NEW HAWAIIAN MEDUSAE

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CREEPING MEDUSAE

In a revision of the genus *Eleutheria* Quatrefages by Lengerich (12)[1] certain genera of previous authors, including the long-recognized *Cladonema* of Dujardin and the more recent *Cnidonema* of Gilchrist are placed in synonomy.

According to this revised classification *Eleutheria* comprises those Anthomedusae with branched tentacles the divisions of which bear groups of nematocysts or suckers or both. A velum is present and in some there is a brood pouch dorsal to the stomach.

Although some of its members are adapted for swimming, the genus also includes the creeping medusae of which all known species are small in size and inhabit shallow water.

The polyp phases of all species of *Eleutheria,* so far determined, are Tubularian hydroids.

While investigating the fauna associated with seaweeds about the shores of Oahu, there came to my attention several forms of creeping medusae apparently distinct from any previously reported.

Eleutheria oahuensis, new species (figs. 1, 2).

Bell typically convex dorsally, flattened ventrally but capable of considerable change of shape; mouth occupying the center of the ventral surface which is often greatly protruded; brood pouch dorsal to the stomach communicating with the bell cavity by a series of small openings; radial canals apparently 8 in number but in living specimens usually obscured by the granular substance of the bell; tentacles as many as 18, bifurcated, dorsal branch, when mature, provided with two clusters of nematocysts on the aboral border, in addition to those of the capitate extremity; ventral branch of each tentacle terminating in a sucker; crimson eye-spot at the base of each well-developed tentacle; color of bell brown or reddish brown by transmitted light; tentacles clear, transparent, except for the granular contents of the axial canals; diameter of bell 0.5 mm.

Type locality, Waikiki reef, Oahu, where it is especially abundant.

In a typical specimen of this creeping medusa various degrees of development are seen in the tentacles. The early phases of the

[1] The numbers in parenthesis refer to Literature Cited (p. 16).

tentacles are represented by finger-like lobes without branches, suckers or nematocysts. As development takes place the lobes become bifurcated, a sucker appearing at the distal extremity of the ventral branch and the dorsal one is terminated by a spherical group of nematocysts. Later a cluster of stinging cells appears on the aboral border of the tentacle proximal to the capitate extremity and in a fully developed tentacle another group of nematocysts is formed on the same border but near the bifurcation. (See fig. 1, *a*.)

When the animal is at rest mature tentacles are extended to a length of about twice the diameter of the bell. When moving, the tentacles are successively raised and lowered in short, rapid jerks, the suctorial branches being used as organs of locomotion. (See fig. 1, *b*.) If turned on its back the animal is capable of moving to a limited extent, supporting itself on the capitate extremities of the dorsal tentacular branches. This abnormal position is soon corrected, however, by the animal righting itself. On being dropped into a container of quiet water the medusa settles straight to the bottom, showing no adaptation for swimming. Positive thigmotaxis is expressed in a very high degree in the behavior of the creeping medusa.

The phototropic behavior of the medusa was determined by shading one-half of a petrie dish partially filled with water and placing ten specimens on the line between light and shade. During the first hour movement was more or less at random, some specimens penetrating the darkened area and others moving about in the light. At the end of three hours all medusae were at rest in the lightest area, showing a positive response to strong but diffused light of the laboratory near a window.

The habitat of the medusa is correlated with its general behavior. The species is associated with *Ulva* and other seaweeds near the shore line where there often is high light and heat intensity as well as considerable dilution of sea water. Specimens placed on a fragment of *Ulva* covered by 3 mm. of water survived direct sunlight for one hour, the temperature of the water during this time reaching 30.2°C. When transferred directly to fresh water the animal dies in three or four minutes, disintegration of the tentacles beginning almost at once. The medusa will, however, survive indefinitely in sea water diluted by an equal part

