

Numbers of Hawaiian species: supplement 4¹

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This is the fourth supplement to the earlier tabulations of species known from the Hawaiian Islands (Eldredge & Miller, 1995, 1997, 1998; Miller & Eldredge, 1996).

The Hawaiian Islands, by virtue of their geographic isolation, rich volcanic soils, and enormous topographic and climatic diversity, have produced a highly endemic biota, which includes many of the world's outstanding examples of adaptive radiation. The biota includes more than 23,000 species (Table 1). Much of this biota has proved vulnerable to extreme population reduction and even extinction from introduced predators, competitors, and diseases. Although Hawai'i comprises only ca. 0.2% of the land area of the United States, it has 31% of the nation's endangered species and 42% of U.S. endangered birds. Of the total of nearly 1,000 native flowering plant species, nearly 120 (12%) are down to ca. 20 or fewer individuals in the wild. Almost 75% of the historically documented extinctions of plants and animals in the United States has occurred in Hawai'i (A. Allison & S.E. Miller, unpubl.).

Hawaii Biological Survey is continually posting species checklists in searchable interfaces for the Hawaiian biota on our web server at: <http://hbs.bishopmuseum.org/>

More than 15,000 species are currently available (including terrestrial arthropods, native and alien land and freshwater snails, foraminiferans, flowering plants, amphibians, reptiles, birds, and mammals; marine invertebrates are being added).

In a recent review of the biota of Bermuda, Sterrer (1998) in "How many species are there in Bermuda?" compares that island's biota with that of the Hawaiian Islands. "Hawaii and Bermuda share gross similarities in latitude, isolation, and distance to the nearest continent, as well as a long record of natural history and research, any comparison of the biodiversity of the two archipelagos must consider a host of differences." Among these are significant geological and meteorological considerations; historical differences in human colonization patterns; and differential knowledge of Hawaiian and Bermudan biota. Bermuda has at least 8,299 species of which 4,597 are marine and 3,702 are terrestrial; Hawai'i, which has $2.68 \times$ more species, has an overall endemism rate of 38.0%, more than $10 \times$ that of Bermuda (3.0%) (Sterrer, 1998).

The aquatic fauna of a unique habitat—Sailor's Hat crater, an artificially formed anchialine pool on Kaho'olawe—was described for the first time (Brock & Bailey-Brock, 1998). The atyid shrimp *Halocaridina rubra*, an endemic species, is the only species that is restricted to anchialine habitats. In addition, the gastropod *Bittium zebrum* is widely distributed in the Indo-Pacific; the serpulid tubeworm, *Vermiliopsis torquata*, is common in tidepools but is unknown in other anchialine pools; the aquatic insect, *Trichocorixa reticulata*, a nonindigenous species, is found in many coastal saline pools; 2 amphipods, *Nuuanu amikai* and *Eriopsia laakona*, have been reported from anchialine pools; other taxa were unidentified (Brock & Bailey-Brock, 1998).

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Table 1. Estimates of numbers of known species of Hawaiian biota (based on Eldredge & Miller, 1995, 1997, 1998; Miller & Eldredge, 1996; and including this paper and other papers in this issue of the *Records*). Algae, other protists, lichens, cnidarians, echinoderms, amphibians, and mammals remain the same as previous editions; other categories are based on updated counts.

Taxon	Total	Endemic	NIS
Algae	811	2	5?
Other protists	1128	2?	?
Fungi	1364	?	?
Lichens	723	240	?
Flowering plants	2443	1054	1090
Other plants	763	241	44
Cnidarians	356	75	10
Insects	8069	5315	2653
Other arthropods	1065	353	654
Molluscs	1653	956	89
Annelids	413	80	36
Crustaceans	1202	61+	51
Echinoderms	283	150	0
Other invertebrates	1337	439	33+
Fish	1207	144	73
Amphibians	5	0	5
Reptiles	27	0	23
Birds	294	63	46
Mammals	44	1	19
Totals	23,187	9176	4831

Bacteria

Antibody titers of the cat-scratch disease, bacillary angiomatosis, or bacteremia, *Bartonella henselae*; Hawai'i has a 47.4% prevalence (Jameson *et al.*, 1995); from the data, it appears that average daily temperature and annual precipitation play a role in the prevalence of cat infection. The intracellular bacteria, *Wolbachia*, was noted from *Drosophila simulans* from Hawai'i (Bourtzis *et al.*, 1998).

