

# The Sponges of the Island of Hawaii<sup>1</sup>

M. W. DE LAUBENFELS<sup>2</sup>

THE ISLAND OF HAWAII lies farthest to the east and south of the chain of islands which comprise the Hawaiian archipelago. It has an area of more than 10,000 square kilometers. From it, capes project slightly north of 20° and south of 19° north latitude, also slightly west of 156° and east of 155° west longitude. Its two highest volcanic peaks, Mauna Kea and Mauna Loa, project respectively 4,201 and 4,170 meters above sea level. The whole island consists of four amalgamated volcanic cones, rising from an ocean floor which is about 5 kilometers deep; thus the unit rises more than 9 kilometers above its substrate. Only comparatively narrow regions of shallow water bound the island. In fact, along the steep north shore, there is practically no area which has a depth of less than 10 or 20 meters. The other shores, however, do have offshore regions less than 10 meters deep, and up to as much as 100 meters wide. The northeast side receives the trade winds, and therefore heavy rainfall; as a result a small river empties into the sea at Hilo. No other permanent streams occur on the island.

In the summer of 1945, Professor R. W. Hiatt of the University of Hawaii made an intensive study of an extremely arid and inaccessible region on the south shore of Hawaii, known as Halapé. His collection of sponges was turned over to me for study.

In May, 1948, a grant from the University of Hawaii enabled me to make a rather

thorough collection about the shores of the island. There I was given the utmost assistance by the officials of the Territorial Board of Agriculture and Forestry; on the east side by Mr. Ernest Yap; and on the west side by Mr. Homer Hayes. I am also grateful to the President of the Territorial Board of Agriculture and Forestry, Mr. Colin Lennox, and to the Director of the Division of Fish and Game, Mr. Vernon Brock, for their assistance in the project.

Studies were made by using small boats, both row boats and motor-powered craft. The sea bottom was carefully observed by means of a glass-bottom "viewing box." Assistance in collecting was rendered by "skin divers," who swim down to a depth of a few meters.

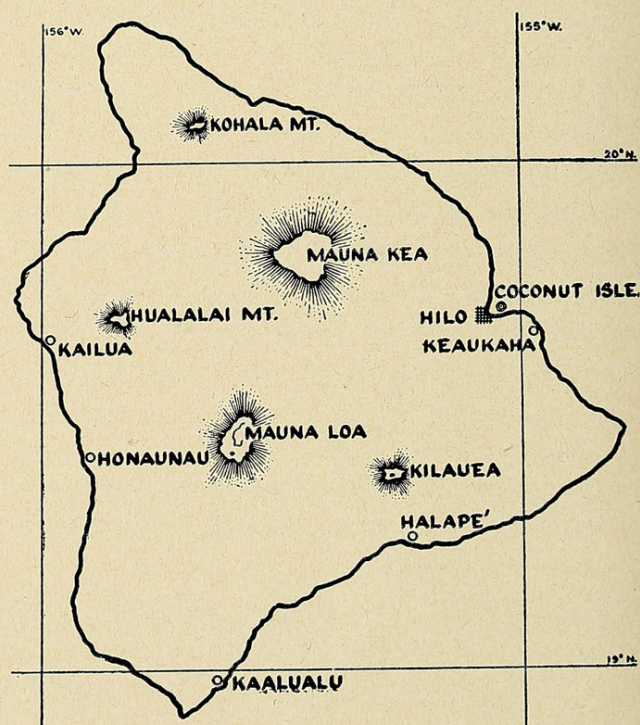


FIG. 1. The island of Hawaii, showing localities mentioned.

<sup>1</sup> Contribution No. 7, Hawaii Marine Laboratory. Manuscript received June 27, 1950.

<sup>2</sup> Formerly Professor of Zoology, University of Hawaii; now Professor of Zoology, Oregon State College, Corvallis, Oregon.



Some collecting was possible by wading, especially by turning over stones. No dredging was used in the present study.

Because of the scarcity of suitable environment, the number of species of shallow-water sponges around the island of Hawaii is only moderate. Twenty-eight kinds are recorded, of which nine are here described as new. Four of the others are peculiar to the Hawaiian Islands and thus only about half of the species are represented elsewhere.

The sponges of Kaneohe Bay, island of Oahu, in the central portion of the Hawaiian Islands, have recently been described (de Laubenfels, 1950: 3-36). The species which are there described are not here redescribed, but the page reference is given. All others are described because of the possibility that later studies may lead to the conclusion that some are new species, although here identified with previously described names. Many early descriptions are seriously incomplete, so that identification with them must be tentative. A key to genera is also included, as follows:

KEY TO GENERA

- 1. No proper spicules present. . . . . 2  
  Proper spicules present. . . . . 3
- 2. Spongin network present. . . . . *Spongia*  
  Spongin network absent. . . . . *Chondrosia*
- 3. Spicules of silica present. . . . . 4  
  Spicules of calcium carbonate present 27
- 4. Spicules only monaxon. . . . . 5  
  Triaxons or tetraxons also present. . . 23
- 5. No microscleres present. . . . . 6  
  Microscleres present. . . . . 12
- 6. Spicules are tylostyles. . . . . *Terpios*  
  Spicules are not tylostyles. . . . . 7
- 7. Spicules are of several sorts. . . . *Rhaphisia*  
  Spicules are all simple oxeads. . . . . 8
- 8. Extensive subdermal spaces present. .  
  . . . . . *Halichondria*  
  Extensive subdermal spaces absent. . . 9
- 9. Spicules conspicuously protrude from  
  the surface. . . . . *Phycopsis*  
  Spicules do not conspicuously pro-  
  trude from the surface. . . . . 10

- 10. Dermal network present, with meshes  
  much finer than those of the interior  
  . . . . . *Callyspongia*  
  No such dermal network present. . . . 11
- 11. Sponge in the form of definite tubes  
  . . . . . *Reniera*  
  Sponge not tubular. . . . . *Haliclona*
- 12. Microscleres are spirasters. . . . *Spirastrella*  
  Microscleres not spirasters. . . . . 13
- 13. Microscleres include spherasters. . . *Tethya*  
  Microscleres do not include spheras-  
  ters. . . . . 14
- 14. Microscleres only smooth microxeas  
  . . . . . *Petrosia*  
  Other microscleres present. . . . . 15
- 15. Microscleres only roughened raphides  
  . . . . . *Tedamia*  
  Other microscleres present. . . . . 16
- 16. Microscleres only toxas. . . . . *Toxadocia*  
  Other microscleres present. . . . . 17
- 17. Microscleres only amphidiscs. . . . .  
  . . . . . *Hiattirochota*  
  Other microscleres present. . . . . 18
- 18. Megascleres include acanthostyles. . .  
  . . . . . *Microcionia*  
  Acanthostyles absent. . . . . 19
- 19. Megascleres only strongyles. *Xytopsiphum*  
  Other megascleres present. . . . . 20
- 20. Megascleres tylotes and oxeads. *Damiriana*  
  Megascleres monactinal. . . . . 21
- 21. Microscleres do not include aniso-  
  chelas. . . . . *Axocielita*  
  Microscleres do include anisochelas. . 22
- 22. Microscleres include toxas. . . . . *Carmia*  
  Microscleres do not include toxas. . .  
  . . . . . *Mycale*
- 23. Sterrasters present. . . . . *Geodia*  
  Sterrasters absent. . . . . 24
- 24. Aspidasters present. . . . . *Erylus*  
  Aspidasters absent. . . . . 25
- 25. Microscleres only euasters. . . . . *Myriastrea*  
  No astrose spicules present. . . . . 26
- 26. Monoloph spicules present. . . . . *Plakina*  
  Monoloph spicules absent. . . . . *Plakortis*
- 27. Numerous oxeads present. . . . . *Leuconia*  
  Oxeads rare or absent. . . . . *Leucetta*



## DESCRIPTIONS OF SPECIES

*Spongia oceania* de Laubenfels

Described in de Laubenfels (1950: 7).

