

Principal stated differences between the continental and the Hawaiian forms of *Lasiurus cinereus* are that the latter is slightly smaller and there occurs in it, besides the gray pelage often indistinguishable from that of the continental races, a red phase (G. S. Miller, 1939). G. M. Allen (1942, p. 32) says, in comparing it with the South American race, "the Hawaiian form is darker, and in the red phase lacks to a large extent the hoary tips to the hairs of the upper surface in that race and in the North American *L. cinereus*." My own observations indicate that further comparisons should be made before we accept the notion of color phases in the Hawaiian form. Differences appear to be rather slight and to result from conditions of age and wear rather than genetic anomaly.

The bat of Hawai'i is still poorly represented in collections; Sanborn and Crespo were able to gather only nine specimens for study. There have been remarkably few direct encounters with this bat. A Mr. W. H. Pease, who forwarded the specimen to London from Honolulu (Gray, 1862) says, "It is

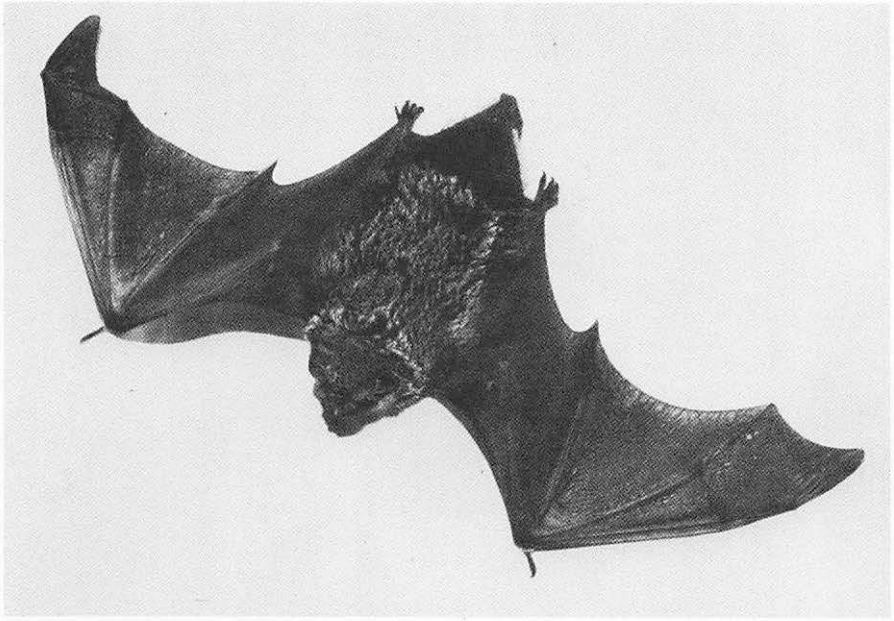


FIGURE 5.—Hoary bat clinging to a piece of fabric. It climbed and crawled readily by using the limbs, hind feet, and thumbs (claws of the thumbs are visible at the wrists). Grizzled body fur is apparent in this specimen. (Sakata Art Studio.)

quite a curiosity to our natives, very few of them having seen one." When a bat was seen flying in the daytime at Lahaina, Maui, in 1874 it was reported by a Honolulu newspaper (Anon., 1874). And the *Hawaiian Gazette* saw fit to print (Anon., 1887a) that "Douglass Monsarrat, during his recent sojourn on Hawaii, caught an Hawaiian bat which he has preserved in alcohol." Similar records are found scattered over the years. Several bats must come to the close attention of humans each year, and even now some are occasionally noted in the press. In my first seven years of residence in the Hāmākua District, where people have known of my interest in zoology, five downed bats were reported locally, two others were brought from Hilo, one was found at Nā'ālehu, and a ninth specimen was obtained from Kaua'i. The bat has never been abundant in recent times, and there are few estimates of its numbers. P. L. Breese once estimated the entire population at about several hundred (Altonn, 1960).

As to conservation of the species, G. M. Allen (1942, p. 33) says, "While at the present the species may be in no particular danger, it is likely that any considerable changes, such as reduction in the amount of sheltering tree growth, will affect the species adversely." The hoary bat is highly unselective in the kind of tree it chooses for roosting, and this is an apparent advantage to it. The depletion of native forest cover in agricultural development of lands and

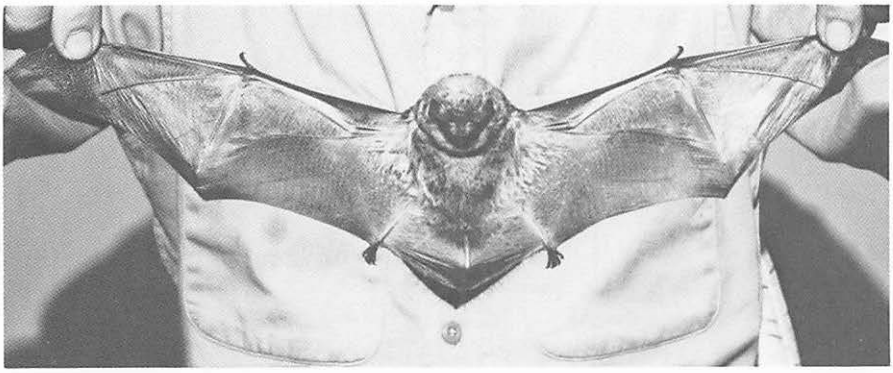


FIGURE 6.—Ventral aspect of the hoary bat. Specimen captured at Honoka'a, on Hawai'i. Wing span is about 13 inches (33 cm). Males weigh approximately ½ ounce (13 to 15 g), and females are slightly heavier (14 to 18 g). (Sakata Art Studio.)

its replacement with introduced trees in urban areas may not be a significant hazard to the bat population. There seem to be, in all lowland areas that were formerly forested, enough tree cover and wild gulch habitat to provide adequate shelter. We do not know with certainty what changes may have occurred in distribution of this bat, or if range and abundance were greatly altered when the native forests were removed from large areas of the islands.

Additional reports on the species include those of Poole and Schantz (1942), who record the type specimen; Anon. (1960a, 1960b) dealing with a possible means of arrival of colonizing stock; and Meinecke (1954) who contributes miscellaneous observations. P. H. Baldwin (1950) and E. H. Bryan, Jr. (1955) have reported original data and summarized those of others. Anon. (1963c), E. H. Bryan, Jr. (1963), and Tomich (1964, 1965b) report variously on research progress and attempts to stimulate further investigation of this species.

During intensive field operations in 1963 to 1965 I collected a series of specimens in all months, and biological and behavioral data from these and from the population at large on Hawai'i Island were recorded. I am indebted to James T. Yamamoto of Honoka'a for able assistance with the field work. "Rarity" of the hoary bat is a myth which stems from a lack of understanding by the casual observer of how a nonsocial and scattered population should appear. However, the bat is not abundant, although it possibly numbers a few thousands rather than a few hundreds. Fall and winter evening concentrations on feeding grounds just offshore sometimes result in a spectacular display of numbers. At dusk on September 22, 1963, 12 bats were in sight at one time, scattered over Hilo Bay. The largest group I recorded was of 22 well-dispersed foraging bats at Honoka'a Landing on the evening of October 18, 1964. These were seen from shore with the aid of 7 x 50 field glasses, over the water in an

area extending about 0.5 mile seaward. Banks (1953) has reported this behavior of the hoary bat on the west coast of Hawai'i Island. Titian Peale, naturalist of the U. S. Exploring Expedition (1838–1842) spent the weekend of November 14–15, 1840, in the vicinity of Nāpō'opo'o, also on the western side of Hawai'i (Wilkes, 1845, p. 90), and must have seen a similar concentration that led him to remark, as previously indicated, that the bat was "quite common."

If this bat is not ruthlessly molested by man, it will probably maintain a moderate population. Even collection for legitimate scientific purposes should be carefully regulated in order to assure survival of this unique native mammal as the pressures of human civilization bear increasingly upon it.

In 1985 the hoary bat is somewhat better understood than in former times, but no comprehensive studies of it have been launched. So far as is known, the major population is on Hawai'i and it may be locally numerous on the western side of the island, especially in South Kona District. Except also for Kaua'i where it is found with some regularity, the bat apparently is elsewhere rare or absent. Evidence of former common occurrence on O'ahu is recorded by von Kotzebue (1821) in a tract not cited earlier in this book. On December 8, 1816, a party proceeding westward from Honolulu toward "the Pearl River," when about six miles out of that village and possibly near the mouth of the present Moanalua Valley, noted (p. 345) that, "the air was filled with a small species of bats." One was shot in flight. There are no subsequent records to suggest any such abundance of the hoary bat on O'ahu.

Listing as an endangered species (United States Department of the Interior, 1970, 1984b) was done near the same time that some populations, as on Hawai'i and Kaua'i, were recognized as being in fair numbers. Hence, priority for funding of research has been low. Tomich (1974a, 1974b) discusses in further detail the 1816 record and the matter of need for protection. The bat may be a regular resident of lowland reconstituted forest, to include orchards of the macadamia nut (*Macadamia* sp.). Insecticides are proposed for control of thrips (Insecta: Thysanoptera) which damage macadamia flowers; this may stimulate research on the bat to obtain registry of such pesticides under EPA regulation. A summary of foods taken by bats in the lowlands of the Hāmākua coast on Hawai'i (Whitaker and Tomich, 1983) reinforces the evidence of adaptation to alien vegetation. Kepler and Scott (1983) report on distributional records made during systematic studies of forest bird populations. Wet forests are a suitable, but not ideal, habitat for the hoary bat. See also Belwood and Fullard (1984).

Lasiurus cinereus semotus may use rock structures for shelter more than is realized. The bat is typically tree-roosting, but occasional specimens are found in rock crevices and in buildings. One bat was reported to attempt a daylight

escape among rock falls and sulfurous fumes from a shuddering, reactivated eruption crater in Hawaii Volcanoes National Park, only to fail as if from asphyxiation and fall into the gathering flow of lava (Tomich, 1974a). Late summer deposits of fat account for 20 to 25 percent of body weight early in winter as a possible preparation for lesser activity during cooler months of the year. However, winter torpor or colonial occupancy of deep cave shelters is yet to be demonstrated (Tomich, 1974c). During extensive searches for animal life in lava tubes by personnel of the IBP in 1973, remains of four bats were found at random in the dark zone of one cave, near a surface opening. Elevation of the site is near 6,000 feet on the northeast flank of Mauna Loa, in terrain not ideal for bats compared with lowland locations. Since then, bat skeletons were collected in a few other lava tubes on Hawai'i and on Maui. In all examples the bats appear to have entered the caves accidently. There was no evidence of guano deposits (F. C. Howarth, pers. comm.). Meyers (1960) found a remarkably similar response to caves by continental hoary bats. Fat reserves suggest a capability for hibernation, as in caves of higher, cooler local climates, but it seems unlikely that stable conditions of deep caverns are of advantage to the physiological needs of the hoary bat in Hawai'i.

The western side of Hawai'i is identified as a region of high concentrations of bats. Sufficient numbers were seen in 1975 to invite investigation by D. M. Turner (pers. comm.), a biologist experienced in bat research in Nevada, and then a resident of South Kona. A collecting permit was applied for (Parcher, 1975) but I heard nothing more of this effort. In another achievement of SOS projects, bats were recorded in large numbers in South Kona District, in 1977 (Fujioka and Gon, 1983). These observations provide new horizons for understanding the hoary bat in Hawai'i.

Comparative morphometric studies of museum skins and skulls of hoary bats from populations in Hawai'i, North America, and South America reveal a divergence of the Hawaiian entity from North American stock, and the probable need, after all, for declaring the Hawaiian population distinct from the continental forms as a separate species (Findley and Tomich, 1983).

Concerning parasites, the hoary bat in Hawai'i harbors a tapeworm common to the Hawai'i and North American populations (Rausch, 1975). Mites (Dusbábek, 1973; McDaniel and Tenorio, 1979) show an even wider distribution, with one form common to bats in Hawai'i and Surinam (South America). F. J. Radovsky notes (pers. comm.) that a parasitic mite of *Lasiurus cinereus* in Hawai'i (Mesostigmata: Macronyssidae) appears to be indistinguishable from *Steatonyssus furmani* Tipton and Boese, 1958. *S. furmani* is known otherwise only from collections of *L. borealis*, in North America. In that region *L. cinereus* is not known to be parasitized by any member of *Steatonyssus* sp. This record of *S.* c.f. *furmani* on the hoary bat in Hawai'i

raises questions on the origin and history of migrations to Hawai'i and host/parasite relationships within the genus *Lasiurus*. No fleas are found on *L. cinereus* in Hawai'i and this is expected because bat fleas are adapted largely to host species which are colonial and roost habitually within closed spaces such as caves, rock crevices, tree cavities, or man-made structures. Many colonial bats have no fleas even when found in traditional roosts (Haas, Beck and Tomich, 1983).

New information on bats in general and on the hoary bat outside Hawai'i is contained in Wimsatt (1970), Bogan (1972), Zinn and Baker (1979), Fenton, Jacobson, and Stone (1973), Shump and Shump (1982), and Hill and Smith (1984). Daniel (1979) delivers insight on adaptation of a New Zealand bat (*Mystacina*) over the eons in those islands, to the giant *kauri* tree (*Agathis*). The bat lives often in the central hollow column of ancient trees where it has adopted the habit of burrowing, for protection from the elements, in dry rotted wood.

Tadarida brasiliensis. Brazilian free-tailed bat.

ORIGINAL DESCRIPTION: *Nyctinomus brasiliensis* St.-Hilaire, Annales des Sciences Naturelles 1:343. 1824.

TYPE LOCALITY: Brazil.

NATIVE RANGE: Much of North, Central, and South America; in the United States as far north in summer as Oregon, Nebraska, and South Carolina. The subspecies *mexicana* is confined to western United States and Mexico.

RANGE IN HAWAI'I: As a probable introduction, O'ahu.

Like the Asiatic pipistrelle, this bat is a hypothetical species for Hawai'i associated with Koebele's program for biological control of insect pests. Large numbers are assumed to have been introduced from California in 1896, but none became established (R. C. L. Perkins, 1925). Five specimens in alcohol (Bishop Museum Acc. #3820), accompanied by few useful data, are the basis for this species in Hawai'i. All are definitely referable to *Tadarida brasiliensis mexicana*. It is a vigorous, colonial, migratory form that is abundant in California during the warmer months. We know that bats were brought to Hawai'i from San Francisco in 1896 (Anon., 1896a) aboard the steamship *Australia*, which plied regularly between Honolulu and San Francisco in that era and was scheduled to arrive in Honolulu on May 29, the day 225 bats were released (Anon., 1896b, p. 163). Koebele had worked in California for several years before coming to Hawai'i in 1893, and had visited there early in 1896, after his return from Japan. He departed again for Hawai'i on April 2 (HSPA letter #144). The five specimen bats were presumably some of those dead on

arrival in Honolulu, or which were recovered at a later date. That there were perhaps several shipments and that they were all unsuccessful is supported by Koebele's annual report for 1896 (Koebele, 1897, p. 80).

Attempted establishment of bats in Hawai'i seems to have ended here, but hopes of the sugar planters for further action remained alive for some years. Perkins (1903) reiterated the earlier failures; Lowrie (1904) favored bats from Puerto Rico for mole cricket control; L. G. Blackman (1904) suggested bats for control of the Chinese rose beetle, mosquito, leafhopper, and flying roach, optimistically predicting easy adaptation of "those belonging to the genera *Vesperugo* and *Molossus*." R. C. L. Perkins (1904) referred to previous failures, but suggested that Mexican, Central American, and Australian species would thrive in the Hawaiian climate better than the endemic *Lasiurus*. Nothing seems to have come of these suggestions.

Resurgence of interest was shown when H.L.L. (1914) pointed out how Campbell (1913) had established *Tadarida brasiliensis* in an artificial roost in Texas (the practical success of which venture was later questioned by Storer in 1926). In summary, H.L.L. (1914, p. 107) says, "The introduction of this Texas bat into Hawaii would be an especially easy matter to accomplish. Rocky caves are their natural haunts, and there are many 'bat caves' in Texas known to be inhabited by millions of bats. It should be possible to catch any desired number of these animals in a single day at one of these caves, and they could be landed in Hawaii ten or twelve days later."

Mention of bats for leafhopper control in 1919 met with some resistance (Anon., 1919b), and the final and perhaps most analytic mention of bats for agricultural purposes (1920) is by Fred Muir (HSPA letter, Library File E71), "It is . . . very doubtful if we have enough small, night flying insects to keep a large bat population going. Even the one species of bat at present in the islands does not seem to be able to increase in numbers." Insectivorous bats as a group, of course, do vary greatly in food preferences. Some forms depend greatly on minute flies; others are capable of eating large moths and beetles, and many even forage for insects on the ground (G. M. Allen, 1939, pp. 86–87).

Many details of the story on bat introductions are missing. Dr. Koebele went home to Germany early in World War I and never returned to Hawai'i. His personal files seem to have been lost. A few additional sidelights emerge from the available correspondence. A woman animal dealer from Albuquerque, New Mexico, offered for sale to Koebele two species of bats, in 1898, at three dollars per dozen (HSPA letter #165), and an editor of the Alameda (California) *Call* requested in 1901 material for a story on the methods of bat handling and results of the work (letter #32). These demonstrate that both economic and popular interest were stimulated by these pioneer attempts to import and establish bats in Hawai'i.

It is easy to view these early fumblings with disdain from the standpoint of modern population ecology, but the sincerity and concern of participants cannot be questioned. They were earnest in their desire to strike a workable solution to serious economic problems. Bats, under special circumstances, could even now very likely be acclimated to Hawai'i, but their effectiveness in insect control would be negligible. The question has become academic because of the threat that rabies might be introduced by new bats, and because another potential reservoir of rabies would be added to the local fauna with each new species established. This disease has been found in bats in at least 31 states of the United States mainland since 1951 (Sulkin, 1962; J. E. Wood, 1962).

Assuming that *Tadarida brasiliensis* was among the bats brought from California, its failure can be attributed to any of several factors, such as homing or migratory instinct that would carry it to sea, or inability to adjust to a mild rather than a hot summer climate.

Oryctolagus cuniculus. European rabbit (to include the original wild form, domestic breeds, and feral populations).

ORIGINAL DESCRIPTION: *Lepus cuniculus* Linnaeus, Systema Naturae, Ed. X, 1:58. 1758.

TYPE LOCALITY: Germany.

NATIVE RANGE: Western Mediterranean region including Morocco, Algeria, and Spain, adjacent Atlantic islands and those east to Crete; British Isles; central Europe north to Germany, east to Poland, and south to Italy. Distribution modified by human agency (adapted from Ellerman and Morrison-Scott, 1951, p. 443). Established in Australia, New Zealand, and on islands of the central Pacific Ocean and western North America (see also DeVos, Manville, and Van Gelder, 1956, pp. 169, 173–174).

RANGE IN HAWAI'I: Introduced to several small islands, notably Laysan and Lisianski; also Ford Island in Pearl Harbor, and Mānana off O'ahu, Molokini between Maui and Kaho'olawe, and Lehua off Ni'ihau; escapes have been detected on Hawai'i, O'ahu and Kaua'i; presently surviving only on Mānana and Lehua.

This rabbit still lives in the primitively wild state over much of its original range, and the first domestic breeds were probably selected from Spanish stock (Müntzing, 1959). The Hawaiian populations are most likely from the same general source and should be referred to *Oryctolagus cuniculus cuniculus* which ranges throughout central Europe north of the Mediterranean and west to Ireland (Thompson and Worden, 1956, p. 9). Some free-living colonies of this rabbit in Hawai'i and elsewhere have reverted to the wild type in color and

other characteristics so as to resemble greatly the ancestral stocks. The rapidity of this phenotypic change and adaptation is shown for an Alaskan colony by O'Farrell (1965). Thomsen and Evans (1964) report on a Washington population that may have been more than 70 years old and which has largely assumed the wild-type agouti pelage, and Tomich, Wilson, and Lamoureux (1968) describe the one on Mānana, which is about the same age and also retains only traces of domestic color traits (Fig. 7). Watson (1961b) reports on Hawaiian and other Pacific colonies.

Rabbits and their allies have been by tradition grouped with the rodents, but critical studies have revealed them to be actually widely divergent from the Order Rodentia in such characteristics as fenestration of the skull, possession of four upper incisor teeth instead of two, more cheek teeth than in any rodent, and a tail that is always short, if present at all. They belong more properly in a separate Order Lagomorpha. Their origin is still obscure, as A. E. Wood (1957) points out. Van Valen (1964) suggests a line of evolution descending from specific primitive insectivores.

Records of rabbit introduction to Hawai'i are few, but there is evidence that they were brought in soon after European settlement. Andrew Bloxam observed on May 17, 1825, in reference to "the Pearl River," O'ahu (Bernice P. Bishop Museum, 1925) there was "in one spot an island of nearly one mile in length, on this a quantity of rabbits have been turned up and are now becoming wild and numerous; they are of a black and white color, and the island is named for them." He was referring, of course, to Ford Island in Pearl Harbor, which we may suppose was then called Rabbit Island. Mānana currently bears the popular name "Rabbit Island" and is the only islet near O'ahu that now has a rabbit population. Chung (1931) reports introduction to Hawai'i in 1853, of breeding stock from Australia.

Although the Ford Island colony disappeared at some unknown date, it may have set a pattern for early rabbit management in Hawai'i, which was to turn the animals out on small islands to fend for themselves. Hall (1873) records an early use permit for Mokuola (Coconut) Island, a three-acre islet in Hilo Bay. Of the three recently existing feral rabbit colonies, we know little of that on Molokini, and some of the few naturalists who have written about the island fail to mention rabbits (for instance, Forbes, 1913a; and Caum, 1930). Perhaps the colony was established after 1930. Franck (1937, p. 229) reports having seen two white rabbits there, from a boat in the sheltered cove of the island, in 1936. D. H. Woodside informs me (pers. comm.) that the rabbits were still there in the 1950s. In answer to my inquiry of November 1965, to the United States Coast Guard (B. V. Weston, pers. comm.), their operating units found that "no wildlife exists on Molokini." This suggests that the rabbit population there had died out.

FIGURE 7.—Feral rabbits (*Oryctolagus cuniculus*) freshly shot on Mānana Island, one mile off O'ahu. These rabbits have descended from domestic stocks placed there about 1890, and now all have the wild-type brown pelage with white underparts. Weight is 3½ to 4½ pounds (1.6 to 2.1 kg). (Raymond J. Kramer photo.)

The Lehua population is at least as old as that of Molokini and was apparently large in 1931 (Caum, 1936). Woodside saw these animals in the 1950s and described them to me as having strikingly mixed colors. Richardson (1963, p. 44) reports a moderate population in 1960. In 1965 the United States Coast Guard found similar numbers, and noted prominent mixed black, brown, and white pelage patterns. An early abundance and eventual stabilization of rabbit

FIGURE 8.—Main crater of Mānana Island on February 29, 1964, showing dense stands of wild tobacco, impoverished coconut palms, and bunch grasses heavily used by rabbits. Drought conditions were obvious. See also Figure 78. (Kazimierz A. Wodzicki photo.)

numbers in relation to vegetation might well have been the pattern on each of these islands.

Eradication of feral rabbits in Hawai'i has been advocated by ornithologists and others interested in the welfare of nesting sea birds (for example, Richardson, 1963). This would be a difficult undertaking even under ideal conditions. Cox, Taylor, and Mason (1967, pp. 42–43) reported that nearly four years of repeated effort were required to eliminate rabbits from Motunau, an easily accessible nine-acre New Zealand island. A different view of the problem (Tomich, 1965a) is that we should admit that the rabbit has earned a place on the Hawaiian faunal list, and that it should be exploited for its scientific value. Preliminary study of the problem on Mānana (Tomich, Wilson, and Lamoureux, 1968) revealed no detrimental effects on the bird colonies. Both Lehua and Mānana should be investigated by means of thorough ecological research before any management decisions are made. On the larger island, Lehua, where there is some hope of saving a significant segment of remnant native vegetation, removal of the rabbits might be advisable, but is likely to be impossible with means that can be reasonably found to do it.

Two further examples of small-island rabbit colonies are those formerly existing on Laysan and Lisianski. Rabbits were introduced here in 1902 and 1903 by Max Schlemmer, of Honolulu, in connection with a guano mining

business. They increased to great numbers and heavily damaged the plant cover. In 1912–1913 a government party was unsuccessful in eradicating these populations. The effect of this control effort on the Laysan strain was perhaps only one of rejuvenation, for the rabbits remained, depleted the vegetation still further, and were finally shot in 1923. On Lisianski, where control was less stringent, the vegetation was more quickly destroyed and the rabbits succumbed some years before 1923. This grim phase of Hawaiian ecology has been documented by many writers. Principal reporters with firsthand information were W. A. Bryan (1911), Dill and Bryan (1912), Elschner (1915), Thurston (1923), Gregory (1924), Wetmore (1925), E. H. Bryan, Jr. (1942), and Bailey (1956). Warner (1963) has appropriately reviewed the entire series of events.

Vegetation of both islands has made a remarkable recovery. Lamoureux (1963, p. 13) states regarding Laysan: "Not only are many of the original species still present, but the structure of the vegetation appears similar to that described before the island was devastated by rabbits." Three formerly significant elements, the shrubs *Chenopodium*, *Achyranthes*, and *Santalum*, however, he reports are absent. Birds have fared poorly, especially in that the Laysan rail (*Porzanula palmeri*) was extirpated from Laysan and lost altogether from its final refuge at Midway (P. H. Baldwin, 1947a; Fisher, 1949). Moreover, the Laysan form of the millerbird (*Acrocephalus familiaris familiaris*) and of the *'apapane (Himatione sanguinea freethi)* also became extinct during the rabbit era (Greenway, 1958, pp. 392–393, 408–409). While private enterprise has contributed vastly to human progress, the need for wisdom and restraint in its application is underscored by the above examples of tampering with delicately balanced small-island ecosystems. The guano diggers obtained a 20-year lease and began operations in 1892. The guano business appears to have flourished for a time without great detriment to the flora and fauna, but then it faltered, for, according to E. H. Bryan, Jr. (1942, p. 186), the last load of fertilizer was shipped from Laysan in May 1904; but the manager of the company continued to live on the island until November 1915. His purpose in being there after 1910 has not been made clear. Following decline of the guano trade, a second attempted means of gain from the island's resources was to farm the rabbits by turning them out in the native vegetation. According to Dill (Dill and Bryan, 1912, pp. 9–10), they were to be the basis for a proposed meat-canning industry. When this enterprise failed to materialize, no known effort was made immediately to suppress the numbers of rabbits.

At this stage there were few further possibilities for profiting, and the future must have seemed bleak, indeed. However, direct attack on the great populations of sea birds, mainly the Laysan albatross (*Diomedia immutabilis*), for the plumage trade, remained as a final challenge. E. H. Bryan, Jr. (1942, p. 193) reports that as early as 1904, when 75 Japanese were apprehended on

Lisianski on June 16, these feather hunters had already gathered several hundred packages of dried bird wings. This traffic in plumage may have continued uninterruptedly until 1910. Persistent reports of poaching had resulted in the establishment in 1909 of the Hawaiian Islands Bird Refuge, which includes both Laysan and Lisianski (Henshaw, 1911, 1918), but it was only after the arrest of 23 more plumage hunters, and confiscation of a cache of feathers from some 200,000 birds in January 1910, that this third phase of exploitation was fully revealed (Anon., 1910a, 1910b, 1910c). The rabbits were presumably the only further source of disturbance, and they plagued Laysan for another 13 years.

Although there is no known record of early concern about the possible threat of rabbits to agricultural lands of the main islands, on the strength of scare stories from Australia, in 1890 stringent laws were passed to assure that Hawai'i would be protected (Anon., 1954b). Chung (1931, p. 6) shows a facsimile of the application required under Rule XIII of the Board of Agriculture and Forestry for permission to keep domestic rabbits. Regardless of these precautions, it is entirely possible that the test has been made; domestic rabbits may have been accidentally or purposely released over the years, but failed to adapt themselves fully to conditions in the wild. D. H. Woodside (pers. comm.) reports that about 1951 he observed rabbit tracks in the beach sand at 'Anaeho'omalu Bay, South Kohala District, Hawai'i. At this site there is a short stretch of shore vegetation against rough lava flows that are virtually bare for several miles inland. Rabbits are said to have come from pens of a Hawaiian family living there. When I visited the site with G. E. Haas on March 13–14, 1964, one set of fresh tracks revealed that a rabbit had left a *kiawe* thicket, moved slowly to the water's edge, and then rushed back. No rabbits were seen and none was kept at that time by the resident family; they did have several coops of chickens. By August 5, 1968, when I went again to 'Anaeho'omalu, there was a picnic ground in place of the old home and many surveyors' stakes about the area; sign of rabbits was not apparent. The presence of predatory mongooses, cats, and dogs is a probable deterrent to widespread establishment of feral rabbits on the larger Hawaiian Islands, and may even preclude such establishment.

Examination of the later historical record uncovers additional information about rabbits in the Northwestern Hawaiian Islands. Amerson, Clapp, and Wirtz (1974) document introduction to Pearl and Hermes Atoll, a site not usually associated with the rabbit, prior to 1916, and extermination in 1928. These authors suggest that rabbits were brought to Southeast Island (one of nine islets there) in 1908 by Japanese feather poachers; source of the stock was probably Laysan Island or Lisianski Island. A party of the United States Coast Guard found this population in 1916 and caught four animals. Tanager

Expedition personnel shot 90 at Southeast Island on April 26 and 28, 1923, but noted that about 30 remained. On four subsequent visits through 1928 additional rabbits were taken, and none was observed after April 1928.

Ely and Clapp (1973) give more detail about the rabbit on Laysan, and Clapp and Wirtz (1975) place its introduction to Lisianski at any time between 1904 and 1907, after the population was well established on Laysan, rather than as early as 1902 or 1903.

The European rabbit still demonstrates apparently temporary adaptation to habitats on the larger islands. Kramer (1971) cites an example near Hanalei, Kaua'i, and TenBruggencate (1978) reports rabbits in a wild upland area as well as near the main harbor on the same island. In 1978 and 1979 W. S. Devick (pers. comm.) observed an occasional rabbit along plantation roads of the Helemano area of central O'ahu. No established colonies are presently identified. Also, demise of rabbits on Molokini in some past time is now confirmed (Kepler and Kepler, 1980).

The well-known colony on Mānana islet, off O'ahu, received attention through an intensive population study of more than a year (Dixon, 1973). Dixon found that breeding was stimulated by the emergence of green vegetation after seasonal drought. However, natural control seems to be through heavy mortality of nestling and weanling rabbits rather than immediate cessation of breeding as drought approaches. Infertility of females may be a contributing factor in the observed generally low productivity of 6.6 young per adult female per year. Dixon describes the population of Mānana as living in a precarious balance with the environment because of occasional prolonged droughts. The burrow-inhabiting wedge-tailed shearwater (*Puffinus pacificus*) and the rabbit appear to be mutually adaptable in their needs for breeding sites, and frequently both occupy the same burrow. Brown (1973, 1974) studied the nesting sea bird populations of Mānana and found some interference by rabbits with their biology. Lloyd and McCowan (1968) describe joint use of burrows by rabbits and birds on Skokolm Island off Scotland; and Breummer (1983) notes a negative relationship between sea lion pups and rabbit burrows on a New Zealand island.

The Mānana population remains a viable subject for further investigation. Topics are suggested by other island reports (Johnston, 1973; Hall, 1977), aswell as those on continental populations (Jaksić, Fuentes, and Yañez, 1979; Wood, 1980). Although control of the population is neither necessary nor advisable (Taylor, 1968), the method described by Hale and Meyers (1970) reveals some interesting facets of rabbit behavior; and a reference is given to chromosome number in the species (Issa, Atherton, and Blank, 1968). Rapid evolution of transplanted species commands attention and the Mānana popu-

lation appears to be an apt subject for study (see McClusky, Olivier, and others, 1974; and Edmonds, Noland, and others, 1976).

Further reports of interest and applicable to rabbit studies in Hawai'i are those of Gibb, Ward, and Ward (1978), Edmonds, Backholer, and Shepherd (1981), Jaksić and Soriguer (1981), and Skira, Brothers, and Copson (1982).

Rattus rattus. Roof rat.

ORIGINAL DESCRIPTION: *Mus rattus* Linnaeus, Systema Naturae, Ed. X, 1:61. 1758.

TYPE LOCALITY: Sweden.

NATIVE RANGE: Greater part of India, Ceylon, Himalayan foothills, Burma, southern China, Indo-China, Malay States, Sumatra, Java, Borneo, Celebes, Philippine Islands. Has spread with commerce to all tropical and temperate regions of the world; particularly well established in port and coastal areas (based on Ellerman and Morrison-Scott, 1951, p. 581).

RANGE IN HAWAI'I: Found on each of the eight main islands, also on Ford, Kāohikaipu, Mokuolo'e, Mokoli'i, and Moku'auia (all near O'ahu), and Sand and Eastern islands at Midway; may be the rat of Lehua, and possibly occurs on other small islands and islets.

The roof rat in Hawai'i is derived from European-type stocks, and these are referable to the subspecies *Rattus rattus rattus* (Johnson, pp. 26–27, in: Storer, 1962), which has been dispersed by human agency in a westerly direction to the Americas and into the Pacific. This form is distinct from the many known in Southeast Asia, some of which have invaded the Pacific in an easterly dispersal. A prominent characteristic of *R. r. rattus* is a series of three well-established color phenotypes, and although their genetic properties were described nearly 60 years ago (Feldman, 1926), the literature has been burdened with writings that treat the color variants themselves, or groups of them, as separate subspecies. The impropriety of this procedure is emphasized in some reports by the lumping of the original white-bellied wild-type rats ("*R. r. frugivorous*") with the gray-bellied mutant phenotype ("*R. r. alexandrinus*"), under this latter name. Further, all black individuals are called "*R. r. rattus*," whereas such rats consist of two phenotypically indistinguishable forms of quite different genetic origin. Tomich and Kami (1966) have reviewed the problem at length and have shown that Hawaiian populations are typical in having the expected hereditary pattern for coat color (see Figs. 9 and 10). Tomich (1968) discusses the distribution of the several color types on Hawai'i Island.

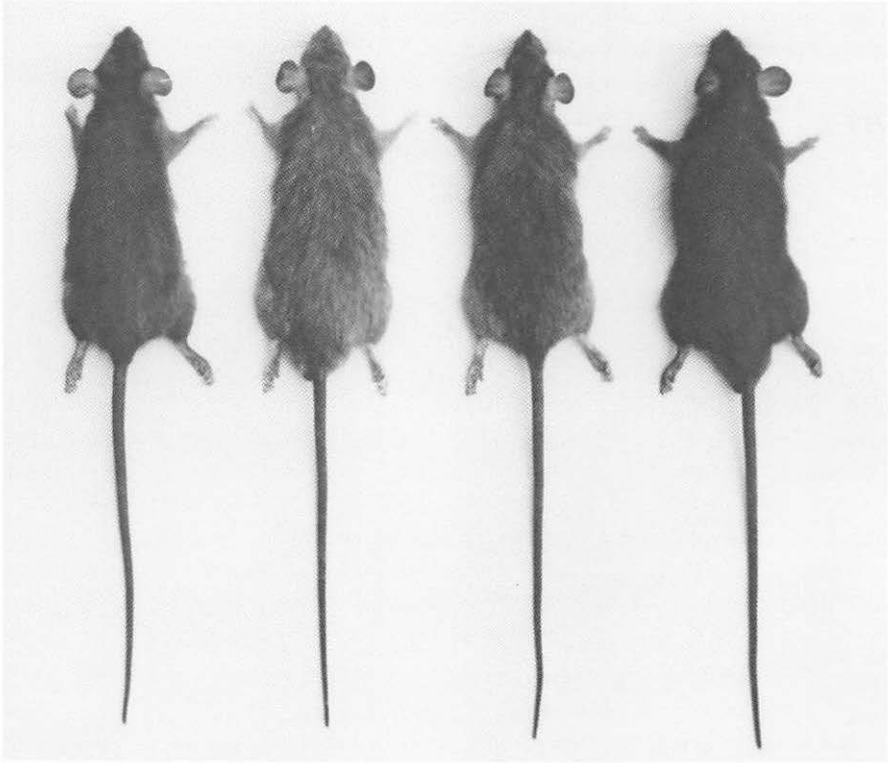


FIGURE 9.—Genetic color types of the roof rat (*Rattus rattus*), dorsal aspect. The outer specimens are mutants for identical black body color, but color in one is controlled by a dominant gene, while color in the other is expressed by a recessive gene pair. The inner specimens are both of the wild-type brown coloration. (Author's photo.)

Rattus rattus in Hawai'i is adapted especially to wooded gulches, sugar cane fields, and dry, wet, or even extremely wet forests. It retains, however, a classical commensal relationship with man, and frequents ornamental vegetation, stone walls, buildings, and other structures. But it obviously does not depend upon man for survival.

This species is locally common at lower and middle elevations, and is found sparsely distributed at higher altitudes, for example, about ranch cabins on cattle range in an open forest of *māmane* (*Sophora chrysophylla*) at Pu'u Kihe, 7,750 feet, on Mauna Kea. Extreme station of record is 9,800 feet, in the attic of the Crater Observatory (a heated building) at Haleakala National Park, Maui, where this rat occurs sporadically. Four specimens were obtained there for identification in July 1962, from Robert J. Badarocco, courtesy of the National Park Service.

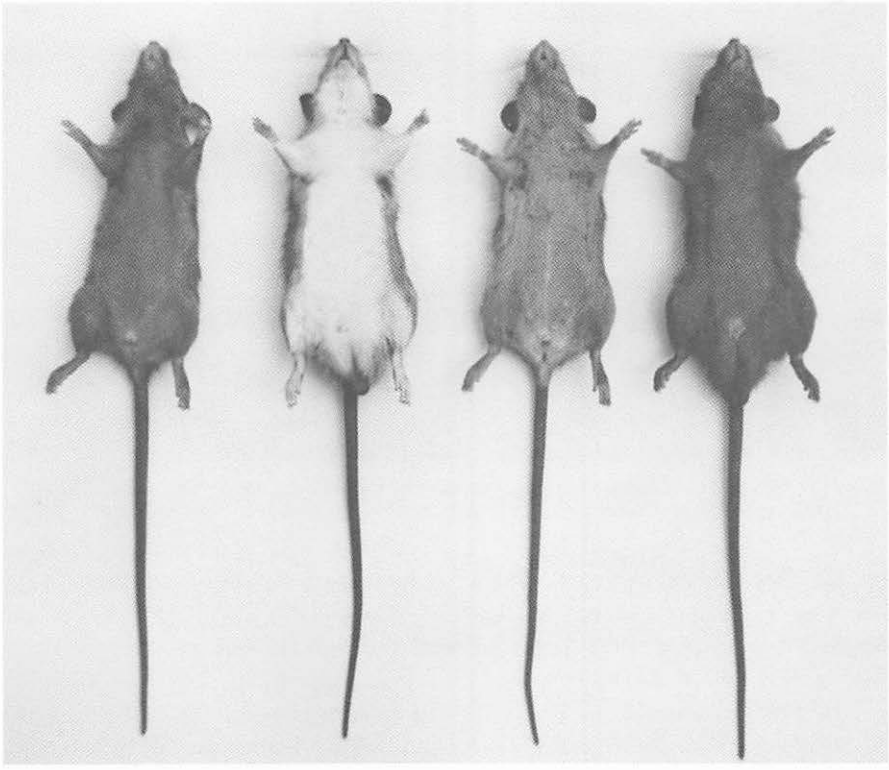


FIGURE 10.—Ventral aspect of rats in Figure 9. The two black rats have identical slate-gray belly color. The white-bellied rat is of the original wild type, but the specimen to its right expresses a mutation for gray that is similar in appearance to that in the black rats. (Author's photo.)

The roof rat has been noted specifically as a predator on native birds. The most striking and unfortunate example is that which resulted in extinction of the Laysan rail (*Porzanula palmeri*) in its last refuge at Midway Islands, and the extirpation of a population of the Laysan finch (*Telespyza cantans*) from this same area (Munro, 1945; P. H. Baldwin, 1945b). Atsatt (in: Munro, 1945, p. 50) identifies the rat positively as *Rattus rattus* when he states that, at both Sand and Eastern islands, "rats are *Rattus rattus alexandrinus*, (the gray or roof rat, the predominant variety, 80% of the whole), and *Rattus rattus rattus* (the black rat)." P. H. Baldwin (1945b, p. 348) reports that in its initial abundance soon after the introduction in 1944, population density on Eastern Island rose to 100 rats per acre (see also Anon., 1946b).

Richardson (1949, p. 228) found the roof rat on Moloka'i, and (1963) what may have been this species on Lehua, in critically important habitats of native

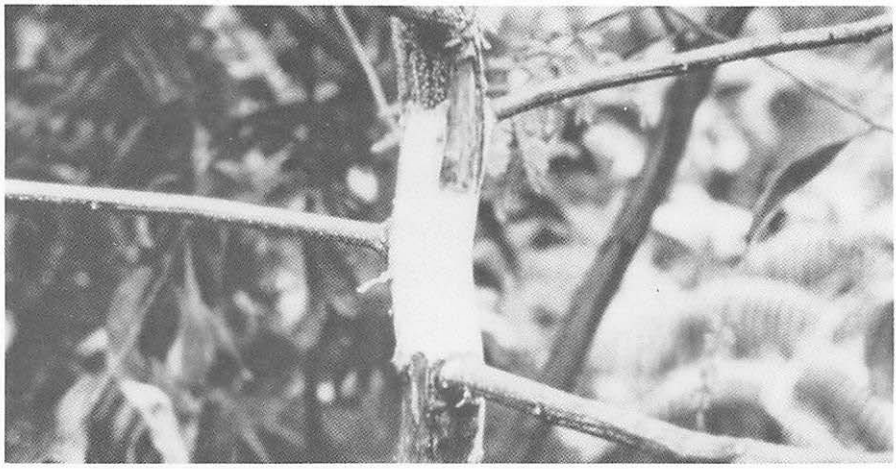


FIGURE 11.—Damage to young *koa* trees by the roof rat. Stems often are girdled, crippling the tree. (Paul Scowcroft photo.)

birds. Schwartz and Schwartz (1950a) report its predation on nestlings of the zebra dove (*Geopelia striata*) on Hawai'i. Korte (1963), Whitesell (1964), and Scowcroft and Sakai (1984) point out that the roof rat may be detrimental to regrowth of native *koa* by stripping bark from saplings.

The classical view of the roof rat as an invader of native ecosystems in the Pacific shortly after the voyages of Captain Cook has been seriously questioned, with both New Zealand and Hawai'i as prominent examples (Atkinson, 1972, 1977). See also Ralph, 1978. In reality, all evidence as derived from the historic record and the sequential decline of native bird species indicate that the period 1870 to 1890 may be a more likely era of final invasion. That the rat has entered even the most remote forests of Hawai'i, where it is the prominent rodent species, has been further documented in recent years (Conant, 1972; Tomich, 1981b).

Single species study and observation of the roof rat has produced an abundance of reference material since 1969. For Hawai'i, see Buxbaum (1973), van Riper (1974), Baker and Allen (1978), and Teraoka, Nagata, and Corn (1981). Additional reports, especially from New Zealand, are as follows: Best (1969, 1973), Daniel (1972), and Michener (1976).

Rattus norvegicus. Norway rat.

ORIGINAL DESCRIPTION: *Mus norvegicus* Berkenhout, Outlines of the Natural History of Great Britain and Ireland 1:5. 1769.

TYPE LOCALITY: England.

NATIVE RANGE: Palearctic Asia, where it is common in the cooler countries, throughout China, Siberia; has spread with commerce and become cosmopolitan, but the metropolis of the species is in the north temperate zone rather than in the tropics (in part from Ellerman and Morrison-Scott, 1951, p. 588).

RANGE IN HAWAI'I: Recorded from Kaua'i, O'ahu, Moloka'i, Lāna'i, Maui, and Hawai'i. May occur on the few smaller islands where permanent human settlements are present; known also from Ford Island in Pearl Harbor.

The Norway rat in Hawai'i is represented by stocks of probable European and American origin. These are remarkably uniform in basic characteristics wherever they occur, and are generally referable to *Rattus norvegicus norvegicus* (Johnson, p. 31, in: Storer, 1962). This rat is best adapted to city, village, and farm environments where foods from domestic or agricultural sources are plentiful. Such nutritional materials may be fundamentally essential, whereas mildness of climate is only secondarily necessary. Schiller (1956) reports survival of Norway rats in a severely cold climate under special conditions of food abundance.

In the mild Hawaiian climate this rat is sometimes locally common in and about lowland sugar cane fields, but is more likely to be absent from them altogether. It occupies also middle elevation planted forests, although it is the least numerous of the rats, and does not inhabit extensively the native forests or wide expanses of grassland. Many field habitats were abandoned in the two decades before 1970, and in Hāmākua District, on Hawai'i, for example, this rat is rarely found except in village and farmyard environments. Extreme known elevation is 5,800 feet, at Halepiula on Mauna Kea, where the rat is associated with water catchment and storage facilities in remnant forest range land. Soils unsuitable for burrowing, the absence of man-made structures, and scarcity of food and easily accessible water seem to restrict *Rattus norvegicus* from many wild habitats.

No rats of this species were trapped in a two-year period on a transect in wet to dry habitats from 3,000 to 10,000 feet elevation in Hawaii Volcanoes National Park; and in neighboring rain forest of Kīlauea Forest Reserve at 5,300 feet, a grid of traps on a 200-acre study area captured only four in the same period (Tomich, 1981a, 1981b). In another study at 20 to 120 feet elevation in Waipi'o Valley (Tomich, 1979), during a similarly intensive project in riparian woodland, just four *Rattus norvegicus* were trapped in nearly five years of operation.

Examples of reports outside Hawai'i and pertinent to the study of this rat are Calhoun (1962), Barnett (1963), Brooks and Barnes (1972), Yabe (1979a, 1979b), Pye and Bonner (1980), and Lattanzio and Chapman (1980).

Rattus exulans. Polynesian rat.

ORIGINAL DESCRIPTION: *Mus exulans* Peale, U. S. Exploring Expedition 8 (Mammalia and Ornithology):47. 1848.

TYPE LOCALITY: Tahiti, Society Islands.

NATIVE RANGE: Southeast Asia, from whence it has spread with man to the East Indies, Philippines, New Guinea, and to the Pacific islands, reaching in its farthest distribution New Zealand, Easter Island, and Hawai'i. Occurs extensively with *Rattus rattus* in these regions, but has not ventured deeply into the Asian continent (based on Ellerman and Morrison-Scott, 1951, p. 590).

RANGE IN HAWAI'I: Found on Kaua'i, O'ahu, Moloka'i, Lāna'i, Maui, Kaho'olawe, and Hawai'i. May occur on Ni'ihau, but is not specifically reported from there. Inhabits also Kure Atoll (at the northwestern end of the chain); Popoi'a and Mokumanu (near O'ahu), and Ka'ula (off Ni'ihau).

Clapp and Wirtz (1975, p. 151) mention reports of rodents on Lisianski, which may have included *Rattus exulans*, but no rodents are presently on the island. Transect studies to 10,000 feet in Hawaii Volcanoes National Park (Tomich, 1965d, 1981a) place *R. exulans* at a maximum elevation of 4,900 feet on Mauna Loa, where a single specimen was caught in systematic trapping over a period of two years. King (1971) caught two rats assignable to *R. exulans* on the rim of the Haleakalā Crater, on Maui, among nesting petrels at 9,400 and 9,700 feet elevation, but did not retain the specimens from this maximum elevation range. Simons (1983) reports an additional six *R. exulans* in the same petrel colony during work conducted in 1979–1981. Again, museum specimens apparently were not retained, but it does seem assured that the Polynesian rat exists, at least sparingly, at this unusually high altitude.

Rattus exulans in Hawai'i is characteristically a lowland rodent, and this may be in part a result of its tropical and subtropical origins. However, its successful colonization of Green Island at Kure Atoll (28° 25′ north), and Stewart Island, New Zealand (47° south), which is its southernmost station (Watson, 1956), suggests a reasonable adaptation to cooler climates. Hawaiian populations are noncommensal in the sense that they do not often occupy human dwellings, but flourish best on agricultural lands. This rat becomes most numerous in sugar cane fields and abandoned pineapple fields, but does well in adjacent wooded or grassy gulch and waste areas. It is usually uncommon in native or planted forests, and is often absent from them at elevations above 2,500 feet. Occurrence is rare in wide expanses of grassland. Only one has been caught in repeated trapping at Makahālau, at 3,800 feet on the Waimea Plain of Hawai'i.

The Polynesian rat is presumed to have come to Hawai'i with early colonizers from the central Pacific. Because it was not used for food in Hawai'i

as it was in New Zealand (Watson, 1956, p. 560), it would seem that the rat came as an immigrant rather than as an introduced species. However, the ancient Hawaiians did use miniature bows and arrows for sport hunting of the Polynesian rat (Stokes, 1917, p. 270; Malo, 1951, p. 233; Buck, 1957, p. 376) and may have purposely brought it in this connection.

The islands have been occupied from possibly as early as the second century (Suggs, 1960). It would appear that the rat could have been in Hawai'i for 1,400 years or longer (Kirch, 1982). Rats are seldom recorded in the early literature of Hawai'i, although one was known from Cook's time, and is presumed to be *Rattus exulans*. The documentation is quite clear, for Cook (1785, Vol. 2, p. 228) said in describing the fauna of Kaua'i, where he made his first landing after cruising up from more southerly waters, "There were . . . some rats, resembling those seen at every island at which we had yet touched."

The Polynesian rat was thought to be rare in Hawai'i early in this century, if not extinct, and R. C. L. Perkins (1903, p. 466) assumed that it had been driven out by other rats. The first museum materials were collected only in 1913–1915 (Stone, 1917). Stone compared these with Peale's *Mus exulans* from Tahiti and *Mus vitiensis* from Fiji, and concluded that it was appropriate to erect the new species, *Rattus hawaiiensis*, to encompass the Hawaiian population. However, as early as 1897, Waite, according to Stone (1917, p. 259), had suggested that populations from the various Polynesian islands should belong to Peale's species (= *Rattus exulans*). G. S. Miller (1924) was of a similar opinion, but Tate (1935) chose to recognize several species groups. Ellerman (1947) examined specimens from most of the range of this rat, on islands and on the Asian mainland as well, and declared in support of Waite and Miller that all populations should be referred to *R. exulans*. Ellerman (1947) studied and listed a total of 12 subspecies, including (p. 64) *Rattus exulans hawaiiensis*, and was first to use this combination.

The common name Polynesian rat is fitting for *Rattus exulans* and is derived from the broad association of this rat with Polynesian cultures. The more inclusive term "Pacific Island rat" has also been used, but local populations have been called, for example, according to Hossack (1907) the "little Burmese rat" (in Southeast Asia), "*kiore*" (in New Zealand), which is equivalent to the Hawaiian *'iole*, and "Hawaiian rat" (in Hawai'i).

Questions still exist concerning degrees of relationship among the far-flung populations of the Polynesian rat, whether within a single archipelago or between widely separated islands. Marples (1955) discusses a segment of thisproblem, and Uchida (1964) reports a probable extension of the known range, to the southern Ryukyu Islands. However, on a visit to Hawai'i in July 1984, Dr. Tatsuo Yabe of Yokohama relayed the information (pers. comm.) that on close scrutiny the Uchida specimens, collected on Iriomote-jima, all

correspond to *Rattus rattus*, and that no authenticated records of *R. exulans* are known from the Ryukyu Islands.

An item of interest has been the supposedly large changes in population density, and decrease in previously known range in Hawai'i. Stokes (1917) hoped for discovery of colonies additional to that on Popoi'a, and Illingworth (1931) pointed out some 15 years later that goodly numbers of the rat did in fact live on parts of O'ahu. Svihla (1936) recorded *Rattus exulans* to be of probable general distribution in Hawai'i. Whether this rat suffered a great decline during the establishment and spread of later arriving species is not known. Supposition, rather than good observational evidence, seems to have been predominant during this period, and no one really knows what happened. A well-documented parallel exists in New Zealand where *Rattus exulans maorium* was known to be abundant over most of the country in early times (Best, 1898; Marples, 1954). It is now common only on the peripheral small islands, and may be absent altogether from North Island. Immigration and spread of *R. rattus* and *R. norvegicus* are implicated in this radical restriction of range (Watson, 1956).

If *Rattus exulans* in Hawai'i yielded to other rodent invaders, ecological readjustments have been made and a resurgence has taken place, because this rat is frequently the most abundant of any in lowland populations, for example, on Hawai'i (Tomich, 1961). Spencer (1938, p. 26) states that it comprises nearly 75 percent of Maui rats. In popularizing Stokes' report (1917) on this rat, Gill (1929) proposed that *R. exulans* is poor at gnawing. The fact remains that it is this species that often does most of the damage to standing sugar cane. At Kure Atoll the population was extremely dense in 1923 at the time of the Tanager Expedition, for Gregory (1924, p. 23) states that "thousands of a new form of the Pacific Island rat were found on Ocean [now Green] Island." High population peaks have recurred there in a similar fashion over the years and are of special interest as a populational feature of a small low island.

Other aspects of *Rattus exulans* may be mentioned here as possible aids to the need for laboratory study of this species. Anon. (1960c) reports laboratory reproduction in New Zealand, and a small breeding colony of O'ahu stock was maintained at the Experiment Station, Hawaiian Sugar Planters' Association, in Honolulu, for a number of years after 1956 (W. R. Smythe, pers. comm.). A ventral dermal gland was described in this species (Quay and Tomich, 1963) and it may be of significance to an understanding of its behavioral patterns. Rudd (1966) has found the same feature in Malaysian rats.

While *Rattus exulans* has not been demonstrated to be a direct threat to forest birds, it is a probable predator on Bulwer's petrel (*Bulweria bulwerii*) of Popoi'a, where Fisher and Baldwin (1946, p. 7) declared that this bird "has been practically wiped out by rats in the last few years." A report from Kure

Atoll studies (Kepler, 1967) documents predation of the Polynesian rat on the Laysan albatross (*Diomedia immutabilis*) in which the rats literally eat the birds alive as they sit impassively on their nests. R. L. Walker reports (pers. comm.) from a March 1966 trip to Kure that *R. exulans* is a serious predator on burrow-nesting species including the wedge-tailed shearwater (*Puffinus pacificus*) and Bonin petrel (*Pterodroma hypoleuca*). There was no evidence of successful breeding by the petrel in later years of rat abundance following a 1961 low in rat numbers.

Studies of the Polynesian rat after 1969 have been numerous, and it is often the subject of single species studies in Hawai'i and other Pacific localities, where the information gained is useful to understanding this rat. Williams (1973) provides a thorough review, through 1971. Wirtz (1972, 1973) completed his work on Kure and found limitations of food resources important to the economy of *Rattus exulans* there (see also, Norman, 1975). Other island populations were examined by McCartney (1970), Bettesworth (1972), Mosby and Wodzicki (1972, 1973), Mosby, Wodzicki, and Shorland (1974), and Moller and Craig (1977), who add to information on basic biology, food habits, and ecological attributes. Continental populations are treated by Dwyer (1978), Koeppl, Slade, and Turner (1979, 1981), and Brooks and Pe (1980); and Taylor (1975) may have reached a final explanation of what has driven the *kiore* of New Zealand from the main islands in these southern latitudes. Refinement of methods for captive rearing has led to increased use of *R. exulans* in controlled laboratory experiments (Egoscue, 1970; Wirtz, 1973; Garrison, 1974; and Davis, 1979).

Mus domesticus. European house mouse.

ORIGINAL DESCRIPTION: *Mus domesticus* Rutty, An Essay Towards a Natural History of the County of Dublin . . ., Vol. 1. 1772.

TYPE LOCALITY: Dublin, Ireland.

NATIVE RANGE: Southern Denmark, in most of the rest of western Europe, and around the Mediterranean Sea (Ferris, Sage, and others, 1983). It has spread widely with commerce and become cosmopolitan as an introduced species. Highly adaptable to temperate latitudes, but occurs widely in the tropics.

RANGE IN HAWAI'I: Found on all major islands, except that specific record is lacking for Ni'ihau. Known also from Midway Islands and Ka'ula, Mokuolo'e, Mānana, Kekepa, and Kapapa (islets near O'ahu).

House mouse populations of Hawai'i are referable to *Mus domesticus*. This form, in its native range, is separated from the more northerly Linné's house mouse, *M. musculus* Linnaeus 1758, by a narrow hybrid zone crossing southern

Denmark and extending through central Europe to the Black Sea. This new view of speciation in *Mus* has emerged from the works of Sage (1981), Marshall and Sage (1981), and Ferris, Sage, and others (1983). *Mus domesticus* is now the preferred name for European mice that have colonized sections of North America, Australia, Tasmania, and Hawai'i. Obvious variations among Hawaiian populations are reported by Graf (1963) on Moloka'i and on Mānana Island, and by Tomich, Wilson, and Lamoureux (1968), also on Mānana. Berry (1964) thoroughly explores the factor of isolation in a Scotch island colony. Long-term study of isolated Hawaiian *M. domesticus* populations should reveal important information on ecology and evolution.

I have found no evidence of any mouse other than *Mus domesticus* established in Hawai'i, nor evidence that any rodent other than *Rattus exulans* was present at the time of Cook's arrival in 1778. R. C. L. Perkins (1903, p. 465) is vague in his supposition of a pre-Cook mouse, and this is unsupported by reference. There is further complication in Perkins' statement of conditions at the time of his writing (p. 466):

> Mice abound throughout the grasslands . . . but it is by no means certain that the species, now so numerous, is the same as the former inhabitant, and it may be that the latter like the native rat has been supplanted by the common foreign mouse.

Perkins seems to suggest in this passage a native mouse, rather than pre-Cook *Mus domesticus*, as the species present about 1825 when mice are first reputed to have been common, and that this form was later replaced by *Mus*. W. A. Bryan (1915, p. 293) confuses the issue further by reference to the rural mouse as "a long-tailed field-mouse," imported in fodder from California. By this he implies that it represented a genus other than *Mus*.

An affirmation of Cook's first appraisal of vertebrates in Hawai'i is given in the summary pages of the journal (Cook, 1785, Vol. 3, p. 117): "The quadrupeds in these, as in all other islands that have been discovered in the South sea, are confined to three sorts, dogs, hogs and rats." Surely such keen observers as Cook and King would have distinguished easily between the small Polynesian rat and the house mouse if they had seen both.

Until proved otherwise we must presume that the ancient Hawaiians' quarry in the sport of bow-and-arrow rodent hunting was confined to *Rattus exulans*. The discussions of Buck (1957, pp. 376–377) and of Malo (1951, p. 233) specify mice, but these may include post-1778 descriptions of the sport and an undiscerning eye for rodents. Stokes (1917, p. 270) also treated rat hunting, and he concluded from all evidence that no mice were known in ancient Hawai'i. Cook (1875, Vol. 2, p. 247) saw tiny bows and arrows on Kaua'i and remarked that they were too fragile and few to be effective in battle, but had not then learned of their actual use.

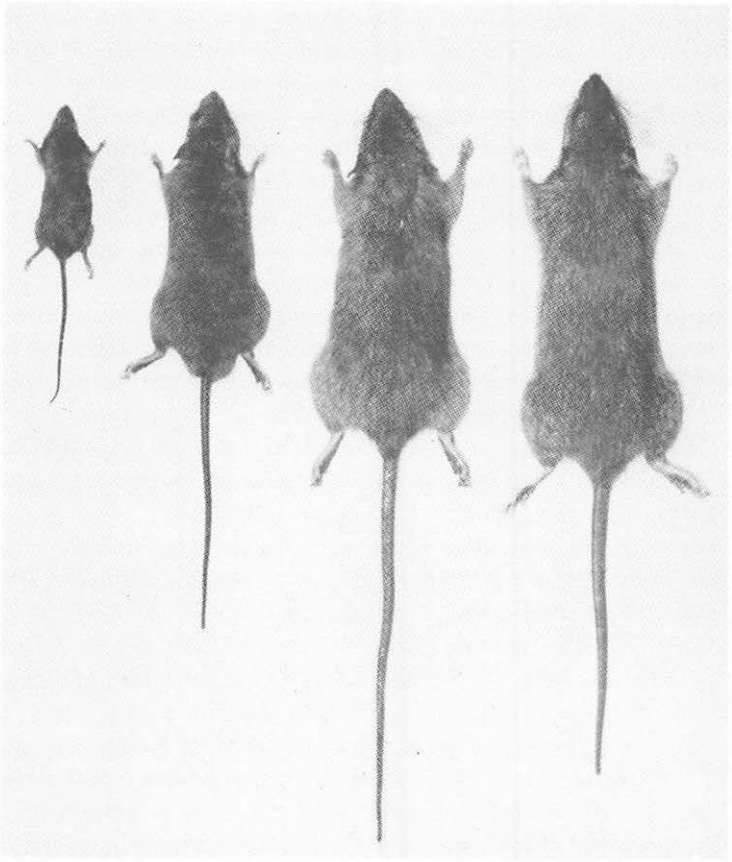


FIGURE 12.—Comparative size proportions and prominent characters of rodents in Hawai'i (left to right). House mouse (*Mus domesticus*): small slender feet and tail, weight about 1/2 ounce (8 to 16 g); Polynesian rat (*Rattus exulans*): medium size, tail about as long as body and with tail scales formed in prominent rings, ears of medium length, stiff bristles in the dorsal pelage, weight 1½ to 3 ounces (40 to 80 g); roof rat (*Rattus rattus*): large size, tail longer than body, ears large, three color types, weight 3½ to 6 ounces (90 to 180 g); Norway rat (*Rattus norvegicus*): large size, heavy body, feet large, tail shorter than body, ears short, weight 4½ to 12½ ounces (125 to 350 g). (William S. Devick photo.)

The house mouse is now ubiquitous in Hawai'i and may occupy in numbers even more ecological niches than does *Rattus rattus*. The mouse accompanies or meets man virtually everywhere he settles because it exists not only as a commensal, but also as a highly adapted wild species. Dense populations occur regularly in sugar cane and pineapple fields and are found also in lower elevation wet forests. Extremely wet forests and upland swamps, however, may be shunned entirely. *Mus domesticus* is sporadically common in mountain

forest and scrub at higher elevations on Mauna Kea, as at Ahumoa (6,800 ft), Pu'u Kihe (7,800 ft), and Halepōhaku (9,200 ft). The highest elevation record for any live rodent before 1979 is a mouse, presumably *Mus*, seen July 13, 1962, in the nearly barren summit region of Mauna Kea at the Keanakāko'i adz cave, at 12,400 feet, and reported by Dwight L. Hamilton of the National Park Service. A dead house mouse was recovered from the rim of a cinder cone at 13,000 feet near Lake Waiau, June 19, 1966, by a survey party. While it is possible that this specimen was from a natural population on the mountain, there is some likelihood that it had arrived with increased traffic to the summit in that period, during the planning phase of the first astronomy observatory there. The summit was for many years accessible only by foot trail from the road's end near Halepōhaku (9,600 ft) and was reached for the first time by an autmobile, specially equipped, via the approximate route of the trail, in 1963 (Brock, 1963). An extension of the road from the 9,600-foot level to the summit was built in April and May 1964, for limited public access and in anticipation of construction of the observatory, which began in 1967.

Populations of mice reaching plague proportions irrupt sporadically during late summer and fall in the drier beach, grassland, scrub, and forest areas, especially on Maui and Hawai'i. Recent population highs occurred in 1963 and 1965 at South Point, Hawai'i (Anon., 1965e), in the Waiki'i-Pu'uwa'awa'a region of Hawai'i in 1963, 1964, and 1967 (Tomich, unpubl.), and in the central lowlands of Maui in 1965 (Anon., 1965f). Rodent abundance on Maui in 1963 may have involved additionally *Rattus rattus* and *Rattus exulans* (Anon, 1963f). K. H. Korte (pers. comm.) recalled several mouse outbreaks on Maui before 1965, usually in the vicinity of Kīhei. A general pattern of August–September peaks in abundance, restless daytime activity, concentration in areas of food and shelter, and random movement, are characteristic during these outbreaks.

Sporadic irruptions of *Mus domesticus* continue and have been noted, through 1984, in the years 1974 and 1979 on Maui and Hawai'i. As arid lands are developed for housing and resort use, such abundances of mice are more troublesome. In the Makakilo area of western O'ahu invasion of newer suburbs first occurred in the summer of 1979. There was another episode in 1982 (Voss, 1982), but at other traditional mouse sites threatened highs were averted or otherwise failed that year. Key factors in mouse outbreaks are now seen as severe drought, sometimes prolonged for several years, followed by early winter heavy rains and consequent revival of food sources. These in turn generate heavy mouse populations through the next summer (Tomich, unpubl.). For the Big Island, in 1979 mice were common beginning in March at such separated locations as South Point (800 ft), Waikoloa (1,000 ft), and Halepōhaku near the tree line (9,400 ft). The infestation ran its usual course

FIGURE 13.—House mouse (*Mus domesticus*) plague of 1979. A 24-hour catch from several repeating live traps. Mice are active at all hours during periods of high population density. The record catch for one trap is 51 mice. (George Komatsu photo.)

through the summer, taking in the entire dry lower slope of Mauna Kea and Kohala Mountain between Waikoloa and Māhukona, and the whole of the South Point region, in a usual pattern (Fig. 13). Watch was not kept at Halepōhaku, but in November when the surge of mice was exhausted in the lowlands, they were invading the several astronomy observatories at the summit of Mauna Kea (13,650 ft) and were seen commonly in that period along the seven-mile access roadway among bare lavas above Halepōhaku. Mice entering the observatory facilities became a threat to delicate electronic devices used in operation of the telescopes. The problem was resolved when a snowstorm blanketed the region late in the year (Anon., 1979). Thereafter mice were no longer seen. For further reference see Bronson (1984).

A sample of nine mice captured inside two observatories by H. George Lundburg and submitted to the State Health Department, was of notably large, fat, and non-breeding animals. It appears they were generated in the middle-elevation, vegetated region of the mountain, and had drifted upslope, finally to the summit. Further speculation suggests that food in the form of wind-drifted insects could have provided early winter sustenance in this barren region of the mountain (Papp, 1980; Howarth and Montgomery, 1980; Ashlock and Gagné, 1983). I have noted seasonal concentrations of ladybird beetles (Coccinellidae) wafted to the summit region, and these could supply a fair quantity of food for

mice. Snow restricted mobility of the mice and probably annihilated the population in a short time. This example again illustrates a facet of at least partial adaptation to conditions above the vegetation zones of the mountain and bears further study.

The broader topic of mouse irruptions, usually termed plagues, has been researched in detail in Australia where economic stakes are high when mice threaten crops of wheat. Seemingly erratic occurrences of plagues have been correlated with drought and rainfall patterns bearing some resemblance to conditions in Hawai'i (Plomley, 1972; Saunders and Giles, 1977; Hone, 1980; Chapman, 1981).

Newer studies of *Mus*, in addition to those already cited on revision of nomenclature, deal largely with social organization, distribution, and genetics (Deol, 1970; Myers, 1978; Rowe, 1970; Berry, Sage, and others, 1981). These last two include samplings from Pa'auilo, on Hawai'i. Further reports from that island are anticipated.

Cavia porcellus. Guinea pig.

ORIGINAL DESCRIPTION: *Mus porcellus* Linnaeus, Systema Naturae, Ed. X, 1:59. 1758.

TYPE LOCALITY: Brazil.

NATIVE RANGE: The ancestral wild form is distributed in South America from the Guianas to Argentina (Gilmore, 1963, p. 455).

RANGE IN HAWAI'I: Formerly as a feral population on Laysan Island.

The guinea pig was kept by nearly all South American cultures in pre-Columbian times, and domestication probably arose among the indigenes of Peru, Colombia, and Equador during an agricultural era about 1000 B.C. The animals were kept primarily as a source of food. Gilmore (1963) and Wade (1967) advanced the notion of single species ancestry, but perhaps because of confusion in taxonomy, named different progenitor species. Weir (1974) reviews available information, including breeding experiments with possible ancestral forms, and concludes the probability of multiple contributions to *Cavia porcellus* from such entities as *C. aperea*, *C. tschudii* and *C. rufescens*. Taxonomy and interrelationships remain obscure among these wild forms, which leaves the question unanswered. The paper of Rood (1972) provides partial explanations. Beauchamp, Jacobs, and Hess (1971) made basic observation of social rank in the domestic guinea pig, in a laboratory colony.

Hawaiian history of guinea pigs in the wild is brief and inglorious. W. A. Bryan (1915, p. 293) says, "The familiar variegated guinea-pig . . . was liberated on Laysan Island at the same time as the rabbits, and has found a

congenial habitat, though its rate of increase has by no means been so rapid as that of the rabbits." This places the introduction at about 1903. A population survived at least until 1911 (Dill and Bryan, 1912), but we may suppose that it was overcome by *Oryctolagus* shortly afterward, for the guinea pig is not mentioned by Elschner (1915) or by later visitors to Laysan. Ely and Clapp (1973) insert the note that four guinea pigs were seen by the 1911–1912 survey party, and that these were killed. Indeed, these four may have been the last of the population on Laysan. Predation on the young by sea birds is suggested by Tinker (1938, p. 113), but specific documentation is lacking.

Balaenoptera acutorostrata. Minke whale.

ORIGINAL DESCRIPTION: *Balaena rostrata* Fabricius, Fauna Groenlandica, p. 40. 1780.

TYPE LOCALITY: Cherbourg, France.

GENERAL RANGE: Widely distributed in oceans of the world, to include temperate and tropical waters, the Arctic and Antarctic.

DESCRIPTION: This is the most colorful and the smallest of the large whales (Fig. 41, front endsheet). It is slender in form and weighs up to 11 tons (10,000 kg); adult males average about 26 feet (8.0 m). Dorsal surface is black to grayish and the venter is white, with a sharp line of demarcation between the two. There is a distinctive white band across each dark flipper. The head is narrow and pointed as indicated by the descriptive name "*acutorostrata.*" It is known also as the "little piked whale." The more usual appellation is derived from a nineteenth-century harpooner named Meinke who mistakenly shot one of this species at a time when whalers were not bothering to take them. Since he had killed the "wrong" whale it became known as "Meinke's whale" and eventually the minke whale.

RANGE IN HAWAI'I: Shallenberger (1981) reports the minke whale as probably of regular seasonal occurrence among the Northwestern Hawaiian Islands. He cites reliable evidence of infrequent identification of this species by persons aboard a research vessel.

Total population stands at 50,000–70,000, but the Pacific stock is small, at perhaps 10,000 animals. Foods are principally fishes, squids, and planktonic krill and copepods (Ridgway, 1972). Mitchell (1972) relates feeding habits to color pattern of the minke whale. Northern Hemisphere populations seem to be the better known. Those of the western Pacific migrate from the latitude of Japan in coastal waters, north to the Bering Sea and Arctic Ocean for the summer, with a return in the fall farther offshore. A similar pattern is observed in the Atlantic along the coast of Norway. This species goes farther into iced

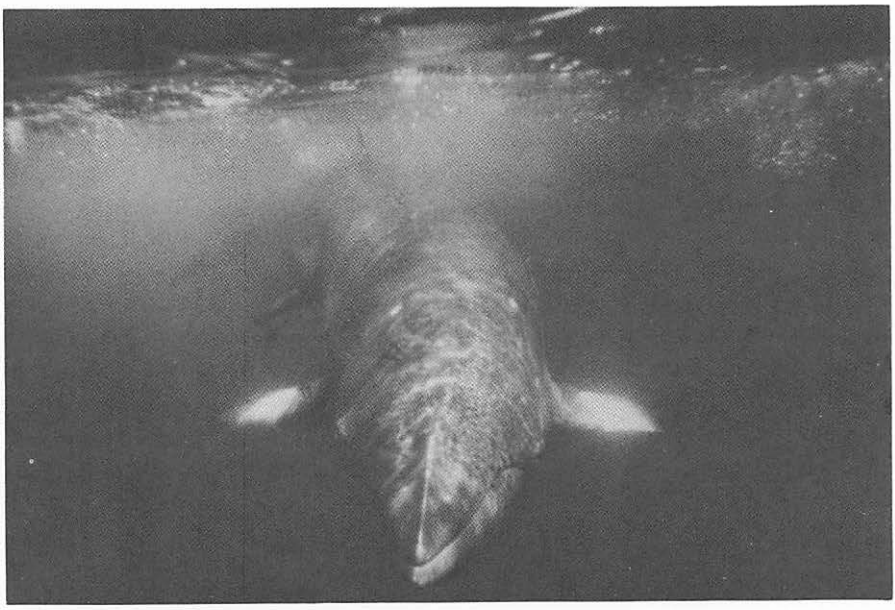


FIGURE 14.—Head on underwater view of a minke whale (*Balaenoptera acutorostrata*). The ridged and pointed rostrum prompt the literal name, "sharp-headed finner," assigned to this species. Sunlight is reflected from the white band on each flipper; also, it distorts our view of the generally solid gray head coloration. (G. Williamson photo, courtesy of General Whale.)

seas than any other, with females most aggressive in this respect. Winn and Perkins (1976) relate some aspects of behavior and compare its sounds with those of other mysticete whales. Leatherwood, Reeves, and others (1982) report that the minke whale is now the mainstay of Japanese factory ship whaling in the Southern Hemisphere.

Balaenoptera physalis. Fin whale.

ORIGINAL DESCRIPTION: [*Balaena*] *physalus* Linnaeus, Systema Naturae, Ed. X, 1:75. 1758.

TYPE LOCALITY: "Oceano Europaeo," specifically the Spitzenberg Sea.

GENERAL RANGE: All oceans, but rarely in tropical waters or among pack ice. Not found in coastal waters.

DESCRIPTION: Ridgway (1972) describes the fin whale (Fig. 41, front endsheet) as having the dorsal surface brownish black, fading irregularly to white on the abdomen. Various contrasted stripings may be present in the color pattern. Lower lip is usually white on the right side, black on the left; coloration of the baleen plates is similarly asymmetric. From above, a pale

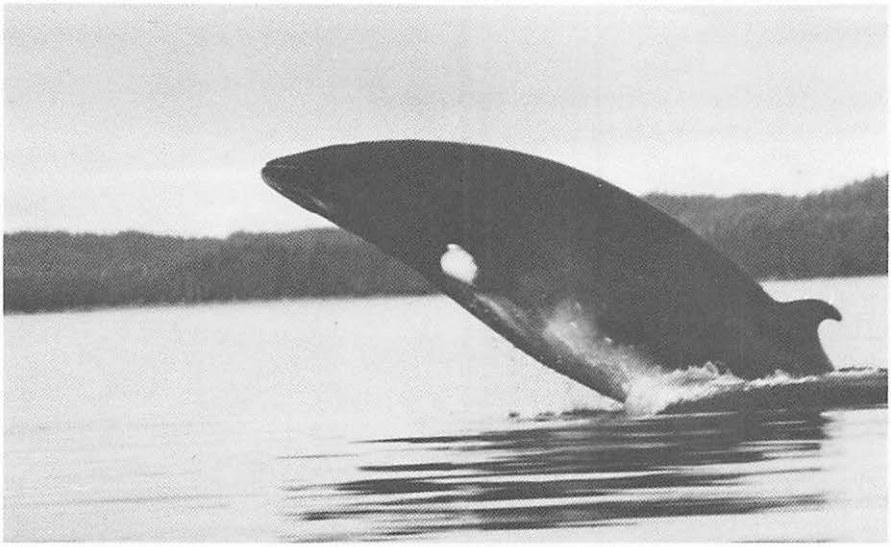


FIGURE 15.—As the smallest and most agile balaenopteran, the minke whale breaches often, sometimes in a dolphin-like manner, re-entering headfirst with little splash. Here the white bar on the flipper and falcate dorsal fin are evident. (D. Calkins photo.)

chevron mark is seen behind the head. Next to the blue whale it is the largest, to about 80 feet (25 m) in length, with averages some 65 feet (20 m).

RANGE IN HAWAI'I: Shallenberger (1981) reports sightings of the fin whale in May 1976 north of O'ahu, and in February 1979 west of O'ahu. It is more common in Hawaiian waters than has been known until recently. Using a system of hydrophones Thompson and Friedl (1982) detected regular winter occurrences off Ka'ena Point. This suggests, as for the blue whale, a pattern of migration through the latitude of Hawai'i to more southern and more northern waters. Fewest sounds, or no sounds, were heard in the period March–July. A single stranding was reported in the 1950s at Kahakuloa, Maui, by Paul Breese; identification was confirmed from a sample of baleen (Shallenberger, 1981).

According to Ridgway (1972) the world population is possibly 100,000, with 15,000 in the North Pacific. The fin whale feeds on krill and fishes, and may take squids. In the 1976 Hawai'i sighting, a single whale apparently was feeding on a school of *'ōpelu* (*Decapterus pennulatus*), a locally abundant small fish. Herman (1980) states that swimming on the right side while skimming the ocean surface for prey is almost certainly related to the asymmetric white to gray disruptive facial color pattern, which extends to the mouth cavity and

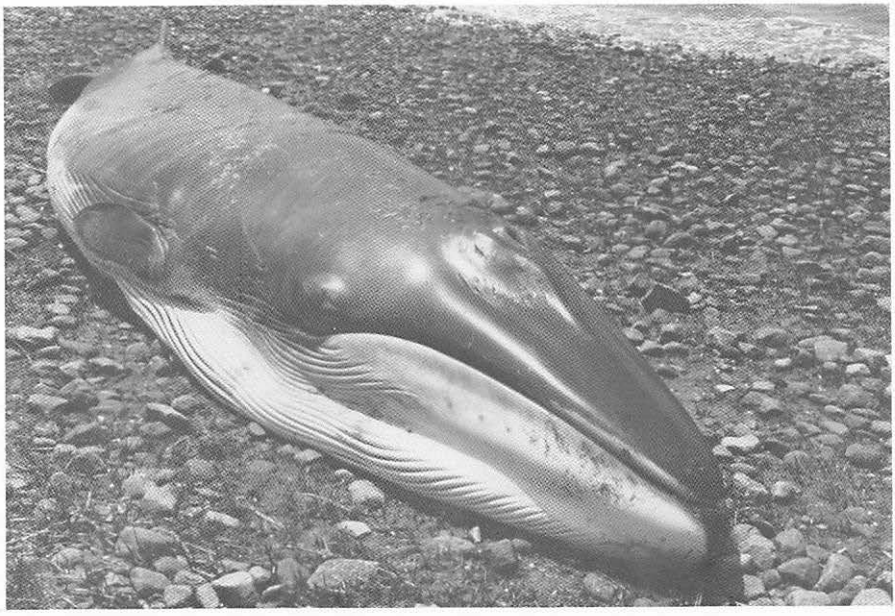


FIGURE 16.—A beached small fin whale (*Balaenoptera physalus*). The asymmetrical coloration is diagnostic; right side of the mandible is white; the left is black, beginning at the tip of the jaw. Note the smooth contour of the head and throat grooves extending far back of the flipper. (Photo courtesy of H. E. Winn.)

tongue, although Leatherwood, Reeves, and others (1982) suggest that the fin whale is characteristically a gulping feeder, rising obliquely to the surface.

The fin whale is the fastest swimming baleen whale. It can cruise easily at 8 knots and travel long distances at speeds up to 18 knots. For this reason it was usually immune to capture by whalers until the advent of steam-powered catcher ships.

Migration in summer is to colder waters for its principal feeding, and to warmer seas for winter breeding. It is an offshore species. The fin whale is now protected from whaling throughout the eastern North Pacific (Leatherwood, Reeves, and others, 1982).

Balaenoptera edeni. Bryde's whale.

ORIGINAL DESCRIPTION: *Balaenoptera edeni* Anderson, Anatomical and Zoological Research . . . Western Yunnan in 1868 and 1875, London, pp. 541–564. 1878.

TYPE LOCALITY: Thaybyoo Choung, Gulf of Martaban, between Sittang and Beeling rivers, Burma.

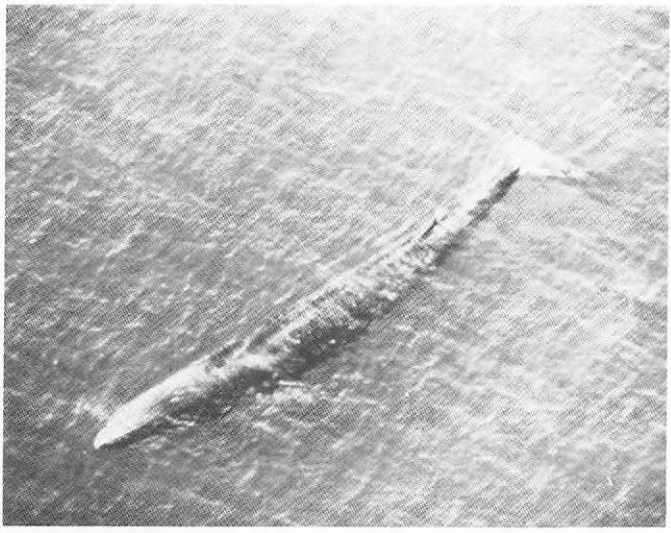


FIGURE 17.—A large fin whale viewed from the air. Impressive bulk and long body are accentuated by the ocean wave pattern. Note the slender tail stock, characteristic of cetaceans, which allows for efficient propulsion by up-and-down movements of the tail (unlike fishes). A light chevron mark behind the head serves to identify this species. (M. Bonnell photo, courtesy of U. S. Minerals Management Service.)

GENERAL RANGE: Tropical and warm temperate waters of the Atlantic, Indian, and Pacific oceans.

DESCRIPTION: Bryde's whale is of moderate size, reaching a length of about 46 feet (14 m). Color is a rather uniform dark smoky gray. A distinctive characteristic is the presence of three prominent parallel dorsal ridges anterior to the blowhole (Fig. 41, front endsheet). A strikingly falcate (hooked) dorsal fin is usual.

RANGE IN HAWAI'I: Shallenberger (1981) lists Bryde's whale as probably rare in Hawai'i and reports a single confirmed observation 54 miles southeast of Nihoa on April 7, 1977. Leatherwood, Reeves, and others (1982) note them as "relatively abundant" over shallows northwest of Hawai'i and near Midway Islands, and that they have "been hunted with some success northeast of Hawai'i."

This species seems not to be strongly migratory, as is evidenced by its distribution within subtropical and tropical waters. When it became, recently, the only remaining large baleen whale in the north Pacific abundant enough to exploit, its distribution became better known. The adult population is estimated at about 15,000 with the large majority in the eastern sector. The species

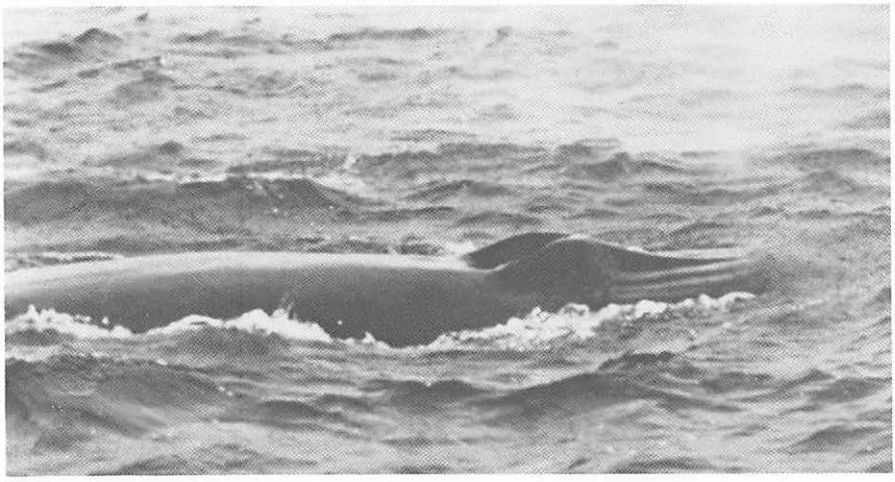


FIGURE 18.—A Bryde's whale (*Balaenoptera edeni*) at the surface for breathing. The raised "splash guards" protect the blowhole from wave wash and spray. These structures are lowered as the blowhole closes. Two of the three distinctive rostral ridges are evident. (G. M. Wellington photo.)

may be continuously distributed from Baja California to the equator (Leatherwood, Reeves, and others, 1982).

Balaenoptera musculus. Blue whale.

ORIGINAL DESCRIPTION: [*Balaena*] *musculus* Linnaeus, Systema Naturae, Ed. X, 1:76. 1758.

TYPE LOCALITY: "Mari Scotico," specifically, the Firth of Forth, Scotland.

GENERAL RANGE: All oceans. Three subspecies are recognized: a small *Balaena musculus musculus* of the Northern Hemisphere, including Hawaiian waters; a large *B. m. intermedia* that summers in the Antarctic; and a "pygmy" form, *B. m. brevicauda*, of the southern Indian Ocean. Additional definition of populations is pending (Rice, 1977).

DESCRIPTION: The blue whale is the largest living mammal, some of the Southern Hemisphere reaching a length of 100 feet (30 m), with a weight of 160 tons. In the North Pacific, specimens to 80 feet are known, weighing perhaps 125 tons (Fig. 41, front endsheet). The blue whale is a long, sleek species, with a single prominent midline rostral ridge. Splash guards protect the blowhole during respiration (Leatherwood, Reeves, and others, 1982). I was impressed in viewing motion pictures of blue whales in calm water to observe the arched body rising almost endlessly as the head submerged, and finally, an appearance of the small dorsal fin, far to the rear. The motion of this animal certainly

typifies the rolling "wheel," from which the word whale is derived, although dives are not as steep as in some other large whales. Body color is light bluish gray overall, broken by gray to whitish mottling. Interior of the mouth is uniformly black (Ridgway, 1972; Leatherwood, Reeves, and others, 1982). Karl von Linné may have intended a witticism in applying the specific epithet *musculus* (meaning a muscle, or "little mouse") to this largest creature he named, as well as to the house mouse, one of the smallest of mammals he named.

RANGE IN HAWAI'I: Though strangely enough not reported from sightings in the Hawai'i region even in recent years of intensive research on cetaceans, the animal was listed simply for "Hawai'i" by Tomilin (1962) without specific data. It is now confirmed from recordings of its voice in a hydrophone field off Ka'ena Point, O'ahu. Over a period of two and one-half years sounds attributed to the blue whale provided data on its regular occurrence in winter and late summer (Thompson and Friedl, 1982). Only in June and October were no sounds heard, and they were infrequent in April and May. The authors postulate the bimodal pattern of their records to indicate two annual migrations past O'ahu, between seasonal population centers. Similar 20-Hz signals of blue whales are reported near Midway Islands. The blue whale is an offshore species, unlikely to be observed from land (Thompson and Friedl, 1982).

Virtually nothing is known of this whale in Hawaiian waters except for its occurrences as recorded from sound tracks. It appears to be making a slow recovery in the North Pacific, from vast over-exploitation by whalers. Small (1971) traces the story in some detail. The work of Gaskin (1982) has numerous data applicable to world populations of the blue whale, bringing up to date many matters and providing a view of possible futures for this and other cetacean species. See also Leatherwood and Reeves (1983).

Megaptera novaeangliae. Humpback whale.

ORIGINAL DESCRIPTION: *Balaena novaeangliae* Borowski, Gemeinnüzzige Naturgeschichte des Thierreiches 2 (Pt. I):21. 1781.

TYPE LOCALITY: Coast of New England, United States of America.

GENERAL RANGE: Nearly worldwide; winters largely in tropical waters near islands or along coasts; summers in temperate and subpolar waters. This whale has been depleted heavily in the North Pacific. Stocks were large prior to 1905 when it was believed there were about 15,000. It was drastically reduced by whaling but may be recovering slowly under protection. The total population today in the entire North Pacific is unlikely to be more than 1,000 animals

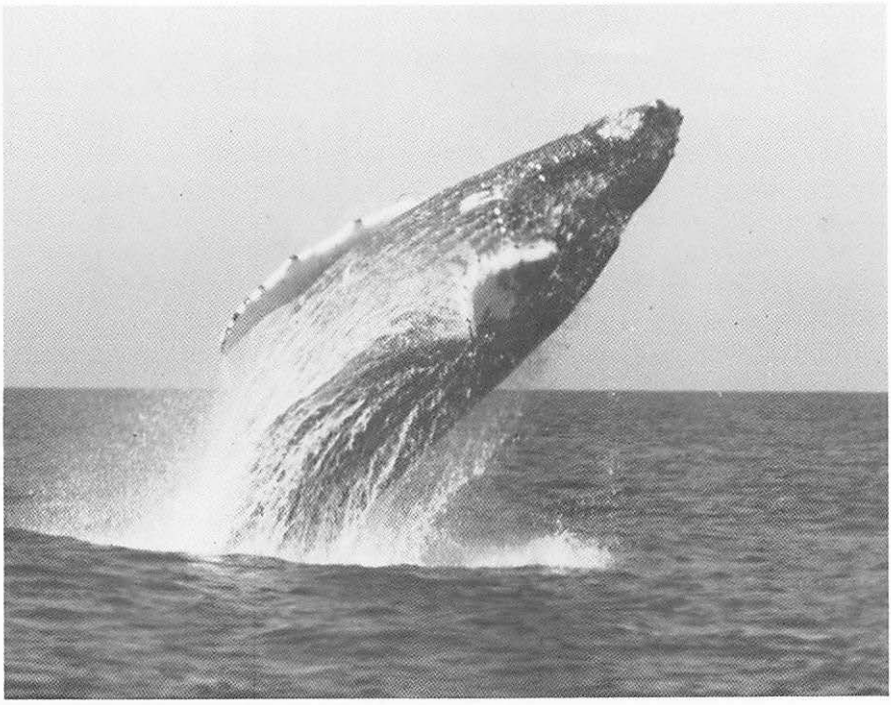


FIGURE 19.—Humpback whale (*Megaptera novaeangliae*) breaching, off Hawai'i. Throat and belly are exposed and the 30-ton animal will strike the water on its back. Knobby protuberances of the right flipper are especially evident. (Dan McSweeney photo.)

(Leatherwood, Reeves, and others, 1982). Winn, Edel, and Taruski (1975) report a similar trend in an Atlantic population that winters in the West Indies.

DESCRIPTION: As recorded by Leatherwood, Reeves, and others (1982), the body is robust, narrowing rapidly behind the dorsal fin. In dorsal aspect the head is broad and rounded. A median head ridge is present but obscured by a series of fleshy knobs. Additional knobs are present on top of the head and on the lower jaw, and there is a distinctive rounded protuberance near the tip of the lower jaw. Length is about 46 feet (14 m). The flippers are extremely long, nearly a third of the body length and as such are a diagnostic feature (Fig. 41, front endsheet). Basic color is gray to black, but there is a variable amount of white spotting, streaking, or patching on the throat and chest.

RANGE IN HAWAI'I: As recorded by Shallenberger (1981), the humpback whales wintering in Hawai'i are found almost exclusively in waters of depths less than 600 feet (185 m) and concentrated over large shallows such as Penguin Bank; the area between Maui, Moloka'i, Lāna'i and Kaho'olawe; and off the northwest shore of Hawai'i. Small shallows such as those near South Point,

Hawai'i, and Ka'ula Island attract concentrations of whales. They are found near French Frigate Shoals, Necker Island, and Nihoa, but probably not in large numbers westward from Ka'ula Island.

This is the common migratory whale of Hawai'i and is reported along the coasts, mainly from January through March. Most records of large whales observed are of this species. Anon. (1953b) and Bartlett (1958) report wintering activities among the islands. Residents of Hawai'i who operate pleasure craft along the Kona Coast have expressed some concern about the danger of whales to small boats. Paul O. Christensen (pers. comm.) has observed that calves leap clear of the water quite unexpectedly, and could conceivably crush a boat by falling upon it. Leon A. Thevenin (pers. comm.) reports cautiously cruising at about seven knots into an area where whales had been seen, only to have a 35-foot specimen surface directly ahead. He avoided collision with the whale by a hard rudder that threw his companion to the deck. This maneuver placed the pilot directly adjacent to the whale's eye as the creature spouted, swam on, and sounded.

The Hawaiian wintering population has been studied carefully since 1977 and its characteristics are well known (Herman and Antinoja, 1977; Wolman and Jurasz, 1977; Herman, Forestell, and Antinoja, 1980; Baker and Herman, 1981). Rice and Wolman (1977) place the wintering population of the shallow banks around Hawai'i at an optimistic 650. Connections between the summering animals of Alaskan waters and those found in Hawai'i have been established by observation and photographs of individuals (Earle and Giddings, 1979; Long, 1985). Martin and others (1984) describe a parallel in Atlantic populations. Males are distinguished from females in the sea in having a scalloped profile posterior to the dorsal fin, revealed especially when sounding (Jurasz, McSweeney and Jurasz, 1980). Dawbin (1966) reports on migration in southern waters.

The humpback whale is a master of sounds, many of which are pleasing to the human ear and are properly termed songs for their regular cadences, fixed order of their production only on the calving grounds, and changes from year to year (Mrozek, 1978; Winn and Winn, 1978; Winn and others, 1979, 1981; Payne and Giddings, 1979; Payne, 1984). Thompson and Friedl (1982) made year-round recordings of humpback whale sounds near O'ahu and found associated with them an abundance of "boing" sounds from November to April, coincident with presence of the humpback whale but not attributable to this or any other known whale species. Payne (1970) offers a recording of humpback whale songs which has secured prominence among top tunes of that era. These recordings have been a valuable adjunct to the classroom "whale unit," and in one known case have inspired a song suitable for elementary instruction (Jah, 1983).

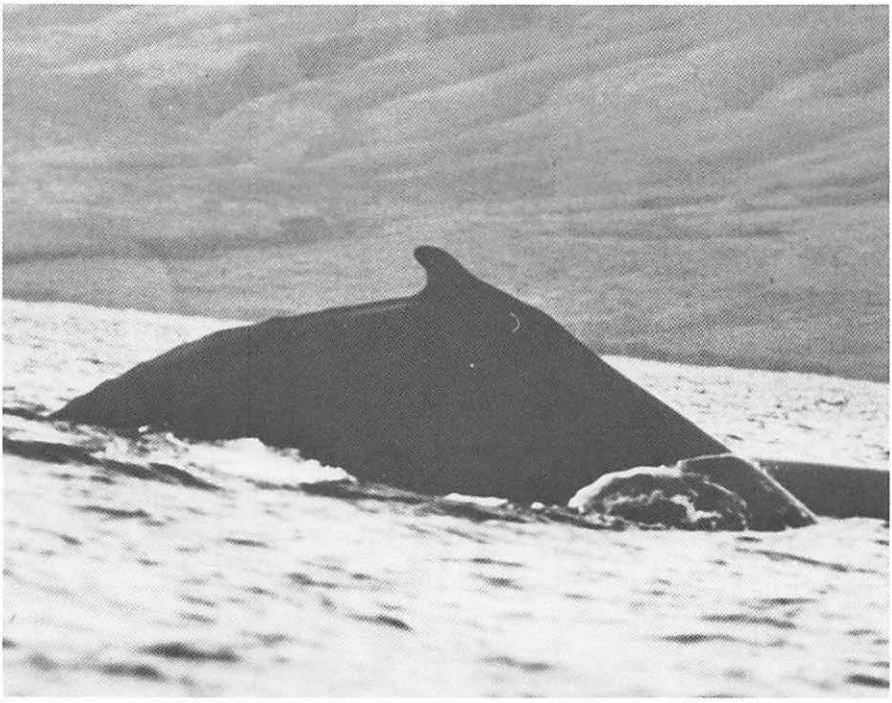


FIGURE 20.—A normal sounding by a humpback whale gives this animal its name. Scalloped profile behind the dorsal fin may mark this specimen as a male. In the background is the rugged slope of West Maui. (Stephen Leatherwood photo.)

Studies of humpback whales and their behavior include those of Machin and Kitchenham (1971); Edel and Winn (1978); Baker and Herman (1984); and Mobley and Herman (1985). Herman (1979) draws some interesting historical perspectives which suggest that this whale is a relative newcomer to Hawaiian waters. The program of research on the humpback whale in Hawai'i is reviewed by Shallenberger (1981).

Amateur whale watching enjoyed an early short period of popularity in Hawai'i (Anon., 1957b, 1962b; Fraser, 1957; G.B.B., 1957) but little of immediate scientific value seems to have come of this pastime. However, observation of cetaceans from shore by informed amateurs or professionals can be especially rewarding. One inveterate observer at La Jolla, California, reputedly installed a rocking chair on the roof of his house for comfort in long periods of whale watching.

Observation in Hawai'i is directed usually to the seasonal presence of the humpback whale, and this activity had a resurgence after 1975 with a statewide whale watch program planned and coordinated by researchers on Maui (Anon.,

1976; Nickerson, 1977). There has been related action in Australia (Anon., 1980a). Increase of popular fascination with the humpback whale of Hawai'i has placed these animals in potential jeopardy even though they are protected by strict provisions of the U. S. Endangered Species Act of 1973 and the Marine Mammals Act of 1975. A proposal for a designated sanctuary area was made in 1977 and this concept is still under development (Hudnall, 1978; Anon., 1979–80; Conant, 1979; Anon., 1980c; Anon., 1982a). McIntyre (1982) places much feeling into the human/whale relationship. Whether the sanctuary is declared or not, it will be important to assure minimal human contact with the whales in their delicate requirements for a normal existence and survival, in a habitat increasingly congested by human activity. Maui County has taken initiative in the matter at the local level (McCabe, 1977).

As a reflection of popular and scientific interest in the humpback whale, the Hawaii State Legislature has designated this magnificent animal as the official marine mammal of the state (State of Hawaii, 1979).

Balaena glacialis. Right whale.

ORIGINAL DESCRIPTION: *B[alaena] glacialis* Müller, Zoologiae Danicae Prodromus, p. 7. 1776.

TYPE LOCALITY: North Cape, Norway.

GENERAL RANGE: Temperate waters of the North Atlantic, the North Pacific, and the Southern Hemisphere. Populations probably are separated by equatorial seas.

DESCRIPTION: The right whale is large and robust (Fig. 41, front endsheet), the head forming a quarter or more of the body length. Total length is about 53 feet (16 m). Color is generally black, but white blotches occur, especially on the ventral surface. Distinctive rugged callosities adorn the rostrum and head. There is no dorsal fin. Payne (1976) shows many details of the right whale.

RANGE IN HAWAI'I: The right whale is identified rarely in Hawaiian waters. Omura and others (1969) indicate that populations of the North Pacific seemingly are identical to those of the North Atlantic.

The right whale was taken exclusively by early shore and other whalers because it floated when killed; hence, it was not lost and was thus the "right" whale to pursue (Nickerson, 1977, p. 23).

Early summaries of whaling logs place the right whale in Hawaiian waters as early as 1851 when a straggler was noted about 250 nautical miles west of Maui (Rountree and others, 1980). Except for a probable sighting north of O'ahu (Stanley, 1975) these authors found no other records until their observation of one whale on March 25, 1979, in the channel between Maui and Lāna'i, documented by photographs. This animal was followed for nearly three hours

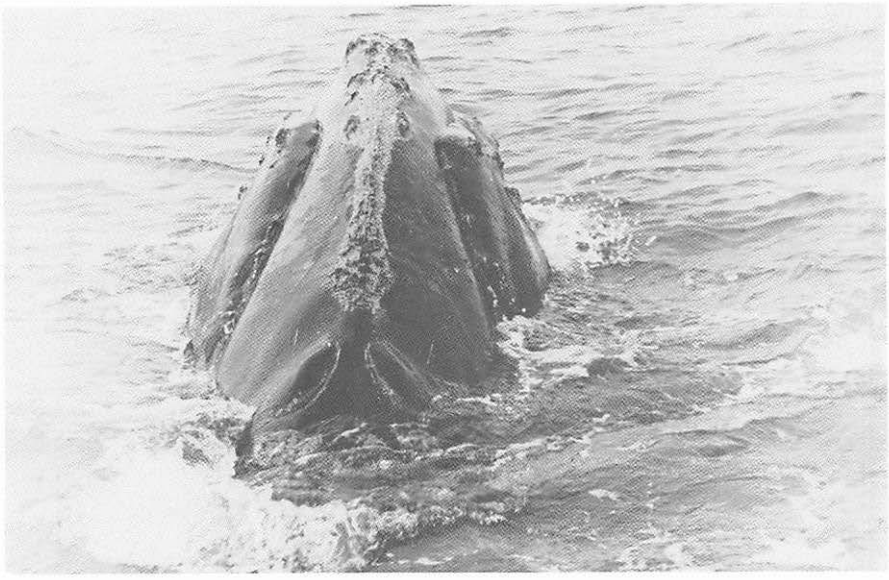


FIGURE 21.—Head of a right whale (*Balaena glacialis*) emerging at sea, as viewed from the rear. Concentrations of callosities form a prominent "bonnet" near the tip of a narrow rostrum. The mouth is closed, bringing edges of the mandible high alongside the head. The paired blowholes are partially open. (N. Fain photo, courtesy of Marineland of Florida.)

as it cruised with a pod of humpback whales. Herman, Baker, and others (1980) discuss further this observation and report an additional sighting April 10, 1979, about 122 km to the west-northwest, off Moloka'i, judged from markings to have been of the same whale. Though breeding grounds of the southern right whale are known along the coast of Argentina, no such localities have been discovered in the Pacific region. Herman, Baker, and others (1980) suggest that Hawai'i may have been a traditional breeding area for the northern right whale. It is one of the most critically endangered whale stocks. The remnant population of the entire North Pacific numbers at most only 100–200 animals. It is observed occasionally north and east of Hawai'i, in Alaskan waters which formerly were a major summering ground (Leatherwood, Reeves, and others, 1982).

Like the humpback whale, the right whale may feed little or not at all in the Hawaiian wintering grounds (Dawbin, 1966). Descriptions of feeding behavior of the right whale and other baleen species are drawn from the Atlantic region (Watkins and Schevill, 1979). The right whale swam steadily with the mouth open for long periods through slicks of plankton, favoring the denser concentrations of this food. Humpback whales fed in the same area, but on densely schooled fish, rushing them usually from below with much splashing at the

surface, opening the mouth as the school was reached and closing it as the whale rose through the surface of the water. Finback whales moved at moderate speeds into schools of fish at less steep angles than the humpbacks, slowly opening and closing the mouth. Enormous volumes of water were engulfed and the throat diameter sometimes nearly doubled as the mouth closed. Between passes at schools of fish the water is ejected through the sides of the mouth by raising the tongue, seining the prey with baleen plates. Lambertsen (1983) describes this adaptation of the tongue and its capacity for cavitation to hold large volumes of water.

Calls of whales during feeding may attract others of their species to good foraging sites. Watkins and Schevill (1976) report on other extensive observations of feeding right whales, noting a peculiar rattle of the baleen plates by animals foraging at the ocean surface. Cummings, Fish, and Thompson (1972) recorded sounds of the related southern right whale along the Argentine coast and compare these to sounds of the northern Atlantic form. Underwater sounds were described as belch-like utterances, moans of several sorts, pulses, and miscellaneous. See also Payne (1984).

Steno bredanensis. Rough-toothed dolphin.

ORIGINAL DESCRIPTION: *Delphinus bredanensis* Lesson, Complément des Ouvres de Buffon 3 (Cétacés):206. 1828.

TYPE LOCALITY: Coast of France.

GENERAL RANGE: All tropical and warm temperate seas.

DESCRIPTION: Length to 8 feet (2.4 m); relatively tall dorsal fin in the middle of the back. Most of the body charcoal gray, irregular white patches on the underside (Fig. 42, back endsheet). The body often is scarred. The common name is derived from the tips of the teeth being roughened by natural furrows (Ridgway, 1972). This dolphin has a dished profile, with no demarcation between beak and melon.

RANGE IN HAWAI'I: The rough-toothed dolphin is found near all major islands in Hawai'i and at least as far north as Necker Island. But there are no records of it among the more distant Northwestern Hawaiian Islands. Group sizes are reported to be small, almost always less than 50 and normally divided into subgroups. The record of a herd of 300 (Tomich, 1969a, p. 43) may have been a misinterpretation of unwritten information.

Shallenberger (1981) has brought the fragmentary information on *Steno* up to date, demonstrating that this species is yet to come under regular research scrutiny, partly because of its range in deep water rather than near shore.

The rough-toothed dolphin was recorded from Honolulu, O'ahu as early as

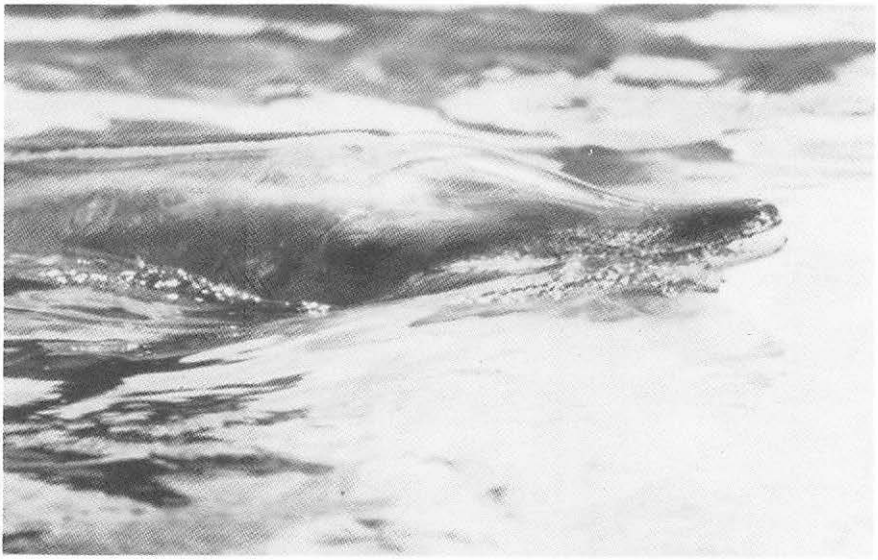


FIGURE 22.—A captive rough-toothed dolphin (*Steno bredanensis*) showing detail of the head: gently sloping forehead, speckled lips, and nearly white lower jaw; and the blowhole indented in the midline, directly above the eye. (K. C. Balcomb photo.)

1923 (Hershkovitz, 1966, p. 16). Strandings were noted at Waiʻanae, Oʻahu, in July 1969 when a single animal came ashore, and at Kīhei, Maui, in June 1976, with 18 animals beached. The Sea Life Park crew captured 23 *Steno* over a period of several years for research and exhibition purposes. Pelagic fishes and squids are identified as foods (Shallenberger, 1981).

With accelerated research on pelagic dolphins in connection with the tuna fishery of the eastern tropical Pacific, Perrin and Walker (1975) determined that the rough-toothed dolphin is present in low densities throughout that region. Records of body temperature were made by Whittow, Hampton, and Ohta (1978). *Steno* has been kept successfully in captivity for display purposes. One result of confinement of a female with male *Tursiops truncatus* was a viable hybrid offspring (Dohl, Norris, and Kang, 1974).

Tursiops truncatus. Bottlenose dolphin.

ORIGINAL DESCRIPTION: *Delphinus truncatus* Montagu, Memoirs of the Wernerian Natural History Society 3:75. 1821.

TYPE LOCALITY: Duncannon Pool, River Dart, Devonshire, England.

GENERAL RANGE: Widely distributed in oceans of the world, including the Black Sea. Ranges north to Japan, Hawaiʻi, California, New Brunswick and Norway; south to southern Australia, New Zealand, Chile, Argentina, and South Africa.

FIGURE 23.—Rough-toothed dolphins in quiet water of an oceanarium. Note the prominent falcate dorsal fin of each animal, showing variation. The low forehead and large pointed flippers are evident. In one animal the blowhole is obviously fully opened. Two appear to be exhaling, or "blowing," sending up small fountains of spray. (Courtesy of Japanese Whales Research Institute.)

DESCRIPTION: A large dolphin (Fig. 42, back endsheet), to about 9 feet (2.8 m). The body appears basically gray, slightly darker on the dorsal surface; an indistinct black stripe runs forward from the eye (Ridgway, 1972). Specimens from Hawaiian waters have been referred to *Tursiops gilli* Dall, 1837, but it is increasingly agreed that the world taxonomy of bottlenose dolphins is still obscure, and the best current course is to list them all as *T. truncatus*. I follow Rice (1977) and Leatherwood and Reeves (1982) in this respect. Typically two ecotypes are identified in studies of the several world populations, a coastal form and an offshore form. There are probably well-defined subspecies based on morphometric characters molded by sea temperature and depth.

RANGE IN HAWAI'I: Distributed throughout the archipelago from Hawai'i to Kure. Among the main islands it is found in shallow inshore waters as well as in deep water of the channels, but most commonly within five miles of shore, generally over offshore flats. Herd size ranges from single individuals and small groups of three to ten animals to aggregations of more than 100. The larger groups are more common among the Northwestern Hawaiian Islands (Shallenberger, 1981). Rice (1960a) suggests rather regular association of this species with the shallower waters about the several islands and reefs from French Frigate Shoals to Kure Atoll. Amerson, Clapp, and Wirtz (1974) cite four observations of the bottlenose dolphin at Pearl and Hermes Atoll, 1918–1964, labeling them as visitors.

A school of at least 80 is recorded from Penguin Bank in March 1965 (Norris, 1965). The bottlenose dolphin is highly adaptable to captivity and training, and is used commonly in dolphin research and in oceanarium shows (Norris, 1965; Lang and Norris, 1966; Brown, Caldwell, and Caldwell, 1966; Murchison and

FIGURE 24.—A typical leap by a fast-swimming bottlenose dolphin (*Tursiops truncatus*). The short rostrum, or "bottlenose," and generally unicolored body pattern are distinctive. This is a relatively large, heavy-bodied species of dolphin. (Robert L. Pitman photo, courtesy of NMFS.)

Pepper, 1972; Hollis, 1985). Shallenberger (1981) records 36 captured in Hawaiian waters during 1963–1969 for these purposes. Lockyer (1978) describes an example of voluntary association with man of a wild dolphin in English waters. Leatherwood, Gilbert, and Chapman (1978) report aerial census techniques, and Leatherwood and Reeves (1982) provide a broad view of the species in United States waters.

Stenella longirostris. Spinner dolphin.

ORIGINAL DESCRIPTION: *Delphinus longirostris* Gray, Spicilegia Zoologica, Pt. I:1. 1828.

TYPE LOCALITY: Unknown.

GENERAL RANGE: Tropical Atlantic, Indian, and Pacific oceans. There is a marked geographical variation, suggesting rather localized regional populations.

DESCRIPTION: Reaches a length of 7 feet (2.1 m). Dorsal body color is charcoal-gray, venter white; anterior half of body darker than posterior. A black stripe extends from the eye to the border of the beak and frontal head. There are other less distinct lines associated with the head and beak. The dorsal fin is erect and angular. Perrin (1972) describes in detail the patterns and their variations among populations of the eastern tropical Pacific and Hawai'i. The patterns can be analyzed in terms of discrete component systems, and most geographical variation appears to be a "dorsal field system" overlying a basic general pattern. The overlay is lightest and least extensive in the Hawaiian form. The spinner dolphin (Fig. 42, back endsheet) is drawn after that of Perrin

(1972, Fig. 26). Perrin (1975a) in a detailed dissertation describes four geographical populations of the spinner dolphin, concluding that all spinners of the Pacific belong to a single species. Subspecific designations are pending (Perrin, 1975b).

RANGE IN HAWAI'I: Norris and Dohl (1980) have produced a definitive report on the spinner dolphin, mapping records of distribution from Kure Atoll to Hawai'i, with dates and descriptions of sites. This dolphin is found gathered in schools of six to about 250 near all major islands and shoal areas. Only at small islands with surrounding abruptly deep water, as at Nihoa, spinner dolphins were not seen. Following are some early observations on this species.

On December 30, 1967, in the company of William S. Devick, I observed an estimated 150 to 250 spinner dolphins cruising in mid-afternoon at the lee (west) side of South Point, on Hawai'i (Tomich, unpubl.). The dolphins were in at least four separate herds of 30 to 70 animals and these herds sometimes were broken into two or three loosely coherent groups. We did not observe one herd to encounter or mix with another, but this may have happened.

Between 2:15 and 3:45 P.M. dolphins were almost continuously in sight as we proceeded north along the rim of the 200- to 320-foot cliff for nearly a mile. Three herds were in sight at one time at 3:20 P.M. and a fourth was seen by other observers at the same hour, 1.5 miles to the south.

Identification is based on sporadic spinning behavior seen on five separate occasions in at least three herds. This activity was similar, in all details we could observe, to that described by Hester, Hunter, and Whitney (1963). Each performance included perhaps three to ten animals of the herd.

The dolphins appeared to be loafing in the calm, wind-protected waters below the cliff. Seas of the region were moderately rough and brisk northeast trade winds blew continuously. The animals were always in motion and swam along shore, out to sea for perhaps 200 yards, and inshore. Mainly they remained near the cliff, moving about in rather aimless and easy fashion, surfacing as arched waves of animals, swimming totally submerged, and disappearing altogether for a time.

From estimated distances of 300 to 500 feet, the sound of blowing was easily audible as the herds or groups surfaced after a dive. Other sounds heard consisted of gurgles and metallic grunts or squeaks, and were probably vocalizations. Dorsal coloration appeared to be brownish or grayish. The white undersides were visible when individual dolphins swam on their backs, and during displays of spinning behavior. There was no evidence of feeding. Rather, a relatively listless cruising suggested rest in a manner similar to that described for *Stenella attenuata* (p. 00). Heavy rain began to fall at 3:45 P.M., obscuring our view of the sea and precluding further observation of the dolphins.

FIGURE 25.—Spinner dolphin (*Stenella longirostris*) in a high, gyrating leap. A wild spray of water is breaking from the body as it rotates. This scene is from Kealakekua Bay, on the Kona Coast of Hawai'i. (Randy Wells photo.)

Perrin (1975a) cites Permetty as describing the spinning behavior of *Stenella longirostris*, from the Atlantic, in 1769, and this appears to be the earliest printed record of it. Norris and Dohl (1980) adopted clifftop observation as a major technique of their studies at Kealakekua Bay.

The spinner dolphin is second in importance to the spotted dolphin (p. 00) as a victim of the tuna fishing industry in the eastern tropical Pacific. T. Smith (1979) maps five populations of the spinner dolphin, along shore and offshore from Baja California to Peru, and extending about 150° west longitude some 7° north of the equator as its closest approach to Hawai'i. In this region estimates of the spinner dolphin killed in nets were some 112,000 in 1973, but the figures declined to about 1,600 in 1980 with improvement of release techniques (Leatherwood and Reeves, 1982). Total population was given at 837,000 for 1979, by T. Smith (1979).

Additional papers, largely from Hawai'i, report on vocalizations (Watkins and Schevill, 1974; Mackey and Liaw, 1981) and body heat budget (Hampton and Whittow, 1976). Shallenberger (1981) notes that the spinner dolphin feeds on squids and fishes, and that it seldom is stranded in Hawai'i. Predators appear to be few, but the cookie-cutter shark (*Isistius*) sometimes snatches circular bites of skin and underlying blubber from even apparently normal healthy spinner dolphins.

Stenella attenuata. Spotted dolphin.

ORIGINAL DESCRIPTION: *Delphinus attenuatus* Gray, List of Mammals of the British Museum, p. 105. 1843.

TYPE LOCALITY: Unknown.

GENERAL RANGE: Tropical Atlantic, Indian, and Pacific oceans. As in the spinner dolphin there is remarkable geographic variation.

DESCRIPTION: Attains a length of 7 feet (2.1 m). The dorsal fin, in the middle of the body, is of medium size and leans notably backward. The flippers are sharp pointed (Fig. 42, back endsheet). Dorsal pigmentation of the body and rostrum is steel blue; otherwise gray predominates. A line of demarkation between dark and light color begins well above the eye and continues to the posterior end of the dorsal fin. From this point a charcoal-gray stripe extends to the base of the tail flukes. There is a ventral white band along the axis of the abdomen. The body tends to be spotted with white but the flippers, dorsal fin, and tail flukes are black, lacking spots. A black stripe extends from the corner of the mouth to the anterior base of the flipper. The eye is encircled by black in a narrow band joining the rostrum above the mouth (Ridgway, 1972). Perrin (1975a) illustrates color patterns and form in specimens from Hawai'i. The Hawaiian population is at the western end of a continuum originating with heavily spotted animals along tropical continental shores of the Americas. Spotting is least in Hawaiian animals. Animals to the south and west of Hawai'i are spotted dorsally.

RANGE IN HAWAI'I: In Hawaiian waters, to an unknown distance offshore, between the islands and at Penguin Bank southwest of Moloka'i. The population is disjunct by about 700 miles from those of the eastern tropical Pacific (Perrin, 1975a; Douglas, Schnell, and Hough, 1984). Shallenberger (1981) indicates the paucity of data available on this species, but it may well be the most abundant dolphin in the Hawaiian region.

While making frequent aerial studies of the seas off O'ahu in January 1966, G. Bateson (pers. comm.) observed on about six occasions several loose cohorts of the spotted dolphin, up to 300 individuals at one time. These animals spent the day in a leisurely fashion in the sheltered waters at either side of Ka'ena Point, but beginning in mid-afternoon they moved out to sea. As this daily search for food began, the larger schools scattered and cruised over a wide area. Shomura and Hida (1965) report on foods eaten by a specimen taken near O'ahu, and identify the animal with that described from Hawaiian waters by True (1903). The spotted dolphin is one of several species trained to perform in oceanarium displays (Anon., 1965j).

The spotted dolphin is the most abundant cetacean on the tuna grounds of the eastern tropical Pacific, and alarming numbers have been killed in the

nets. Losses varied from 185,000 to 460,000 per year in the period 1960–1972. With placement of observers aboard the tuna ships, an intensive research program on methods of releasing the dolphins, and regulatory measures for protecting cetaceans associated with the fishery, losses were reduced to about 4,700 per year by 1980 (Leatherwood and Reeves, 1982). The present population of spotted dolphins is estimated at a little over three million (T. Smith, 1979).

