Volume XXV April 30, 1984 Number 11

A Re-evaluation of the Genus Hibiscadelphus *(Malvaceae)* and the Description of a New Species

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THE GENUS *Hibiscadelphus* was established in 1911 by Joseph F. Rock on the basis of three species found by him in the drier districts of Maui and Hawai'i. Rock, a Botanist with the College of Hawaii (which later became the University of Hawaii) and a Consulting Botanist with the Territorial Division of Forestry, made extensive explorations of the Hawaiian forests. Between the years of 1909 and 1911 he discovered three anomalous species of Malvaceous trees that, while obviously related, were quite different from any of the Malvaceae then known. He recognized that they were closely allied with the genus *Hibiscus* but differed from it in possessing narrow-convolute, zygomorphic corollas, deciduous calyces, and woody capsules. In 1911, on the basis of these primary characteristics, he concurrently described the genus *Hibiscadelphus* and the three species *H. hualalaiensis, H. wilderianus,* and *H. giffardianus*. Since then the additional species *H. bombycinus* (Forbes 1920) and *H. distans* (Bishop and Herbst 1973) have been described.

On January 26, 1981, an undescribed species of *Hibiscadelphus* was discovered on the island of Lāna'i. The epithet given here is descriptive of the distinctive spatulate, cruciform involucral bracts of this species.

Hibiscadelphus crucibracteatus Hobdy, sp. nov., fig. 1

Species haec maxime manifeste ab *H. giffardianus* Rock et *H. wilderianus* Rock differt in bracteis involucris magnis cruciformatis, et in capsula subglobosa, et in petalis anguste acutis inconspicue nervatis.

Tree 6 m high with a rounded crown, trunk 16 cm in diameter with gray smooth bark. Leaves chartaceous, palmately 5 to 7 veined, cordate (5-)7-10(-14) cm long, (4.5)7-8(-13.5) cm wide, margin entire to very broadly and shallowly 7 to 11 lobed, apex bluntly acute, the surfacae glabrous except for dense patches of brown stellate tomentum on the lower surface around the junction of the petiole and in the principal nerve angles. Petioles glabrous, (1.5-)2-3(-5) cm long.

Flowers borne singly in the axils of upper leaves on peduncles of 2-3.5 cm long. Involucral bracts 4 (to 5), free, spatulate, glabrous, green (20-)23-27(-30) mm long, (1.5-)4-5(-7) mm wide near the rounded apex and 2-2.5 mm wide at the middle, with a prominent central vein and a distinct areolate network of finer adjacent veins. Calyx saccate, curved (42-)45-46(-49) mm long with 1 to 3 deeply and unevenly cleft acute lobes, surface finely muricate and sparsely hispidulous, dark purple, apex beaked when in bud. Corolla zygomorphic, narrow-convolute, opening only slightly with 1 or 2 of the 5 narrowly-acute petals divergent at the apex, 50-65 mm long, dark purple with a fine grayish-yellow stellate pubescence forming a uniform layer on the outer and inner exposed surfaces, nerves inconspicuous. Pistil protruding 15-20 mm beyond the corolla, style branches 5, 6 mm long, erect and closely ascendant, dark purple. Stigmas ellipsoid, 2 mm long, black, staminal column pale purple, filaments 2-4 mm long, erect. Anthers 1 mm in diameter, pollen bright yellow-orange. Capsules subglobose with a 3 mm long broadly-conical, apical beak, 24-27 mm long, 23-26 mm wide, woody, 5-angled, calyx and involucral bracts deciduous at maturity, surface finely muricate, densely covered with short, grayish-brown stellate tomentum, dehiscing loculicidally into 5 parts, each carpel producing 1 to 3 seeds, exocarp fibrous, readily distinguished from mesocarp, endocarp chartaceous, deciduous in 10 segments. Seeds irregularly angulate, 5-7 mm in diameter, densely hirsute with 0.5-2 mm long grayish-white matted hair.

