

TAXONOMIC NOTES ON THE PTERIDOPHYTES OF HAWAII—II

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INTRODUCTION

The results of over a decade of intensive studies of Hawaiian pteridophytes in the field, herbarium, and laboratory, have confirmed our suspicion that these plants have been more or less by-passed by most local and visiting botanists for many years. Much of the pteridological research, since the time W. Hillebrand studied these plants well over a century ago, was by such outsiders as E. B. Copeland, C. Christensen, C. Skottsberg, O. H. Selling, W. J. Robinson, and A. A. Heller. The most active period of Hawaiian pteridology prior to 1890 coincided with the "Victorian Fern Craze" in England, a time when H. Mann, W. T. Brigham, J. M. Lydgate, V. Knudsen, E. Bailey, and, of course, Hillebrand himself made many contributions to our knowledge. After 1900 very little new fern research took place, though Otto Degener recognized several valid new species. In 1987 W. H. Wagner and F. S. Wagner presented a course in Hawaiian pteridology at the University of Hawaii and were impressed by the general absence or inadequacy of local knowledge of these plants by students, teachers, land managers, naturalists, and conservationists. This experience led to the initiation of a research program on Hawaiian pteridophytes, sponsored by the National Science Foundation. With the help of such botanists as J. M. Beitel, T. Flynn, J. Lau, J. Obata, W. Takeuchi, and K. Wood, we made extensive explorations and studies, and the results have been extraordinary. We have increased the number of native orthospecies by over twenty, and of nothospecies by over thirty. Also, W. H. Wagner began a study of Hawaiian invasive pteridophytes in 1947, joined in the last decade by K. A. Wilson (1996); 30 established adventives have been recognized. At least two of these recent colonists have hybridized with native species. Our extensive studies both in the field and in the herbarium forced fundamental changes in the disposition of a large number of taxa. Palmer published modern revisions of Hawaii's two tree fern genera, *Cibotium* (1994) and *Sadleria* (1997).

Our original aim of rapidly preparing a manual of Hawaiian pteridophytes was slowed by the wide range of variation in many of the taxa, which gave rise to many questions about their proper taxonomic status, and the discovery of numerous new taxa. Some of the latter have already been described in recent years (Taylor et al. 1993; Wagner 1993; Wagner et al. 1995; Medeiros et al. 1996; Palmer 1997). Most of the remainder are published here, along with some necessary nomenclatural changes. We do not believe by any means that our work is completed. Judging from the results of the recent field explorations over the past few years, we consider it very likely indeed that other new taxa are still undiscovered in the remote areas of the archipelago, such as parts of Kauai and Maui.

Among pteridologists, the pteridophytes of Hawaii have of course long been notorious for their unusual variability. In our own experience with ferns and fern allies from Melanesia, Micronesia, North and Central America we do not doubt this assertion. In fact, more than 120 years ago, John Lydgate wrote (1873) that, "A difficulty that every Hawaiian collector must find, is the tendency to fickleness of form in the species and a consequent merging of the species into one another, which of course renders it very difficult for him to tell just when to draw the line between species or variety, or to be sure that he has the species he thinks he has." Many of the difficult groups center around the following taxa: *Huperzia serrata*, *Selaginella arbuscula*, *Doryopteris decipiens*, *Cibotium glaucum*, *Cyclosorus cyatheoides*, *Sadleria cyatheoides*, *Asplenium macraei*, *Diellia erecta*, *Deparia prolifera*, *Diplazium sandwichianum*, *Dryopteris glabra*, *D. unidentata*, *Elaphoglossum alatum*, and *Adenophorus tamariscinus*. There are also a number of species pairs that present or have presented difficulties and even single extremely variable species, such as *Asplenium kaulfussii* and *Polypodium pellucidum*, both of which have been considered by past authors to comprise several species or varieties.

In the following pages, the category *species* (sp.) or *orthospecies* (orthosp.) is used for presumably monophyletic populations, which are separated by their morphology (and cytology, where known) from other species. A *hybrid* (hybr.) or *nothospecies* (nothosp.) is the category for di- or polyphyletic taxa arising from interspecific crosses. It is indicated by a multiplication sign, e.g., *Pteris* \times *hybrida*. The category of *subspecies* (subsp.) is used for minor taxa that are separable from members of the same species outside of Hawaii. *Variety* (var.) refers to minor separate populations that are found in different islands. *Form* (f.) is used for distinctive (often striking) mutants involving one or a few sporadic individuals.

Our application of the categories may, in some cases, be unusual. If the original taxon is believed to be monophyletic (i.e., by orthospeciation), we use the traditional category of species; however, in a number of situations in Hawaiian pteridophytes, the species may tend to blend into one another. Examples are such taxa as *Adenophorus tripinnatifidus* and *A. hillebrandii* (Wagner 1995). The blending may result from gene exchange between already differentiated taxa or in populations undergoing speciation. There is also the problem of morphological (and physiological) plasticity. One segment of the species may respond to or become adapted to dry, exposed habitats and another to moist, shaded habitats. An example to be described below, *Lycopodium venustulum* var. *verticale*, is a very distinctive xerophyte in contrast to the mesophytic var. *venustulum*. The differences may be due entirely to plasticity, the ability to change in accordance with environmental factors, but there may also be genetic differences involved,

which we can establish only by experiments. The localization of var. *verticale* to dry areas in the upper reaches of Mauna Loa is well defined geographically.

If a taxon's origin is di- or polyphyletic (i.e., by nothospeciation), the population may blend into one or both parental species. We have chosen to name these intergradient populations for two reasons: (a) to draw attention to them, and (b) to encourage further investigation. There is always the possibility in such seeming "hybrid swarms" that we are actually dealing with ancestral gene pools, and that the seeming blending is due to partial separation of an original variable ancestral species. Examples in this paper include *Doryopteris subdecipiens*, a variable collection of intermediates between *D. decipiens* and *D. decora*, and *Diellia* \times *lauii*, a taxon more obviously formed as a series of genetic intermediates between *D. falcata* and *D. unisora*.

Our goal is to develop a robust taxonomy that expresses the major patterns in Hawaiian pteridophytes and recognizes the "fuzzy" blendings between the major nodes of differentiation. We use taxonomic distance (i.e., amount of character differences) in our assessment. Taxa should be sufficiently different to be recognized by ordinary means as applied to higher plants. We reject the "phylogenetic species" concept for various reasons, but especially because it tends to raise populations that are only varietally or subspecifically distinct to full status equivalent to species. The phylogenetic species concept fails to recognize, as such, subspecies or varieties.

LYCOPODIACEAE

PHLEGMARIURUS

Upon demonstrating the distinctness of the genus *Phlegmariurus* from *Huperzia* (Wagner & Beitel 1992), it was necessary to make three new combinations, namely, *Phlegmariurus mannii* (Hillebr.) W. H. Wagner, *P. nutans* (Brack.) W. H. Wagner, and *P. filiformis* (Sw.) W. H. Wagner (Wagner et al. 1995). Since then an additional species, *P. stemmermanniae* Medeiros & W. H. Wagner, closely related to *P. mannii*, has been discovered (Medeiros et al. 1996). Three of the species in this genus are extremely rare—*P. nutans*, *P. mannii*, and *P. stemmermanniae*. They are all candidates to be listed as endangered. With the help of Joel Lau, we studied specimens from the northern Koolau Mountains on Oahu that suggest hybridization between *P. nutans* and the common hanging fir-moss, *P. phyllanthus* (Hook. & Arn.) R. D. Dixit. The two species represent the parental extremes, and the presumed hybrid subtly combines the characters of the parents. *Phlegmariurus nutans* and *P. phyllanthus* can be separated as follows:

Tassles unbranched to 1-branched, 4–8 mm thick except broader toward base; sporophylls somewhat resembling the trophophylls, but mostly 1/4–1/8 as long, the apices long-pointed (1–4 mm); fertile branches usually transitional to sterile shoot; trophophylls somewhat crowded, 10–20 \times 1.5–2.5 mm, the sides nearly straight, only weakly broadened at base, borne at 60–80° to main axis.

P. nutans.

Tassles mostly 1–3-branched (or more-branched), 2–4 mm thick; sporophylls mostly strongly differentiated from the trophophylls, the apices rounded or only slightly pointed; fertile branches mostly abruptly transitional to sterile shoots; trophophylls remote, 10–17 \times 2–4 mm, the sides curved convexly and broadened toward base, borne 80–100° to main axis.

P. phyllanthus.

Phlegmariurus ×koolauensis W. H. Wagner, nothosp. nov.—TYPE: OAHU. Koolau Mountains, Waimano Trail, on major switchbacks after crossing stream, epiphytic in *Acacia Koa-Metrosideros-Dicranopteris* lowland wet forest with *Cyrtandra*, *Cyanea angustifolia*, *Gardenia mannii*, *Psychotria*, *Cibotium*, *Scaevola*, *Bobea*, *Freycinetia*, and lots of *Clidemia*, 1250 ft, 22 May 1987, S. Perlman 5464 (holotype: BISH!). Fig. 1.

Hybrida inter *P. nutantem* et *P. phyllanthum* intermedia; trophophylla moderate conferta, lateribus parum convexis et versus basim latoribus, ex caule ad angulum 70–90° patentia; caules fertiles 3–7 mm crassi, basi latiores, plerumque 1–2-ramosi, area transitoria brevi inter trophophylla et sporophylla instructi; sporophylla plerumque 1–2 mm longa, acuminibus procurentibus.

Intermediate between *P. nutans* and *P. phyllanthus*. Trophophylls moderately crowded, the sides slightly convex and broadened toward the base, borne ca. 70–90° to stem. Tassles 3–7 mm thick, except broader at base, mainly 1–2-branched, with a short transitional area between trophophylls and sporophylls, the sporophylls with projecting points, mostly 1–2 mm long. Chromosome number unknown.

ADDITIONAL SPECIMENS EXAMINED. OAHU (Koolau Mountains): Laie-Waimea, Koolau Divide, wet woods, 2200 ft, 15 May 1933, *H. St. John* 13088 (BISH); Paalaa, ridge south of S. Opaa Gulch, in rainy moss-covered rotten tree, 15 Sep 1932, *Nobua Tsuji* (BISH); 545 m, 25 Sep 1932, *F. R. Fosberg* 8756 (BISH); Palehua/Palikea Trail, 11 Mar 1982, *T. Bennett* 209 (BISH); Kipapa Gulch, on wet woods ridge, ?2000 ft, 8 Aug 1932, *E. Y. Hosaka* 1206 (BISH).

HUPERZIA SPECIES

Gemmiferous fir-mosses in Hawaii may occur on damp vertical rock faces, on the ground, or occasionally as low epiphytes. They differ in a number of respects from *Phlegmariurus*, particularly in spore shape and in the presence of highly evolved dispersal organs called gemmae. The following key and descriptions are based on J. M. Beitel's very thorough notes for his doctoral thesis, which unfortunately was not completed at the time of his death. The sterile hybrids may create much confusion, but they all have conspicuously abortive spores. All of the taxa keyed here have regular, even-sized, normal spores.

Key to Mature Aerial Shoots of Huperzia

1. Leaves shallowly serrulate to deeply sublacerate; the shoot with strong or weak annual constrictions.
 2. Leaves mostly ascending, short and broad, ovate-oblong; stomates on adaxial leaf surface 10–60. *H. subintegra*.
 2. Leaves mostly spreading or reflexed, long and narrow, lanceolate to lanceolate-oblong; stomates on adaxial leaf surface 0–25.
 3. Shoots 14–18 mm wide; largest leaves irregularly and conspicuously serrulate and lacinate, 6–9 × 2.5–5 mm with a short (1.5–2.0 mm) basal “petiole”; annual constrictions conspicuous; gemmae 4.5 × 3.3 mm, the gemmae leaves mostly acute and distally crenulate; adaxial leaf surface lacking stomates. *H. serrata*.
 3. Shoots 8–12 mm wide; largest leaves shallowly crenulate, 4.6 × 1.0–1.4 mm; “petiole” only slightly differentiated; constrictions weakly developed; gemmae 3 × 3 mm, the gemmae leaves more rounded and entire; adaxial leaf surface with 2–25 stomates. *H. erosa*.

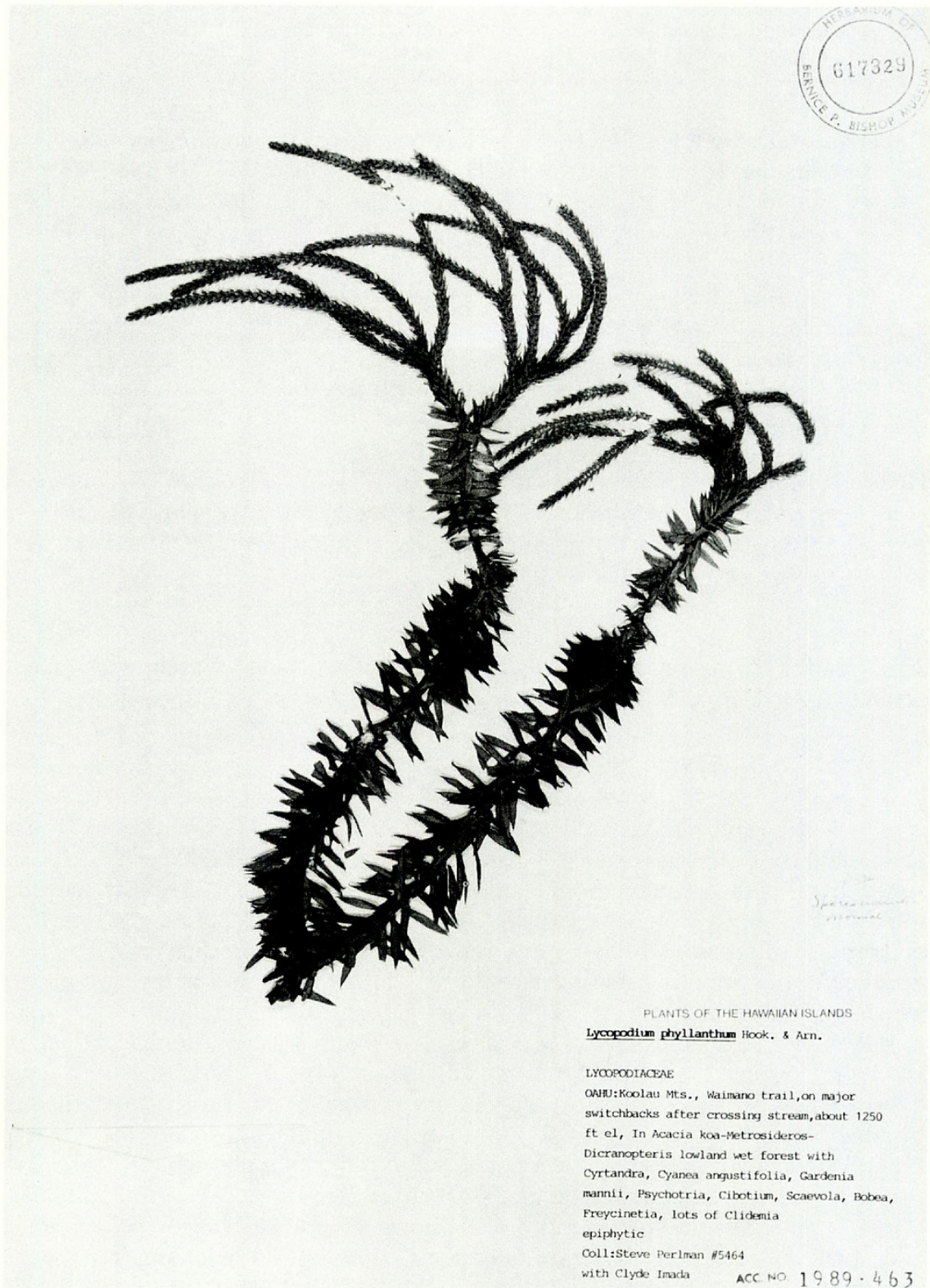


FIG. 1. *Phlegmariurus xkoolauensis* (*P. nutans* × *P. phyllanthus*). Holotype; note the breadth of the sporangial shoots, degree of branching, and leaf shape.

1. Leaves entire; annual constrictions absent.
4. Shoot yellow-pink to red, 6–9 mm wide; largest leaves narrowly lanceolate to linear, 2×0.7 mm, soft, reddish, spreading to reflexed; gemmae 2.2×1.7 mm; lateral gemma leaves sharply pointed; adaxial stomates 50–80. *H. somae*.
4. Shoot yellow to green, 7–12 mm wide; largest leaves broad, $3-4 \times 1.5$ mm, coriaceous, green, ascending; gemmae 3.5×2.5 mm, produced mostly in numerous “whorls” along the shoot; lateral gemma leaves short-pointed; adaxial stomates 80–100; northwestern North America, not recently reported from Hawaii. *H. haleakalae*.

Huperzia erosa Beitel & W. H. Wagner, nom. nov. *Lycopodium serratum* var. *dentatum* Hillebr., Flora of the Hawaiian Islands, 643. 1888, non *Huperzia dentata* (Herter) Holub, 1985.—TYPE: LANAI. W. Hillebrand s.n. (lectotype, here designated: BM!). Fig. 2.