Perrin, Coe, and Zweifel (1976) give basic information on the background of problems in the fishing zone, and on populations. Leatherwood and Ljungblad (1979) provide a record on travels of individual spotted dolphins. Perrin and Powers (1980) cite natural infection by cranial nematodes as a cause of mortality.

Stenella coeruleoalba. Striped dolphin.

ORIGINAL DESCRIPTION: *Delphinus coeruleo-albus* (Meyen), Nova Acta Academiae Caesareae . . . Naturae Curiosorium 16:609, 610. 1833.

TYPE LOCALITY: East coast of South America in vicinity of the Rio de la Plata.

GENERAL RANGE: Widely distributed in temperate and tropical waters around the world.

DESCRIPTION: This is a colorful mammal which lives up to its name "blue-white dolphin." The dorsal body color and face are Prussian blue; the ventral surface is white. A black stripe extends from the flipper to the eye. A second black stripe originates at the eye, extends posteriad to a point above the flipper where it divides to form a short ventrad stripe in that region and an extended stripe sweeping to the anus; both are visible plainly against the white lateral surface. The flippers, dorsal fin, and flukes are black (Fig. 42, back endsheet). Maximum length is about 8 feet (2.4 m), with males slightly larger than females.

RANGE IN HAWAI'I: A specimen taken southwest of Hawai'i about 1840 is reported as lost (Poole and Schantz, 1942; Hershkovitz, 1966). In spite of wide distribution to include warmer waters of the Pacific Ocean, the striped dolphin is rare in Hawai'i.

The first modern record for the region was by Sampson (1970) from the sea about 1,300 miles northeast of Hawai'i. Hubbs, Perrin, and Balcomb (1973) provide a range map for the Pacific Ocean and illustrate common characteristics of three specimens (one from Hawai'i). A specimen captured March 2, 1958, in the Ala Wai Canal, Honolulu, is reported by these authors. It is retained at Bishop Museum as a complete skeleton and external cast. Shallenberger (1981) cites this one stranding for the year 1958, two sightings in the years 1976–1979, and six strandings 1977–1980. Three localities are listed as the vicinity of

FIGURE 26.—A herd of striped dolphin (*Stenella coeruleoalba*) showing three phases of a normal leap (*right to left*). The remarkable pattern of body striping is revealed dramatically. (Robert L. Pitman photo, courtesy of NMFS.)

Ni'ihau, among the Northwestern Hawaiian Islands, and 12 miles west of O'ahu.

Perrin (1975b) reports for the eastern Pacific 26 sites of observation and collection between 20°N and the equator, and provides a revised distribution map. Au, Perryman, and Perrin (1979) extended the discovery of striped dolphins in equatorial waters, defining a bilobed pattern of which tips reached westward to the longitude of Hawaiian waters at 7°N, and of Marquesan waters at 1°S. Herds of 40 to 400 have been sighted in the eastern tropical Pacific, but this species was first reported there only in 1970 (Hubbs, Perrin, and Balcomb, 1973). The north Pacific population appears to be large at some 150,000 to 200,000 animals, and is most abundant in Japanese waters. As late as 1972 (Ridgway, 1972), 10,000 to 20,000 were caught there annually without apparent decline in numbers.

The striped dolphin is not greatly hindered by the tuna fishery of the eastern tropical Pacific, as only four of 3,712 dolphins tagged and released in the years 1969–1976 were of this species (Perrin, Evans, and Holts, 1979). Smith (1979) reported an estimated population of some 357,000 for the region, with only a few hundreds then killed each year as methods improved for releasing dolphins from seines. These losses have declined even further (Leatherwood and Reeves, 1982).

Grampus griseus. Risso's dolphin.

ORIGINAL DESCRIPTION: *Delphinus griseus* G. Cuvier, Annales Musé d'Histoire Naturelle, Paris, 19:13–14. 1812.

TYPE LOCALITY: Brest, France.

GENERAL RANGE: Atlantic, Pacific, and Indian oceans, and lesser seas;

basically a tropical species that extends its range poleward to overlap ranges of temperate water forms, but not penetrating into higher latitudes beyond 50° (Leatherwood and others, 1980).

DESCRIPTION: Length to 14 feet (4.3 m) in the adult. Anterior portion of the body round and fat, posterior portion slender (Fig. 42, back endsheet). Color is slate gray to nearly all white, with extensive scarring. A vertically bifurcated melon and prominent dark dorsal fin are distinctive characteristics (Ridgway, 1972).

RANGE IN HAWAI'I: Rare in Hawaiian waters. There is one verified sighting north of the main islands, and unverified reports north of Maui and off the Kona Coast; strandings are recorded for February 16, 1977, at Wailuku, Maui, and for November 17, 1978, at Kāhala, O'ahu (Shallenberger, 1981).

Leatherwood and others (1980) made an exacting study of the range of Risso's dolphin in the eastern Pacific north of the equator, noting that it is generally a pelagic species. Groups were as large as 220 animals, but about 75 percent of all sightings were of 20 or fewer. The work of Pilleri and Gihr (1969) is on basic anatomy. Leatherwood, Reeves, and others (1982) note that the diet is almost exclusively squids and related cephalopods, with fish an exceptional item.

This cetacean is of moderate size, resembles other small whales, and should be referred to as a whale rather than a dolphin. I propose that it be called Risso's whale.

Peponocephala electra. Melon-head whale.

ORIGINAL DESCRIPTION: *Lagenorhynchus electra* Gray, Zoology of H.M.S. *Erebus* and *Terror* 1 (Mammalia):35. 1846.

TYPE LOCALITY: Hilo Bay, Hawai'i.

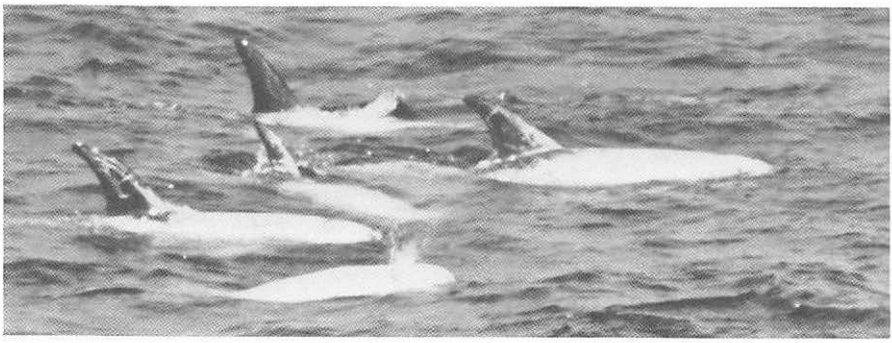


FIGURE 27.—Risso's dolphin (*Grampus griseus*), actually a small whale, in calm seas. A white, heavily scarred and scratched body is typical of adults. The prominent dorsal fin and flippers remain black. (Robert L. Pitman photo.)

GENERAL RANGE: Tropical seas including eastern Atlantic; Japan and Australia; Hawai'i and Central America in the Pacific; Indian Ocean (Perrin, 1976).

DESCRIPTION: Body length is to 9 feet (2.8 m). Its shape (Fig. 42, back endsheet) is similar to that of the false killer whale and pygmy killer whale, but this animal has a much larger number of teeth (more than 15 per row). Color is dark gray which lightens toward the underside and may form distinct patches. The word "melon" as applied to cetaceans comes from the colloquial French, meaning "bowler hat" (Matthews, 1978, p. 28), referring to the bulging forehead.

RANGE IN HAWAI'I: The original record of this species stems from a collection made at Hilo Bay in 1841. Peale's *Phocaena pectoralis* (Peale, 1848, p. 32) is referable to this species (see Hershkovitz, 1966, p. 70). Peale notes that, "sixty of these animals were driven ashore by natives at Hilo Bay, island of Hawai'i, at one time. They were considered a dainty food and yielded a valuable stock of oil." The incident presents an example of what may have been purposeful hunting of a cetacean by the Hawaiians under an opportune circumstance when this group ventured into the shallows of the bay. Shallenberger (1981) indicates numerous sightings off the Wai'anae coast of O'ahu, the North Kohala coast of Hawai'i, and the leeward coast of Lāna'i. Herds are large, often more than 500 animals, and one of 75 to 150 has been observed consistently off North Kohala. Nishiwaki and Norris (1966) list strandings of single specimens at Kahuku, O'ahu, on June 27, 1964, and at Lahaina, Maui, on June 15, 1965. Shallenberger (1981) adds four records for O'ahu in 1955, 1971, and 1976.

Nomenclature was clarified by erection of a new monotype genus, *Peponocephala* (Nishiwaki and Norris, 1966). Shallenberger (1981) considers *Peponocephala* quite aggressive. The characteristically large pods move rapidly and have been observed swimming toward a boat or diver with jaws of individual whales opening and closing with a clapping sound audible under water. It remains one of the least known of the cetaceans. Van Bree and Cadanat (1968) describe characteristics of the skull; Bryden, Harrison, and Lear (1977) and Bryden, Dawbin, and others (1977) provide data from Australian specimens. Perrin (1976) notes it as a straggler off Central America.

Feresa attenuata. Pygmy killer whale.

ORIGINAL DESCRIPTION: *Feresa attenuata* (Gray, Journal of Museum Godeffroy 8:184. 1875.

TYPE LOCALITY: Unknown.

GENERAL RANGE: Tropical and warm temperate waters of Atlantic, Pacific, and Indian oceans.

FIGURE 28.—Fast-swimming melon-head whales (*Peponocephala electra*) traveling in a close pack. Note outline of the head in center of the picture. (D. Au and W. Perryman photo, courtesy of NMFS.)

DESCRIPTION: Length to 8 feet (2.4 m). The body is black, but white patches occur usually around the mouth and on the ventral surface (Fig. 42, back endsheet). In shape it resembles the false killer whale but is a much smaller animal overall (Ridgway, 1972).

RANGE IN HAWAI'I: Pryor, Pryor, and Norris (1965) review the nomenclature of this species, which was known before 1963 from only four scattered records. They report it as quite common in Hawaiian waters and seemingly a regular resident. The original sighting and identification for Hawai'i on July 16, 1963, was of a school of about 50 animals offshore from Kailua, island of Hawai'i. Shallenberger (1981) reports three captured, and numerous sightings, near leeward shores of O'ahu and Hawai'i. A skull was found near Hāwī, Hawai'i. Pods of 50 to 100 animals are reported.

This is another virtually unknown cetacean. Pryor, Pryor, and Norris (1965) note that their newly captured specimen snapped repeatedly at handlers, and when placed in a tank promptly swam rapidly and again snapped at handlers when it leaped free of the water. In time it became tame and never attacked its keepers, but may have caused the death of a pilot whale by butting it. Perrin

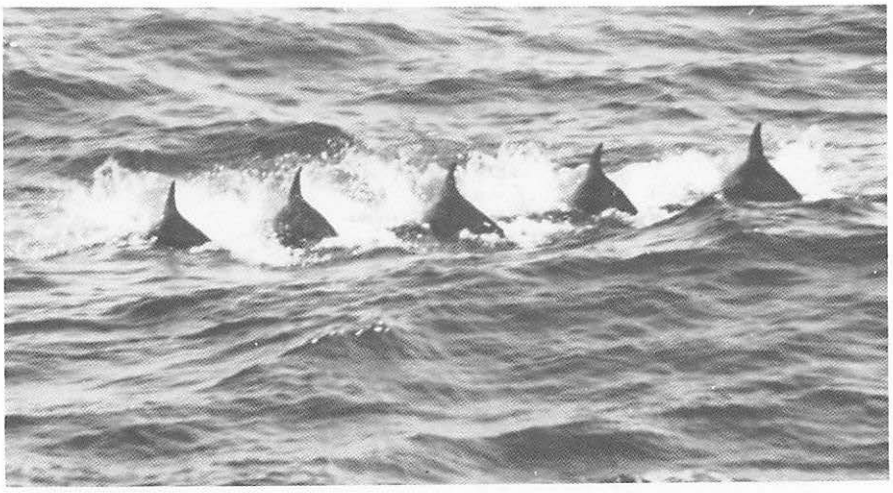


FIGURE 29.—The pygmy killer whale (*Feresa attenuata*) travels often in packs at high speed. Here they are leaping in perfect unison, moving at an angle to the left, away from the camera. (W. H. Brinckerhoff photo.)

and Hubbs (1969) describe in some detail external morphology and skeletal anatomy of an immature specimen.

Pseudorca crassidens. False killer whale.

ORIGINAL DESCRIPTION: *Phocaena crassidens* Owen, A History of British Fossil Mammals and Birds, p. 516. 1846.

TYPE LOCALITY: Lincolnshire fens, England (as a subfossil).

GENERAL RANGE: All temperate and tropical seas.

DESCRIPTION: Length to 18 feet (5.5 m). The body is black, and the white ventral markings of related species are absent (Fig. 42, back endsheet).

RANGE IN HAWAI'I: Found near all the main islands, in shallows as well as in deep water. It usually travels in pods of up to 100 animals that move rapidly from place to place. One stranding is recorded at Mōkapu Peninsula, O'ahu, on October 21, 1980 (Shallenberger, 1981).

False killer whales travel in broad bands up to several miles wide, in Hawai'i and elsewhere, possibly as a search technique for locating food (Brown and others, 1966; Shallenberger, 1981). Squids and fishes are taken, including the larger tunas. Tails, gills, and entrails are discarded (Shallenberger, 1981). Studies in Hawai'i and elsewhere reveal several aspects of biology: Caldwell and others, 1970, and Porter, 1977 (strandings); Whittow and others, 1974 (body temperature); Purves and Pilleri, 1978 (general biology); Hollis, 1985

FIGURE 30.—The false killer whale (*Pseudorca crassidens*) is another species usually found in large schools. Note the slight constriction behind the head and somewhat blunt snout. Larger than the pygmy killer whale. (Robert L. Pitman photo.)

(hybrid offspring). Perryman and Foster (1980) report their predation on dolphins temporarily impeded by capture in tuna seines.

Globicephala macrorhynchus. Short-finned pilot whale.

ORIGINAL DESCRIPTION: *Globicephala macrorhynchus* Gray. The Zoology of the Voyage of H.M.S. *Erebus* and *Terror* 1 (Mammalia): 33. 1846.

TYPE LOCALITY: "South Seas."

GENERAL RANGE: Tropical and temperate waters of the Atlantic, Indian, and Pacific oceans.

DESCRIPTION: Reaches a length of 20 feet (6.0 m). Head round in profile and mouth appears large (Fig. 42, back endsheet). The body is robust but the tail stock slender. Flippers are a sixth of the body length. Most of the body is black but there is a ventral white cross or anchor-shaped patch between the flippers. The bulbous forehead or melon is distinctive (Ridgway, 1972).

RANGE IN HAWAI'I: Shallenberger (1981) reports the short-finned pilot whale throughout the waters surrounding the major islands, with numerous sightings

FIGURE 31.—Trained false killer whale in an oceanarium. The teeth are prominent in upper and lower jaws, but are few in number, 8 to 11 per row. (Courtesy of Sea Life Park.)

between Ka'ula Island and Hawai'i. It is the most commonly observed smaller whale. Sightings among the Northwestern Hawaiian Islands are unconfirmed.

The pilot whale is perhaps the most spectacular dolphin of Hawai'i for its habit of sporadically running aground, singly or in schools, to become stranded, and usually fatally so. A series of such strandings in 1958 and 1959 is reported in Hawaiian newspapers (Anon., 1958a, 1958b, 1958c, 1958d, 1959a, 1959b); these are well documented by photographic evidence (Fig. 77). However, no strandings have been reported in recent years.

This species is adapted easily to oceanarium life and responds well to training procedures, in Hawai'i and elsewhere. Kritzler (1952) records an early example of a captive studied in Florida. Sounds of the short-finned pilot whale are now well known from the population near Hawai'i (Thompson and Friedl, 1982). Hydrophone sounds are described as "500-Hz thumps," given in pulses. Click trains and tonal vocalizations were interposed between thumps, or were given independently. These sounds were detectable year around, correspond-

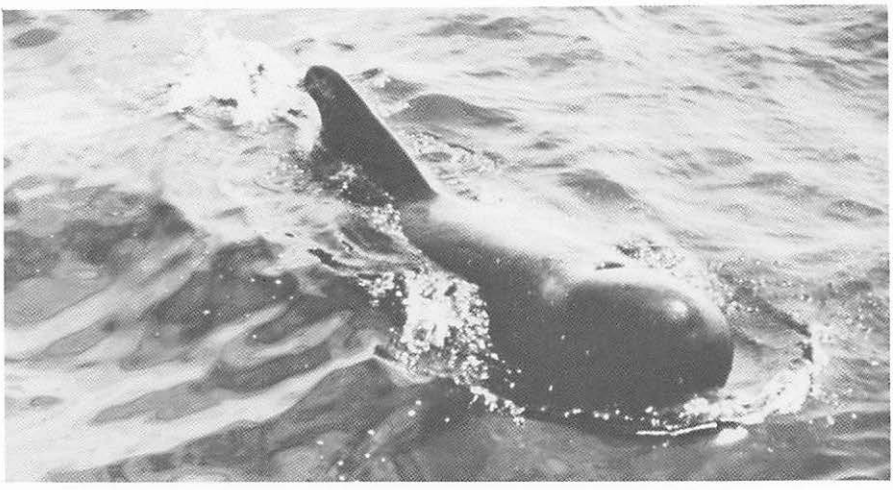


FIGURE 32.—Short-finned pilot whale (*Globicephala macrorhynchus*) at close range. The blowhole is open. The blunt head pushes a prominent wave. (Robert L. Pitman photo.)

ing to observed presence of the whales. According to Shallenberger (1981) pod size is usually large, often greater than 100 and rarely smaller than 30. Food is probably primarily squids. Leatherwood, Reeves, and others (1982) supply additional behavioral and biological information. Taxonomic status of Pacific Ocean populations still is not well defined.

Orcinus orca. Killer whale.

ORIGINAL DESCRIPTION: [*Delphinus*] *orca* Linnaeus, Systema Naturae, Ed. X, 1:77. 1758.

TYPE LOCALITY: European seas.

GENERAL RANGE: All oceans, chiefly in coastal waters of cooler regions.

DESCRIPTION: Length ranges to 28 feet (8.5 m), and females are somewhat smaller than males. The striking black-and-white body pattern is distinctive (Fig. 41, front endsheet). The dorsal fin is 5 to 6 feet (1.8 m) tall in males and noticeably smaller, proportionately, in females.

RANGE IN HAWAI'I: A single, somewhat early record for this species (Anon., 1938a) may be valid, although the original report does not contain evidence of specific identification, or certainty with regard to behavior observed. The killer whale may well be sporadically present in Hawaiian waters. Richards (1952) examined photographs of a whale washed ashore January 25, 1950, at Ka Lae (South Point) on Hawai'i, and determined that the animal was a male killer whale. Skipjack fishermen out of Hilo have reported a particularly large whale "with an eight-foot sail" raiding and destroying set lines (D. H. Woodside, pers.

FIGURE 33.—Killer whales (*Orcinus orca*) moving slowly. The tall erect dorsal fin identifies one animal as an adult male. Distinctive white markings behind the head, and as a variable dull "saddle" at the posterior base of the dorsal fine, are seen easily. (K. C. Balcomb photo.)

comm.). This would adequately describe a large male killer whale, which has an enormous dorsal fin. Shallenberger (1981) records observations of killer whales off the Wai'anae coast, O'ahu, in January 1979; and near Kaua'i in December 1979. Additional data on the Kaua'i incident are offered by Evering (1980). Such sporadic sightings suggest that the killer whale is not resident in Hawaiian waters, but merely passes through from time to time, probably from cooler regions to the north.

There is an abundant literature on this species as it relates to the fishing industry, research activities, oceanarium display, and conservation in other regions of the world (Griffin 1966; Martinez and Klinghammer, 1970; Branson, 1971; Smith, Siniff, and others, 1981; Kulu, Veomett, and Sparkes, 1971; Baldridge, 1972; Denniston, 1973; Hoyt, 1977; Hui and Ridgway, 1978; Steiner and others, 1979; Dahlheim, 1980; Lopez and Lopez, 1985; Whitehead and Glass, 1985). Payne (1984) contains a chapter on communication. There appears to be no authenticated example of *Orcinus* attacking man. Although a sailing yacht was struck and sunk in the Atlantic, the collision could be construed as accidental (Notarbartolo di Sciara, 1977). A similar accident occurred near California, involving an unidentified whale (Anon., 1975b).

Physeter macrocephalus. Sperm whale.

ORIGINAL DESCRIPTION: *Physeter macrocephalus* Linnaeus, Systema Naturae, Ed. X, 1:76. 1758.

TYPE LOCALITY: Kairston, Orkney Islands, Scotland.

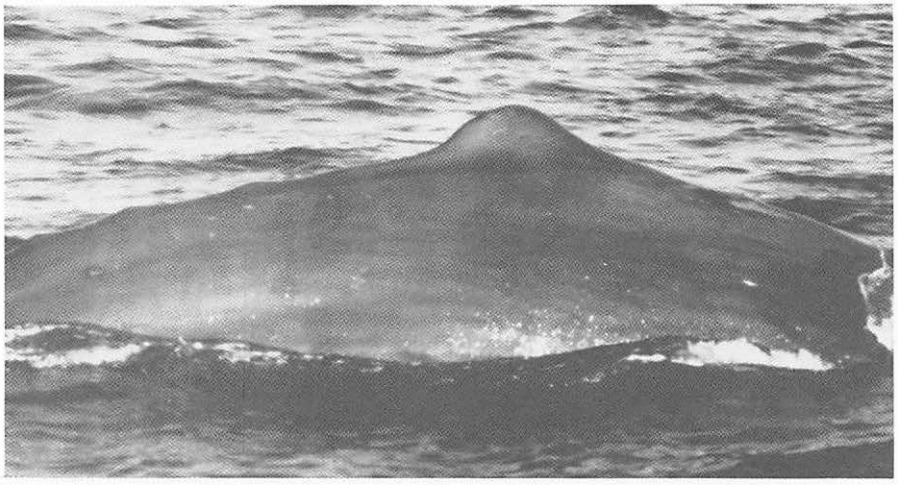


FIGURE 34.—Sperm whale (*Physeter macrocephalus*) in process of diving. A somewhat crenulated skin is noticeable. The whale is submerging to the right. The dorsal fin is variable in this species. (G. L. Friedrichsen photo, courtesy of NMFS.)

GENERAL RANGE: All oceans except the polar ice fields.

DESCRIPTION: The sperm whale (Fig. 41, front endsheet) is a distinctive, large, toothed whale with narrow jaws opening well back from the front of the head. The huge squared, blunt head contains a spermaceti organ. Color is slate gray or bluish gray, generally paler on the abdomen. Some minor patches of white may be present. Color is paler in young specimens as well as in aged ones. Its length ranges up to 60 feet (19 m), with females strikingly smaller. This whale has a single, left blowhole, far toward the tip of the head, and the breath plume rises forward at an angle of about 45 degrees. The flippers are small and paddle-like. Husson and Holthuis (1974) establish the currently used specific name of the sperm whale.

RANGE IN HAWAI'I: The sperm whale is a distinct and well-known species that is now of occasional occurrence in Hawaiian waters. Tinker (1938, p. 156) makes what appears to be a fair appraisal of this mammal, indicating that it was rather common during the whaling days of the mid-nineteenth century.

Occasional sperm whales encountered among the islands were still sought well into the 1880s (Anon., 1887b, 1887c). In the former account, in reference to a whale harpooned and lost off Hawai'i, "Although the *Lydia* cruised round the spot for four days no trace of it could be found," the scarcity and value of large whales in that period is indicated. The skeleton of a stranded sperm whale is reported from Sand Island, at Midway, in 1909 (F. D. Walker, 1909, p. 60). W. A. Bryan (1915, p. 298) assembled a specimen which still hangs in Bishop

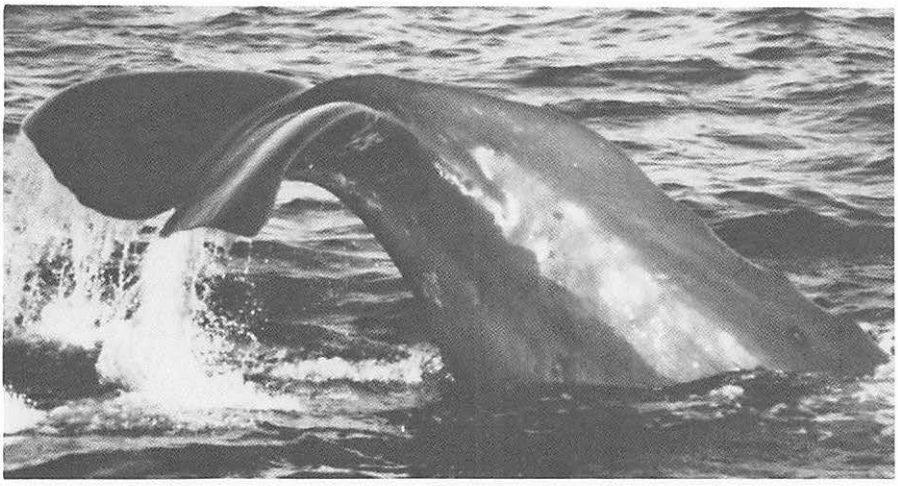


FIGURE 35.—Sperm whale in final stage of diving. The body is pitched steeply downward by a thrust of the tail as it emerges from the water. (G. L. Friedrichsen photo, courtesy of NMFS.)

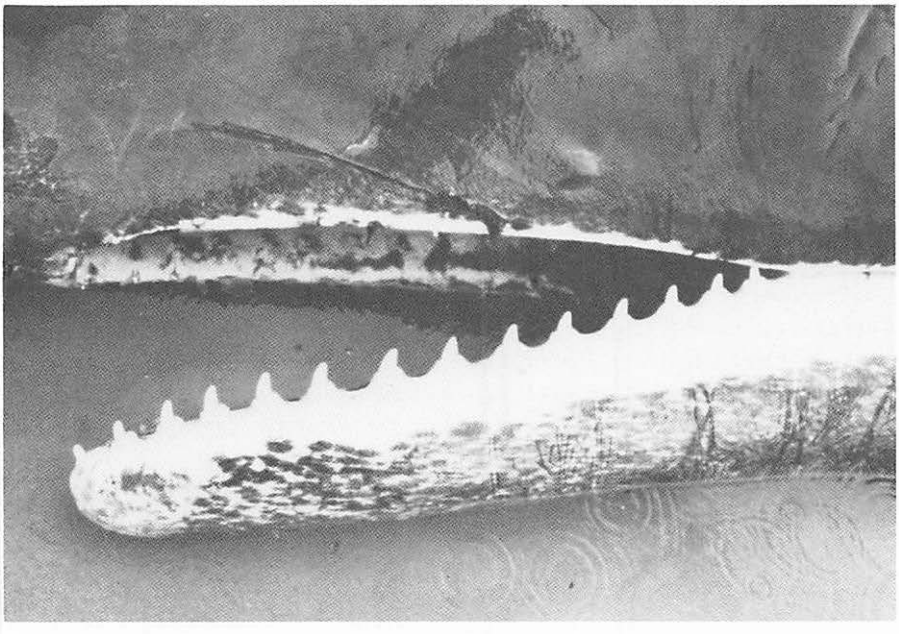


FIGURE 36.—Jaws of a sperm whale. Only the lower teeth are functional, fitting into depressions of the maxillary palate when the mouth is closed. (Robert L. Pitman photo.)

Museum. This was indeed a monumental task that stands as an indicator of the stature of Bryan's contribution to Hawaiian zoology. A dead sperm whale cast ashore on O'ahu in 1954 (Anon., 1954a) was considered a rarity. Rice (1960a), however, found this species "not uncommon" in 1958–1959, in the open ocean among the Northwestern Hawaiian Islands. Leatherwood, Reeves, and others (1982) note that the "Hawaiian Ground" was one of four well-known year-around sperm-whaling areas, and although infrequent among the main islands, the species is considered common about the Northwestern Hawaiian Islands. Woodward (1972) records mandibles of a sperm whale on the reef at Kure, April 23, 1964, and remains of a stranded animal 30 to 40 feet long on July 8, 1967. Shallenberger (1981) notes a total of four strandings, all on O'ahu, through 1979. Mass strandings are fairly common worldwide, as indicated by records from Baja California and Oregon (Gilmore, 1980), and from the island of Tasmania (Rounsevall and others, 1981).

Ridgway (1972) gave the figure of 70,000 to 100,000 as the number of sperm whales in the Northern Pacific population. Males migrate into colder waters, as of the Bering Sea, but females remain below the latitude of 40°. Click sounds of the sperm whale identified from hydrophone recordings off O'ahu confirm the presence of sperm whales near Hawai'i in all months of the year (Thompson and Friedl, 1982).

The sperm whale was sought from earliest times because it floats when killed and yields in addition to other products a valuable oil from the huge spermaceti organ. Clarke (1978, 1979) discusses several properties of this structure. Frost (1979, pp. 295–305) explores the possibility of extracting a substitute for spermaceti oil from the *jojoba* plant (*Simmondsia*). This whale is protected presently by international treaty as an endangered species. Machin (1974) has developed statistical means for quantifying populations, and these have been applied also to the humpback whale.

The sperm whale is a deep-diving species. It subsists on squids, the smaller ones as well as the fabled giant squid. Pelagic fishes seldom are taken. Caldwell, Caldwell, and Rice (1966) report on a full range of sperm whale behavior. Watkins and Schevill (1977) describe herding as related to foraging.

Kogia breviceps. Pygmy sperm whale.

ORIGINAL DESCRIPTION: *Physeter breviceps* deBlainville, Annales Françaises Étrangères d'Anatomie et de Physiologie 2:337. 1838.

TYPE LOCALITY: Region of Cape of Good Hope, South Africa.

GENERAL RANGE: Worldwide in tropical and warm temperate waters.

DESCRIPTION: This small whale reaches a length of up to 12 feet (3.7 m). The dorsal skin is gray to charcoal and the venter gray to white from the mouth to the anal region. There is a variable zig-zag white patch just behind the

FIGURE 37.—Head of a pygmy sperm whale (*Kogia breviceps*). Note the rather square profile, undershot jaw, and prominent "false gill" behind the eye. Compare with Figure 38. (F. G. Wood photo.)

external ear (Fig. 42, back endsheet). The mouth is broad and superficially shark-like. As in the sperm whale, there are teeth only in the lower jaw, and the left nostril only is functional, placed near the tip of the blunt head. The body is robust, the abdomen appearing to be twice the size of that in dolphins of comparable size. The small dorsal fin is placed usually well to the rear.

RANGE IN HAWAI'I: The pygmy sperm whale is occasional in Hawai'i, recorded chiefly from strandings and observations of free-swimming animals. Shallenberger (1981) lists eight strandings and incidental catches on Kaua'i, O'ahu, Moloka'i and Maui, 1949–1979; and three near-shore sightings on O'ahu and Maui within this period. Foster (1982) reports an additional stranding at Kīhei, Maui.

The pygmy sperm whale, like its ponderous relative the sperm whale, feeds on squids and is well adapted to this habit. The resemblances of this small whale and the sperm whale are genuine, although Barnes, Domning, and Ray (1985) suggest that the kogias should be classified in a separate new family, Kogiidae. The enlarged head is equipped with a spermaceti organ which may

FIGURE 38.—Head of a dwarf sperm whale (*Kogia simus*) stranded at Pōka'i Bay, O'ahu. The fresh specimen shows a slightly pointed profile, small mouth, and prominent "false gill." Compare with Figure 37. (D. Bryant photo.)

function in echo-location (Karol and others, 1978). Fleischer (1975) notes similarities also in the hearing apparatus.

Kogia simus. Dwarf sperm whale.

ORIGINAL DESCRIPTION: *Physeter* (*Euphysetes*) *simus* Owen, Transactions of the Zoological Society of London 6(1):30, pls. 10–14. 1866.

TYPE LOCALITY: India (Waltair, Madras).

GENERAL RANGE: Reported from seas adjacent to South Africa, India, Ceylon, Japan, Hawai'i, California, Baja California, and eastern United States (Rice, 1977). Leatherwood, Reeves, and others (1982) note that the total range is a matter of speculation, particularly since the species is only recently taxonomically separated from *Kogia breviceps*.

DESCRIPTION: *Kogia simus* is similar to *K. breviceps*, but smaller, measuring to 9 feet (2.7 m). The two are distinguishable otherwise by the dorsal fin, relatively small and in the posterior half of the body in *K. breviceps*, but prominent and situated about midway in *K. simus* (Fig. 42, back endsheet) (Leatherwood, Reeves, and others, 1982). *Kogia simus* has 7 to 12 teeth per

row (lower jaw only) compared with 12 to 16 in *K. breviceps*. Additional references to *Kogia* are Handley (1966) and Ridgway (1972).

RANGE IN HAWAI'I: The dwarf sperm whale was identified at sea by Kenneth Norris (pers. comm.) under favorable viewing conditions, and one stranding is reported from Pōka'i Bay, Wai'anae, O'ahu. The species perhaps is rare in the vicinity of Hawai'i, but more careful scrutiny and reporting of strandings may tell us otherwise, in time. Kami and Hosmer (1982) record two strandings of dwarf sperm whales, and of three other cetaceans found in Hawai'i, on Guam.

Ziphius cavirostris. Cuvier's beaked whale.

ORIGINAL DESCRIPTION: *Ziphius cavirostris* G. Cuvier, Recherches sur les Ossemens Fossiles, Ed. II, 5:350, 352. 1823.

TYPE LOCALITY: Near Fos, Bouches-du-Rhone, France (fossil skull).

GENERAL RANGE: All temperate and tropical seas.

DESCRIPTION: This beaked whale grows to about 21 feet (6.4 m) in length. The head is small relative to the body length (Fig. 42, back endsheet). The male has one pair of conical teeth at the tip of the lower jaw; other teeth are vestigial. In the female, teeth generally are hidden in the gum. Color varies from brown or gray to black, but is often pale in the facial region.

RANGE IN HAWAI'I: Richards (1952) reports one found on an O'ahu beach in 1950 (apparently the first record of an actual specimen taken in Hawai'i). Galbreath (1963) recovered another at Midway Islands in 1961. G. Bateson (pers. comm.) reports occasional observations of a beaked whale, presumably *Ziphius*, in waters about the main Hawaiian islands. Additional records are from Kure Atoll (Woodward, 1972), Pearl and Hermes Atoll, and O'ahu, with sightings also in open ocean west of Lāna'i and north of Maui (Shallenberger, 1981).

Cuvier's whale appears to be a pelagic species, as few strandings or observations are recorded from continental shores. Herd size is apparently small. It is assumed that they do not venture into polar waters. Annual cycles of migration take place in the vicinity of Japan (Ridgway, 1972). Squids are a preferred food, though bottom fishes, sea cucumbers, crabs, and sea stars are taken, suggesting a sea-floor feeding habit.

Mesoplodon densirostris. Blainville's beaked whale.

ORIGINAL DESCRIPTION: *Delphinus densirostris* deBlainville, Nouveau Dictionnaire d'Histoire Naturelle, Ed. II, 9:178. 1817.

TYPE LOCALITY: Unknown.

FIGURE 39.—Cuvier's beaked whale (*Ziphius cavirostris*) stranded on the California coast. Note teeth exposed at the tip of the jaw (found only in the adult male), slightly bulging rostrum, and numerous scars as splotches and lines over the body. (W. J. Houck photo.)

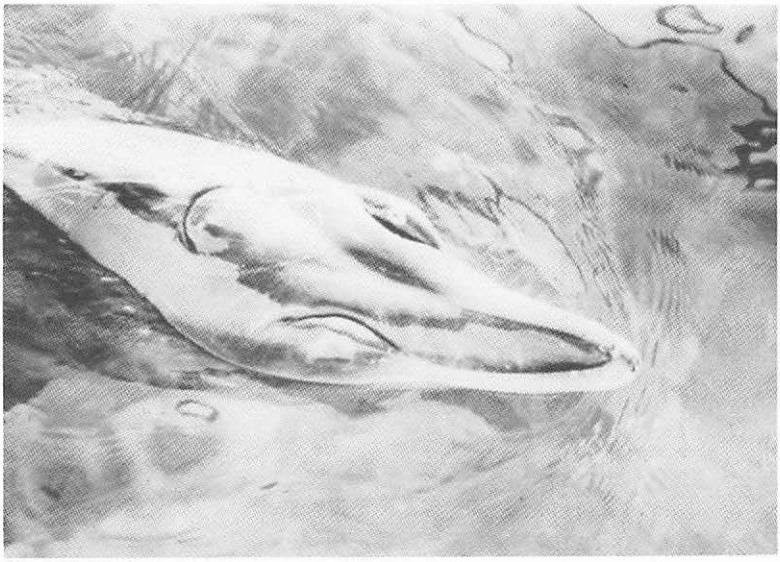


FIGURE 40.—Head detail of a stranded, live, Blainville's beaked whale (*Mesoplodon densirostris*). Sides of the mandible, which in males may bear a single tooth each, rise high alongside the narrow, dished rostrum. The blowhole is closed. (W. A. Huck photo, courtesy of Marineland of Florida.)

GENERAL RANGE: Tropical and warm temperate waters of all oceans.

DESCRIPTION: The body is spindle-shaped, ranging in length up to 15 feet (4.5 m). Color is black with the abdomen slightly pale (Fig. 42, back endsheet). A single pair of teeth is located on large, wedge-shaped prominences at the sides of the lower jaw; only the tips of the teeth are exposed. These lateral jaw prominences reach greatest development in the adult male. Actual length of the teeth is as much as 8 inches (20 cm) (Ridgway, 1972).

RANGE IN HAWAI'I: Early records include two specimens, one stranded on Sand Island and one on Eastern Island, Midway, in April 1961 (Galbreath, 1963). Shallenberger (1981) lists 13 sightings off the Wai'anae coast of O'ahu; and one each near Lā'au Point, Moloka'i, and off the Kona coast. Pods were small, numbering three to seven animals.

Shallenberger (1981) notes that this whale is slow moving and generally stays clear of boats. Diving times as long as 22 minutes are recorded. Squid is a known food item. This whale is primarily a warm water species, not venturing poleward beyond about 45°. Leatherwood, Reeves, and others (1982) conclude that it is a pelagic species more widely distributed than other beaked whales, and is recorded only uncommonly on the Pacific Coast of North America.

Besharse (1971) reports some data on skeletal changes related to age, using specimens collected at Midway Islands.

Canis familiaris. Domestic dog (including feral dogs and wild forms such as the dingo and pariah dog).

ORIGINAL DESCRIPTION: *Canis familiaris* Linnaeus, Systema Naturae, Ed. X, 1:38. 1758

TYPE LOCALITY: Uppsala, Sweden.

NATIVE RANGE: Ancestral forms are probably of Eurasian origin.

RANGE IN HAWAI'I: As strays or feral packs sporadically or continuously in the past, and at present, on all the larger islands where suitable prey or other food sources are available.

Ancestry of the domestic dog has been reviewed in close perspective by Reed (1959, 1960) and by Degerbøl (1961). Reed reports an early record of *Canis familiaris* in the Near East from diggings at Jericho, aged some 8,000 to 9,000 years. Degerbøl's find at the Star Carr site in England is about 9,500 years old, and he says of it, "As the Star Carr dog is a true dog, and not a tamed wolf in the first generation of taming, the domestication must have started much earlier than the date of the site." Lawrence (1967) places domestication of the dog earlier than 10,300 years ago, when man was still in the hunter-gatherer cultural stage, supporting fragmentary evidence from other sources which had previously suggested this possibility.

Various jackals, especially the golden jackal (*Canis aureus* Linnaeus), have been proposed in the ancestry of *C. familiaris*. However, jackals and dogs are now known to differ in certain dental characters, as well as in chromosome numbers (for *C. aureus* $2n=74$, and for *C. familiaris* $2n=78$). Lorenz (1955), who was a strong proponent of the jackal ancestry proposal, withdrew his support from it (Reed, 1960, p. 126). Smaller Eurasian races of the wolf (*C. lupus* Linnaeus) are probable single ancestors of the domestic dog (Lawrence, 1967).

Dogs in Hawai'i have two histories, the first dealing with stocks that accompanied Polynesian culture to the islands, and the second resulting from introduction of mixed or selected breeds of dogs from over the world. For the dog in Polynesia, Luomala (1960a) has presented a masterly analysis of its place in this cultural setting, making numerous references to Hawai'i. It is significant that at the time of their European discovery, the dog occurred in only four Polynesian archipelagos, including Hawai'i and New Zealand. It had died out in several others (Luomala, 1960b, p. 221). Dogs had been transported to many Pacific islands by sixteenth-century voyagers and were quickly absorbed into these societies, at first as prized possessions, and only gradually for other

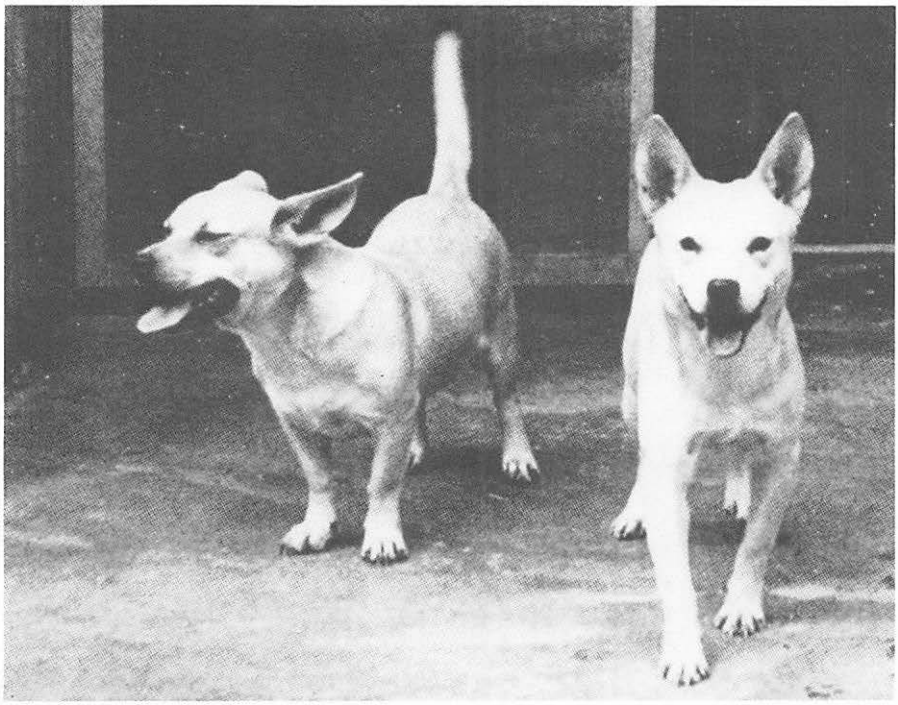


FIGURE 43.—Polynesian dog (*Canis familiaris*) as phenotypically reconstituted at Honolulu Zoo in a selective breeding program. White color, pricked ears, bandy legs, and short hair were desirable traits. (Courtesy of Honolulu Zoo.)

purposes, including food. In Hawai'i dogs were kept as pets, for food, as items of barter, and for sacrifice, and were prominent in sorcery and folklore. Ellis (1917, p. 349) noted from his usual keen observations that, "numbers of dogs of small size, and sometimes like a terrier, are raised every year as an article of food. . . . We have sometimes seen them kept in yards, with small houses to sleep in. A part of the rent of every tenant who occupies land, is paid in dogs for his landlord's table." And further, Ellis (1853, p. 346), states that the custom of fattening dogs for feasts was maintained long after European contact. At one such feast more than 400 dogs were served. Bird (1964), although a careful observer of native customs, never mentioned dogs in the 1873 diet of the Hawaiians, which suggests that their use was slight at that time. Anon. (1907) tends to shed further light on this subject.

There has been much conjecture about the physical characteristics of the dog in Polynesia, and its classification. Luomala (1960b) has made a splendid review, in detail, of the many bits and substantial pieces of available information. Svihla (1957) studied dental caries in ancient Hawaiian materials, and

observed that such defects are not present in modern dogs subsisting largely on meat diets. Wood-Jones (1931) had previously characterized the dog of Hawai'i from skeletal and other data, suggesting that many of its features were then still identifiable in living village animals. In 1966 a new program of the Honolulu Zoo was designed to phenotypically reconstruct the early Hawaiian dog by selective breeding of existing types (see p. 93).

It would seem that feral dogs were absent from the early Hawaiian cultures, probably because the land was lacking in means for their support. With the introduction and intermixing of larger European breeds of dogs, and the herding of sheep, predation by dogs on sheep began, and control measures were needed (Ana, 1848). At first, apparently, trouble was engendered by village dog packs raiding sheep herds (Kenway, 1851, p. 73), and much derision was heaped on these dogs as time went on, as exemplified by Lee (1853, p. 11):

> The greatest drawback that we have to encounter in raising sheep, is the loss arising from packs of worthless, half famished curs, that are constantly prowling like so many hordes of wolves in the woods bordering our best sheep districts. . . . Already we have a countless multitude of dogs, but they are a snarling, cowardly, sheep-stealing pack—a "cross of everything under the sun having any affinity to the canine race" and fit only to eat strychnine.

As stray bands of sheep took to the mountains, dogs followed them, and a firm predator-prey relationship was established. C. S. Judd (1936) believed that the sheep on Mauna Kea had been kept down for many years by dogs that attacked principally the lambs. When the dogs seriously affected cattle raising on the lower slopes of the mountain by killing young stock, a poisoning program about the year 1920 effectively eliminated the dogs.

Prowling dogs, even now, are a sporadic or continual source of harassment to livestock, big game, and backyard poultry, as well as a potential threat to the welfare of humans. Much damage done by dogs close to towns is probably from owned animals that stray after dark. Feral packs may also live in the vicinity of cities. The Archives of Hawaii index, between 1941 and 1949, lists 20 newspaper reports of marauding dogs, largely on O'ahu. These are exemplified by Anon. (1946a, 1949), dealing with animals said to have strayed from military camps that were closed out.

Dogs propagate readily in the wild, but it is not usual for a distinctive strain to develop in such populations. They are too readily interbred with stray mongrels, pig hunters' hounds, and even pedigreed bird dogs lost in the field. R. L. Walker (pers. comm.) reports a pack of dogs in Pōhakuloa Gulch on Mauna Kea, that lived off the feral sheep there, as being uniformly large, muscular, rather short-haired, and yellowish-colored animals. One of these animals shot by Walker in 1962 is shown in Figure 44.

Feral dogs attack not only sheep and cattle, but also wild pigs, feral goats, the axis deer, and flightless geese. Goats are probably not greatly susceptible

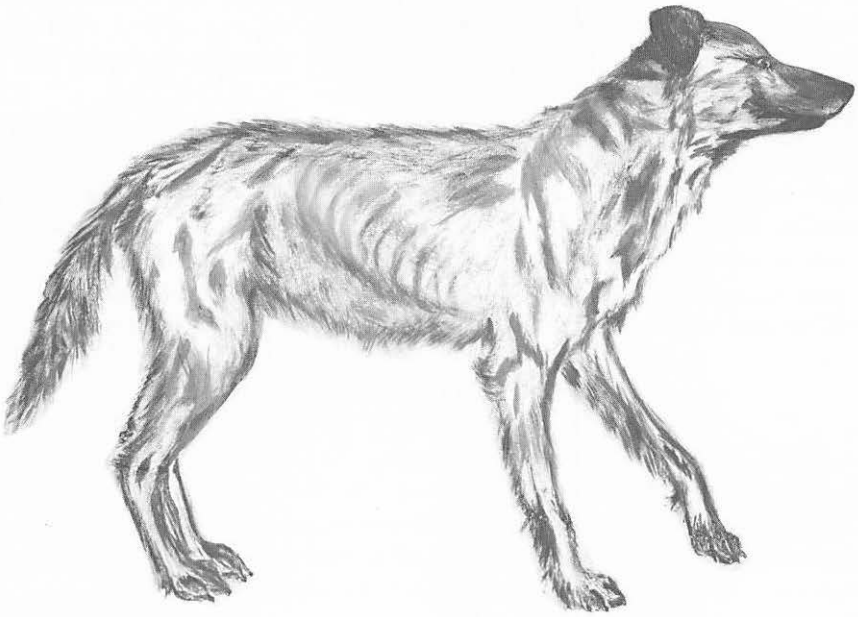


FIGURE 44.—Feral dog (*Canis familiaris*) shot on the game range of Mauna Kea, Hawai'i in 1962. Though lean, this specimen weighed 44 pounds (18 kg). Feral sheep are a usual prey of the feral dog. (Drawn by Marcia Tomich.)

to injury by dogs because of their adaptation to rugged terrain where dogs cannot easily follow. Yocom (1964, p. 39) describes briefly a response of goats to feral dogs, and (p. 46) does not consider dogs as a limiting factor of populations on Maui. Nichols (1960a, pp. 27–28) described predation by dogs on Lāna'i and Moloka'i axis deer, and found that dog control was necessary for protection of the Lāna'i herd. R. L. Walker (1966) describes the dog as a negative factor in management of the Hawaiian goose.

Unarmed persons are subject to a minor risk from dog packs in remote regions, although serious attacks seem not to have been reported. D. H. Woodside (pers. comm.) relates having been forced to seek refuge on the hood of his jeep when dogs rushed him, on the slope of Hualālai, Hawai'i, about 1958.

R. E. Bachman has told me of the following experience: About January 15, 1963, in the vicinity of Ahua 'Umi Heiau at the southeast base of Hualālai, he watched from a distance of some 50 yards as four dogs harassed a small pig. The pig repeatedly escaped and ran into a shallow lava cave, only to be dragged out again by the dogs. When Bachman attracted the attention of the dogs by

moving slightly, the four lost interest in the pig and raced toward him. When the pack was close, Bachman shot the largest dog, which resembled an Airedale, and the others swerved and ran on past. With further shots Bachman wounded a smaller black dog, but this one and the others, two small nondescript mongrels, escaped. Bachman has spent much time in this isolated region in connection with game management work, and says that he is quite often aware of dogs, but they are usually wary and seldom plainly seen. Occasionally they are heard barking. His observations suggest that dog packs have a circuitous range of many miles and return only occasionally to any specific area.

On the morning of May 21, 1962, after camping near the beach at Halulu, Lāna'i, I strolled along the shore. A large pointer suddenly burst from the thickets and bounded toward me. As I stopped short the dog also stopped, some five yards away. Its behavior displayed a mixture of aggressiveness and fear. The dog would not come closer, but with a more timid companion, also a pointer, followed me back to the camp. There the first dog accepted what food could be spared and ran off to share it. Neither would enter the vehicle so that they might be returned to their owners. Both were fine hunting dogs, each with a firm collar, but they were thin, indicating incomplete adaptation to a feral existence. No knowledge of recently lost dogs was uncovered in Lāna'i City, which suggests that these animals had been free for several months or longer.

Cursory examination of a dog dropping which I found on the Judd Trail at 5,200 feet elevation, also near Ahua 'Umi Heiau, on January 12, 1963, revealed fur and incisor teeth of a rat, probably *Rattus rattus*. Droppings from 2,300 feet elevation in the Pu'uanahulu Game Management Area, collected at a scent post on a flat *pāhoehoe* rock January 30, 1965, contained remains of at least two *R. rattus* identified by mandibles and hair of two color types, leg and thoracic parts of a mantid (*Tenodera*), and rind fragments of some sort of fruit. These data attest to the omnivorous feeding habits of feral dogs in addition to their better known behavior as predators or scavengers on large mammals.

Considerable information about dogs has accrued in the past 15 years, some of it applicable to conditions in Hawai'i, but still no specific studies of local feral populations have emerged. Titcomb (1969c) has put the historical data into new perspective for all of Polynesia. That the wolf is the single ancestor of the domestic dog may still be tenable as is supported by Scott (1968), Clutton-Brock (1977), and Fox (1978), but some unsettling evidence is presented by Atkins and Dillon (1971) who claim that anatomy of the brain places the dog closer to the coyote and jackal. Simonsen (1976) finds evidence of similarities in blood proteins among all canids, with the suggestion of a common ancestor for the dog and wolf. The concept of early arrival of the domestic dog in America remains viable, with ancestry of these stocks of probable Asian origin (Olsen, 1974).

Feral dogs in Hawai'i are identified increasingly as predators on such native bird populations as the *nēnē* (State of Hawaii Department of Land and Natural Resources, 1974; Stone, Walker, and others, 1983), and on colonial sea birds (Byrd and Boynton, 1979; TenBruggencate, 1984a, 1984b, 1985). There is, however, additional evidence that the roof rat is a staple food of feral dogs on Hawai'i (Tomich, 1981a) and on Maui (C. H. Diong, pers. comm.), in that scats contain typically the matted fur and bones of this rat on both islands. A report from Alabama (Causey and Cude, 1980) showed that free-ranging dogs frequently pursued deer, but that foods were basically from smaller animals. Beck (1973) provides supplementary data. Another work, on the dingo in Australia, gives insights into movement patterns of that form of the dog (Whitehouse, 1977). Finally, the legendary "Pele's dog," or a relative of it on Mauna Loa at high elevation as if resident there for a period of years, was observed closely and photographed, but could not be captured or befriended (Engledow, 1961; Bryan, 1964; Mendonca, 1978).

The project begun in 1966 for phenotypic reconstitution of the Polynesian dog fared well at first, and results accrued quickly. In time, however, the stock lost vitality through inbreeding. Funds for staff and for upkeep of the dogs became insufficient to maintain accurate pedigree records, and the project was ultimately abandoned in 1980 (J. L. Throp and J. S. W. Marr, pers. comm., 1983). It is regrettable that the support for such a commendable endeavor could not have been firmer. The workers did succeed in producing animals that were probably reasonable likenesses of the ancient dog of Hawai'i (Fig. 43); one of them was sent as mascot for the *Hokule'a*, a replica of the Hawaiian double-hulled canoe that was sailed to Tahiti in 1976 using Polynesian methods of navigation (Haugen, 1976). Whipple (1977) and Throp (1978) describe aspects of this canine genetic adventure in some detail. A new attempt should be made, as ultimate success seems likely.

Herpestes auropunctatus. Small Indian mongoose.

ORIGINAL DESCRIPTION: *Mangusta auropunctata* Hodgson, Journal of the Asiatic Society of Bengal 5:235. 1836.

TYPE LOCALITY: Nepal.

NATIVE RANGE: Northern Arabia eastward through Iraq, Iran, Afghanistan to Kashmir; India south to the central states, eastward to Nepal, Assam, and Burma; Hainan Island, Thailand, Indo-China, and the Malay Peninsula (adapted from Ellerman and Morrison-Scott, 1951, p. 295).

RANGE IN HAWAI'I: Occurs on O'ahu, Moloka'i, Maui, and Hawai'i; widespread and firmly established throughout these four islands; escaped from captivity about 1965 on Mokuolo'e (Coconut Island) in Kāne'ohe Bay, O'ahu, and apparently established. Present also on Ford Island in Pearl Harbor.

In Hawai'i *Herpestes auropunctatus* is called simply the mongoose, which is a practical name for a singular mammal having no near relatives in the Americas. We should be aware, nonetheless, of the opinion of Ellerman and Morrison-Scott (1951, p. 295) who designate this animal as the small Indian mongoose to distinguish it from similar species such as *H. edwardsi* (Geoffroy), the Indian gray mongoose, and *H. fuscus* Waterhouse, the Indian brown mongoose. Blanford (1891, p. 121) and Powell (1914) applied the same common name, small Indian mongoose, to this species. The specific name *auropunctatus* mean, literally, "gold-spotted," and our species has also been called the gold-spotted mongoose. The plural is mongooses, a plain fact not always taken seriously in the local patois (Anon., 1963b). Walker and Hudson (1945) augment further the lighter side of the mongoose problem.

P. H. Baldwin, Schwartz, and Schwartz (1952, p. 336), who present the most comprehensive material for Hawai'i, have adequately treated systematics and explain fully the designation *Herpestes auropunctatus auropunctatus* as it applies to the West Indian and Hawaiian populations. This form ranges in northern India from Manipur to Orissa, and into Nepal, as one of five designated subspecies, and is thus locally available in Calcutta, from whence at least one lot of mongooses originated for transport to Jamaica. Related species of mongooses, their classification, and some structural characteristics have been treated by Pocock (1916, 1937, 1941), by Ellerman and Morrison-Scott (1951), and by Hinton and Dunn (1967).

Herpestes auropunctatus in Hawai'i has been aggressive in its spread to all regions of each island occupied. P. H. Baldwin, Schwartz, and Schwartz (1952, pp. 341–342) neatly characterize its range by saying, "Mongooses live from sea level to approximately the highest elevations on Moloka'i (4970 feet), O'ahu (4025 feet), and Maui (10,025 feet). On Hawai'i, the range extends from sea level to the upper limit of vegetation near 10,000 feet and excludes only the barren summits of Mauna Loa and Mauna Kea which rise to 13,680 and 13,784 feet, respectively." However, these authors provide specific maximum elevational records of only 6,000 feet in Kīpahulu Valley on Maui; and 7,000 feet, evidently on Mauna Loa, Hawai'i. The mongoose is unlikely to be found much above these levels. Sign on the Mauna Loa Trail occurs to about 7,000 feet, as observed on numerous occasions during two years of the IBP program (Tomich, unpubl.). In a two-day transect study along the road from the Humu'ula Sheep Station at 6,700 feet to Halepōhaku at 9,200 feet on Mauna Kea, in 1969, mongooses were trapped only to a level of 7,200 feet. None ever reached the open pit refuse disposal site at Halepōhaku, according to residents of a construction camp there. On the eastern slope of Mauna Kea we trapped the mongoose with some regularity in wooded pasture lands of Kūka'iau Ranch to the Pu'u Kihe cabin at 7,750 feet. Extreme station of record was 7,800 feet

in a small forestry planting just above the cabin at the Forest Reserve boundary (Haas, Wilson, and Tomich, 1972).

Greatest concentrations are in beach and lowland areas, but the species does well at middle and higher elevations at favorable locations. It is found, for example, at the Pōhakuloa military camp (6,700 ft), supported to some degree by the refuse dump. Carrion of feral sheep on the higher reaches of Mauna Kea apparently does not attract the mongoose to this cold habitat. The work of Kami (1964) suggests to me that scavenger beetles in cattle dung serve as an important food source and engender a commensal relationship between mongooses and cattle on the range. The Mokuolo'e population originated from escapes among animals brought there for use in food-fish toxins research, and finds adequate food on that small island.

The mongoose in Hawai'i originated from Indian stocks brought originally to Jamaica. Thus the account of this species begins properly in the Caribbean where rat problems were serious in sugar cane fields well before 1870. Espeut (1882) relates the first known introduction to Jamaica in 1872, and (p. 714) extolls the success of the venture, but, admitting damage to quail and other ground-nesting birds, he observes that, "snakes, lizards, crabs, toads and the grubs of many beetles and caterpillars have been destroyed. . . . " It is apparent that the mongoose in Jamaica was then acclaimed not only for rodent control but also for control of sugar cane insects and "pests" in general. Espeut's unbounded enthusiasm for this animal led him also to wonder why it was not taken to Australia and New Zealand to kill rabbits. Anon. (1883b) reviews the original introduction and indicates that further shipments had been made to Jamaica.

Possibly on the strength of Espeut's paper, Hawaiian sugar planters became interested in the mongoose as a predator on rodents in their fields (Anon., 1883a). This latter article recommends caution and also provides some earlier history, in these excerpts:

> Whether it would be wise to introduce the animal to these Islands may be a question. It would be important first to learn more of the nature of the creature, for they might prove an evil. They certainly are as fond of poultry as of rats, and possibly have other undesirable qualities.
>
> As long ago as 1816, Lunan, in his article on the sugar cane, "Hortus Jamaicensis," vol. ii, p. 206, drew attention to the capabilities of the Mungoose as a rat catcher in the following words: "There is an East Indian animal called *mungoes* which bears a natural antipathy to rats; if this animal was introduced here [Jamaica] it might probably extirpate the whole race of these noxious vermin."
>
> It appears, however, that until some twenty years ago, no attempt had been made to introduce the Mungoose into the island, and even then the results were unsatisfactory or fruitless.
>
> The introduction and complete naturalization of an animal possessing such strong predatory habits and remarkable powers of reproduction as the Mungoose must have an important influence on all indigenous and introduced animals capable of being affected by it.

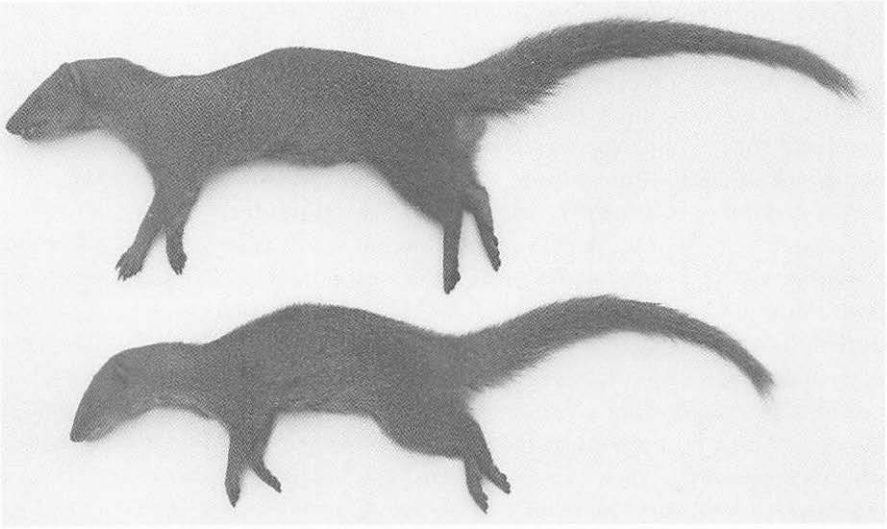


FIGURE 45.—Small Indian mongoose (*Herpestes auropunctatus*). Freshly killed male (above) and female (below). The small eye, slender body, and tapered tail are shown in these specimens. Adult males weigh 16 to 32 ounces (450 to 900 g) and females are smaller, at 11 to 18 ounces (300 to 500 g). (William S. Devick photo.)

Regardless of these admonitions, in the very same year 72 mongooses were brought to Hawai'i, on September 30, 1883, and released along the Hilo-Hāmākua coast of Hawai'i Island (E. H. Bryan, Jr., 1938b). Two years later another "large number" of these animals was procured for the Hāmākua plantations (Anon., 1885).

Offspring of these animals or subsequent introductions from the West Indies were established also on Maui, Moloka'i, and O'ahu. Details of this operation, if recorded, have not come to my attention. Some resistance was met in an attempt to bring the mongoose to Kaua'i, for Tinker (1938, p. 83) relates that a shipment of them reached the island, but was thrown overboard in the harbor before the mongooses could be released on land (original source not found).

In retrospect for Jamaica and the Caribbean region, the mongoose has not been accepted with favor. Eric (1896) recognized some true qualities of the species, and stated (p. 108), "However interesting the mongoose may be from a natural history point of view, the fact remains that it has over-run every part of Jamaica, has done, and is doing incalculable damage in every direction." Before 1900 extensive control programs were in operation (Anon., 1898). Some saw hope in natural biological control through parasitic infestations of ticks (Anon., 1897), a notion that was later refuted (Thompson, 1950), or the unlikely function of extensive cannibalism (Anon., 1902b).

Williams (1918) found the mongoose valuable only under special environmental conditions, when he thoroughly analyzed its food habits. Urich (1931) summarizes mongoose problems in Trinidad; and Meyers (1931) suggests complications for the West Indies in general from decimation of insectivorous vertebrates by the mongoose.

Spencer (1950) introduces a new era in the understanding of *Herpestes auropunctatus* in the West Indies, and is followed by Seaman (1952), Wolcott (1953), and by Pimentel (1955a, 1955b) whose interest lay in the species as a reservoir of rabies and leptospirosis. Tierkel and others (1952) deal specifically with rabies in Puerto Rican populations.

There is some parallel, in the chronology just recited, in the Hawaiian experience with this mongoose. Hinton and Dunn (1967) discuss the matter for the West Indies and for Hawai'i as well. After early glowing reports such as Anon. (1888), some writers turned against the animal (Anon., 1904a), although for what specific purpose does not seem to be known. Some control was practiced (Pemberton, 1923), but in general it seems that the mongoose was left alone. Later commentators, in contrast to those from the West Indies, left the question open, or rose in token defense (E. H. Bryan, Jr., 1938b; L. W. Walker, 1945b).

A central question for Hawai'i is whether the mongoose is a negative factor in relation to birds, both native and introduced, and whether it is of positive value in rodent control. This animal is thorougly omnivorous, as is shown from sources presented earlier, but the suggestion that it eats sugar cane (G. M. Allen, 1911) is unfounded. Beccari and Rock (1921) charged that the mongoose ate fallen fruits of native fan palms (*Pritchardia*), possibly in excessive amounts. F. M. (1913), Pemberton (1925, 1933), La Rivers (1948), Kami (1964), and P. H. Baldwin, Schwartz, and Schwartz (1952) have contributed to the knowledge of food habits of the mongoose in Hawai'i; these last authors have exhaustively treated this subject, and have also considered at length the economics of mongoose populations. Specific cases of bird predation are reported by W. A. Bryan (1908) and by Ord (1964). Schwartz and Schwartz (1950b, 1951) found the mongoose an important predator on the ring-necked pheasant (*Phasianus colchicus*), but one of lesser importance on the California quail (*Callipepla californica*). Woodworth and Woodside (1953) were inconclusive as to whether poisoning of mongooses aided in pheasant production. P. H. Baldwin (1945a), Elder (1958), and R. L. Walker (1966) list the mongoose as a factor in decline of the Hawaiian goose. King and Gould (1967) suggest that the mongoose is responsible for depletion or extirpation of Newell's shearwater (*Puffinus newelli*) on O'ahu, Moloka'i, Maui, and Hawai'i. Pemberton (1925) and Kami (1964) observed similar high incidences of rodent remains in mongoose excreta from sugar cane fields near Honoka'a, on

Hawai'i, and nothing to suggest that highly beneficial insects were taken. Their respective figures of 88 and 72 percent of rodent remains in samples taken 40 years apart may be significantly different, yet slight differences in methods and lack of specific identification of the rodents precludes reliance on comparative tests of their data. These results suggest, however, that cane-field mongooses do subsist largely on rodents; that they may act as a prominent factor in rodent control is unlikely. Rodents are still a major source of economic loss to cane planters locally on nearly all islands. Problems on Maui and Hawai'i are perhaps as great or greater than on Kaua'i where the mongoose does not exist, but actual comparative studies are lacking.

Local control of mongooses by poisoning and trapping, as indicated in previously cited reports, is a relatively simple matter (Greenhall [1963] reports further on an easily constructed trap). Eradication, if advisable, would be a formidable task on any of the islands now occupied, with presently available methods.

Seaman and Randall (1962) record remarkable accounts of predation by *Herpestes auropunctatus* on deer fawns in the Virgin Islands, and these may have a parallel in relationships between the mongoose in Hawai'i and young of the several game mammals. The habit of attacking larger prey about the mouth may be strongly ingrained in the genus *Herpestes*. Lewis (1940) describes one of the Indian species actually felling a donkey in this manner.

Behavioral observations on the mongoose in Hawai'i are few. L. W. Walker (1945a) provides useful data on an apparently generalized habit concerned with breaking hard objects to obtain food from them (in this instance an egg). Pocock (1941, p. 27) describes *Herpestes smithi* Gray opening the giant African snail (*Achatina fulica*) by beating the shell on stones, and Brownlow (1940) reports the same behavior in a captive *H. urva* Hodgson which substituted any suitable object at hand in the playful exercise of this art (both examples in India). Eisner and Davis (1967) describe an essentially identical response of an African mongoose (Genus *Mungos*) to shell-covered food items, and Van Gelder (1953) has found a parallel trait in a New World skunk (Family Mustelidae).

Pearson and Baldwin (1953) calculate a mean figure of 2.4 young per litter and perhaps two litters per year, replacing the erroneous information listed by Eric (1896). The gestation period for *Herpestes auropunctatus* in India is reported as 49 days, from one observation (Powell, 1914); a figure of 60 to 65 days reported by Frere (1929) may be for another species.

A specific investigation of adrenal size and function was made by Tomich (1965c) and is supported by McKeever and Tomich (1963). Kolmer (1918) made an early brief study of adrenal anatomy in an unspecified species.

Continental United States has been kept free of mongooses, and their importation is forbidden by specific legislation on the well-founded assumption

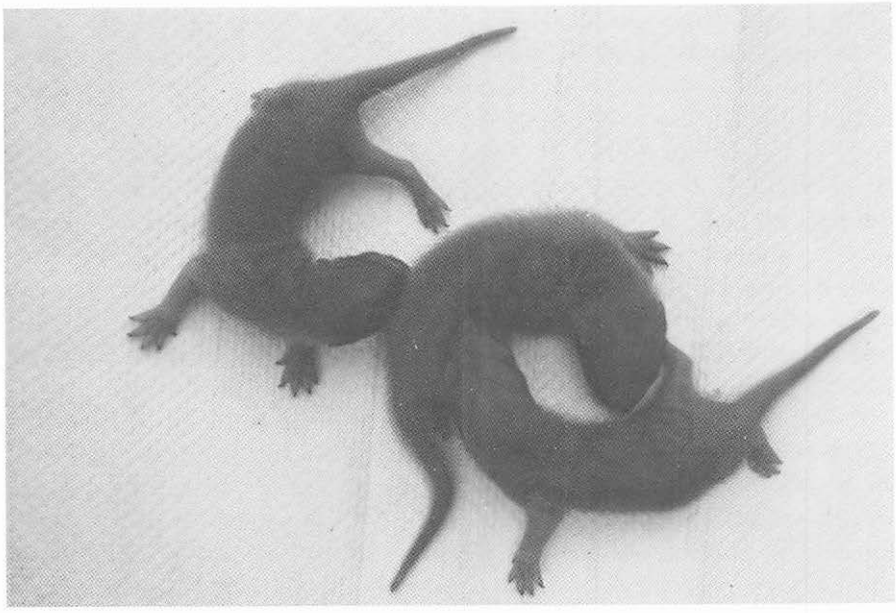


FIGURE 46.—Mongoose pups three days old. At birth the pups weigh about ¾ ounce (20 g); the body is pink but thinly covered with yellowish hair, and eyes are closed. Litter size ranges usually from one to three. (Harry T. Kami photo.)

that these alien species are undesirable. Several authors deal with this problem over the years (Anon., 1901b, 1908b; H. H. T. Jackson, 1921; Simpson, 1944; and J. D. Scott, 1965). Anon. (1967a) records a zoo specimen in Hawai'i. Westerman (1953) reports failure of *Herpestes auropunctatus* to invade the interior of tropical South America from coastal colonies.

The most important issue of the past ten to 15 years concerning the mongoose in Hawai'i was its discovery and possible establishment on Kaua'i. A lactating female, said to have been killed by an automobile, was recovered late in November 1976, about 0.5 mile east of the Wahiawa Bridge by Ernest Ventura of the neighboring town of Kalāheo. Wildlife officials were alerted of the find on December 3 and shortly thereafter made a confirming examination of the specimen. A few sightings had been reported previously on the island, the earliest on July 2, 1968, in the same locale as the 1976 incident. No sightings were verified by success in trapping or otherwise obtaining a later specimen. A log of possibly valid sightings through February 1977 produced a tally of 14 reports in addition to the known specimen, at locations widely distributed over well-traveled portions of the island (Telfer, 1977). The implications for native wildlife, in the event of naturalization of the mongoose to Kaua'i, are obvious.

Meanwhile, basic understanding of the mongoose has been expanded in its native range as well as where purposely introduced. In Hawai'i predation on the native goose (*Nesochen sandvicensis*) is well documented. Eggs and the brooding female alike are especially vulnerable, though there is some evidence that the gander is effective in protecting goslings from attack. Banko and Manuwal (1982), in extensive field and pen experiments on Maui and Hawai'i, determined that egg predation accounted for 62 percent, and attacks on incubating females ten percent, of all unsuccessful nests of wild geese they studied. Mongooses were implicated in almost every instance through the characteristic style of egg breakage and tooth marks observed on bones of killed nesting birds. Baker and Russell (1979) document a specific example of a goose taken from her nest by a mongoose, with subsequent loss of the nest.

A pattern has begun to emerge, explaining to some degree the remarkable tenacity of the small Indian mongoose in tropical and subtropical climates, and the functioning of a social structure in which individual home ranges overlap greatly, yet there is maintained a generally solitary existence among the adult animals. A limited home range in Hawai'i is indicated (Tomich, 1969b) from mean distances between successive captures of 0.25 mile in males and 0.10 mile in females. Over extended time, range lengths seldom exceeded 1.00 mile in males and 0.40 mile in females. For the stable regional population studied there were no detected shifts of established animals to new areas. Gorman (1979) obtained similar results from studies in Fiji, but Nellis (1974) found home range of a Virgin Islands population remarkably similar in both sexes.

In earlier work Gorman (1975, 1976a) confirmed an omnivorous diet and negative aspects of the mongoose as an introduced predator; and described the mechanism of scent marking in which each mongoose is individually identified by others of the population. It is this social system which appears to permit separation of individuals within overlapped territories (see also, Gorman, Nedwell, and Smith, 1974). Basic studies of the male reproductive system (Mokkapati, 1974; Sitaramaiah and Dominić, 1977), and aspects of the reproductive and growth cycles (Gorman, 1976b; Tomich and Devick, 1970) are complementary to the above reports. Stemmermann and Hayashi (1970) and Hayashi and Stemmermann (1972) suggest that mongooses in Hawai'i are highly susceptible to visceral lesions. Rood and Nellis (1980) demonstrate a method of marking the pelage for field identification; Rasa (1975) deals with behavior; and Acharjyo and Mokapatra (1976), longevity of captives. King and Moors (1979) report on the broad subject of life history in small carnivores as it may be applied to control methods. Knowledge of vocal sounds suggests their importance as a means of communication supplementary to that of odor (Mulligan and Nellis, 1975), and facile tree-climbing behavior in Hawai'i is affirmed by Zimmer (1980).

Physiological parameters of cardiac output (Lin and Kobayashi, 1976) and of thermal factors (Nellis and McManus, 1974; Ebisu and Whittow, 1976) add to understanding of the mongoose in its adjustment to environmental conditions. Chromosome studies (Fredga, 1967; Cohen and Chandra, 1970; Mittal and Kaul, 1975) reveal a novel chromosome arrangement which may provide some insights into the characteristics of *Herpestes auropunctatus* as a species.

Felis catus. House cat (includes feral populations).

ORIGINAL DESCRIPTION: *Felis catus* Linnaeus, Systema Naturae, Ed. X, 1:41. 1758.

TYPE LOCALITY: Uppsala, Sweden.

NATIVE RANGE: Ancestral species occupy Europe, western Asia, and Africa.

RANGE IN HAWAI'I: Established in the wild on all eight main islands; has been present from time to time with man or in a feral state on others, for example, Tern Island at French Frigate Shoals (Anon., 1964k).

The domestic cat (Zeuner, 1963, pp. 387–400) has a relatively short history that is not well known. The European wild cat (*Felis silvestris* Schreber) appears to be the chief ancestor of common breeds, but also included are the African yellow cat (*F. libyca* Forster), and perhaps others. Ranges of these wild species are extensively overlapped. The first tamed cats are recorded from Egypt, about 3,800 years ago.

Felis catus is generally agreed to have been present in Hawai'i since the early days of European contact (R. C. L. Perkins, 1903, p. 394; W. A. Bryan, 1915, p. 293). It is likely that ships' cats would have made attractive prizes for the island natives and that shore populations became quickly established after Cook's time. Specific dates of early introductions have not been uncovered, nor is the history of spread to the wild recorded. Rothschild (1893) reports cats as common in Lāna'i and O'ahu forests in 1892, and R. C. L. Perkins (1903) indicates they were abundant on Lāna'i during one of his visits of that era. Ni'ihau had no feral cats in 1936 according to the observations of Franck (1937, p. 322), but Fisher (1951, p. 33) reported them as common about 1950. Franck (1937), however, states that on his 1936 visit to Kaho'olawe, cats were present and had evidently been abundant, for the lone island resident said, "I used to shoot six or seven cats a night and catch three or four in traps."

Feral cats are most common at the lower and middle elevations, but do go also high into the rugged mountains. A ranger at Haleakala on Maui said in 1963 that cats were occasional along the lower roads, near Headquarters (7,000 ft elev.), and in the crater at a similar elevation, apparently entering through Kaupō Gap. They seem not to be present frequently on the very high slopes of Mauna Kea and Mauna Loa, on Hawai'i, but do range, perhaps regularly, to at

least 5,600 feet in the saddle between these peaks, and to 7,000 feet on the east flank of Mauna Kea near Kahinahina.

Feral cats are notorious for their actual or alleged predation on birds. R. C. L. Perkins (1903, p. 394) reports a serious case involving apparently a variety of native forest species on Lāna'i, and Richardson and Woodside (1954) report another, involving the dark-rumped petrel (*Pterodroma phaeopygia*), at 9,000 to 10,000 feet on Mauna Kea. Other investigators (for example, Schwartz and Schwartz, 1950b) suspect the cat as a factor in bird predation.

Field data on food habits are few. L. Nichols, Jr. (pers. comm.) examined stomach contents of several feral cats on Lāna'i about 1958 and determined the principal diet as *Mus domesticus* and lizards (introduced Scincidae); also found were occasional scorpions, centipedes, and fledgling passerine birds. Near Kahinahina on Hawai'i, two stomachs each contained the remains of a skylark (*Alauda arvensis*).

Two cats I collected from semiarid rangeland near the Saddle Road Junction (2,500 ft elev.) in April 1964, also on Hawai'i, were living well off the land. The stomach of one contained the remains of a skylark. That of the other contained parts of two *M. domesticus*, crushed shells of two eggs (possibly skylark), and fragments of a hawk moth (*Sphingidae*) and of three other moths. In the colon were remains of two mice, of a skylark, and of one or more moths, from earlier feeding.

These few data illustrate an excellent adaptation of the house cat to living in the wild. Both the specimens examined were young adult females; one was pregnant and with slight fat deposits; the other was lactating heavily and in good condition. *M. domesticus* had been extraordinarily abundant in the region the previous late summer and seemed to have still been common. Rather frequent road kills of cats in that part of the island suggest a relatively dense population. In the field the cat-mouse relationship may be as firm as in the farmyard, but it is apparent that available small birds are also a substantial food source. Eating of lizards and arthropods demonstrates a versatility in feeding habits which may allow survival when rodents and birds are scarce.

The feral cat is without doubt of some significance in wild bird conservation and game bird propagation, but opportunities for its study have never been fully presented. A basic understanding of these areas of wildlife management should include intensive investigation of the feral house cat and an orderly program for disposing of unwanted pets that might otherwise be turned out to fend for themselves.

House cats in Hawai'i take readily to the wild and it is difficult to draw distinctions between feral animals living near human habitations and doorstep cats foraging away from home. Several times in trapping for the mongoose in the sugar cane and small farm belt we have caught cats. Some were meek,

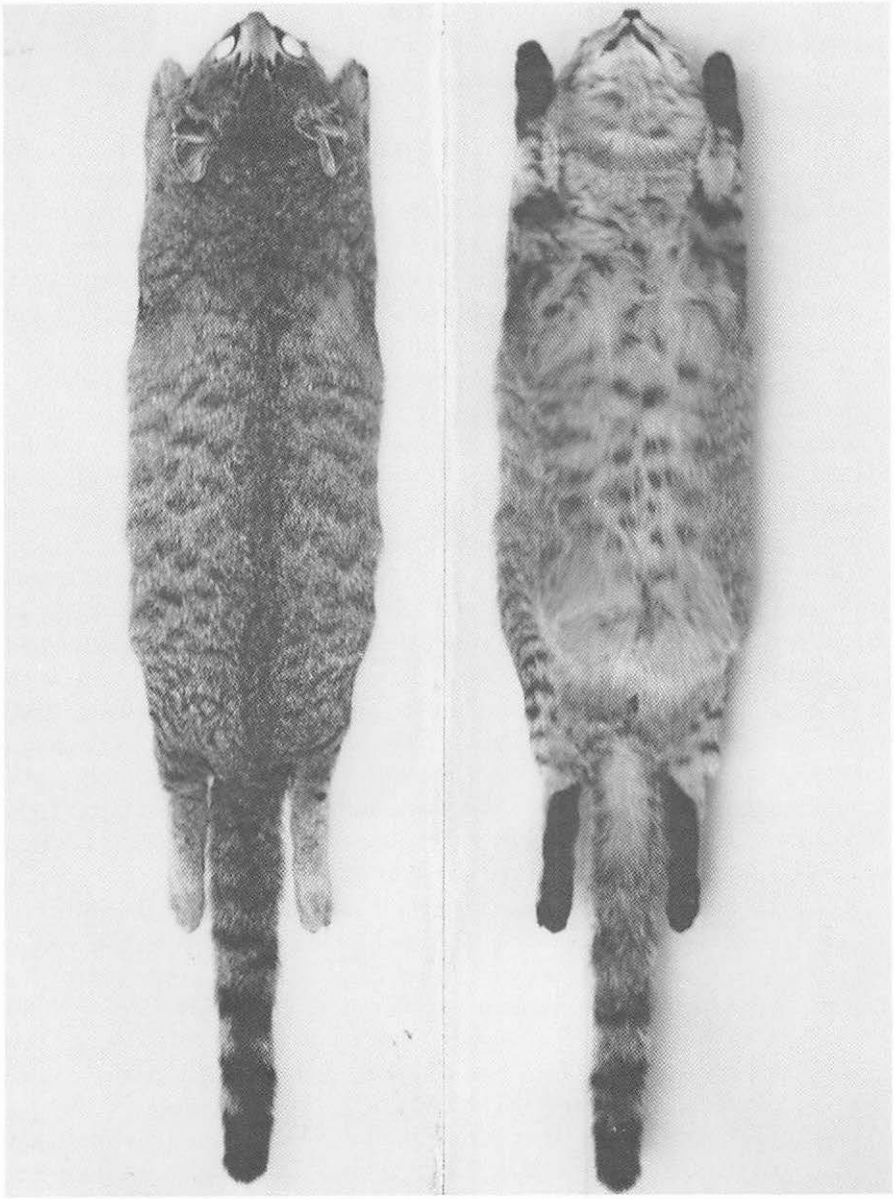


FIGURE 47.—Dorsal and ventral aspects of a feral cat (*Felis catus*) collected on Hawai'i Island in April 1964. Feral cats have apparently no physical traits differing from those of domestic cats. This specimen is an adult female that weighed about 5 pounds (2.25 kg). (Author's photo.)

friendly individuals recently abandoned far from homes; others were wild, furious fighters that had struggled in the cage traps and defiantly faced us. When released most cats rushed off for home or into the nearest cover; some stood by timidly.

The mild climate of Hawai'i is conducive to survival of cats in the wild. Temperate regions in general permit the existence of feral populations, but these are absent where winter climates are severe, as indicated by the content and geographical distribution of several available studies (E. L. Hubbs, 1951; W. B. Jackson, 1951; W. H. Marshall, 1961; Watson, 1961c; Warner, 1985). Van Vechten (1950) treats the cultural aspects of the domestic cat, and this aids in the understanding of this animal and its behavior.

It seems improbable that any Hawaiian population is sufficiently isolated or genetically restricted to have effectively selected color, form, or behavioral characteristics other than wildness and ability to survive free of man, but this should be measured. The striped wild-type or tabby pelage is often observed among feral cats, but comparative frequencies are undetermined for this phenotype in feral and domestic populations (Fig. 47).

Cats with short tails that may be straight or twisted are found quite commonly in Hawai'i. I have noted them at Honoka'a, Kawaihae, and Hōnaunau (on Hawai'i), and in Honolulu (on O'ahu). These observations suggest the presence of the Manx phenotype (named for the Isle of Man, in the Irish Sea) or similar mutations originating in the Orient. Spaulding (1930) records an 1850 importation said to be of the Manx type. A point to observe is that genetically the Manx cat is not a breed as such, but exists only as the heterozygous expression of a mutation that is lethal in homozygous form (Todd, 1964). Thus, Manx cats mated *inter se* produce a ratio of 1:2 for normal tail and Manx phenotype, respectively, and every fourth embryo dies.

The feral cat remains the same enigma it was 15 years ago. I know of no major publications on its presence in Hawai'i. More than ever, this species demands attention if we are to understand its place in local ecosystems. It is increasingly suspect as an important predator of Newell's shearwater (*Puffinus newelli*), a threatened bird of Kaua'i, and as recently as 1982 may have destroyed up to 80 percent of one colony nesting there (TenBruggencate, 1982). See also Simon (1984). Interest in cats of the Line Islands by the U.S. Fish and Wildlife Service is commendable, where eradication is the intent for protection of sea birds (Rauzon, 1981, 1983). There is brief information on cats in rain forest habitat on Hawai'i, where two animals were trapped in work with small mammals there in 1972–1974 (Tomich, 1981a). Haas, Tomich, and Wilson (1971) summarize the record of a pestiferous flea associated with cats and man in Hawai'i.

We are fortunate that researchers have taken the feral cat seriously in several

sectors of the world and are investigating many facets of cat biology. Feeding preferences are reported by Pearson (1971), Coman and Brunner (1972), George (1973), Fitzgerald and Karl (1979), Jones and Coman (1981), and Liberg (1982, 1984) on larger land masses; and on small islands by Jones (1977), Dilks (1979), Taylor (1979), and Jehl (1984). Population ecology is treated by Laundré (1977), Hall and Pelton (1979), Liberg (1980), and Jones and Coman (1982b). Liberg (1981) provides a review of several subjects, Davis (1982) methods of census, and Jones and Coman (1982a) report a three-year study of reproduction. Background information on genetics is presented by Lamoreux and Robinson (1971), van Aarde and Blumenberg (1979), and O'Brien and Nash (1982).

It is not my intention to summarize these new reports on feral cats but to bring them to the attention of investigators who may be stimulated to examine this resource and apply it to research and management projects in Hawai'i.

Monachus schauinslandi. Hawaiian monk seal.

ORIGINAL DESCRIPTION: *Monachus schauinslandi* Matschie, SitzungBerichte der Gesellschaft Naturforschender Freunde zu Berlin, p. 258. 1905.

TYPE LOCALITY: Laysan Island, Hawai'i.

NATIVE RANGE: Resident only among the Hawaiian Islands and regional waters; vagrant at Johnston Atoll.

RANGE IN HAWAI'I: Breeding range is confined to the Northwestern Hawaiian Islands. Recorded regularly in recent years from Kure Atoll, Midway Islands, Pearl and Hermes Atoll, Lisianski Island, Laysan Island, Maro Reef, and French Frigate Shoals. Sporadically occupies Nihoa Island and is recorded rarely off Kaua'i, Lehua, O'ahu, and Hawai'i islands.

The genus *Monachus* embraces three species of monk seals in widely separated populations, the type species, *M. monachus*, of the Mediterranean region, *M. tropicalis* among the West Indies, and *M. schauinslandi* of the Hawaiian chain. King (1956) presents anatomical data and discusses the probable origin and relationships of the group. The Hawaiian species is more closely related to the Caribbean species than to that of the Mediterranean. Kenyon and Rice (1959) found the differences between them to be slight, and indicate that further study of more adequate materials may reveal that *M. schauinslandi* should be considered a subspecies of *M. tropicalis*.

However, for the present we may remark at the singularity of the Hawaiian monk seal as the only endemic species of mammal in Hawai'i (the hoary bat and the Polynesian rat are represented by endemic subspecies of species having extensive ranges outside Hawai'i).

G. M. Allen (1942, p. 456) states in reference to the zoogeography of the Hawaiian monk seal:

FIGURE 48.—Defiant female Hawaiian monk seal (*Monachus schauinslandi*) with her pup, on a beach at Laysan Island, in June 1962. Young seals are slaty black until the first molt when about 30 days old. Females fast during lactation and draw nourishment from fat reserves. (David B. Marshall photo.)

This Pacific colony may be presumed to have been derived from the Caribbean at some time in the Tertiary, when, as seems well established, the latter was in open connection with the Pacific. In late Tertiary times the Panamanian union with South America was again established, cutting off the Caribbean from Pacific waters. That the seals should now be limited to the Hawaiian group in the Pacific, however, must indicate that they are a relict group, which once had a wider distribution, with a preference for tropical seas.

The Hawaiian monk seal was probably abundant when Europeans discovered Hawai'i, for the inhabitants at that time made little use of the northwestern islands or their resources. The historical record is incomplete, but it indicates that this species was rapidly decimated from over-exploitation by sealers, whalers, and the few persons who came to live and work on these remote islands. It was near extinction about 1900 but gradually increased under total protection, and the population count once rose to well over a thousand individuals. This species is one of the few mammals of Hawai'i that has been intensively studied, and serves as an example of how knowledge may lead to understanding in management of mammalian populations. However, human use, occupancy, and other encroachments on seal habitat must be closely regulated if the species is not to descend again toward oblivion. D. B. Marshall (1964) makes an important point in this regard. The breeding range is now

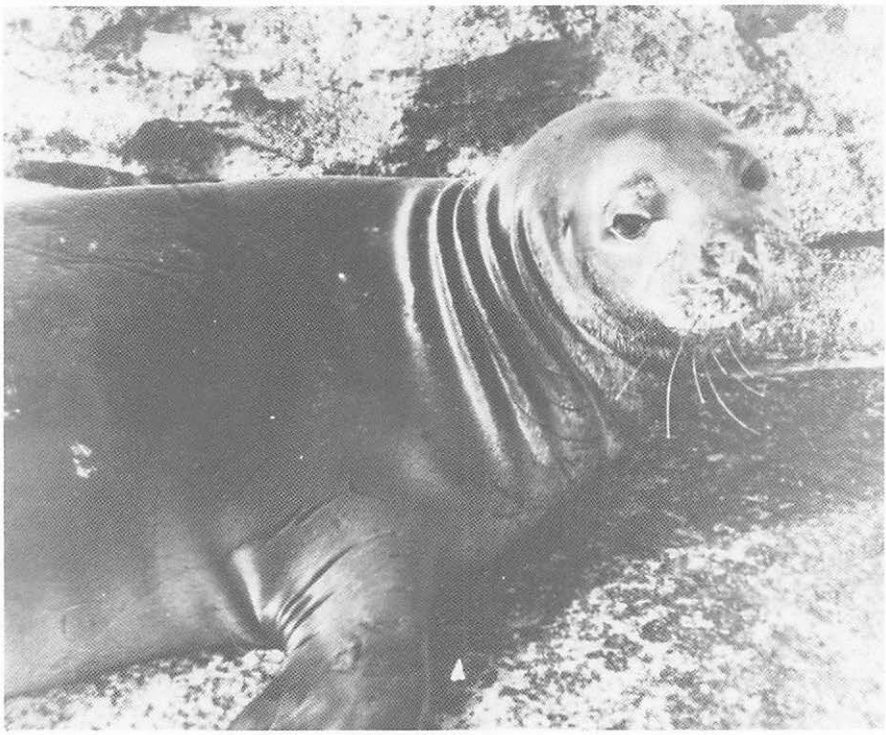


FIGURE 49.—Yearling monk seal at Laysan Island, showing detail of facial features and virtual absence of an external ear. Adult males weigh about 380 pounds (175 kg); females are larger and weigh about 575 pounds (260 kg). (Ronald L. Walker photo.)

chiefly on Laysan, Lisianski, and Pearl and Hermes Atoll, but the seal occurs regularly along the Hawaiian chain beyond Necker Island. R. L. Walker (pers. comm.) noted it in 1965 in the surge zone at Nihoa, and on wave-washed ledges of Necker Island. This animal tends to remain near the land rather than to wander greatly in the sea; for this reason it should be included among those species attached to the land, as a marine littoral form. Shreiber and Kridler (1969) report movement of one young male to Johnston Atoll.

Earliest record of *Monachus schauinslandi* is 1824, as discussed by Kenyon and Rice (1959, p. 215). These authors, and Rice (1960b) have made thorough studies of populations in the field. King and Harrison (1961) present detailed anatomical material; Kenyon and Fiscus (1963) establish a method of age determination; Butler and Udvardy (1966) report on behavior in response to an insect pest, and Wirtz (1968) considers growth and development. Bailey (1952), Svihla (1959), King (1964), and Rice (1964) have contributed review articles,

with some new information, and in this way have spread knowledge broadly to the reading public.

It is remarkable that *Monachus schauinslandi* was not described until early in this century (Matschie, 1905). Many brief articles over the years have preserved records of this animal and aided in publicizing its plight as a rare or endangered species, for example, Anon., 1838; A. B. Lyons, 1890; Anon., 1894; Atkinson and Bryan, 1913; J. A. Allen, 1918; Bailey, 1918; Galtsoff, 1933; and T. M. Blackman, 1941.

Present condition of the monk seal is not as encouraging as it was 15 years ago. Numbers declined into the 1970s (Kenyon, 1972) and may be well below 700 animals (Gilmartin, 1981). Johnson, DeLong, and others (1982) trace the trends after 1958. Increase was noted only at French Frigate Shoals. Human disturbance is a well-known factor in driving seals from their customary beaches and in disrupting the crucial mother-pup relationship. When Tern Island at French Frigate Shoals was abandoned by man in 1979 there was rapid increase in use of the site by seals (Schulmeister, 1981). Newly identified factors are shark attacks on the young, ciguatera poisoning acquired from eating certain reef fishes, and parasitism (Whittow, Balazs and Schmidt, 1979; Gilmartin, DeLong, and others, 1980). Sharks may prey successfully on adult seals (Balazs and Whittow, 1979a). Plastic debris such as net fragments from larger fishing boats is a hazard to monk seals of Hawaiian waters (Balazs, 1979b; Andre and Ittner, 1980; Conant, 1984) and is noted also as a hazard to seals of Alaska (Fowler, 1983). Torn nets often are repaired by replacing sections of net and then discarding remnants in the sea.

Though the Hawai'i population of monk seals has again declined, it is in better condition than its congeners. Neither Anderson (1978) nor Ronald and Duguy (1979) offer much encouragement regarding the Mediterranean form; the Caribbean form is officially extinct (Kenyon, 1977). The Hawaiian seal may have separated from that of the Caribbean much earlier than was thought formerly, well before the main Hawaiian islands had emerged (Repenning and Ray, 1977).

Recent studies of *Monachus schauinslandi* provide new insights into its ecology and behavior. Occasional extended movements have been recorded (Schreiber and Kridler, 1969; Johnson, Johnson and Taylor, 1981). Activity and feeding patterns were noted by MacDonald (1982) and Rauzon and Kenyon (1982), and Alcorn and Henderson (1984). A parasitic mite is described by Furman and Dailey (1980); physiological characteristics are reported by Kridler, Olsen, and Whittow (1971), Ohata, Matsuura, and others (1972), and by Whittow, Szerkerczes, and others (1975). Balazs and Whittow (1978, 1979b) prepared a comprehensive bibliography of the species and I refer the reader to that excellent resource. United States Department of the Interior (1984a)

reviews the official recovery plan written for this species. The American Society of Mammalogists (1984b) urges the designation of critical habitat as a measure in protection of the monk seal.

Mirounga angustirostris. Northern elephant seal.

ORIGINAL DESCRIPTION: *Macrorhinus angustirostris* Gill, Proceedings of the Chicago Academy of Sciences 1:33–34. 1866.

TYPE LOCALITY: Saint Bartholomew's Bay, Baja California, Mexico.

NATIVE RANGE: Breeds regularly on offshore islands from Baja California to central California, i.e., Cedros Island, Mexico, to Point Reyes, California. Ranges widely into the more northern waters of the eastern Pacific (Ronald, Selley, and Healey, 1982).

RANGE IN HAWAI'I: Vagrant, or perhaps a rare seasonal visitant, in the Northwestern Hawaiian Islands (three separate examples 1978–1980 at Midway Islands); and possible records for the neighboring Pearl and Hermes Atoll and Kure Atoll in the 1800s. Presence of the elephant seal in Hawai'i was first confirmed in February 1978 by George H. Balazs, who examined a living specimen at Midway (Fig. 80). The animal was a young female tagged a year earlier at San Miguel Island, off Southern California, by Burney J. Le Boeuf of the University of California at Santa Cruz. Balazs later confirmed the occurrence of an immature male and a mature male, but details of these sightings have not been published (Balazs, pers. comm.) These seals swam some 3,500 miles to have reached the Midway Islands outpost from the Mexican or California rookeries. See also Altonn (1978) and United States Department of Commerce (1978) who reported on the initial discovery.

The elephant seals are relatives of the monk seals, classified to a different subfamily of the phocid, or hair, seals (Anderson and Jones, 1967). The male is a particularly large beast, largest of all the pinnipeds, up to 15 feet (4.5 m) in length and weighing as much as 2.7 tons. Females reach a length of about 12 feet (3.6 m), but weigh only up to 0.7 ton. The male has an elongated, erectile proboscis, hence the name "elephant" seal (Ronald, Selley, and Healey, 1982). Social rituals are intense in the breeding colonies, with fierce competition between males for dominance status (Bartholomew, 1952). Foods on the Pacific coast include bony fishes, sharks and rays, and squids (Morejohn and Baltz, 1970).

Populations have recovered from nineteenth-century sealing (described by Scammon, 1968), with overcrowding now forcing establishment of new colonies. Perhaps these social pressures promote a greater than usual dispersal from traditional breeding grounds, resulting in the appearance of the several wandering animals in Hawaiian waters. The elephant seal is a hardy species,

spending its time at sea except when on the rookeries. Grinnell (1933) presents some information on the California population of that era. Both numbers and ranges were expanding. Cooper and Stewart (1983), Condit and Le Boeuf (1984), and Bodkin, Jameson, and Van Blaricom (1985) bring the record further up to date.

Equus caballus. Domestic horse (including feral populations and certain extinct ancestral forms).

ORIGINAL DESCRIPTION: *Equus caballus* Linnaeus, Systema Naturae, Ed. X, 1:73. 1758.

TYPE LOCALITY: Scandinavia.

NATIVE RANGE: Ancient ancestral forms evolved in Eurasia from New World stocks that spread to Asia, Europe, and Africa across the Bering Land Bridge. Residual American horses (also *Equus*) disappeared soon after the end of the Pleistocene.

RANGE IN HAWAI'I: Formerly present as distinctly feral populations on Hawai'i, Maui, and Kaua'i.

History of the horse in domestication is reviewed by Zeuner (1963, pp. 299–337). The late Pleistocene Eurasian equines have been regarded as geographically distinct subspecies of *Equus caballus*, or as separate species. Of these the recently extinct tarpan (*Equus caballus gmelini* Antonius) has probably been the chief contributor to modern breeds, and the living *Equus przewalskii* Poliakov may be a minor ancestor (Benirschke, Malouf, and others, 1965; Koulischer and Frechkop, 1966). Heavy draft breeds, spirited riding horses, and miniature horses have very likely been derived from the same basic stocks by selective breeding. Horses were already in domestication in the region of Turkestan or southern Russia, or in both, some 4,000 to 5,000 years ago.

Horses were first brought to Hawai'i in 1803, aboard the merchant ship *Lelia Bird*, under the command of Captain William Shaler (but often reported as captained by R. J. Cleveland). H. W. S. Cleveland (1886, p. 71) reports fully on this subject, explaining that for this voyage, after they had purchased the ship in Hamburg, Germany, his father and his partner, Shaler, decided on command of the ship "by tossing a copper." Shaler won, and Cleveland's name appeared on the ship's papers as supercargo.

Cleveland goes on to state (pp. 96–98) that the ship called at San Borgia (Baja California), where a missionary priest presented to it a stallion and a mare in foal, taken on board May 20, 1803. Another mare, also in foal, was purchased at Cabo San Lucas. Shaler arrived at Kealakekua Bay, Hawai'i, June 21, and the next day landed one of the mares at nearby "Tooagah" Bay. "This was the first

horse ever seen in Hawai'i, and it excited great astonishment among the natives." The ship proceeded to Maui where the remaining mare and stallion were landed, presumably at the present site of Lahaina. Kamehameha I, for whom the horses were intended as a gift, "only remarked that he could not perceive that their ability to carry a man quickly from one place to another would be sufficient compensation for the great amount of food they would necessarily require."

Horses were soon common in the islands, perhaps largely from many further importations from Spanish California. Andrew Bloxam (Bernice P. Bishop Museum, 1925, p. 30) observed on his arrival in Honolulu on May 6, 1825, that "horses are very plentiful on the island," and that they were "let out at a dollar per diem." In 1832 the first of the famous *paniolo* (Mexican cowboys) arrived at Waimea, on Hawai'i, and they and their native successors have become legendary in association with the expansive Parker Ranch (Hobbs, 1939).

The Royal Hawaiian Agricultural Society has left us with several impressions of the horse in the Hawaiian culture. Apparently there were those residents who regarded it as a mere working beast or as a casual possession for inexpensive transportation, and those who prized it as a refined segment of the economy. It was obvious that by 1850 there were many steeds of poor quality. G. P. Judd (1853) reports on progress in horse breeding. Cummins and Meek (1851) and Meek, Howland, and others (1854) deplore the lack of proper control of the horse population. Lee (1853) objected to certain methods of handling the animals, and Hopkins (1854, pp. 105–106) quite plainly stated in relation to O'ahu:

> About one-half of the horses on the Island are never used for any purpose but multiplication,—are never bitted or backed,—are born, live and die without being of any advantage to anyone, or having served any purpose, useful or ornamental, but the impoverishment of the land, and the propagation of nuisance.

The Hawaiians took readily to the loose ownership and use of horses in a manner mildly comparable to that of the Plains Indians, and this must have contributed to the foregoing objections of those desirous of maintaining and improving strains of saddle, carriage, and draft horses.

Adoption of the horse by the natives was, however, not immediate after its arrival, especially outside of O'ahu, for Bird (1964, p. 107) relates that when the missionary Titus Coan came to Hilo in 1835, in succeeding years he visited outlying villages on foot because, "Horses were only regarded as wild animals in those days." Nor were they used in that era for dragging timbers from the forests to build churches, for the Hawaiians themselves did this work (p. 110). Bird observes also (p. 167) of the natives of Honolulu in 1873, "The passion for riding, in a people who only learned equitation in the last generation, is most curious." And (p. 188), "Except for short shopping distances in Honolulu, I

FIGURE 50.—Horses and mules roaming freely on pasture at the beach front in Waipi'o Valley, on Hawai'i. These are owned animals but few are used regularly. July 1960. (Howard Pierce photo.)

have never seen a native man or woman walking . . . and I have seen men take the trouble to mount horses to go 100 yards."

Miss Bird rode several hundred miles on horseback about the islands in 1873 and, as a proper English lady, was generally unfavorably impressed by the quality and care of horses. When her steamer first docked in Honolulu, she saw an assemblage of some 200 horses, each with a Mexican saddle and standing in the sun, she wrote (pp. 15–16):

> They were sorry, lean, undersized beasts, looking in general as if the emergencies of life left them little time for eating and sleeping . . . heavy-headed and heavy-hearted, with flabby ears and pendulous lower lips, limp and rawboned. . . . Every now and then a flower-wreathed Hawaiian woman, in her full radiant garment, sprang on one of these animals astride, and dashed along the road at full gallop.

Further notations (pp. 69, 119, 120, 187) bear a similar theme. On Kaua'i (p. 195), when a mount was caught in quicksand it was abandoned because it was "only a horse."

The Hawaiian horse must have been somewhat reluctant to take to the wild and often roamed about settlements, which may have led to the observation (Bird, 1964, p. 180), "Horses are abundant and cheap on Kaua'i: a fairly good one can be bought for $20. . . . Indeed the horses seem to outnumber the people."

We have relatively little information about truly feral horses, possibly because attention was focused on the stray or half-owned animals near the villages. C. S. Judd (1936) provides a realistic summary:

> Wild horses were never so abundant as wild cattle on Mauna Kea but they have been there in feral state since soon after their introduction in 1803.
>
> These horses were very hardy animals, strong for their small stature and had excellent feet. The last of them were driven out of the Mauna Kea forest reserve in 1932 but there are two or three still in one of the upper paddocks of the Parker Ranch on the land of Humuula.

Horses were less prolific than cattle, and less able to survive in the forests or high in the mountains. Moreover, they were probably a desirable animal to capture for return to domestication. I have discovered no records of mass slaughter of horses, or of other means of reducing their numbers. Reports of the Territorial Board of Commissioners of Agriculture and Forestry show that when pigs, sheep, cattle, and goats were removed by the hundreds and thousands from the Forest Reserves in the two-year period prior to 1925, only one wild horse was taken; two horses were removed in 1927 and six in 1929.

G. Swedberg (pers. comm., 1964) found on Kaua'i that at one time a fair number of horses ranged uncontrolled above Kekaha Town and west of the Kōke'e Road. These animals undoubtedly bred in the wild but were not a true feral population. Tinker (1938, p. 116) probably refers to this group of horses, which disappeared some time after 1937. Another Kaua'i population, consisting of a few short-coupled, large-headed, and heavy-footed horses, occupied the bottom of Waimea Canyon near the Kukui Trail and in the Hanalei-Hā'ena region for as far in the past as local residents could remember, according to Swedberg. These horses had undergone some genetic selection in the wild. A hazy ownership of them was claimed, but they were not managed in the usual sense as domestic horses.

For Moloka'i, N. K. Pekelo, Jr., reports (pers. comm., 1965) that unbranded horses had ranged in Hālawa Valley since the 1946 *tsunami*; there is no history of truly feral horses on that island. J. S. Medeiros (pers. comm.) states that on Maui feral horses once roamed in the Erehwon Ranch adjacent to the west end of Haleakala National Park, and the upper reaches of Haleakalā Ranch in the same region. These animals were present as late as 1942, and as many as ten were known there about that time. They did not venture into Haleakalā Crater as is assumed by Yocom (1964, p. 25). Stray horses occupied Lāna'i at various

times, and the last of these were hunted out in 1951–1952 with the last of the cattle, according to Medeiros.

On Hawai'i stray and loosely controlled horses are still present in Waipi'o Valley, and perhaps elsewhere, but these are owned animals; I know of no feral horses in the State of Hawaii today.

The total effect of horses on the lands must have been slight compared with that of other ungulates. Yet, cropping and trampling of vegetation must be ascribed to them, and registered as a factor in the depletion of vegetation and soils.

McKnight (1959) provides refreshing material on American continental populations that arose from animals left by the Spanish explorers.

There is little to add in 1985 to the story of the horse in Hawai'i. There is an apparent increase of recreational riding; the cattle ranch horse is a mainstay, as always, even though increasingly supplanted by pickup trucks and motor bikes. Recent titles on evolution of the horse, development of domestic breeds, and their management are Clabby (1976), Edwards (1979), Macgregor-Morris (1982), and Waring (1983). The work of Keith (1980) may have some parallels for older days of horse-farming in Hawai'i, and a behavioral note is supplied by Janzen (1978). Interest in the feral horse of the western United States has been intensified by Monagan (1982) and Eberhardt, Majorowicz, and Wilcox (1982). These last authors note a report of 59,000 feral horses currently on public lands in the West.

Equus asinus. Donkey (including wild, domestic, and feral types).

ORIGINAL DESCRIPTION: *Equus asinus* Linnaeus, Systema Naturae, Ed. X, 1:73. 1758.

TYPE LOCALITY: "Asia."

NATIVE RANGE: Northeast Africa.

RANGE IN HAWAII: Donkeys have existed in the feral state on Hawai'i, Kaua'i, Moloka'i, and possibly other of the main islands, and at Midway Islands. Present now only on Hawai'i.

The donkey is a direct descendant of the wild Nubian ass (*Equus asinus asinus*). It is of ancient association with man in Egypt, in domestication there at least 5,000 years (Reed, 1959, p. 1632). Of the several geographic races of wild asses in Asia (*Equus hemionus* Pallas), including the kiang, kulan, and Syrian onager, only this last race (*Equus hemionus hemionus*) was tamed, about the same time as the donkey, but has not intermixed with it.

Arrival of donkeys in Hawai'i was seemingly late; the first record I have found is for 1825. Brookshier (1945) has prepared a thorough paper on the donkey in Hawai'i, although few of his sources are given. The 1825 importation

of four donkeys to O'ahu from England by Richard Charlton, the first British consul to Hawai'i, was heralded by Andrew Bloxam (Bernice P. Bishop Museum, 1925, p. 14) who observed the animals on board Charlton's ship *Active* when they met in the harbor at Valparaiso, Chile. He records (p. 14): "On February 6, 1825, Captain Charlton sailed for the Hawaiian Kingdom, with a 'most extraordinary cargo on board, consisting of donkeys and Jew's harps.'" Bloxam observed (pp. 30–38) that the four animals were sold at auction on their arrival at Honolulu, and he later used one of them briefly in his explorations of O'ahu.

Brookshier (1945) indicates that no mention of the donkey is to be found for the 1830s and 1840s, but that the animals were used on Hawai'i prior to 1847 by the bullock hunters to carry hides from the hunting grounds to Hilo. In the 1850s and 1860s they were an item of export to the Pacific coast and to other Pacific islands. Donkeys in Hawai'i were put to general use in agriculture and in packing. At one time they carried rice over the Pali trail from windward O'ahu to the Nu'uanu Mill in Honolulu. On Hawai'i they carried taro up the steep trail out of Waipi'o Valley, and were later replaced in this work by mules.

The "Kona nightingale" (Anon., 1934, 1938c) was useful for transport of coffee fruit and supplies in the stony coffee fields of the Kona districts of Hawai'i, but since the 1950s jeeps have gradually taken over these tasks.

Donkeys were released at an unspecified date at Midway Islands and were present there in 1923 (E. H. Bryan, Jr., and Collaborators, 1926). Hadden (1941) refers to this event in the historical sense as if they were then no longer present. He says (p. 180), "Donkeys that were turned loose on Eastern Island managed to survive by going down to the edge of the beach, where they pawed holes in the sand and drank water which trickled into these holes." Elschner (1915, p. 63) had apparently made the original record on this same colony when he observed, in 1915, "About twenty burros were on the island having been brought from Laysan when the phosphate mining ceased; they are masters of the island and have become quite savage." He also described their means of obtaining water. Because guano mining ceased on Laysan about 1904 (E. H. Bryan, Jr., 1942, p. 186), the donkeys may have been transported to Midway as early as that year, and remained there for 20 years or more.

There are few other records of feral donkeys and they must have been few in total numbers. However, in the great roundups of livestock from the forest reserves on Hawai'i in the 1920's, fewer horses than donkeys were taken out. The Report of the Territorial Board of Commissioners of Forestry and Agriculture of 1931 reveals (p. 36) that 27 donkeys were eliminated in 1929, and 68 in 1930. Cummins and Meek (1851, p. 77) regarded stray donkeys as possibly locally abundant, and as a nuisance to horse breeding.

Two populations of feral donkeys are established on Hawai'i. L. Nichols, Jr.

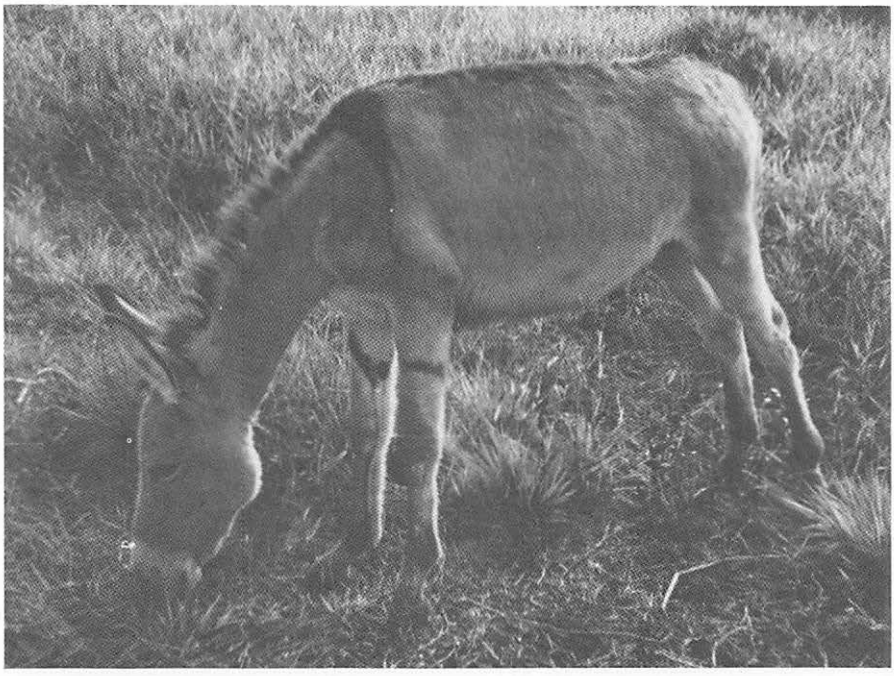


FIGURE 51.—Feral donkey (*Equus asinus*) captured as a colt on Hawai'i and transported to Kaua'i where it was tamed. Wild-type markings seen on this specimen are usual in domestic strains. An adult donkey weighs approximately 550 pounds (250 kg). (Gerald E. Swedberg photo.)

(pers. comm.) counted 19 of these animals from the air in 1964 in the lava fields of the Ka'ūpūlehu-Kīholo area of North Kona District. Few people were then even aware of this population. The McCandless Ranch of South Kona District estimated in November 1965, some 50 to 60 donkeys present on its range lands (Norman Nichols, pers. comm.).

A few donkeys roamed the northern part of Kaua'i in the period ca. 1900–1920 (G. Swedberg, pers. comm.), but these were finally killed for meat, which was prepared as jerky by the Hawaiians living there. U.S. Geological Survey parties abandoned donkeys in Pelekunu Valley, Moloka'i, in the late 1930s. A small population persisted there until 1964 when the last animals were shot by indiscriminate hunters (Noah K. Pekelo, Jr., pers. comm.).

Feral donkeys appear to be of no great ecological significance because of their scarcity and their use of arid lowlands marginal for cattle raising or support on native vegetation. McKnight (1958) provides good background material, from the western United States, which should stimulate interest in the Hawaiian populations.

In 1985 the donkey remains a curiosity in Hawai'i and several feral populations are still at large. With recent land development schemes, some have come into prominence and have been used in promotional materials on the Kohala coast of Hawai'i as an example of the appeal of rural living (Anon., 1971b). In another story, donkeys of the South Kona McCandless Ranch were featured relative to an annual Coffee Festival (Anon., 1972c).

With opening of the coastal Queen Ka'ahumanu Highway (Keāhole Airport to Kawaihae, on Hawai'i) donkeys coming to shoreline springs became a hazard to automobile traffic. I noted for the first time on September 21, 1981, that signs warning of donkey crossings were erected along the route near the 86-mile marker, in the land division of Ka'ūpūlehu. These are standard highway signs with a well-drawn silhouette of a donkey on a yellow background. There is a scattering of backyard and farm pet donkeys in Hawai'i, caught usually in the wild and tamed. The Honolulu Symphony announced (Anon., 1968c) that one such animal was to be used in the set for a production of "Pagliacci." Donkeys are durable creatures. The animal in Figure 51 was owned originally by Swedberg, and later by Ralph Daehler who informed me in 1980 (pers. comm.) that he transferred it to O'ahu, where I observed it on display as a sleek matronly specimen at the Waimea Arboretum and Botanical Gardens. However, the animal was returned to the wild herd on Hawai'i in 1982 because of chronic dermatitis which was uncontrollable in the moist climate of the gardens (Davis, 1983).

In the southwestern United States feral donkeys have become a pest on National Park lands where they overgraze range lands, foul springs, and restrict access to water by native ungulates and other wildlife. Hillinger (1977) provides background on the problem, and describes some current solutions. Moehlman (1972), Woodward (1979), McCort (1980), and Blake, Douglas, and Thompson (1981) have studied donkeys on a Georgia island and in Death Valley, California, relative to intraspecific behavior and population genetics.

Equus asinus x Equus caballus. Mule.

The mule is specifically a hybrid between a jack and a mare, and the hinny a product of a stallion and a jenny. Both forms are generally referred to as mules; the preferred hybrid is the true mule. The hinny differs from the mule in having a fuller horselike tail, in having a body disproportionately large in comparison with the legs, and in having a more tractable disposition. Both hybrids are sterile because of incompatible chromosome series in the parent species (Benirschke, Low, and others, 1964), a fact that has not been widely recognized.

