HOLOTHURIOIDEA

FROM DEPTHS EXCEEDING 6000 METERS

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CONTENTS

INTRODUCTION

The present paper deals with the holothurians collected by the Galathea Expedition at depths exceeding 6000 metres. These depths were reached in five indo-pacific trenches, viz. the Philippine, the Sunda, the Banda, the New Britain, and the Kermadec Trenches.

Previous to the Galathea Expedition only a single species of holothurians was known from depths of more than 6000 metres. This species was taken by the Swedish Albatross Expedition in 1948 in the Puerto Rico Trench at a depth of 7625-7900 m. It belonged to the genus *Peniagone* or *Scotoanassa,* but could not be determined to species (MADSEN 1953).

The investigations of the Galathea Expedition revealed that the holothurians form an extremely dominating animal group on the soft bottom of the deep sea. At depths exceeding 6000 metres their number of species as well as of individuals exceeds that of the four other echinoderm groups together. In these respects very few other animal groups can compare with them. In the amount of weight per square unit of bottom the holothurians are far ahead of any other animal group and probably the same applies to their ecological importance. The prevalence of holothurians was stated without exception for the five deeps investigated.

Of the five holothurian orders four are represented in the material, viz. the Elasipoda with 8, the Aspidochirota with 3, the Molpadonia with 2, and the Apoda with 1 species. The absence of the Dendrochirota is probably not due to chance, but might be explained by their peculiar feeding habits. Whereas the other holothurians take their food from the bottom material, the dendrochirotes live on plankton which they filter off the water by means of their long, dendritic tentacles. Apparently, the water of the deep sea is too poor in nutrient matter to offer satisfactory conditions for the dendrochirotes. Similarly, the preponderance of the holothurians over the other echinoderm groups might also be explained by their feeding habits. The relatively poor food conditions of the deep sea also do not favour the predatory animals. The feeders on bottom detritus seem to be the animals best adjusted to these conditions.

The prevalence of the holothurians in the deepest deep sea is clearly shown by the fact that all the trawlings brought up holothurians.

Also the five stations where we worked with the 0.2 m² Petersen Grab showed the same results. The two most successful ones gave one holothurian each. At st. 424 of the Philippine Trench the grab contained no other animals than a single *Myrio-*

trochus bruuni, while at st. 499 of the Banda Trench several other animals were present. The grab contained at these two stations 26 and 43 litres of bottom material, respectively. The three samples without holothurians contained 20, 16, and 6.5 litres, respectively.

Of the 13 identifiable species the following five are new to science: the elasipods *Scotoplanes galatheae* and *Peniagone vedeli,* the aspidochirote *Paroriza grevei,* the molpadid *Hadalothuria wolffi,* and the synaptid *Myriotrochus bruuni.* The genus *Hadalothuria* is new to science.

One species could only be determined to genus. It is a *Peniagone* from st. 495 of the Banda Trench. About ten fragments, probably belonging to the same individual, were found. The skin contained numerous calcareous bodies. The velum and some of the tentacles were present, but all the tubefeet were lacking, and it was not possible to form any idea of the shape of the animal. The species may possibly be identified if more material could be obtained from the lower depths. In the present paper no identification will be made.

ELASIPODA

Elpidia glacialis Théel 1876

THÉEL 1876, pp. 1-30, pl. 1-3.
– 1882, pp. 18-19.
DANIELSSEN & KORÉN 1882, p. 17-19, fig. 16-30.
PERRIER 1902, pp. 423-24.
MORTENSEN 1932, pp. 41-43; pl. 1, fig. 4-5.
HEDING 1940, pp. 370-71.
– 1942, pp. 16-19, fig. 16-17.

Material:

St. 465, Sunda Trench, 10° 20′ S, 109° 55′ E, 6930-7000 m, 7 specimens. St. 466, Sunda Trench, 10°21′ S, 110°12′ E, 7130-7160 m, bluish clay, c. 3000 specimens. St. 517, New Britain Trench, 6°31′ S, 153°58′ E, 8920 m, 14 specimens. St. 521, New Britain Trench, 5°59′ S, 153°28′ E, 8810-8940 m, clay, 63 specimens. St. 649, Kermadec Trench, 35°16′ S, 178°40′ W, 8210-8300 m, grey clay with pumice, c. 1800 specimens. St. 650, Kermadec Trench, 32°20′ S, 176°54′ W, 6620 m, brown clay with pumice, 1 specimen.

Besides, 14 specimens from st. 602 in the Tasman Sea are included in the present paper. The data of this station are the following: 43°58′ S, 165°24′ E, 4580 m, bluish clay.

Previous records. *Elpidia glacialis* is the first described and the best known of the elasipods. It was taken for the first time by a Swedish expedition in the Kara Sea, where it was common at depths between 70 and 230 m. The 40 specimens taken by this expedition were thoroughly described by THÉEL (1876). Later, especially by the Ingolf and the Godthaab Expeditions, the species was shown to have a general distribution in the deep Norwegian Sea and in the Baffin Bay (HEDING 1942, MORTENSEN 1932).

It is remarkable that whereas *Elpidia glacialis* is the most common deep sea holothurian in this northern area, it has hitherto not been taken by any expedition in the otherwise so well investigated northern part of the Atlantic. On the other hand, it was reported from off Morocco and from a Challenger station between Australia and the Antarctic. These records have met with much doubt, mostly for zoogeographical reasons. The general opinion was that *Elpidia glacialis* was only found north of the Wyville Thompson Ridge, and north of the corresponding submarine ridge in the Davis Strait, separating Baffin Bay from the North Atlantic. The finding of the species in the Indian and Pacific Oceans by the Galathea makes, however, the correctness of these records probable. Off Morocco 8 specimens were taken by the Travailleur and the Talisman at depths of 2300 and 2210 m (PERRIER 1902), and one by the Valdivia at 2480 m (HEDING 1940). The single specimen of the Challenger was taken at 42°42′ S, 134°10′ E, at a depth of 4750 m (THÉEL 1882).

Since *Elpidia glacialis* was held to be one of the type species of the "cold area" north of the Wyville Thompson Ridge, the demonstration of its occurrence as a dominating species in three of the five deeps investigated is of considerable zoogeographical interest. *Elpidia glacialis* should now rather be regarded as a cosmopolitan species, which under extreme conditions, as in the Norwegian Sea with its negative bottom temperatures and in the deep sea trenches, becomes one of the most characteristic holothurians.

The material of *Elpidia glacialis* procured by the Galathea Expedition is furthermore so rich in number of individuals that it allows the demonstration of a geographical variation within the species. On the basis of differences in the number, size, and position of the dorsal papillae, and to a lesser degree in the spicules, the species may be divided into five geographical subspecies.