Shoots with indistinct constrictions; leaves $4-6 \times 1.0-1.4$ mm, reflexed to spreading, ascending, lustrous; adaxial surface with 2–25 stomates; margins distally and irregularly shallow-dentate.

Huperzia erosa resembles the Eastern North American fir-moss known as *H. porophila*, and to a lesser extent *H. lucidula*.

Huperzia subintegra (Hillebr.) Beitel & W. H. Wagner, comb. nov. *Lycopodium serratum* var. *subintegrum* Hillebr., Flora of the Hawaiian Islands, 643. 1888.—TYPE: KAUAI. “High mountains of Kauai,” W. Hillebrand s.n. (lectotype, here designated: BONN!).

Huperzia subintegra has been confused with *H. sulcinervia* (Spring) Trevisan. After finding the type of *H. sulcinervia* at P, Beitel concluded that the specimen is actually the hybrid of *H. serrata* and *H. somae* (= *H. \times sulcinervia*, see below).

HUPERZIA HYBRIDS

Huperzias are noted for their ability to hybridize, and this has caused much taxonomic confusion in the past. Presumably some of the sexual species arose as sterile hybrids that became allopolyploids, but others remain as sterile hybrids, their spores abortive and imperfectly formed. Apparently, in some cases, this makes little difference with respect to reproductive success, because all huperzias, whether fertile or sterile, have the ability to spread by their elaborate gemmae, which are shaped like flattened samaras and at maturity are pitched into the wind by a special abscission mechanism, as a result of being brushed by adjacent plants, wind, or by rain drops. In the following enumeration we give names to the known hybrids in accordance with our policy in the Hawaiian fern project. Such names become useful if there are mistakes in analyzing parentage, or convenient if it is found that a given hybrid is of economic value (e.g., pharmaceutically). We give herewith the nothospecies binomial, its presumed parents, a few of the best characters in comparison with its more well-known parent, the holotype, and some additional collections, if there are only a few. Where there is a large number of collections, we just indicate the number noted by Beitel. The best-known hybrid collections are from West Maui and the Koolau Mountains of Oahu.

Huperzia \times erubescens (Brack.) Holub (pro sp.), Folia Geobot. Phytotax. 20: 72. 1985.—TYPE: MAUI. Mt. Haleakala, 6000 ft, Wilkes s.n. (holotype: US!)

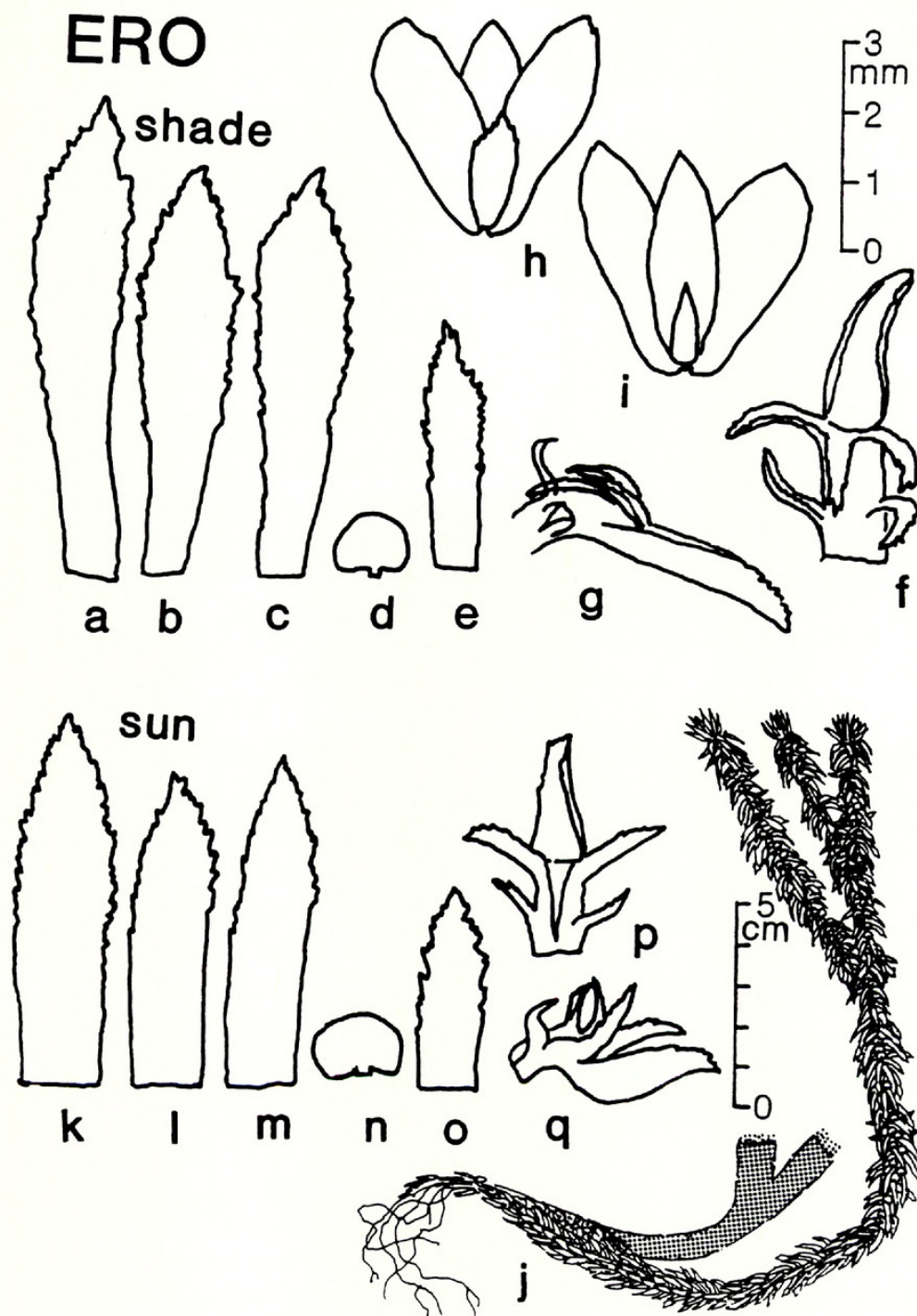


FIG. 2. *Huperzia erosa*. Parts of plants growing in shade (above) and sun (below); a, b, c, k, l, m = leaves (note irregularly and shallowly dentate margins); e, o = reduced constriction leaves; d, n = sporangia; g, p, q = gemmiphores; h, i = gemmae; j = a whole plant. (Drawing from notes of J. M. Beitel.)

Huperzia xerubescens, intermediate between *H. haleakalae* and *H. somae*, shows narrower leaves, more sharply pointed gemmae leaves, and fewer stomates than *H. haleakalae*.

ADDITIONAL SPECIMEN EXAMINED. KAUAI: Waialeale summit, W. H. Wagner 65496 & M. Tessene (MICH).

Huperzia ×medeirosii Beitel & W. H. Wagner, nothosp. nov.—TYPE: MAUI. West Maui, tabular summit of Mt. Eke, low sedge and moss vegetation, 4450 ft, *R. Hobdy* 901 (holotype: MICH!).

Inter *H. haleakalae* et *H. subintegrum* intermedia, foliis quam illis *H. haleakalae* brevioribus latioribusque, gemmis quam illis *H. haleakalae* brevioribus, et marginibus parum dentatis neque integris.

Huperzia ×medeirosii, intermediate between *H. haleakalae* and *H. subintegra*, shows shorter and broader leaves, shorter gemmae, and slightly dentate margins, unlike *H. haleakalae*.

ADDITIONAL SPECIMENS EXAMINED. MAUI: West Maui, on excessively exposed windy, foggy crest of plateau, *O. Degener* 5736 (BONN, MICH, MO, NY-2 sheets); Puu Kukui, alpine bog, *G. C. Munro* 609 (BISH); 1750 m, *C. Skottsberg* 1094 (BM, US).

Huperzia ×sulcinervia (Spring.) Trevis (pro sp.). *Lycopodium sulcinervium* Spring, Bull. Acad. Roy. Sci. Belg. 8: 514. 1841.—TYPE: "Hawaiian Islands," *Gaudichaud s.n.* (holotype: PC!).

Lycopodium helleri Herter, Bot. Jahrb. Syst. 43, Beibl. 98: 43. 1909.—TYPE (fide Herter): OAHU. Summit of Konahuani, 950 m, 1895, *A. A. Heller s.n.* (G, P).

Huperzia ×sulcinervia, intermediate between *H. serrata* and *H. somae*, has fewer stomates above, and smaller, narrower leaves and gemmae than *H. serrata*. This nothospecies is remarkably common in the Koolau Mountains of Oahu.

ADDITIONAL SPECIMENS EXAMINED. HAWAII: Kulani, *C. N. Forbes* 986H (BISH); Kilauea iki, Kilauea Volcano, wet shaded fern forest, 4000 ft on walls of crater, 1927, *Russ s.n.* (BISH).—LANAI: Mts East end, *C. N. Forbes* 216L (BISH); Lanaihale, *G. C. Munro* 281 (BISH).—OAHU (32 collections from the Koolau Mts, mainly at BISH and MICH).

Huperzia ×gillettii Beitel & W. H. Wagner, nothosp. nov.—TYPE: OAHU. Koolau Range, Poamaha Trail, Paulaa-Wahiawa, 2600 ft, 2 Mar 1941, *C. Wong s.n.* (holotype: MICH!). Fig. 3.

Inter *H. serrata* et *H. subintegrum* intermedia, caulibus quam illis *H. serratae* minus constrictis et foliis minoribus, minus profunde dentatis, et proximaliter minus decrescentibus.

Huperzia ×gillettii, intermediate between *H. serrata* and *H. subintegra*, has less constricted shoots and smaller leaves, the latter less deeply dentate and with less narrowing of the basal part of the leaf than *H. serrata*. Like *H. ×sulcinervia*, this hybrid is common in the Koolau Mountains of Oahu.

ADDITIONAL SPECIMENS EXAMINED (mainly MICH and BISH). OAHU: Waikani-Scofield Trail, 2400 ft, 29 Jun 1947, *W. H. Wagner* 5096 (MICH); also 29 collections from Koolau Mts and 3 from Waianae Mts-Kaala.—HAWAII: Kohala Mts at top of Alakahi Valley, *W. H. Wagner* 65398 & *M. Tessene* (MICH).—KAUAI (5 collections).—MAUI: East Maui (2 collections); West Maui (2 collections).—MOLOKAI (1 collection).

Huperzia ×carlquistii Beitel & W. H. Wagner, nothosp. nov.—TYPE: MAUI. West Maui, east slope of Mt. Eke, open bogs in dense moss mats, 3100 ft, *R. Hobdy* 903 (holotype: MICH!).

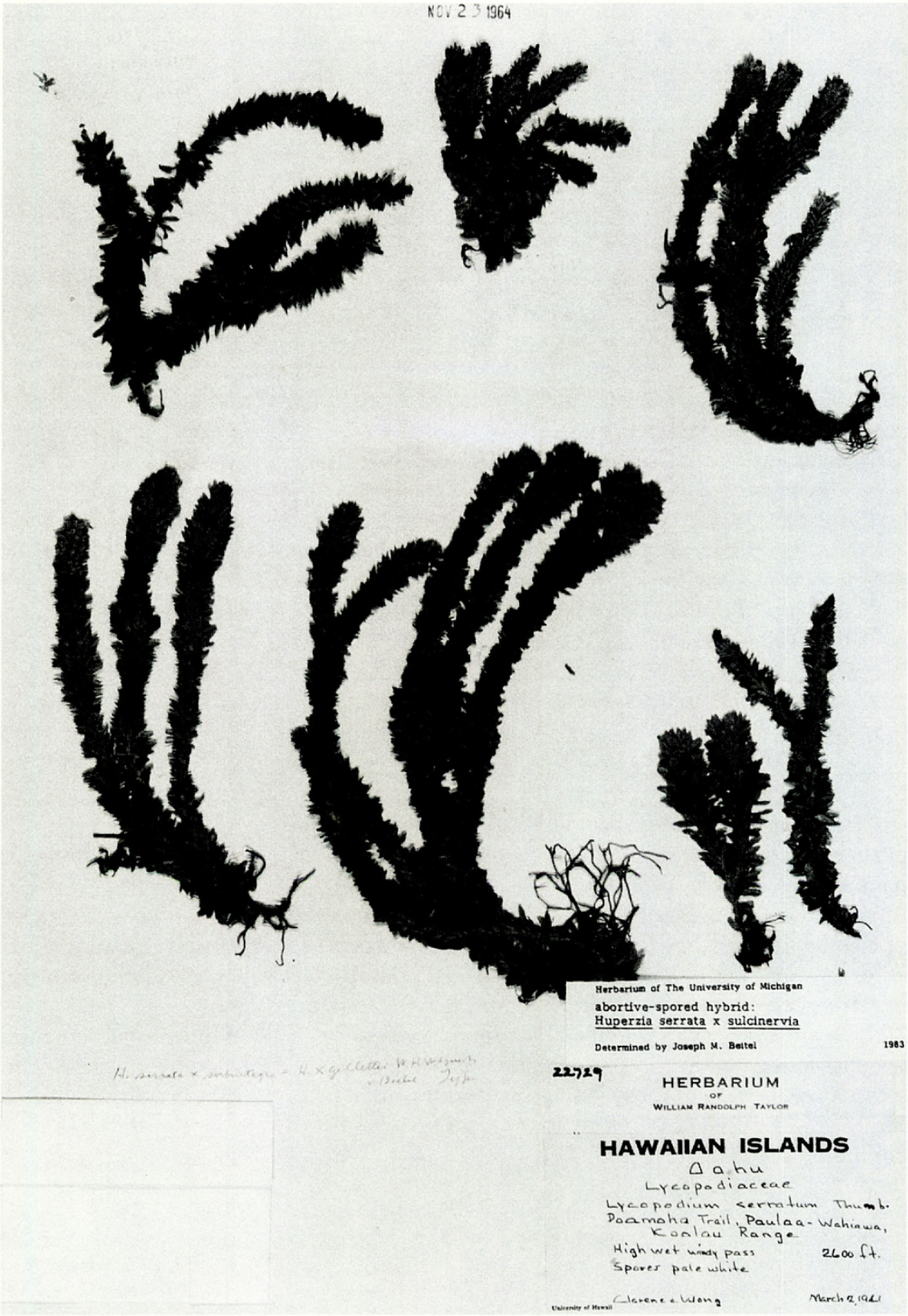


FIG. 3. *Huperzia xgillettii* (*H. serrata* x *H. subintegra*). Holotype; note leaves, which are shorter and “stubbier” than those of *H. serrata*.

Inter *H. somae* et *H. subintegrum* intermedia, parum rubra, foliis quam illis *H. subintegrae* brevioribus latioribusque, margine distaliter plus crenulatis.

Huperzia xcarlquistii, intermediate between *H. somae* and *H. subintegra*, has more reddish stems, and shorter and wider leaves, which are more crenulate at the distal margins, than are those of *H. subintegra*. It is rare and known only from one locality.

LYCOPODIUM

Lycopodium volubile G. Foster [= *Pseudodiphasium volubile* (G. Foster) Holub] is a showy and conspicuous clubmoss, which ranges widely over the islands and subcontinents of the Southwestern Pacific region. It was reported by Hillebrand (1888) as "collected only by Menzies, probably on Mauna Loa." From the information available to us there is no evidence of any other report. Menzies's collection could have been a casual, solitary natural introduction by a stray spore, or, more likely, the report is an error in locality. *Lycopodium volubile* was apparently never seen by any collectors before or after the report by Menzies, and we therefore exclude it from our flora. We have not seen the Menzies collection and do not know its whereabouts.

The only Hawaiian representative of *Lycopodium* s.s. is related to *L. clavatum* L. The species, *L. venustum* Gaudich., is widespread at high elevations in wet forests and trailsides throughout the high islands. It is fairly constant morphologically, but in dry sites on Mauna Loa, Hawaii, there is a very distinctive variety, described below, readily recognized by its upright form.

***Lycopodium venustum* var. *verticale* W. H. Wagner, var. nov.**—TYPE: HAWAII. Kau District, Ainapo to Puu Pili, Kapapala, trailing in open woods, 4000 ft, 21 Dec 1937, *H. St. John 18429 et al.* (holotype: BISH!). Fig. 4.

Caules erectissimi, fasciculum densum columnarem formantes; folia recta vel parum incurvata; strobili 1.5–4.0 cm longi, 2 (raro 3 vel 4) in quoque pedunculo, paene sessiles vel pedicellis brevibus 0.2–0.9 mm longis instructi.

Lycopodium venustum var. *verticale* differs from var. *venustum* in its strictly upright branches that form a dense columnar fascicle, leaves that are somewhat incurved to straight, and its strobili 1.5–4.0 cm long, 2 (rarely 3 or 4) per peduncle, nearly sessile or with short pedicels only 0.2–0.9 mm long.

Lycopodium venustum var. *venustum* has spreading and horizontal branches, which produce open rampant growth, and leaves that are strongly incurved. The strobili are generally long, 2.5–10 cm and borne 3–6 per peduncle with pedicels 6 cm long. The new variety is apparently genetically distinct over its range and adapted to exposed, dry habitats.