These hardy animals have been produced in Hawai'i wherever horses and donkeys were run or strayed together. Comments of Cummins and Meek

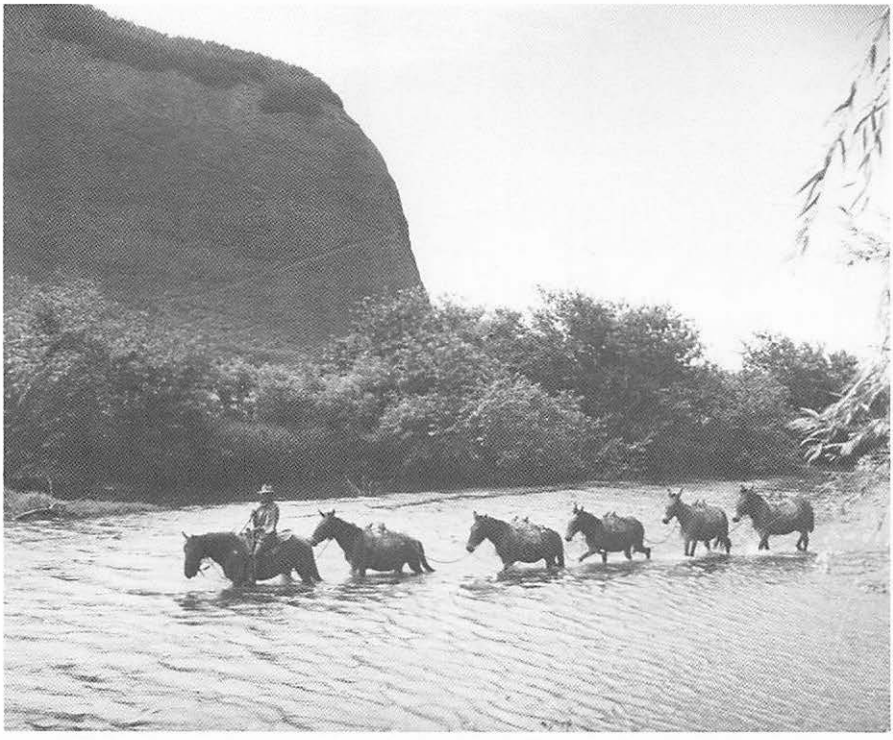


FIGURE 52.—Mule train returning to Waipi'o Valley after hauling taro to its rim nearly 900 feet (275 m) above. Jeeps took over this work in 1961. The distant zigzag trail is a route to Waimanu Valley. July 1960. (Howard Pierce photo.)

(1851) suggest that mules were present in Hawai'i well before 1851. Whether the first mules were shipped in, or were bred here after importation of donkeys in 1825, is a matter of conjecture. Malo (1951, p. 41) clarifies the situation very little when he says, "The recently imported animals from foreign lands, which came in during the time of Kamehameha I, and as late as the present time, that of Kamehameha III, are the following . . . The donkey (*hoki*) and the mule (*piula*)."

Lee (1853, p. 13) recognized the worth of the mule, but indicated a lack of direction in its production when he said of it, "This is a very valuable animal, and is principally used by the natives as a beast of burden to bring their poi and other produce to market. Now and then we see a fine mule ten or 12 hands high, but generally they are small and inferior."

Mules became especially important with extensive development of sugar plantations, possibly by the 1880s. They were stabled by the hundreds until the use of trucks and track-layer tractors became general after World War II. Anon.

(1908a) reveals the need for and scarcity of mules in the early 1900s and reports on 1906–1907 importations. An additional 750 mules were imported in 1908, more than a hundred of which were for military use (Report of the Territorial Board of Commissioners of Agriculture and Forestry for 1909, p. 137). Mules, whether produced in Hawai'i or brought in, were transported freely among the islands; one is recorded even from Kaho'olawe, in 1913 (H. P. Judd, 1938a). Cooke (1949, pp. 55–56) describes breeding and use of mules on Moloka'i.

The program for elimination of livestock from the forest reserves does not prominently mention mules and these are not tabulated in reports, but a few were rounded up. Tinker (1938, p. 133) reports mules abandoned by taro growers in the Pelekunu Valley on Moloka'i. R. J. Kramer (pers. comm.) observed four in the upper Hālawa Valley on the same island, in 1961. Others still roam in these or similarly remote places. On June 22, 1962, I observed a fat red mule in Waimanu Valley, on Hawai'i, where it kept the entrance trail open by beating a path through the tangled accumulation of grasses (*Panicum*) that was as deep as six feet. A few mules are purposely employed to munch and trample vegetation along access trails of the Upper Hāmākua irrigation ditch system on Kohala Mountain, in order to keep trails open. Mules are also indispensable in general maintenance of the Kohala Ditch in deep canyons of the same mountain (Anon., 1968b).

In Waipi'o Valley, on Hawai'i, mules supplanted the donkeys that earlier carried bags of taro over the steep mile-long trail to the road at the valley rim, and were in turn gradually replaced by jeeps when the trail became a negotiable road after 1946. Theodore Kaaekuahiwi of Kukuihaele was the last taro grower to operate one of these picturesque mule trains on the *pali* road, in 1961. Mules still range freely in the valley, but are used for local transport of taro from more distant paddies to the valley road. Pierce (1965) reports employment of mules to haul commercial fertilizer to the higher fields of a Ka'ū District sugar plantation, on Hawai'i.

In its relationship to the environment, the mule has been generally innocuous. As a sterile offspring of the horse and donkey, it is unable to form its own populations and its numbers in the wild have been small. Social organization is apparent among them, and they generally move about in loose bands often including horses, as in Waipi'o Valley. One January evening in 1965, as I stood on the dunes near the beach, I watched several mules pass by and cross the stream near its mouth to the meadow beyond. Two others then appeared on the same route and halted among the low dunes. Both were especially alert and observed the several ahead, some 200 yards off. One sounded a distinct neigh that phased over to a typical braying; then both mules hurried off to join their companions. Altmann (1951) presents an excellent account of mule-horse sociology.

The mule story continues into more modern times with a few notes on persistence of this form in commerce and as a curiosity. As recently as 1973 one sugar plantation maintained mules for transport of seed cane from less accessible fields (Anon., 1973a). A tourist-oriented mule ride service has been available for several years on Moloka'i and was reported as resuming after a year of shutdown (Anon., 1982c). Mules continue to be bred in Hawai'i, and a resident of Āhualoa Homesteads on Hawai'i rides a sporty animal with appaloosa markings.

Savory (1970) provides an illustrated review of the mule and its parentage; Chandley and others (1974) delve into the genetics of infertility in horse-donkey hybrids.

Sus scrofa. Pig (includes originally wild forms, domestic swine, and those reverted to the wild).

ORIGINAL DESCRIPTION: *Sus scrofa* Linnaeus, Systema Naturae, Ed. X, 1:49. 1758.

TYPE LOCALITY: Germany.

NATIVE RANGE: As a truly wild species (Eurasian wild boar) the pig has occupied all of Europe and northern Africa, Asia Minor, southern Asia, and north to Taiwan, Japan, and Korea. Its range is now much restricted and has been influenced by man through hunting as well as introduction (adapted from Ellerman and Morrison-Scott, 1951, p. 345).

RANGE IN HAWAI'I: Formerly present in the feral state on probably all eight major islands; briefly present also on Laysan. Found now only on Ni'ihau, Kaua'i, O'ahu, Moloka'i, Maui, and Hawai'i.

Reed (1959, pp. 1635–1636; 1960, pp. 138–141) discusses references to a supposed single ancestor of the domestic pig as the subspecies *Sus scrofa vittatus* Boie of southeastern Asia. These imply a much earlier domestication than is supported by archaeological evidence and suggest an improbable prehistoric transfer of these stocks to the Near East and Europe. This same author notes in modern populations of Western pigs a marked preadaptation for easy taming and suggests a reinvestigation of the possibility that pigs may have been domesticated at several times from different wild populations. He reports that Jarmo, in Iraqi Kurdestan and occupied about 8,500 years ago, is the oldest presently known site where domestic pig remains have been found (Reed, 1961, p. 33).

Pigs of Asian ancestry were introduced to Hawai'i during ancient times by the Polynesians, and served as an important source of food. They were also, according to Luomala (1960a, pp. 225–226), used in sorcery and had more prestige in religion than had the dog. Pork could be eaten only in the men's

house, and was taboo to women. Buck (1957) illustrates boar-tusk bracelets and provides other references to the pig in Hawaiian culture. These animals are presumed to have been rather small in size, and to have remained readily in domestication. Cook (1785, Vol. 2, p. 234) noted on Kaua'i in 1778 that pigs were in abundance and ran without restraint about the houses, and (Vol. 2, p. 543) of those traded for on Hawai'i in 1779, "we could seldom get any above fifty or sixty pounds weight." Ellis (1917, p. 23) observed in 1823 that the natives possessed among their original quadrupeds, "a small species of hogs, with long heads and small erect ears." These were sometimes found in the mountains and were the only ferocious animal of the islands. He noted further (p. 162) at Kapāpala, "Few of the Hawaiian females are without some favorite animal. It is usually a dog. Here, however, we observed a species of pet we had not seen before. It was a curly-tailed pig, about a year and a half old, three or four feet long, and apparently well fed. It belonged to two sisters of our host."

Cook brought English pigs on his first voyage to Hawai'i (Cook, 1785, Vol. 2, p. 217), and landed a boar and sow on Ni'ihau February 2, 1778. Many importations have followed. In the early 1820s at least a few pigs were exported to establish this animal in the colonies of the Pacific Northwest (Scouler, 1905, p. 166). Presumably all eight main islands of Hawai'i that supported Polynesian settlements also had pigs. Anon. (1902a) indicates wild pigs on Kaho'olawe before 1840, and these may have been in part of Polynesian stock. They disappeared at some unknown date, and probably had been gone long before 1913 when Forbes (1913a) visited the island. I have found no early reports of feral pigs on Ni'ihau, but Franck (1937, p. 322) found them there in 1936, and Fisher (1951, p. 33) found great numbers of them. The 1891 record of this species on Laysan (F. D. Walker, 1909) was likely of animals kept only for a short time, and though allowed to roam over the island, were presumably eventually slaughtered for food. Some may have been reared there, however, for Walker notes (p. 30) that the pigs were found foraging on an abundant "yam" (= *Boerhavia*, which has a fleshy root) and very little other food was required. No mention is made of their possible effect on nesting of sea birds. This activity may have been slight, or it may have been ignored. Pigs are not mentioned on Laysan by later writers.

Feral pigs have long been distributed in the upland forests and pastures of the six larger islands they inhabit, except on Maui where they were found as late as the 1960s only in the West Maui Mountains in the Kahakuloa area (J. S. Medeiros, pers. comm.), and in East Maui at Kīpahulu Valley (Warner, 1967). Hawai'i has the largest, most widely distributed populations.

The old Polynesian type of *Sus scrofa* has been absorbed or replaced by stocks of European origin. Warner (1959) and Nichols (1962d) are of the opinion

FIGURE 53.—Young male feral pig (*Sus scrofa*) in the mountains of Hawai'i Island. A long snout, coarse mane, straight tail, and black color are characteristic of these pigs. Mature boars usually weigh up to 150 pounds (70 kg), but much larger specimens are on record (Nichols, 1962c). (Lyman Nichols, Jr., photo.)

that the feral Hawaiian pig of today is typically like the Eurasian wild boar of Tennessee and California, which is intermixed with semidomestic strains of pigs. Hence, the island pigs are referable to the same subspecies, *Sus scrofa scrofa*. Young are usually black, but may have the wild-type longitudinal reddish striping in the juvenal pelage (Fig. 54). Adults are generally also black, but occasional spotting or white feet indicate persistence of domestic strain traits in some populations. Pullar (1953) observes similar conditions in Australian pigs.

In the middle of the nineteenth-century R. J. Hollingsworth (1853, p. 75) made the following recommendations in relation to efficient hog raising with selected breeds in Hawai'i:

> Concerning location, I would advise those interested in this matter to allow their hogs to run at large, and if possible that run to comprise a ravine that abounds with wild apples, guavas, etc., as those fruits afford food for hogs one half the year at least, and as security against the swine going wild, accustom them to be herded at the sound of a horn, and entice them into a pen every night, by dealing out some luscious kind of food."

FIGURE 54.—Feral piglet about 3 weeks old captured on open range near Waimea, Hawai'i. After several days of hand feeding, it foraged amiably about the garden. Object in the mouth is an earthworm rooted from the loose soil. Wild-type pelage stripings are evident. (Courtesy of Samuel Kaaekuahiwi, Jr.)

Doubtless such practices led to escape of some of the selected stock and frequent admixture with the wild pig of early Hawai'i, or progeny of later introductions that had penetrated the heavy forests and other wilderness regions. C. S. Judd (1936) indicates that ranchmen in his time, or in some earlier era, purposely released imported boars of selected breeds on Mauna Kea to improve quality of the feral pigs.

On most ranches on Hawai'i, pigs are now managed to the extent that they are regularly hunted as food. Young males are often castrated and freed for later harvest, and sows are not usually taken. In hunting, the pigs may be shot, roped from horseback, or caught by hand with the aid of dogs. Feral pigs taken alive are frequently reared or fattened in pens.

Vollrath (1947) reviews methods in commercial pork production. Domestic pigs are generally confined in piggeries remote from the wild populations. I have observed, however, as in Puna District, Hawai'i, in 1964, that relatively tame wild-type pigs are sometimes loosely mingled with inferior domestic types in some farmyards where the animals are permitted to run loose in the adjacent forest.

Feral pigs, in spite of their obvious quality of providing a substantial source of food (and no Hawaiian feast is complete without a pig, or several of them, roasted in the *imu*), have been considered a pest when numerous in specific

FIGURE 55.—Excited feral boar on Hawai'i Island. The mane is bristled and the tusks are bared; alerted pigs audibly gnash their tusks when apprising danger, and this behavior serves to hone the edges of these teeth (Lyman Nichols, Jr., photo.)

forest regions. Watersheds, forests, and range are damaged when pigs root excessively and disturb the forest floor and its plant cover, or the perennial sods of pasture lands. The following reports from the Territorial Board of Commissioners of Forestry and Agriculture indicate the problem as recognized some 60 years ago:

> The central forest of O'ahu is riddled with wild pigs which are removing the undergrowth and it is most desirable that the new appropriation be extended to cover this pest as well as the goats. Already, with contributed funds we have begun to tackle this difficult work by constructing a pig hunters' cabin on the Koolau Range in the Ewa Forest Reserve. [Report for 1925, p. 21.]

> The damage done by wild pigs continues, especially on the Koolau Range on O'ahu. These are not being exterminated rapidly because of the remoteness of their haunts and the difficulties which hunters experience in reaching their range. [Report for 1929, p. 22.]

McEldowney (1930) speaks further on the same issue. With increased human population on O'ahu, pigs have receded in numbers and today they are not easily found. L. W. Bryan (1937c) reviews the history and status of pigs on Hawai'i, and Tower (1926), Tillett (1937), Vitousek (1941), and Nichols (1962e) present stirring episodes from the rugged sport of hunting pigs on O'ahu and Hawai'i.

In modern game management *Sus scrofa* figures prominently, particularly on Hawai'i, and specific attention has been given it. A research project begun in 1958 (Warner, 1959) was carried on until 1964, with the assembling of a wide variety of useful data (Nichols, 1961a, 1962d, 1963, 1964a). These progress reports show that a firm foundation has been laid for the understanding of the pig as a game animal closely associated with the economic interests of landowners. Hanson and Karstad (1959) present comparative data on feral swine in the southern states, and Henry (1968) reports on their estrous cycle and gestation period.

With substantial progress in control of feral goats on some National Park lands and the court-ordered elimination of feral sheep from habitat of endangered native birds on Mauna Kea in the 1970s, the feral pig has emerged as the most prominent agent of ecological perturbation, of wet forests in particular.

Recognition of the pig as a destructive factor in Kīpahulu Valley (incorporated into Haleakala National Park in 1969, largely as a gift of The Nature Conservancy) came at first gradually (Banko and Wilson, 1968), but less than ten years later pig damage in the open lower valley assumed emergency proportions (Lamoureux and Stemmermann, 1976). With firm evidence that strawberry guava (*Psidium cattleianum*), a shade-tolerant alien tree, was invading the forest through transport by pigs, plans were formulated for intensive investigation (Smith and Diong, 1977), and these plans have since been carried forward with the management recommendation (C. W. Smith, Editor, 1982) for protection of the whole valley by eradication efforts and the

formation of a buffer zone. The pig and strawberry guava headed a list of undesirable alien species. See also Jacobi (1976), Diong (1980), Yoshinaga (1980), and Gagné (1982) for methods of trapping pigs; alien vegetation and pigs; and effects of pigs on bog plants. Several sources indicate that pigs are now widely spread in wet uplands of West Maui.

Meanwhile, research on the pig at the state level has continued, with a final report issued for Hawai'i Island (Giffin, 1978). Other work on this island includes that of Cooray and Mueller-Dombois (1981). At Hawaii Volcanoes National Park, major studies of the feral pig continue in the formulation and execution of management plans (Katahira, 1980; Higashino and Stone, 1982). This work emphasizes fencing of pigs from key areas and is proving to be a feasible management program which can be expanded. See also Warshauer, Jacobi, and others (1983), and Brower (1985).

A conference entirely on the subject of feral pigs was held in August 1980, at Hawaii Volcanoes National Park. It suffices to say that research on control and management of pigs is at an exciting level. Programs appear now to be limited only by available funds and manpower. In keeping with objectives of this book it is impossible to provide more detail. Attention is fixed on management of the feral pig in continental United States (Pine and Gerdes, 1973; Barrett, 1978; Wood and Barrett, 1979; Barrett and Pine, 1980; Singer and others, 1981). Reports from elsewhere include Diong, 1973; Hone and O'Grady, 1980; Hone, O'Grady, and Pedersen, 1980; and Andrzejewski and Jezierski, 1978. Challies (1975) relates pigs to a New Zealand island biota. Aspects of techniques and biology are treated by Henry (1969), Andrzejewski (1974), Covacevich (1976), and Baber and Coblentz (1982). Hunting of pigs in Hawai'i is still a favored activity as indicated by Takimoto (1974). Regular reports on the status of the pig as a game mammal are issued, as exemplified by Telfer (1982), Bachman (1982), and Saito (1983) relative to hunting within state game management areas.

Axis axis. Axis deer.

ORIGINAL DESCRIPTION: *Cervus axis* Erxleben, Systema Regni Animalis, p. 312. 1777.

TYPE LOCALITY: Banks of the Ganges River, India.

NATIVE RANGE: Ceylon and Peninsular India, northward to Kumaon, Nepal, Sikkim, Bengal (Ellerman and Morrison-Scott, 1951, p. 360).

RANGE IN HAWAI'I: Principally on Lāna'i and Moloka'i; one remnant population on O'ahu; introduced on Maui in 1960.

The axis deer in Hawai'i is a true wild species that has descended from an original stock of eight animals brought to Moloka'i in 1868. There are two

subspecies of axis deer, the nominate *Axis axis axis* (Erxleben) of the Indian mainland, and *Axis axis ceylonensis* (Fischer), found only on the island of Ceylon (= Sri Lanka). It is probable that Hawaiian populations are derived from the Indian form. The axis deer is usually designated as *Axis*, a genus distinct from that of the elk (*Cervus*), but its affinities with the elk are plainly evident in behaviorism, in antler form, and in the fact that upper canine teeth are sometimes present. Nichols (1960a, p. 5) reports this observation from Hawaiian specimens: "Fawns are born with a small pair of upper canines implanted in the maxilla; these are usually shed before the animal reaches one year of age, but may occasionally be found remaining in the cartilage of the upper jaw of adults." Graf and Nichols (1966, pp. 652–653) expound fully on this matter.

The original deer arrived in Honolulu in December 1867 on the trader *Loch Na Garr* out of Hong Kong, as a gift to Kamehameha V. Three bucks and four does had survived the voyage and a male fawn was born aboard ship during the layover in Honolulu harbor. The deer were transshipped in the King's yacht to his private lands on Moloka'i in January 1868, where they established the first herd. At some later date several were returned to O'ahu and released, and in 1920 a group of 12 was introduced to Lāna'i. Various authors have referred to these events (Tinker, 1938, pp. 120–121; Lennox, 1950; Nichols, 1962a, p. 90), but the bases for their statements are not all known to me. Cooke (1949, pp. 64–67) is perhaps the best single source of information, inasmuch as he includes quotes of newspaper articles researched by the Archives of Hawai'i. It appears that the deer were shipped from India via Hong Kong through consular connections and that Dr. William Hillebrand (1821–1886), the eminent physician-botanist, had made arrangements for obtaining them when in Calcutta. Hillebrand, in spite of his concern for the threat by feral cattle to integrity of native forests, was instrumental in the importation of many alien plants and animals (Degener, 1932–1980, Bk. 5, p. D) and the axis deer was quite possibly among them. Another version of the event, as related by Tinker (1938, p. 120), but undocumented and unlikely in view of the several newpaper articles quoted by Cooke, places the deer as a gift from the Hawaiian Consul to Japan, and originating from the Imperial deer park of Japan.

On O'ahu a herd was present on Diamond Head prior to 1898, but had died out sometime thereafter. The Moanalua Valley herd began about 1910 from escapes, and increased to about a thousand head in 1938, but deer were very scarce there by 1950. R. J. Kramer (pers. comm.) estimated in 1962 that there were about 25 in the valley, in *kiawe (Prosopis)* thickets above Salt Lake. Pressures from land development, poaching, and stray dogs have kept this herd small and may have annihilated it.

The herd on Moloka'i increased to an estimated 1,000 within 20 years (Anon., 1947a) and in about 30 years became a pest in its relatively protected status on

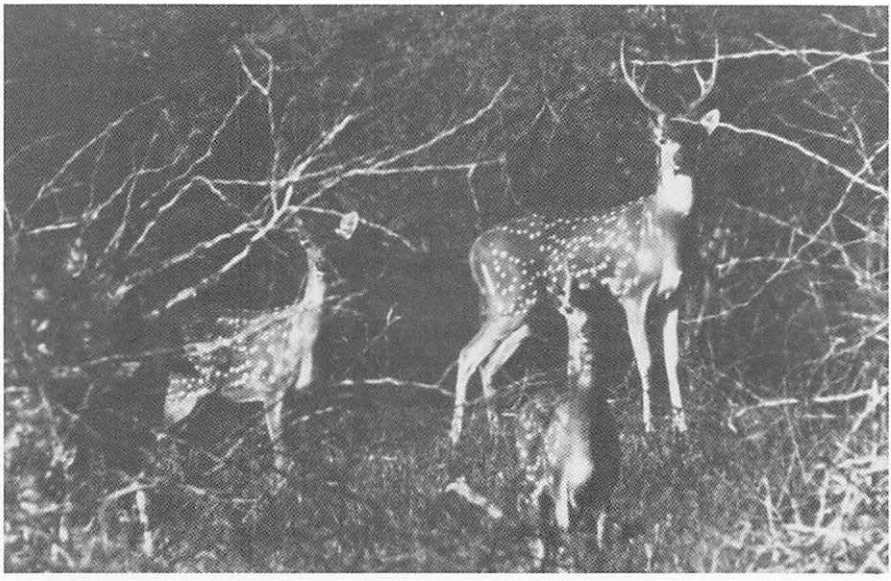


FIGURE 56.—A group of alert axis deer (*Axis axis*), on the island of Lāna'i. The young male in the foreground has spike antlers. The spotted pelage is present in adults as well as in the fawns. Thickets of the introduced *kiawe* (*Prosopis*) provide excellent food and cover. (Lyman Nichols, Jr., photo.)

private lands. Sabin (1934), for all the discrepancies in other facets of his article, may be on good authority when he states, concerning these same deer (p. 40), "At the end of the century they had become so numerous that experienced hunters were engaged to dispose of a considerable proportion. These hunters were from California, remained in the islands about a year, killing nearly 3000 deer." Cooke (1949, p. 67) gives the number as 3,500 to 4,000 dear killed, and Graf and Nichols (1966, p. 634) specify the years as 1900 to 1901.

The Lāna'i herd, since 1959, and a large portion of the Moloka'i herd, since 1956, have been under management of the State Division of Fish and Game, agreements having been made with the landholders for public hunting at the discretion of the Division (Nichols, 1962b).

Management studies of these populations were begun in 1956. William Graf worked on Moloka'i deer for more than a year and Lyman Nichols, Jr., worked principally on Lāna'i for three years. The high quality of these well-organized investigations has been revealed through a preliminary summary report (Nichols, 1960a), and one detailed paper (Graf and Nichols, 1966).

The future of the axis deer as an important game species seems assured on Moloka'i and Lāna'i (Nichols, 1964e) as it has adapted easily to these environments. Public hunting was permitted on Lāna'i beginning in 1954, and on

FIGURE 57.—Mature male axis deer on Lāna'i. Only males bear antlers, which may reach a length of more than 35 inches (88 cm). A large buck weighs about 200 pounds (90 kg); a doe weighs about 120 pounds (50 kg). (Lyman Nichols, Jr., photo.)

Moloka'i in 1959. Nichols (1961b) describes in popular style a Moloka'i hunting expedition.

Because of demand for increased hunting domain, as early as 1950 efforts were made to introduce axis deer onto other islands (Lennox, 1950). These initial attempts were opposed principally by botanists, agriculturists, and ranchers (exemplified by Lyon, 1950), and no deer were then shipped. The problem was then further examined (Graf, 1958, 1959a) and in 1960, on the basis of the management assurances that the deer would not penetrate native

forests, fed largely on introduced plants, were free of dangerous parasites and disease, and that their populations would be controlled by hunting, axis deer were released by legislative mandate on Maui. Nichols (1962a, 1962c) briefly discusses this event and related problems. The deer on Maui did not immediately increase and further importations of breeding stock were considered but not carried out.

Later attempts were made several times to legally extend the range of *Axis axis* to the island of Hawai'i, with the closest bid for success in 1963. The 1950 proposal (Anon., 1950) had brought immediate response (H. S. Baldwin, 1950a, 1950b), followed by later articles also in the *Hilo Tribune-Herald*, from outside the Territory on June 20 and 21, a rebuttal from the Board of Agriculture and Forestry on June 22, and an announcement on June 30 that the Board would defer action on shipment of deer.

To illustrate the political complexity and emotional effect of proposals that would establish deer at new localities in Hawai'i, there follows a chronology of selections from more than 25 newspaper articles that appeared in the 1963 incident. This affair ended in a court order to permanently ban state-supported introduction of deer to the island of Hawai'i (Anon., 1964g). Arguments pro and con were essentially the same in 1963 as in 1950.

A bill was submitted to the 1963 Hawaii Legislature to appropriate money for capture and transport of deer (Hughes, 1963a). The bill was brought to public attention by H. S. Baldwin (1963), and other newspaper articles followed (for example, Anon., 1963d). Hughes (1963b) prepared a feature article in which many statements of those opposing the introduction were questioned and refuted. When the bill was passed and release of funds was imminent (Anon., 1964a), a new tide of opposition arose. Game management officials prepared and distributed an objective evaluation of the problem in support of the proposal (Anon., 1964b). Arguments against the proposal tended to be unsound or biologically unrealistic, were seemingly prompted by desires to preserve selfish interests, or suggested a ridiculous alternative (Anon., 1964c, 1964d, 1964e; Brand, 1964). However, two substantial objections to introduction of the deer were voiced from areas unrelated to economics (H. S. Baldwin, 1964; Anon., 1964f). Those citizens promoting deer introduction had the staunch support of the game biologists, as indicated, but felt that their plans (Kaya, 1963) were swept aside by the newspapers (Parker, 1964).

The proposal resurfaced in 1968 after a period of quiet, when the last legal barrier to introduction had been overturned (Anon., 1968a). In October 1969 arrangements were made for transfer of seven deer, as a first lot held in pre-shipment quarantine on Lāna'i, in spite of continued opposition from ranchers, scientists, and a growing environmental movement. The governor finally was convinced to oppose the plan and ordered a delay of shipment on

October 15. No immediate alternative action was taken. A skimming of numerous news articles of the time includes Anon., 1969a, b, c, and d. From that point the matter seethed for a while. Two other items of this currency are Titcomb 1969a and 1969b, followed by summary articles stretching into 1974 (American Society of Mammalogists, 1972; Hawaii Audubon Society, 1972a, 1972b, 1974). The matter was being argued out by the Animal Species Advisory Commission in its advisory capacity to the State (Anon., 1970) and the matter fell also under the virtually impossible requirement for an acceptable Environmental Impact Statement (Anon., 1972b; Benson, 1972). The issue withered after 1973 as the environmental movement of the time gained stature. Meantime, dogs broke into the pen of deer, by then gracefully aging on Lāna'i, killing or scattering them (Anon., 1973b; Tune, 1974).

The major herd of axis deer is on Lāna'i, with the 1981–1982 population estimated at 2,800. Legal hunting accounted for 393 deer in the 1981 season. On Moloka'i there were about 500 deer, with no open season for the second consecutive year because of low numbers. A trend for increase was evident. The axis deer on Maui occupies privately controlled lands and is not censused with regularity by state game managers. Some extension of range is noted in the dryland exotic forest of the Kīhei region, between Makena and 'Ulupalakua (Ueoka, 1982).

Comparative studies of many aspects of populations in Hawai'i and in India or Sri Lanka would be of value. Graf and Nichols (1966, pp. 640–644) have observed that antler lengths in Hawaiian deer are possibly as great as those in India and that the local deer may have even heavier and wider antlers than those in India. These authors report a maximum beam length of 37 inches, while the record head for India is slightly more than 39 inches (Martin, 1913). Blood factors in Indian specimens were studied by Naik and Others (1964) and these could be of importance to an understanding of the Hawaiian deer.

Significant additional writings, largely on deer in the native range of India, are those of Schaller (1967), Pillai and Hingorani (1970), Sharatchandra and Gadgil (1980), Johnsingh (1981), and Dinerstein and Dublin (1982).

Odocoileus hemionus. Mule deer.

ORIGINAL DESCRIPTION: *Cervus hemionus* Rafinesque, American Monthly Magazine 1:436. 1817.

TYPE LOCALITY: Mouth of the Big Sioux River, South Dakota, United States of America.

NATIVE RANGE: Western North America from about the 60th parallel in Canada and southern Alaska to central Mexico, and generally west of the 100th meridian.

FIGURE 58.—Adult female mule deer (*Odocoileus hemionus*) in the verdant forest of Kaua'i. This species was introduced in 1961, from western Oregon, and became quickly established. (Gerald E. Swedberg photo.)

RANGE IN HAWAI'I: Island of Kaua'i. Has been imported rarely in the past to other islands, but not liberated.

Odocoileus hemionus is called by two common names stemming from the notion prior to the work of Cowan (1936) that two species were represented: black-tailed deer (*O. columbianus*) of the North Pacific coast, and mule deer of the South Pacific coast and interior. Indeed, the two presently recognized subspecies often called black-tailed deer are, as Cowan reiterates (in: W. P. Taylor, 1956, p. 339), an incipient species having in common structural and behavioral characteristics that differ from those of the other subspecies of mule deer. Because we are dealing now with a single variable entity, mule deer should be the name of choice for the entire species, as used by E. R. Hall (1965, p. 15). Translated literally, the specific epithet *hemionus* means mule (half donkey), and can be referred to the large ears possessed by all forms of *O. hemionus*, although some observers note that the tail of the interior forms suggests in miniature the tail of a mule.

The stocks of mule deer in Hawai'i are from wild fawns captured in the coastal region of Oregon, and are definitely referable to *Odocoileus hemionus columbianus*. Swedberg (1963, 1967) has recorded introduction of these deer to

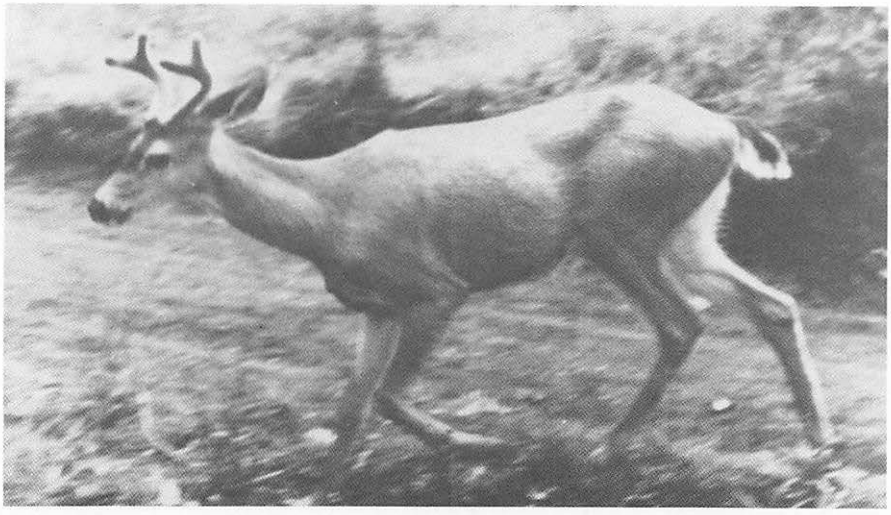


FIGURE 59.—Two-year old buck mule deer on Kaua'i, June 13, 1962. Antlers are in velvet and still growing. The hardened antlers are shed each winter after the breeding season. A large male will weigh 140 pounds (60 kg) and females weigh about 80 pounds (33 kg). (Gerald E. Swedberg photo.)

Kaua'i. They were pen-reared for nearly a year in Oregon before shipment to Hawai'i. A group of ten was turned out on Polihale Ridge of the Pu'u Ka Pele Game Management Area, Kaua'i, on June 19, 1961. A second release of ten occurred at the same site on June 12, 1962. Fifteen additional deer were released on April 13, 1966. There were nine males and 26 females in these three shipments. The chosen range lies at the western end of the island in moderately dry native and introduced forest (30 to 50 inches of rainfall per year), at an elevation of some 2,000 to 3,000 feet.

There is some evidence that *Odocoileus hemionus* was occasionally brought to Hawai'i in the previous century. Clark (1939) relates a fanciful story concerning Captain Alexander Adams who commanded voyages in and out of Hawai'i in the early 1800s. Two "plain North American deer" may have been brought by Adams from the Pacific Northwest about 1816 in the brig *Forester*, one of the early ships owned in Hawai'i. Corney (1896, pp. 40–41) probably records the start of this voyage of the *Forester* from Hawai'i in 1815, when he says, "Mr. Biggot, the supercargo, took command, and got one Adams to navigate and some islanders to work the ship. He then sailed from Karakakooa [Kealakekua] Bay for the coast of California." In February 1817 (p. 71), the *Forester*, then renamed *Kaahumanu*, was being fitted out for Canton at Lahaina, Maui, with Alexander Adams in command. Wilson (1922) provides the original data for this importation of deer, as written by James Macrae in 1825.

Tinker (1938, p. 120) notes a "200-pound buck" brought from Oregon in 1857 aboard the brig *Advance*, by Captain Collins, but there is no known record of mule deer being released permanently into the wild except for the much later introductions to Kaua'i.

The population became readily established, and limited hunting was first projected for 1968 (Swedberg, 1964b). Particular attention was paid to aspects of this growing herd and some ecological data on the invasion of a new habitat have accrued from these observations. However, the mule deer of coastal Oregon has not been a spectacular success as a game animal in Hawai'i, much to the comfort of those who would protect native plant life from introduced herbivores. It does not frequently make the news. A hunting season was actually opened for the first time in 1969, but few deer were taken (Anon., 1971a). The animal was then expanding its range and numbers were estimated at 600. Hunting the mule deer on Kaua'i has become a popular sport, but the success ratio is low at about two deer per 100 hunting trips. Of 21 taken in 1981 under a bucks-only rule, all were in excellent physical condition. The deer consume largely introduced plants in their present range, although they eat readily native species such as *koa (Acacia)* and *pilo (Coprosma)* where these are available. The population of 300 to 350 animals (1981) remains stable, and although it has a high potential for increase, illegal kills of does and extra-seasonal take of bucks probably explain lack of herd growth (Telfer, 1982). Management information is available, but specific research on this deer in Hawai'i is of low priority.

The mule deer is well known in its native range, and the following reports treat many aspects of it: Dixon (1934), Leopold and others (1951), Linsdale and Tomich (1953), Taber and Dasmann (1956), W. P. Taylor (1956). Newer studies from the continental range are those of Wallmo (1981) on the aggregate populations, of Bandy, Cowan, and Wood (1970), Cowan and Raddi (1972), Mierau (1972), Westrom, Nelson, and Connolly (1976), and Freddy and Bowden (1983) on aspects of biology; and of Miller (1970), Müller-Schwarze (1971, 1972), Truett (1977), and Volkman, Zemanek, and Müller-Schwarze (1978) on behavior.

Antilocapra americana. Pronghorn.

ORIGINAL DESCRIPTION: *Antilope americana* Ord, in: Guthrie, A New Geographical, Historical and Commercial Grammar, Philadelphia, Ed. II, 2:292, 308. 1815.

TYPE LOCALITY: Plains and highlands of the Missouri River, United States of America.

NATIVE RANGE: Formerly western North America, including southern

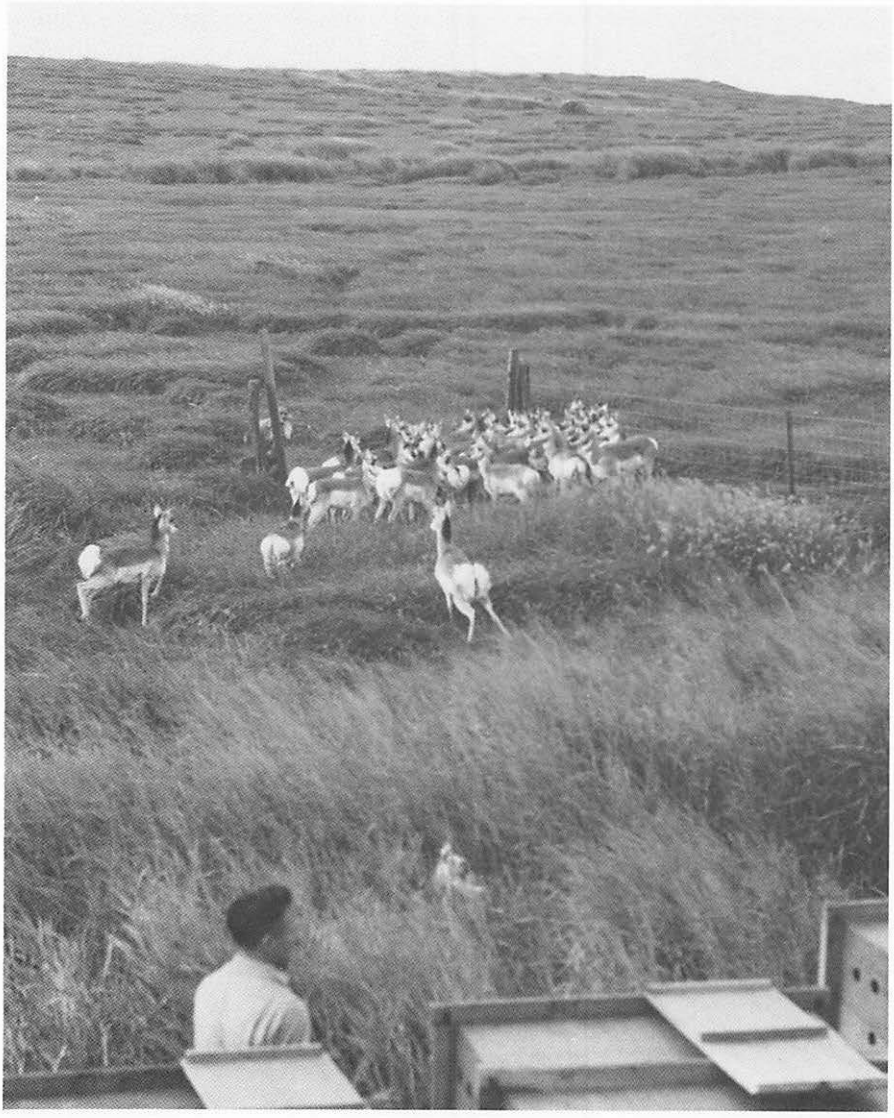


FIGURE 60—Releasing pronghorn *(Antilocapra americana)* from shipping crates for stocking of the central plateau of Lāna'i, December 10, 1959. This lush grassland has not been grazed by livestock since 1948. (Dole photo.)

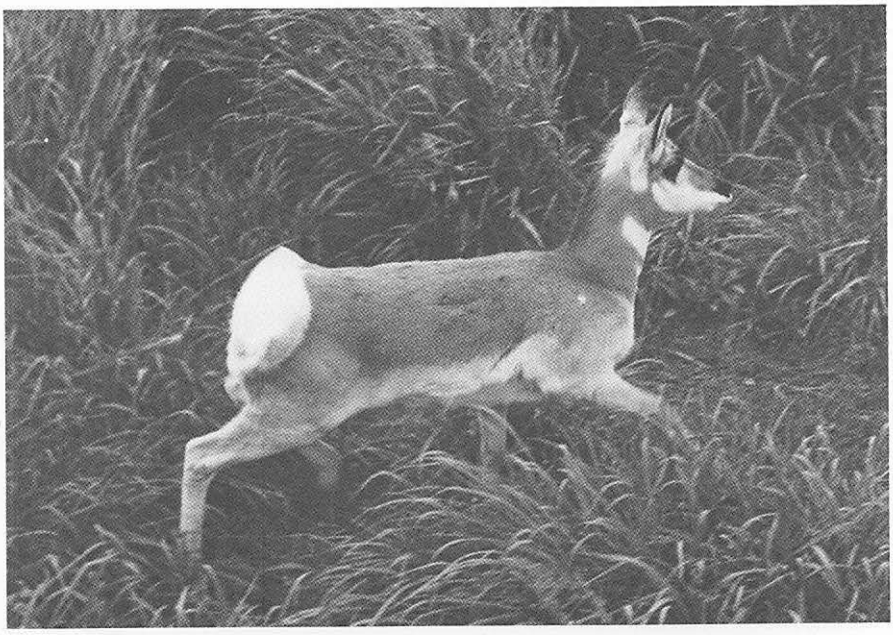


FIGURE 61.—Young pronghorn in the holding pen before its release on Lāna'i. Flared rump patches denote excitement. Horns grow on both sexes, but larger in males than in females. The branched horn sheath is shed annually. Body weight is about 120 pounds (50 kg) in a large male, and 90 pounds (36 kg) in a female. (Dole photo.)

Canada to central Mexico; present range restricted principally to Oregon, Montana, Nevada, Wyoming, and Texas.

RANGE IN HAWAI'I: Island of Lāna'i.

The pronghorn is the lone survivor of a large American artiodactyl family that is unique in shedding a branched horn sheath from a bladelike bony core, and is not a true antelope (the cervids shed bony antlers annually and the bovids, which include true antelopes, retain a permanent horn sheath on a bony core). Hawaiian stock is from Montana and hence of the Great Plains subspecies, *Antilocapra americana americana*.

Nichols (1960b) has documented the introduction of this animal. A group of 38 brought in crates via truck, ship, and air from the native range in Montana was released immediately upon arrival on Lāna'i, December 10, 1959 (Fig. 60). Initial survival was poor because of injury in the brush and drinking salt water, but at least 18 vigorous pronghorn were present in the following month, and 8 kids were born that season. The herd as counted in October 1964, had increased to 129 (L. Nichols, Jr., pers. comm.). An allowable herd size of about 250 was reached in 1966, and some hunting was permitted for the first time.

The pronghorn has occupied the dry open plateau of northwestern Lāna'i at elevations ranging from about 750 to 1,700 feet.

It was thought that adaptation of the pronghorn to Lāna'i, if carefully studied, could provide keys to restoration of this species in parts of its formerly extensive range in western North America. But after more than 20 years the pronghorn has not adapted well to Lāna'i, probably because of nutrient deficiencies in the available range, which result in poor production and survival of kids.

An independent study of the population was initiated in 1971 (Altonn, 1971), but faltered for unexplained reasons. Meantime numbers have dwindled. As of 1983 the population was reduced to less than a dozen and moving toward extinction. Thus it is of no further active interest for management as a game animal (R. L. Walker, pers. comm.; Ueoka, 1983, 1984).

Important studies of pronghorn antelope are few, but include those of Einarsen (1948) and Buechner (1950). Yoakum (1967) has reviewed the literature on this unusual animal. Other examples of investigation of the species in its native range are those of O'Gara (1970, 1978), Wesley, Knox, and Nagy (1973), Müller-Schwarze, Müller-Schwarze, and others (1974), and Kinndschy, Sundstrom, and Yoakum (1983).

Bubalus bubalis. Water buffalo (includes wild, domestic, and feral populations).

ORIGINAL DESCRIPTION: *Bos bubalis* Linnaeus, Systema Naturae, Ed. X, 1:72. 1758.

TYPE LOCALITY: Rome, Italy (description based on a domesticated form).

NATIVE RANGE: Indigenous to Southeast Asia and westward (prehistorically) to Iraq. Survives in India as a wild species in the Nepal Terai (lowland swamps), river plains of Assam, and in Orissa; present also in Ceylon, Indo-China, and Borneo (based on Ellerman and Morrison-Scott, 1951, p. 383).

RANGE IN HAWAI'I: As a locally common domestic animal formerly on Kaua'i, O'ahu, Moloka'i, and Hawai'i; briefly feral on Moloka'i; a few remain in domestication on Kaua'i, O'ahu, and Hawai'i.

In addition to the water buffalo's classical range in Southeast Asia, Hatt (1959, p. 68) reports it also as a wild species known to an Iraqi culture of some 5,500 years ago. The animal subsequently died out there and was later introduced into this and other regions of the Near East in domesticated form. Control of *Bubalus bubalis* by man may have begun in the Indus Valley, as recently as 5,000 years ago. Zeuner (1963, pp. 245–252) reviews the history and characteristics of the species; acceptance of domestication seems to have occurred in connection with attraction to cultivated crops as forage. Relatively

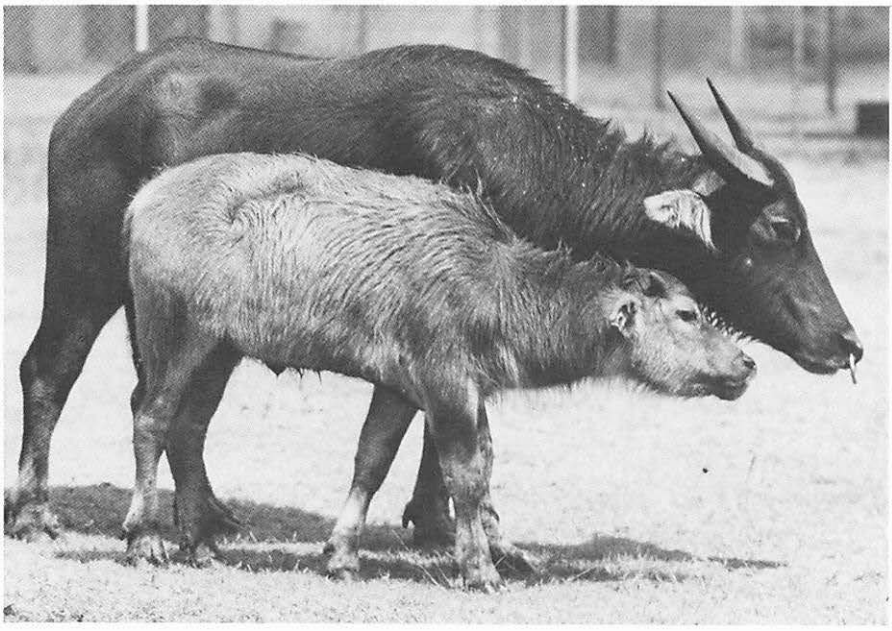


FIGURE 62.—Water buffalo (*Bubalus bubalis*); young cow with bull calf three months old. Hair is generally sparse on older adults. Body weight in larger strains may reach 1,400 to 1,800 pounds (635 to 815 kg); horn length of 43 inches (about 110 cm) has been recorded for Hawai'i (Anon., 1953a). (Honolulu Zoo photo by Douglas Davidson.)

few modifications of the water buffalo have come with domestication, and there may still be some degree of inbreeding between domestic and wild or feral stocks in southern Asia. Mutants have not been extensively selected, but fairly distinctive breeds are reported from India (Phillips, 1945). These various breeds can be identified with geographic regions, suggesting infrequent transport of animals from one place to another over long periods of time. Water buffalo I have seen in Egypt have generally smaller horns than those of India and southeastern Asia. Daniel and Grubh (1966) have prepared a treatise on this animal in India.

The animal was introduced into Hawai'i from China for use in rice cultivation. Rice was apparently first grown experimentally in Hawai'i as early as 1857 (Lund, 1932); another source places the date at 1862 (Anon., 1862). As the industry developed, oxen and horses were found inadequate for field preparation, and the buffalo finally replaced them (Coulter and Chun, 1937). Oberlin (1940) reports the early 1880s as the time of first introduction and gives details I have not uncovered in original form (apparently from Tinker, 1938, pp. 132–134, who treats many facets of buffalo in Hawai'i). One basic source is a

brief news note (Anon., 1881) that sets an exact time of one importation as late January 1881. Perhaps it was the first.

The water buffalo has always been an object of curiosity in Hawai'i and has complemented many picturesque rural settings. Anon. (1902c) provides basic information on the species from a British source, and a spate of ensuing articles alludes to this same theme (Anon., 1903a, 1903b, 1904b). Poets and artists have been inspired by this beast (Merrit, 1924; Gessler, 1930; Westgate, 1932; Gallet, 1935), and photographers have frequently used it in their compositions.

Population figures are not well established. Anon. (1903d) reports 80 at that time for the Territory, and Anon. (1923), in an obviously incomplete report, lists 25, all on Kaua'i. When the rice industry declined in the late 1920s, the buffalo were gradually reduced in number by butchering them, or they were left to roam freely. In Waipi'o Valley, on Hawai'i, Masaru Matsunami, a long-time resident, reported in 1964 (pers. comm.), as follows:

> In 1926 about 30 buffalo were left, and some ran wild in the valley. On at least one occasion they interfered with night fishing in Waipio Stream when a fisherman cast his net over one or more of the animals quietly immersed in the water. A buffalo sprang from the stream with the net entangled on its horns. Gill nets set in the river were also accidentally damaged by buffalo. Five animals were butchered in 1926 and two or three others were sold locally for this purpose. A butcher bought 17 and drove them to his shop in Laupahoehoe for slaughter. Nelson Chun was the last rice grower in Waipio Valley and he continued this practice until 1927.

Mr. Chun informs me (pers. comm.) that four buffalo remained in his herd in 1927 and that these were used for sledding wood, cultivating taro paddies, and other tasks. Two were finally butchered and the remaining two died of liver fluke infection about 1934 after cattle had been brought to pasture in the valley.

Tinker (1938, pp. 132–134) reports that water buffalo used in Pelekunu Valley on Moloka'i were abandoned about 1921 when farming was discontinued there. These developed a feral population confined to the valley. The number of animals was gradually reduced by hunters, and they were finally extirpated in 1932 when workmen dismantling a ship that grounded on the Moloka'i coast shot the last of them for food.

The fate of the Kaua'i population may not be recorded; one zoo specimen remained in the 1960s, at the Coco Palms Hotel in Wailua. A remnant group was maintained through the years on O'ahu, preserved partly in the Honolulu Zoo, where one died of old age in 1953 (Anon., 1953a). In 1960 one was purchased locally for the zoological collection, at which time Paul Breese estimated that about a dozen were still in use on O'ahu.

When the Peace Corps Training Camp was set up in Waipi'o Valley, Hawai'i, a pair of buffalo was purchased and shipped to the valley from O'ahu in 1963. A female, ironically, drowned in Waipi'o Stream, but was replaced by another

(Anon., 1964h). These animals were confined and were used in connection with the Peace Corps program (Schriver, 1964). With the birth of a calf from the surviving pair in April 1965, a nucleus herd was established in the valley. Williams (1968) reports that two of four in the valley in January 1968 were being shipped to Kaua'i.

O'ahu buffalo were maintained through the years by the Ing brothers, who operated a nursery at Kāne'ohe. Plans were made to sell their five remaining animals late in 1964 when the pasture was assigned to another use (Anon., 1964i). While repairing the fence on November 16, Henry Ing was attacked and injured by an angry bull (Anon., 1964j). The five buffalo were sold and shipped to a private zoo in California on December 4 (Morse, 1964). The buffalo did not drop immediately from the scene on O'ahu, and an elderly taro grower continued to plow his paddies with one at Waiāhole (Morse, 1965).

A token population of a dozen or more animals was retained in Hawai'i after 1975 as somewhat of a curiosity from former times. A Kohala High School project, of up to ten animals, including the Waipi'o Valley herd, has been instructive (Anon., 1972a; Clark, 1975).

In 1983 J. S. W. Marr (pers. comm.) reported, as director of the Honolulu Zoo, six owned by that institution, three of which were on loan to the University of Hawai'i for research purposes. The herd at Kohala High School was dispersed in 1977–1978 when assistance in their care by owners of a private feedlot was no longer provided. Two of the buffalo were transferred to the Pana'ewa Zoo at Hilo, three to the Maui Zoo, and others were sold to private agencies with the proceeds donated to the school scholarship fund (David Fuertes, pers. comm.). The statewide population appears, then, to be fewer than 15. Currently, world attention is focused on the water buffalo for its long history of association with man as a source of power, milk, meat, and fuel, with suggestions that it could be more widely employed in the rural tropics (Tullock and Grassia, 1981; Norman, 1982).

Bos taurus. Domestic cattle (includes managed and feral populations).

ORIGINAL DESCRIPTION: *Bos taurus* Linnaeus, Systema Naturae, Ed. X, 1:71. 1758.

TYPE LOCALITY: Uppsala, Sweden.

NATIVE RANGE: The wild progenitor of domestic cattle once occupied forested regions of Europe, North Africa, and southwestern Asia, but is now extinct.

RANGE IN HAWAI'I: Feral cattle were historically abundant on Kaua'i, O'ahu, Moloka'i, Maui, and Hawai'i. They also ranged freely on Lāna'i, apparently under loose control; finally extirpated from O'ahu in 1962; now present only on Kaua'i, Moloka'i, and Hawai'i, in generally inaccessible forest or lava regions.

The urus or wild ox, *Bos primigenius* Bojanus, is the accepted ancestor of all the common breeds of domestic cattle, including the humped zebu and its derivatives. The urus persisted as a wild species in Europe until its extinction in 1627, but was never tamed. It has been referred to as the aurochs, but this name is more properly applied to the European bison, *Bison bonasus* Linnaeus. Through selective breeding, a strain of cattle that is phenotypically similar to known descriptions of the urus has been reconstituted in Germany (Zeuner, 1963, pp. 201–211). Early domestic cattle in the Near East, North Africa, and southeastern Europe date back at various sites to 6,000 and as much as nearly 10,000 years ago (Reed, 1961, p. 34; Wendorf, Close, and Schild, 1985).

Captain George Vancouver brought the first cattle to Hawai'i on his second voyage, in 1793. Circumstances surrounding this importation are of interest, and their record is available from the seafarer's journals (Vancouver, 1798, Vol. 2, pp. 120, 127, 147). Vancouver had intended to bring the cattle directly to Kamehameha I at Kealakekua Bay, Hawai'i, but he dropped anchor first at Kawaihae on February 16.

Calms and adverse winds impeded sailing and the cattle were extremely weak. In the emergency, a cow and bull were put ashore near Kawaihae on the 19th. The cow died in the canoe en route to shore, and the bull lived only a few days. Vancouver's five remaining cows were landed in Kamehameha's canoes at Kealakekua Bay on February 22, "in a healthy state though in low condition." Loss of the last bull was a disappointment to Vancouver, but he was heartened because two of the cows seemed to be in calf.

On his third voyage, in 1794 (1798, Vol. 3, p. 11), Vancouver was more fortunate with his cargo of cattle, most of which was landed at Kealakekua on January 15. "These consisted of a young bull calf nearly full grown, two fine cows, and two very fine bull calves, all in high condition." The animals left there in the previous year had thrived; one cow had produced a heifer, and Vancouver states, "I had little doubt, by this second importation, of having at length effected the very desirable object of establishing in this island a breed of these valuable animals." Vancouver had sailed to Hawai'i as a midshipman under Cook in 1778 and 1779 (B. Judd, 1929, p. 81) and was greatly dedicated to Cook's cause of stocking the islands with various domestic animals. He asked (p. 53) for a ten-year taboo on the slaughter of cattle, sheep, "and other European animals," and this Kamehameha granted, with some reservations.

Vancouver tarried along the west coast of Hawai'i before finally leaving that island, and on February 28, referring to the Waimea Plain that stretched above him, he wrote (p. 64):

> In this valley is a great tract of luxuriant, natural pasture, whither all the cattle and sheep imported by me were to be driven, there to roam unrestrained, to "increase and multiply"

> far from the sight of strangers, and consequently less likely to tempt the inhabitants to violate the sacred promise they had made; the observance of which, for the time stipulated in their interdiction, cannot fail to render the extirpation of these animals a task not easily to be accomplished.

These were prophetic words, indeed, and Vancouver departed from Hawai'i on March 4, 1794, satisfied that his project would succeed. The original cattle were from Mission San Carlos, near Monterey, California. The 1794 importation came from "New Albion," possibly more specifically, the lower Columbia River region. Thus two separate sources are known for the nucleus cattle herd of Hawai'i.

Anon. (1938b), in quoting from the writings of Delano (1817), captain of the American trader *Perseverance* (B. Judd, 1929, p. 18), indicates that cattle on Hawai'i had multiplied considerably by 1801, and were being used for beef. Also, one of the original bulls landed by Vancouver in 1794 was reported to have been brought to Maui in 1806, as the first of any cattle to be shipped from Hawai'i to another island.

Corney (1896, p. 109) noted in 1818 on Hawai'i:

> The cattle go about wild, and are not allowed to be shot without permission from King Kamehameha. Mr. Manning the Spaniard [i.e., Don Marin], keeps a large herd of tame cattle, and makes excellent butter and cheese . . . and they are penned up regularly, but allowed to go out in the morning.

Ellis (1917, p. 301) in describing Joseph Goodrich's first trip to Mauna Kea, in the summer of 1823, stated: "Leaving Towaihae . . . he had walked to Waimea, on the skirts of which he encamped with Mr. Parker, who was employed in the shooting of wild cattle." This person was John Palmer Parker, who later founded the Parker Ranch. And further, in relation to these same cattle (p. 303):

> Although there are immense herds of them . . . the only advantage they derive is by employing persons, principally foreigners, to shoot them, salt the meat in the mountains, and bring it down to the shore for the purpose of provisioning native vessels.

Speaking of conditions on Maui in 1825, Andrew Bloxam (Bernice P. Bishop Museum, 1925, p. 27) stated: "There are some cows on the southern part of the island kept for breeding, and also a few horses, but none in the neighborhood of Lahaina." This suggests that cattle, as well as horses, may have populated Maui at a slower rate than they populated Hawai'i. Wyllie (1850, p. 51), in reference to Hawai'i, notes, perhaps erroneously, that "few cattle were killed until after 1830; they were killed mostly for their hides; they were greatly thinned off, and being so much harassed, retreated farther up the mountain."

Certainly, there was an early diversified use of cattle, and the king's rules must have been quite flexible in their application, in part because of rapid increase in the herds.

Vancouver's New Albion cattle were vaguely described only as black. Exact

descriptions of these and other early imported stock seem to be unavailable, although there is occasional reference to the longhorn type. Brookshier (1945, p. 17) credits Don Marin, who arrived in Hawai'i in 1791, with bringing the first longhorn cattle to O'ahu from Mexico. Date and information source are unspecified. L. H. Miller (1900–1903, p. 39) observed on a visit to the Kūka'iau Ranch, on windward Hawai'i: "The old native cattle are often very long horned, one old bullock head here extends to six feet and some inches." Gregory (1924, p. 32) also indicates, with the accession of "two mounted heads of Hawaiian long-horned cattle" to the Bishop Museum collections in 1923, that Spanish-type cattle were present. On August 12, 1963, I examined such materials as were available in a storage gallery of the museum. One specimen is the mounted head of a large red bull with excellent horns extending 73⅜ inches between their tips. A skull with similar typical lateral-extending horns has a span of 70⅜ inches. These two have no apparent accession numbers, but they may be those received in 1923, if they are actually of Hawaiian origin. A third specimen (Acc. #5121, dated June 20, 1957) comprises a partial skull with intact curved horns, and is from a large bull of a different lineage. These horns measure 39 inches between their tips, and the longer one is 32 inches from base to tip. Meek (1851) suggests a wide range of origins for Hawaiian cattle as early as 1850, to include other Pacific islands and Australia, but the source of the information is lacking.

Bird (1964, p. 138) describes roving stock of Hāmākua District in 1873 thus: "The cattle are a hideous breed—all bones, hide and horns." These and later strains must have varied greatly in form and color through the years and were extracted from the several beef and dairy breeds introduced into the islands. Occasional outstanding and powerful bulls have been noted (Hobbs, 1939). The last bull taken from the Maulua section of Kūka'iau Ranch, in 1942, was described by Robert R. Martin (pers. comm.) as large, ferocious, and black. The mounted head is displayed in the ranch village social hall. Its strongly curved horns measure each 16 inches long and span a respectable 29¼ inches. Surviving feral cattle are presently described as a scrub type. Carlson (1957) and Carlson and Bryan (1959) show a spectacular photograph of a spotted cow fleeing through a Kona District forest (see also Fig. 63).

Progress in breeding of the domestic cattle in Hawai'i has been continuous (as exemplified by Anon., 1886) and herds are generally now of highly selected purebred or crossbred stock. Henke (1929) reports on the industry to that period, and includes numerous historical references. Towne and Wentworth (1955) suggest a brisk trade in cattle as early as 1811, to supply settlements on the northern Pacific coast of America. Anon. (Editor, 1826) reports the curing of beef in 1825 (presumably by salting it) by operators in remote Hawaiian forests. Hides were also an item of trade, as was tallow, and these products

FIGURE 63.—Feral cow (*Bos taurus*) bolting from the camera in the wet forest of Hawai'i Island. These cattle are wary and difficult to approach. This scrub specimen of Hereford extraction is typical of present-day feral cattle in Hawai'i. (Norman K. Carlson photo.)

were usually sought more than the cured beef. Wilkes (1845) observed cattle in the interior of Hawai'i in 1840. Anon. (1859) describes a hunt in that year on Mauna Kea. Bird (1964, p. 210) noted in 1873 while visiting Humu'ula,

> Mauna Kea, and the forests which skirt its base, are the resort of thousands of wild cattle, and there are many men nearly as wild, who live half savage lives in the woods, gaining their living by lassoing and shooting these animals for their skins. . . . [The cattle] usually keep near the mountain top in the daytime for fear of the hunters, and come down at night to feed. About 11,000 were shot and lassoed last year.

Bullock hunting figured prominently in the tragic death of David Douglas (1799–1834), the intrepid Scottish botanical explorer and mountain climber whose body was found above the present village of Laupāhoehoe in a pit trap, trampled by a captured bullock (Goodrich and Diell, 1839; Harvey, 1947, pp. 232–237). Mysterious circumstances surrounding the incident suggest foul play by the hunter who worked the trap, but the death was never adequately explained (Harvey, 1947, pp. 251–253). Traces of the traps may still be seen at the site, at 6,000 feet elevation, known as Kaluakauka (the Doctor's Pit). Wilkes (1845, pp. 203–204) sketched the layout of these traps on his 1840 visit there. In 1934 a stone monument and bronze plaque were erected at the site in Douglas' memory by the Burns Club of Hilo (L. W. Bryan, 1934, pp. 28–30), and a grove of Douglas fir (*Pseudotsuga*) is planted there. The story of this tragedy is occasionally recounted in the news media, as exemplified by J. Bryan (1964).

Cattle were used as draft animals, as Wyllie (1850, p. 53) further reports:

> Oxen—these noble animals were used by the missionaries, about 1825–26. Many excellent teams are now in daily use in the city. . . . Several plantations kept from ten to fifteen yoke of good working oxen. Good yokes and good teamsters are much wanted to complete well trained and experienced teams.

Oxen continued to be commonly used until an unspecified date (Anon., 1938b), but probably into the period (at least on Kaua'i) of a well-developed sugar industry in the 1880s. Anon. (1903d) reports for the Territory in 1900, 38 working bullocks, which indicates by that time their nearly complete replacement by horses and mules, although ox teams were still employed at Molokai Ranch, Moloka'i, as late as 1908 (Cooke, 1949, p. 85). William F. Mendes of Honoka'a relates (pers. comm., 1983) that as a boy in the 1920s he drove oxen for his father's business of cutting and hauling firewood to sugar plantation camps of the Hāmākua coast on Hawai'i, out of the Āhualoa Homesteads.

The first tannery in Hawai'i was opened in Honolulu in 1904 (Anon., 1904c, 1905). Cattle for the O'ahu markets, in the absence of refrigerator ships, have by tradition been shipped alive from the outer islands for slaughter. The colorful operation of loading cattle onto the inter-island steamers by driving them into the surf, towing them out, and slinging them aboard, has attracted much attention (Anon., 1903c). This method has been only recently completely outmoded by the mobility of truck transport and adequate docking facilities, but it remained in use at least until 1947 (Clarke, 1947).

Reynolds (1850) summarizes early conditions in the keeping of livestock in Hawai'i. With the abundance of cattle, problems soon arose in relation to their control. Johnson (1850) discusses the matter of fencing, and R. J. Baker (1944) notes regulations imposed for Honolulu in 1850. An early description of the effects of cattle on the eastern Waimea Plain and in the Hāmākua forests is thus vividly presented (Anon., 1856):

> It is in the memory of many foreigners now living there, when the whole of these plains were covered with a thick wood, to the very edge of the slope. Where now hardly a tree is to be seen for miles, we were informed by an old resident, that twenty-five years ago he lost himself with his team in the woods. . . . The clearing of the land has been almost entirely effected by cattle. The few head brought by Vancouver in 1793 increased so rapidly, that early in the present century thousands of them were killed for their hides. At this moment they swarm in the thick jungle that covers the windward or eastern slope toward Hamakua. They are now gradually destroying this, and thousands of old dead trees both standing and lying prostrate, form the present boundary of these woods, and exhibit the mode in which the destruction is effected; for whilst the old trees die of age, no young ones are seen taking their places, as during the last thirty or forty years, the cattle have eaten or trodden them down.

Hillebrand (1856, p. 36) cast a warning about the consequences of continued overpopulation of cattle and pleaded for moderation, when he said:

> The small area of our islands is too valuable to be devoted to cattle rearing. Allow them to multiply for all the legitimate purposes of the dairy, home consumption and supplying of shipping. . . . If we rear them for the sake of their hides and tallow, I imagine the expense of producing them is too great. We forfeit by it the vital sources of our soil.

There appears to have been little interest or action toward the extirpation of feral cattle, even late in the second half of the nineteenth-century. During this period we suppose a gradual usurpation of former forest lands for sugar cane, pineapples, and cattle ranching. Many miles of stone fences, wherever stone was available, outline boundaries of old paddocks. Some are effective stock barriers today. Some purposely include low ports for the passage of pigs, as I have observed in the Puna District, on Hawai'i. On the upper slopes of Mauna Kea, pasture limits were not easily defined, and the cattle ranged as high as the plant cover extended. In 1889 a survey party availed itself of the presence of cattle to supplement their rations (E. D. Baldwin, 1889), and the cattle were probably abundant enough that such poaching was overlooked.

The largest and most persistent cattle problem was on Hawai'i, and much of the discussion centers on this island. C. S. Judd was a proponent of forest protection and has presented a summary account of action taken (C. S. Judd, 1936). He states:

> The first steps toward the protection of the *mamane* forests on Mauna Kea slopes were taken in 1907 when adjacent ranchers built fences at the upper limits of their pastures to keep their tame cattle from joining bands of wild cattle higher up on the mountain slopes.
>
> The first proclamation making the mountain a forest reserve was signed by the governor on June 5, 1909, and embraced 66,600 acres of practically all government land.

In early writings, C. S. Judd (1918, p. 129) asked for the curbing of unowned cattle, and stated: If this one element of damage were removed once and forever, a great deal will have been accomplished for forest protection in Hawai'i." Later (1927a) he called for extensive research in forestry and noted an apt remark made by Albert Koebele in 1900. Judd was so impressed by the ecological disturbances wrought by cattle that he (C. S. Judd, 1927b) labeled the time from 1815 to 1921 as the "cattle period in Hawaiian forestry." This suggests that workable control measures were in effect about 1920, although Anon. (1919a) made an additional strong plea for them. Lyon (1919, p. 300) states, in reference to loss of O'ahu forests: "Cattle have been the greatest factor in pushing the forests back to their present narrow limits, and at certain vital points cattle are still allowed to penetrate the remaining forests."

Fencing of the forests on Hawai'i was followed by stock removal. L. W. Byran (1937b) reports that the last cattle were taken from the fenced reserves on Mauna Kea about 1931, and refers (p. 9) to what was probably the remnant herd in the lower wet Maulua section that was extirpated in 1942 when the last bull and 11 other head were trapped by Kūka'iau Ranch men (p. 143). The same

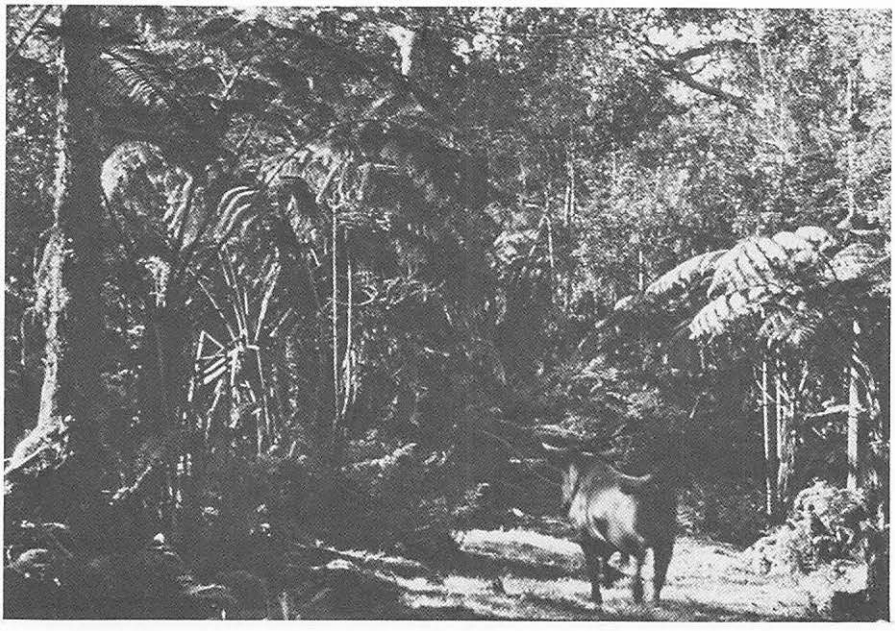


FIGURE 64.—Feral bull retreating through the rain forest of South Kona District, Hawai'i. Principal vegetation is the tree fern (*Cibotium*) and the *'ōhi'a* tree (*Metrosideros*). Feral cattle are small; bulls may weigh perhaps 1,000 pounds (450 kg) and cows about 600 pounds (275 kg). (Norman K. Carlson photo.)

author pointed to the last stand of feral cattle as the "southeast slopes of Mauna Loa above the 5,000 foot contour," where about 200 head were estimated then to remain.

Some stray cattle of Hereford and possibly Shorthorn derivation were still known on Kaua'i in the 1960s, according to game division personnel. These animals were in the forests of the Pu'u Ka Pele and Kōke'e areas and were mostly unbranded ranch stock that could not be effectively controlled by ordinary range practices. Cattle were formerly present and hunted in the region of Hipalau, on that island (H. P. Judd, 1939a).

Although feral cattle are generally recognized as a reservoir of tuberculosis, because these herds do not mingle with domestic stock no statewide program is in effect to extirpate them. Strict attention has been paid, however, to the problem on O'ahu. The Biennial Report of the Hawaii Department of Agriculture and Conservation, 1960–61, reports (p. 30) that cattle tuberculosis there was nearly under control, and that, "in the premises quarantine on Oahu, 25 cattle were trapped out of the wild mountainous terrain and sent directly to slaughter." Dr. Ernest H. Willers, State Veterinarian, stated (pers.

comm.) on May 23, 1962, that this herd had finally been removed and that O'ahu was free of feral cattle.

Moloka'i was once inhabited by feral cattle, but the last of these were shot out in the years 1938–1940, from the vicinity of Pu'u Kolekole (Noah K. Pekelo, Jr., pers. comm.). Cooke (1949, pp. 45–52) records facets of cattle rearing, tallow production, and range abuse on Moloka'i, and describes the practice in which a captured feral bullock was tied to a tame "pin-ox" that eventually led the wild animal down to ranch headquarters. Kaho'olawe was used, with marginal success, as a cattle station after 1918 (E. H. Bryan, Jr., 1931), but abandoned, for feral animals seem not to have existed there in 1931. Uncontrolled cattle were known on Maui until about 1930, in the Kula Forest Reserve, particularly in Pu'u Keōkea and Polipoli areas (J. S. Medeiros, pers. comm.). These cattle were finally extirpated under incentive permits granted to hunters who killed specified numbers of goats.

On Hawai'i there may have been as many as 2,000 head of stray or feral cattle in the 1960s. In July 1962, L. Nichols, Jr., noted (pers. comm.) abundant sign in the Puna Forest Reserve above the Kalapana-'Opihikao area, and in the same region R. E. Bachman reported (pers. comm.) additional frequent sign of cattle in January 1966. In November 1965, Norman Nichols kindly made a brief inquiry among ranchers of west Hawai'i and reported (pers. comm.) that McCandless Ranch was aware of some 1,500 feral head on their lands; Yee Hop Ranch, 200; Dillingham Ranch at Honomalino, about 200. These were all in South Kona District on the flank of Mauna Loa. Small bands were thought to exist on other remote ranches, and some cattle may well have occupied also portions of the adjacent forest reserves. Adequate data were not available for plotting exact range and abundance of these animals. A report of the Territorial Board of Agriculture and Forestry (Anon., 1958e) indicates that control measures where then being applied in limited fashion in the Kona districts. L. W. Bryan (1937b, p. 9) found the animals living in a rough lava-strewn area, over which a horse or man makes slow progress. Once the cattle started to run they were difficult to catch, even with dogs. He found also that, "except in dry weather, these animals are usually in good condition and the meat is well worth packing out."

In spite of the potential hazard of tuberculosis, practices on some ranches have included a loose management of these scrub cattle, in which they were caught, males castrated, and selective marketing done. Feral cattle are, of course, owned by the ranch they occupy.

However interesting stray cattle may be from an ecological viewpoint, it is certain that Hawai'i has seen more than enough of the results of their presence. A strong program should be activated for eliminating these animals from public

lands, and cattlemen should support any reasonable program proposed for the elimination of their own feral herds.

Few studies have been made on the process of change in flora and lands under the pressure of cattle, although one thorough report relates reproduction of *koa (Acacia koa)* to grazing (Baldwin and Fagerlund, 1943). Cuddihy (1984) expanded this early study to include the soils and entire vegetation of the same ecosystem on the mid-slope of Mauna Loa. Swezey (1919) found insects to be a factor in *koa* seed production. It is most unfortunate that sample areas of native flora could not have been protected by fences, from the earliest times. It is heartening to know that a system of reserves, as proposed by Warner (1961), was initiated in 1970, although some researchers then gave little credence to the practical aspects of even this simple expedient (Degener and Degener, 1961). By 1984 the State Natural Area Reserve System included about 20 reserves.

As of 1983 feral cattle are still generally entrenched as indicated in earlier years. New herds were reported on Moloka'i in 1972 (Pekelo, 1973), and they occupied a strip of upland forest and ranch land about ten miles long. Another modern day episode concerning feral cattle is taking place in the uplands of south Mauna Loa. A stock of abandoned cattle had thrived on Kahuku Ranch in a pocket below the cliffs at South Point, in the vicinity of the old site of Wai'ahukini. When this land changed hands in 1969, Freddie Rice, then Kahuku manager, obtained a contract to remove all cattle from the area. He found some surprisingly wild-type stock. Selecting a dozen cows and one bull that was particularly attractive, he released them in the higher range land of Kahuku Ranch where safari type expeditions were projected for photography and some hunting, to include use of the bison and mouflon sheep brought to the ranch in 1968. In 1971 the original feral bull was replaced by one of Texas longhorn stock introduced from Verdugo Ranch in California. However, the project was left gradually to its own devices when Rice moved on to another job (Frederick H. Rice, Jr., pers. comm.).

The cattle have thrived at the mountain site and remain isolated from managed ranch stock. A cursory ranch survey in September 1983 censused 34 head in the release area, and an unknown number were thought to be present on the vast slope of Mauna Loa extending above South Kona (Gilbert Medeiros, pers. comm.). Kahuku Ranch has no plans for control or management of the herd. This raises some question about the future of these lands and adjacent reserve lands, and the natural biota they support.

The colorful story of cattle in early ranch days is related by Brennan (1974) in his report on the Parker Ranch. Halloran (1972) issued a summary of cattle types in Hawai'i before selective breeding of refined beef animals was well

established. Rouse (1973) places modern and older Hawaiian cattle in perspective by including examples and data in his world survey. Finch and Western (1977) provide information on ecology of cattle in some currently primitive societies. The flavor of the Old West persists in occasional flurries of cattle rustling, as noted by Rood (1974). Rustling is, of course, a serious crime, with heavy penalties levied against the culprits.

Cattle ranging free on small islands are not usual in Hawai'i, but examples from New Zealand are of interest (Taylor, Bell, and Wilson, 1970; and Dilks and Wilson, 1979).

Capra hircus. Domestic goat (includes wild, domestic, and feral forms).

ORIGINAL DESCRIPTION: *Capra hircus* Linnaeus, Systema Naturae, Ed. X, 1:68. 1758.

TYPE LOCALITY: Sweden.

NATIVE RANGE: Wild forms (subspecies) occur on the Greek Islands, in the Caucasus, southern Turkmenia in Russian Turkestan, Asia Minor, Iraq, Iran, to Baluchistan and western Sind, India (adapted from Ellerman and Morrison-Scott, 1951, p. 405).

RANGE IN HAWAI'I: Goats are now present and at least sparsely distributed on all main islands except Ni'ihau and Lāna'i. Populations not under satisfactory control exist on limited areas of Kaua'i, Maui, Hawai'i, Kaho'olawe, and perhaps Moloka'i.

The familiar domestic goat (Reed, 1959, p. 1634; 1960, pp. 130–134) probably arose about 8,500 years ago in southwestern Asia, from a presently extant ancestor, *Capra hircus aegagrus* Erxleben, and is not distantly removed from this wild form. Twisted horns of certain domestic and feral strains, as distinguished from the scimitar-shaped horns of wild goats, have seemingly developed through selection for this mutation. None of the various wild ibexes (*Capra* spp.) has been domesticated, and hence make no contribution to breeds of domestic *C. hircus*. The goat in Hawai'i is properly referred to at the subspecific level as *Capra hircus hircus*.

Feral goats in Hawai'i are readily tamed and many of those staked out among the plantation villages were captured as kids. Thus there is often no distinction between feral and domestic forms, although selected strains usually are kept from mixture with stocks of feral origin. The feral goats are generally black, black and brown, or brown, suggesting possible natural selection for these darker colors. White flank patches are sometimes present. Some flocks, as on Hualālai, are made up largely of spotted, pale-shaded, or silver animals. Hair is often short, although a beard and full mane give some animals a shaggy appearance. Typical curved horns that swing upward and backward, as well as

FIGURE 65.—Feral billy goat (*Capra hircus*) in the rocky uplands of Lāna'i. This is a robust specimen with horns and color pattern typical of this population. Nichols (1961c) reports horns spreading to more than 26 inches (66 cm). An illustration in E. P. Walker (1966, p. 1474) shows an almost identical color pattern, but scimitar-shaped horns, in a wild goat (also *Capra hircus*) from Crete. Hawaiian feral goats weigh about 50 to 90 pounds (23 to 41 kg) for females, and 80 to 120 pounds (33 to 50 kg) for males. (Lyman Nichols, Jr., photo.)

those flattened and twisted outward, are present in Hawaiian populations. Yocom (1964) describes goats in specific areas on Maui and Hawai'i, and Graf (1959b, 1963) briefly considers the factors of isolation and habitat in relation to pelage, horn form, and hoof wear on Moloka'i and Lāna'i.

Captain Cook left goats on Ni'ihau during his first voyage to Hawai'i, on February 2, 1778. He remarks as follows (Cook, 1785, Vol. 2, p. 217):

> On the return of the boat, I went myself with the pinnace and launch up to the point . . . taking with me a ram-goat and two ewes . . . and the seeds of melons, pumpkins, and onions; being very desirous of benefiting these poor people, by furnishing them with some additional articles of food.

Thus were the fruits of an advanced civilization first thrust upon the native Hawaiians.

Although the original goats had increased to six within one year, all were

killed in a dispute over their possession between rival chiefs of Ni'ihau and Kaua'i (Cook, 1785, Vol. 3, p. 95). Cook must have left other goats on Hawai'i early in the winter of 1778–1779 when his party was lavishly entertained and provisioned for several weeks at Kealakekua Bay. It was only on his return to the bay for emergency repair of a mast that disorders arose and resulted in Cook's death. The small matter of landing of livestock could easily have been omitted from the record under these circumstances.

George Vancouver was among Cook's officers and later returned several times to Hawai'i in command of his own vessel while extending the Pacific explorations. On the first of these visits, in 1792, Vancouver (1798, Vol. 1, p. 156) notes that Tianna [Kaiana], one of the chiefs at Kealakekua, already had several goats and that he did not present this chief with others. At Kawaihae the captain observed in 1793 (Vol. 2, p. 115) that another chief, Kahomotoo [probably Keeaumoku], "had taken the greatest care of the goats I had presented him with on a former occasion."

It appears, then, that goats were well known in Hawai'i by 1793, and must soon after have become common. Marques (1905), in a summary article, reports them as abundant by 1850, and apparently widely distributed in the wild. Goats may have been an item of trade for many years for their skins, and A. S. Baker (1916) reports evidence that they were systematically trapped even in remote places at some unknown time before 1916.

The poor quality of feral-type goats as milk producers is indicated by Thurston (1920), who advised the importation of selected breeds for milking. His scheme was unsuccessful, we may surmise, because of a probable lack of interest in the feeding and care of highly bred domestic stocks by the ordinary person who was to have benefited from it.

Problems of goats in excess numbers were most prominent on Hawai'i, and were closely interwoven with other livestock problems. There was little active concern about them before 1910, but the record of progress after that time is clear, as outlined in reports of the Territorial Board of Commissioners of Forestry and Agriculture. In the 1913 report is the statement (p. 53), "Through the co-operation of corporations and individuals much, of course, has been and is being done, in fencing, in protection, and in some cases in forest planting." Specific mention of goats was made in the 1922 report (p. 24):

> An investigation and special report was made and forwarded to the Governor during the past year on the wild goat menace throughout the Territory. The basis for this report, in addition to general observations, was the participation, in June, 1922, in a two-day goat drive chiefly by boy scouts on the government leased lands of Puuanahulu and Puuwaawaa, Hawai'i, which resulted in extermination of 7000 wild goats. The conclusions reached in this report are that the unchecked wild goat population constitutes a menace to forest and grazing interests in the Territory, especially on Hawaii and Maui, that the most feasible way to control this pest is to conduct extensive drives and follow them up by extermination by

> expert hunters, that the land owners and Territory should cooperate in this work, and that $20,000 should be appropriated as the government's share in the undertaking.

By 1929 there was further advancement, as is reported for that year (p. 22):

> Warfare on the goats must be continued on Hawaii where the inaccessible lava flows provide retreats and breeding places. The situation is well in hand on the other islands where wild goats have become a rarity in most sections.

In 1931 (p. 38) a summary of populations in the islands indicated only 150 goats on O'ahu, but 75,000 on Hawai'i (apparently from L. W. Bryan, 1930). C. S. Judd (1936) indicated that goats on Mauna Kea were not of particular importance, as were the sheep, but had moved over there from Mauna Loa during the dry season of 1925 (apparently from L. W. Bryan, 1927). However, goats remained common in the vicinity of Mauna Kea (Nichols, 1964d). L. W. Bryan (1939) reports on the Ka'ū fence, which would seem to have been a barrier erected on the southeast flank of Mauna Loa primarily to keep goats of the lava uplands from invading the lower forests. Sheep and cattle are not reported as ever having been abundant in this region.

Although goats were, and are, significant as a factor in forest and range deterioration, if not in the extinction of some specialized plant forms, they have been controlled on the smaller islands through unrestricted hunting. H. P. Judd (1939b) reports on the decimation of O'ahu goats probably well before 1920, and they are scarce there today. Goats had been present on Ni'ihau in the early 1900s (H. P. Judd, 1938b), but were annihilated from there about 1910 (Forbes, 1913b) as reported by H. P. J. (1930, p. 193) when "the contract of clearing goats off Ni'ihau was given to a Hawaiian hunter, and in a few years the last goat was brought in." At this time (1930) goats were few on Lāna'i, and were thought to have been eradicated from Kaho'olawe, although C. S. Judd (1916) had estimated 5,000 on the latter island in 1906. Von Tempski (1928) and MacPhee (1931) indicate a large population on Kaho'olawe in or about 1918 when effort was made to reclaim the island for cattle raising. The 1966 population was estimated at more than 2,000 (Comdr. C. Zirzow, U.S.N., pers. comm. to R. J. Kramer).

Goats persisted as a managed game animal on Lāna'i only through regulated hunting (Anon., 1955b; Medeiros, 1964a), and on Kaho'olawe they lived unattended by humans for many years. Kaua'i goats occupy some rugged and remote areas (M. Miller, 1937), but are carefully managed as a game species (Swedberg, 1964a, 1965), with hunting permitted only at specified times. East Moloka'i forests, however, still supported uncontrolled numbers of goats as late as 1964 (L. Nichols, Jr., pers. comm.)

Goats have presented the greatest problems of control on Hawai'i, and lesser ones on Maui. Trouble has occurred especially within the national parks where alien animals are undesirable in any numbers, in keeping with a firm purpose

FIGURE 66.—A goat drive on the rugged coastal slope of Hawaii Volcanoes National Park, island of Hawai'i. This is ideal goat habitat and a chronic problem area. Animals of this region are usually solid black, but white flank patches, spotting, and pale shading can be seen. (National Park Service photo.)

of the parks system to encourage and preserve only the native fauna and flora. A wise companion policy which restricts the parks from public hunting, unfortunately, left the parks with an overabundance of goats, and a difficult dilemma. Geerdes (1964) summarized these conditions for the park on Hawai'i, since 1921. Lamb (1938) considered the problem alleviated at that time, following a program of drives and fencing. Yocom (1964, 1967) in a brief ecological study of the populations in both the Hawai'i and Maui parks, suggested fencing as a final solution to the goat problem. Repeated drives in Hawaii Volcanoes National Park (Anon., 1965d) did little more than skim the surplus animals from the landscape. Feral goats may be an important factor in the ecology of the Hawaiian goose (P. H. Baldwin, 1947b), in the parks and elsewhere.

The goat appears to be a permanent member of the Hawaiian fauna because of its usefulness as a game animal (Nichols, 1961c). Graf (1957) suggests that this species be hybridized with one or several of the ibexes (*Capra* sp.), in order to improve its quality as game. No actual program was ever set up for this. The goat deserves more attention than has been given it, and it should be intensively studied from the aspects of characteristics, adaptive qualities, management, and control. Turbott (1948), Riney and Caughley (1959), and

Atkinson (1964) have presented results of studies in New Zealand that should be of interest to investigators in Hawai'i.

With a firm resolve about 1972 to face the problem squarely, and with funding to accomplish it, the U. S. National Park Service has effectively eliminated the goat from Hawaii Volcanoes National Park. Considerable political urging was needed, but the results are in. The 1984 estimated number of goats is fewer than 30, and these employ all the wiles of the species for survival, including retreat to deep lava caves when pursued.

As late as 1970, park policy, in its applications, had favored a sustained yield program dictated by local hunting interests (Smith, 1971). The basic plan for goat eradication, however, was laid (Baker and Reeser, 1972) and soon thereafter put into practice. The fencing of manageable units of land was a key element, and this allowed for drives and final clearing of stragglers with the aid of especially schooled dogs, imported with a trainer from New Zealand (Altonn, 1972). By 1975 the massive herds were eliminated. In the eastern coastal Kalapana Extension of the park, regeneration of several native plants is well advanced (Williams, 1980). The assessment of Mueller-Dombois (1980) for the whole lowland area is also encouraging in the face of almost total devastation wrought by goats over many generations of uncontrolled habitation. Plants such as the native bean, *Canavalia kauensis*, a previously undescribed species, showed a remarkable recovery when protected from goats. A comprehensive resource management plan for Hawaii Volcanoes was adopted as a basic measure to prevent recurrence of such catastrophies as were caused by an abundance of goats (United States Department of the Interior, 1978). Effects of goats on the more resilient, yet plastic, *Acacia koa* of the park uplands is reported by Spatz and Mueller-Dombois (1973). Constant surveillance of park lands and strict maintenance of fences must be practiced in order to keep goats of adjacent ranch lands from repopulating the protected park area. Katahira and Stone (1982) report on current status of goat management and prospects for the future. Some promise is seen in release of radio-collared goats which join other goats and reveal their location.

The problem of goat damage and goat numbers at Haleakala National Park on Maui is a different one in several respects. Unfortunately, it missed the wave of the 1970s for alleviation and now becomes even more costly. The goat-infested terrain is rugged and at generally high elevation. Kjargaard (1982) brings the matter into sharp focus, noting that goats have escaped into rain forest not normally occupied, but that combined strategies should "turn the corner on the goat problem." Some private contracting and volunteer work groups are assisting the Park Service effort (Hawaii Audubon Society, 1982). Jacobi (1980) reports the plight of the *māmane* tree (*Sophora chrysophylla*) of the Haleakalā Crater, attacked here not by sheep, but by goats.

Meanwhile, the goat remains a much-sought game animal. It may have been exterminated on Lāna'i in deference to the more desirable mouflon and axis deer on that island. None was observed in the 1981 game survey (Ueoka, 1982). On Kaua'i, access to portions of Waimea Canyon was closed as a measure for maintaining a sustained yield of goats, and a general closed season was being considered. At the same time, the cliff areas of the Nāpali Coast of the island showed marked increase in goat numbers, to include the Hanakāpī'ai-Hanakoa region encompassing the Hono'onāpali Natural Area Reserve. Although hunting is urged as a means of controlling the goat population in this critically important reserve, because of heavy hiker traffic along the coastal trail, firearms have been forbidden. Archery hunting is recommended to continue indefinitely. Rare endemic plants such as species of *Hibiscus, Brighamia, Lepidium,* and *Munroidendron* are recognized in the region, where "heavy use of forest vegetation" is observed. The Nāpali Coast population was estimated at 1,650 goats as of June 30, 1982 (Telfer, 1982), but with substantial reductions after initiation of bow hunting (Telfer, 1984).

Background information on the goat is valuable for understanding the animal (Payne, 1969; Noddle, 1974; Schaller, 1977). Research on biology of the feral goat in Hawai'i has seldom gained support, but work from other regions is useful to application here (Rudge, 1969, 1970a, 1970b, 1972; Williams and Rudge, 1969; Rudge and Smit, 1970; de Vries and Black, 1943; Watts and Conley, 1984). The papers of Dawson, Denny, and others (1975), Coblentz (1976), Kolz and Johnson (1980), and O'Brien (1982) provide more specialized information. Baldwin (1978) adds an acceptable note, and Hughes (1981) details an example of commercial production, with selected breeds of farm goats, in these modern times.

Ovis aries. Domestic sheep (includes domestic and feral stocks).

ORIGINAL DESCRIPTION: *Ovis aries* Linnaeus, Systema Naturae, Ed. X, 1:70. 1758.

TYPE LOCALITY: Sweden.

NATIVE RANGE: Domestic sheep were derived from wild sheep of central and western Eurasia. Few wild populations remain.

RANGE IN HAWAI'I: Firmly established on Hawai'i, principally on Mauna Kea and Hualālai. Altitudinal distribution on Hawai'i has been mainly from about 2,000 feet, as near Pu'uwa'awa'a, to more than 13,000 feet among the bare cinder cones of Mauna Kea summit region. Descended to sea level in the Ka'ū District, Hawai'i, when it was present there, and on Kaho'olawe, which was the only other island occupied by feral sheep.

Ancestry of the domestic sheep has been defined by several incongruous

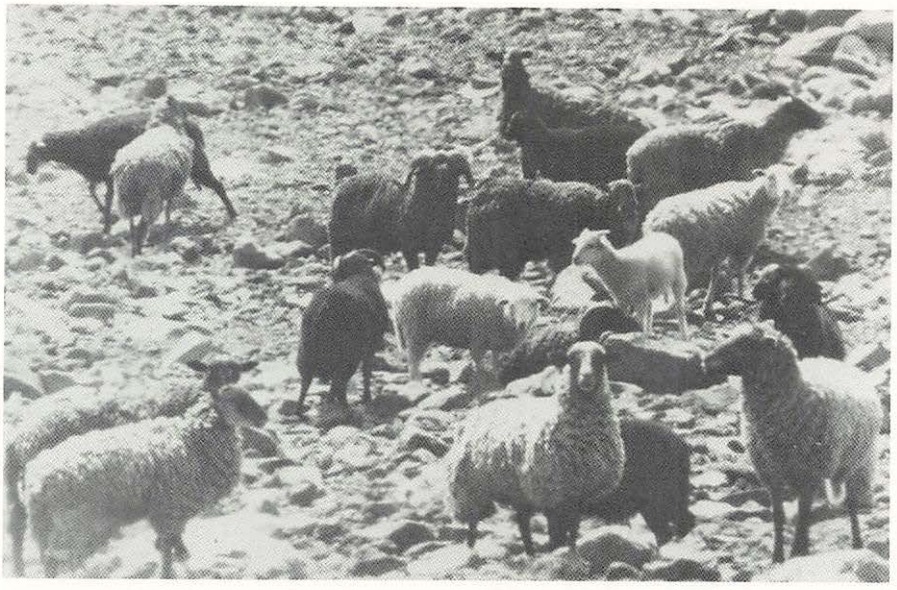


FIGURE 67.—Feral sheep (*Ovis aries*) in the lava wastelands on Mauna Kea, Hawai'i. Only the males are horned. Colors range from black to reddish brown to white. The wool is often soiled and ragged. Adults weigh 60 to 150 pounds (27 to 70 kg). (Lyman Nichols, Jr., photo.)

hypotheses involving unknown basic species, as explained by Reed (1959, p. 1635). One classification considers all Eurasian sheep, with the exception of a remote eastern Siberian race of the bighorn, *Ovis canadensis* Shaw, as subspecies of the argali, *Ovis ammon* Linnaeus. Such a view restricts the lineage of *O. aries* to the several forms of this one species. The domestic sheep and mouflon are included among these subspecies as *O. ammon aries* and *O. ammon musimon*, respectively, as listed by Uloth (1961). However, Hatt (1959, pp. 75–76) distinguishes between a domestic *O. aries* and a wild *O. orientalis* Gmelin in Iraq, and Perkins (1964) points to this second species, the red sheep, as a prominent ancestor of the domestic forms. He places domestication of sheep at nearly 11,000 years ago because of the presence in abundance of remains of young *Ovis orientalis* in the Shanidar deposits of Iraq, demonstrating human control of the sheep population. Other probable forebears of domestic sheep remain in the wild state, along with *O. orientalis*, but only as generally dwindling, small, and intermixed populations. Zeuner (1963, pp. 153–198) discusses sheep at length.

Feral sheep on Hawai'i are often referred to as Merinos, but other breeds are undoubtedly infused into this population. Kaho'olawe sheep differed in some respects from those of Hawai'i, particularly in the absence of black or

FIGURE 68.—Feral rams with unusually long horns, in bunch-grass habitat on Mauna-Kea. These sheep are derived at least in part from Merino ancestors. The strongly spiraled horns may reach a length of 34 inches (86 cm) (Nichols, 1964g). (Ronald L.. Walker photo.)

brown in the wool color (R. J. Kramer, pers. comm.). Munro (1947) discusses sheep on Hawai'i, Lāna'i, and Ni'ihau, and implies that differences in their characteristics arose through isolation.

Domestic sheep are relatively adaptable to a feral existence, provided they are not exposed to wild predators. Feral populations are actually established only on islands where no large native carnivores are present. Examples outside Hawai'i are reported by Boyd and others (1964), Wilson and Orwin (1964), and Wodzicki (1961), and form useful comparisons with Hawaiian populations. The first introduction of sheep to Hawai'i is attributed (Wyllie, 1850, p. 45) to Captain James Colnett, who is said to have landed a ram and two ewes on Kaua'i in April 1791. B. Judd (1929, p. 51) refers to Wyllie's statement and reports the ship as the *Argonaut*, a merchantman that had come from the Pacific coast of North America.

Vancouver documented his importations more completely and precisely. He put a ram, two ewes, and a lamb born in passage from California, ashore at Kawaihae on Hawai'i, February 14, 1793 (Vancouver, 1798, Vol. 2, p. 115), in the care of Kahomotoo (Keeaumoku), a chief whom he had met and presented with goats on the 1792 stopover. He then proceeded to Kealakekua and sent ashore his remaining sheep (Vol. 2, p. 127), a ram and two ewes.

On this third visit to the islands (Vol. 3, p. 11) Vancouver landed two each of rams and ewes at Kealakekua on January 19, 1794, as a gift to Kamehameha I. In coasting northwest after leaving the island of Hawai'i, he remarked (p. 70)

on March 5, "I had reserved some sheep for establishing the breed in each of the islands." But as they waited off Moloka'i, an expected chief did not appear, the day being taboo, and they sailed on without leaving the sheep as intended. It is not clear if others of the six remaining animals were left on O'ahu or other islands visited. However, sheep became firmly established as a result of these early importations and were accorded royal protection, as were the cattle.

Sheep raising did not thrive quickly (Meek and others, 1853), but some animals must have wandered early and were able to survive at least for a time, for Ellis (1917, p. 304) reports that Joseph Goodrich stated, after his second trip to Mauna Kea, most likely in 1825, "Very near to the summit, upon one of the peaks, I found eight or ten dead sheep; they probably fled up there to seek refuge from the wild dogs." Kenway (1851, p. 72) envisioned the drier unforested western portion of the Waimea Plain as a sheep run. If cattle had used this area in earlier years, as Vancouver intended they should, they were in Kenway's time already driven from it by the bullock hunters:

> The outer plain of Waimea, extending to the base of Mauna Kea and sloping toward the sea, a hitherto unused and useless tract . . . is a fine example, and on this land alone, a profitable and interesting population [of sheep] might be brought to exist, break the dismal silence and redeem the idle wilderness.

The Parker Ranch Humu'ula Sheep Station was formally established in 1876, although the site was occupied well before 1873 for ranching purposes (Bird, 1964). Stray and feral dogs reputedly hindered sheep farming in early times, and continue to harass the residual domestic flocks as well as the managed feral populations. This aspect is discussed under *Canis familiaris*. Dogs have likely been a selective factor in the development of wildness in feral strains of sheep, but its effect has not been quantified.

Lāna'i was another early site for sheep raising, as was Ni'ihau (Anon., 1893). Although nearly 100,000 domestic sheep were tallied for the Territory of Hawaii in 1903 (Report of the Territorial Board of Commissioners of Agriculture and Forestry for 1909, p. 138), this industry has almost disappeared. Dr. Estel Cobb of the University of Hawaii informed me in 1962 (pers. comm.) that some 10,000 sheep then remained, principally on Ni'ihau and on Hawai'i, but with small flocks scattered throughout the islands. The Humu'ula operation became a classic in Hawaiian ranching and is the source of many descriptive articles, exemplified by Anon. (1902d, 1906). Plans for closing out the station as a sheep farm in 1964 (Anon., 1963e) were carried out. Economic reasons, including competition in both the lamb and wool markets, costly replacement of equipment, poaching, and predation by dogs and by pigs (on lambs), forced this action.

Ecological disturbances caused by feral sheep on public lands were long overshadowed by cattle problems, and have not so frequently come to public

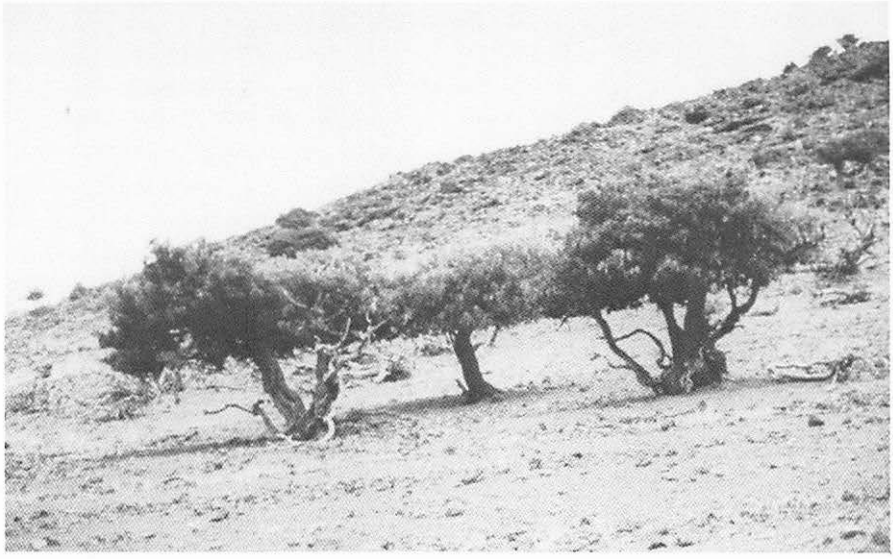


FIGURE 69.—Highlined *māmane* trees in heavily depleted sheep range on Mauna Kea. The browse line is at 54 inches (1.8 m). (Jon G. Giffin photo.)

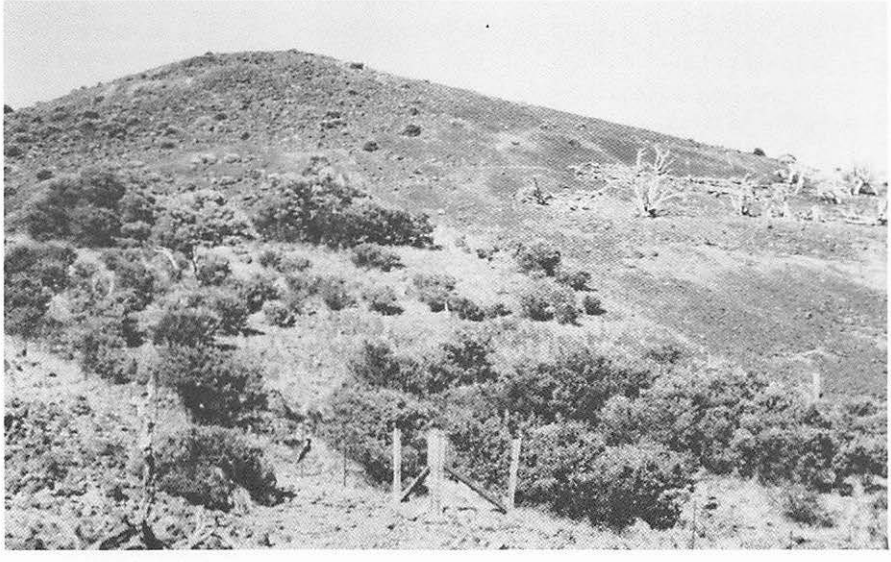


FIGURE 70.—One-acre sheep exclosure at Pu'u Kole, Mauna Kea, established in 1963. Substantial recovery of vegetation is apparent in this photo, after 16 years, in 1979. A grove of unprotected trees at the far right died out during the experiment. (Jon G. Giffin photo.)

attention. Feral sheep were also more restricted in range and less plentiful than cattle, until cattle were brought under reasonable control. The principal concentration of sheep has been in the forest of *māmane* (*Sophora chrysophylla*) at the middle and upper levels of Mauna Kea. When cattle were restricted from this area, sheep continued to thrive in large numbers and to further derange the soils and vegetation.

Serious effort to control sheep on Mauna Kea was under way by 1934 (L. W. Bryan, 1935), but the same author reported three years later (1937a) an estimated 40,000 sheep still present. In a summary paper (1947) he estimated that nearly 71,500 sheep had been slaughtered on Hawai'i in the period from 1921 to 1946. By 1949 there was concern that the population structure had been disrupted on Mauna Kea, and that the numbers of sheep were dwindling (L.W. Bryan, 1950). A closed season was declared in 1949. The sheep recovered and under a management plan became a popular game animal. Anon. (1955a, 1955b) report a favorable season that year; Collins (1957) demonstrated the quality of hunting afforded by the feral sheep in that period, and Nichols (1964g) reports further on this subject. Management practices included the building of roads to permit hunters access to remote areas of sheep concentration. Nichols (1964f) described construction of enclosures for the evaluation of browsing and its effect on growth and reproduction of *māmane* in this region.

The Mauna Kea sheep population has demonstrated cyclic aspects observable in annual census figures. Following the low of 1949 of perhaps 500 animals, mostly rams, by 1958 there were some 3,000 in all, and a peak number of about 4,000 in 1960. Ewes now consistently outnumber rams. A population reduction to about 1,100 in 1962, in spite of less liberal hunting regulations, may be attributable to a natural decline in the reproductive rate, as shown in population tables (Bachman, 1963).

The downward trend leveled off (Nichols, 1964c), and a 1963 recommendation for a desirable herd size of 1,300 to 1,500 may have been realistic in relation to the necessity for re-establishment of natural *māmane* seedlings at higher altitudes. Under such a plan, gradual increase of sheep could be permitted to follow increments of available forage. Some areas of traditional sparseness of sheep were reserved for archery hunting (Nichols, 1961b; Kosaka, 1965).

The future of feral sheep, however, became seriously threatened in the 1970s as ecological problems intensified relative to its habit of consuming the dominant forest species of its principal habitat on Mauna Kea, the *māmane* tree. This plant is a nutritious legume likened to alfalfa as a food for herbivorous mammals. Three endemic passerine birds depend for sustenance on this tree in Mauna Kea habitats, and the *palila* (*Loxioides bailleui*) occupies no other range

except the native forest on the upper slopes of the mountain. Survival of the *palila* as a species depends on survival and health of the *māmane* forest. Its principal foods are seeds from green pods of *māmane* and insects associated with this and the *naio* tree. Van Riper (1980a, 1980b) has provided the most recent and most detailed documentation of these facts. The ultimate cause of decline of the *palila* is related to decline of the forest. Scowcroft (1976a, 1976b, 1978, 1981, 1983), meanwhile, has researched the problem of the mechanism of forest decline. All avenues have led back to the root cause—too many sheep over too long a period.

Legislation of the period produced firmly set laws for the protection of native wildlife, under the federal Endangered Species Act of 1973 and the Hawaii Endangered Species Act of 1975. The *palila* was listed by federal statute as an endangered species in 1967. As such, the bird was entitled to the preparation of a "Recovery Plan," a document which surfaced in due time (United States Fish and Wildlife Service, 1978).

A highly professional-quality management plan for the sheep (Giffin, 1976) was a valuable contribution to the solution of the sheep/*palila* controversy in that no basis could be found to justify continued presence of sheep other than the desire of hunters to have them there. The issue was clouded somewhat by accelerated development of astronomy facilities on Mauna Kea and the time-consuming formulation of a master plan for the state lands of the entire upper mountain (State of Hawaii Department of Land and Natural Resources, 1977). As a policy document the Mauna Kea Plan presented an ambivalent position by providing for ample sheep hunting and at the same time declaring for protection of the endangered *palila* and its life-supporting *māmane* habitat. Mull (1977) wrote an analysis of these incongruities.

The federal Endangered Species Act includes provision for a citizens' suit to enforce protection when an agency fails to do so (Section 9). As early as June 22, 1976, the Hawaii Chapter of the Sierra Club threatened to sue the state when "business as usual" management practices persisted on Mauna Kea, in further jeopardy of the *palila* (Anon., 1977). When another 18 months passed with no perceptible action by the State, the Sierra Club (1978) filed a lawsuit in the Federal Court of Honolulu. A decision rendered on June 6, 1979, held that the proposal for restricting sheep to a portion of the *māmane* forest was an ineffective solution and ordered all feral sheep and goats removed (Kobayashi, 1979). In an oddly timed decision, game officials closed the sheep, goat, and pig seasons for the period August 4–September 20 "because of the low population of game mammals on the mountain."

An intransigent state administration did "nothing," as the judge phrased it, in the next 11 months toward meeting a court-ordered July 31, 1981 deadline for clearing the sheep from Mauna Kea to promote interests of the *palila*

(Kobayashi, 1980). In a sequel article, Woo (1980) reports that the administration finally relented. Hunting would begin June 7, 1980, and continue indefinitely on succeeding weekends. Sakai (1980a) reports that some 780 sheep and 75 goats remained on Mauna Kea at the start of the eradication. Various tactics were used, including hunting by the wildlife staff from helicopters. When numbers dwindled the animals were considered for practical purposes to have been eradicated on July 31, 1981, satisfying the legal constraints (State of Hawaii, Department of Land and Natural Resources, 1981b). After 20 years, the position taken by Warner (1960, 1961) had been vindicated. It is not presently clear that repopulation is not in progress from stock living usually on ranch lands below the aging and deteriorated boundary fence, although precautions against repopulation have been outlined (Bachman, 1984). Juvik and Juvik (1984) provide a measured overview of the entire problem.

Farming of domestic sheep has been at a low ebb for a number of years, but a resurgence is evident as local markets for lamb, mutton, wool, and skins have strengthened. Examples of new herds of prized domestic breeds are reported for Maui (Tanji, 1978) and Hawai'i (Sakai, 1980b). To date none of these is being run in the vicinity of Mauna Kea.

Ovis musimon. Mouflon.

ORIGINAL DESCRIPTION: *Aegoceras musimon* Pallas, Zoogeographica Rosso-Asiatica 1:230. 1811.

TYPE LOCALITY: Sardinia.

NATIVE RANGE: Islands of Sardinia and Corsica. Introduced variously into southern, central, and eastern Europe; also into Texas in the United States.

RANGE IN HAWAI'I: Recently established on western Lāna'i, and on Hawai'i, on Mauna Loa and among the feral sheep of Mauna Kea. Introduced to Kaua'i but failed to survive.

The mouflon is usually considered a true species of wild sheep, but some European writers (Uloth, 1961; Pfeffer, 1967) treat it as a subspecies of the argali of Asia, *Ovis ammon* (Linnaeus). The mouflon has been widely distributed through Europe by man, from its original range on the two Mediterranean islands. In the United States it thrives in zoological gardens and on private game range in Texas (De Vos, Manville, and Van Gelder, 1956, p. 169). Origin of Hawaiian populations is unknown, other than from several specific zoos and private animal collections on the United States mainland, and from the Honolulu Zoo. It is a vigorous stock and seems to be typical of the species.

First release of mouflon in Hawai'i was on Lāna'i, on July 30, 1954 (Medeiros, 1954). This and subsequent releases on that island included 28 animals (R. L. Walker, 1959b). This sheep is well adapted to the rugged ridge

and gully lands sloping from the central plateau of Lāna'i westward to the sea. The population increased rapidly and when it reached about 200 sheep in 1964 (Medeiros, 1964b), a first season for the taking of 40 rams was declared (Anon., 1964p).

Mouflon were considered for addition to the fauna of Kaua'i, and four were released in 1958 (R. L. Walker, 1959b). These disappeared and no further stock was released there. Establishment of the species on Hawai'i is related to the mouflon-feral sheep interbreeding program, and is discussed in the following section.

As of 1984 populations of mouflon are managed for regular public hunting on Lāna'i and on Mauna Kea. A release in the Kahuku Ranch on the south rift of Mauna Loa appears to be established on these private lands, with an estimated population of several hundred, largely in alpine scrub habitat at 4,000 to 6,000 feet elevation (C. H. Bredhoff, Jr., pers. comm.).

The species is well distributed throughout the Lāna'i game management area with a 1981 population of nearly 900. Of 61 hunters, 41 percent were successful in bagging a permitted ram during that season. It was judged that as many as 41 rams could be taken in subsequent years without altering the favorable known 1:2 ram to ewe ratio (Ueoka, 1982).

In 1980 the mouflon assumed a new prominence as it was not included in the court ruling for removal of feral sheep and goats from Mauna Kea. Thus it is in the wings as the surviving hope of hunters for a viable stock of big game on the mountain. The unfortunate prognosis is that the mouflon, now standing at perhaps 500 animals, presents many of the undesirable features of feral sheep in the *māmane-naio* forest. Predictably, in a matter of time it will threaten the *palila* just as the feral sheep did (Scott, Mountainspring, and others, 1984). It is probably well said that what Mauna Kea needs now is an opportunity for rest and recovery, not more sheep.

As a sequel to feral sheep studies, Giffin (1980) has produced an excellent evaluation of the mouflon. Besides providing a detailed background of the species in native range and as introduced to other parts of the world, this report covers its biology on Mauna Kea and implications for management. The following paragraph paraphrases Giffin's work.

Mouflon occupy primarily the eastern slope of Mauna Kea where 78 were released between 1962 and 1966 in the vicinity of Kahinahina. Spread to new areas has been slow and there was a tendency for segregation from feral sheep. Few of these intermingled with the mouflon. It is probable that standing water is not utilized, rather that moisture is obtained from green plants and dew. The population rose to an estimated 525 by 1979, even after annual harvests beginning in 1975. These sheep range into ranch lands below the game management boundary, utilizing breaks in the fence for passage. About 40

FIGURE 71.—Male mouflon (*Ovis musimon*) used in the project for hybridization with feral sheep at Pōhakuloa, on Hawai'i. Hybrid and pure mouflon have been released among the feral sheep of Mauna Kea. Adult mouflon rams weigh as much as 160 pounds (73 kg) and ewes attain perhaps 90 pounds (40 kg). (Lyman Nichols, Jr., photo.)

percent of sheep counted in surveys were on ranch lands. Mouflon travel generally in small groups, but as many as 140 were observed in one herd, representing up to three fourths of the animals of the local region. Monitoring of exclosures established in 1963 shows that mouflon are carrying on the suppression of native vegetation much as did the feral sheep, in particular at the critical upper tree line where the forest is heavily depleted, to include stripping of bark from *māmane* trees.

Giffin (1980) makes good use of the world literature and includes an extensive bibliography of the mouflon. The papers of Kilham (1972) and Uloth (1976) are additions to this stock of information. McEldowney (1976) prepared an exhaustive bibliography useful to all aspects of concern about Mauna Kea. Powell (1985) reviews the plight of the native silversword (*Argyroxiphium*), another victim of browsing livestock on the mountain.

Ovis musimon x Ovis aries. Mouflon—domestic sheep hybrid.

Hybrids between these two forms are well known and are completely interfertile. This tends to support the assertion that these sheep are not distinct species. Borland (1964) lists the chromosome number of the domestic sheep as 54 and that of the mouflon is the same (Kurt Benirschke, pers. comm.).

In order to carry out a program to increase the quality of big game in Hawai'i (Nichols, 1962b), the hybridization of penned mouflon and feral sheep began with the importation of mouflon to Pōhakuloa, Hawai'i, in 1957 (R. L. Walker, 1959a, 1960; Uloth, 1959). The intended result of this breeding project was a sheep that was 7/8 mouflon, to be achieved by a series of selective matings, as proposed and outlined by Graf (1957). Desired features of such an animal were a superior trophy head, wildness, and a tendency to congregate only in small scattered bands. This last character has a special significance to management because previous range damage resulted not only from overpopulation of feral sheep, but also from their habit of gathering into large flocks and thoroughly denuding one area before moving on to another.

By June 1961, there were 36 feral ewes confined in small breeding pens, and more than 70 were held in a 300-acre paddock for breeding. A total of 40 first- and second-generation offspring had been produced (Report of the State of Hawaii Department of Agriculture and Conservation, 1961, p. 103). The program, however, was discontinued in 1963 for a variety of reasons and a principal stock of pure mouflons was released in November at the Kahinahina pens, at about 8,000 feet elevation on the east flank of Mauna Kea. Hybrids had been freed mainly at Pu'u Lā'au, also in the high sheep range, at 7,400 feet on the west flank. Observations revealed that mouflon rams released singly associated with bands of feral sheep, but when several mouflon were in the same area these maintained the habit of gathering into small bands of their own

FIGURE 72.—Young male F_1 hybrid between a mouflon ram and a feral sheep ewe (*Ovis musimon* × *O. aries*). Characteristics intermediate between those of the parents are shown by body conformation, horn form, pelage, and tail length. (Ronald L. Walker photo.)

species. Nonetheless, hybridization did occur readily in the wild, and crossbred animals tended to flock with the feral sheep. Management techniques, to include heavy reduction of feral rams by selective hunting, were suggested as a means of increasing the rate of introgression of mouflon genes into the Mauna Kea flocks (these data from Bachman, 1964). Nichols (1964c) reports a census taken in that year. Some thought should be given to preserving a line of the original feral sheep uncontaminated by mouflon characteristics. This unique form has been possibly 150 years in development and is worthy of genetic, serologic, and other evaluation, in captivity if not in the wild.

Giffin (1980) summarizes briefly some data on interactions of the mouflon and feral sheep on Mauna Kea. Ninety-nine pen-reared hybrids were released at Pu'u Lā'au on the western side of the mountain in June–July 1962, and 12 mouflon rams were released there in August 1962 and October 1963. At Kahinahina on the eastern flank 30 ram and 48 ewe mouflon, and no hybrids, were freed between November 1963 and February 1966. It is here, on the east side, where the population of mouflon emerged, with feral sheep making lesser

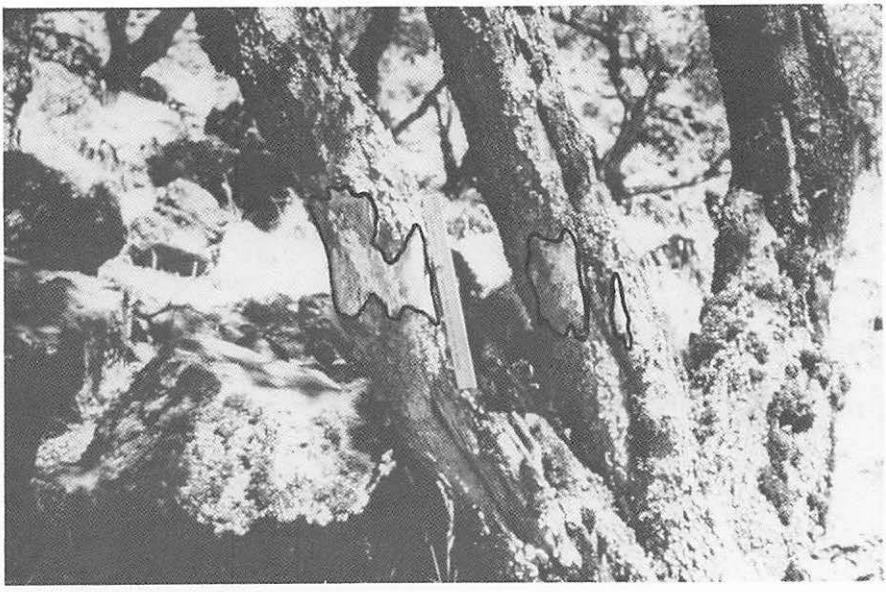


FIGURE 73.—Bark stripped from *māmane* trees of the mouflon range, Mauna Kea, Hawai'i. Damaged areas are outlined in black. Habits of mouflon are similar to those of feral sheep. (Paul G. Scowcroft photo.)

use of the area. A few sheep of either species sometimes associated with herds of the other, but gatherings of single species were the rule. Hybrids in this area were noted to run with either group.