The northern form is distinguished from all the specimens found by the Galathea by having the dorsal papillae arranged in an anterior and a posterior group. HEDING (1942), who studied the variation in the dorsal papillae of the more than 500 specimens of the Ingolf and Godthaab expeditions from the Norwegian Sea and Baffin Bay, was able to demonstrate an individual as well as a local variation in this character. In the Norwegian Sea the animals usually had 4 pairs of papillae, with 3 and 1 in the anterior and posterior group, respectively. The same was the case with the deepest of the four Godthaab stations in Baffin Bay, whereas the animals from the three remaining Godthaab stations usually had 5 pairs of papillae, 4 in the anterior and 1 in the posterior group. Sometimes extra papillae were present, but even then the arrangement in an anterior and a posterior group was retained. The specimen of the Valdivia, according to HEDING (1940), agrees in the arrangement of the dorsal papillae with the specimens from the Norwegian Sea.

The numerous specimens from the Sunda Trench were nearly all in a very poor state of preservation. Only about 30 were fairly intact. All these had only three pairs of papillae (fig. 1). The first pair is placed at the head just above the tentacle crown. The second pair has a somewhat varying position, from anterior to the second pair of tubefeet to above the third pair. Finally, the third pair of papillae is placed above the interval between the third and fourth pairs of tubefeet. The form from the Sunda Trench is thus easily distinguished from the northern form, firstly by the number of dorsal papillae which in the northern form is never less than four, and, secondly, by their arrangement. In the Sunda form they can not be divided into an anterior and a posterior group.

It is in this connection remarkable that the specimen from the Challenger station south of Australia had also three pairs of dorsal papillae. THÉEL

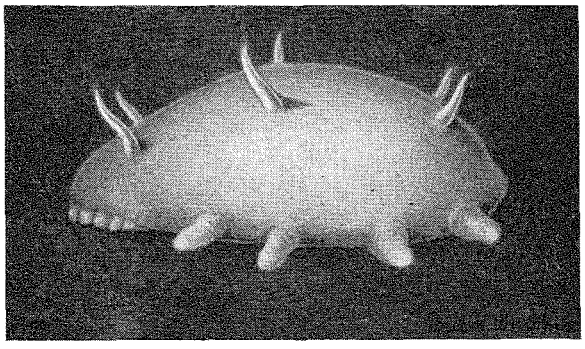

Fig. 1. *Elpidia glacialis sundensis.* (Poul H. Winther del.).

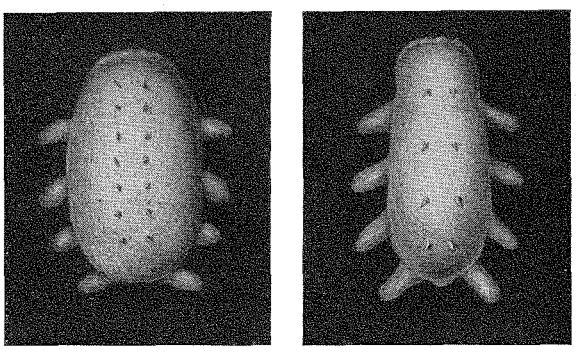

Fig. 2. Left, *Elpidia glacialis solomonensis;* right, *E. g. kermadecensis.* Most of the specimens of *E. g. kermadecensis* have one more pair of papillae than shown on the figure. Both subspecies vary in shape between the extremes here indicated. (Poul H. Winther del.).

remarks to this that we are here evidently dealing with a very variable character, and he states that the specimen is otherwise similar to the typical *Elpidia glacialis*. Considering the agreement in the number of papillae between this specimen and the specimens from the Sunda Trench, THÉEL is probably not right in regarding the low number of papillae as an insignificant individual variation. It indicates rather a geographical variation on a larger scale.

The 1800 specimens from st. 649 in the Kermadec Trench (fig. 2, right) are finely preserved. The dorsal papillae are here extremely small, almost devoid of calcareous bodies, and in most cases withdrawn into the skin. Usually, they are only indicated by some white spots on the dorsal side. The single specimen from st. 650 had the papillae somewhat better developed. They were about one millimeter long, and densely provided with transverse calcareous rods. The length of this specimen, which was slightly defect, was c. 30 mm. Although the size of the papillae is thus subject to some variation within the Kermadec Trench, there seems in this character to be a clear difference from the northern form and the Sunda form. In these two forms the dorsal papillae of a 30 mm long specimen measures c. 5 mm. Since the papillae are very stiff because of the calcareous bodies, the small size of the papillae in the specimen from st. 650 is not due to contraction.

The papillae were counted on 100 specimens. Of these 96 had 5 pairs, 3 had 4 pairs, and 1 specimen had 6 pairs. The specimen from st. 650 had 5 pairs of papillae. The papillae are placed all along the dorsal side, usually at quite regular intervals. In some specimens, however, the corresponding left and right papillae are placed more or less obliquely to each other, the intervals between the succeeding

papillae thus being unequal. Such irregular arrangements of the papillae are, however, always insignificant deviations from the regular type, and there is never any indication of an arrangement in an anterior and a posterior group.

In the specimens from the New Britain Trench (fig. 2, left) the dorsal papillae are just as reduced as in the specimens from st. 649 of the Kermadec Trench. They are in most of the specimens totally withdrawn into the body. Their arrangement is regular as in the Kermadec specimens, but their number is different. In 24 of the 63 specimens from st. 521 the papillae could be counted. 1 specimen had 6 pairs, 19 had 7 pairs, and 4 had 8 pairs of papillae. Of the 14 specimens from st. 517 the papillae could be counted on 6. 5 specimens had 7 pairs and 1 had 8 pairs.

The 14 specimens from the Tasman Sea have equally reduced and similarly arranged papillae as those from the Kermadec and New Britain Trenches. In their number they occupy an intermediate position between the two forms. The papillae could be counted in 7 of the specimens. There were 3 specimens with 5 pairs, 3 with 6 pairs, and 1 with 7 pairs.

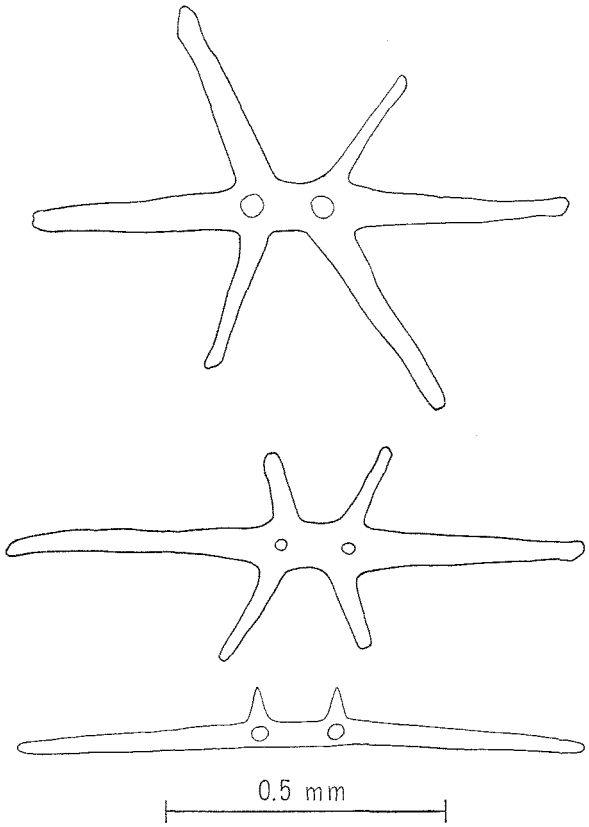

Fig. 3. *Elpidia glacialis kermadecensis.* Spicules; the lower one in lateral view.

