Descriptions and Redescriptions of the Hawaiian Octocorals Collected by the U. S. Fish Commission Steamer "Albatross" (2. Gorgonacea: Scleraxonia)[1]

FREDERICK M. BAYER[2]

THIS PAPER CONTINUES a general revision of the Octocorallia of Hawaiian waters, collected chiefly by the U. S. Fish Commission steamer "Albatross" during 1902. Part 1, which covered the Alcyonacea, Stolonifera and Telestacea, appeared in *Pacific Science*, volume 6, number 2 (1952). The present part commences the treatment of the Gorgonacea and considers the members of the suborder Scleraxonia, including the problematical genus *Keroeides*.

Order GORGONACEA

The limits of this order are not very clearly defined. Those forms with a distinct axis, horny or calcareous, give comparatively little trouble. Their colonies are distinctive, their gastrovascular cavities are uniformly short, and they fall conveniently into the order as it is usually defined:

Octocorals building sessile, usually tree-like colonies. Zooids uniformly with short gastrovascular cavities connected with one another by gastrodermal solenia. Colonial coenenchyme divided into an outer and an inner layer. In the outer layer ("cortex" or "rind") the sclerites are free; in the inner layer ("medulla" or "axis") the sclerites, if present, are surrounded by horny substance or are cemented together by calcareous matter to form a solid axis; or the axis may be purely horny, with or without non-spicular calcareous matter in the horny substance.

Unfortunately, there are all too many species that lack the characteristic features so commonly ascribed to the Gorgonacea. Several species long ranked in this order have recently (Verseveldt, 1940) been transferred on histological grounds to the Alcyonacea, making it difficult to distinguish clearly the former order from the latter. For all practical purposes, however, it would seem advisable to adhere more or less closely to the long-standing diagnosis of the Gorgonacea, and if a specimen shows a recognizable distinction between cortex and medulla, together with predominantly short gastrovascular cavities, to assign it to this order.

The peculiar genus Keroeides, although it has abundant spicular deposits in the outer layer of the axis, has a definite, chambered central chord and thus is clearly a holaxonian. However, it is here considered along with the Scleraxonia because of its general resemblance to them.

The order Gorgonacea is subdivided as follows:

1. The central axis is either purely horny, or horny with non-spicular (except in *Keroeides*) calcareous deposits often in coaxial

[1] Published with the permission of the Secretary of the Smithsonian Institution. Manuscript received June 23, 1955.

[2] Associate Curator, Division of Marine Invertebrates, United States National Museum.

layers, or of long calcareous internodes alternating with short nodes of entirely horny material; often a chambered central chord in the axis: Suborder HOLAXONIA.

2. The central axis is not wholly or largely horny, but is instead a medullar zone filled with true spicules, often distinctly different from those of the rind, more or less tightly bound together by horny or calcareous matter; if jointed, the horny nodes are filled with spicules and the internodes are composed of inseparably fused spicular sclerodermites. Medulla never with a soft, cross-chambered central chord: Suborder SCLERAXONIA.

Suborder SCLERAXONIA

The subdivision of the Gorgonacea into its two suborders is likewise not entirely satisfactory. From a practical standpoint, the line separating the Scleraxonia from the Holaxonia should be drawn between those forms with spicules in the axis cylinder and those with the calcium carbonate of the axis in strictly non-spicular form, but the natural line falls elsewhere. Thus, the genus *Keroeides*, already mentioned, should be a scleraxonian on a basis of its spicular axis but is in reality a holaxonian.

The following key may assist in the recognition of the families, each represented by a single genus, discussed in the present paper.

1. The axis consists of spongy, spicule-filled, horny nodes alternating with longer calcareous internodes made up of spicules cemented together. . Family **Melithaeidae**
1. The axis is not made up of alternating nodes and internodes 2
2. The axis is a medullar region composed of completely fused calcareous sclerodermites derived from spicules . . . . . Family **Coralliidae**
2. The axis is a medullar region composed of separable spicules bound together by horny material and sometimes by their own projections 3
3. The axis has a cross-chambered central chord; axial spicules smooth, terete, more or less flattened, rather sinuous, occasionally anastomosing. . Family **Keroeididae**
3. The axis may have numerous gastrodermal canals, especially in the proximal parts, but never a chambered central chord; axial spicules furnished with branching processes 4
4. Polyps large, exsert, with a strong, well-defined anthocodial crown and points; monomorphic; cortex set off from medulla by a ring of boundary canals . . . . . Family **Anthothelidae**
4. Polyps retractile into a thick cortex, not exsert; no strong anthocodial crown and points; dimorphic; cortex not set off from medulla by a ring of boundary canals . . . . . Family **Paragorgiidae**

Family *PARAGORGIIDAE*

DIAGNOSIS: Dimorphic Scleraxonia with medullar region penetrated to the branch tips by gastrodermal canals and not separated from the cortex by a ring of boundary canals.

Genus PARAGORGIA
Milne Edwards and Haime

Paragorgia Milne Edwards and Haime, 1857, Hist. nat. coral. 1: 190. Kükenthal, 1924, Das Tierreich 47: 28.

DIAGNOSIS: Colonies erect, often branched in one plane. Branches approximately round in cross section, usually knobby. Polyps dimorphic: autozooids large, completely retractile within low or hemispherical verrucae; siphonozooids small, in minute verrucae. Cortex with two layers, not separated from the medulla by boundary canals. Medulla perforated to branch tips by central, gastrodermal canals and smaller solenia. Spicules of the cortex chiefly capstans in the outer zone, spindles in the inner. Spicules of medulla mostly spindles or rods, coarsely spined and branched.

TYPE SPECIES: *Alcyonium arboreum* Linnaeus, by monotypy.

Paragorgia dendroides sp. nov.
Figs. 1; 2*d*

Paragorgia nodosa Nutting, 1908, U. S. Natl. Mus., Proc. 34: 569. *Nec* Koren and Danielssen, 1883, Nye Alcyonider: VII, 18, pl. 9.

DIAGNOSIS: Slender *Paragorgia* with autozooids on all sides, often clustered, in dome-like verrucae; siphonozooids on cortex surface and autozooid verrucae as minute protuberances. Cortex divided into inner and outer layers by a network of small solenia; medulla with wide, central canals and large solenia. Outer cortical sclerites chiefly octoradiate capstans with blunt sculpturing; inner cortical sclerites as warty spindles. Medulla with longer, more rudely sculptured spindles. Tentacular rhachis with longitudinal tract of pointed rods mostly arranged lengthwise.

DESCRIPTION: The specimen consists of five fragments, the largest of which is 55 mm. in height; in its thickest part, the largest branch measures 6.5 mm. in diameter. Ramification is irregular and apparently not strictly in one plane. The autozooids occur singly or in clusters and form conspicuous, dome-like verrucae 2–3 mm. in height. Several autozooids usually are clustered at the twig tips making them clavate. The siphonozooids form much smaller verrucae, about 0.5 mm. in diameter, openly scattered on the surface of the cortex and on the autozooid verrucae. The canal system is complex and agrees in general with the description of that of *Paragorgia arborea* given by Verseveldt (1940: 20). There is a fairly distinct division of the coenenchyme into a cortical rind and a medullar axis.

The salmon pink cortex (including the walls of the autozooid verrucae) is divided into an inner and an outer layer by a network of cortical solenia that communicate between the zooids; smaller solenia penetrate both inner and outer zones of the cortex. In the peripheral layer the typical sclerites are small capstans, chiefly octoradiates, 0.06–0.1 mm. in length (Fig. 1*b*). The cortical zone inside the solenial network is a thin, in places discontinuous, layer best developed in the verrucae, which contains warty spindles 0.2–0.23 mm. in length (Fig. 1*c*). The spicules of the cortex are pale pink.

The medulla, which is generally much paler in color than the cortex, is perforated by large solenia and, at the center, by three of four wide, longitudinal, gastrodermal canals, all intercommunicating through a system of smaller solenia. The pale peripheral part of the medulla contains large, colorless, coarsely warted rods up to about 0.4 mm. in length (Fig. 1*f*), and a very sparse scattering of pink spindles like those of the inner cortex. Immediately surrounding the large central canals is a pink area filled with colored sclerites shaped like those of the surrounding tissues but somewhat shorter and more rudely sculptured (Fig. 1*e*).

The autozooids have eight interseptal tracts of spicules extending up the tentacle bases and along the rhachis of the tentacles. Below the tentacles the sclerites are arranged obscurely *en chevron* between the septal insertions, becoming mostly longitudinal on the tentacle backs (Fig. 2*d*). Spicules do not extend into the pinnules, but the endodermal layer of the tentacles, including the pinnules, is charged with minute birefringent granules. The characteristic octoradiate capstan is a common form in the anthocodiae, but the principal spicule type in the tentacles seems to be the bluntly pointed rod with conical warts (Fig. 1*a*). There are also minute rods with spiny ends, a few crosses, and double forms.

HOLOTYPE: U.S.N.M. No. 25357. Ukula Point, Kauai, bearing S. 82°30′E., 13.1 miles distant, in 423–438 fathoms; fine coral sand, foraminiferans, rock; bottom temperature 41.0° F. June 24, 1902. "Albatross" station 4030.

REMARKS: The Hawaiian material was originally listed by Nutting under the name *Paragorgia nodosa* Koren and Danielssen. That species is generally considered to be identical with *Paragorgia arborea* (Linnaeus), and the original figures of the spicules of *P. nodosa* tend to support such a conclusion. Although it is impossible to decide if the Hawaiian "*Paragorgia nodosa*" is the same as the "*Paragorgia nodosa*" recorded by Nutting (1912) and Kinoshita (1913) from Japan (their specimens are lost), it is certainly not *P. arborea* (see Fig. 2). The Hawaiian material may prove to be the same as one of Kinoshita's provisionally described species, *Paragorgia tenuis* and *P. granulosa*, but, without reference to type material, this is another question that must go unanswered. During a recent visit to Tokyo I was unable to locate Kinoshita's type specimens of *Paragorgia* among the collections of the Zoological Institute, Tokyo University, where many of his types are preserved. The only course is to establish the Hawaiian specimen as a new species until additional material is available to clear up the problem.

Family *CORALLIIDAE*

This distinctive family of scleraxonians is unique in possessing an unjointed axial cylinder, or medulla, of solid calcium carbonate. According to recent authors, it contains but two valid genera. These may be separated thus:

Among the spicules there are numerous regular capstans: Genus *Corallium* Cuvier

Among the spicules there are rods, plates, and irregular forms, but no capstans: Genus *Pleurocoralloides* Moroff

For the coralliums proper, J. E. Gray (1867) proposed the use of three genera based upon the form of verrucae and the manner of branching: *Corallium*, for *C. rubrum; Pleurocorallium*, for *C. secundum;* and *Hemicorallium*, for *C. johnsoni*. In regard to spicules, *C. secundum* and *C. johnsoni* differ widely from *C. rubrum*, the former two have double clubs whereas the latter has only capstans. On this account, Ridley (1882) later recognized *Pleurocorallium* (including *Hemicorallium*) as distinct from *Corallium*. Most modern workers, however, recognize only *Corallium*, with *Pleurocorallium* and *Hemicorallium* as junior subjective synonyms.

The genus *Pleurocoralloides* Moroff, originally described from Japan, is not thus far known from the Hawaiian Islands.

Genus CORALLIUM Cuvier

Madrepora (pars) Linnaeus, 1758, Syst. Nat. Ed. 10, 1: 797.

Corallium [ächte rothe Steincoralle] Müller in Knorr, 1766, Delic. Nat. 1: 7, pl. A I, figs. 1, 2; p. 23, pl. A VII, fig. 1; p. 24, pl. A VIII, figs. 2–4; p. 127 (pars); nec pp. 9, 10, 11, 12, 13, 25, 128. [The generic names published in this work, though cited both by Neave, *Nomenclator Zoologicus*, and by Schultze, *Nomenclator Animalium*, are unavailable as the work is non-binominal.]

Isis (pars) Linnaeus, 1767, Syst. Nat. Ed. 12, 1 (2): 1288.

Nec *Isis* Linnaeus, 1758, Syst. Nat. Ed. 10, 1: 799.

Nec *Corallium* Burman, 1769, Index alter Herb. Amb. p. [3]. [=*Isis* Linnaeus, 1758.]

Corallium Cuvier, 1798, Tabl. élém.: 673. Lamarck, 1801, Syst. anim. s. vert.: 378. Gray, 1867, Zool. Soc. Lond., Proc.: 126. Ridley, 1882, Zool. Soc. Lond., Proc.: 221. Kishinouye, 1904, Imp. Fish. Bur. Tokyo, Jour. 14: 20. Hickson, 1907. Siboga Exped. Monog. 13c[1]:2.

Hemicorallium Gray, 1867, Zool. Soc. Lond., Proc.: 126.

Pleurocorallium Gray, 1867, Zool. Soc. Lond., Proc.: 126. Ridley, 1882, Zool. Soc. Lond., Proc.: 221. Johnson, 1899, Zool. Soc. Lond., Proc.: 57.