Fungi: Myxomycetes

Ten species and one variety of dictyostelid cellular slime molds noted, seven of which have not been reported previously from Hawai'i (Landolt & Wong, 1998).

Flowering Plants

The total of 2443 taxa includes native and naturalized plants, including Polynesian introductions that have naturalized. Of the naturalized flora, there are 1068 species, plus 22 Polynesian introductions which are naturalized (W.L. Wagner, pers. comm.).

The *Manual for the flowering plants of Hawai'i. Revised edition* (Wagner *et al.*, 1999) includes 33 new native taxa, 108 records of naturalized species previously undocumented, 75 records for naturalized species previously known only in cultivation or as adventives, 233 new island records, and 13 significant intrainland range extensions of both naturalized and native species. Seven articles on plants are included in the *Records of the Hawaii Biological Survey for 1998* [Bishop Mus. Occas. Pap. 58 and 59].

Cnidaria: Anthozoa

The suspected neoplasma in the Hawaiian deep-water coral *Madrepora kauaiensis* Vaughan is reinterpreted as cavities produced by a new species of endoparasitic petraroid ascothoracid barnacle, *Petrarca madreporae* Grygier (in Grygier & Cairns, 1996).

Annelida

Two species of nauid oligochaete [*Haemonaid waldvogeli*, *Dero* (*Aulophorus*) *furcata*] have been reported, living symbiotically with the introduced apple snail *Pomacea canaliculata* (Britton & Wetzel, 1999), these are the first documented freshwater oligochaetes reported from Hawai'i. One leech [*Placobdelloides bdellae*] is newly reported from Kaua'i (Englund, 1999).

Mollusca

A new species of the "*Octopus aegina* group" has been discovered in shallow, coastal, subtropical waters of the Hawaiian Islands (Huffard & Hochberg, 1997). Three newly recognized snails were reported by Cowie (1999).

Arthropoda: Insecta and Related Forms

Nishida (1997a,b) provided a full bibliography and updated checklist for the Hawaiian insects and related arthropods. The major systematic papers that include Hawaiian material: review of the planthopper genus *Nesodryas* (Asche, 1998); investigations on the Salticidae (Berry *et al.*, 1998); notes on the mite genus *Euptyctima* (Niedbala, 1998); and a review of the genus *Aeletes* of the Hawaiian Islands (Yelámos, 1998). Nine additional articles on insects are included in the *Records of the Hawaii Biological Survey for 1998* [Bishop Mus. Occas. Pap. 58 and 59].

Arthropoda: Crustacea: Anostraca

A recent review identified *Artemia franciscana* from Laysan (Triantaphyllidis *et al.*, 1998), replacing *Artemia salina* var. *pacifica* reported by Sars (1904) and *Artemia salina* of Caspers (1981).

Arthropoda: Crustacea: Isopoda

The total number of oniscidean isopod species in Hawaii is 19, belonging to 13 genera and 7 families; 4 new species are described (Taiti & Howarth, 1997): *Hawaiioscia microphthalmia*, *H. rotundata*, *H. paeninsulae*, *Aulaconiscus caecus* [*Aulaconiscus*, n. gen.]. Oniscidean *Halophiloscia couchii* (Kinahan) reported from Midway Atoll, first Hawaiian and first Pacific record (Taiti, 1999).

Arthropoda: Crustacea: Copepoda

A new species of parasitic copepod, *Jusheyhoea moseri* Kabata, from deep-water fishes is described (Kabata, 1991).