Giffin cites an example (Roberts, 1932) in which free-ranging domestic sheep and mouflon on a small island produced no crossbred lambs until all mouflon, except two rams, were removed. In the following season 28 hybrids appeared in the herd. Thus, it may be that in the absence of mouflon ewes in the Pu'u Lā'au region, production of additional crossbred lambs was commonplace after 1963. Giffin (1980) remarks that crossbred lambs produced during the time of his study were thought to be progeny of hybrid adults. These data suggest that a gradual segregation was taking place between the two forms of sheep under conditions in the wild rather than a melding of their characteristics.

The eradication program included removal of obviously hybrid animals and no mouflon stock was known to remain on the western flank of Mauna Kea at the end of that program.

Some Perspectives in Hawaiian Mammalogy

HAWAIIAN NAMES FOR MAMMALS

The ancient Hawaiians were close observers of nature, and, as was noted in 1836 in the first prominent Hawaiian dictionary (Andrews, 1922, p. xvii), the language "was very rich in terms for every variety of clouds. It has names for every species of plant on the mountain or fish in the sea." This does not mean necessarily that they had developed a system of nomenclature based on phyletic relationships of living organisms, for as Malo (1951, p. 45) explains, "All products of the ocean, whether they move or do not move, are called fish (*ia*)," and he indicates further (p. 47), that while *i'a* means primarily fish, at a meal it means also the principal food eaten, or in the absence of fish or meat, any savory substance.

Nonetheless, fish and cultivated plants in their many forms and varieties were given individual names. Stokes (1917, p. 20) says, "The early Hawaiian biological nomenclature was very profuse and apparently exact as to variety. . . . There were over sixty terms for varieties of taro; and three or four terms for the fish *ulua* in its different stages of growth." But as he also states, "As the old systems became obsolete through foreign influence the Hawaiians seemed to lose their aptitude in 'giving a thing a name.' "

That whales and dolphins had a lesser significance to the Hawaiians than the more immediately encountered plants and animals is evidenced by only two or three names designating apparently all whales and only two for all the many dolphins.

The ancient Hawaiians knew the pig, the dog, the rat, the bat, and the seal, and distinguished each of these by name. There was a tendency in their naming to designate one species in terms of another. Thus, even in this short list, the seal, which was apparently discovered by these Polynesians only long after the dog was named, became a special sort of a dog, perhaps loosely a "surf-dog." One might be tempted to conclude that basic similarities were recognized in the structure of these two mammals which are ordinarily listed as members of the same order. Apparently, however, very general mammalian characteristics and a restricted choice of comparative forms guided this designation, for many

later-introduced species were named in terms of the native rat or pig quite without regard for actual systematic relationships. As a result, the mongoose became *'iole manakuke* or "mongoose rodent." In other cases of previously unknown mammals, the English names were transliterated, usually in the Hawaiian phonemic system. The horse, however, received the puzzling name of *lio* and the mule, instead, is called *hoki*, which would logically apply to the horse. A similar error of reference left the goat as *kao* (presumably from cow).

In making up the following list, I have drawn substantially upon Pukui and Elbert's *Hawaiian Dictionary* (1971). Clarifications of their usages, from the viewpoint of the mammalogist, are occasionally in order. As an example, *'iole-po'o-wai* I have restricted to the Norway rat because of its proclivity for swimming and successfully living near water (Cottam, 1948), as compared to the roof rat, which usually prefers higher ground, attics, or trees. Some recently liberated big game animals have had no Hawaiian names applied to them; and with the decreased use of Hawaiian as a spoken language, there seems no advantage in searching out a designation of the mouflon, for example, beyond the general category of *hipa* (for sheep).

Wallaby: kanakalu, kanagaru, kanekalu, kanegaru. Kangaroo (Eng.).
Bat: *'ōpe'ape'a, pe'a, pe'ape'a.* Ancient Hawaiian.
Rabbit: *lāpaki.* Rabbit (Eng.). Also *'iole-lāpaki,* lit., rabbit rodent (or rabbit rat).
Roof rat: *'iole.* Also *'iole-nui,* lit., big rat.
Norway rat: *'iole.* Also *'iole-nui,* lit., big rat; *'iole-po'o-wai,* lit., water-diving rat.
Polynesian rat: *'iole.* Ancient Hawaiian.
House mouse: *'iole.* Also *'iole li'ili'i,* lit., little rat.
Guinea pig: *'iole-pua'a.* Lit., pig rodent.
Dolphin: *nai'a, nu'ao.* Ancient Hawaiian.
Whale: *koholā, palaoa.* Ancient Hawaiian.
Sperm whale: *koholā kēpama.* Sperm (Eng.) whale. Also *kēpama, pāma.*
Dog: *'īlio.* Ancient Hawaiian.
Mongoose: *'iole-manakuke.* Lit., mongoose (Eng.) rodent. Also *manakuke.*
Cat: *pōpoki.* Said to be derived from "poor pussy" (Eng.). Also *'oau, 'owau.* From the imitated call of the cat.
Seal: *'īlio-holo-i-kauaua.* Lit., dog running in the toughness. Probably from activity of seals in the surf.
Horse: *lio.* Possibly derived from *lilio* (reduplication of *lio*) which describes a frightened person. It is of interest that *lī'ō* (which has quite a different pronunciation) means to quiver, leap away, or shy, as a frightened horse.
Donkey: *kēkake, 'ēkake.* Donkey (Eng.). Also *piula* (on Moloka'i). Mule (Eng.).
Mule: *hoki.* Horse (Eng.). Likely a result of early misapplication. In turn, *hoki* has come to mean barren, as of a woman, in modern usage. Also *miula, piula.* Mule (Eng.).
Pig: *pua'a.* Ancient Hawaiian.
Axis deer: *kia, dia.* Deer (Eng.).
Mule deer: *kia, dia.* Deer (Eng.).
Pronghorn: *'anekelopa.* Antelope (Eng.).
Water buffalo: *pipi Pākē.* Lit., Chinese beef (Eng.).
Cattle: *pipi, bipi.* Beef (Eng.). Also *pua'a pipi,* lit., beef pig, in early usage.

Goat: *kao*. Cow (Eng.). Apparently an early misapplication that became established usage. Also *kūnānā*, lit., stand look; *nānā*.
Sheep: *hipa*. Sheep (Eng.).
Mouflon: *hipa*. Sheep (Eng.).

MAMMALS IN CRAFTS AND ART

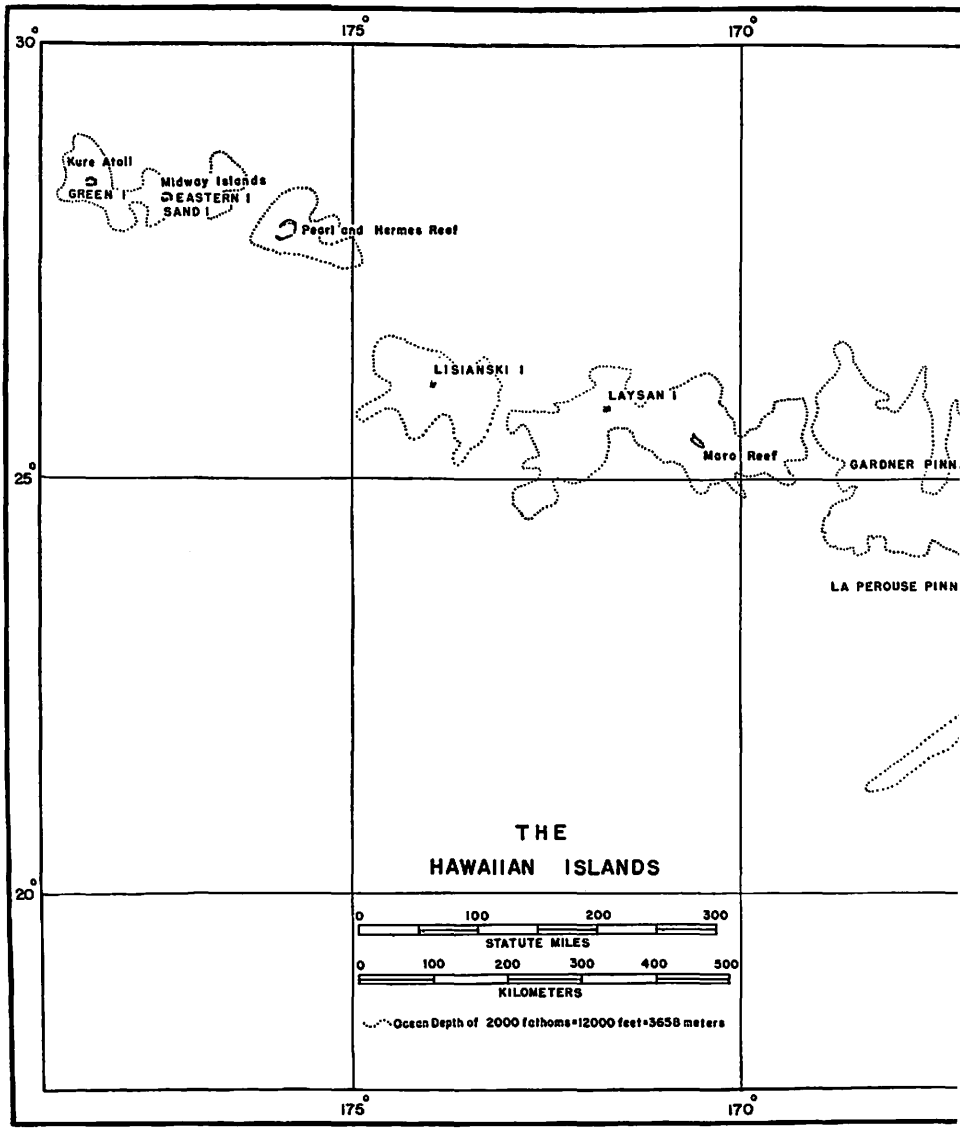
The pig, dog, and sperm whale are the main sources of mammalian raw materials used in fashioning implements and ornaments. The Polynesian rat served as a stimulus for the construction of miniature bows and arrows used in the sport of hunting of this creature, but see also Apple (1985). Buck (1957) has thoroughly treated these subjects in his well-indexed book.

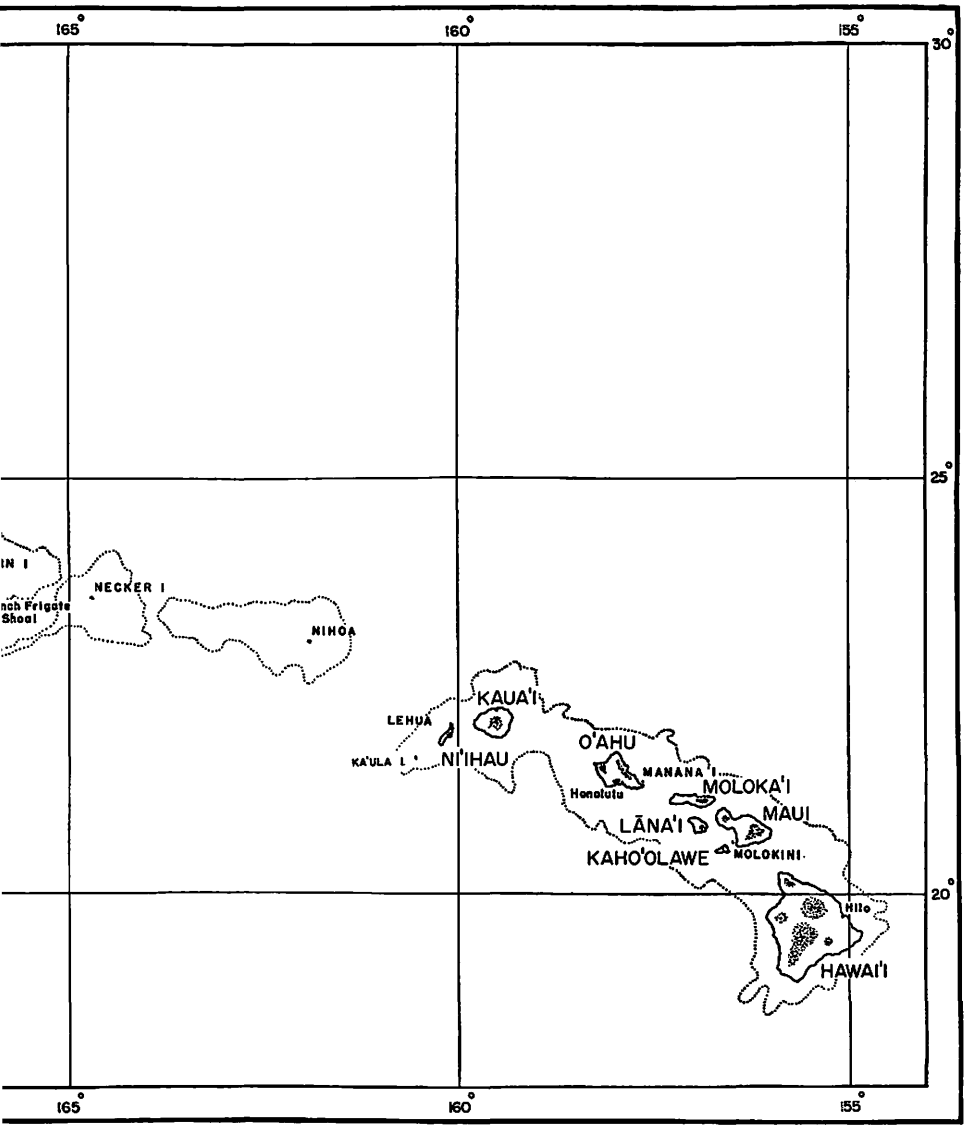
Sewing implements included ivory bodkins and needles of ivory or of unspecified kinds of bone. For the weaving of nets, mesh gauges and shuttles were sometimes made of bone or ivory. Whale rib is mentioned as one source of bone. Fishhooks, on the other hand, were fashioned from human bone in preference to other mammalian materials, although dog bone and whale ivory were employed, the latter for especially large hooks.

Weapons were generally made of wood, but stone and sharks' teeth were

Overleaf

FIGURE 74.—Map of the Hawaiian Islands. Hawaii became the 50th state of the United States of America on August 21, 1959. The State of Hawaii is subdivided into five counties, which include the following islands or groups and nearby islets: County of Hawaii (island of Hawai'i); County of Maui (Maui, Moloka'i, Lāna'i and Kaho'olawe); County of Kalawao (a small portion of Moloka'i administered by the Hawaii Department of Health); City and County of Honolulu (O'ahu); County of Kaua'i (Kaua'i and Ni'ihau). Kaho'olawe, Ka'ula Island, Midway Islands, and Kure Atoll are under federal military jurisdiction. All lands from Nihoa northwest to Kure Atoll, with the exception of Midway Islands, which are not legally a part of the State of Hawaii, are a part of the City and County of Honolulu. This entire far-flung segment of the Hawaiian archipelago beginning with Nihoa has been called, by tradition, the Leeward Islands; however, the State of Hawaii Department of Planning and Economic Development, for official approval of geographic names (Report GN-3, dated October 4, 1968), selected the more appropriate name, Northwestern Hawaiian Islands, for this group. This same report has also approved the names French Frigate Shoals (plural) and Pearl and Hermes Atoll (not Reef). The Northwestern Hawaiian Islands, with the exception of Midway Islands and Kure Atoll, comprise The Hawaiian Islands National Wildlife Refuge, whose function is administered by the Bureau of Sport Fisheries and Wildlife of the United States Department of the Interior; cooperating agencies include the State of Hawaii Department of Land and Natural Resources (Division of Forestry and Wildlife) and the University of Hawaii.


30°
175°
170°
Kure Atoll
GREEN I
Midway Islands
EASTERN I
SAND I
Pearl and Hermes Reef
LISIANSKI I
LAYSAN I
Maro Reef
GARDNER PINN
LA PEROUSE PINN
25°
THE
HAWAIIAN ISLANDS
20°
0 100 200 300
STATUTE MILES
0 100 200 300 400 500
KILOMETERS
Ocean Depth of 2000 fathoms=12000 feet=3658 meters
175°
170°


165°
160°
155°
30°
25°
20°
NECKER I
NIHOA
KAUA'I
LEHUA
KA'ULA I.
NI'IHAU
O'AHU
MANANA I.
Honolulu
MOLOKA'I
MAUI
LĀNA'I
KAHO'OLAWE
MOLOKINI
Hilo
HAWAI'I

sometimes incorporated. One whalebone club is described. Strangling cords, used in public executions, sometimes had ivory handles. Cutting or scraping implements of various sorts had handles made from the jawbone of a dog.

Ornaments included the hook-shaped neck pendant (*palaoa*) carved from whale ivory. Wearing this object had replaced the earlier Polynesian fashion of wearing a whole sperm whale tooth, or a copy of these teeth made from stone, as a pendant. In later times walrus tusks were imported as a source of ivory. The Hawaiians also strung canine teeth of dogs on cords to make complete necklaces, and used ivory beads sparingly in others. Ivory carvings were employed for adornment in the tiny form of objects such as turtles and sea shells.

Whole boar tusks, or sections of them, each drilled with two holes and threaded, formed bulky bracelets. Dog-tooth leg ornaments were intricately fashioned. These were worn by male dancers and consisted of drilled canine teeth loosely threaded in rows on sheets of strong netting worn about the calves. A pair of their leggings required the four canine teeth from each of 400 to 500 dogs.

The drawing or figuring of human and animal forms was not employed in the highly developed arts of printing tapa cloth, decorating gourds, and weaving feather capes. Carved wooden images include no mammals other than man. Thus, the lower mammals are represented only in petroglyphs.

Petroglyphs, or rock carvings, are a principal residual art form of many primitive peoples (Coon, 1963), and often show relationships of man to the lower animals. Heizer and Baumhoff (1959) indicate a possibly exclusive connection between hunting of game and the occurrence of certain American Indian petroglyphs.

Similar interpretations may be made from the carvings found in Hawai'i. Ellis (1917, Appendix, p. 346) inquired about these figures on his tour around Hawai'i Island in 1823, and recorded his impressions of them as "efforts of an uncivilized people towards the construction of a language of symbols." Emory (1924) reports on the extensive materials available on Lāna'i, which include many of the recently introduced domestic animals. McAllister (1933a) discusses the relative scarcity of petroglyphs at O'ahu sites.

A report from the island of Hawai'i (Bernice P. Bishop Museum, 1964b) extends Ellis' interpretations and describes the petroglyph fields in the vicinity of Puakō and 'Anaeho'omalu. These petroglyphs are usually single inscriptions and were not meant to tell stories. The modern artist, however, is easily tempted to form composite pictures from them by grouping selected tracings (see Frontispiece).

Ellis (1917) made this astute observation with regard to petroglyphs, "On inquiry, we found that they had been made . . . from a motive similar to that

which induces a person to carve his initials on a stone or tree, or a traveller to record his name in an album, to inform his successors that he had been there." With the introduction of writing, petroglyphs continued to be made, to include, as at 'Anaeho'omalu, well-carved names, and dates in the late 1800s. We may presume that it is this same trait in modern times that stimulates the marring of public picnic tables and signboards with variously written or carved inscriptions. I was impressed, in strolling along North King Street in Honolulu on March 12, 1984, to observe at a busy bus stop in the Pālama area the following ditty in graffito:

Gil was here
Now he is gone
He left his mark
To carry on.

Cox and Stasack (1970) provide a guide to petroglyph fields in Hawai'i. But overly zealous viewers of these records in stone should be restrained from acts of vandalism against them. The petroglyphs need more protection than they have been accorded.

WHALES AND DOLPHINS

That the cetaceans were of minor importance as a food source for the ancient Hawaiians is shown by the lack of a distinctive nomenclature for the many species (p. 170). It is probable that the sporadic occurrence of this group of mammals and the ineffectual means of hunting them were contributing causes. Nonetheless, cetaceans were sometimes purposely driven onto the beaches, and those washed ashore were valued, for W. A. Bryan (1915, p. 302) says, "In ancient times all the whales and porpoises cast ashore were the property of the . . . chiefs, and the wearing of whale-ivory ornaments was limited to that class."

Whaling became important to Hawai'i when the whalers began to use the islands as a wintering base for refitting and obtaining supplies. This era extended approximately from 1830 to 1880 (Thrum, 1912). Most whale catching occurred in distant northern and southern waters, but some was done close to Hawai'i, under government regulation (Jones, 1938). Shallenberger (1981, pp. 22–23) has summarized in further detail the history of whaling in Hawai'i, noting that shore-based activity was of importance out of Honolulu, Lahaina, and Hilo in the 1850s and 1860s. It is of interest that international whaling on the high seas intruded into Hawaiian waters as late as 1976, in which year a Soviet fleet was operating in the region (Benson, 1976). A Japanese whaler had taken 40 sperm whales the week of July 15–23, 1976, only 30 miles north of Gardner Pinnacles (Shallenberger, 1981, p. 23).

Since the middle 1960s interest in the cetaceans of Hawaiian waters, and consequent information on them, have increased by quantum leaps. Certainly,

facts from the whole of the northern Pacific, if not the oceans of the world, must be taken into consideration if only for a brief treatment. All of the 22 species referable to the Hawaiian region are widely ranging, and several are cosmopolitan even though possibly existing as discrete populations separated by environmental and behavioral elements and continental land barriers. See National Geographic Society (1976) for world distribution of whales, and Breiwick and Braham (1984) on the status of endangered whale species.

Whales and dolphins are ancient, and the early evidence that they are derived from carnivore-like mammals returned to the sea is gaining more specific support (Gaskin, 1982; Gingerich, Wells, and others, 1983; Barnes, 1984) with discovery of fossil remains that provide a new link between terrestrial and marine forms. Whales of 50 million years ago might have spent a significant amount of time on land. Present patterns in distribution of living forms tended to be fixed during recent glacial times as climates and seas stabilized (Marcuzzi and Pilleri, 1971). One analysis of systematics (Hershkovitz, 1966) remains a classic and is supplemented by newer clarifications (Rice, 1977). Whereas whales and dolphins have many common characteristics as generally pelagic marine mammals, the toothed forms and baleen whales are widely divergent from one another and now are classified, quite appropriately, in separate Orders (Rice, 1977). Whitmore and Sanders (1975), and Mitchell (1975) indicate, however, that confusion still exists in known timing of these events of divergence. See also Gaskin (1982) and Barnes, Domning, and Ray (1985).

A sampling of standard works on whales, some with popular appeal, includes Ridgway (1972), Dozier (1977), Matthews (1978), Slijper (1979), Ellis (1980), and Leatherwood and Reeves (1983). Every public library has some of these works. Books more specifically about cetaceans of the North Pacific, some including Hawai'i, are those of Valencić and Valencić (1978), Haley (1978), Shallenberger (1981), and Leatherwood, Reeves, and others (1982), all serving as manuals of identification. Commercial whaling as glamorized in earlier days and into the realm of the factory ship, is emphasized by Robertson (1954), Scammon (1968), Matthews (1968), and Olmstead (1969). Past fisheries for the smaller cetaceans are covered by Mead (1975).

The science and art of training the smaller whales and dolphins blossomed in Hawai'i in a well-structured oceanarium (Sea Life Park) and adjunct basic research facility (The Oceanic Institute) located near Waimānalo, on O'ahu. These pioneering groups produced much new information, supplemented in time by associated and cooperating agencies. Reports related to this era are those of Anon. (1965b), Conly (1966), Pryor (1973, 1981), and Bateson (1974). Books based on this new dimension of man's relationship to the cetaceans are those of Norris (1974), Pryor (1975), and Cousteau and Diolé (1975). Applica-

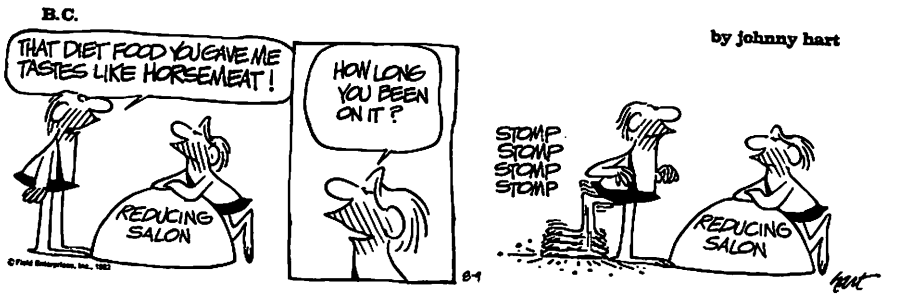


FIGURE 75.—(By permission of Johnny Hart and Field Enterprises, Inc.)

tion of dolphin training to practical military objectives has been investigated, with some success and accumulation of a great deal of new knowledge about the animals. Some of the work was performed in Hawai'i (Anon., 1967g; Wood, 1973; and Barton, 1977).

Association of man and dolphins has a history in antiquity as summarized by Montagu and Lilly (1963) and Busnel (1973). Records of dolphins bearing up swimmers in distress as they do their own kind, and of those who come to socialize with man at the fringe between their respective normal habitats, are well documented (Lockyer, 1978; Connor and Smolker, 1985). The temptation of humans to claim communication with these alert and caring creatures is sometimes overpowering, with assertion of reception of messages. Books and other reports have been written on the subject (e.g., Gawain, 1981; O'Rear, 1981). My cautious conclusion is that such experiences are not gained by ordinary mortals.

Serious investigation of language symbolism and possible cognitive exchange of messages between dolphin and man has been supported abundantly by public and private funding sources. Bateson (1966) provides insights into methods. An early summary was made by Lilly (1967) who marveled at the large brain and sophisticated patterns of vocal communication in dolphins. Lilly (1975) then took the concept several steps beyond. Factors of animal communication obscured from time to time by the intimate relationship that develops between trainer and trainee, whether the latter be dog, horse, ape, or dolphin, are the acute sensory perceptions of these subject animals of unconscious signals of trainers; and the strong desire of trainers to demonstrate that communication is indeed transpiring. These subjects are far out of my field, but there have developed some recent undercurrents of doubting much of what has been purported to be progress in man's communication with apes, and with dolphins as well (Caldwell and Caldwell, 1973; Parfit, 1980; Crail, 1981; Prescott, 1981; Ludel, 1982; Gaskin, 1982; and a final touch by Hart, 1982 [see Fig. 75]). My recommendation is that individual rungs of comfort be sought on

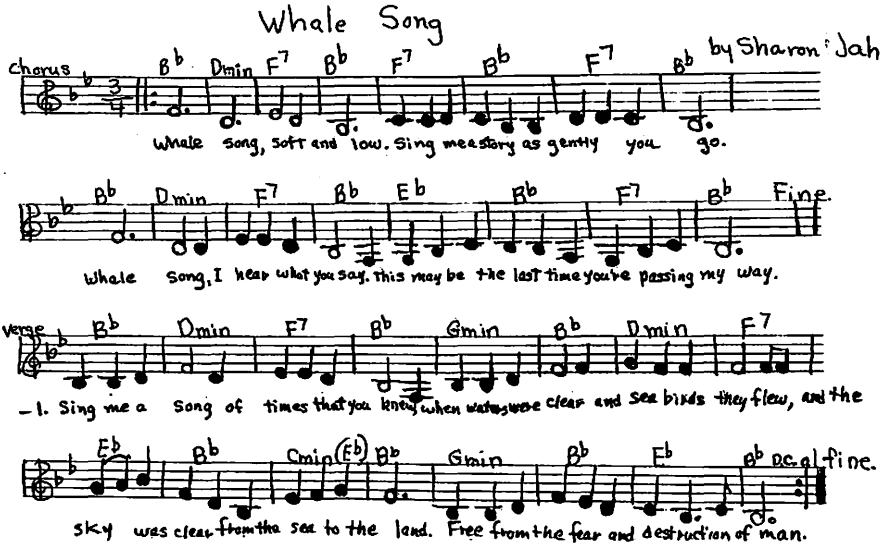


FIGURE 76.—The Whale Song. Composed and taught in a first grade classroom as part of nature conservation studies. (By permission of Sharon Jah.)

this ladder of myth and truth. Perhaps the tide has turned and the science of cetacean behavior will rise to new levels of excellence (Connor and Norris, 1982; Norris and Møhl, 1983).

Humans have observed frequently from past ages that cetaceans exploited for food or commercial purposes have tended to become fewer in number. As improved methods for whale catching developed, it was only a matter of moving on to the next most available stock or species of whale. Formation of the International Whaling Commission in 1946 has appeared to some to have resulted largely in formal means for systematically destroying remaining whale populations (Simon, 1965; Anon., 1966; Burton, 1980). The problem came increasingly into focus in the 1970s as a better informed international public

became alarmed and dismayed, or angry, with the unabated slaughter. Prominent books of this era are Scheffer (1969), Ommanney (1971), McIntyre (1974), Schevill (1974), Friends of the Earth (1978), Frost (1979), Brower (1980). Activist "Save the Whale" groups, of which there are many, have been effective in turning the tide of whale slaughter, sometimes only as a result of direct confrontation at sea with the harpoon boats. These groups can be exemplified by the Greenpeace Foundation (Benson, 1976; Herron, 1976; Perlman, 1977).

In a surprise development the International Whaling Commission voted in July 1982 to suspend all whaling after 1986. Japan, USSR, the Republic of Korea, Peru, Norway, and Iceland were the five remaining whaling nations as of that year. About 10,900 whales per year could be killed under quota in 1983 (Anon., 1982b; McClosky, 1982). Enforcement by sanction appeared to be the most promising way to proceed, as needed, but there are factors which may make such enforcement difficult or impossible (Richburg, 1984; Walsh, 1984; Plutte, 1984). There is much to be learned about surviving whale stocks and how they might be understood and managed for revival; but promising basic work has been accomplished (Peterle and Lehman, 1972; National Geographic Society, 1976; Beddington and May, 1982; Gaskin, 1982; Hofman and Bonner, 1985). Harvest of krill, the major crustacean food of baleen whales, has been proposed as an additional means of extracting protein from the ocean, and this is a matter of potential concern.

Meanwhile, the quest for biological data has gone forward. Association of dolphins with the tuna fishery of the eastern Pacific has resulted in the deaths of tens of thousands of these animals. This problem attracted sizeable research budgets, highly qualified scientists, and virtually is solved (Coe and Souza, 1972; Perrin and Hunter, 1972; Perrin, Smith, and Sakagawa, 1974; Barham, Toguchi, and Reilly, 1977; Norris, 1977). Further data are placed under species accounts of the *Stenella*. Several workers have contributed to marking and censusing techniques (Norris and Pryor, 1970; Evans, Hall, and others, 1972; Eberhardt, Chapman, and Gilbert, 1979; Perrin, Evans, and Holts, 1979; Leatherwood, Reeves, and others, 1982). An extensive work on age determination in the Odontoceti is that of Perrin and Myrick (1980). Hain and Leatherwood (1982) report on albinism in cetaceans; Perrin, Brownell, and De Master (1984) treat reproduction and estimation of population size; and Le Boeuf and Würsig (1985) generalize on modern research aims.

Disease and parasites of whales and dolphins seem not to debilitate entire populations, nor are parasites necessarily harmful, yet sufficient examples are accruing to demonstrate that these elements are at work. Arvy (1979) reports a long-standing infection by trichina in the Arctic; but a substantial sample from Newfoundland was negative (H. J. Smith, 1976). Lvov, Ždanov, and 15 others

FIGURE 77.—Short-finned pilot whales (*Globicephala macrorhynchus*) that stranded at 'Anini Beach, Kaua'i, May 10, 1959. Information on stranded cetaceans, if properly taken and recorded, can add to our information about these animals. (*Honolulu Advertiser* photo.)

(1978) suggest that influenza from whales may be similar to human strains. Whale lice (marine crustaceans) are illustrated and catalogued by Leung (1967) and Lincoln and Hurley (1974), and are not strictly parasitic. Various internal worms are reported by Pendergraph (1971), Forrester and Robertson (1975), and Gibson and Harris (1979). Some such parasites, as documented by Ridgway and Dailey (1972), Dailey and Walker (1978), and Stroud and Roffe (1979), are frequently observed in cases of death by stranding.

Stranded specimens of cetaceans are of special value, provided they can be properly identified. Many unusual and unique records have been obtained from such animals. Photographing fresh specimens, preserving them by freezing, or salvaging skeletal parts, are all recommended procedures that can lead to a satisfactory identification. Of vital importance also to taxonomy of cetaceans is proper measurement of the fresh carcass. Norris (1961) has presented a set of simple methods that are followed easily. Stranded animals are not necessarily doomed, and some can be floated and will return safely to the open sea. Hazards to beached dolphins or whales are sunburn, overheating, suffocation under their own body weight, and drowning as incoming tides sweep over them before the sea rises high enough for bouyancy. Anon. (1980)

provides information on tending stranded specimens and a reference list of institutions interested in such animals. For an example of a rescue squad at work see Foster, 1982.

BIOLOGICAL ASPECTS OF THE RODENTS

Because rodents of Hawai'i are often studied as a group and reports on them combine information on more than one species, it is a practical procedure to summarize biological aspects of all four species under this general heading.

Primary interests in these rodents are from the economic and public health viewpoints. The second of these includes also esthetics because rats are naturally repugnant to many humans. The early Polynesians were concerned about depredations of rats on temple offerings, and we may assume that religious esthetics played a part in efforts to protect these sacred articles from rats. Buck (1957, pp. 523–524) describes and figures rat guards, made from gourds threaded on poles supporting elevated platforms bearing pig carcasses. Overhang of the platform edges was designed also to thwart rats that might climb unguarded poles. Stokes (1917, p. 270) briefly notes that the Hawaiians kept foods away from rats, dogs, and hogs by suspending them in netted bags, but E. H. Bryan, Jr. (1938c) does not consider *Rattus exulans* as a serious early household pest. Handy (1940) reports negative association of this rat with Hawaiian gardening.

Rats became a prominent pest in sugar cane fields as soon as the industry was well established in the 1870s, but these rodents were thrust more spectacularly into public attention in December 1899 when the first case of human bubonic plague was diagnosed in Honolulu (Bergin, 1945; Link, 1954). The infection ran its course on O'ahu and disappeared by 1910. It had spread in the meantime to the neighbor islands of Kaua'i, Maui, and Hawai'i, where it persisted for varying periods; on Kaua'i, at least until 1902. The final human case on Maui was in 1938, but infected fleas or rodents were detected in the same region, near Makawao, as late as 1951. On Hawai'i, by the time plague had receded in Hilo and vicinity (having spread as far as Hakalau, 17 miles away), it then appeared in the Hāmākua District some 40 miles out of Hilo, in 1910. Here it was known in active form for 47 years. There were 112 human cases, and nearly all were fatal. The last occurred in 1949, and plague was repeatedly cultured from Hāmākua fleas and rodent tissues until 1957.

A series of investigators has reported observations or research findings on plague in Hawai'i, adequately summarizing this bacterial disease of rodents that is transmissible to man principally through the bites of infected fleas (Eskey, 1934; Dopmeyer, 1936; Mumford, 1942; Kartman, Prince, and Quan, 1956; Gross, 1957; Hess, 1957; Quan and others, 1965; Meyer, McNeill, and Wheeler, 1965). Field research in Hawai'i terminated in 1968, though still with

some uncertainties about the status of plague. These have been alleviated only recently after a 25-year period in which the plague organism could not be isolated or otherwise demonstrated in active form (Barnes, 1982; Tomich, Barnes, and others, 1984).

Appeals for popular assistance and understanding in rodent control have been made many times (Anon., 1901a, 1940, 1941, 1943a, 1965a; Donaldson, 1940). Economic loss from rodents occurs in cities and villages, but is primarily a problem of the sugar cane industry, of coffee farming, and more recently of macadamia-nut culture. General reports and early investigation of this problem have been stimulated mainly by the sugar interests. See Pemberton (1924, 1925), Elliot (1925), Barnum (1930), Spencer (1938), Smythe (1964, 1965). Specific economic or public health control measures and bait tests are included in the following: Doty (1932, 1933, 1945, 1951), Doty and Wismer (1949), Eckart (1936), Bonnet, Mau, and Gross (1951), Bonnet and Gross (1953), Gross, Baker, and Bonnet (1951), and Smythe (1959). Storer and Mann (1946) have gathered worldwide references to rodent control. From the late 1960s onward, new reports on the above topics include Lindsey (1969), Lindsey, Nass, and Hood (1971), Hood, Nass, and Lindsey (1970), Nass, Hood, and Lindsey (1970, 1971a, 1971b), Lindsey, Nass, and others (1973), Hilton, Robinson, and Teshima (1972), Teshima (1977), and Hirata (1977), whose studies were directed toward crop protection in Hawai'i. Mendenhall and Pank (1980) consider hazards to wildlife from toxicants used against rats. Resistance by rats to the toxicant warfarin is confirmed in *Rattus rattus* from research in England by Greaves, Rennison, and Redfern (1976) and by Greaves, Redfern, and Anasuya (1976). Jackson (1969) reports on radiation effects from atomic test explosions in the Pacific. Newer summaries of rodent control and rodent biology literature are found in Institute for Technical Interchange (1968), WHO and FAO (1971, 1973), and Hone and Mulligan (1982).

Behavioral, distributional, populational, and other biological data relating to programs for suppression of rodents or plague through increased understanding of the several rodents have been reported at various times: by Agee (1922), Spencer and Davis (1950), Kartman (1955), Kartman and Lonergan (1955b), Bianchi (1961), Tomich (1961, 1965d, 1965e, 1970), and Tomich and Haas (1966).

Newer works on anatomy, behavior, and populations are those of McCartney and Peters (1969), Hirata and Nass (1974), Temme and Jackson (1978), Tamarin and Malecha (1971, 1972), Stroud (1982), Conant (1972), Tomich (1981a, 1981b), and Tomich and Bridges (1981). A monograph on global groups of commensal *Rattus* appeared after much delay, and should be given due consideration (Schwarz and Schwarz, 1967). A world view of genetics in *R. rattus* reveals the complexity of genetic makeup in this species (Yosida, 1980),

and has been preceded by a number of reports of cytogenetics in Hawai'i and the Pacific (Malecha and Tamarin, 1969, 1971; Tamarin, Malecha, and others, 1972; Patton and Meyers, 1974; and Schwabe, 1979). Taylor, Calaby, and Van Deusen (1982) employ newer systematic methods for a regional treatment of *Rattus*, and this may lead to better understanding of populations found in Hawai'i. Finally, Barnett (1973) and Wodzicki (1979) relate man to his commensal rats, in historical perspective.

Rodent endoparasites are now well known in Hawai'i, and Kartman (1954) and Ash (1962b) have made important contributions in this area. Ectoparasites, particularly fleas as a factor in plague, have received a greater share of attention: Ewing (1924), Eskey (1934), Gross and Bonnet (1949), Kartman and Lonergan (1955a), Mitchell (1964), Haas (1965a, 1965b, 1966b), Haas and Tomich (1966). These last five papers deal with the basic ecology of fleas—a subject vital to the modern concept of plague control. Newer papers on rodent parasites in Hawai'i and the Pacific are those of Haas (1969), Mosby and Wodzicki (1972), Haas, Wilson, and Tomich (1972), and Tenorio and Goff (1980).

Rodent food habits have had specific attention in Hawai'i, as exemplified by Caum (1922) and Kami (1966), but are considered also by Spencer (1938) and Doty (1945). More recent efforts on feeding preferences of rats are those of Fall, Medina, and Jackson (1971), Bhardwaj and Khan (1978), Fellows and Sugihara (1977), Yabe (1979b), and Yabe and Wada (1983), to include the Pacific region. Bites on sleeping persons involving *Rattus norvegicus* have been occasionally reported (Anon., 1961). *Rattus rattus* was prominent in this regard during a 1943–1944 rat outbreak on Midway Islands (M. S. Johnson, 1945) when rats invaded barracks, nibbled skin from fingers and toes of sleeping men, and caused some more serious bites. H. G. Scott (1965) reviews the general topic of rat bite. The Norway rat is the typical aggressive sewer rat on O'ahu, where it has been known to invade residential bathrooms through main lines and laterals. Similar behavior is reported from California (Bickel, 1965).

Biological control of rodents, as first attempted through introduction of the mongoose, is treated under that species. The barn owl, *Tyto alba*, is a recent introduction for this same purpose (Tomich, 1962; Au and Swedberg, 1966), but its present usefulness as a significant factor in reduction of rodent numbers is questionable. Tomich (1971) and Baker and Russell (1980) offer further information on this topic. Byrd and Telfer (1980) open a new chapter which is condemnatory of the barn owl for its adaptation to feeding on a wide variety of native sea birds on Kaua'i and Ka'ula Island. The immediate question arises as to whether these species need protection from this "avian mongoose," which was suspect by some observers from the time of introduction (Hawaii Audubon Society, 1981). Reduction in numbers, or disappearance, of noddy terns (*Anous*

sp.) along the Hāmākua coast of Hawai'i since the 1960s may be attributable also to the barn owl. Evidence for or against this hypothesis can be found in owl middens at nest caves of the sea cliffs, and should be sought out.

Examples of biological studies of rodents in the Pacific that are applicable to Hawai'i include R. H. Baker (1946), D. H. Johnson (1946), J. T. Marshall, Jr. (1955), Watson (1961a), Storer (1962), Jackson (1965), Kirkpatrick (1966a, 1966b), Wodzicki (1968a). Additional pertinent papers are those of Wodzicki (1968b), Twibell (1973), and Redhead (1980). Of interest in regard to populating of Pacific islands by rats is this candid statement of James Cook on October 1, 1777, after he had anchored in the calm waters of Taloo harbor at Eimeo, near Tahiti (Cook, 1785, Vol. 2, p. 81):

> The ship being a good deal pestered with rats, I hauled her within thirty yards of the shore, as near as the depth of water would allow, and made a path for them to get to the land, by fastening hawsers to the trees. It is said that this experiment has succeeded, but, I believe, we got clear of very few, if any, of the numerous tribe that haunted us.

At the neighboring island of Ulietea a month later Cook (1785, Vol. 2, p. 113) moored his two ships within 20 feet of land and provided a gangway for rats to reach the shore. Such inducements may have occasionally enhanced the prolonged process of rodent colonization among the Pacific islands, including Hawai'i, before docking facilities were constructed.

DISEASES AND PARASITES OF MAMMALS

There are few definitive studies of maladies among the free-ranging mammals in Hawai'i, and I have not searched out the literature of specific veterinary interest. Most available reports are related to applied public health and medicine, and have served these professions very well. Others have resulted from a basic scientific inquiry that has had no immediate practical goal. In sorting out references to disease and parasitism, I found that some were best integrated into the Species Accounts, especially those of the rodents and mongoose; others are listed under Biological Aspects of Rodents, or under Mammals and Diseases of Man. Hence, this section is short.

Ford-Robertson and Bull (1966) have studied several parasites of *Rattus exulans* in New Zealand. Helminths of dogs and cats have been examined and represent a wide range of forms (Ash, 1962a; Gubler, 1966). Haas and Wilson (1967) report on ecological aspects of two species of dog fleas. The small Indian mongoose is a true host of the cat flea according to Haas (1966a). Chapin (1925) and Markowski (1952) discuss a tapeworm from the Hawaiian monk seal. For the pig and goat, Alicata (1952) and Nichols (1962d, 1963, 1964h) list and discuss various parasites and pathologies; for the pig in New Zealand, Ineson (1954) presents comparative material. Alicata and Swanson (1937), Alicata (1938b, 1950, 1961), and Alicata, Swanson, and Goo (1940) consider helminths

of cattle; Alicata (1947, 1964) summarizes the parasitology of all the prominent domestic animals in Hawai'i. Hance (1938) reports on selenium as a toxin in forage.

MAMMALS AND DISEASES OF MAN

In Hawai'i man is in relatively little danger from his animal associates and their parasites or other infections. Plague has been the most serious disease arising from mammals, and has already been considered in relation to rodents. The mongoose may be at least a minor element in the epidemiology of plague (Mott-Smith, 1910; Meyer, McNeill, and Wheeler, 1965). Murine typhus is of some significance (Cole and Koepke, 1947). Leptospirosis has commanded attention as a disease acquired from rodents, the mongoose, and possibly also from domestic mammals, and has been reported on by Alicata (1937b), Enright and Fennel (1939), Alicata and Breaks (1943), Wallace, Gross, and Lee (1961), and Minette (1964). More recent reports include those of Higa and Fujinaka (1976), Tomich (1979), Anderson, Brock, and others (1982), and Anderson, Higa, and others (1982). Shrader (1977) and State of Hawaii, Department of Health (1984) summarized statewide epidemiology of leptospirosis. Rodents may carry a usual variety of food contaminants, and Dean (1929) warns against disease inoculation in rat control because of a possible hazard to man. Trichinosis and liver fluke infection have been uncommon, but of some medical significance (Alicata, 1937a, 1937b, 1938a, 1953; Alicata and Bonnet, 1956). Among the rare helminthic infections are *Capillaria hepatica* (Ewing and Tilden, 1956; Fujii, 1963), and *Angiostrongylus cantonensis* (Horio and Alicata, 1961; Alicata, 1962a, 1962b, 1963). Alicata (1964) is a revision of his 1947 paper and provides an improved view of parasitic infections in Hawai'i. This work was issued late in 1967. It includes many bibliographic references not accessible to me.

Newer material on murine typhus (Traub, Wisseman, and Farhang-Azad, 1978); rabies (Jonkers, Alexis, and Loregnard, 1969; Sasaki and Gooch, 1983); on trichinosis in the mongoose of the Caribbean (Alicata and Amiel, 1971), and in Hawai'i (Anon., 1975a); and on its response to plague in Hawai'i (Higa, Matsuura, and Watanabe, 1971) are all of significance. Daniel (1967) reports on ungulates common to Hawai'i and New Zealand.

Rabies is unknown as an endemic disease in Hawai'i and its importation is assiduously guarded against. In 1967 a rabies scare of large proportions was generated by the announcement of health officials on October 5 that rabies was indeed present in Honolulu. It was suspected that the source was a rabid rat or rats carried with household goods imported by air from Southeast Asia. Unfortunately, the first reportedly infected animals were destroyed before they were positively identified. By October 8 the house cat and mongoose were

added to the list of infected animals, and by October 14 a total of 27 positive cases was declared, including also pigs and dogs. These animals came largely from locations between Diamond Head and Wahiawā, in a region nearly 25 miles long. Anon. (1967b), Harada (1967), Milz (1967), and other daily newspaper articles document this information. Elaborate plans were quickly made for combating a massive spread of the disease.

Diagnoses were principally the responsibility of the U. S. Army Laboratory at Schofield Barracks, but shared by the Department of Agriculture Animal Industries Laboratory. By October 14 a panel of rabies experts summoned from other states had cast doubt on the accuracy of diagnoses. Confirmatory tests were being performed at federal and other facilities, and there was increasing evidence of misdiagnosis in Hawai'i (Anon., 1967c). By early December it was clear that actual rabies infection was unlikely (Anon., 1967d). All specimens from suspected Hawaiian animals were negative for final tests (Anon., 1967e), and the state was declared free of the disease in mid-January 1968 (Sanger, 1968), with apparently only one dissenting voice (see Arakaki, 1968).

The spectacle of these events underscores the potential in Hawai'i for the accidental introduction of animal-borne disease and the need for continued adequate protection from it. Rabies is discussed further in relation to bats (p. 30) and in the following section on Animal Quarantine.

Pseudorabies was reported as a disease of dogs and swine in Hawai'i in 1983. Whereas it may become important in these domestic and feral populations, it is unlikely to be of significance to man. On a world basis, infections in humans are rare (State of Hawaii, Department of Health, 1983). Testing for pseudorabies in Hawai'i began in 1978.

A recent development is a newsletter for dissemination of information in Hawai'i concerning various animal-borne diseases (State of Hawaii, Department of Health, 1982a).

Tuberculosis emerged as a significant disease of the axis deer, pig, and feral cattle of Moloka'i in 1970 after a lapse of 11 years (Hawaii Audubon Society, 1970) and has continued as a problem in ungulates of that island (Hawaii Audubon Society, 1973; Pekelo, 1973; Anon., 1981b). At the same time brucellosis was confirmed in feral pigs in the Kona districts of Hawai'i (Benham, 1971).

Another dimension of disease is the potential for transfer of pesticide residues from plant materials to game animals, and the threat of secondary acquisition of toxic substances by man. Even though strict regulation by the EPA is designed to protect the public health, at least one matter in Hawai'i requires close scrutiny after the fact. Some tests have confirmed that heptachlor is present in game species in and near pineapple fields on Lāna'i (Walden, 1983).

ANIMAL QUARANTINE

The chance immigration of new mammal species to Hawai'i, or their purposeful introduction as casual pets and for other uses, is strictly policed and regulated. Legitimate needs of laboratory experimentation, zoo management, and keeping of household pets are generally well served through permit.

Although modern vessels can be kept free of rats, there is a constant possibility that laxity aboard ship or in port, with regard to control measures and other safeguards, may allow transfer of commensal rodents to Hawaiian shores. Such entry would normally pass unnoticed, but should diseased rats carry plague or other human infections to port populations, a serious and persistent situation might again be established.

The rapid air transport of freight, and of uninformed persons with small pets in increasing variety, affords the occasional small mammal an excellent chance of arriving in prime condition. This increases the probability that immigrant rodents, bats, carnivores, or other groups may successfully invade the islands and bring pathogens with them.

Since its establishment in 1903, the Department of Agriculture has been charged with the regulation or prevention of entry of animals and their diseases. An early example of this duty is related to livestock inspection (Norgaard, 1905). Similar work is carried out today, and as the dog or cat owners arriving in Hawai'i learn (with few countries of origin excepted), their pets are bound to a 120-day quarantine and observation period. The primary object of this detention is for the interception of rabies, should it be introduced with any of these animals. One dog en route from Guam to Massachusetts in August 1967 was seized in violation of regulations and was subsequently proved to be infected with rabies. This was the first time this disease was detected in Hawai'i, but of course, it was not from a resident or free-ranging animal, and caused no particular concern (Anon., 1967b, p. A-4).

Occasionally, review of the 120-day quarantine obligation is demanded by a questioning public, but it is apparent that until methods for diagnosis of incubating rabies can be devised, the present system provides the best available public health protection (State of Hawaii, Department of Health, 1982b; Sasaki and Gooch, 1983).

A trickle of illegally introduced or escaped mammals continues, and some older records of importations have come to my attention. The deer referred to by Clark (1939) are traced in the record to the 1825 diary of James McCrae (Wilson, 1922). The same document relates how two Siberian bears were brought to Honolulu in 1822 on a voyage from Kamchatka. Other unnamed animals may have been included in the lot. In later times an escaped black bear (*Ursus americanus* Pallas) roamed in the Ko'olau mountains of O'ahu for ten or

more years (Whitten, 1970; Kramer, 1971), a large monkey ranged free for several years near Hilo (Anon., 1968d), and another monkey lived at Kure Atoll for at least two years (Kramer, 1971). Gerbils kept and propagated as pets were intercepted in 1969 (Anon., 1969a). Grant and Pettit (1981) report a tree squirrel (*Sciurus*) at large on Midway Atoll in 1979. Kaua'i has had its share of such introductions with the arrival of one or more of the California ground squirrel (*Spermophilus beecheyi* Merriam) as stowaways in a van of household goods, and surviving a 44-day journey by eating chicken feed conveniently located in the van (TenBruggencate, 1979; Tomich, 1982). After one squirrel was captured there was no further evidence of them. Actual establishment of the black-tailed prairie dog, *Cynomys ludovicianus* (Ord), was reported early in 1981 by wildlife biologists who found a flourishing colony in a Kaua'i pasture. Prompt control measures were applied and one of the rodents was caught alive in the area. Examination revealed that it was free of disease (Anon., 1981a). The colony was thus extirpated. It is likely that this introduction was purposeful, which underscores the limited control that reasonably can be exercised over such importations.

Dogs have been difficult to transport without incident, perhaps because of their innate friendliness and their needs for food, water, and exercise. Not infrequently one has escaped in unloading or transfer from one aircraft to another. The Report of the Department of Agriculture and Conservation for the fiscal period ending June 30, 1961, p. 20, states that one dog that escaped was retrieved only 13 days later when killed by an automobile in the vicinity of the airport. Three other pets also escaped on separate occasions the same year, but were quickly recovered. One owner voluntarily followed his dog into the ocean in order to capture it.

The program for protection of agriculture and natural resources from detrimental animals is enforced by the Division of Plant Industry, Plant Quarantine Branch, under Regulation 2 (State of Hawaii, Department of Agriculture and Conservation, 1960). Over the years enforcement of this law, and its stringent forerunners, has managed to prevent the unauthorized establishment of new mammals in Hawai'i (with the exception of a wallaby, in 1916). Two or more gray squirrels (*Sciurus*) were reported at large at Schofield Barracks, O'ahu (Anon., 1943b), but these were all captured or disappeared. A fruit bat (possibly *Pteropus*) was found alive in the rigging of a ship from the Philippines (Anon., 1946c) and another is said to have been intercepted in the possession of a worker from Guam.

William C. Look, Chief Plant Inspector, has listed for me (pers. comm., 1965) many examples of such live interceptions. Among these is an opossum (*Didelphis*) confiscated from a home on O'ahu in February 1961; a fox squirrel

(*Sciurus*) from Kansas confiscated on Moloka'i in May 1961; a chipmunk (*Eutamias*) in air baggage from Washington in November 1962; an unidentified small bat found in a cargo aircraft arriving in October 1963, from Singapore via the Philippines and Wake Island; a kinkajou (*Potos*) captured in Waikīkī in the same month; a rat (*Rattus*) discovered in a sea van from the United States mainland in January 1964; and a tree shrew (*Tupaia*) from the Philippines that escaped at the air terminal in April 1965, and was recovered alive ten days later.

N. A. Wilson (pers. comm.) has furnished detailed information about a live mouse caught January 31, 1965, aboard a military cargo airplane arriving at Hickam Field, O'ahu, from Japan, via Wake Island. The killed specimen was forwarded to Bishop Museum and subsequently identified as a deer mouse, *Peromyscus maniculatus gambelii* (Baird). This subspecies ranges naturally from Washington to Lower California and is not known to be established outside its native range. Investigation revealed that the aircraft's mission had originated at Travis Air Force Base, California, about a week earlier, and that food-stuffs were carried to Viet Nam before the return through Hawai'i. The immigrant mouse had almost certainly boarded the airplane at Travis and, if so, had nearly completed a round trip of some 17,000 miles when intercepted.

Although importation of pest animals is heavily guarded against, we should hope that a mammal incident parallel to that of the giant African snail does not arise (Pemberton, 1938). We may be hopeful also that the political climate in relation to snakes for Hawai'i will warm sufficiently to permit the entry of a variety of these fascinating vertebrates for display in zoological collections. Their introduction for field rodent control, on the other hand, is not presently recommended.

INTRODUCTION OF ALIEN MAMMALS

There are processes for legal introduction of new species of mammals to Hawai'i or of extending the ranges of established species to other islands, especially in relation to sport hunting. The mouflon, pronghorn, mule deer, and axis deer were prominent in this regard in the 1950–1970 period, and additional species were then being considered (Walker, 1967). From the standpoint of practical game management, which promised to diversify and increase quality of game by replacing the less desirable feral livestock (Nichols, 1962b), these new animals may have been ideal introductions. The hunting public pressed for obtaining their seemingly legitimate desires for purely recreational aims; and economic aspects of big game hunting in the form of services and supplies are a reality.

However, botanists, entomologists, ornithologists, and other scientists with

genuine interests in preserving remnants of an invaluable endemic biota were early and persistent in expressing justifiable concern about the invasion of native environments by new alien elements. These concerns follow general principles recognized the world over and which have been voiced many times (for example: McAtee, 1925; Fisher, 1948; DeVos, Manville, and Van Gelder, 1956; E. R. Hall, 1963). Unfortunately, these principles have been ignored more often than observed, because it is the nature of man to exploit his surroundings for economic or other gain, to ignore wisdom of the past, and to fail to recognize the extreme vulnerability to disturbance that is characteristic of island biotic communities.

It has been unfortunate that the study of these communities won little early support in Hawai'i and that we could not present its case in a logical manner based upon decisive evidence from the field (Tomich, 1965e). Even Degener (1930), who has been an outspoken advocate of natural ecosystems in Hawai'i for more than 60 years, in his early works dismissed the topic of introduced ungulates in a few incisive paragraphs about the problem and a pessimistic view of the future for plant species unprotected outside park and other reserve boundaries. It was long observed that birds, plants, and other members of the biota had disappeared and that others were failing, but no plan of action was feasible in the 1950–1970 period to ameliorate or halt such depletions or to prevent every introduction of new browsing animals.

The mouflon was established successfully for public hunting on Lāna'i in 1954 and was released in numbers on Hawai'i, at Mauna Kea, beginning in 1962. These introductions drew little comment; nor did the release of pronghorn on Lāna'i in 1959, although feral goats, axis deer, and, as mentioned, mouflon, were already entrenched. Cattle and sheep were removed from Lāna'i about 1948, the cattle by means of a special hunt (J. S. Medeiros, pers. comm.). Many of the erosion scars resulting from past overgrazing by domestic herds were disappearing in the 1960s. No thought, apparently, was given to the native vegetation in spite of this seeming improvement under a wildlife management scheme with commercial herds no longer present.

The first strong protests arose, from botanists and others concerned about new disturbances to native flora, when mule deer were to be released on Kaua'i in 1961. Final decisions on what organisms will be permitted or denied entry to various islands are largely political, and in this case the botanists lost. Riney (1959) discussed the problem at length and derived answers that undoubtedly satisfied many persons. The basic argument presented is that the game animals can be effectively and inexpensively controlled, anywhere in Hawai'i. Not mentioned in this argument is the facet of whether introduced game, indeed, *would* be controlled, and at what levels. On this same premise Riney

recommended for the islands the sika deer (*Cervus nippon* Temminck) of Japan and the sambar (*C. unicolor* Kerr) of Southeast Asia, as well as "several species of wallaby" from Australia, each of which was to occupy its own ecological niche. And, it might be added, turn Hawai'i into a modern Noah's Ark.

The most controversial issue on introductions has been the proposal to transfer axis deer from Lāna'i or Moloka'i, to Hawai'i. There was significant opposition from several sources and the idea was blocked first in 1950, and again in 1963. The National Parks administration is unequivocally opposed to the threat of additional alien species on parks land. Chronic occupation with destructively abundant feral goats has not encouraged support for axis deer, which might spread easily to the parks. Foresters have objected to the deer because of anticipated harm to sapling trees designated for timber production. The most vociferous elements in these earlier years were the livestock and agricultural interests. It is they, primarily, who defeated the proposal in 1950, if not also in 1963, not for the protection of native biota but for reasons of self preservation against possible competition by deer with stock, and depredation on crops. It was only in the third round for introduction of the deer to the island of Hawai'i, in 1968, that environmental interests and the flow of the times toward protection of endangered plants and animals took their full effect, based on evidence of science. Details of the long struggle for and against introduction of the axis deer are presented under the account of that species. It appears that the deer are now permanently excluded.

Few private ranchers have considered seriously bringing big game to their own lands, largely because of anticipated conflicts of such animals with ranch livestock. However, Kahuku Ranch on the south rift of Mauna Loa, on Hawai'i, introduced the American bison, *Bison bison* (Linnaeus), to occupy lands unsuitable, or marginally suitable, for cattle. An original herd of 12 was shipped to the ranch on April 13, 1968. They were to be allowed to increase in number near headquarters and then be pastured on cold, wet paddocks at the 6,000-foot level (Southward, 1968). Objects of the introduction were beef production and possible big game hunting. The bison did not fare well in the higher lands, and so were transferred to the coastal plain of Kamaoa (above South Point). As of August 1983 the herd numbered 33 animals (C. H. Bredhoff, Jr., pers. comm.). Kahuku Ranch introduced also mouflon sheep, with eight received late in July 1968 (Ketchum, 1968). A recent book (Riney, 1982) should be consulted for advice in reference to management of such introduced species.

Game ranching, African style, began in Hawai'i when Molokai Ranch established an elaborate "Game Farm and Hunting Preserve" in connection with a tourist resort being developed at Pāpōhaku Beach in the Kaluako'i District of western Moloka'i. The State of Hawaii Board of Agriculture (1972)

approved on March 24, 1972, a request for import of 54 animals of nine species—goat, sheep, and various antelope—to these agriculturally zoned lands. This is another matter on the fringe of our concerns with penned wild species, but it is of special interest for the scrutiny it received which modified the original proposal. The public first learned of the plan on March 1 through a newspaper report (Hostetler, 1972). An application by the ranch on January 13 asked also for introduction of the collared peccary, *Tayassu tajacu* (Linnaeus), a small native pig from the American southwest, but this species was withdrawn from the request because it is impractical to construct and maintain fences reasonably able to contain such a small agile animal. Concerns expressed by botanists, environmentalists, and conservation groups included the likelihood of escape for some species by jumping fences or other means, and consequent invasion of forested lands on Moloka'i. The animals were to be obtained from zoos, ranches, and game farms in the continental United States, and quarantined and tested at a Tehachapi, California, facility.

Altonn (1974) visited Molokai Ranch about two years later and found six of the nine permitted introductions, some with offspring, and three giraffes just then imported from the Honolulu Zoo. A principal object of the project was to provide a safari experience for visitors to the region. The animals were free to roam in a 300-acre paddock. A maximum planned area of 1,000 acres was projected as the venture matured.

Under its official name, Molokai Ranch Wildlife Park, the project was opened to the public in 1978 for camera safari in motor vans driven by guides (Cowan, 1984). By mid-1985 the park was expanded to 2,000 of the 66,000 acres of the ranch to accomodate the growing herds of African and Asian large mammals and ratite birds. Included were the giraffe, eland, Barbary sheep, Indian black buck, oryx, greater kudu, sika deer, and axis deer (Molokai Ranch press release).

Population was 500 animals. They have adapted well to the rolling, semiarid grassland-shrub-savannah habitat of former cattle range. The introduced *kiawe* is a prominent browse species of the region. Weedy plants unpalatable to cattle are important in the diet. Residual native plants and their status within the wildlife paddocks are not mentioned in the several promotional tracts issued by developers of the safari concept on Moloka'i.

Students of alien mammals in Hawai'i would do well to continue the examination of conditions brought about by introductions to other island habitats, for example, New Zealand. Materials of interest in addition to those listed in the species accounts are those of Wodzicki (1950, 1961, 1963, 1965), Riney and others (1959), Howard (1959, 1965), and Anderson and Henderson (1961).

THE FATE OF KAHO'OLAWE

This presently desolate island deserves special attention both in the historical sense and in the present. Its history is basically that of mismanagement through overuse by domestic and feral livestock. Sheep were first brought to Kaho'olawe as a farming enterprise in 1858, but the venture faltered quickly because the stock was diseased (W. F. Allen, 1858; L. Hollingsworth, 1938). The island had previously been used as a place of banishment for convicts and was, of course, earlier occupied by the Hawaiians. Pigs, dogs, and goats were already established in 1858. Historical aspects of the island's economy are reviewed by Wilkes (1845, p. 245), Anon. (1902a), C. S. Judd (1916), E. H. Bryan, Jr. (1931, 1932), Greene (1941).

Sheep, possibly descended from the 1858 venture, had apparently remained continuously on the island. C. S. Judd (1916, p. 121) reported 3,200 there in 1906, and Forbes (1913a, p. 4) estimated 300 present in that year, but these were being reduced in numbers so that the island could be used for cattle. W. F. Allen's 1858 estimate of ample pasturage for 20,000 sheep seems extravagant, but it does suggest that the island was then rather verdant. Zschokke (1932) explores the obvious changes that have taken place in the land surface of Kaho'olawe, and climatic changes there possibly caused by deterioration of forests on Maui.

The island was placed in Forest Reserve status in 1911, but was withdrawn in 1918 after only eight years of protection in which over 5,000 goats were killed or captured (Report of the Territorial Board of Commissioners of Agriculture and Forestry, 1919, pp. 39–40). A 21-year lease was drawn, to begin January 1, 1919, allowing for the running of cattle after the remaining goats were removed, which had to be done in the first year. Conditions must have looked very favorable for use of Kaho'olawe, at least on paper. The *kiawe* (*Prosopis*) had spread so that a large annual crop of beans could be utilized, along with several thousand acres of *pili* grass (*Heteropogon*). "The whole purpose of the lease is to develop, conserve and improve the island rather than to exploit it," the above report optimistically announced. Cattle were landed in spite of the fact that some goats remained; conditions for Kaho'olawe did not improve over the years, and were complicated by depletion of forage and water. McAllister (1933b) indicates that both were being imported for the few cattle then present. Franck (1937, p. 232) learned on his visit in 1936 that about 300 cattle and 20 horses were pastured in that period. One family and some cattle were on the island in 1941 (Greene, 1941), but it was apparently abandoned soon after, and the cattle were removed or died off.

Final degradation of Kaho'olawe for use as a bombing target in World War II, and its continued employment for this and other military purposes (Anon.,

1964l, 1964m) has been indeed an unfortunate episode in sapping the vitality of Hawaiian lands. However, we are told, when constructive suggestions are made for reclaiming the island, that its use for such purposes is "absolutely essential" to national security (Anon., 1964m, 1964o, 1965c).

It seems likely that Kaho'olawe will be returned eventually to civilian use, despite the excessive cost that will be required to clear it of unexploded ordnance. A first positive step toward rehabilitation should be to immediately extirpate the feral livestock still present. Although it would be desirable to learn about the nature of these isolated populations, they are inaccessible to study, management, or control by sport hunting. The obvious expedient is to destroy them, even though it would also be an expensive operation. In this way a head start would be made in the recovery of the vegetation, the loss of which is the island's basic illness, increasingly aggravated in time by rampant soil erosion.

The above paragraphs were prepared in 1967. A resurgence of sociological interest in Kaho'olawe came in the 1970s when the Hawaiian community was no longer to be denied a voice in management of the island. Under statute, and prompted by civil suits, an EIS was prepared in connection with the bombing (United States Department of the Navy, 1972, 1977). When political activism forced a confrontation with the state government, a legislative study was made (Hawaii State Legislature, 1977), and one conclusion drawn, p. 238, is as follows:

> It is quite evident that Kaho'olawe, although not the key to the future of the Hawaiians, is a dramatic symbol of their concerns today. It has jolted many people out of their complacency and caused them to reexamine both themselves and the world in which they live. It has helped to focus attention on other issues of concern to Hawaiians, including reparations, native claims, and other areas of grievance on the economic, political, social, and cultural fronts. Kaho'olawe stands as the tip of the iceberg—the real issue is the Hawaiians.

The determination of the Hawaiian community to have answers is portrayed vividly in the report of Ritte and Sawyer (1978); and aspects of earlier *kama'āina* ranching and history are recorded by Ashdown (1979), and by MacDonald (1972). Myhre (1970), Critchlow (1982), Motteler (1983), and Schmidt and Silva (1984) report on additional background and developments.

Some progress was made in reduction of the hordes of goats and some sheep that roamed the island, but only the sheep have been eliminated, in spite of a long-standing and firm contractual requirement that the population of cloven-hoofed animals shall be limited to 200. The Navy notes (United States Department of the Navy, 1977, p. A-14), "From 1970 to date, more than 16,000 animals have been destroyed. Feral sheep have been eradicated." Efforts to eradicate goats were intensified, to include all areas of the island and to take

place in a very short period of time. Helicopter hunts were employed at a later stage of the program (Anon., 1980). A ten-day hunt accounted for about 900 goats killed, with an estimated 800 remaining. Hunting was to be repeated at six-month intervals. Under such a program and schedule goats will never be eliminated from Kaho'olawe, much less be kept below the required magic number of 200 reserved as perpetual breeding stock. Tenorio and Goff (1980) report that limited 1979–1980 rodent sampling at three sites on the island produced only *Mus domesticus*. Further effort is needed to determine if, indeed, the rats no longer survive. Ritte and Sawyer (1978) had occasional visits by feral cats at their camps during a 35-day stay on the island in 1976, and suspected that unseen rats depleted their vital supplies of water by gnawing plastic containers.

LESSER ISLANDS AND THE "LEEWARD CHAIN"

Our concern, with small exception, has been with the eight main islands of Hawai'i proper, Ni'ihau, Kaua'i, O'ahu, Moloka'i, Lāna'i, Kaho'olawe, Maui, and Hawai'i. These contain all but a minor fraction of the lands in the entire archipelago (E. H. Bryan, Jr., 1954, p. 4) and as such are of primary importance as habitat for mammals. The small to very small size of the minor islands is probably a greater factor than isolation in the determination of what mammal species, if any, occupy them on a sustained basis, and this is a proper subject for an extended investigation. Amerson (1975) and Dueser and Brown (1980) provide some guidelines.

Hawai'i Island has three adjacent islets, Keaoi (2.5 acres) at the southeast, and Mokupuku and Paoakalani near the north end. The first of these has been examined (P. H. Baldwin, 1946), but the others are possibly inaccessible, at least from the sea. Probably none is occupied by mammals.

Molokini, 3 miles off southwest Maui, is Maui's largest adjacent land mass (19 acres), and it has been mentioned in relation to *Oryctolagus*. Caum (1930) has studied its botany. 'Ālau, at the east end of Maui, and Hulu and Mōke'ehia at the northeast, are the most prominent of many islets and high rocks along its windward shore. These named, and possibly others as well, could conceivably support populations of *Mus*. All these bits of isolated terrain have ecological significance that should not be overlooked. Lāna'i and Kaho'olawe have similar lands that are biologically unknown. Mokuho'oniki, at the east end of Moloka'i, and Mōkapu and 'Ōkala off its northern peninsula, are its prominent islets.

O'ahu's windward islets are relatively well explored, especially with regard to vegetation and sea bird colonies. Mānana has been discussed in relation to *Mus* and *Oryctolagus*. Green (1942) remarks further about this islet and Mokumanu as well. Fisher (1945) was concerned about human interferences with all of O'ahu's windward islets, and his evaluations were instrumental in the

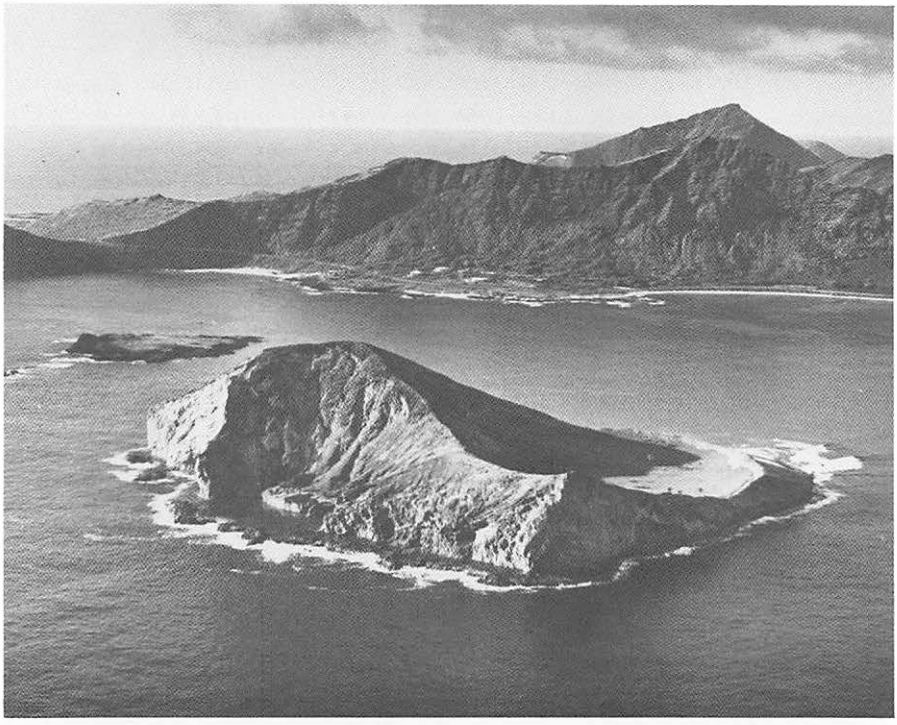


FIGURE 78.—Mānana Island, off the Southeast tip of O'ahu, as seen from the northeast. Area is 63 acres (25 ha) and elevation is 361 feet (110 m). The shallow crater at the right supports a low vegetation and several coconut palms. Populations of the house mouse (*Mus domesticus*) and feral rabbit (*Oryctolagus cuniculus*) survive Mānana's extremely dry summers. The adjacent inshore islet is named Kāohikaipu. (*Honolulu Star-Bulletin* photo by Warren R. Roll.)

declaration of nearly all of them as State Bird Reservations in 1945. The entire list of these, including some that are mere rocks, comprises Mānana (Rabbit Island), by far the largest (63 acres), and Kāohikaipu, both off the southeast end of O'ahu; Mokulua (two islets), Popoi'a, Mōkōlea Rock, and Mokumanu (two islets); Mokuolo'e (Coconut Island), Kekepa, Kapapa, Ahu O Laka, and Mokoli'i (Chinaman's Hat) in Kāne'ohe Bay; Mokuālai, Kukuiho'olua, Pulemoku, Moku'auia, and Kīhewamoku off the northeast shore of the island. Popoi'a has a special significance as the type locality of *Rattus exulans hawaiienis*, and has been referred to in the account of this rat. Colonization of Popoi'a, a raised reef of about 3 acres, suggests that *R. exulans* may be found on other similar islets among the main islands. This might depend in part on past frequency of their use by man as fishing stations or for other purposes. Thorough work of the Smithsonian Pacific Ocean Biological Survey Program has revised our knowl-

edge of mammals found on the islets of windward O'ahu (John H. Fitch, unpublished notes). These data are included in Table 1. New records are for *Mus domesticus*, first reported from Kapapa November 20, 1963, and from Kekepa on January 31, 1968, and for *Rattus rattus* seen on Kāohikaipu March 10, 1968. There is serious doubt that *Rattus exulans* still occupies Popoi'a. It is perhaps significant that not more than one rodent is known from any of the islets where man has not settled.

Kaua'i has only one islet, Moku'ae'ae, off its north shore, known principally for its colony of the red-footed booby (*Sula sula*). Lehua is a 291-acre island at the north end of Ni'ihau, and this is cited in the accounts of *Oryctolagus* and *Rattus rattus*. Ni'ihau has only one other prominent islet, Kūakamoku, on its west shore.

Ka'ula (136 acres), an isolated island about 20 miles southwest of Ni'ihau, is not a part of the Hawaiian Islands Bird Reservation; rather it is under the jurisdiction of the United States Navy. Caum (1936) and E. H. Bryan, Jr. (1938a) present biological data on this island. A specimen of *Mus domesticus*, Acc. #2449 in the Bishop Museum collections, dated August 14, 1937, confirms the presence of this species, at least formerly, on Ka'ula. Byrd and Telfer (1980) confirm the presence of *R. exulans* on this island.

Ka'ula, like Kaho'olawe (and Mānana in World War II), is subjected to military target practice; it is also a lighthouse station. The island has been a nesting base for several species of noddies and terns. These birds have been functionally important to the fishermen of Kaua'i in helping them to locate schools of fish. Anon. (1965g, 1965h) report on attempts to halt transfer of Ka'ula to the Navy from the Coast Guard, which had control of it for about 50 years. Naval units had already been bombing the island "for some years," and with assent of a local group (Anon., 1965i) may continue this activity for some time to come. It is necessary to "put the heavy stuff on Kaula due to Kahoolawe's close proximity to Maui." Evans (1976) and Balazs (1979a) provide important background and bibliographic information related to military uses of Ka'ula.

The remaining northwestern lands of Hawai'i make up the Northwestern Hawaiian Islands. Nihoa, Necker Island, French Frigate Shoals (with its residual La Pérouse Pinnacle), and Gardner Pinnacles are the last of the high islands; those beyond have been reduced and re-formed, usually as atolls, with a maximum elevation of 35 feet (Laysan Island). The high islands have significance for mammals as present or former habitat of *Monachus*. This is true also for the rest of the chain—Laysan, Lisianski Island, Pearl and Hermes Atoll, Midway Islands, Kure Atoll, and isolated or associated reefs. E. H. Bryan, Jr. (1942) has admirably described, mapped, and given historical accounts of all of the northwestern islands. Laysan and Lisianski are referred to in their many

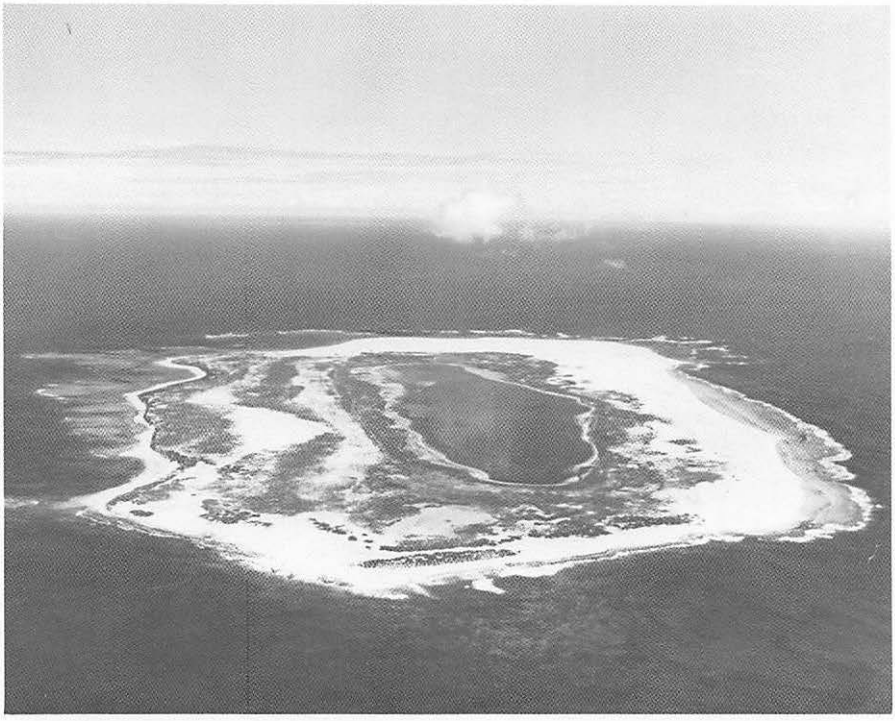


FIGURE 79.—Laysan Island viewed from the south in June 1962. White coral sand, dark vegetation, and the central lagoon, are readily distinguished. Size is about 1,000 acres (400 ha). The Hawaiian monk seal (*Monachus schauinslandi*) is the only mammal found here. (David B. Marshall photo.)

aspects in my discussion of *Oryctolagus*. Laysan was once occupied also by the guinea pig, pig, and donkey, but see also Schauinsland, 1899. Midway Islands, consisting of Sand and Eastern islands, later received the Laysan donkeys, as well as domestic dogs and *Rattus rattus* and *Mus*, as described in the section on these species, and by Fisher and Baldwin (1946), M. S. Johnson (1945), and Fisher (1949). Wray (1939) provides an historical reminder of the danger of wartime pursuits to this and others of the Northwestern Hawaiian Islands. Green Island at Kure marks an extreme in the range *R. exulans*, which is its only land mammal.

The Northwestern Hawaiian Islands have still a great potential as natural areas in spite of the catastrophes that have at times overtaken their flora and fauna. Lamoureux (1964) emphasizes this point and reviews the possibilities for botanical studies. Constant vigilance and action will be necessary to prevent short-sighted interferences, by well-meaning expeditions to these islands, from causing further loss to all their biological reserves. D. B. Marshall (1964) and

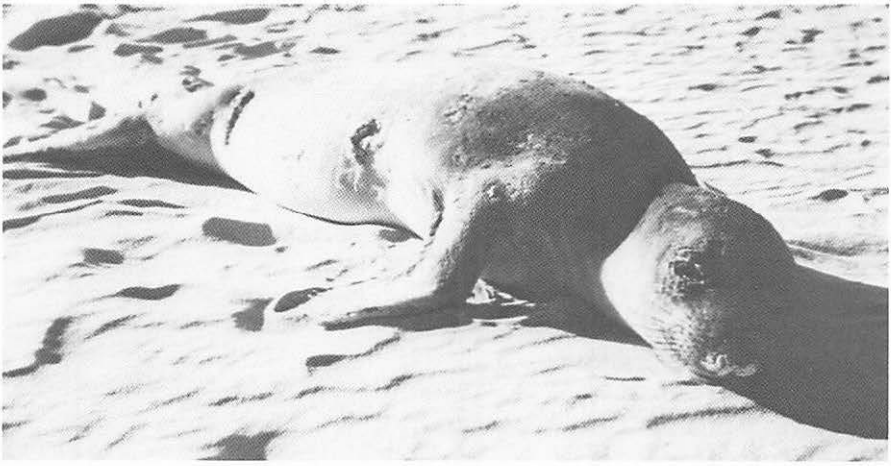


FIGURE 80.—Young female of the northern elephant seal (*Mirounga angustirostris*), the first of this species identified with photographic record in Hawai'i: Midway Islands, February 1978. The animal had been tagged at a California rookery. (George H. Balazs photo.)

American Society of Mammalogists (1965) indicate a need for real concern in this matter. The Pacific Ocean Biological Survey Program generated a series of fine inventory and survey reports, including intensive searches of the literature. Records of mammals, terrestrial and marine, may be found as follows: Nihoa (Clapp, Kridler, and Fleet, 1977); Necker (Clapp and Kridler, 1977); French Frigate Shoals (Amerson, 1971); Gardner Pinnacles (Clapp, 1972); Laysan (Ely and Clapp, 1973); Lisianski (Clapp and Wirtz, 1975); Pearl and Hermes Atoll (Amerson, Clapp, and Wirtz, 1974); and Kure Atoll (Woodward, 1972). United States Department of the Navy (1977) reviews all islands, islets, atolls, and shoals of Hawai'i and gives a table (pp. 29C–29F) of 132 entities, including sizes of each in acres. A beginning of biological surveys for islets supporting sea birds, or having potential for harboring such birds, is indicated by Kepler, Kepler, and Simons (1984).

Gagné and Conant (1983) summarize information on the biota of Nihoa accumulated during periodic visits to the island—a total of more than six months spent there—in the years 1980–1983. The northern elephant seal is a new addition to the faunal list of Midway Islands (Fig. 80).

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One *Herpestes auropunctatus* lived to an age of about 9.7 years, having been held in a zoo for 8.7 years.

AFFONSO, G. T.

1895. "The Forest of Hamakua." *Paradise Pacific* 8(1):3.

Describes forest as perhaps largest in Hawai'i, indicates homesteading in progress, and gives an account of hunting wild pigs with dogs, near "Waipahu Gulch."

AGEE, H. P.

1922. "Combating the Field Rat." *Hawaiian Planters' Rec.* 26:109–116.

Reports on conditions in Java, with comparative data from Hawai'i (pp. 112–114), in particular on rat burrows. Recognizes annual cycles in rodent populations and advises that research be done to determine best time of year for rat control.

ALCORN, DORIS J., and J. R. HENDERSON

1984. "Resumption of Nursing in 'Weaned' Hawaiian Monk Seal Pups." *'Elepaio* 45:11–12.

Each female bears a single pup but rarely may nurse also a second pup weaned early by its own mother; or she may adopt a weaned pup in event of death of her natural offspring.

ALDRICH, MOIRA, K. BECK, and ALISON CURRY

1975. "Wallabies of Kalihi Valley." *Ko Kākou* 1(2):53–59.

Review of the Hawai'i wallaby story and account of meeting the animal in its cliff-face habitat. Series of photographs by Harold White.

ALEXANDER, W. D.

1892. "Scientific Expedition to Mauna Kea—a Week at the Summit." *Friend* 50:74–75.

No mention of mammals except pack animals. Good descriptions of the summit area; weather data are included.

ALICATA, J. E.

1937a. "Trichinosis in Hawaii." *Proc. 11th Ann. Meeting, Hawaiian Acad. Sci.* B. P. Bishop Mus. Spec. Pub. 31. No pagination.

Summarizes results of survey of Hawai'i Island. Parasite was present in the several species of rats in all districts except Puna. Percentage of infestations were 2.6 in four species of rats, 0 in *Mus musculus*, 24.2 in *Herpestes auropunctatus*, and 14.6 in feral *Sus scrofa*. Five human cases were found in 1936.

1937b. "A Study of Trichinosis and Infectious Jaundice in the Hawaiian Islands." *Trans. 47th Ann. Meeting, Hawaii Territorial Medical Assoc.*, pp. 95–103.

Trichinosis first disclosed in the Territory on April 16, 1936. Survey of larger islands showed infected hosts on Maui and Hawai'i, but not on O'ahu or Kaua'i. Leptospirosis first detected on October 12, 1936. Human cases were reported from Kaua'i, Maui, and Hawai'i.

1938a. "A Study of *Trichinella spiralis* in the Hawaiian Islands." *Public Health Rep.* 53:384–393.

Reviews and extends materials in Alicata, 1937a, 1937b. Trichinae were found in rats, mongoose, and pig on Hawai'i, and in rats and mongoose on Maui. Infection on other islands is not precluded. Eleven human cases are reported; known sources included uncooked sausage made from feral pigs and pork in a lunch-counter sandwich.

1938b. *Observations on the Life History of* Fasciola gigantica, *the Common Liver Fluke of Cattle in Hawaii, and the Intermediate Host,* Fossaria ollula. Hawaii Agricultural Exp. Sta. Bull. 80. Univ. Hawaii. 22 pp.

Historical account and life cycle of parasite and intermediate host. Several mammals experimentally infected.

1944. "A Study of Leptospirosis in Hawaii." *Plantation Health* 8(4):6–34.

Important pioneer epidemiological work [12.2 percent of 860 residents, at 16 sugar plantations (island of Hawai'i) had positive serological agglutinations for *Leptospira icterohemorrhagiae*]; clinical studies, rodent and mongoose infection, control practices.

1947. "Parasites and Parasitic Diseases of Domestic Animals in the Hawaiian Islands." *Pacific Science* 1:69–84.

Lists and discusses internal and external parasites of domestic mammals and birds. Some reference to infestations of feral species. Cites 48 publications.

1950. *Prevention and Treatment of Important Cattle Parasites.* Univ. Hawaii Agricultural Extension Service Bull. 50. 23 pp.

Practical outline of measures for parasite control in domestic herds. Species are identified and illustrated.

1952. *Prevention and Treatment of Parasites in Swine.* Univ. Hawaii Agricultural Extension Service Bull. 53. 31 pp.

Farmers' circular. Part II, Swine, pp. 21–31, considers lice, mites, roundworms, and coccidia of domestic hogs. Depicts the various species and suggests practical means for their control.

1953. *Human Fascioliasis in the Hawaiian Islands.* Hawaii Agricultural Exp. Sta. Tech. Pap. 261. Univ. Hawaii. 6 pp. (Also *Hawaii Medical J.* 12:196–201.)

Summarizes 19 case reports of infection; *Fasciola gigantica* was found in all cases where a parasite was identified. *Fasciola hepatica* is rare and confined to cattle. Relates human and animal fascioliasis, giving incidence in cattle on various islands.

1961. "Survival of the Infective Larvae of *Cooperia punctata* of Cattle on Pastures in Hawaii." *Proc. Helminthological Soc. Washington* 28:181–183.

Infective larvae seeded in grass plots survived as long as five months under favorable moisture conditions.

1962a. "*Angiostrongylus cantonensis* (Nematoda: Metastrongylidae) as a Causative Agent of Eosinophilic Meningo-Encephalitis of Man in Hawaii and Tahiti." *Canadian J. Zool.* 40:4–8.

Summary of development of a theory linking the parasite and the disease.

1962b. "Rat Lungworms, a Cause of a New Disease of Man in the Pacific." *Hawaii Farm Sci.* 11:1–3.

Discusses discovery of eosinophilic meningo-encephalitis and the life cycle of its causative agent.

1963. "Incapability of Vertebrates to Serve as Paratenic Host for Infective Larvae of *Angiostrongylus cantonensis.*" *Parasitology* 49:48.

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ALICATA, J. E., and D. K. AMIEL

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ALICATA, J. E., and D. D. BONNET

1956. "A Study of Watercress in Hawaii as a Possible Source of Human Infection with Liver Flukes (*Fasciola*)." *Proc. Helminthological Soc. Washington* 23:106–108.

Liver fluke infection is locally common among cattle, and possibly among feral pigs. Fluke larvae may contaminate watercress beds via irrigation water. Culture conditions in cress beds on four islands are tabulated and rated as to possible danger to human consumers of cress.

ALICATA, J. E., and VIRGINIA BREAKS

1943. "A Survey of Leptospirosis in Honolulu." *Hawaii Medical J.* 2:137–142.

Causative agent first isolated in 1936; 82 human cases 1936–1942 in the Territory. Reports 13 positive sera from 344 humans, 39 from 100 dogs, but none from 100 cats. Kidney sections from 350 rats were 2.9 percent infected, as were 4 from 12 mongooses. *Leptospira icterohaemorrhagiae* and *L. canicola* were found.

ALICATA, J. E., and L. E. SWANSON

1937. Fasciola gigantica, *a Liver Fluke of Cattle in Hawaii, and the Snail,* Fossaria ollula, *Its Important Intermediate Host.* Hawaii Agricultural Exp. Sta. Tech. Pap. 5. Univ. Hawaii. (Also *J. Parasitology* 23:106–107.)

Establishes identity of the liver fluke in Hawai'i, its eggs and its cercariae. *Fossaria ollula* is recorded for the first time as the intermediate host.

ALICATA, J. E., L. E. SWANSON, and G. W. H. GOO

1940. *Methods of Controlling the Liver Fluke of Cattle in Hawaii.* Hawaii Agricultural Exp. Sta. Circ. 15. Univ. Hawaii. 23 pp.

Historical sketch of liver fluke occurrence; infection dates back at least to 1892. Describes life cycle of *Fasciola gigantica.*

ALLEN, G. M.

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ALLEN, W. F.

1858. Letter dated May 31, to Messrs. Wyllie & Allen, describing Kaho'olawe (original in Archives of Hawaii). Published 1938 in *Paradise Pacific* 50(5):22, 27.

Report of a scouting trip to Kaho'olawe preparatory to introduction of sheep. Wild dogs, then subsisting on wild goats and hogs, are discussed. Soil was good, supporting gardens of the 50 natives who lived most of the year on the island to fish adjacent waters. Pasturage was considered possibly ample for 20,000 sheep. Some plants were listed by common name.

ALTMANN, MARGARET

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ALTONN, HELEN

1960. "Rare Isle Bat Isn't a Belfry Dweller." *Honolulu Star-Bulletin*, April 17, Feature Sec., p. 2.

Brings discussion of several aspects of bat characteristics up to date and into line with facts: this bat is solitary and does not roost in caves, is a subspecies of the hoary bat, and so forth. Data largely from P. L. Breese.

1971. "Lanai Antelope Habits Studied." *Honolulu Star-Bulletin*, May 5, p. C-5.

Reports beginning of research on pronghorn in the unusual climatic regime of Hawai'i, by a doctoral candidate from Alberta, Canada.

1972. "Specially Trained Dogs are Called Key to Goats." *Honolulu Star-Bulletin*, May 2, p. B-4.

Notes excellent success with New Zealand dogs imported to Hawaii Volcanoes National Park in a goat control program. Goats in open terrain could be herded like sheep.

1974. "In Africa? No, It's Molokai." *Honolulu Star-Bulletin*, July 28, p. C-1.

Describes a visit to Molokai Ranch African Game Farm, learning that hoped-for acceptance of the idea was turning favorable. No mention was made of escapes.

1978. "Unique Visitors Arrive by Air, by Sea." *Honolulu Star-Bulletin*, March 15, p. C-1.

Notes identification of an elephant seal (*Mirounga angustirostris*) from California at Midway Islands, and of a sea eagle probably from Siberia at Kure Atoll; both in February, by George Balazs.

AMERICAN SOCIETY OF MAMMALOGISTS

1965. "Annual Meeting." *J. Mammalogy* 46:732–733.

Resolution requesting that federal clearance be obtained for military and other personnel before landings on remote islands, including wildlife refuges in Hawai'i, as a measure for protection of island biota.

1972. "Resolution on Proposed Release of Axis Deer on Island of Hawaii." *J. Mammalogy* 53:933.

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1984a. "Directory of Members." *J. Mammalogy* Supplement to 65(2). 70 pp.

Complete current register of combined national and international membership. Society founded in 1919.

1984b. "Resolution Supporting Designation of Critical Habitat for the Endangered Hawaiian Monk Seal." *J. Mammalogy* 65:740.

Example of resolutions adopted at annual meetings to press various causes pertaining to mammals and mammalogy in Hawai'i and elsewhere.

AMERSON, A. B., JR.

1971. "The Natural History of French Frigate Shoals, Northwestern Hawaiian Islands." *Atoll Res. Bull.* 150:1–383.

Reviews information on introduced dog, cat, and pig; occasional records of cetacea; and the monk seal as a common resident.

1975. "Species Richness on the Nondisturbed Northwestern Hawaiian Islands." *Ecology* 56:435–444.

Examines 18 islets (these are mapped). Area of vegetation and elevation were prominent factors in diversity of plants. Numbers of bird species are predictable on basis of diversity of plants and area of islet.

AMERSON, A. B., R. B. CLAPP, and W. O. WIRTZ II

1974. "The Natural History of Pearl and Hermes Reef, Northwestern Hawaiian Islands." *Atoll Res. Bull.* 174:1–306.

Records rabbit (historically), monk seal, bottlenose dolphin, and spinner dolphin on research trips 1963–1969.

ANA, K.

1848. Letter dated November 16 for William Beckley, Waimea, Hawaii. Interior Dept. of Translations, Book 2. Archives of Hawaii, Honolulu.

Inquiry as to progress in poisoning program for wild dogs, which reportedly had killed "many sheep and goats," apparently in the Waimea region of Hawai'i.

ANDERSON, B. S., J. A. BROCK, J. M. GOOCH, N. H. WIEBENGA, N. E. PALUMBO, S. PEI, and V. T. SATO

1982. "A Study of the Epidemiology of Leptospirosis on Aquaculture Farms in Hawaii." State of Hawaii Dept. of Health, Honolulu. 153 pp., mimeo.

A collaborative project by the Department of Health, Department of Land and Natural Resources, and the University of Hawaii.

ANDERSON, B. S., H. H. HIGA, J. A. BROCK, MARY K. SERDULA, J. A. GOOCH, N. H. WIEBENGA, N. E. PALUMBO, and H. P. MINETTE

1982. "A Study of the Epidemiology of Leptospirosis on Taro Farms in Hawaii." State of Hawaii Dept. of Health, Honolulu. 42 pp., mimeo.

A collaborative project by the Department of Health, Department of Land and Natural Resources, and the University of Hawaii.

ANDERSON, J. A., and J. B. HENDERSON

1961. *Himalayan Thar in New Zealand.* New Zealand Deerstalkers Assoc., Spec. Pub. 2. 37 pp.

Ecological study of *Hemitragus jemlahicus* (H. Smith), a prominent game species of wild goat. This work is remarkable in that it was done by a group of dedicated sportsmen. The tahr (official English spelling) has occupied South Island since 1904.

ANDERSON, S., and J. K. JONES, JR. (Editors)
1967. *Recent Mammals of the World: A Synopsis of Families.* New York: Ronald Press. 453 pp.

Basic work. Includes for each family: Diagnosis, General Character, Habits, Habitat, Recent Distribution, Recent Genera, Geographic Range, Major Fossil Groups, and Remarks. Sponsored by the American Society of Mammalogists.

ANDERSON, SHEILA
1978. "A Monk in Retreat." *New Science* 78:906–908.

Reviews plight of Mediterranean monk seal which is down in numbers to 500–1,000 animals and may be failing as a species. Range map indicates Atlantic shore and island colonies.

ANDRE, J. B., and RUTH ITTNER
1980. "Hawaiian Monk Seal Entangled in Fishing Net." *'Elepaio* 41:51.

Example from French Frigate Shoals in which a young seal was accidentally tethered over a shallow reef by a remnant of trawl net 9 x 2 m in size.

ANDREWS, L.
1922. *A Dictionary of the Hawaiian Language.* Honolulu: Territory of Hawaii, Bd. Commns. Public Archives. 674 pp.

Revision by Henry H. Parker of an 1865 edition, containing about 15,000 words. Original list of some 6,000 words was drawn up in 1836; introduction to this first work (pp. x–xvii) describes the Hawaiian vocabulary and system of naming things.

ANDRZEJEWSKI, R.
1974. "Spotty Mutation of the Wild Boar *Sus scrofa* Linnaeus, 1758." *Acta Theriol.* 19:159–163.

White-cream color with black spotting is a recessive mutation having negative survival value in wild populations. There was high mortality in young during the first year.

ANDRZEJEWSKI, R., and W. JEZIERSKI
1978. "Management of a Wild Boar Population and Its Effects on Commercial Land." *Acta Theriol.* 23:309–339.

Objective of reducing damage to crops apparently was achieved by supplementary feeding in spite of resultant increased numbers of pigs.

ANON.
1838. "Ocean Island." *Hawaiian Spectator* 1:336.

Brief historical sketch and description of Kure (formerly Ocean Island) to accompany a fold-out chart of the island. States that "at times, there is a considerable number of hair seals."

1856. "The Influence of the Cattle on the Climate of Waimea and Kawaihae, Hawaii." *Sandwich Ils. Monthly Mag.* 1:44–47. (Reprinted in *Hawaiian Planters' Rec.* 30:289–292.)

Describes weather conditions on Waimea Plain. Cattle were a large factor in clearing the original forest. Concludes that without the forest, wind patterns, and hence rain patterns, are altered.

1859. "Cattle Hunting on Hawaii." *Pacific Commercial Advertiser*, August 11, p. 2.

Colorful narrative of the hide trade and of drives that brought cattle off Mauna Kea for slaughter in corrals. In the drive observed, in one hour several hundred cattle and about 1,000 unwanted pigs were rounded up by some 25 horsemen.

1862. "The Sandwich Islands." *Friend* 19:11.

Said of a resident, M. Marin, "He has near Hana-rura [i.e., Honolulu] numerous herds of cattle. . . . He possesses horses, and will increase the breed of asses and mules, which are more

useful in these mountains. . . . He has lately grown rice from Chinese seeds, after many fruitless attempts."

1874. "Notices of the Week. A Bat." *Pacific Commercial Advertiser*, October 3, p. 3.

"A recent visitor at Lahaina informs us he saw a genuine bat there flying about in the daytime."

1881. "Notes of the Week." *Saturday Press* (Honolulu), January 22, p. 9.

"The four small Chinese buffaloes that were brought here by the *Quinta*, are to be used in the rice fields, as they are in China." (Reprinted, 1939, in *Paradise Pacific* 51(10):16).

1883a. "The Mungoose." *Planters' Monthly* 1:249–251.

Discussion of success of mongoose in Jamaica, and inquiry as to the desirability of bringing it to Hawai'i.

1883b. "The Mungoose." *Planters' Monthly* 1:307–308.

On the introduction to Jamaica (p. 308): "In 1872, B. Espent [= Espeut] introduced nine mungooses, four males and five females, one of the latter with young, direct from India. . . . Several subsequent importations have been made into Jamaica, but the arrivals sent from England have not done as well as those direct from India."

1885. *Planters' Monthly* 4:65.

Records an importation of Jamaican *Herpestes auropunctatus* to Hawai'i, by a Mr. Marsden, on his return from a trip to New Orleans, apparently in 1885, and the intention of releasing them in Hāmākua District, on Hawai'i.

1886. "Improvement of Cattle in the Islands." *Planters' Monthly* 5:131–133.

States necessity of improving cattle by acquiring superior stock. Table shows that 793 cows and 158 bulls were imported 1876–1885.

1887a. "Specimen of Hawaiian Bat Caught on Hawaii." *Hawaiian Gazette*, June 7, p. 5.

Records capture at unspecified location, island of Hawai'i, of a bat (presumably *Lasiurus cinereus semotus*).

1887b. "A Whaling Episode." *Pacific Commercial Advertiser*, January 18, p. 11.

On December 20, 1886, a large sperm whale harpooned off the coast of Hawai'i rose under the chief officer's boat, smashing it. The line parted and the whale escaped.

1887c. "A Stranded Whale." *Pacific Commercial Advertiser*, February 7, p. 5.

A sperm whale caught by whalers off Waipi'o, Hawai'i, was lost in tow. Several days later the remains, apparently stripped by sharks, were seen along the coast near Kohala.

1888. "Editorial on the Mongoose." *Planters' Monthly* 7:196.

Five years after introduction, *Herpestes* was considered a success in Hāmākua District, Hawai'i. Reportedly, in former years often one-fourth to one-half of the cane crop was destroyed by rats, and, "Now a field is harvested clean and not a stalk of cane is damaged."

1893. "Lanai and Niihau." *Paradise Pacific* 6(4):51.

Lāna'i declared the principal sheep-raising district of Hawai'i; history of ownership is outlined. Ni'ihau, "now little more than a sheep ranch."

1894. "Occupation of Necker Island." *Friend* 52:45.

"Capt. King landed with some difficulty on the 27th of May, and hoisted the Hawaiian flag upon the highest point. . . . One hair seal was captured" [= Hawaiian monk seal].

1896a. "Local Brevities." *Pacific Commercial Advertiser*, May 30, p. 7.

"Two hundred and twenty-five bats were received by the *Australia*, addressed to Prof. Koebele, and they were set free at dark last night. Before releasing them they were fed on beetles. They enjoyed the repast."

1896b. "Ocean Steamer Table for 1896." *Hawaiian Annual for 1896*, pp. 163–164. Honolulu: Thrum.

Complete schedule of trans-Pacific steamer traffic in and out of Honolulu; gives dates of arrival and sailings, and ports of origin and destination.

1897. "The Mongoose in Jamaica." *Planters' Monthly* 16:437–438.

An account stating without specific evidence that the mongoose destroyed many native animals, and rats; that ticks had overcome the mongooses (see Thompson, 1950); and in the presence of fewer mongooses, the natural community of native species was slowly recovering.

1898. *Planters' Monthly* 17:244.

Reports the mongoose an abundant nuisance in Jamaica, Fifty traps on 4,000 acres caught 1,407 mongooses in 48 days, and were still catching about 100 per week afterward.

1901a. "Rat Extermination." *Paradise Pacific* 14(12):13.

Reports a noticeable decrease of rats throughout Honolulu and commends sanitary and control measures in force, following 1899 outbreak of bubonic plague.

1901b. "The Mischievous Mongoose." *Paradise Pacific* 14(6):9.

Brief note on the mongoose in Hawai'i and quote from undated article in *Philadelphia Record.* A mongoose was brought to Philadelphia from Jamaica to publicize objection to a movement by sportsmen to introduce the mongoose to some United States cities. The animal was not admitted, and was destroyed.

1902a. "Kahoolawe an Ancient Place of Banishment." *Hawaiian Annual for 1903*, pp. 117–122. Honolulu: Thrum.

Discusses historical use of the island. Notes (p. 119) its first lease in 1858 as a sheep station. Suggests (pp. 120, 121) that wild pigs were present before 1840, apparently from the observations of Wilkes (1845, p. 245) of pigs on Kaho'olawe in 1840.

1902b. "Mongoose in Jamaica." *Paradise Pacific* 16(1):7–8.

Brief popular account of rodent control methods in Jamaica, including introduced mongoose. Implies that after mongooses destroyed a variety of small prey they turned upon one another.

1902c. "The Wandering of the Water Buffalo." *Smithsonian Inst. Ann. Rep. for 1901*, pp. 679–682. (Reprinted from *London Spectator*, August 31, 1901, pp. 278–279.)

Discusses transport of domesticated buffalo from original home in India to many parts of the world, and its uses, characteristics, and habits. Mentions source material by Lockwood Kipling (not found).

1902d. "Sheep Raising in the Hawaiian Islands." *Paradise Pacific* 15(12):28–29.

Describes operation at Humu'ula, Hawai'i. Greatest enemy of sheep was wild dogs, "which are very numerous in the mountains . . . and eradicated only by the laying of poison . . . and by shooting them when seen."

1903a. "The Rice Field Buffalo." *Paradise Pacific* 16(5):17–18.

Popular accurate account of habits, world distribution, and use as a domestic animal. Passing mention of Hawai'i; no references cited, but the basic source is obviously Anon. (1902c).

1903b. "Around and About Honolulu." *Paradise Pacific* 16(8):12–13.

Photo of water buffalo in Honolulu. Describes uses, in particular in Pauoa Valley, in that city. "The first buffaloes were brought here many years ago from the southern part of China." No references given.

1903c. "Embarkation of Cattle." *Paradise Pacific* 19(12):67.

Describes method of loading cattle on outer islands without docking facilities, for steamship transport; three photos show operation off Moloka'i.

1903d. "Livestock Statistics." *Hawaiian Annual for 1903*, p. 53. Honolulu: Thrum.

Table of livestock in the Territory of Hawaii as of June, 1900. Included are 80 water buffaloes, 38 working bullocks, 1,438 asses and burros, 6,506 mules. Sheep, other cattle, and horses were more numerous.

1904a. "The Obnoxious Mongoose." *Paradise Pacific* 17(4):8.

The mongoose in Hawai'i is considered as a pest to be exterminated. "The only plan of extinction lies in catching a number of these animals, inoculating them with some poisonous virus and then turning them loose."

1904b. "The Buffalo in Hawaii." *Paradise Pacific* 17(10):17–18.

General account, similar to that of Anon. (1903a) and apparently from the same source. Photograph, casual mention of Hawai'i.

1904c. "A New Industry." *Paradise Pacific* 17(12):51–53.

"The making of leather has at last become a permanent industry in Hawaii." Describes operation of tannery: hides came mostly from Hawai'i but some sheep skins were imported from Australia and New Zealand. Eight photos.

1905. "A New Hawaiian Industry." *Hawaiian Forester and Agriculturist* 2:223–226.

Announces the establishment of a modern hide-tanning plant at Kalihi (O'ahu) employing 13 men. Describes a long-felt need for a tanning industry in Hawai'i, predicting great success for the venture. Chief products were from kangaroo, sheep, and cattle. Two photos.

1906. "Sheep in Hawaii." *Paradise Pacific* 19(12):51.

Describes briefly the sheep industry, in particular the operation at Humu'ula, on Hawai'i, where the breed was the Merino. Six photos.

1907. "Graft?" *Paradise Pacific* 20(10):19.

Reports an undated note from the *Sunday Advertiser* to the effect that a citizen complained that her pet dog was taken to the pound by the dog warden and killed before the legal time limit had expired, to furnish food for a *lū'au* given by one Supervisor Kealoha and others.

1908a. "Mule Breeding in the Territory of Hawaii." *Bd. Commns. Agriculture and Forestry, Fourth Rep.*, pp. 183–185. One photo.

In previous two years nearly 600 mules were imported, principally from California, at the high cost of about $225 per head. Recommends increase of mule production in the islands by importation of first-class breeding stock and careful management. Mules were in demand by all sugar plantations.

1908b. "The Proscribed Mongoose." *Paradise Pacific* 21(4):21.

Summarizes attempts at introduction of mongooses to the United States mainland in violation of the Lacy Act. Three arrived at San Francisco, one at Los Angeles, and three at Philadelphia. All were destroyed. Notes that Washington and Philadelphia zoos have living specimens. No references.

1910a. "*Thetis* in Tomorrow with her Japanese Prisoners." *Pacific Commercial Advertiser*, February 1, p. 1.

Advance message and story on the problem of illegal activities in the Hawaiian Islands Bird Refuge relative to the albatross populations.

1910b. "Feathers from Two Hundred Thousand Birds are Brought In." *Pacific Commercial Advertiser*, February 3, pp. 1, 2.

Indicates that Max Schlemmer made a visit to Japan in previous year, in connection with feather trade on Hawaiian Islands. "Captain Jacobs expressed the opinion that the men under arrest are merely tools of the backers who operate from Tokio and Honolulu."

1910c. "Killing Birds on the Side." *Pacific Commercial Advertiser*, February 4, p. 1.

"The fact remains, however, that Schlemmer's connection with the bird-destroying operation has been well established, and that the men were not on the island looking for guano, but for bird feathers and wings."

1916a. "Teddy Bears Will Prove Excellent Attraction." *Pacific Commercial Advertiser*, August 20, p. 1.

Reports that three wallabies (=*Petrogale penicillata*) were received with other Australian mammals on August 18, 1916, from the Sydney Zoological Garden, and caged at the 'Ālewa Heights, Honolulu, private zoo of Richard H. Trent.

1916b. "Richard H. Trent's Wallabies Flee from Their Cages." *Pacific Commercial Advertiser*, August 21, p. 1.

Reports escape, on August 19, 1916, of a pair of adult *Petrogale penicillata* from a private zoo, predicting, "Unless the animals are caught they may become permanent denizens of the mountain districts and . . . may propagate . . . a breed of Hawaiian wallabies." A 25-dollar reward was offered for return of the wallabies alive.

1919a. "Preserve the Remnants of Our Native Forests." *Hawaiian Planters' Rec.* 20:173–177.

"If we would save what is left of our native rain-forests we must eliminate the cattle now present in them, prevent their further invasion by stock with proper fences, and build barrier forests along their exposed edges." Four photos.

1919b. "Bats as Leafhopper Enemies." In: *Directors' Report for October–November*, Hawaiian Sugar Planters' Assoc., Honolulu.

R. C. L. Perkins responds to C. E. Pemberton's suggestion that bats might prove to be a valuable predator of leafhoppers that fly at dusk, by reiterating past failures of bat introductions.

1921. "Kalihi Wallabies Increase; Big Hunt Is Being Arranged." *Pacific Commercial Advertiser*, March 29, Sec. 2, p. 1.

Indicates firm establishment of an O'ahu population of *Petrogale penicillata*, and reports some obvious damage to vegetation; "its depredations are already resulting in a rapid rise in the price of ti leaves." (=*Cordyline*, used in the preparation of Hawaiian foods.)

1923. "Live Stock in the Territory of Hawaii from Taxation Records, January, 1923." *Hawaiian Forester and Agriculturist* 20:134.

Statistical table of domestic animals, including dogs, for O'ahu, Maui, Hawai'i, and Kaua'i.

1927. "Bringing Plants and Animals to Hawaii." *Paradise Pacific* 40(8):22–23.

Excerpts from Wyllie (1850) concerning introductions of domestic mammals by early European voyagers.

1930. "Professor Rock Will Return to Direct Great Botanical Garden." *Honolulu Advertiser*, July 1, pp. 1, 4.

A grand plan conceived by a Hawaiian philanthropist, which momentarily held the fancy of Joseph Rock. As it would have resulted in the introduction of untold numbers of exotic species to the Hāmākua Coast of Hawai'i, from the cane fields to upper Mauna Kea slopes, it is just as well that the project withered.

1934. "The President's Itinerary in Hawaii." *Paradise Pacific* 46(7):5–12.

Photo of two boys on a donkey (p. 5), entitled, "The Kona Nightingale." Links visit of President Franklin D. Roosevelt with symbol of the Democratic Party.

1938a. "Fight Between Killer Whales Ends in Draw." *Honolulu Star-Bulletin*, February 26, p. 11.

On February 23, 1938, D. S. Judd of HSPA Experiment Station observed two whales apparently fighting some 500 yards off Olowalu, Maui, "combatants leaping high out of the water, churning the sea into foam . . . and spouting vigorously." Identification not verified in this report (presumably *Orcinus orca*).

1938b. "Oxen Motive-Power for Hawaiian Sugar on Kauai." *Paradise Pacific* 50(11):27.

Undated photograph of eight-ox team pulling rail cars in a cane field.

1938c. *Paradise Pacific* 50(12):plate between pp. 16 and 17.

Excellent Hawaii Tourist Bureau photo of three children on a donkey, "The Kona Nightingale," in Kona District, Hawai'i.

1938d. "Bull in a Sugar-Cane Field." *Paradise Pacific* 50(2):34.

Quotes from Captain Amasa Delano (Delano, 1817) who visited Hawai'i in 1801 and 1806. He observed on Maui in 1806 what was said to be the first bull transported to that island.

1940. *Paradise Pacific* 52(8):27.

Photo entitled, "Outdoor Sport Hunting of Rats," showing two hunters and their bag of rats; apparently meant to accompany text of Donaldson, 1940.

1941. "The Menace of Rodents." *Paradise Pacific* 53(2):3.

Account of the establishment in 1901 of the Shipping Agents Wharf Committee which taxed incoming freight to support rodent control, and the history of the development and application of this concept.

1943a. *Rats and Their Control.* Chamber of Commerce, Honolulu. 32 pp.

Profusely illustrated manual on rat damage, general habits, control methods, and identifica-

tion. Designed to arouse the public to aid public agencies in rodent control. "Starve them out, kill them off, build them out." Four human diseases are noted as rat-borne.

1943b. "Officials Hear Gray Squirrels Run Wild Here." *Honolulu Star-Bulletin*, December 21, p. 5.

A gray squirrel (=*Sciurus*) was caught at Schofield Barracks, O'ahu; others were reported at large in the area. Concern was expressed by the Board of Agriculture.

1946a. "Wild Dog Packs Roaming Island Farms and Ranches." *Honolulu Star-Bulletin*, January 31, p. 1.

Reports nightly killing of chickens, hogs, and cattle. Dogs feral on all islands, especially Hawai'i. Source of animals in part those abandoned by military units that had moved out. Appeals for unified effort to curb the populations.

1946b. "Rats on Midway." *Rodent Mail* 2:91–92.

Describes, largely from M. S. Johnson (1945), invasion of Midway Islands by *Rattus rattus* in 1942 or 1943, great increase in numbers, harm caused, and control methods. *Mus domesticus* was present long before 1941.

1946c. "Unwelcome Visitor to Hawaii." *Honolulu Advertiser*, April 10, p. 1.

Reports a "fruit-destroying bat" found asleep in the rigging of a ship from the Philippines.

1947a. "60 Years Ago—1887." *Honolulu Advertiser*, January 22, Edit. page.

Reports deer (=*Axis axis*) on the Moloka'i Bishop Estate lands numbering at least 1,000 (20 years after introduction).

1947b. "Facilities for Research in the Natural Sciences in the Hawaiian Islands." *Pacific Science* 1:119–126.

Lists and discusses more than 20 agencies or institutions, public and private. Wildlife research and rodent control are mentioned; no museum collection of mammals is apparent.

1949. "Menace from Wild Dogs." *Honolulu Advertiser*, September 6, Edit. page.

Discusses problem of feral dogs in O'ahu hills since World War II. Advises trapping, and if this is not successful, organized shooting that will not harm domestic dogs.

1950. "Molokai Deer Will Be Released on Big Island; Plan Protested." *Hilo Tribune-Herald*, June 3, p. 3.

Reports that "experimental release" of axis deer on Hawai'i has been under consideration for 10 to 15 years, according to the president of the Board of Agriculture and Forestry. Damage to forests would be negligible; deer could be controlled by hunting.

1953a. "Water Buffalo Dies of Old Age as Zoo 'Curiosity.' " *Honolulu Star-Bulletin*, March 31, p. 1.

Reports loss of aged bull estimated to be 30 years old. Horns were 43 inches long. The buffalo was 10 1/2 feet long and stood 5 1/2 feet at the shoulder.

1953b. "Whales Disport off Diamond Head, Waikiki." *Honolulu Advertiser*, March 11, p. 1.

"Large school" of unidentified whales was seen in the waters off Diamond Head, and a research vessel reported that, earlier, humpback whales were concentrated between O'ahu and Moloka'i, on Penguin Bank.

1954a. "Dead Whale Identified as Now-Scarce Sperm." *Honolulu Advertiser*, October 1, p. C-1.

A 35-foot specimen that beached off Kahuku Point, O'ahu, about September 24, was identified by P. L. Breese, director of the Honolulu Zoo. Sperm whales have been scarce since whaling days, and this may be the first record of such a stranding on O'ahu's shores, according to Breese.

1954b. "Outmoded Law Is Reminder of Hawaii's Rabbit Scare." *Honolulu Star-Bulletin*, September 18, p. 12.

Discusses the 1890 law that carefully circumscribes the raising of rabbits in Hawai'i, drawn up as a result of reports on the spread of feral rabbits in Australia. "Amended in 1917, 1925, 1935, 1941, and as late as 1944, it now involves little more than the issuance of a permit to private and commercial rabbit breeders."

1955a. "New Rules on Sheep Hunting on Big Island." *Honolulu Advertiser*, January 11, p. A-4.

"Wild sheep hunting on the Big Island has become a sport instead of a slaughter," according to L. W. Bryan, State Forester. Hunting was legal, by permit, on weekends and holidays. Limit was one ram per day; total sheep population estimated at 1,000 to 2,000.

1955b. "Hunters Enjoy Good Season." *Honolulu Star-Bulletin*, July 21, p. 32.

Reports best sheep season on Hawai'i since 1949, when a closed season was declared. A total of 245 sheep was taken by 205 hunters in a two-month season. In an eight-day season on Lāna'i 187 male goats were taken by 164 hunters.

1957a. "New Home." *Honolulu Star-Bulletin*, May 14, p. 1–B.