ADDITIONAL SPECIMENS EXAMINED. HAWAII: Volcanoes National Park, subalpine *Metrosideros*-shrub community on aa lava, about 1 mile up Mauna Loa Summit Trail, plant on west side of trail at 7000 ft elevation sign, about 0.5 mi past the fence with gate (plot 16), 29 Jul 1912, *C. L. Newell & F. R. Fosberg 213* (BISH-3 sheets); Mauna Loa, 8000 ft station, *U.S. Expl. Exped.*, Kau District, 26; Steinback Highway, on sparsely shrubby aa lava, 8000 ft, 15 Feb 1952, *O. Degener & A. Greenwell 21821* (BISH); creeping over aa lava, with *Rhynchospora lamarum*, *Oreobolis furcatus*, *Geranium cuneatum*, *Styphelia tameameia*, *Argyroxiphium kauense*, and *Vaccinium reticulatum*, in open *Metrosideros* woodland, Kahuku Ranch, SW rift zone of Mauna Loa, 6000 ft, *S. Carlquist 2113* (BISH); above Kipuha Ahiu, 22 Jun 1915, *C. N. Forbes 91614*; Kahuku Parkland, jeep road, 5 mi NE of Nene Cabin, 6900 ft, 24 Jun 1971, *H. St. John 26783A* (BISH); Mauna Loa Trail, 2133 m, 24 Jun 1966, *V. J. Krajina 660624004* (BISH).

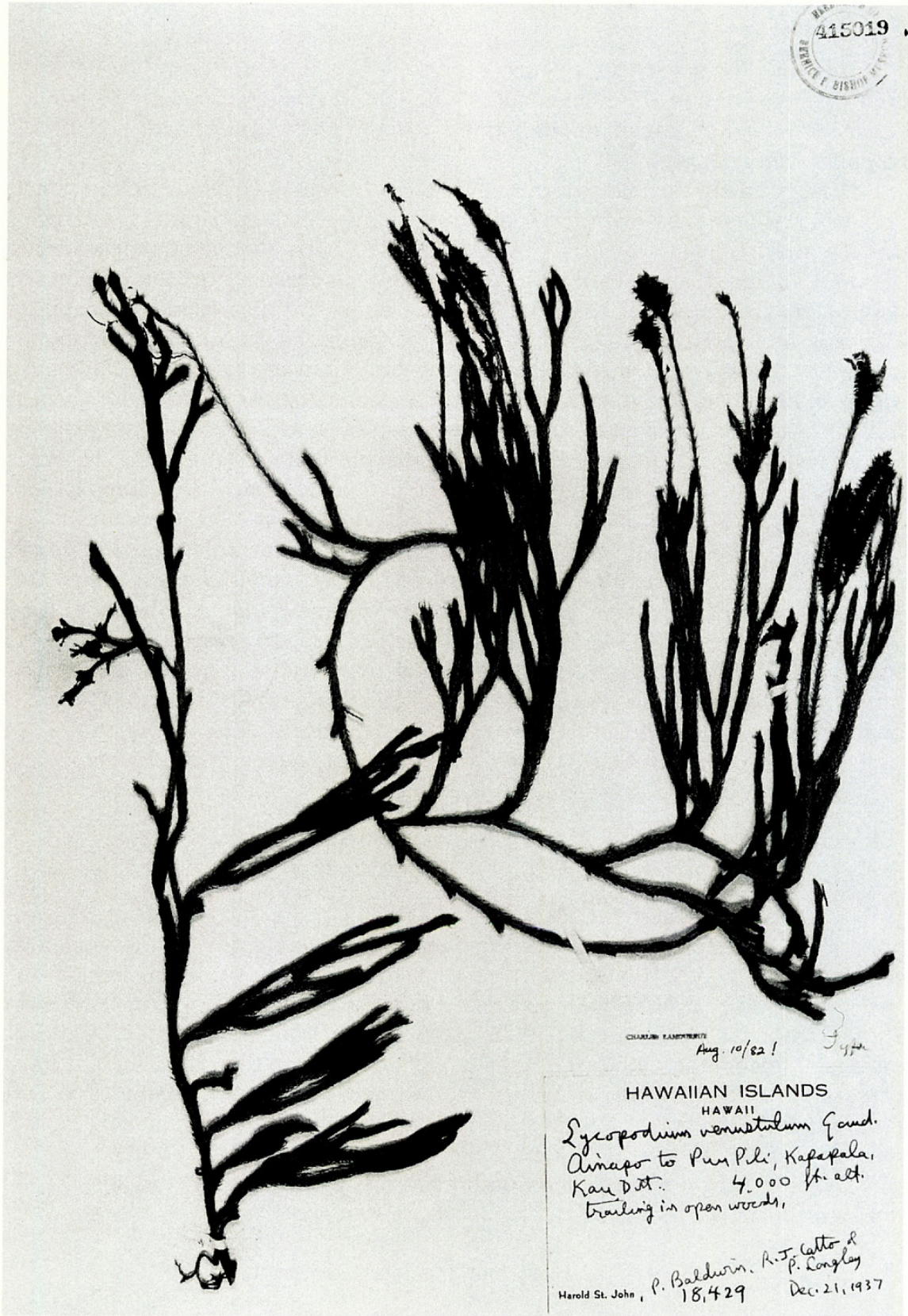


FIG. 4. *Lycopodium venustulum* var. *verticale*. Holotype; note upright branches with appressed leaves.

OPHIOGLOSSACEAE

This very distinct family is poorly represented in Hawaii. Recently we discovered that the presumed endemic adder's-tongue, known traditionally as *Ophioglossum concinnum* Brack., is inseparable from the very widespread Old World *O. polyphyllum* A. Br.

The extremely rare grapefern of Hawaiian forests is believed to be extinct, although serious efforts to rediscover it may be rewarded. All early authors mention its rarity. The plant superficially resembles the fairly common young plants of *Marattia douglasii*, and can therefore be readily confused or overlooked by the uninitiated. In the past it has been found in all of the high islands, apparently always in moist, mossy forest. Prior to 1930 it was found on Kauai on the mountain above Wahiawa Bog, on Oahu above Honolulu, in scattered localities on Molokai, Lanai, and Maui, and in Hawaii in two forests between Hilo and Kilauea. In light of the recent trend to separate *Sceptridium* from *Botrychium*, we propose the following new combination: ***Sceptridium subbifoliatum*** (Brack.) W. H. Wagner & F. S. Wagner (basonym: *Botrychium subbifoliatum* Brack., U.S. Expl. Exped. 16: 317, t. 44, f. 2. 1854.)

The five known representatives of the Ophioglossaceae in Hawaii are now as follows: *Sceptridium subbifoliatum* (extremely rare), *Ophioglossum petiolatum* Hook. (frequent), *O. nudicaule* L. f. (rare), *O. polyphyllum* A. Br. (rare), and *Ophioderma pendula* (L.) C. Presl (common). The last is represented mostly by a small falcate-leaved form, but specimens and populations more like the typical form are occasionally discovered (e.g., East Maui, Nahiku, Kuhiwa Road, 1400 ft, on mossy tree trunks, 10 Jun 1995, *R. Hobdy* 3804, MICH; cf. Horner 1958.)

PTERIDACEAE

DORYOPTERIS

Hawaii's representatives of the genus *Doryopteris* are, for the most part, variable, and have created taxonomic confusion. The most extreme treatment was that of R. M. Tryon (1942), who placed all the elements known to him in one species (*D. decora*) with two varieties. Later, he put the Hawaiian species in another genus, *Cheilanthes*, but that interpretation has been negated by recent molecular systematic studies (Gastony & Rollo 1995), and the Hawaiian taxa have been retained in *Doryopteris*. Accordingly, we propose the new combination ***Doryopteris takeuchii*** (W. H. Wagner) W. H. Wagner, comb. nov. (basonym: *Cheilanthes takeuchii* W. H. Wagner, Contr. Univ. Michigan Herb. 19: 66. 1993.).

The key below records our present interpretation. Two of the species, *D. angelica* and *D. subdecipiens*, are here newly described.

Key to the Hawaiian Species of *Doryopteris*

1. Stipe up to 2–3 mm wide, with very conspicuous adaxial lateral ridges 1.0–2.2 mm tall; blade usually large, up to 30 × 30 cm; areoles in 2–3 rows parallel to costa. *D. angelica*.
1. Stipe up to 1.3 mm wide, often wire-like, not ridged or only slightly ridged; blade usually only up to 15 × 18 cm; areoles in 1–2 rows parallel to costa.
 2. Lowest rachis sector (between the basal and next higher pinnae) with well-developed laminar wings; ultimate segments commonly up to 6 mm wide. *D. decipiens*.

2. Lowest rachis sector lacking well-developed laminar wings; ultimate segments mostly 5 mm or less wide.
3. Second rachis sector (between pinna pairs 2 and 3) usually with at least a partially developed laminar wing. *D. subdecipiens*.
3. Second rachis sector lacking a laminar wing.
4. Second rachis sector only slightly shorter than first; blade outline triangular; segments 2–4 mm wide; blades in nature forming a bushy mass of upright segments. *D. decora*.
4. Second rachis sector as short as 1/2 the length of the first; blade outline elliptic-triangular to elliptic; segments 3–5 mm wide; blades normally planate. *D. takeuchii*.

Doryopteris angelica K. Wood & W. H. Wagner, sp. nov.—TYPE: KAUAI. Waimea District, upper Kuia, *Metrosideros-Alphitonia-Acacia* montane mesic forest, in NE upper gulch, N aspect, 3000–3200 ft, 6 Nov 1994, K. R. Wood 3707 & J. Lau (holotype: PTBG!). Figs. 5, 6.

Lamina deltata, illae *D. decipiens* similis sed maxima, usque ad 30 × 30 cm; sectio infima rhachidis ala laminari bene evoluta instructa; stipes longissimus crassissimusque, quam lamina 3–4plo longior, usque ad 2.3 mm latus, crista adaxiali conspicua 1.0–2.2 mm alta instructus.

Blade deltate, similar to *D. decipiens* but very large, up to 30 × 30 cm; stipe base scales up to 5.5 × 0.8 mm, with narrow jet black sclerified band ca. 0.3 mm wide running down center with thin white stripe on either side, scale tip curly and hairlike, up to 1.5 mm long; lowest rachis section with well-developed laminar wing; stipe 3–4 times as long as blade, up to 2.3 mm wide, with very conspicuous adaxial ridges, 1.0–2.2 mm tall.

This is a highly localized fern with unusually large fronds and robust stipes, which is very rare and local on dry steep forested slopes at ca. 1000 m on Kauai.

This peculiar species calls for detailed study to explain the unusual stipe development and its divergence in size and petiole structure from *D. decipiens*, which occurs nearby in similar habitats. Also, the scales are longer than those of *D. decipiens*, and the narrowed tip is curly rather than straight. Ken Wood of the National Tropical Botanical Garden discovered *D. angelica* and recognized its distinctive characteristics.

ADDITIONAL SPECIMENS EXAMINED. KAUAI: Waimea District, Mahanaloa Valley, upper valley, steep windswept ridge with *Wilkesia*, above amphitheater, 3 plants seen, 3000–4000 ft, 14 Dec 1994, K. R. Wood 3844 (BISH); Makaha Valley, upper southeast gulch, ca. 10 plants in area, 3020 ft, 24 Nov 1944, K. R. Wood 3783 & F. Davis.

Doryopteris subdecipiens W. H. Wagner, sp. nov.—TYPE: OAHU. Lualualei Naval Station, ridges SSW of Waianae Mountains, first ridge, 27 Apr 1987, W. H. Wagner 87218.5b, F. S. Wagner, D. Palmer & W. Takeuchi (holotype: MICH!). Figs. 7, 8.

D. decipiens similis, sed segmentis conspicue angustioribus, plerumque tantum 2.5–3.5 mm latis; locos petrosos expositos habitat.

Second rachial sector usually with or without (rare) a partially developed laminar wing. Segments narrow, usually only 2.5–3.5 (–4.0) mm wide, sometimes (especially on lava flows on Hawaii) forming a mass of approximate upright segments.

This species is uncommon in dry exposed rocky sites at 150–670 m on Kauai, Oahu, Lanai, Maui, Kahoolawe, and Hawaii.

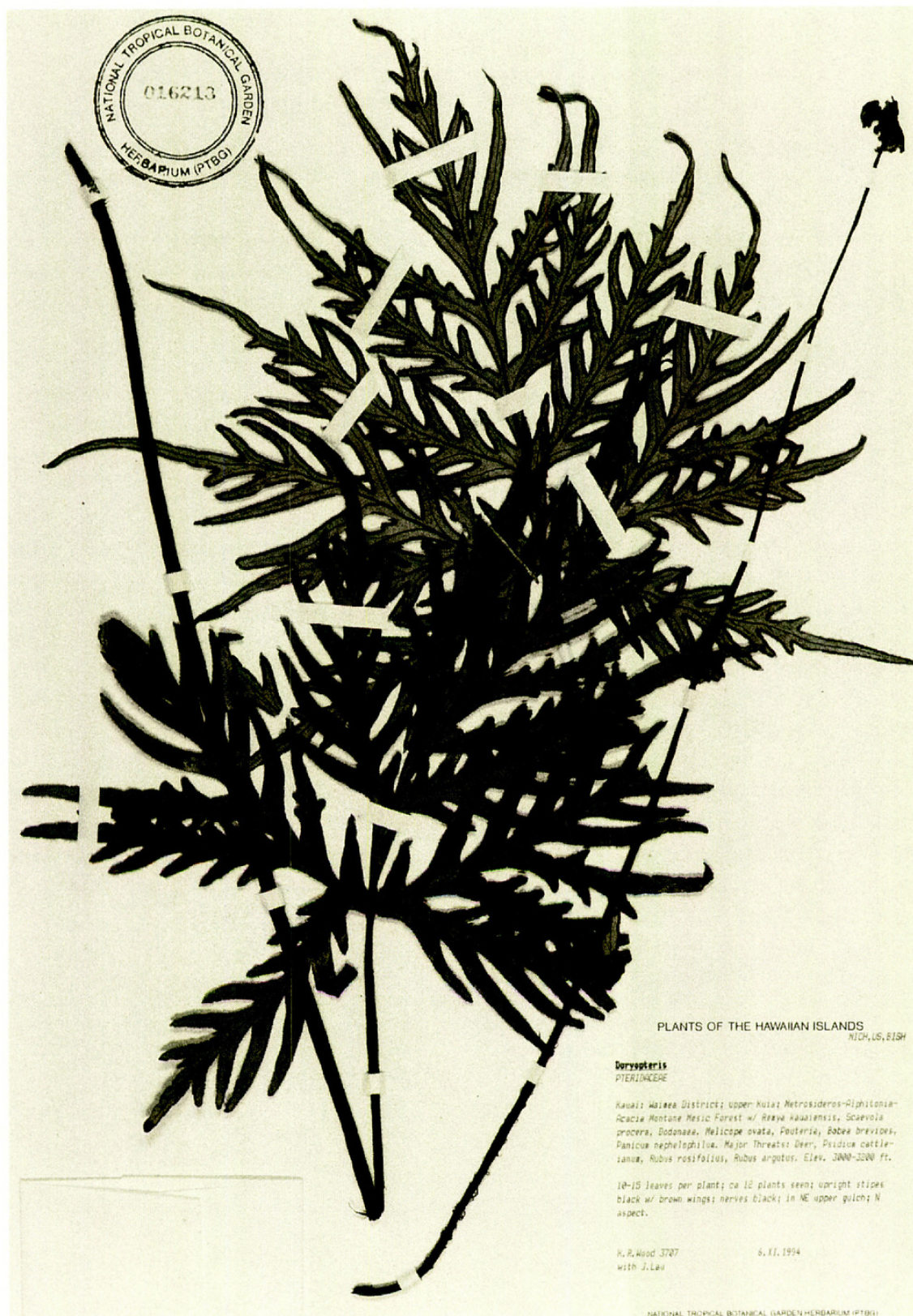


FIG. 5. *Doryopteris angelica*. Holotype; note thick, strongly winged stipe and scales along lower stipe.



FIG. 6. *Doryopteris angelica*. Note massive rhizome and stipes.