Arthropoda: Crustacea: Cirripedia

The chthamalid barnacle *Chthamalus proteus* Dando & Southward is reported from the main Hawaiian Islands and Midway Atoll (Southward *et al.*, 1998); this species has been found previously only from the Caribbean, Gulf of Mexico, and Brazil. Newly described ascothoracidan, *Petrarca madreporae* Grygier (*in* Grygier & Cairns, 1996) from galls in deep-water corals.

Arthropoda: Crustacea: Decapoda

Ten species of Hawaiian lobsters are photographed in color (Hoover, 1998). The pagurid hermit crab *Propagurus deprofundis* (Stebbing) is reported for the first time from Hawaiian waters (McLaughlin & de Saint Laurent, 1998). Seventeen of the largest and most common shallow water hermit crabs are photographed in color (Hoover, 1997a,b). New species of shrimp *Cinetorhynchus hawaiiensis* Okuno & Hoover [family Rhynchocinetidae] described (Okuno & Hoover, 1998), *C. concolor* (Okuno) newly reported (Okuno & Hoover, 1998). New island record for the atyid shrimp *Halocaridina rubra* (Holthuis) on Kaho'olawe in artificially formed Sailor's Hat crater (Brock & Bailey-Brock, 1998), previously known from O'ahu, Maui, and Hawai'i. First record of the nonindigenous atyid shrimp, *Neocaridina denticulata sinensis* (Kemp), numerous streams on O'ahu (Englund & Cai, 1999). The parthenopid crab, *Aethra edentata* Edmondson, previously known only from Hawai'i, is reported from the Ogasawara and Mariana Islands (Ng & Takeda, 1998).

Bryozoa

Four new records of introduced fouling bryozoans [*Bugula dentata*, *B. robusta*, *Caulibugula dextrograpta*, *C. caliculata*] are reported (Zabin, 1999).

Echinodermata

Detailed observations on the deep-water echinoid, *Chaetodiadema pallidum* Agassiz & Clark, were given by Burch & Burch (1998).

Chordata: Pisces

New species described from Hawaiian waters: *Oxyurichthys heisei* Pezold [Gobiidae] (Pezold, 1998); *Pseudoamiops diaphanes* Randall and *Apogon deetsie* Randall [Apogonidae] (Randall, 1998a); *Sargocentron iota* Randall [Holocentridae] (Randall, 1998b); *Eustomias tomentosus* Clarke [Melanostomiidae] (Clarke, 1998). New records of fishes from Hawaiian waters: *Xanthichthys caeruleolineatus* Randall (Randall & Mundy, 1998); *Sargocentron spinosissimum* (Temminck & Schlegel) (Randall, 1998b); *Callichelys catostoma* (Forster) (McCosker, 1998); the long-nosed chimaera *Rhinochimaera pacifica* (Mitsukurii) is reported for the first time (Chave & Malahoff, 1998). *Balistes polylepis* Steindachner, previously considered to be waif in Hawaiian waters, is considered confirmed through a photograph of one guarding a nest which indicated the spawning has occurred (Randall & Mundy, 1998). The formerly known *Vitraria clarescens* Jordan and Everman is now considered a junior synonym of the freshwater goby *Sicyopterus stimpsoni* (Gill) (Greenfield *et al.*, 1998).

Chordata: Reptilia

Eighteen species of parasites [6 species of coccidia, 7 species of nematodes, 2 species of cestodes, 1 pentastomid species, and 2 species of ectoparasitic mites] are reported from the geckos *Hemidactylus frenatus* and *Lepidodactylus lugubris* (Hanely *et al.*, 1998).