Reports capture of a young female brush-tailed rock-wallaby that wandered into Tripler Army Hospital (at Moanalua Valley, O'ahu), and its transfer to the Honolulu Zoo. See Figure 3 for photograph that accompanied this article.

1957b. "Sportive Whale Puts on Show Off Blow Hole." *Honolulu Advertiser*, January 3, p. C-8.

A "black whale" was cavorting with a group of "porpoises" on January 1, 1957, just off the south shore of O'ahu. Whales were visiting Hawaiian waters late that season according to Gerald Burtnett, "the President of the Wailupe Whale Watchers Assoc."

1958a. "Cat Crew Has Whale of a Time." *Honolulu Advertiser*, May 13, p. A-6.

A 14-foot injured pilot whale that drifted to Waikīkī Beach, O'ahu, was brought to shore, then released outside the reef.

1958b. "Sharks End Brief Hour of Fame for a Whale." *Honolulu Star-Bulletin*, May 13, p. 1.

Reports that in June 1957, a 13-foot pilot whale was kept alive for a week at the Honolulu Aquarium. It also carries same story as in 1958a, adding that sharks killed the current specimen.

1958c. "Only One Beached Whale Survives." *Honolulu Star-Bulletin*, October 4, p. 2.

Reports 24 pilot whales, or blackfish, beached at Kaiolohia Bay, Lāna'i. Lengths were 7 to 15 feet. This was the first such event in modern times on Lāna'i. One photo.

1958d. "12 Pilot Whales Washed Up on Kauai Beach." *Honolulu Advertiser*, October 29, p. B-7.

Reports on a grounding of October 28, at Kalihi Beach, Kaua'i. About half the whales were saved by being helped back into deep water.

1958e. "Dart Gun Control." *Ann. Rep. Territory of Hawaii, Bd. of Agriculture and Forestry*, 1957–58, p. 19.

Notes that feral cattle in North and South Kona districts were being captured by stunning with nicotine salicylate. Object was to control cattle and hence tuberculosis carried by them.

1959a. *Honolulu Star-Bulletin*, May 11, p. 1.

Reports 28 pilot whales stranded near 'Anini, Kaua'i, on May 10. "Several measured 12 feet in length and weighed an estimated 500 pounds." Photo of whales on rocky beach (Fig. 77).

1959b. "Pilot Whale Swims at Aquarium, but Chances of Survival are Dim." *Honolulu Star-Bulletin*, May 15, p. 1.

Describes capture of injured whale at Waimānalo Beach, O'ahu, transfer to Honolulu Aquarium, and listless behavior in captivity.

1959c. "Whale to Travel Aboard *Himalaya*." *Honolulu Star-Bulletin*, September 8, p. 16.

Pygmy sperm whale caught in Ala Wai Harbor, O'ahu, in June 1958, died at aquarium, was frozen, and now being sent to the University of British Columbia for study.

1960a. "Epic Flight by Hoary Bat Started Hawaiian Species." *Science News Letter*, 77:297.

Probable means of colonization of Hawai'i by *Lasiurus cinereus* is discussed, from data supplied by D. H. Johnson. A single pregnant female could have established the species.

1960b. "Hoary Bat Flew Out of the Dawn to the Islands." *Honolulu Advertiser*, April 3, p. A-6.

News story drawn from Anon. (1960a).

1960c. "The Polynesian Rat Bred in Captivity." *New Zealand Dept. Scientific and Industrial Research, Rep. for 1960*, p. 46. Wellington: Govt. Printer. (Also, *Pacific Science Information Bull.* No. 12.)

Rattus exulans was successfully established as a laboratory animal by Animal Ecology Section, D.S.I.R., in New Zealand, opening the way for extended experimental use of this species.

1961. "Rats Attack 3-Month-Old Boy in Punchbowl Area." *Honolulu Star-Bulletin*, March 1, p. 1.

Reports severe nighttime injury to face and hand of infant sleeping in a Honolulu basement apartment. Family members were alerted only when the child screamed. Follow-up story in March 2 edition indicates that a second, older child was also bitten.

1962a. *Noxious Weeds of Hawaii.* Honolulu: State of Hawaii, Div. Plant Industry, Staff Rep. 89 pp.

A manual for weed control. Defines the noxious weed; outlines biological, chemical, and mechanical control methods; names 52 weed species and provides detailed data on each.

1962b. "Now-Rare Whales Were Once Basic to Hawaii's Economy." *Honolulu Star-Bulletin*, March 11, Hawaiian Life Sec., p. 6.

Reviews briefly the old whaling industry. "Aina Haina residents a few years ago founded a whale-watchers club and awarded special pins to members."

1963a. *Weeds Manual for the Hawaiian Sugar Industry.* Honolulu: Hawaiian Sugar Planters' Assoc., Staff Rep. xi + 7 pp., 162 plates.

A revision of Pope (1929) "Manual of Wayside Plants of Hawaii." Consists primarily of full-page illustrations; includes index, instructions for collecting plants, and bibliography. Preface by Noel S. Hanson.

1963b. "On the Plural of Mongoose." *Honolulu Star-Bulletin*, January 29, Progress Ed., p. 7.

States: "For the plural, a Hawaiian would say, 'Ho, plenty mongoose' with mild emphasis on the 'plenty' if a few, and heavy emphasis on the first syllables of both words, if many."

1963c. "Hamakuan Invites Help in Unravelling Private Life of Furtive Hawaiian Bat." *Hilo Tribune-Herald*, December 15, p. 14.

Request for volunteer observers and for known information and specimens. Discusses the bat and the need for research on it. Data supplied by P. Q. Tomich.

1963d. "Introduction of Axis Deer to Big Island Is Opposed." *Hilo Tribune-Herald*, April 7, p. 1.

Reports unanimous vote of Mauna Kea Soil and Water Conservation District to oppose the deer introduction. Lists seven enumerated "presentations of facts," and notes that the deer "would introduce negative elements opposed to our purpose."

1963e. "Niihau Will Have Last Major Ranch after Parker Quits Sheep-Raising." *Honolulu Star-Bulletin*, February 8, p. 2.

Reports announced plans for closing of Humu'ula as a sheep station in 1964. Reviews history of sheep farming in that area, and in Hawai'i. As many as 30,000 sheep were run at Humu'ula in the past. Main problems were feral dogs, pigs, and poachers.

1963f. "Maui Rodent Control Crews are Expanded." *Honolulu Star-Bulletin*, November 21, p. 37.

Announces emergency fund released for rodent control in an unusually severe outbreak that had become apparent two months previous. Crop damage was a principal complaint, mainly in the Kīhei and 'Ōma'opio farm areas.

1964a. "State Plans to Release Axis Deer on Isle as Soon as $$$ Allotted." *Hilo Tribune-Herald*, January 3, p. 5.

Proposes release of about 50 deer from Pu'u Lā'au area holding pen on Mauna Kea. Deer were to be captured on Moloka'i or Lāna'i as soon as the $4,000 appropriation was made available.

1964b. "*Should Axis Deer Be Introduced to the Island of Hawaii.*" State of Hawaii, Div. Fish and Game, Honolulu, Staff Rep. 7 pp., mimeo.

Discusses arguments for and against introduction of axis deer in light of current biological knowledge of the species. Anticipated range is mapped. Introduction is recommended.

1964c. "Ranchers to Fight Release of Deer." *Hilo Tribune-Herald*, January 12, p. 1.

Hawaii Cattlemen's Association goes on record as urging that funds not be released for transport of deer. Association president declares that deer would be a "nuisance like the mongoose."

1964d. "Big Island Rancher Takes Issue to Court." *Hawaii Tribune-Herald*, March 7, p. 1.

Temporary restraining order is issued against introduction of axis deer at request of ranch owner. Disease transmission and competition with cattle for food cited by rancher as objections. "A game animal with fewer problems should be considered—such as the eland antelope." [The eland, *Taurotragus oryx* (Pallas), weighs about 1,800 pounds and stands nearly 6 feet tall at the shoulder.]

1964e. "Parker Ranch Opposes Axis Deer on Big Isle." *Hawaii Tribune-Herald*, May 1, p. 2.

Ranch owner believes he has "great cause for apprehension" over deer, because in their movements they could spread anthrax and tuberculosis from district to district among cattle.

1964f. Park Head against Axis Deer Release." *Hawaii Tribune-Herald*, Sepember 10, p. 1.

Reports on Circuit Court hearing. Superintendent of Hawaii Volcanoes National Park states undesirability of all exotic animals in Park areas. Other views, pro and con, were expressed.

1964g. "Judge Bans Axis Deer for Big Island." *Hawaii Tribune-Herald*, September 22, p. 1.

Reports issuance by Circuit Court of Hawaii of a permanent injunction prohibiting release of axis deer on Hawai'i. Evidence indicated deer would damage private and federal property; proposal for release was deemed "unreasonable and unnecessary."

1964h. *Hawaii Tribune-Herald*, July 22, p. 1.

Photo of female water buffalo just brought to Waipi'o Valley as a mate for a male already present, and note on use of these animals in Peace Corps training program.

1964i. "For $750 You, Too, Can Own a Water Buffalo." *Honolulu Advertiser*, October 29, p. B-1.

Reports Ing Brother's five buffalo as up for sale because road construction was encroaching on the area where the buffalo were kept. Purchase price for three had been $750, several years earlier. Peace Corps stock for Waipi'o Valley was obtained from this herd.

1964j. "Man Gored, Treed by Water Buffalo." *Honolulu Advertiser*, November 17, p. A-2.

Relates attack by a male buffalo on a man who entered the paddock. The man was tossed four times and injured on a thigh, but managed to escape by climbing a tree.

1964k. "C G Searchers: Here Kitty, Kitty." *Honolulu Advertiser*, December 10, p. A-2.

Reports difficulty of removal of a cat that strayed on an islet of French Frigate Shoals from a barge delivering construction materials. After five months the cat was still at large, susbsisting apparently on birds.

1964l. "Coast Marines Hold Training on Kahoolawe." *Honolulu Advertiser*, July 17, p. E-3.

Note indicating occupation of Kaho'olawe by reservists for directing fire in bombing and shelling of the island in military exercises.

1964m. "House, Eyeing Bomb Isle Return, Told Navy Needs It as Target." *Honolulu Advertiser*, March 13, p. A-2.

Indicates that the State of Hawaii ceded Kaho'olawe to the Federal Government in 1952. Suggestion that island was not being used stimulated explanation of present and future need for it.

1964n. "Big Blasts Slated at Kahoolawe." *Hawaii Tribune-Herald*, July 22, p. 3.

Announces test series involving massive charges of TNT (as large as 500 tons, a later report stated) on land "to determine the survivability of shipboard structures and equipment," on vessels anchored offshore.

1964o. "Future Project?" *Hawaii Tribune-Herald*, May 3, Soils stewardship supplement.

Notes that only Kaho'olawe, of all the Hawaiian Islands, gets no conservation attention. Sees a challenge, in the present poor condition of the island, for a worthwhile project of rehabilitation.

1964p. "Mouflon Sheep Hunting Season Slated on Lanai." *Hawaii Tribune-Herald*, July 19, p. 3.

Reports announcement of the first open season in Hawai'i on August 16 and 23, 1964, for the taking of a total of 40 male mouflon "with a horn length of a half curl or better."

1965a. "How to Tell One Rat from Another." *Hawaii's Sugar News* 15(2):3.

Sketches and brief notes to promote easy identification of three rats found in Hawai'i.

1965b. "New Light Shed on Dolphins." *Life* 59(17):122–123, 125–126.

Popular article on use of various dolphins in communications research. Shows behavioral characteristics and research methods involving Hawaiian dolphins. Three species are figured in seven photos.

1965c. "Kahoolawe Study Weighed." *Honolulu Advertiser*, April 21, p. A-4.

Reclaiming of Kaho'olawe for civilian use was suggested by Maui citizens in a meeting with the Army Corps of Engineers. Indicates that no revenue from the owners (federal government) is paid to the State of Hawaii.

1965d. "Hundreds of Goats in Park Roundup." *Hawaii Tribune-Herald*, March 2, p. 1.

Describes drive of late February that netted more than 1,200 goats in the lower coastal areas of the Hawaii Volcanoes National Park. A light airplane and 14 mounted drivers took part. Goats were sold at auction in one lot, and resold alive, for food, on Hawai'i, Maui, and O'ahu. Another drive was planned for May; the goats from a previous drive were sold for their skins, which were shipped to Japan.

1965e. Mice Infest Ka Lae Range, Homes." *Hawaii Tribune-Herald*, September 5, p. 12.

Reports abundance of *Mus domesticus* in South Point region of Hawai'i Island as just past the peak. Previous high was in 1963, and the one before that time could not be recalled by local people.

1965f. "Maui's Pied Pipers Will War on Mice." *Honolulu Advertiser*, September 13, p. A-8.

Calls attention to abundance of *Mus domesticus* in lowlands of Maui to include Kīhei, Kahului, 'Ōma'opio, and West Maui. Principal problem was nuisance created by mice entering homes and hotels.

1965g. "Kaula Isle Sanctuary Proposed." *Honolulu Advertiser*, March 15, p. A-15.

When the Coast Guard was in the process of turning Ka'ula over to the Navy, Representative Patsy Mink of Hawai'i requested a study relative to preservation of the island as a bird sanctuary, pointing out the importance of the island to the local economy.

1965h. "Bird Sanctuary for Kaula Eyed." *Hawaii Tribune-Herald*, June 22.

Reports additional effort to protect Ka'ula birds from military activities. Secretary of the Interior Udall asked for a reappraisal in the hope that the flora and fauna could be preserved by placing the island in sanctuary status.

1965i. "Conservationists Withdraw Objection to Kaula Bombings." *Honolulu Advertiser*, July 19, p. 1.

A "conservation group" on Kaua'i decided that live bombing on "Ka'ula Rock" is necessary and should continue. At least one citizen objected to this action.

1965j. "Porpoises Do an Aerial Hula at Sea Life Park." *Sunset* 135(4):20–24.

Popular description of Sea Life Park, an O'ahu oceanarium, "where bottlenose, Pacific spotted, and rare steno porpoises show what they have learned from intensive training."

1966. "Whaling Talk Ends without a Pact." *Honolulu Advertiser*, February 18, p. B-8.

Delegates from Canada, Japan, U.S.S.R., and the United States to the International Whaling Commission, meeting in Honolulu, could not agree on catch limits and methods. Reviews briefly the present restrictions on Pacific whaling.

1967a. "In Hawaii, Face to Face with a Mongoose." *Sunset* 138(1):34.

Brief popular review of the mongoose in Hawai'i with photo of pet captive that was to be displayed in the Honolulu Zoo.

1967b. "Rabies Warning Up for Oahu." *Honolulu Advertiser*, October 6, pp. 1, A-4, C-2.

Reports first detection of presumably positive rabies in a wild animal, from a rat that bit a

small boy September 28, 1967, at Schofield Barracks army post. Plans for preventing spread of the disease in domestic and wild mammals are outlined.

1967c. "Army Launches Rabies Mis-diagnosis Probe." *Honolulu Advertiser*, October 25, pp. 1, A-3.

Irregularities in procedures at the laboratory were charged by five enlisted men; Inspector General's investigation was to take place; evaluation of long-term needs for disease diagnosis requested by Governor John A. Burns.

1967d. "How Rabies Expert Views 'Scare.' ". *Honolulu Advertiser*, December 9, p. C-1.

Dr. William McD. Hammon, consultant from the University of Pittsburgh, suggests that inexperience with rabies by workers in Hawaii led to diagnoses that could not be confirmed by mainland laboratories.

1967e. "Rabies Scare Blamed on Lab." *Honolulu Advertiser*, December 23, p. A-3.

Director of Atlanta Public Health Service Laboratory, after tests on about 100 "cats, dogs, mongooses, pigs, mice, rats and just about everything," reports no confirmed rabies for Hawaii. Confusion at the Schofield Medical Laboratory was cited as a contributing factor in misdiagnoses.

1967f. "Newsnote." *Pacific Science* 21:565–566.

Reviews *tsunami* warning system and recent destructive *tsunami* in the Pacific Basin. Shows map of wave travel time to Hawai'i from other regions.

1967g. "Animals Aid in Search and Rescue." *Oceanology Internatnl.* 2:17.

Dolphins and seals will assist human aquanauts in the 1968 Sealab 3 experiments off California.

1968a. "High Court Action to Permit Isle Deer." *Hawaii Tribune-Herald*, January 11, p. 8.

The State Supreme Court reversed an earlier ruling (Anon. 1964g), stating that introduction of axis deer on state-owned land "is a reasonable exercise of the police power."

1968b. "Bill Sproat Retires at Kohala." *Hawaii Tribune-Herald*, January 28, p. 12.

A story of men and mules on the Kohala Ditch Trail, Hawai'i. The third generation of Sproats was to assume supervision of the ditch system. Similar story in the *Honolulu Sunday Star-Bulletin and Advertiser*, same date, p. A-10.

1968c. "Lot of Donkey Business, Snorts New Opera Extra." *Sunday Star-Bulletin and Advertiser*, February 18, p. A-10.

Describes plans for a pet donkey to pull a cart across the stage, for the first time, in a local production.

1968d. "Sinewey Swinger, Runaway Monkey Actor?" *Hawaii Tribune-Herald*, February 19, p. 8.

A monkey seen in February 1968 near Hilo may have been the one that escaped from a film set in the area, in October 1962.

1969a. "Snakes and Gerbils Gambol About Isle." *Honolulu Advertiser*, July 31, p. C-5.

Relates how two pairs of gerbils were illegally imported for biology class work in 1968, multiplied, and were taken home by students; 23 animals were recovered in all.

1969b. "Big Isle Axis Deer Plan Wins Support." *Honolulu Advertiser*, September 25, p. D-16.

Notes recommendation by State Division of Fish and Game for introduction of the deer.

1969c. "Science Group Opposes Axis Deer on Isle." *Hawaii Tribune-Herald*, October 9, p. 1.

Governor's Committee on Preservation of Scientific Areas opposed the plan on basis of impending Inernational Biological Program which was to begin research on native ecosystems.

1969d. "Deer on Way Here Wednesday." *Hawaii Tribune-Herald*, October 13, p. 9.

The Board of Land and Natural Resources reaffirmed permission which had first been granted some five years earlier.

1969e. "Burns Holds up Deer Shipment." *Hawaii Tribune-Herald*, October 15, p. 1.

Further review was indicated. Sheep were found in the 300-acre holding pen on Mauna Kea, and these were to be removed before the deer could be transported.

1970. "New State Unit Faces Question on Axis Deer." *Honolulu Advertiser*, December 16, p. A-24.

First appointments were made to the Animal Species Advisory Commission, created that year by the State Legislature. Ten deer had been held for more than a year on Lāna'i, for shipment to Hawai'i.

1971a. "Either Deer are Getting Smarter or—Well, You Can Try Again." *Honolulu Star-Bulletin*, August 28, p. B-16.

Notes 11 deer taken from Kaua'i mule deer herd in first hunting season, of 1969; two in 1970. Hunter numbers were 90 and 120, respectively, and because of expanded range 500 would be permitted to hunt in 1971.

1971b. "Vanishing but Not Gone." *Hawaii Tribune-Herald*, December 23, p. 1.

Notes a captive herd of 25 donkeys in the Waikoloa Project, caught on the 31,000 acres of arid lands being developed for resort, housing, and vacation ranch uses.

1972a. "Baby Buffalo Has a Lot of Heart." *Honolulu Advertiser*, February 16, p. A-4.

Notes 10 water buffalo in Hawai'i: seven at Kohala High School, two at Honolulu Zoo, and one at the Rice Institute on Kaua'i.

1972b. "Axis Deer Impact Statement Proposed." *Hawaii Tribune-Herald*, March 16, p. 12.

A Senate resolution was introduced by State Senator Yoshinaga requiring that an EIS be prepared relative to proposed transshipment of deer to Hawai'i from Lāna'i.

1972c. "Smell That Coffee Roasting." *West Hawaii Today*, November 16, p. 16.

Notes former use of donkeys in coffee culture. Photo of a herd recently rounded up on McCandless Ranch of Kona District.

1973a. "Economy at Ewa: the Mule Train." *Honolulu Advertiser*, July 6, p. B-1.

Ewa Plantation near Waipahu, O'ahu (Oahu Sugar Co.). Mules carry four bundles each of seed-cane cuttings from ditch-irrigated fields. There were 11 mules in use, "a lot cheaper than diesel fuel." Four photos.

1973b. "Pro-Axis Deer Forces Plan New Drive on Big Island." *Honolulu Advertiser*, July 9, p. A-8.

Hunting organizations were seeking a political solution to the problem. Rebuttals were made by several scientists. Article just below on the same page could be interpreted as support for deer introduction by a strong politician not then in State government.

1975a. "Trichinosis Traced to Pig on Big Island." *Honolulu Advertiser*, March 24, p. A-2.

Reports on nine cases in back-country visitors who consumed under-cooked pork in or near Waimanu Valley. A State Health Department report that is quoted notes over 50 cases in Hawai'i since 1952, 44 from island of Hawai'i.

1975b. "Whale Sinks Sloop Bound for Hawaii." *Honolulu Star-Bulletin*, July 9, p. 1.

A 46-foot sailboat sank after colliding with an unidentified whale 300 miles off the California coast. All crew members were picked up by a racing yacht.

1976. "Help Sought from Whale Watchers." *Honolulu Star-Bulletin*, February 5, p. F-5.

An organized statewide whale watch was planned especially for counting the wintering humpback whales. It was noted also that daily watching at Mā'alaea Bay, Maui, was in effect to warn jet-foil craft of whales in the sea lanes.

1977. "Sierra Club Eyeing Suit." *Hawaii Tribune-Herald*, March 16, pp. 1, 8.

Reports letter from Sierra Club to president of International Council for Bird Preservation stating that governor of Hawai'i has been warned that if sheep and goats are not removed from Mauna Kea, the Sierra Club will file suit. (Date of the letter is confirmed as June 22, 1976.)

1979. "Mauna Kea Dons Her Winter Cloak." *West Hawaii Today*, November 29, pp. 1, 26.

Notes and photos on a first heavy snowfall of November 25 in the summit region.

1979–80. *Hawaii Humpback*, Vol. 1, nos. 1–3. Wailuku: Straight Ahead Publishing.

A brief-lived quarterly on Hawaiian natural history emphasizing the plight of whales and the need for a humpback whale sanctuary.

1980a. "Goat Hunting from Helicopter." *Honolulu Advertiser*, May 28, p. A-5.

When ground troops could not reach elusive goats, small helicopters were employed as part of a training exercise, on Kaho'olawe. The Navy hoped to reduce the goat population to below 200 animals by 1986.

1980b. "A Coast-watching Scheme for Marine Mammals." *Wildlife Australia* 17:66–71.

Gives keys for identification, charts, and silhouettes of various species. Provided by South Australia Museum.

1980c. *First Aid for Stranded Marine Mammals*. Massachusetts: International Fund for Animal Welfare. 24 pp.

An instruction booklet in 10 brief sections, data cards, and whom to call in the event of strandings. No Hawai'i address is given (but get in touch with Sea Life Park).

1980d. "Whale Sanctuary for Hawaii?" *Hawaii Coastal Zone News* 5(1):1–2.

Proposal resulting from 1979 conference noted in review process, with some local objections to the concept as restricting local recreation and commercial fishing.

1981a. "Veterinarians Check Captured Prairie Dog and Find No Disease." *Honolulu Advertiser*, March 21, p. A-4.

Reviews account of one specimen examined from the established colony between Moloa'a and Kīlauea, northeastern Kaua'i.

1981b. "4 of 22 Pigs in Hunt Condemned for Disease." *Honolulu Advertiser*, June 18, p. A-4.

Special hunt on west Moloka'i for pigs followed eradication of cattle herd infected by bovine tuberculosis, with result that pigs also were found to be heavily infected.

1982a. "Whale Sanctuary Opinions Aired." *Hawaii Coastal Zone News* 7(2):2–3.

Reviews progress in proposal for federal (NOAA) Hawaii Humpback Whale National Marine Sanctuary. An original proposal to NOAA was submitted in 1977.

1982b. "Saving the Whales." *Honolulu Advertiser*, July 24, p. A-12.

Reviews decision, from meeting in England, for phasing out of commercial whaling. Companion article of July 25 notes that 1983 quota was cut 25 percent, to 10,900.

1982c. "Molokai Mules May Ride Again." *Honolulu Advertiser*, December 7, p. A-5.

Notes that mule-train excursions to the isolated Kalaupapa peninsula via a steep trail had been suspended about one year. A new operator had applied for resumption of service.

ANON. (Editor)

1826. *Voyage of H. M. S. Blonde to the Sandwich Islands, in the Years 1824–1825*. London: Davison. 260 pp.

In narrative (p. 170) of a trip, starting from Laupāhoehoe, to the summit of Mauna Kea: "Five hours walk brought them to the hut of a rough but useful European . . . whose employment is to catch and kill wild cattle and cure beef, which he does very skillfully."

APPLE, R.

1985. "Kauai Archer Wins Island Bride." *Hawaii Tribune-Herald*, June 30, p. 19.

Weekly column *Mo'olelo na Apu* draws on a legend which implies that bow and arrow hunting may have been applied to birds, as well as to the sport hunting of rats.

ARAKAKI, J.

1968. "Lt. Col. Dean Still Says He's Right in Rabies Case." *Honolulu Star-Bulletin*, January 17, p. E-8.

The former chief of the Schofield Medical Laboratory defends his position on rabies diagnoses. Specimens from Guam determined positive by his laboratory were confirmed by federal laboratories.

ARMSTRONG, R. W. (Editor)

1973. *Atlas of Hawaii.* Honolulu: Univ. Press of Hawaii. 222 pp. (Revised, 1983.)

This work, prepared under the direction of members of the Department of Geography, University of Hawaii, includes sections written by 34 contributors and compilers. A three-page summary is given of mammals.

ARVY, LUCIE

1979. "Trichinosis in Cetaceans." *In*: G. Pilleri (editor), *Investigations on Cetacea* 10, pp. 325–330. Berne: Brain Anatomy Institute. 366 pp.

This parasitic infection has been known in the European Arctic since the thirteenth century, circulating among carnivores, man, and sea mammals, including some cetaceans. Modern data are from studies in Alaska.

ASH, L. R.

1962a. Helminth Parasites of Dogs and Cats in Hawaii." *J. Parasitology* 48:63–65.

Stray animals were examined on O'ahu. From 96 dogs, 9 species of helminths are reported, 4 not previously known in Hawai'i. In 107 cats examined, 11 species were found, 5 of which were reported for the first time.

1962b. "The Helminth Parasites of Rats in Hawaii and the Description of *Capillaria traverae* sp. n." *J. Parasitology* 48:66–68.

Fifteen species of helminths were found in examination of 73 *Rattus rattus* and *R. norvegicus* on O'ahu. Of these, 13 are reported for the first time from that island. *C. traverae* inhabits the small intestine of both hosts.

ASHBURNER, M., H. L. CARSON, and J. N. THOMPSON (Editors)

1982. *The Genetics and Biology of Drosophila.* Vol. 3b. New York: Academic Press. 428 pp.

Evolution and speciation in selected groups of pomace flies, including the Hawaiian members of the genus.

ASHDOWN, INEZ M.

1979. *Recollections of Kaho'olawe.* Honolulu: Topgallant. 71 pp.

A factual account of the period 1917–1941 in which Angus MacPhee strived to rehabilitate the island. Legendary accounts are interspersed. Pages 9–14 describe removal and control of goats in first four years.

ASHLOCK, P. D., and W. C. GAGNÉ

1983. "A Remarkable New Micropterous *Nysius* Species from the Aeolian Zone of Mauna Kea, Hawaii Island (Hemiptera: Heteroptera: Lygaeidae)." *Internatl. J. Entomology* 25:47–55.

Describes *N. wekiuicola*, discusses adaptations, range, and history of discovery among snow patches and rough lava. The bug lives as a predator and scavenger on other arthropods.

ATKINS, D. L., and L. S. DILLON

1971. "Evolution of the Cerebellum in the Genus *Canis*." *J. Mammalogy* 52:96–107.

Anatomical studies of the brain show that the wolves are distinctive among six canids examined, and that the dog bears close resemblances to the coyote and the jackal. A phylogeny is proposed for incorporation of these findings.

ATKINSON, A. L. C., and W. A. BRYAN

1913. "A Rare Seal." *Bull. New York Zoological Soc.* 16:1050–1051.

Summarizes important historical data on the Hawaiian monk seal, and on the islands occupied by this species.

ATKINSON, I. A. E.

1964. "Relations between Feral Goats and Vegetation in New Zealand." *Proc. New Zealand Ecological Soc.* 11:39–44.

A detailed examination of the reciprocal effects of goats and native vegetation in selected localities. Four successional stages are recognized in depletion of forest understory. Vegetation-soil patterns have distinct effects on goat populations.

1972. "Spread of the Ship Rat (*Rattus r. rattus* L.) in New Zealand." *J. Royal Soc. New Zealand* 3:457–472.

Overturns the usual notion that both *R. rattus* and *R. norvegicus* arrived in New Zealand shortly after Cook's voyages. *R. rattus* could have invaded South Island as late as 1890. Some native birds and *R. exulans* vanished in this chronology.

1977. "A Reassessment of Factors, Particularly *Rattus rattus* (L.), that Influenced the Decline of Endemic Forest Birds in the Hawaiian Islands." *Pacific Science* 31:109–133.

A companion paper of Atkinson (1972), dealing with Hawai'i. Theme is that *R. rattus* arrived as late as 1870 or 1880, and is responsible for accelerated decline of birds; recorded by island, between 1873 and 1932.

AU, D. W., W. L. PERRYMAN, and W. F. PERRIN

1979. *Dolphin Distribution and Relationship to Environmental Features in the Eastern Tropical Pacific.* NMFS Southwest Fisheries Center, Admin. Rep. LJ-79–43. 59 pp.

Deals with spinner, spotted, striped, and common dolphins based on data from observers with the tuna fishing fleet and research ships cruising outside the fishing zones. Shallow thermoclines in the regional water masses are important, as are conjunction of the ocean currents, in the concentration of dolphins and fish.

AU, S., and G. SWEDBERG

1966. "A Progress Report on the Introduction of the Barn Owl (*Tyto alba pratincola*) to the Island of Kauai." *'Elepaio* 26:58–60.

Documents four releases of barn owls on Kaua'i, 1959–1964, establishment of the species, example of mortality, and known range up to June 1965.

BABER, D. W., and B. E. COBLENTZ

1982. "Immobilization of Feral Pigs with a Combination of Ketamine and Kylazine." *J. Wildlife Mgmt.* 46:557–559.

Authors report subject materials as superior to others in subduing box-trapped pigs for examination and release, on Santa Catalina Island, California.

BACHMAN, R. E.

1963. "Mauna Kea Sheep Survey." State of Hawaii, Div. Fish and Game, Honolulu, Project W-5-R-15. 5 pp., mimeo.

One-day survey by 22 men on July 25, 1963, revealed 1,138 sheep counted in belt between 7,000 and 11,500 feet elevation around the mountain. Sheep were concentrated in areas less accessible to hunters. Table shows 1950–1963 population data.

1964. "Hybridization of the Mouflon (*Ovis musimon*) with the Feral Sheep (*Ovis aries*)." State of Hawaii, Div. Fish and Game, Honolulu, Project W-5-R-15. 6 pp., mimeo.

Reports abandonment of pen hybridization in favor of increased field-release of mouflon; summarizes history and results of mouflon project. Between November 1957 and July 1964, 99 hybrid and 72 pure mouflon were freed on Mauna Kea. Management recommendations are given.

1982. "Status, Trends and Utilization of Game Mammals and Their Associated Habitats on the Island of Hawaii." State of Hawaii, Div. Forestry and Wildlife, Honolulu, Project W-17-R-7. 9 pp., mimeo.

Reports virtual elimination of feral sheep and goats from Mauna Kea hunting areas as a result of a court-mandated removal of these species. The mouflon population stood at 504 animals; 17

were taken in an October hunting season. Plans were made for fencing of a bog area to protect rare plants from feral pigs.

1984. "Status, Trends and Utilization of Game Mammals and Their Associated Habitats on the Island of Hawaii." State of Hawaii, Div. Forestry and Wildlife, Honolulu, Project W-17-R-9. 4 pp., mimeo.

Feral sheep and goats continue to infiltrate and propagate on Mauna Kea in spite of seasonal hunting and other control efforts. Sixteen sheep and two goats were taken during the regular mouflon season; 32 sheep and nine goats were seen on a 4-hour helicopter census of May 4, 1984 (after the hunting season).

BARNES, L. G.

1984. "Search for the First Whale." *Oceans* 17(2):20–23.

An incisive popular account of whale phylogeny. Supports the concept that all living species arose from a common stock of the Archeoceti. This is the generally accepted view. Chart.

BAYLEY, A. M.

1918. "The Monk Seal of the Southern Pacific." *Natural History* 18:396–399.

Account of the discovery of main breeding grounds of *Monachus schauinslandi* at Pearl and Hermes Atoll, in the winter of 1912–1913.

1952. "The Hawaiian Monk Seal." *Museum Pictorial* 7:1–32.

Detailed historical survey of the species, 1824–1951, with references. Illustrations include 28 photos of the seal and the islands it occupies.

1956. "Birds of Midway and Laysan Islands." *Museum Pictorial* 12:1–130.

History and narrative (pp. 8–34), with 11 photos, give good review of the islands. Mammals (p. 17): brief summary is given of status of the rabbit, rats, and seal.

BAKER, A. S.

1916. "Ahua a Umi." *Hawaiian Annual for 1917*, pp. 62–70. Honolulu: Thrum.

Historical treatment of King 'Umi's *heiau* on the great plain between Mauna Loa, Mauna Kea, and Hualālai, describing (p. 67) modification of the structure in recent times to serve as a trap and corral for goats. Five figs.

BAKER, C. S., and L. M. HERMAN

1981. "Migration and Local Movement of Humpback Whales (*Megaptera novaeangliae*) through Hawaiian Waters." *Canadian J. Zool.* 59:460–469.

Bi-weekly to weekly aerial surveys 1977–1979 winter seasons, mid-January through mid-April. Whales arrived first in numbers off island of Hawai'i, peak numbers moving northwest, apparently using clockwise surface ocean currents in movement from and to Alaska feeding grounds.

1984. "Aggressive Behaviour between Humpback Whales (*Megaptera novaeangliae*) Wintering in Hawaiian Waters." *Canadian J. Zool.* 62:1922–1937.

Describes competition between males, apparently for the breeding females, which includes forceful attacks. Such aggression may be more common than is generally supposed.

BAKER, J. K., and MELINDA S. ALLEN

1978. "Roof Rat Depredations on *Hibiscadelphus* (Malvaceae) Trees." *In*: C. W. Smith (editor), 1978, pp. 2–5.

Rattus rattus caused serious damage to this rare plant by eating bark, buds, flowers, nectar, and seed. As much as 90 percent of the seed crop was destroyed.

BAKER, J. K., and D. W. REESER

1972. *Goat Management Problems in Hawaii Volcanoes National Park: a History, Analysis, and Management Plan.* National Park Service Natural Resources Rep. 2. 63 pp., mimeo; 22 pp. in final printed form.

Plan for unit fencing, goat drives, perpetual monitoring of freed areas, and restoration of the native vegetation as a permanent solution to a long-standing Park problem.

BAKER, J. K., and CHRISTA A. RUSSELL

1979. "Mongoose Predation on a Nesting Nene." *'Elepaio* 40:51–52.

Mongoose a prime suspect in death of a brooding goose found 25 m from a nest and almost completely eaten, in dense shrubbery. The gander then abandoned the site.

1980. "Rat and Mouse Predation by Barn Owls on the Island of Hawaii." *'Elepaio* 40:142–143.

Reviews various reports and adds information on 31 pellets taken from Hawaii Volcanoes National Park. *Rattus rattus* and *Mus* were taken in equal numbers.

BAKER, R. H.

1946. "A Study of Rodent Populations on Guam, Mariana Islands." *Ecological Monogr.* 16:393–408.

Report on good short-term ecological study, with data on two species found in Hawai'i, *Rattus exulans* and *Mus domesticus*. Paper is based on live-trapping of 172 rodents of three species, but includes varied biological data.

BAKER, R. J.

1944. "The Case of the Wild Bullock." *Paradise Pacific* 56(10):24–26.

Describes activities of free-ranging livestock in and about Honolulu of 1850, and events leading to adoption of rules for their impoundment.

BALAZS, G. H.

1979a. "Bibliography of Kaula Island, Hawaiian Archipelago." *'Elepaio* 40:5–8.

Useful source paper with some references to mammals; 211 entries.

1979b. "Synthetic Debris Observed on a Hawaiian Monk Seal." *'Elepaio* 40:43–44.

Reports case of monk seal encircled by a synthetic band apparently from a box of frozen bait as used by longline fishermen. Scars on other seals suggest similar accidents.

BALAZS, G. H., and G. C. WHITTOW

1978. *Bibliography of the Hawaiian Monk Seal,* Monachus schauinslandi *Matschie 1905.* Hawaiian Institute of Marine Biol. Tech. Rep. 35. 27 pp.

A list of 338 entries known to the authors as of February 10, 1978. Includes newspaper accounts and many unpublished reports.

1979a. "First Record of a Tiger Shark Observed Feeding on a Hawaiian Monk Seal." *'Elepaio* 39:107–109.

Reports on seal-shark encounters from fragmentary past records back to 1959. Question of whether sharks actually kill seals is unanswered, although injuries are apparent.

1979b. *Revised Bibliography of the Hawaiian Monk Seal,* Monachus schauinslandi *Matschie 1905.* Univ. Hawaii Sea Grant Misc. Rep. UNIHI-SEAGRANT-MR-79-03. 27 pp.

Revision of Balazs and Whittow (1978), enlarged to contain 416 items, through January 31, 1979.

BALDRIDGE, A.

1972. "Killer Whales Attack and Eat a Gray Whale." *J. Mammalogy* 53:898–900.

Describes incident on California coast where five or six *Orcinus* attacked a calf about 18 feet long, and fed extensively on the carcass. The same pack may have made habitual attacks on the gray whale population of the region.

BALDWIN, E. D.

1889. "A Trip to the Summit of Mauna Kea." *Hawaiian Annual for 1890,* pp. 54–58. Honolulu: Thrum.

Account of advance survey party of August 1889. Cattle were shot for food. Route followed some of the numerous cattle tracks up the flank of the mountain; these trails extended to the limits of vegetation. Descriptions are well done.

BALDWIN, HELEN S.

1950a. "Afoot and Afield." *Hilo Tribune-Herald*, June 11, p. 4.

Underscores June 3 announcement of proposal to introduce 32 female and 8 male axis deer to Mauna Kea. Reviews history and characteristics of the deer; makes plea for defeat of the proposed introduction.

1950b. "Afoot and Afield." *Hilo Tribune-Herald*, June 18, p. 4.

Describes, in popular style, activities of a captive deer kept as a pet at Pāpa'ikou, on Hawai'i, for more than three years. Reviews other features of the species and the proposal to introduce it to Mauna Kea.

1963. "Bill to Introduce Deer to Big Isle Is Opposed." *Hilo Tribune-Herald*, March 24, p. 4.

Calls attention to proposed legislation that would provide entry of axis deer to Hawai'i Island. Reviews briefly history of deer. Makes plea for defeat of bill on basis of damage likely to occur in forests, especially to rare native plants, admitting that feral livestock has been the chief offender on Moloka'i and Lāna'i where deer are present.

1964. "Conservationists Oppose Deer." *Hawaii Tribune-Herald*, April 19, p. 6.

Reviews, during time of court proceedings, the reasons why axis deer are considered as a potentially harmful agent in the forests of Hawai'i. Damage already done by cattle and other livestock does not, in Mrs. Baldwin's judgment, justify introduction of another species that would promote further damage.

1978. "A Bicentennial Year for Hawaii's Wild Goats, Too." *Hawaii Tribune-Herald Orchid Isle*, March 26–April 1, p.4.

Summary of the goat in Hawai'i with reference to waggish person (unidentified) who stamped outgoing mail with the slogan "1978—Bicentennial Year of the Feral Goat in Hawaii."

BALDWIN, P. H.

1945a. "The Hawaiian Goose: Its Distribution and Reduction in Numbers." *Condor* 47:27–37.

Lists ten introduced mammals that were in part responsible for alarming reduction in numbers of the *nēnē* (*Nesochen sandvicensis*).

1945b. "The Laysan Rail." *Audubon Mag.* 47:343–348.

Laysan rail reported as apparently extinct because of man, rabbits, and rats that invaded Laysan, Lisianski, or Midway Islands. Discusses bird-rat relationships on other Pacific islands.

1946. "Bulwer Petrel Breeding on Eastern Hawaiian Islands." *Condor* 48:42–43.

Keaoi Islet, 2.5 acres in area and 500 feet off the central southeastern shore of Hawai'i Island, showed no evidence of rodents or other mammals when visited on August 8, 1945.

1947a. "The Life History of the Laysan Rail." *Condor* 49:14-21.

Rails died out on Laysan when rabbits obliterated vegetation. Colony of birds that was moved earlier to Midway was extirpated by rats in 1944.

1947b. "Foods of the Hawaiian Goose." *Condor* 49:108–120.

Briefly discusses feral goats, sheep, and cattle as affecting *nēnē* habitat by depressing vegetation.

1950. "Occurrence and Behavior of the Hawaiian Bat." *J. Mammalogy* 31:455–456.

Miscellaneous notes by a trained observer; this is the main published source of reliable field data on *Lasiurus cinereus* in Hawai'i.

BALDWIN, P. H., and G. O. FAGERLUND

1943. "The Effect of Cattle Grazing on Koa Reproduction in Hawaii National Park." *Ecology* 24:118–122.

Native *koa* (*Acacia koa*) is particularly susceptible to cattle damage because reproduction is suppressed. Saplings spring from shallow roots when cattle are excluded from senile forests.

BALDWIN, P. H., C. W. SCHWARTZ, and ELIZABETH R. SCHWARTZ
1952. "Life History and Economic Status of the Mongoose in Hawaii." *J. Mammalogy* 33:335–356.
Best general summary. Treats broad problems qualitatively, analyzes all known data on food habits. Suggests many topics for further inquiry.

BANDY, P. J., I. McT. COWAN, and A. J. WOOD
1970. "Comparative Growth in Four Races of Black-tailed Deer (*Odocoileus hemionus*). Part I. Growth in Body Weight." *Canadian J. Zool.* 48:1401–1410.
Tested four geographic races of deer, Alaska to California, in pen experiments. Growth rate was less in more southern coastal stocks (source of deer released in Hawai'i).

BANKO, P. C., and D. A. MANUWAL
1982. "Life History, Ecology, and Management of Nene (*Branta sandvicensis*) in Hawaii Volcanoes and Haleakala National Parks." National Park Service Cooperative Park Studies Unit, Univ. Washington. CPSU/UW 82–3. 153 pp., mimeo.
Attention is called especially to evidence presented on egg predation by the mongoose.

BANKO, W. E.
1981. "History of Endemic Hawaiian Birds. Part I, Population Histories—Species Accounts." Univ. of Hawaii, Dept. of Botany, Honolulu. 253 pp., mimeo.
Example of reports of the Cooperative National Park Resources Study Unit of the National Park Service and University of Hawaii. More than 50 such papers, technical reports and proceedings have been issued by CPSU/UH in the period 1977–1983.

BANKO, W. E., and N. WILSON
1968. "Notes on the Mammals of Kipahulu Valley, Maui, Hawaii." *'Elepaio* 29:29–31.
The goat, pig, mongoose, roof rat, Polynesian rat, and the house mouse were found. Brief basic data were collected on numbers and elevational distribution. Extracted from R. E. Warner (editor), 1967.

BANKS, REBECCA
1953. "Kailua Bats among World Rarities." *Hilo Tribune-Herald*, February 22, p. 1.
Notes winter occurrence of *Lasiurus cinereus* at Kailua Bay, Hawai'i. About seven were seen in the evenings, foraging over the water.

BARHAM, E. G., W. K. TOGUCHI, and S. B. REILLY
1977. "Porpoise Rescue Methods in the Yellowfin Purse Seine Fishery and the Importance of Medina Panel Mesh Size." *Marine Fish. Rev.* 39(5):1–10.
Describes development and improvement of methods for release of dolphins. Photos show the "backdown" process. All but one of 300 dolphins were released uninjured in one test described. Smaller mesh size was installed after tests for dolphin entanglement.

BARNES, A. M.
1982. "Surveillance and Control of Bubonic Plague in the United States." *Symp. Zool. Soc. London* 50:237–270.
Includes review of disappearance of plague in Hawai'i about 1960, and problems associated with its diagnosis in animal reservoirs.

BARNES, L. G., D. P. DOMNING, and C. E. RAY
1985. "Status of Studies on Fossil Marine Mammals." *Marine Mammal Science* 1:15–53.

Reflects latest advances in research on all forms. For the whales and dolphins a revised phylogeny and classification is presented, which may change some earlier views.

BARNETT, S. A.

1963. *The Rat: A Study in Behaviour.* Chicago: Aldine Pub. Co. 288 pp.

A presentation of principles of ethology, using *Rattus norvegicus*, and to some extent, *R. rattus*, as subjects. Psychological, biological, and physiological approaches are combined. 344 references.

1973. "Rats as Animals." *Australian Natural History* 17:360–363.

A brief summary of the adaptation of commensal rats, as species, to man and to one another.

BARNUM, C. C.

1930. "Rat Control in Hawaii." *Hawaiian Planters' Rec.* 34:421–443.

General review of previous work in Hawai'i and elsewhere, and results of eight-month study on Kaua'i. Considers *Rattus exulans* as practically extinct on the main islands. Refers to plague in Hāmākua District on Hawai'i (pp. 422–423).

BARRETT, R. H.

1978. "The Feral Hog on the Dye Creek Ranch, California." *Hilgardia* 46:283–355.

Comprehensive four-year study of pigs in wooded ranch lands. Ecology and management are emphasized.

BARRETT, R. H., and D. S. PINE

1980. "History and Status of Wild Pigs, *Sus scrofa*, in San Benito County, California." *California Fish and Game* 67:105–117.

Pig is primarily a pest but also a significant game species, occupying over 54 percent of the county, largely in woodlands.

BARTHOLOMEW, G. A.

1952. "Reproductive and Social Behavior of the Northern Elephant Seal." *Univ. California Pub. Zool.* 47:369–472.

A basic work on subject species, 20 photographic plates.

BARTLETT, S.

1958. "Whales and Divers Romp." *Honolulu Star-Bulletin*, February 19, p. 1.

A humpback whale estimated at 40 feet long, and a calf, from a pod of six whales, were pursued by three skin divers in a 15-foot boat on February 16 near Mokolea Islet, O'ahu. When the whales stopped for a time the men entered the water near them.

BARTON, C.

1977. "The Navy's Natural Divers: United States Navy Marine Mammal Training Program." *Oceans* 10:34–39.

Popular account of the use of dolphins in undersea recovery of lost oceanographic gear.

BATESON, G.

1966. "Problems in Cetacean and Other Mammalian Communication." *In*: K. S. Norris (editor), *Whales, Dolphins and Porpoises*, pp. 569–579. Berkeley: Univ. California Press. 789 pp.

Draws inferences from observation, of canids especially, on how to study communication in dolphins. Notes importance of differences wrought in cetaceans as aquatic mammals.

1974. "Observations of a Cetacean Community." *In*: Joan McIntyre (editor), *Mind in the Waters*, pp. 146–165. New York: Scribner. 240 pp.

Applies a lifetime of experience in the study of animal behavior to the new science of understanding dolphins. Reports on research at Sea Life Park, Hawai'i.

BEAUCHAMP, G. K., W. W. JACOBS, and E. H. HESS
1971. "Male Sexual Behavior in a Colony of Domestic Guinea Pigs." *Bull. Ecological Soc. America* 52:23.
Abstract of paper delivered at annual meeting. Traces role of male in courtship of female through the breeding cycle.

BECCARI, O., and J. F. ROCK
1921. "A Monographic Study of the Genus *Pritchardia*." *B. P. Bishop Memoirs* 8(1):1–77 + 24 Plates.
Authors note, pp. 7, 17, that mongoose, rats, and pigs were depleting native *loulu* trees by consuming fruits and hence hindering reproduction.

BECK, A. M.
1973. *The Ecology of Stray Dogs: A Study of Free-ranging Urban Animals*. Baltimore: York Press. 96 pp.
Although a study of dogs in a city environment, it has some implications for management of stray or feral animals in rural and wilderness regions. Reviewed by Devra Kleiman, *J. Mammalogy* 55:250–251 (1974).

BEDDINGTON, J. R., and R. M. MAY
1982. "The Harvesting of Interacting Species in a Natural Ecosystem." *American Scientist* 70:62–69.
Deals with population dynamics as related to commercial whaling, relating all to primary producers and the basic krill which supports eight species of baleen whales. Food chains and long-term population changes are depicted.

BELWOOD, JACQUELINE J., and J. H. FULLARD
1984. "Echolocation and Foraging Behaviour in the Hawaiian Hoary Bat, *Lasiurus cinereus semotus*." *Canadian J. Zool.* 62:2113–2120.
An instrumented inquiry into the nature of feeding habits and related social behavior among bats feeding on insects attracted to floodlights. Moths were consumed in abundance even though flies were by far the most available prey. Light rains did not impede food gathering.

BENHAM, B.
1971. "Kona Report: There are Wild Pigs with Communicable Diseases." *Hawaii Tribune-Herald*, July 4, pp. 2, 17.
Notes that tests of a year earlier were initial indicators of brucellosis. A handout sheet was being distributed to hunters as a warning of infected areas and how to avoid the disease.

BENIRSCHKE, K., R. J. LOW, MARGARET M. SULLIVAN, and R. M. CARTER
1964. "Chromosome Study of an Alleged Fertile Mare Mule." *J. Heredity* 55:31–38.
Reviews subject of sterility in mules. No proved case of fertility is on record, but occasional females are declared fertile. Horse has diploid chromosome number of 64, donkey 62; hybrids have 63 elements. Animal in question was a donkey. 23 references.

BENIRSCHKE, K., N. MALOUF, R. J. LOW, and H. HECK
1965. "Chromosome Complement: Differences between *Equus caballus* and *Equus przewalskii* Poliakoff." *Science* 148:382–383.
Diploid chromosome number in each of four Przewalski horses was 66, compared to 64 in the domestic horse. These two species are interfertile, and this study suggests possible intermixing of *E. caballus* genes in surviving captive stocks of *E. przewalskii* long before their capture.

BENSON, B.
1972. "Lawsuit Looms in Deer Issue Here." *Honolulu Advertiser*, March 2, p. C-4.

The state was noted as being required to file an EIS on the proposal for transfer of axis deer to the island of Hawai'i. A letter to the governor from a staff member of the Smithsonian Institution suggested that the state might be subject to lawsuit if no EIS were filed, in the event deer were shipped.

1976. "Between 'Devil,' Deep Blue Sea." *Honolulu Advertiser*, July 24, p. A-3.

Report of voyage of *Greenpeace VII*, which encountered a Russian whaling fleet of 10 ships at work 800 miles northeast of Honolulu on July 19. Greenpeace Foundation, a Canadian organization, was reported as having 3,000 supporters.

BERGER, A. J.

1972. *Hawaiian Birdlife*. Honolulu: Univ. Press of Hawaii. 270 pp. (Revised edition, 1981.)

Definitive work on the birds of Hawai'i, including strongly stated pleas for the protection and conservation of native species through habitat preservation.

BERGIN, MRS. W. C. (MARTHA N.)

1945. "Bubonic Plague in Hawaii—1899–1900." *Paradise Pacific* 57(3):28–29.

Describes first diagnosis of plague in Honolulu, about December 8, 1899, and early suppressive measures resulting in the "Big Fire" which destroyed the Chinese quarter on January 20, 1900.

BERNICE P. BISHOP MUSEUM

1925. *Diary of Andrew Bloxam, Naturalist of the "Blonde," on Her Trip from England to the Hawaiian Islands, 1824–25*. B. P. Bishop Mus. Spec. Pub. 10. 96 pp.

Excellent narrative of local travels on O'ahu and Hawai'i. References to mammals are scattered but include prominently the donkey (pp. 14, 30), rabbit (p. 44), and cattle (p. 52).

1964a. *Dictionary Catalog of the Library of the Bishop Museum, Honolulu, Hawaii*. Vols. 1–9. Boston: G. K. Hall & Co.

Photographic reproduction of the entire card catalog, exclusive of serials. Preface by Margaret Titcomb sketches establishment and growth of the Museum and its Library.

1964b. "Report of the Puako Petroglyph Field in the Proposed State Historic Petroglyph Park, Puako, South Kohala." Department of Anthropology, Honolulu. 23 pp., 4 figs., 5 pls., mimeo.

Meaning of the petroglyphs (pp. 14–18) indicates a principal relationship to travelers along the shore of the island, to visitors from other islands, and some indication of numbers, activity, and occupation of such persons.

1967a. *A Catalog of Publications*. Honolulu: Bishop Museum Press. 31 pp.

A listing of individual publications in various series, and miscellany, issued from 1892 to 1967, with prices and notations of those out of print.

1967b. *Occasional Papers*. Honolulu: Bishop Museum Press. 20 pp.

Complements item 1967a and completes the listing of publications offered by the Bishop Museum, through Vol. 23 of the *Occasional Papers* series.

BERRY, R. J.

1964. "The Evolution of a Population of the House Mouse." *Evolution* 18:468–483.

A study of mice on Skokolm Island, off Scotland. After 70 years the population differs from mainland forms in skeletal characteristics and over-all size, in part because of limited genetic material in the founder members.

BERRY, R. J., and W. B. JACKSON

1979. "House Mice on Eniwetak Atoll." *J. Mammalogy* 60:222–225.

Compares body size, organ weights, and blood characteristics of *Mus domesticus* from several widely separated islands of the world, including population at Pa'auilo, Hawai'i.

BERRY, R. J., R. D. SAGE, W. Z. LIDICKER, and W. B. JACKSON

1981. "Genetical Variation in Three Pacific House Mouse (*Mus musculus*) Populations." *J. Zool.* 193:391–404.

Compares sample taken near Pa'auilo, Hawai'i, with other island stocks of the world. Concludes that the three Pacific stocks examined are derivatives of western European populations.

BESHARSE, J. C.

1971. "Maturity and Sexual Dimorphism in the Skull, Mandibles, and Teeth of the Beaked Whale, *Mesoplodon densirostris*." *J. Mammalogy* 52:297–315.

Of 19 specimens known to science only one is an adult female, taken at Midway Islands. This is compared with a subadult female from the same locality. Bibliography of 31 entries.

BEST, E.

1898. "The Kiore Maori, or Native Rat." *J. Polynesian Soc.* 7:47.

Briefly recounts stories, perhaps more properly, legends, of how *Rattus exulans* in New Zealand, in former times would take to the lakes or sea in great numbers, until drowned, in the manner of the lemming.

BEST, L. W.

1969. "Food of the Roof-rat, *Rattus rattus rattus* (L), in two Forest Areas of New Zealand." *New Zealand J. Science* 12:258–267.

Foods consisted of arthropods, berries, and seeds. Birds were not an important food. Seasonal variation in the use of foods was related to their abundance in the field.

1973. "Breeding Season and Fertility of the Roof Rat, *Rattus rattus rattus*, in Two Forest Areas of New Zealand." *New Zealand J. Science* 16:161–170.

Notes that the breeding seasons of rats are shortened with increase of latitude. Spring and summer peaks occur, with no midwinter breeding, at 41° and 43° S.

BETTESWORTH, J. D.

1972. "*Rattus exulans* on Red Mercury Island." *Tane* 18:117–118.

Flesh and down of gray-faced petrel chicks and fragments of one skink suggest predation on these native vertebrates.

BHARDWAJ, D., and J. A. KAHN

1978. "Sugar Preferences of 'Black Rats,' *Rattus rattus* L." *Zool. J. Linn. Soc.* 64:41–50.

Preference tests indicate slight differences among rats in tastes for various common sugars, in laboratory and in commensal warehouse colony.

BIANCHI, F. A.

1961. "The Rat Population of the Hawaiian Sugar Cane Fields." *Abstracts Symposium Pap., Tenth Pacific Sci. Cong.* (Honolulu), p. 209.

Presents distributional and behavioral data on the several rats important in cane culture; suggests that research be applied to rat ecology in order to promote more efficient control.

BICKEL, V. R.

1965. "Rats Enter Toilet through Unused Sewer Connections." *California Vector Views* 12:71.

After *Rattus norvegicus* was repeatedly found swimming in toilet bowls of two Yuba City residences, an open spur line of the sewer system was found and plugged, eliminating the problem.

BIRD, ISABELLA L.

1964. *Six Months in the Sandwich Islands.* Honolulu: Univ. Hawaii Press. 278 pp.

A series of 31 letters written during and between horse-back tours to primitive and remote regions of Hawai'i in 1873, by a cultured and supposedly invalid Englishwoman who sometimes

traveled alone. A reissue of the 1875 first edition. Many pertinent photographs are included. Excellent descriptive material with notes on mammals, horses in particular.

BLACKMAN, L. G.
1904. "Introduction of Bats." *Hawaiian Forester and Agriculturist* 1:115–117.
Letter encouraging the possible introduction of bats; gives discourse on habits, diversity, and anticipated value of bats in insect control. Suggests the matter be considered by those competent to judge.

BLACKMAN, T. M.
1941. "Rarest Seal." *Natural History* 47:138–139.
Historical notes on the species and observations on four Hawaiian monk seals at Eastern Island, Midway, in 1939–1940. Three photos.

BLAKE, J. G., C. L. DOUGLAS, and LINDA F. THOMPSON
1981. "Spatial Variation in Transferrin Allele Frequencies among Herds of Feral Donkeys in Death Valley National Monument, California." *J. Mammalogy* 62:58–63.
Studies of blood sera show that herds have distinctive gene frequencies because of isolation during the breeding season even though there is overlap and intermingling at other times.

BLANFORD, W. T.
1891. *The Fauna of British India: Mammalia.* London: Taylor and Francis. 617 pp.
Comprehensive early work; contains basic data on Old World species now found in Hawai'i.

BLUMENSTOCK. D. I.
1961. *Climates of the States: Hawaii.* Washington, D.C.: U.S. Dept. Commerce, Weather Bureau. 20 pp. (Revised edition, 1967.)
Describes general features of islands in the State of Hawaii, and detailed features of the climate. Summaries of climatic data are presented. Maps, tables.

BODKIN, J. L., R. J. JAMESON, and G. R. VAN BLARICOM
1985. "Pup Production, Abundance, and Breeding Distribution of Northern Elephant Seals on San Nicolas Island, Winter, 1981." *California Fish and Game* 71:53–59.
The colony continues to grow exponentially. Many beaches apparently good for pupping remain unused.

BOGAN, M. A.
1972. "Observation on Parturition and Development in the Hoary Bat, *Lasiurus cinereus*." *J. Mammalogy* 53:611–614.
Pregnant female captured in northward spring migration, in New Mexico, readily adapted to caging and hand feeding. Mealworms and water were taken. Young bats remained constantly attached to the mother, even during exercise flights, until the age of six or seven days.

BONNET, D. D., and B. GROSS
1953. "Susceptibility of *Rattus hawaiiensis* Stone to Warfarin." *Science* 118:44–45.
Found warfarin more toxic to *R. norvegicus* than to *R. hawaiiensis* (= *exulans*), and more toxic to members of the latter species not conditioned to its use.

BONNET, D. D., E. S. C. MAU, and B. GROSS
1951. "Cage Tests with Warfarin on the Hawaiian Rat, *Rattus hawaiiensis* Stone, and on the House Mouse, *Mus musculus* Linn., in Hawaii." *Public Health Rep.* 66:1734–1737.
Mean day of death for *R. hawaiiensis* (= *exulans*) was slightly greater at 7.9 days than in other rats previously tested. For *Mus* it was 8.6 days.

BORLAND, R.
1964. "The Chromosomes of Domestic Sheep." *J. Heredity* 55:61–64.
Established diploid chromosome number as 54, from examination of 40 sheep of various breeds, by bone-marrow cell technique. Cites references to mouflon-sheep, and goat-sheep hybrids.

BOYD, J. M., J. M. DONEY, R. G. GUNN, and P. A. JEWELL
1964. "The Soay Sheep of the Island of Hirta, St. Kilda. A Study of a Feral Population." *Proc. Zoological Soc. London* 142:129–164.
Ecological and biological studies of a primitive domestic breed isolated since 1930 on a 1,500-acre island off Scotland. Low survival of yearlings seems to stabilize the population level.

BRAND, N.
1964. "Axis Deer." *Hilo Tribune-Herald*, January 17, p. 4.
Letter to the Editor reviewing proposal for introduction of deer to Hawai'i Island. Considers possible esthetic, recreational, and economic benefit from axis deer of dubious value when weighed against an admittedly small threat to the economy of the cattle industry.

BRANSON, J.
1971. "Killer Whales Pursue Sea Lions in Bering Sea Drama." *Commercial Fish. Rev.* 33:39–40.
A pod of seven killer whales harassed a group of about 20 sea lions (*Eumentopias jubata*) for more than an hour near a Soviet trawler hauling net. The whales maintained the advantage, tiring the sea lions.

BREESE, P. L.
1959. "Hawaiian Wildlife Is Full of Surprises." *Honolulu Advertiser*, June 23, Statehood ed., Sec. 7, p. 24.
Includes a popular and authentic review of the few native, and several introduced, mammals in Hawai'i.

BREIWICK, J. M, and H. W. BRAHAM (Editors)
1984. "The Status of Endangered Whales: an Overview." *Marine Fish. Rev.* 46:1–64.
Treats the eight species of rare great whales, five of which (blue, fin, humpback, right, and sperm) are on the Hawai'i faunal list. Detailed, up-to-date, worldwide. Others are the bowhead, gray, and sei, not found in Hawai'i.

BRENNAN, J.
1974. *The Parker Ranch of Hawaii: The Saga of a Ranch and a Dynasty*. New York: John Day. 220 pp.
An appropriate historical record of cattle ranching in the Parker/Smart family, from 1809, prefaced by historical sketches back to 1758.

BREUMMER, F.
1983. "Sea Lion Shenanigans." *Natural History* 97(7):32–41.
Neophoca hookeri (Gray) 1844 is a rare subantarctic species. On Enderby Island, 300 miles south of New Zealand, 10 percent of pups die each year by crawling into burrows of rabbits, where they lodge and suffocate. Other hazards are indicated. Photos.

BROCK, R.
1963. "Mauna Kea Hillclimb." *Hot Rod* 16(April):48–51, 106, 108.
Describes early failures, and final conquest of Mauna Kea by an automobile on January 30, 1963. Driver, Jimmie Pfleuger, used a Willys Jeep powered by a Chevrolet Corvette engine and equipped with modified Firestone Duplex tires. Seven photos.

BRONSON, F. H.

1984. "The Adaptability of the House Mouse." *Scientific American* 250(3):116–125.

Mus domesticus has a uniquely flexible reproductive potential. Dietary, physical and social controls are major factors aiding successful penetration and occupancy of a spectrum of habitats, worldwide.

BROOKS, J. E., and A. M. BARNES

1972. "An Outbreak and Decline of Norway Rat Populations in California Rice Fields." *California Vector Views* 19(2):5–14.

Abnormal conditions of food abundance (rice) associated with an outbreak during fall and winter. Fertility was low in following breeding season.

BROOKS, J. E., and T. H. PE

1980. "Early Post-natal Growth and Behavioral Development in the Burmese House Rat, *Rattus exulans*." *J. Zool.* 190:125–136.

Neonatal (0–4 days), transitional (5–14 days), and socialization (15–22 days) periods are described for litters produced by wild-caught females. Patterns indicate conservatism rather than specialization, which is of advantage and may account for success of the rat as a Pacific island colonizer.

BROOKSHIER, F. A.

1945. "On the Burro Trail in Hawaii." *Paradise Pacific* 57(12):17–20.

Well-rounded authentic account of history and status of the donkey in Hawai'i. Four photos, and linoleum block print by the author.

BROWER, K.

1980. *Wake of the Whale.* San Francisco: Friends of the Earth. 160 pp.

Records of close encounters with cetaceans and other marine life in oceans of the world, with particular emphasis on Hawai'i. Conservation oriented, reviewing the problems of international threats to whale and dolphin populations. Photography by Chris Curtsinger. Large, coffee table format.

1985. "The Pig War." *Atlantic Monthly* 256:44–47, 50–58. August.

Popular, authentic, on-the-scene report on the effects of the feral pig on vegetation of Hawaii Volcanoes National Park, and means of eradication chiefly by tracking with dogs.

BROWN, D. H., D. K. CALDWELL, and MELBA C. CALDWELL

1966. "Observations on the Behavior of Wild and Captive False Killer Whales, with Notes on Associated Behavior of Other Genera of Captive Delphinids." *Los Angeles County Museum Contrib. Sci.* 95. 32 pp.

Includes Hawai'i data on *Pseudorca*, *Tursiops*, and *Stenella*. Reveals much about the character of these and other forms of cetaceans. Comprehensive bibliography.

BROWN, W. Y.

1973. "The Breeding Biology of Sooty Tern and Brown Noddys on Manana or Rabbit Island, Oahu, Hawaii." Ph. D. dissertation, Univ. Hawaii, Honolulu. 233 pp.

Notes minor interactions with the resident feral rabbit. See Brown, 1974.

1974. "Rabbit Destruction of Tern Eggs." *Auk* 91:840–841.

From studies on Mānana Island, Hawai'i. One rabbit charged an incubating bird, knocked it off the nest, then pushed the egg downslope with its nose. Three other examples of egg-rolling are recorded.

BROWNSLOW, A. L.

1940. "The Crab-Eating Mongoose *Herpestes urva* (Hodgs.) in Captivity." *J. Bombay Natural History Soc.* 41:893–894.

Describes habit of mongoose seizing a stone or golf ball in the forepaws, rising, and crashing the object downward and backward, jumping so as to clear the hind legs. The object is thus flung far behind.

BRYAN, E. H., JR.

1931. "Kahoolawe, the Island of Dust." *Proc. Hawaiian Acad. Sci., Sixth Annual Meeting.* B. P. Bishop Mus. Spec. Pub. 19, pp. 13–14.

Descriptive sketch and historical aspects of the island. Reclamation from sheep and goats began in 1910 when the island was proclaimed forest reserve, but failed, and the area was withdrawn in 1918. It was then leased as a cattle ranch and remained in that status in 1931, having sheep, goats, 100 or more cattle and horses, dogs, cats, five adult humans and four children.

1932. "Kahoolawe Field Trip." *In: Report of the Director for 1931.* B. P. Bishop Mus. Bull. 94, pp. 26–27.

Mammals noted during February 12–20, 1931: a mouse, domestic cattle, horse, a mule, sheep, goats, dogs, and cats; nine human beings.

1936. "Hawaiian Natural History Made Popular." *Paradise Pacific* 48(3):20–23.

Brief discussion of achievements in study of physical and biological phenomena in Hawai'i, and a list of major works on these subjects. Under titles of Geology, Native Plants, Ornamental Plants, and Zoology. 38 annotated references are listed.

1938a. "Kaula: An Island of Hawaii." *Paradise Pacific* 50(4):27, 38–39.

Summary of historic, geographic, and biological aspects of the island. On page 39, "The lighthouse personnel have also captured a rat and a mouse."

1938b. "The Much Maligned Mongoose." *Paradise Pacific* 50(4):32–34.

Good historical summary of the introduction and biological relations of this species in Hawai'i; partly documented.

1938c. *Ancient Hawaiian Life.* Honolulu: Advertiser Publ. Co. 113 pp.

Index lists references to the dog, pig, rat, and to whaling. Author suggests that the Hawaiian rat (=*Rattus exulans*) (p. 21) may not have been a significant household pest in early Hawaiian culture.

1939. Review of *Animals of Hawaii. Paradise Pacific* 51(2):25.

A favorable review of Tinker (1938). Notes scarcity of references, and comments "An annotated bibliography . . . would have been a great help."

1942. *American Polynesia and the Hawaiian Chain.* Honolulu: Tongg. 253 pp.

Geographical and historical treatment of numerous Pacific islands; pages 154–207 cover Northwestern Hawaiian Islands from Ka'ula to Kure. Maps, photos, and 22-page bibliography are included. References to mammals are scattered, but indexed, and narrate in excellent style substantial data on mammals among the various islands. Discusses (p. 191) proper spelling of Lisianski (Island).

1954. *The Hawaiian Chain.* Honolulu: Bishop Museum Press. 71 pp.

Geographical account of the entire series of the Hawaiian islands. Origin, history, flora, and fauna are treated. "Hawaii from the Air" (pp. 30–68) delightfully describes prominent features of the islands as seen from aircraft. Many excellent photos and maps; bibliography.

1955. "The Hawaiian Bat." *'Elepaio* 15:63–64.

Summary of behavioral and distributional information is given, as are specific observations of William H. Meinecke. Lists several records of occurrence 1891 to 1955.

1961. "The Pacific Scientific Information Center." *Abstracts Symposium Pap., Tenth Pacific Sci. Cong.* (Honolulu), p. 463.

Center was established at Bishop Museum, Honolulu, Hawai'i, in 1960. Objectives are spelled out, and current services are listed. Assistance in gathering data and materials is solicited.

1963. "'Bat-watchers' Asked to Help." *Sunday Star-Bulletin and Advertiser,* Honolulu, December 29, p. B-12.

Condensed report (see Anon., 1963c) encouraging research on ecology of the bat in Hawai'i, with additional comments.

1964. *Bryan's Sectional Maps of Honolulu and the Hawaiian Islands.* Honolulu: South Seas Sales. 77 pp.

Profile and map of the Hawaiian Chain, index to streets on O'ahu with 45 area maps, and maps of seven main islands showing principal roads, towns, and other features. Updated frequently.

BRYAN, E. H., JR., and collaborators

1926. *Insects of Hawaii, Johnston Island and Wake Island.* B. P. Bishop Mus. Bull. 31. 94 pp. (Tanager Expedition Pub. No. 3.)

Includes an extensive report on the insect fauna of the Northwestern Hawaiian Islands, with additional observations of general ecological significance.

BRYAN, E. H., JR., C. K. WENTWORTH, AMY GREENWELL, MARIE C. NEAL, AMY SUEHIRO, and ALISON KAY

1957. "The Natural and Cultural History of Honaunau, Kona, Hawaii." B. P. Bishop Mus., Honolulu. 149 pp., mimeo.

Small mammals are briefly reviewed (pp. 112–115) by Bryan. Information is generally good but names are out of date.

BRYAN, J. A.

1964a. "Scot's Death Isle's Biggest Mystery." *Hawaii Tribune-Herald,* July 12, p. 5.

Reviews on its 130th anniversary, the unexplained death of David Douglas. Photo shows monument and tablet erected at site of the cattle trap where the body was found, in the forest above Laupāhoehoe.

1964b. "Pele's Phantom Dog Returns." *Sunday Star-Bulletin and Advertiser,* November 10, p. 1.

After four days of snowfall on Mauna Loa and an absence of some months, the white dog was again in residence at the observatory, taking shelter in an old packing crate. It accepted food left nearby. Tracks in the snow suggested that the dog had come down from a higher elevation. One photo.

BRYAN, L. W.

1927. "The Mauna Kea Forest Reserve." *Paradise Pacific* 40(12):105–106.

Summary of early work in this area and an estimate of its potential. Wild goats (p. 105) had just come over in 1925 from Mauna Loa, where there had been a drought.

1930. "Hawaii's Wild Goat Problem." *Paradise Pacific* 43(12):77–78.

Historical sketch of introduction and spread of goats in Hawai'i. Estimates 75,000 as current population on Hawai'i, only large island where they were out of control. Discusses control measures by drives and shooting, and philosophy of control. One photo.

1933. "Forest Trails of Hawaii." *Paradise Pacific* 46(12):35–37.

Describes trips into rugged areas on Hawai'i, such as Waimanu Valley, Kohala Ditch Trail (see Fig. 1), Mauna Kea Summit, and Hualālai. States rules for travel into forest reserves.

1934. "Kaluakauka." *Paradise Pacific* 46(12):28–30.

Kaluakauka means "the doctor's pit." Account of the dedication, on July 12, 1934, the 100th anniversary of the death of David Douglas, of a plaque and monument at the site of his death in a cattle pit in the upper lands of Laupāhoehoe, on Hawai'i. Three photos.

1935. "Emergency Conservation Work. Associate Forester's Narrative Report, Island of Hawaii for October, November and December, 1934." *Hawaiian Planters' Rec.* 39:155–162.

On page 159 author underscores urgent need for elimination of wild sheep and goats from

Mauna Kea Forest Reserve to prevent total loss of *māmane* forest. Control was by shooting, but poisoning was being considered.

1937a. "Wild Sheep in Hawaii." *Paradise Pacific* 49(3):19, 31.

Estimates the current Mauna Kea Forest Reserve feral sheep population at 40,000, and reviews program of eradication. Describes drive in which 3,000 sheep were corralled in six hours by more than 30 riders; slaughter took two days. Two photos.

1937b. "Wild Cattle in Hawaii." *Paradise Pacific* 49(9):9, 30.

Brief history of feral cattle on Hawai'i; description, range, and hunting anecdotes. Three photos.

1937c. "Wild Pigs in Hawaii." *Paradise Pacific* 49(12):31–32.

Popular history of pigs in Hawai'i. Hunting pigs with dogs is described. Control by Civilian Conservation Corps is considered; notes on economic relations. Three photos.

1939. "New Forest Fence on Big Island." *Paradise Pacific* 51(5):25, 32.

Describes construction of 17.5-mile Ka'ū Forest Reserve fence (on Mauna Loa at 5,000 to 6,000 feet elevation). Work done by Civilian Conservation Corps.

1947. "Twenty-five Years of Forestry Work on the Island of Hawaii." *Hawaiian Planters' Rec.* 51:1–80.

Excellent summary of the rehabilitation of forest reserve watersheds. On pages 4–6: from 1921 to 1946, 29,831 pigs, 134,551 goats, 71,468 sheep, 738 cattle, 18 horses, 65 dogs, and 357 donkeys were eliminated from fenced forest areas—a total of 237,028 feral animals, averaging over 10,000 per year.

1950. "Wild Sheep on Mauna Kea Forest Reserve." *Paradise Pacific* 62(12):112–113, 122.

Brief history of sheep on Mauna Kea, but chief concern is that sheep, by 1950, had declined to fewer than 500. Air count revealed only 171, largely old rams. Predation by dogs and hunting were considered significant as decimating factors. Four photos.

BRYAN, W. A.

1908. "Some Birds of Molokai." *B. P. Bishop Mus. Occ. Pap.* 4:133–176.

Reports (pp. 48, 49, 51) six examples of the dark-rumped petrel (*Pterodroma phaeopygia*), apparently killed by mongooses, at their nesting grounds on rugged inland cliffs of Moloka'i. Attributes decline in numbers of birds to such predation. Describes also (p. 55) a successful attack of a mongoose on a black-crowned night-heron (*Nycticorax nycticorax*).

1911. "Laysan Island: A Visit to Hawaii's Bird Reservation." *Mid-Pacific Mag.* 2:303–315.

Colorful description of the origin, esthetics, and scientific value of the Hawaiian Islands Bird Reservation, with particular attention to Laysan. Describes effects of rabbits on vegetation and warns of the danger of their continued presence. Compares conditions on two visits, in 1903 and 1911.

1915. *Natural History of Hawaii.* Honolulu: Hawaiian Gazette. 596 pp.

An over-all source on the people, geology, geography, botany, and zoology of Hawai'i. Brief general accounts of land mammals (pp. 291–296) and of cetaceans (pp. 300–304). These are laudable as early summaries, but specific documentation is infrequent.

BRYDEN, M. M., W. H. DAWBIN, G. E. HEINSOHN, and D. H. BROWN

1977. "Melon-headed Whale, *Peponocephala electra*, on the East Coast of Australia." *J. Mammalogy* 58:180–187.

Three strandings are reported. Skull of one specimen was obtained, and full body measurements and other data from two others. Extensive table of measurements is given for the three skulls.

BRYDEN, M. M., R. J. HARRISON, and R. J. LEAR

1977. "Some Aspects of the Biology of *Peponocephala electra* (Cetacea: Delphinidae). I.

General and Reproductive Biology." *Australian J. Marine Freshwater Res.* 28:703–715.

Reviews brief literature on this species and records stranding of 53 in Australia at 27°S. Following paper, II (pp. 717–722), reports three nematodes and one cestode from same stranded animals.

BUCK, P. H. (TE RANGI HIROA)

1957. *Arts and Crafts of Hawaii.* B. P. Bishop Mus. Spec. Pub. 45. (Reprinted 1964.)

This substantial research work gives summary (pp. 2–3) of mammals in ancient Hawaiian culture; many other indexed references. Pig, dog, rat, and sperm whale figure prominently; passing mention of bat and additional sea mammals.

BUECHNER, H. K.

1950. "Life History, Ecology, and Range Use of the Pronghorn Antelope in Trans-Pecos, Texas." *American Midland Naturalist* 43:257–354.

Excellent report derived from observation and field study of a wild population.

BULL, P. C.

1981. "The Consequences for Wildlife of Expanding New Zealand's Forest Industry." *New Zealand J. Forestry* 26:210–231.

An important document relating various practices of timber and pulp production to needs especially of native birds. Further replacement of native forest with exotics is a questionable procedure for which only partial amelioration is possible.

BUNNELL, F. L., and A. S. HARESTAD

1983. "Dispersal and Dispersion of Black-tailed Deer: Models and Observations." *J. Mammalogy* 64:201–209.

Two patterns, of "non-dispersers" and "dispersers," were noted. Movements greater than 12 km were rare, and generally by males, at one to two years.

BURTON, R.

1980. *The Life and Death of Whales.* New York: Universe Books. 185 pp.

Draws together a sample of the immense stock of information about whales. Traces the history of regulation from early incidents to the first law preventing the killing of whales, in 1904; to the International Whaling Agreement of 1937, establishment of the International Whaling Commission in 1946, and its shortcomings to date.

BUSNEL, R.-G.

1973. "Symbiotic Relationship between Man and Dolphins." *Trans. New York Acad. Science* (Ser. II) 35:112–131.

Author quotes the statement of Pliny the Elder (A.D. 32–79) concerning the cooperation of man and wild dolphins in net fishing of mullets near Lattes, France, and confirms the practice as still carried on (about 1970) in Mauritania on the west coast of Africa.

BUTLER, G. D., JR., and M. D. F. UDVARDY

1966. "Basking Behavior of the Hawaiian Monk Seal on Laysan Island." *J. Wildlife Mgmt.* 30:627–628.

In July, flies, mainly *Musca domestica*, drove most seals from the vegetation to the water's edge soon after daylight. The seals went to sea or returned inland in the evening.

BUXBAUM, KAREN

1973. "Status of Dark-rumped Petrel on Maui, 1972." *'Elepaio* 34:11–12.

Reports predation by *Rattus rattus* as minor during a program of trapping; concludes that continued existence of colonies of the bird in Haleakalā Crater will depend on control of this rat.

BYRD, G. V., and D. S. BOYNTON

1979. "The Distribution and Status of Wedge-tailed Shearwaters on Kauai." *'Elepaio* 39:129–131.

Study of 18 colonies indicates that dogs are a principal threat to nesting birds and may have eliminated some colonies in the past.

BYRD, G. V., and T. C. TELFER

1980. "Barn Owls Prey on Birds in Hawaii." *'Elepaio* 41:35–36.

Documents generally serious predation on six species of sea birds on Kaua'i and Ka'ula Island. Adult and nestling birds were taken. Presence of *Rattus exulans* is confirmed for Ka'ula Island.

CAIRNS, J., JR. (Editor)

1980. *The Recovery Process in Damaged Ecosystems.* Ann Arbor: Ann Arbor Science Publishers. 167 pp.

Analyses of how U. S. ecosystems (forest and aquatic) may be restored through natural processes. Chapter 7, by D. Mueller-Dombois, reports on die-back of *'ōhi'a* forests in Hawai'i.

CALABY, J. H.

1966. *Mammals of the Upper Richmond and Clarence Rivers, New South Wales.* C.S.I.R.O. Div. Wildlife Res. Tech. Pap. 10. 55 pp.

Local status, habitat, and habits of the brush-tailed rock-wallaby are presented (pp. 37–39). Native habitat in Australia resembles that selected in Hawai'i. One photo.

CALDWELL, D. K., and MELBA C. CALDWELL

1973. "Is It True that Dolphins Are More Intelligent than Men and More Talkative than Women?" *Underwater Naturalist* 8:14–18.

Views of serious-minded behaviorists. Consider dolphin to be about as intelligent as a good dog. Each dolphin has a distinctive "signature" whistle and can be identified by others of its kind, but they do not have a language of their own. Concludes that man/dolphin communication is unlikely to surpass man/dog communication.

CALDWELL, D. K., MELBA C. CALDWELL, and DALE W. RICE

1966. "Behavior of the Sperm Whale, *Physeter catodon* L." *In*: K. S. Norris (editor), 1966, pp. 677–717.

Extensive treatment of data from whalers' logs, and modern observations.

CALDWELL, D. K., MELBA C. CALDWELL, and C. M. WALKER, JR.

1970. "Mass and Individual Strandings of False Killer Whales, *Pseudorca crassidens*, in Florida." *J. Mammalogy* 51:634–636.

An estimated 150 to 175 animals were involved in an early January 1970 stranding. Other such records are summarized, worldwide.

CALHOUN, J. B.

1962. *Ecology and Sociology of the Norway Rat.* U. S. Public Health Service Pub. 1003. 288 pp.

Population of outdoor pen in Maryland studied for 27 months. Basic data gathered for further work on rodents and for possible application to problems of man.

CAMPBELL, C. A. R.

1913. "The Eradication of Mosquitoes by the Cultivation of Bats." *International Institute of Agriculture, Bur. Agricultural Intelligence and Plant Diseases, Monthly Bull.* 4:1175–1181.

Presents a plan for the elimination of malaria by encouraging bats to occupy roosts constructed near human population centers, premised on the belief that bats are effective agents in the control of malarial mosquitoes (in Texas).

CARLQUIST, S.

1970. *Hawaii, A Natural History.* New York: Natural History Press. 463 pp. Revised 1980 (see below).

Introductory treatise on geology, climate, native flora and fauna above the shoreline. Organized by ecological concept; profusely illustrated.

1980. *Hawaii, A Natural History.* Lāwa'i, Kaua'i: Pacific Tropical Botanical Garden. 468 pp. A revised edition of Carlquist, 1970 (paper).

1981. "Chance Dispersal." *American Scientist* 69:509–513.

Reviews the development of remote biota, with emphasis on Hawai'i, as results of transport of various kinds over long periods of time.

CARLSON, N. K.

1957. "The Last Stand of the *Koa* Trees." *Honolulu Advertiser*, June 2, Hawaiian Holiday Sec., p. 9.

Describes work of two saw mills on Kona coast of Hawai'i. Seven photos by the author, including one of a feral cow leaping over a fallen tree.

CARLSON, N. K., and L. W. BRYAN

1959. "Hawaiian Timber for the Coming Generations." Trustees of Bishop Estate, Honolulu. 111 pp.

A report on the Hōnaunau Forest, South Kona, Hawai'i. A detailed review of forestry and lumbering related largely to exotic tree species. Brief history of feral cattle (p. 17) and photo of feral cow leaping over a fallen tree (p. 33). Many other photos.

CARSON, H. L.

1970. "Chromosome Tracers of the Origin of Species." *Science* 1968:1414–1418.

A remarkable record of evolution in pomace flies (*Drosophila*) as related to the Hawaiian Islands. Speciation appears in some cases to have arisen from a single founder individual from a nearby island.

CASE, T. J.

1978. "A General Explanation for Insular Body Size Trends in Terrestrial Vertebrates." *Ecology* 59:1–18.

A thorough treatise on the many aspects of the subject matter—food, competition, time, predation, behavior.

CASEY, TONNIE L. C., and J. D. JACOBI

1974. "A New Genus and Species of Bird from the Island of Maui (Passeriformes: Drepanididae)." *B. P. Bishop Mus. Occ. Pap.* 24:215–226.

Describes as new to science the *po'o uli, Melamprosops phaeosoma*, from limited range in extremely wet forest of upland east Maui.

CAUM, E. L.

1922. "Why Do Rats Eat Cane?" *Hawaiian Planters' Rec.* 26:213–215.

Caged albino rats fed exclusively on cane were stunted in growth and did not breed. Concludes that cane is unnecessary in the diet and that various cane field insects and weeds are adequate. One theory advanced was that cane borers invade rodent-damaged cane; another was that rats gnaw cane to seek borers.

1930. "Notes on the Flora of Molokini." *B. P. Bishop Mus. Occ. Pap.* 9(1):15–18.

Reviews previous collections made in 1913 and 1925; 21 species were found. Discusses differences in composition and abundance as suggested by the two collections. Birds, but not rabbits, are mentioned.

1936. "Notes on the Flora and Fauna of Lehua and Kaula Islands." *B. P. Bishop Mus. Occ. Pap.* 11(21):1–17.

Plant cover (in 1931 and 1932) was rather extensive on both islands but subject to suppression by nesting sea birds, and on Lehua by rabbits, "overrun as the island is by rabbits." On Lehua 26 plants were collected; on Ka'ula, 15. Only 6 were common to the two islands.

CAUSEY, M. K., and C. A. CUDE
1980. "Feral Dog and White-tailed Deer Interactions in Alabama." *J. Wildlife Mgmt.* 44:481–484.

Dogs monitored by radio telemetry provided an estimate of 308 feral dogs on 24,000 hectares. Although deer were chased frequently, none was captured and killed by the dogs in a 30-month study. Dogs fed on rodents, rabbits, tortoises, carrion, and rarely on deer fawns.

CHALLIES, C. N.
1975. "Feral Pigs (*Sus scrofa*) on Auckland Island: Status and Effects on Vegetation and Nesting Sea Birds." *New Zealand J. Zool.* 2:479–490.

Pigs were introduced in 1807. By 1972–1973 they appeared to be no longer changing the island vegetation or numbers and distribution of sea birds.

CHANDLEY, A. C., R. C. JONES, H. M. MOTT, W. R. ALLEN, and R. V. SHORT
1974. "Meiosis in Interspecific Equine Hybrid I. The Male Mule (*Equus asinus* x *E. caballus*) and Hinny (*E. caballus* x *E. asinus*." *Cytogenet. Cell Genet.* 13:330–341.

Further research on the infertility of the mule and hinny, attributed to incompatible sets of chromosomes in the horse and donkey.

CHANG, J. H.
1961. "Microclimate of Sugar Cane." *Hawaiian Planters' Rec.* 56:195–225.

Report of experiments performed on Maui and O'ahu, emphasizing water relations in culture of sugar cane. Results are graphically illustrated.

1963. "The Role of Climatology in the Hawaiian Sugar-Cane Industry: An Example of Applied Agricultural Climatology in the Tropics." *Pacific Science* 17:379–397.

Summarizes studies of climate in Hawai'i and elsewhere over previous 30 years, in relation to sugar cane culture. Provides a useful guide to the climate factor for ecological field work. 57 references.

CHAPIN, E. A.
1925. "Descriptions of New Internal Parasites." *Proc. U. S. National Mus.* 68:Art. 2, 1–4.

Describes *Contracaecum turgidum* as a new species of nematode from stomach of Hawaiian monk seal. Also lists the cestode, *Diphyllobothrium hians*, presumably from the small intestine.

CHAPMAN, A.
1981. "Habitat Preference and Reproduction of Feral House Mice, *Mus musculus*, during Plague and Non-plague Situations in Western Australia." *Australian Wildlife Res.* 8:567–579.

In this region mice are adapted to remote desert localities as well as cultivated wheat lands, and reproduce seasonally. Abundant rainfall in two previous years triggered a plague of mice in the fall of 1975. Lack of shelter appeared to contribute to decline at the onset of winter.

CHRIST, J. H.
1958. *Improving Hawaiian Soil Resources.* U. S. Dept. Agriculture, Soil Conservation Service, Honolulu. 46 pp.

Survey of needs and practices in soil conservation. Describes physical features and economics of Hawaiian lands and crops. Wildlife problems are mentioned (p. 37). Many illustrations.

CHRISTOPHERSEN, E., and E. L. CAUM
1931. *Vascular Plants of the Leeward Islands, Hawaii.* B. P. Bishop Mus. Bull. 81. 41 pp., 16 plates.

Reviews briefly (pp. 9, 14) effects of rabbits on vegetation of Laysan and Lisianski. Plate VII shows barren appearance of these islands in 1923.

CHUN, S. C., and S. W. TINKER

1940. *Stories of Hawaiian Animals for Boys and Girls.* Honoulu: privately published. 69 pp.

Brief instructive texts accompany cartoon-type sketches of the common mammals. Other vertebrates are included. Based on Tinker (1938).

CHUNG, H. L.

1931. *Rabbit Raising in Hawaii.* Univ. Hawaii Agricultural Extension Service Bull. 12. 34 pp.

Farmers' bulletin on commercial rabbit raising. No references to feral populations. Earlier reference to rabbit introduction: *Polynesian*, Oct. 22, 1853 (not found), "Mr. Tanner has recently introduced from Australia . . . a pair of white rabbits."

CLABBY, J.

1976. *The Natural History of the Horse.* New York: Taplinger. 116 pp.

Emphasis on domestic breeds with chapters on evolution and behavior.

CLAPP, R. B.

1972. "The Natural History of Gardner Pinnacles, Northwestern Hawaiian Islands." *Atoll Res. Bull.* 163:1–25.

Notes records of monk seal which is of probable regular occurrence in small numbers, but does not breed there.

CLAPP, R. B., and E. KRIDLER

1977. "The Natural History of Necker Island, Northwestern Hawaiian Islands." *Atoll Res. Bull.* 206:1–102.

Records (Table 21) 13 surveys for monk seal, 1886–1973. From six to 18 were recorded on 10 of these visits.

CLAPP, R. B., E. KRIDLER, and R. R. FLEET

1977. "The Natural History of Nihoa Island, Northwestern Hawaiian Islands." *Atoll Res. Bull.* 207:1–147.

Records monk seal (Table 30) as an uncommon visitor from 1940–1973. About a dozen were seen in 1857 when Kamehameha IV visited the island.

CLAPP, R. B., and W. O. WIRTZ II

1975. "The Natural History of Lisiansky Island, Northwestern Hawaiian Islands." *Atoll Res. Bull.* 186:1–196.

Reviews introduction of European rabbit, though details are still fragmentary; notes possible records of *Mus* and *Rattus* from early shipwrecks; and (Table 46) records monk seal data for 1805–1969.

CLARK, B.

1939. "Telling the Kamaaina." *Honolulu Star-Bulletin*, April 13, p. 13.

Reports on the fate of Captain Alexander Adams' deer (= *Odocoileus*). Two were brought from North America about 1816, and both were used for food to restore health to the ailing Billy Pitt, a former advisor of Kamehameha I. (See W. F. Wilson, 1922).

CLARK, H.

1975. "Out Where the Buffalo Wallow." *Honolulu Advertiser*, February 23, p. A-3.

Status report on water buffalo in Hawai'i, noting largest herd, of seven, is at Kohala High School where the animals are kept as a Future Farmers project. John Tompkins, a former Peace Corps volunteer, is noted as the current expert on water buffalo in the state.

CLARKE, M. R.

1978. "Structure and Proportions of the Spermaceti Organ in the Sperm Whale." *J. Marine Biol. Assn. U.K.* 58:1–17.

The head of a sperm whale may exceed a third of the total weight. The spermaceti sac tissue is as much as 98.8 percent oil. Two following papers in the same issue investigate properties of spermaceti oil (pp. 19–26) and bouyancy control (pp. 27–71).

1979. "The Head of the Sperm Whale." *Scientific American* 240(1):128–141.

Suggests bouyancy function of the spermaceti organ during deep dives, from study and anatomical description, is primarily through heat exchange with water circulated in nasal passages.

CLARKE, MARIAJANE

1947. "The Humuula, Kamaaina Ship." *Paradise Pacific* 59(12):28–31.

Details of current method of shipping cattle to Honolulu, with particular attention to loading operations at Kailua, North Kona District, Hawai'i. Slings were then still used. Eight photos.

CLEVELAND, H. W. S.

1886. *Voyages of a Merchant Navigator of the Days that Are Past.* New York: Harper. 245 pp.

A compilation from the journals and letters of the author's father, Richard J. Cleveland, who sailed during the period 1792–1821. Records many observations on early Hawai'i, including the landing of the first horses, in 1803.

CLINE, M. G. (Editor)

1955. *Soil Survey of the Territory of Hawaii.* U. S. Dept. Agriculture, Soil Conservation Service, Series 1939, No. 25. 644 pp.

Part I (pp. 1–64), "The Natural and Cultural Setting of Hawaiian Soils," briefly reviews the physical features, weather, vegetation, land use, and human inhabitants.

CLUTTON-BROCK, JULIET

1977. "Man-made Dogs." *Science* 197:1340–1342.

Maintains that the wolf is ancestral to the domestic dog and develops the thesis that highly social canids are natural partners of man, who also arose as a highly social predator of other mammals.

COBLENTZ, B. E.

1976. "Functions of Scent-urination in Ungulates with Special Reference to Feral Goats (*Capra hircus* L.)." *American Naturalist* 110:549–557.

Keen insights into a formerly confused issue. Billy goats soil the pelage with urine as a ritual associated with preparation for the breeding season. Lingering odors have social significance among goats.

COE, J., and G. SOUSA

1972. "Removing Porpoise from a Tuna Purse Seine." *Marine Fish. Rev.* 34(11–12):15–19.

Describes and figures the process of "backing-down" for release of dolphins.

COHEN, M. M., and H. S. CHANDRA

1970. "The Somatic Chromosomes of the Small Indian Mongoose: Autoradiographic Analysis of an Unbalanced Translocation Heterozygote." *Cytogenetics* 9:173–185.

Notes a novel sex chromosome arrangement: Y/autosome translocation yielding $2n = 36$ in the female and $2n = 35$ in the male, with no Y chromosome discernible. Study materials were taken near Mysore, India.

COLE, L. C., and J. A. KOEPKE

1947. "A Study of Rodent Ectoparasites in Honolulu." *Public Health Rep.*, Suppl. 202, pp. 25–41.

Relates occurrence of endemic typhus in man to seasonal incidence of the rat flea, *Xenopsylla cheopis*, and the mite, *Laelaps hawaiiensis*. Other ectoparasites are considered.

COLLINS, W.

1957. "Mauna Kea—Hunter's Paradise." *Paradise Pacific* 69(7):16–19.

Describes game, habitat, and hunting of wild pigs and sheep on Mauna Kea with a polished European sportsman. Four photos.

COMAN, B. J., and H. BRUNNER

1972. "Food Habits of the Feral House Cat in Victoria." *J. Wildlife Mgmt.* 36:848–853.

Analysis of 80 stomach samples. Rabbits, rats, and phalangers comprised 88 percent by volume of total food intake. Few birds were taken. In remote bush areas cats subsisted largely on small indigenous mammals. In farming regions the introduced rabbit and house mouse were staple foods.

CONANT, P.

1972. "Mammals of Waihoi Valley, with Special Reference to Rodents." *In*: J. I. Kjargaard (editor), *Scientific Report of the Waihoi Valley Project*, Chap. 9, pp. 168–202.

Quantitative data on *Rattus rattus*, *R. exulans*, and *Mus domesticus* from Maui. The natural ecosystems at higher elevations in the valley are protected from cattle by natural barriers; pigs and goats are absent.

CONANT, SHEILA

1979. "Humpback Whale Protection." *'Elepaio* 39:85–86.

Summarizes status of the species in Hawaiian waters and reports success of Hawaii Audubon Society as an aid in achievement of favorable National Marine Fisheries policy of protection. Text of the policy is presented.

1984. "Man-made Debris and Marine Wildlife in the Northwestern Hawaiian Islands." *'Elepaio* 44:87–88.

Reviews the problem local to Hawai'i, with world bibliography.

CONDIT, R., and B. J. LE BOEUF

1984. "Feeding Habits and Feeding Grounds of the Northern Elephant Seal." *J. Mammalogy* 65:281–290.

A wide variety of foods included pelagic deep-water squid, Pacific hake, sharks, rays, and ratfish. Usual range away from the rookeries extends from northern Baja California to Vancouver Island; rarely in Hawai'i and Alaska.

CONLY, R. L.

1966. "Porpoises: Our Friends in the Sea." *National Geographic* 130(3):396–425.

A review of oceanarium communication research on various cetaceans during development of this science and the art of training these animals.

CONNOR, R. C., and K. S. NORRIS

1982. "Are Dolphins Reciprocal Altruists?" *American Naturalist* 119(March):358–374.

A philosophical presentation of a wide range of cetacean behavioral lore. Authors conclude that complex social systems exist in this group and are in only the early stages of understanding by man.

CONNOR, R. C., and RACHEL S. SMOLKER

1985. "Habituated Dolphins (*Tursiops* sp.) in Western Australia." *J. Mammalogy* 66:398–400.

Dolphins that came regularly for food over a period of some 20 years and were befriended by

local visitors and residents, were also good subjects for behavioral studies. Several dolphins were individually identified.

CONRAD, AGNES C.
1967. "The Archives of Hawaii." *J. Pacific History* 2:191–197.
Outlines the beginnings and progress in keeping of the archives in Hawai'i, and the present classifications of subject matter. Earliest document is dated 1790.

COOK, J.
1785. *A Voyage to the Pacific Ocean.* 2nd ed. Vols. 2–3. London: Hughs.
Narrates (Vol. 2, pp. 190–252) the discovery of the Hawaiian Islands in 1778, the first landing (on Kaua'i), and explorations made on this first visit to the islands. The second visit, on return from northwest America (Vol. 2, pp. 529–548; Vol. 3, pp. 1–169) was written in part by Captain King, Cook's successor. Pagination varies in the several editions.

COOKE, G. P.
1949. *Moolelo o Molokai.* Honolulu: Honolulu Star-Bulletin. 164 pp. (Title only in Hawaiian.)
Title translated would be "Story of Moloka'i." A historical account of the Molokai Ranch and its predecessor, American Sugar Company, principally during the years 1908–1949. Includes also facts and legends from earlier times.

COON, C. S.
1963. "The Rock Art of Africa." *Science* 142:1642–1645.
Reviews four new works on the subject. African rock art includes painting as well as engravings, dating from as early as 8,000 B.C. to recent times. Examples in cover photo.

COOPER, C. F., and B. S. STEWART
1983. "Demography of Northern Elephant Seals, 1911–1982." *Science* 219(4587):969–971.
Notes recolonization of California islands by young, pregnant females. Population now growing at 14 percent per year with 25,000 pups born to this species in 1982; only six in 1911.

COORAY, R. G., and D. MUELLER-DOMBOIS
1981. "Feral Pig Activity." *In*: Mueller-Dombois, Bridges, and Carson (editors), *Island Ecosystems*, 1981, Chap. 6, pp. 309–317. US/IBP Synthesis Series, 15.
Pigs, a relatively new stress factor in the Kīlauea rain forest (5,300 feet elevation), have eliminated an original ground cover by rooting the forest floor, and thus encourage establishment of resistant exotic plants. Food, however, is about 90 percent the starchy core of tree ferns (*Cibotium*).

CORBET, G. B., and J. E. HILL
1980. *A World List of Mammalian Species.* Ithaca: Comstock Publishing Associates. 226 pp.
A comprehensive list of living species of mammals. Emendations made up to October 1979. Based on Simpson (1945). Endangered species are indicated. Includes domesticated forms. Prepared at British Museum (Natural History).

CORNEY, P.
1896. *Voyages in the North Pacific.* Honolulu: Thrum. 138 pp.
Narrative of travels in merchant ships, 1811–1820, with several accounts of conditions in and about the Hawaiian Islands. Reprinted from the *London Literary Gazette* of 1821.

COTTAM, C.
1948. "The Aquatic Habits of the Norway Rat." *J. Mammalogy* 29:299.
Rats at a fish hatchery in West Virginia became conditioned to the feeding time of the fish and readily entered the water, actively swimming for food in competition with the fish.

COULTER, J. W., and C. K. CHUN
1937. *Chinese Rice Farmers in Hawaii.* Univ. Hawaii Research Pub. 16. 72 pp.
Rice industry developed rapidly in the 1870s. First oxen, then horses, and finally water buffalo, were used for tilling the paddies. Horses were trained especially for threshing.

COUSTEAU, J., and P. DIOLÉ
1975. *Dolphins: The Undersea Discoveries of Jacques-Yves Cousteau.* New York: Doubleday. 304 pp.
Popular account of dolphins and dolphin research and conservation. History of man and dolphins. Profusely illustrated.

COVACEVICH, J.
1976. "A Nest Constructed by Wild Pigs." *Victorian Naturalist* 93:25–27.
In various habitats pigs construct farrowing nests of readily available materials. A grassland nest is described and pictured.

COWAN, I. M.
1936. "Distribution and Variation in Deer (Genus *Odocoileus*) of the Pacific Coastal Region of North America." *California Fish and Game* 22:155–246.
Synonymizes *O. columbianus* of the coast with *O. hemionus* of the interior, showing north-south intergradations of Cascade-Coast Range populations, and their meeting with those of the Sierra Nevada and Great Basin primarily via the mountains of Southern California.

COWAN, I. M., and A. G. RADDI
1972. "Pelage and Molt in the Black-tailed Deer [*Odocoileus hemionus* (Rafinesque)]." *Canadian J. Zool.* 50:639–647.
Four different pelages were found: natal, juvenile, adult summer, and adult winter. Mature deer molt twice each year.

COWAN, VIRGINIA
1984. "Hawaiian Safari Exploring the Molokai Ranch Wildlife Park." *O'ahu.* August: 50, 52, 54.
Account of a tour of the project as now available to visitors. Pilipo Solatorio, guide and caretaker, figures prominently in descriptions of encounters with various wild mammals.

COX, H. J., and E. STASACK
1970. *Hawaiian Petroglyphs.* B. P. Bishop Mus. Spec. Pub. 60. 100 pp.
Report and appropriate review, with maps, from 1954–1960 surveys of the statewide sites where early pictorial artwork may be found in the rocks. Work of an archaeologist-artist team.

COX, J. E., R. H. TAYLOR, and RUTH MASON
1967. *Motunau Island, Canterbury, New Zealand: An Ecological Survey.* New Zealand Dept. Scientific and Industrial Res. Bull. 178. 112 pp.
An examination of the soils, vegetation, and vertebrate animals, and human influence on a nine-acre island, in current and historical perspective. The European rabbit was present from about 1854 to 1964.

CRAIG, R. D., and F. P. KING (Editors)
1981. *Historical Dictionary of Oceania.* Westport: Greenwood Press. 392 pp.
Emphasizes exploration, government, politics, commerce and personalities. Five appendixes.

CRAIL, T.
1981. *Apetalk and Whalespeak: The Quest for Interspecies Communication.* Los Angeles: J. P. Tarcher. 298 pp.

Reviews realm of scientific and pseudoscientific animal/man dialog. The author struggles to maintain open-mindedness—to the end.

CRITCHLOW, L.
1982. "Navy: No Damage to Kaho'olawe." *Hawaii Tribune-Herald*, May 13, pp. 1, 10.
Catchy headline reporting that few archaeological sites have been damaged by bombing, none in recent intensive exercises. Outlines program for civilian visits to the island and steps taken in rehabilitation program.

CUDDIHY, LINDA W.
1984. "Effects of Cattle Grazing on the Mountain Parkland Ecosystem, Mauna Loa, Hawaii." Botany Dept., Univ. Hawaii. CPSU/UH Tech. Rep. 51. 135 pp., mimeo.
Historical review and modern research report with vegetation/soils analyses, comparing National Park lands with adjacent ranch lands. Park is fully protected from cattle only since 1948. Vegetation is notably resilient.

CUMMINGS, W. C., F. F. FISH, and P. O. THOMPSON
1972. "Sound Production and Other Behavior of Southern Right Whales, *Eubalaena glacialis*." *Trans. San Diego Natural Hist. Soc.* 71:1–13.
Information is yet sketchy, but this population, in shallow waters of the breeding grounds, made typical low-frequency sounds characteristic of baleen whales; but there were no repetitive stanzas as reported from the northern right whale recorded in the open ocean.

CUMMINS, T., and J. MEEK
1851. "Report on Horses." *Royal Hawaiian Agric. Soc.* 1(2):77–78.
Inferior stallions and "donkeys in crowds running at large" were considered detrimental to improvement of quality in island horses; greater emphasis was suggested on breeding of mules to meet the demand for plantations and farms.

DAHLGREN, E. W.
1917. *The Discovery of the Sandwich Islands.* Uppsala: Almqvist and Wiksells. 220 pp.
Discusses in detail the question of whether or not the Hawaiian Islands were visited by the Spaniards before their discovery by Cook in 1778.

DAHLHEIM, MARILYN E.
1980. "Killer Whales Observed Bowriding." *Murrelet* 61:78.
In 1978 five killer whales rode the bow wave of a 30-m fishing boat traveling at 5 km/hour for 2.5 minutes, the first reported incident of so large a whale species performing this activity.

DAILEY, M. D., and W. A. WALKER
1978. "Parasitism as a Factor (?) in Single Strandings of Southern California Cetaceans." *J. Parasitology* 64:595–596.
Disorientation and loss of equilibrium, and trematodes (*Nasitrema*) in the central nervous system, may provide a partial explanation of strandings of 60 dolphins examined among five species.

DALRYMPLE, G. B., E. A. SILVER, and E. D. JACKSON
1973. "Origin of the Hawaiian Islands." *American Scientist* 61:294–308.
Recent studies indicate that the Hawaiian volcanic chain is a result of relative motion between the Pacific plate and a melting spot in the Earth's mantle, presently lying southeast of the island of Hawai'i.

DANIEL, J. C., and B. R. GRUBH
1966. "The Indian Water Buffalo, *Bubalus bubalis* (Linn.), in Peninsular India." *J. Bombay Natural History Soc.* 63:32–53. (Not seen.)

DANIEL, M. J.

1967. "A Survey of Diseases in Fallow, Virginia and Japanese Deer, Chamois, Tahr, and Feral Goats and Pigs in New Zealand." *New Zealand J. Science* 10:949–963.

Wild ungulates in New Zealand are of little or no significance as carriers of *Brucella*, *Leptospira*, or *Salmonella*.

1972. "Bionomics of the Ship Rat (*Rattus r. rattus*) in a New Zealand Indigenous Forest." *New Zealand J. Science* 15:313–341.

Lowland forest populations were studied over three years by removal and release methods. Provides useful data for comparison in Hawai'i. Feral cat was noted as a principal predator.

1976. "An Imported Fauna." *Australian Natural History* 18:370–373.

Ecological mistakes made by introduction of alien fauna to New Zealand are emphasized. A good summary, with photographs, of native and alien mammals.

1979. "The New Zealand Short-tailed Bat, *Mystacina tuberculata*, a Review of Present Knowledge." *New Zealand J. Zool.* 6:357–370.

Subject species anciently present in New Zealand provides interesting contrasts and parallels with *Lasiurus cinereus* in Hawai'i.

DAVIS, D. E. (Editor)

1982. *CRC Handbook of Census Methods for Terrestrial Vertebrates*. Boca Raton: CRC Press. 424 pp.

Attention is called here especially to Liberg's methods for the feral cat (pp. 222–224), but the book is comprehensive for species in various habitats worldwide.

DAVIS, L. S.

1979. "Social Rank Behaviour in a Captive Colony of Polynesian Rats (*Rattus exulans*). *New Zealand J. Zool.* 6:371–380.

Behavioral interactions intensified by limited space for housing the colony show that dominance is established by overt aggression. In nature, dispersal may be favored as an alternative.

DAVIS, MARLEEN G.

1983. "Kona Nightingale Returns to Habitat." *Notes From Waimea Arboretum and Bot. Garden* 10(1):13.

Reports that the Garden donkey, originally caught 19 years earlier in the Kona region of Hawai'i, had been returned and freed at the same site in December 1982, after six years of display at the Garden.

DAWBIN, W. H.

1966. "The Seasonal Migratory Cycle of Humpback Whales." *In*: K. S. Norris (editor), 1966, pp. 145–170.

Describes characteristics of a large Southern Hemisphere population migrating in the region of New Zealand and Australia.

DAWSON, T. J., M. J. S. DENNY, ELEANOR M. RUSSELL, and BEVERLY ELLIS

1975. "Water Usage and Diet Preferences of Free Ranging Kangaroos, Sheep and Feral Goats in the Australian Arid Zone during Summer." *J. Zool.* 177:1–23.

Sheep required most water because of feeding on halophytic shrubs, and usually drank morning and evening. Goats watered at two- to three-day intervals. Kangaroos required the least water.

DEAN, A. L.

1929. "Danger from Rat Virus." *Pineapple News* 3:148.

Points out that cultures of disease organisms intended to infect rats may invade human foods and produce substances toxic to man.

DEGENER, O.

1930. *Plants of Hawaii National Park.* Honolulu: Honolulu Star-Bulletin. 313 pp.

Authentic guide to the more prominent ferns and flowering plants of Hawaii Volcanoes National Park and adjacent regions on Hawai'i. Includes descriptions of ancient Hawaiian customs related to plants, and a review of Hawaiian geological history. The occasional references to mammals are valuable. Indexed, richly illustrated.

1932–1980. *Flora Hawaiiensis: The New Illustrated Flora of the Hawaiian Islands.* Vols. 1–7. Privately published by Otto Degener, Waialua, O'ahu, Hawai'i.

A large work presenting by number nearly 350 families of native and introduced ferns and flowering plants. Each species is given full-page description and treatment, with an illustration overleaf. Neat screw-clamp binding permits insertion of later sheets in order among those issued earlier. Volumes 1–4 (1192 pp.) in second edition, 1946, under one cover; Volumes 6–7 co-authored by Isa Degener.

DEGENER, O., and ISA DEGENER

1961. "Past, Present and Future of the Hawaiian Flora." *Abstracts Symposium Pap., Tenth Pacific Sci. Cong.* (Honolulu), pp. 130–131.

Paints a vivid picture of the rapid exploitation by man of the endemic flora; cites purposeful introduction of domestic and wild mammals as a particularly deleterious factor; recommends extensive collection of remaining species to assure that herbarium materials at least will be available for study.

DEGERBØL, M.

1961. "On a Find of a Preboreal Domestic Dog (*Canis familiaris* L.) from Star Carr, Yorkshire, with Remarks on Other Mesolithic Dogs." *Proc. Prehistoric Soc.* 27:35–55.

Reports on dog materials from England at a site carbon-14-dated as 9488 ± 350 years B.P. (before present). Discusses changes occurring in derivation of the dog from wolf ancestry.

DELANO, A.

1817. *A Narrative of Voyages and Travels, in the Northern and Southern Hemispheres.* Boston: House. 598 pp.

Chapter 21 (pp. 387–403) describes a visit to Hawai'i in 1806. Landings were made on Hawai'i and Maui. Delano had made an earlier visit in 1801.

DENNISTON, G. C.

1973. "Killer Whale Behavior with Young." *Murrelet* 54:22.

On two occasions three adult killer whales with young appeared to be escorting, in flanking and rear guard positions, groups of six and three smaller whales, as if protecting them, at Puget Sound, Washington.

DEOL, M. S.

1970. "The Determination and Distribution of Coat Colour Variation in the House Mouse." *Symp. Zool. Soc. London* 26:239–250.

Black and yellow pigments account for coat color and these are regulated by chromosomal complement. Natural selection as well as pleiotropic effects account for perpetuation or loss of mutant stocks in the population.

DE VOS, A., R. H. MANVILLE, and R. G. VAN GELDER

1956. "Introduced Mammals and Their Influence on Native Biota." *Zoologica* 41(4):163–194.

Brief comments on the serious problems arising from worldwide mammalian introductions; reviews, by region, many introductions and their outcome. Table 7 includes wild species brought to Hawai'i; these and feral livestock in Hawai'i are discussed (pp. 185–187).

DE VRIES, T., and J. BLACK
1983. "Of Men, Goats and Guava—Problems Caused by Introduced Species in the Galapagos." *Noticias Galapagos* 38:18–21.
Not seen, but suggests parallels with conditions in Hawai'i.

DILKS, P. J.
1979. "Observations on the Food of Feral Cats on Campbell Island." *New Zealand J. Ecology* 2:64–66.
The Norway rat provides the major diet of cats. Cats are few in number but extirpation is recommended as a possible measure for return of sea birds which nested formerly on the island (52°S).

DILKS, P. J., and P. R. WILSON
1979. "Feral Sheep and Cattle and Royal Albatrosses on Campbell Island; Population Trends and Habitat Changes." *New Zealand J. Zool.* 6:127–139.
After fencing and removal of sheep from the northern part of the island in 1970, interactions were compared in time. Recovery of vegetation in sheep-free zone indicates resistance of the grassland-scrub vegetation to long-term grazing. A small herd of cattle retained stable numbers.

DILL, H. R., and W. A. BRYAN
1912. *Report of an Expedition to Laysan Island in 1911.* U. S. Dept. Agriculture Biological Survey Bull. 42. 30 pp.
Part I, by Dill (pp. 9–10), mentions Hawaiian monk seal, documents introduction of rabbits and describes their effects on vegetation, and notes presence of guinea pigs in thick *Juncus* at south end of island. Part II, by Bryan (pp. 26–28), compares rabbit populations of 1903 and 1911, describes introduction of rabbits and guinea pigs about 1903, and predicts depletion of vegetation by these mammals.

DINERSTEIN, E., and HOLLY T. DUBLIN
1982. "Daily Defecation Rate of Captive Axis Deer." *J. Wildlife Mgmt.* 46:833–835.
Counting pellet groups is used in estimating population density of ungulates. Basic data are here provided for axis deer (captive in Seattle, Washington).

DIONG, C. H.
1973. "Studies of the Wild Pig in Perak and Johore." *Malayan Nature J.* 26:120–151.
Basic ecology and management report on populations of pigs which may resemble the early Polynesian pig in Hawai'i.
1980. "Responses of Feral Pigs to Trap Types and Food Baits." *In*: C. W. Smith (editor), 1980, pp. 91–99.
Describes live trapping of pigs in remote rain forest, evaluating various methods, and behavioral adaptation of pigs to traps.

DIXON, J. D.
1973. "Natural History of a Small, Insular Population of Rabbits, *Oryctolagus cuniculus* (L.), in Hawaii." M.S. Thesis No. 1146, Univ. Hawaii. 87 pp.
Analysis of 1,075 captures of 87 rabbits January 1972–March 1973.

DIXON, J. S.
1934. "A Study of the Life History and Food Habits of Mule Deer in California." *California Fish and Game* 20:181–182, 315–354.
A detailed report by a gifted field naturalist. Some aspects have been superseded by later works, but many fundamentals of behavior and ecology are presented.

DOHL, T. P., K. S. NORRIS, and INGRID KANG
1974. "A Porpoise Hybrid: *Tursiops* x *Steno*." *J. Mammalogy* 55:217–221.

A calf born to a female *Steno bredanensis* after sharing an oceanarium tank (Sea Life Park) for more than a year with two male *Tursiops*. Calf thrived and showed strong *Steno* traits as it developed. Question of actual genetic divergence (at implied interfamilial level) is raised.

DONALDSON, R.

1940. "Let's be Rough on Rats." *Paradise Pacific* 52(6):17.

Cites historical references to rodents in Hawai'i, in popular vein. "Rats are energetic enemies of the human race . . . and should be destroyed."

DOPMEYER, A. L.

1936. "Plague Eradicative Measures on the Island of Maui, Territory of Hawaii." *Public Health Rep.* 41:1533–1556.

Summarizes (p. 1537) occurrence of plague in Hawai'i; treats biological aspects of the outbreak in the Makawao District, and practical control procedures. Photos, maps, tables. *Rattus exulans* and *R. rattus* were present; *R. norvegicus* was absent.

DOTY, M. S., and D. MUELLER-DOMBOIS

1966. *Atlas of Bioecology Studies in Hawaii Volcanoes National Park.* Hawaiian Botanical Soc. Science Pap. No. 2. (Issued 1970 as Hawaii Agricultural Exp. Sta. Misc. Publ. 89.) 507 pp.

A successful pioneer effort to catalogue the natural attributes of the largest protected land area in Hawai'i.

DOTY, R. E.

1932. "The Use of Corn Oil for Thallium Wheat Torpedoes." *Hawaiian Planters' Rec.* 36:117–125.

Presents results of several experiments designed to test attractants for use on rat bait. Corn oil mixed with a paraffin waterproofing is recommended as superior.

1933. Some Notes on the Use of Thallium Torpedoes." *Hawaiian Planters' Rec.* 37:96–97.

Compares corn oil-paraffin rat bait packets with plain paraffin packets, in field tests. Concludes corn oil is a useful lure for rats.

1945. "Rat control on Hawaiian Sugar Cane Plantations." *Hawaiian Planters' Rec.* 49:91–239.

Comprehensive review of rodent control problems and methods in Hawai'i based on previous work there and elsewhere, and on new experimental and technical information. Biological data on rats and the mongoose are included. 87 references.

1951. "Warfarin (Compound 42): A Promising New Rodenticide for Cane Fields." *Hawaiian Planters' Rec.* 55:1–21.

Establishes a firm experimental basis for the use of warfarin against *R. norvegicus* and *R. rattus* in Hawai'i. Field experiments were made on Kaua'i.

DOTY, R. E., and C. A. WISMER

1949. "Controlling Molding of Rolled Oats Rat Bait with Chemicals." *Hawaiian Planters' Rec.* 53:65–73.

Careful laboratory and field tests with many mold inhibitors revealed paranitrophenol as a choice substance not affecting bait consumption by rats.