TYPE: USA, HAWAI'I—Lāna'i Island. Found on upper windward slopes of Puhielelu Ridge, 750 m, 2 January 1982, *R. Hobdy and A. Fielding 1186* (holotype, BISH-442296). ADDITIONAL SPECIMENS EXAMINED: (all collected from the only known tree) USA, *Hobdy 983.5* (BISH), *Hobdy 1041.5* (BISH), *Hobdy and Connally 1100* (BISH), *Hobdy 1410.5* (BISH), *Hobdy 1655.5* (BISH).

Hibiscadelphus crucibracteatus is most closely allied with *H. wilderianus* of Maui and *H. giffardianus* of Hawai'i from which it differs most prominently in possessing large spatulate cruciform involucral bracts, shorter subglobose capsules, and narrowly-acute, inconspicuously-veined petals. It also differs, though less significantly, in possessing a narrower flower, a longer calyx, a dark purple calyx and corolla, shorter erect filaments, bright yellow-orange pollen, and narrow black stigmas. Its spatulate involucral bracts indicate its alliance with *H. wilderianus* while its calyx which is prominently beaked in bud indicates its alliance with *H. giffardianus*.

Hibiscadelphus crucibracteatus is presently known only from the single tree growing in a remnant pocket of native forest in company with *Antidesma platyphyllum, Diospyros ferrea, Planchonella sandwicensis, Alphitonia ponderosa, Psychotria mauiensis, Pisonia sandwicensis, Eugenia sandwicensis,* and *Pleomele fernaldii* on an otherwise rather barren and eroded ridge on the windward slopes of Lāna'i (fig. 2). It was discovered by Peter Connally of the Hawaii State Department of Land and Natural Resources. Upon seeing a tree unfamiliar to him he collected a twig with two leaves and a small bud and sent it to me for identification. Mr. Connally was immediately contacted and informed of the nature of his find, and urged to keep a close watch for flowering and fruiting material by which its taxonomic position might be evaluated. A year and a half of observation was required before complete specimens could be obtained and it became clear that it represented a distinct new species.

THE FAMILY MALVACEAE AND RELATIONSHIPS OF *HIBISCADELPHUS*

The family Malvaceae contains about 75 genera with some 1500 species of small shrubs to medium sized trees scattered primarily throughout the tropics and sub-tropics of the world (Cronquist 1980). Within Malvaceae three major evolutionary lines are recognized taxonomically as the tribes Ureneae, Malveae, and Hibisceae (Bates 1968). *Hibiscadelphus* is a member of the tribe Hibisceae which consists of ca. 25 genera including *Thespesia, Montezuma, Gossypium, Kokia, Hibiscus, Kosteletzkya, Abelmoschus,* and *Wercklea*. Hibisceae is further divisible into