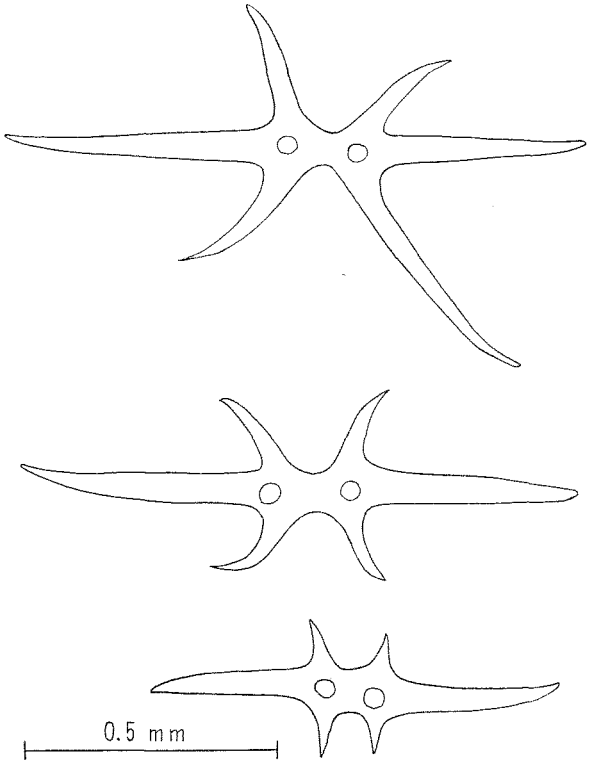

Fig. 4. *Elpidia glacialis solomonensis.* Spicules.

The spicules also show a geographical variation in *Elpidia glacialis*. In the specimens from the Kermadec Trench the spicules have rather slender arms, which are straight and distinctly set off from the main rod (fig. 3). Altogether, 10 specimens from st. 649 and the single one from st. 650 were examined. They were all very similar. On the other hand, there is some variation in the spicules in one and the same animal, some of the spicules being more slender than those figured.

The spicules of the specimens from the New Britain Trench are mostly very characteristic (fig. 4). The arms of the spicules are not so distinctly set off from the main rod, but pass into it by rounded curves. They are more attenuating towards the ends and somewhat curved as against the straight arms in the Kermadec specimens. The smaller spicules are very robust and have short, conical arms. 10 specimens from st. 517 and 5 from st. 521 were examined. As in the Kermadec specimens the spicules of the different specimens are very similar, but subject to some variation within one and the same specimen. Among the typical spicules described there are some which can not be distinguished from those of the Kermadec specimens.

The specimens from the Sunda Trench are equally characteristic (fig. 5). The spicules are here

extremely slender, and the arms unusually long. The vertical apophyses, which in the Kermadec and New Britain specimens are rather short, are here more developed. The spicules were examined in 10 specimens from st. 466 and 5 from st. 465. They show the same remarkable similarity as in the specimens from the two other trenches. The variability within the single specimen is neither in these specimens inconsiderable; the more robust spicules can not be distinguished from the more slender ones of the Kermadec specimens.

The specimens from the Tasman Sea are distinguished by having the vertical apophyses of the spicules extremely long (fig. 6). They project far out from the skin and give the animals a quite hairy appearance. The spicules are very slender and smaller than those of the specimens from the three deeps. The small size of the spicules does not seem to be due to the small size of the specimens from the Tasman Sea. Among the specimens from the investigated deeps, the smallest ones have as large spicules as the larger specimens.

For comparison 58 specimens from the northern region were examined. They were selected from the Ingolf stations no. 113, 117, and 120 from the Norwegian Sea (10 specimens from each), and from the Godthaab stations no. 54, 119, and 144 from the Baffin Bay (10, 8, and 10 specimens, respectively).

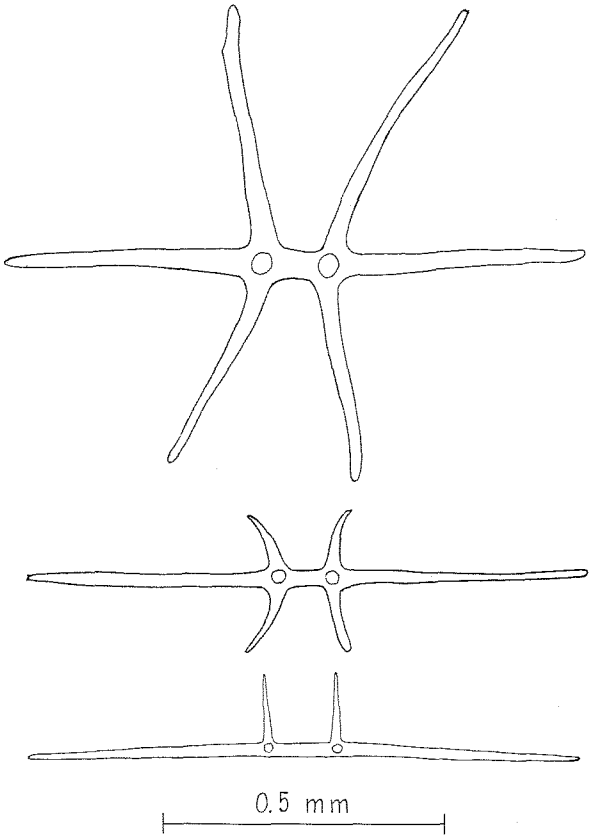

Fig. 5. *Elpidia glacialis sundensis.* Spicules; the lower one in lateral view.