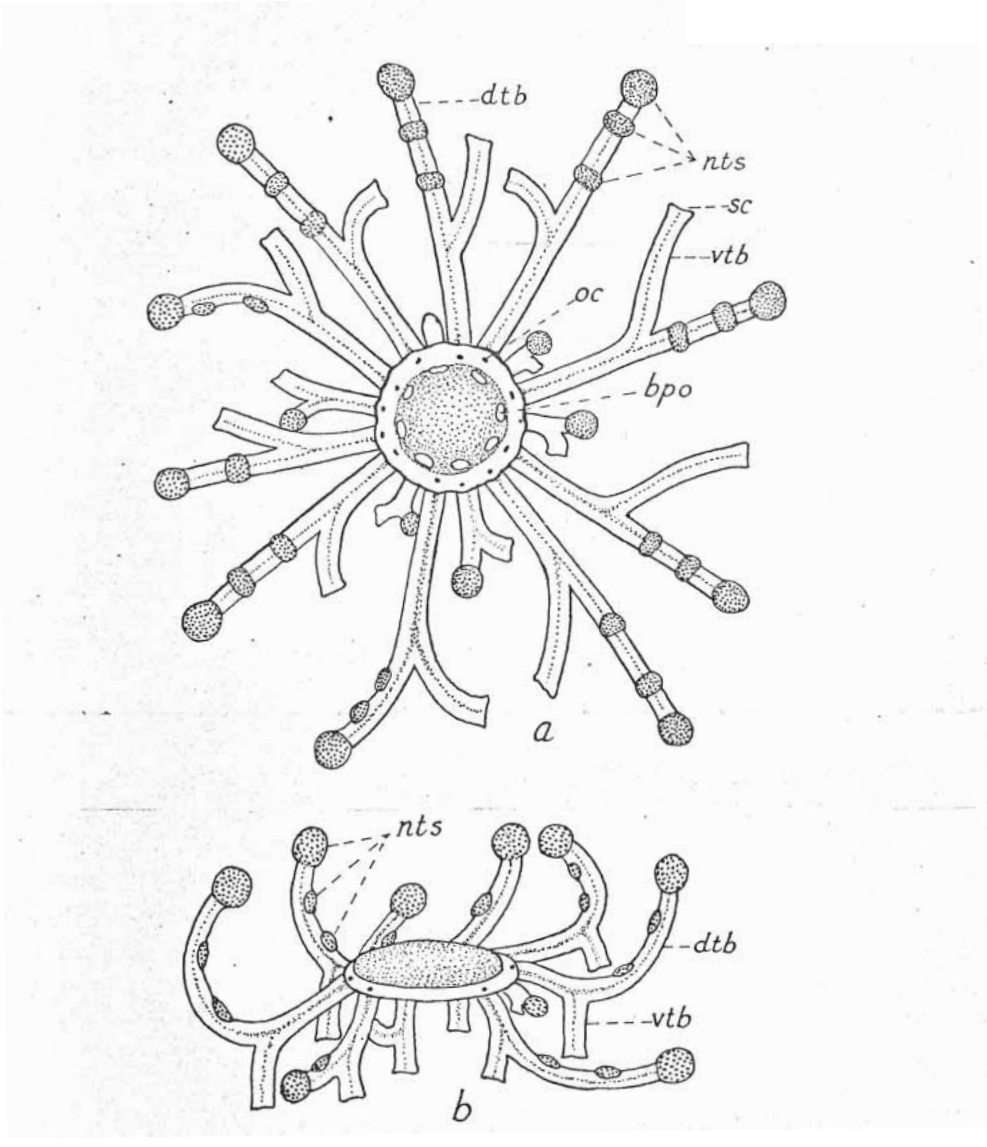

FIGURE 1.—*Eleutheria oahuensis*, new species: *a*, dorsal view with tentacles extended; *b*, lateral view, animal creeping; *bpo*, opening of brood pouch; *dtb*, dorsal tentacular branch; *nts*, nematocysts; *oc*, ocellus; *sc*, sucker; *vtb*, ventral tentacular branch.

of fresh water. Rain, surface water and sewage doubtless often reduce the salinity of the near-shore waters in which these animals live.

Nematocysts of the medusa are clear, oval cells, having, in an undischarged state, spindle-shaped axes. (See fig. 2, *c.*) When discharged, the contents of the cell are thrust out as a thick, basal projection with lateral spines and a long, tubular thread. (See fig. 2, *d.*)

In the aboral umbrellar tissue near the base of each well-developed tentacle and in line with its axis there is a crimson ocellus or eye-spot. Normally the eye-spot is a concentrated group of pigment granules but in some ocelli the granules are greatly diffused.