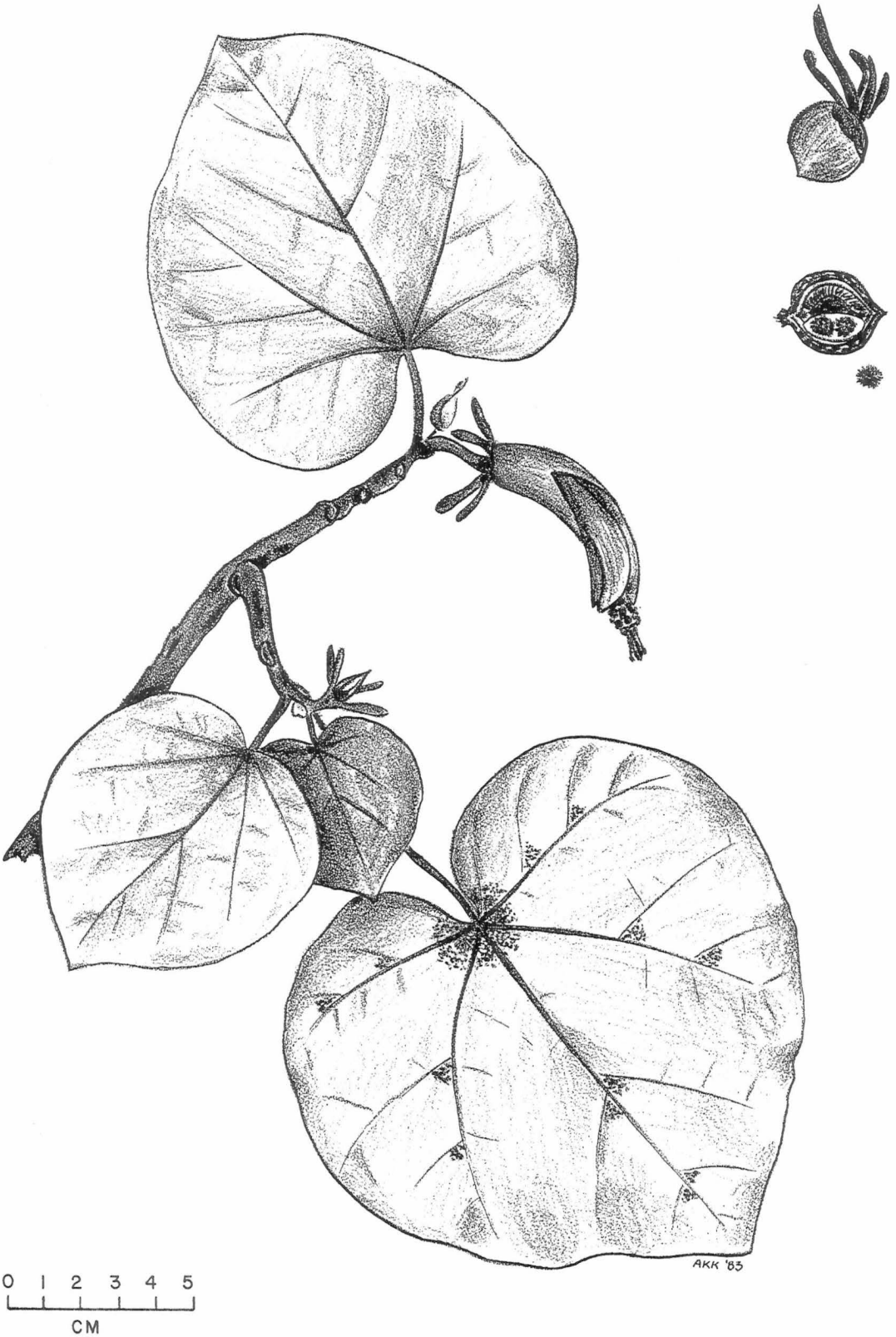

Figure 1. *Hibiscadelphus crucibracteatus* Hobdy

two sub-groups based on morphological characters of the style branches, stigmas and seeds, and on chromosome numbers. The native *Gossypium sandvicense*, $n=26$ (tetraploid), and the endemic species of *Kokia*, $n=12$, with their unbranched, lobed stigmas, angulate seeds, and basic gametic chromosome numbers of $n=12$ and 13 are relatively remote from the native species of *Hibiscus*, $n=40, 41, 42, 70$ (Niimoto 1966), and *Hibiscadelphus*, $n=20$ (Carr and Baker 1977), with their longer branched, spreading or ascendant style branches, more or less reniform seeds, and more variable gametic chromosome numbers. Among the genera in Hibisceae, *Hibiscadelphus* is perhaps most closely allied with *Hibiscus*, although neither genus appears to be directly derived from the other.

Hibiscus is a large and diverse genus of widespread distribution with perhaps 250 distinct species worldwide (Bates 1965). Chromosome numbers vary among several polypoloid series and range from $n=11$ to $n=70$ or more. *Hibiscus* is a very complex group exhibiting several phyletic lines and probably has had a long evolutionary history. In contrast the species of *Hibiscadelphus* with its small number of species, limited distribution, and narrow range of morphological and chromosomal characters presents a much simpler taxonomic problem; however, the origin and derivation of the genus itself remains obscure. The gametic chromosome number of $n=20$ found in *Hibiscadelphus* is not unique among the Hibisceae, but its uniformity indicates stability within the group.