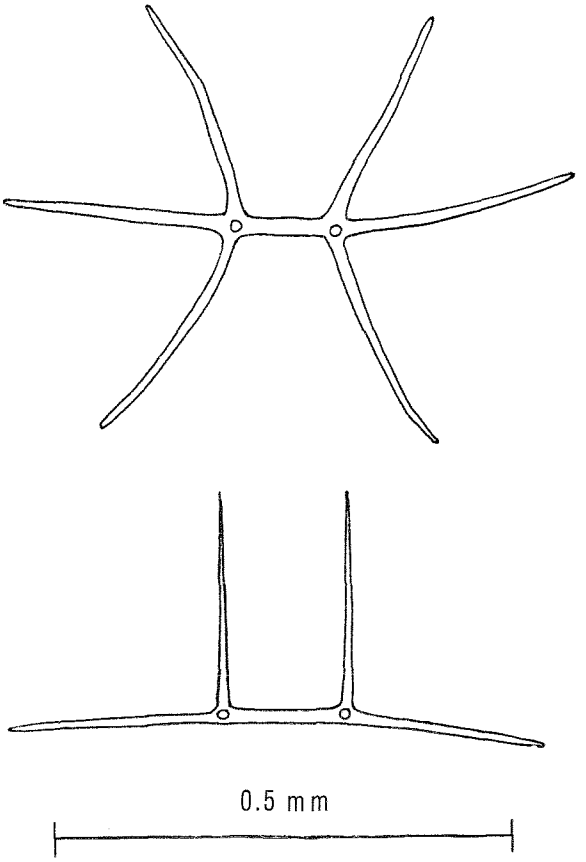

Fig. 6. *Elpidia glacialis théeli.* Spicules; the lower one in lateral view.

The specimens from the 3 Godthaab stations and from the Ingolf station 120 had very slender spicules. In some of the specimens they are similar to those of the Sunda form, both in shape and size. In other specimens they are smaller and differ from those of the Tasman Sea only in their smaller vertical apophyses.

The specimens from the Ingolf station 113 had generally rather robust spicules. Some of the spicules had straight arms and reminded, on the whole, very much of those of the Kermadec form. Others had more curved arms and were more similar to the New Britain specimens. The specimens from station 117 were intermediate between those from the two other Ingolf stations.

The information gained by the examination of the Ingolf specimens is very instructing. The three stations are all situated north east of Iceland, rather near each other, and belong definitely to the same continuous population. In this population we have a range of variation in the spicules, which nearly

amounts to that between the specimens from the three deeps. But again, the variation within the same station is considerably smaller than that between specimens from different stations.

Though a geographical variation seems to exist in the spicules, these should, however, be employed with much caution in the intraspecific taxonomy of the species. Even when the spicules in several specimens from one or a few stations are similar, this uniformity need not be of any subspecific value. It may be an insignificant local variation, only. Moreover, the shape of the spicules is a rather ill defined character. It is not easy to select a "typical" spicule among many differing ones.

Among the normal spicules small wheel-shaped ones are sometimes found in the arctic form. They were not found in any of the Galathea specimens, and also not in the Challenger specimen. They are, however, very rare in the arctic form. Among the 58 preparations made from the arctic specimens, only 6 contained a wheel. Wheels occur sporadically in various other elasipods and should be regarded as a juvenile character (EKMAN 1926). No taxonomic importance should be attached to their presence or absence.

A few points of taxonomic interest remain to be mentioned. In the specimens from the Sunda Trench the body is semicircular in cross section as in the arctic specimens. All the pacific specimens are, on the contrary, more or less depressed.

In the specimens from the Tasman Sea the skin is rather soft and dotted with violet spots. In the specimens from the three deeps it is hard, brittle, and light greyish as in the arctic form.

All the specimens have 10 tentacles and 4 pairs of tubefeet.

The calcareous ring does not show any variation of taxonomic value.

The body lengths of the specimens are as follows:

Sunda Trench	20-35 mm
Kermadec Trench	17-30 mm
New Britain Trench	11-27 mm
Tasman Sea	7-12 mm

On the basis of the above differences it might be justified to erect five geographical subspecies of *Elpidia glacialis*. They are distinguished as follows:

A. Dorsal papillae large; body vaulted.
   1. Dorsal papillae divided into an anterior and a posterior group, with 3-4 and 1 pairs, respectively.
      Elpidia glacialis glacialis.
   2. 3 pairs of dorsal papillae, placed on the head, the mid part, and the hind part of the body, respectively.
      Elpidia glacialis sundensis.

B. Dorsal papillae small and regularly distributed; body depressed.
   I. Spicules with very high vertical apophyses.
      3. 5-7 pairs of dorsal papillae; skin soft, with violet spots.
         Elpidia glacialis théeli.
   II. Spicules with low vertical apophyses.
      4. 4-6 pairs of dorsal papillae.
         Elpidia glacialis kermadecensis.
      5. 6-8 pairs of dorsal papillae.
         Elpidia glacialis solomonensis.

Elpidia glacialis glacialis comprises the arctic finds and the finds off Morocco. *E. g. sundensis* is known from the Sunda Trench and from south of Australia. *E. g. théeli, kermadecensis,* and *solomonensis* were found in the Tasman Sea, the Kermadec Trench, and the New Britain Trench, respectively.

Elpidia glacialis kermadecensis and *E. g. solomonensis* are nearly related. The occurrence of the two very differing subspecies *E. g. sundensis* and *E. g. théeli* rather near each other on either side of Tasmania indicates a zoogeographical border south of this island, probably along the submarine ridge running from Tasmania to the Antarctic. Where the border between *E. g. glacialis* and *E. g. sundensis* is to be drawn is not yet to be decided.

The types of the four subspecies taken by the Galathea are preserved in the Zoological Museum of Copenhagen. The typelocalities and the body lengths of the types are as follows: *E. g. kermadecensis,* st. 649, 22 mm. *E. g. solomonensis,* st. 517, 25 mm. *E. g. sundensis,* st. 466, 35 mm. *E. g. théeli,* st. 602, 10 mm.

Periamma naresi (Théel 1882)

Peniagone naresi THÉEL 1882, pp. 47-49; pl. 9, fig. 1-2; pl. 33, fig. 15.

Material:

St. 466, Sunda Trench, 10°21′ S, 110°12′ E, 7130-7160 m, bluish clay, 114 specimens.

Previous records. The species was hitherto known in one specimen only, taken by the Challenger at a depth of 3292 m between Australia and the Antarctic.

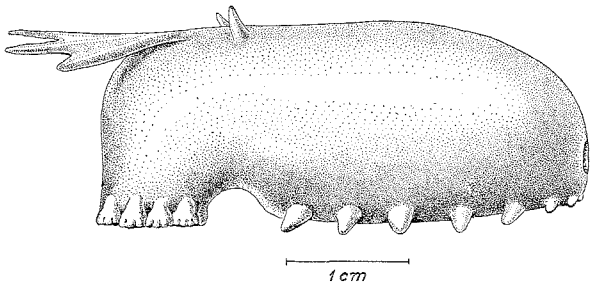

Fig. 7. *Periamma naresi.* (Julie Tesch del.).

The single previously known specimen lacked the hind tip of the body. THÉEL's description is, however, so thorough that the specimens from the Galathea without hesitation may be referred to the same species.

The large material from the Sunda Trench makes a more complete description of the species possible. Besides, it gives a good impression of the individual variation within the species, and particularly of the variation in external appearance due to the different states of preservation.