Budding, which commonly occurs, is the only method of reproduction observed in this medusa. A mature animal elongates, becoming constricted near the middle, and finally separates into two parts. (See fig. 2, *a.*) The daughter medusa when detached varies in size from about one-fourth to one-half the diameter of a full-grown individual. (See fig. 2, *b.*) The presence of numerous medusae of small size, each bearing a few completely formed tentacles, indicates that budding is a constant method of multiplication in this species, if not the exclusive one. Complete divisions have been observed to take place in from 12 to 20 hours. No polyp phase of this medusa is known. Some creeping medusae alternate with Tubularian hydroids, none of which has been observed in the shallow waters of Hawaii.

The principal food of the medusa seems to be minute copepods which abound among *Ulva* and other seaweeds. By means of its stinging cells the medusa paralyzes a copepod and completely engulfs it, often becoming greatly distorted in the process of ingestion.

There is no direct evidence that the medusa is the prey of other organisms. Because of its defensive weapons and the great numbers of individuals observed, the presumption is that it is well protected against possible enemies. Loss of tentacles, however, is apparently of common occurrence. Medusae taken from matted seaweeds which adhere closely to stones and support a rich fauna of polychaetous worms, isopods, and other organisms, often show a large proportion of mature individuals with but one or a few

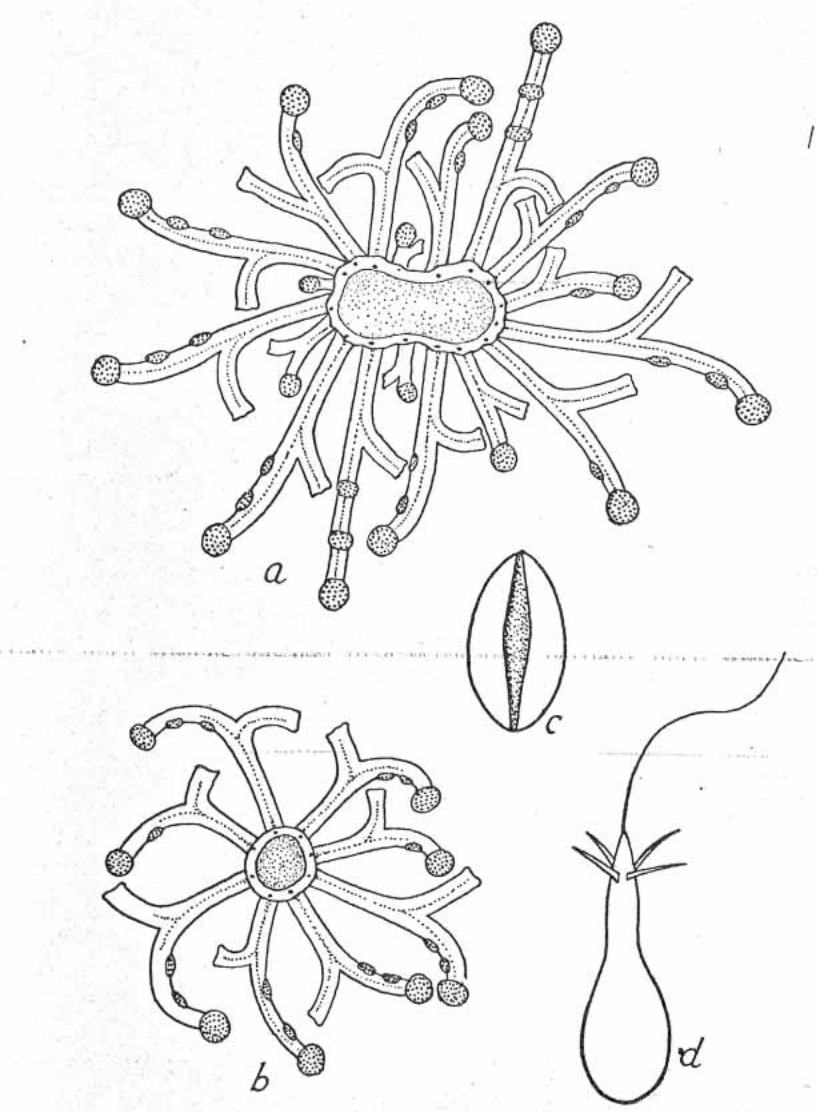

FIGURE 2.—*Eleutheria oahuensis*, new species: *a*, specimen undergoing division; *b*, daughter medusa separated from parent; *c*, undischarged nematocyst; *d*, discharged nematocyst.