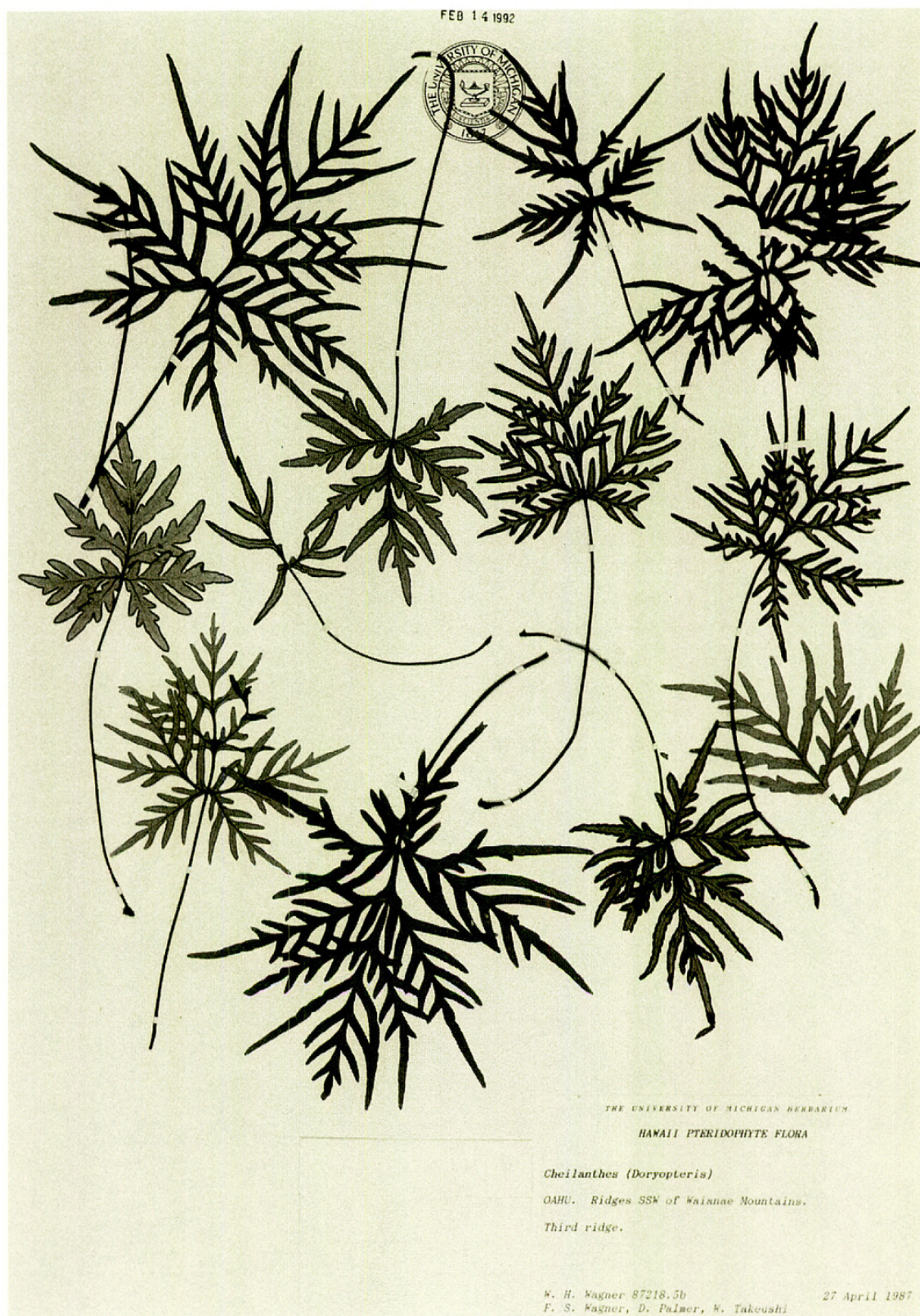


FIG. 7. *Doryopteris subdecipiens*. Holotype; note variation of leaves from *D. decora*-like to *D. decipiens*-like.

FIG. 8. *Doryopteris subdecipiens*. Leaf variations.

Doryopteris subdeci piens is probably a hybrid swarm between two strikingly different species, *D. deci piens* (Hook.) J. Sm. and *D. decora* Brack. (syn. *D. tryonii* O. Degener), but it might also be a variable ancestral species. Because the two extremes are connected by intermediate forms, *D. deci piens* has also been considered a variety of *D. decora* (Tryon 1942; Tryon & Tryon 1982).

Three collections show specimens with characters averaging closer to one or the other of the putative parent species:

(a) Closer to *D. deci piens*, with casually anastomosing veins and wider segments. Lanai: "(with much *D. deci piens* admixture)" near Keomuku Road, on slope at side of rocks in good soil among *Lipochaeta*, pili, and *Sida*, 10 Jan 1964, O. Degener & I. Degener 30105 (MICH).

(b) Closer to *D. decora*, with narrower segments, fewer veins anastomosing. Oahu: Lualualei Naval Station, ridges SSW of Waianae Mountains, third ridge, 27 Apr 1987, W. H. Wagner 87218.5a, F. S. Wagner, D. Palmer, W. Takeuchi (MICH-3 sheets); Kauaokale, Kawaula, summer-arid habitat in haolekoa scrubland with wili-wili emergents, roadcut-exposed ledges, W. Takeuchi & L. Pyle 3766 (MICH-12 sheets).

ADDITIONAL SPECIMENS EXAMINED. LANAI: Honopu, in good soil weed-covered and subject to seasonal wetting and drying, 600 ft, 16 Jan 1964, O. Degener 30122 (MICH).—KAUAI: Haeleele Valley, in arid region, 13 Jun 1926, O. Degener 988 (MICH); Waimea Canyon State Park, Mile 113 on Hwy 550, Waimea Canyon in dry forest on steep dry slopes, 3000–3500 ft, 21 May 1987, T. Flynn 2216, D. Lorence & R. DeLappe (MICH).

DENNSTAEDTIACEAE

HYPOLEPIS

The genus *Hypolepis* is represented in Hawaii by a single species, traditionally identified as *H. punctata* (Thunb.) Mett. Brownsey (1987), in his detailed revision, however, treats this fern as *H. hawaiiensis*, and applies the name *H. punctata* to a species of southeastern Asia, which is separated from the Hawaiian one by its less divided and more herbaceous frond covered by an abundance of glandular hairs. Accordingly, we adopt the name ***Hypolepis hawaiiensis*** Brownsey for our species.

MICROLEPIA

The primarily Old World genus *Microlepia* is taxonomically difficult, but in Hawaii is represented by only three orthospecies: *M. strigosa* (Thunb.) C. Presl (very common), *M. speluncae* (L.) T. Moore (frequent), and *M. mauiensis* W. H. Wagner (very rare). The Hawaiian representative of the variable *M. strigosa*, locally called "palapalai," is similar to *M. substrigosa* Tagawa of Japan, Taiwan, and China, and it may be confused with it (B. J. Hoshizaki, pers. comm.). Of the four taxa known in the islands, *M. mauiensis* can be immediately recognized by its densely hairy fronds and flexuous rachis. The remaining taxa are only moderately hairy to nearly glabrous. In addition to the three species listed above, a fourth taxon, known from the islands of Kauai to Hawaii, forms large clones, as does *M. speluncae*, but shows a number of resemblances to *M. strigosa*. An examination of its morphology and spores indicates that it is a sterile hybrid of these two species, and we describe it below. The three taxa concerned are keyed as follows:

1. Fronds spaced 0.7–1.5 cm apart along the rhizome, 0.5–1 m tall; blades narrowly deltate to lanceolate; indusia attached partially or wholly along the sides, with many long hairs; upper surface hairy; pinnules ascending. *M. strigosa*.
1. Fronds spaced 2–4 cm apart along the rhizome, 1.5–2+ m tall; blades deltate to ovate-deltate; indusia attached mainly at base, glabrous or with a few short hairs; upper surface glabrous or sparsely hairy; pinnules perpendicular or subascending.
2. Spores regular; lamina herbaceous; blades deltate to ovate; pinnules nearly perpendicular; segments cut mostly less than 1/2. *M. speluncae*.
2. Spores irregular and abortive; lamina chartaceous; blades deltate to deltate-lanceolate; pinnules subascending (ca. 10–20°); segments cut ca. 1/2 or more. *M. xadulterina*.

Microlepia xadulterina W. H. Wagner, nothosp. nov.—TYPE: OAHU. Wailupe, steep-sided plane by river, along upper slopes, 1200–1250 ft, 30 Jan 1988, W. Takeuchi & Paquin 3762 (holotype: MICH-5 sheets!). Figs. 9, 10.

Hybrida inter *M. speluncae* et *M. strigosam* intermedia; plantae clonales; rhizomata usque ad 6–9 mm crassa; frondes quam illae *M. speluncae* breviores, usque ad 3 × 1 m; lamina subcoriacea; sori submarginales, indusiis ex parte in lateribus affixis; sporae abortivae, amplitudine formaque variae.

Intermediate between *M. speluncae* and *M. strigosa* (near which it usually grows); plants clonal, forming large patches; rhizomes reaching up to 6–9 mm thick; fronds smaller than *M. speluncae*, to 3 × 1 m; lamina subchartaceous; sori submarginal, indusia partially attached on the sides; spores abortive, of various sizes and shapes.

We have also observed a large colony (not vouchered) of *M. xadulterina* growing on Hawaii at Bird Park (Kau District, Kipuka Pua Ulu), where both of the parental orthospecies co-occur.

ADDITIONAL SPECIMENS EXAMINED. KAUAI: eastern tributary of Hanakapiai stream, 1 mi from its mouth, "giant form," 350–750 ft, 21 Aug 1947, W. H. Wagner 5619 (MICH).—OAHU: Waianae Mountains, Kapuna Gulch, Mokuleia Trail, ca. 2000 ft, 2 Jul 1991, W. H. Wagner 91039 (MICH); Waianae Mountains, shady gulches ca. 1/2 mi E of Puu Hakaka, 23 Aug 1961, W. H. Wagner 9589a & R. A. White (MICH-2 sheets).

THELYPTERIDACEAE

CYCLOSORUS

The current status of genera recognized in Thelypteridaceae is in a state of flux. Following the recommendation of Smith (1990), we recognize four genera, which we are adopting for the Hawaiian species, namely *Macrothelypteris*, *Pseudophegopteris*, *Thelypteris*, and *Cyclosorus*. Holttum (1977) maintained six genera for our species: *Macrothelypteris*, *Pseudophegopteris*, *Amauropelta*, *Cyclosorus*, *Christella*, and *Pneumatopteris*, and later (pers. comm.) recognized a seventh, *Steg-nogramma*. Smith (1990) included Holttum's additional genera in *Thelypteris* or *Cyclosorus*. This requires the following changes:

Cyclosorus boydiae (D. C. Eaton) W. H. Wagner, comb. nov. (basonym: *Aspidium boydiae* D. C. Eaton, Bull. Torrey Bot. Club 6: 361. 1879).



FIG. 9. *Microlepia xadulterina*. Holotype (median pinnae).



FIG. 10. *Microlepidia xadulterina*. Holotype (terminal pinnae).

Cyclosorus exindusiatus (W. H. Wagner) W. H. Wagner, comb. nov. (basionym: *Thelypteris exindusiata* W. H. Wagner, Contr. Univ. Michigan Herb. 20: 245. 1995).

Cyclosorus ×incestus (W. H. Wagner) W. H. Wagner, comb. nov. (basionym: *Thelypteris ×incesta* W. H. Wagner, Contr. Univ. Michigan Herb. 19: 79. 1993).

Cyclosorus ×palmeri (W. H. Wagner) W. H. Wagner, comb. nov. (basionym: *Thelypteris ×palmeri* W. H. Wagner, Contr. Univ. Michigan Herb. 19: 81. 1993).

Cyclosorus wailele (Flynn) W. H. Wagner, comb. nov. (basionym: *Thelypteris wailele* Flynn, Contr. Univ. Michigan Herb. 20: 246. 1995).

The most complex species-group in this family is that clustering around *C. cyatheoides*. It includes not only this highly variable species, but several that have been first recognized as distinct only in the past few years, namely *C. boydiae*, *C. exindusiatus*, *C. ×palmeri*, and *C. wailele*. *Cyclosorus boydiae*, to be discussed below, is confined to streams, where it is a rheophyte on boulders and rock shelves; *C. exindusiatus* occurs in low-altitude forest on Kauai; *C. ×palmeri* forms extensive hybrid clones where *C. cyatheoides* co-occurs near *C. dentatus*; and *C. wailele* is narrowly limited to wet dripping walls of rock faces on Kauai.

Cyclosorus boydiae as a species has remained somewhat questionable since Hillebrand (1888) originally named it *Aspidium cyatheoides* var. *depauperatum*. D. C. Eaton in 1879 first distinguished it as a species, which he named for Miss E. S. Boyd, calling it *Aspidium* (*Cyrtomium*) *boydiae*. The type specimen was from Oahu. By 1977, Holttum remarked that the plant was "known from few collections," and indeed even today it still remains very rare and local, known only from a few small colonies in the Koolau Mountains of Oahu and in the Kipahulu Valley of East Maui (Medeiros et al. 1993). Although he upheld it as a species, Holttum hesitated about its distinction from *C. cyatheoides*, believing it possible that it is, as Hillebrand had thought, merely a depauperate form; however, recent studies on Oahu and Maui indicate without question that *C. boydiae* is a species very distinct from *C. cyatheoides*. Of more interest here is the fact that the representatives of the two areas are distinguishable as two varieties on the basis of differences in their ensembles of characters. The following key contrasts them.

Pinnae of fully developed fronds gradually narrowed to tip, 4–6 mm wide at middle but widest at base; basal auricle with straight or concave proximal side; terminal pinna 2.4 (1.7–2.6) × 0.6 (0.4–0.9) cm; texture soft and chartaceous; veins and cartilaginous margin not or hardly translucent (alive) and inconspicuous; sori mostly in one row, uncommonly in two (full-sized fronds); indusia 0.6–1.0 mm in largest diameter; Oahu. *C. boydiae* var. *boydiae*.

Pinnae of fully developed fronds abruptly narrowed to an obtuse tip, widest in middle: 6–7 mm; basal auricle with convex proximal side; terminal pinna 3.6 (3.5–3.9) × 1.1 (1.1–1.2) cm; texture stiff and subcoriaceous; veins and cartilaginous margin translucent (alive) and conspicuous; sori commonly in two rows; indusia 0.8–1.2 mm in largest diameter; Maui, Hawaii.

C. boydiae var. *kipahuluensis*.

Cyclosorus boydiae var. **boydiae**.—TYPE: OAHU. "Valleys of Oahu," 80–100 ft, E. S. Boyd (holotype: NY!).

ADDITIONAL SPECIMENS EXAMINED. OAHU: Koolau Mts, Hauula Forest Reserve, Kaluanui Stream, 550–600 ft, plants scattered on damp mossy rock shelves along stream, with *C. cyatheoides*, 31 Aug 1947, W. H. Wagner 5761 (MICH); Koolauloa Mts between Punaluu and Kaipapau, 12–19 Feb 1909, C. N. Forbes s.n. (BISH), 3–8 May 1909 C. N. Forbes s.n. (BISH); Punaluu, along stream, 21 Nov 1908, J. F. Rock s.n. (BISH); Punaluu, 14–21 Nov 1909, J. F. Rock 188200 (BISH); ca. 1888, J. R. Judd s.n. (BISH); Koolau Mts, side of stream on stone, Aug 1908, J. F. Rock 21 (BISH); Poamoho stream on banks and shelves, ca. 200 plants scattered along 1/3 mi of stream, ca. 1800 ft, 5 Sep 1993, D. D. Palmer 2020, J. Obata & R. Fenstmacher (MICH).

Cyclosorus boydiae* var. *kipahuluensis W. H. Wagner & Medeiros, var. nov.—

TYPE: MAUI. East Maui, Kipahulu Valley, lower level, south side, 1350 m, 9 Jun 1987, R. Hobdy & A. Medeiros 2847 (holotype: MICH-2 sheets!).

Figs. 11, 12.

Differt a var. *boydiae* pinnis longioribus latoribusque ($3.5\text{--}3.8 \times 1.1\text{--}1.2$ mm) textura plus coriacea marginibus venisque translucentibus cartilagineis, et indusiis majoribus.

Differs from var. *boydiae* in longer and broader pinnae ($3.5\text{--}3.8 \times 1.1\text{--}1.2$ mm), texture more coriaceous, margins and veins translucent cartilaginous, and larger indusia.

ADDITIONAL SPECIMENS EXAMINED. MAUI: Kipahulu Valley, 1315–1350 m, open stream courses in crevices, ledges, and mossy surface of rocks, 24 Mar 1987, A. Medeiros & R. Hobdy 2841 (MICH); Kipahulu Valley floor, 1225 m, on thin soil on boulders along rocky stream, R. E. DeWriede 30 (BISH).—HAWAII: “Hawaii,” 1879, D. D. Baldwin s.n. (BISH).

The plants of both varieties of *C. boydiae* may grow microsympatrically with *C. cyatheoides*, which takes on a reduced habit resembling those of the varieties of *C. boydiae*, with fronds much smaller than normal and with a large holdfast root system. Among the associated species at the type locality for var. *kipahuluensis* are *Hymenasplenium unilaterale*, *Athyrium microphyllum* (stunted), *Thelypteris globulifera*, *Broussaisia arguta*, *Carex alligata* (stunted), *Clermontia arborescens*, *Prunella vulgaris* (weedy alien), *Metrosideros polymorpha*, and *Vaccinium dentatum*. Those of the associates that are normally forest trees or shrubs are at this site mostly small, juvenile individuals. Most of the vegetation is stunted, as a result no doubt of the lack of a well-developed soil layer and occasional catastrophic flooding by water from storms.

ASPLENIACEAE

ASPLENIUM SPECIES

The widespread *Asplenium horridum* undergoes considerable individual variation, including forms that have been described as separate species. We cannot support Robinson's taxon *Asplenium glabratum* as a separate species. The character distinguishing it from *A. horridum* is few or no scales on the frond, but this is a highly variable condition, differing in different collections and even on different fronds of the same plant. We see no reason to uphold it as a taxon at any level. Another variant, *Asplenium mirabile*, was described by Copeland (Philip. J. Sci. 96: 440. 1914) on the basis of a peculiar specimen from Kauai (Kealia, 300 ft, Jan 19, Faurie 239; holotype at MICH!). We first thought it was a hybrid. The frond is



FIG. 11. *Cyclosorus boydiae* var. *kiahuluensis*. Holotype; note the extensive root system "holdfast."