DOUGLAS, M. E., G. D. SCHNELL, and D. J. HOUGH

1984. "Differentiation between Inshore and Offshore Spotted Dolphins in the Eastern Tropical Pacific Ocean." *J. Mammalogy* 65:375–387.

Extends understanding of variation in subject populations through use of cluster analysis and generation of discriminant axis. Strengthens earlier reports on this topic.

DOZIER, T. A.

1977. *Whales and Other Sea Mammals.* New York: Time-Life Films. 128 pp.

Includes excellent photographs and reliably based narrative accounts of whales, dolphins, and whaling, for a generally popular appeal. Many of the species are found in Hawaiian waters.

DUESER, R. D., and W. C. BROWN
1980. "Ecological Correlates of Insular Rodent Diversity." *Ecology* 61:50–56.
Numbers of rodent species increased with size of islet, elevation, and complexity of vegetation. *Rattus norvegicus* and *Mus domesticus* were among five species recorded.

DUSBÁBEK, F.
1973. "A Systematic Review of the Genus *Pteracarus* (Acariformes: Myobiidae)." *Extrait de Acarologica* 15:240–288.
Includes descriptions of *Pteracarus completus completus* Dusbábek and Wilson as a new species and new subspecies of mite collected from the hoary bat at Waipi'o Valley and Honoka'a, island of Hawai'i.

DWYER, P. D.
1978. "A Study of *Rattus exulans* (Peale) (Rodentia: Muridae) in the New Guinea Highlands." *Australian Wildlife Res.* 5:221–248.
Grassland, garden, and house populations were examined, with notation that garden and house rats are in some jeopardy because of domestic pigs associated with villages, and that recruitment from grassland may be needed in order to sustain commensal populations.

EARLE, SYLVIA A., and A. GIDDINGS
1979. "Humbpacks: the Gentle Whales." *National Geographic* 155:2–17.
Close human associations with whales and feeding behavior are described from waters of Hawai'i and Glacier Bay, Alaska. Maps of world distribution.

EBERHARDT, L. L., D. G. CHAPMAN, and J. R. GILBERT
1979. "A Review of Marine Mammal Census Methods." *Wildlife Monogr.* 63. 46 pp.
Current methods are: (1) mark-recapture; (2) catch per unit effort (both used for exploited populations); and (3) direct visual observation (using photography whenever possible). Paper is based on statistical procedures; extensive reference list.

EBERHARDT, L. L., A. K. MAJOROWICZ, and J. A. WILCOX
1982. "Apparent Rates of Increase for two Feral Horse Herds." *J. Wildlife Mgmt.* 46:367–374.
Aerial counts in Oregon showed 20 percent increases per year. These depended on high survival of the adults over an eight-year period. Estimates of horses on U. S. Bureau of Land Management holdings—56,000; burros—17,000.

EBISU R. J., and G. C. WHITTOW
1976. "Temperature Regulation in the Small Indian Mongoose (*Herpestes auropunctatus*)." *Comp. Biochem. Physiol.* 54A:309–313.
The mongoose has effective physiological mechanisms for dealing with hot and moderately cold environments, which may explain its presence in a wide range of habitats.

ECKART, T. G.
1936. "Rat Control Investigations at the Lihue Plantation Company, Ltd." *Hawaiian Planters' Rec.* 40:157–170.
Reports on poison bait studies designed to increase effectiveness and economy of a major rat-control program in sugar cane fields.

EDEL, R. K., and H. E. WINN
1978. "Observations on Underwater Locomotion and Flipper Movement of the Humpback Whale *Megaptera novaeangliae*." *Marine Biol.* 48:279–287.

The uniquely long flippers provide a high degree of maneuverability under water, with aid of the flukes and tail moved in other than vertical planes.

EDMONDS, J. W., J. R. BACKHOLER, and ROSAMOND C. H. SHEPHERD
1981. "Some Biological Characteristics of the Feral Rabbit, *Oryctolagus cuniculus* (L.), Population of Wild and Domestic Origin." *Australian Wildlife Res.* 8:589–596.
Points out that, except on islands, establishment of rabbits in Australia was generally by stocks already adapted to the wild. Domestic rabbits generally failed when released or escaped on the mainland. A complicated pattern of survival and selection for coat color is presented.

EDMONDS, J. W., F. I. NOLAND, ROSAMOND C. H. SHEPHERD, J. R. BACKHOLER, and R. JACKSON
1976. "Rabbits on Gippsland Islands." *Victorian Naturalist* 93:110–112.
Fragmentary information is given on origin and dates of introduction to these islands, offshore from Victoria, Australia. Character of each population is different.

EDMONDSON, C. H.
1948. "Records of *Kogia breviceps* from the Hawaiian Islands." *J. Mammalogy* 29:76–77.
Summarizes world distribution of the pygmy sperm whale. Reports a 1942 specimen from Kahului Harbor, Maui, and one taken in 1947 near Lahaina, Maui.

EDWARDS, E. H.
1979. *Encyclopedia of the Horse.* London: Octopus Books. 256 pp.
Comprehensive reference book on the horse: history, breeds, uses, care, and management. Richly illustrated, index, glossary.

EGOSCUE, H. J.
1970. "A Laboratory Colony of the Polynesian Rat, *Rattus exulans*." *J. Mammalogy* 51:261–266.
A colony of stock from the Marshall Islands was maintained in Utah for six years, with extensive data on productivity. This rat was considered successfully adapted to laboratory propagation.

EHRLICH, P., and ANNE EHRLICH
1981. *Extinction: The Causes and Consequences of the Disappearance of Species.* New York: Random House. 305 pp.
Authors' dedication: "To *Homo sapiens*, which through the extinction of others endangers itself." A timely review of the problem with many examples cited worldwide.

EINARSEN, A. S.
1948. *The Pronghorn Antelope and Its Management.* Baltimore: Monumental Printing Co. 238 pp. (Sponsored by the Wildlife Management Institute.)
A comprehensive report on a study of pronghorn in Oregon, Idaho, Nevada, and California. Includes historical survey, characteristics, biology, management practices, and hunting data. Written in colorful style.

EISNER, T., and J. A. DAVIS
1967. "The Mongoose Throwing and Smashing Millipedes." *Science* 155:577–579.
A captive banded mongoose, *Mungos mungo* (Gmelin), is described in its behavior for opening coiled, marble-sized glomerid millipedes by hurling them with the forepaws, backward under the body, against a rock. Illustrated.

ELDER, W. H.
1947. "Notes on Some Asiatic Rodents in the British Museum." *Proc. Zoological Soc. London* 117:259–271.
Discusses (p. 262) *Rattus exulans* (Peale), stating: "Partly a parasitic form, this is smaller on

average than *R. rattus* and its immediate allies. Races examined include *exulans, concolor, browni, ephippium, aemuli, negrinus, surdus, todayensis, vulcani, stragulum, hawaiiensis, raveni.* Tail dark."

1958. "Preliminary Report on the Ne-ne in Hawaii." *Ninth Annual Rep. Wildfowl Trust*, pp. 112–117.

"Mongooses and dogs may be serious predators. . . . The known nesting area is to be posted, patrolled, and its predators poisoned."

ELLERMAN, J. R., and T. S. C. MORRISON-SCOTT

1951. *Checklist of Palaearctic and Indian Mammals.* London: British Mus. (Natural History). 810 pp.

An excellent reference source on nomenclature and distribution of Old World wild species brought to Hawai'i, although some taxonomic usages have been revised by later authors. Second edition (1966) has few changes; pagination remains the same.

ELLIOTT, R.

1925. "Sugar Losses in Cane Damaged by Rats and Beetle Borer." *Hawaiian Planters' Rec.* 29:140–144.

Compares economic loss attributed to rats with that from the cane borer (*Rhabdocnemis obscura*), at Pā'auhau, Hāmākua District, on Hawai'i.

ELLIS, R.

1980. *The Book of Whales.* New York: Knopf. 202 pp.

Richly illustrated, with highly readable text. Concerned with those species generally referred to as whales, excluding the pilot whale and other dolphin-like forms.

ELLIS, W.

1853. *Polynesian Researches.* 2nd ed., Vols. 1–4. London: Fisher, Son and Jackson.

Describes (Vol. 4, pp. 346–347) the occurrence and use of dogs in Hawai'i. In 1823 Ellis saw nearly 200 dogs baked at one time for a feast and learned of 400 prepared on another occasion in the entertainment of visiting royalty, on the island of Hawai'i.

1917. *A Narrative of a Tour through Hawaii, or Owhyhee: With Remarks on the History, Traditions, Manners, Customs, and Language of the Inhabitants of the Sandwich Islands.* Honolulu: Hawaiian Gazette. (Reprint of the London 1827 edition.) 367 pp.

Tour made in 1823; published in several editions 1825 through 1828, in 1917, and in 1964. Excellent brief observations on cattle, sheep, dogs, and pigs. Horse and goat mentioned. 1917 edition is indexed.

ELSCHNER, C.

1915. *The Leeward Islands of the Hawaiian Group.* Honolulu. 68 pp. (Reprinted from the *Honolulu Advertiser.*)

Detailed narrative of conditions on the several islands, data largely from a 1915 trip of the *Thetis*, with particular reference to geography, geology, and soil chemistry. Mentions rabbits on Laysan (p. 37) and on Lisianski (p. 56). On Sand Island, at Midway, cows and pigs were kept; feral donkeys occupied Eastern Island.

ELY, C. A., and R. B. CLAPP

1973. "The Natural History of Laysan Island, Northwestern Hawaiian Islands." *Atoll Res. Bull.* 171:1–361.

Examines in detail the records of mammals: one cetacean of natural occurrence, the resident monk seal, mule and/or donkey, cattle and pigs, guinea pig, rabbit.

EMERSON, J. S.

1838. "The Shipwrecked Japanese." *Hawaiian Spectator* 1:296–300.

Account of a Japanese junk, with four survivors of an original crew of nine, landing on O'ahu in December 1832, after losing its course 10 or 11 months previously in a typhoon. Refers also to another crew wrecked about the same time on the coast of North America that returned, through Honolulu, to the Orient.

EMORY, K. P.

1924. *The Island of Lanai: A Survey of Native Culture.* B. P. Bishop Mus. Bull. 12. 129 pp.

Excellent source material. Sketches of geography and history (pp. 4–5). Section on petroglyphs (pp. 94–123) treats the subject intensively, including discussion and illustration of mammal figures such as cat, dog, pig, sheep, goat, deer, and horse.

1961. "Report on Hawaii and Tahiti. *Abstracts Symposium Pap., Tenth Pacific Sci. Cong.* (Honolulu), p. 60.

Reports probable pre-Cook European contact in Hawai'i, from evidence in current archaeological research.

ENGLEDOW, E.

1961. "Mauna Kea's Phantom Dog Back." *Honolulu Star-Bulletin*, May 18, pp. 1, 1A.

Notes white mongrel dog, first seen in 1959, returned to the weather observatory at 11,150-foot elevation, apparently in excellent health, 23 miles from the nearest human habitation.

ENRIGHT, J. R., and E. A. FENNEL

1939. "Weil's Disease in Hawaii." *Proc. Sixth Pacific Sci. Cong.* (California) 5:337–342.

Epidemiological report. First proved case of leptospirosis in 1936. Disease was prominent among cane field workers in Puna District, Hawai'i, but occurred on all larger islands except Moloka'i; on Lāna'i workers, housewives, and school children were infected. Rodent control programs and problems of laboratory diagnosis are discussed.

ERIC, A.

1896. "The Mongoose in Jamaica." *Planters' Monthly* 15:106–108.

Describes in popular terms success of mongoose as a rat killer, its propensity to spread into new habitat, and its omnivorous habits. Overestimates fecundity (p. 107): six to eight litters per year and litter size of five to ten. States (p. 108) that, although interesting, the mongoose had done much damage on the island.

ESKEY, C. R.

1934. *Epidemiological Study of Plague in the Hawaiian Islands.* U. S. Treasury Dept. Public Health Bull. 213. 70 pp.

Includes historical survey of plague in Hawai'i, and extensive data on fleas and rodents in the then current or recent foci of plague infection on Maui and Hawai'i, and on O'ahu. Classification and control of rodents are discussed.

ESPEUT, W. B.

1882. "On the Acclimatization of the Indian Mungoos in Jamaica." *Proc. Zoological Soc. London* 1882:712–714.

Describes introduction of nine mongooses into Jamaica on February 13, 1872, aboard the *Merchantman*, out of Calcutta, India. Few, if any, further introductions were made.

EVANS, LINDA R.

1976. "Kaula—Hawaii's Forgotten Bird Island." *'Elepaio* 37:61–63.

Review of the uses and attributes of a 136-acre island, with a plea for a halt to military bombing before the bicentennial of European discovery, in 1978.

EVANS, W. E., J. D. HALL, A. B. IRVINE, and J. S. LEATHERWOOD

1972. "Method for Tagging Small Cetaceans." *Fish. Bull.* 70:61–65.

A dart-type vinyl "spaghetti" tag has proved best for tagging large numbers of dolphins without capturing them. Other methods, requiring capture, are discussed.

EVERING, G.

1980. "Orcas Sighted in Hawaii." *Hawaii Humpback* 1(3):16, 51.

Popular account of two killer whales seen in Kaua'i Channel December 24, 1979, from the research vessel *Easy Rider*. Two photos.

EWING, G. M., and I. L. TILDEN

1956. "*Capillaria hepatica*: Report of Fourth Case of True Human Infestation." *J. Pediatrics* 48:341–348.

Describes fatal case of a 15-month old child on Hawai'i. Rats were suspected as a source of the parasite.

EWING, H. E.

1924. *Ectoparasites of Some Polynesian and Malaysian Rats of the Genus* Rattus. B. P. Bishop Mus. Bull. 14, pp. 7–11.

Describes two new forms, *Laelaps hawaiiensis* sp. n. and *Hoplopleura pacifica* sp. n., ex *R. hawaiiensis* (=*exulans*), from Popoi'a Islet off O'ahu.

F. M. [FRED MUIR]

1913. "Mongoose as Insect Destroyers." *Hawaiian Planters' Rec.* 7:89.

Reports on food habits in cane fields; "over eighty percent of the stools is composed of the remains of insects." And, "near the shore there is always a large percentage of remains of small crabs." Many kinds of insects were identifiable.

FAGERLUND, G. O.

1947. "The Exotic Plants of Hawaii National Park." Hawaii National Park Natural History Bull. 10. 62 pp., mimeo.

Discusses (pp. 6–7) effects of cattle, goats, and pigs on original vegetation, and ecology of alien species. Plants, with notations, are listed by families.

FAGERLUND, G. O., and A. L. MITCHELL

1944. "A Checklist of the Plants, Hawaii National Park." Hawaii National Park Natural History Bull. 9. 76 pp., mimeo.

Man-caused changes in vegetation are discussed (pp. 13–15). Invasion by domestic and feral livestock was accompanied or followed by soil deterioration and invasion by alien plants.

FALL, M. W., A. B. MEDINA, and W. B. JACKSON

1971. "Feeding Patterns of *Rattus rattus* and *Rattus exulans* on Eniwetok Atoll, Marshall Islands." *J. Mammalogy* 52:69–76.

Results from a much-studied former nuclear test site. *Rattus rattus* was better adaptable to islets disturbed by atomic tests, using a wide range of foods. *Rattus exulans* thrived best where remnant coconut plantations remained, and was absent from some islets.

FELDMAN, H. W.

1926. "Unit Character Inheritance of Color in the Black Rat, *Mus rattus* L." *Genetics* 11:456–465.

A classical analysis of color types in *Rattus rattus* applicable to Hawaiian populations. One allelic series embraces the dominant wild type (agouti back, white belly), a recessive gray-belly mutant, and a non-agouti black mutant recessive to both of these. A second series includes a black mutant dominant over the entire agouti series. Other color factors are considered.

FELLOWS, D. P., and R. T. SUGIHARA

1977. "Food Habits of Norway and Polynesian Rats in Hawaiian Sugarcane Fields." *Hawaiian Planters' Rec.* 59(6):67–86.

This important paper provides a modern view of the subject and explores possibilities for rat control through habitat management. *R. exulans* is more important in damage to first-year cane; *R. norvegicus* to second-year fields.

FENTON, M. B., S. L. JACOBSON, and R. N. STONE
1973. "An Automatic Ultrasonic Sensing System for Monitoring the Activity of Some Bats." *Canadian J. Zool.* 51:291–299.

Technique offers promise for study of bat activity away from roosts without disturbing the bats.

FERRIS, F. D., R. D. SAGE, C.-H. HUANG, J. T. NIELSEN, V. RITTE, and A. C. WILSON
1983. "Flow of Mitochondrial DNA across a Species Boundary." *Proc. Natnl. Acad. Science USA* 80:2290–2294.

Electrophoretic and immunological analysis of eight diagnostic proteins confirms separation in Denmark of the northeastern *Mus musculus* from the more southwestern *M. domesticus* of Europe, across a narrow hybrid zone.

FINCH, R. H.
1947. "The Mechanics of the Explosive Eruption of Kilauea in 1924." *Pacific Science* 1:237–240.

Discusses an unusual volcanic activity for Hawai'i in which steam-powered explosions hurled rocks as large as 14 tons from Kīlauea Crater.

FINCH, VIRGINIA A., and D. WESTERN
1977. "Cattle Colors in Pastoral Herds; Natural Selection or Social Preference?" *Ecology* 58:1384–1392.

Heat stress as a factor in cattle mortality is less in lighter-colored animals. That there is ecological significance of coat color is widely recognized by herdsmen of the Boran cattle (*Bos indica*) of Kenya.

FINDLEY, J. S., and P. Q. TOMICH
1983. "Morphological Affinities of the Hawaiian Hoary Bat." Unpublished ms., 9 pp.

FISHER, H. I.
1945. "Oahu's Offshore Islets as Bird Refuges." *'Elepaio* 6:29–32.

Review of current interferences by persons landing, and by continued military bombings and gunnery. Recommends (p. 32), and this would encompass Mānana Island rabbit and mouse populations, "that no person, however well-meaning, be allowed to change the fauna, flora or surface of the islets in any way."

1948. "The Question of Avian Introductions in Hawaii." *Pacific Science* 2:59–64.

Brief mention of feral cats, dogs, and hogs as bird predators. Discusses rat and mongoose habits in relation to predation.

1949. "Populations of Birds on Midway and the Man-Made Factors Affecting Them." *Pacific Science* 3:103–110.

Discusses rats (pp. 106–107) which arrived in 1943 as the most serious depressant of bird populations, and principally responsible for the extirpation of the Laysan finch and for extinction of the Laysan rail. Kinds of rats are not specified.

1951. "The Avifauna of Niihau Island, Hawaiian Archipelago." *Condor* 53:31–42.

Briefly reviews history of land use, noting that vegetation is increasing. Besides domestic cattle, horses, and sheep, feral cats and pigs and *Rattus rattus*, are common on the island. Goats were exterminated in 1912. Three photos and map.

FISHER, H. I., and P. H. BALDWIN
1946. "War and the Birds on Midway Atoll." *Condor* 48:3–15.

Rats and mice, species not listed, and dogs, are discussed under factors of psychobiological disturbance to birds. Elimination of all pets, including caged rabbits, is recommended.

FITZGERALD, B. M., and B. J. KARL

1979. "Foods of Feral House Cats *Felis catus* L. in Forests of the Orongorongo Valley, Wellington." *New Zealand J. Zool.* 6:107–126.

Emphasizes from a review of literature that cats are primarily predators of small mammals. Few birds are eaten in study area, but forest species may have been reduced in the past.

FITZGERALD, B. M., B. J. KARL, and H. MOLLER

1981. "Spatial Organization and Ecology of a Sparse Population of House Mice (*Mus musculus*) in a New Zealand Forest." *J. Animal Ecology* 50:489–518.

A territorial system is described in which mice exclude other mice of the same sex from their home ranges. Vacated ranges were acquired rapidly by neighboring mice.

FLEISCHER, G.

1975. "Über das Spezialisierte Gehörorgan von *Kogia breviceps* (Odontoceti)" [Concerning the specialized hearing organ of *Kogia breviceps* (Odontoceti)]." *Z. Säugetierk.* 40:89–102. (In German, English summary.)

Kogia is representative of a group of toothed whales which hear by a specialized type of vibration in the middle ear. There is no tympanic membrane.

FORBES, C. N.

1913a. "Notes on the Flora of Kahoolawe and Molokini." *B. P. Bishop Mus. Occ. Pap.* 5(3):3–15.

In two-hour stay on Molokini (H. P. Judd, 1938) rabbits were apparently not seen. Fifteen plant species "form a fairly good vegetable covering over the island."

1913b. "An Enumeration of Niihau Plants." *B. P. Bishop Mus. Occ. Pap.* 5(3):17–30.

Collection was made during January 1912, by J. F. G. Stokes. Most available land was then in pasturage for sheep and horses; the island was formerly overrun by goats, but these were exterminated shortly before the 1912 visit.

FORD-ROBERTSON, J. DE C., and P. C. BULL

1966. "Some Parasites of the Kiore, *Rattus exulans*, on Little Barrier and Hen Islands, New Zealand." *New Zealand J. Science* 9:221–224.

Lists nine species: *Trypanosoma lewisi, Hymenolepis diminuta, Mesolaelaps australiensis, Hoplopleura pacifica, Xenopsylla vexabilis, Pygiopsylla hoplia, Parapsyllus longicornis, Nosopsyllus fasciatus*, and *Mastophorus muris*.

FORRESTER, D. J., and W. D. ROBERTSON

1975. "Helminths of Rough-toothed Dolphins, *Steno bredanensis* Lesson 1828, from Florida Waters." *J. Parasitology* 61:922.

Two adults stranded on a sandbar were infected with cestodes, nematodes, and trematodes of five species in all, with total helminth burdens of 196 and 452, respectively, in the forestomach, intestine, liver, and bile duct.

FOSTER, JEANETTE

1982. "Beached Whale Gets a New Life." *Honolulu Advertiser*, August 12, p. A-4.

When a pygmy sperm whale stranded on Maui it was taken out to sea within two hours, where it may have survived.

FOWLER, C. W.

1983. "History and Status of the Northern Fur Seals of the Pribilof Islands." *Abstracts Symposium Pap. 15th Pacific Science Congr.* (Dunedin), Vol. 1, p. 75.

Decline associated with increased commercial fishing results from loss of young after they leave the pupping beaches. Mortality from entanglement in net fragments discarded in the sea may be an important factor.

FOX, M. W.
1978. *The Dog: Its Domestication and Behavior.* New York: Garland Press. 296 pp.
Reviews field of information on the dog and provides useful summary of the subject matter.

FRANCK, H. A.
1937. *Roaming in Hawaii.* New York: Stokes. 349 pp.
A stimulating account of conditions in Hawai'i in 1935–1936 by a carefully observant and somewhat iconoclastic visiting author. Notes on mammals are occasional.

FRÄNGSMYR, T. (Editor)
1983. *Linnaeus: The Man and His Work.* Berkeley: Univ. California Press. 204 pp. (Translated from the Swedish.)
A collection of four essays concerning different aspects of "the famous arbiter of systematics." Reviewed By P. L. Farber in *Science* 221:49 (July 1, 1983).

FRASER, J.
1957. "Call of 'Thar She Blows' Expected Soon at Wailupe." *Honolulu Star-Bulletin,* January 11, p. 10.
Brief description of wintering from January into March, of whales in Hawaiian waters. Some information from Albert H. Banner. Reports membership of some 300 to 400 members in "Wailupe Whale Watchers."

FREDDY, D. J., and D. C. BOWDEN
1983. "Sampling Mule Deer Pellet-Group Densities in Juniper-Pinyon Woodland." *J. Wildlife Mgmt.* 47:476–485.
Review and refinement of this census method, in Colorado. Dwells on sampling and subsampling procedures. Four additional short papers, pp. 497–516, relate to mule deer.

FREDGA, K.
1967. "Chromosome Studies in Six Different Tissues of a Male Indian Mongoose (*Herpestes auropunctatus*) and Comments on the Nomenclature of the Species." *Mammalian Chromosomes Newsl.* 8:19–21.

FRERE, A. G.
1929. "Breeding Habits of the Common Mongoose (*Herpestes edwardsii*)." *J. Bombay Natural History Soc.* 33:426–428.
Reports three approximations of gestation period as 60 to 65 days. Matings were observed over a period of several days. (Commented upon by Pocock, 1941, p. 60.)

FRIENDS OF THE EARTH
1978. *The Whale Manual.* San Francisco: Friends of the Earth Books. 153 pp.
A comprehensive assessment of the international whaling controversy, with persuasive data and logic informing the world of the folly of continued ruthless overkill by Japanese and Russian whaling, and a sensitive approach to the plight of the Eskimo as a whaler.

FROST, S.
1979. *The Whaling Question.* San Francisco: Friends of the Earth Books. 341 pp.
Report on an inquiry into the world of whale fishery, resulting in prohibition of all whaling by Australia and in Australian waters. Treats biology, classification, whaling, management, alternatives to whale products, social attitudes. Main bibliography of about 160 entries.

FUJII, W. K.
1963. "Life History and Serological Studies on *Capillaria hepatica* (Bancroft, 1893) Travassos, 1915, from Hawaiian Rats." M.S. Thesis No. 320, Univ. Hawaii. 58 pp.
Reviews data on incidence in man and rats in Hawai'i, reports on life history of the parasite in experimental *Rattus norvegicus*, and morphology of all stages. Serologic diagnosis was unsuccessful.

FUJIOKA, K. K., and S. M. GON III
1983. "An Unusual Concentration of the Hawaiian Hoary Bat in the South Kona District, Island of Hawaii." Unpublished ms., 16 pp.
Recorded 108 bats flying almost due north on the evening of July 30, 1977, and such flights averaged 55 per night in a 10-day period. On August 2, 16 bats were seen flying about the entrance to a collapsed lava tube in the same vicinity.

FULLARD, J. H.
1984. "Acoustic Relationships Between Tympanate Moths and the Hawaiian Hoary Bat (*Lasiurus cinereus semotus*)." *J. Comp. Physiol.* 155A:795–801.
Demonstrates that moths hear vocal sounds of approaching bats and initiate evasive measures. A basic pattern found in continental bat/moth interactions is present in Hawai'i. Observations made on Kaua'i.

FURMAN, D. P., and M. D. DAILEY
1980. "The Genus *Halarachne* (Acari: Halarachnidae), with the Description of a New Species from the Hawaiian Monk Seal." *J. Medical Entomology* 17:352–359.
Halarachne laysanae is described as a new species of parasitic mite from the nasal passages and mouth of the monk seal. It is a natural parasite not likely of measurable detriment to the seal.

G. B. B. [G. B. BURTNETT?]
1957. " A Whale of a Story." *Honolulu Advertiser Hawaiian Weekly*, March 24.
Describes formation of the "Wailupe Whale Watchers" in 1952, for the purpose of loosely organizing the watching of whales in Hawai'i and elsewhere.

GAGNÉ, BETSY H.
1982. "Silversword Alliance in the Bogs of East Maui: A Continuing Report." *In*: C. W. Smith (editor), 1982a, p. 62.
In 10 years of record, damage by pigs has increased; one area was fenced in 1981 to deter pigs. Abstract only.

GAGNÉ W. C.
1972. "Book Reviews." *'Elepaio* 32:66–68.
Includes review of Raymond J. Kramer's *Hawaiian Land Mammals*, 1971.

GAGNÉ, W. C., and SHEILA CONANT
1983. "Nihoa: Biological Gem of Northwestern Hawaiian Islands." *Ka 'Elele* 10(7):3–4.
Underscores the need for vigilance to prevent landings of weeds, ants, rats, and disease in order to avert ecological disaster to an important native biota.

GALBREATH, E. C.
1963. "Three Beaked Whales Stranded on the Midway Islands, Central Pacific Ocean." *J. Mammalogy* 44:422–423.
Reports recovery in 1961 of skeletal parts of two whales referable to *Mesoplodon densirostris* and of one identified as *Ziphius cavirostris*.

GALLET, HARRIET
1935. "Page the Water Buffalo." *Paradise Pacific* 47(11):1.
Humorous poem of eight lines; accompanied by a photograph.

GALTSOFF, P. S.

1933. *Pearl and Hermes Reef, Hawaii: Hydrographical and Biological Observations.* B. P. Bishop Mus. Bull. 107. 54 pp.

Primary purpose of study was to survey the oyster fishery. Excellent historical account (pp. 3–12) and map of the atoll. Land use regulations of the U. S. Secretary of Agriculture (p. 12) protect existing wildlife and deny introduction of domestic or wild vertebrates. Sixty-eight Hawaiian monk seals were counted.

GARRISON, M. V.

1974. "Nutrition and Behavioral Studies with Polynesian Rats." Ph.D. Thesis, West Virginia Univ. 85 pp. *Diss. Abstr.: Int. B. Sci. Engl.* 35(12)6191–B.

An example of the use of *Rattus exulans* (wild-caught in Hawai'i) for comparative feeding studies with the laboratory rat.

GASKIN, D. E.

1982. *The Ecology of Whales and Dolphins.* Exeter: Heineman Educational Books. 472 pp.

Assembles information on population biology of whales, including distribution, evolution, diets, energy budgets, management, and environmental contaminants. A modern synthesis of cetology. Reviewed by Randall Reeves in *Science* 220:711 (May 13, 1983); and by Robert Brownell in *J. Mammalogy* 65:533–534 (1984).

GAWAIN, ELIZABETH

1981. *The Dolphin's Gift.* Mill Valley: Whatever Publ. 256 pp.

Includes a diary of a two-week visit to a remote location in Western Australia where a family of dolphins comes from the sea, permitting people to feed them and stroke them. Much of the substance of the book is paraphrased from works of others. Experiences are described in personal and speculative terms.

GEERDES, J. R.

1964. "Some Ideas on the Feral Goat Control Program of Hawaii Volcanoes National Park: Past, Present and Future." *In*: C. F. Yocom, "Ecological Study of Feral Goats on United States National Park Lands in Hawaii," pp. 53–70. Humboldt State College, Div. Natural Resources, Arcata, California. 70 pp., mimeo.

Excellent documentary of the Park goat problem from 1921 to present.

GEIST, V., and F. WALTHER (Editors)

1974. *The Behaviour of Ungulates and Its Relation to Management.* IUCN Publ. New Series, No. 24, Vols. 1, 2.

Series of scientific reports including those on pigs, pronghorn, deer, and sheep.

GEORGE, W. C.

1973. "Domestic Cats as Predators and Factors in Winter Shortages of Raptor Prey." *Wilson Bull.* 85:384–396.

A three-year study of three rural cats as avid hunters of local wild rodents, in Illinois, depriving native hawks of their normal food resource.

GESSLER, C.

1930. "The Carabao." *Paradise Pacific* 43(12):plate between pp. 42–43.

A poem of ten lines depicting patience of the water buffalo and mountains, and a water color, "An Oahu Rice Field," by Staats Cotsworth.

GIBB, J. A., C. P. WARD, and G. D. WARD

1978. "Natural Control of a Population of Rabbits, *Oryctolagus cuniculus* (L.), for 10 Years in the Kourarau Enclosure." *New Zealand D.S.I.R. Bull.* 223. 89 pp.

Presents a thesis that both food shortage and predation are essential components in long-term decline and recovery to peak numbers.

GIBSON, D. I., and EILEEN A. HARRIS

1979. "The Helminth-Parasites of Cetaceans in the Collection of the British Museum (Natural History)." *In*: G. Pilleri (editor), *Investigations on Cetacea*, Vol. 10, pp. 309–324. Berne: Brain Anatomy Institute. 360 pp.

A summary and documentation of 300 lots from cetaceans collected over the past 140 years.

GIFFIN, J. G.

1976. "Ecology of the Feral Sheep on Mauna Kea." State of Hawaii, Div. Fish and Game, Honolulu, Project W-15-5-11. 90 pp., mimeo.

Final report, incorporating earlier studies. Recommends that the remaining 1,800 animals (as of 1975) should be substantially reduced or totally removed to prevent further decline of vegetation; and that alternative sheep hunting areas be provided.

1978. "Ecology of the Feral Pig on the Island of Hawaii." State of Hawaii, Div. Fish and Game, Honolulu, Project W-15-3-11, 1968–1972. 122 pp., mimeo.

Final report on biology and management of the subject species on island of Hawai'i. A fine comprehensive treatment.

1980. "Ecology of the Mouflon Sheep on Mauna Kea." State of Hawaii, Div. Forestry and Wildlife, Honolulu, Project W-17-R; R-III. 65 pp., mimeo.

Final report based on studies 1975–1979. Well illustrated, comprehensive. Notes that mouflon are expanding into habitat vacated on removal of feral sheep—a habitat vastly overused in the past. Density of mouflon in occupied areas is already about twice the recommended carrying capacity.

GILL, LORIN T.

1929. "The Rat that Does Not Gnaw." *Nature Mag.* 14:278–280.

Reviews in popular style Stokes' findings on *Rattus exulans*, emphasizing a supposedly weakly developed gnawing habit based on the failure of rats to escape from wooden cages.

GILMARTIN, W.

1981. "Hawaiian Monk Seal Recovery Uncertain." *Seal Report*, pp. 3, 6.

Publication of Center for Environmental Education, Washington, D.C. Beach counts of 500 to 600 seals indicate dire straits of the species compared to 1957 and 1958 when 1,103 and 1,206 were tallied. Human disturbance of mothers with pups, shark attacks, and eating of fish with ciguatoxin are cited as major factors in death of seals.

GILMARTIN, W. G., R. L. DELONG, W. A. SMITH, LYNN A. GRINER, and M. D. DAILEY

1980. "An Investigation into Unusual Mortality in the Hawaiian Monk Seal, *Monachus schauinslandi*." *In*: R. W. Grigg and Rose T. Pfund (editors), *Proc. Symposium on Status of Resource Investigation in the Northwestern Hawaiian Islands*, pp. 32–41. Seagrant Misc. Rep. UNIHI-Seagrant-MR-80-04.

Reports on 1978 sickness and mortality at Laysan Island and other sites, with a sample of 24 specimens. Young and very old animals were affected. Parasite-associated pathology and ciguatera toxin were the main abnormalities detected in detailed testing.

GILMORE, R. M.

1963. "Fauna and Ethnozoology of South America." *In*: J. H. Steward (editor), Vol. 6, *Handbook of South American Indians*, pp. 345–464. Smithsonian Inst., Bur. American Ethnology, Bull. 143. 715 pp.

Origin, description, and history of the domesticated guinea pig are given (pp. 454–460).

1980. "One Mass Stranding, Not Two, of Sperm Whales at La Paz, Baja California, 1954." *Bull. Southern California Acad. Sciences* 79:133–134.

Corrects record, noting strandings of nine sperm whales in the Gulf of California, April 1953; of 22 at La Paz, January 1954; of 56 farther north near Mulegé, January 1979; and of 41 near Florence, Oregon, June 1979.

GINGERICH, P. D., N. A. WELLS, D. E. RUSSELL, and S. M. I. SHAH

1983. "Origin of Whales in Epicontinental Remnant Seas: New Evidence from the Early Eocene of Pakistan." *Science* 220:403–406.

Fossil remains associated with land mammals in fluvial sediments strengthen earlier inferences that whales originated from terrestrial carnivorous mammals and made a gradual transition to the sea in times of highly productive shallow waters.

GOODRICH, J., and J. DIELL

1839. "Letter to Richard Charlton, British Consul in Honolulu." *Hawaiian Spectator* 2:429–436.

Conveys the news from Hilo, of the death of David Douglas in a cattle trap on the slopes of Mauna Kea, and a detailed description of cirumstances surrounding the event. Dated July 15, 1834.

GOODRICH, J. K.

1914. *The Coming Hawaii.* Chicago: McClurg. 329 pp.

Popular introduction to Hawai'i for the pre-World War I era. Flora and fauna are considered (pp. 163–187). Statements about mammals are very general; sources are usually not given. Mentions (p. 173) sixteenth-century Spanish visitors to Hawai'i.

GORMAN, M. L.

1975. "The Diet of Feral *Herpestes auropunctatus* (Carnivora: Viverridae) in the Fijiian Islands." *J. Zool.* 175:273–278.

Mongoose is an omnivore, has little value in rodent control and acts as a predator on native fauna.

1976a. "A Mechanism for Individual Recognition by Odour in *Herpestes auropunctatus* (Carnivora: Viverridae)." *Animal Behaviour* 24:141–145.

Study shows that individual recognition occurs among mongooses because of scent profile differences.

1976b. "Seasonal Changes in the Reproductive Pattern of Feral *Herpestes auropunctatus* (Carnivora: Viverridae), in the Fijiian Islands." *J. Zool.* 178:237–246.

Peak of male activity September–December with spermatogenesis all year. Peak of pregnancy August–February. Day length considered the proximate regulatory factor. Females had a mean of 1.8 embryos per pregnancy.

1979. "Dispersion and Foraging of the Small Indian Mongoose, *Herpestes auropunctatus* (Carnivora: Viverridae) Relative to Evolution of Social Viverrids." *J. Zool.* 187:65–73.

Confirms sedentary character and solitary habit of this mongoose from work in Fiji, comparing with data from Hawai'i.

GORMAN, M. L., D. B. NEDWELL, and R. M. SMITH

1974. "An Analysis of the Contents of the Anal Scent Pockets of *Herpestes auropunctatus* (Carnivora: Viverridae)." *J. Zool.* 172:389–399.

Scent contains a series of saturated carboxylic acids resulting from bacterial metabolism. Marking behavior is illustrated (p. 390), in which the mongoose does a handstand against a tree, pressing anal areas high against the trunk.

GRAF, W.

1957. "The Development of a Wild Type of Sheep and Goat through Hybridization of Feral Stock with Wild Stock." State of Hawaii, Div. Fish and Game, Honolulu. Consultant's report. 4 pp., mimeo.

Preliminary discussion and a set of procedures for hybridizing the Hawaiian feral sheep x *Ovis musimon*, and the Hawaiian feral goat x *Capra ibex*, in order to improve quality of these two game animals.

1958. "Report on New Zealand: Observations and Comments on Deer Control and Wildlife Management in New Zealand." Territory of Hawaii, Div. Fish and Game, Honolulu. 10 pp., mimeo.

Evaluation of conditions and practices of deer management in New Zealand as they may pertain to Hawai'i. A part of an overall study of deer in Hawai'i.

1959a. "The Deer Problem in Hawaii." Territory of Hawaii, Div. Fish and Game, Honolulu. 5 pp., mimeo.

Discusses the political and biological questions related to management and introduction of the axis deer to islands not now colonized. Brief history given of the species in Hawai'i, emphasizing effects of deer and livestock on forests.

1959b. "The Axis Deer (*Cervus axis*) in the Rainzone of Molokai Island." *American Philosophical Soc. Year Book*, pp. 236–238.

Report of activities and findings under Grant 277—Johnson Fund. Both deer and goats showed deformed hooves attributed to lack of wear on the wet soil. Goats, but not deer, ranged above 2,500 feet and showed characteristics of horns and color attributable to isolation.

1963. "The Effect of Isolation on House Mice (*Mus musculus*) and the Feral Goat (*Capra* sp.) on the Hawaiian Islands." *American Philosophical Soc. Year Book*, pp. 326–329.

Report on Grant 3143—Penrose Fund. Preliminary evidence shows differentiation among populations of mice and goats where barriers exist because of terrain, water, or behavior.

GRAF, W., and L. NICHOLS, JR.

1966. "The Axis Deer in Hawaii." *J. Bombay Natural History Soc.* 63:629–734.

A report on the physical characteristics, habits and behavior, reproduction and development. Compares the population of Hawai'i with the ancestral animal of India. Additional papers are anticipated from an unpublished book-length manuscript of which this article is part.

GRANT, G. S., and T. N. PETITT

1981. "Birds on Midway and Kure Atolls during the Winter of 1979–1980." *'Elepaio* 41:81–85.

A black tree squirrel (*Sciurus*) was observed on December 19, 1979, on Sand Island, Midway, near the school building.

GRAY, J. E.

1862. "Notice of a Species of *Lasiurus* Sent from the Sandwich Islands by Mr. W. H. Pease." *Proc. Zoological Soc. London*, Pt. 30, p. 143.

Bat taken in Hawai'i in 1861 is compared with British Museum specimen of *L. grayi* (=*L. cinereus*) from Chile and considered indistinguishable from it.

GREAVES, J. H., R. REDFERN, and B. ANASUYA

1976. "Inheritance of Resistance to Warfarin in *Rattus rattus* L." *J. Stored Products Res.* 12:225–228.

Genetic basis for resistance to anti-coagulant toxicants has a multifactorial basis, unlike condition in *R. norvegicus* where resistance derives from a single major gene.

GREAVES, J. H., B. D. RENNISON, and R. REDFERN

1976. "Resistance of the Ship Rat, *Rattus rattus* L., to Warfarin." *J. Stored Products Res.* 12:65–70.

Exceptional resistance was noted in 49.7 percent of 694 rats in 28-day tests, from 17 of 41 populations sampled in England.

GREEN, T. H.
1942. "Destruction of Bird Life on Rabbit Island." *'Elepaio* 3:16–17.
Letter of reply from the United States Army to complaints that practice artillery fire was being directed at Mānana Island included the statement (p. 16) that "no such firing will be conducted on Rabbit Island except when direct war time benefits can be obtained."

GREENE, G.
1941. "Kahoolawe—Time and Tide." *Paradise Pacific* 53(3):28–29.
Discusses early use of the island as a place of exile, reviews leases and land use from 1854 to about 1941 when it was occupied by one family and some cattle. Quotes generously from McAllister, 1933b.

GREENHALL, A. M.
1963. *A Bamboo Mongoose Trap.* U. S. Fish and Wildlife Service, Washington, D.C., Wildlife Leaflet 453. 4 pp.
Instructions for making trap from sections of giant bamboo. Steps illustrated. Use in Trinidad described.

GREENWAY, J. C., JR.
1958. *Extinct and Vanishing Birds of the World.* American Commn. International Wild Life Protection Spec. Pub. 13. 518 pp.
Describes in detail what is known about lost species and subspecies, including those of Hawai'i.

GREGG M. SINCLAIR LIBRARY
1963. *Dictionary Catalog of the Hawaiian Collection*, Vols. 1–4. Boston: G. K. Hall.
Photographic reproduction of the entire card catalog; excludes the news clippings file. Preface by Janet E. Bell reviews characteristics of the library system from the Hawaiian Kingdom through Statehood, current purposes, and content of the collections.

GREGORY, H. E.
1924. *Report of the Director of 1923.* B. P. Bishop Mus. Bull. 10. 38 pp.
Describes (pp. 19–24) the Tanager Expedition: background, route, personnel, and some results. The Hawaiian monk seal was rediscovered, and the Polynesian rat (= *Rattus exulans*) was first reported from Kure Atoll. On page 32, list of miscellaneous accessions.

GRIFFIN, E. I.
1966. "Making Friends with a Killer Whale." *National Geographic* 129(3):418–446.
Account of first tests of docility in a captive, "Namu," during adaptation to oceanarium life after transport in floating cage from Namu, British Columbia, to Seattle.

GRINNELL, J.
1933. "Review of the Recent Mammal Fauna of California." *Univ. California Pub. Zool.* 40(2):71–234.
Concise basic data on several species, including *Homo sapiens*, common to California and Hawai'i faunal list.

GROSS, B.
1957. "Observations on Rodent Plague in Hawaii." *Abstracts Symposium Pap., Ninth Pacific Sci. Cong.* (Bangkok), p. 241.
Reports *Rattus hawaiiensis* (= *exulans*) as the predominant plague-infected rodent in numbers and percentage. Presents host index data on fleas. Suggests flea control as an important plague suppressive measure.

GROSS, B., R. H. BAKER, and D. D. BONNET

1951. "Use of Warfarin-Treated Oats as a Plague Suppressive Measure in Hawaii." *Public Health Rep.* 66:1727–1733.

Tests in Hāmākua District, Hawai'i, showed other rats, but not *Rattus hawaiiensis* (= *exulans*) subject to control by warfarin. Author suggests differences in food preferences as a cause.

GROSS, B., and D. D. BONNET

1949. "Snap Traps versus Cage Traps in Plague Surveillance." *Public Health Rep.* 64:1214–1216.

Snap traps caught 4.9 times as many rats as cage traps in the same line. More cage-trapped animals had fleas than did snap-trapped animals, but more fleas were collected per trap day by use of snap traps.

GROUP 70

1980. *Revised Environmental Impact Statement for Hale Pohaku Mid-Elevation Facilities Master Plan, Hamakua, Mauna Kea, Hawaii.* Honolulu: Dept. Land and Natural Resources. 194 pp. + Appendixes A-E.

Contains useful biological information about Mauna Kea as related to development of astronomy support facilities at 9,400 feet elevation; record of public input.

1983. *Mauna Kea Science Reserve: Complex Development Plan. Final Environmental Impact Statement, Mauna Kea, Hamakua, Hawaii.* Honolulu: Research Corporation, Univ. Hawaii. 284 pp. + 53 pages of correspondence.

Projects facilities development through year 2000 for the 13,000-acre science reserve under lease by the University of Hawaii from State Department of Land and Natural Resources, for research in astronomy.

GUBLER, D. J.

1966. "A Comparative Study on the Distribution, Incidence, and Periodicity of the Canine Filarial Worms *Dirofilaria immitis* Leidy and *Dipetalonema reconditum* Grassi in Hawaii." *J. Medical Entomology* 3:159–167.

One or both parasites were found in 45.2 percent of blood smears from 666 dogs examined on five major islands. Adult stages were recovered from the heart and from subcutaneous tissue.

H. L. L. [H. L. LYON]

1914. "Birds and Bats for Hawaii." *Hawaii Planters' Rec.* 11:103–107.

Bats are discussed on pages 105–107. Caution is advised in selecting proper kinds of bats to introduce for insect control. Discusses artificial bat roosts in Texas, suggesting their adaptation to use in Hawai'i.

H. P. J. [H. P. JUDD]

1930. "The Goat Menace on Hawaii." *Friend* 100:193–194.

Reviews status of goat populations on the eight main islands, cites examples of serious damage by them, and suggests methods of control. Goats were a problem mainly on Hawai'i, but were reported eradicated only from Ni'ihau and Kaho'olawe.

HAAS, G. E.

1965a. "Comparative Suitability of the Four Murine Rodents of Hawaii as Hosts for *Xenopsylla vexabilis* and *X. cheopis* (Siphonaptera)." *J. Medical Entomology* 2:75–83.

Selected criteria from extensively replicated experiments in closed chambers ranked suitability in decreasing order for *X. vexabilis*: *Rattus exulans, R. norvegicus, R. rattus, Mus musculus*; for *X. cheopis*: *R. norvegicus, R. exulans, M. musculus.*

1965b. "Temperature and Humidity in the Microhabitat of Rodent Fleas in Hawaiian Cane Fields." *J. Medical Entomology* 2:313–316.

Rattus exulans and *Mus musculus* nests offer temperature and relative humidity suitable for continuous breeding by the flea, *Xenopsylla vexabilis*.

1966a. "Cat Flea-Mongoose Relationships in Hawaii." *J. Medical Entomology* 2:321–326.

Ecological, behavioral, and physiological evidence is presented to show that *Herpestes auropunctatus auropunctatus* is a true host of *Ctenocephalides felis*.

1966b. "A Technique for Estimating the Total Number of Rodent Fleas in Cane Fields in Hawaii." *J. Medical Entomology* 2:392–394.

Use of subterranean nest boxes for *Rattus exulans* and *Mus musculus* was combined with use of cage traps to provide data for estimates of the monthly total numbers of rodent fleas per hectare of sugar cane field.

1969. "Quantitative Relationships between Fleas and Rodents in a Hawaiian Cane Field." *Pacific Science* 23:70–82.

Studies of *Xenopsylla vexabilis* as a parasite of *Rattus exulans* and *Mus musculus*, employing nest box techniques.

HAAS, G. E., A. J. BECK, and P. Q. TOMICH

1983. "Bat Fleas (Siphonaptera: Ischnopsyllidae) of California." *Bull. So. California Acad. Sciences* 82(3):103–114.

Collections over a period of 40 years reveal only 12 of 23 bat species infested, by five taxa of fleas. None of the solitary, tree-roosting, or rare bats harbored fleas. Distribution maps, table of host-parasite associations.

HAAS, G. E., and P. Q. TOMICH

1966. "Survey Methods for Ectoparasites." World Health Organization Seminar on Rodents and Rodent Ectoparasites, Geneva, October 24–28. WHO/VC/217, pp. 181–184, mimeo.

Discusses the literature and techniques pertinent to field studies of fleas in plague research; based on studies performed by State of Hawaii Plague Research Unit at Honoka'a, island of Hawai'i.

HAAS, G. E., P. Q. TOMICH, and N. WILSON

1971. "The Flea in Early Hawaii." *Hawaiian J. History* 5:59–74.

Traces history of the cat flea (*Ctenocephalides felis*) as a pest of inhabited sites in Hawai'i as early as 1809. The text is largely anecdotal and in part inferential. Other flea species are considered.

HAAS, G. E., and N. WILSON

1967. "*Pulex simulans* and *P. irritans* on Dogs in Hawaii (Siphonaptera: Pulicidae)." *J. Medical Entomology* 4:25–30.

Domestic dogs were usually parasitized by larger numbers of the flea *Pulex simulans*, than by *P. irritans*. The feral pig was also a host of *P. irritans*. Ecological distribution of the fleas is mapped.

HAAS, G. E., N. WILSON, and P. Q. TOMICH

1972. "Ectoparasites of the Hawaiian Islands, I. Siphonaptera." *Contrib. American Entomological Institute* 8(5):1–76.

Identification, distribution, and host associations of the 10 species of fleas established in Hawai'i. These are almost exclusively parasitic on mammals. *Parapsyllus laysanensis* Wilson, from nests of albatross and shearwater, is described as new.

HADDEN, F. C.

1941. "Midway Islands." *Hawaiian Planters' Rec.* 45:179–221.

Author was HSPA quarantine inspector at Midway 1936–1941. Discusses history, land use, insects, and birds; mentions pig, cattle, donkey, and absence of rats.

HAFEZ, E. S. E. (Editor)
1968. *Adaptation of Domestic Animals.* Philadelphia: Lea and Febiger. 415 pp.
The physiology and biogeography of domestic mammals, worldwide.

HAIN, J. H. W., and S. LEATHERWOOD
1982. "Two Sightings of White Pilot Whales, *Globicephala melaena*, and Summarized Records of Anomalously White Cetaceans." *J. Mammalogy* 63:338–343.
First recorded examples for this species. Tabulates examples of probable albinism in 12 additional cetaceans. Discusses possible genetic bases for white coloration.

HALE, C. S., and K. MYERS
1970. *Utilization of the Grooming Habit for Poisoning Rabbits.* Australian C.S.I.R.O. Div. Wildlife Res. Tech. Memo. 2. 19 pp.
Explores use of compound 1080 mixed with lanolin spread in rabbit warrens, and ingested by rabbits in cleaning feet, as a means of control.

HALEY, DELPHINE (Editor)
1978. *Marine Mammals of the Eastern North Pacific and Arctic Waters.* Seattle: Pacific Search Press. 256 pp.
Accounts of cetacean species (through p. 144) with range maps and photos, including Hawaiian region, by various authors. Readable and informative. Northern elephant seal, pp. 206–211, and monk seal, pp. 212–216.

HALL, E. O.
1873. Letter dated October 1, 1873, to Acting Governor R. A. Lyman. Interior Dept. Translations, Book 12. Honolulu, Archives of Hawaii.
Suggests that a request be granted for a Mr. Siemsen to use Coconut Island, in Hilo Bay, for "propagating of rabbits for a proper compensation, without giving Mr. Siemsen any control power of the island in question."

HALL, E. R.
1963. "Introduction of Exotic Species of Mammals." *Proc. 16th International Cong. Zoology* 1:267.
Discusses various aspects of transfer of large and small mammals between continents. "Introducing an exotic species is a destructive action resulting from the ignorance of well-meaning persons . . . is unscientific, economically wasteful, politically short-sighted, and biologically wrong."
1965. "Names of Species of North American Mammals North of Mexico." *Univ. Kansas Mus. Natural History Misc. Pub.* 43:1–16.
Lists common and scientific names of wild American mammals, designed to establish a standard for application of vernacular names at the species level.
1981. *Mammals of North America.* New York: Wiley. Vols. 1, 2. 1181 pp.
Revision of Hall and Kelson, 1959 (New York: Ronald Press). Basic taxonomic work.

HALL, E. R., and J. K. JONES, JR.
1961. "North American Yellow Bats, *Dasypterus*, and a List of the Named Kinds of the Genus *Lasiurus* Gray." *Univ. Kansas Mus. Natural History Pub.* 14:73–98.
Lists (pp. 93–95) all known species of *Lasiurus*, authority, date, and available information on type locality.

HALL, H. F., and M. R. PELTON
1979. "Abundance, Distribution and Biological Characteristics of Free-roaming House Cats in Northeastern Tennessee, USA." *Carnivore* 2:26–30.

Cats were studied at 48 sites in a three-county area. Numbers captured were exceeded only by those of opossums, at 5.8/100 trap nights. Adverse impact by cats on local wildlife was probable.

HALL, L. S.

1977. "Feral Rabbits on San Juan Island, Washington." *Northwest Science* 51:293–297.

A gradient was observed from plentiful in the south end, to few or no rabbits in the north end, caused by a combination of vegetation, soils, and rainfall. Land use patterns favor continued existence of rabbits. Many other data are reported.

HALL, W. L.

1904. "The Forests of the Hawaiian Islands." *Planters' Monthly* 23:355–380.

Excellent summary of conditions on five major islands in that era. Lowland forest monotypic (introduced *Prosopis*); upland was any of five types of native trees, or mixture of several. Basic philosophy of forest protection and use is classical and bears study.

HALLORAN, A.

1972. *The Hawaiian Longhorn Story.* Hilo: Petroglyph Press. 22 pp.

Broad historical account of wild cattle in Hawai'i; includes photos of trophy heads and horns, and of present-day feral stock. Lists colors of known specimens.

HAMPTON, I. F. G., and G. C. WHITTOW

1976. "Body Temperature and Heat Exchange in the Hawaiian Spinner Dolphin, *Stenella longirostris.*" *Comp. Biochem. Physiol.* 55A:195–197.

Exacting physiological studies. Free-swimming subjects maintained deep-body temperatures between 36.1° and 37.9°C (means 37.4°, SE ± 0.03°). Conclude that small dolphin species live near lower critical body temperatures, requiring constant activity.

HANCE, F. E.

1938. "Selenium—I." *Hawaiian Planters' Rec.* 42:197–210.

General consideration of properties of the element, its absorption by plants, and its effects on grazing animals eating poisoned forage. *Koa haole* (*Leucaena glauca*) in Hawai'i may carry high concentrations of selenium in some districts.

HANDLEY, C. O.

1966. "A Synopsis of the Genus *Kogia* (Pygmy Sperm Whales)." *In*: K. S. Norris (editor), 1966, pp. 62–69.

Traces nomenclature, narrowing to the present two species worldwide. Some notes on abundance and distribution, biology, and behavior.

HANDY, E. S. C.

1940. *The Hawaiian Planter.* Vol. 1. B. P. Bishop Mus. Bull. 161. 227 pp.

Thorough treatise on plants used on all islands, and methods and areas of cultivation. Discusses (p. 8) the belief that taro is spread to inaccessible ledges by rats carrying small corms away for food. Rat (p. 149) was the chief pest of sweet potato growers. Refers to a presumed seasonal migration of rats to and from lowland fields.

HANDY, E. S. C., and ELIZABETH G. HANDY

1972. *Native Planters in Old Hawaii: Their Life, Lore, and Environment.* B. P. Bishop Mus. Bull. 233. 641 pp.

Extensive revision of Handy (1940), with collaboration of Mary K. Pukui. Dog, goat, and hog are discussed (pp. 242–253).

HANSON, R. P., and L. KARSTAD

1959. "Feral Swine in the Southeastern United States." *J. Wildlife Mgmt.* 23:64–74.

Comprehensive review of history and ecology of the feral pig in the region from Texas to North Carolina; 25 references.

HAPGOOD, F.
1984. "Fruit Fly Fandango." *Science 84* 5(7):68–74.
A sly and authentic vignette of *Drosophila* research and researchers in Hawaii. The "Kaneshiro effect" of female receptivity of males is explained for its place in evolution. Photos by R. A. Mendez.

HARADA, W.
1967. "Isle Rabid Animal Account Increases." *Sunday Star-Bulletin and Advertiser*, October 8, pp. 1, A-1A.
Reports total of seven infected animals, shows map of locations and species, gives warnings and instructions in relation to diseased animals, and indicates ban on interisland transport of animals.

HART, J.
1982. "B. C." *Hawaii Tribune-Herald*, August 9, p. 11.
A cartoon parody with an imputed relationship of horsemeat in the diet to counting by footstomping.

HARTT, CONSTANCE E., and MARIE C. NEAL
1940. "The Plant Ecology of Mauna Kea, Hawaii." *Ecology* 21:237–266.
Account of ecological and floristic features of the summit area of Mauna Kea. Excellent background for management work. Extensive plant lists, history, photos.

HARVEY, A. G.
1947. *Douglas of the Fir*. Cambridge: Harvard Univ. Press. 290 pp.
A biography of David Douglas (1799–1834), the intrepid Scottish botanist and mountain climber. Pages 212–247 describe his travels in Hawai'i, his tragic death in a cattle pit, and the tributes made to his memory.

HASELWOOD, E. L., and G. C. MOTTER (Editors)
1983. *Handbook of Hawaiian Weeds*. Honolulu: Univ. Hawaii Press. 504 pp.
A second edition, revised by Robert Hirano of Lyon Arboretum. Nomenclature conforms with standard list (St. John, 1973). Illustrated.

HASTINGS, BARBARA
1985. "Oahu's Wallabies are on the Rocks: New Species May Die Unrecorded." *Honolulu Advertiser*, April 8, pp. A-3, A-5.
In spite of protected status, some are shot, dogs prey on others, and drought may be an additional factor in reduction of population to fewer than 40 animals.

HATT, R. T.
1959. *The Mammals of Iraq*. Mus. Zoology, Univ. Michigan, Misc. Pub. 106. 113 pp.
Comprehensive report on present and extinct forms and their historical record. Excellent data on domesticated species.

HAUGEN, K.
1976. "Hokulea Dog to Tahiti." *Honolulu Star-Bulletin*, July 31, p. A-9.
The Polynesian Voyaging Society voted to send the dog *hōkū* (meaning star) back to Tahiti, from Honolulu where it was remanded to quarantine after the round trip to Tahiti on the Polynesian voyaging canoe *Hōkūle'a*.

HAWAII AUDUBON SOCIETY

1970. "Axis Deer." *'Elepaio* 31:14–17.

Abstracts from *Honolulu Star-Bulletin* relative to tuberculosis in axis deer on Moloka'i, noting that 1961 was year of previous detection. Following articles relate experiences of George Munro with axis deer on Moloka'i and Lāna'i.

1972a. "Again? Axis Deer? Yes" *'Elepaio* 32:83–88.

A series of reports and opinions concerning axis deer introductions from such sources as Animal Species Advisory Commission, Russell Apple, *Honolulu Star-Bulletin*, F. Raymond Fosberg, and J. Kenneth Baker, with HAS commentary.

1972b. *'Elepaio* 32:105.

Letter from Dr. Otto Degener dated February 23 concerning damage to native plants on Moloka'i and Lāna'i as a result of browsing by hoofed animals, including the axis deer. Compares 1930 Munro plant collections with Degener collections of 1964, on Lāna'i.

1973. "Axis Deer TB Reappears on Molokai." *'Elepaio* 33:99–100.

Reprint of *Star-Bulletin* article by Helen Altonn. A new case of bovine tuberculosis is reported in axis deer July 1972; others had occurred in October 1971 and March 1970, all from deer on private land.

1974. *'Elepaio* 34:103–105.

Three notes and reprints of newspaper articles on status of plan for introduction of axis deer to Big Island. Animal Species Advisory Commission, *Honolulu Star-Bulletin*, and DLNR are involved.

1981. "I Told You So." *'Elepaio* 41:87.

Brief editorial followed by reprinted letters of Otto Degener to Honolulu newspapers, cogent if perhaps overdrawn, as early warning about the introduction of the barn owl to Hawai'i and likely consequences. The owl is characterized as a "mongoose with wings."

1982. "The Haleakala Goat Problem." *'Elepaio* 41:18–19.

Notes that proposed fencing program is lost to cutbacks in NPS construction projects, which are limited to those "dealing with human health and safety issues."

HAWAII LIBRARY ASSOCIATION

1965. *Union List of Serials in Libraries of Honolulu*. 3rd edition. Honolulu: Hawaii Library Assoc. 624 pp.

A record of serial holdings in 21 library collections; an invaluable aid to library research.

HAWAII STATE LEGISLATURE

1970. "A Bill for an Act Relating to Preservation of Natural Resources by Providing for a System of Natural Areas." Act 139. S.B. No. 1971–70.

Adopted as Chapter 195, Revised Laws of Hawaii, sections 195-1 through 195-8, June 22, 1970. Establishes an advisory Natural Area Reserves System Commission consisting of 11 members.

1977. *Kaho'olawe: Aloha No.* Honolulu: Interim Committee on Kahoolawe. 291 pp.

A legislative study of the island of Kaho'olawe. Chapter 10, pp. 183–199, is entitled "Conservation," a comprehensive historical review with species lists, and emphasis on goats and goat control. "Chronology of Events," pp. 40–54, is of interest.

HAYASHI, T., and G. N. STEMMERMANN

1972. "Lipid Pneumonia in the Hawaiian Feral Mongoose." *J. Pathology* 108:205–210.

Describes changes in lungs of mongooses afflicted with lipid pneumonia and draws parallels with this condition in humans.

HEIZER, R. F., and M. A. BAUMHOFF

1959. "Great Basin Petroglyphs and Prehistoric Game Trails." *Science* 129:904–905.

Strongly suggests that "rock-writings" in Nevada are connected with hunting magic, and are located along routes of deer migration.

HENKE, L. A.

1929. *A Survey of Livestock in Hawaii.* Univ. Hawaii Res. Pub. 5. 82 pp.

Comprehensive review divided into three parts: (1) historical; (2) the leading beef ranches; and (3) current status of livestock. This report is well documented from the Archives of Hawaii and other sources.

HENRY, V. G.

1968. "Length of Estrous Cycle and Gestation in European Wild Hogs." *J. Wildlife Mgmt.* 32:406–408.

Normal estrus occurs every 21 to 23 days and lasts about 2 days. Eighty percent of 41 recorded gestational periods ranged from 114 to 118 days. These figures are comparable to those obtained from domestic swine.

1969. "Estimating Whole Weights from Dressed Weights for European Wild Hogs." *J. Wildlife Mgmt.* 33:222–225.

Males lost 21.4 percent and females 23.5 percent from field dressing, as determined from 121 pigs examined. Regression charts are provided.

HENSHAW, H. W.

1911. "Our Mid-Pacific Bird Reservation." *U. S. Dept. Agriculture Year Book for 1911*, pp. 155–164.

A report based on the Nutting Expedition to Laysan in 1911, with an account of the establishment in 1909 of the Hawaiian Islands Bird Reservation. Historical notes mention rabbits and emphasize results of the plume hunters' activities.

1918. "A Mid-Pacific Bird Reservation." *Mid-Pacific Mag.* 15:282–285.

Briefly describes the Hawaiian Islands Bird Reservation. Deplores presence of rabbits on Laysan for their threat to the vegetation, flora, and bird life. Author was Chief, U. S. Biological Survey.

HERMAN, L. M.

1979. "Humpback Whales in Hawaiian Waters: A Study in Historical Ecology." *Pacific Science* 33:1–15.

The humpback whale is identified as an invader of Hawaiian waters only within the past 200 years, and most likely was unknown to the Hawaiians of prehistory. Whaling pressures in other Pacific regions and long-term changes in ocean temperatures may have induced the whales to adopt Hawaiian wintering grounds.

HERMAN, L. M. (Editor)

1980. *Cetacean Behavior.* New York: Wiley-Interscience. 463 pp.

Definitive source on behavior, including social integration, communication and cognitive behavior. Part of work based on studies in Hawai'i.

HERMAN, L. M., and R. C. ANTINOJA

1977. "Humpback Whales in the Hawaiian Breeding Waters: Population and Pod Characteristics." *Scientific Rep. Whales Res. Inst.* 29:59–85.

A landmark paper reporting on concentration and more general distribution. Population was 200–250 animals, but recruitment a low 10 percent per year. Human harassment is of concern. World population is reviewed.

HERMAN, L. M., C. S. BAKER, P. H. FORESTELL, and R. C. ANTINOJA

1980. "Right Whale *Balaena glacialis* sightings near Hawaii: a Clue to Wintering Grounds?" *Marine Ecol. Progr. Ser.* 2:271–275.

Enlarges on records of sightings in Hawaiian waters. Suggests that Hawai'i may have been a

prominent breeding area of the right whale, and that its place is taken by the more recently established humpback whale.

HERMAN, L. M., P. H. FORESTELL, and R. C. ANTINOJA
1980. *The 1976–77 Migration of Humpback Whales into Hawaiian Waters: Composite Description.* Washington, D.C.: Marine Mammal Commn. Rep. MMC-77/19. 54 pp.
Analysis of 928 observer-network whale sightings from air, sea, and shore, period January 7–April 20, 1977. Peak sightings in third week of February. Social groupings, including escort whales accompanying mothers with calves, are described. Human harassment factor is evaluated.

HERRON, M.
1976. "A Not-altogether Quixotic Face-off with Soviet Whale Killers in the Pacific." *Smithsonian* 7(5):22–31.
A vivid account of the voyage of the *Phyllis Cormack*, the Greenpeace Foundation vessel, and their means of protesting factory ship whaling. Photos by Rex Weyler.

HERSHKOVITZ, P.
1966. *Catalog of the Living Whales.* U. S. National Mus. Bull. 246. 259 pp.
Summarizes the difficult and chaotic nomenclature of the Cetacea. Includes an exhaustive treatment of the literature, and employs a modern phylogenetic sequence based on dental characters and adaptive specialization.

HESS, A. D.
1957. "Comments on the Plague Control Program of the Territory of Hawaii." Dept. Health, T. H., Honolulu, Field Rep. 7 pp., mimeo.
Reviews history of disease and its control. Recommends an acceleration of research to support eradication of plague, which then seemed to be feasible.

HESTER, R. J., J. R. HUNTER, and R. R. WHITNEY
1963. "Jumping and Spinning Behavior in the Spinner Porpoise." *J. Mammalogy* 44:586–588.
Motion picture analyses of a leaping captive indicate maximum free flight of 1.25 seconds, rise of 6 feet, and speed of 14 miles per hour. Spinning sequence is figured.

HIGA, H. H., and I. T. FUJINAKA
1976. "Prevalence of Rodent and Mongoose Leptospirosis on the Island of Oahu." *Public Health Rep.* 91:171–177.
Infection rates ranged from 19.0 to 33.3 percent, by species, in 845 rodents and 282 mongooses tested. Four serotypes were isolated.

HIGA, H. H., W. T. MATSUURA, and W. H. WATANABE
1971. "Plague Antibody Response in the Mongoose." *Hawaii Medical J.* 30:92–94.
Inoculation with avirulent plague organisms stimulates antibody formation in the mongoose, suggesting that this animal, consuming plague infected rats in the field, could be a useful indicator of natural plague infection.

HIGASHINO, P. K., and C. P. STONE
1982. "The Fern Jungle Exclosure in Hawaii Volcanoes National Park: 13 Years without Pigs in a Rain Forest." *In*: C. W. Smith (editor), 1982a, p. 86.
Summarizes changes showing increase of native vegetation inside a 900 m^2 exclosure and decline on the outside, with increase of exotics.

HILL, J. E., and J. D. SMITH
1984. *Bats: A Natural History.* Austin: Univ. Texas Press. 243 pp.

Well-recommended tome on biology of bats. Includes chapters on origin, evolution, and relationships of bats to man.

HILLEBRAND, W.

1856. "Annual Address." *Trans. Royal Hawaiian Agricultural Soc.* 2(3):13–41. (Reprinted in *Hawaiian Planters' Rec.* 22:174–200.)

Scholarly discussion of land use in Hawai'i. Reviews the fate of Asian and European forests, and from examples and indicators studied locally, warns against a similar fate for Hawaiian forests.

1888. *Flora of the Hawaiian Islands.* Heidelberg: Carl Winter. 673 pp. Facsimile edition (1965), New York: Hafner.

A classical work in basic botany and in Hawaiian plants, published after the author's death in 1886.

HILLINGER, C.

1977. "Wild Burros Overrunning National Parks." *Honolulu Advertiser*, November 25, p. G-1.

Reports, for western states, local devastation of heavily used lands and historical sites. Shooting for control has stimulated various animal protection societies to lobby for "saving" the burros, which has been successful—and expensive of public monies.

HILTON, H. W., W. H. ROBINSON, and A. H. TESHIMA

1972. "Zinc Phosphide as a Rodenticide for Rats in Hawaiian Sugarcane." *Proc. 14th Cong. Internatnl. Soc. Sugar Cane Technologists*, pp. 561–570.

Reports zinc phosphide as the first rodenticide registered under federal regulation (EPA) for broadcast application over a food crop. Residues degrade rapidly and are not translocated into the growing sugar cane plant.

HINDS, N. E. A.

1930. *The Geology of Kauai and Niihau.* B. P. Bishop Mus. Bull. 71. 103 pp.

Basic work on physical description of these islands. Refers also briefly to Lehua and Ka'ula islets as isolated tuff cones.

HINTON, H. E., and A. M. SARAH DUNN

1967. *Mongooses: Their Natural History and Behaviour.* Berkeley: Univ. California Press, 144 pp.

Reviews title subjects and folklore, largely from library research. Includes data on *Herpestes auropunctatus* in Hawai'i. Contains many illustrations of the various species of true mongooses, and 259 references; indexed. Reviewed by P. Q. Tomich (1968), *J. Mammalogy* 49:797.

HIRATA, D. N.

1977. "Species Composition of Rats on Mauna Kea Sugar Company from 1967 through 1976." *Hawaiian Sugar Technologists 1977 Report*, pp. 91–94.

Change from use of anticoagulants in rat control programs to use of zinc phosphide in 1970–1971 resulted in a rise in numbers of the Norway rat, and reduction in numbers of the Polynesian rat. This may reflect differentials in the relative efficacy by species, for these two standard toxicants. Numbers of roof rats remained stable at low densities.

HIRATA, D. N., and R. D. NASS

1974. "Growth and Sexual Maturation of Laboratory-reared Wild *Rattus norvegicus*, *R. rattus*, and *R. exulans* in Hawaii." *J. Mammalogy* 55:472–474.

Young were reared from pregnant field-caught rats, weaned at about four weeks, and weighed through 20 weeks of growth. A range of ages and weights at maturity was demonstrated.

HOBBS, JEAN F.

1939. "Our Fourth Industry Is Livestock." *Hawaiian Annual for 1939*, pp. 95–110. Honolulu: The Printshop Co.

A substantial historical account of horses and cattle in Hawai'i. Mexican cowboys (the original "*paniolo*") first arrived in Waimea, on Hawai'i, in 1832. Quotes Eben "Raw-Hide Ben" Low (pp. 97–100) for a colorful sketch of early-day wild cattle roping by the hard-riding hide hunters, and the later capture of an elusive bull by Low, in 1891.

HOFFMEISTER, D. F.

1953. "A Plea for Uniformity of Common Names of Mammals." *J. Mammalogy* 34:285.

Presents the problem of a lack of a standard list of common names for American mammals. Suggests adoption, without change, of a list in a recently published field guide, which applies common names at the species level.

HOFMAN, R. J., and W. N. BONNER

1985. "Conservation and Protection of Marine Mammals: Past, Present, and Future." *Marine Mammal Science* 1:109–127.

Historical review noting the gradual formulation of policy and philosophy of the present day.

HOLLINGSWORTH, LOUISE

1938. "The Kahoolawe Boom of 80 Years Ago." *Honolulu Star-Bulletin*, July 16, Feature Sec., p. 1.

Full-page article from material derived by the Territorial Archivist, Maude Jones, from correspondence of Robert C. Wyllie. Wyllie drew a lease on Kaho'olawe in 1858 for 20 years, at $505 per year. The venture failed in 1859 when "scab" became rampant in the stock of sheep. On May 13, 1859, sheep count was 2,075.

HOLLINGSWORTH, R. J.

1853. "Report of the Committee on Swine." *Trans. Royal Hawaiian Agricultural Soc.* 1(4):74–76.

Recommends that pig farming be better organized, and that stock be kept in a semiferal state to produce the largest amount of pork at the least expense.

HOLLIS, R.

1985. "Half 'n' Half: Hapa Baby Born to Sea Life Whale and Dolphin." *Sunday Star-Bulletin and Advertiser*, May 19, p. A-1.

Reports birth of a hybrid false killer whale x bottlenose dolphin (male *Pseudorca*, female *Tursiops*) at Sea Life Park, O'ahu. Only one previous such live birth is noted, from Japan. One photo.

HONACKI, J. H., K. E. KINMAN, and J. W. KOEPPL

1981. *Mammal Species of the World: A Taxonomic and Geographic Reference.* Lawrence: Allen press. 694 pp.

A standard reference to mammalian nomenclature. Compiled with aid of 200 mammalogists in 23 countries.

HONE, J.

1980. "Probabilities of House Mouse (*Mus musculus*) Plague and Their Use in Control." *Australian Wildlife Res.* 7:417–420.

With estimates of probabilities for occurrence of high mouse populations, based on rainfall patterns, develops decision analysis for control strategy related to cost factors.

HONE, J., and H. MULLIGAN

1982. *Vertebrate Pesticides.* Dept. Agriculture, New South Wales, Science Bull. 89. 130 pp.

A review of 38 pesticides used against a wide variety of vertebrate pests. Properties, action, usage, and status are given in tabular form. Extensive world bibliography.

HONE, J., and J. O'GRADY

1980. *Feral Pigs and Their Control.* New South Wales Dept. Agriculture, Div. Animal Production Bull. A 4.1.1. 23 pp.

Deals with agricultural impact, biology and control methods, emphasizing trapping and baiting techniques possibly applicable in Hawai'i.

HONE, J., J. O'GRADY, and H. PEDERSEN

1980. *Decisions in the Control of Pig Damage.* New South Wales Dept. Agriculture. AG Bull. 5. 22 pp.

A practical guide to procedures for cost analysis and other aspects of pig control relative to crop depredation, disease transmission, and the habits of pigs.

HOOD, G. A., R. D. NASS, and G. D. LINDSEY

1970. "The Rat in Hawaiian Sugarcane." *Proc. Fourth Vert. Pest Control Conf.*, West Sacramento, CA, pp. 34–37.

Reviews cycle of sugar cane crop as it relates to cover and food sources for rats.

HOPKINS, C. G.

1854. "Report of the Committee on Horses." *Trans. Royal Hawaiian Agricultural Soc.* 2(1):105–106.

Protests poor quality and management of horses in Hawai'i, and encourages improvement of breeding stocks. Reflects progressive attitude of this early period in agriculture.

HORIO, R. S., and J. E. ALICATA

1961. "Parasitic Meningo-Encephalitis in Hawaii: A New Parasitic Disease of Man." *Hawaii Medical J.* 21:139–140.

Case report of human infection with the rat lungworm, *Angiostrongylus cantonensis*, from voluntary consumption of raw garden slugs (*Veronicella leydigi*) as a folk remedy.

HOSSACK, W. C.

1907. *Aids to Identification of Rats Connected with Plague in India, with Suggestions as to the Collection of Specimens.* Allahabad: Pioneer Press, Indian Mus. 10 pp.

Mus concolor (= *Rattus exulans*) is referred to as the little Burmese rat, in a rodent list (p. 6).

HOSTETLER, H.

1972. "Antelope-Hunting Plan on Molokai." *Honolulu Advertiser*, March 1, p. 1.

Notes that informal public and professional input had been made to the African Game Farm plan, with some concern about the ability of fences to hold some larger species.

HOWARD, W. E.

1959. *The Rabbit Problem in New Zealand.* New Zealand Dept. Scientific and Industrial Res., Info. Ser. 16. 45 pp.

A fresh view of a long-standing serious ecological difficulty. Summarizes historical aspects, rabbit biology, habitats, control measures.

1965. *Control of Introduced Mammals in New Zealand.* New Zealand Dept. Scientific and Industrial Res., Info. Ser. 45. 96 pp.

Because certain problem species cannot be eradicated, long-term objective should be to properly control and manage these as needed, to maintain habitat integrity.

HOWARTH, F. G.
1981. "Community Structure and Niche Differentiation in Hawaiian Lava Tubes." *In*: Mueller-Dombois, Bridges, and Carson (editors), *Island Ecosystems*, Chap. 7, pp. 318–336. US/IBP Synthesis Series, 15.

Describes a newly discovered complex ecosystem. In the dark zone of one large cave, 10 species of obligate (troglobitic) cavernicolous arthropods were described as new to science. The animals are generally unpigmented, with reduced eyes, and fragile.

HOWARTH, F. G., and S. L. MONTGOMERY
1980. "Notes on the Ecology of the High Altitude Aeolian Zone on Mauna Kea." *'Elepaio* 41:21–22.

In the summit region wind-drifted insects from lower elevations are concentrated by large surface boulders and provide food for a remarkably adapted predatory bug (*Nysius*) and several spiders.

HOYT, E.
1977. "*Orcinus orca*: Separating Facts from Fantasies." *Oceans* 10:23–26.

Popular account of the killer whale and man off Vancouver Island, B.C.; reputed numbers, diet, relations to man.

HSU, T. C., and K. BENIRSCHKE
1967–1977. *An Atlas of Mammalian Chromosomes*. Vols. 1–10. New York: Springer-Verlag. Folios 3–518.

Karyotype maps of an abundance of species, with notes on origins of materials used for each particular folio. Explanations given in introduction to Vol. 10.

HUBBS, C. L.
1951. "Eastern Pacific Records and General Distribution of the Pygmy Sperm Whale." *J. Mammalogy* 32:403–410.

Records of occurrence of *Kogia breviceps* along the Pacific American coasts; excellent description and five photographs of California specimens.

HUBBS, C. L., W. F. PERRIN, and K. C. BALCOMB
1973. "*Stenella coeruleoalba* in the Eastern and Central Tropical Pacific." *J. Mammalogy* 54:549–552.

First report of this species in Hawai'i, from a specimen taken in 1958. Range map and photographs.

HUBBS, E. L.
1951. "Food Habits of the Feral House Cat in the Sacramento Valley." *California Fish and Game* 37:177–189.

Reviews information on feral cats in general. In a rich agricultural area cats ate largely rodent pests, but also took significant numbers of small game mammals, game birds, and song birds.

HUDNALL, J.
1978. "Whale Park." *Oceans* 11(2):8–15.

A report on the behavior of humpback whales near Hawai'i and the need for creation of a sanctuary in waters off Maui. Underwater photos in color. Author's interests date from 1974. Includes data on whales and hydrofoil passenger vessels.

HUGHES, J.
1963a. "Fight for Axis Deer on Big Island Is More than Decade Old." *Hilo Herald-Tribune*, March 25, p. 2.

Announces introduction of legislative bill to provide for bringing 50 deer to Hawai'i Island.

Reviews the problem from standpoint of biologist's report (Nichols, 1960a), and current attitudes of landholders. Sets stage, as it were, for ensuing strife.

1963b. "Biologist Balks at Recent Reports on Axis Deer." *Hilo Tribune-Herald*, April 22, p. 8.

L. Nichols, Jr., takes issue with accuracy of statements previously published in the newspaper, pointing in detail to various fallacies that are refuted by actual biological evidence gathered by qualified researchers. Lyon's paper, discussed at length, is apparently that of H. L. Lyon (1950).

HUGHES, MAXINE

1981. "Young Puna Man Turned On to Goat Farming." *Hawaii Tribune-Herald Orchid Isle*, October 4–10, pp. 2, 24.

Details of modern milk production unit with 28 animals primarily of Nubian stock.

HUI, C. A., and S. H. RIDGWAY

1978. "Survivorship Patterns in Captive Killer Whales (*Orcinus orca*). *Bull. So. California Acad. Sciences* 77:45–51.

Oceanarium captives (data from more than 30 animals) showed a 7.0 percent per year mortality rate in females and a 2.1 percent rate in males. Females captured when young appeared to make the best adjustment to captivity.

HUSSON, A. M., and L. B. HOLTHUIS

1974. "*Physeter macrocephalus* Linnaeus, 1758, the Valid Name for the Sperm Whale." *Zool. Meded. Rijkmus. Natural History* 48:205–217.

Detailed review of early literature. Adduces synonymy *Physeter macrocephalus* Linnaeus, 1758 (=*P. catodon* Linnaeus, 1758).

ILLINGWORTH, J. F.

1931. "Entomology." *In*: *Report of the Director for 1931*. B. P. Bishop Mus. Bull. 82, pp. 18–20.

First to point out that *Rattus exulans* was, contrary to popular belief, still abundant, at least on O'ahu. Concluded that the species was doing well, especially away from human populations.

IMBER, W., and K. B. CUMBERLAND

1977. *New Zealand: Pacific Land Down Under*. New York: J. J. Binns. 283 pp.

A full geographic treatment highly suitable for comparisons with Hawaii. Lavish photographic illustration by Imber. Text contributions of eight faculty members, University of Auckland. 113 photos.

INESON, M. J.

1954. "A Comparison of the Parasites of Wild and Domestic Pigs in New Zealand." *Trans. Royal Soc. New Zealand* 82:579–609.

Many species of protozoans, helminths, and arthropods were found. Incidence of infestation is correlated with habits of feral and domestic pigs in their respective habitats.

INSTITUTE FOR TECHNICAL INTERCHANGE

1968. *Rodents as Factors in Disease and Economic Loss*. Proceedings of a Conference held June 17–27 in Hawaii. Honolulu: East-West Center. 285 pp.

Contains papers by 50 participants, summarizing research and control activities from the Asian and Pacific regions. Comprehensive reports on the state of the art, grouped under six headings.

ISSA, M., G. W. ATHERTON, and C. E. BLANK

1968. "Chromosomes of the Domestic Rabbit, *Oryctolagus cuniculus*." *Cytogenetics* 7:361–375.

Detailed analysis of karyotype in the domestic rabbit. The chromosome number ($2n = 44$) was established in 1926.

JACKSON, H. H. T.

1921. "A Mongoose in Kentucky." *J. Mammalogy* 2:234–235.

Reports a live mongoose of "the same species . . . introduced into Cuba, Porto Rico, and several other places," caught November 18, 1920, at Midway, Woodford County, under a haystack. The skin was preserved.

JACKSON, W. B.

1951. "Food Habits of Baltimore, Maryland, Cats in Relation to Rat Populations." *J. Mammalogy* 32:458–461.

Reports on cats in slum area by examination of 500 stools. Diet contained 6.7 percent rat remains (*Rattus norvegicus*), not a significant factor in rat population control. Estimates of cat and rat abundance are presented.

1965. "Litter Size in Relation to Latitude in Two Murid Rodents." *American Midland Naturalist* 73:245–247.

Presents data on *R. rattus* and *R. exulans* from several world regions. Litter size in both species increases with latitude. *R. exulans* from Hawai'i is represented.

1969. "Survival of Rats on Eniwetok." *Pacific Science* 23:265–275.

Analysis of earlier data and a review of long term effects of atomic detonations 1946–1958.

JACOBI, J. D.

1976. "The Influence of Feral Pigs on Native Alpine Grasslands in Haleakala National Park." *In*: C. W. Smith (editor), 1976, pp. 107–112.

In a two-year period pigs rooted 23.3 percent of the surface in a 120-ha area (the largest native grassland in Hawai'i). Exotics are established in disturbed ground and may be supplanting native species.

1980. "Problems with the Long-term Maintenance of Mamane (*Sophora chrysophylla*) in the Central Crater Area of Haleakala National Park." *In*: C. W. Smith (editor), 1980, pp. 167–169.

Formerly cattle and goats, presently goats, with a new threat by an expanding axis deer population outside the Park, are noted among elements of concern in chronic damage to the *māmane*. Fencing, as in the plan for Hawaii Volcanoes National Park, is recommended.

JAH, SHARON

1983. "The Whale Song." Unpublished ms., Honokaa School, 1 p.

Lyrics and accompanying tune composed in a first grade classroom (see Fig. 76).

JAKSIĆ, F. M., E. R. FUENTES, and J. L. YAÑEZ

1979. "Spatial Distribution of the Old World Rabbit (*Oryctolagus cuniculus*) in Central Chile." *J. Mammalogy* 60:207–209.

Relates use of shrubs as cover to intensity of predation on rabbits by various birds and mammals.

JAKSIĆ, F. M., and R. C. SORIGUER

1981. "Predation upon the European Rabbit (*Oryctolagus cuniculus*) in Mediterranean Habitats of Chile and Spain: A Comparative Analysis." *J. Animal Ecology* 50:269–281.

An example of studies of the rabbit in its native hot summer habitat with comparative data from populations introduced to a similar habitat of South America, but under different conditions of predation, with marked behavioral changes in the rabbits.

JAMES, HELEN F., and S. L. OLSON

1983. "Flightless Birds." *Natural History* 92(9):30–40.

Evidence from Hawai'i suggests that flightless birds may have been numerous also on other Pacific islands. At least 45, perhaps more, defenseless species have vanished from Hawai'i in recent times with the occupancy of man.

JANZEN, D. H.

1978. "How Do Horses Find Their Way Home?" *Biotropica* 10:240.

Observation of a pack horse following the track of a companion, partly on a wave-washed beach, suggests olfactory cues were of importance when found.

JARVES, J. J.

1843. *History of the Hawaiian or Sandwich Islands.* Boston: Tappan and Dennet. 407 pp.

Presents (pp. 98–107) a plausible account of evidence for pre-Cook European contact, stating (p. 98), "Not a reasonable doubt can exist that the Hawaiian islands were visited by Europeans two centuries or more before the Cook era."

JEHL, J. R., JR.

1984. "Comings and Goings on a Desert Island." *Natural History* 93(2):6–12.

Chronology of extinctions and recolonizations of birds as related to available water and introduction of the house cat, at Socorro Island off Mexico.

JOHNSINGH, A. T. J.

1981. "Importance of Fruits in the Diet of the Chital in Dry Season." *J. Bombay Natural History Soc.* 78:594.

Rumen contents of seven axis deer were 13 to 70 percent fruits. After the rains the deer turned to newly growing grasses for food.

JOHNSON, A. M., R. L. DELONG, C. H. FISCUS, and K. W. KENYON

1982. "Population Status of the Hawaiian Monk Seal (*Monachus schauinslandi*), 1978." *J. Mammalogy* 63:415–421.

Formal statement of the predicament of this seal. Decline after 1958 occurred at all the sites except French Frigate Shoals, where numbers increased and stabilized.

JOHNSON, D. H.

1944. "Geographical Affinities of the Mammals of the Hawaiian Islands and of New Zealand." *J. Mammalogy* 25:333–336.

Considers mammals that were present in the two respective regions before European contact late in the eighteenth-century. Bats came from nearest continent; seals were influenced by latitude; other groups were Asian, transported by man.

1946. "The Rat Population of a Newly Established Military Base in the Solomon Islands." *U. S. Naval Medical Bull.* 46:1628–1632.

Describes invasion of *Rattus exulans* from native villages into new military camps, and the immigration to the same areas of *R. rattus*, from other islands. *Rattus praetor* was present; *Mus* was absent.

JOHNSON, E.

1850. "Remarks on Fences." *Trans. Royal Hawaiian Agricultural Soc.* 1(1):73–76.

Want of livestock fences (p. 73) was already a source of difficulty in Hawai'i. Discusses responsibility for fence building, means, and materials. Stone, wood, and hedges are mentioned as materials.

JOHNSON, M. S.

1945. "Rodent Control on Midway Islands." *U. S. Naval Medical Bull.* 45:384–398.

Original report on the serious ecological consequences resulting from invasion of Midway Islands by the roof rat. Rats were first reported in 1943; *Mus* was already present.

JOHNSON, P. M.

1979. "Reproduction in the Plain Rock-wallaby, *Petrogale penicillata inornata* Gould in Captivity, with Age Estimation of the Pouch Young." *Australian Wildlife Res.* 6:1–4.

The reported 30–32 day gestation period, 7-month pouch life, and 18-month attainment of sexual maturity may be comparable to these events in the Hawai'i population, though data are not yet available.

JOHNSON, PATRICIA A., B. W. JOHNSON, and L. T. TAYLOR

1981. "Interisland Movement of a Young Hawaiian Monk Seal between Laysan Island and Maro Reef." *'Elepaio* 41:113–114.

Discusses techniques for marking seals with hair bleach as superior to application of flipper tags. One marked seal made the 100 km trip from Maro Reef to Laysan Island in four days or less. Maro Reef is suggested as an important feeding ground of the monk seal.

JOHNSTON, G. C.

1973. "Predation by Southern Skua on Rabbits on Macquarie Island." *Emu* 73:25–26.

The skua (*Catharacta skua*) is a large opportunistic gull, attacking rabbits of any age or size in the manner of a hawk, making the kill with blows from the beak. Young rabbits are most often taken.

JONES, E.

1977. "Ecology of the Feral Cat, *Felis catus* (L.) (Carnivora: Felidae) on Macquarie Island." *Australian Wildlife Res.* 4:249–262.

A population of some 250–500 cats on a 46.3-square-mile island was opportunistic and fed well on rabbits and sea birds in particular; to a lesser extent on rats, mice, and the *weka*; and on beach carrion. Cats were feral by 1820 and present coat color is 48 percent orange, 42 percent tabby, and black and tortoise shell together, 10 percent.

JONES, E., and B. J. COMAN

1981. "Ecology of the Feral Cat, *Felis catus* (L.), in South-Eastern Australia I. Diet." *Australian Wildlife Res.* 8:537–547.

Native mammals amounting to 40 percent of the diet included 11 species, in one region; in others, the European rabbit and house mouse made up as much as 85 percent of the food. Birds provided nine to 18 percent. Lower vertebrates and arthropods were of lesser importance.

1982a. "Ecology of the Feral Cat, *Felis catus* (L.), in South-Eastern Australia II. Reproduction." *Australian Wildlife Res.* 9:111–119.

A three-year study indicated that breeding is nearly year around, but concentrated in the spring and summer. Two successive litters were produced, averaging 4.4 kittens per litter.

1982b. "Ecology of the Feral Cat, *Felis catus* (L.), in South-Eastern Australia III. Home Ranges and Population Ecology in Semiarid North-West Victoria." *Australian Wildlife Res.* 9:409–420.

Six cats radio-monitored for 8 to 21 months had discrete home ranges of 3.3 to 9.9 km^2 for males and 0.7 to 2.7 km^2 for females. Abundance of cats fluctuated seasonally.

JONES, J. K., JR., S. ANDERSON, and R. S. HOFFMANN

1976. *Selected Readings in Mammalogy.* Lawrence: Univ. Kansas Mus. Nat. History. Monogr. 5. 640 pp.

An overview of mammalogy for students anticipating careers in mammalogy.

JONES, J. K., D. C. CARTER, and H. H. GENOWAYS

1982. "Revised Checklist of North American Mammals North of Mexico, 1982." *Occas. Pap. Mus. Texas Tech. Univ.* 80:1–22.

A standard list, periodically revised.

JONES, MAUDE

1938. "Whaling in Hawaiian Waters." *Paradise Pacific* 50(4):20.

Historical notes on three permits for taking whales in Hawai'i, granted in 1847, 1854, and 1858. Stations were located at Honua'ula (on Lāna'i), Mā'alaea Bay (on Maui), and on Kaho'olawe. No references.

JONKERS, A. H., F. ALEXIS, and R. LOREGNARD

1969. "Mongoose Rabies in Granada." *West Indies Medical J.* 18:167–170.

From 1965 to 1968 rabies was isolated from 29 of 600 *Herpestes auropunctatus* examined on an island where the disease is established. Stresses a need for better information on mongoose population levels, and on suspected latent enzootic rabies in this species.

JUDD, BERNICE (Compiler)

1929. *Voyages to Hawaii Before 1860.* Honolulu: Star-Bulletin. 108 pp.

A study based on historical narratives in the Library of the Hawaiian Mission Children's Society. Catalogues and annotates material under (1) chronological list of vessels; and (2) index of vessels and persons.

JUDD, C. S.

1916. "Kahoolawe." *Hawaiian Annual for 1917*, pp. 117–125. Honolulu: Thrum.

Historical summary of the island's use from about 1830 when it first became a place of banishment. Describes remnants of original vegetation, development of introduced flora, overstocking with grazing animals, and resultant deterioration. Steps in attempted rehabilitation after 1910 are outlined. Three photos.

1918. "Forestry as Applied in Hawaii." *Hawaiian Forester and Agriculturist* 15:117–133.

Review of forests and forest uses in Hawai'i. Treats (pp. 128–129) effects of cattle and goats on the forests. "The continued grazing of cattle today in the native forest for the pecuniary benefit of a few . . . is very short-sighted."

1927a. "Factors Deleterious to the Hawaiian Forest." *Hawaiian Forester and Agriculturist* 24:47–53.

Describes the waste of the forest cover, quoting Albert Koebele, who said in 1900, "The greatest enemies of the beautiful Hawaiian forests . . . are cattle." Outlines steps taken to protect remaining fragments, and calls for extensive ecological research.

1927b. "The Story of the Forests of Hawaii." *Paradise Pacific* 40(10):9–18.

Divides recent time approximately into four periods: (1) prediscovery (before 1778); (2) sandalwood (1791–1856); (3) cattle (1815–1921); and (4) water conservation (1921–).

1936. "Hawaii's Forests Winning Their Battle with Wild Animals." *Honolulu Star-Bulletin*, March 21, 3rd Sec., pp. 1, 7.

Best general account of grazing problems on Mauna Kea. Refers in particular to sheep, and reviews dog-sheep relationships. Five photos. Tinker (1938, pp. 130–131) quotes extensively from this article.

JUDD, G. P.

1853. "Report of the Committee on Horses." *Trans. Royal Hawaiian Agricultural Soc.* 1(4):70–72.

Reports improvement of breeds in the past year through acquisition of good stocks. States (p. 71): "We believe the first horses were brought to the islands in 1802 by Capt. Shaler in the *Lilly Bird*, and presented to Kamehameha I." No source given.

JUDD, H. P.

1938a. "A Visit to Kahoolawe." *Paradise Pacific* 50(10):11–12.

Account of general observations by a member of the 1913 Bishop Museum expedition. Bands of goats were seen here and there, and there were clouds of red dust. At least one mule, "the famous bucking mule of the island," was there.

1938b. "A Week on Niihau." *Paradise Pacific* 50(9):9–10.

Comments on a trip to Ni'ihau "several years" before 1938. Mentions sheep and cattle in the stretches of pasture land and hunting of feral goats in the hills. States that *kiawe* (*Prosopis*), by 1938, had grown along the shores since the undated visit, possibly about 1906.

1939a. "Cattle Hunting on Kauai." *Paradise Pacific* 51(1):17–18.

Brief account of past days of feral cattle on Kaua'i, and of a hunt in the region of Hipalau, "a few decades ago."

1939b. "Disappearing Sport of Goat Hunting." *Paradise Pacific* 51(9):21–22.

Remarks on reduction in numbers of goats on O'ahu: "As recently as 1908 there were goats to be shot at not far from Kolekole Pass." Discusses various methods of attempted eradication on Hawai'i, where goats were still numerous.

JURASZ, V. P., D. McSWEENEY, and C. M. JURASZ

1980. "Possible Sexing Technique for Humpback Whales (*Megaptera novaeangliae*)." *Canadian J. Aquat. Sciences* 37:2362–2364.

Profile of region from dorsal fin to caudal peduncle is smooth in female and scalloped in male; 410 photographs from Alaska and Hawai'i whale studies suggest this morphological feature is constant.

JUVIK, J. O., and R. P. AUSTRING

1979. "The Hawaiian Avifauna: Biogeographic Theory in Evolutionary Time." *J. Biogeogr.* 6:205–224.

Deals with birds as basic indicators of equilibrium in numbers of species relative to land area, over time. Estimates that Ni'ihau and Kaho'olawe each may have had five or six land bird species.

JUVIK, J. O., and SONIA P. JUVIK

1984. "Mauna Kea and the Myth of Multiple Use: Endangered Species and Mountain Management in Hawaii." *Mountain Res. Devel.* 4:191–202.

A superb analysis of the biopolitics of ecosystem manipulation on Mauna Kea, as seen by professional geographers. There is little optimism expressed for survival of endangered biota in the long term, given trends in regulatory function and "states' rights."

KAMI, H. T.

1964. "Foods of the Mongoose in the Hamakua District, Hawaii." *Zoonoses Res.* 3:165–170.

Rodent pelage and bones were found in 72 percent of droppings in cane fields, and in 24 percent of those from pasture lands. Insects were the most important food in pastures and occurred in 80 percent of droppings collected there.

1966. "Foods of Rodents in the Hamakua District, Hawaii." *Pacific Science* 20:367–373.

Stomach contents of 1,205 rodents showed that field populations of *Rattus exulans* subsisted primarily on sugar cane; *R. rattus* on cane, grass stalks, and fruits; and *Mus musculus* (=*domesticus*) on insects and grass seeds.

KAMI, H. T., and A. J. HOSMER

1982. "Recent Beaching of Whales on Guam." *Micronesica* 18:133–134.

Reports two *Kogia simus*, in 1972 and 1974; *Peponocephala electra* and *Globicephala macrorhynchus* in 1980; and *Orcinus orca* in 1981. Strandings are not commonplace on Guam.

KAROL, R., C. LITCHFIELD, D. K. CALDWELL, and MELBA C. CALDWELL

1978. "Compositional Topography of Melon and Spermaceti Organ Lipids in the Pygmy Sperm Whale *Kogia breviceps*: Implications for Echolocation." *Marine Biol.* 47:115–123.

The large fat-rich melon (up to 92 percent wax ester content in the core) may have an acoustical role, but the process has not been studied in live animals.

KARTMAN, L.

1954. "Observations on *Trypanosoma lewisi* and *Grahamella* sp. in the Blood of Rats from the Hamakua District, Island of Hawaii." *J. Parasitology* 40:571–579.

T. lewisi infected mainly *R. exulans*, but also occurred in *R. rattus* and *R. norvegicus*. The flea *Xenopsylla vexabilis hawaiiensis* may be the principal intermediate host. *Grahamella* seemed to be a new species and was found only in *R. exulans*.

1955. "The Body Temperature of Wild *Rattus* spp. on the Island of Hawaii." *Pacific Science* 9:369–370.

Large samples of *R. exulans*, *R. rattus*, and *R. norvegicus* each had a mean of 37.6°C. Smaller specimens by weight had lower body temperature than larger ones.

KARTMAN, L., and R. P. LONERGAN

1955a. "Wild-Rodent-Flea Control in Rural Areas of an Enzootic Plague Region of Hawaii." *Bull. World Health Org.* 13:49–68.

A bait box that dusted visiting rats with DDT was developed and recommended for control of fleas in three species of *Rattus*. Biological data are given and the region is described.

1955b. "Observations on Rats in the Enzootic Plague Region in Hawaii." *Public Health Rep.* 70:585–593.

Report on mark and release trapping of three species of *Rattus*. Populations were notably sedentary and continuously distributed, favoring the perpetuation of plague.

KARTMAN, L., F. M. PRINCE, and S. F. QUAN

1956. "Studies on *Pasteurella pestis* in Fleas: Comparative Plague-Vector Efficiencies of *Xenopsylla vexabilis hawaiiensis* and *Xenopsylla cheopis*." *Bull. World Health Org.* 14:681–704.

Two species of rat fleas occurring in Hawai'i were tested in San Francisco with a plague strain from Maui. *Xenopsylla cheopis* was about twice as efficient as *X. vexabilis* in plague transmission.

KATAHIRA, L. K.

1980. "The Effects of Feral Pigs on a Montane Rain Forest in Hawaii Volcanoes National Park." *In*: C. W. Smith (editor), 1980, pp. 173–178.

Reports on studies of native vegetation by photo points, sampling transects, and exposure plots, 1975–1980. Recovery of vegetation on protected plots was rapid.

KATAHIRA, L. K., and C. P. STONE

1982. "Status of Management of Feral Goats in Hawaii Volcanoes National Park." *In*: C. W. Smith (editor), 1980, pp. 102–105.

Concise review of the goat in the Park, detail of the eradication program including the acknowledged difficulty and expense of removing "the last goat."

KAYA, S.

1963. "Axis Deer." *Hilo Tribune-Herald*, April 14, p. 4.

Letter to the Editor. Reports unanimous approval by the Island of Hawaii Fish and Game Association of introduction of the deer. Discusses report (Graf, 1959a), which emphasizes conclusion that deer can be controlled, as an important management criterion in relation to desirability of the deer in forests.

KEITH, T. B.

1980. *The Horse Interlude: A Pictorial History of Horse and Man in the Inland Northwest.* Moscow: Univ. Press of Idaho. 195 pp.

History, horses, and farming in the wheat country of Oregon, Washington, and Idaho.

KENNEDY/JENKS ENGINEERS

1981. "Environmental Assessment, Kitano Hydroelectric Project." Kekaha: Kekaha Sugar Company. Ca. 150 pp., various paginations, mimeo.

Contains faunal and floral surveys not otherwise available for the study region. Calls attention to irretrievable commitment of natural resources should the project materialize.

KENWAY, G. S.
1851. "Report on Sheep." *Trans. Royal Hawaiian Agricultural Soc.* 1(2):71–74.
Vividly describes sheep as then poorly managed; suggests use of Waimea Plain, on Hawai'i, for profitable herding of sheep, and makes general recommendations for establishing a stable sheep industry.

KENYON, K. W.
1972. "Man Versus Monk Seal." *J. Mammalogy* 53:687–696.
A first indication of recent decline in number of the seal, primarily as a result of disturbance by man on island beaches.
1977. "Caribbean Monk Seal Extinct." *J. Mammalogy* 58:97–98.
After extensive air and surface search in 1973, author concludes that this species has been extinct since the early 1950s. The remotest areas of monk seal habitat have been invaded by fishermen.

KENYON, K. W., and C. H. FISCUS
1963. "Age Determination of the Hawaiian Monk Seal." *J. Mammalogy* 44:280–281.
Determines age of a male at about 20 years and that of a female at about 11 years from study of annular layers of teeth, as worked out on more northern species of seals. Rings may result from fasting during yearly molt.

KENYON, K. W., and D. W. RICE
1959. "Life History of the Hawaiian Monk Seal." *Pacific Science* 13:215–252.
Definitive general account that discusses historical aspects of the species, presents many original data and many photos, and provides abundant appropriate references.

KEPLER, C. B.
1967. "Polynesian Rat Predation on Nesting Laysan Albatrosses and Other Pacific Seabirds." *Auk* 84:426–430.
Describes wounds and behavior of albatrosses on nests in nocturnal and daylight attacks by *Rattus exulans*. Rat-induced mortality was apparently a significant factor in over-all nest failure.

KEPLER, C. B., and ANGELA K. KEPLER
1980. "The Birds of Molokini Island, Maui." *'Elepaio* 40:147–150.
Found no mammals during 24-hour stay. Conclude that rabbits no longer occupy the islet.

KEPLER, C. B., ANGELA K. KEPLER, and T. R. SIMONS
1984. Hawaii's Seabird Islands, No. 1: Moke'ehia." *'Elepaio* 44:71–74.
Introduces a projected series of reports in standard format for ecological evaluation of islets. Mōke'ehia (off Maui) supports sea birds, and no mammals are present.

KEPLER, C. B., and J. M. SCOTT
1983. "Distribution and Behavior of the Endangered Hoary Bat (*Lasiurus cinereus semotus*) in Hawaii." Unpublished ms., 16 pp.
Report on 117 sightings of bats, 1976–1981, and review of additional records support the view that the species is occasional, except on the islands of Hawai'i and Kaua'i where known breeding populations are established.

KETCHUM, L.
1968. "Eight Mouflon Join Kahuku Ranch Menagerie." *Hawaii Tribune-Herald*, August 2, p. 10.

Notes arrival of the animals from California and plans for these and other exotics on the 30,000-acre ranch owned by Damon Estate; Harold F. Rice, Jr., manager. One photo.

KILHAM, W. H., JR.

1972. "Tracking the Mouflon of Corsica." *Animal Kingdom* 75(5):24–27.

Popular evaluation of residual stock in native habitat, with review of life history and behavior, in mountains of Corsica. Forty-five sightings were made. Total population is small.

KING, CAROLYN M.

1984. *Immigrant Killers: Introduced Predators and Conservation of Birds in New Zealand.* Auckland: Oxford Univ. Press. 224 pp., well illustrated.

Examines especially effects of the stoat (*Mustela erminea*) and other mustelids on endemic birds. Concludes that Polynesian and European man have had far greater negative impact than all predaceous mammals combined.

KING, CAROLYN M., and P. J. MOORS

1979. "The Life-history Tactics of Mustelids, and Their Significance for Predator Control and Conservation in New Zealand." *New Zealand J. Zool.* 6:619–622.

Deals with carnivores such as the stoat (*Mustela erminea*), which are difficult or impossible for man to eradicate, and suggests strategies which may apply to management of the mongoose in Hawai'i.

KING, JEAN S.

1978. "Hawaii's Wildlife—Legacy and Stewardship." *'Elepaio* 38:122–125.

Address given before the Western Regional Conference of National Audubon Society, by Senator King. A status report on the conservation of native ecosystems.

KING, JUDITH E.

1956. "The Monk Seal (Genus *Monachus*)." *British Mus. (Natural History) Zoology Bull.* 3:203–256.

Account of the history, distribution, features, and habits of the three species of *Monachus*. Comparisons are made with other phocids. Exhaustive bibliography; two plates on osteology of *M. schauinslandi*.

1964. "The Monk Seal of the Pacific." *Z. Säugetierk.* 29:37–42.

Historical summary of facts about *Monachus schauinslandi* as taken from the literature. Population data, 1824–1954, are given; pertinent references listed.

KING, JUDITH E., and R. J. HARRISON

1961. "Some Notes on the Hawaiian Monk Seal." *Pacific Science* 15:282–293.

Biological and anatomical description of a young pup, including food, parasites, skeleton, circulatory system, and other soft anatomy, from a frozen specimen sent to London. Expressed need for further study to determine nearness of relationship to *M. tropicalis*.

KING, W. B.

1971. "Report of the Research Conducted June–August 1970 on the Status of the Dark-rumped Petrel in Haleakala National Park." Report to the National Park Service, U. S. Dept. Interior. 17 pp., mimeo.

Standard body measurements of two rats caught, at 9,400 and 9,700 feet on the crater rim, assign the specimens to *Rattus exulans*. Study materials were not preserved.

KING, W. B., and P. J. GOULD

1967. "The Status of Newell's Race of the Manx Shearwater." *The Living Bird* 6:163–186.

Discusses (p. 174) probable or known predators in Hawai'i, including the mongoose, rat, feral cat, and feral dog.

KINNDSCHY, P. R., C. SUNDSTROM, and J. D. YOAKUM

1983. *Wildlife Habitats in Managed Rangelands—The Great Basin of Southeastern Oregon: Pronghorns.* Portland: USFS Pacific Northwest Station. Tech. Rep. PNW—145.

Concludes that as land development proceeds, habitat deteriorates for the pronghorn and must be managed to ensure thrifty populations.

KIRCH, P. V.

1982. "The Impact of the Prehistoric Polynesians on the Hawaiian Ecosystem." *Pacific Science* 36:1–14.

States that "we are only beginning to understand what effects the Polynesians may have had on landforms and shorelines," as a result of recent archaeological work. Lowland forest, for example, generally reached to the shoreline in primeval times. Fire changed the vegetation drastically.

1985. *Feathered Gods and Fishhooks: An Introduction to Hawaiian Archaeology and Prehistory.* Honolulu: Univ. Hawaii Press. 360 pp.

Details early settlement, evidence for fishing and farming, and periods of cultural development, from Polynesian discovery to European contact.

KIRKPATRICK, R. D.

1966a. "Mammals of the Tokelau Islands." *J. Mammalogy* 47:701–704.

Lists the Polynesian rat, dog, cat, and pig as the only mammals found. Reviews literature and describes past and current status of each species.

1966b. "Mammals of Johnston Atoll." *J. Mammalogy* 47:728–729.

Lists the house mouse, roof rat, cat, and dog as the only mammals found. Describes current distribution and status of each.

KJARGAARD, J. I.

1982. "Population, Distribution and Adverse Effects of Feral Goats at Haleakala National Park." *In*: C. W. Smith (editor), 1982, p. 110.

Enumerates difficulties of control but suggests combination of hunting from ground and air in conjunction with boundary and internal fencing projects.

KJARGAARD, J. I. (Editor)

1972. "Scientific Report of the Waihoi Valley Project." University of Hawaii, Honolulu. 252 pp., mimeo.

Project sponsored by National Science Foundation under the Student Originated Studies program. Comprehensive biological work in difficult, wet terrain, by 13 students. Pages 168–201, by Patrick Conant, are on mammals.

KNAPP, R.

1965. *Die Vegetation von Nord- und Mittelamerica und der Hawaii-inseln* [The vegetation of North and Central America and of the Hawaiian Islands]. Stuttgart: Fischer. 373 pp. (In German.)

Includes an exhaustive bibliography; Chapter 10 pertains to Hawai'i. Reviewed by D. Mueller-Dombois, *Science* 149:1083–1084, 1965.

KOBAYASHI, K.

1979. "Court Ruling Gives Palilas a Lease on Life." *Honolulu Advertiser*, June 7, p. A-3.

Notes that game hunting in other areas of the island would still provide hunting opportunities. Some interesting insights as to the political psyche are given.

1980. "Judge May Act to Prod State to Save Rare Birds." *Honolulu Advertiser*, May 20, p. A-3.

Judge Samuel King notes that DLNR, among other things, had missed a February 1 progress report, and that its chairman could be jailed or a master appointed to "take over the department."

KOEBELE, A.

1897. "Report of the Entomologist." *Planters' Monthly* 16:65–85. (Also 1898, 17:258–269.)

States (p. 80), in relation to insect control that "it was found advisable to introduce Bats . . . . So far the results of the introduced California Bat, of which over 600 reached the Islands living, has not been very encouraging, since little is seen of them in Honolulu. Several trials with Japanese bats resulted in failure."

KOEPPL, J. W., N. A. SLADE, and R. W. TURNER

1979. "Spatial Associations of *Rattus exulans* in Central Java, Indonesia." *J. Mammalogy* 60:795–802.

Aspects of social behavior are analyzed by the "nearest neighbor" method in extensive mark and release field study.

1981. "Allochronic Associations of *Rattus exulans*." *J. Mammalogy* 62:557–567.

A somewhat complicated approach to population analysis dealing with the tendencies for individuals by sex and age group to occupy in time and in succeeding generations the same sites within a habitat. The subject species demonstrates little in the way of such allochronic patterns.

KOLMER, W.

1918. "Zur vergleichenden Histologie, Zytologie und Entwicklungsgeschichte der Säugernebenniere" [On the comparative histology, cytology and development of mammalian adrenal glands]. *Arch. Mikroscopisch Anatomie* 91:1–139. (In German.)

Pages 40–41 describe condition in a mongoose which may have been *Herpestes auropunctatus*. Sex differences are not given.

KOLZ, A. L., and R. E. JOHNSON

1980. "Self-adjusting collars for Wild Mammals Equipped with Transmitters." *J. Wildlife Mgmt.* 44:273–275.

Steel cable with slip-ring assembly and nylon sheath provides antenna, collar, and support for transmitter.

KORTE, K. H.

1963. *Rodent Damage in Koa Reproduction*. State of Hawaii, Div. Forestry, Kahului, Maui. Report to the State Forester.

On Maui, there is evidence that the tree rat (= *R. rattus*), during a heavy population buildup, will girdle *koa* (*Acacia*) saplings 1 to 2 inches in diameter by stripping off bark up as high as 4 feet.

KOSAKA, E.

1965. "Mauna Loa, Puuanahulu, and Pohakuloa Game Management Areas Big Game Aerial Surveys." State of Hawaii, Div. Fish and Game, Honolulu, Project W-5-R-16. 3 pp., mimeo.

A January 4–5, 1965, count revealed 381 sheep, 230 goats, and 1 pig, in about 75 percent coverage of the three areas (open only to archery hunting). Game was concentrated in the more densely vegetated sectors.

KOULISCHER, L., and S. FRECHKOP

1966. "Chromosome Complement: A Fertile Hybrid between *Equus przewalskii* and *Equus caballus*." *Science* 151:93–95.

Experimental crossing of captive Przewalski stud with Norwegian and Pyrenees ponies resulted in one fertile male offspring. Diploid chromosome numbers of the parents were 66 and 64, respectively, and that of the hybrid was an expected 65.

KRAJINA, V. J.

1963. "Biogeoclimatic Zones on the Hawaiian Islands." *Bull. Ecological Soc. America* 44:76.

Abstract of paper presented at the University of Massachusetts meeting of the Society, August 27, 1963. "These islands should become a classic region for the synecological studies in tropical and subtropical climates. Such studies would become a scientific basis for multiple land use."

KRAMER, R. J.

1971. *Hawaiian Land Mammals.* Rutland: Charles E. Tuttle 347 pp.

Basic accounts of land mammals, including personal experiences and observations of the author during 10 years' residence in Hawai'i.

KRIDLER, E., D. L. OLSEN, and G. C. WHITTOW

1971. "Body Temperature of the Hawaiian Monk Seal." *J. Mammalogy* 52:476.

Rectal temperatures of animals on shore was 36.9°C, with a range of 35.9° to 37.8°.

KRITZLER, H.

1952. "Observations of the Pilot Whale in Captivity." *J. Mammalogy* 33:321–334.

An example of pioneer work in capture and holding of marine mammals in oceanaria. One specimen of *Globicephala* lived for nine months after rescue from stranding in 1948. States that stranded pilot whales lodge on their sides and often drown with incoming tide.

KULU, DEBORAH D., IRIS VEOMETT, and R. S. SPARKES

1971. "Cytogenetic Comparison of Four Species of Cetaceans." *J. Mammalogy* 52:828–832.

Sampling included *Delphinus delphis* and *Orcinus orca.* Modal chromosome number was 44. Study of karyotypes raises questions of classification, especially with *Orcinus.* Earlier reports are discussed.

LAMB, S. H.

1938. "Goat Drives in Hawaii National Park." *Paradise Pacific* 50(12):91.

Estimated 50 goats per square mile in parts of the Park, in 1938. Describes drives that followed, results, and disposition of goats. "Now that these lands . . . are surrounded by goat-tight fences it is believed that the numbers of goats can be kept very low."

1981. *Native Trees and Shrubs of the Hawaiian Islands.* Santa Fe: Sunstone Press. 160 pp.

Compiled treatment of the subject matter profusely illustrated with black and white photos. Identification, classification, distribution, habitat, characteristics of woods.

LAMBERTSEN, R. H.

1983. "Internal Mechanism of Rorqual Feeding." *J. Mammalogy* 64:76–88.

The capacity for engulfment of large volumes of water by feeding baleen whales is made possible by remarkable elasticity of the tongue, which transforms into a sac-like structure everting posteriorly through the floor of the mouth, between layers of a ventral thoracic pouch.

LAMOREUX, LYN, and R. ROBINSON

1971. "Cat Gene Frequencies in Richmond, California." *Genetica* 42:61–64.

Coat color was classified in 107 adult semiferal cats according to described genetic phenotypes. Results are similar to those in example cited for Chicago. Appears to have application to condition in feral cats of Hawai'i.

LAMOUREUX, C. H.

1963. "The Flora and Vegetation of Laysan Island." *Atoll Res. Bull.* No. 97. 14 pp. 13 figs. (Reprinted March 1965, with changes indicated by footnotes.)

Traces history of Laysan plants from notes and museum specimens as early as 1828, through devastation by rabbits and recovery, to 1961. Flora includes 38 species, 27 of which are native; 5 current vegetational associations are described.

1964. "The Leeward Hawaiian Islands." *Newsl. Hawaiian Bot. Soc.* 3:7–11.

Briefly reviews political history of the islands, points out their significance as preserves and for scientific research, and summarizes for each the current status of botanical knowledge.

LAMOUREUX, C. H., and LANI STEMMERMANN

1976. "Report of the Kipahulu Bicentennial Expedition." Dept. Botany, Univ. Hawaii CPSU/UH Tech. Rep. 11. 18 pp., mimeo.

A retracing of the route of the 1967 Kipahulu Expedition for the purpose of rectifying a botanist/forester controversy concerning introduction of weeds to pristine areas by research activities. The foresters' allegations were unfounded.

LANG, T. G., and K. S. NORRIS

1966. "Swimming Speed of a Pacific Bottlenose Porpoise." *Science* 151:588–590.

A trained but unrestrained dolphin tested on straight ocean courses off O'ahu, Hawai'i, attained top speeds of 29.9 km per hour (16.1 knots) for 7.5 seconds and 21.9 km per hour (11.8 knots) for 50 seconds.

LA RIVERS, I.

1948. "Some Hawaiian Ecological Notes." *Wasmann Collector* 7:85–110.

Detailed observations of hunting and scavenging behavior of mongooses, and results of stomach analyses (pp. 89–99) on tidal lands of Pearl Harbor, O'ahu. Domestic cat is mentioned as a mongoose predator.

LATTANZIO, R. M., and J. A. CHAPMAN

1980. "Reproduction and Physiological Cycles in an Island Population of Norway Rats." *Bull. Chicago Acad. Science* 12(1). 68 pp.