tentacles, the others evidently having been destroyed. Although I have not observed any organism attacking medusae it is probable that enemies are responsible for the depletion of their tentacles. Caprellids which are very destructive of hydroid colonies, feeding ravenously on the polyps, apparently do not molest creeping medusae although they are associates of the same habitat. Four specimens of the medusa were confined with an adult caprellid in a small watch glass. After 18 hours the crustacean had not devoured the medusae, and while observed showed evidence of actually avoiding their well-defended tentacles.

The species has been collected on both the windward and leeward shores of Oahu and is especially abundant near the Marine Biological Laboratory at Waikiki.

Eleutheria bilateralis, new species (fig. 3).

This species differs from *Eleutheria oahuensis* chiefly in the arrangement of the clusters of nematocysts on the dorsal tentacular

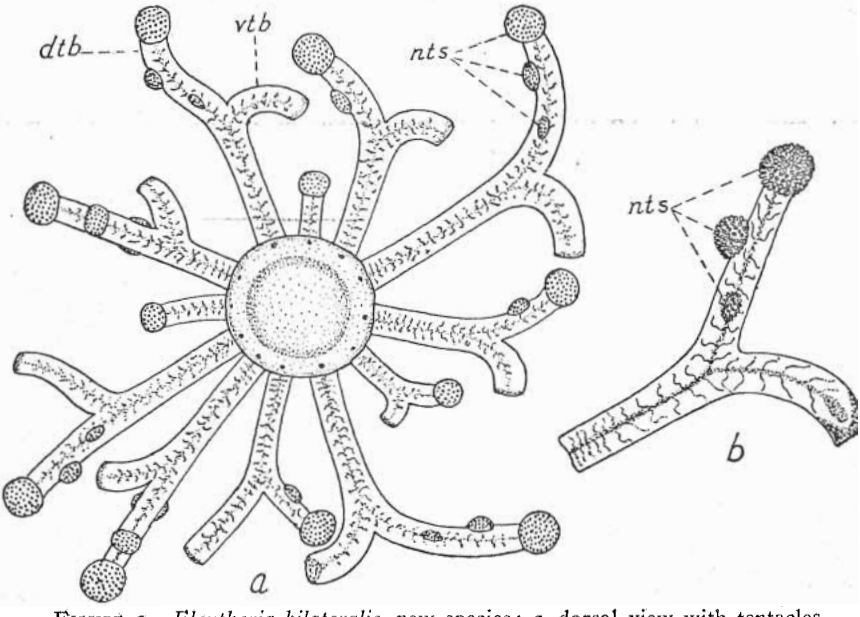

FIGURE 3.—*Eleutheria bilateralis,* new species: *a,* dorsal view with tentacles extended; *b,* tentacle showing clusters of nematocysts; *dtb,* dorsal tentacular branch; *nts,* nematocysts; *vtb,* ventral tentacular branch.

branch. Instead of two groups of nematocysts on the aboral border supplementary to the capitate extremity as in *E. oahuensis* one is placed aborally and two others are bilaterally arranged, one on either lateral border of the tentacle proximal to the aboral one. (See fig. 3, *a, b.*)

Although variable in number, the tentacles usually number about 12 and are stouter than in *E. oahuensis*. There is a brood pouch dorsal to the stomach and a crimson ocellus at the base of each tentacle.

Reproduction by budding has been observed. Color of bell, by transmitted light, brown. Diameter of bell of large specimen 0.6 mm.

Type locality, Waikiki reef, Oahu, where it occurs among algae near shore. The species has also been collected at Kawaialoa and at Hanauma Bay, Oahu. At Waikiki it is less common than *E. oahuensis*.

Eleutheria acuminata, new species (fig. 4).

