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Three New Species of the Phaeophyta from Hawaii[1]

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Among the species of the Phaeophyta recognized in collections as growing on the shores of Hawaii there are at least three which do not seem to have been formally described before. In order that these may be referred to by name in the literature, formal descriptions and illustrations of their types are published here for the first time.

Padina thivyi n. sp.

Thalli modice calcifacti, usque ad 3 cm. alt., orbiculares, penicillis spissis rhizoideorum saepe imbricati. Membrana duarum cellularum omnino crassa et usque ad 200 μ crass. ad thalli basim, cellulae strati superioris usque ad 3 plo altiores quam strati inferioris a sectione verticali visae.

Holotypus No. 13084 in B. P. Bishop Museum, in Figure 1 illustratus.

Thalli light clay-colored in nature, orbicular and with the inrolled apical margin tangentially broader than the radius. Surface uniformly and lightly calcified on both surfaces and with concentric zones produced alternately on both surfaces by fugaceous hairs. Rhizoids in dense tufts from the lower surface so that the thalli are nearly resupinate on the substratum and imbricated on each other. Membrane 45 to 56 microns thick 1 cm. basal of the inrolled margin and up to 200 microns thick at the thallus base. Composed of but two layers of cells throughout the vegetative areas, the upper of which becomes much the thicker. Reproductory sori usually only on the upper surface of the wider of the alternately wide and narrow areas delimited

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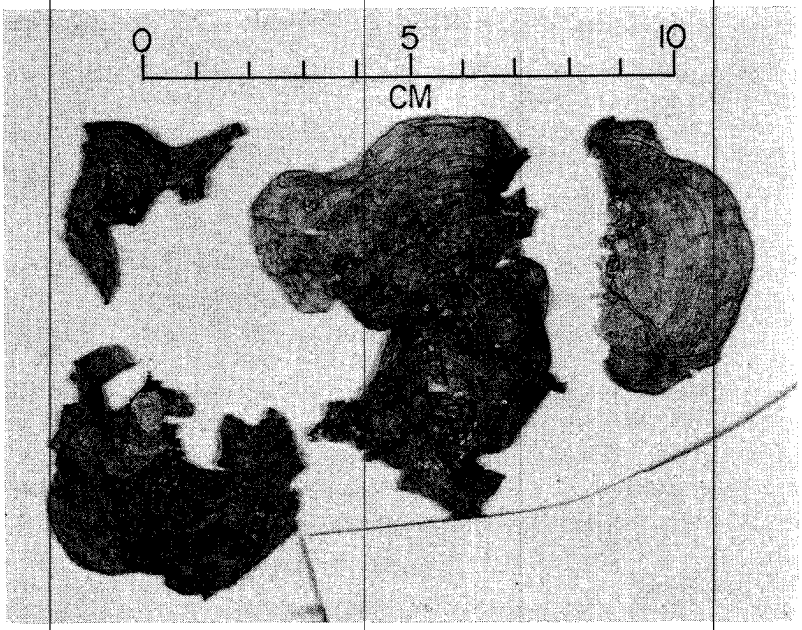

FIGURE 1.—Photographic reproduction of part of the Holotype herbarium preparation of *Padina thivyi*. Collection number 13084.

by the concentric zones. The sori lack paraphyses and are at first covered by a noncellular indusium of cuticular material.

The Holotype (Fig. 1) was collected in Hawaii by the senior author on the reef flat seaward of the Natatorium at Waikiki, Honolulu, Oahu, near 21°16.2′ N. Lat. and 157°49.6′ W. Long., 27-XII-1955. This exsiccatum preparation is deposited by the senior author in the B. P. Bishop Museum herbarium and numbered 13084. The specific epithet is in respect of Dr. Francesca Thivy, the principal student of this genus.