The addition of three species of *Hibiscadelphus* since 1911 broadens the concept of the genus. *H. bombycinus*, *H. distans*, and *H. crucibracteatus* all possess characters that fall outside Rock's original generic concept. *H. bombycinus* differs in having straplike involucral bracts. *H. distans* differs in having broadly dentate leaves, basaly connate involucral bracts, and a less woody, uniquely dehiscent capsule. *H. crucibracteatus* differs in having 4 to 5 broadly spatulate involucral bracts and narrow black stigmas.

The discovery of *H. distans* in 1972 provoked new questions about the genus. This species, which is geographically separate from other species of *Hibiscadelphus*, also possesses morphological characters that differ markedly. *H. distans* has persistent calyces and involucral bracts and much less woody capsules, characters that are more typical of the genus *Hibiscus*. Its narrow-convolute, zygomorphic corollas and chromosome number of $n=20$, on the other hand, more closely align it with other species of *Hibiscadelphus*. Its capsules, however, differ from those of both genera in possessing an endocarp within each locule that opens only ventrally and becomes freed of the mesocarp rather than one that splits both ventrally and dorsally upon dehiscence (Bishop and Herbst 1973). The fact that *H. distans* is found on Kaua'i, which is at least 4 million years older than the other islands upon which species of *Hibiscadelphus* have been found (Macdonald and Abbott 1970), suggests that it represents the earliest evolutionary divergent lineage. A closer look at *H. distans* and its relationships within its genus and tribe might produce useful new information.

In 1967 Hutchinson expressed the opinion that *Hibiscadelphus*, along with a number of other Malvaceous genera, should be united with *Hibiscus*, although he did not state his reasons for coming to this conclusion. For the present, however, recognition of the genus appears reasonable as it lacks any clear relationship with other Hawaiian Hibisceae.

ECOLOGY AND STATUS OF *HIBISCADELPHUS*

All six species of *Hibiscadelphus* once inhabited open mesic forests at middle elevations where rainfall was moderate. These mixed Hawaiian forests were known for their diversity of interesting tree species with representatives of each being moderately to widely scattered. Species of *Hibiscadelphus* appear to have been thus scattered either as single individuals or in small clusters. The niche they occupied in the ecology of these forests, however, is uncertain since their

populations are now depleted and their habitats largely destroyed or severely altered. But the fact that these plants have narrow curved flowers, large and prominently exserted anther clusters and stigmas, and a good supply of nectar indicates that they may have had an important pollination-feeding relationship with the native Meliphagid and Drepanidine birds. Nectar analysis of *H. distans* nectar tends to substantiate this.

Hibiscadelphus distans nectar has a hexose-rich sugar ratio of 0.058. This indicates a preponderance of Glucose and Fructose and a paucity of Sucrose. This balance of nectar sugars has been shown to be preferred by nectarivorous birds (I. Baker, pers. comm.). *Hibiscadelphus distans* nectar also has a high amino acid content. It measures 7+ on the histidine scale (a log-scale to the base 2 that runs from 1 to 10). This value, while not too unusual, is considerably higher than the mean value for typical nectarivorous birds (Baker and Baker 1980), and would indicate a user that obtained a major portion of its diet, and hence its nutrition and energy, from the nectar.

Prime candidates for this role were some of the members of the diverse Drepanidine complex and, most especially, the large Meliphagids in the genera *Moho* and *Chaetoptila*. These latter birds, ranging in total length from 7 inches to an impressive 13.5 inches, were known to be strongly nectarivorous and aggressive in their defense of good nectar supplies (Berger 1972). *Hibiscadelphus* trees when in full bloom must have been worthy of this kind of behavior.

The Meliphagids were once quite common even in the lowland forests. Recent fossil finds have substantiated this and revealed other now extinct species, while indicating that many presently common Drepanidines were less abundant (Olson and James 1982). The decline and extinction of this major nectarivorous bird family in Hawai'i is perhaps closely linked with the decline of *Hibiscadelphus*.

Hibiscadelphus is relictual throughout its entire range. The species *H. wilderianus, H. bombycinus, H. giffardianus,* and *H. crucibracteatus* have been known only from single trees, while the other two, *H. distans* and *H. hualalaiensis,* have been known from but 10 and 12 individuals respectively. The present number of plants known to occur in the wild totals only 14 individuals among 3 species with no successful regeneration occurring.