Literature Cited

- Asche, M.** 1998. A review of the planthopper genus *Nesodryas* Kirdaldy and related taxa (Homoptera: Fulgoroidea: Delphacidae). *Proc. Hawaii. Entomol. Soc.* **33**: 89–124.
- Berry, J.W., J.A. Beatty & J. Proszynski.** 1998. Salticidae of the Pacific Islands. III. Distribution of seven genera with descriptions of nineteen new species and two new genera. *J. Arachnol.* **26**: 149–89.
- Bourtzis, K., S.L. Dobson, H.R. Braig & S.L. O’Neill.** 1998. Rescuing *Wolbachia* have been overlooked . . . *Nature* **39**(6670): 852–53.
- Britton D.K. & M.K. Wetzel.** 1999. First records for freshwater oligochaetes (Annelida, Oligochaeta, Naididae) in the Hawaiian Islands with notes on their association with an alien snail (Mollusca, Gastropoda, Ampullaridae). *Bishop Mus. Occas. Pap.* **59**: 39–42.
- Brock, R.E. & J.H. Bailey-Brock.** 1998. An unique anchialine pool in the Hawaiian Islands. *Int. Rev. Hydrobiol.* **83**: 65–75.
- Burch, B.L. & T.A. Burch.** 1998. Observations on *Chaetodiadema pallidum* in the Hawaiian Archipelago, p. 591–95. In: Mooi, R. & M. Telford, eds., *Echinoderms. San Francisco*. A.A. Balkema, Rotterdam.
- Caspers, H.** 1981. On the ecology of hypersaline lagoons on Laysan Atoll and Kauai Island, Hawaii, with special reference to the Laysan duck, *Anas laysanensis* Rothschild. *Hydrobiologia* **82**: 261–71.
- Chave, E.H. & A. Malahoff.** 1998. *In deeper waters. Photographic studies of Hawaiian deep-sea habitats and life-forms.* University of Hawaii Press, Honolulu. 125 p.
- Clarke, T.A.** 1998. Pelagic fishes of the genus *Eustomias* (Melanostomiidae) presently associated with *Eustomias achirus* Parin and *Pokhilskaya* with the description of five new species. *Copeia* **1998**: 676–86.
- Cowie, R.H.** 1999. New records of alien nonmarine mollusks in the Hawaiian Islands. *Bishop Mus. Occas. Pap.* **59**: 48–51.
- Eldredge, L.G. & S.E. Miller.** 1995. How many species are there in Hawaii? *Bishop Mus. Occas. Pap.* **41**: 3–18.
- . 1997. Number of Hawaiian species: supplement 2, including a review of freshwater invertebrates. *Bishop. Mus. Occas. Pap.* **48**: 3–22.
- . 1998. Number of Hawaiian species: supplement 3, with notes on fossil species. *Bishop Mus. Occas. Pap.* **55**: 3–15.
- Englund, R.A.** 1999. New records and range extensions of native Odonata (Coenagrionidae) and introduced aquatic species in the Hawaiian Islands. *Bishop Mus. Occas. Pap.* **59**: 15–19.
- . & **Y. Cai.** 1999. The occurrence and description of *Neocaridina denticulata sinensis* (Kemp, 1918) (Crustacea: Decapoda: Atyidae), a new introduction to the Hawaiian Islands. *Bishop Mus. Occas. Pap.* **58**: 58–65.
- Greenfield, D.W., A.Y. Suzumoto & C. Chong.** 1998. *Vitratia clarescens*, a junior synonym of the freshwater Hawaiian goby *Sicyopterus stimpsoni* (Teleostei: Gobiidae).