THÉEL is not able to state the exact number of tubefeet in his incomplete specimen. 6 pairs of tubefeet were present, all fairly well developed. Our specimens have 8-9 pairs of tubefeet. The 6 foremost pairs are more or less well developed, while the remaining 2-3 pairs are quite reduced and placed at the hind tip of the body. In some of the specimens the anterior 6 pairs are equally large and the difference in size between these and the small posterior ones thus very pronounced. In other specimens the 5th and 6th tubefeet are decreasing in size, and the transition to the small ones more gradual. As appears from the above THÉEL's specimen is actually almost complete. It lacks only the hindmost tip of the body with 2-3 pairs of reduced tubefeet. The tubefeet are conical with a small sole, as described by THÉEL.

On the anterior part of the dorsal side is found a velum consisting of two pairs of united papillae, followed by a pair of small, free papillae. Only in a few specimens is it as well developed as on THÉEL's figure. Usually, it measures about one fourth of the length of the animal. A single 4.5 cm long specimen with a 2 cm long velum was, however, found. The length of the free papillae is about 2 mm. The shape of the velum is extremely varying (fig. 8). In the typical case the two middle papillae are largest, but they may also be of the same size or even smaller than the exterior ones. In some specimens the papillae are free in nearly half their length, while in others only their tips are free. In one specimen the velum consisted of four small, almost free papillae. This was very similar to that of *Periamma robustum* (THÉEL 1882, pl. 6, fig. 1-3). In many specimens the velum was quite irregularly formed.

The size and shape of the velum are characters much used in the taxonomy of the species of *Periamma* and *Peniagone*. The variability in this respect in the material of *Periamma naresi* shows that the taxonomic value of this character is very limited. The minute description of the velum, which is often found in the diagnoses of these species, is often more misleading than guiding in the taxonomy. Especially, when a species is described on a single more or less badly preserved specimen, and this is the case with several of them, the description of the velum has not much interest.

Most of the specimens have developed a necklike part between the head and the body. In their external appearance they are very similar to PERRIER's figure of the closely related species *P. roseum* (PERRIER 1902, pl. 13, fig. 10-12). The mouth disc and the flat ventral sole of the body are quite level with each other, but separated by a distinct furrow. On THÉEL's figure there is no neck, the mouth disc shows obliquely forwards, and the ventral side is a little convex. The same appearance is found in the specimens of the Galathea, which are much contracted and filled with mud. It may be pointed out that another species of *Periamma, P. furcata,* was similarly first described without a neck, but later proved to possess one (HÉROUARD 1902 and 1923).

The length of the specimens is 3-6 cm, and their proportions are somewhat varying. The dorsal side is strongly vaulted; the height is one third to one fourth of the length. The diameter of the tentacle crown and the breadth of the ventral sole is a little more than one fourth of the body-length. Some spe-

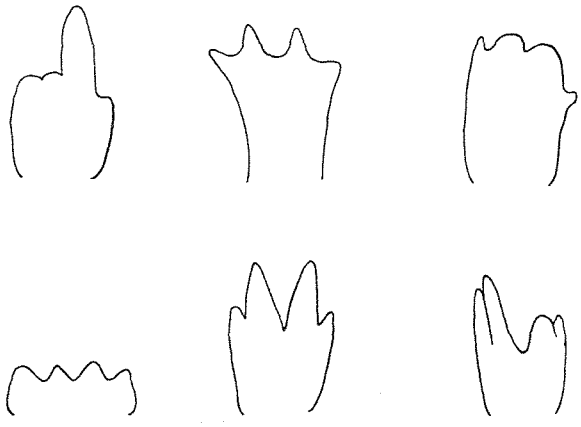

Fig. 8. *Periamma naresi.* Different shapes of the velum.

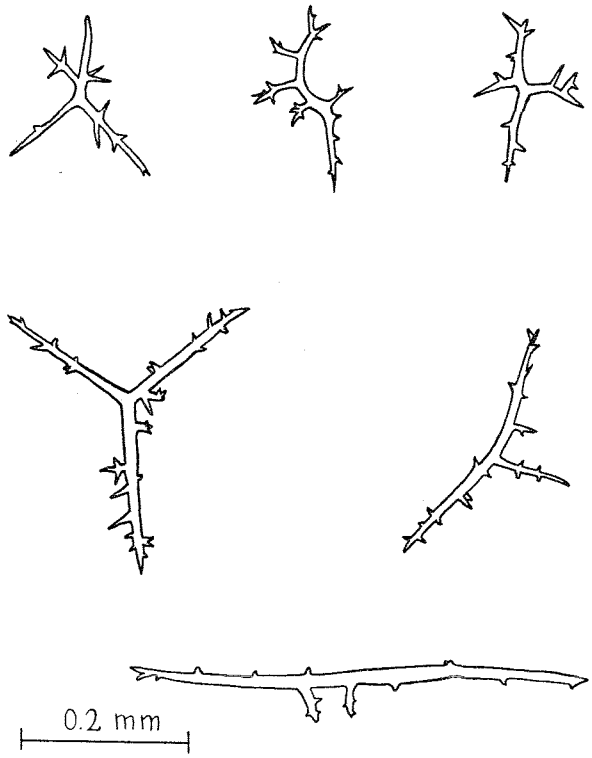

Fig. 9. *Periamma naresi.* Spicules.

cimens were more slender, about five times as long as broad.

The 10 tentacles are all of equal size and provided with a broad end disc with small processes.

The anus is terminal to subdorsal.

The very characteristic spicules refer the specimens with certainty to *P. naresi* (fig. 9). Three types of spicules are found: regular trifid, unbranched to irregularly branched, and C-formed. The regular trifid are distributed in two size-groups, the large with arm-lengths of c. 0,22 mm, and the much more numerous small ones with the arms half as long. THÉEL states the arm-lengths of the small spicules to be 0,06 mm, but this is apparently a misprint, since the measures on his figure agree with those mentioned above.

Scotoplanes globosa Théel 1879

Scotoplanes globosa THÉEL 1882, pp. 29-31; pl. 4; pl. 5, fig. 3; pl. 34, fig. 8-9; pl. 44, fig. 12.
VANEY 1908, pp. 409-410; pl. 3, fig. 25-28.
Scotoplanes théeli OHSHIMA 1915, pp. 242-243.

Material:

St. 650, Kermadec Trench, 32°20′ S, 176°54′ W, 6620 m, brown clay with pumice, 31 specimens.
St. 653, Kermadec Trench, 32°09′ S, 176°35′ W, 6140-6160 m, brown clay with pumice, 1 specimen.
St. 658, Kermadec Trench, 35°51′ S, 178° 31′ W, 6660-6720 m, brown sand with clay and stones, 17 specimens.

Previous records. *Scotoplanes globosa* was recorded from two Challenger stations and from one station of the Scotch Antarctic Expedition, all from the southern hemisphere, viz. off Chile, south-west of Cape of Good Hope, and the Antarctic Sea south-west of Australia. The depths were 3564-4809 m. *Scotoplanes théeli,* which is here regarded as a synomym of *S. globosa,* was recorded from two Albatross stations at the northern Japan at 545 and 970 m.