This species appears to be common throughout the Hawaiian Islands. Hiatt found it at Halap  in 1945. I found it at Kaalualu and Honaunau, and, with the viewing box, observed numerous specimens (not collected), especially along the Kona coast from Honaunau to Kailua.

*Haliclona permollis* (Bowerbank)  
de Laubenfels  
Fig. 2

This species is represented by U. S. National Museum, Register Number 22791 (Halap  No. I-106b), collected by Hiatt in August, 1945, at Halap , on the undersides of rocks at the seaward edge of a rocky shore, depth less than 1 meter. I have found this species also on the island of Oahu.

This is a soft incrusting sponge, usually lavender in life. There is absolutely no dermal specialization of skeleton—the endosomal structures merely stop short. There are no extensive subdermal canals.

The skeleton comprises only one sort of spicule, an oxea 3 by 100 to 7 by 105 $\mu$ . These are often arranged so as to outline polygonal meshes, each side just one spicule long. The spicules are joined to one another by spongin at the corners of these meshes. This structure is called isodictyal. In places there may also be tracts, almost fibers, of parallel rows of spicules held together by spongin.

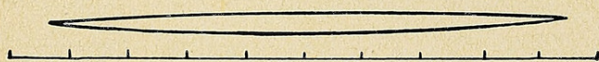


FIG. 2. *Haliclona permollis*: spicule, from a camera lucida drawing. (The scale shows 100 microns by tens.)

This species was first described as *Isodictya permollis* by Bowerbank (1866: 278) and transferred to *Haliclona* by de Laubenfels (1936: 40).

*Reniera aquaeducta* Schmidt  
Fig. 3

This species is represented by U. S. National Museum, Register Number 22792 (My No. H. 79), collected May 15, 1948, at Keaukaha, at low tide, barely submerged. I found it again on May 16, 1948, at Kaalualu, and Hiatt took it in August, 1945, at Halap .

This sponge consists of a number of tubes 20 to 25 mm. high, 3 to 9 mm. diameter, with walls 0.8 to 2 mm. thick. In life it was bluish violet and of spongy consistency. The surface is smooth.

The skeleton comprises only oxeas, 5 by 120 to 7 by 100 $\mu$ . These are arranged much as in the preceding species.

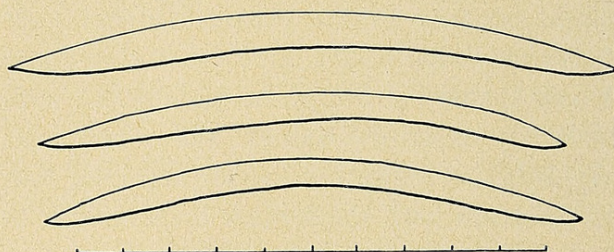


FIG. 3. *Reniera aquaeducta*: spicules, from camera lucida drawings. (The scale shows 100 microns by tens.)

This species was first described by Schmidt (1862: 72) from the Mediterranean as *Reniera aqueductus*. It has since been recorded from various localities in both the North and South Atlantic, but this appears to be the first record for the Pacific Ocean. The species is probably cosmopolitan, but is nowhere abundant. An important discussion of it may be found in Burton (1930: 511).

*Xytopsiphum meganese* new species  
Fig. 4

The type specimen of this species is U. S. National Museum, Register Number 22782 (My No. H. 83), collected May 16, 1948, at Kaalualu, at low tide, barely submerged.

This sponge is a paper-thin incrustation spreading laterally indefinitely. In life it was yellow-gray to ochre in color. There is a definite dermis with its contained spicules tangentially arranged.



The skeleton consists of strongyles, 3 by 210 to 3 by 240 $\mu$ , and normally shaped arcuate chelas 16 $\mu$  long.

The genus *Xytopsiphum* appears to be confined to the Hawaiian Islands; the type, *X. kaneohe* de Laubenfels, was described from Oahu by de Laubenfels (1950: 12). This Oahu species is characterized by slightly smaller megascleres (which is trivial) and by chelas radically different from those of the present species. The chelas of the former, while technically arcuate, are U-shaped with thick shafts and minute clads. The new species, *meganese*, is set off by having normal chelas with thin shafts and well-developed clads.

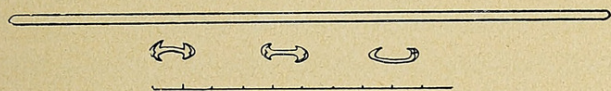


FIG. 4. *Xytopsiphum meganese*: spicules, from camera lucida drawings; one of the strongyles and three views of the arcuate chelas. (The scale shows 100 microns by tens.)

The name which is here selected is derived from the Greek words for "large" and "island," indicating that it is the species which is characteristic of the large island of Hawaii.

#### *Callyspongia diffusa* (Ridley) Burton

Described in de Laubenfels (1950: 12).

This species appears to be moderately common throughout the Hawaiian Islands. Hiatt found it at Halap  in 1945. I found it at Kaalualu in 1948.

#### *Damiriana hawaiiiana* de Laubenfels

Described in de Laubenfels (1950: 14).

This species appears to be moderately common throughout the Hawaiian Islands. Hiatt found it at Halap  in 1945. I found it at Kailua in 1948.

#### *Toxadocia violacea* de Laubenfels

Described in de Laubenfels (1950: 14).

This species appears to be moderately common throughout the Hawaiian Islands. I

found it not only on Oahu, but also near Hilo in 1948.

#### *Petrosia puna* new species

Fig. 5

The type specimen of this species is U. S. National Museum, Register Number 22780 (My No. H. 72; Halap  No. I-106), collected in August, 1945, by Hiatt at Halap . It was said to be abundant on the undersides of stones at the seaward edge of a rocky shore at depths less than 1 meter.

This sponge is an incrustation, pale drab in life, of hard consistency. There is a tendency for its dermal spicules to be tangentially arranged. The endosome is densely packed with spicules and is only microcavernous. There is no localization of the different kinds of spicules.

The skeleton consists of megascleres of two size ranges. The larger type may be oxeas 13 by 166  $\mu$ , styles 14 by 132  $\mu$ , or strongyles 13 by 135  $\mu$ ; each of the three occurs in approximately equal abundance. The size range of smaller spicules, almost as abundant as the larger, consists entirely of oxeas about 4 by 96  $\mu$ .