FIG. 12. *Cyclosorus boydiae* var. *kipahuluensis*. Middle of frond of living plant, showing the long pinnae stalks and translucent veins and margins.

old and had shed most of its narrow black fibrillae. Without question it is merely a bizarre form of *A. horridum*, as demonstrated not only by the type of scales but also by the lower pairs of pinnae. The primary distinction from the typical form of that common species is that the pinnae are not merely lobed but are very deeply pinnatisect and pointed. An even more extreme form is shown in Fig. 13 (Molokai, Mopuleka Valley, Sep 1912, *C. N. Forbes 598M*; MICH). In this specimen, which is a younger frond than that from Kauai, all of the indument is still present. This, plus the form of the basal pinnae, supports the contention that "*A. mirabile*" is merely an individual variant. Although the Kauai specimen has discharged all of its spores, the one from Molokai still shows sori full of spores, and these are normal. The taxon, recognized for its unique appearance, should be named ***A. horridum* f. *mirabile*** (Copel.) W. H. Wagner, comb. nov. (basionym cited above).

What we presently interpret as a single species, *Asplenium kaulfussii* Schlecht., was considered by Hillebrand (1888) to comprise six species (*A. kaulfussii*, *A. enatum* Brack., *A. mannii* Hillebr., *A. bipinnatum* Hillebr., *A. lydgatei* Hillebr., and *A. meiotomum* Hillebr.). Hillebrand wrote that "to unite the six...species into one did not seem advisable on account of the great diversity of the extreme forms on one hand, and because the material collected until now leaves some gaps yet in the succession of forms." In this case, apparently, the variations seemed so extensive that Hillebrand was forced to break them up, probably not considering that the situation was matched by a number of other Hawaiian ferns. For three of the species he recognized he used the same varietal epithets, namely var. *gemmiperum* and var. *dareoides*, to indicate the two distinct conditions in each. In our opinion, all of these taxa represent mere variations of a single, extremely mutable species. Of Hillebrand's varieties the least significant ones are his three varieties *gemmiperum* because on any given plant some leaves may be proliferous and others non-proliferous. The most notable are his three varieties *dareoides*, distinguished by the bipinnate condition and the segments oblong-cuneate to linear (see Fig. 14); this form apparently usually has all leaves similarly cut (except for rare individuals with partial reversion to the once-pinnate condition). These very striking plants have been frequently collected on Oahu, so we recognize them taxonomically. Because of the sporadic occurrence, however, we treat them as a form: ***Asplenium kaulfussii* f. *dareoides*** (Hillebr.) W. H. Wagner, stat. nov. (basionym: *Asplenium kaulfussii* var. *dareoides* Hillebr., *Flora of the Hawaiian Islands*, 593. 1888).

Asplenium trichomanes is worldwide one of the best known ferns associated with rocky habitats. It has an enormous range, one of the most widespread of all pteridophytes, and includes a number of subspecies. In Hawaii it is known only from East Maui and the island of Hawaii. As Hillebrand pointed out, "The Hawaiian plants have an unusually strong rootstock." The very numerous stipes in mature plants from many offsets form a strikingly dense, solitary mass up to 10×4 cm (see Fig. 15). This unusual characteristic seems to be unknown elsewhere in the range of *A. trichomanes*, and Brackenridge appreciated the extraordinary growth habit by recognizing *Asplenium densum* (U.S. Expl. Exped. 16: 151, t. 20, f. 3. 1854). We believe that the Hawaiian taxon is morphologically too similar otherwise to *A. trichomanes* to be considered a separate species. In recognition of its peculiar morphology, however, we treat it as a subspecies, ***Asplenium trichomanes* subsp. *densum*** (Brack.) W. H. Wagner, comb. et stat. nov. (basionym cited above).



FIG. 13. *Asplenium horridum* f. *mirabile*. Deeply dissected form; note the nearly undivided basal pinna (lower left).



FIG. 14. *Asplenium kaulfussii* f. *dareoides*. Note dissection of pinnae into linear pinnules.



FIG. 15. *Asplenium trichomanes* subsp. *densum*. Dried specimen of a fully developed plant found growing on exposed aa rock. Note dense clusters of fronds and multiple connected rhizomes; this specimen is 4 cm thick after pressing.

One of the most striking rain forest ferns of Kauai is the finely dissected *Asplenium schizophyllum* C. Chr. Brackenridge in 1854 gave it the appropriate name *A. dissectum*, but this name was already occupied; accordingly, Christensen (1906) provided the new name *A. schizophyllum*. This species grows only on Kauai and on Hawaii, a curious distribution pattern involving only the two ends of the high island chain. A similar but undoubtedly related species is known only from East Maui; it differs in a number of characters and is described below as *A. haleakalense*. Apparently this spleenwort was first noticed by Mann and Brigham, who designated it on a herbarium label (BISH) as "*Asplenium dissectum* Brack. v. *minus composita*." The two taxa may be distinguished by the following couplet:

- Fronds 4-pinnate, deltate to deltate-lanceolate, up to 60 cm long; lowest pinnae equal to or slightly longer than those above; lower stipe lacking scattered glands; sori 2.9 (2–4) mm long; indusia delicate, 0.5–0.7 mm wide. *A. schizophyllum*.
Fronds 3-pinnate, deltate-lanceolate to lanceolate, up to 40 cm long but mostly 2/3 or less that length; lowest pinnae equal to or shorter than those above; lower stipe with scattered minute glands; sori 3.5 (2.8–4.5) mm long; indusia leathery, 0.6–0.9 mm wide. *A. haleakalense*.

Asplenium haleakalense W. H. Wagner, sp. nov.—TYPE: MAUI. North slope of Haleakala, 20 Aug 1919, C. N. Forbes 1214M (holotype: BISH!). Fig. 16.

A. schizophylli simile, sed tripinnatum, frondibus lanceolatis vel lineari-lanceolatis, 30 (20–60) cm longis, pinnis infimis plerumque reductis, 5 (2.5–10) cm longis; stipes inferus glandulis angustis albis instructus; sori 3.5 (2.8–4.5) mm longi.

Similar to *A. schizophyllum*. Rhizomes short-creeping. Scales dark to blackish, narrow, commonly with extremely sclerified tip 1/3–4/5 the length of the scale. Stipe base in lowest 1–5 cm with scattered narrow, white, gland-tipped 1-celled hairs, 0.1–0.2 mm long (these apparently falling from old stipes). Lower ultimate segments mainly wedge-shaped. Sori 3.5 (2.8–4.5) mm long.

Rare in wet forest on tree trunks, fallen logs, and mossy banks, 1700–2000 m.

ADDITIONAL SPECIMENS EXAMINED. MAUI: Haleakala, Nature Conservancy Waikamoi Preserve, below Hosmer Grove, wet forest at ca. 1800–1830 m, 5 Mar 1988, W. L. Wagner et al. 5821 (BISH); forests below Puu Luau, 5600 ft, 18 Oct 1979, R. Hobdy 694 (BISH); Kipahulu Valley, Haleakala National Park Service Expedition III, west camp, *Metrosideros-Cheirodendron-Vaccinium* forest on slope in partial shade, 3 Mar 1984, C. A. Russell 565 (BISH); Wai Anapanapa, Haleakala, Kipahulu-Kuhiwa divide, 2000 m, rain forest near tree line, H. St. John & H. L. Mitchell 21005 (BISH); forest below Puu Luau, 6000 ft, 20 Mar 1984, R. Hobdy 2026 (2 sheets, one a dwarf, BISH); upper Waikamoi Forest, 6200 ft, 27 Mar 1987, W. L. Wagner 87143 et al. (extremely large specimen, MICH).

ASPENIUM HYBRIDS

In temperate North American and European floras the genus *Asplenium* is noted for its numerous interspecific hybrids. Most of these, however, involve the small, less than 25 cm tall, rock-inhabiting species. In the tropics, few hybrids have been reported between the large-statured terrestrial or epiphytic species that reach frond lengths of over 75 cm. We have now encountered several hybrids in Hawaii, only one of which involves species that are relatively small and appear to be related to temperate species; we describe this hybrid below. We also present a key to the very large hybrids, and describe two of them.

Since our description of *Asplenium hobdyi* (Wagner 1993), at that time known only from Molokai, Maui, and Hawaii, we have discovered it along the Kauaiki-nana Stream below Pihea Trail in the Kokee region of Kauai. More recently the following remarkable hybrid was found there by D. Palmer and T. Flynn.



FIG. 16. *Asplenium haleakalense*. Holotype; note relatively small size and lanceolate, 2-pinnate blades.

Asplenium ×flagrum W. H. Wagner & D. D. Palmer, nothosp. nov.—TYPE: KAUAL. Kokee, Kauaikinana Stream, on the open slope from the Pihea Trail, down to the stream, large colony, 24 Aug 1993, *D. D. Palmer & T. Flynn 2000* (holotype: BISH!). Fig. 17.

Hybrida inter *A. hobdyi* et *A. normale* intermedia, et proliferationibus multis rhachidi adaxiali et poliferaione terminali singulari instructa, forma frondis pinnaeque ubique intermedia; sporangia plerumque abortiva ante maturationem, tantum aliquot sporis abortivis factis.

Intermediate between *A. hobdyi* and *A. normale*. Stipe-base scales narrowly triangular, clathrate, nearly black. Upper part of frond elongate, gradually narrowed and whiplike, with propagules borne one at the tip or 1–5 at intervals of 1–9 cm along the upper rachis. Blade 1-pinnate, linear, 30–60 × 1–3 cm. Pinnae short-stalked to sessile, alternate, oblong-dimidiolate, the anterior margins coarsely and shallowly crenate with 3–6 marginal projections to entire. Lamina glabrous, chartaceous to coriaceous, dark green; 4–7 veins on the anterior side of the pinna. Sori with rather thick indusia. Sporangia mostly abortive, dying at a uniform age; only a few sporangia among hundreds maturing in the sori and producing notably abortive spores.

The hybrid is remarkable in two respects. The proliferations combine two conditions, that of *A. normale* (a single terminal proliferation that is encased in 1–3-folded pinnae) and that of *A. hobdyi* (several proliferations along the upper rachis and with normal foliar termination); the *A. normale*-like proliferations are reduced in relative size in the hybrid. The sori show the rare condition of almost completely abortive sporangia (Wagner & Chen 1965). The sporangial abortion is unusual in that practically all the sporangia appear to stop growth at a certain stage and thus produce a mat of uniformly immature sporangia punctuated very rarely by one or more fully developed sporangia. *Asplenium ×flagrum* is predicted to be a hexaploid with 432 chromosomes, as apparently *A. hobdyi* has 144 chromosomes and the Hawaiian *A. normale* (unlike earlier reports from elsewhere) has 288 chromosomes (F. S. Wagner, unpubl.). Further studies of this noteworthy plant should be made.

The three large-fronded hybrid combinations so far discovered, *A. ×kokeense*, *A. ×sphenocookii*, and *A. ×waikamoi*, may be separated with the following key.

1. Laminas somewhat fleshy, gray-green, dull; veins up to 1.2 mm apart; stalks of lower pinnules 4.5 × 1.0 mm; foliar proliferations frequently present.
A. ×sphenocookii (*A. cookii* × *A. sphenotomum*).
1. Laminas thin-coriaceous, dark green, shiny; veins up to 0.8 mm apart; stalks of lower pinnules hardly developed; foliar proliferations absent.
 2. Marginal teeth inconspicuous and blunt-pointed, up to 0.2 mm long; lower pinnae narrowly triangular.
A. ×kokeense (*A. aethiopicum* × *A. cookii*; Wagner et al. 1995).
 2. Marginal teeth conspicuous, narrow and sharp-pointed, up to 2.5 mm or more long; lower pinnae linear-attenuate.
A. ×waikamoi (*A. acuminatum* × *A. aethiopicum*).

Asplenium ×sphenocookii W. H. Wagner, nothosp. nov.—TYPE: KAUAL. Kokee State Park, Pihea Trail, ca. 1/4 mi before junction with Alakai Swamp Trail, large clone, 9 May 1987, *T. Flynn et al. 2144* (holotype: MICH!).

Fig. 18.

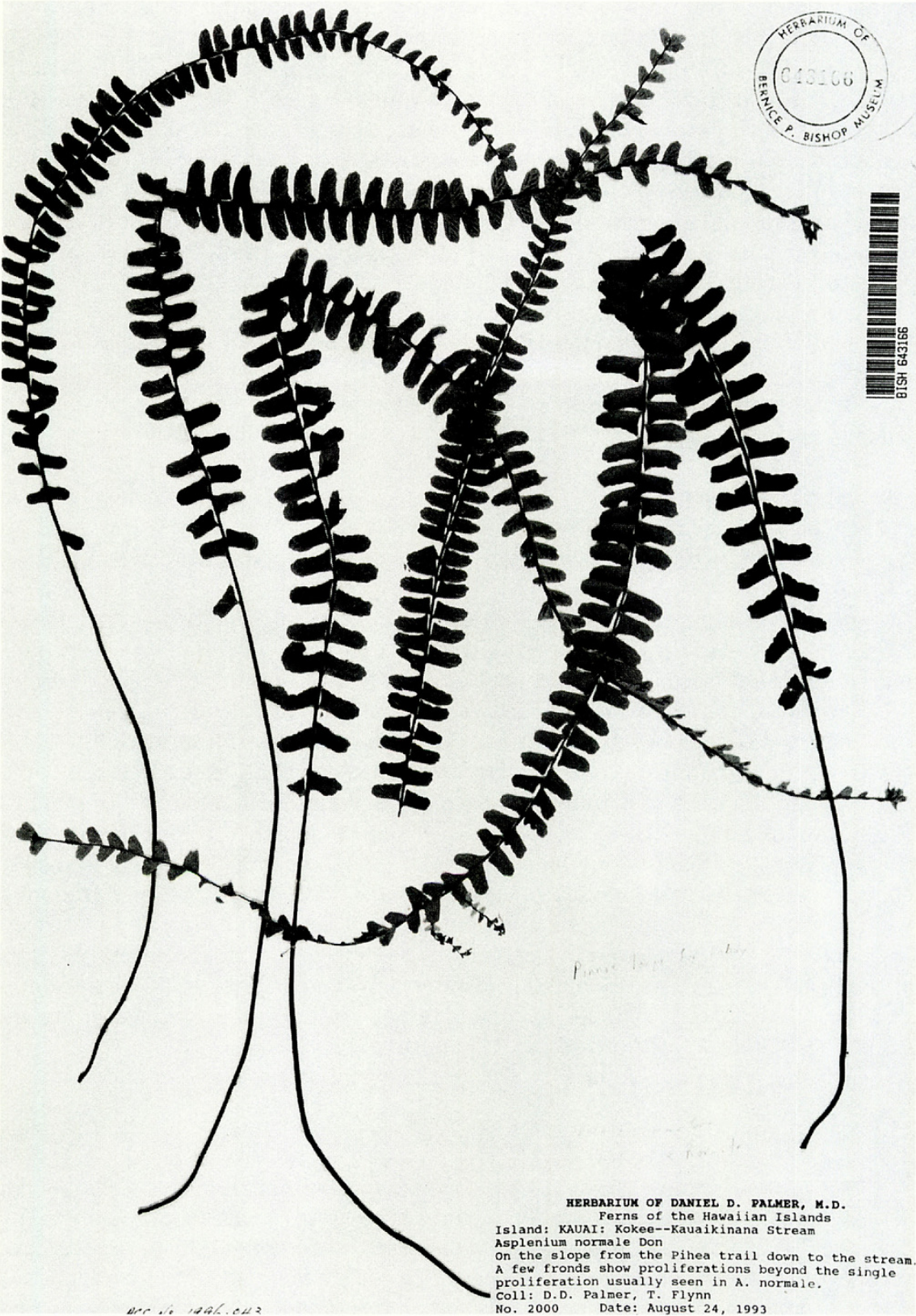


FIG. 17. *Asplenium* \times flagrum (*A. hobdyi* \times *A. normale*). Holotype; note different position of propagules, several arising from upper rachis vs. solitary at tip surrounded by clustered pinnae.

Inter *A. cookii* et *A. sphenotomum* intermedia, frondibus aliquantum carnosus, obscure griseo-viridibus, venis usque ad 1.1 mm inter se distantibus, stipitibus pinnarum bene evolutis (4×1 mm), proliferationibus plerumque praesentibus.

Large terrestrial fern intermediate between *A. cookii* Copel. and *A. sphenotomum* Hillebr., forming clones in forest. Rhizomes long-creeping. Trichomes of stipe base linear, $1-3 \times 0.1-0.3$ mm, black. Fronds deltate, 80×25 cm. Stipes $35 \times 0.3-0.4$ cm, dark purple gray. Blades bipinnate, deltate, 55×25 cm. Proliferations few, scattered, in upper half of pinnae and near frond tips. Rachises dark gray except in terminal 10–15 cm. Pinnae usually 20 pairs, elongate-deltate, somewhat attenuate. Pinnules elongate-deltate, usually basally auriculate on anterior side, or on both sides of basal pinnules, stalked in lower pinnae, the stalks 4.5×1.0 mm. Margins coarsely round-dentate. Trichomes absent. Texture thick; lamina easily cracked when bent, gray-green. Veins widely separated, mainly 0.9–1.1 mm apart. Sori extremely oblique, subparallel to costules, up to 1.5 mm long; indusia thick, white; spores abortive.