The species is distinct in forming patches of very broadly orbicular, or even circular, prostrate, soft, individuals. The imbricated thalli are attached to one another and the substratum by rhizoids arising, usually, from the under surfaces of the thalli. They are densely associated in irregularly scattered rounded tufts. It appears that as the thalli become bound to one another the older covered portions die and disintegrate. A thallus that is 2.2 cm. from base to inrolled apical margin may have a margin as much as 9 cm. long.

The apical margin of a thallus generally curves up away from the substratum and thus is rolled toward the free or lighted side of the membrane. This side is referred to here as the upper side of the thallus. In sections vertical to the flat surface, the cells of the upper layer, even just behind the apex (Fig. 2*a*), are taller than those of the lower layer. Although not very different in height in the apical portion of the thallus, at the base of the thallus, where the lower layer of cells is but 40 to 50 microns thick, the upper layer can be expected to be 120 to 150 microns thick.

Unusual cases have been seen among imbricated thalli where the margin of that thallus nearest the substratum had its margin curving down toward the substratum, and it appeared there were rhizoids arising from both surfaces.

The hairs fall off shortly after a zone of them is exposed by the unrolling of the thallus tip. The location of each hair zone remains marked by a scar which is usually on the surface of a concentric ridge. In radial sections vertical to the flat surfaces these ridges appear as arches in the membrane, and those which arch toward the upper surface project the more strongly. This arching may have its origin in the cells of the hair zone surface. These are (Fig. 2*b*) shorter in vertical height than the adjacent cells. Similar concentric zones of hairs are produced alternately on the lower surface of the thallus, but these persist longer and perhaps are not so conspicuous in their production of superficial lines on the thallus surface.

The reproductory stuctures may occur on either surface in sori that are usually without paraphyses and covered, at first, with an indusium of the cuticle that covered the initials. While the sori on some thalli are regularly separated by two concentric scars, this is not always true. They have been seen between every scar for a short distance and, in one case, even lining both sides of an individual scar. As a rule the sori are on the upper surface, but individuals have been seen where the only reproductory structures present were on the lower surface. Unilocular organs were seen with their contents divided into more than four parts.

This species is common on the reef flats of Oahu, Hawaii.

Hawaiian material examined in addition to the Holotype: M. Doty, No. 9781, reef flat, Waikiki, Oahu, 29-I-1952; J. Newhouse and R. Tsuda, #35, prostrate on large rock in 7-8′ of water at Hauula Beach Park, Oahu, 3-II-1962. Exsiccati specimens of this