Rats on an island of 44 acres in Chesapeake Bay demonstrated characteristics similar to those of populations worldwide, with slight differences related to urban and rural habitat conditions, densities, and climate factors. Rats are adaptable generalists rather than specialists.

LAUNDRÉ, J.

1977. "The Daytime Behavior of Domestic Cats in a Free-roaming Population." *Animal Behaviour* 25:990–998.

Study on a Wisconsin farmstead. Cats fluctuated daily between solitary and group living. Social interactions are described.

LAURET, M.

1982. "The Distribution of Brush-tailed Rock Wallaby (*Petrogale penicillata*) on Oahu." *'Elepaio* 43:25–26.

Cites records of wallaby as far as 24 km from traditional Kalihi Valley colony, but found during a year of observation (1981) none more distant than 0.4 km. Concludes that social factors may promote dispersal but that dry cliff and cave habitat suitable for new colonies is lacking.

LAWRENCE, BARBARA

1967. "Early Domestic Dogs." *Z. Säugetierk.* 32:44–59.

Reports new evidence of man-dog associations in Turkey and in Idaho, United States of America. The Idaho material forms the oldest known record of a domesticated dog (8400 B.C.). This dog originated in Eurasia and must have come to America with man in his migration to the Nearctic.

LAZELL, J. D., JR.

1980. "Kalihi Rock Wallaby of Hawaii." *Tigerpaper* 7:31–32.

Contrasts Australian *Petrogale p. penicillata* with stock in Hawai'i, noting marked differences in coloration, and 20–25 percent smaller size in Hawaiian specimens. A founder effect and attendant rapid evolution in Hawai'i are suggested as reasons for these divergences.

1981. "Strange Rock Wallabies of Oahu." *Explorers J.* 59(2):66–67.

Same text as previous paper (Lazell, 1980) with section inserted describing capture of four specimens and the examination of tissue proteins from one animal by Australian geneticists.

LAZELL, J. D., JR., T. W. SUTTERFIELD, and W. D. GIEZENTANNER

1984. "The Population of Rock Wallabies (Genus *Petrogale*) on Oahu, Hawaii." *Biological Conservation* 30:99–108.

In an 18-day trapping period (1981) 20 individuals were captured, and 12 of these were recaptured. Total population was estimated at 247 animals. Management and protection of the colony are recommended.

LEATHERWOOD, S., J. R. GILBERT, and D. G. CHAPMAN

1978. "An Evaluation of Some Techniques for Aerial Censuses of Bottlenose Dolphins." *J. Wildlife Mgmt.* 42:239–250.

Three census designs were used and compared. Strip sampling produced the most reliable results. Recommends that herd size (count of individuals) be determined on flights separate from herd count flights.

LEATHERWOOD, S., and D. K. LJUNGBLAD

1979. "Nighttime Swimming and Diving Behavior of Radio-tagged Spotted Dolphin, *Stenella attenuata*." *Cetology* 34:1–6.

In research on tuna fishing grounds near Clipperton Island a spotted dolphin caught in seining operations from herd of some 920 animals was followed for 11 hours, traveling from 10.7 down to 2.3 knots.

LEATHERWOOD, S., W. F. PERRIN, VICKY L. KIRBY, C. L. HUBBS, and MARILYN DAHLHEIM

1980. "Distribution and Movements of Risso's Dolphin, *Grampus griseus*, in the Eastern North Pacific." *Fish. Bull.* 77:951–963.

Demonstrates from more than 200 records, 194 of which were unpublished previously, that this dolphin is abundant and widely distributed in tropical and warm temperate waters of the northeastern Pacific. Herd size was as large as 30.

LEATHERWOOD, S., and R. R. REEVES

1982. "Bottlenose Dolphin and Other Toothed Cetaceans." *In*: J. A. Chapman and G. A. Feldhamer (editors), *Wild Mammals of North America*, Chap. 18, pp. 369–414. Baltimore: Johns Hopkins Univ. Press.

Major data on *Tursiops truncatus*, but all species are treated in a remarkably concise and comprehensive review of these dolphins and of whales, whaling, and tuna fishery.

1983. *The Sierra Club Handbook of Whales and Dolphins*. San Francisco: Sierra Club Books. 320 pp.

Comprehensive and authoritative guide to the cetaceans. Includes all known species, distribution, distinctive features, population status. Illustrated by Larry Foster.

LEATHERWOOD, S., R. R. REEVES, W. F. PERRIN, and W. E. EVANS

1982. *Whales, Dolphins, and Porpoises of Eastern North Pacific and Adjacent Arctic Waters: A Guide to Their Identification*. NOAA Tech. Rep. NMFS Circ. 444. 243 pp.

Emphasizes description and identification of cetaceans at sea. Modern population estimates; appendixes on marking techniques, strandings, and how to report them. Fully illustrated; more than 300 photos.

LE BOEUF, B. J., and B. WÜRSIG

1985. "Beyond Bean Counting and Whale Tales." *Marine Mammal Science* 1:128–148.

Notes increase in application of research on marine mammals with consequent gains in knowledge, and a positive effect of popular interest. Incisive treatment of direction in modern investigation.

LEE, W. L.

1853. "Annual Report of the President." *Trans. Royal Hawaiian Agricultural Soc.* 1(4):3–14.

Discusses (pp. 9–13) cattle, sheep, pigs, horses, and mules, with emphasis on breed improvement and management problems. Registers disapproval (p. 13) of methods used by cowboys, and their side effects, on horses broken for carriage and farm work.

LENNOX, C. G.

1950. "Factors Considered by Board of Commissioners of Agriculture and Forestry in Approving Projects to Introduce Deer to Hawaii." Territory of Hawaii, Bd. Commns. Forestry and Agriculture, Honolulu, President's Report. 8 pp., mimeo.

Reviews responsibilities of the Board to the public; background investigations of the deer problem; history of axis deer on O'ahu, Moloka'i, and Lāna'i; relationships of deer to lands and plants; and controversy following approval of deer introduction to Hawai'i Island.

1951. "Exotic Animals in Hawaii: A History and Analysis of the Present Day Situation." Hawaiian Acad. Sci., Honolulu. 6 pp., mimeo.

Concise survey of introduction, historical highlights, and present status of axis deer, and of feral goats, sheep, cattle, and pigs, on the eight main Hawaiian islands. Prepared by Committee on Conservation.

LEOPOLD, A. S., T. RINEY, R. McCAIN, and L. TEVIS, JR.

1951. *The Jawbone Deer Herd.* State of California, Div. Fish and Game, Sacramento. Game Bull. 4. 139 pp.

Detailed report on a seasonally migratory mule deer population. Summer, winter, and actual migratory behavior are traced through observation of tagged animals. Includes biological and population data, and management recommendations.

LEOPOLD, L. B., and C. K. STIDD

1949. "A Review of Concepts of Hawaiian Climatology." *Pacific Science* 3:215–225.

Summarizes factors of climate, including storm types, patterns of rainfall, winds, and their relationships to vegetation and crops. 41 references.

LEUNG, Y.

1967. "An Illustrated Key to the Species of Whale-lice (Amphipoda, Cyamidae), Ectoparasites of Cetacea, with a Guide to the Literature." *Crustaceana* 12:279–291.

Indicates that whale-lice are cosmopolitan. Twenty species of whales and dolphins are listed as hosts for about 20 species of these commensal crustaceans. Key is illustrated. Extensive bibliography.

LEWIS, E. S.

1940. "Mongoose Attacking a Donkey." *J. Bombay Natural History Soc.* 41:893.

Two donkeys were grazing when one suddenly fell over, its feet kicking in the air. "A huge slaty-coloured jungle mongoose . . . had seized the donkey by the snout and would not let go." Probably this was *Herpestes edwardsi*, which weighs up to six pounds.

LIBERG, O.

1980. "Spacing Patterns in a Population of Rural Freeroaming Domestic Cats." *Oikos* 35:336–349.

Cats near households were studied. Females had small home ranges which seldom changed. Ranges of males were larger with less overlap than those of females. Intraspecific aggression and adaptation to households were cited as important factors in spacing patterns. A detailed study.

1981. *Predation and Social Behavior in a Population of Domestic Cat: An Evolutionary Perspective.* Lund: Univ. Lund, Dept. of Animal Ecology. 135 pp.

A synthesis of five papers, some unpublished, on home range, foods, predation, breeding behavior, and social factors among free-roaming semiferal cats, in Sweden. Extensive bibliography.

1982. "Correction Factors for Important Prey Categories in the Diet of Domestic Cats." *Acta Theriol.* 27:115–122.

Feeding experiments permitted conclusions about relationships between ingested prey items and the residual material passed in the feces. An equation is proposed for calculating daily food intake of free-ranging cats.

1984. "Food Habits and Prey Impact by Feral and House-based Domestic Cats in a Rural Area in Southern Sweden." *J. Mammalogy* 65:424–432.

Formal publication of earlier reports on subject. Small mammals provided bulk of diet.

LILLY, J. C.

1967. *The Mind of the Dolphin: A Nonhuman Intelligence.* New York: Doubleday. 310 pp.

An earlier work in a series of books on the relationships between man and the smaller cetaceans during periods of close association, training, and probing of intellects.

1975. *Lilly on Dolphins/Humans of the Sea.* New York: Doubleday. 500 pp.

A revised edition of two books, *Man and Dolphin* and *Mind of the Dolphin.* Includes also various lectures and papers. Subject animal is primarily *Tursiops truncatus.*

LIN, Y. C., and R. H. KOBAYASHI

1976. "Cardiovascular Function of the Unanesthetized Small Indian Mongoose, *Herpestes auropunctatus.*" *Comp. Biochem. Physiol.* 53A:375–379.

Baseline physiological studies of animals from the Hawai'i population. Cardiac output and metabolic rate were high.

LINCOLN, R. J., and D. E. HURLEY

1974. "Catalogue of the Whale-lice (Crustacea: Amphipoda: Cyamidae) in Collections of the British Museum (Natural History)." *Miscellanea, Bull. British Mus. (Natural History) Zool.* 27:65–72.

Collection represents materials from 12 species of whales and two of dolphins, worldwide; 17 species of whale lice are listed.

LINDSEY, G. D.

1969. "Characteristics of Sugarcane Damage Caused by Rodents in Hawaii." *Sugar J.*, February, pp. 22–24.

Refines earlier notions about identification of rat species by kinds of damage done to cane stalks. Concludes that rind chips are best clues, experience is needed, and fresh damage is most easily assessed.

LINDSEY, G. D., R. D. NASS, and G. A. HOOD

1971. "An Evaluation of Bait Stations for Controlling Rats in Sugarcane." *J. Wildlife Mgmt.* 35:440–444.

Concludes, from tracer-labeled bait experiments, that stations at edges of fields are ineffective in controlling rats for significant distances into the fields.

LINDSEY, G. D., R. D. NASS, G. A. HOOD, and D. N. HIRATA

1973. "Movement Patterns of Polynesian Rats in Sugar Cane." *Pacific Science* 27:239–246.

Radio-telemetry studies coupled with livetrapping produced similar results. Recommend control in adjacent waste areas during early part of cane cycle. Burrows of rats were located by telemetry.

LINK, V. B.
1954. *A History of Plague in the United States.* U.S. Public Health Service, Public Health Monogr. 26. 120 pp.
Includes (pp. 69–76) chapter entitled "Plague in the Territory of Hawaii," tracing the course of this infection from its first occurrence in Honolulu in 1899 to its last persistent stronghold in Hāmākua District on Hawai'i.

LINNAEUS, C.
1758. *Systema Naturae,* Ed. X, Vol. 1. *Holmiae: Laurentii Salvii.* 532 pp.
Of the several previous and subsequent classificatory works of Linnaeus (Karl von Linné), this tenth edition has been selected under International Rules of Zoological Nomenclature as the base for the system of technical naming of mammalian and other species of organisms.

LINSDALE, J. M., and P. Q. TOMICH
1953. *A Herd of Mule Deer.* Berkeley: Univ. California Press. 567 pp.
A record of observations of *Odocoileus hemionus columbianus* made on the Hastings Natural History Reservation in California. Considers many aspects of ecology and behavior of wild deer in natural surroundings.

LLOYD, H. G., and D. McCOWAN
1968. "Some Observations on the Breeding Burrows of the Wild Rabbit *Oryctolagus cuniculus* on the Island of Skokolm." *J. Zool.* 155:540–549.
Describes burrow systems and relates their joint use by nesting rabbits, shearwaters, and puffins. Rabbit nests often are stopped off with earth plugs before parturition of females.

LOCKYER, CHRISTINA
1978. "The History and Behaviour of a Solitary Wild, but Sociable Bottlenose Dolphin (*Tursiops truncatus*) on the West Coast of England and Wales." *J. Natural Hist.* 12:513–528.
Aside from the one animal reported on, the author provides other examples from the literature, including the specimen of Risso's dolphin, "Pelorus Jack," who accompanied boats in Cook Strait, New Zealand, for over 20 years.

LOFTUS, W. J.
1976. "Low Profile. That's What Oahu's Wallabies Maintain." *Honolulu* 10(11):34–35.
Detailed historical account of the brush-tailed rock-wallaby, adding facets not published earlier. Photo of Richard H. Trent, who introduced this species to Hawai'i.

LONG, B.
1985. "Dan McSweeney, Kona's Whale Watcher." *Big Island Trading Post* 3(20):1, 2, 11, May 15.
Interview with a dedicated researcher whose specialty is a documentation of humpback whales in Hawai'i through extensive photo records. The project operates on a slender budget, but includes comparative studies of the whales on the summering grounds in Alaskan waters.

LOPEZ, J. C., and DIANA LOPEZ
1985. "Killer Whales (*Orcinus orca*) of Patagonia and their Behavior of Intentional Stranding While Hunting Nearshore." *J. Mammalogy* 66:181–183.
These predators habitually hunt at sea lion and sea elephant colonies, purposely stranding from turbulent water in order to seize the calves on pebbly beaches. Agility of the whales and surge permit refloating in the succeeding three or four waves.

LORENZ, K. Z.
1955. *Man Meets Dog.* Boston: Houghton Mifflin. 211 pp.

A treatise on a theory of the origin of the domestic dog. Stresses social and behavioral aspects. Includes, also, similar information on the domestic cat.

LOWRIE, W. J.

1904. "Notes on Bats." *Planters' Monthly* 23:354–355.

In relation to mole cricket control: "As they [bats] do flourish in Porto Rico, certainly they should flourish in Hawaii. . . . I strongly recommend the Planters' Association to import a lot there."

LUDEL, JAQUELINE

1982. "Language Acquisition in Chimps and Dolphins: Anthropocentrism—Still and Again." *Co-Evolution Quart.*, Fall, pp. 46–53.

Suggests that we might as well attempt to teach quadrupeds, which are anatomically unadapted for bipedalism, to walk on two legs, as to attempt to teach language to apes and dolphins, which are similarly unadapted for speech. Finally, the door is left open for the possibility that human language may yet be taught to other creatures, with attendant implications.

LUND, A. S. T.

1932. "The Hawaiian Rice Industry at the Crossroads." *Paradise Pacific* 45(12):70–74.

Appraisal of rice industry from its beginnings in 1857. Plowing was done by water buffalo and mules. Six photos.

LUOMALA, KATHARINE

1960a. "The Native Dog in the Polynesian System of Values." *In*: S. Diamond (editor), *Culture in History: Essays in Honor of Paul Radin*, pp. 190–240. New York: Columbia Univ. Press. 1014 pp.

Historical treatise comparing, in particular, data from Society Islands, Hawaiian Islands, and New Zealand. Much insight is given into the character of the Hawaiian dog.

1960b. "A History of the Binomial Classification of the Polynesian Native Dog." *Pacific Science* 14:198–223.

A critical analysis of the taxonomists' classifications and theories about the characteristics of ancient Pacific island dogs, from the viewpoint of an anthropologist. Hawaiian form is included.

LVOV, D. K., M. ŽDANOV, and 15 others.

1978. "Comparison of Influenza Viruses Isolated from Man and Whales." *Bull. WHO* 56:923–930.

Strains from a South Pacific whale were compared with strains from Russian cities isolated during epidemics. A possible chain of infection from sea birds to whales is postulated.

LYON, H. L.

1919. "Some Observations on the Forest Problems of Hawaii." *Hawaiian Planters' Rec.* 21:289–300.

Good review of vegetational aspects of forests, largely on Hawai'i. Considers also forest-cattle relationships. Many photos of select forest areas.

1950. "What Habitat Will the Spotted Deer Choose If Liberated on the Island of Hawaii?" Paper read at Ninth Annual Meeting, Hawaiian Academy of Science, November 30. 9 pp., mimeo.

Objects to proposal for introducing axis deer to Hawai'i Island on basis of its anticipated establishment in wet lowland forests, its destruction of these forests, competition with cattle for forage, and that deer predictably will become a reservoir of anthrax.

LYON, M. W., JR., and W. H. OSGOOD

1909. *Catalogue of the Type-Specimens of Mammals in the United States National Museum, Including the Biological Survey Collection.* U. S. National Mus. Bull. 62. 345 pp.

Selects (p. 276) lectotype of *Atalapha semota* (=*Lasiurus cinereus semotus*) from a series of nine specimens used in the original description. Locality, "Hawaiian Islands," catalogued January 4, 1887.

LYONS, A. B.

1890. "In Bird Land" (Part of the journal of a visit to Laysan Island). *Friend* 48:90–91.

A "sea lion" was seen and photographed (=Hawaiian monk seal). Gathered "only 21 species of flowering plants, nearly all of them Hawaiian or cosmopolitan plants."

LYONS, C. J.

1884. "Hawaiian Islands as a Field For Scientific Observation." *Hawaiian Monthly* 1:133–135.

A thoughtful and stimulating plea for research to explain natural phenomena in Hawai'i for the sake of knowledge and for practical use thereof.

McCABE, R.

1977. "Maui Establishes Whale Reserve." *Honolulu Star-Bulletin*, December 12, p. C-6.

A county action establishing unofficially "the first whale reserve in the U. S." Objective was to protect, and perhaps popularize, the wintering humpback whales.

McALLISTER, J. G.

1933a. *Archaeology of Oahu*. B. P. Bishop Mus. Bull. 104. 201 pp.

Notes that O'ahu sites are poor in petroglyphs. The dog is the only mammal prominently represented (p. 23, Fig. 26, Plate 10). Pig pens are discussed (p. 34).

1933b. *Archaeology of Kahoolawe*. B. P. Bishop Mus. Bull. 115. 61 pp.

Excellent description of Kaho'olawe's features and relics. In 1931 both water and food were imported for the few cattle there (p. 5).

McATEE, W. L.

1925. "Introduction upon Introduction." *Auk* 42:160.

States that, "in the case of . . . animals and plants not strictly domesticated, successful introductions have almost invariably had regrettable consequences."

McCARTNEY, W. C.

1970. "Arboreal Behavior of the Polynesian Rat (*Rattus exulans*)." *Bioscience* 20:1061–1062.

Rats in coconut plantation at Eniwetok were observed under red flood lights. Runway systems between trees were established on interconnecting palm fronds.

McCARTNEY, W. C., and SARA J. PETERS

1969. "Comparative Behavioral Development of *Rattus rattus* and *Rattus exulans*." *American Zool.* 9:568.

Abstract only. Developmental stages are similar for both species, indicating that behavioral development in the genus is evolutionarily conservative. Weaning occurs at about day 24.

McCLELLAN, E. N.

1936. "Pre-Cook Discoverers of the Hawaiian Islands." *Paradise Pacific* 48(3):10–13.

Synopsis of a lengthy discussion by Jarves (1843) concerning early charting of Hawai'i by European voyagers.

McCLOSKY, MAXINE

1982. "At Last: The IWC Bans Whaling." *Sierra* 67(6):17–20.

After decades of effort, the end of commercial whaling hove into sight after a change in membership of the Commission provided the three-fourths majority vote. A three-year diminution

in allowable numbers of whales to be taken was declared, with all whaling to halt in 1986. Zero quotas are subject to future revision.

McCLUSKY, J., T. J. OLIVIER, L. FREEDMAN, and E. HUNT
1974. "Evolutionary Divergences between Populations of Australian Wild Rabbits." *Nature* 249:278–279.
A rapid rate of evolution (over a period of 110 years since introduction) is noted. A condition of equilibrium would be expected to follow these first adjustments to new environments.

McCORT, W. D.
1980. "The Behavior and Social Organization of Feral Asses (*Equus asinus*) on Ossabaw Island, Georgia." *Diss. Abstr. Int., B. Sci. Eng.* 41(1):56-B.
Dominance relations, territoriality, group composition and sexual selection are discussed as possibly typical of a feral donkey population.

McDANIEL, B., and JOANN M. TENORIO
1979. "*Olabidocarpus americanus* (Acari: Listrophoroidea: Chirodiscidae) from the Hawaiian Hoary Bat, *Lasiurus cinereus semotus*, with description of the male." *J. Medical Entomology* 15:180–182.
Female mites had been described from such widely separated locales as Texas (on the northern yellow bat) and Surinam (on the red bat); both host species are in genus *Lasiurus*. Males were described for the first time from the hoary bat on the Hāmākua coast, island of Hawai'i.

MacDONALD, C. D.
1982. "Predation by Hawaiian Monk Seals on Spiny Lobsters." *J. Mammalogy* 63:700.
Confirms earlier evidence by observation of a seal capturing, crushing, and eating one lobster, and by finding parts of other freshly killed lobsters in the vicinity.

MacDONALD, G. A.
1962. "The 1959 and 1960 Eruptions of Kilauea Volcano, Hawaii, and the Construction of Walls to Restrict the Spread of Lava Flows." *Bull. Volcanologique* 24:249–294, 9 plates.
Analytical description of the most spectacular eruptive series of modern times, and of attempts to divert the outflow of lava.

MacDONALD, G. A., and A. T. ABBOTT
1970. *Volcanoes in the Sea: The Geology of Hawaii.* Honolulu: Univ. Hawaii Press. 441 pp. (Revised 1983, with F. Peterson.)
A thorough account of the processes of volcanism in Hawai'i, in generally nontechnical language.

MacDONALD, G. A., and J. B. ORR
1950. *The 1949 Summit Eruption of Mauna Loa, Hawaii.* U. S. Geological Survey Bull. 974-A. 33 pp.
Account of a prolonged eruptive period extending from January 6 until about the end of May, during which 77 million cubic yards of magma were extruded. Photos, maps, tables.

MacDONALD, G. A., F. P. SHEPARD, and D. C. COX
1947. "The Tsunami of April 1, 1946, in the Hawaiian Islands." *Pacific Science* 1:21–37.
Detailed account of shoreline inundations in Hawai'i following a crustal movement in the Aleutian Deep. Losses included 151 lives and about 25 million dollars in property damage. Water rose from 2 to 55 feet above sea level. Speed of the waves was about 490 miles per hour and they came at 15-minute intervals. Maps and photos are included.

MacDONALD, P.
1972. "Fixed in Time: A Brief History of Kahoolawe." *Hawaiian J. History* 6:69–90.
Good overview up to time of publication. Discusses feral animals. 91 reference items.

McELDOWNEY, G. A.

1930. "Forestry on Oahu." *Hawaiian Planters' Rec.* 34:267–287.

On pages 272–273, wild cattle and goats were said to be considered under control in O'ahu forests, but pigs remained a menace and were among the most serious management problems. Many photos of erosion control work.

McELDOWNEY, HOLLY

1976. "A Bibliography of Mauna Kea, Island of Hawaii." Ms., 22 pp, completed March 1976.

A collection of more than 300 titles covering all aspects of this important mountain.

MACGREGOR-MORRIS, PAMELA (Editor)

1982. *The Book of the Horse.* New York: Simon and Schuster. 208 pp.

Origins, domestication, history, breeds, training; glossary, index.

MACHIN, D.

1974. "A Multivariate Study of External Measurements of the Sperm Whale (*Physeter catodon*)." *J. Zool.* 172:267–288.

Modern statistical study of whale sizes by sex and population, using principal component analysis (four main components) and canonical analysis (comparing data from several locations). An earlier paper (see below) presents data on the humpback whale.

MACHIN, D., and BARBARA L. KITCHENHAM

1971. "A Multivariate Study of External Measurements of the Humpback Whale (*Megaptera novaeangliae*)." *J. Zool.* 165:415–421.

(See Machin, 1974.)

McINTYRE, JOAN

1974. *Mind in Waters: A Book to Celebrate the Consciousness of Whales and Dolphins.* New York: Scribner. 240 pp.

A comprehensive review of whales, understanding whales, and means for protecting them from slaughter.

1982. *The Delicate Art of Whale Watching.* San Francisco: Sierra Club Books. 144 pp.

A philosophical and poetic treatise on the averred subject matter. The undisguised locale for the humpback whales is Hawai'i.

MACKAY, R. S., and H. M. LIAW

1981. "Dolphin Vocalization Mechanisms." *Science* 212:676–678.

Dolphins can make whistling sounds at great depths (not using the larynx). Clicks and buzzes are produced from vibrations of tissue of the nasal plugs. Air sacs act as reservoirs. A low frequency ultrasonic technique was applied in these experiments.

McKEEVER, S., and P. Q. TOMICH

1963. "Observations on the Adrenal Glands of the Mongoose." *Anatomical Rec.* 147:163–169.

Reports on histological study of adrenals from *Herpestes auropunctatus* on the island of Hawai'i. Sexual dimorphism in relative weight of adrenal glands from adult mongooses is attributed to development of a distinct inner zona fasciculata in adult females.

McKNIGHT, T. L.

1958. "The Feral Burro in the United States: Distribution and Problems." *J. Wildlife Mgmt.* 22:163–179.

A thorough examination of the feral burro, found in all western states except Washington and Montana, with sound recommendations for action that promise improved management practices.

1959. "The Feral Horse in Anglo-America." *Geographical Rev.* 49:506–525.

Historical and current treatment of the mustang in western North America. Contrasts can be noted with conditions in Hawai'i. Five photos and map.

1964. *Feral Livestock in Anglo-America.* University of California Pub. Geography 16. 78 pp.

A discourse on feral exotic mammals; data gathered largely through mailed questionnaires. Contains good basic philosophies. Hawai'i data are included on cattle, sheep, goat, and pig.

McMURTRIE, H.

1834. *Cuvier's Animal Kingdom.* Vol. 3, *Mammalia.* London: Henderson. 508 pp.

An English translation from the French. Contains original description of *Petrogale penicillata,* based on plate only, dated December 1, 1825; synonym, Vol. 5, p. 504, based on drawings by Lewin.

MacPHEE, KATHARINE D.

1931. "Kahoolawe." *Paradise Pacific* 44(2):7–8.

Vividly describes goat drives during the period of attempted rehabilitation of Kaho'olawe, and transport of goats to Maui where they were sold for meat. "Over thirteen thousand goats were taken from the island." Dates not given.

MALECHA, S. R., and R. H. TAMARIN

1969. "Plasma Transferrins in Three Species of *Rattus* on Pacific Islands." *American Naturalist* 103:664–669.

Unlike *R. exulans* and *R. norvegicus, R. rattus* in Hawai'i and Eniwetok exhibits marked polymorphisms at the genetic transferrin locus, in a well defined allelic system. These can be used as markers in population studies.

1971. "Genecology of the Transferrin Locus in *Rattus rattus* in Hawaii." *Genetics* 68, suppl. 1, Part 2:41.

Abstract only. Results appear to preclude specific conclusions about significance of the transferrin locus in the population sampled.

MALO, D.

1951. *Hawaiian Antiquities.* B. P. Bishop Mus. Spec. Pub. 2, 2nd ed. 278 pp.

A meticulous description of Hawaiian culture, translated from the Hawaiian in 1891. Some material is applicable to the study of mammals.

MANTA CORPORATION

1979. "Tern Island Study: Final Report." U. S. Fish and Wildlife Service, Honolulu. Vols. 1, 2. 387 pp., mimeo.

A preparatory study of various possible management actions for the subject site, at French Frigate Shoals. Provides (pp. 10–15) a good review for application of NEPA regulation, background, and practical approaches. Vol. 2 contains public input interviews.

MARCUZZI, G., and G. PILLERI

1971. "On the Zoogeography of Cetacea." *In*: G. Pilleri (editor), *Investigations on Cetacea* 3, Pt. I, pp. 101–170. Berne: Brain Anatomy Institute.

Indicates close relationships between biogeography and systematics in terms of distribution, which was relatively fixed during the Pleistocene. Maps and other figures are given.

MARKOWSKI, S.

1952. "The Cestodes of Pinnipeds in the Arctic and Other Regions." *J. Helminthology* 26:171–214.

Lists (p. 173) *Bothriocephalus* sp. from *Monachus schauinslandi,* taken on Laysan Island; = *Diphyllobothrium hians* (Diesing, 1850) according to the author, and is recorded also from two other seals, *Phoca vitulina* and *Erignathus barbatus.* Synonymy of *D. hians* is discussed at length.

MARPLES, R. R.

1954. "Note on the Type Specimen of the Maori Rat." *Trans. Royal Soc. New Zealand* 82:703–704.

Maori rat (=*Rattus exulans*) was originally described as *Mus maorium*. Type skull is remeasured; abundance and scarcity of this rat in historic times are noted.

1955. "*Rattus exulans* in Western Samoa." *Pacific Science* 9:171–176.

Gives synonymy of this species from Tate (1935), biological and physical data, and habits. Suggests that physical differences are measurable between populations on islands only a few miles apart.

MARQUES, A.

1905. "Goats in Hawaii." *Hawaiian Annual for 1906*, pp. 48–55. Honolulu: Thrum.

Account of the history and status of the goat in Hawai'i. Its rapid increase after introduction in 1778 is evidenced by export of over 26,500 skins in 1850.

MARSHALL, D. B.

1964. "Treasure Islands—of Wildlife." *Audubon Mag.* 66(3):160–165.

"We stopped at Tern Island of French Frigate Shoals. It resembles a giant aircraft carrier. . . . This is a sad reminder of what could happen to other islands of the Hawaiian Island Refuge if they are not carefully guarded."

MARSHALL, J. T., and R. D. SAGE

1981. "Taxonomy of the House Mouse." *Symp. Zoological Soc. London* 47:15–25.

Native *Mus* of Europe and Asia are considered in an updating of Schwarz and Schwarz (1943) and Ellerman and Morrison-Scott (1951). Five European species are identified: *M. musculus* and *M. domesticus* as commensals; *M. spretus*, *M. abbotti*, and *M. hortulanus* as primarily wild species. Two Asian forms, *M. molossinus* and *M. castaneus* may be related to *M. musculus*, but taxonomy of Asian species remains fluid.

MARSHALL, J. T., JR.

1955. "Rats of Arno Atoll, Marshall Islands." *J. Mammalogy* 36:259–263.

Brief but excellent data on *R. exulans* and *R. rattus*: behavior, nests, foods, parasites, economic importance.

MARSHALL, W. H.

1961. "A Note on the Food Habits of Feral Cats on Little Barrier Island, New Zealand." *New Zealand J. Science* 4:822–824.

Migratory sea birds, resident vertebrates, and insects provide the diet, which varies from winter to summer. Analysis of 94 droppings showed sea birds, land birds, and *R. exulans* to be the principal food items.

MARTIN, A. S., S. K. KATONA, D. MATILLA, D. HEMBREE, and T. D. WATERS

1984. "Migration of Humpback Whales between the Caribbean and Iceland." *J. Mammalogy* 65:330–333.

A wintering population of the region of Puerto Rico is demonstrated to summer in the North Atlantic to the latitude of Iceland and southern Greenland. A catalog of tail fluke photos served to identify individuals.

MARTIN, R. D. (Editor)

1975. *Breeding Endangered Species in Captivity*. New York: Academic Press. 420 pp.

Treats many aspects of captive breeding programs in the context of the worldwide problems of extinctions. Chapter on the Hawaiian goose.

MARTIN, S. J.

1913. "Record Cheetal (*Axis axis*) Head." *J. Bombay Natural History Soc.* 22:622.

Reports antler length of 39¼ inches, from the Bahraich forests. Editor's note reports two 39-inch lengths on record, one from Uttar Pradesh and the other from near Jubbulpore.

MARTINEZ, D. R., and E. KLINGHAMMER

1970. "The Behavior of the Whale *Orcinus orca*: A Review of the Literature." *Z. Tierpsychol.* 27:829–839.

Notes subject species as a top carnivore has like behavior throughout the world. Many activities are carried on at the surface of the sea, facilitating observation. Japanese and Russian literature were not available for inclusion.

MATSCHIE, G. F. P.

1905. "Eine Robbe von Laysan" [A seal from Laysan]. *Sitzung. Ges. Naturf. Freunde Berlin*, pp. 254–262. (In German.)

Original description of *Monachus schauinslandi*; name is proposed on page 258. Type specimen was collected in 1896.

MATSUURA, M.

1956. "Identifying Native Dry Forest Trees of Puuwaawaa." Univ. Hawaii Extension Service, Club Circ. 108. 32 pp., mimeo.

An illustrated key for practical use in a region of Hawai'i Island particularly rich in native species. Twenty-four species are considered; Hawaiian names only are given.

MATTHEWS, L. H.

1978. *The Natural History of the Whale.* New York: Columbia Univ. Press. 219 pp.

Concise narrative account of the cetaceans, including history of cetology, kinds of whales and dolphins, behavior and disease.

MATTHEWS, L. H. (Editor)

1968. *The Whale.* New York: Simon and Schuster. 287 pp.

History, biology, classification of whales, whaling and the training and display of various dolphins and whales. Many illustrations from classical art and modern photography. Factory ship whaling is emphasized.

MAYR, E.

1943. "The Zoogeographic Position of the Hawaiian Islands." *Condor* 45:45–48.

Study of the birds shows origin of nearly all stocks is North America. Plants, insects, arachnids, and mollusks are overwhelmingly of Polynesian origin.

MEAD, J. G.

1975. "Preliminary Report on the Former Net Fisheries for *Tursiops truncatus* in the Western North Atlantic." *J. Fish. Res. Board Canada* 32:1155–1162.

Summarizes history of dolphins and small-whale hunting. Pilot whale was taken off Cape Cod from mid-1700s to early 1900s. *Tursiops* was taken until 1929.

MEDEIROS, J. S.

1954. "Experimental Introduction of the European Mouflon." Territory of Hawaii, Div. Fish and Game, Honolulu, Project 5-R-5. 3 pp., mimeo.

Reports on the initial introduction of mouflon sheep as a wild species in Hawai'i. On July 30, 1954, ten were released on Lāna'i in the Anapuka area at the west side of the island. Animals were surplus stock from the Honolulu Zoo.

1964a. "Lanai Feral Goat Survey." State of Hawaii, Div. Fish and Game, Honolulu, Project W-5-R-15. 3 pp., mimeo.

A survey made March 9–13, 1964, revealed an estimated population of 1,810 goats (905

actually counted) between Maunalei and Kapua gulches. Goats had increased greatly since the previous year; higher altitude range was heavily overgrazed.

1964b. "Lanai Mouflon Survey (1964)." State of Hawaii, Div. Fish and Game, Honolulu, Project W-5-R-15. 2 pp., mimeo.

On March 11–12, 116 sheep were counted; total population was estimated at about 200. Recommended that 40 permits be issued for a first open season on rams only.

MEEK, J.

1851. "Report on Neat Cattle." *Trans. Royal Hawaiian Agricultural Soc.* 1(2):75–76.

Suggests taking care to avoid overstocking the ranges; refers to origin of Hawaiian cattle: most were traceable to the Pacific Coast of America, but the herds also showed traits of breeds imported from other islands in the Pacific and from Australia.

MEEK, J., T. CUMMINS, and C. G. HOPKINS

1853. "Report of the Committee on Sheep." *Trans. Royal Hawaiian Agricultural Soc.* 1(4):79–80.

Discusses problems of sheep raising, and the indecision in the choice of breeding for mutton or wool. Newly imported Southdown stock suggested a possible two-purpose sheep industry.

MEEK, J., H. S. HOWLAND, J. I. DOWSETT, F. P. MANINI, and T. CUMMINS

1854. "Report of the Committee on Horses." *Trans. Royal Hawaiian Agricultural Soc.* 2(1):105–106.

Laments poor quality and poor care of horses kept in increasing numbers by the native Hawaiians and by other residents. Recommends impoundment of strays, and a system of controlled horse breeding.

MEINECKE, W. H.

1954. "Hawaiian Bat Seen in Kau, Hawaii." *'Elepaio* 15:14–15.

November 1947, and July 1954, records are listed for Waiōhinu. Few bats seen there even with purposeful evening observation.

MENDENHALL, V. M., and L. F. PANK

1980. "Secondary Poisoning of Owls by Anticoagulant Rodenticides." *Wildlife Soc. Bull.* 8:311–315.

Differential effects were noted among the various anticoagulants in tests on the barn owl, and other owls, with rats from Hawai'i. Some combinations were lethal to owls.

MENDONCA, B. G.

1978. "The First Twenty Years; an Unscientific Remembrance." *In*: J. Miller (editor), *Mauna Loa Observatory, a 20th Anniversary Report*, pp. 17–23. U. S. Dept. of Commerce, NOAA, Air Resources Laboratories, Silver Springs, MD. 158 pp.

Reports (pp. 20–23) on a white dog noted near the observatory sporadically from 1959 to 1966. Its sources of food and shelter were never determined, but the dog seemed well adapted to the mountain environment.

MERRIT, RUTH C.

1924. "To a Water-Buffalo." *Paradise Pacific* 37(1):30.

A poem in five stanzas depicting the difficulties of befriending a penned water buffalo in order to photograph it; one photo taken by another cameraman.

MEYER, K. F., D. McNEILL, and C. M. WHEELER

1965. "Results of a Preliminary Serologic Survey of Small Mammal Populations for Plague on the Island of Hawaii." *World Health Org. Bull.* 33:809–815.

Reports indirect evidence of plague infection, by means of the passive microhaemagglutina-

tion test, in regions where the plague organism had not been found for eight years or had never been found. Percentages of positive reactors were as follows: *Rattus rattus* 0.6, *R. norvegicus* 1.9, *R. exulans* 1.5, *Mus musculus* 1.1, and *Herpestes auropunctatus* 12.5.

MEYERS, J. G.
1931. "The Present Position of the Mongoose in the West Indies." *Tropical Agriculture* 8:94–95.
Historical sketch of introduction and its effect. Mongoose is considered undesirable for agriculture because of probable harm to insectivorous vertebrates. Intensive research is recommended, to be supported by funds long used for bounty payments.

MEYERS, N.
1979. *The Sinking Ark.* New York: Pergamon Press. 307 pp.
A thoughtful consideration of the problem of conserving endangered species, worldwide.

MEYERS, R. F.
1960. "*Lasiurus* from Missouri Caves." *J. Mammalogy* 41:114–117.
Dead or debilitated hoary bats were found deep inside a few cave systems occupied by typical cave bats, but usually away from colonies. Entry of caves by hoary bats appears to be accidental, and the cave environment unfavorable to survival or exit.

MICHENER, GAIL R.
1976. "Tail Autotomy as an Escape Mechanism in *Rattus rattus.*" *J. Mammalogy* 57:600–603.
Loss of the tail sheath and consequent shortening of this member are described in a population of the roof rat in equatorial Africa. Relationship of genetic phenotype to predation is discussed.

MIERAU, G. W.
1972. "Studies on the Biology of an Antlered Female Mule Deer." *J. Mammalogy* 53:403–404.
Reviews subject, giving example, and some evidence of inheritance of trait, in Colorado.

MILLER, F. L.
1970. "Distribution Patterns of Black-tailed Deer (*Odocoileus hemionus columbianus*) in Relation to Environment." *J. Mammalogy* 51:248–260.
Deer in a 340-acre paddock responded to changes in temperature, relative humidity, and rainfall; home range varied in size seasonally.

MILLER, G. S., JR.
1924. *The Characters and Probable History of the Hawaiian Rat.* B. P. Bishop Mus. Bull. 14, pp. 3–6.
Compares *Rattus hawaiiensis* (=*exulans*) with various Malayan rats. Concludes that the Hawaiian form is closely related to Malayan and possibly also to other Pacific rats, and that it came recently to Hawai'i through the agency of man.

1939. "Note on the Lectotype of *Lasiurus semotus* (H. Allen)." *J. Mammalogy* 20:369.
Explains tabular error in forearm measurement of lectotype. The bat is thus shown to be closely related to the hoary bat (*L. cinereus*), not the red bat (*L. borealis*) as was supposed.

MILLER, L. H.
1900–1903. "Verbatim Copy of Hawaii Journals." (Originals in Bancroft Library, University of Califoria, Berkeley.) 51 pp., mimeo.
Author notes (p. 1) that, on arrival in Honolulu January 4, 1900, he had to come ashore in a small boat because of strict quarantine on account of plague. Describes (pp. 4–5) quarantine duty

in Chinatown and the great fire of January 20. Natural history notes on O'ahu, Hawai'i, and Kaua'i are almost exclusively on subjects other than mammals.

MILLER, MILDRED

1937. "A Kalalau Goat Hunt." *Paradise Pacific* 49(3):12, 30.

Brief account of pack trip on the Nāpali Coast of Kaua'i in search of goats, with .22 caliber rifles. Four photos.

MILLER, R. S., and D. B. BOTKIN

1974. "Endangered Species: Models and Predictions." *American Scientist* 62:172–181.

Background information and simulation models which may indicate outcome of various management alternatives.

MILZ, BARBARA

1967. "Is It Rabies? Experts Say Yes and No." *Honolulu Advertiser*, October 14, pp. 1, A-4.

Public Health Service team reports they found no positive evidence of rabies in preliminary tests of tissues in Hawai'i. There was confusion over the source of pig brains undergoing tests.

MINETTE, H. P.

1964. "Leptospirosis in Rodents and Mongooses on the Island of Hawaii." *American J. Tropical Medicine and Hygiene* 13:826–832.

Serology and culture revealed seven serotypes of *Leptospira*: *L. icterohaemorrhagiae*, *L. ballum*, *L. australis*, *L. canicola*, *L. sejroe*, *L. pyrogenes*, and *L. pomona*. The last two were detected only by serologic techniques. Host preferences are given and new host and distributional records are reported. Culturally positive, serologically negative rodents were found.

MITCHELL, C. J.

1964. "Ectoparasitic and Commensal Arthropods Occurring on the Rats of Manoa Valley, Oahu (Acarina, Anoplura, and Siphonaptera)." *Proc. Hawaiian Entomological Soc.* 18:413–415.

Infestation data given for 11 species of arthropods on a total of 98 rats (*R. exulans*, *R. rattus*, and *R. norvegicus*) collected from March through September.

MITCHELL, E.

1972. "Whale Pigmentation and Feeding Behaviour." *American Zool.* 12:655.

Reports on the Balaenopteridae. Maximum disruptive pattern, as in the minke whale which takes a broad spectrum of prey (as nekton), may provide concealment from prey with good vision, during vertical feeding runs.

1975. "A Phylogeny of the Cetacea." *American Zool.* 15:824.

Abstract only. Fossil evidence of whales is limited and the question of diphyly is unresolved. Mysticeti invaded aquatic habitats rapidly and exploited food resources other than those derived by carnivory.

MITTAL, O. P., and B. KAUL

1975. "Chromosome Behavior with Special Reference to Sex Mechanism in *Herpestes auropunctatus* (Hodgson)." *Cytologia* 40:221–225.

Confirms the anomalous chromosome count ($2n = 35$ in the male and $2n = 36$ in the female) first reported in 1964.

MOBLEY, J. R., JR., and L. M. HERMAN

1985. "Transcience of Social Affiliations Among Humpback Whales (*Megaptera novaeangliae*) on the Hawaiian Wintering Grounds." *Canadian J. Zool.* 63:762–772.

A pod consists of one or several whales. Usual size was three—a cow, a calf, and an adult male.

Frequent change in pod size suggests that adult males change affiliation in seeking receptive females. Singing by many males at the same time may be a form of communal display.

MOEHLMAN, PATRICIA D.

1972. "Getting to Know the Wild Burros of Death Valley." *National Geographic* 141(5):502–517.

A study of behavior in a protected population, with insights concerning the problem of a feral animal in a native ecosystem reserve. Many photos by I. S. Lerner.

MOKKAPATI, S.

1974. "The Anatomy and Histology of Male Accessory Reproductive Glands of the Mongoose, *Herpestes auropunctatus* Hodgson." *Proc. 61st Indian Science Congr.* Sect. 7, 3:52.

Abstract only, of description.

MOLLER, H., and J. L. CRAIG

1977. "Aspects of the Ecology of Kiore (*Rattus exulans*) on Tiritiri Matangi Island." *Proc. New Zealand Ecological Soc.* 24:129–130.

After removal of sheep and cattle from 220 ha islet, the rat thrived in weedy cover with dramatic annual fluctuation in numbers (125 rats/ha down to 11/ha). Reproduction was strongly seasonal and mean number of embryos was 7.0 per pregnancy.

MONAGAN, D.

1982. "Horse of a Different Culture: When Horses Return to the Wild, Does Their Ancient Nature Reappear?" *Science 82* 3(4):46–53.

Account of social behavior of feral horses under varied ecological conditions.

MONTAGU, A., and J. C. LILLY

1963. *The Dolphin in History.* Los Angeles: Clark Memorial Library. 55 pp.

Includes two symposium papers: "The History of the Dolphin," by Montagu; and "Modern Whales, Dolphins, and Porpoises, As Challenges to Our Intelligence," by Lilly. Systematics, and recent as well as classical references, are included from the world literature.

MONTGOMERY, S. L.

1975. "Comparative Breeding Site Ecology and Adaptive Radiation of Picture-winged Drosophila (Diptera: Drosophilidae) in Hawaii." *Proc. Hawaiian Entomological Soc.* 22:65–103.

Wide variety of breeding sites in native plants is described among 80 species of pomace flies, with implications for evolutionary processes.

1983. "The Case of the Killer Caterpillars." *National Geographic* 164:218–225.

New discoveries in rainforest ecosystems. Predaceous larvae of the moth (Geometridae: *Eupithecia*) feed generally on native pomace flies which they are highly adapted to capture and devour. Photos by Robert F. Sisson.

MOREJOHN, G. V., and D. M. BALTZ

1970. "Contents of the Stomach of an Elephant Seal." *J. Mammalogy* 51:173–174.

Confirms that off central California the elephant seal is a deep-diving bottom feeder, eating selectively various sharks, rays, squids, eels and other bony fishes.

MORSE, G.

1964. "From Mud to Makeup: Beast Hollywood-Bound." *Honolulu Advertiser*, December 4, p. A-6.

Photo of water buffalo being loaded aboard ship for transport to California. Anticipates use of the animals in cinema industry.

1965. "Oligario, Carabao Till Taro." *Honolulu Advertiser*, September 29, p. B-1.

Photo and story concerning elderly native of the Philippines who still employed water buffalo, as he had for many years, in taro culture on O'ahu.

MOSBY, JULIE M., and K. WODZICKI

1972. "Some parasites of the Kimoa (*Rattus exulans*) on the Tokelau Islands." *New Zealand J. Science* 15:698–704.

A mite, one cestode, and four nematodes were found in examination of 373 rats. These six species of parasites are widely, but often sporadically, distributed among Pacific islands.

1973. "Food of the Kimoa (*Rattus exulans*) in the Tokelau Islands and Other Habitats in the Pacific." *New Zealand J. Science* 16:799–810.

Rats have adapted to limited variety in food resources. Diet is 87 percent coconut. Insects and crustaceans make up the remainder. Such adaptability may explain widespread colonization by *R. exulans*.

MOSBY, JULIE M., K. WODZICKI, and F. B. SHORLAND

1974. "Fatty Acid Composition of the Depot Fats of the Polynesian Rat, *Rattus exulans*, Tokelau Islands." *New Zealand J. Zool.* 1:67–70.

Reveals that storage of fat from coconut-rich diets is largely the same form as coconut oil, but that some is converted to related fatty acids. There is differential storage of various fats in different regions of the body.

MOTTELER, L. S.

1983. "Place-Name Research on Kaho'olawe." *Ka 'Elele* 10(2):3–5.

The process of locating and affirming names of places is explained. Access accorded the Protect Kaho'olawe 'Ohana has enhanced this effort. A full-page map is included.

1983. "55 Years at Bishop Museum." *Ka 'Elele* 10(4):3–4.

A biographical sketch of E. H. Bryan, Jr., marking his 85th birthday, April 13, 1983, and a tribute to his long service to Bishop Museum. A following article (pp. 4–5) honors librarian Margaret Titcomb (1891–1982) and botanist Marie C. Neal (1889–1965).

MOTT-SMITH, E.

1910. *Annual Report of the President.* Territory of Hawaii, Bd. of Health, Honolulu, pp. 16, 107–113.

Reports susceptibility of the small Indian mongoose to experimental plague infection.

MROZEK, C,

1978. "Giant Nightingales of the Deep: Singular Songs of Humpback Whales." *Oceans* 11(2):2–7.

Factual summary of sound-making capabilities in this whale and others, significance of this mode of communication, and need for protecting the species throughout its range.

MUELLER-DOMBOIS, D.

1980. "Spatial Variation and Vegetation Dynamics in the Coastal Lowland Ecosystem, Hawaii Volcanoes National Park." *In*: C. W. Smith (editor), 1980, pp. 235–248.

Indicates trends in recovery of vegetation following removal of goats from an arid grassland-shrubland, after eight years.

MUELLER-DOMBOIS, D., K. W. BRIDGES, and H. L. CARSON (Editors)

1981. *Island Ecosystems: Biological Organization in Selected Hawaiian Communities.* US/IBP Synthesis Series, 15. Stroudsburg: Hutchinson Ross. 583 pp.

Integrated results and conclusions from work of 35 investigators and numerous graduate trainees, 1971–1976, in virtually all elements of natural ecosystems. Projects were concentrated on the slopes of Mauna Loa in Hawaii Volcanoes National Park and vicinity.

MULL, MAE E.

1977. "Feral Sheep vs. the Mamane Ecosystem in the Mauna Kea Plan." *'Elepaio* 38:54–55.

Reviews the Mauna Kea Plan (of the State Department of Land and Natural Resources) as adopted June 9, 1977, pointing out shortcomings for protection of natural resources. Legal proceedings are anticipated.

MÜLLER-SCHWARZE, D.

1971. "Pheromones in the Black-tailed Deer (*Odocoileus hemionus columbianus*)." *Animal Behaviour* 19:141–152.

Detailed analysis of significance in scents produced (in urine and by tarsal-metatarsal, interdigital, antorbital, and caudal glands), all of which have roles in social organization. Illustrated.

1972. "Social Significance of Forehead Rubbing in Blacktailed Deer (*Odocoileus hemionus columbianus*)." *Animal Behaviour* 20:788–797.

An extension of earlier studies of scent marking. Among deer, which make few sounds, scent posts may replace vocal calls as a means of advertising sociological information. Illustrated.

MÜLLER-SCHWARZE, D., CHRISTINE MÜLLER-SCHWARZE, A. G. SINGER, and R. M. SILVERSTEIN

1974. "Mammalian Pheromones: Identification of Active Component in Subauricular Scent of the Male Pronghorn." *Science* 183:860–862.

Secretion of a gland beneath the ear is used to mark brush or other objects in territory. Behavioral and biochemical aspects are examined. Cover photo.

MULLIGAN, B. E., and D. W. NELLIS

1975. "Vocal Repertoire of the Mongoose *Herpestes auropunctatus*." *Behaviour* 60:237–267.

Acoustical analysis reveals 12 categories of calls: *weep, squawk, honk, weeonk, conversation, ruck-a-ruck, growl, pant, spit, bark, chuck,* and *scream.* Sound is considered an important medium of communication in usual habitat of dense vegetation.

MUMFORD, E. D.

1942. "Native Rats and the Plague in the Pacific." *American Scientist* 30:213–217.

Summarizes distribution of the various *Rattus,* and also *Mus,* of the Pacific, and their fleas. Relates their occurrence to the possible or actual presence of plague. Plague is reported only from Hawai'i and New Caledonia.

MUNRO, G. C.

1945. "Tragedy in Bird Life." *'Elepaio* 5:48–51.

Gives general account of bird species known or thought to be lost from Laysan since an 1891 visit, and mentions rats on various small Pacific islands. Appended is a letter by R. S. Atsatt documenting loss of the Laysan rail, Laysan finch, and perhaps also the feral canary from Midway Islands, because of the introduction of *Rattus rattus.*

1947. "Animals of Hawaii." *Honolulu Advertiser,* September 22.

Discusses changed characteristics of feral sheep on Hawai'i, Lāna'i, and Niihau and adaptions to these new environments. Mentions collection of selected wool specimens presented to Bishop Museum; reports also on cattle, goat, and cat.

MÜNTZING, A.

1959. "Darwin's Views on Variation under Domestication in the Light of Present-Day Knowledge." *Proc. American Philosophical Soc.* 103:190–220.

Domestic rabbit (pp. 205–206), is derived from wild rabbits imported to Central Europe from Spain during the Roman period and kept in large enclosures. More than 50 well-established breeds are now maintained, most of which were selected after 1900.

MURCHISON, A. E., and R. L. PEPPER

1972. "Escape Conditioning in the Bottlenosed Dolphin (*Tursiops truncatus*)." *Cetology* 8:1–5.

A dolphin was trained to approach rather than avoid an intense acoustic stimulus as a means of escape from the stimulus. Research performed in Hawai'i.

MYERS, P.

1978. "A Method for Determining the Age of Living Small Mammals." *J. Zool.* 186:551–556.

Measurement from x-ray photographs is established as a reliable means of assessing age in small mammals. Live animals were handled under light anesthesia.

MYHRE, SHEILA B.

1970. "Kahoolawe." *Hawaiian Botanical Soc. Newsl.* 9:21–31.

A survey of the literature emphasizing information on changes in vegetation as a result of introduced ungulates.

NAIK, S. N., H. M. BHATIA, A. J. BAXI, and P. V. NAIK

1964. "Hematological Study of Indian Spotted Deer (Axis Deer)." *J. Experimental Zool.* 155:231–235.

Blood was examined from four axis deer in a Bombay zoo and compared with that of two muntjacs for several blood factors. Sickle cell occurred in fresh axis deer blood.

NASS, R. D., G. A. HOOD, and G. D. LINDSEY

1970. "Distribution of Aerially Applied Ratbait in Hawaiian Sugarcane." *Sugar J.*, June, pp. 34–35.

Determines that air drop of hulled oats, whole corn, and laboratory food pellets is feasible for distribution of rat toxicants. In dry weather about a third of baits lodged above ground in the mat of 14-month old cane.

1971a. "Fate of Polynesian Rats in Hawaiian Sugarcane Fields during Harvest." *J. Wildlife Mgmt.* 35:353–356.

With radiotelemetry techniques 22 *R. exulans* were tracked through a harvest cycle. Of these, 77 percent were killed by machinery. Of the 23 percent surviving, three were killed within two days by mongooses, leaving only two survivors.

1971b. "Influence of Gulch-baiting on Rats in Adjacent Sugarcane Fields." *J. Wildlife Mgmt.* 35:357–360.

Reports that tracer-labeled baits air-dropped in gulches were taken by the Polynesian rat trapped as far as 450 feet into adjacent cane fields.

NATIONAL GEOGRAPHIC SOCIETY

1976. "Whales of the World." *National Geographic* 150(6):722–767. December issue.

Part I (by William Graves) entitled "The Imperiled Giants"; and Part II (by Victor Scheffer), "Exploring the Lives of Whales." Supplement map and chart (page 722A) depicts major species, their world range, and migratory routes. Research, conservation, and whaling industry are emphasized.

NATURE CONSERVANCY NEWS

1982. Vol. 32, No. 3. May/June. 32 pp.

Entire issue devoted to Hawai'i problems and programs, in four principal articles. A separate flyer, "The Nature Conservancy of Hawaii," summarizes progress to date and the launching of the "Endangered Hawaiian Forest Bird Project" in 1980.

NEAL, MARIE C.

1965, *In Gardens of Hawaii.* B. P. Bishop Mus. Spec. Pub. 50. 924 pp.

A floral guide to Hawai'i, treating primarily the plants of the lower elevations used as ornamentals; a revision and enlargement of the 1948 edition. Standard Hawaiian botanical references are listed; illustrations figure 673 species.

NELLIS, D. W.

1974. "The Biology of the Mongoose (*Herpestes auropunctatus*) on St. Croix." *Diss. Abst. Int., B. Sci. Eng.* 34:4756–4757.

Aspects of biology are in general agreement with those studied in Hawai'i. Litter size is 2.16, with possibly two litters per year; however, home range was similar in area for males (2.68 acres) and females (2.85 acres), unlike this situation in Hawaiian populations.

NELLIS, D. W., and J. J. McMANUS

1974. "Thermal Tolerance of the Mongoose, *Herpestes auropunctatus*." *J. Mammalogy* 55:645–647.

Based on laboratory experiments in the Virgin Islands, mongoose could survive in temperature regimes of Middle America, Mexico, and the tier of U. S. southern states. Species is established in South America: British Guiana, Surinam, French Guiana, Venezuela, and Colombia.

NELSON, R. E., and P. R. WHEELER

1963. *Forest Resources of Hawaii*—1961. State of Hawaii, Div. Forestry, and U. S. Forest Service, Honolulu. 48 pp.

Assesses and describes status of forests and forestry in Hawai'i. Wildlife and forestry practices are briefly treated (pp. 5–6). Maps, photos, tables.

NICHOLS, L., JR.

1960a. "Ecology of the Axis Deer." State of Hawaii, Div. Fish and Game, Honolulu, Project W-5-R-11. 32 pp., mimeo.

Condensed results of three-year study, primarily on Lāna'i. Selected data are presented on physical characteristics, habitat, habits, reproduction, foods, and population. Management recommendations are made. This is an excellent basic work.

1960b. "The History of the Antelope Introduction on Lanai Island, Hawaii." State of Hawaii, Div. Fish and Game, Honolulu. 4 pp., mimeo.

Describes release in 1959 and early phases of establishment of the pronghorn in Hawai'i. Management consisted of providing drinking water units. Recommendations are made for handling and release of possible future shipments of pronghorn.

1961a. "Ecology of the Wild Pig." State of Hawaii, Div. Fish and Game, Honolulu, Project W-5-R-12. 4 pp., mimeo.

Reports initial effort on renewed study of *Sus scrofa* on Hawai'i. Outlines research plan; reports on methods, including capture with drugged darts. Mauna Kea and Kohala Mountain pigs are characterized. Reports one hunter killed by pig (no details) on Kohala Mountain.

1961b. "The Howling Bucks of Molokai." *Hunting Yearbook* 12:38–41, 85–86.

Popular account of two research hunting expeditions into forests of eastern Moloka'i. Describes calls of mature bucks, other behavior, and biological features. Males may weigh over 200 pounds, and does about 120 pounds. Four photos.

1961c. "Goats over the Gulches." *Outdoor Life* 127(6):60–63, 121–123.

Authentic popular report on goat hunting on Lāna'i. Coat is described (p. 62) as black, brown, or cream-colored, with a heavy black stripe down the back and another across the shoulders in the non-black animals. Horns may be straight or flaring, and measure as much as 26 to nearly 30 inches between tips. Five photos.

1962a. "Management of the Axis Deer in Hawaii." *Proc. 42nd Annual Conf. Western Assoc. State Fish and Game Commns.*, pp. 90–97.

Outlines introduction and management history of *Axis axis* in Hawai'i, gives results of recent ecological studies, and discusses the controversy arising from proposed introduction of the species on the island of Hawai'i.

1962b. "Big Game Management in Hawaii." *Trans. 27th North American Wildlife Conf.*, pp. 413–423.

Explains briefly but concisely the program for management of big game in Hawai'i. Seven species occur among the various islands of the state. Suggests gradual replacement of feral species with exotic wild forms.

1962c. "Wildlife Management vs. Agriculture—Or Is It?" *Mauna Kea Soil and Water Conservation Dist., Seventh Annual Rep.*, pp. 25–26.

Discusses problem of sport hunting in Hawai'i, with particular reference to the axis deer. Suggests ways in which private lands can be managed for mutual benefit of hunter and landowner.

1962d. "Ecology of the Wild Pig." State of Hawaii, Div. Fish and Game, Honolulu, Project W-5-R-13. 20 pp., mimeo.

Report of extensive field work largely on the northern half of Hawai'i, during the fiscal year 1961–1962. Excellent data on a wide variety of subjects: taxonomy, anatomy, behavior, habitat, range, parasites, pathology, and others.

1962e. "How Wild are Boars?" *Outdoor Life* 130(6):42–43, 75–78.

Descriptive account of exciting and dangerous feral pig hunting on Hawai'i, with assistance of Raymond Arraujo and his dog. A forest-inhabiting pig weighed more than 450 pounds. Those of higher mountain habitats sometimes attained 250 pounds. Recounts several cases of injury to hunters, including one fatality. Seven photos by the author.

1963e. "Ecology of the Wild Pig." State of Hawaii, Div. Fish and Game, Honolulu, Project W-5-R-14. 11 pp., mimeo.

Progress report for fiscal year 1962–1963, on the island of Hawai'i. Preliminary findings are given on reproductive cycle, foods, parasites, movements, and effects of drought.

1964a. "Ecology of the Wild Pig." State of Hawaii, Div. Fish and Game, Honolulu, Project W-5-R-15. 11 pp., mimeo.

Progress report for fiscal year 1963–1964 of work on Hawai'i. Presents findings on the reproductive cycle of field-caught pigs held in large pens, on tooth development and growth rate in their known-age offspring, and on movement of free-ranging tagged pigs.

1964b. "Puuanahulu Game Management Area Sheep Survey." State of Hawaii, Div. Fish and Game, Honolulu, Project W-5-R-15. 3 pp., mimeo.

Reports on June 1964, helicopter survey of a feral sheep population on the middle northwest slope of Mauna Kea, Hawai'i. An estimated 180 animals were present. The area is one of rough *'a'ā* lava flows, and open only to archery hunting.

1964c. "Mauna Kea Sheep Survey." State of Hawaii, Div. Fish and Game, Honolulu, Project W-5-R-15. 6 pp., mimeo.

July 8–12, 1964, sheep count revealed 1,166 feral sheep, 23 mouflon, and 50 hybrids. Total estimate of sheep was 1,300 to 1,500. Mouflon and hybrid count was thought to be low compared to actual numbers in population. Range conditions are described.

1964d. "Kipuka Ainahou Game Survey." State of Hawaii, Div. Fish and Game, Honolulu, Project W-5-R-16. 2 pp., mimeo.

Reports on a one-day survey in July 1964 by eight men on foot. Totals of 16 sheep, 1 pig, and 125 goats were counted. Area is in Mauna Loa Game Management Area, in saddle between Mauna Loa and Mauna Kea. Range appeared little used and in good condition.

1964e. "Lanai Deer Survey." State of Hawaii, Div. Fish and Game, Honolulu, Project W-5-R-16. 5 pp., mimeo.

Count of March 9–13, 1964, resulted in estimate of 1,900 to 2,200 deer. Range damage was negligible but some pineapple plants were eaten at edges of fields. Either-sex hunt for taking 500 deer, and water units to serve in drought periods, were recommended.

1964f. "Big Game Range Surveys." State of Hawaii, Div. Fish and Game, Honolulu, Project W-5-R-15. 3 pp., mimeo.

Reports establishment of four one-acre, and two smaller, sheep- and pig-tight exclosures in representative habitats on Mauna Kea, at elevations from 6,800 to 9,600 feet, for long-term study of range use.

1964g. "Triple-Header Hunt in Hawaii." *Fishing and Hunting Yearbook* 15:72–73, 119–122.

Well-written narrative account of two-day hunt on Mauna Kea, Hawai'i, for pigs, sheep, and goats. Describes hunting conditions. Prime ram had horns 32¼ and 33¾ inches on the outside curve, with a spread of 19 1/8 inches. Six photos show game taken, and illustrate feral sheep, mouflon, and their hybrid offspring.

1964h. "Summary of Disease-Testing Results from Wild Big Game in Hawaii." State of Hawaii, Div. Fish and Game, Honolulu, Res. Rep. 8 pp., mimeo.

Reports preliminary results from Hawai'i and Moloka'i in which *Leptospira* and *Brucella* were commonly found in feral pigs and in feral goats. Other parasites are considered. Suspected cases of scrub typhus and of leptospirosis are noted in persons performing game autopsies.

NICKERSON, R.

1977. *Brother Whale: A Pacific Whalewatchers Log.* San Francisco: Chronicle Books. 155 pp.

Introduction to whales, whaling history, and current serious popular interest in their conservation. Concludes there is no justification for whaling today. Setting is centered on the wintering grounds of the humpback whale off Lahaina, Maui.

NISHIWAKI, M.

1967. *Distribution and Migration of Marine Mammals in the North Pacific Area.* (Symposium No. 4, Eleventh Pacific Sci. Cong., Tokyo.) Ocean Res. Inst., Univ. Tokyo, Bull. 1. 64 pp.

A useful summary introducing many data and references from the western region. Maps and illustrations supplement brief accounts of taxonomy and range.

NISHIWAKI, M., and K. S. NORRIS

1966. "A New Genus, *Peponocephala*, for the Odontocete Cetacean Species *Electra electra*." *Whales Res. Inst., Tokyo, Scientific Rep.* 20, pp. 95–99.

Compares *P. electra*, by means of drawings, with seven species of *Lagenorhynchus*, including *L. obliquidens*. Many photos of *P. electra*; also distributional records.

NITECKI, M. H. (Editor)

1984. *Extinctions.* Chicago: Univ. Chicago Press. 354 pp.

Record of a symposium of May 1983. Papers by leading authors on current and past extinctions, including the geological record.

NODDLE, BARBARA

1974. "Ages of Epiphyseal Closure in Feral and Domestic Goats, and Ages of Dental Eruptions." *J. Archaeol. Science* 1:195–204.

Feral goats were about a year behind domestic goats in closure (and hence cessation of limb growth). In all goats closure is much later than in modern domestic sheep.

NORGAARD, V. A.

1905. "Official Regulations Regarding Livestock." *Hawaiian Forester and Agriculturist* 2:422–424.

Three circulars issued by Territorial veterinarian regarding inspection of imported livestock at the pier, the specific diseases to be looked for, and steps to be taken when glanders is found in horses already in the Territory.

NORMAN, C.

1982. "Water Buffalo: Neglected, Misunderstood." *Science* 215:1478.

Refers to a report by the U. S. National Research Council entitled, "The Water Buffalo: New Prospects for an Underutilized Animal." Summarizes history of the species in tropical Asia and eastern Mediterranean. Suggests better use should be made of it and notes recent introductions to Latin America, Brazil, and southern U. S.

NORMAN, F. I.

1975. "The Murine Rodents *Rattus rattus, exulans* and *norvegicus* as Avian Predators." *Atoll Res. Bull.* 182:1–13.

Reviews worldwide examples, including those from Hawai'i, of *R. exulans*.

NORRIS, K. S.

1961. "Standardized Methods for Measuring and Recording Data on the Smaller Cetaceans." *J. Mammalogy* 42:471–476.

Report of the Committee on Marine Mammals, American Society of Mammalogists. Detailed instructions and discussion of need for uniformity in kinds of information taken. Many field hints, one figure.

1965. "Trained Porpoise Released in the Open Sea." *Science* 147:1048–1050.

Pacific bottlenose dolphin, *Tursiops*, after capture and training, was tested for speed in the open ocean. Report emphasizes training procedures, behavioral responses, and possible uses of subjects so trained. Cover photo shows the animal leaping at sea.

1974. *The Porpoise Watcher.* New York: W. W. Norton. 250 pp.

Easy reading; traces development in narrative, concise terms, of research on behavior of free-living and captive dolphins and whales in California and Hawai'i, ca. 1952–1972. Autobiographical sketches by a well-known, broadly schooled scientist. Ends with a chapter on ecological forebodings concerning "the whale problem."

1977. "Tuna Sandwiches Cost at Least 78,000 Porpoise Lives a Year, but There Is Hope." *Smithsonian* 7(11):44–53.

A thoughtful progress report on the program for developing means for dolphins to escape from purse seines, with cooperation of the fishermen.

NORRIS, K. S. (Editor)

1966. *Whales, Dolphins, and Porpoises.* Berkeley: Univ. California Press. 789 pp.

A report on the First International Symposium on Cetacean Research, held in Washington, D.C., in 1963; 50 authors present results of current findings; numerous references.

NORRIS, K. S., and T. P. DOHL

1980. "Behavior of the Hawaiian Spinner Porpoise, *Stenella longirostris*." *Fish. Bull.* 77:821–849.

Excellent portrayal of this species, including morphology, systematics, distribution, behavior, daily activity patterns, and diet. Major research effort was at Kealakekua Bay, Hawai'i.

NORRIS, K. S., and B. MØHL

1983. "Can Odontocetes Debilitate Prey with Sound?" *American Naturalist* 122:85–104.

Traces a hypothesis that some toothed whales and dolphins emit sounds so intense that prey may be impaired and more easily captured. Extensive review of the subject. Sperm whale presents a special case. Some observations on dolphins in Hawai'i.

NORRIS, K. S., and KAREN W. PRYOR

1970. "A Tagging Method for Small Cetaceans." *J. Mammalogy* 51:609–610.

An ear tag for deer was adapted to placement on the dorsal fin of *Steno* and *Stenella*, in Hawaiian waters, and was effective in identification for at least 3.5 years.

NOTARBARTOLO DI SCIARA, G.

1977. "A Killer Whale (*Orcinus orca* L.) Attacks and Sinks a Sailing Boat." *Natura* 66:218–220.

A transoceanic racing craft off the coast of Brazil was struck without warning and sank in 15 minutes. Crew swimming and in life raft were not attacked by the four or five orcas. Other instances are cited.

NOWAK, R. M., and J. L. PARADISO
1983. *Walker's Mammals of the World*, 4th ed. Vols. 1–2. Baltimore: Johns Hopkins Univ. Press. 1,472 pp.
Revision and expansion of earlier editions. For professional and general readers. Nearly 2,500 illustrations.

OBERLIN, ANNE
1940. "Just a Relic of Another Era." *Paradise Pacific* 52(11):32–34.
Illustrated philosophic sketch of the water buffalo in Hawai'i and elsewhere; "the first pair of water buffalo came to Honolulu in the early 1880's, brought here by Walter Hill for a Chinese rice farmer named Ah In. . . . The original animals . . . came from Southern China."

O'BRIEN, P. H.
1982. "Flehmen: Its Occurrence and Possible Function in Feral Goats." *Animal Behaviour* 30:1015–1019.
This widely occurring ungulate behavior is described for goats, in Australia. Uses include social monitoring and learning processes.

O'BRIEN, S. J., and W. G. NASH
1982. "Genetic Mapping in Mammals: Chromosome Map of the Domestic Cat." *Science* 216:257–265.
Of some 25 mutant morphological genes described, 10 contribute in various combinations to more than 100 breeds of cats presently maintained. Mapping results are compared with those in man (Primates) and mouse (Rodentia).

O'FARRELL, T. P.
1965. "The Rabbits of Middleton Island, Alaska." *J. Mammalogy* 46:525–527.
From an original population of four white rabbits released in 1954, after six and one-half years there was a well-established but greatly fluctuating population of several thousand that were white, black, slate gray, wild-type agouti, and red in color, in decreasing order of abundance for each color.

O'GARA, B. W.
1970. "Derivation of Whole Weights for the Pronghorn." *J. Wildlife Mgmt.* 34:470–472.
Testing of a sample of 133 animals by weight of various parts permits close estimates of weight in the entire animal. Tables are presented.
1978. "*Antilocapra americana*." Mammalian Species No. 90, pp. 1–7. Published by the American Society of Mammalogists.
Basic outline of the species: description, range, ecology, bibliography.

OHATA, C. A., D. T. MATSUURA, G. C. WHITTOW, and S. W. TINKER
1972. "Diurnal Rhythm of Body Temperature in the Hawaiian Monk Seal (*Monachus schauinslandi*)." *Pacific Science* 26:117–120.
Variation was 1°C, increased by normal activity and lowest when at rest in direct sunlight. An ingested "radio pill" transmitted the data.

OLMSTEAD, F. A.
1969. *Incidents of a Whaling Voyage*. Rutland: Charles E. Tuttle Co.
Vivid accounts of Atlantic and Pacific whaling by a passenger aboard a vessel of the sperm whale fleet, out of New London, Connecticut, en route to Hawai'i in 1839–1840.

OLSEN, J. S.

1974. "Early Domestic Dogs in North America and Their Origins." *J. Field Archaeol.* 1:343–346.

Suggests that we should look to collections of dogs in Asia (China) for learning the ancestry of dogs in North America.

OLSON, S. L., and HELEN F. JAMES

1982a. "Fossil Birds from the Hawaiian Islands: Evidence for Wholesale Extinction by Man Before Western Contact." *Science* 217:633–635.

Other aspects of authors' 1982b report (see below). Questions earlier biogeographical conclusions about islands because a large unknown segment of original biota may have disappeared wherever man settled.

1982b. *Prodromus of Fossil Avifauna of the Hawaiian Islands.* Smithsonian Contrib. Zool. 365. 59 pp.

Introduces a vast find of bird fossils found since 1971, principally on Moloka'i, O'ahu, and Kaua'i. Also an excellent review of geology, climate, and biogeography. Forty new extinct bird species are indicated.

OMMANNEY, F. D.

1971. *Lost Leviathan.* New York: Dodd, Mead. 280 pp.

Basic work on whales and whaling industry, including world statistics on kill and decline of whale numbers.

OMURA, H., S. OHSUMI, T. NEMOTO, K. NUSU, and T. KASUYA

1969. "Black Right Whales in the North Pacific." *Scientific Rep. Whales Res. Inst.* 21:1–78.

Extensive data, largely from viewpoint of whale fishery activities.

ORD, W. M.

1964. "Mongoose Attacks Young Red-Foot Booby at Nest." *'Elepaio* 25:3.

Describes predation on nestling *Sula sula* about three weeks old in colony at Ulupa'u Head, O'ahu. The mongoose seized the bird by the nape of the neck, but killed it only after some 10 to 15 minutes of struggle.

O'REAR, B.

1981. "Communing with Dolphins Turns This Lady On." *Hawaii Tribune-Herald,* September 18, p. 24.

Interviews with Estelle Meyers who communicates non-verbally, "through telepathy," with dolphins, a phenomenon that has given rise to the rainbow and dolphin visual communication symbol for peace in the world; and with Dexter Cate, another proponent of the view that man can learn to communicate with dolphins.

PALMER, H. S.

1927. *Geology of Kaula, Nihoa, Necker, and Gardner Islands and French Frigates Shoal.* B. P. Bishop Mus. Bull. 35. 35 pp. (Tanager Expedition Pub. No. 4.)

Basic descriptions of the physical characteristics of these several isolated land areas.

1930. "Geology of Molokini." *B. P. Bishop Mus. Occ. Pap.* 9(1):1–14.

Physical description of this 19-acre islet off Maui. Geologic history is summarized (p. 14). Map and photos.

1936. "Geology of Lehua and Kaula Islands." *B. P. Bishop Mus. Occ. Pap.* 12(13):1–36.

Thorough structural descriptions of these small islands off Ni'ihau (Ka'ula, 136 acreas; Lehua, 291 acres). Geologic history of each is summarized (pp. 30–31). Several maps and photos.

PAPP, R. P.

1980. "High Altitude Aeolian Ecosystems in the Hawaiian Islands." *In*: C. W. Smith (editor), 1980, pp. 259–264.

From experience at other sites (California), reviews the information on Mauna Loa, Mauna Kea, and Haleakalā. Concludes that a substantial invertebrate fauna occupies these high altitude habitats.

PARCHER, L. K.

1975. "Notice of Receipt of Application for Endangered Species Permit." *Federal Register* 40(169):39910, August 29.

Application for mist-net collection, handling, and marking of 50 Hawaiian hoary bats in Ka'ū and South Kona districts, Hawai'i, by David M. Turner.

PARFIT, M.

1980. "Are Dolphins Trying to Say Something, or Is It All Much Ado about Nothing?" *Smithsonian* 11:73–80.

Explores the world of J. C. Lilly in cetacean communication by visiting research facilities in Florida, California, and Hawai'i. Reflects that man/dolphin communication research is clearly a frontier.

PARKER, V. R.

1964. *Newsletter.* Island of Hawaii Fish and Game Association, No. 2. Hilo, Hawai'i. 3 pp.

Reviews newspaper coverage of the axis deer introduction controversy and accuses local editors of bias in favor of cattlemen. Presents logical arguments for deer introduction based on management principles and conclusions of competent biologists.

PARSONS, BRINCKERHOFF-HIROTA ASSOCIATES

1974. "Preliminary Environmental Impact Statement, Kohakohau Dam Project, Waimea, Hawaii." State of Hawaii Department of Land and Natural Resources. 161 pp., mimeo.

Contains biotic inventory of a high rainfall area of Kohala Mountain; orographic and other physical data.

PATTON, J. L., AND P. MEYERS

1974. "Chromosomal Identity of Black Rats (*Rattus rattus*) from the Galapagos Islands, Ecuador." *Experimentia* 30:1140–1142.

Chromosome number is $2n = 38$ in these rats as in populations of south India, western Asia, Europe, Africa, North and South America, and Australia. Presumably *R. rattus* in Hawai'i are of this morph. A second morph, $2n = 42$, occupies eastern and Southeast Asia, and the Indian subcontinent.

PAYNE, R. S.

1970. *Songs of the Humpback Whale.* Del Mar: Communications Research Machines.

A long-playing stereo recording. Two sides, presenting a complete repertory of whale songs.

1976. "At Home with Right Whales." *National Geographic* 149:322–339.

Experiences with the right whale along the coast of Patagonia, Argentina. Descriptions of behavior as noted during studies of vocal sounds. Excellent photos show many details of this whale.

PAYNE, R., and A. GIDDINGS

1979. "Humpbacks: Their Mysterious Songs." *National Geographic* 155:18–25.

Songs, which occur only on wintering grounds, change gradually through a season and evolve in a broad range of capability over the years.

PAYNE, S.

1969. "The Origins of Domestic Sheep and Goats: A Reconsideration in the Light of Fossil Evidence." *Proc. Prehist. Soc.* 1968. New Ser. 34:368–384.

Promotes the interesting hypothesis that four major groups of caprine animals survived the Pleistocene and from one group modern sheep and goats have both emerged—goats in Europe and the Near East, and sheep in the Aralo-Caspian basin. Presently "wild" stocks may be actually feral, and perhaps sheep have survived only in domestication.

PEALE, T. R.

1848. *United States Exploring Expedition.* Vol. 8, *Mammalia and Ornithology.* Philadelphia: Lea and Blanchard. 338 pp.

Describes briefly (p. 24) general characteristics of the bat seen at Kealakekua Bay, Hawai'i: "It measures about twelve inches across the wings; is of a ferruginous gray colour; the interfemoral membrane is large and includes the tail which is about the length of the body." Original description of *Rattus exulans*, from Tahitian specimens (p. 47).

PEARSON, O. P.

1971. "Additional Measurements of the Impact of Carnivores on California Voles (*Microtus californicus*)." *J. Mammalogy* 52:41–49.

Relates carnivores, the feral cat included, to cycles of abundance in vole populations. An extension of earlier work, which included the house mouse, in a 35-acre study area.

PEARSON, O. P., and P. H. BALDWIN

1953. "Reproduction and Age Structure of a Mongoose Population in Hawaii." *J. Mammalogy* 34:436–447.

Reports on 221 *Herpestes auropunctatus* examined on Hawai'i in one year. Age estimates were made from skull characteristics. Male and female reproductive tracts are described. Average litter size (from fetus counts) is 2.7. Some females may bear two litters per year.

PEKELO, N., JR.

1973. "Some Field Notes from Molokai." *'Elepaio* 33:98.

Describes a military-style hunt for feral cattle, for the purpose of eliminating bovine tuberculosis, ending December 1, 1972. About 375 cattle were present in the region between Kawela Gulch and Waialua Valley, on private land and in forest reserve.

PEMBERTON, C. E.

1923. "Investigations Pertaining to the Field Rat and Other Problems in Hamakua." *Hawaiian Planters' Rec.* 27:169–175.

A progress report with specific data on rat damage in various sugar cane fields of Hāmākua District, on Hawai'i. Outline of methods (p. 175) for mongoose control with KCN in dead mouse baits. States that mongoose does not eat sugar cane, as others had asserted.

1924. "Rat Control." *Hawaiian Planters' Rec.* 28:191–201.

Discusses methods and economics of rodent control at the Honoka'a Sugar Company, on Hawai'i. Summarizes relationship of rat control to plague control in Hāmākua District.

1925. *The Field Rat in Hawaii and Its Control.* Hawaiian Sugar Planters' Assoc., Exp. Sta., Entomological Ser. Bull. 17. 46 pp.

Report of work, 1918–1923, on the Hāmākua coast (in particular at Honoka'a Sugar Company), on Hawai'i. Discusses biology of rats, environment, control methods, and bubonic plague.

1933. "Some Food Habits of the Mongoose." *Hawaiian Planters' Rec.* 37:12–13.

Results of a short series of feeding tests, and of fecal analyses, on O'ahu.

1938. "The Giant African Snail *Achatina fulica* (Fer.) Discovered in Hawaii." *Hawaiian Planters' Rec.* 42:135–140.

Thriving cultures of the snail were discovered on Maui after a Honolulu resident who had obtained stocks from Maui sought information at the Board of Agriculture and Forestry on propagation methods. Original snails were 12 imported by mail from Japan to Maui in November 1936. A second importation, from Formosa to O'ahu, also in 1936, was discovered.

PENDERGRAPH, G. E.

1971. "First Report of the Acanthocephalan, *Bolbosoma vasculosum* (Rudolphi, 1819), from the Pygmy Sperm Whale, *Kogia breviceps*." *J. Parasitology* 57:1109.

Two specimens were found in the small intestine of one animal washed ashore at Sapelo Island, Georgia. The usual hosts are various Atlantic fishes.

PERKINS, D., JR.

1964. "Prehistoric Fauna from Shanidar, Iraq." *Science* 144:1565–1566.

Presents evidence for domestication of sheep at a site level dated at 10,870 ± 300 years ago. This is the earliest known record of domestication.

PERKINS, R. C. L.

1903. "Vertebrata." *In*: David Sharp (editor), *Fauna Hawaiiensis, or the Zoology of the Sandwich (Hawaiian) Islands*. Vol. 1, Pt. 4, pp. 365–466. London: Cambridge Univ. Press.

Pages 465–466, only, deal with mammals. Gives brief but informative summary of several species. "The bats, imported for special purposes, appear to have died out." Considers bat the only endemic (but does not mention seal).

1904. "Introduction of Bats." *Hawaiian Forester and Agriculturist* 1:138–139.

Letter favoring introduction of bats, but casting doubt on the likelihood, in view of previous failures, of finding a species suitable to Hawaiian conditions.

1925. "The Early Work of Albert Koebele in Hawaii." *Hawaiian Planters' Rec.* 29:359–364.

Aside from a discussion of Koebele's work on insects is the statement: "Although he never cared to make any attempt to introduce birds, various . . . bats were sent, but . . . failed to become established, though individuals were seen alive for a year after their introduction" (p. 363).

PERLMAN, E.

1977. "Confrontation. Greenpeace Foundation Puts Itself on the Line." *Oceans* 10:58–61.

Outlines methods used to dramatize sincerity of purpose—for example, interposing small, fast boats between harpooners and whales.

PERRIN, W. F.

1972. "Color Patterns of Spinner Porpoises (*Stenella* cf. *S. longirostris*) of the Eastern Pacific and Hawaii, with Comments on Delphinid Pigmentation." *Fish. Bull.* 70:983–1003.

Provides chart (p. 1002) showing divergences from a general cape pattern in terms of discrete component systems for three unnamed subspecies. Hawaiian form has darkest dorsal markings.

1975a. "Variation of Spotted and Spinner Porpoise (Genus *Stenella*) in the Eastern Pacific and Hawaii." *Bull. Scripps Inst. Oceanogr.* 21:1–206.

Detailed analysis of all available museum materials: treating historical notes; variations in color, external morphology, and skeleton; and providing a classification for the two species in question. Basic paper.

1975b. "Distribution and Differentiation of Populations of Dolphins of the Genus *Stenella* in the Eastern Tropical Pacific." *J. Fish. Res. Board Canada* 32:1059–1067.

Hawaiian race of the spotted dolphin and of the spinner dolphin, distinct from those of the various populations to the southeast, remain unnamed pending further collection of information and comparisons of specimens.

1976. "First Record of the Melon-headed Whale, *Peponocephala electra*, in the Eastern Pacific, with a Summary of World Distribution." *Fish. Bull.* 74:457–458.

Notes specimen caught in tuna net off Central America. Map of worldwide records.

PERRIN, W. F., R. L. BROWNELL, JR., and D. P. DE MASTER (Editors)

1984. *Reproduction in Whales, Dolphins and Porpoises*. Rep. Intnl. Whaling Commn., Spec. Issue 6. 495 pp.

Proceedings of the conference entitled, "Cetacean Reproduction: Estimating Parameters for Stock Assessment and Management," La Jolla, California, 28 November–7 December, 1981.

PERRIN, W. F., J. M. COE, and J. R. ZWEIFEL

1976. "Growth and Reproduction of the Spotted Porpoise, *Stenella attenuata*, in the Offshore Eastern Tropical Pacific." *Fish. Bull.* 74:229–269.

Summarizes tuna/fisherman/dolphin interdependencies as introduction. Gestation of 11.5 months. Age at maturity is estimated from incremental dentinal layers at 5.1 to 8.3 years. Gross annual production of calves is 14.4 percent of the population per year.

PERRIN, W. F., W. E. EVANS, and D. B. HOLTS

1979. "Movements of Pelagic Dolphins (*Stenella* spp.) in the Eastern Tropical Pacific as Indicated by Results of Tagging, with Summary of Tagging Operations, 1969–76." *NOAA Tech. Rep. NMSF SSRF-737*, pp. 1–14.

Five species of dolphins were tagged with recovery of 97 of the spotted dolphins and seven of the spinner dolphins, liberty ranging from two hours to four years.

PERRIN, W. F., and C. L. HUBBS

1969. "Observations on a Young Pygmy Killer Whale (*Feresa attenuata* Gray) from the Eastern Tropical Pacific Ocean." *Trans. San Diego Soc. Natural Hist.* 15:297–308.

Reviews records of occurrence. Specimen from 300–400 miles off Costa Rica described.

PERRIN, W. F., and J. R. HUNTER

1972. "Escape Behavior of the Hawaiian Spinner Porpoise (*Stenella* cf. *S. longirostris*)." *Fish. Bull.* 70:49–60.

Experiments in tanks at Sea Life Park provide data for design of escape system to be built into tuna seines.

PERRIN, W. F., and A. C. MYRICK, JR. (Editors)

1980. *Age Determination of Toothed Whales and Sireneans.* Reps. Internatnl. Whaling Commn. Spec. Issue 3. Cambridge: Internatnl. Whaling Commn. 229 pp.

Contains series of papers on several whale species, and methods for age determination.

PERRIN, W. F., and J. E. POWERS

1980. "Role of a Nematode in Natural Mortality of Spotted Dolphins." *J. Wildlife Mgmt.* 44:960–963.

Examination of skulls from 704 dolphins killed incidental to tuna fishing revealed decreasing evidence of infection with age by the parasite *Crassicauda* sp.: Spiruridae, suggesting that younger animals with severe infection may die. Parasites may be a major factor in natural mortality of dolphin populations.

PERRIN, W. F., T. D. SMITH, and G. T. SAKAGAWA

1974. "Status of Populations of Spotted Dolphin, *Stenella attenuata*, and Spinner Dolphin, *Stenella longirostris*, in the Eastern Tropical Pacific." *USNMF Southwest Fisheries Center Admin. Rep.* LJ-74-42, 22 pp.

Statistical analyses of dolphin kill related to purse seiner sets for tuna on schools of dolphins.

PERRIN, W. F., and W. A. WALKER

1975. "The Rough-toothed Porpoise, *Steno bredanensis*, in the Eastern Tropical Pacific." *J. Mammalogy* 56:905–907.

Provides four additional records, in the latitude range of 7° to 14° N and longitude 90° to 104° W, about 20 animals in all. The *Steno* were caught by tuna seiners, along with as many as 400 spotted dolphins and 1,800 spinner dolphins per haul.

PERRYMAN, W. L., and T. C. FOSTER
1980. *Preliminary Report on Predation by Small Whales, Mainly the False Killer Whale,* Pseudorca crassidens, *on Dolphin* (Stenella *spp. and* Delphinus delphis) *in the Eastern Tropical Pacific.* La Jolla: NOAA Southwest Fisheries Center Admin. Rep. LJ-80-05, 9 pp.

Pseudorca was identified as attacker in 19 of 22 incidents during backdown process as dolphins were being released from the net.

PETERLE, T. J., and J. W. LEHMAN
1972. "DDT in Cetacea II." *In*: G. Pilleri (editor), *Investigations on Cetacea* 4, pp. 275–277. Berne: Brain Anatomy Institute. 299 pp.

Reviews reports of DDT in marine mammals of the world. Discusses methods, including search for heavy metals. Four samples of whales tested were negative for DDT in blubber and brain tissue.

PETERSON, DANA (Editor)
1976. *Scientific Report of the Manawainui Research Project, East Maui, Hawaii.* University of Hawaii, Honolulu. Ca. 200 pp., mimeo.

Project sponsored by National Science Foundation under the Student Originated Studies Program. Objective was evaluation of physical/biological assets of a remote valley. Control and management of feral animals and control of human use of the area were major recommendations.

PFEFFER, P.
1967. "Le Mouflon de Corse (*Ovis ammon musimon* Schreber, 1782); Position Systematique, Ecologie et Ethologie Comparées" [The Corsican mouflon (*Ovis ammon musimon* Schreber, 1782); systematic position, comparative ecology and ethology]. *Mammalia* (Suppl.), 31. 262 pp. (In French.)

PHILLIPS, R. W.
1945. "The Water Buffalo of India." *J. Heredity* 36:71–76.

Figures and describes eight breeds, showing their general distribution. Differences are often indistinct, involving usually body and horn formation. Color is black, gray, or brown, but white splashings may occur on the head.

PIERCE, H.
1965. "Farm and Garden." *Hawaii Tribune-Herald,* February 15, p. 8.

Photograph of early morning passage of mule train through Pāhala village, Hawai'i, and notes on use of mules as "pieces of plantation equipment that don't break down."

PILLAI, R. S., and B. H. HINGORANI
1970. "A Population Census of Chittal or Spotted Deer, *Axis axis,* and Some Other Wild Animals in Dehra Dun Forest Division, Uttar Pradesh, India." *Rec. Zool. Surv. India* 62:227–238.

A population estimate by use of a drive-count technique in area of 12,144 acres (27 sampling units) representing 7.7 percent of regional habitat. Density was about one deer per 12 acres.

PILLERI, G., and M. GIHR
1969. "On the Anatomy and Behaviour of Risso's Dolphin (*Grampus griseus* G. Cuvier)." *In*: G. Pilleri (editor), *Investigations on Cetacea* 1, pp. 74–93. Berne: Brain Anatomy Institute. 219 pp.

Cursory observations off the coast of Spain. Much detail on anatomy, with plan for external measurements.

PIMENTEL, D.
1955a. "The Control of the Mongoose in Puerto Rico." *American J. Tropical Medicine and Hygiene* 4:147–151.

Tested standard poisons for control in connection with rabies. Thallium sulfate in three feedings was effective in 90-percent control of field populations. Warfarin fed for 3 to 14 days was ineffective in cage experiments.

1955b. "Biology of the Indian Mongoose in Puerto Rico." *J. Mammalogy* 36:62–68.

Reports on study of *Herpestes auropunctatus* related to its control as a reservoir of rabies and leptospirosis. Habits, range, parasites, and foods are included.

PIMM, S. L., and JUNE W. PIMM

1982. "Resource Use, Competition, and Resource Availability in Hawaiian Honeycreepers." *Ecology* 63:1468–1480.

Notes usual factors of habitat destruction and introduced mammals in extinction of birds, but adds large size and natural aggressiveness in passerine birds as probable contributing factors.

PINE, D. S., and G. L. GERDES

1973. "Wild Pigs in Monterey County, California." *California Fish and Game* 59:126–137.

Mark and release study in rugged mountain region. Retrapped pigs moved a mean distance of 0.2 mile; for pigs shot by hunters the mean was 2.6 miles. Biological data are reported.

PLOMLEY, N. J. B.

1972. "Some Notes on Plagues of Small Mammals in Australia." *J. Natural History* 6:363–384.

The usual widely distributed commensal/feral rodents, *Mus domesticus*, *Rattus rattus*, and *R. norvegicus*, gained access to Australia since 1788. Study of these populations has implications for knowledge of outbreaks (of *Mus* in particular) in Hawai'i.

POCOCK, R. I.

1916. "On the External Characters of the Mongoose (Mungotidae)." *Proc. Zool. Soc. London* 1:349–374.

Detailed comparison of ear, vibrissae, rhinarium, feet, anal glands, and external genitalia, in 12 apparently distinct mongooses, including *Herpestes auropunctatus*.

1937. "The Mongoose of British India, Including Ceylon and Burma." *J. Bombay Natural History Soc.* 39:211–245.

Lists six species of *Herpestes*: *viticollis*, *urva*, *fuscus*, *edwardsii*, *smithii*, and *javanicus* (=*auropunctatus*). Systematics of six Indian species, including subspecies, are presented.

1941. *The Fauna of British India.* Vol. 2. *Mammalia.* London: Taylor and Francis. 503 pp.

Page 29 lists *Herpestes javanicus auropunctatus* (Hodgson) as the then current name for this mongoose. It was originally described as *Mangusta auropunctatus* Hodgson in 1836, by the Asiatic Society of Bengal 5:235. Type locality of subspecies *auropunctatus* is Nepal.

PLUTTE, W.

1984. "The Whaling Imperative." *Oceans* 17(2):24–26.

Strong tradition, a sense of conservation of whale stocks, and resistance to interference by outsiders contribute to continuation of Norwegian whaling industry (90 small ships, 1,000 workers).

POOLE, A. J., and VIOLA S. SCHANTZ

1942. *Catalog of the Type Specimens of Mammals in the United States National Museum, Including the Biological Surveys Collection.* U. S. National Mus. Bull. 178. 705 pp.

Lists (p. 149) the lectotype of *Lasiurus cinereus semotus*, collected in Hawai'i, apparently on Kaua'i, and catalogued in 1887.

PORTER, J. W.

1977. "*Pseudorca* Strandings." *Oceans* 19(4):8–15.

Popular narrative of 30 false killer whales stranded off Florida coast July 1976. A large male with an ear lesion was closely attended by others of the group until he died three days later. Many observations of the group are recorded, with possible explanations of strandings.

PRICE, E. O.

1984. "Behavioral Aspects of Animal Domestication." *Quart. Rev. Biol.* 59:1–32.

Biological and social bases for animal domestication. Feralization is described as the domestication process in reverse. Extensive bibliography.

POWELL, J. E.

1914. "Notes on the Habits of the Small Indian Mongoose (*Mungos auropunctatus*)." *J. Bombay Natural History Soc.* 22:620.

Observations on tame mongooses that lived about the author's home in India. Gives gestation period as seven weeks; describes behavior of females with young, and usefulness in snake and scorpion control.

PRESCOTT, J. H.

1981. "Clever Hans: Training the Trainer, or the Potential for Misinterpreting the Results of Dolphin Research." *Annals New York Acad. Science* 364:130–136.

Explores pitfalls in reading the procedures and results of cetacean behavioral work. Identifies acute but generally unrecognized perceptions in dolphins.

POWELL, ELIZABETH

1985. "The Mauna Kea Silversword: A Species on the Brink of Extinction." *Newsl. Hawaiian Bot. Soc.* 24:44–57.

Reviews plight of subject plant in relation to sheep and man on the mountain. Preparatory to extensive study of the problem. Bibliography.

PRYOR, KAREN

1973. "Behavior and Learning in Porpoises and Whales." *Naturwissenschaften* 60:412–420.

A formal research report on observations of nine species of cetaceans at Sea Life Park, O'ahu, Hawai'i, including differences in temperament, responses, and of aggression toward humans. A plea is made for conservation of wild stocks of the world.

1975. *Lads Before the Wind: Adventures in Porpoise Training.* New York: Harper and Rowe. 278 pp.

An intimate account of development, successes, and shortcomings of training, handling, and housing of dolphins and other cetaceans and their public display at Sea Life Park, Hawai'i. The book is highly readable and deals with numerous personalities at the Park in the era 1963–1971.

1981. "Why Porpoise Trainers Are Not Dolphin Lovers: Real and False Communication in the Operant Setting." *Annals New York Acad. Science* 364:137–143.

An updating on the inner working of dolphin training as it relates to the broader field of communication between man and animals.

PRYOR, T., KAREN PRYOR, and K. S. NORRIS

1965. "Observations on a Pygmy Killer Whale (*Feresa attenuata* Gray) from Hawaii." *J. Mammalogy* 46:450–461.

An adult was taken captive near Hawai'i Island in 1963 and kept alive 20 days in an oceanarium. Behavior of the living animal and anatomy of the carcass are described. Nomenclature is reviewed.

PUKUI, MARY K., and S. H. ELBERT

1971. Hawaiian Dictionary: Hawaiian–English, English–Hawaiian. Honolulu: Univ. Hawaii Press. 188 pp.

Combined revision of 1957 (Hawaiian–English) and 1964 (English–Hawaiian) editions by the same authors. Includes historical and explanatory preface, notes on grammar, pronunciation, and abbreviations. About 25,000 Hawaiian words defined. Hawaiian equivalents for some 12,500 English words.

PUKUI, MARY K., S. H. ELBERT, and ESTHER T. MOOKINI
1974. *Place Names of Hawaii.* Honolulu: Univ. Press of Hawaii. 289 pp.
Useful and authentic source for location and meaning of some 4,000 place names; appendixes and references to subject matter.

PULLAR, E. M.
1953. "The Wild (Feral) Pigs of Australia: Their Origin, Distribution and Economic Importance." *Mem. National Mus. Melbourne* 18:7–23.
Useful for comparison with Hawaiian strains. Says of juvenile pattern (p. 14), "Dorsal longitudinal striping in shades of brown and fawn are sometimes seen in the suckers, but they disappear as they grow older."

PURVES, P. E., and G. PILLERI
1978. "The Functional Anatomy and General Biology of *Pseudorca crassidens* (Owen) with a Review of Hydrodynamics and Acoustics in Cetacea." *In*: G. Pilleri (editor), *Investigations on Cetacea* 9, pp. 68–227. Berne: Brain Anatomy Institute. 254 pp.
A thorough treatment of the false killer whale in the indicated subject matter.

PYE, T., and W. N. BONNER
1980. "Feral Brown Rats, *Rattus norvegicus*, in South Atlantic Ocean." *J. Zool.* 192:237–255.
Rat established on South Georgia (54° S) about year 1800. The population is dependent on tussock grass cover for nesting sites. Predation on several sea birds is seasonal. Co-existence has emerged, with rats well adapted to the rigorous climate.

QUAN, S. F., C. M. WHEELER, M. I. GOLDENBERG, and L. KARTMAN
1965. "The Susceptibility of *Rattus* Species from Two Areas of Hawaii to Infection with *Pasteurella pestis.*" *American J. Tropical Medicine and Hygiene* 14:638–642.
R. norvegicus and *R. exulans* from the plague district on Hawai'i were more resistant to experimental infection than were these species from O'ahu. *Rattus rattus* from the same two islands showed no such differences.

QUAY, W. B., and P. Q. TOMICH
1963. "A Specialized Midventral Sebaceous Glandular Area in *Rattus exulans.*" *J. Mammalogy* 44:537–542.
A new glandular structure, then unknown in other forms of *Rattus*, is described from a Hawaiian population of the Polynesian rat. It is largest in adult males, averaging 43 mm long by 4.7 mm wide. Significance of the gland is undetermined.

RALPH, C. J.
1978. "The Roof Rats' Role in Hawaiian Extinction." *'Elepaio* 39:6–7.
Review of Atkinson, 1977.

RASA, O. ANNE E.
1975. "Mongoose Sociology and Behaviour as Related to Zoo Exhibition." *In*: Nicole DuPlaix-Hall (editor), *Internatnl. Zoo Yearbook*, pp. 65–73. Zoological Soc. London 15. 463 pp.
Some comparisons of mongooses including *Herpestes auropunctatus*, with information on maintaining captives.

RAUSCH, R. L.
1975. "Cestodes of the Genus *Hymenolepis* Weinland, 1858 (sensu lato) from Bats in North America and Hawaii." *Canadian J. Zool.* 53:1537–1551.
The tapeworm *Hymenolepis lasionycteridis* Rausch is described as a new species from the

hoary bat in Hawai'i and from other genera of bats in western United States. Zoogeographic implications are discussed.

RAUZON, M. J.

1981. "The Effect of Cats on Howland, Baker, and Jarvis Islands." Term Report, Geography 365, University of Hawaii. 20 pp., mimeo.

Obscure tropical possessions of U.S., these atolls are significant bird refuges in need of environmental management. History of cat-rat-bird populations. An approach is made to study and eventual eradication of cats.

1983. "Effects of Feral Cats on Jarvis Island, Central Pacific Ocean." *Pacific Science Association, 15th Cong.* (Dunedin). Abstracts, Vol. 2, pp. 194–195.

Sooty terns (*Sterna fuscata*) and various boobies (*Sula* sp.) provide the major food for about 200 cats on the island. Study, to be followed by eradication of the cats, is in progress.

RAUZON, M. J., and K. W. KENYON

1982. "Hawaiian Monk Seal Inshore Diving Behavior." *'Elepaio* 42:107–108.

At Tern Island, French Frigate Shoals, seals dove habitually for hours at a time. Average length of 265 submersions was 9.5 minutes, range 1 to 31 minutes. If food was taken there was no evidence of it when the animals surfaced.

REDHEAD, T. D.

1980. "A Relationship between Rainfall and Rat Damage to Sugar-Cane in North Queensland." *Queensland J. Agricultural and Animal Sciences* 37:181–188.

Analysis of a 29-year record shows that the proportion of the crop lost to rats is significantly related to amounts of rainfall of drier seasons in the preceding year. A tested predictive equation is presented.

REED, C. A.

1959. "Animal Domestication in the Prehistoric Near East." *Science* 130:1629–1639.

Reviews evidence on the age and chronology of common domestic mammals, revising some previous conclusions on the basis of new methods and data. Cereal agriculture antedates domestication of all animals except the dog.

1960. "A Review of the Archaeological Evidence on Animal Domestication in the Prehistoric Near East." *In*: R. J. Braidwood and B. Howe, *Prehistoric Investigations in Iraqi Kurdistan*, pp. 119–145. Stud. Ancient Oriental Civilization 31. Chicago: Univ. Chicago Press. 184 pp.

A critical analysis, from a zoologist's viewpoint, of the archaeological literature on the origins of animal domestication for the prehistoric periods of Egypt and southwestern Asia. Dog, goat, sheep, pig, and cattle are treated in detail.

1961. "Osteological Evidences for Prehistoric Domestication in Southwestern Asia." *Z. Tierzüchtung Züchtungsbiol.* 76:31–38.

Presents new dates for early domestication of pigs, sheep, and cattle. Discusses the problem of distinguishing between dog and wolf remains.

REGENSTEIN, L.

1975. *The Politics of Extinction.* New York: Macmillan. 280 pp.

An emotional appeal and approach concerning government agencies, hunting and the extinction of wild species. Preface by Cleveland Amory.

REPENNING, C. A., and C. E. RAY

1977. "The Origin of the Hawaiian Monk Seal." *Proc. Biol. Soc. Washington* 89:667–688.

New information from anatomical studies suggests that *Monachus schauinslandi* may have been separated from ancestral stocks as long as 15 million years ago, colonizing the Pacific Ocean

at a time when Atlantic equatorial currents swept between North and South America. Some Hawaiian islands were then present.

RESTARICK, H. B.

1927. "Juan Gaetano: Did He Discover Hawaii?" *Paradise Pacific* 40(5):14–15, 32.

Further discussion tending to show that Gaytan discovered the Marshall group in 1542, and that no description is available of a 1555 voyage.

REYNOLDS, S.

1850. "Reminiscences of Hawaiian Agriculture." *Trans. Royal Hawaiian Agricultural Soc.* 1(1):49–53.

Summarizes (pp. 51–53) early husbandry of cattle, sheep, goats, horses, and swine, from the time of their introduction into the islands by early voyagers.

RICE, D. W.

1960a. "Distribution of the Bottle-Nosed Dolphin in the Leeward Hawaiian Islands." *J. Mammalogy* 41:407–408.

Reports observations of *Tursiops truncatus* at Kure Atoll, Midway Islands, Pearl and Hermes Atoll, Laysan Island, and French Frigate Shoals in 1957–1958. As many as 50 occurred in one school.

1960b. "Population Dynamics of the Hawaiian Monk Seal." *J. Mammalogy* 41:376–385.

Data from the entire range of the species are analyzed. Total number of seals about 1,350; had apparently not reached maximum density. Increased pup mortality is predicted as a likely natural population control.

1964. "The Hawaiian Monk Seal." *Natural History* 73(2):48–55.

Timely, accurate, popularized account of the species. Many excellent photos. Protection from human interference among the Northwestern Hawaiian Islands should insure survival of this seal.

1977. "A List of the Marine Mammals of the World, 3rd edition" *NOAA Tech. Rep. NMFS SSRF-711*, pp. 1–15.

A leading basic nomenclature. Follows plan recognizing the toothed whales (Odontoceti) as distinct from the baleen whales (Mysticeti) in separate orders of the cetaceans. Extensive synonymy of species is given, from recent literature.

RICE, D. W., and A. A. WOLMAN

1977. "Census of Humpback Whales around the Hawaiian Islands." Natnl. Marine Mammal Lab. (NOAA), Seattle. 22 pp., mimeo.

Draft copy submitted to International Whaling Commission. Actual counts ranged from 321 to 425 per year. Mean estimate for total population is 650 whales.

RICHARDS, L. P.

1952. "Cuvier's Beaked Whale from Hawaii." *J. Mammalogy* 33:255.

Reports on two whales grounded at South Point, island of Hawai'i, between January 25 and October 25, 1950. One was a Cuvier's beaked whale; the other a killer whale. Both are apparently first records of these species actually collected in Hawai'i.

RICHARDSON, F.

1949. "The Status of Native Land Birds on Molokai, Hawaiian Islands." *Pacific Science* 3:226–230.

Considers relationships of introduced mammals to welfare of the birds. Concludes that significant undisturbed high native forest areas remain and that these can be saved from invasion by restricting large mammals from Pelekunu and Wailau valleys.

1963. "Birds of Lehua Island off Niihau, Hawaii." *'Elepaio* 23:43–45.

Record of visit on August 10–11, 1960. One dead rat found, and evidence present of possible

rat predation on adults of Bulwer's petrel. Rabbits were moderately abundant. Recommends eradication of rats and rabbits and the declaration of Lehua as a State Bird Reservation.

RICHARDSON, F., and H. I. FISHER

1950. "Birds of Moku Manu and Manana Islands off Oahu, Hawaii." *Auk* 67:284–306.

Note (p. 289) *Mus musculus* present on Mānana and of little significance to birds; rabbits also present in low to moderate numbers and likewise not apparently in conflict with nesting of sea birds. No mammals on Mokumanu.

RICHARDSON, F., and D. H. WOODSIDE

1954. "Rediscovery of the Nesting of the Dark-Rumped Petrel in the Hawaiian Islands." *Condor* 56:323–327.

Predation by feral cats (p. 326) is considered serious in Mauna Kea nesting regions (on Hawai'i), but light at Haleakalā (on Maui). Interference and predation by goats, pigs, and mongoose are insignificant.

RICHBURG, K.

1984. "Whales Test U.S.-Japan Relations." *Honolulu Advertiser*, November 24, p. A-23.

A *Washington Post* article outlining status of whaling issue. Japan faces a 50% cut in rights to fish in American waters if it persists in whale hunting. No agreement had been reached. The 1984 sperm whale season had begun.

RIDGWAY, S. H. (Editor)

1972. *Mammals of the Sea: Biology and Medicine.* Springfield: Charles C. Thomas. 812 pp.

A basic work including essentially all aspects of the cetaceans in chapters contributed by 12 specialists.

RIDGWAY, S. H., and D. M. DAILEY

1972. "Cerebral and Cerebellar Involvement of Trematode Parasites in Dolphins and Their Possible Role in Stranding." *J. Wildlife Diseases* 8:33–43.

Seven dolphins (*Delphinus*) stranded on the California coast 1966–1970 all had similar pathologies from adult trematodes in and about the liver, and severe brain necrosis from numerous trematode ova in that organ, probably contributing to stranding and death.

RINEY, T.

1959. "Can Hawaii Support Another Species of Deer?" State of Hawaii, Bd. Commns. Agriculture and Forestry, Honolulu. 10 pp., mimeo.

Author, as consultant, studies questions of control, forest damage, and anthrax transmission, as they may arise from further introduction of deer, specifically *Odocoileus hemionus*, to Kaua'i. Recommends introduction on basis of conclusion that deer can be controlled or eliminated as desired, and suggests additional species for Hawai'i at large.

1982. *Study and Management of Large Mammals.* New York: Wiley-Interscience. 552 pp.

Recommended as a source book for programs in developing countries; hence should be of value for Hawai'i, especially in the area of game ranching.

RINEY, T., and G. CAUGHLEY

1959. "A Study of Home Range in a Feral Goat Herd." *New Zealand J. Science* 2:157–170.

Results of a 16-month study on the North Island, New Zealand. Social groupings are described. Nanny-kid groups ranged within an open area 1,050 yards across. Billies extended their range into adjacent forest for the winter months, seasonally segregating the sexes.

RINEY, T., J. S. WATSON, C. BASSETT, E. G. TURBOTT, and W. E. HOWARD

1959. *Lake Monk Expedition: An Ecological Study in Southern Fiordland.* New Zealand Dept. Scientific and Industrial Research Bull. 135. 75 pp.

Survey of a representative interior section of the South Island. Relates introduced mammals, the red deer (*Cervus elaphus* Linnaeus) in particular, and birds, to the vegetation.

RIPPERTON, J. C., and E. Y. HOSAKA

1942. *Vegetation Zones of Hawaii.* Hawaiian Agricultural Exp. Sta. Bull. 89. Univ. Hawaii. 58 pp.

Characterizes climate, soils, and vegetation of Hawai'i; derives and describes Vegetation Zones A-E; tabulates zonal distribution of 316 plant species on pasture lands on the six principal islands of the Territory.

RITTE, W., JR., and R. SAWYER

1978. *Na Mana'o Aloha O Kaho'olawe.* Honolulu: Fisher Printing Co. 119 pp.

"The many feelings of love for Kaho'olawe." A deeply spiritual account of events in 1976–1977 concerning the desires of native Hawaiians to release Kaho'olawe and its heritage from bombing attacks by military forces. A collection of diaries and letters.

R. M. TOWILL CORPORATION

1982. *Revised Environmental Impact Statement for the Kahauale'a Geothermal Project, District of Puna, Island of Hawaii.* Honolulu: The True/Mid-Pacific Geothermal Project. Vols. 1–3. Various paginations. Sections 1–13; Appendixes A-I.

Comprehensive review of geothermal state-of-the-art as it may affect natural and cultural ecosystems, and human populations. Extensive public and agency input. These documents have been labeled as generally "inadequate" by environmental and community groups.

ROBERTS, J. A. F.

1932. "Colour Inheritance in Sheep. VI. The Genetic Constitution of the Wild Mouflon." *J. Genetics* 25:1–16.

Records sheep/mouflon interactions on Lambay Island, Ireland, where normally the species were reproductively isolated over a period of 20 years.

ROBERTSON, R. B.

1954. *Of Whales and Men.* New York: Alfred A. Knopf. 300 pp.

An engaging record of whalers and their work aboard a factory ship in the heyday of modern whale killing, plying Antarctic waters in the 1950–1951 season. The author was senior medical officer (a psychiatrist by specialty) for a crew of 650 Scottish and Norwegian whalemen.

ROBYNS, W., and S. H. LAMB

1939. "Preliminary Ecological Survey of the Island of Hawaii." *Bull. Jardin Botanique de l'Etat, Bruxelles* 15:241–293.

Excellent over-all report. Concludes that lava flows and human interference are important complicating factors in plant succession. Many photos of vegetation types.

ROCK, J. F.

1913. *The Indigenous Trees of the Hawaiian Islands.* Honolulu: Published under patronage. 518 pp.

An exhaustive work treating 43 families. Establishes (pp. 2–87) botanical regions for Hawai'i. Species and vegetation types are illustrated by 215 photographs. Facsimile edition with addenda (1974). Lāwa'i: Pacific Trop. Bot. Garden.

RODECK, H. G.

1954. "Uniformity of Common Names of Mammals." *J. Mammalogy* 35:142–144.

Comments on the proposal of Hoffmeister (1953) in relation to establishment and use of common names. Rejects idea of rigid adoption of a single name for each species over its entire range. Suggests trial list subject to revision over a period of time.

ROLLS, E. C.
1969. *They All Ran Wild.* Sydney: Angus and Robertson. 444 pp.
The story of pests on the land in Australia. Recommended easy reading.

RONALD, K., and R. DUGUY
1979. *The Mediterranean Monk Seal: Proc. First Internatnl. Conf.* New York: Pergamon Press. 183 pp.
Conference sponsored by United Nations Environment Program. Collected reports have implications for conservation of the Hawaiian monk seal.

RONALD, K., JANE SELLEY, and PAMELA HEALEY (Editors)
1982. "Seals." *In*: J. A. Chapman and G. A. Feldhamer (Editors), *Wild Mammals of North America: Biology, Management, Economics*, Chap. 40, pp. 769–827. Baltimore: Johns Hopkins Univ. Press. 1148 pp.
Sections on Hawaiian monk seal (pp. 793–794) and northern elephant seal (pp. 795–796) are of particular importance and interest to the student of mammals in Hawai'i.

ROOD, J.
1974. "Isle Cattle Rustling Doubles in Six Months." *Hawaii Tribune-Herald*, June 26, p. 1.
Police reported 99 cattle killed or stolen from Big Island pastures in the first half of the year. There were 19 suspects but no convictions in the period.

ROOD, J. P.
1972. "Ecological and Behavioural Comparisons of Three Genera of Argentine Cavies." *Animal Behaviour Monogr.* 5:1–83.
Distinguishes patterns of social behavior between *Cavia aperea* and *C. porcellus*. Hybrids were intermediate in behavior.

ROOD, J. P., and D. W. NELLIS
1980. "Freeze Marking Mongooses." *J. Wildlife Mgmt.* 44:500–502.
Surface freezing of the skin with a refrigerant (dichlorodifluromethane = CCl_2F_2 in aerosol spray cans kills the pigment-producing melanocytes in the hair follicles so that regrown hair is permanently white. The spray is applied to areas clipped of fur in distinctive patterns.

ROOTS, C.
1976. *Animal Invaders.* Vancouver: David and Charles, Ltd. 203 pp.
The story of success and failure, worldwide, in animal introductions. Many references to examples in Hawai'i. Bibliography.

ROTHSCHILD, W.
1893. *The Avifauna of Laysan and the Neighboring Islands: With a Complete History to Date of Birds of the Hawaiian Possessions.* Pts. 1 & 2. London: R. H. Porter. 317 pp.
Occasional notes on mammals of the main islands. In résumé of Palmer's diary of 1892 (between pp. 58 and 59): rats (pp. 2–3) attacked bird skins freshly prepared on Kaua'i; feral cats were common on Lāna'i (p. 15) and on O'ahu (pp. 17, 18, 19) in forest areas.

ROUNSEVALL and others
1981. "A Mass Stranding of Sperm Whales, *Physeter macrocephalus* Linnaeus, 1758, at Macquarie Harbor, Tasmania." *Victorian Naturalist* 98:228–233.
Detailed description. Of 26 stranded whales, eight escaped and apparently survived. A total of 20 separate strandings of this species is recorded for Tasmania.

ROUNTREE, V., J. DARLING, G. SILBER, and M. FERRARI
1980. "Rare Sighting of a Right Whale (*Eubalaena glacialis*) in Hawaii." *Canadian J. Zool.* 58:209–312.

Third sighting for Hawai'i, March 25, 1979. North Pacific population is estimated at 100–200, though killing has been banned since 1937. Location, in 'Au'au Channel off West Maui.

ROUSE, J. E.

1973. *World Cattle III: Cattle of North America.* Norman: Univ. Oklahoma Press. 650 pp.

Third volume of series (Vols. 1, 2, 1970). Hawai'i references are indexed. Summarizes history in Hawai'i, development of the industry, and breeds. Photos (pp. 376–377) of feral cattle in South Kona District.

ROWE, F. P.

1970. "The Response of Wild House Mice (*Mus musculus*) to Live-traps Marked by Their Own and by a Foreign Mouse Odour." *J. Zool.* 162:517–520.

Mice are attracted to traps which have previously captured other mice. Differentials in attraction are related to age and sex, indicating a strong social significance attached to mouse odors.

RUDD, R. L.

1966. "The Midventral Gland in Malaysian Murid Rodents." *J. Mammalogy* 47:331–332.

Reports a well-developed midventral gland in 9 of 12 species examined; gland corresponds closely to that found in *Rattus exulans.*

RUDGE, M. R.

1969. "Reproduction of Feral Goats *Capra hircus* L. near Wellington, New Zealand." *New Zealand J. Science* 12:817–827.

In mountainous river valley setting, reproduction was year-around with slight increase of activity in summer. Goats matured at age six months.

1970a. "Dental and Peridontal Abnormalities in Two Populations of Feral Goats (*Capra hircus* L.) in New Zealand." *New Zealand J. Science* 13:260–267.

Mainland and Macauley Island goats differed in degree and kind of tooth problems, but effects on survival in both populations were negligible.