Three clones are known in rain forest near a trail in Kokee State Park on Kauai at 3950 ft.

Asplenium* × *waikamoi W. H. Wagner & D. D. Palmer, nothosp. nov.—TYPE: MAUI. Waikamoi Forest preserve, several hundred feet below road to Waikamoi Flume, 12 Nov 1997, *J. Lau* 2809 (holotype: MICH!). Fig. 19.

Inter *A. acuminatum* et *A. aethiopicum* intermedia, frondibus textura tenui-coriacea, nitido-viridibus, venis usque ad 0.8 mm inter se distantibus, dentibus marginalibus conspicuis acutisque, proliferationibus absentibus.

Terrestrial fern intermediate between *A. acuminatum* and *A. aethiopicum*, forming extensive clones in wet forest. Rhizomes not seen but apparently wide-creeping. Fronds elongate to triangular, up to 80×40 cm. Stipes dark purple, dull, up to 25 cm long, 3.5 mm wide near base. Blades bipinnate, elongate-triangular. Proliferations absent. Rachises dark purple, dull. Pinnae up to 30, linear to lanceolate. Pinnules mainly long-lanceolate and attenuate, but commonly narrowly cuneate, slightly or not auriculate, lacking a well-defined stalk, merely gradually widening from base. Margins deeply dentate with narrowly linear short teeth up to 2.5 mm long. Texture thin but coriaceous, laminas dark green and shiny. Veins strongly ascending to nearly parallel, close, mainly 0.4–0.8 mm apart. Sori submedial to medial, strongly oblique, leaving bare non-soriate lamina in distal 1/4 to 1/2 of pinnules; indusia thin, narrow; spores abortive.

Only one large population is known, on East Maui, on the slopes of Haleakala.

DIELLIA

One of the most interesting endemic genera of Hawaiian ferns is *Diellia* (W. H. Wagner et al. 1995). Plants of dry forest, most have now become rare or extinct. The only species that occurs on all of the high islands is *D. erecta*. On Kauai we have records of three species: *D. erecta*, *D. mannii*, and *D. pallida*, the latter two endemic there. As far as we know, both *D. erecta* and *D. mannii* are extinct on this island and *D. pallida* nearly so. On Oahu there are still three species: *D. falcata* and *D. unisora*, both local endemics in the Waianae Mountains, and *D. erecta*, known only from two localities on Oahu, both in the southern Koolau Mountains foothills. On Maui, the only other island with more than one species, two are recorded: *D. erecta* and *D. (formerly Asplenium) leucostegioides*. Of these, only the former has been found since 1879.

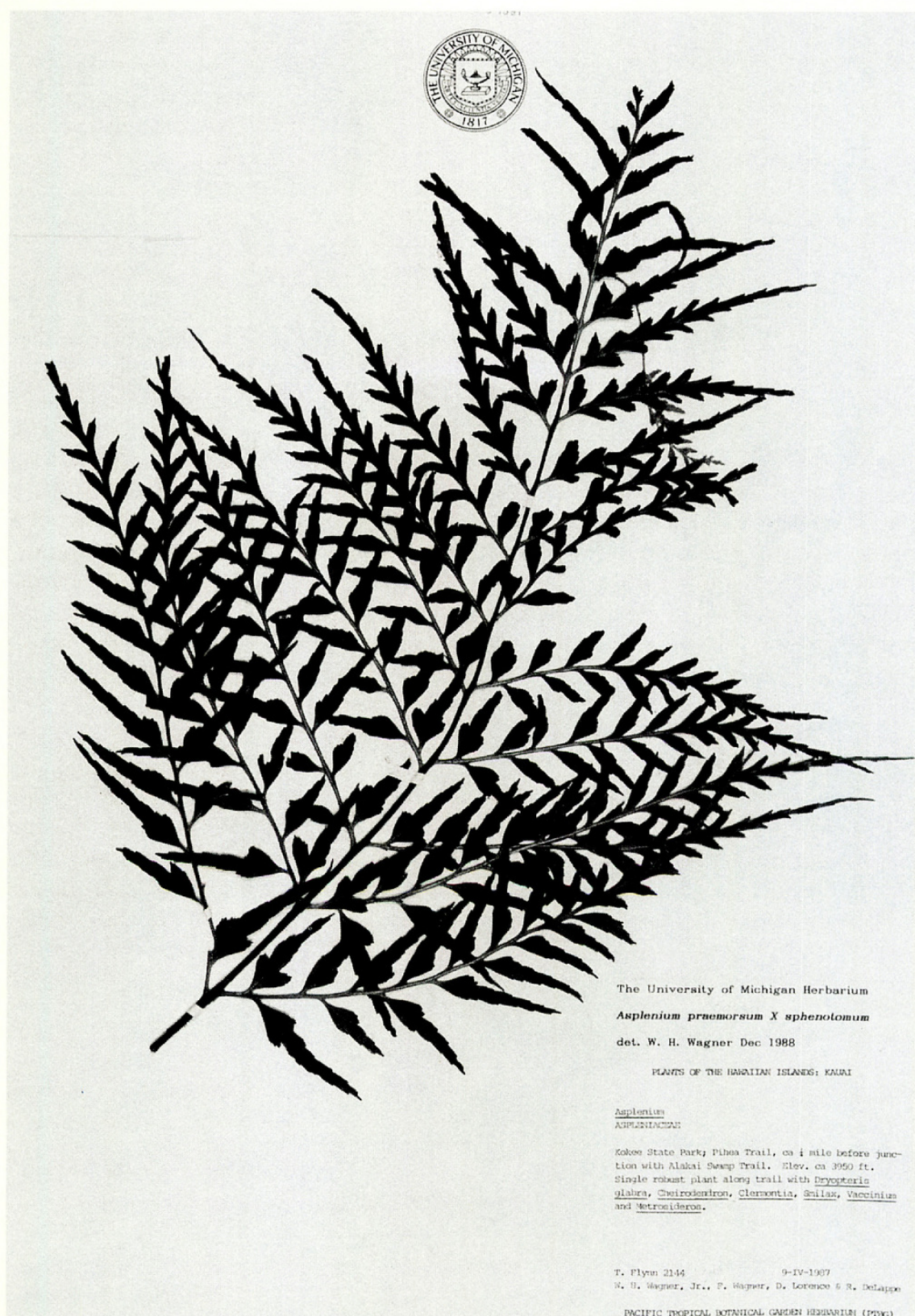


FIG. 18. *Asplenium* \times *sphenocookii* (*A. cookii* \times *A. sphenotomum*). Holotype; note proliferation along upper rachis, stalked lower pinnae, and short, blunt marginal teeth.



FIG. 19. *Asplenium* \times *waikamoi* (*A. acuminatum* \times *A. aethiopicum*). Holotype; note narrow, sharp, strongly ascending teeth.

Joel Lau, of The Nature Conservancy of Hawaii, encountered for the first time two species occurring together, or near each other, in the Waianae Mountains of Oahu. He found there what appears to be a hybrid population of *D. falcata* \times *D. unisora*. The hybrids are apparently unstable, but the specimen chosen as the type of *D. \times lauii*, described below, is approximately medial between the parents. In the same population, however, we found individuals more like *D. falcata* and other individuals more like *D. unisora*. Thus, we are probably dealing with a hybrid swarm involving recombination. Examination of the spores indicates that they are normal, unlike those of many pteridophyte hybrids, and thus capable of reproducing different combinations of the parental genes.

Diellia \times lauii W. H. Wagner, nothosp. nov.—TYPE: OAHU. Waianae Mountains, Honouliuli Preserve, South Palawai Gulch, 720 m, 17 Jun 1991, J. Lau & G. Uchida 3395 (holotype: BISH!). Fig. 20

Inter *D. falcata* et *D. unisora* variabiliter intermedia; *D. falcatae* affinis sed axibus frondium aterioribus nitidioribusque, pinnis distalibus numerosioribus minoribusque, coenosoris numerosioribus.

Variable intermediate between *D. falcata* and *D. unisora*. Mature plants similar to *D. falcata*, but leaf axis, including stipe, somewhat shiny and dark purple. Fronds smaller and narrower. Largest pinnae linear, 30–45 \times 5–7 mm at base and greatly narrowing toward the pointed tip. Apex of frond usually made up of many small increasingly reduced pinnae rather than one large, wide tip. Sori separate except sometimes fused at the base of the pinnae, and tending to become irregular coenosori on the prolonged frond apex. Spores normal.

ADDITIONAL SPECIMEN EXAMINED. OAHU. Waianae Mts, Honouliuli Conservation Preserve, Palawai Gulch, on very steep and rocky slope of loose soil, locally common, ca. 700 m, 9 Jun 1991, W. H. Wagner 91021 J. Lau, D. D. Palmer & F. S. Wagner (holotype: MICH!).

DRYOPTERIDACEAE

DRYOPTERIS

The genus *Dryopteris* has been taxonomically the most difficult of Hawaiian pteridophytes. From our experience thus far, we anticipate that species definitions will be clarified further, and that perhaps still unrecognized species will be revealed. Of the accepted species there are no questions about the distinctness of *D. walli-cheana* (Spreng.) Hyl., *D. subbipinnata* W. H. Wagner & Hobdy, *D. fusco-atra* (Hillebr.) W. J. Rob., *D. hawaiiensis* (Hillebr.) W. J. Rob., *D. crinalis* (Hook. & Arn.) C. Chr., and *D. podosora* W. H. Wagner & Flynn. The major issues arise in two assemblages: those clustering around *D. glabra* (Brack.) Kuntze (ca. 5–7 taxa), and those clustering around *D. unidentata* (Hook. & Arn.) C. Chr. (ca. 3–6) taxa.

Dryopteris nuda Underw. (in Heller 1897) has been a source of confusion caused by the identity of purported isotypes. Underwood's excellent holotype was illustrated by Robinson (1912, pl. 43); it is housed at NY. The data on the specimen are: "Kauai, on the ridge west of the Hanapepe River, in dry woods, 27 August 1895, Heller 2750." The mixture of specimens distributed under Heller's

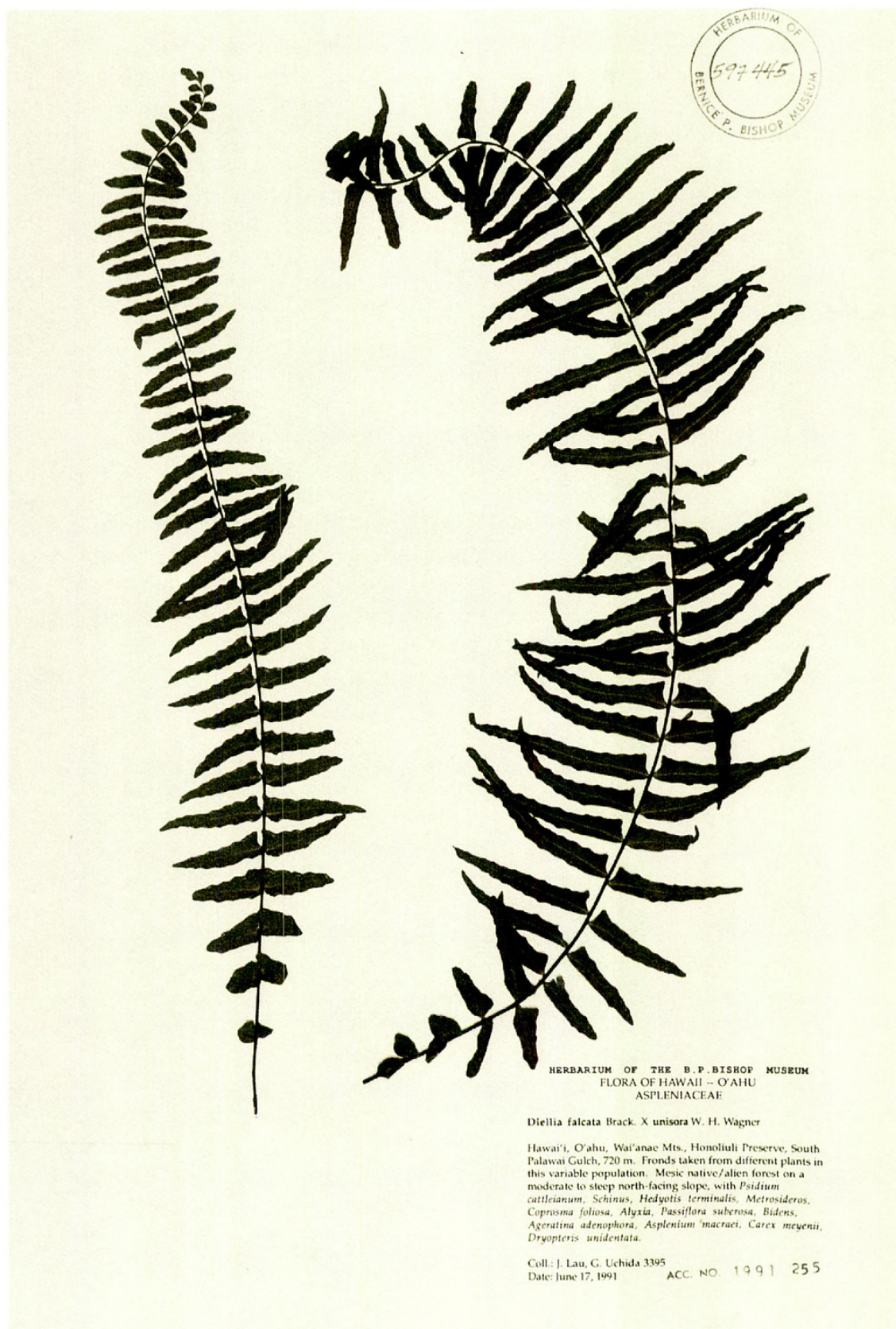


FIG. 20. *Diellia x lauui*. (*D. falcata* × *D. unisora*). Holotype; note numerous terminal small pinnae and narrow black rachis.

field number alleged to be isotypes of this name (e.g., at BISH) are mainly *D. glabra*, as is the specimen at K labeled as the "type" of *D. nuda*. In general, the habitat of true *D. nuda* is dry woods and forest edges, unlike that of *D. glabra*, which tends to grow mostly in rain forest.

There has been widespread confusion about the most common exindusiate dryopterids in Hawaii. The species cited as *D. acutidens* C. Chr. in former checklists has now been identified as ***Dryopteris unidentata*** (Hook. & Arn.) C. Chr. The holotype of *D. unidentata* at Kew is shown in Fig. 21. The species formerly called *D. unidentata* in Hawaii is now known to be *D. sandwicensis* (Hook. & Arn.) C. Chr., and the species formerly referred to as *D. sandwicensis* is now known to be *D. mauiensis* C. Chr. The extent of variation in the exindusiate dryopterids of Hawaii is so great that there may be several additional species involved. For example, the strongly paleaceous fern with abundant large overlapping scales, identified as *D. unidentata* and found around Kokee, Kauai, may be an undescribed closely related species. Thorough exploration for and collecting of this complex are much to be desired. A member of this exindusiate group of species that merits recognition at this time is the essentially glabrous and extremely large, finely divided *D. tetrapinnata*, described below, one of the most spectacular and easily identified ferns in the Hawaiian flora. Herat (1979) treated this fern as a variety of *D. unidentata*, but he wrote "I have not seen this in the field and until more is known I wish to retain it as a variety." Since that time we have examined dozens of examples of this plant, and we have no doubt that it is a distinct species. There is no question either that it belongs to the complex including *D. unidentata*, characterized by the exindusiate sorus borne on the upper branch of the segment veinlets.

Dryopteris tetrapinnata W. H. Wagner & Hobdy, sp. nov.—MAUI: Middle Waikamoi Forest, along road to flume trail, 27 Mar 1987, W. H. Wagner 87161, F. S. Wagner, R. Hobdy & F. Duval (holotype: MICH!). Figs. 22, 23.

Filix gigantea frondibus usque ad 3 m altis, stipitibus squamis nigellis vestitis, usque ad 30×2 m, tetrapinnatis, segmentis ultimis lobisque minimis, $2-6 \times 0.8-1.5$ mm, soris submarginalibus exindusiatisque.

A huge and beautiful fern with very finely divided fronds. Stipe base scales long and narrow, up to 30×2 mm, dull blackish brown. Fronds oblong-ovate, up to 3×1.5 m, the stipe up to 1×0.1 m. Blade tetrapinnate with up to 25 pinna pairs. Ultimate segments or lobes with acute tips, $2-6 \times 0.8-1.5$ mm. Rachis stramineous. Rachis and costa with scattered, fine, somewhat clathrate scales. Veinlets 1-5 per ultimate segment. Sori submarginal, indusia absent.

Dryopteris tetrapinnata is confined to the Waikamoi forest area, in deep very wet forest, at ca. 1000-1400 m. It is found only on the slopes of Haleakala. If raised from spores, it would make an excellent addition to a shady, moist tropical glass-house in temperate climates.