As can be seen from the synonymy above, the name *Corallium* has a rather motley history. It is an old name of dubious origin, going back to the ancient Greeks, classically applied to the red coral of commerce, the

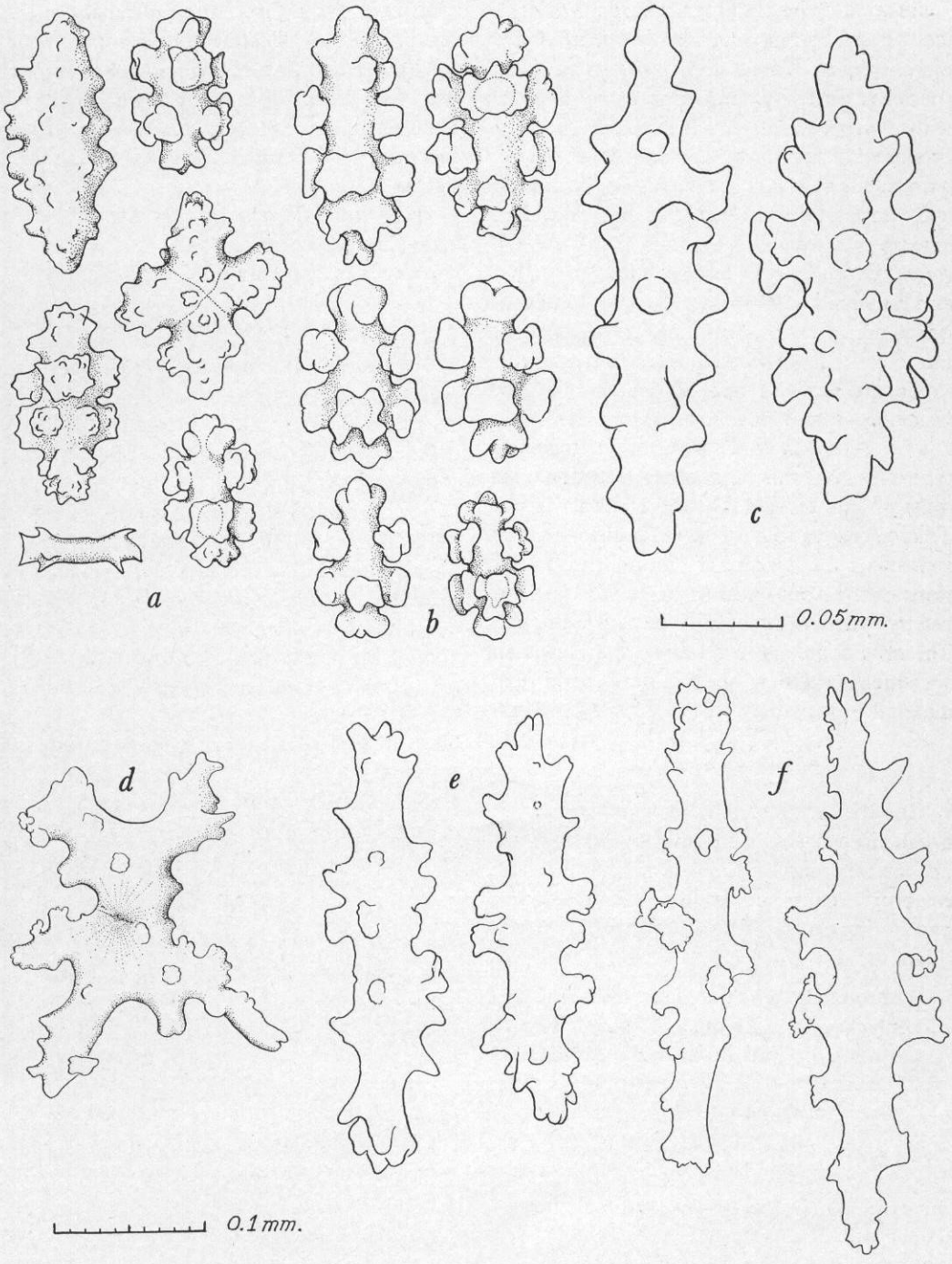

FIG. 1. *Paragorgia dendroides* sp. nov. Spicules of: *a*, Anthocodia; *b*, outer cortex; *c*, inner cortex; *d*, medulla; *e*, medulla surrounding main stem-canals; *f*, peripheral zone of medulla. Scale at *c* applies to *a–c*; scale at *d* applies to *d–f*.

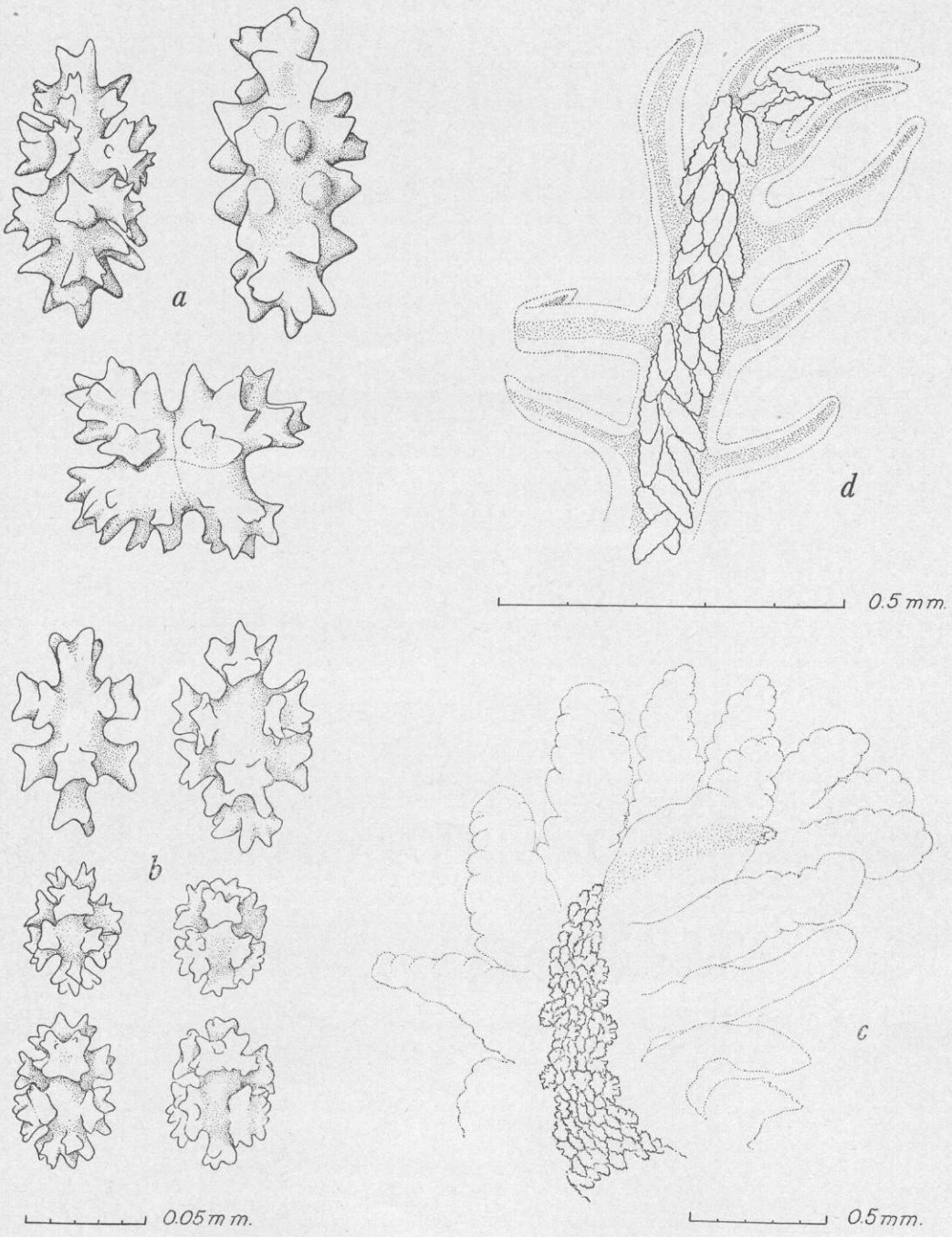

FIG. 2. *a–c*, *Paragorgia arborea* (Linnaeus). *a*, Spicules of anthocodia; *b*, spicules of outer cortex; *c*, tentacle (the stippled area indicates the course of the spicular tract where it is concealed by a pinnule). *d*, *Paragorgia dendroides* sp. nov., tentacle (the stippled area indicates distribution of miliary granules). Scale at *b* applies to *a* and *b*; scales at *c* and *d* to those figures only.

"true red stony coral." Unfortunately, one of the applications of the name *Corallium* to a different coral (Burman, 1769) antedates Cuvier's publication of it in the usual sense by almost 30 years and thus threatens the time-honored usage of the name. If the generic names in Burman's Index to the *Herbarium Amboinense* are nomenclaturally available, *Corallium* Cuvier must be conserved by the International Commission on Zoological Nomenclature or disappear as a junior synonym of *Isis* Linnaeus.

DIAGNOSIS: Dimorphic Scleraxonia with solid axis composed of calcareous scleroderm-ites derived from spicules. Cortical spicules are modified capstans with six, seven, or eight radii, double clubs derived from capstans, spindles, rods, crosses, and irregular forms.

TYPE SPECIES: *Madrepora rubra* Linnaeus, 1758 (by subsequent monotypy, the first species being assigned by Lamarck, 1801).

REMARKS: The various species of *Corallium* are identified by the arrangement, shape, and distribution of autozooid verrucae; the manner of branching; and the types of spicules present in the verrucae and in the rind.

The character of branching is convenient for identification, since it seems to remain constant within species, but it is not a primary character in determining relationships. The differences in spiculation are useful both in determining and in relating the various species. The basic type of spicule appears to be the octoradiate capstan. It is found in most species and is the prototype of the other forms, which have been produced by the suppression, modification, and exaggeration of certain radii. Color is not always a reliable feature since it may vary within the species, but is a useful secondary character.

The types of spicules found in *Corallium* are:

1. Long rods or spindles, with more or less prominent, simple warts. This type occurs principally in the autozooid verrucae and the tentacles.

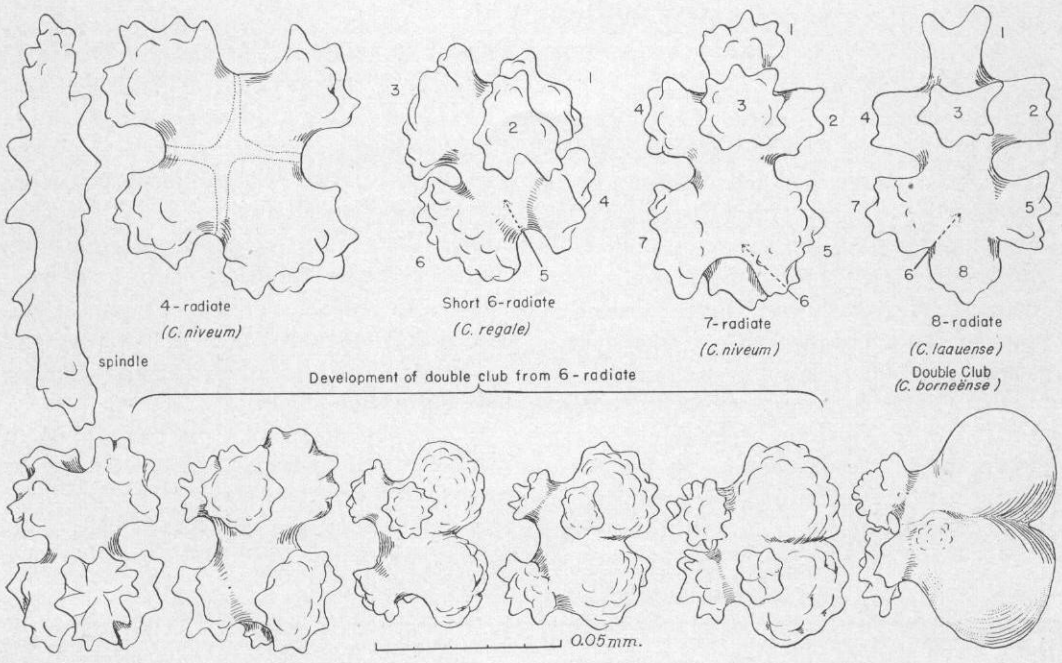

FIG. 3. Spicule types in the genus *Corallium*.

2. Multiradiate forms:
   a. Crosses or 4-radiates (Kreuze).
   b. Capstans (Gürtelstäbe), with 6, 7, or 8 radii (Sechser, Siebener, Achter). The length of the "waist" or smooth girdle may vary considerably; in a few species, the shaft of the 6-radiates may be so abbreviated that the spicules are nearly spherical (Fig. 9*g*). This is the irregular form that Kükenthal describes in *C. tricolor* ("zahlreiche unregelmässige, fast kugelige, mit dicken, ausstrahlenden Fortsätzen bedeckte Skleriten") and *C. maderense* ("unregelmässig strahlige Kugeln"), but it is not the same as the irregular type of *C. bōshūense* and *C. sulcatum*.
3. Double clubs, "double carafes" or "opera-glass spicules" (Doppelkeulen). These are derived from capstans, as shown in Figure 3.
4. Irregular forms, which are massive, lumpy sclerites of the sort found in *Corallium boshūense* and *C. sulcatum* from Japan, and in *C. ducale* from Guadalupe Island, west Mexico. This type of spicule is not found in any of the six species now known from Hawaiian waters.

Although modern students place all species of capstan-bearing Coralliidae in the one genus *Corallium*, there actually are groups of closely related species within the genus. Disregarding the sad experiences of others, I attempted anew to bring these groups into some logical arrangement. This has proved to be even more hopeless than it was half a century ago when Kishinouye studied the problem. After long and serious consideration, I can do no more than to point out certain of the relationships in the hope that some eye more penetrating than my own may detect among them a clue to the solution.

One very distinct group of species includes those that have in common double club spicules, hemispherical verrucae, and papillate rinds. Two species, *Corallium secundum* and *C. elatius*, constitute the group.

Another is the group of species that have pits in the axis beneath the autozooids. *Corallium stylasteroides* and *C. tortuosum* are very closely related, and have no double club spicules; *C. inutile* and *C. japonicum* are similar in many respects to the former pair, but have well-developed double clubs. The original precious coral, *C. rubrum*, may also belong with this group.

Perhaps the most circumscribed and homogeneous group of all is the one characterized by thick cortex, hemispherical verrucae in clusters, and double club spicules. It appears to be a very closely knit complex of species including *Corallium kōnojoi*, *C. borneënse*, *C. niveum*, and *C. pusillum*.