Besides, there are in the Zoological Museum of Copenhagen 34 specimens labelled *S. globosa* (det. HEDING) from South Africa (no further statement of the locality), and two specimens labelled *S. théeli* (det. DEICHMANN) from 3762 m off Hawaii (Albatross station no. 2919). Moreover, 7 specimens were taken by the Galathea off the Gold Coast (st. 32, 4°05′N, 2°13′ W, 2047 m).

The specimens agree well with THÉEL's description, both in regard to the external characters and the spicules. There are three pairs of dorsal papillae, the hindmost quite rudimentary and placed just behind the second pair. The ten tentacles are provided with unbranched processes on the broad end discs. Finally, the spicules quite conform with THÉEL's figures. They are partly C-formed, partly spinous rods, rarely with branches. In the tentacles there are curved, smooth rods.

Of the 6 pairs of tubefeet the hindmost pair is placed in front of the anus and is more or less rudimentary, in one specimen even absent.

OHSHIMA's species *Scotoplanes théeli* can in all probability not be upheld. It can not be distinguished from *S. globosa* by means of the spicules, but differs, according to OHSHIMA, in the shape of the body, the arrangement of the dorsal papillae, and in the absence of an intestinal caecum.

Regarding the first character, THÉEL's specimens were 1.5 to twice as long as broad, while OHSHIMA's specimens were more oblong, twice as long as broad, or longer. Considering the changes to which the animals are subject on account of the preservation, no importance should be attached to small a difference. The ratio of length to breadth is variable in the specimens from the Galathea, in some more, in others less than 2 to 1.

In the placing of the dorsal papillae OHSHIMA mentions two differences between the species. The

second pair was in THÉEL's specimens placed about half-way between the middle and the hind tip of the body, but in OHSHIMA's either at the middle or in front of the middle. In our specimens the position of the second pair of papillae is somewhat varying. In most of them they are placed behind the middle, but in some they are seated just at the middle.

OHSHIMA states, as a further difference in the position of the papillae, that the rudimentary third pair in *S. théeli* is not placed directly behind the second pair, but a little more laterally. Though THÉEL does not mention it in his text, his figures show that the third pair of papillae is also here placed somewhat laterally to the second pair. The same applies to the specimens of the Galathea.

The presence of a rectal caecum in *S. globosa* was mentioned by THÉEL, but in OHSHIMA's specimens it was absent. Three specimens from st. 658 were dissected, and none of them had any caecum. On the other hand, two specimens from another Galathea station in the Kermadec Trench, st. 668 (depth 2630 m), both proved to have a rectal caecum. In one only a small vesicle was present, but in the other it formed an enormous mud-filled pouch on the rectum. The said specimens from South Africa in the Museum of Copenhagen show similar conditions. They have the skin so transparent that the intestines are visible through it, and they are therefore well suited for studying the rectum. The rectum is in all the specimens strongly filled with mud and thereby more or less distended. In some cases the distension has the shape of a caecum. There is thus apparently no sharp distinction between a distended rectum and a rectum provided with a caecum. This character should therefore not be used for separating *S. théeli* from *S. globosa*.

Scotoplanes galatheae n. sp.

Material:

St. 435, Philippine Trench, 10°20′ N, 126°41′ E, 9790 m, very stiff clay, 1 specimen.

The type is preserved in the Zoological Museum of Copenhagen.

Diagnosis: *Scotoplanes* with five pairs of well developed lateral tubefeet. Dorsal papillae lacking, or only present on the anterior part of the dorsal side. Tentacle crown very conspicuous and directed straightly forward. Spicules of two types: slightly spinous rods in the tentacles, tubefeet and very rarely in the body-wall, and C-formed ones in the body-wall.

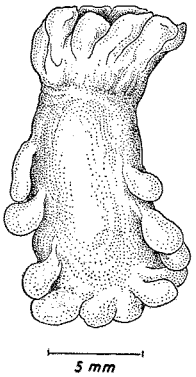

Fig. 10. *Scotoplanes galatheae*. Ventral view. (Poul H. Winther del.).

The single specimen taken is 17 mm long, including the tentacles, and 8 mm broad. The body is rather flat, oval, and along the lateral edges provided with 5 pairs of c. 2 mm long, outwardly directed tubefeet, placed at fairly regular intervals.

The mouth is terminal and surrounded by 10 very conspicuous tentacles, directed straightly forward. These are all of the same size, c. 2 mm long and 1 mm broad, the end discs being a little broader and carrying 8-10 small knobs along their edges.

The specimen is complete, except that the skin is slightly torn on the anterior part of the dorsal side. This defect appears at about the place, where some *Scotoplanes*-species possess a velum. Possibly, *S. galatheae* also has a velum at this place.

The skin is soft, and of a greyish colour.

In order to study the spicules preparations were made of a tentacle, a tubefoot, and a piece of the skin of the dorsal and ventral side (fig. 11). The tentacles and tubefeet have rod-shaped, 0.15-0.30 mm long, transverse, sligthly spinous spicules. In the skin these rods seem to be almost absent; only a single one was found in the preparation from the ventral skin, and none at all in that from the dorsal. Instead, C-shaped spicules are found in the skin, most numerous on the ventral side. They are 0.03-0.05 mm long, and are entirely absent in the tentacles and tubefeet.

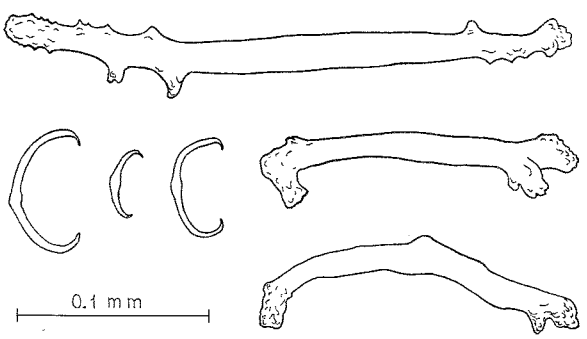

Fig. 11. *Scotoplanes galatheae*, Spicules.

The presence of C-shaped spicules together with rods, and of these two types only, refers the species with certainty to the genus *Scotoplanes* Théel. In the family Elpidiidae only *Periamma* has also C-shaped spicules, but they are here found together with 3-branched ones. These may be reduced to simple rods in the tentacles and tubefeet, but in *S. galatheae* there is nothing to indicate that the rods are derived from branched spicules.

HÉROUARD (1923) erected the genus *Ellipinion* for four species of *Scotoplanes*. The two genera differ only in the arrangement of the dorsal papillae. *Scotoplanes,* as defined by HÉROUARD, has dorsal papillae both anteriorly and posteriorly, while in *Ellipinion* they are only present anteriorly. Their spicules are, however, so similar that species belonging to each of the genera may have indistinguishable spicules. This is e. g. the case with *S. globosa* and *S. (Ellipinion) mollis*. The genus *Ellipinion* is therefore hardly justified.