ADDITIONAL SPECIMENS EXAMINED. MAUI: Olinda Water Reserve, Waikamoi, Pipeline Trail, 11 Aug 1965, W. H. Wagner 65464, E. Bonsey & M. Tessene (MICH); Haleakala, Ukulele, 25 Jul 1919, C. N. Forbes 915M (A, BISH-3 sheets, MICH); Pipeline Trail, Olinda, 29 Jun 1927, O. Degener 28073 (MICH); Olinda Water Reserve, wet habitat, 11 Aug 1951, H. L. Bonsey 187 (MICH-2 sheets);



FIG. 21. Type specimen of *Polypodium unidentatum* (= *Dryopteris unidentata*) at K. Note positions of the pinnae and remote narrow pinnules, and especially the small narrow scales along the rachis.

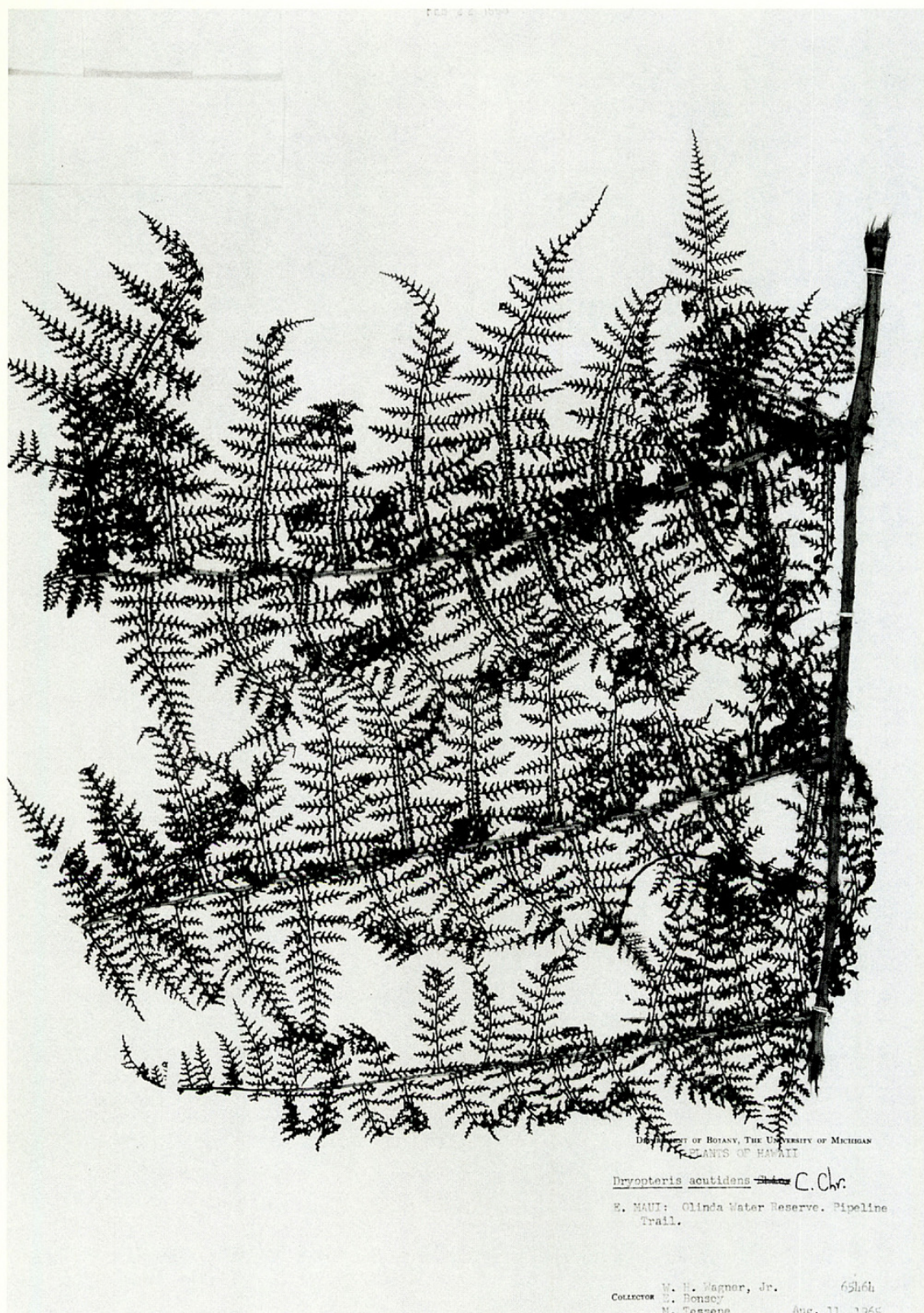


FIG. 22. *Dryopteris tetrapinnata*. Note extremely dissected pinnae, these from approximately the middle of the frond.

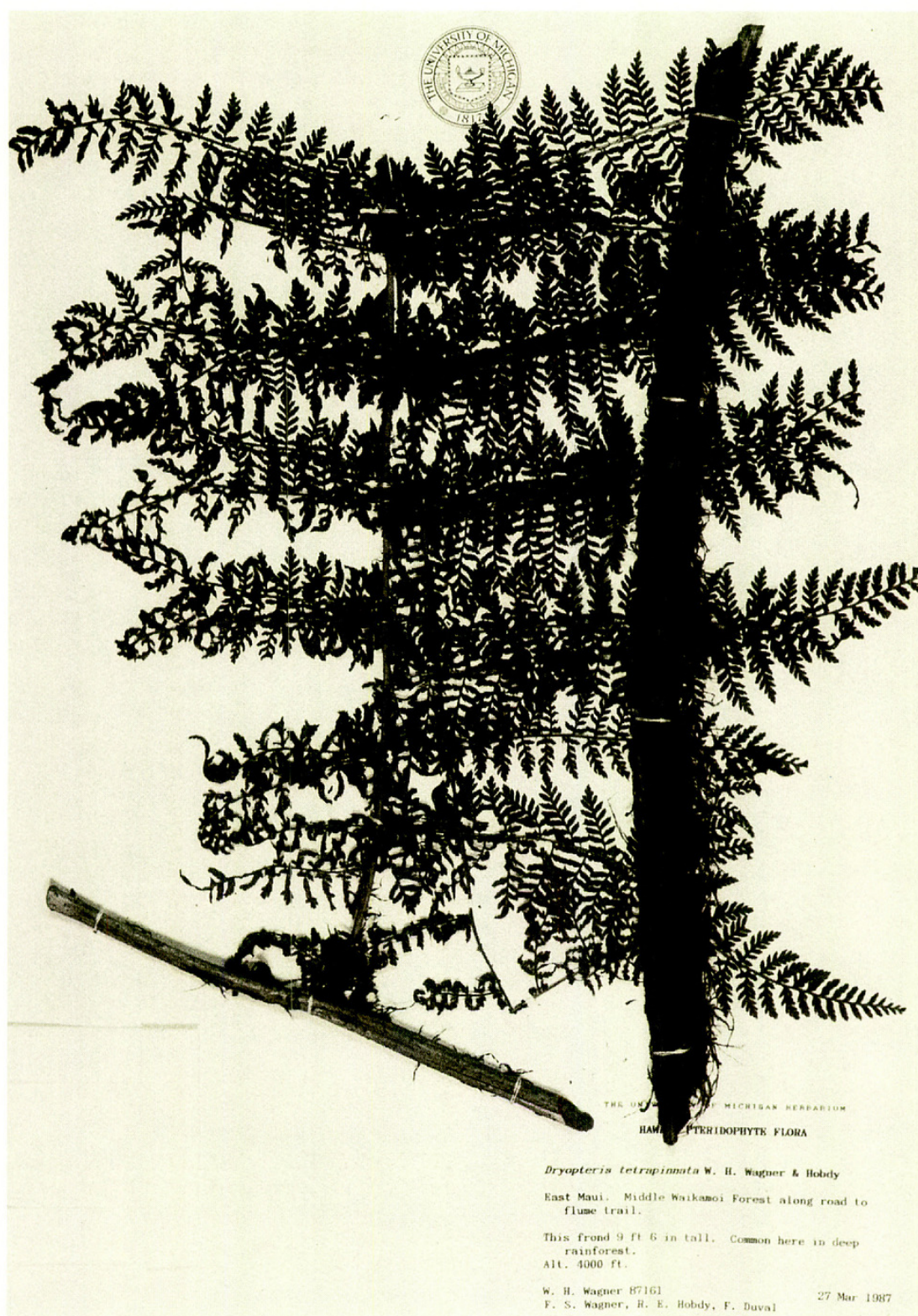


FIG. 23. *Dryopteris tetrapinnata*. Holotype; note massive lower stipe with dense, long, nearly black scales.

Middle Waikamoi Forest along road to flume trail, 4000 ft, 27 Mar 1987, W. H. Wagner 87149, F. S. Wagner, R. Hobdy & F. Duval (MICH-2 sheets; juvenile frond), W. H. Wagner, et al. 87161 (MICH); Jule Slope, ca. 5000 ft, 7 Apr 1960, C. N. Forbes 2166 (BISH-3 sheets); Pipeline, 7 Feb 1928, H. L. Lyon s.n. (BISH-4 sheets); Waikamoi Flume Road, 4200 ft, 22 Jun 1980, R. Hobdy 842 (BISH), 19 Dec 1979, R. Hobdy 738 (BISH), 24 Sep 1980, R. Hobdy 883 (BISH).

Dryopteris alboviridis W. H. Wagner, sp. nov.—TYPE: KAUAI. Kokee, Pihea Trail, 9 Apr 1987, W. H. Wagner 87175, F. S. Wagner, T. Flynn & D. Lorence (holotype: MICH!). Fig. 24.

Frondes tripinnatae, ovato-lanceolatae, parum attenuatae; pinnae infimae pin-nulis basalibus proximalibus aliquantum auctis; lamina crassa, chartacea, cinereo-viridis, glabra praeter fibrillas sparsas axibus majoribus; axes pinnarum cristis adaxialibus instructi; sori supra medium distantiae inter costam et marginem positi, indusiati.

Glabrous fern of steep rain forest slopes. Rhizome short-creeping. Scales of stipe base brown, linear to elongate-triangular, $4-6 \times 0.3-1.1$ mm. Fronds 45–60 cm long including the pale green stipe 15–20 cm long. Blade 3-pinnate, ovate-lanceolate, somewhat attenuate, widest at second pinna pair. Rachis yellowish. Adaxial pinna axes with raised ridges. Pinnae 12–18 pairs per pinna, lowest pinna pairs $12-16 \times 4-6$ cm. Lowest pinnae with moderately exaggerated basal proximal pinnules. Pinnules oblong to lanceolate, up to $2.5-4 \times 1-2$ cm, with slightly rounded tips. Margins mostly very coarsely crenate to pinnatifid to pinnatisect. Frond glabrous except for scaly stipe base and widely scattered fibrils on larger blade axes. Texture thick chartaceous. Color whitish to gray-green (alive). Tertiary veinlets $2.5\times$ -forked. Sori 8–10 mm in diameter, supramedial, indusiate.

This species occurs on the lower slopes of steep, wet gulches where a number of other rare species exist, including *Dryopteris parvula*, *D. podosora*, *Sadleria wagneri*, and *S. unisora*. *Dryopteris alboviridis* differs from *D. glabra*, which grows with it on the same slopes, in several characters. *Dryopteris glabra* has a medium to dark green color, finer cutting (up to 4 times), with smaller ultimate segments, more pointed pinna tips, crenate-dentate margins, thin herbaceous texture with conspicuous veins, narrower vein interval, and smaller sori 6–8 mm in diameter.

ADDITIONAL SPECIMENS EXAMINED. KAUAI: below trail from Mohihi road to Pihea Peak (ca. 50 m beyond end of boardwalk), abundant, 6 Feb 1995, Wagner 95001, F. S. Wagner, T. Flynn & D. D. Palmer (MICH); Kumuwele Ditch Trail, along border between Kokee State Park and Na-Pali-Kona Forest Preserve, 3600–3800 ft, $159^{\circ}39'W$, $22^{\circ}07'N$, common along trail near dry southern end, M. R. Crosby & W. R. Anderson 2018 (MICH); summit of Mt. Waialeale, 17 Aug 1965, M. Tessene W65498 (MICH); Kokee State Park, Na-Pali-Kona Forest Reserve, 4060 ft, 10 Jun 1990, W. L. Wagner & D. Lorence 6371 (MICH-2 sheets); woods of Wahiawa, Aug 1908, J. F. Rock s.n. (MICH).

Described below is one of the most distinctive *Dryopteris* species in the islands, occurring in East Maui in an entirely different habitat—on the mainly dry, windswept rim of Haleakala crater. Compared to other members of the *Dryopteris glabra* group, *D. hobdyana* is distinguished by its large size, 3-dimensional fronds, the usually ascending to upright pinnae, the massive rhizome, and abundant, flattened, deciduous scales along the stipe and rachis. We believe that it exists only in the exposed rim zone of the volcano. Because of their curious usually folded nature, the fronds are difficult to spread out and press. This species needs additional field study, especially in connection with possible contacts and hybridization with the common *D. glabra* in wetter areas, downslope from the rim occurrences of *D. hobdyana*.

Dryopteris hobdyana W. H. Wagner, sp. nov.—TYPE: MAUI. Ridgetop east of Hanawi Stream, growing in a subalpine clearing at the upper edge of dense forest, 7100 ft, 22 Jun 1995, R. Hobdy 3832 (holotype: MICH!). Figs. 25, 26, 27.



FIG. 24. *Dryopteris alboviridis*. Holotype; note cutting (coarser than in *D. glabra*) and oblong pinnules with relatively low and wide crenations.

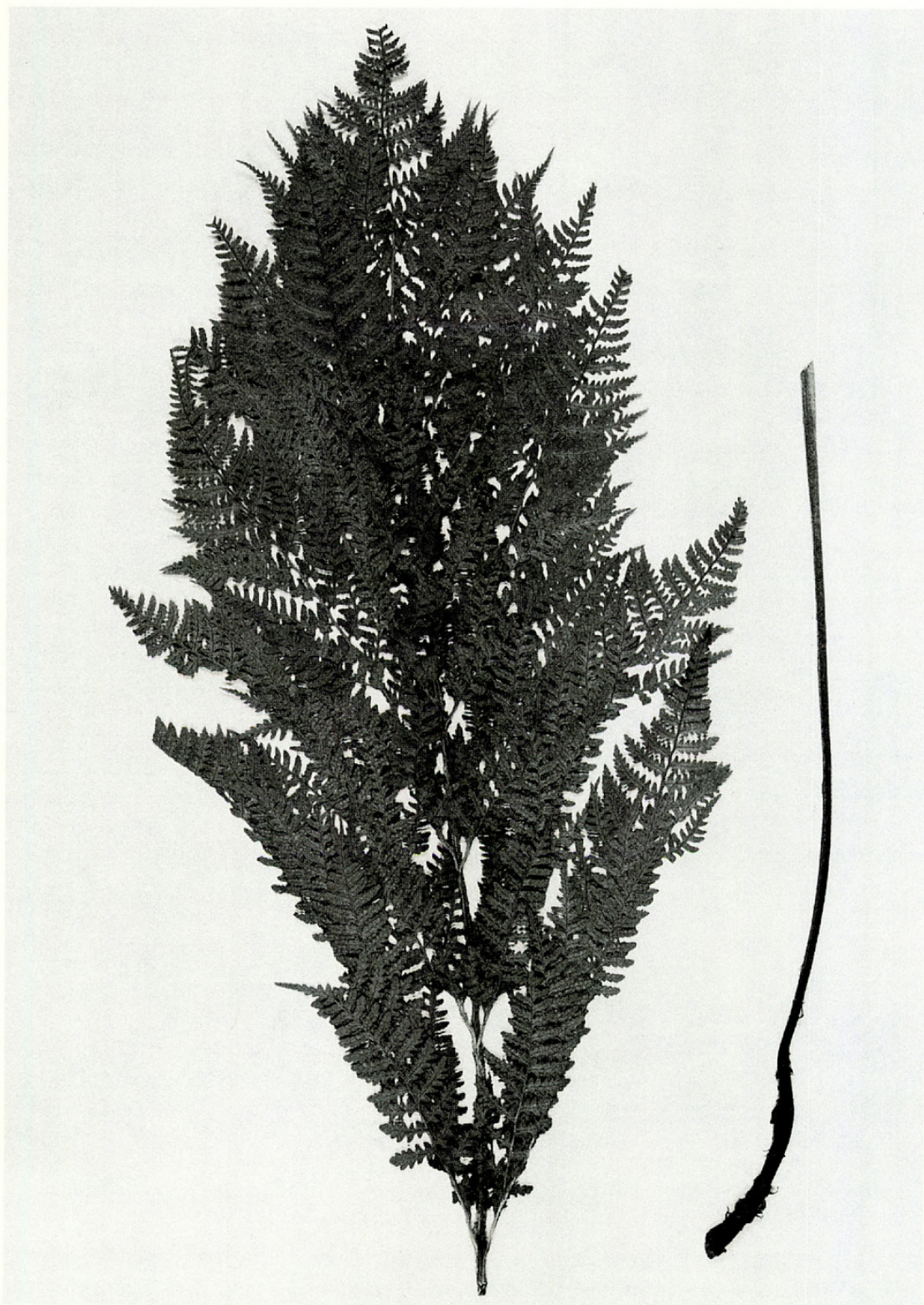


FIG. 25. *Dryopteris hobdyana*. Specimen showing the orientation of the pinnae and the effect of handling of the stipe with resultant loss of the scales.