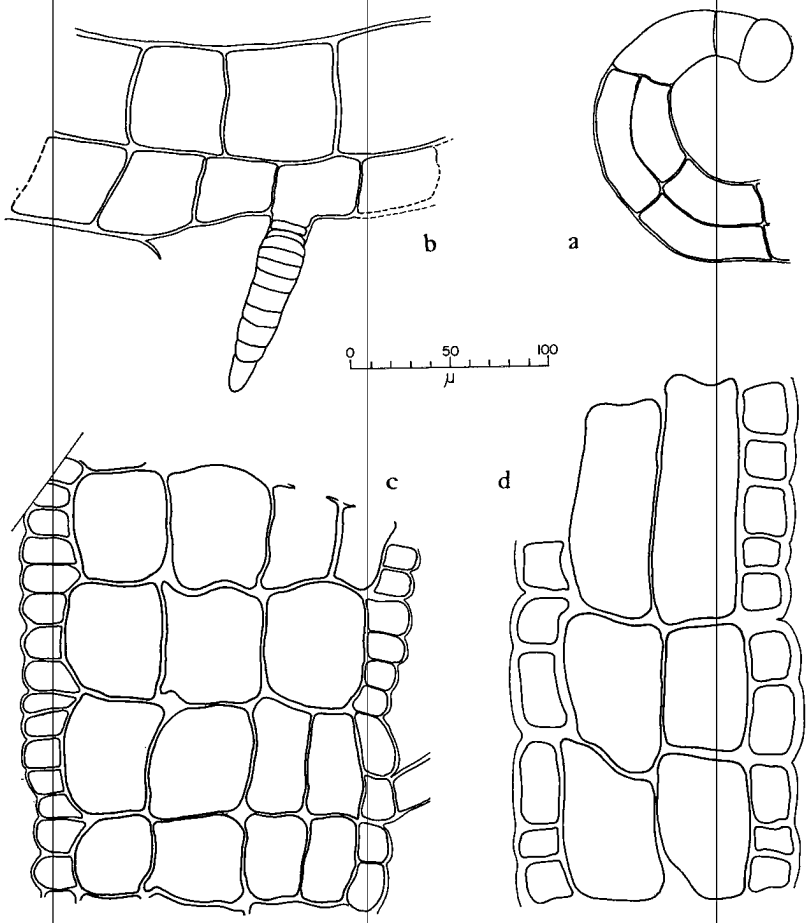

FIGURE 2.—**a.** Camera lucida drawing of a longitudinal, *i.e.,* radial, section through the inrolled margin of a thallus of *Padina thivyi.* The upper surface is the concave surface. Collection number 9781. **b.** Camera lucida drawing of a part of a longitudinal section made through a zone of hairs, but showing only one hair, on the flat surface near the tip of a thallus of *Padina thivyi.* Note the thinning of the thallus in the hair zone on the lower surface. Collection number 9781. **c.** Camera lucida drawing from a cross, *i.e.,* tangential, section from near the base of a thallus of *Zonaria hawaiiensis.* Note that the cortical cells number fundamentally the same on both surfaces. Collection number 12651. **d.** Camera lucida drawing from a longitudinal, *i.e.,* radial, section near a young fertile area and near the apical margin of a thallus from the Holotype preparation of *Zonaria hawaiiensis.* Collection number 12558.

collection have been distributed to a number of individual and institutional herbaria throughout the world.

Zonaria hawaiiensis n. sp.

Thalli usque ad 4 cm. alt., ad basim usque 8 cellulas et 280 μ crass. Regiones vegetativae a sectione transversa visae 4 cellularum et 120 μ crassae prope regiones fertiles maxime iuveniles. Cellulae corticales utraque in superficie magnitudine similes. Sori sine paraphysibus.

Holotypus No. 12558 in B. P. Bishop Museum, in Figure 3 illustratus.

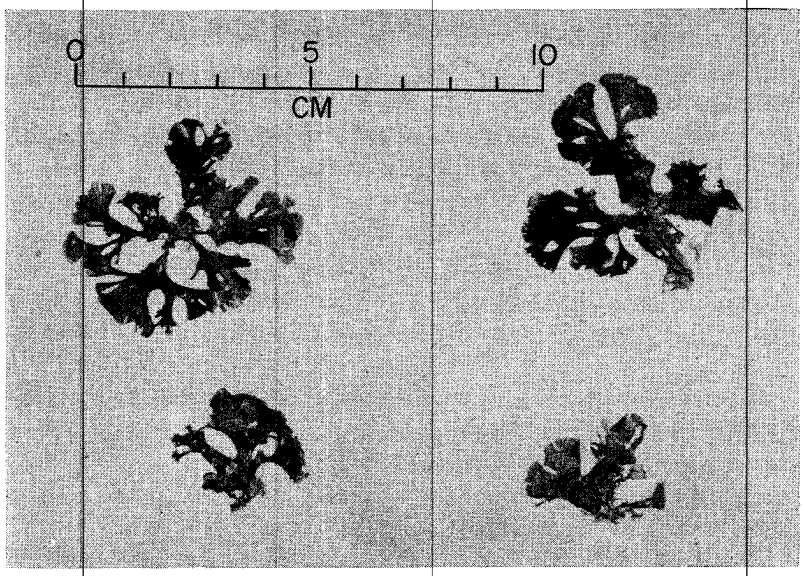

FIGURE 3.—Photographic reproduction of part of the Holotype herbarium preparation of *Zonaria hawaiiensis*. Collection number 12558.

Thalli iridescent blue in nature, cuneate or fan-shaped and often radially split into palmately associated fronds up to 4, rarely 6, cm. tall. The membrane becomes four cells and 100 to 145 microns thick within the first fertile zone below the flat margin of apical cells. Near their bases the thalli may be 6 or 8 cells and 200 to 280 microns thick. Attached by rhizoids covering the basal part of the lower sur-

face. The rhizoids occur in patches or lines elsewhere even on the upper surface where the thalli are in contact with other segments or objects. Reproductory structures unilocular and in extensive sori, *i.e.*, patches of irregular density, or scattered between the concentric lines and, while usually confined to the upper surface, may be found on both surfaces especially toward the base of the thallus. Unilocular organs up to 64-83 microns tall and 48-70 microns in diameter with the contents dividing into four or more parts.

The Holotype, illustrated in Figure 3, was collected by the senior author on the sea-facing, low-tide surface of a strip of beach rock at Halena, Molokai, 27-XII-1953, near 21°6′ N. Lat. and 157°13′ W. Long. This exsiccatum preparation is deposited and numbered 12558 in the B. P. Bishop Museum herbarium.

Herbarium specimens of this alga are dark brown with dark, narrow concentric lines crossing the segments at, usually, regular intervals. They lack calcification and are soft to the touch when alive. The segments tend to be narrow with a thallus that is 2.5 cm. tall but rarely over 1 cm. broad. Indusia, but not paraphyses, have been found associated with the reproductory structures. The cortical cells are similar in size on the two surfaces (Figs. 2*c* and 2*d*), and there are often four covering each medullary cell beneath. Such cortical cells, although of quite different shapes, average 9-14 by 21-28 microns in surface view, generally with the long axis parallel to the radius of the thallus.

The present species is distinct from the other species known from the Central and North Pacific in being much more delicate in nature and smaller in its dimensions, and in being only four cells thick in the youngest fruiting areas. The species is common on the reefs of Oahu in the Hawaiian Islands.

Hawaiian materials examined in addition to the Holotype: M. Doty, No. 12651, reef flat opposite the Aquarium, Waikiki, Oahu, 8-X-1954; J. Newhouse and R. Tsuda, #25, reef flat one mile east along the north shore of Kaena Point, Oahu, 3-II-1962. Exsiccati specimens of this latter collection have been distributed to a number of individual and institutional herbaria throughout the world.

Sargassum hawaiiensis n. sp.

Thallus e haptero conico oriens, caules rotundato, nonnulos aculeos ferentes, effectus. Laminae folii interdum ramosae, saepe plus

quam 6 cm. long. et 1 cm. lat., irregulariter denticulatae, crypotstomatis punctatae et costa percurrente praeditae. Vesiculae et receptacula in partibus thalli summis visa. Vesiculae in pedicellis tenuibus cylindricis, sphericae et sine mucrone aut alia ornamentatione. Receptacula ut segmenta longa tenuia racemorum laxe ramosorum, partem summam rami qui ea fert celantia, visa.