S. galatheae is clearly distinguished from the hitherto described species of the genus. Only *S. murrayi* Théel has also five pairs of tubefeet, but this species has large dorsal papillae both on the anterior and posterior part of the back. The spicules, which are very unspecific in the species of *Scotoplanes,* are in *S. galatheae* characteristic by their distribution. While the two types of spicules in other species of the genus occur scattered among each other, the rods in *S. galatheae* are almost confined to the tentacles and tubefeet, and the C-shaped spicules found only in the body-wall.

Peniagone vedeli n. sp.

Material:

St. 649, Kermadec Trench, 35°16′ S, 178°40′ W, 8210-8300 m, grey clay with pumice, 160 specimens. St. 650, Kermadec Trench, 32°20′ S, 176° 54′ W, 6620 m, brown clay with pumice, 260 specimens. St. 651, Kermadec Trench, 32°10′ S, 177°14′ W, 6960-7000 m, brown clay with pumice, 6 specimens. St. 653, Kermadec Trench, 32°09′ S, 176°35′ W, 6140-6160 m, 1 specimen. St. 658, Kermadec Trench, 35°51′ S, 178°31′ W, 6660-6720 m, brown sand with clay and stones, c. 600 specimens.

Typelocality: St. 658. The type, 4.2 cm long, is preserved in the Zoological Museum of Copenhagen.

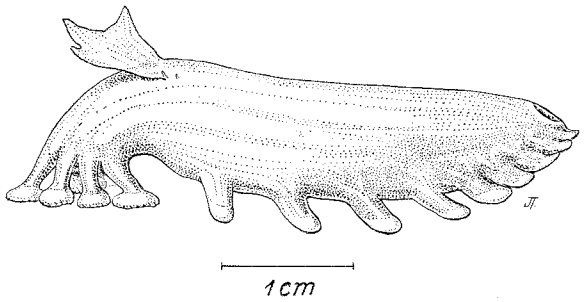

Fig. 12. *Peniagone vedeli.* (Julie Tesch del.).

Diagnosis: *Peniagone* with 9-11 pairs of ventro-lateral tubefeet placed along the whole length of the body. Velum well developed, composed of two pairs of papillae, and followed by 1 or 2 pairs of free, rudimentary papillae. Spicules very varying, mostly with a rather long primary rod and slightly inwardly curved, spiny arms, which are usually twice as long as the primary rod; the vertical apophyses short, very robust, and strongly provided with spines.

The numerous specimens taken were nearly all in a very poor state of preservation. The tubefeet and tentacles are mostly totally lacking, and the velum is only in a few specimens so well preserved as to give an idea of its shape. By a comparison of different specimens it is, however, possible to form a good idea of the outer appearance of the species.

The specimens are from 3 to 9 cm long. The breadth of the body is in most of the specimens about one sixth of the length, but may amount to one fourth.

The mouth is approximately ventral, very small, and surrounded by ten equally developed tentacles. These measure, in a 6 cm long specimen, c. 1 cm; they have a slender stalk and a conspicuous, c. 5 mm broad, end disc provided with numerous small papillae on the surface and irregular incisions round the edge.

The 9-11 ventro-lateral tubefeet are placed along the whole length of the body. The 4-5 foremost are about 5 mm long and placed at distinct intervals, while the following are decreasing in size and placed close to each other. The hindmost 2-3 pairs are sometimes hardly visible. The height of the body decreases towards the posterior end. The flatness of the hindmost part of the body is further emphasized by the closely placed tubefeet, which nearly form a lateral brim.

In the development of the velum there is some variation in the specimens. It may measure about one fourth of the length of the animal, but mostly

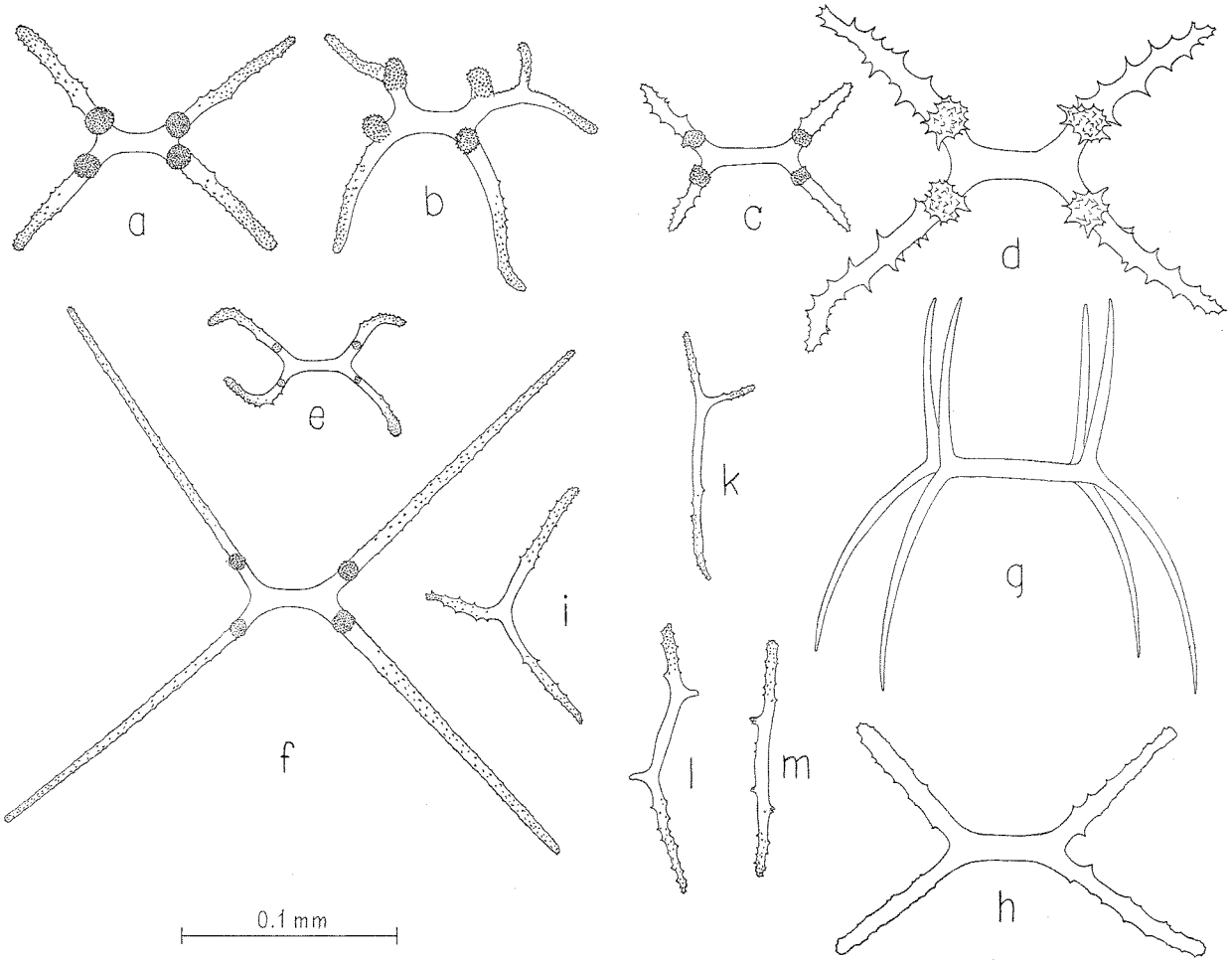

Fig. 13. *Peniagone vedeli*. Spicules; a-g. from the skin; h. from the peritoneal covering of the skin; i-m. from the tentacles.