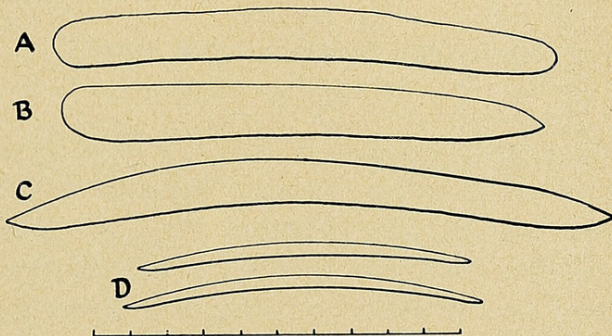


FIG. 5. *Petrosia puna*: spicules, from camera lucida drawings. A, Strongyle; B, style; C, oxea, larger size; D, two of the smaller oxeas. (The scale shows 100 microns by tens.)

This new species exhibits many points of difference from all others in the genus *Petrosia* except the genotype, which was first described as *Reniera dura* by Schmidt (1862: 77). This species, *dura*, is so far recorded only from the Mediterranean. From it the new



Hawaiian species differs as follows: The larger spicule category of *dura* is reported to comprise only oxeas and strongyles, whereas *puna* has, also, abundant styles. The smaller spicule category of *dura* comprises about equally abundant oxeas and strongyles; *puna* has only oxeas.

The specific name which is here selected is the Hawaiian name for the south coast of the island of Hawaii, the region where this species of *Petrosia* has been found.

***Tedania ignis*** (Duchassaing and Michelotti) Verrill

Described in de Laubenfels (1950: 21).

This species appears to be quite common in the waters about the Hawaiian Islands. Hiatt found it at Halap  in 1945. I found it in 1948 near Hilo, also at Kaalualu, and near Honaunau.

***Hiattrochota proteus*** de Laubenfels

Described in de Laubenfels (1950: 20).

This species is moderately common throughout the Hawaiian archipelago. In addition to the records on Oahu, I found it in 1948 at Kaalualu and at Honaunau.

***Microciona maunaloa*** new species

Fig. 6

The type specimen of this species is U. S. National Museum, Register Number 22775 (My No. H. 74), collected May 14, 1948, near Hilo. This was obtained in Hilo Harbor near Coconut Island, at a depth of 2 meters, by diving.

This sponge is a paper-thin incrustation, spreading laterally indefinitely. In life it was a pale caramel-brown with definite pink tinges. In alcohol it turned blue. This reaction is unique and amazing. The consistency was soft.

In places where the whole sponge was only 400  $\mu$  thick there was an ectosomal region 150  $\mu$  thick. This was composed of a dermal membrane 10  $\mu$  thick, but otherwise almost

no protoplasmic structures at all. Instead, it was full of tufts or bouquets of spicules, the heads at almost the same spot at the underlying surface of the endosome, the points all toward the outer surface but diverging at acute angles. The broad external expanse of each such bouquet is about 100  $\mu$  wide, the individual spicules about 150  $\mu$  long. The endosome is a rather dense mass of flesh, 250  $\mu$  thick, and, of course, permeated by canals and chambers. In it many spicules lie in confusion. Larger erect spicules pierce it, their heads on or near the substrate, their points toward the surface. The echinating spicules are confined to a thin region adjacent to the substrate.

The skeleton includes several size ranges of megascleres. The large spicules which protrude through the whole thickness of the incrustation are smooth tylostyles, upwards of 13 by 425  $\mu$ . Those scattered through the flesh are often about 9 by 240  $\mu$ . Those of the dermal tufts are about 6 by 160  $\mu$ , but some are only 6 by 120  $\mu$ . The echinating spicules are conspicuously spined acanthostyles about 8 by 42  $\mu$ . The microscleres include toxas 56 to 132  $\mu$  long and palmate isochelas 14  $\mu$  long; both types are quite commonplace in shape. In addition, however, there are abundant palmate isochelas of amazingly small size, only 5 to 6  $\mu$  long.

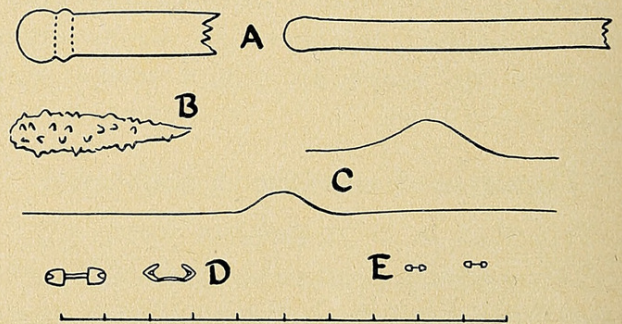


FIG. 6. *Microciona maunaloa*: spicules, from camera lucida drawings. A, Heads of tylostyles (the rest of these spicules is not shown); B, acanthostyle; C, two extremes of the toxa shape; D, larger palmate isochela; E, smaller isochelas. (The scale shows 100 microns by tens.)

This species is well characterized by its very small chelas. Several species in the genus



*Eurypon* have such microscleres, but not others in *Microciona*. The color is also unique; most species of *Microciona* are red. The extent to which the ectosomal spicules make symmetrical bouquets is also somewhat unusual in this very large genus.

The name which is here selected is that of the huge volcanic mountain Mauna Loa.

*Mycale maunakea* new species

Fig. 7

The type specimen of this species is U. S. National Museum, Register Number 22781 (My No. H. 75), collected May 14, 1948, in Hilo Harbor near Coconut Island at a depth of about 2 meters, by diving.

This sponge is incrusting, about 1 mm. thick. In life it was translucent, pale pink, and soft. It exhibited some recognizable oscules about 200  $\mu$  in diameter.

The ectosome is a transparent dermis, 50 to 75  $\mu$  thick, containing many microscleres but no megascleres. The endosome contains abundant spicular tracts which never anastomose and almost never branch. At the distal termination of each column, just under the dermis, the spicules of each tract diverge slightly, making dermal tufts which are much like miniature brooms. Such tufts are commonplace. These isolated non-reticulate tracts are 30 to 40  $\mu$  diameter and about 100 to 200  $\mu$  apart.

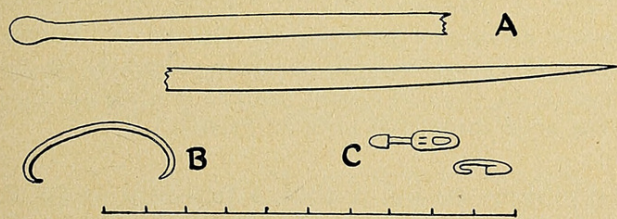


FIG. 7. *Mycale maunakea*: spicules, from camera lucida drawings. A, Tylostyle; B, sigma; C, palmate anisochelas. (The scale shows 100 microns by tens.)

The megascleres are smooth tylostyles 2 by 160 to 6 by 240  $\mu$ , often 5 by 210  $\mu$ . The microscleres include sigmas 37 to 42  $\mu$  in chord length and palmate anisochelas of peculiar shape. They are nearly isochelas,

which is remarkable inasmuch as intermediates between isochelas and anisochelas are rare. They are very narrow with almost no lateral development on their convex side. Their lengths range from 13 to 22  $\mu$ .