The final group, easily as diverse as the preceding one is uniform, is a perplexing array of species characterized by one feature: long spindles in the autozooid verrucae, which are usually tall. The species vary in form from profusely branched to only sparsely ramified; they may or may not have double club spicules; and some have cortical papillae (aside from siphonozooids) while others have not. The group includes *Corallium sulcatum*, *C. laauense*, *C. regale*, *C. abyssale*, *C. bōshūense*, *C. variabile*, *C. halmaheirense*, *C. johnsoni*, *C. tricolor*, *C. maderense*, *C. imperiale*, and *C. ducale*. *Corallium reginae* Hickson has verrucal spindles but, unlike the other species just listed, it has low, hemispherical verrucae. It is of interest to note that, of the three species having short, nearly globular 6-radiates, two (*maderense*, *tricolor*) are Atlantic while one (*regale*) is Hawaiian. *Corallium sulcatum*, *C. bōshūense* and *C. ducale*, all with massive, irregular sclerites, may form a sub-group.

Of the 20 species of *Corallium* known to inhabit the Indo-Pacific region, six are at present known from Hawaiian waters, and two from the eastern Pacific off Baja California (Guadalupe Is.). These may be separated as follows:

1. The autozooid verrucae and tentacles contain long spindles with conical processes 2

1. The autozooid verrucae and tentacles have no long spindles 6
2. Double clubs present 3
2. Double clubs not present . . . . . **laauense** sp. nov.

3. Autozooids biserial; branching dichotomous with alternate branches dominant, thus producing a zigzag stem . . . . . **abyssale** sp. nov.
3. Autozooids directed toward one face of the colony, not biserial; stem not zigzag 4

4. Branching symmetrically dichotomous, in one plane; calyces short-cylindrical or blunt-conical; massive, irregular sclerites present . . . . . **ducale** Bayer
4. Branching chiefly pinnate; calyces tall, cylindrical 5

5. Verrucae with eight grooves extending their full length. The 6-radiate spicules are of ordinary form and not almost spherical; 7-radiates are not uncommon; 8-radiates and double clubs abundant . . . . . **imperiale** Bayer
5. Verrucae grooved only in the apical part, otherwise practically smooth. The 6-radiate spicules are short, almost spherical, often with the radii much reduced; 7-radiates quite rare; 8-radiates and double clubs abundant . . . . . **regale** sp. nov.

6. Double clubs present. Axis not pitted beneath the autozooids 7
6. Double clubs not present; crosses numerous. Axis with distinct pits, often with raised and beaded rims, beneath the autozooids . . . . . **tortuosum** sp. nov.

7. Rind practically smooth, white, moderately thick. Verrucae large, often clustered in groups . . . . . **niveum** sp. nov.
7. Rind strongly papillate, salmon-pink, rather thin. Verrucae small, not clustered in groups except on twig tips . . . . . **secundum** Dana

In view of the possibility that species of *Corallium* described from other parts of the Indo-Pacific may occur also in Hawaii, the following key to all 20 species known from that area is offered as a double check upon determinations made by use of the regional key.

KEY TO THE SPECIES OF *Corallium* KNOWN FROM THE INDO-PACIFIC REGION

1. Autozooids occur all around the stems and branches 17
1. Autozooids are more or less strictly biserially arranged or predominantly face one side of the colony 2

2. Spindles with simple warts are present in the distal part of the autozooid verrucae and in tentacle backs 3
2. No spindles in autozooid verrucae . . . 12

3. Double clubs present 4
3. Double clubs not present 11

4. Massive, irregular sclerites present 5
4. Massive, irregular sclerites not present . 7

5. Ramification in one plane, openly branched in a predominantly dichotomous plan; no branchlets much smaller than the main branches arising from the front of the colony . . . . . **ducale** Bayer (Guadalupe Is., Mexcio)
5. Primary branching in one plane, but numerous slender branchlets much smaller than the main branches arising from the front of the colony 6

6. Axis white, rind yellow, not furrowed. Autozooid verrucae tall, cylindrical, not conspicuously grooved . . . . . **bōshūense** Kishinouye (Japan)
6. Axis pink, rind light red, longitudinally furrowed. Autozooid verrucae cylindrical, with eight conspicuous grooves . . . . . **sulcatum** Kishinouye (Japan)

7. Rind with double clubs and 8-radiate spicules only; no 6- and 7-radiate forms 8

7. Rind with 6-radiates as well as 8-radiates and double clubs 9

8. Autozooid verrucae hemispherical, 1.5 mm. in height. Cortex red, axis dark pink with pale concentric rings . . . . . **reginae** Hickson (East Indies)
8. Autozooid verrucae cylindrical 10

9. Outer walls of autozooid verrucae distinctly grooved their full length along the lines of septal insertion. Rind with 6-, 7-, and 8-radiates, double clubs and crosses . . . . . **imperiale** Bayer (Guadalupe Is., Mexico)
9. Outer walls of verrucae with grooves in the distal part only, and there not always distinctly. Rind with short, spheroidal 6-radiates, 8-radiates and double clubs; 7-radiates uncommon . . . . . **regale** sp. nov. (Hawaii)

10. Autozooid verrucae widely separated (8–10 mm. apart), biserial, 2 mm. in height; branching sparse, the main stem zigzag . . . . **abyssale** sp. nov. (Hawaii)
10. Autozooid verrucae closely and irregularly placed, facing one side of the colony, 2.7 mm. in height; branching profuse . . . **variabile** (Thomson and Henderson) (Ceylon)

11. Spindles of verrucae reaching 0.15 mm. in length; 8-radiates frequently exceeding 0.10 mm. Rind with prominent papillae; color white. Axis white . . . . . **laauense** sp. nov. (Hawaii)
11. Spindles of verrucae about 0.09 mm. in length; 8-radiates up to 0.07 mm. Rind not papillate; color orange red. Axis pink . **halmaheirense** Hickson (East Indies)

12. Double clubs present 13
12. Double clubs not present. Spicules are 6-, 7-, and 8-radiates and crosses . . . . . **japonicum** Kishinouye (Japan)

13. Octoradiates present 14
13. Octoradiates not present 16

14. Autozooid verrucae in clusters. Rind not papillate. Twigs thick and stubby 15
14. Autozooid verrucae evenly distributed, not in clusters (except at tips of twigs). Rind densely papillate. Twigs slender, abundant on front face of colony . . . . . **secundum** Dana (Hawaii)

15. With both 6- and 7-radiates. White . . . . . **niveum** sp. nov. (Hawaii)
15. Without 6- and 7-radiates. Orange . . . . . **pusillum** Kishinouye (Japan)

16. Autozooid verrucae clustered in groups. Rind smooth. End twigs thick . . . . . **kōnojºi** Kishinouye (Japan)
16. Autozooid verrucae evenly distributed, not in groups. Rind papillate. End twigs slender . . . . . **elatius** (Japan)

17. Double clubs present 18
17. Double clubs not present 19

18. Rind very thin. Axis with pits beneath the autozooids. Other spicules are 6-radiates . . . . **inutile** Kishinouye (Japan)
18. Rind thick. Axis without pits beneath the autozooids. Other spicules are 6-, 7-, and 8-radiates and crosses . . . . . **borneënse** Bayer (Borneo)

19. Spicules only 8-radiates. Axis white . . . . . **stylasteroides** Ridley (Mauritius)
19. Many crosses present in addition to 8-radiates. Axis pink . . . . . **tortuosum** sp. nov. (Hawaii)

Corallium abyssale sp. nov.

Fig. 4; 5*a*; 7*a–d*

DIAGNOSIS: Branching asymmetrically dichotomous, especially proximad, in one plane. Autozooids biserial, verrucae with spindles. Siphonozooids in groups around autozooids. Rind papillate. Spicules: crosses, 8-radiates, double clubs; spindles in verrucae.

DESCRIPTION: The colony branches in one plane in an asymmetrically dichotomous manner, alternate branches dominating to produce

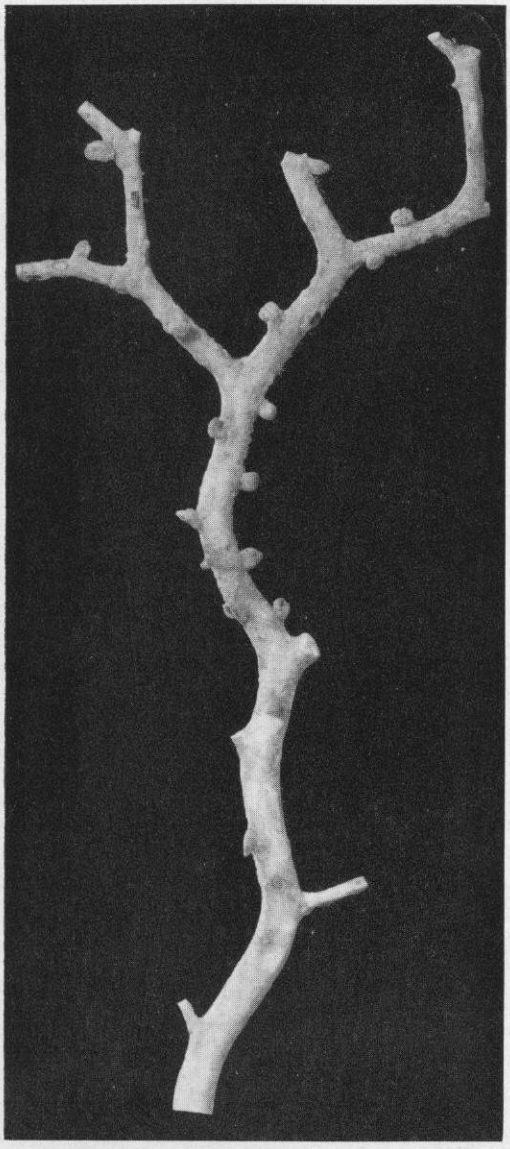

FIG. 4. *Corallium abyssale* sp. nov. The type specimen.

a zigzag, sympodial main stem; in the upper part of the colony the dichotomy becomes symmetrical and quite regular. The axis is solid, round, and smooth, 4 mm. in diameter at the lowest point, tapering to 2.5 mm. at the top (no twig tip is preserved intact). The autozooids are very widely separated and few in number, essentially biserial in arrangement although an occasional individual is out of line; the verrucae are 2 mm. in height, cylindrical, with eight longitudinal grooves in the distal half, corresponding to the septal insertions. The siphonozooids form low, wart-like protuberances in groups around the autozooids. The surface of the rind bears in addition scattered, prominent papillae that are smaller than siphonozooids and probably represent nematocyst batteries. The rind is extremely thin and is rubbed off in places.

The spicules of the autozooid verrucae include long, blunt spindles 0.12–0.13 mm. long in addition to the forms found in the rind proper. The rind spicules are 8-radiates, often coarse and clumsy-looking; stubby crosses; and double clubs with wide, depressed, weakly sculptured heads and short handles with radiating processes. In the oral disk and pharyngeal region there are spiny rodlets that appear to be derived from the 8-radiate type.

The rind (in alcohol) is pale brown, probably discolored; the axis is pale pink with a somewhat darker center; the spicules are colorless.

HOLOTYPE: U.S.N.M. No. 49326. Off Kauai: Hanamaulu warehouse bearing South 49°30′ West, 8.4 miles distant; depth, 1000–1314 fathoms, gray sand, mud, and foraminiferans; bottom temperature 36.6° F. "Albatross" station 4185, August 13, 1902.

REMARKS: *Corallium abyssale* does not closely resemble any other known species of the genus, although it is like *C. sulcatum* Kishinouye and several other species in having tall, sulcate verrucae with spindles in the spiculation.

According to the original field label, this specimen was "pink" when fresh.

Corallium regale sp. nov.
Figs. 5*c*; 7*e–g*

DIAGNOSIS: Autozooids on front and two sides of branches; verrucae tall, cylindrical, grooved only at their distal tips, containing

long, irregular spindles. Siphonozooids visible as simple pores on bases of autozooids and rind. Rind smooth. Spicules: short, globose 6-radiates, 7-, and 8-radiates (the 7's quite rare), crosses, double clubs; spindles in autozooid verrucae only. Color pink.

DESCRIPTION: The type consists of a branch with a few short twigs, insufficient to show the pattern of branching. The axis is round, smooth, and solid. The autozooids are arranged along two sides and one face, leaving the rear of the branch bare; they form tall, cylindrical verrucae 1.5–2.0 mm. in height and 1.5 mm. in diameter, 8-lobed and grooved toward the distal ends. The siphonozooids appear as small pores, sometimes in small, wart-like protuberances, on the bases of the autozooids and on the rind. The surface of the rind is not papillate, although there are surface irregularities. The rind is moderately thick, and in places expanded from the sides of the branches as recurved flaps supported by thin, calcareous outgrowths of the axis, to form tunnels inhabited by polychaete commensals.

The autozooid verrucae contain long, irregular rods 0.09–0.12 mm. in length. In both verrucae and general cortex are found 6-, 7-, and 8-radiates, the first usually short, often with the radii much reduced; the 7's of usual form, quite uncommon; the 8's also of usual form, common; also a few crosses, and double clubs with rudely sculptured heads. Small, spinose rodlets are present in the oral disk and pharyngeal region.

The spicules are pale pink by reflected light. The colony as a whole, including the axis, is pale pink.

HOLOTYPE: U.S.N.M. No. 49520. French Frigate Shoal: 23°47′10″ North, 166° 24′ 55″ West; 395–387 fathoms; coarse sand, shell, coral rock; bottom temperature 41.0° F. "Albatross" station 3973, May 29, 1902.

REMARKS: The scant material at hand gives little indication of the appearance of the entire colony. The branching is probably in one plane, as indicated by the origin of the twigs from the sides of the branch, and furthermore probably is pinnate.

Corallium regale is most closely related to *Corallium sulcatum* Kishinouye and *C. imperiale* Bayer, but differs from both in having the peculiar, almost spherical 6-radiates found also in *C. maderense* and *C. tricolor* of the Atlantic.

Of all the Hawaiian precious corals, *C. regale* has the best color and might be of commercial value if it could be fished in quantity.

Corallium laauense sp. nov.