- Copeia* **1998**: 501–03.
- Grygier, M.J. & S.D. Cairns.** 1996. Suspected neoplasms in deep-sea coral (Scleractinia: Oculinidae: *Madrepora* spp.) reinterpreted as galls caused by *Petrarca madreporae* n. sp. (Crustacea: Acsothoracida: Petrarciidae). *Dis. Aquat. Org.* **24**: 61–69.
- Hanley, K.A., K. Petren & T.J. Case.** 1998. An experimental investigation of the competitive displacement of a native gecko by an invading gecko: no role for parasites. *Oecologia* **115**: 196–205.
- Hoover, J.P.** 1997a. Hawaiian hermit crabs, part 1. *Fresh. Mar. Aquarium* **20**(9): 8–12.
- . 1997b. Hawaiian hermit crabs, part 2. *Fresh. Mar. Aquarium* **20**(10): 182–84, 186, 188–89.
- . 1998. Hawaii's lobsters. *Freshw. Mar. Aquarium* **21**(10): 8–12, 14, 16.
- Huffard, C.L. & F.G. Hochberg.** 1997. First record of the “*Octopus aegina* group” in the Hawaiian Islands Archipelago. AMU/WSM 1997 Annual Meeting, p. 36. [Abstract]
- Jameson, P., C. Greene, R. Regnery, M. Dryden, A. Marks, J. Brown, J. Cooper, B. Glaus & R. Greene.** 1995. Prevalence of *Bartonella henselae* antibodies in pet cats throughout regions of North America. *J. Infect. Dis.* **172**: 1145–1149.
- Kabata, Z.** 1991. *Jusheyhoea moseri* n. sp. (Copepoda: Chondracanthidae), a parasite of macrourid fishes in Hawaiian waters. *Syst. Parasitol.* **20**: 155–59.
- Landolt, J.C. & G.J. Wong.** 1998. Dictyostelid cellular slime molds from Hawai‘i. *Pac. Sci.* **52**: 98–103.
- McCosker, J.E.** 1998. A revision of the snake-eel genus *Callechelys* (Anguilliformes: Ophichthidae) with the description of two new Indo-Pacific species and a new callechelyn genus. *Proc. Calif. Acad. Sci.* (4) **50**(7): 185–215.
- McLaughlin, P.A. & M. de Saint Laurent.** 1998. A new genus for four species of hermit crabs formerly assigned to the genus *Pagurus* Fabricius (Decapoda: Anomura: Paguridae). *Proc. Biol. Soc. Wash.* **111**: 158–87.
- Miller, S.E. & L.G. Eldredge.** 1996. Numbers of Hawaiian species: supplement 1. *Bishop Mus. Occas. Pap.* 45: 8–17.
- Ng, P.K.L. & M. Takeda.** 1998. *Aethra edentata* Edmondson, 1951 (Crustacea, Decapoda, Brachyura, Parthenopidae), new records for the Izu-Mariana Arch. *Bull. Natl. Sci. Mus. Tokyo* (A) **24**: 7–10.
- Niedbala, W.** 1998. *Euptyctima* (Acari: Oribatida) of the Hawaiian Islands. *Proc. Hawaii. Entomol. Soc.* 33: 125–146.
- Nishida, G.M.** 1997a. Hawaiian terrestrial arthropod bibliography. *Bishop Mus. Tech. Rep.* **11**, iii + 255 p. [<http://www.bishop.hawaii.org/bishop/HBS/arthbib.html>]
- . 1997b. Hawaiian terrestrial arthropod checklist. Third edition. *Bishop Mus. Tech. Rep.* **12**, iv + 263 p. [<http://www.bishop.hawaii.org/bishop/HBS/arthresearch.html>]
- Okuno, J. & J.P. Hoover.** 1998. *Cinetorhynchus hawaiiensis*, a new shrimp forming a cryptic species pair with *C. reticulatus* Okuno, 1997, and new records of three congeneric species (Crustacea: Decapoda: Rhynchocinetidae). *Nat. Hist. Res.* **5**: 1–31.
- Pezold, F.** 1998. Three new species of *Oxyurichthyes* (Teleostei: Gobiidae) from the Indian and Pacific Oceans. *Copeia* **1998**: 687–95.
- Randall, J.E.** 1998a. Review of the cardinalfishes (Apogonidae) of the Hawaiian Islands, with descriptions of two new species. *Aqua* **3**(1): 25–38.
- . 1998b. Revision of the Indo-Pacific squirrelfishes (Beryciformes: Holocentridae: