A NEW VARIETY OF THE HEXACTINELLID SPONGE, RHABDOCALYPTUS DAWSONI (LAMBE) AND THE SPECIES OF RHABDOCALYPTUS

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The sponge herein described was sent to us for identification by the United States Bureau of Fisheries. It was "taken on a halibut hook in 100 fathoms of water off Cape Spencer, Alaska." It is a remarkably fine specimen, falling under *Rhabdocalyptus dawsoni* (Lambe). The differences from the type are for the most part the usual quantitative ones which mark off the members of a widely ranging species that live at some considerable distance from one another. A more definite point of difference is exhibited by the spicules lining the paragastric cavity and this makes it advisable to classify the form as a (presumably geographical) variety.

RHABDOCALYPTUS DAWSONI var. ALASCENSIS, new variety

Diagnosis.—Variety marked off from the type by the autogastralia. These are hexacts with tangential rays, 315μ to 385μ long, minutely spinose; parenchymal ray usually shorter than tangential rays, smooth or feebly spinose; free ray smooth or occasionally feebly spinose, smoother and distinctly shorter than the other rays.

Type-locality.—Off Cape Spencer Alaska.

Holotype.—Cat. No. 21382, U.S.N.M.

Rhabdocalyptus (*Bathydorus*) *dawsoni* was established by L. M. Lambe (1892, p. 73), for four specimens taken in 20–40 fathoms off the coast of British Columbia. F. E. Schulze (1897, p. 37; 1899, p. 54) after examining preparations made from one of Lambe's specimens assigned the form to *Rhabdocalyptus* Schulze (Schulze 1887, p. 155), one of the genera with discoctasters (Lambe's discohexasters, 1892, pl. 6, fig. 2*e*; the spicule often gives the appearance of having only six instead of eight main rays). Schulze further reports (1899, p. 55) on his study of three specimens and some fragments of this species taken by the *Albatross* off the coast

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of California and British Columbia at depths ranging from 55 to 437 meters. The species is vase-shaped, as are the species in general (*R. plumodigitatus* Kirkpatrick is cup-shaped), of the genus. The largest specimen of *R. dawsoni* hitherto taken is Lambe's type, about 275 mm. high.

The sponge (pl. 1) herein described is a dried vase, widely open above, about 510 mm. high, tapering somewhat toward the upper (cloacal) and lower ends; cross diameter at middle of body about 250 mm.; lower end irregular as if molded over the substratum; extreme lower end only about 55 mm. wide. Wall of vase at middle of body about 22 mm. thick. Rim of cloacal aperture torn away on one side; normal aperture would measure about 130 mm. in diameter. Dried sponge is of a light yellowish color; firm but fragile and very light in weight.

The autodermalia have been lost, washed or rubbed off, from almost the entire surface of the body. The meshes of the hypodermal network are therefore exposed; they are polygonal, something less than 1 mm. in diameter, the intervening strands narrow. Beneath this network the open ends of numerous (doubtless afferent) radial canals are plainly visible. The gastral membrane is well preserved, smooth, showing neat squarish meshes just visible to the eye and distinctly smaller than those of the hypodermal reticulum. Beneath this membrane the open ends of numerous radial (doubtless efferent) canals may be seen as on the outer surface.

The surface of the sponge shows many depressed areas which are apparently mere accidental growth features. Some of them, as being protected places, are lined with, some practically filled with, prostal pentacts. Some of them contain also dense matted tufts of long projecting spicules (prostalia lateralia). These include many slender subcylindrical diacts, in general smooth but roughened subterminally, with rounded ends; characteristic spicules measure 10–17 mm. in length, diameter about 12μ. Other stouter diacts occur, smooth in general but roughened subterminally, tapering gradually from the middle toward the slender ends which terminate in rounded or fairly sharp points; characteristic spicules measured 16–19 mm. in length, diameter at the middle 35μ to 56μ. Schulze records, for the type, the prostalia lateralia as consisting of prostal oxypentacts (hypodermalia, see p. 37) and smooth oxydiacts 10–15 mm. by about 40μ.

The cloacal rim bears a marginal fringe 10–20 mm. high made up of long diacts, smooth in general, roughened subterminally. Spicules resembling the stouter ones described above and as large as 22 mm. by 63μ occur. The slenderer ones, many of which accompany the larger as comitalia, resemble the slender diacts described above. Schulze (1899) finds that the fringe in his specimens of the type is

8–10 mm. high and that the spicules composing it are to be classed as ascending prostalia lateralia.

There is no definite root tuft but there are some matted tangles of long projecting spicules at the lower end of the body resembling in appearance and composition those on the lateral surface. The larger form of diact may reach in these basal tufts a length of 25 mm. diameter at middle 100μ. These spicules commonly taper continuously from the middle toward the ends, but in some spicules the tapering ceases at a little distance from the extremity and the ends are clavate.

The parenchymalia are diacts, stout and slender, strewn in all directions through the parenchyma. There are many bundles of the usual sort consisting of one stout diact (principal) accompanied by slender ones (comitalia). The spicules are like those described above as projecting from the lateral surface and basal end, except that the class of stout oxydiacts includes relatively shorter and stouter spicules grading down to 8–10 mm. by 40μ to 90μ, sometimes with smooth ends. Just below the gastral surface and tangential to it still smaller diacts of this class occur. They may be as small as 1 mm. by 28μ near the middle; the actual middle as in the case of the larger spicules may show bosses representing the vestigial rays; one end of the spicule is occasionally rounded, the other end pointed. An occasional stout hexact is found in the parenchyma; these are probably autogastralia that have passed into the sponge wall during maceration. Typically the parenchymalia in these sponges include no hexacts. In the type Lambe finds the parenchymalia principalia are stout smooth oxydiacts, 11.06 mm. by 100μ. Schulze notes the occurrence of diacts, in general smooth but with roughened ends, 10 mm. long and over. Lambe finds the parenchymalia comitalia are diacts up to 8.8 mm. by 10μ; ends roughened, enlarged and blunt pointed or rounded and club-shaped. The variety and the type evidently agree well enough in these matters. Moreover the parenchymalia exhibit, in details, too much variation within the same individual to afford good points for the distinguishing of species.

The spicules regarded as of importance in the classification of these sponges are the autodermalia, hypodermal pentacts, autogastralia (there are no hypogastralia, paratangential bundles of parenchymal diacts alone underlying the autogastralia, Ijima 1897, p. 47), oxyhexasters and discoctasters.

Autodermalia.—As said, these have been lost over nearly the whole surface. Fortunately they are still present in some small areas close to the cloacal aperture. Both pentact and hexact forms occur. Four-rayed forms (stauracts) were not observed but they may be normally present. The rays are roughened (minutely spinose), blunt-pointed, 60μ to 70μ long. The spicules are similar to those recorded for the

type by Lambe (stauracts and pentacts, rays 60μ long) and Schulze (pentacts, rays 80μ long).

Hypodermal pentacts.—Present as prostalia in large numbers over parts of the dermal surface, projecting several millimeters. Some of the surface depressions are, as said, filled with a tangle of these spicules. Parenchymal ray is smooth, slender and tapering, becoming very slender toward the free end, reaching 6.5 mm. in length. Paratangential rays about 2.4 mm. long; spines 140μ long and shorter, on superior-lateral surfaces of ray. Some of the pentacts actually in the substance of the sponge are somewhat smaller than the prostalia and have spineless paratangential rays. The spicules do not differ essentially from those of the type. Lambe gives the proximal (parenchymal) ray as 8 mm. long, paratangential rays about one-third as long. Schulze records that the prostal pentacts include those with (typical) spined paratangential rays and others with these rays smooth; and that the paratangential rays are sometimes bent over toward one side (paratropal).

In the *autogastralia* the Alaskan sponge differs in a definite detail from the type, even though the specimens assigned to the type would seem to fall in two groups in respect to this point and should therefore, it would seem, be separated in some fashion in the formal classification. Thus Lambe (1892, p. 73; pl. 6, fig. 2*k*) records the autogastralia as oxyhexacts, rays roughened and similar, ray length only about 60μ. In Schulze's specimens these spicules are hexacts in which the tangential and parenchymal rays are about 120μ long and minutely spinose; the free ray longer than the others, up to 300μ long, and more strongly spinose. Schulze (1897, p. 36) does not speak of this difference between his record and that of Lambe and the difference may conceivably be due to Lambe's having examined a specimen in which the actual autogastralia had been largely washed away.

In the autogastralia of the Alaskan sponge (fig. 2) the four tangential rays are strong, minutely and sharply spinose, tapering to points, characteristically about 350μ long and 40μ thick at the base. The length of these rays, measuring from center of spicule, ranges in general from 315μ to 385μ. One of the four is occasionally shorter (250μ) than the others and smooth. Smaller spicules (presumably younger forms) also occur very sparingly; in these the six are about all alike, the ray length in the actual measurements ranging from 210μ to 140μ. The tangential rays of the autogastralia in general are arranged regularly as to make squarish meshes, the side of the mesh approximately equalling in length a spicule ray. The parenchymal ray is usually but not always shorter than the tangential rays of the same spicule, the range in actual measurement being 250μ to 380μ; tapering, pointed, smooth, or feebly spinose. Free ray

typically (that is, nearly always) smooth, although occasionally it is feebly spinose, noticeably shorter than any of the other rays, tapering to a point or sometimes to a rounded point; common range in length 175μ to 220μ, but the ray is occasionally as short as 80μ or as long as 250μ. This ray when exceptionally short does not taper and is terminally rounded or dilated. Thus the autogastralia differs greatly from those recorded by Lambe and in less degree, but yet qualitatively, from those of Schulze's specimens.

There are no hypogastralia. And yet in radial sections we have seen inequiended, diacts, five or six in a section 10 mm. wide, arranged radially to the gastral surface as the parenchymal rays of the hypodermal pentacts are arranged radially to the dermal surface. The larger end of the diact is directed toward the gastral surface and the axial cross is very much nearer this extremity than it is to the more attenuated parenchymal end, the lengths of the two rays in a typical spicule being as one to three. These facts give some ground for regarding the inequiended diacts as vestigial hypogastralia. Hypogastral pentacts are absent in most members of this family, the Rossellidae (Schulze 1897, p. 13). The inequiended diacts observed in position were without comitalia; about 2 mm. long, 45μ thick at middle of spicule, tapering toward both ends, minutely spinose at both ends, which were sharp or rounded. In macerations longer spicules of the same kind were observed, the length varying up to 7 mm. At the site of the axial cross there may or may not be conspicuous bosses.

The *oxyhexasters*, varying to the hexactine shape (the intermediate forms being sometimes known as hemioxyhexasters) of the Alaskan sponge agree well enough with those of the type. For the latter (Lambe and Schulze) the diameter is recorded as 60μ to 100μ; principal rays smooth and very short; terminals 2–3, long, smooth, or feebly roughened. The spicules of the Alaskan sponge reach a somewhat larger size, 90μ to 144μ diameter.

The *discoctasters* of the Alaskan sponge are like those of the type. In the latter (Lambe and Schulze) they are set down as having a diameter 60μ to 100μ; the (eight) main rays 20μ long; terminals 6–10 in number and 20μ to 30μ long, moderately divergent, the terminal knob (disk?) very small. The diameter of the spicule in the Alaskan sponge is commonly about 92μ. The strikingly small size and the shape of these spicules are regarded by Schulze (1897, p. 13) as constituting the most important of the species-characters.

The *microdiscohexasters* recorded by Schulze were not observed in the Alaskan sponge. The specimen to be sure was a dried one and these very small spicules may have been lost. On the other hand the parenchymal tissue has been so remarkably preserved

(mummified) near the gastral surface that individual cells and intercellular connections are still plainly recognizable and the spicules should be visible, one would think, if actually present. Schulze (1897, p. 37; 1899, p. 55) observed these spicules both in the *Albatross* specimens and in preparations made from one of Lambe's specimens. He records them as numerous; diameter 20μ to 35μ; terminal rays 8–12, longer than the principals, delicate and knobbed. He notes (1904, p. 35) that these very small and delicate spicules are rare and difficult to observe in some individuals of many *Rhabdocalyptus* species. Ijima (1897, p. 45) thinks they are probably never absent, although rare in some species. Schulze (1904, p. 36) regards their apparent absence, as in the cases of *R. lophodigitatus* (*plumodigitatus*) Kirkpatrick and *R. australis* Topsent, as having no significance for classification.

Ijima in his splendid report (arranged for publication by Yaichiro Okada) on the Siboga hexactinellida lists (1927, p. 377) the known species of *Rhabdocalyptus*, 13 in number. The following brief diagnoses of the species other than *R. dawsoni* will serve to indicate the persistent lines of past variation within this group.

R. tener F. E. Schulze (1899, p. 57), coast of California. Autodermalia, pentacts and hexacts. Autogastralia larger than autodermalia, hexacts with free ray longer and more spinose than the others. Oxyhexasters (varying, as in the other species of the genus, to the hexactine shape, Ijima 1897, p. 45) with spheroidal central thickening; terminal rays exceedingly slender. Discoctasters 80μ to 100μ diameter; the nodal protuberances, representing the six primary rays of the primitive hexact, unusually large and conspicuous. Microdiscohexasters not observed.

R. nodulosus F. E. Schulze (1899, p. 58), coast of California. Autodermalia, stauracts and pentacts. Autogastralia, strong oxyhexacts, free ray usually longer and more spinose than the others. Oxyhexasters with spheroidal central thickening. Discoctasters large, 240μ to 300μ diameter.

R. asper F. E. Schulze (1899, p. 60), coast of California. Autodermalia, pentacts and stauracts. Autogastralia, hexacts and pentacts. Prostal hypodermal pentacts all large; some with tangential rays that measure as much as 1–2 cm. in length and are smooth or with only a rough shagreenlike surface. Oxyhexasters 140μ to 160μ diameter. Discoctasters 150μ to 200μ diameter.

R. mirabilis F. E. Schulze (1899, p. 61), coast of Alaska. Autodermalia for the most part small diacts; some pentacts and stauracts. Autogastralia, oxyhexacts; free ray 500μ long and spinose; other rays 200μ long, roughened. Oxyhexasters about 120μ diameter.

Discocasters 160μ diameter; protuberances representing the six primary rays large; terminal disks of secondary rays comparatively large and usually with six marginal teeth.

R. (*Acanthosaccus*) *tenuis* (F. E. Schulze, 1899, p. 66), coast of California. Autodermalia, pentacts, stauracts, and diacts. Autogastralia, oxyhexacts; free ray 600μ to 800μ long and over, more strongly spinose than the other rays; latter rays 200μ to 300μ long. Oxyhexasters represented only by the (derived) oxyhexact form 150μ to 200μ diameter. Discoctasters 200μ diameter; main rays short, sometimes exceedingly short; terminal rays numerous, long and slender, bearing end disks having 5–6 marginal teeth. (*Acanthosaccus* F. E. Schulze 1899, p. 65, was merged in *Rhabdocalyptus* by Ijima 1904, p. 128.)

R. mollis F. E. Schulze (1887, p. 155; Ijima 1897, p. 50; Ijima 1904, pp. 253–301), Japan. Autodermalia, diacts with a few stauracts and pentacts. Autogastralia, oxyhexacts, rays all similar. Oxyhexasters with rays conspicuously barbed proximally. Discoctasters 130μ to 176μ diameter.

R. capillatus Ijima (1897, p. 51; 1904, pp. 276, 302), Japan. Autodermalia predominantly diacts. Autogastralia predominantly hexacts, rays all similar or free ray twice as long as the others. Oxyhexasters 106μ to 136μ. Discoctasters small, 82μ to 106μ diameter; terminals much longer than the main rays, in a solid bunch and distinctly flaring.

R. victor Ijima (1897, p. 52; 1904, pp. 238, 301), Japan. Height may reach almost 3 feet (859 mm.). Autodermalia, stauracts. Autogastralia, oxyhexacts, rays all similar. Oxyhexasters 180μ to 280μ diameter; principals very short or obsolete. Discoctasters 180μ to 240μ diameter.

R. unguiculatus Ijima (1904, pp. 268, 302), Japan. Autodermalia, diacts with a few stauracts or tauacts (3 rayed forms). Autogastralia, oxyhexacts; free ray much longer than the others, 440μ to 550μ; parenchymal ray 230μ to 300μ; tangentials 275μ to 330μ. Oxyhexasters 130μ to 160μ diameter. Discoctasters 143μ to 190μ diameter; terminals much longer than main rays; end-disks with marginal teeth which are largest and strongest on side that is turned away from axis of the tuft of terminals.

R. plumodigitatus Kirkpatrick (1902, p. 220; syn. *R. lophodigitatus* Kirkpatrick 1901, p. 458), South Africa. Shape, that of a subglobular cup. Autodermalia and autogastralia, diacts 600μ to 1,000μ long. Oxyhexasters 90μ to 100μ diameter. Discoctasters of two forms: large ones, 130μ to 160μ diameter, main ray bearing 6–8 very much longer terminals; small ones, 60μ diameter, with more divergent terminals. Microdiscohexasters not observed.

R. baculifer F. E. Schulze (1904, p. 34), South Africa. Autodermalia, diacts 200μ to 600μ long. Autogastralia, diacts commonly longer than the autodermalia. Oxyhexasters 100μ to 160μ diameter; principal rays very short, often vestigial. Discoctasters 160μ diameter. Schulze regards this species as very close to the preceding. He looks on the presence of only one form of discoctaster as the most important differential.

R. australis Topsent (1901, p. 37; Ijima 1904, p. 237), Antarctic. Autodermalia predominantly diacts but stauracts and pentacts also abundant. Autogastralia, hexacts, all rays similar. Paratangential rays of hypodermal pentacts shagreened (that is, finely tuberculate) and also with spines. Oxyhexasters 140μ to 160μ diameter. Discoctasters 180μ diameter; terminals few, three rarely four. Microdiscohexasters not observed.

R. roeperi F. E. Schulze (1887, p. 158), having hypodermal pentacts with spineless paratangential rays, was transferred by Ijima (1897, p. 55) to *Staurocalyptus* Ijima (1897). Likewise *R. dowlingii* L. M. Lambe (1893, p. 37) from British Columbia was transferred to *Staurocalyptus* by Ijima (1897, p. 53).

It will be seen from this survey that ten of the thirteen known species of the genus occur on the two sides of the North Pacific, the coasts of Alaska, British Columbia, and California on the East, the coast of Japan on the West. The variety here recorded is the only form in which the free ray of the autogastral hexact spicule is known to be smoother and smaller than the other rays, although one would expect to find in *R. asper* (see above) spicules of this kind. The opposite development, leading to a free ray longer and more spinose than the others, has occurred in a number of forms (seven). In a few forms all six rays are similar. In two the hexacts have degenerated to diacts.

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EXPLANATION OF PLATES

PLATE 1

The sponge, from the side; actual height about 510 mm.

PLATE 2

FIGURE 1. The sponge from above, × about one-third.
2. Gastral membrane showing the autogastralia in place, the tangential rays of the latter forming a reticulum with, in general, squarish meshes. Photograph × 47.

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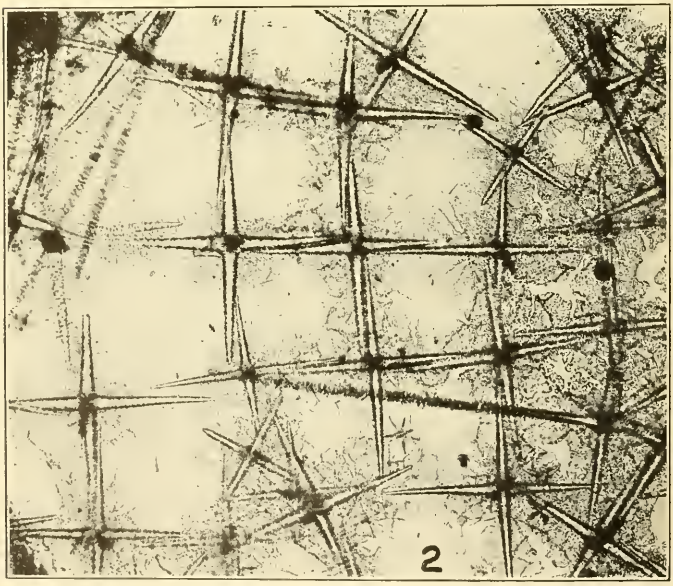

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