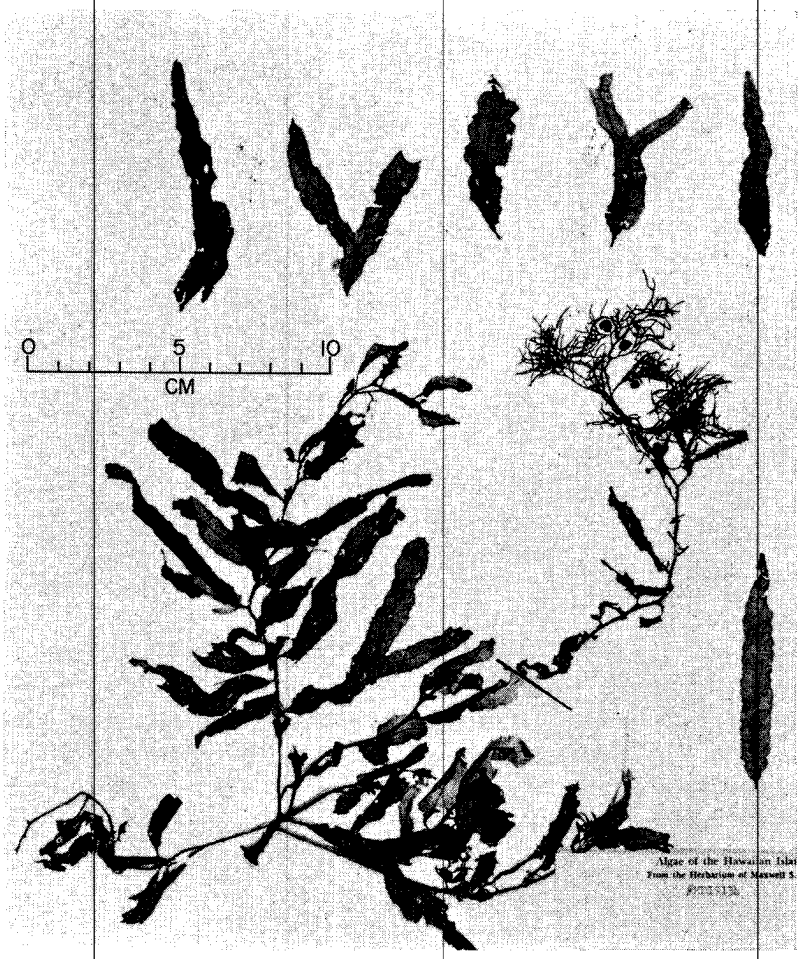

FIGURE 4.—Photograph of the Holotype herbarium preparation of *Sargassum hawaiiensis*. Note that the separate leaves and the fertile branch shown were separately picked out of the dredged material and mounted with the intact thallus in this one preparation. Collection number 19134.

Holotypus No. 19134 in B. P. Bishop Museum, in Figure 4 illustratus.

Thalli erect from a conical holdfast, round stems with a few prickles on their surfaces, bearing leaves, vesicles, and receptacles above. Leaves often forked, often over 6 cm. long and 1 cm. broad, denticulate, with a nearly percurrent midrib and many small cryptostomata scattered over their surfaces. Vesicles spherical and seen only on uppermost parts of thallus among receptacles, borne on delicate pedicels that are cylindrical and but little longer than the vesicles themselves. Receptacles forming a loose cluster of cylindrical branches 0.2 to 0.3 mm. in diameter when dried, with the individual branch segments sometimes over 1 cm. long. Receptacular clusters devoid of leaves and located on the apical part of the thallus.

The Holotype illustrated in Figure 4 was collected by Mr. Tetsuo Matsui from the dredged material coming aboard the vessel *Miss Honolulu* operating under the direction of Mrs. Mary Eleanor King and Bernice P. Bishop Museum on the "Pele cruises" off Kaneohe Bay, Oahu, Hawaii, near 21°31.3′ N. Lat. and 157°48.3′ W. Long., in 25 fathoms of water over a generally sandy bottom, 25-VII-1959. This Holotype exsiccatum preparation is deposited in the herbarium of B. P. Bishop Museum and numbered 19134.

This fragmentary material cannot be placed among the specific taxa with which it has been compared. While it might be considered a form of one of the other round- and rough-stemmed species of the Central Pacific, its large leaves and its vesicles having terete pedicels seem to insure its representing a species different from them. The Holotype was compared with various of the Eastern Pacific species and in each case distinctions judged to be of specific value were found. While realizing the unsatisfactory nature of these statements, this brief paper would not seem to be the place to launch into a discussion of the taxonomy of *Sargassum* and the variations one could expect in the different, perhaps related, species from biogeographically adjacent areas.