It appears that the genus was scarce even at the time of Cook's first voyage to Hawai'i as none of the early botanists collected or noted these plants. Dr. William Hillebrand in collaboration with Rev. J. M. Lydgate collected the first specimen in Kawaihae, Hawai'i sometime prior to 1868, but made no attempt to describe or make mention of it in his *Flora of the Hawaiian Islands* which was published posthumously in 1888. The specimen became the basis for Forbes' description of *H. bombycinus* in 1920.

Most *Hibiscadelphus* species were discovered well after the destruction of Hawai'i's flora had attained very serious proportions, so we cannot blame its present scarcity solely on the introduced goats, sheep, and cattle or on the clearing of lands for agricultural crops and pastures, although these factors are now certainly exerting a strong impact. During the last two centuries its primary habitat in the mesic forests has been steadily altered and destroyed. Today virtually no mesic forests remain that retain their full complement of floral and faunal components and it is apparent that important links in *Hibiscadelphus*' reproductive scheme have been disrupted. Further, the gene pools of the remaining species are severely depleted. Extinction in the wild appears inescapable in the foreseeable future.

If we are to save representatives of the four remaining species, we must propagate them in botanical gardens and arboreta. There future studies might reveal additional information on the evolution of the Malvaceae in Hawai'i and the Pacific.