Fig. 5*e*, *f*; 7*h–j*

DIAGNOSIS: Verrucae cylindrical, longitudinally grooved, placed on two sides and front of branches, containing long spindles. Surface of rind costate, with scattered, conical papillae. Rind with cruciform and 8-radiate spicules.

DESCRIPTION: The material at hand consists of some terminal twigs that give off lateral branchlets in one plane. The autozooids are distributed on two sides and the front of the branches; they form cylindrical, longitudinally grooved verrucae about 1 mm. tall. The siphonozooids appear as small warts with an apical pore, near the autozooid bases. The rind is longitudinally costate and bears small, conical papillae. In some of the branch axils the rind extends as a thin, membranous expansion as it may also do along the two edges of the twigs, where it may be recurved, the margins of opposite sides joining to form closed tunnels. The axis is practically round, and in the largest parts preserved shows an indication of broad, longitudinal grooving.

The spiculation consists of blunt, spinose rods or spindles up to 0.145 mm. long in the autozooid verrucae; crosses and 8-radiates in verrucae and rind; and the usual small rods in the pharyngeal region and oral disk.

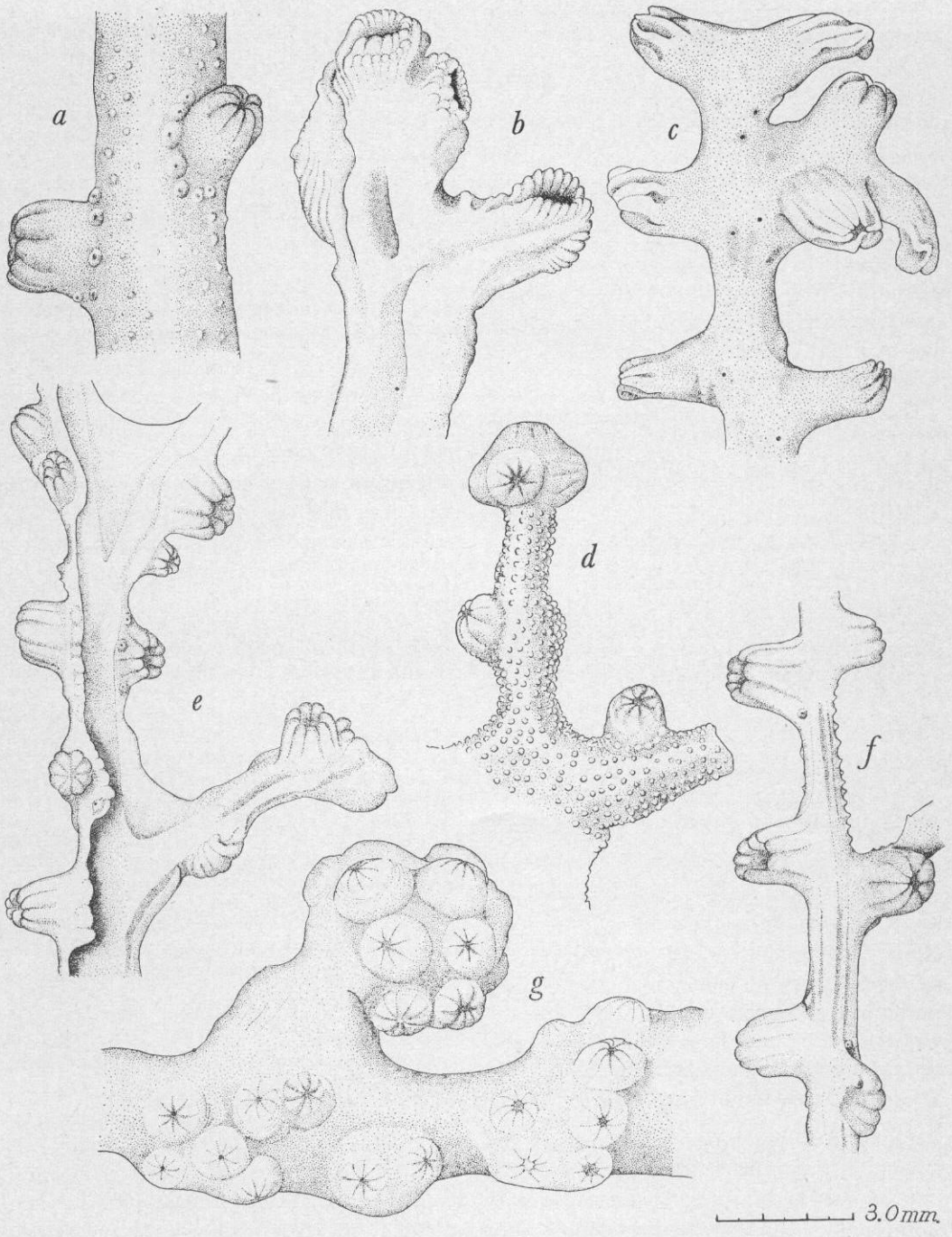

FIG. 5. *a*, *Corallium abyssale* sp. nov.; two autozooids on branch from upper part of colony; *b*, *C. tortuosum* sp. nov., tip of branch, cortex removed; *c*, *C. regale*, sp. nov., tip of branch; *d*, *C. secundum* Dana, one of the small twigs from front of colony; *e–f*, *C. laauense* sp. nov., two branchlets, *e* with the coenenchymal flaps induced by the presence of commensal polychaete; *g*, *C. niveum* sp. nov., one of the decurved, clavate twigs from front of colony; left is distad. Scale applies to all figures.

The rind is white or faintly pink; the axis is white. Spicules colorless.

HOLOTYPE: U.S.N.M. No. 49327. Molokai Island: Lae-o Ka Laau Light bearing North 46° West, 11 miles distant; depth 319–281 fathoms; broken shell and gravel; bottom temperature 43.8° F. "Albatross" station 3828, April 1, 1902.

REMARKS: In the form of its calyces and its seemingly finely divided branching, *Corallium laauense* resembles *C. sulcatum* Kishinouye, but the latter has double clubs and massive, irregular forms among its spicules.

The flaps and tunnels of rind are induced by the presence of a commensal polychaete annelid belonging to the family Polynoidae.

Corallium secundum J. D. Dana

Fig. 5*d*; 6*d*, *e*; 8*a–d*

Corallium secundum Dana, 1846, U. S. Expl. Exped., Zooph.: 641, pl. 60, fig. 1. Kishinouye, 1904, Imper. Fish. Bur., Tokyo, Jour. 14: pl. 6. Kükenthal, 1924, Das Tierreich 47: 49.

Pleurocorallium secundum Ridley, 1882, Zool. Soc. Lond., Proc.: 224, pl. 9, figs. 6–11. ?Wright and Studer, 1889, Challenger Zool. 31 (1): 186.

DIAGNOSIS: Branching in one plane, with slender, prickle-like twigs on front surface of colony. Autozooid verrucae hemispherical, distributed on front surface of branches and on the twigs. Siphonozooids near bases of autozooids. Rind prominently papillate. Spicules: crosses, 6-, 7-, and 8-radiates, and double clubs. Verrucae without long spindles.

DESCRIPTION: Colonies with the major branching in one plane, flabellate; the small twigs are slender and prickle-like and occur only on the front face of the colony. The solid axis is somewhat flattened at right angles to the major plane of ramification, and is longitudinally striated. The autozooid verrucae, which are restricted to the side of the colony that bears the short twigs, are evenly distributed and not clustered in groups except at the tips of the twigs where there may be two or three. The siphonozooids occupy small verrucae near the autozooid bases. The rind is closely papillate on all sides of the branches, but more densely so on the front. Sections have not been made to determine the nature of the papillae.

The principal spicule type is the double club; large, well-formed 8-radiates are present but not common; 6- and 7-radiates are comparatively rare. The tentacles have small 8-radiates, and in the pharyngeal region there are spiny rods and crosses of small size. The verrucae have no long spindles.

The rind is salmon pink, the verrucae not noticeably different in color. The axis is pale pink, often almost white, sometimes with a darker center. The spicules are pink by reflected light.

HOLOTYPE: U.S.N.M. No. 600. Sandwich Islands [Hawaiian Islands]. United States Exploring Expedition.

RECORDS: Pailolo Channel, between Molokai and Maui: Mokuhooniki Islet bearing North 31° West, 2.7 miles distant; depth 127–154 fathoms; broken coral, coarse gravel, rock; bottom temperature 60°–61° F. "Albatross" station 3863, April 10, 1902.

Mokuhooniki Islet bearing North 27° West, 3.3 miles distant; depth 136–148 fathoms; sand and pebbles; bottom temperature 64.8° F. "Albatross" station 3885, April 17, 1902.

REMARKS: *Corallium secundum* was long known only from the unique type, which is now decorticated. The locality "Sandwich Islands" also was held open to question. The description and figures of the spiculation given herein were made from specimens taken at two "Albatross" stations as mentioned above.

A polychaete annelid of the family Polynoidae infests this coral, causing it to produce covered tunnels along the twigs and branches.

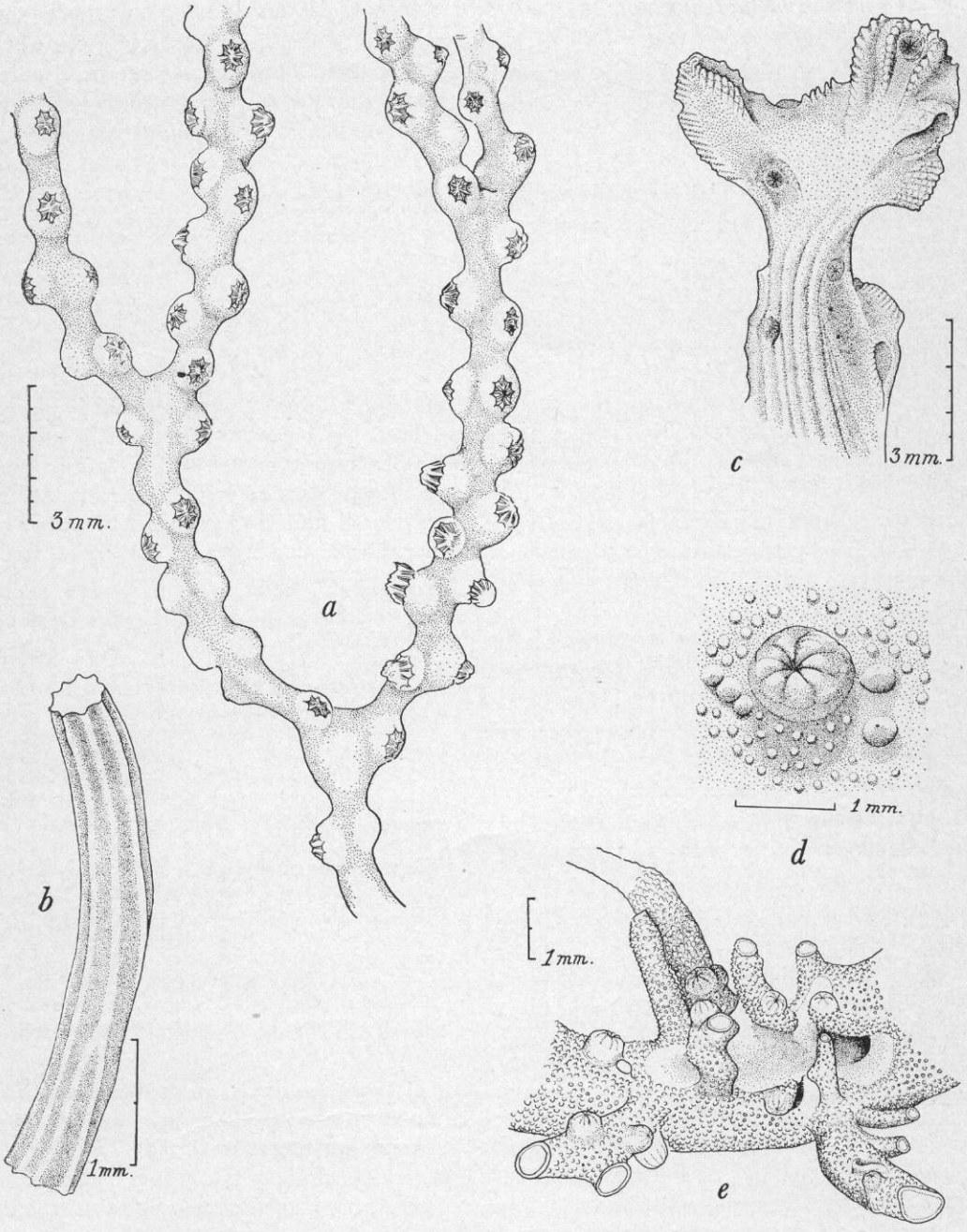

FIG. 6. *a*, *b*, *Acabaria bicolor* (Nutting): *a*, Part of the type specimen; *b*, part of axial internode, cortex removed; *c*, *Corallium tortuosum* sp. nov., branch tip with rind intact; *d–e*, *Corallium secundum* Dana, *d*, part of branch with worm tunnel; *e*, autozooid verruca with adjacent siphonozooids and cortical papillae.

Corallium tortuosum sp. nov.
Fig. 5*b*; 6*c*; 8*e–g*

DIAGNOSIS: Colonies irregularly branched in one plane. Autozooids on all sides, seated in calycular pits in the solid axis. Rind thin. Siphonozooids scattered. Spicules: crosses and 8-radiates only, in both rind and verrucae; small crosses and irregular rodlets in pharyngeal region.