Earlier (1950: 24) I identified a common sponge of Oahu as *Mycale cecilia*. It, too, is an incrusting sponge with narrow isochelas. But the microscleres in the Oahu sponge are quite commonplace in shape, and its tylostyles have unusually long heads, whereas the megascleres of the *Mycale* from the island of Hawaii are distinctive. At the moment it does not appear that any other species of *Mycale* has the utterly non-reticulate structure characteristic of the new species *maunakea*, and no other has chelas of the same peculiar shape. Those most nearly the same are found in *Mycale sulcata* Hentschel (1911: 307) (Australian and East Indian), but this species is digitate (not incrusting), has styles (not tylostyles), and has trichodragmas and two size ranges of chelas.

The name which is here selected is that of the extinct volcano Mauna Kea, which dominates the island of Hawaii.

*Carmia contarenii* (Martens) de Laubenfels

Fig. 8

This species is represented by U. S. National Museum, Register Number 22787 (My No. H. 84), collected May 16, 1948, at

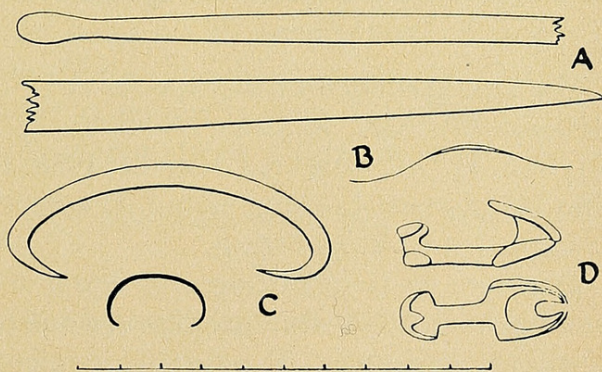


FIG. 8. *Carmia contarenii*: spicules, from camera lucida drawings. A, Tylostyle head and point, but the mid-portion is not shown; B, toxa; C, large and small sigmas; D, palmate anisochelas. (The scale shows 100 microns by tens.)



Kaalualu. It was found on the underside of a large stone barely submerged at low tide.

This sponge is incrusting, pale drab, and soft. The ectosome includes an optically evident reticulation of spicular tracts, as does the endosome. There are also many spicules which are merely strewn in confusion.

The megascleres are tylostyles with elongate heads, reaching a maximum of at least 13 by 350  $\mu$ , or 10 by 400  $\mu$ . The microscleres include sigmas 5  $\mu$  thick and 80  $\mu$  in chord length, smaller sigmas only 25  $\mu$  in chord length, toxas about 60  $\mu$  long, commonplace palmate anisochelas 40  $\mu$  long (which are often arranged in rosettes), and smaller palmate anisochelas only 10  $\mu$  long.

Martens in 1824 described *Spongia contarenii* from European waters. Topsent (1928: 78) redescribed it, placing it in *Mycale*. It was referred to *Carmia* by de Laubenfels (1936: 118). All records so far are from Europe, where it is common. The Hawaiian sponge which is here described is identified as *contarenii* only with grave doubts. It is so small a specimen and so devoid of striking characteristics, however, that it seems most unwise to erect a new species name for it. It exhibits no points of definite difference from *contarenii* and is at least closely related to the European species. Were more and better developed specimens available, grounds might be found for considering it a new species.

#### *Axocielita kilauea* new species

Fig. 9

The type specimen of this species is U. S. National Museum, Register Number 22779 (My No. H. 76), collected May 14, 1948, in Hilo Harbor near Coconut Island, at a depth of about 2 meters, by diving.

This sponge is incrusting and about 0.5 mm. thick. In life it was vermilion-red and of mediocre consistency. The surface is microhispid but lipostomous.

The ectosome does include a fleshy membrane, but it is rather vaguely developed. The whole sponge is so thin that it is also true

that the endosomal structures lack conspicuous pattern.

The skeleton is composed of two types of megascleres. There are relatively large styles, often 12 by 280  $\mu$ , but sometimes at least 15 by 630  $\mu$ . Some are merely loose in the flesh, but others stand erect on the substrate, their points projecting slightly beyond the surface. The spicule heads that are in contact with the substrate are usually slightly spined. A second megasclere type is a smooth, straight tylostyle, about 2 by 144  $\mu$  in dimensions. These are often strewn in confusion but are more common at or near the surface than they are near the base of the sponge. The microscleres include commonplace toxas, 30 to 60  $\mu$  long, usually 50  $\mu$ . There are also peculiar chelas, perhaps of two sorts. Chelas of this type (or these types) are each about 14  $\mu$  long. Practically all of them reveal merely a C shape, but after long search one face-view of a palmate isochela of apparently commonplace form was found. When such chelas lie on their sides, they look somewhat like the above-mentioned C shape, but they are

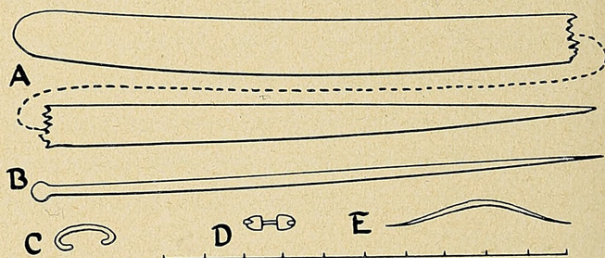


FIG. 9. *Axocielita kilauea*: spicules, from camera lucida drawings. A, Style; B, tylostyle; C, peculiar microsclere, probably in isochela, common in this species; D, the one typical palmate isochela; E, toxa. (The scale shows 100 microns by tens.)

very likely to lie in such a position as to reveal the shape of their shovels; here they do not. Two explanations may exist to explain the peculiar situation in *Axocielita kilauea*. First, there may be such wide, peculiar lateral expansions on the shaft that equilibrium results from the side position. Second (and more likely), it may be that nearly all of these chelas have such exceedingly narrow shovels that they inevitably fall over on their sides.



The other species now in *Axocielita* have rather large, commonplace palmate isochelas. The species *kilauea* also exhibits minor differences in the sizes and shapes of its megascleres.

The specific name selected is that of the famous volcanic crater in the southern portion of the island of Hawaii.

***Phycopsis aculeata* (Wilson)**  
de Laubenfels

Fig. 10

This species is represented by U. S. National Museum, Register Number 22784 (My No. H. 85), collected May 16, 1948, while wading, from a substrate of volcanic rock barely below low tide at Kaalualu.

This sponge is massive, the fragment collected being about 1 by 2 by 3 cm. The surface is strongly hispid and lipostomous. In life it was dark gray with an interior much paler than the exterior. The consistency was stiff and the sponge rather easily broken.

The ectosome, as delimited by darker color and somewhat denser structure, is about 2 mm. thick. The endosome is microcavernous, also dense.

The skeleton is composed of but a single sort of spicule. This is a smooth, sharply pointed oxea, 23 by 940 to 32 by 1,200  $\mu$  or more. The few megascleres that are smaller are doubtless developmental forms. These spicules are sometimes in confusion, but a significantly large proportion of them stand perpendicular to the surface, with about a third of their length protruding from it.

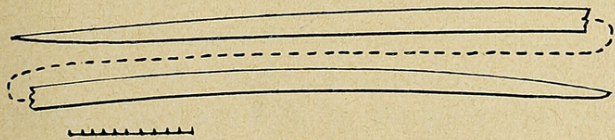


FIG. 10. *Phycopsis aculeata*: spicule, from a camera lucida drawing. (The scale shows 100 microns by tens.)

This species was first described as *Axinyssa aculeata* by Wilson (1925: 445), from the Philippines, and was transferred to *Phycopsis* by de Laubenfels (1936: 131).

***Halichondria dura* Lindgren**

Fig. 11

This species is represented by U. S. National Museum, Register Number 22785 (My No. H. 73), collected May 14, 1948, from a depth of 2 meters in the harbor of Hilo, by diving.

This sponge is incrusting and reaches a thickness of about 3 mm. In life it was yellow and of a hard consistency. The surface is somewhat hispid and is lipostomous.

The ectosome is definitely set off as a layer perhaps 60  $\mu$  thick by the occurrence of extensive subdermal cavities which are 200  $\mu$  wide and 200  $\mu$  high. The endosome is of "crumb-of-bread" structure with abundant spicules in confused arrangement.

The skeleton consists chiefly of just one kind of spicule, an oxea. There is great variation in size. Very many of these spicules, however, are between 20 by 650 and 27 by 680  $\mu$ .

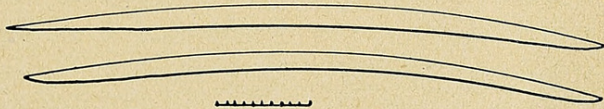


FIG. 11. *Halichondria dura*: spicules, from camera lucida drawings. (The scale shows 100 microns by tens.)

The identification of this specimen is made with some hesitation. The hispid surface is not typical of *Halichondria*, but some portions of *Halichondria* are slightly hispid, and the present specimen is only slightly hispid. The other items are all quite typical of *Halichondria*. Within this huge genus, the closest to the Hilo sponge is *dura*. This was described by Lindgren (1897: 480) from Java.

***Rhaphisia myxa* new species**

Fig. 12

The type specimen of this species is U. S. National Museum, Register Number 22783 (My No. H. 82), collected May 16, 1948, at Kaalualu, by wading. It was just below low tide on a substrate of volcanic rock.

This sponge is incrusting and 1 to 2 mm.



thick. In life it was white; the consistency was extremely slimy but, at the same time, sticky or glue-like. The surface is smooth and lipostomous.

The ectosome is not sharply set off from the endosome. The latter is microcavernous with some vague tracts, about 100 to 125  $\mu$  apart and 20  $\mu$  in diameter, and containing 3 to 10 spicules per transverse section.

The skeleton, other than the ubiquitous colloidal stuff, consists of spicules which may be regarded as comprising only a single category but with much individual variation. Some are simple, smooth, sharply pointed oxeas 4 by 112  $\mu$ . Others, probably juvenile, are as small as 1 by 85  $\mu$ . Many are as large as from 5 by 117 to 6 by 150  $\mu$ , and the larger ones frequently have unusual shapes. It is common for them to be centrotylote, and some are also strongylote. Many, not centrotylote, have two distinct angular bends near the mid-point.

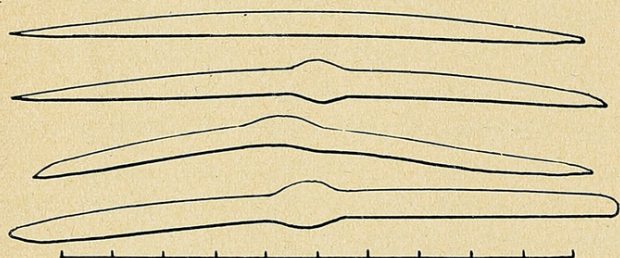


FIG. 12. *Rhabhisia myxa*: spicules, from camera lucida drawings. (The scale shows 100 microns by tens.)

All the sponges now in *Rhabhisia*, except the genotype, have much larger spicules than those of this new species. The genotype is *Rhabhisia laxa* Topsent (1892: xvii) from the Mediterranean region and is clearly the closest relative to the Hawaiian form. It also was viscous, but lacked the peculiar spicule shapes of *myxa*.

The species name here selected is derived from the Greek for slimy, and refers to the extreme development of a viscous colloid by this species.

### *Spirastrella keaukaha* new species

Fig. 13

The type specimen of this species is U. S. National Museum, Register Number 22777 (My No. H. 78), collected at Keaukaha, May 15, 1948, far back from the surf on volcanic rock barely below low tide. This species was found also at Kaalualu and at Honaunau and is abundant all around Hawaii.

This is an incrusting species often as much as 3 mm. thick, spreading laterally indefinitely. In life it was orange-brown to red-brown, with a paler interior, but often with a very dark layer about 0.6 to 1 mm. below the surface—a layer about 50 to 120  $\mu$  thick. The consistency was rather like that of cheese. The surface is smooth and lipostomous, but subdermal canals (which doubtless terminated at oscules which close quickly and readily) are easily visible.

The ectosome is characterized by greater density and pigmentation than the microcavernous endosome. The microscleres are exceedingly abundant in the dermal layer.

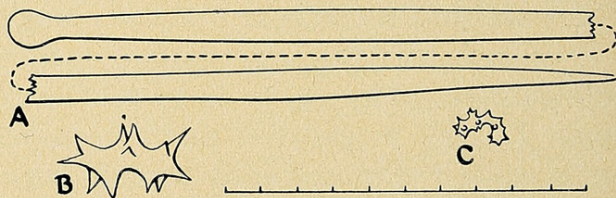


FIG. 13. *Spirastrella keaukaha*: spicules, from camera lucida drawings. A, Tylostyle; B, larger spiraster; C, smaller spiraster. (The scale shows 100 microns by tens.)

The skeleton is composed of tylostyles and spirasters. The former are smooth and straight, 8 by 328  $\mu$ , usually in confusion but oftenest with points directed toward the surface of the sponge. The microscleres are of two size ranges. The larger spirasters are about 40  $\mu$  long, the smaller about 16  $\mu$  long. Both kinds are astonishingly nearly straight, only slightly spiral. The smaller variety has spines which are more obtuse than might be expected.



There are now many names in the genus *Spirastrella*, and the opinion is here expressed that all the massive or ramose forms need to be removed to other genera, such as *Anthosigmella*. The remainder, all incrusting forms, are all much alike and require separation on slender margins of difference. It is here considered probable that there really are about six species in the world. This new species, *keaukaha*, is distinctive for the dark subdermal layer (not quite always present) and the almost straight axis of the spirasters.

The species name selected is that of the locality of the type specimen.

### *Terpios zeteki* de Laubenfels

Described in de Laubenfels (1950: 28).

This species appears to be very common throughout the Hawaiian Islands. I found it to be abundant, not only on Oahu, but also at Kaalualu and at Honaunau in 1948.

### *Tethya diploderma* Schmidt

Described in de Laubenfels (1950: 30).

This species appears to be abundant throughout the Hawaiian Islands. I found it to be so on Oahu and also found specimens at Kaalualu and Honaunau in 1948. Hiatt found it at Halap  in 1945.

### *Myriastra debilis* Thiele

Fig. 14

This species is represented by U. S. National Museum, Register Number 22789 (My No. H. 71), collected in August, 1945, by R. W. Hiatt at Halap . It was growing on dead coral in the surf area.

This species is massive, reaching a thickness of at least 1 cm. In life it was pale and the consistency was cartilaginous. The surface is partly smooth and partly hispid, and the Hawaiian specimens appear lipostomous.

The ectosome is vaguely corticate, the endosome is semi-radiate. Presumably all well-developed specimens will be definitely corticate and of radiate architecture with the

spicules all more or less perpendicular to a spherical surface.

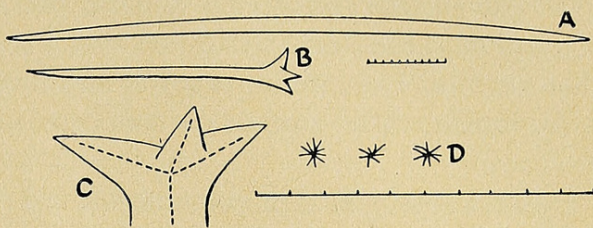


FIG. 14. *Myriastra debilis*: spicules, from camera lucida drawings. A, Oxea; B, plagiotriaene; C, head or cladome of a plagiotriaene; D, three oxyeuasters. (The smaller scale matches A and B, showing 100 microns by tens. The larger scale matches the more highly magnified C and D, showing 100 microns by tens.)

The skeleton consists of very numerous spicules, often in confusion, but many are perpendicular to the surface. There are smooth, sharply pointed oxeas 18 by 720  $\mu$ . There are plagiotriaenes with rhabds 16 by 320  $\mu$  and very short clads; the latter are often less than 32  $\mu$  long. Some broken bits of long thin spicules, only 2 or 3  $\mu$  in diameter, are here interpreted as being fragments of the rhabds of anatriaenes whose cladomes (not found) formerly protruded from the surface but have been broken off. The microscleres are oxyeuasters about 10  $\mu$  in diameter. They are astonishingly rare.

Thiele (1900: 25) described *Myriastra debilis* from the East Indies. He did find the anatriaenes, but their absence from the Hawaiian specimen does not necessarily mean that it is not the same species. Thiele's specimens agreed with ours in lacking the protriaenes and in having similar short-clad plagiotriaenes and microscleres.

### *Geodia gibberella* new species

Fig. 15

The type specimen of this species is U. S. National Museum, Register Number 22778 (My No. H. 66), collected in August, 1945, by R. W. Hiatt at Halap . It was found at a depth of 3 meters on a coral "head" in the channel between the steep shore and a small off-shore island. This species seems to be uncommon in the Hawaiian Islands.



This sponge is massive to subglobular and is over 1 cm. in diameter. Its color is dirty gray. The surface consistency is hard, almost stony (due to the sterraster armor), but somewhat flexible. The interior is softer and more compressible. The surface is smooth and lipostomous.

The ectosome is a fibrous cortex nearly 1 mm. thick and is densely packed with sterrasters. The endosome shows a fundamental tendency to radiate architecture but realizes this structure only vaguely.

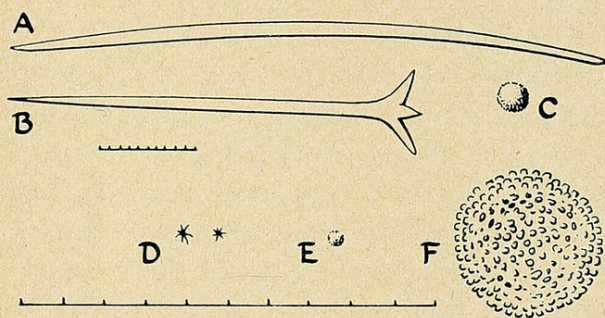


FIG. 15. *Geodia gibberella*: spicules, from camera lucida drawings. A, Oxea; B, plagiotriaene; C, sterrasters; D, oxyeuasters; E, spheraster; F, sterraster. (The smaller scale for A, B, and C shows 100 microns by tens. The larger scale matches the more highly magnified D, E, and F and shows 100 microns by tens.)

The megascleres are sharp-pointed oxeas 15 by 620  $\mu$  and plagiotriaenes with rhabds 18 by 410  $\mu$  and clads 60  $\mu$  long. The microscleres include the large sterrasters which are characteristic of *Geodia*, but not as large as they are in most of the species of this genus; they have a diameter of only about 37  $\mu$  and are nearly spherical. The mature sterrasters are practically all in the cortex, but their sharp-rayed juvenile forms, as usual, occur sparingly in the endosome. Additional microscleres of two sorts also occur—oxyeuasters 6  $\mu$  in diameter and oxyspherasters only 5  $\mu$  in diameter. The euasters are abundantly present in a thin layer over the outer surface of the sterraster armor.

Lamarck (1815: 333) described *Geodia gibberosa*, the type of the genus. It is an abundant West Indian species, not certainly recorded from any other locality. It and this

Hawaiian species stand out from the rest of the genus for lack of anatriaenes and protriaenes and for the possession of minute spherasters. Clearly *gibberosa* is the nearest relative to *gibberella*. But the West Indian *Geodia* has large (30  $\mu$ ) oxyeuasters.

The species name which is here selected is a diminutive of *gibberosa*.

### *Erylus proximus* Dendy

Fig. 16

This species is represented by U. S. National Museum, Register Number 22786 (My No. H. 57), collected February 19, 1948, by dredging at a depth of 50 meters in the open ocean 2.5 kilometers south of Pearl Harbor, Oahu. This species is not common, but is widely distributed in the Hawaiian archipelago. Hiatt collected it (his No. I-38a G) in August, 1945, at Halapé.

This is an amorphous sponge, often growing in interstices of dead coral or cracks in rocks. In life the ectosome was dark gray to black, the endosome a paler gray or drab. The consistency was cartilaginous. The surface is microtuberculate. The pores are about 70  $\mu$  in diameter and 300 to 400  $\mu$  apart. The rare oscules are about 1.5 mm. in diameter.

The ectosome is a fibrous cortex densely

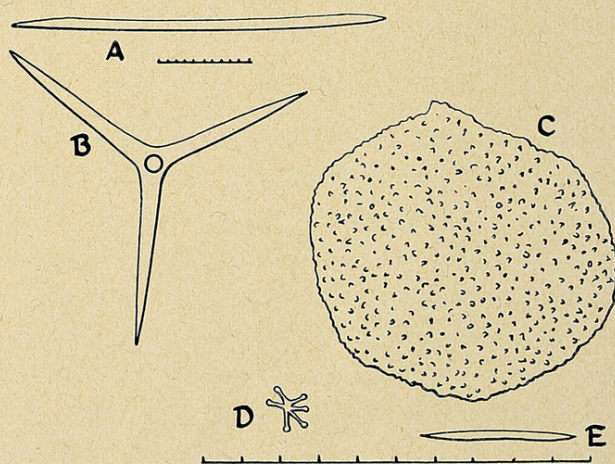


FIG. 16. *Erylus proximus*: spicules, from camera lucida drawings. A, Oxea; B, tetraxon; C, aspidaster; D, tylaster; E, microxea. (The smaller scale for A and B shows 100 microns by tens. The larger scale matches the more highly magnified C, D, and E and shows 100 microns by tens.)



packed with aspidasters and is about  $100\ \mu$  thick. The endosome is microcavernous and confused.

The skeleton includes oxeas 8 by 500 to 12 by  $420\ \mu$  and tetraxons that might almost or quite suitably be called calthrops. Their nearly equal rays are 5 by 105 to 15 by  $200\ \mu$ ; one is often slightly longer than the others and might be considered a rhabd but is not clearly so. In addition to these definite megascleres, there are oxeas 3 by  $50\ \mu$ , perhaps also megascleres, but probably to be regarded as microscleres. There are abundant aspidasters in the cortex. These microscleres are less than  $10\ \mu$  thick, but are  $80\ \mu$  in diameter—irregularly rounded discs. They are densely covered with conical projections, probably homologous with the rays of asters, but also resembling the spines on acanthoscleres. Finally, eutylasters  $15\ \mu$  in diameter are also present.

This species was described by Dendy (1916: 258) from the Indian Ocean, the only previous record. The agreement with Hawaiian specimens is amazingly close.

### *Plakortis simplex* Schulze

Described in de Laubenfels (1950: 33).

This species appears to be moderately common throughout the Hawaiian Islands. I found it at Keaukaha in 1948.

### *Plakina monolopha* Schulze

Fig. 17

This species is represented by U. S. National Museum, Register Number 22788 (My No. H. 87), collected May 17, 1948, at Honaunau at a depth of about 1 meter.

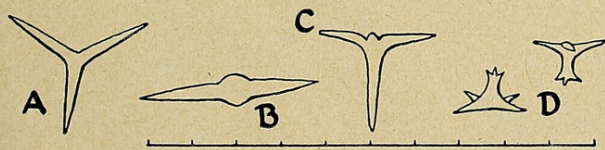


FIG. 17. *Plakina monolopha*: spicules, from camera lucida drawings. A, Triaxon; B, centrotylote oxea; C, tetraxon; D, monoloph spicules. (The scale shows 100 microns by tens.)

This is a thin crust 0.6 to 0.8 mm. thick, drab, soft, and lipostomous. There is little ectosomal specialization. The endosome is densely fleshy, with canals  $100\ \mu$  in diameter perpendicular to the surface and 200 to  $500\ \mu$  apart. Doubtless in life these ascended to minute oscules.

The commonest spicules are regular triaxons, with rays 3 by 20 to 4 by  $24\ \mu$ . There are sagittal tetraxons with two clads about this same size, the third clad very small, and the rhabd slightly longer. There are oxeas, about 4 by  $36\ \mu$ , usually centrotylote. Finally, there are the distinctive monoloph calthrops; these tetractinellid or pentactinellid spicules have three or four simple sharp smooth rays, about 3 by  $12\ \mu$ , in one plane, as divergent from each other as possible. The odd ray is at right angles to them and about as long but terminates in about four sharp spines.

This species was first described by Schulze (1880: 407) from the Mediterranean. It has since been recorded from various European regions and by Thiele (1898: 28) from Japan. It is doubtless cosmopolitan, but neither really abundant anywhere nor ever conspicuous.

### *Chondrosia chucalla* de Laubenfels

This species is represented by U. S. National Museum, Register Number 22790 (My No. H. 77). It was collected at Halapé in 1945 by R. W. Hiatt (His No. II 679). This was from lava rock in a tide pool at the west end of Keaoi Island, at low tide. It was common in this vicinity.

This is a massive, subspherical sponge. The Hawaiian specimens are about 1 cm. thick and 3 by 6 cm. in lateral dimensions. The color is black as to surface, dark drab as to interior. The surface is smooth, shining, and slimy. The pores are all closed, but oscules, each about 1 mm. in diameter, can be discovered in groups of 2 or 3, such groups about 1 cm. apart.

The skeleton of all sponges probably includes a greater or lesser amount of non-



living colloidal material. In this species (and genus) there is a relatively large quantity of this, and here it is in a fairly stiff gel condition. The ordinary methods of search reveal no inorganic skeleton—that is to say, no spicules at all. Exceedingly rare spicules may be present, but this is surmise.

This species was first described as *Chondrosia collectrix* by Lendenfeld (1888: 74) from Australia, its only previous locality record. There was already a different *Chondrosia collectrix*, that of Schmidt (1870: 25). Therefore de Laubenfels (1936: 184) set up the new name *chucalla* for Lendenfeld's species.

*Leuconia kaiana* new species

Fig. 18

The type specimen of this species is U. S. National Museum, Register Number 22776 (My No. H. 86). This was collected in August, 1945, by R. W. Hiatt (His No. III 870) at Halapé. This species was found abundantly on coral about 2 meters deep on the outer, surf-pounded slope of the small island of Keaoi. This, or a similar *Leuconia*, is widespread in the Hawaiian region. I have found it also at Pearl Harbor, Oahu.

This species is hollow—that is to say, it possesses a relatively large cloaca. The shape is very roughly cylindrical, larger in the middle than at the ends, but the cylindrical shape is further modified by the occurrence of small, short branches. A total height of at least 3 cm. is reached and a diameter of 8 mm.; the walls are almost 1 to 2 mm. thick. The cloaca penetrates nearly the entire length of the sponge.

The color is whitish and the consistency fragile. The surface is hispid, but there is no coronal fringe around the oscules. The latter are about 2 mm. in diameter.

The ectosome contains many tangent rays of polyactinal spicules. The endosome has an architecture perhaps to be termed rhagon, but almost that which has been termed sylleibid. In the latter, the flagellate chambers are concentrated in clusters, but the clusters are

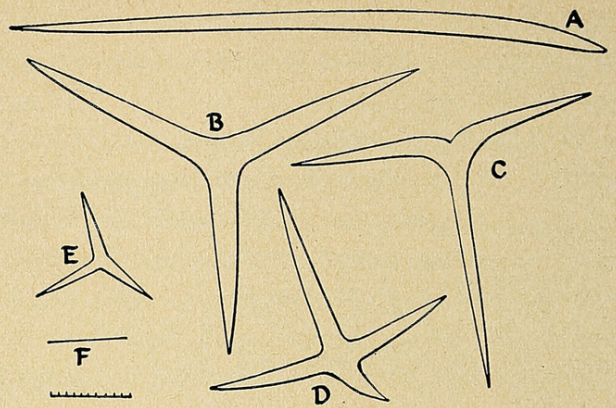


FIG. 18. *Leuconia kaiana*: spicules, from camera lucida drawings. A, Oxea; B, regular triaxon of the chamber layer; C, sagittal triaxon, from subdermal area, and oscular region; D, tetraaxon from lining of cloaca—the curved ray projects into the cloaca; E, smaller triaxon; F, microxea. (The scale shows 100 microns by tens.)

rather distinct from each other.