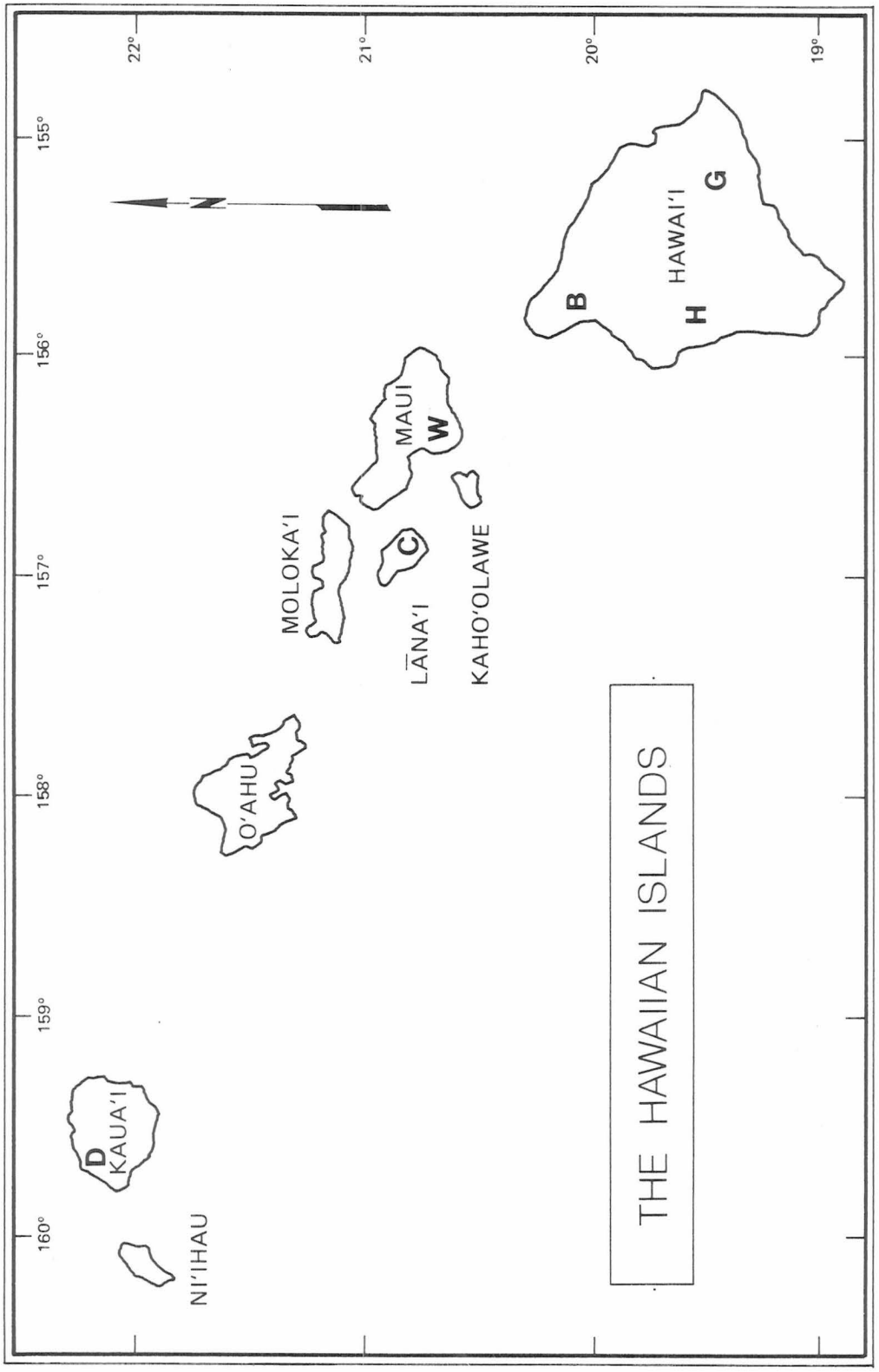

Figure 2. Distribution of *Hibiscadelphus*. B, *H. bombycinus;* C, *H. crucibracteatus;* D, *H. distans;* G, *H. Giffardianus;* H, *H. hualalaiensis;* W, *H. Wilderianus*.

ACKNOWLEDGEMENTS

I am grateful to Peter Connally, the discoverer of *Hibiscadelphus crucibracteatus,* for his interest, dedication, and patience while helping me work with this new species. His observations and collections allowed me to keep abreast of developments from the neighboring island of Maui.

I also wish to thank Derral Herbst for his many helpful comments and suggestions throughout this project, David M. Bates for his review of the manuscript and for his insights on the relationships within Malvaceae, Harold St. John for his help with technical problems and with the Latin, Warren L. Wagner for his review of the manuscript, Gerald Carr for providing chromosomal information, and A. K. Kepler for her excellent illustration.

LITERATURE CITED

Baker, H. G., and I. Baker. 1980. Studies of Nectar Constitution and Pollinator-Plant Coevolution. In: *Coevolution of Animals and Plants* by L. E. Gilbert & P. H. Raven (Eds.). University of Texas Press.

Bates, D. M., 1965. Notes on the Cultivated Malvaceae I. *Hibiscus. Baileya* 13:56-130.

. 1968. Generic Relationships in the Malvaceae, Tribe Malveae. *Gentes Herb.* 10:117-135.

Berger, A. J. 1972. *Hawaiian Bird Life.* Honolulu: University Press of Hawaii.

Bishop, L. E., and D. R. Herbst. 1973. A New *Hibiscadelphus* (Malvaceae) From Kauai. *Brittonia* 25:290-293.

Carr, G. D., and J. K. Baker. 1977. Cytogenetics of *Hibiscadelphus* (Malvaceae): A Meiotic Analysis of Hybrids in Hawaii Volcanoes National Park. *Pac. Sci.* 31(2):191-194.

Cronquist, A. 1980. *An Integrated System of Classification of Flowering Plants.* New York: Columbia Univ. Press.

Forbes, C. N. 1920. New Hawaiian Plants. *Occ. Pap. B. P. Bishop Mus.* 7(3): 33-39.

Hutchinson, J. 1967. *The Genera of Flowering Plants.* vol. 2. Oxford Univ. Press.

Macdonald, G. A., and A. T. Abbott. 1970. *Volcanoes in the Sea.* Honolulu: University Press of Hawaii.

Niimoto, D. H. 1966. Chromosome Numbers in Some *Hibiscus* Species and Other Malvaceae. *Baileya* 14:29-34.

Olson, S. L., and H. F. James. 1982. *Prodromus of the Fossil Avifauna of the Hawaiian Islands.* Smithsonian Institution Press.

Rock, J. F. 1911. *Hibiscadelphus.* In: New and Noteworthy Hawaiian Plants by L. Radlkoffer & J. F. Rock. *Hawaii Board Agric. Forest. Bot. Bull.* 1:1-15.