DESCRIPTION: The colonies are irregularly branched, but show a definite tendency to remain in one plane. The trunk is round or oval in cross section, about 10 mm. in diameter and longitudinally grooved; the smaller branches are basically round in cross section but are more or less distorted by the autozooid calyces which indent the solid axis. The autozooids appear as raised areas on the trunk and branches; each is set in a depression surrounded by a raised rim. This rim is usually highest above and open toward the base of the colony, so that the calycular margin forms a projecting shelf over the zooid. The calyces on the twigs usually have the best developed rims, and since two are often opposed at the twig tips, a cross section of the axis there assumes a roughly x-shaped outline. The projecting calycular rim is strongly beaded and is often darker in color than the surrounding areas. The polyps do not form projecting verrucae, but retract flush across the calycular pit, and have the usual 8-rayed orifice at the center. The rind is exceedingly thin and contains few spicules, except between the longitudinal cortical solenia, each of which follows a groove in the axis. The cortex therefore appears to have lines of spicules running through it longitudinally. The siphonozooids occur as tiny verrucae between the lines of spicules in the cortex, i.e., along the solenia, especially basad from the autozooids.

The spicules are the same in both cortex and verrucae. There are two types, 8-radiates and numerous crosses. In the pharyngeal region and oral disk of the anthocodiae there are the usual minute, irregular rodlets and crosses.

The colonies are pale pink or salmon pink in color, the region surrounding the autozooids darker. Since the twig tips bear several calyces, they are customarily darker than the rest of the axis. The spicules are pink by reflected light.

HOLOTYPE: U.S.N.M. No. 49331. Pailolo Channel: Mokuhooniki Islet bearing North 35° West, 3.1 miles distant; depth 130–151 fathoms; coral, sand, shell, foraminiferans; bottom temperature 61° F. "Albatross" station 4100, July 23, 1902.

RECORDS: South coast of Molokai: Lae-o Ka Laau Light bearing North 74°30′ West, 8.1 miles distant; depth 92–212 fathoms; fine gray-brown sand; bottom temperature 67° F. "Albatross" station 3838, April 4, 1902.

Pailolo Channel: Mokuhooniki Islet bearing North 31° West, 2.7 miles distant; depth 127–154 fathoms; broken coral, coarse gravel, rock; bottom temperature 60–61° F. "Albatross" station 3863, April 10, 1902.

Pailolo Channel: Mokuhooniki Islet bearing North 27° West, 3.3 miles distant; depth 136–148 fathoms; sand and pebbles; bottom temperature 64.8° F. "Albatross" station 3885, April 17, 1902.

West coast of Hawaii: Kawaihae Light bearing North 82°30′ East, 4.1 miles distant; depth 198–147 fathoms; coral, sand, foraminiferans; bottom temperature 49° F. "Albatross" station 4045, July 11, 1902.

REMARKS: The largest specimens are about three inches high. Although the branching is mainly in one plane, twigs here and there grow out in various directions. The branches are twisted and tortuous with numerous swellings, cysts, tunnels and other deformities caused by the many epizooic and commensal animals that infest it. All specimens of *Corallium tortuosum* that I have examined are infested with a small zoanthid which pits and distorts the axis. The depressions caused by the zoanthid are distinguishable from those formed by the polyps of the *Corallium* itself

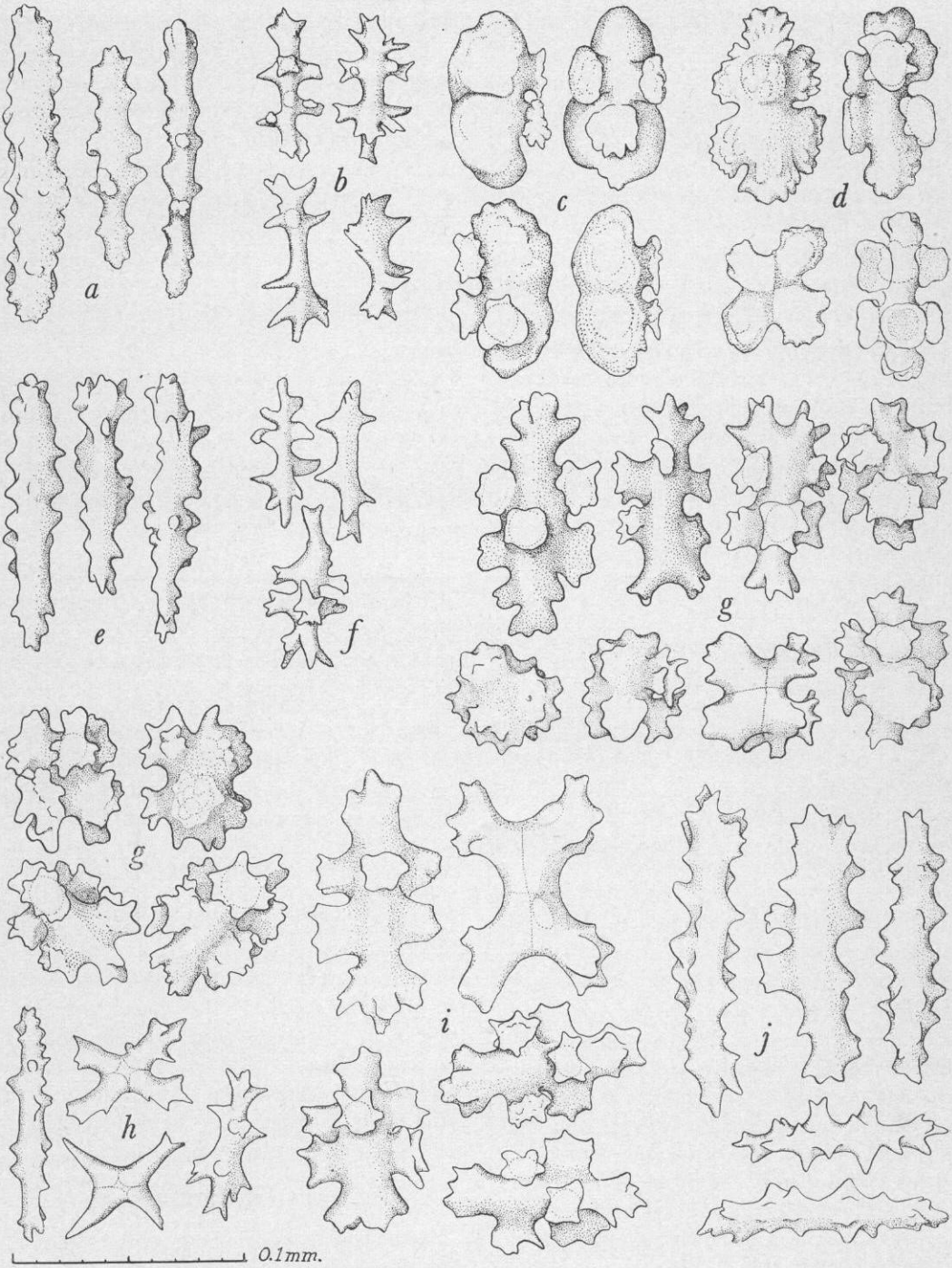

FIG. 7. Spicules of *Corallium* spp. *a–d*, *C. abyssale* sp. nov.: *a*, Verrucal spindles; *b*, spinose rods of pharyngeal region; *c*, double clubs of cortex; *d*, cross and 8-radiates of cortex. *e–g*, *C. regale* sp. nov.: *e*, Verrucal spindles; *f*, spinose rods of pharyngeal region; *g*, 6-, 7-, and 8-radiates, double clubs of cortex. *h–j*, *C. laauense* sp. nov.: *h*, Of pharyngeal region; *i*, 8-radiates and cross of cortex; *j*, verrucal spindles. Magnification of same for all figures.

by their larger size and lack of raised, beaded margin. The coral is also host to a polynoid polychaete, to which the tunnels and cavities in the axis are due. One specimen has in the main stem some chambers filled with a sponge, which may either be directly responsible for the cavities or merely occupying space left by some other inhabitant.

The Japanese *Corallium inutile* is similarly infested with actinians but, according to Kishinouye (1904: 19), the axis is not affected.

Corallium stylasteroides Ridley, 1882, is very similar in general appearance to *C. tortuosum*, but lacks the numerous cruciform spicules so conspicuous in the Hawaiian material.

Corallium tortuosum appears to be the most abundant precious coral in Hawaiian waters but, due to its small size and usually deformed axis, it probably has no commercial possibilities.

Corallium niveum sp. nov.

Fig. 5*g*; 8*h–j*

DIAGNOSIS: Colonies irregularly branched in one plane. Autozooid verrucae low, in groups, on front of colony only. Rind thick, not papillate. Spicules: 6-, 7-, and 8-radiates, crosses and double clubs, in verrucae and rind alike.

DESCRIPTION: The colonies are irregularly branched in one plane, the major branches often diverging strongly from near the base. The axis is solid, round, or oval, and longitudinally grooved; it is not pitted by the autozooids. The branches are stout, the largest ones 5–10 mm. in diameter at the base, tapering to about 2 mm. toward the tips, which are clavate. The autozooids form rather large, hemispherical verrucae with 8-rayed orifices, clustered in groups occurring almost exclusively on the front face of the colony. Each twig tip ends in a cluster of autozooids and thus assumes a clavate form. Small twigs arise from the front of the colonies, each ending in a recurved cluster of polyps which is directed toward the base of the colony. The siphonozooids are inconspicuous, appearing as simple pores in the thick rind. The surface of the rind is finely wrinkled or corrugated, but bears no papillae.

The spicules of both verrucae and cortex are 6-, 7-, and 8-radiates, crosses and double clubs. In the pharyngeal region and oral disk of the polyps there are small spiny rods and crosses.

The rind and axis both are white; the spicules are colorless.

HOLOTYPE: U.S.N.M. No. 49328. Pailolo Channel: Mokuhooniki Islet bearing North 31° West, 2.7 miles distant; depth 127–154 fathoms; broken coral, coarse gravel, rock; bottom temperature 60°–61° F. "Albatross" station 3863, April 10, 1902.

RECORD: Pailolo Channel: Mokuhooniki Islet bearing North 35° West, 3.1 miles distant; 130–151 fathoms; coral, sand, shell, foraminiferans; bottom temperature 61° F. "Albatross" station 4100, July 23, 1902.

REMARKS: *Corallium niveum* is related to *C. pusillum* Kishinouye, from Japan, which differs in lacking the 6- and 7-radiate spicules and in its orange color.

Family *ANTHOTHELIDAE*

DIAGNOSIS: Monomorphic Scleraxonia with the cortex separated from the medulla by a circle of boundary canals. Medulla but rarely perforated by solenia in the branch tips. Gastric cavities of polyps reaching to medulla but not penetrating it.

This family has been divided into three subfamilies, of which only the typical one has been reported from Hawaiian waters.

Subfamily ANTHOTHELINAE

DIAGNOSIS: Anthothelidae with elongate, pointed cortical sclerites; the medullar spicules not long needles; spindles of tentacle bases bent and often clavate. Polyps with cylindrical, projecting calyces.

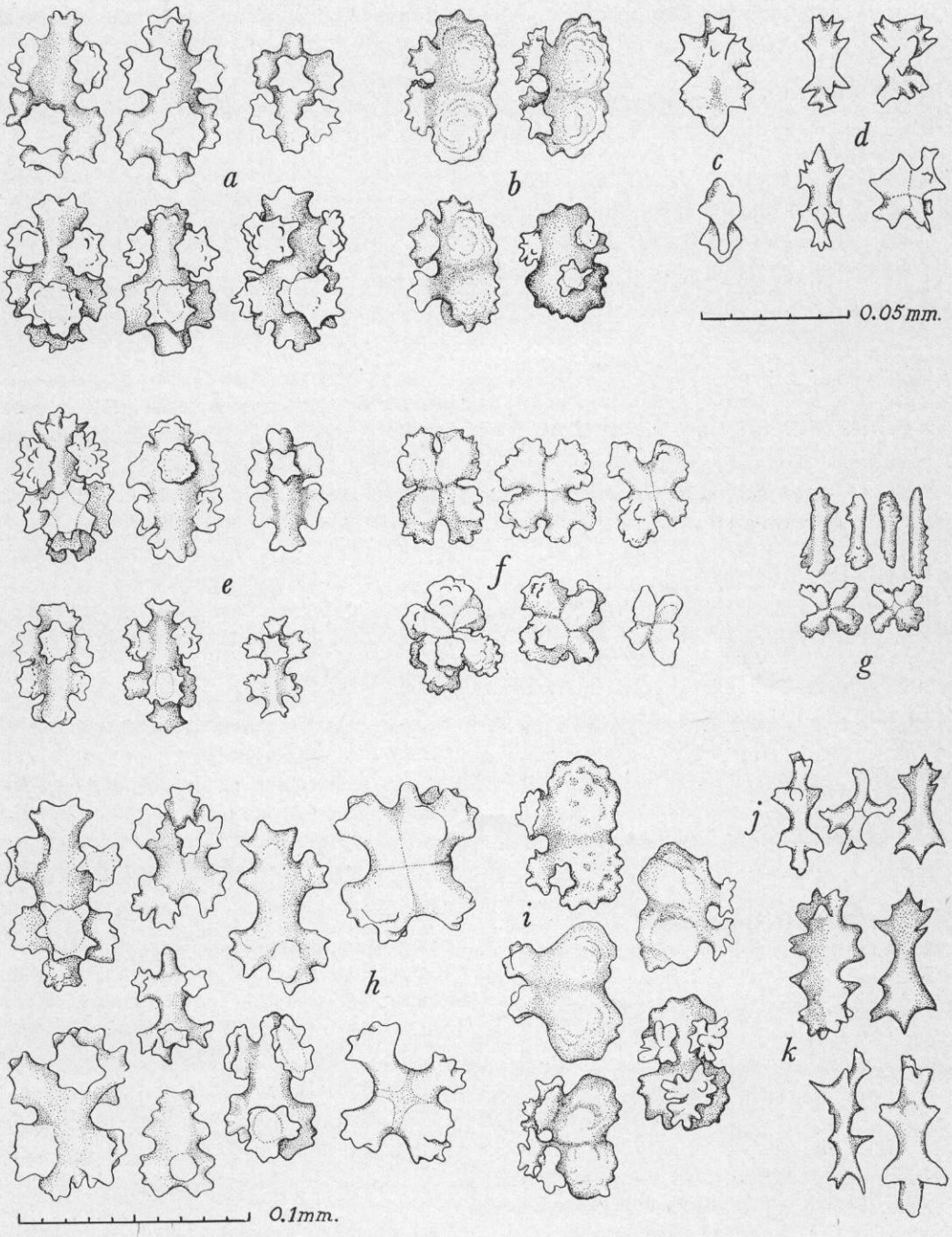

FIG. 8. Spicules of *Corallium* spp. *a–d*, *C. secundum* Dana: *a*, 8-radiates of cortex; *b*, double clubs; *c*, of tentacles; *d*, of pharyngeal region. *e–g*, *C. tortuosum* sp. nov.: *e*, 8-radiates and *f*, crosses, from cortex; *g*, of pharyngeal region. *h–k*, *C. niveum* sp. nov.: *h*, Crosses, 6-, 7-, and 8-radiates, and *i*, double clubs, of cortex; *j*, pharyngeals; *k*, pharyngeals at greater magnification. Scale at *c* and *d* applies also to *k*; scale at *h* to all others.