The skeleton includes oxeas 25 by 750  $\mu$ , perpendicular to the surface, and partially protruding so that they render it hispid. The spicules of the chamber layer are chiefly regular triaxons with rays about 35 by 300  $\mu$ . Many sagittal triaxons with their clads near the surface and parallel to it also occur. The clads are about 20 by 200  $\mu$ ; the rhabds penetrate the chamber layer perpendicular to the surface and are about 20 by 300  $\mu$ . Many tetraaxons line the cloaca, two medium-sized rays tangentially placed in its lining, a small bent ray protruding into the cloaca, and a longer ray piercing the chamber layer, perpendicular to the cloacal surface. The latter ray is about 25 by 225  $\mu$ ; the paired rays are about 25 by 175  $\mu$  in dimensions. Many small, regular triaxons are present, especially near the inner and outer surfaces. Their rays are about 10 by 100  $\mu$ . Microxeas also occur, only 1 by 90  $\mu$ .

The species is probably closest to that *Leuconia* which was first described as *Leucandra taylori* by Lambe (1900: 261) from Vancouver Island, British Columbia. The smaller triaxons of Lambe's species had rounded (strongylote) ends, and it did have a coronal fringe around the oscules. Both *taylori* and *kaiana* seem related to the com-



mon species of the genus *Rhabdodermella* of the American Pacific coast.

The species name which is here selected is that of the famous ancient Hawaiian nobleman, Prince Kaiana.

*Leucetta solida* (Schmidt) Dendy and Row

Described in de Laubenfels (1950: 34).

This species appears to be moderately common about the Hawaiian Islands. I found it on Oahu, and R. W. Hiatt found it at Halapé in August, 1945.

### ECOLOGICAL OBSERVATIONS

My first study was made in Hilo Harbor, near Coconut Island. The representative of the Territorial Board of Agriculture and Forestry who accompanied me was a capable diver and brought up much material for examination from depths of about 2 meters. The location, although on the windward side of the island, is sheltered from the full force of the sea. No sponges were common in this area, nor were any found to be large. On the other hand, the fauna here was unique. Five species were found—three were new, one (*Halichondria*) perhaps new although tentatively identified, and another has been reported from only one other locality (Oahu, also in the Hawaiian Islands). The species are:

*Halichondria dura* (?): also East Indies (?).

*Toxadocia violacea*: also Oahu.

*Mycale maunakea*: new.

*Axocelita kilauea*: new.

*Microciona maunaloa*: new.

My second study was made at Keaukaha, near Hilo on the windward coast but a location which was much more exposed to the force of the ocean than was the one at Hilo. Only a few years previously (1946) this coast had been devastated by a huge tsunami (a so-called "tidal wave"). Here the collecting was done by wading at low tide. Four species of sponge were found: three are certainly world-wide and the fourth (*Spirastrella*) is possibly also world-wide although here it is

tentatively identified as a new species. These species are:

*Tedania ignis*: also Oahu, Kaalualu, Halapé, West Indies, etc.

*Reniera aqueducta*: also Halapé; circum-equatorial.

*Plakortis simplex*: also Oahu; circumequatorial.

*Spirastrella keaukaha*: new (?); also Kaalualu and Honaunau. Closely related species are equatorial.

My third study was made at Kaalualu, near the extreme southern point of the Hawaiian Islands. Here again we collected by wading at low tide. I found the greatest variety of sponges here of any place studied on the island of Hawaii—10 species in all. They are:

*Callyspongia diffusa*: also Oahu, Indian Ocean, East Indies.

*Xytopsiphum meganese*: new.

*Tedania ignis*: also Keaukaha, Halapé, Oahu, West Indies, etc.

*Carmia contarenii*: also European, etc.

*Hiattrochota proteus*: also Oahu and Honaunau.

*Phycopsis aculeata*: also Philippines.

*Rhaphisia myxa*: new.

*Spirastrella keaukaha*: also Keaukaha and Honaunau.

*Terpios zeteki*: also Oahu, Halapé, Honaunau, and Panama.

*Tethya diploderma*: also Oahu, Halapé, Honaunau, and circumequatorial.

My fourth study was made at Honaunau, on the sheltered lee coast (Kona Coast) on the west side of the island. Here collections were made with the help of representatives of the Territorial Board of Agriculture and Forestry, who dove down to depths of 2 meters to collect specimens.

After collections at Honaunau, studies were made along the Kona Coast as far north as Kailua, but by so doing we were able to locate just one additional species (*Damiriana hawaiiiana*).



It should be observed that, of any of the places studied on the larger island, the sponge fauna of the Kona Coast of Hawaii is the most like that of the island of Oahu. Seven species were found, of which five have already been reported from Oahu, and I strongly suspect that the two additional species also occur on Oahu. The species are:

*Spongia oceania*: also Oahu and Halapé.

*Hiattrochota proteus*: also Oahu and Kaalualu.

*Damiriana hawaiiiana*: also Oahu.

*Spirastrella keaukaha*: also Keaukaha and Kaalualu.

*Tethya diploderma*: also Oahu, Kaalualu, Halapé; circumequatorial.

*Terpios zeteki*: also Oahu, Kaalualu, and Panama.

*Plakina monolopha*: also Mediterranean, Japan, etc.

As already noted, R. W. Hiatt made a most interesting ecological study in August, 1945, at Halapé. This is somewhat farther north and east than Kaalualu. The study was made along a stretch of coast so nearly inaccessible that it was probably in a natural state and not disturbed by human meddling. The region may be analyzed into three subdivisions as follows:

1. The shore of the large island. There were steep cliffs of lava, boulders at the water's edge, one small patch of sand, and some tide pools.
2. A shallow, protected area inside the lee of a small island. The depth was about 4 meters, with scattered coral heads. A current of about 2 to 3 kilometers per hour set through this area, running parallel to the coast.
3. A small island called Keaoi—a sort of pahoehoe blister with some tide pools. The outer edge of this island was pounded by surf.

Sponges were recorded as follows:

1. Under rocks, just below tidemark  
*Halichondria permollis*: world-wide.  
*Reniera aquaeducta*: world-wide.  
*Petrosia puna*: new, rare.  
*Tethya diploderma*: world-wide, common.  
*Geodia gibberella*: new, uncommon.
2. Collected by diving  
*Spongia oceania*: local, common.  
*Tedania ignis*: wide distribution, common.  
*Tethya diploderma*: world-wide, common.  
*Geodia gibberella*: local, not common.
3. In various locations on Keaoi islet  
*Spongia oceania*: local. This was found on a shelf in a cove, also deep on the exposed outer edge.  
*Damiriana hawaiiiana*: local, rare.  
*Tedania ignis*: wide distribution, abundant in a variety of locations.  
*Myriastrea debilis*: also East Indies. This occurred where it received the full force of the surf. On the mainland I have found species of *Myriastrea* similarly placed.  
*Chondrosia chucalla*: also Australian. This was common in some tide pools on the islet.  
*Leuconia kaiana*: new. This was common, in deep water on the exposed outer edge.  
*Leucetta solida*: world-wide. This genus often occurs in these exposed situations.

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