FIG. 26. *Dryopteris hobdyana*. Habit in living state; growing in prairie-like exposed habitat.

Rhizoma magnum, ramosissimum, usque ad 40 cm diametro; stipes rhachisque fibrillis imbricatis et squamis appressis dense tecta (foliis veteribus exceptis); pinnae plerumque valde ascendentes et plicatae.

Ferns with densely scaly stipes and rachises. Rhizomes short-creeping to erect, massive, multi-branched, up to 40 cm across. Stipe base scales overlapping, thin, gray-brown, curly, variable in size, up to 2×0.4 mm. Fronds deltate, often appearing narrowly deltate to sub lanceolate overall, due to pinnae ascending, overlapping,



FIG. 27 *Dryopteris hobdyana*. Base of blade, showing the pinna orientation and especially the dense, overlapping scales along the stipe.

and folding. Stipes up to 35 cm long. Blades tetrapinnate, 15–85 × 8–35 cm (nearly non-ascending, shade form). Rachis brown to purplish, shiny, but in younger and medium-sized fronds covered abundantly with overlapping thin flat scales to narrow fibrils. Pinnae up to 20 pairs, lanceolate. Pinnules linear-lanceolate, ultimate segments oblong to ovate, stalked to broadly adnate. Margins denticulate. Laminar trichomes flat, overlapping, gray-tan scales along rachis and major costae, and

minute widely scattered shining golden glands along the abaxial segment axes. Texture firm herbaceous. Color dull green. Veins closely set, corresponding to teeth of ultimate segments. Sori 0.5–0.9 mm in diameter, with tiny indusia.

Dryopteris hobbiana is common in mostly open sites above 6000 ft.

ADDITIONAL SPECIMENS EXAMINED. MAUI: slopes and rim of Haleakala, woods near Ukulele, above Olinda, Jul 1910, *C. N. Forbes 167M* (BISH); Keanae Top, 3 Aug 1919, *C. N. Forbes 1022* (BISH); N slope, 17 Aug 1919, *C. N. Forbes 1066* (BISH-2 sheets), 20 Aug 1919, *C. N. Forbes 1223* (BISH); bogs below Waianapanapa, 23 Aug 1919, *C. N. Forbes 1229M* (BISH); foot of pali, east of Waikikeia, moist wooded gulch, 25 Dec 1926, 6000 ft, *H. St. John 17772 & R. J. Catto* (BISH); ridgetop east of Hanawi Stream, "arising from a dense mat of last season's marcescent fronds," 7100 ft, 22 Jun 1995, *R. Hobdy et al. 3832* (MICH), 26 Jun 1994, *R. Hobdy 3675* (MICH-4 sheets).

NEPHROLEPIDACEAE

NEPHROLEPIS

Approximately 30 often poorly understood species of this genus occur in the tropics and subtropics, especially in southeastern Asia. Two native and two naturalized orthospecies and two nothospecies (described below) are known in Hawaii. *Nephrolepis* is a popular genus for horticulture, especially for those who have difficulty growing plants. The Boston fern, *N. exaltata* cv. *bostoniensis*, and its many derivatives are, if anything, too successful. In Hawaii, the weedy roadside swordfern, *N. multiflora*, is extraordinarily abundant in certain areas, especially on rock cliffs and old lava fields. Below is a key to the taxa in Hawaii that are known to participate in the formation of hybrids.

1. Adaxial groove of pinna with erect, short hairs; stipe base with imbricate, dark brown, pale-margined scales; sori submarginal. *N. multiflora*.
1. Adaxial groove of pinna without hairs; stipe base lacking scales; sori supramedial to medial.
 2. Pinna apices coarsely and rather deeply dentate; tubers occasionally produced; adaxial rachis scales bicolorous (darker at attachment), commonly dense; sori medial. *N. cordifolia*.
 2. Pinna apices shallowly dentate to nearly entire; tubers absent; adaxial rachis scales concolorous, dense to sparse; sori supramedial. *N. exaltata* subsp. *hawaiiensis*.

We compared mature Hawaiian material of *N. exaltata* (at MICH and US) with numerous specimens from the Caribbean region (Table 1) and recognize the Hawaiian populations as a new subspecies. If a world monograph of this difficult genus is carried out, it is possible that the Hawaiian taxon will be shown to represent a distinct species.

***Nephrolepis exaltata* (L.) Schott subsp. *hawaiiensis* W. H. Wagner, subsp. nov.—**

TYPE: OAHU. Waianae Mts, Kanehoa Trail, SW of Kunea, abundant along trail, 27 Aug 1961, *W. H. Wagner 9621*, *B. Stone*, *P. Hill*, *S. Carlquist*, *R. B. Thorne & R. A. White* (holotype: MICH!).

Differt a var. *exaltata* pinnis mediis fere horizontalibus, latoribus, 10.8 (6–16) mm latis, plerumque sine auricula antica, coriaceis; 5–12 pinnae proximales soris irregulariter et late dispersis.

Rhizomes scales very dark chestnut brown; rachis usually glabrous; pinnae horizontal, 10.8 mm average width, the anterior basal auricle mostly absent or poorly developed, tapering abruptly to rounded tip, coriaceous; lower pinnae with irregularly scattered, strongly separated sori.

TABLE 1. Comparison of *N. exaltata* subsp. *exaltata* and subsp. *hawaiiensis*.

	<i>N. exaltata</i> subsp. <i>exaltata</i> (Caribbean)	<i>N. exaltata</i> subsp. <i>hawaiiensis</i> (Hawaii)
Adaxial rachis	Scaly to glabrous	Mainly glabrous
Middle pinna orientation	Somewhat ascending	Nearly horizontal
Medial pinna width	10.3 (6–12) mm	10.8 (6–16) mm
Anterior pinna auricle lower one-third	Well developed, overlapping rachis; only occasionally reduced	Mostly absent or slightly developed
Pinna tip	Tapering gradually to pointed tip	Tapering abruptly to rounded tip
Upper pinna margin	Shallowly serrulate	Entire to slightly crenulate
Texture	Chartaceous	Coriaceous
Soriation in lower pinnae of fertile frond	More abrupt change from soriolate to non-soriolate, and more regular (involving 2–8 lower pinnae)	More gradual change to non- soriolate, more irregularly and widely spaced (involving 5–12 lower pinnae)

Crosses between the introduced *N. multiflora* and the native species are occasionally encountered, these often forming extensive clones with abortive spores. Both hybrids described here have at least some hairs in the adaxial costal groove that characterizes the weed species. The hybrids may be recognized by characters intermediate between the parents; however, different fronds in the respective hybrid clones are highly variable, so that field collections should be ample enough to show the central tendencies.

Nephrolepis* × *medlerae W. H. Wagner, nothosp. nov.—TYPE: OAHU. Aiea, ridge trail, one large colony on both sides of trail, also partially epiphytic, ca. 1600 ft, 12 Jun 1991, W. H. Wagner 91025, F. S. Wagner, J. Obata & D. D. Palmer (MICH). Fig. 28.

Inter *N. exaltata* subsp. *hawaiiensis* et *N. multiflora* intermedia; pinnae mediae usque ad 7 × 1.4 cm; pinna apice attenuato-acuta, integra vel non profunde crenata; pinnae proximales rotundatae et soros fortuito et sparsim dispersos ferentes; rhachis squamis deciduis pallide badiis instructa; auricula antica debiliter evoluta.

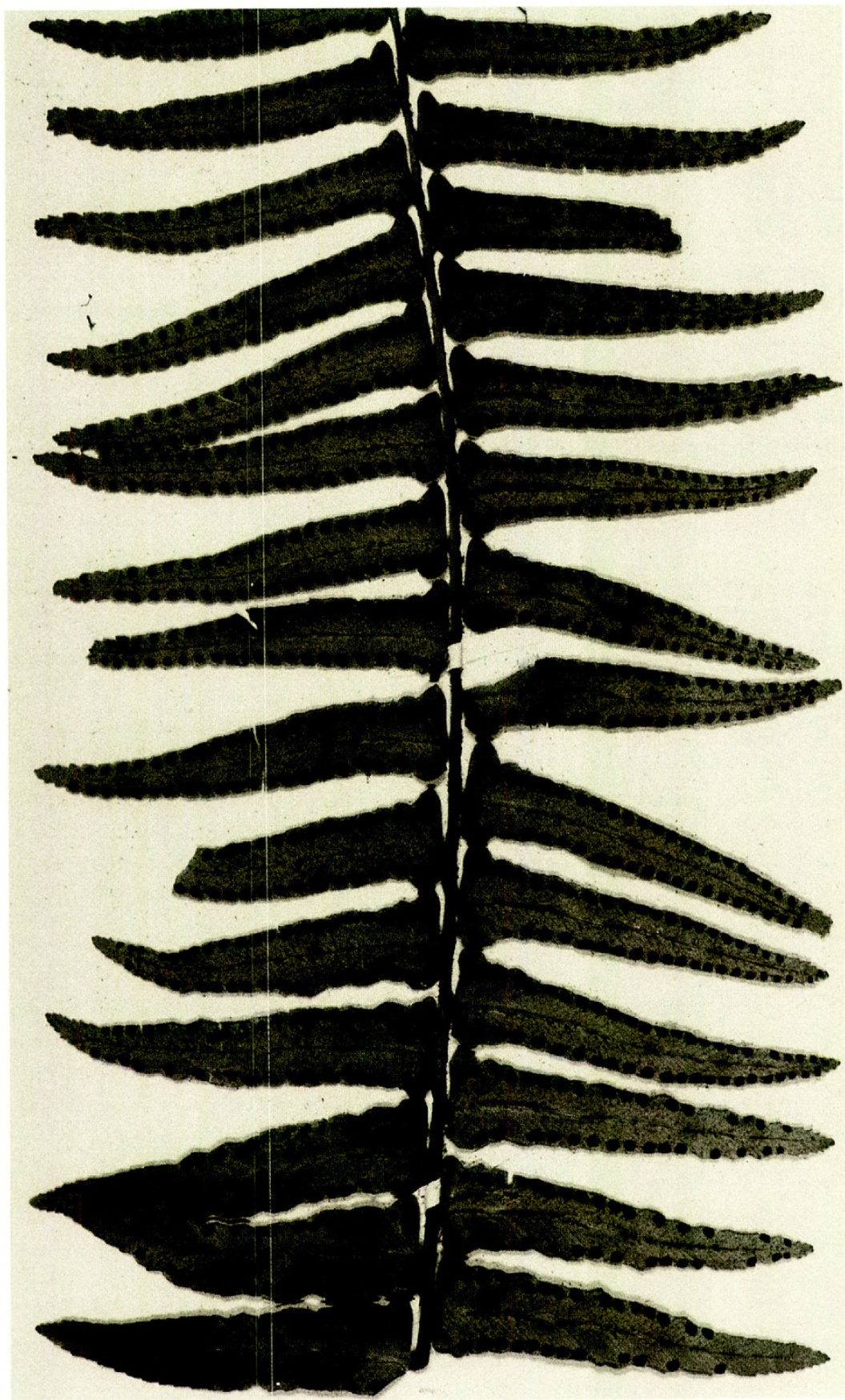


FIG. 28. *Nephrolepis* \times medlerae (*N. exaltata* \times *N. multiflora*). Portion of holotype (1.1 \times natural size); lower middle section of frond; note elongate pinnae, poorly developed anterior basal auricle (especially in lower part of frond), and scattered sori on lower pinnae.

Variable intermediate between *N. exaltata* subsp. *hawaiiensis* and *N. multiflora*. Medial pinnae up to 7×1.4 cm; pinna tips attenuate-acute, entire to shallowly crenate; lower pinnae rounded and with randomly and widely scattered sori; rachis with deciduous pale tan scales; anterior auricle weakly developed on lower pinnae.

Nephrolepis* × *copelandii W. H. Wagner, nothosp. nov.—TYPE: HAWAII. Puna District, Wao Kele O Puna Natural Forest Reserve, edge of woods at end of road in Fern Forest Vacation Estate, 24 Jul 1991, W. H. Wagner 91044, F. S. Wagner & D. D. Palmer (holotype: MICH!). Fig. 29.

Inter *N. cordifolia* et *N. multiflora* intermedia; pinnae proximales usque ad 4.5×0.9 cm; pinna apice \pm obtusa aliquantum abrupte angustata, dentata vel dentato-crenata; pinnae proximales magis angulosae, soris in seriebus regularibus dispositis; rhachis squamis \pm persistentibus atro-brunneis instructa; auricle antica bene evoluta.

Variable intermediate between *N. cordifolia* and *N. multiflora*. Medial pinnae up to 4.5×0.9 cm; pinna tips rather abruptly narrowed to a more or less blunt apex, dentate or dentate-crenate; lower pinnae more angular, with sori arranged in regular rows; rachis with more or less persistent dark brown scales; anterior auricle well developed.

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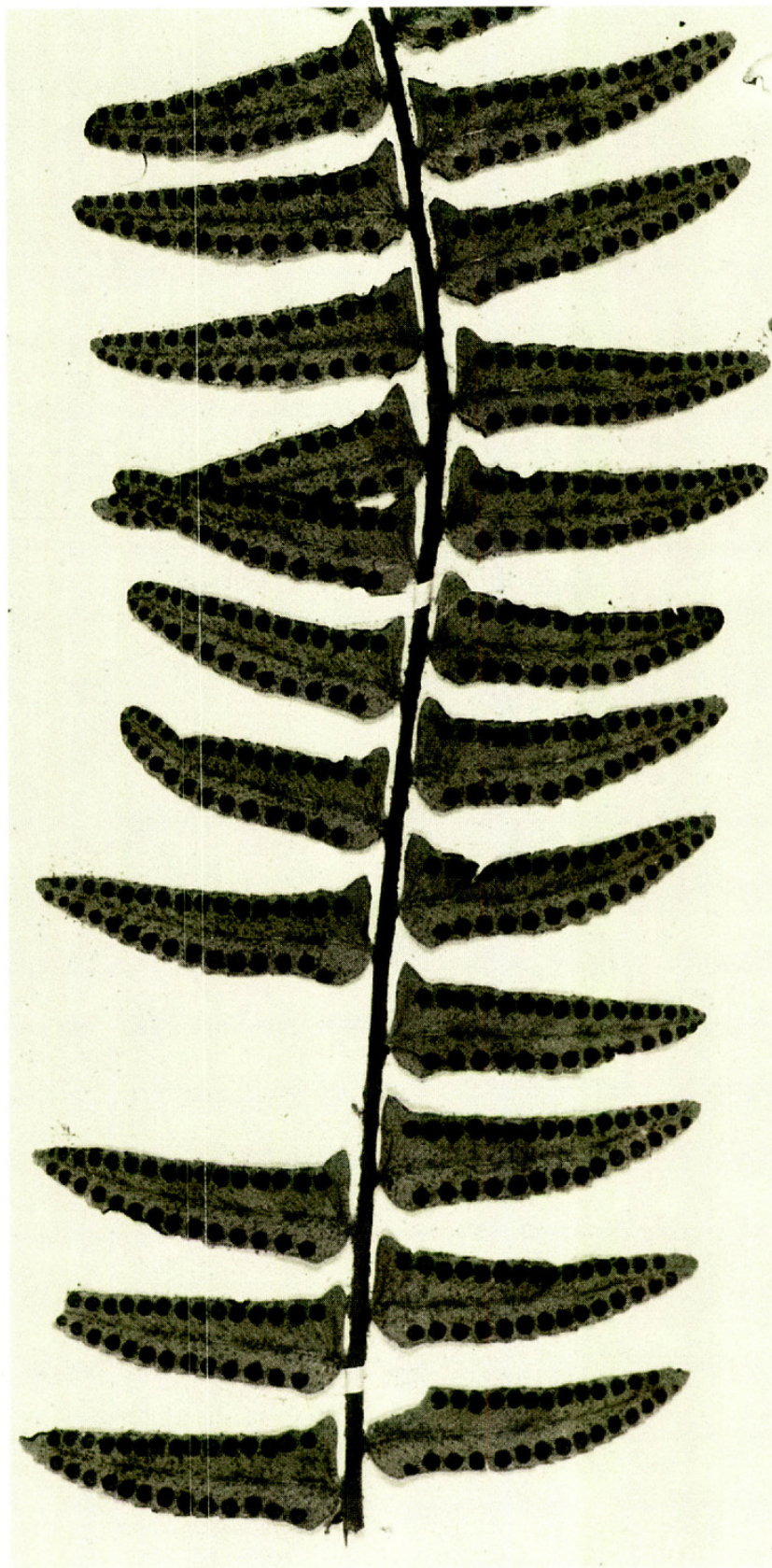


FIG. 29. *Nephrolepis xcopelandii* (*N. cordifolia* \times *N. multiflora*). Portion of holotype (1.1 \times natural size); lower middle section of frond; note "stubby" pinnae, well-developed pointed auricles in lower part of frond, and symmetrically arranged sori on lower pinnae.

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