Genus ANTHOTHELA Verrill

Briareum (pars) M. Sars, 1856, in: Sars, Koren and Danielssen, Faun. Litt. Norv., 2: 63.

?Gymnosarca Kent, 1870, Quart. Jour. Microscop. Sci. (2) 10: 397, pl. 21.

Anthothela Verrill, 1879, U. S. Natl. Mus., Proc. 2: 199. Verrill, 1883, Mus. Comp. Zool., Bul. 11: 40. Studer, 1887, Arch. Naturgesch. 53 Jahrg. Bd. 1: 28. Broch, 1912, Norske Selsk. Skr. 2: 4. Kükenthal, 1924, Tierreich 47: 14.

?Stereogorgia Kükenthal, 1916, Zool. Anz. 47: 178. Kükenthal, 1919, Tiefsee-Exped. 13 (2): 120. Kükenthal, 1924, Tierreich 47: 39.

DIAGNOSIS: As for the subfamily.

TYPE SPECIES: *Briareum grandiflorum* M. Sars, 1856 (by monotypy).

REMARKS: The colonies are usually ramose, arising from a membranous basal expansion, which may also produce polyps. The anthocodiae are at least partially retractile into the tubular calyces. The branches are usually tortuous and not infrequently anastomose. It is not unusual to find colonies (especially the Californian species) overgrown by sponges.

Anthothela nuttingi nom. nov.
Fig. 9*a–e*

Clematissa alba Nutting, 1908, U. S. Natl. Mus., Proc. 34: 582, pl. 44, fig. 4; pl. 48, fig. 4.

Muriceides alba Kükenthal, 1924, Tierreich 47: 166.

Nec *Anthothela alba* Molander, 1929, Further Zool. Res. Swedish Antarct. Exped. 2 (3): 18.

DIAGNOSIS: Colony ramose; branches stout, clavate. Zooids on all sides; calyces tubular, not grooved. Transverse collaret and opercular points well-developed. Anthocodial spindles reaching 0.85 mm., clubs 0.65 mm.; thorny spindles of cortex up to 0.9 mm., less spiny rods up to 0.6 mm.; spiny rods and spindles of medulla up to 1.2 mm., smooth rods 0.6+ mm.

DESCRIPTION: The loosely branched main stem is stout, 6.5 mm. in diameter at its thickest part; the branches taper from 3.5 mm. in diameter at their origins to 2.5 mm. just below the swollen tips. The medullar part of the stem near the base is perforated by solenia, which diminish and seem to disappear entirely toward the branch tips. A ring of boundary canals separates the cortex from the medullar region.

The polyps are irregularly placed on all sides of the stem and branches and are more crowded at the twig tips; the anthosteles are prominent, cylindrical, ungrooved calyces; the anthocodiae have a well-differentiated opercular armature containing numerous transverse collaret rows of slender spindles which merge without noticeable break into the eight *en chevron* tracts that form the opercular points. The latter contain large clubs 0.4–0.6+ mm. long, and thorny spindles reaching 0.75 mm. The thorny spindles of the rind reach 0.9 mm. in length, and the smoother rods about 0.6 mm. The spiny rods and spindles of the medullar region attain a length of 1.2 mm., and the practically smooth rods often exceed 0.6 mm. All spicules are colorless, and the colony is ivory white throughout.

HOLOTYPE: U.S.N.M. No. 25378. Center of Moku Manu (Bird Island) bearing South 77° 30′ East, 11.1 miles distant; depth 762–1000 fathoms; white mud, foraminiferans, rock; bottom temperature 38° F.; "Albatross" station 4157, August 6, 7, 1902.

REMARKS: Molander (1929) has pointed out that Grieg's *Clavularia alba* is actually referable to *Anthothela*. This necessitates a new name for Nutting's "*Clematissa*" *alba*.

Family *MELITHAEIDAE*

DIAGNOSIS: Monomorphic Scleraxonia with a jointed axis consisting of short nodes of horny matter with numerous rod-like spicules,

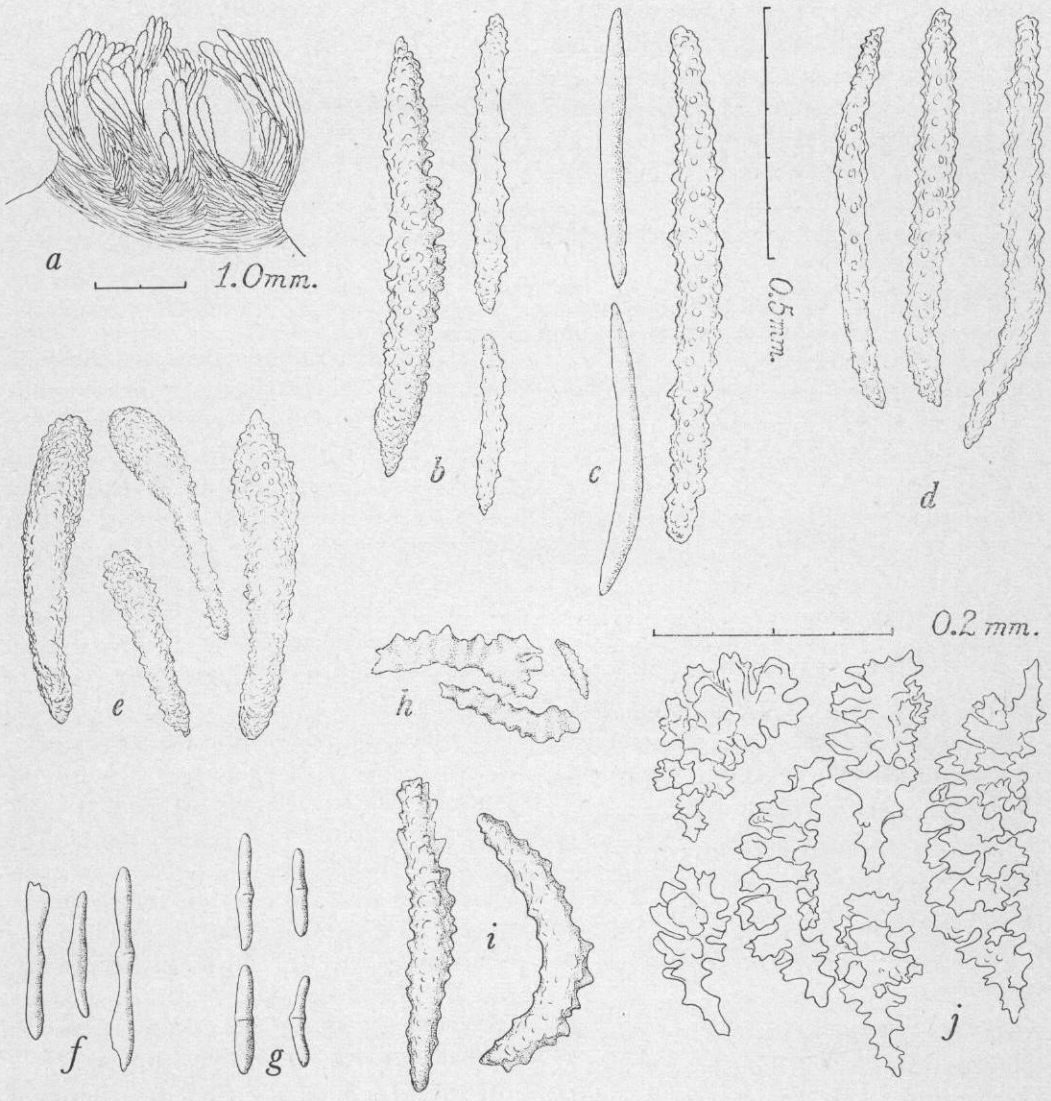

FIG. 9. *a–e*, *Anthothela nuttingi* nom. nov.: *a*, Anthocodial armature; *b–e*, spicules of cortex (*b*), medulla (*c*), anthocodia (*d*), anthocodia (*e*) (clubs). *f–j*, *Acabaria bicolor* (Nutting): Spicules of axis internodes (*f*), axis nodes (*g*), tentacles (*h*), operculum (*i*), cortex (*j*). Scale at *a* applies to that figure only; scale at *c* applies to *b–e*; scale at *j* applies to *f–j*.

and long internodes of fused spicules with little horny matter. Branching proceeds from the nodes.

REMARKS: The taxonomy of this exceedingly vexing group is badly in need of a thorough-going, modern revision. Until the time when such a study is forthcoming, the student whose sorry fate it is to encounter melithaeids is referred to Hickson's memoir on the family (1937). The separation of genera, which is very difficult, may be facilitated by the following summary of characters as given by Hickson.

a. Spicules at the surface of the coenenchym of various kinds. Blattkeulen and Stachelkeulen very rare or absent and when present few in number. Genus *Melitodes* (= *Melithaea*)

b. Spicules at the surface mainly "birotulate" in form. Genus *Melitella*

c. Numerous Blattkeulen and Stachelkeulen at the surface. Genus *Mopsella*

d. Spicules at the surface mainly long spindles, a few Stachelkeulen present in some species. Genus *Acabaria*

e. Spicules at the surface Blattkugeln forming a complete pavement-like protection for coenenchym and verrucae. Genus *Wrightella*

f. Coenenchym comparatively thick, polyps small and capable of complete retraction into the coenenchym. Internodes of axis solid. Genus *Clathraria*

Genus Acabaria Gray

Acabaria Gray, 1859, Zool. Soc. Lond., Proc.: 484. Hickson, 1937, Zool. Soc. Lond., Trans. 23 (3): 146. Hickson, 1940, Pub. Mar. Biol. Sta. Ghardaqa 2:4.

DIAGNOSIS: Melithaeidae with cortical spiculation consisting principally of spindles and clubs that are not broad leaf-clubs.

TYPE SPECIES: *Acabaria divaricata* Gray (by monotypy).

REMARKS: Hickson (1940, p. 4) gives the following definition of the genus:

Melitodidae with comparatively slender branches bearing, in the contracted condition, prominent verrucae. Many of the littoral species dwarf in size (40–50 mms.) and very variable in color and in the form of the corallum, others reaching a larger size (250 mms. or more in height) and flabellate in form with many anastomoses and uniformly red in color. The spicules are mainly spindles and clubs. In some species, but not in others, clubs with expanded spines at one end are found. These are known as Stachelkeulen (spiny clubs or foliaceous clubs).

Acabaria bicolor (Nutting)
Fig. 6*a*, *b*; 9*f–j*

?*Melitodes variabilis* Hickson, 1905, Fauna Geogr. Maldive and Laccadive Arch. 2: 809, pl. 67, fig. 11. Thomson and Simpson, 1909, Alcyo. Investigator 2: 169.

Verrucella bicolor Nutting, 1908, U. S. Natl. Mus., Proc. 34: 597, pl. 46, figs. 6, 7.

DESCRIPTION: The axis consists of alternating, spiculiferous horny nodes and calcareous internodes. The branching is dichotomous, not in one plane, and arises from the horny nodes. The polyps are retractile into dome-like calyces 1–1.25 mm. in diameter at the base, loosely arranged in a biserial manner and inclined toward one side of the branch, leaving the other side free of polyps. The rim of the calycinal aperture is distinctly 8-lobed. The anthocodiae are provided with a distinct operculum consisting of one or two rows of curved, thorny spindles transversely placed and eight radii of 2–3 pairs of slightly bent, thorny spindles set *en chevron* beneath the tentacles. The tentacles distally contain smaller, rod-like forms with conical spines. The cortex is filled mainly with rather spiny spindles; clubs with more or less foliate projections are less abundant than the spindles. The horny nodes are filled with small, belted rods, and the internodes with longer rods firmly cemented together. The calcareous axis is marked by deep longitudinal grooves.

The rind is pinkish orange, the crown and points bright orange and the remaining anthocodial spicules bright yellow. The axis is pink, the nodes brown.

HOLOTYPE: U.S.N.M. No. 25333. Kauai: Nawiliwili Light bearing North 86° West, 1.6 miles distant; 233–40 fathoms; coarse brown coral sand and shell; bottom temperature 48.5° F. (at the greatest depth); "Albatross" station 3982, June 10, 1902.

RECORD: Beach at Manana Island, off Oahu. C. E. Cutress, March, 1955.

REMARKS: Nutting's type of *Verrucella bicolor* consists of only a few terminal branches, but is sufficient to establish beyond a doubt that it is not a member of *Verrucella*. Nutting completely overlooked the principal diagnostic features of the specimen, which are obvious without removing it from the bottle. The spicules, moreover, do not even remotely resemble those of *Verrucella*.

The specimen collected by C. E. Cutress was found thrown up on the beach and thus probably lived in quite shallow water. It agrees in most regards with the type of *bicolor*, but is darker red in color. The colony is a low, dichotomously branched bush. Although not branched in one plane, the polyps all incline toward one side of the colony, leaving the opposite surface bare.

Family *KEROEIDIDAE*

DIAGNOSIS: "Colony erect; axis rigid, consisting of a central cord and of a cortical layer composed of smooth spicules conglomerated together by a horny matrix; Axenepithel remaining only at the tip of branches; polyps retractile into more or less well-developed calyces; spicules not scaly."