Shape of body resembles that of *Eleutheria oahuensis* and *Eleutheria bilateralis* but differs from both in the number and form of tentacles and the number and arrangement of the clusters of tentacular nematocysts.

The tentacles may number as many as 24, their bases so closely crowding the margin of the bell that some of the series may occupy a more ventral position than others. A marked acumination of the dorsal branch of each tentacle occurs toward its distal extremity, which is capped by a spherical cluster of nematocysts. Supplementary groups of nematocysts consist of two on the aboral border of the tentacle, one on the oral border and a small cluster, proximal to the others, on each lateral border. (See fig. 4, *a, b.*)

The radial canals are obscured by the granular substance of the bell. A dorsal brood pouch opens into the bell-cavity by a variable number of pores, as many as 18 having been observed by transmitted light. The granular substance of the umbrella extends into the bases of the tentacles in such a way as to give the body of the medusa a stellate appearance when viewed dorsally. A crimson ocellus is at the base of each tentacle.

Reproductive processes have not been observed in this species. Color of bell, by reflected light, pearl-white, by transmitted light, brown. Diameter of bell of large specimen 0.8 mm.; tentacles twice the length of diameter of the bell.

Type locality, Hanauma Bay, Oahu, where the species is abundant among algae in shallow water.

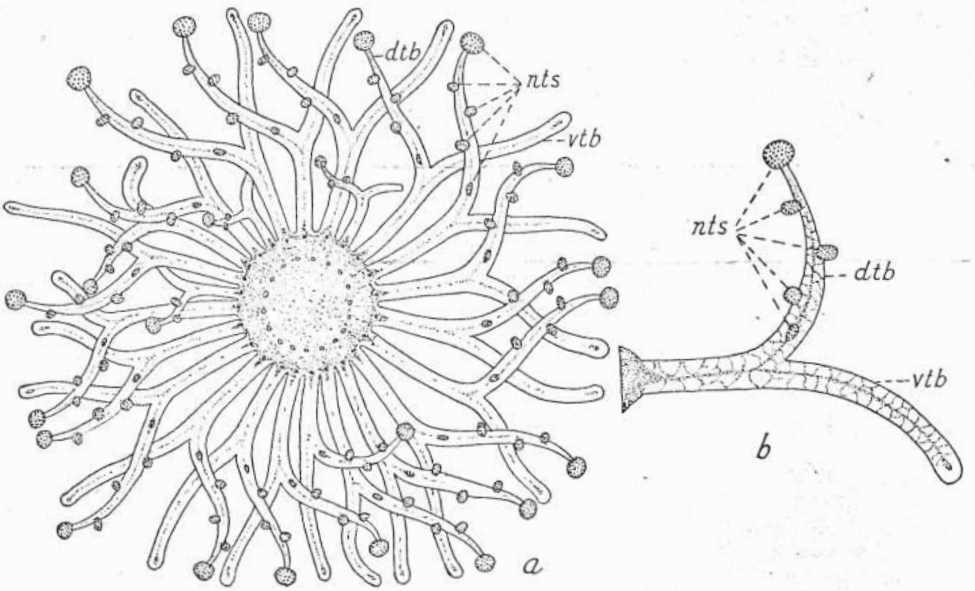

FIGURE 4.—*Eleutheria acuminata*, new species: *a*, dorsal view with tentacles extended; *b*, tentacle showing clusters of nematocysts; *dtb*, dorsal tentacular branch; *nts*, nematocysts; *vtb*, ventral tentacular branch.

The acuminate extremities of the tentacles, which taper to less than one-half their basal diameters, are very distinctive of this species and cause the capitate tips to appear unusually prominent.

Eleutheria alternata, new species (fig. 5).

Bell with densely granulate area restricted to the central area surrounded by a clear peripheral zone through which 8 radial canals extend. Circular canal remote from the clear margin of the bell which overhangs the bases of the tentacles. Tentacles as many as 13 in number, stout, not tapering toward their distal extremities. Capitate group of nematocysts supplemented by 6 clusters of stinging cells arranged in two alternating series on the aboral border of the dorsal tentacular branch. (See fig. 5, *a*, *b*.) Color of central region of bell dark brown by transmitted light, other parts clear, transparent with canals of umbrella and tentacles defined by granules. Diameter of bell of a large specimen 0.8 mm.

Type locality, Hanauma Bay, Oahu.

This form is distinct from other Hawaiian species of creeping medusae in the character of the umbrella and in the arrangement

of the clusters of nematocysts on the tentacles. So far but three specimens have been observed, all from the type locality and all presenting identical characteristics.

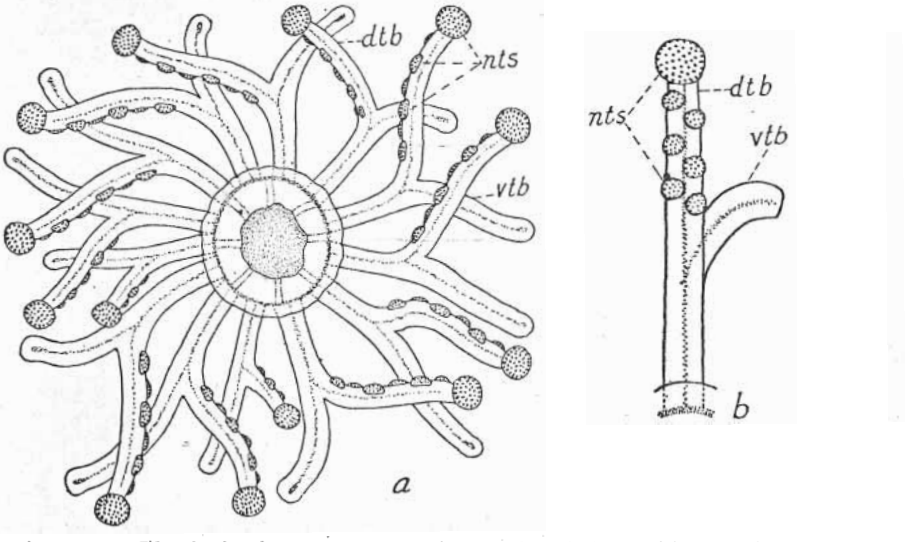

FIGURE 5.—*Eleutheria alternata*, new species: *a*, dorsal view with tentacles extended; *b*, aboral view of tentacles showing clusters of nematocysts; ***dtb***, **dorsal tentacular** branch; *nts*, nematocysts; *vtb*, ventral tentacular branch.

On revising the genus *Eleutheria* the following species and synonomy were recognized by Lengerich (12):

Eleutheria radiata (Dujardin)
Cladonema radiatum Dujardin (6).
Dendronema stylodendron Haeckel (8).
Eleutheria perkinsii (Mayer)
Cladonema perkinsii **Mayer (13).**
Eleutheria robsonia Lengerich (12).
Eleutheria claparèdei Hartlaub (9)
Eleutheria dichotoma Claparède (5).
Eleutheria dichotoma Quatrefages (16)
Eleutheria vallentini Browne (3)
Wandalia charcoti Bedot (1).
Eleutheria hodgsoni Browne (4).
Cnidonema capensis **Gilchrist (7).**
Cnidonema haswelli Briggs (2).

Kishinouye (11) described *Urashimea globosa*, which he considered to be one of the Cladonemidae. Mayer (14) was not cer-

tain of the position of this species and Lengerich does not recognize it.

Of the six species of *Eleutheria,* as arranged by Lengerich, three (*E. radiata, E. perkinsii,* and *E. robsonia*) are adapted for swimming, and three (*E. claparèdei, E. dichotoma,* and *E. vallentini*) for creeping. Of the creeping forms two are European in distribution: *Eleutheria claparèdei* Hartlaub, described from the Bay of Naples, and *Eleutheria dichotoma* Quatrefages, known from the shores of England, Belgium, and France, and from the Mediterranean Sea. Both of these possess tentacles with nematocysts only at the capitate extremities of the dorsal branches. With respect to the location of the defensive organs of the tentacles all known Hawaiian forms show distinct differences from the European species.

The third previously recognized species of creeping medusa, *Eleutheria vallentini* Browne (3), known only from the southern hemisphere, was first described from the Falkland Islands in 1902. More recently medusae considered by Lengerich to be synonymous with this species have been reported from various localities, including Wandel Island by Bedot (1), McMurdo Sound by Browne (4), the Kerguelen Islands by Vanhöffen (17), Cape of Good Hope by Gilchrist (7) and Port Jackson, Australia, by Briggs (2).

The species of the southern hemisphere, if the several forms are to be considered identical, is more closely allied to the Hawaiian ones than are the Hawaiian to those of Europe. An affinity between *Eleutheria vallentini* and the Hawaiian species is seen in that all possess clusters of nematocysts on the dorsal branch of each mature tentacle in addition to the capitate group at its extremity. In *Eleutheria vallentini,* however, the clusters of nematocysts may be numerous and are not confined to the aboral margin of the tentacle but are also distributed on its lateral and oral borders.

Based on the arrangement of the clusters of nematocysts, it is seen that two of the Hawaiian forms, *Eleutheria oahuensis* and *Eleutheria alternata* are more remotely related to *Eleutheria vallentini* than the other two. In *Eleutheria bilateralis* of Hawaii the two proximal clusters of nematocysts are lateral in position but none is on the oral border of the tentacle. In *Eleutheria acuminata* one cluster occupies an oral position and two are laterally

placed. The large number of tentacles and their acuminate character would, however, seem to be sufficient to specifically distinguish it from the species of the southern hemisphere. Moreover, *Eleutheria vallentini* is five or six times as large as any of the Hawaiian species.

The Hawaiian forms seem to be transitional between the northern (European) species and the one ranging through the southern seas. They represent the first creeping medusae to be reported from the North Pacific Ocean.

The following key includes the species of Hawaiian *Eleutheria*:

A. Clusters of nematocysts (supplementary to capitate group) confined to aboral border of tentacles.
  a. Margin of umbrella not overlapping the base of tentacles ..... **E. oahuensis.**
  b. Margin of umbrella overlapping the base of tentacles ..... **E. alternata.**

B. Clusters of nematocysts (supplementary to capitate group) not confined to aboral border of tentacles.
  a. Tentacles acuminate at distal extremities. Clusters of nematocysts on aboral, lateral and oral borders of tentacles ..... **E. acuminata.**
  b. Tentacles not acuminate at distal extremities. Clusters of nematocysts on aboral and lateral borders of tentacles only ..... **E. bilateralis.**

A SESSILE MEDUSA

Of the five orders of Scyphomedusae recognized by Mayer (14) the Stauromedusae represent a peculiar and highly specialized group. Correlated with their sessile mode of life are evidences of degeneration, as shown by the absence of such sense organs as ocelli and otocysts and in the loss of power of pulsation exhibited by free-swimming forms.

Degrees of specialization are also observed within the order. In some genera capitate tentacles are typical of the notches between the marginal lobes. These tentacles may be modified into adhesive bodies or anchors serving as accessory clinging organs. In other genera the anchors are absent entirely or present in the early stages, disappearing with the maturity of the individuals.

The larval phases of the sessile medusae also exhibit degenerate features. Planulae are without cilia and have no power of swimming, their mode of locomotion being confined to creeping.

Except in the family Tesseranthinae of Haeckel (8), all adult

Stauromedusae are attached by a peduncle developed from the aboral surface, seaweeds usually serving as a support. A typical mature specimen resembles, in a general way, the scyphistoma stage of the more regular Scyphomedusae.

The normal habitat of previously recorded species of sessile medusae is the shallow water of cold latitudes. Up to this time none has been reported from tropical or subtropical localities.

Of the sessile Stauromedusae Mayer (14) considered nine genera as well established and two as doubtful. The best-known genera are *Lucernaria* O. F. Müller and *Halyclystus* Clark, the former being characterized by the absence of marginal anchors in the mature stage and the presence of a single-chambered peduncle; the latter by the presence of anchors and four perradial chambers in the stalk.

Oka (15) described a species from Japan as *Lucernaria nagatensis* which was placed by Kishinouye (10) under the preoccupied generic term *Schizodiscus*. Mayer (8) established a new genus to accommodate this species now recognized as *Kishinouyea nagatensis* (Oka).