1970b. "Mother and Kid Behavior in Feral Goats (*Capra hircus* L.)." *Z. Tierpsychol.* 27:687–692.

Studies by DSIR, in New Zealand, of free-ranging goats suggest that behavioral traits suppressed during domestication may emerge in feral populations. (In English, German summary.)

1972. "Horns as Indicators of Age in Goats (*Capra hircus* L.)." *New Zealand J. Science* 15:255–263.

Saw-cuts in horns of marked feral goats demonstrated no regularity in formation of growth rings, in time. In the moderate climate of the study area horn rings could not be used as precise indicators of age.

RUDGE, M. R., and T. J. SMIT

1970. "Expected Rate of Increase of Hunted Populations of Feral Goats (*Capra hircus* L.) in New Zealand." *New Zealand J. Science* 13:256–259.

Underscores high rate of productivity. Population could more than double every two years; or if reduced by 80 percent could increase to 90 percent of original numbers in four years.

SABIN, W.

1934. "Hunting in Hawaii's Islands." *Paradise Pacific* 46(12):34–41.

Popular article of wide coverage. Notes (p. 34) hunting of rats by early Hawaiians, and of pigs, sheep, goats, and deer. Photo of "Island deer" is of penned elk (p. 36); that of "Goat hunters" includes sheep but no goats; and one of "Chinese fallow deer" is apparently of the sika deer (p. 40), and implies that this is the species wild on Moloka'i.

SAGE, R. D.

1981. "Wild Mice." *In:* H. L. Foster, J. D. Small, and J. G. Fox (editors), *The Mouse in Biomedical Research.* Vol. 1, Chap. 4, pp. 39–90. New York: Academic Press.

Landmark review of the mammalian genus *Mus* to introduce the laboratory researcher to the biology of ancestors and relatives of the laboratory mouse, including natural history and genetic variability. The laboratory mouse is derived almost exclusively from *Mus domesticus*.

ST. JOHN, H.

1973. *List and Summary of the Flowering Plants in the Hawaiian Islands*. Pacific Trop. Bot. Garden Mem. 1. 519 pp.

Unified systematic presentation of 2,668 endemic taxa, 66 indigenous taxa, and 4,988 cultivated/adventive taxa of the higher plants known in Hawai'i.

SAITO, R. S.

1983. "Status, Trends and Utilization of Game Mammals and Their Habitats on the Island of Oahu." State of Hawaii Div. Forestry and Wildlife, Honolulu, Project W-17-R-8. 5 pp., mimeo.

Nine pigs were taken in one of three designated hunting areas. Some data reported on mark and release of the brush-tailed rock-wallaby.

1984. "Status, Trends and Utilization of Game Mammals and Their Associated Habitats on the Island of Oahu." State of Hawaii Div. Forestry and Wildlife, Honolulu, Project W-17-R-9. 4 pp., mimeo.

Pig, goat, axis deer, and rock-wallaby are treated in summary form, but specific data are given on mark and release of the wallaby. Feral dogs raided the trapping area. A wallaby sanctuary is recommended.

SAKAI, SHARON

1980a. "State Moves to Eradicate Sheep." *West Hawaii Today*, May 29. p. 1.

Article makes it clear that the DLNR plan for Mauna Kea, to fence off 25 percent of the mountain for preservation of *palila* habitat, was unacceptable as a solution to the problem.

1980b. "Kahua Ranch Raising Sheep." *West Hawaii Today*, June 27, pp. 1, 44, 46.

Reports new start in sheep with some 450 Romedales from Ni'ihau and Suffolk rams from California, on the slopes of Kohala Mountain. Lambs, wool, and skins were to be produced for local use. Photos by Noel Black.

SAMPSON, W. F.

1970. "*Stenella caeruleoalba* in the Northern Pacific Ocean." *J. Mammalogy* 51:809.

A group of 14 noted on August 16, 1969, ranging in length from four to seven feet.

SANBORN, C. C., and J. A. CRESPO

1957. *El Murciélago Blanquizco* (Lasiurus cinereus) *y Sus Subespecies* [The hoary bat (*Lasiurus cinereus*) and its subspecies]. Museo Argentino Ciencias Naturales "Bernardino Rivadavia" Bull. 4. 13 pp. (In Spanish.)

Complete account of classification. Subspecies exist in three distinct geographic regions: *cinereus*, North America; *villosissimus*, South America; *semotus*, Hawai'i. Biological data, largely on South American form, characterize the species. Nine Hawaiian specimens were examined.

SANGER, S.

1968. "Rabies Quarantine Lifted." *Honolulu Star-Bulletin*, January 18, p. 1.

Reviews and rings down curtain on suspected rabies on O'ahu. Announces lifting of ban on interstate transport of animals.

SASAKI, D. M., and J. M. GOOCH

1983. "Cost Effectiveness of Hawaii's Anti-Rabies Quarantine Program." *Hawaii Medical J.* 42:157–160.

Reviews the 120-day quarantine requirement for dogs and cats brought into the state (a few

countries of origin are excepted), imposed since 1912. Various alternatives are explored. Recommends that government absorb greater share of program costs to reduce incidence of smuggled pets, but that present program be maintained.

SAUNDERS, G. R., and J. R. GILES

1977. "A Relationship between Plagues of the House Mouse, *Mus musculus* (Rodentia: Muridae), and Prolonged Periods of Dry Weather in South-eastern Australia." *Australian Wildlife Res.* 4:241–247.

Eight mouse plagues between 1900 and 1970 were preceded, except in one case, by drought during two consecutive previous winters. When such a drought pattern occurred, abundance of mice usually followed.

SAVORY, T. H.

1970. "The Mule." *Scientific American* 223(6):102–109.

Detailed account of mule: history, breeding, uses, and population estimates. Indicates occasional fertile individuals.

SCAMMON, C. M.

1968. *The Marine Mammals of the Northwestern Coast of North America, Together with an Account of the American Whale Fishery.* New York: Dover. 319 pp.

A reprint of the 1874 edition. New introduction by Victor Scheffer. Includes a chapter on the elephant seal (pp. 115–123).

SCHALLER, G. B.

1967. *The Deer and the Tiger.* Chicago: Univ. Chicago Press. 370 pp.

Classic studies of Indian ungulates, their behavior, ecology, and their predators. Pages 37–92 are devoted to the axis deer.

1977. *Mountain Monarchs: Wild Sheep and Goats of the Himalaya.* Chicago: Univ. Chicago Press. 425 pp.

Socio-ecological approach to study of wild species, including behavior, which may have bearing on the understanding of feral sheep and goats in Hawai'i.

SCHAUINSLAND, H.

1899. *Drei Monate auf einer Koralleninsel (Laysan)* [Three months on a coral island (Laysan)]. Biologische Centralblatt Vol. 19. (Also published separately, Bremen: M. Nossler. 104 pp; both in German.)

Report on Laysan in the summer of 1896, in which intensive observation and collection of the flora and fauna were done. Provides excellent records for period before introduction of rabbits.

SCHEFFER, V. B.

1969. *The Year of the Whale.* New York: Charles Scribner's Sons. 213 pp.

A philosophical study of a sperm whale—fiction based on fact. Relates to history and conservation of whales.

1980. "Benign Uses of Wildlife." *Internatnl. J. Study Animal Problems* 1:19–32.

Notes that since the 1960s trends are toward non-consumptive use of wildlife, such as photography and safari trips, which have both increased, and away from sport hunting, which has decreased. Many references.

SCHEFFER, V. B., and D. W. RICE

1963. *A List of Marine Mammals of the World.* U.S. Fish and Wildlife Service, Special Scientific Rep., Fisheries 341. 12 pp.

Brief systematic treatment, giving also distribution and common names; discusses some problem areas in taxonomy. Bibliography lists major taxonomic works and important short papers.

SCHEVILL, W. E. (Editor)

1974. *The Whale Problem: A Status Report.* Cambridge: Harvard Univ. Press. 419 pp.

Conference widely supported by research and conservation groups, following placement of eight commercially hunted whale species on the U.S. Endangered Species List; held June 10–12, 1971. Primary concern was to define data on numbers, biology, and basic ecology. Digest given, pp. 3–20.

SCHILLER, E. L.

1956. "Ecology and Health of *Rattus* at Nome, Alaska." *J. Mammalogy* 37:181–188.

At this northernmost coastal station of *R. norvegicus* (62°30′) both summer reproduction and winter mortality were high in a population living in the marginal habitat of exposed refuse dumps. Frostbite often resulted in loss of ears, feet, and tail, but enough intact rats survived to maintain the colony.

SCHMIDT, R. C., and CAROL L. SILVA

1984. "Population Trends on Kahoolawe." *Hawaiian J. History* 18:39–46.

Demographers' analyses of generally scanty data, but good review of periods when livestock dominated the island.

SCHREIBER, R. W., and E. KRIDLER

1969. "Occurrence of the Hawaiian Monk Seal (*Monachus schauinslandi*) on Johnston Atoll, Pacific Ocean." *J. Mammalogy* 50:841–842.

A yearling male tagged at Laysan Island, Hawai'i, in March 1968, was noted at Johnston Atoll from July to December, 547 nautical miles from the tagging site.

SCHRIVER, S.

1964. "Ambassadors of Good Will, the Peace Corps." *National Geographic* 126:297–345.

Color photo (pp. 302–303) of trainees in Waipi'o Valley, on Hawai'i, preparing for service in Southeast Asia by plowing flooded paddy with water buffalo.

SCHULMEISTER, SUSAN

1981. "Hawaiian Monk Seal Numbers Increase on Tern Island." *'Elepaio* 41:62–63.

When the islet was no longer used by the military after 1979, the seal population increased from about six to 24 animals, within one year.

SCHWABE, H. W.

1979. "Pigmentation Correlated Differences in Behaviour of House Rats (*Rattus rattus* L.)." *Zool. Jb. Syst.* 106:406–426. (In German, English summary.)

New silver-gray mutant strain in colony of wild-caught *Rattus rattus* is described as "more active and savage and less curious and aggressive" in comparison to black ancestral stock.

SCHWARTZ, C. W., and ELIZABETH R. SCHWARTZ

1949. *A Reconnaissance of Game Birds in Hawaii.* Bd. Commns. Agriculture and Forestry, Honolulu. 168 pp.

A thoroughly readable account of avian game species on the six major islands. "The Lay of the Land" (pp. 6–17) is excellent background material; in this section and on pp. 137–140, mammals are briefly considered in relation to the land and to the game birds.

1950a. "Breeding Habits of the Barred Dove in Hawaii with Notes on Weights and Sex Ratios." *Condor* 52:241–246.

Reports predation on nestlings in nest 11 feet above ground (p. 245) and attributes it to *Rattus rattus.*

1950b. "The California Quail in Hawaii." *Auk* 67:1–38.

Lists (p. 25) rats, feral cats and pigs, and the mongoose, as likely predators on quail. Does not consider the mongoose as a critical deterrent to quail, from all evidence available in Hawai'i.

1951. "An Ecological Reconnaissance of the Pheasants in Hawaii." *Auk* 68:281–314.

The ring-necked and green pheasants were the principal species; the chief predator (pp. 302–303) is probably the mongoose. Few data are available on rats, cats, and pigs as pheasant predators.

SCHWARZ, E., and HENRIETTA K. SCHWARZ

1943. "The Wild and Commensal Stocks of the House Mouse, *Mus musculus* Linnaeus." *J. Mammalogy* 24:59–72.

Discusses subspeciation in the house mouse from the examination of some 5,000 specimens in major Western museums. Origin, dispersal, and biological segregation of various stocks is considered.

1967. "A Monograph of the *Rattus rattus* Group." *Annales Escuela Nacional Ciencias Biológicas Mejico* 14:79–178.

Authors advance the unorthodox view that the widely spread commensal rats, *R. rattus*, *R. norvegicus*, and *R. exulans*, are all subspecies of what is termed the *Rattus rattus* group."

SCOTT, H. G.

1965. "Rat Bite—Epidemiology and Control." *J. Environmental Health* 27:900–902.

Reviews the rat-bite problem in the United States, indicating types of injuries sustained and means of reducing incidence.

SCOTT, J. D.

1965. *The Duluth Mongoose.* New York: Morrow. 159 pp.

A fanciful story drawn from the incident of a live mongoose (possibly *Herpestes edwardsi*) acquired by the Duluth Municipal Zoo, in 1962. Contains fictional as well as factual materials. Reviews the evolution of federal statutes barring importation of certain potential pest animals.

SCOTT, J. M., S. MOUNTAINSPRING, C. VAN RIPER, III, C. B. KEPLER, J. D. JACOBI, T. A. BURR, and J. G. GIFFIN

1984. "Annual Variation in the Distribution, Abundance, and Habitat Response of the Palila (*Loxioides bailleui*)." *Auk* 101:647–664.

Relates status of subject bird to habitat, disease potential, and need for further elimination of grazing ungulates from the restricted range of the species.

SCOTT, J. P.

1968. "Evolution and Domestication of the Dog." *Evolutionary Biol.* 2:243–275.

Further evidence of the wolf as ancestor of the dog; anatomy, chromosomes, and behavior. Dogs have been domesticated for possibly 12,000 years.

SCOULER, J.

1905. "Dr. John Scouler's Journal of a Voyage to N. W. America." *Oregon Historical Quart.* 6:166.

Three pigs sent from Fort Vancouver (on the lower Columbia River) on March 29, 1826, were being shipped to a new inland post at Fort Colville; these were offspring of pigs brought from Hawai'i (data from Harvey, 1947, pp. 69–70).

SCOWCROFT, P. G.

1976a. "Hawaii's Declining Scrub Forest—The Mamane-Naio Ecosystem of Mauna Kea." U. S. Forest Service, Honolulu. 19 pp., mimeo.

Discusses factors that probably or actually limit regeneration of high elevation forest. Cites feral sheep as most important, from study of exclosure plots established 13 years earlier.

1976b. "Mamane Forest Decline on Mauna Kea: A Reality or Myth." *In*: C. W. Smith (editor), 1976, pp. 187–198.

Area above 8,000 feet was losing more trees than were gained between 1954 and 1975, as detected from sampling of air survey photo maps.

1978. "Direct Sowing of Treated Mamane Seeds: An Ineffective Regeneration Technique." *In*: C. W. Smith (editor), 1978, pp. 247–255.

Concludes that hand seeding is not effective in establishing stands of *māmane*, and that planting of nursery stock is a preferred method.

1981. "Regeneration of Mamane: Effects of Seedcoat Treatment and Sowing Depth." *Forest Science* 4:771–779.

For success, seeds must be buried, seedcoats must be broken down, and soil moisture must be adequate. Treatment with acid (60-minute soak in concentrated sulfuric acid followed by tap water washing), or abrasion with sandpaper, vastly hastens germination.

1983. "Tree Cover Changes in *Māmane* (*Sophora chrysophylla*) Forests Grazed by Sheep and Cattle." *Pacific Science* 37:109–119.

Significant loss of tree cover between 1965 and 1975, especially at tree line in range of feral sheep, and in lower forest exposed also to cattle. Slow improvement is predicted if such areas are protected from grazing by ungulates.

SCOWCROFT, P. G., and H. F. SAKAI

1984. "Stripping of *Acacia koa* Bark by Rats on Hawaii and Maui." *Pacific Science* 38:80–86.

Damage may be locally serious. Recommends control of rats during first five years of *koa* planting or regeneration.

SEAMAN, G. A.

1952. "The Mongoose and Caribbean Wildlife." *Trans. 17th North American Wildlife Conf.*, pp. 188–197.

Good popular summary of salient aspects of mongoose introduction, biology, ecology, economic relations, and control among the West Indies. Some reference to Hawai'i.

SEAMAN, G. A., and J. E. RANDALL

1962. "The Mongoose as a Predator in the Virgin Islands." *J. Mammalogy* 43:544–545.

Brief summary of introduction, occurrence, and food habits in Virgin Islands. Predation on fawns of white-tailed deer, *Odocoileus virginianus* (also an introduced species), is described. In three examples, one or two mongooses attacked fawns about the nose and lips, and are apparently capable of subduing fawns in this manner.

SHALLENBERGER, E. W.

1981. "The Status of Hawaiian Cetaceans." U. S. Marine Mammal Commn. Rep. MMC-77/23, Washington, D.C. 79 pp., mimeo. See also a 1979 draft, 103 pp.

First comprehensive report on subject. Treats environment, relations to man, history, species accounts, range maps, strandings, bibliography. Recommendations for research. See also a 1979 draft, 103 pp.

SHALLENBERGER, R. J. (Editor)

1984. *Hawaii's Birds*. Honolulu: Hawaii Audubon Society. 3rd edition, revised. 96 pp.

A well-illustrated pocket field guide to birds found in Hawai'i.

SHARATCHANDRA, H. C., and M. GADGIL

1980. "On the Time-budget of Different Life-history Stages of Chital (*Axis axis*)." *J. Bombay Natural History Soc.* 75(suppl.):949–960.

Excellent characterization of behavioral patterns in the axis deer. Well illustrated.

SHOMURA, R. S., and T. S. HIDA

1965. "Stomach Contents of a Dolphin Caught in Hawaiian Waters." *J. Mammalogy* 65:500–501.

Foods of a male *Stenella attenuata* taken three miles off O'ahu were 86 percent squids of two species, and small fishes of five different families.

SHORT, J.

1982. "Habitat Requirements of the Brush-tailed Rock-wallaby, *Petrogale penicillata*, in New South Wales." *Australian Wildlife Res.* 9:239–246.

A systematic classification of occupied and unoccupied habitat revealed that caves and ledges, vertical access routes, and exposure to the sun were decisive factors in suitable cliff-face habitat. Hence warmth, dryness, and protection from predators were basic needs.

SHRADER, W. A., JR.

1977. "Leptospirosis in Hawaii." *Hawaiian Medical J.* 36:135–138.

Summarizes 128 cases for the period 1960–1975. Reviews reporting, diagnosis, and treatment of 19 cases at Honoka'a Hospital.

SHUMP, K. A., JR., and ANN U. SHUMP

1982. "*Lasiurus cinereus*." Mammalian Species No. 85, pp. 1–5. Published by the American Society of Mammalogists.

A description and summary of the hoary bat in its world range, and an extensive bibliography.

SIBLEY, C. G., and J. E. AHLQUIST

1982. "The Relationships of the Hawaiian Honeycreepers (Drepaninini) as Indicated by DNA-DNA Hybridization." *Auk* 99:130–140.

Ties in geological history of the island chain and the melting spot or "hot spot" theory of island development with arrival and derivation of honeycreepers from a cardueline ancestor, between 20 and five million years ago, possibly before islands beyond French Frigate Shoals (to the southeast) had even emerged from the ocean floor.

SIERRA CLUB

1978. *Environmental News Release.* Sierra Club Legal Defense Fund, Inc. Dated January 27. 3 pp.

Names the *palila* and four co-plaintiffs in a well-prepared lawsuit against the State of Hawaii. The *palila* is noted as suing "for its life." Suit asks for removal of feral goats and sheep from Mauna Kea by January 1980.

SIMON, N.

1965. "Of Whales and Whaling." *Science* 149:943–946.

A statement of conditions in the modern whaling industry. Pelagic operations are carried out only in the Southern Hemisphere, by Japan, USSR., and Norway. Unless strict regulation is adhered to, the resource will soon disappear.

SIMONS, T. R.

1983. *Biology and Conservation of the Endangered Dark-rumped Petrel* (Pterodroma phaeopygia sandwichensis). Univ. Washington: National Park Service Cooperative Studies Unit. CPSU/UW 83-2. 311 pp.

Pages 115–119 and 215–251 present data on predation by rats, mongoose, and cat; and disturbance by goats. A few mongooses or cats can be extremely disruptive of breeding success in a petrel colony.

1984. "A Population Model of the Endangered Dark-rumped Petrel." *J. Wildlife Mgmt.* 48:1065–1076.

Most serious threats to the bird are introduced mammals, primarily the feral cat and mongoose.

SIMONSEN, V.

1976. "Electrophoretic Studies on Blood Proteins of Domestic Dogs and Other Canids." *Hereditas* 82:7–17.

Results indicate that dog and wolf are closely related, but there is much overlap in various enzymes among canids in general. Some workers consider the dog and wolf to have had a common ancestor.

SIMPSON, FLORA L.

1944. "Mongoose *Mele*." *Paradise Pacific* 56(7):10.

A breezy popular account of the origin and habits of the mongoose in Hawai'i, and of human responses to this animal. Notes, without reference, that two mongooses were taken from Hawai'i to the St. Louis Zoo.

SIMPSON, G. G.

1945. *The Principles of Classification and a Classification of Mammals*. American Mus. Natural History Bull. 85. 350 pp.

Monumental work treating both fossil and recent groups. Stresses structural and phylogenetic relationships based in the paleontological record. Classification is carried to the generic level.

SINGER, F. J., D. K. OTTO, A. R. TIPTON, and C. P. HABLE

1981. "Home Ranges, Movements, and Habitat Use of European Wild Boar in Tennessee." *J. Wildlife Mgmt.* 45:343–353.

Additional studies of wild populations introduced to Tennessee which may have application to conditions in Hawai'i.

SITARAMAIAH, M., and C. J. DOMINIĆ

1977. "Accessory Reproductive Glands of the Male Indian Mongoose, *Herpestes auropunctatus* Hodgson." *J. Mammalogy* 58:85–87.

New information on prostate and bulbo-urethral glands, and levels of various sugars and acids in fluid contents.

SKIRA, J. J., N. P. BROTHERS, and G. R. COPSON

1982. "Coat Colour and Fitness of Rabbits on Macquarie Island." *Australian Wildlife Res.* 9:121–123.

After 100 years of isolation on a subantarctic island, black pelage persisted in 16 percent of rabbits; remainder were agouti (wild type) except for rare examples of other colors. No physical differences could be attributed to pelage color.

SLIJPER, E. J.

1979. *Whales*. New York: Cornell Univ. Press. 511 pp.

Translation of the classic Dutch work first published in 1958. Final chapter, on conservation, is revised and updated by R. J. Harrison of Cambridge University, evaluating the work of the much criticized International Whaling Commission through 1978.

SMALL, G. L.

1971. *The Blue Whale*. New York: Columbia Univ. Press. 248 pp.

A scholarly work on the fate of this most sought-after whale. Broad background materials on the "whaling question" of the era in which the book was written. Extensive biological data.

SMITH, A. W.

1971. "Goats in the Parks." *Natnl. Parks Conserv. Mag.* 45(11):1, 35.

An activism-oriented assessment of the deputized hunter program of 1970–1971 at Hawaii Volcanoes National Park in which it is concluded that the intended objective is to provide perpetual

sport hunting in the park, not the elimination of goats. Earlier reports on the same matter are found in the same publication 45(6):32 and 45(8):28.

SMITH, C. W.

1982. "Towards a Management Plan for Kipahulu Valley." *In*: C. W. Smith (editor), 1982, pp. 152–155.

A concise review of management needs for eradication of pigs and exotic plants such as strawberry guava.

SMITH, C. W. (Editor)

1976. "Proceedings First Conference in Natural Sciences, Hawaii Volcanoes National Park," August 19–20. Univ. Hawaii Dept. Botany CPSU/UH, Honolulu. 243 pp., mimeo.

A collection of research reports, abstracts, and summaries of papers pertinent to ecosystem and species analysis and management.

1978. "Proceedings Second Conference in Natural Sciences, Hawaii Volcanoes National Park," June 1–3. Univ. Hawaii Dept. Botany CPSU/UH, Honolulu. 354 pp., mimeo.

A collection of research reports, abstracts and summaries of papers pertinent to ecosystem and species analysis and management.

1980. "Proceedings Third Conference in Natural Sciences, Hawaii Volcanoes National Park," June 4–6. Univ. Hawaii Dept. Botany CPSU/UH, Honolulu. 396 pp., mimeo.

A collection of research reports, abstracts, and summaries of papers pertinent to ecosystem and species analysis and management.

1982. "Proceedings Fourth Conference in Natural Sciences, Hawaii Volcanoes National Park," June 2–4. Univ. Hawaii Dept. Botany CPSU/UH, Honolulu. 189 pp., mimeo.

A collection of research reports, abstracts, and summaries of papers pertinent to ecosystem and species analysis and management.

SMITH, C. W., and C. H. DIONG

1977. "Proposal to study Feral pigs in Kipahulu Valley, Haleakala National Park." Botany Dept., Univ. Hawaii CPSU/UH Tech. Rep. 19. 52 pp., mimeo.

An outline for basic research on the pig for the purpose of establishing a sound pig management program.

SMITH, H. J.

1976. "An Investigation of North Atlantic Whales for Trichinosis." *J. Wildlife Disease* 12:256–257.

All of 218 whales of five species (Newfoundland) negative for trichinosis.

SMITH, T. (Editor)

1979. "Report of the Status of Porpoise Stocks Workshop." *NMFS Southeast Fisheries Center Admin. REP. LJ-79-41.* 120 pp.

Basic management data refined for revision of regulations and procedures directed to protection of dolphin populations relative to the eastern tropical Pacific pelagic tuna fishery.

SMITH, T. G., D. B. SINIFF, R. REICHLE, and S. STONE

1981. "Coordinated Behavior of Killer Whales, *Orcinus orca*, Hunting a Crabeater Seal, *Lobodon carcinophagus*." *Canadian J. Zool.* 59:1185–1189.

Pod of seven whales discovered seal on an ice floe, swam together toward the floe causing a wave to break over it, tipping the seal into the water. Cites other papers on foods and feeding by killer whales.

SMYTHE, W. R.

1959. "Field Test of Endrin Dog Biscuits." Hawaiian Sugar Planters' Assoc., Honolulu, Field Report. 2 pp., mimeo.

Describes pilot study at Pā'auhau Sugar Co. on Hawai'i principally for control of *Rattus exulans*. Results were considered favorable; more extensive field tests suggested.

1964. "Hawaiian Sugar Cane Rat Control Methods and Problems." *Proc. Second Vertebrate Pest Control Conf., California Agricultural Extension Service*, pp. 77–80.

Present problems stem from high labor costs and shift to two- and three-year crops since about 1946. Control by anticoagulants is inadequate for *Rattus exulans*. Air drop of more effective poisons is anticipated as a final solution to major problems. Paper includes good summary of conditions and present methods.

1965. "Notes on the Natural History, Behavior and Control of the Polynesian Rat, *Rattus exulans*." 24th Annual Conf., Hawaiian Sugar Technologists, pp. 167–171.

Summarizes information gained by the author in seven years of experience with rodents and rodent control in Hawai'i, and in review of basic knowledge of *Rattus*; undocumented.

SOUTHWARD, W.

1968. "Kahuku Ranch Is Buffaloed." *Honolulu Advertiser*, April 10, p. C-1.

Announces arrival in Hilo of nine female and three male yearling American bison trucked and airlifted from near Pierre, South Dakota, for establishment of a private herd in Ka'ū District of Hawai'i Island. One photo.

SPATZ, G., and D. MUELLER-DOMBOIS

1973. "The Influence of Feral Goats on *Koa* Tree Reproduction in Hawaii Volcanoes National Park." *Ecology* 54:870–876.

Comparison of root sucker growth within a goat-free enclosure and in adjacent areas of high goat density revealed distortion of natural *koa* community evolution through browsing by goats. Growth was nearly disrupted where suckers were exposed continuously to browsing.

SPAULDING, T. M.

1930. "The Hawaiian Cat." *Paradise Pacific* 43(11):8.

Discusses probable arrival of the bob-tailed Manx cat in Hawai'i, about 1850, citing a reference in the *Daily Hawaiian* of October 2, 1866. Two of these cats were obtained from a ship that called at Honolulu for supplies.

SPENCER, H. J.

1938. "Hawaiian Rat Control Project." U. S. Bureau of Biological Survey Control Methods Research Lab., and cooperating agencies in Hawai'i. 97 pp., ms.

Final unpublished report on extensive territory-wide rodent control work done from December 1935 to June 1938. Data are given on a large variety of subjects, in both narrative and tabular form. Mongoose, dogs, cats, and cattle are related to rodent control.

1950. "Mongoose Control Research Project, Virgin Islands, U. S. A." U. S. Fish and Wildlife Service, Washington, D.C. 8 pp., mimeo.

Mongoose control desirable to allow establishment of bobwhite quail. Zinc phosphide, arsenic trioxide, and ANTU were the most practical of six poisons tested. Field methods and mongoose habits are discussed. Trapping and sport hunting are suggested to supplement poisoning.

SPENCER, H. J., and D. E. DAVIS

1950. "Movements and Survival of Rats in Hawaii." *J. Mammalogy* 31:154–157.

Reports mark and release of rats in a 47-acre area on O'ahu. All species had a limited home range, and a survival time of only a few months. *Rattus rattus*, *R. norvegicus*, and *R. exulans* were present.

STANLEY, H.

1975. "The Whalewatcher." *Newsl. American Cetacean Soc.* 9:10–11.

From description, probably the first reported modern sighting of a right whale in Hawai'i, north of O'ahu, in 1975.

STATE OF HAWAII

1979. Hawaii Revised Statutes, Title 1, Emblems and Symbols, Chapter 5-12. Session Laws of Hawaii 1979, Act 110, Section 1.

[§5-12] STATE MARINE MAMMAL. The humpback whale is established and designated as the official marine mammal of the State, to be effective so long as the legislature of the State does not otherwise provide. [L 1979, c 110, §1]

STATE OF HAWAII, BOARD OF AGRICULTURE

1972. "Last Minute Submission."

Letter of request from the Chairman, Advising Committee on Land Vertebrates, in behalf of Molokai Ranch. Dated March 20, with six letters of opinion and inquiry, January 13— March 23, attached. From Dept. of Agriculture files.

STATE OF HAWAII, BOARD OF AGRICULTURE AND CONSERVATION

1960. *Regulations of the Division of Entomology and Marketing: Plant Quarantine Regulation 2. Concerning the Introduction of Feral and Other Non-Domestic Animals into Hawaii.* Honolulu. 3 pp.

Publication of amended Regulation 2, as adopted July 29, 1947. States restrictions on the importation of animal life, and the permits and bondings required.

STATE OF HAWAII, DEPARTMENT OF EDUCATION

1968—. *Index to the Honolulu Advertiser and Star-Bulletin.* Honolulu: Office of Library Services, in cooperation with The Friends of the Library of Hawaii. Various paginations.

Subject matter is alphabetic, by volume. Cumulative 1929–1967 indexes in five volumes; 1968–1969 supplement follows, with annual supplements 1970—.

STATE OF HAWAII, DEPARTMENT OF HEALTH

1982a. *Zoonoses: Veterinary Public Health Update* 1(1):3. Honolulu: Communicable Disease Division.

Announces a newsletter service for veterinary and veterinary public health professions under above title, begun in September 1982. Volume 1(2) reviews rabies in the U.S. and the quarantine procedure in Hawai'i.

1982b. "Rabies Activity in Hawaii." *Zoonoses* 1(2):5–8.

Reviews precautionary and testing services available in the state, elements of the current 120-day quarantine, and results of a questionnaire mailed to a list of 130 veterinarians in Hawai'i. See also *Zoonoses* 1(4):1–4, "Rabies Update."

1983. "Pseudorabies Diagnosed in Hawaii." *Zoonoses* 2(1):1–3.

The first case of this acute viral infection of domestic animals (Aujeskey's disease) was confirmed June 13, 1983, from a dog on the island of Hawai'i. The dog became ill four days after being used for pig hunting in a local rain forest. Nearly all warm-blooded animals may be susceptible, except adult swine which are considered the primary reservoir. The etiological agent is a neurotropic herpes-virus, which is only rarely transmissible to man.

1984. "Leptospirosis Surveillance in the U. S. & Hawaii: 1979–1983." *Zoonoses* 3(2):3–9.

Five-year summary indicating more reported cases in Hawai'i than in any other five-year period. The 118 cases amounted to 22.5% of those reported nationally. Clusters of cases were related to taro farming and dairy farming.

STATE OF HAWAII, DEPARTMENT OF LAND AND NATURAL RESOURCES

1962. *Hunting in Hawaii.* Div. Fish and Game, Honolulu. 12 pp.

Two pages summarize hunting regulations. One page each devoted to axis deer, goat, pig, and sheep, with sketch by R. J. Kramer; biological data and tips for hunters. Revised in 1967 to include data and sketches by R. L. Walker on mouflon and pronghorn.

1974. "1972 Report of Nene Restoration Program." *'Elepaio* 34:136–142.

Review and abstract of report on the Hawaiian goose. Cites examples of predation by dogs and outlines predator control program in which compound 1080 was successful in eliminating dog and rat. Cat and mongoose were considered as probable predators.

1977. "A Master Plan for Mauna Kea." 17 pp., mimeo.

A brief policy statement to guide resource management, regulate public use, and control development of astronomy facilities. Adopted June 9 after an appropriate public hearing process.

1981a. *Prime Forest Lands Inventory.* Div. Forestry and Wildlife, Honolulu. 12 pp.

An example of mapping techniques using computer enhanced LANDSAT imagery. Deals entirely with site condition and potential for growth of managed alien or native species, ignoring the concept of existing natural ecosystems. Includes maps, one in color, with overlay of defined prime forest areas.

1981b. *Status Report on Mauna Kea Feral Sheep, Feral Goat, and Palila Management Studies.* Div. Forestry and Wildlife, Honolulu. 5 pp.

Reviews program for removal of sheep and goats from the Game Management Area, between June 6, 1980 and July 31, 1981. An estimated 40 sheep and six goats remained—wary, elusive animals, some of which moved in and out of the control area.

1984. *Hawaii Wildlife Plan.* Div. Forestry and Wildlife, Honolulu. 113 pp.

A comprehensive policy document providing specific direction to wildlife programs and operational plans. Supporting data in six appendixes include exhaustive species lists, and administrative documents. Illustrated in color.

STEARNS, H. T.

1966. *Geology of the State of Hawaii.* Palo Alto: Pacific Books. 266 pp.

A basic readable work on geological history and processes. Abundantly illustrated.

STEARNS, H. T., and G. A. MACDONALD

1946. *Geology and Ground Water Resources of the Island of Hawaii.* Territory of Hawaii, Div. Hydrography, Bull. 9. 363 pp.

One of a series of 13 monographs, 1935–1960, covering the major islands of Hawai'i. Excellent descriptive style; many photographs, charts, tables, and maps; scholarly basic work.

STEINER, W. W., J. H. HAIN, H. E. WINN, and P. J. PERKINS

1979. "Vocalizations and Feeding Behavior of the Killer Whale (*Orcinus orca*)." *J. Mammalogy* 60:823–827.

Sonograms are analyzed for pod of foraging whales off Newfoundland.

STEMMERMANN, G. N., and T. HAYASHI

1970. "The Normal and Morbid Anatomy of the Hawaiian Feral Mongoose." *J. Pathology* 100:177–185.

Pathological lesions were common in the lungs, liver, stomach, and other organs, in descending order of frequency. The intestinal tract is peculiar in being lined with a layer of acellular connective tissue.

STOKES, J. F. G.

1917. "Notes On the Hawaiian Rat." *B. P. Bishop Mus. Occ. Pap.* 3(4):261–271.

Suggests that *Rattus exulans* may yet be found on several islets, in particular off O'ahu. Behavioral notes are recorded from caged rats caught on Popoi'a Islet, including those on feeding habits. Discusses facts and legends about bow-and-arrow hunting of rats. Photos of the rat are included.

1939. "Hawaii's Discovery by Spaniards: Theories Traced and Refuted." *Hawaiian Historical Soc. Extract Pap.* 20:39–113.

Authentic review of the evidence accumulated in a controversy of long duration. Relies

heavily on E. W. Dahlgren's 220-page memoir of 1917. Restates conclusion that there is no evidence and little probablilty of pre-Cook Spanish landings in Hawai'i. Bibliography contains 53 entries.

STONE, C. P., R. L. WALKER, J. M. SCOTT, and P. C. BANKO
1983. "Hawaiian Goose Research and Management—Where Do We Go From Here?" *'Elepaio* 44:11–15.
Incisive analysis of a depleted habitat/endangered species problem. Places high priority on need for chemical control of the mongoose.

STONE, W.
1917. "The Hawaiian Rat." *B. P. Bishop Mus. Occ. Pap.* 3(4):253–260.
Narration on scarcity of the native rat in Hawai'i, the finding of bones in shelters on Kaho'olawe and on O'ahu, and the collection of fresh specimens from Popoi'a Islet, off O'ahu. *Rattus hawaiiensis* is described as new (p. 260). Photos of type specimen.

STORER, T. I.
1926. "Bats, Bat Towers and Mosquitoes." *J. Mammalogy* 7:85–91.
Describes bat roosts built near San Antonio, Texas (Campbell, 1913); guano samples from the roosts were minutely examined and no remains of mosquitos were found.

STORER, T. I. (Editor)
1962. *Pacific Island Rat Ecology.* B. P. Bishop Mus. Bull. 225. 274 pp.
Definitive studies by six authors. Habitats, nomenclature, and distribution, methods, populations, reproduction, parasites, economic relations, control. Comprehensive bibliography of Hawaiian and Pacific titles. Work done on Ponape and adjacent islands, 1955–1958.

STORER, T. I., and MARGERY P. MANN
1946. *Bibliography of Rodent Control.* National Research Council Insect Control Comm. Rep. 182. 385 pp.
Lists titles of 3,401 articles from the world literature pertaining to rodent and rabbit control, classed under nine sections, with the addition of 456 Russian titles. Occasional annotations are included.

STROUD, D. C.
1982. "Population Dynamics of *Rattus rattus* and *R. norvegicus* in a Riparian Habitat." *J. Mammalogy* 63:151–154.
Studies of movement patterns and other topics in temperate climate stream-side populations, for 16 months. Notes similarities in comparable work in Hawai'i, New Zealand, and Wales.

STROUD, R. K., and T. J. ROFFE
1979. "Causes of Death in Marine Mammals Stranded along the Oregon Coast." *J. Wildlife Disease* 15:91–97.
Primary cause of death from parasitic and bacterial sinusitis as a result of infection with *Crassicauda grampicola.* One Risso's dolphin was included among animals examined.

SUGGS, R. C.
1960. *The Island Civilizations of Polynesia.* New York: New American Library. 256 pp.
Reviews information on early settlement of Hawaiian Islands (pp. 152, 155, 167–168). Radiocarbon datings indicate these approximate early occupancies: Hawai'i A.D. 120, O'ahu 1005, Kaua'i 1239, Moloka'i 1408.

SULKIN, S. E.
1962. "The Bat as a Reservoir of Viruses in Nature." *Progr. Medical Virology* 4:157–207.

Traces history of rabies in American bats; first detected in the United States in 1951 (pp. 162–163). Reviews conditions under which this virus and others may exist in bats. 128 references.

SUTTERFIELD, T.

1982. "Methods of Censusing Rock Wallabies on Oahu." *In*: C. W. Smith (editor), 1982, p. 158.

Live traps yielded 20 captured in 116 trap nights (four were pouch young). There were nine captures of six marked animals. Population estimate was 53 ± 12 wallabies in the 1.6-ha study area.

SUTTON, STEPHANNE B.

1974. *In China's Border Provinces: The Turbulent Career of Joseph Rock, Botanist-Explorer.* New York: Hastings House. 334 pp.

Reveals that the major contributions of Joseph Rock (1884–1962) to Hawaiian botanical exploration were a very minor segment of his highly productive life (lived largely in China) in biology, archaeology, and linguistics.

SVIHLA, A.

1935. "The Hawaiian Rat." *Mid-Pacific Mag.* 48:344–346.

General account of *Rattus exulans* in Hawai'i. Asserts that this species, and *Mus musculus* as well, came as stowaways with the Polynesians. No references are given.

1936. "The Hawaiian Rat." *Murrelet* 17:1–14.

Results of three-month study in 1935. Suggests that the species probably inhabits all the larger islands of Hawai'i. Discusses distribution, abundance, habits, food, burrows, enemies and parasites, and trapping methods.

1957. "Dental Caries in the Hawaiian Dog." *B. P. Bishop Mus. Occ. Pap.* 22(2):8–13.

Reports on Bishop Museum specimens of dogs from ancient burial sites. Caries were prevalent and may have been due to a sugar-rich diet.

1959. "Notes on the Hawaiian Monk Seal." *J. Mammalogy* 40:226–229.

Brief summary of species among the Hawaiian Islands in the past and present, and general habits. Describes growth and behavior of two pups kept at the Waikiki Aquarium in Honolulu.

SWEDBERG, G.

1963. "A Progress Report on the Introduction of the Blacktail Deer to Kauai Island, Hawaii." State of Hawaii, Div. Fish and Game, Honolulu. 4 pp., mimeo.

Documents procurement of ten *Odocoileus hemionus columbianus* yearlings from Oregon in 1961, and of ten more in 1962, and their release in the Pu'u Ka Pele Game Management Area on Kaua'i. Gentle release method, release area, and responses to the new environment are described.

1964a. "Na Pali and Waimea Goat Population." State of Hawaii, Div. Fish and Game, Honolulu, Project W-5-R-15. 5 pp., mimeo.

Presents data on Kaua'i goat populations and recommendations for regulation of hunting. An estimated 1,608 goats occupied Waimea Canyon in 1963.

1964b. "Blacktail Deer—Kauai." State of Hawaii, Div. Fish and Game, Honolulu, Project W-5-R-15. 5 pp., mimeo.

Reports that introduced *Odocoileus hemionus* are increasing normally, with some 65 deer in the population. Exotic and native plants are eaten; three years after the initial release deer were found as far as five miles from the release site.

1965. "Na Pali and Waimea Canyon, Kauai, Goat Season and Census." State of Hawaii, Div. Fish and Game, Honolulu, Project W-5-R-16. 5 pp., mimeo.

Reports estimate of 900 feral goats on Nāpali Coast and 1,100 in Waimea Canyon in May–June, 1965. Tables show 1959–1964 record of hunting data, and results of current censusing.

1967. "The Blacktail Deer Introduction to Kauai." State of Hawaii, Div. Fish and Game, Honolulu. 9 pp., mimeo.

Reviews details of establishing *Odocoileus hemionus* on Kaua'i, including shipment, release, dispersal, losses, conflicts with man, and foods. Population was estimated at 150 in June 1967.

SWEZEY, O. H.

1919. "Cause of Scarcity of Seeds of the *Koa* Tree." *Hawaiian Planters' Rec.* 21:102–105.

Seeds are eaten by larvae of four species of moth (Tortricidae); often nearly 100 percent of the seeds are destroyed.

1925. "Biographical Sketch of the Work of Albert Koebele in Hawaii." *Hawaiian Planters' Rec.* 29:364–368.

Documents entomological work in Hawai'i, 1893–1910, and many foreign trips made in search of new enemies of pest insects. Bats are not mentioned. Two photos of Koebele.

TABER, R. D., and R. F. DASMANN

1956. "Behavior of Columbian Black-Tailed Deer in Reference to Population Ecology." *J. Mammalogy* 37:143–164.

Studies of *Odocoileus hemionus columbianus* in Lake County, California. Social relationships between deer and deer groups are analyzed for their effects on density-related aspects of population ecology.

TAKIMOTO, T.

1974. "Pig Hunting in the Kau Hills." *Hawaii Tribune-Herald*, July 7, p. 5.

Stirring account of pig hunting, with dogs, in rough country. Photographs.

TAMARIN, R. H., and S. R. MALECHA

1971. "The Population Biology of Hawaiian Rodents: Demographic Parameters." *Ecology* 52:383–394.

Results of 13-month study of *Rattus rattus* and *R. exulans* in lowland weed forest on O'ahu. Populations were marked by low productivity and low survival.

1972. "Reproductive Parameters in *Rattus rattus* and *Rattus exulans* of Hawaii, 1968 to 1970." *J. Mammalogy* 53:513–528.

Suggest that productivity in *R. rattus* is controlled mainly by environmental factors rather than being density dependent. *Rattus exulans* was present in generally low numbers, and productivity was low in both species.

TAMARIN, R. H., S. R. MALECHA, W. W. STEINER, and M. N. DENNIS

1972. "Genetic Events in Rat Populations at Eniwetok Atoll." *Pacific Science* 26:226–228.

Studies on three islets of the transferrin locus and of coat color, apparently all in *R. rattus*, showed significant changes in frequencies between 1968 and 1970.

TANJI, E.

1978. "Sheep Ranch on Maui? Ewe Better Believe it." *Honolulu Advertiser*, December 8, p. A-24.

Reports shipment of 200 sheep from northern California to 'Ulupalakua Ranch for production of lamb for local markets.

TATE, G. H. H.

1935. "Rodents of the Genera *Rattus* and *Mus* from the Pacific Islands, Collected by the Whitney South Sea Expedition, with a Discussion of the Origin and Races of the Pacific Island Rat." *American Mus. Natural History Bull.* 68, Art. III, pp. 145–178.

Considers island rats from viewpoint of systematics, with best data on what are now considered races of *R. exulans*, including Hawaiian populations.

1948. "Studies on the Anatomy and Phylogeny of the Macropodidae (Marsupialia)." *American Mus. Natural History Bull.* 91, Art. II, pp. 233–352.

Lists (pp. 272–273) four subspecies of *Petrogale penicillata* and gives some of their characteristics.

TAYLOR, A. P.

1927. "Did the Spaniards Discover Hawaii?" *Paradise Pacific* 49(4):29–31.

Historical treatment of the possible discovery of the Hawaiian Islands in 1555 by Juan de Gaytan.

TAYLOR, J. MARY, J. H. CALABY, and H. M. VAN DEUSEN

1982. "A Revision of the Genus *Rattus* (Rodentia, Muridae) in the New Guinean Region." *Bull. American Mus. Nat. Hist.* 173(Art.3):177–336.

Employs sophisticated analytical methods for separation of species and subspecies in regional populations of a difficult species complex, including *R. exulans*. *Rattus rattus* and *R. norvegicus* are of recent arrival in New Guinea.

TAYLOR, R. H.

1968. "Introduced Mammals and Islands: Priorities for Conservation and Research." *Proc. New Zealand Ecological Soc.* 15:61–67.

Urges caution in disruption of island ecosystems for purposes of removing exotics. Careful study should precede and follow such actions to minimize jeopardy to native species. Examples are given.

1975. "What Limits Kiore (*Rattus exulans*) Distribution in New Zealand?" *New Zealand J. Zool.* 2:473–477.

Concludes that once the house mouse, roof rat, and Norway rat occupy an area in New Zealand at the latitudinal limits of its distribution, there is no longer a niche available for the *kiore*, unlike the situation in Hawai'i and elsewhere in the subtropical and tropical Pacific.

1979. "Predation on Sooty Terns at Raoul Island by Rats and Cats." *Notornis* 26(Pt. 2):199–202.

At 29° S, the island supports cats and the Norway and Polynesian rats. Combined predation predictably would eliminate the large colony of sooty terns. The rats serve as an alternative food for the cat when terns are at sea in winter. Other bird species nest only on outlying islets where no mammals are present.

TAYLOR, R. H., B. D. BELL, and P. R. WILSON

1970. "Royal Albatrosses, Feral Sheep and Cattle on Campbell Island." *New Zealand J. Science* 13:78–88.

A 42-acre island was given Reserve status after farming and subsequent roaming of feral sheep and feral cattle. Fencing program is recommended for testing effect on ecosystem of thus protecting half the island.

TAYLOR, W. P.

1956. *The Deer of North America.* Harrisburg: The Stackpole Co. 668 pp. (Sponsored by Wildlife Management Institute.)

Comprehensive treatment of *Odocoileus hemionus* (pp. 332–617) by nine authors. Systematics, habitat, productivity, population estimates, ecology, management, and hunting are among subjects covered.

TELFER, T. C.

1977. *Report of the Apparent Establishment of Small Indian Mongoose on Kauai.* State of Hawaii Div. Fish and Game, Wildlife Biologist's Report dated February 9. 5 pp.

Summarizes information on stated subject through date of issue. Interisland barge was considered as one possible vehicle of transport.

1982. "Status, Trends and Utilization of Game Mammals and Their Associated Habitats on

the Island of Kauai." State of Hawaii, Div. Forestry and Wildlife, Honolulu, Project W-17-R-7. 17 pp., mimeo.

Reports that 21 mule deer were taken in 1981, pigs decreased slightly in numbers, and goats were locally abundant.

1984. "Status, Trends and Utilization of Game Mammals and Their Habitats on the Island of Kauai." State of Hawaii, Div. Forestry and Wildlife, Honolulu, Project W-17-R-9. 12 pp., mimeo.

Annual report for the period July 1, 1983, to June 30, 1984.

TEMME, M., and W. B. JACKSON

1978. "Palatal Ridges as an Epigenetic Marker in *Rattus rattus* and *Rattus exulans* Populations." *Z. Säugetierk.* 43:193–203. (In English with English and German summaries.)

Explores a technique for possible separation of rat populations by divergences in seven major palatal ridge characters. Data from Eniwetok and Galápagos Islands.

TENBRUGGENCATE, J.

1978. "The Bunnies of Kauai." *Honolulu Advertiser*, May 18, p. A-8.

Reports recent occurrence of the domestic rabbit along the Powerline Trail in central Kaua'i, and in an area away from human habitation near Nāwiliwili Harbor. Origin of the stocks was unknown.

1979. "Kauai Squirrel Hunt: For One—Maybe More." *Honolulu Advertiser*, December 13, p. A-12.

Possibly two escaped as a van from California was opened. One was captured as reported in the same newspaper December 18.

1982. "Cats Blamed in Loss of Shearwaters at Kauai Nesting Site." *Honolulu Advertiser*, September 30, p. A-6.

Only seven of 38 marked nests were still active near the usual fledging time in a colony above Kalāheo. The colony of possibly hundreds of nests was discovered in 1979, in dense fern on a steep slope. One cat was observed in a nesting burrow.

1984a. "Dogs Kill Three-fourths of Sea Birds in Colony." *Honolulu Advertiser*, February 23, p. A-10.

The Laysan albatross, with as many as 42 birds established at Barking Sands, Kaua'i, was seriously depleted in two raids by feral dogs. A second new colony, at Kīlauea Point, had been fenced against such predators.

1984b. "Survival: Gooney Birds Losing Kauai Battle of Existence to Dogs." *Honolulu Advertiser*, March 10, p. B-8.

Further details on predation by dogs on the Laysan albatross. As many as 120 birds have been established on Kaua'i, but those on all nesting grounds remain vulnerable.

1985. "Gooney Bird Population is Growing Fast on Kauai Despite Many Kills by Dogs." *Honolulu Advertiser*, April 13, p. A-8.

Largely through immigration, population is about 300 birds despite predation by dogs in unfenced colonies. Nesting birds are particularly vulnerable to dogs.

TENORIO, JOANN M., and M. L. GOFF

1980. *Ectoparasites of Hawaiian Rodents*. B. P. Bishop Mus., Spec. Pub. Dept. Entomology. 32 pp.

Includes keys to identification, illustrations, and summary species accounts for six fleas, two sucking lice, and 14 mites. Previously unpublished host and geographic records are included.

TERAOKA, W., K. NAGATA, and CAROLYN CORN

1981. "Predation on *Pipterus albidus* Fruit by Rodents." *'Elepaio* 41:134.

A small rat, possibly *R. rattus*, was observed in mid-day foraging on native *Pipterus* fruits in Wai'anae Mountains, O'ahu, at 520 m.

TESHIMA, A.
1977. "Bait Bags—A New and Improved Form of Rat Bait Distribution." *Hawaiian Sugar Technologists Rep.*, 35th Ann. Conf., Honolulu, pp. 246–250.
Baits are air-dropped in heat-sealed, 4-mil plastic bags, each containing 150 g of bait.

THOMPSON, G. B.
1950. "Ticks of Jamaica, B. W. I." *Ann. Mag. Natural History* (Ser. 2) 3:220–229.
Refutes (pp. 222–223) a notion forwarded by a 1903 popular article, and by others, for instance Anon. (1897), that there was an important relationship between ticks and the mongoose. Larval forms of *Boöphilus* (in Puerto Rico) and of *Ornithodorus* (in Jamaica), were reported, but occurred only rarely on *Herpestes*.

THOMPSON, H. V., and A. N. WORDEN
1956. "The Rabbit." London: Collins. 240 pp.
A comprehensive review of *Oryctolagus cuniculus* the world over, particularly in its relation to man. Ecological aspects are emphasized.

THOMPSON, P. O., and W. A. FRIEDL
1982. "A Long Term Study of Low Frequency Sounds from Several Species of Whales off Oahu, Hawaii." *Cetology* 45:1–19.
Identifies sounds of humpback, fin, blue, sperm, and pilot whales from hydrophones on sea bottom at 400 fathoms, off Ka'ena Point. Confirms seasonal presence of blue whales in Hawaiian waters. Patterns were identified for all species through a 29-month listening period.

THOMSEN, J. J., and C. A. EVANS
1964. "The Feral San Juan Rabbit as a Potentially Useful Laboratory Animal." *Laboratory Animal Care* 14:155–160.
Describes population on islands in Puget Sound, Washington, as rising from several domestic breeds released as early as 1900, in a history apparently similar to that of Hawaiian colonies. Relative immunity to Shope papilloma virus is of significance to research on this disease.

THROP, J. L.
1978. "Out of the Ashes, A Dog?" *Animal Kingdom* 81(3):4–10.
A popular, breezy, but basic account of the attempt at Honolulu Zoo by then director Throp, to revive the Polynesian dog as a modern breed. Fanciful illustrations.

THRUM, T. G.
1912. "Honolulu's Share in the Pacific Whaling Industry of By-Gone Days." *Hawaiian Annual for 1913*, pp. 47–68.
First whaler was fitted out at Honolulu in 1832 (p. 47). Peak of activity was in 1859 when arrivals of whaling ships in Hawai'i totaled 549; local fleet had 20 ships (pp. 53–54). Lists (pp. 63–68) by years, 1832–1880, all ships based at Honolulu, and their take in whale products.

THURSTON, L. A.
1920. "Solving Hawaii's Milk Problem." *Pacific Commercial Advertiser*, June 22, Sec. 3, p. 3.
Recommends importation of quality goat breeds such as Saanen, Nubian, and Toggenberg. "Through the milk goat, Hawaii can quickly and radically reduce the cost of living and enable the person of small means to produce an ample supply of milk for family use."
1923. "Notes on the Scientific Exploring Expedition of 1923 to the Uninhabited Northwestern Islands of the Hawaiian Group." *Honolulu Advertiser*, June 1, pp. 1–4.
Popular account of practical aspects of the Tanager Expedition, written aboard the ship, off Nihoa, on May 24, 1923. Emphasizes rabbit problem on Laysan and Lisianski.

TIERKEL, E. S., G. ARBONA, A. RIVERA, and A. DE JUAN

1952. "Mongoose Rabies in Puerto Rico." *Public Health Rep.* 64:274–278.

Rabies present at least as early as 1841. The island was apparently rabies-free from 1933 to 1950 when an outbreak occurred, traced in origin to *Herpestes auropunctatus*. Mongoose was imported between 1870 and 1877.

TILLETT, E. E.

1937. "Hunting Wild Pigs in Hawaii." *Paradise Pacific* 49(3):9, 29.

Popular account of pig hunting, emphasizing the need for reduction of numbers. Describes charge of mounted rider by a pig, on Mauna Kea.

TINKER, S. W.

1938. *Animals of Hawaii: A Natural History of the Amphibians, Reptiles, and Mammals Living in the Hawaiian Islands.* Honolulu: Nippu Jiji. 188 pp.

A pioneer work written in popular style primarily as a schoolbook, but contains some valuable original material from observation and interviews; occasional references are given. Land mammals are discussed on pages 72–139. Survey of cetaceans (pp. 139–179).

1980. *A List of Amphibians, Reptiles, and Mammals of the Hawaiian Islands.* Honolulu: Privately published. 8 pp.

Includes listing of all orders of mammals, indicating families and species found in Hawai'i. The cetaceans are excluded.

TITCHEN, KATHY

1974. "Wallaby Watchers are Sought." *Honolulu Star-Bulletin*, March 27, p. C-4.

Report on studies of Kalihi Valley wallaby by two students, with some new insights gained. Reprinted 1975 in *'Elepaio* 35:103.

TITCOMB, MARGARET

1961. "La Bibliothèque du Bishop Museum de Honolulu" [The library of the Bishop Museum in Honolulu]. *Bull. Soc. d'Études Océaniennes* 11:316–319. (In French.)

Explains the position of the Bishop Museum and its library in service to research in the Pacific region. Lists some rare materials in the library and summarizes the content of the whole library collection.

1969a. "The Axis Deer—Impending Threat to the Big Island." *'Elepaio* 30:21–25.

Discusses pros and cons of deer introduction. Urges opposition to the proposal.

1969b. "Axis Deer—Welcome or Not?" *'Elepaio* 30:52–57.

A collection of articles relating to attempts at transfer of axis deer to the Big Island, including excerpts from *Honolulu Star-Bulletin*.

1969c. *Dog and Man in the Ancient Pacific.* B. P. Bishop Mus. Spec. Pub. 59. 91 pp.

Provides comparative data for Hawai'i from other regions of the Pacific, including a tracing of dispersal with man from Asia. Written in collaboration with Mary K. Pukui.

TODD, N. B.

1964. "The Manx Factor in Domestic Cats." *J. Heredity* 55:225–230.

Reviews phenomenon of taillessness in cats. The Manx cat is not a breed, but rather results from the heterozygous condition between $+^m$ (normal tail) and *M* (Manx allele). The homozygous *MM* is an autosomal lethal. New data are presented on the degree of taillessness in the Manx phenopype.

TOMICH, P. Q.

1961. "Reservoirs and Vectors of Plague in Hawaii: Rodent Populations of the Hamakua District." *Abstract Symposium Pap., Tenth Pacific Science Cong.* (Honolulu), p. 210.

A summary of nomenclature, species composition, and reproductive data, with emphasis on

Mus musculus (= *Mus domesticus*) and *Rattus exulans* which were, respectively, 56.2 percent and 34.4 percent of all rodents collected in routine trapping.

1962. "Notes on the Barn Owl in Hawaii." *'Elepaio* 23:16–17.

Documents the several releases of barn owls (*Tyto alba*) on Kaua'i, O'ahu, and Hawai'i in 1958–1961, 74 birds in all. The owls were spreading on Kaua'i and Hawai'i but apparently failed on O'ahu. No nests were found. Object of the introduction was rodent control.

1964. "A Call for Bat Observers." *'Elepaio* 25:26.

Reports progress in field study of *Lasiurus cinereus*, and suggests that sight records of bats anywhere in Hawai'i would be valuable for tracing seasonal occurrence.

1965a. "A Question of Values." *'Elepaio* 25:54–55.

A statement of concern about the proposed eradication of feral rabbits from Mānana Island, a bird reservation. Scientific value of the present stable ecosystem is stressed, and intensive study is proposed to replace hasty management practices.

1965b. "The Hoary Bat in Hawaii." *'Elepaio* 25:85–86.

A brief commentary on the status and character of *Lasiurus cinereus* that accompanied a mounted skeleton of this bat presented to Bishop Musuem. Article offered for publication by E. H. Bryan, Jr.

1965c. "Weight Variation in Adrenal Glands of the Mongoose in Hawaii." *Pacific Science* 19:238–243.

Adrenals are of similar size in young of either sex, much smaller in adult males, and larger in adult females than in any other age or sex class. Seasonal variation is slight. Characteristics of adrenal glands in carnivores and rodents are compared; population theory is briefly considered.

1965d. *A Survey of Rodents in Hawaii Volcanoes National Park.* State of Hawaii, Dept. of Health, Honokaa, Field Rep. 4 pp.

The four common species were found among 64 rodents taken in headquarters and camp areas. A new altitudinal record of 4,000 feet is reported for *Rattus exulans*.

1965e. "Guidelines for Research on Terrestrial Ecology in Hawaii." State of Hawaii, Dept. of Health, Honoka'a, Hawai'i. 5 pp., mimeo.

Stresses need for centrally organized basic research on lands, flora, and fauna in order to provide firm bases for administrative decisions in state agencies concerned with biological problems. Recommends establishment in Hawai'i of a research organization suitable for accomplishing these objectives, suggesting its sponsorship by the University of Hawaii.

1968. "Coat Color in Wild Populations of Roof Rat in Hawaii." *J. Mammalogy* 49:74–82.

Demonstrates ecological distribution of pelage types in *Rattus rattus*. White-bellied (wild-type) and the mutant dominant black rats are found in all sections of Hawai'i Island. Mutant gray-bellied and recessive black rats were absent from the southwest coastal region, but present elsewhere on the island.

1969a. *Mammals in Hawaii: A Synopsis and Notational Bibliography.* B. P. Bishop Mus. Spec. Pub. 57. 238 pp.

Cloth bound First Edition. Out of print 1981.

1969b. "Movement Patterns of the Mongoose in Hawaii." *J. Wildlife Mgmt.* 33:576–584.

Mark and release of 546 mongooses in a 3-year study confirms that this species is sedentary. Range lengths in time seldom exceeded one mile.

1970. "Movement Patterns of Field Rodents in Hawaii." *Pacific Science* 24:195–234.

Presents results of studies conducted from 1959 to 1964 in Hāmākua District, on Hawai'i. Four species of rodents (5,650 individuals) were tagged and released. Population level, recapture frequency, longevity, daily movement, range length, and dispersal are considered.

1971. "Notes on Foods and Feeding Behavior of Raptorial Birds in Hawaii." *'Elepaio* 31:111–114.

Rodents, particularly *Mus musculus* (= *Mus domesticus*), are a staple food of the barn owl and short-eared owl. The Hawaiian hawk has a more varied diet.

1973. "Mammals." *In*: R. W. Armstrong (editor), *Atlas of Hawaii*, pp. 67–69. Honolulu: Univ. Press of Hawaii. 222 pp. (Revised edition, 1983.)

Summary and classification of two native land or shore-based species, 20 pelagic cetaceans, three Polynesian introductions, and 15 established species arriving after 1778. Distribution among the islands is listed.

1974a. "The Hoary Bat in Hawaii: Daredevil of the Volcanoes." *Natnl. Parks Conserv. Mag.* 48:10–13.

Summary of status, with new information, emphasizing plight of the bat under legislative measures of that era. Several bats were observed near volcanic eruption sites.

1974b. "Hawaii's Only Native Land Mammal." *Defenders* 50:520.

Brief capsular review of the hoary bat in Hawai'i. One color photograph.

1974c. "Status Report on the Hoary Bat in Hawaii." *Proc. Fifth Wildlife Soc. Symposium.* Hawaii Chapter, The Wildlife Society, Honolulu. Abstract only, p. 12.

Review of subject species, indicating progress in collection of study materials, study of parasites, and suggestions for additional research projects.

1979. "Studies of Leptospirosis in Natural Host Populations I. Small Mammals of Waipio Valley, Island of Hawaii." *Pacific Science* 33:257–279.

Long-term trends of infection among four rodent species and the mongoose are described. Free-ranging rats acquired or lost infection in time. Three pathogenic serotypes were cultured from host animals, but only saprophytic leptospires were isolated from streams and ponds.

1981a. "Rodents." *In*: Mueller-Dombois, Bridges, and Carson (editors), *Island Ecosystems*, Chap. 3, pp. 105–110. US/IBP Synthesis Series, 15.

Altitudinal distribution of *Rattus exulans*, *R. rattus*, and *Mus domesticus* 3,000 to 10,000 feet on Mauna Loa. Extreme upper records for the three species were 4,900 feet in mountain parkland; 8,000 feet at tree line in subalpine scrub; and 9,500 feet in alpine scrub, in the order named.

1981b. "Community Structure of Introduced Rodents and Carnivores." *In*: Mueller-Dombois, Bridges, and Carson (editors), *Island Ecosystems*, Chap. 6, pp. 301–309. US/IBP Synthesis Series, 15.

Six species (three rodents, a mongoose, feral cat, and feral dog) are considered. *Rattus rattus* was moderately abundant; other species generally occasional, in the Kilauea rain forest at 5,300 feet elevation.

1982. "Ground Squirrels." *In*: J. A. Chapman and G. A. Feldhamer (editors), *Wild Mammals of North America: Biology, Management, Economics*, Chap. 10, pp. 192–208. Baltimore: Johns Hopkins Univ. Press. 1184 pp.

Under "colonization," notes examples, including aborted accidental introduction to Kaua'i (data supplied by Thomas Telfer), of spread of range through transport by man.

1983. "Trends in the Impact of Introduced Mammals on Native Ecosystems in Hawaii". *Pacific Science Association, 15th Cong.* (Dunedin). Abstracts, Vol. 2, p. 240.

Notes with cautious optimism that long term benefits are accruing from research and management programs in Hawai'i, but predicts that additional endemic species of plants and animals will be lost.

TOMICH, P. Q., A. M. BARNES, W. S. DEVICK, H. H. HIGA, and G. E. HAAS

1984. "Evidence for the Extinction of Plague in Hawaii." *American J. Epidemiology* 119:261–273.

Examines past record of plague in Hawai'i with conclusion that the disease died out in its final residual focus shortly after 1957. Suggestive serological findings of the period 1964–1967 were nullified by later definitive testing procedures.

TOMICH, P. Q., and K. W. BRIDGES

1981. "Rodents." *In*: Mueller-Dombois, Bridges, and Carson (editors), *Island Ecosystems*, Chap. 9, pp. 407–412. US/IBP Synthesis Series, 15.

Analysis of body weight as a temporal variant in *R. rattus* and *M. domesticus* on the Mauna Loa transect. Some trends and correlations are apparent.

TOMICH, P. Q., and W. S. DEVICK
1970. "Age Criteria for the Prenatal and Immature Mongoose in Hawaii." *Anat. Record* 167:107–114.
Anatomical markers are established for the embryonic, fetal, nestling, and juvenile stages. The gestation period approximates 49 days. The full set of permanent teeth is attained at 22 weeks.

TOMICH, P. Q., and G. E. HAAS
1966. "Utilizing Ecological Information as a Basis for Rodent Control." World Health Organization Seminar on Rodents and Rodent Ectoparasites. Geneva, October 24–28. WHO/VC/217:87–100, mimeo.
Summarizes preliminary conclusions and recommendations arising from rodent ecology studies of State of Hawaii Plague Research Unit at Honoka'a, island of Hawai'i.

TOMICH, P. Q., and H. T. KAMI
1966. "Coat Color Inheritance of the Roof Rat in Hawaii." *J. Mammalogy* 47:423–431.
Reviews historical aspects of color phenotype studies in *Rattus rattus rattus*, back to 1865. Genotype determinations of more than 100 rats from various districts on Hawai'i confirm that findings of Feldman (1926) apply to these populations.

TOMICH, P. Q., N. WILSON, and C. H. LAMOUREUX
1968. "Ecological Factors on Manana Island, Hawaii." *Pacific Science* 22:352–368.
Summarizes historical and current aspects of flora and fauna of a 63-acre bird island, stressing vegetation-sea bird-feral rabbit relationships. Biological data are given on the rabbit and house mouse, and on vertebrate ectoparasites. Intensive long-term research is recommended and outlined.

TOMILIN, A. G.
1962. *Cetacean Fauna of the Seas of the U.S.S.R. and Adjacent Countries. In*: Fauna of the U.S.S.R., Vol. 9. Translated from the Russian by V. G. Heptner (editor), 1967. Jerusalem: Israel Program for Scientific Translation.
Page 38 of original lists Hawai'i as a site of occurrence of the blue whale.

TOWER, B. A.
1926. "Hunting on Hawaii, Hawaii's Largest Island." *Paradise Pacific* 39(2):18–22.
Hunting was incidental to general travel. Describes shooting pigs and attacks by pigs on hunters. Two action photos.

TOWNE, C. W., and E. N. WENTWORTH
1955. *Cattle and Men.* Norman: Univ. Oklahoma Press. 384 pp.
Excellent history of the evolution and use of domestic cattle. Notes (pp. 227–228) repeated shipment of Hawaiian cattle, from 1811 to 1835, to supply settlers in the area now comprising British Columbia, Washington, and Oregon.

TRAUB, R., C. L. WISSEMAN, and A. FARHANG-AZAD
1978. "The Ecology of Murine Typhus—A Critical Review." *Tropical Diseases Bull.* 75:237–317.
A world view of *Rickettsia mooseri*, its principal vector, the flea *Xenopsylla cheopis*, and the rodent reservoirs *Rattus* and *Mus*. Other arthropod vectors are considered. Bibliography of 530 references.

TROUGHTON, E.
1965. *Furred Animals of Australia*, Ed. VIII. Sydney: Halstead Press. 376 pp.

Plate XIII shows *Petrogale penicillata*. This species (p. 178): "is well known to visitors of the Jenolan Caves. Elsewhere they have become so scarce from the ravages of fox and gun as to cause anxiety for the survival of the species."

TRUE, F. W.

1903. "Notes on the Porpoise of the Genus *Prodelphinus* from the Hawaiian Islands." *U. S. Fish Commn. Bull.* 23(3):809–816.

Discusses in detail data from the head of one specimen, and head plus appendages of another, taken in Hawaiian waters in 1901. Referable to *Stenella attenuata*. Sketch of entire animal and four photos of skulls.

TRUETT, J. C.

1977. "Birth and First-day Behavior of Wild Mule Deer Fawns." *J. Wildlife Mgmt.* 41:150–151.

Notes on indicated subjects, in Arizona. At 24 hours of age twin fawns lay still instead of bolting when approached by an observer.

TULLOCK, D. G., and A. GRASSIA

1981. "A Study of Reproduction in Water Buffalo in the Northern Territory of Australia." *Australian Wildlife Res.* 8:335–348.

A paper representative of intensive ecological work on this species, comparing it with domestic cattle.

TUNE, J.

1974. "Wild Dogs on Lanai Kill Big Island's Deer Herd." *Honolulu Star-Bulletin*, March 24, p. 2.

Eleven penned deer were killed by marauding dogs. Animal Species Advisory Commission was to report on its recommendations for transport of deer to the Big Island. The deer had been penned in January 1969. An EIS was in preparation, but there were no immediate plans to capture more deer.

TURBOTT, E. G.

1948. "Effects of Goats on Great Island, Three Kings, with Descriptions of Vegetation Quadrats." *Auckland Inst. Mus. Rec.* 3:253–272.

Comprehensive study of a vegetation exposed to goats descended from four left on the island in 1889. Whole population of 393 animals was destroyed in 1946, at the time of the study.

TWIBELL, J.

1973. "The Ecology of Rodents in the Tonga Islands." *Pacific Science* 27:92–98.

Three species of *Rattus* are present, showing distinctive ecological preferences. Economic effects are evaluated.

UCHIDA, T. A.

1964. "Preliminary Notes on the Remarkable Murine Fauna of Iriomote-jima, the Yaeyama Group of the Ryukyu Islands." *Rep. Comm. Foreign Scientific Res., Kyushu University*, No. 2, pp. 75–92. (In Japanese with English title and summary.)

First report of murine rats from Iriomote-jima; one resembles *Rattus rattus*, another resembles *R. exulans*, and they are provisionally allocated to these species.

UEOKA, M. L.

1982. "Status, Trends and Utilization of Game Mammals and Their Associated Habitats in the County of Maui." State of Hawaii, Div. Forestry and Wildlife, Honolulu, Project W-17-R-5. 6 pp., mimeo.

Shows that axis deer and mouflon are the most important game animals in public hunting programs of this region. Game outside public hunting areas is generally not considered.

1983. "Status, Trends and Utilization of Game Mammals and Their Associated Habitats in the County of Maui." State of Hawaii Div. Forestry and Wildlife, Honolulu, Project W-17-R-8. 7 pp., mimeo.

Confirms for Lāna'i that the pronghorn is nearly extinct, and probable absence of the feral goat; axis deer and mouflon thrive there. Data also for Maui and Moloka'i. Axis deer are few on Maui, associated largely with resort areas at lower elevations.

1984. "Status, Trends and Utilization of Game Mammals and Their Associated Habitats in the County of Maui." State of Hawaii Div. Forestry and Wildlife, Honolulu, Project W-17-R-9. 6 pp., mimeo.

Annual updating for the reporting period July 1, 1983 to June 30, 1984. Two pronghorn seen on Lāna'i were apparently the last living representatives of this species in the state.

ULOTH, W.

1959. "Kritische Bemerkungen zur Einburgerung des Muffelwildes, *Ovis musimon* Schreber, 1782, auf Hawaii" [Critical observations on the introduction of the mouflon, *Ovis musimon* Schreber, 1782, into Hawai'i]. *Säugetierk. Mitt.* 7:177–178. (In German.)

1961. "Erfolgreiche Kreuzung des Mouflon (*Ovis ammon musimon*) mit verwilderten Hausschafen (*O. a. aries*) des Mauna-Kea-Gebietes auf Hawaii" [Successful hybridization of the mouflon (*Ovis ammon musimon*) with feral sheep (*O. a. aries*) of the Mauna Kea region on Hawai'i]. *Säugetierk. Mitt.* 9:162–163. (In German.)

1976. *Das Muffelwild* [The mouflon]. DDR Wittenberg Lutherstadt: A. Ziemsen Verlag. 104 pp. (In German.)

A definitive monograph on the origin, distribution, biology and management of the mouflon, worldwide in scope, including detailed information on populations in Hawai'i.

UNITED STATES DEPARTMENT OF COMMERCE

1978. "Northern Elephant Seal Appears on One of the Northwestern Hawaiian Islands." *Monthly Report Northwest and Alaska Fisheries Center, National Marine Fisheries Service.* February, 19 pp.

First agency report of subject species in Hawaiian waters.

UNITED STATES DEPARTMENT OF THE INTERIOR

1964. *Index to Topographic Maps of Hawaii and American Samoa.* U. S. Geological Survey, Washington, D.C. Single folded sheet, 4 pp. and maps.

References to dated section maps, showing location of each by name, and scale. Local and United States mainland sources are listed. Revised September 1964 and April 1981 to include maps of Guam.

1970. "U. S. List of Endangered Fish and Wildlife." *Federal Register* 35, No. 199. October 13.

Includes Hawaiian hoary bat (*Lasiurus cinereus semotus*). Places this form under provisions of the Endangered Species Conservation Act of 1969, effective on publication in the Federal Register.

1978. "Natural Resources Management Plan, Hawaii Volcanoes National Park." National Park Service. 22 pp., mimeo.

Pages 11–17 deal with feral mammals, appendix of 38 pages is entitled "Fire Management Plan and Environmental Assessment." A June 1982 Addendum of 47 pages incorporates document into an action plan. Consult also a "November 1984 Update" which is a report of progress and a further refinement of the original plan.

1984a. "Recovery Plans Approved for Hawaiian Wildlife." *Endangered Species Tech. Bull. U. S. Fish and Wildlife Service* 9(4):1, 4–10.

Reviews (pp. 8–10) recovery plan for the Hawaiian monk seal.

1984b. *Endangered and Threatened Wildlife and Plants.* U. S. Fish and Wildlife Service, 50 CFR 17.11 and 17.12, July 20. 24 pp.

Revised list for USA, including all such mammals, birds, plants, and insects for Hawai'i.

UNITED STATES DEPARTMENT OF THE NAVY

1972. *Final Environmental Impact Statement, Kahoolawe Island Target Complex, Hawaiian Archipelago.* 31 pp. + Appendixes A-N.

Studies include historical data, natural resources, and "beach recreation," noting 13 beaches with a combined length of four miles. Mammals are listed, pp. C-9, C-10, C-11.

1977. *Draft Supplement to the Final Environmental Impact Statement, Kahoolawe Island Target Complex, Hawaiian Archipelago.* vi + various pages of appendixes updated. Honolulu: Pacific Division, Naval Facilities Engineering Command.

Navy determines that it must use Kaho'olawe, with (pp. 31A, 32A) "considerations that offset adverse environmental effects."

UNITED STATES FISH AND WILDLIFE SERVICE

1978. "Palila Recovery Plan." Washington, D.C.: USFWS. 35 pp. and appendixes, mimeo.

Document prepared by a team of eight scientists and administrators in Hawai'i as a format for management to promote recovery of the endangered *palila* (*Loxioides*) on Mauna Kea, Hawai'i.

URICH, F. W.

1931. "The Mongoose in Trinidad." *Tropical Agriculture* 8:95–97.

Explains operation and failure of the bounty system. Summarizes changes among Trinidad fauna as possibly related to the mongoose. Suggests protection of boa snakes as mongoose predators. Cites seven papers dated 1914 to 1930.

VALENCIĆ, J., and ROBIN VALENCIĆ

1978. *The Complete Whale Watchers Guide.* Dana Point, CA: Quest Marine Research. Hawaii Edition, 41 pp.

Popular accurate field guide to the whales of the eastern Pacific and Hawai'i. Outlines restrictions on approach and harassment of whales, and gives summary of current world whaling.

VAN AARDE, R. J., and B. BLUMENBERG

1979. "Genotype Correlates of Body and Adrenal Weight in a Population of Feral Cats *Felis catus.*" *Carnivore* 2:37–45.

VAN BREE, P. H., and J. CADENAT

1968. "On a Skull of *Peponocephala electra* (Gray, 1846) (Cetacea, Globicephalinae) from Sénégal." *Beaufortia* 14:193–202.

From study of a new specimen and a series of skulls and locality data, authors confirm wide distribution of the species and suggest common name of "Many-toothed blackfish" as more appropriate than "Hawaiian porpoise."

VANCOUVER, G.

1798. *A Voyage of Discovery to the North Pacific Ocean, and Round the World.* Vols. 1–3. London: Robinson.

Journals of Captain George Vancouver, 1790–1795, in the ships *Discovery* and *Chatham.* A principal aim of the voyage was to find, if possible, a navigable communication between the North Pacific and North Atlantic oceans. Three separate visits were made to the Hawaiian Islands, in 1792, 1793, and 1794.

VAN GELDER, R. C.

1953. "The Egg-Opening Technique of a Spotted Skunk." *J. Mammalogy* 34:255–256.

A captive *Spilogale putorius* (Linnaeus) attempted to bite a hen's egg, then pushed it backward between the forelegs with the forepaws and gave it a quick kick to the rear with one hind foot. This action was repeated until the egg broke.

VAN RIPER, C., III

1974. "Unusual Uses of Ricebird's Nests in Hawaii." *'Elepaio* 35:5.

Reports six examples of *Rattus rattus* using nests of *Lonchura*, on the slopes of Kohala Mountain, Hualālai, and Mauna Kea, on Hawai'i. In one case a litter of rats was present.

1980a. "Observations on the Breeding of the Palila *Psittirostra bailleui* of Hawaii." *Ibis* 122:462–475.

Detailed examination of dependence of a highly specialized bird on the *māmane-naio* forest of Mauna Kea. Habitat degradation and consequent reduced genetic fitness appear to account for endangerment of the *palila*.

1980b. "The Phenology of the Dryland Forest of Mauna Kea, Hawaii, and the Impact of Recent Environmental Perturbations." *Biotropica* 12:282–291.

Provides information applicable to management policy. Local site conditions, heavy past browsing, and subsequent failure in competition with *Myoporum* results in some loss of range by *Sophora*.

VAN RIPER, SANDRA G., and C. VAN RIPER, III

1982. *A Field Guide to the Mammals in Hawaii.* Honolulu: Oriental Pub. Co. 69 pp.

Concise summary of subject information with popular appeal; richly illustrated by color photographs and range maps.

VAN VALEN, L.

1964. "A Possible Origin for Rabbits." *Evolution* 18:484–491.

From author's summary: Dental evidence indicates that the Lagomorpha probably originated from a stock in common with the Mongolian insectivore, *Pseudictops*, which is tentatively placed in the Anagalidae. This group appears to have originated near a Late Cretaceous leptictid insectivore.

VAN VECHTEN, C.

1950. *The Tiger in the House.* New York: Knopf. 367 pp.

Popular but classical account of the cat as a domestic animal in the home, in the arts, and in literature. Deep insight is given into cat behavior. Text written in 1920.

VITOUSEK, R. A., JR.

1941. "Big Game in Paradise." *Paradise Pacific* 53(2):29–31.

Colorful account of a pig hunt in the mountains of O'ahu, with dogs, and an inexperienced hunter in the party.

VOLKMAN, N. J., K. F. ZEMANEK, and D. MÜLLER-SCHWARTZE

1978. "Antorbital and Forehead Secretions of Black-tailed Deer (*Odocoileus hemionus columbianus*): Their Role in Age-class Recognition." *Animal Behaviour* 26:1098–1106.

Further extension of earlier studies indicating that scent messages are interpreted by deer within a system of dominance relations.

VOLLRATH, H.

1947. *Pork Production in Hawaii.* Univ. Hawaii Agricultural Extension Service Bull. 31. 60 pp.

Farmers' bulletin on methods for commercial breeding of penned herds; no mention of wild stock. Good survey of the industry in Hawai'i; extensive nationwide references.

VON KOTZEBUE, O.

1821. *A Voyage of Discovery into the South Sea and Bering Straits . . . in the Years 1815–1818.* London: Longman and others. Vols. 1–3.

Seen as Bibliotheca Australiana #17. New York: Da Capo Press, 1967. Pages 345–346 describe observation of bats on O'ahu, December 8, 1816.

VON TEMPSKI, ARMINE

1928. *Dust.* New York: Stokes. 323 pp.

A novel concerning Kaho'olawe, based in part on the historical facts of its overuse by livestock, and attempts to reclaim it from large populations of goats about 1918.

VOSS, B.

1982. "In Makakilo, a Mouse in the House Means There's More in the Bush." *Honolulu Advertiser,* July 23, p. A-1.

Describes invasion of mice and means taken for control. Residents were urged to trap the animals.

WADE, D. W.

1967. "The Guinea Pig in Andean Folk Culture." *Geographical Rev.* 57:213–224.

Cites evidence that the guinea pig was domesticated at an indefinite time much earlier than 1000 B.C. Retains the older view of its origin that the most likely progenitor is *Cavia cutleri* Bennet rather than *C. aperea.* Association of the guinea pig, or *cuy,* with man is explored in detail.

WADSWORTH, H. A.

1933. "A Historical Summary of Irrigation in Hawaii." *Hawaiian Planters' Rec.* 37:124–162.

Describes "*Menehune* ditches," and other systems to the present time. Extensive bibliography, 19 photos.

WAGNER, W. H.

1950. "Ferns Naturalized in Hawaii." *B. P. Bishop Mus. Occ. Pap.* 29(8):95–121.

Discusses in detail ferns introduced through commerce. These came largely in the past 60 to 70 years. At least 15 species are well established in the wild.

WAKEFIELD, N. A.

1971. "The Brush-tailed Rock-wallaby (*Petrogale penicillata*) in Western Victoria." *Victorian Naturalist* 88:92–102.

Reviews the history and status of several populations in this Australian province, indicating some encouraging rediscoveries. Photos of habitat in hills known as the Grampians indicate remarkable similarities with occupied habitat in Hawai'i. A depleted vegetation may account for low surviving populations.

WALDEN, LAURIE B.

1983. "The Pesticide Crisis." *The Leader* 4(6):5–6.

National Wildlife Federation report on heptachlor contamination resulting from application for control of ants in pineapple fields. Hunters were advised not to consume game birds or deer on Lāna'i because of possible heptachlor contamination in these animals.

WALKER, E. P.

1964. *Mammals of the World.* Vol. 3. *A Classified Bibliography of Literature Regarding Mammals.* Baltimore: Johns Hopkins Univ. Press. 769 pp.

A listing of a major portion of the world references on mammals, from the larger card catalogs in the eastern United States. Together with a 113-page section in Vol. 1, more than 70,000 titles were presented. Main categories are Orders, Geographical, Genera, Periodicals. Vols. 1–2 describe or illustrate all known genera.

WALKER, F. D.

1909. *Log of the Kaalokai.* Honolulu: Hawaiian Gazette Co. 64 pp.

On a visit to Laysan in 1891, pigs were present, imported in connection with the guano mining business set up in 1890 under direction of "Governor Freeth" (pp. 28–30).

WALKER, L. W.

1945a. "'Rock Happy' Mongoose." *Paradise Pacific* 57(12):53.

Describes behavior of a mongoose at a feeding station in relation to hen's egg. One female repeatedly kicked an egg backward between the hind feet, as far as six feet; the egg finally broke and was eaten. Other mongooses ignored eggs.

1945b. "The Hawaiian Mongoose—Friend or Foe." *Natural History* 54(11):396–400.

Well-written popular account of history and current status. Describes behavior at feeding station on O'ahu. Ten excellent photos.

WALKER, R. L.

1959a. "Experimental Hybridization of the Wild Mouflon Sheep (*Ovis musimon*) with Feral Sheep of the Mauna Kea Game Management Area, Island of Hawaii." Territory of Hawaii, Div. Fish and Game, Honolulu, Project W-5-R-9. 7 pp., mimeo.

Reports objectives and beginnings of the project. First mouflon (for breeding pens) were received from U. S. mainland on December 13, 1957; feral ewes were trapped and others purchased locally.

1959b. "Experimental Introduction of the European Mouflon (*Ovis musimon*)." Territory of Hawaii, Div. Fish and Game, Honolulu, Project W-5-R-9. 4 pp., mimeo.

Summarizes releases of mouflon in Hawai'i up to May 1958: 4 on Kaua'i; 28 on Lāna'i, including 15 released in April 1958. "Animals were procured from zoos in the United States." The Kaua'i introduction of 4 sheep, on December 12, 1956, failed; 20 survivors were known on Lāna'i.

1960. "The Hybridization of the Mouflon with the Hawaiian Feral Sheep as a Management Technique." *Proc. 40th Annual Conf., Western Assoc. State Fish and Game Commn.*, pp. 148–155.

Reviews history of sheep in Hawai'i as an early domestic animal and later as a feral game species. Mouflon hybrid is proposed as an improved game and trophy animal that would do minimal damage to the range. Status of current hybridization project is reviewed.

1963. "Ancient and Recent Animal Life." State of Hawaii, Div. Fish and Game, Honolulu. 4 pp., mimeo.

A summary of terrestrial vertebrate animal life in a wild, feral, or semiferal state on the major Hawaiian islands. Author lists and comments briefly on most mammals.

1966. "*Nene* Restoration Project Report." *'Elepaio* 26:96–100.

Reviews 1949–1966 efforts to re-establish the Hawaiian goose in its former range on Hawai'i and Maui. Predation is recorded (p. 99) of feral dogs on geese flightless during molt, and of mongooses on clutches of eggs.

1967. "A Brief History of Game Bird and Mammal Introductions into Hawaii—With a Look to the Future." State of Hawaii, Div. Fish and Game, Honolulu. 13 pp., mimeo.

Includes plans for additional introductions of new game species and stocking of established species on selected islands where these were not now present.

1970. "Book Review." *'Elepaio* 30:92–93.

In review of Quentin Tomich's *Mammals in Hawaii*, notes presence of escaped crab-eating macaque on Big Island in 1960s, a black bear that roamed Ko'olau Mountains on O'ahu for at least 15 years, and another monkey at large at Kure Atoll in 1968.

WALKER, R. L. (Editor)

1984. *Trans. 24th Annual Forestry Wildlife Conf.* Honolulu, Hawaii, May 10–12, 1984. Honolulu: Department of Land and Natural Resources. 164 pp.

Conference topic is "Natural Resources Management on Hawaii's Public Lands." Papers by staff of various agencies, including private landholders. A significant updating of information on land use, conservation, wildlife management, and water resources.

WALKER, R., and L. HUDSON

1945. *Midway Photos and Verse (—or Worse).* San Diego: Hester. 87 pp.

Excellent photos, and cartoons, and verse, about wildlife on Midway Islands and elsewhere in Hawai'i; in humorous vein. One item concerns the seal, three concern the mongoose.

WALL, A. E. P.

1960. *The Big Wave, May 23, 1960.* Hilo: Hilo Tribune-Herald. 32 pp.

Photographic and narrative account of the seismic wave series, or *tsunami*, generated by the Chilean earthquake of 1960, as it affected Hilo, island of Hawai'i. The fourth wave caused extensive damage and loss of life. Statistics are given on this and 40 previous *tsunami*.

WALLACE, G. D., B. GROSS, and R. LEE

1961. "Leptospirosis Survey of Small Mammals on the Island of Hawaii." *Abstracts Symposium Pap., Tenth Pacific Sci. Cong.* (Honolulu), p. 435.

Rodents and the mongoose in Puna District were examined by serological and cultural methods; 45 percent of 1,238 mammals were infected. *Leptospira icterohaemorrhagiae* was identified in 323 isolates, *L. ballum* in five.

WALLMO, O. C. (Editor)

1981. *Mule and Black-tailed Deer of North America.* Lincoln: Univ. Nebraska Press. 605 pp.

Brings up to date studies of the most important U.S. game species. Reviews: *J. Mammalogy* 63:185–186 (1982); *Science* 217:926 (1982).

WALSH, J.

1984. "Can Fish Quota Save the Whales?" *Science* 224:850.

Editorial on possible cuts in fish harvest quotas in American waters as lever to enforce moratorium on pelagic whaling by Japan.

WARING, G. T.

1983. *Horse Behavior: The Behavioral Traits and Adaptations of Domestic and Wild Horses, Including Ponies.* Park Ridge: Noyes. 292 pp.

A highly recommended work for anyone dealing with horses. Reviewed by Ronald Keiper, *Science* 220:1044 (June 3, 1983).

WARNER, R. E. [a]

1959. "Ecological Investigations on the Hawaiian Pig." State of Hawaii, Div. Fish and Game, Honolulu, Project W-5-R-10. 5 pp., mimeo.

Reports on literature search, origin of Hawaiian stocks of pigs, distribution, and some biological data. Concludes that Hawaiian pigs are closely similar to the Eurasian wild boar.

1960. "A Forest Dies on Mauna Kea." *Pacific Discovery* 13(2):6–14.

A pessimistic account of feral sheep management on Mauna Kea. Population levels and annual harvest are graphed for the 1950–1960 decade. Many photos show extensive range damage.

1961. "The Problem of Native Forest Destruction in Hawaii." *Abstracts Symposium Pap., Tenth Pacific Sci. Cong.* (Honolulu), pp. 251–252.

Reports that 1957–1959 investigations revealed continued habitat deterioration on all islands; feral pigs, goats, and sheep, and removal of native forest to plant alien timber species, were prime factors. Recommends establishment of natural areas under state parks jurisdiction as a means of preserving examples of native forests.

1963. "Recent History and Ecology of the Laysan Duck." *Condor* 65:2–23.

Reviews (pp. 6–8) destruction of original habitat, principally by rabbits introduced in 1903, listing also the guinea pig, swine, and a cow or goat as contributors; and describes habitat conditions at that time on Laysan Island.

WARNER, R. E. [b]

1985. "Demography and Movements of Free-ranging Domestic Cats in Rural Illinois." *J. Wildlife Mgmt.* 49:340–346.

Cats yielded valuable biological field data, were highly predatory on wildlife, and were generally attached to small farmsteads for shelter and supplementary food. None of the population was truly feral.

WARNER, R. E. (Editor)

1967. *Scientific Report of the Kipahulu Valley Expedition.* Honolulu: The Nature Conservancy. 184 pp.

Results of a multidisciplinary survey of subject valley to determine its value for possible inclusion in Haleakala National Park.

WARSHAUER, F. R., J. D. JACOBI, ANNE M. LA ROSA, J. M. SCOTT, and C. W. SMITH

1983. "The Distribution, Impact and Potential Management of the Introduced Vine *Passiflora mollissima* (Passifloraceae) in Hawaii." Univ. Hawaii Coop. Natnl. Park Res. Studies Unit Tech. Rep. 48. 39 pp.

Agents of dispersal include feral pig, cattle and pheasants. Biological control may be the only means for regional control. The plant smothers native forest trees. Specifics for control are unknown, but *Heliconius* butterflies show promise.

WATKINS, W. A., and W. E. SCHEVILL

1974. "Listening to Hawaiian Spinner Porpoises, *Stenella* cf. *longirostris* with a Three-dimensional Hydrophone Array." *J. Mammalogy* 55:319–328.

Tests on spinner dolphins resident at Kealakekua Bay, Hawai'i, demonstrated that the system worked, gathering information on 11 subjects, to include direction, depth, speed of the animals, exchange of vocalizations and levels of splash sounds in aerial display.

1976. "Right Whale Feeding and Baleen Rattle." *J. Mammalogy* 57:58–66.

When feeding with relatively large amounts of baleen exposed, rattle sounds are detected in the air and under water. If a purpose exists for the sound, it has not been determined.

1977. "Spatial Distribution of *Physeter catodon* (Sperm Whale) Underwater." *Deep-Sea Res.* 26:693–699.

Whales are distributed widely under water, apparently for foraging, but may group together when surfacing to breathe. Acoustic contact is probable.

1979. "Aerial Observation on Feeding Behavior in Four Baleen Whales: *Eubalaena glacialis, Balaenoptera borealis, Megaptera novaeangliae* and *Balaenoptera physalus.*" *J. Mammalogy* 60:115–163.

Describes humpback whale as rushing schools of fish usually from below, sometimes feeding together with finback whales in dense schools of fish or patches of plankton.

WATSON, J. S.

1956. "The Present Distribution of *Rattus exulans* (Peale) in New Zealand." *New Zealand J. Sci. Technology* 37:560–570.

The problem of interspecific competition is considered. Statistical data are presented on characters for identification of New Zealand rats (same species as in Hawai'i). For *Rattus exulans* detailed records and maps show distribution, and some biological data are given.

1961a. "Rats in New Zealand: A Problem of Interspecific Competition." *Proc. Ninth Pacific Sci. Cong.* (Bangkok) 19:15–17.

Reviews relative abundance, current and historical, for *R. norvegicus, R. rattus,* and *R. exulans* in New Zealand.

1961b. "Feral Rabbit Populations on Pacific Islands." *Pacific Science* 15:591–593.

Reviews briefly the history of the Hawaiian rabbit colonies formerly present on Laysan and Lisianski, and those presently established on Mānana, Molokini, and Lehua.

1961c. "Mammals." *In*: W. M. Hamilton, Little Barrier Island (Hauturu) (2nd ed.). *New Zealand D. S. I. R. Bull.* 137:132–135.

Notes on status and history of several introduced species on a small island off New Zealand. Particular data are given on ecology of a population of the feral cat.

WATSON, L.

1981. *Sea Guide to Whales of the World.* New York: Dutton. 302 pp.

A complete reference book, well illustrated with precise line drawings in color. Summary and description for each of the known cetaceans.

WATTS, T., and W. CONLEY

1984. "Reproductive Potential and Rates of Increase for Feral Goat Populations." *J. Wildlife Mgmt.* 48:814–822.

In the high desert of New Mexico excessive mortality of juveniles resulted in slow decline of population during the study period. Simulation models utilize insular and continental data, including reference to Hawai'i and New Zealand.

WEIR, BARBARA J.

1974. "Notes on the Origin of the Domestic Guinea Pig." *In*: I. W. Rowlands and Barbara J. Weir (editors), *The Biology of Hystrichomorph Rodents. Symp. Zool. Soc. London* 34:437–446.

Explores discovery, derivation of common name, and relations to wild stocks through breeding experiments.

WENDORF, F., ANGELA E. CLOSE, and R. SCHILD

1985. "Prehistoric Settlements in the Nubian Desert." *American Scientist* 73:132–141.

Provides new dates for domestication of cattle and suggests a separate effort in the Sahara contemporary with those in the Near East and adjacent Europe.

WENTWORTH, C. K.

1925. *The Geology of Lanai.* B. P. Bishop Mus. Bull. 24. 72 pp.

Thorough treatment of physical features, including water resources; useful to any ecological study of the island. Notes (p. 58) changes wrought by human occupancy.

1926. *Pyroclastic Geology of Oahu.* B. P. Bishop Mus. Bull. 30. 121 pp.

General outline of O'ahu geology, followed by particular treatment of some 20 craters on the southeast end of the island and those forming offshore islets.

1947. "Cycles in Rainfall and Validity in Prediction of Rainfall in Hawaii." *Pacific Science* 1:215–220.

Examines the feasibility of making accurate predictions on basis of past rainfall cycles. Concludes that the error in prediction of rainfall is too great for practical application.

WESLEY, D. E., K. L. KNOX, and J. G. NAGY

1973. "Energy Metabolism of Pronghorn Antelopes." *J. Wildlife Mgmt.* 37:563–573.

Comprehensive data on energy requirements under various ambient conditions of young and adult animals.

WESTERMANN, J. H.

1953. *Nature Preservation in the Caribbean.* Found. Sci. Res. Surinam and Netherlands Antilles Pub. 9. 106 pp.

Herpestes auropunctatus was introduced onto the South American continent (British Guiana)

from Caribbean stock after 1872. Has spread to settled coastal areas but does not seem to penetrate the jungles. (From De Vos and others, 1956.)

WESTGATE, INEZ W.
1932. "The Carabao." *Paradise Pacific* 45(9):7.
A poem of five couplets extolling the apparent deeply philosophic mien of the water buffalo.

WESTROM, D. R., B. C. NELSON, and G. E. CONNOLLY
1976. "Transfer of *Bovicola tibialis* (Piaget) (Mallophaga: Trichodectidae) from the Introduced Fallow Deer to the Columbian Black-tailed Deer in California." *J. Medical Entomology* 13:169–173.
Cites example of an alien louse species on its normal host having become established on native deer when the two deer were kept in adjacent paddocks.

WETMORE, A.
1925. "Bird Life Among Lava Rock and Coral Sands." *National Geographic* 48:73–108.
Popular narrative of the Tanager Expedition. Account of the rabbits of Laysan and Lisianski is given (pp. 86, 103–104).

WHIPPLE, C. T.
1977. "The Polynesian Poi Dog." *Dog Fancy* 8(2):26–28.
Background story on development of the Honolulu Zoo project and its successes to that era. One dog made the round trip to Tahiti in the modern Polynesian voyaging canoe, *Hōkūle'a*, in 1976.

WHITAKER, J. O., JR., and P. Q. TOMICH
1983. "Food Habits of the Hoary Bat, *Lasiurus cinereus*, from Hawaii." *J. Mammalogy* 64:150–151.
Volant non-native insects of small to large size were the principal foods, marking this bat as a generalized feeder adaptable to lowland exotic vegetation types.

WHITEHEAD, H., and CAROLYN GLASS
1985. "Orcas (Killer Whales) Attack Humpback Whales." *J. Mammalogy* 66:183–185.
Two prolonged attacks are described, off Newfoundland. The pods of orcas obtained bites of flesh but did not attempt to kill their prey.

WHITEHOUSE, S. J. O.
1977. "Movements of Dingoes in Western Australia." *J. Wildlife Mgmt.* 41:575–576.
Wild dogs (120) tagged as puppies provided a 10 percent return as captured by professional trappers and ranchers. Distances traveled from point of release averaged 21.7 km for males and 11.0 km for females.

WHITESELL, C. D.
1964. "Silvical Characteristics of *Koa* (*Acacia koa* Gray)." U. S. Forest Service Res. Pap. PSW-16. 12 pp.
States (p. 8) that the mule deer on Kaua'i eats *koa* sprouts; also cites forester's report from Maui that the roof rat girdles *koa* saplings.

WHITMORE, F. C., JR., and A. E. SANDERS
1975. "The Cetacea 30 Million Years Ago." *American Zoologist* 15:824.
Abstract only. Notes appearance in the geological record of early Miocene times of the first member of both the toothed Odontoceti and the baleened Mysticeti, as successors to the declining Archeoceti.

WHITTEN, H. A.

1970. "Bear and Hiker Meet; Both Make Hasty Retreat." *Honolulu Star-Bulletin*, February 4, p. A-3.

Traces complete story of the black bear that lived in O'ahu forests, 1956–1970: escape, attempts at capture, and details of encounters with humans.

WHITTOW, G. C., G. H. BALAZS, and G. D. SCHMIDT

1979. "Parasitic Ulceration of the Stomach in a Hawaiian Monk Seal." *'Elepaio* 38:83–84.

Seal that died ashore at Tern Island, French Frigate Shoals, was heavily infested with a roundworm, *Contracaecum*. Whether or not parasites were a cause of death was uncertain.

WHITTOW, G. C., I. F. G. HAMPTON, D. T. MATSUURA, C. A. OHTA, R. M. SMITH, and J. F. ALLEN

1974. "Body Temperature of Three Species of Whales." *J. Mammalogy* 55:653–656.

Three captive Hawaiian species, *Pseudorca*, *Globicephala*, and *Orcinus*, were studied by means of an ingested radio transmitter sending signals of temperature change to 0.1°C. Best records were from *Pseudorca*, which ranged from 36.0° to 37.2°C.

WHITTOW, G. C., I. F. G. HAMPTON, and C. A. OHTA

1978. "Body Temperature of the Rough-toothed Dolphin." *J. Wildlife Mgmt.* 42:184–185.

A "radio-pill" fed the subject animal in a fish permitted telemetric measurements of a free-swimming captive over a period of 29 hours. Temperature ranged from 36.7° to 37.6°C (mean 36.9°).

WHITTOW, G. C., J. SZERKERCZES, E. KRIDLER, and D. L. OLSEN

1975. "Skin Structure of the Hawaiian Monk Seal (*Monachus schauinslandi*)." *Pacific Science* 29:153–157.

This seal tolerates strong solar radiation but has no apparent mechanism for evaporative cooling. Sweat glands are present but perhaps not functional. Epidermis is pigmented; pelage short and bristly.

WHO and FAO

1971. *Bibliography on Rodent Pest Biology and Control 1960–1969*. BVC/71.9b. Parts I–IV. Geneva: WHO/FAO.

A World Health Organization/Food and Agriculture Organization joint effort. World literature for the indicated period; some entries are abstracted. 7,780 entries. Indexed.

1973. *Bibliography on Rodent Pest Biology and Control 1950–1959*. BVC/71.9b. Parts I, II. Geneva: WHO/FAO.

A World Health Organization/Food and Agriculture Organization joint effort. World literature for the indicated period; some entries are abstracted. 3,791 entries. Indexed.

WILKES, C.

1845. *Narrative of the United States Exploring Expedition*, Vol. 4. Philadelphia: Lea and Blanchard. 539 pp.

Describes (pp. 98–102) an overland horseback trip on Hawai'i, from Kona to Kīlauea to Hilo, in 1840, and evidence of cattle, wild dogs, and hide hunters in the interior of the island. Notes (pp. 203–204) hide hunters from Spanish California, and site of David Douglas' death.

WILLIAMS, C. B.

1918. "The Food of the Mongoose in Trinidad." *Dept. Agriculture Trinidad and Tobago, Bull.* 17:167–186.

Summarizes previous work done in the region, lists individually the content of 166 mongoose stomachs containing food items, summarizes each category of foodstuff, and concludes (p. 185) that, except in few special ecological settings, the mongoose is undesirable.

WILLIAMS, G. R., and M. R. RUDGE
1969. "A Population Study of Feral Goats (*Capra hircus* L.) from Macauley Island, New Zealand." *Proc. New Zealand Ecological Soc.* 16:17–28.
Data are derived from 3,200 goats taken in extermination of a previously undisturbed feral population on an 800-acre island. Horn form, coat color, tooth condition, and population structure are described.

WILLIAMS, J.
1968. "Half of Isle Buffalo Herd Goes on Loan." *Hawaii Tribune-Herald,* January 25, p. 1.
A pair of Waipi'o Valley buffalo were sent to the new University of Hawaii Rice Research Institute on Kaua'i, leaving an old female and a female calf born in April 1967.

WILLIAMS, J. M.
1973. "The Ecology of *Rattus exulans* (Peale) Reviewed." *Pacific Science* 27:120–127.
A landmark paper; extensive bibliography.

WILLIAMS, JULIE
1980. "Native vs. Exotic Woody Vegetation Recovery Following Goat Removal in Eastern Coastal Lowlands of Hawaii Volcanoes National Park." *In:* C. W. Smith (editor), 1980, pp. 373–382.
Predicts that prominent native species will recover in time, but that some exotics may persist.

WILSON, P. R., and D. F. G. ORWIN
1964. "The Sheep Population of Campbell Island." *New Zealand J. Science* 7:460–490.
A population, feral for 30 years on the southernmost of New Zealand's outlying islands, is ecologically evaluated. A downward trend in numbers reflects gradual depression of the vegetation. Barrier fences are recommended in connection with further investigation of this unique population.

WILSON, W. F.
1922. *With Lord Byron at the Sandwich Islands in 1825: Being Extracts From the MS Diary of James Macrae, Scottish Botanist.* Honolulu: Privately published.
On pages 38–39 it is mentioned that two deer from northwest coast of America were released in "Hanaruru Valley" by Alexander Adams, but later killed and eaten. Some notes also on cattle, sheep, pig, dog, and cat.

WIMSATT, W. A. (Editor)
1970. *Biology of Bats,* Vols. 1, 2. New York: Academic Press. 883 pp.
Includes 17 chapters by 12 authors dealing with anatomy, physiology, behavior, and ecology of bats. Extensive reference sections and index.

WINN, H. E., P. BEAMISH, and P. J. PERKINS
1979. "Sounds of Two Entrapped Humpback Whales (*Megaptera novaeangliae*) in Newfoundland." *Marine Biol.* 55:151–155.
Whales entrapped in cod nets on the summer feeding grounds made sounds similar to parts of the winter "songs" heard typically in the breeding grounds.

WINN, H. E., R. K. EDEL, and A. G. TARUSKI
1975. "Population Estimate of the Humpback Whale (*Megaptera novaeangliae*) in the West Indies by Visual and Acoustic Techniques." *J. Fish. Res. Bd. Canada* 32:499–506.
Northwest Atlantic population about half the previous estimate, only some 300–500, and one of 11 groups known in the world. Survey made in breeding grounds near West Indies. Though hunted nearly to extinction, chances of recovery were said to be good. This species protected from factory ship whaling in Atlantic since 1955, and worldwide since 1968.

WINN, H. E., and P. J. PERKINS

1976. "Distribution and Sounds of the Minke Whale with a Review of Mysticete Sounds." *Cetology* 19:1–12.

Notes that minke whale is not often seen at sea because of a usual lack of visible blow, but when research ship is stopped periodically minke whales in vicinity will come to it.

WINN, H. E., T. J. THOMPSON, W. C. CUMMINGS, J. HAINS, J. HUDNALL, H. HAYS, and W. W. STEINER

1981. "Song of the Humpback Whale: Population Comparisons." *Behav. Ecol. Socio-biol.* 8:41–46.

Songs sampled in North Pacific (Hawai'i and Mexico) were essentially similar, but clearly different from song shared by two North Atlantic populations (Cape Verde Islands and West Indies). A third distinct dialect was recorded from the Southern Hemisphere (Tonga).

WINN, H. E., and L. K. WINN

1978. "The Song of the Humpback Whale *Megaptera novaeangliae* in the West Indies." *Marine Biol.* 47:97–114.

The basic song evolves through a series of different sounds in a fixed order and is produced only in the winter tropical calving grounds, probably only by the young sexually mature males.

WIRTZ, W. O., II

1968. "Reproduction, Growth and Development, and Juvenile Mortality in the Hawaiian Monk Seal." *J. Mammalogy* 49:229–238.

Data from 53 known-age seals at Kure Atoll in 1964 and 1965: 15 live pups per year per 100 adults; 56 percent of adult females had pups in either of the two seasons, usually in March through May. Pups leave the atoll about five weeks after birth. Subsequent growth period until maturity is very likely spent at sea.

1972. "Population Ecology of the Polynesian Rat, *Rattus exulans*, on Kure Atoll, Hawaii." *Pacific Science* 26:433–464.

In absence of predators rats on a 214-acre islet thrive seasonally. Reduced food resources during winter months appears to be a prime limiting factor.

1973. "Growth and Development of *Rattus exulans*." *J. Mammalogy* 54:189–202.

Field and laboratory data on stock from Kure Atoll. Mean litter size is about 4.0 and gestation lasts 19–21 days. Males continue to grow after the twelfth week, but in females the rate is much reduced, resulting in sexual dimorphism of adult rats.

WODZICKI, K.

1950. *Introduced Mammals of New Zealand.* New Zealand Dept. Scientific Industrial Res. Bull. 98. 255 pp.

Survey of the past and present status of exotics in New Zealand from the vertebrate ecologist's viewpoint. Species and groups are treated in units. Includes many forms found also in Hawai'i. Numerous tables and illustrations.

1961. "Ecology and Management of Introduced Ungulates in New Zealand." *Terre et Vie* 108:130–157.

Of particular interest for the Hawaiian scene are discussions of feral pigs, sheep, and goats. Control methods are explained. Over 15,000 sheep were destroyed between 1951 and 1958.

1963. "Ssaki importowane w lasach Nowej Zelandii—Introduced Mammals in New Zealand Forests." *Acta Biologica Cravoviensia, Series: Zoologia* 4:111–134. (Title in Polish and English.)

Describes origin, distribution, and effects of exotic mammals of New Zealand forests. Twenty-six wild and six feral species are successfully established.

1965. "The Status of Some Exotic Vertebrates in the Ecology of New Zealand." *In*: H. G. Baker and G. L. Stebbins (editors), *The Genetics of Colonizing Species*, pp. 425–460. New York: Academic Press. 588 pp.

Summarizes introduction and establishment of birds and mammals in particular, but considers all biogeographical elements. Of 207 introduced vertebrates, 91 are established (13 fishes, 3 frogs, 43 birds, 32 mammals), affording excellent opportunities for ecological and evolutionary study.

1968a. "An Ecological Survey of Rats and Other Vertebrates of the Tokelau Islands." Dept. Maori and Island Affairs, and D.S.I.R., Wellington, New Zealand. 89 pp., 8 appendixes, mimeo.

Results of a three-month expedition during 1966–1967, emphasizing economics and control of *Rattus exulans*, the only rodent found in the island group.

1968b. *The Tokelau Rat Survey* 2. *Follow-up Report*. Dept. Maori and Island Affairs, and D.S.I.R., Wellington, New Zealand. 35 pp., appendix. Offset.

Confirms that *R. exulans* is the only rodent of the Tokelau Islands. While control of rats with toxicants may be desirable, for the long term it is suggested that plantation management may be more successful in reducing rat damage to coconuts.

1979. "Relationships between Rats and Man in the Central Pacific." *Ethnomedicine* 3/4:433–446.

Thumbnail review of *Rattus exulans* in the pre-European Pacific: in legend, as food, and in its effects on cultivated crops ("a tolerated nuisance"). Author suggests that filariasis and leptospirosis were carried. Rodents (three new species added) in the post-European Pacific are much more of a burden to man, as is well summarized.

WODZICKI, K., and J. E. C. FLUX

1967. "Guide to the Introduced Wallabies in New Zealand." *Tuatara* 15:47–59.

Reports historical data, distribution, descriptions, measurements, and status of six species, including *Petrogale penicillata*. One plate.

WODZICKI, K., and S. WRIGHT

1983. "Les Oiseaux et les Mammiferes Introduit en Nouvelle Zelande at leurs Effets sur l'Environnement" [The birds and mammals introduced in New Zealand and their effects on the environment]. *C. R. Soc. Biogeogr.* 59(2):231–256. (In French, English summary.)

A modern review of an important subject. English translation in preparation.

WOLCOTT, G. N.

1953. "The Food of the Mongoose (*Herpestes javanicus auropunctatus* Hodgson) in St. Croix and Puerto Rico." *Univ. Puerto Rico J. Agriculture* 37:241–247.

Stomach contents of 42 St. Croix and 56 Puerto Rico mongooses (= *Herpestes auropunctatus*) were examined. Food on both islands was largely beneficial lizards, and Orthoptera and other insects of little economic importance; hence mongoose is detrimental, or of negligible value in pest control.

WOLMAN, A. A., and C. M. JURASZ

1977. "Humpback Whales in Hawaii: Vessel Census, 1976." *Marine Fish. Rev.* 39(7):1–5.

Total whales seen were 373 in period February 24—March 6, 1976, among the main islands. Areas of concentration are noted on maps.

WOO, D.

1980. "Goat Season Opens to Save *Palila* Bird." *Honolulu Advertiser*, May 24, p. A-7.

Notes that Judge King had ordered, on August 1, 1979, eradication of feral sheep and goats within two years. Attorney General's office advised that the hunting would begin or contempt orders should probably be issued against the state.

WOOD, A. E.

1957. "What, If Anything, Is a Rabbit?" *Evolution* 11:417–425.

Reviews suggested relatives of the Lagomorpha, which have been many. Concludes that relationships with rodents are vague and distant, that the ultimate origin is from insectivores, and it may have been through the condylarth ungulates.

WOOD, D. H.

1980. "The Demography of a Rabbit Population in an Arid Region of New South Wales." *J. Animal Ecology* 49:55–79.

Four-year study of colonies in sandy soils revealed that rabbits survived well there during droughts. Population levels were rather stable, unlike those in other soils of the region, which fluctuated widely.

WOOD, F. G.

1973. *Marine Mammals and Man: The Navy's Porpoises and Sea Lions.* New York: Luce. 264 pp.

A nontechnical account of work, primarily on dolphins. Some projects done at Kāne'ohe Bay, Hawai'i. Clears misconceptions about "military objectives."

WOOD, G. W., and R. H. BARRETT

1979. "Status of Wild Pigs in the United States." *Wildlife Soc. Bull.* 7:237–246.

Summarizes interest in pigs as game (100,000 taken annually), as an alien pest and as a disease reservoir. Some management recommendations are made.

WOOD, J. E.

1962. "Report on the Activities Involving Rabies in Wildlife." *Wildlife Disease Assoc. Newsl.* 29:2–5.

Summarizes findings of Committee on Rabies in Wildlife in the United States. Rabies virus has been recovered from 20 species of bats in 31 states. Current and completed research projects are listed.

WOOD-JONES, F.

1931. "The Cranial Characters of the Hawaiian Dog." *J. Mammalogy* 21:39–41.

Good general description of the Hawaiian dog as having a long body, short bandy legs, short hair, erect ears, and being usually white or pale yellow in color. Dogs of mixed origin in Hawaiian villages (ca. 1930) showed many of these characteristics. Two skulls from ancient burial sites are described.

WOODWARD, P. W.

1972. "The Natural History of Kure Atoll, Northwestern Hawaiian Islands." *Atoll Res. Bull.* 164:1–318.

Summarizes data on nine species of mammals: three cetaceans of natural occurrence, three introductions of pets, the Polynesian rat, and the resident monk seal.

WOODWARD, SUSAN L.

1979. "The Social System of Feral Asses (*Equus asinus*)." *Z. Tierpsychol.* 49:304–316. (In English with English and German summaries.)

Feral donkeys of southeastern California deserts formed unstable social groups. Home range is defined in km^2. Animals are well adapted to low carrying capacity of arid lands.

WOODWORTH, J. R., and D. H. WOODSIDE

1953. "Mongoose Poison Experiment." Territory of Hawaii, Div. Fish and Game, Honolulu, Project 5-R-4. 19 pp., mimeo.

Study of pheasant production relative to mongoose population densities. Tested warfarin and zinc phosphide in cages and in field. Single dose of warfarin bait was lethal in field, and recommended for use. Mongoose control seemed to enhance pheasant increase.

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YOAKUM, J.
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Includes 354 references, on all topics, years 1723–1966.

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1967. "Ecology of Feral Goats in Haleakala National Park, Maui, Hawaii." *American Midland Naturalist* 77:418–451.
A review of the goat in Hawai'i with particular reference to the problem of its control on park lands. Includes many data from Yocom, 1964.

YOSHINAGA, A. Y.
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Relates activities of the feral pig to spread of exotics. Exclosure and sampling techniques were applied.

YOSIDA, T. H.
1980. *Cytogenetics of the Black Rat: Karyotype Evolution and Species Differentiation.* Baltimore: Univ. Park Press. 256 pp.
As one reviewer puts it, *Rattus rattus* is a "genetic marvel." This book follows some 130

papers published on cytogenetics of this taxon. Various chromosome numbers of 38 to 42 suggest a complex of biological species rather than a single species. Reviewed (1981) in *J. Mammalogy* 62:866–867.

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1982. "Hawaii Service Trip Program News." *Mālama I Ka Honua* 14(5):3.

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ZEUNER, F. E.

1963. *A History of Domesticated Animals.* New York: Harper and Row. 560 pp.

A thorough study of domestication from the age of early civilizations to the present. Many excellent illustrations of art objects, skeletal materials, and living specimens supplement the text. Includes also forms such as birds and insects.

ZIEGLER, A. C.

1982. Letter of December 30 to P. Q. Tomich.

Notes that skulls and long bones from partial skeletons of bats in a lava tube cavern on Maui appear to be quite different from corresponding parts of *Lasiurus cinereus* in Hawai'i.

ZIMMER, N. G.

1980. "Observations on Mongooses Climbing Trees." *'Elepaio* 40:113–114.

One mongoose was observed about 30 feet up in a vertical-stemmed *'ōhi'a* tree; another had twice climbed 25 feet into a similar tree. An observed ascent took only five seconds; descent was head first.

ZIMMERMANN, E. C.

1948. *Insects of Hawaii*, Vol. 1. *Introduction.* Honolulu: Univ. Hawaii Press. 206 pp.

A scholarly work introductory to a serious study of the Hawaiian insect fauna; highly useful to any biological endeavor involving field materials of Hawai'i. Geological history of Hawai'i, dispersal of species and groups, analysis of the Hawaiian biota, and development of the endemic fauna, are all considered.

ZINN, T. L., and W. W. BAKER

1979. "Seasonal Migration of the Hoary Bat, *Lasiurus cinereus*, through Florida." *J. Mammalogy* 60:634–635.

Data on numbers, collected systematically over a period of years; and on food habits (dragonflies, wasps, and beetles were eaten).

ZSCHOKKE, T. C.

1932. "The Forests of Kahoolawe." *Univ. Hawaii Agricultural Extension Service Extension Letter* 12:7.

Briefly reviews present and past conditions of Kaho'olawe vegetation, citing changes in weather pattern because of forest destruction on Haleakalā (Maui) and overgrazing, as factors in depletion of the island. States that "soil and subsoil to the depth of fifteen feet have been blown into the ocean."

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