REMARKS: To the above diagnosis, taken from Kinoshita (1910), I would add: central chord of axis chambered; spicules of outer rind as thick spindles, irregularly tuberculate, or thick plates; in the anthocodiae, small bifurcate spicules shaped like crutches.

Genus KEROEIDES Studer

Keroeides Studer, 1887, Arch. Naturgesch., 53 Jahrg. Bd. 1: 30. Wright and Studer, 1889, Challenger Zool. 31 (1); 168. Kinoshita, 1910, Annot. Zool. Japon. 8 (4): 225. Stiasny, 1937, Siboga Exped. Monog. 13b[8]: 113.

This genus is easily recognized by its spiculiferous "scleraxonian" axis which, however, is penetrated by a chambered central chord.

Keroeides so perfectly bridges the gap between Scleraxonia and Holaxonia that its placement in the present system is difficult. For the sake of convenience, I am treating it in the same part of this report along with the scleraxonians. Its chambered axial chord points conclusively to its holaxonian affinities, and Kinoshita was unquestionably correct when he stated that *Keroeides* is no scleraxonian.

TYPE SPECIES: *Keroeides koreni* Wright and Studer, by subsequent monotypy, the first species being assigned by Wright and Studer, 1889.

The species known from, or likely to be found in, Hawaiian waters may be separated by the following key.

1. Superficial spicules as closely set large plates like paving stones..... .....**mosaica** sp. nov.
1. Superficial spicules as smaller spindles or elongate plates.....2
2. Colonies unbranched or very sparingly branched.....**fallax** sp. nov.
2. Colonies profusely branched in one plane 3
3. Calyces small, usually 1 mm. or less in width at the base and 0.5–0.75 mm. in height, blunt conical; branches slender, end-twigs about 0.5 mm. in diameter; superficial spicules all rather large, pointed spindles. Bright red..... .....**koreni** Wright and Studer
3. Calyces larger, often 2.5 mm. in width at the base and 1.5–2.0 mm. in height, cylindrical or very slightly tapered; branches robust, end-twigs 1.0–1.5 mm. in diameter; superficial spicules large spindles interspersed with smaller, slender spindles. White or yellowish.....**pallida** Hiles

Keroeides mosaica sp. nov.

Fig. 10*a–f*

DIAGNOSIS: Rind with large, closely fitting, polygonal, pavement-like plates. Twigs stiff;

branching lateral. Tentacular crutches 0.06–0.08 mm. long. White.

DESCRIPTION: The branching is lateral and apparently in one plane but the type is too fragmentary to demonstrate the overall pattern. The branches are rather stiff, bending upward, about 2 mm. in diameter and not noticeably tapering. The polyps are arranged in single rows bilaterally along the branches, either alternate or opposite; an occasional individual faces more toward one side or the other. The calyces are low and dome-like, the younger ones scarcely projecting above the general surface of the rind. The anthocodiae are fully retractile within the calyces.

The spicules of the outer rind are large, rounded or polygonal plates up to 3 mm. in length and 1.5 mm. in width, closely fitted as in mosaic. The plates near the verrucal margin become more elongate and merge into the warted spindles of the anthocodiae. In the tentacles there are small spinose rods, and crutch-shaped spicules 0.06–0.08 mm. long; the gullet has small spindles. The major sclerites are milky white, the smaller forms quite clear and colorless. The axis is made up of smooth, terete spindles closely bound together by a horny matrix; there is a chambered central chord. The axis is light brown in color, due to the horny material.

HOLOTYPE: U.S.N.M. No. 49336. Off Molokai: Lae-o Ka Laau Light bearing North 74° 30′ West, 8.1 miles distant; depth 92–212 fathoms; fine gray-brown sand; bottom temperature 67° F. (reading probably made in shallow water at beginning of drag); "Albatross" station 3838, April 4, 1902.

REMARKS: This very distinct species bears a strong superficial resemblance to certain of the species of the holaxonian genus *Paracis*, but its spicular axis immediately distinguishes it.

Keroeides fallax sp. nov.

Fig. 11*a–d*

Muricella tenera Nutting, 1908, U. S. Natl. Mus., Proc. 34: 586.

Nec *Muricella tenera* Ridley, 1884, Zool. Coll. H.M.S. "Alert": 335.

DIAGNOSIS: Sparingly branched: simple or once-forked. Calyces tall. Outer rind with thick spindles. Tentacular crutches 0.15–0.17 mm. long. Color, cream white (alcohol).

DESCRIPTION: The colonies are ordinarily only once bifurcate and often are simple, arising from a disk-like base attached to stones or shells. The stem is about 2.5 mm. in diameter and tapers to 1.0 mm. in the smallest part of the twigs. The polyps are set in the biserial arrangement typical of the genus, with an occasional individual out of line as is usual in the other species. They are well separated, often 10 mm. or more apart; the calyces are tall and nearly cylindrical, slightly tapered distally, about 2 mm. in diameter at the base and 1.5 mm. high. The anthocodiae usually remain exsert, though the tentacles are folded tightly inward.

The spicules of the rind are large, blunt, somewhat flattened spindles densely packed together. Spindles of the verrucae smaller, longitudinally arranged, merging with the spicules of the anthocodial wall, which are spinose rods. In the tentacles are curved rods and "crutches," the latter being much larger than those of *K. mosaica*, reaching a length of 0.17 mm. The spicules of the axis are smooth, terete spindles, occasionally fused together, set in a horny matrix. In the walls of the long gullet there are many sharply pointed spinose spindles of small size.

In alcohol, the colonies are creamy white; the axis is light brown.

HOLOTYPE: U.S.N.M. No. 49337. South coast of Molokai: Mokuhooniki Islet bearing North 46°45′ East, 12 miles distant; depth 134–130 fathoms; sand, shell, and rock; bottom temperature 69.7° F.; "Albatross" station 3854, April 9, 1902.

RECORD: Off Molokai: Lae-o Ka Laau Light bearing North 74°30′ West, 8.1 miles distant; depth 92–212 fathoms; fine gray-

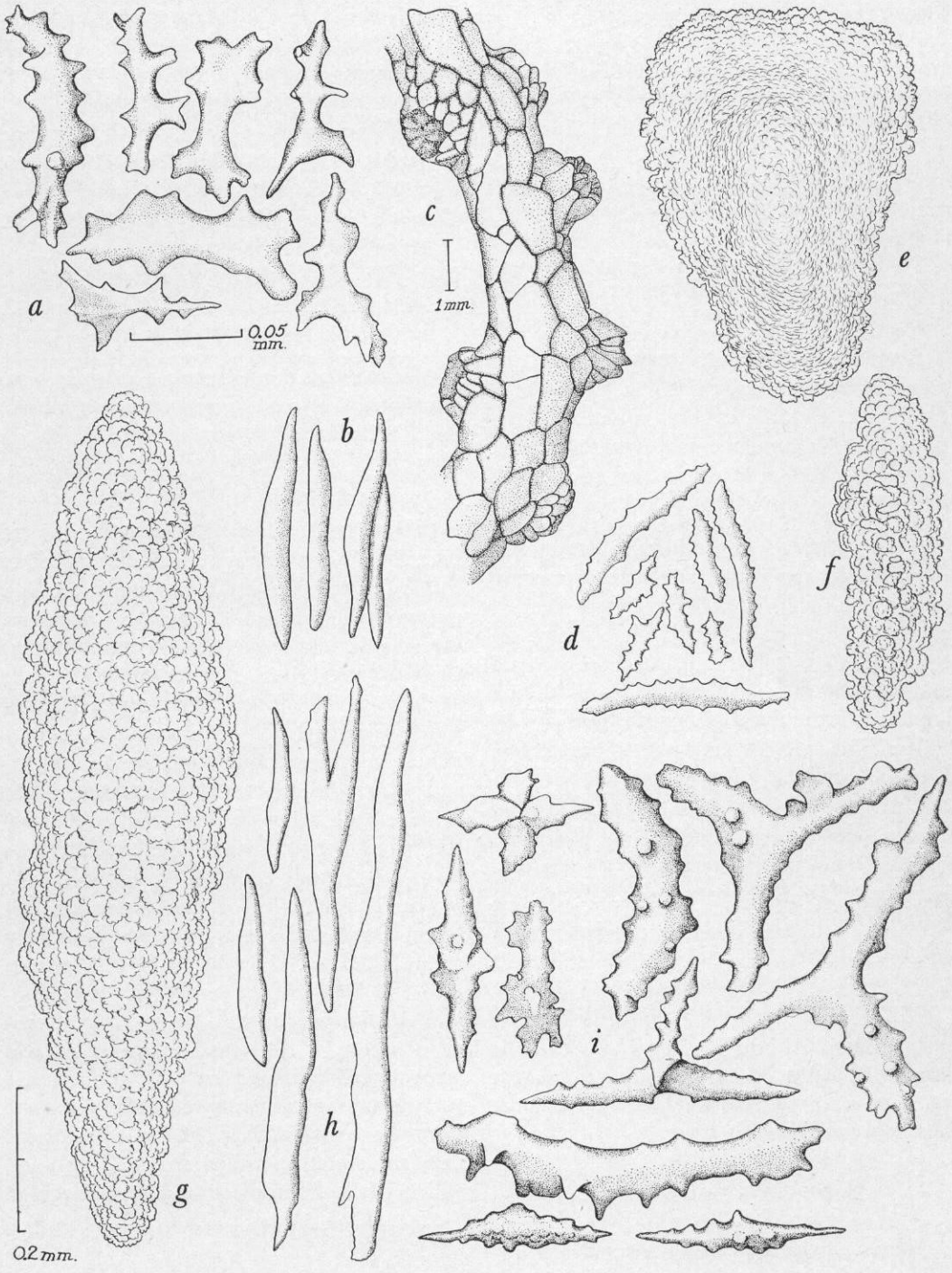

FIG. 10. *a–f, Keroeides mosaica* sp. nov.: *a*, Spicules of tentacles; *b*, spindles of axis; *c*, part of branch; *d*, flat rods from tentacles; *e–f*, smaller plates from rind. *g–i, Keroeides pallida* Hiles: Spicules of cortex surface (*g*), axis (*h*), anthocodia (*i*), including tentacular crutches. Scale at *a* applies to *a* and *i*; *c*, to *c* only; *g*, to all others.

brown sand; bottom temperature 67° F. (probably at shallow end of drag); "Albatross" station 3838, April 4, 1902.

Keroeides koreni Wright and Studer
Fig. 11*e–g*

Keroeides koreni Wright and Studer, 1889, Challenger Zool. 31 (1): 169, pl. 40, fig. 3. Kinoshita, 1910, Annot. Zool. Japon. 8 (4): 225. Bayer, 1949, Pacific Sci. 3 (3): 198. pl. 3, fig. 3.

DIAGNOSIS: Profusely branched in one plane, flabellate. Calyces small, subconical, projecting. Rind with blunt spindles, sometimes bent. Tentacular crutches up to 0.1 mm. long, often with several branches at one end. Red.

DESCRIPTION: The colonies are richly branched in one plane, rarely anastomosing or not at all; flabellate. The twigs are slender, about 0.5 mm. in diameter. The calyces are small, 1.0 mm. or less in diameter at the base and 0.5–0.75 mm. in height, subconical, and arranged in the usual biserial fashion.

The rind spicules are large, more or less flattened spindles often blunt and oval in outline. The tentacles have spiny rods, often curved, and the usual crutch- or Y-shaped spicules. The crutches measure 0.07–0.1 mm. in length. The gullet contains small, pointed spindles with rude sculpture. The spicules of the axis are long, occasionally fused together, quite smooth and terete.

The colony in alcohol is bright red.

REMARKS: Although *Keroeides koreni* is known from the Marshall Islands it has not yet been reported from the Hawaiian Islands, but it may well occur there.

Keroeides pallida Hiles
Fig. 10*g–i*

Keroeides pallida Hiles, 1899, Willey's Zool. Res. 2: 201, pl. 22, figs. 12–16.

Keroeides gracilis Nutting, 1908, U. S. Natl. Mus., Proc. 34: 569.

Nec *Keroeides gracilis* Whitelegge, 1897, Austral. Mus., Mem. 3: 308, pl. 16, figs. 1–5.

Paramuricea aequatorialis Nutting, 1908, U. S. Natl. Mus., Proc. 34: 580.

Nec *Paramuricea aequatorialis* Wright and Studer, 1889, Challenger Zool. 31 (1): 100, pl. 22, fig. 6; pl. 26, fig. 3.

Clematissa verrilli Nutting, 1908, U. S. Natl. Mus., Proc. 34: 584.

Nec *Clematissa verrilli* Wright and Studer, 1889, Challenger Zool. 31 (1): 107, pl. 22, fig. 10; pl. 26, fig. 6.

DIAGNOSIS: Colonies branched in one plane, flabellate. Calyces large and conspicuous. Rind with large spindles between which are many small spindles. Tentacular crutches 0.12–0.17 mm. long. Color, cream white.

DESCRIPTION: The robust colonies are branched in one plane and assume a flabellate form; the branches are rather stout, the end twigs measuring 1.0–1.5 mm. in diameter. The calyces are large, 2.0–2.5 mm. wide at the base and 1.5–2.0 mm. tall, cylindrical or slightly tapered, biserially arranged. The anthocodiae are usually withdrawn almost completely in preservation.

The spicules of the rind are large, blunt spindles with many smaller spindles filling up the spaces between them. The large spindles do not fit closely together as they do in *K. fallax*. The spindles of the calyces are obliquely oriented at the base, longitudinally toward the apex. The calycular spicules merge into the anthocodial armature, which consists of thorny rods set *en chevron* in the tentacle bases. In the tentacles there are also some large, Y-shaped crutches about 0.12–0.17 mm. long, which have a different shape from those of *K. fallax*. The spicules of the axis are smooth, rather crooked spindles, which often anastomose and fuse together.