The genus *Kishinouyea* resembles *Lucernaria* in the absence of anchors or perradial marginal tentacles but differs from it in having four perradial chambers in the stalk. A canal in the lower part of the peduncle opening by a pore in the middle of the flattened foot or surface of attachment is another characteristic of the genus *Kishinouyea*. The Hawaiian species here recorded belongs to this genus.

Kishinouyea hawaiiensis, new species (fig. 6).

Medusa symmetrically bell-shaped, the aboral surface broadly rounded and sharply differentiated from the peduncle. Eight arms united in pairs, the interradial notches about one-half the depth of the perradial. No perradial tentacles or anchors. Adradial tentacles short, capitate and adhesive, from 16 to 21 terminating each lobe. (See fig. 6, *a*.) Peduncle cylindrical with four perradial chambers (fig. 6, *b*) and a canal terminating in a pore in the middle of the flattened foot (fig. 6, *c*). Gonads five pairs of oblong sacs laterally arranged on the medial surface of each united pair of lobes. (See fig. 6, *d*.) Color in life, greenish brown.

Type specimen from Kahana Bay, Oahu, on seaweeds in shallow water. Height of bell (preserved specimen) 6.5 mm., greatest diameter 4.8 mm.; length of peduncle 1.8 mm., diameter of

peduncle 1.25 mm. Type specimen and another taken on Waikiki reef, Oahu, in the Bishop Museum.

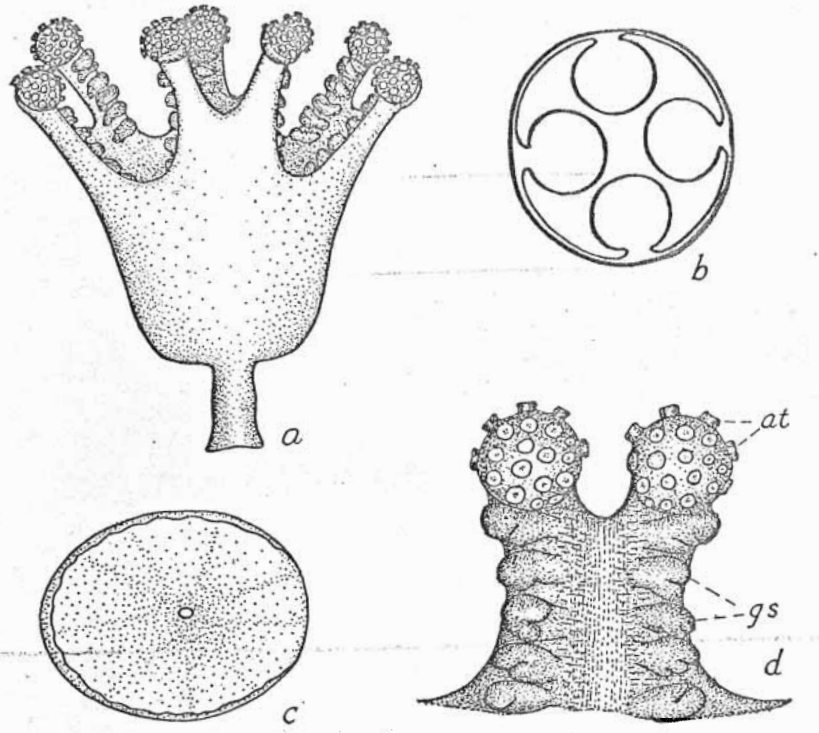

FIGURE 6.—*Kishinouyea hawaiiensis*, new species: *a*, lateral view of the medusa; *b*, cross section of peduncle showing four chambers; *c*, basal end of peduncle showing central pore-opening of a canal of the peduncle; *d*, medial surface of a lobe showing gonads and adhesive tentacles; *at*, adhesive tentacles; *gs*, gonads.

From *Kishinouyea nagatensis* the Hawaiian species differs in the adradial lobes not being bent at right angles to the oral surface, as reported for the Japanese form, but only slightly reflected outward. Adradial tentacles in the Hawaiian species are not arranged in clusters of five as in *Kishinouyea nagatensis*. The gonads seem to be arranged in a similar manner in the two species but are fewer in number in the Hawaiian form. Sections of the stalk of the Hawaiian species show four symmetrically arranged chambers, the same number being present in *Kishinouyea nagatensis*.

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