RECORDS: South coast of Molokai: Mokuhooniki Islet bearing North 49°45′ East, 12.6 miles distant; depth 115–134 fathoms; coarse sand and shell; bottom temperature 68.5° F.; "Albatross" station 3853, April 9, 1902.

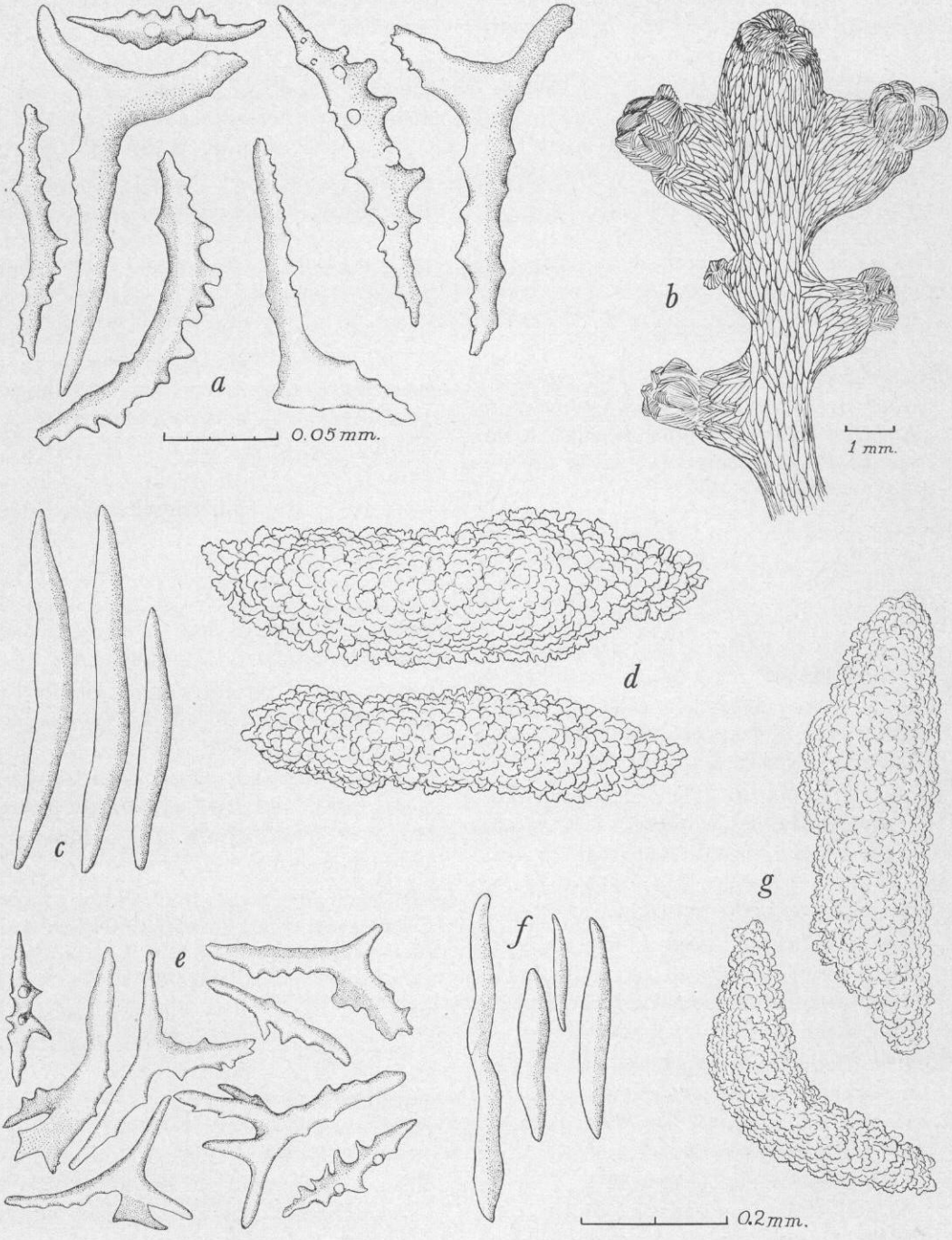

FIG. 11. *a–d, Keroeides fallax* sp. nov.: *a*,Tentacular crutches; *b*, branch tip; *c*, axial spicules; *d*, spindles of cortex. *e–g, Keroeides koreni* Wright and Studer: *e*, Tentacular crutches and pharyngeal rods; *f*, axial spindles; *g*, cortical spindles. Scale at *b* applies only to *b*; scale at *a* to *a* and *e*; scale at *g* to all others.

Pailolo Channel: Mokuhooniki Islet bearing North 18° East, 5.6 miles distant; depth 138–140 fathoms; fine sand and mud; bottom temperature 60.2°–60.5° F.; "Albatross" station 3859, April 9, 1902.

REMARKS: *Keroeides pallida* may be distinguished from *K. fallax* by its more profuse branching and coarser habit, by the small spindles clearly visible between the large sclerites, and by the form of its tentacular crutches.

REFERENCES

AURIVILLIUS, MAGNUS. 1931. The gorgonaceans from Dr. Sixten Bock's expedition to Japan and the Bonin Islands, 1914. *Svenska Vetensk. Akad., Handl.* III, 9 (4): 1–337, 65 figs., 6 pls.

BAYER, FREDERICK M. 1949. The Alcyonaria of Bikini and other atolls in the Marshall group. Part 1: The Gorgonacea. *Pacific Sci.* 3(3): 195–210, 6 figs., 4 pls.

——— 1952. Descriptions and redescriptions of the Hawaiian octocorals collected by the U. S. Fish Commission steamer "Albatross." (I. Alcyonacea, Stolonifera, and Telestacea.) *Pacific Sci.* 6(2): 126–136.

BROCH, HJALMAR. 1912. Die Alcyonarien des Trondhjemsfjordes. II. Gorgonacea. *Norske Vidensk. Selsk., Skr.* 1912 (2): 1–48, 29 figs.

BURMANNUS, JOANNES. 1769. *Index alter in omnes tomos Herbarii Amboinensis Cl. Georgii Everhardi Rumphii, quem de novo recensuit, auxit, et emendavit.* Pp. [22]. Lugduni Batavorum, apud Cornelium Haak. Amstelaedami, apud Johannem Schreuderum.

CUVIER, GEORGES. An 6 [1798]. *Tableau élémentaire de l'histoire naturelle des animaux.* xvi + 710 pp., 14 pls. Baudouin, Paris.

DANA, JAMES DWIGHT. 1846. Zoophytes. Vol. 7. *United States Exploring Expedition.* . . . vi + 740 pp., 45 figs. and atlas of 61 col. pls. (1849). [Printed by C. Sherman], Philadelphia.

GRAY, JOHN EDWARD. 1859. Description of some new genera of lithophytes, or stony zoophytes. *Zool. Soc. London, Proc. 1859:* 479–486.

——— 1867. Additional note on Corallium johnsoni. *Zool. Soc. London, Proc.* 1867: 125–127.

HICKSON, SYDNEY JOHN. 1905. The Alcyonaria of the Maldives. Part III. The families Muriceidae, Gorgonellidae, Melitodidae, and the genera Pennatula, Eunephthya. In: *Fauna and Geography of the Maldive and Laccadive Archipelagoes.* [J. Stanley Gardiner, ed.] Vol. 2, rpt. 4, pp. 807–826, pl. 67. University Press, Cambridge.

——— 1907. Die Alcyoniden der Siboga-Expedition. I. Coralliidae. *Siboga Expeditie* Monog. 13c [Livr. 35]. 8 pp., 1 pl. E. J. Brill, Leiden.

——— 1937. The family Melitodidae. *Zool. Soc. London, Trans.* 23 (3): 73–212, 38 figs., 1 pl.

——— 1940. The species of the genus Acabaria in the Red Sea. *Mar. Biol. Sta. Ghardaqa, Pub.* 2: 1–22, 6 figs., 2 pls.

HILES, ISA. 1899.The Gorgonacea collected by Dr. Willey. In: *Zoological Results based on material from New Britain, New Guinea, Loyalty Islands and elsewhere, collected during the years 1895, 1896, and 1897 by Arthur Willey.* Part 2, pp. 195–206, pls. 22, 23. University Press, Cambridge.

JOHNSON, JAMES YATE. 1899. Notes on the Coralliidae of Madeira, with descriptions of two new species. *Zool. Soc. London, Proc.* 1899: 57–63, 1 fig., 3 pls.

KENT, W. SAVILLE. 1870. On two genera of alcyonid corals, taken in the recent expedition of the yacht "Norma" off the coast of Spain and Portugal. *Quart. Jour. Micros. Sci.* (N. S.) 10: 397–399.

KINOSHITA, KUMAO. 1910. On the Keroeididae, a new family of Gorgonacea, and some notes on the Suberogorgiidae. *Annot. Zool. Jap.* 7 (4): 223–230, 1 fig., pl. 6.

KISHINOUYE, KAMAKICHI. 1904. Notes on the natural history of corals. *Imp. Fish. Bur., Tokyo. Jour.* 14 (1): 1–32, 4 figs., 9 pls.

KNORR, GEORG WOLFGANG. 1766–1767. *Deliciae Naturae selectae; oder, auserlesenes Naturalien-Cabinet, welches aus den drey Reichen der Natur zeiget was von . . . Liebhabern aufbehalten und gesammlet zu werden verdienet. Ehemals herausgegeben von G. W. Knorr . . . fortgesetzt von dessen Erben, beschrieben von P. L. S. Müller, und in das Französiche übersetzt von M. V. de la Blaquière.* 2 vols. [13] + viii; xx + 144 pp. 91 pls. Nürnberg.

KOREN, J., and D. C. DANIELSSEN. 1883. *Nye Alcyonider, Gorgonider og Pennatulider tilhørende Norges Fauna.* [1] + xvi + 38 pp., 13 pls. Bergens Museum.

KÜKENTHAL, W. 1916. System und Stammesgeschichte der Scleraxonier und der Ursprung der Holaxonier. *Zool. Anz.* 47: 170–185.

——— 1919. Gorgonaria. In: *Wissenschaftliche Ergebnisse der Deutschen Tiefsee—Expedition . . . .* Vol. 13, pt. 2. 1–948, 297 figs., pls. 30–89. Gustav Fisher, Jena.

——— 1924. Gorgonaria. *Das Tierreich.* No. 47. xxviii + 478 pp., 209 figs. Walter de Gruyter & Co., Berlin und Leipzig.

LAMARCK, J. B. P. A. 1801. *Systême des animaux sans vertèbres.* viii + 432 pp. Paris.

LINNAEUS, C. 1758. *Systema naturae.* Ed. 10, vol. 1. [2] + 824 pp. Holmiae.

———1767. *Systema naturae.* Ed. 12, vol. 1, pt. 2. 533–1327 + [18] pp. Laur. Salvii, Holmiae.

MILNE EDWARDS, H., and J. HAIME. 1857. *Histoire naturelle des coralliaires ou polypes proprement dits.* 3 vols. xxxiv + 326; 633; 560 pp., atlas of 36 pls. Paris.

MOLANDER, A. R. 1929. Die Octactiniarien. In: *Further zoological results of the Swedish Antarctic Expedition 1901–1903.* Vol. 2 (2). iv + 86 pp., 27 figs., 5pls. P. A. Norstedt & Söner, Stockholm.

NUTTING, C. C. 1908. Description of the Alcyonaria collected by the U. S. Bureau of Fisheries steamer "Albatross" in the vicinity of the Hawaiian Islands in 1902. *U. S. Natl. Mus., Proc.* 34: 543–601, 11 pls.

RIDLEY, S. O. 1882. On the arrangement of the Coralliidae, with descriptions of new or rare species. *Zool. Soc. Lond., Proc.* 1882: 221–233, pl. 9.

——— 1884. Alycyonaria. In: *Report on the Zoological Collections made in the Indo-Pacific Ocean during the Voyage of H.M.S. "Alert" 1881–1882.* xxv + 684 pp., 54 pls. British Museum (Natural History), London.

SARS, MICHAEL. 1856. Nye Polyper. In: *Fauna Littoralis Norvegiae.* Vol. 2. ii + 101 pp., 12 pls. Fr. D. Beyer, Bergen.

STIASNY, GUSTAV. 1937. Die Gorgonacea der Siboga-Expedition. Suppl. II, Revision der Scleraxonia, etc. *Siboga Expeditie.* Monog. $13b^8$ [Livr. 130]. vi + 133 pp., 8 pls. E. J. Brill, Leiden.

STUDER, THÉOPHILE. 1887. Versuch eines Systemes der Alcyonaria. *Arch. f. Naturgesch.* 53 Jahrg. 1: 1–74, 1 pl.

THOMSON, J. ARTHUR, and J. J. SIMPSON. 1909. *Alcyonaria of the Investigator. II, The Alcyonaria of the littoral area.* xii + 319 pp., 9 pls. Indian Museum, Calcutta.

VERRILL, ADDISON EMERY. 1879. Notice of recent additions to the marine Invertebrata, etc. Part I. *U. S. Natl. Mus., Proc.* 2: 165–205.

——— 1883. Report on the Anthozoa, and on some additional species dredged by the "Blake" in 1877–79, and by the U. S. Fish Commission steamer "Fish Hawk" in 1880–82. *Harvard Univ., Mus. Compar. Zool., Bul.* 11 (1); 1–72, pls. 1–8.

VERSEVELDT, J. 1940. Studies on Octocorallia of the families Briareidae, Paragorgiidae and Anthothelidae. *Temminckia* 5: [5] + 142 pp., 52 figs.

WHITELEGGE, THOMAS. 1897. The Alcyonaria of Funafuti, part II. *Austral. Mus., Mem.* 3 (5): 307–320, 2 pls.

WRIGHT, E. PERCEVAL, and TH. STUDER. 1889. Alcyonaria. *Report on the scientific results of the voyage of H.M.S. "Challenger."* Vol. 31, part 64. lxvii + 314 pp., 49 pls. Eyre & Spottiswoode, London.