it is much smaller, apparently contracted, and its shape is then difficult to decide. Fig. 12 shows a specimen with an unusually well developed velum; this is composed of two pairs of papillae, of which the two central ones are the largest. The papillae of the velum may be free in a great part of their length, or may be free in their outmost tips only. Behind the velum one or two pairs of rudimentary, free papillae are found. They are sometimes only indicated by their water vascular canals.

The anus is placed above the hindmost tubefeet.

The skin is soft and mucous, and so transparent that the longitudinal muscles are clearly visible through it. Its outer layer, which is generally worn off, is quite rough due to the densely crowded spicules.

The spicules show a very wide range of variation both in size and shape. By far the most common type is that shown in fig. 13 a-b, with the arms curved slightly inwardly and densely provided with small spines. At the base each arm carries a vertical, rather short, but very robust and spiny apophysis. The arms are sometimes more or less irregularly shaped, e. g. provided with side-branches. Among these spicules some rather differing ones are found, e. g. some with very short arms (c), some very large and robust, with few, but strong spines (d), others with long slender arms (f), and finally, very rarely occurring, quite smooth spicules with strongly curved arms and high, slender apophyses (g).

In the inner, peritoneal covering of the skin the spicules are usually very slender, smooth, and lack the apophyses. Often they are as large and slender as in fig. 13f, but they may be more short-armed and somewhat spiny (h).

Common to all the spicules are their long primary rods. The spicules are never cross-shaped.

In the tentacles and tubefeet, and sometimes in the body-wall, the spicules are reduced to trifid or rod-shaped (i-m). The longitudinal muscles contain slender rods.

The spicules were studied in 60 specimens. The

dominant type of spicules is not always the same. In some specimens the most common type was e. g. that shown in fig. 13d. The variation within the same specimen is very great, and all the spicules portrayed in fig. 13 may be found in one animal.

Among the previously described species, *P. vedeli* seems to be most nearly related to *P. azorica* v. Mar. (VON MARENZELLER 1893, pp. 12-13; pl. 1, fig. 4; pl. 2, fig. 5). The outer appearance is very similar in the two species; the number and distribution of the tubefeet is for instance the same. They differ, however, in the calcareous bodies. I had the opportunity to examine 6 specimens of P. azorica in the Zoological Museum of Copenhagen, viz. 2 taken by the Princesse Alice off the Açores, and 4 taken by the Ingolf south and south-west of Iceland. The spicules of the dorsal skin are all very uniform, with strongly curved arms and high, slender apophyses. They are quite in accordance with VON MARENZELLER'S figure and very similar to that of *P. vedeli* portrayed in fig. 13g. But as said before this type of spicules is quite exceptional in *P. vedeli*. In the ventral skin a very wide range of variation in the spicules was found. The variation is greater than described by VON MARENZELLER. In one specimen from the Princesse Alice and in one from the Ingolf the ventral spicules could not be distinguished from the dorsal ones. In the four other specimens the ventral spicules were more slender, had shorter apophyses, and less curved arms than the dorsal spicules. But even here a few spicules were found, which were quite similar to the dorsal ones.

As appears from the above, the two species are most clearly distinguished in the development of the dorsal spicules. In *P. azorica* they all belong to a type, which is found only exceptionally in *P. vedeli*.

The species is named after A. H. Vedel, Viceadmiral of the Danish Navy and Member of the Galathea Committee.

Benthodytes sanguinolenta Théel 1882

THÉEL 1882, pp. 104-05; pl. 23; pl. 40, fig. 4-5; pl. 42, fig. 6.
LUDWIG 1894, pp. 53-60; pl. 1, fig. 1-8.
KOEHLER & VANEY 1905, p. 72.
CLARK 1913, p. 233.
– 1920, p. 142.
– 1923, p. 420.
OHSHIMA 1915, p. 245.
HEDING 1940, p. 367.

Material:

St. 495, Banda Trench, 5°26′ S, 130°58′ E, 7290-7250 m, clay, 5 specimens. St. 497, Banda Trench, 5°18′ S, 131°18′ E, 6490-6650 m, soft clay, 3 specimens.

Previous records. The species was previously recorded from numerous stations in the Indian Ocean and the Pacific, at depths of 768-5206 m. The westernmost record was at Cape of Good Hope.

The material from St. 495 consists of one large specimen and four juvenile ones. The large specimen is 21 cm long and 3-4 cm broad, including the 1 cm broad marginal brim. It has been ripped up along the whole of the ventral side, and the alimentary canal is absent. No spicules were found in it, though both the ventral and dorsal skin, the tentacles, the gonads, and a piece of a longitudinal muscle were examined. The colour of the specimen is reddish purple, darker on the ventral side and the head, lighter on the back. Against the light dorsal side the small, dark red papillae are rather conspicuous. The fully outstretched papillae are several mm long and very slender. Mostly they are, however, completely retracted, and only indicated by small spots. In some places they form a somewhat irregular double row along each dorsal radius, but in other places they are more scattered over the dorsal side. The number of tentacles is 18 or 19.

The 4 juvenile specimens from st. 495 are 6-8 cm long and only 0.5 cm broad. The ventro-lateral tubefeet are placed at distinct intervals and do not form a lateral brim. On the head and partly on the hindmost part of the body they are, however, rather well developed and closely placed. Only a few dorsal papillae are left; they seem to have been placed in a single row along each radius. The number of tentacles is somewhat difficult to state. One specimen had 18 tentacles, but two other specimens had apparently only 16 and 17 tentacles, respectively. Calcareous bodies are absent from the skin and the tentacles; in one specimen a longitudinal muscle was examined and found to possess numerous very slender, transverse rods.

The 3 specimens from st. 497 are rather poorly preserved. There is one, 15 cm long, complete specimen, and 2 specimens which lack the hind part of the body; they are 8 and 10 cm long, respectively. The body is nearly cylindrical; the diameter of the body is about 1 cm in the two incomplete specimens, and a little more in the complete one. The specimens are thus intermediate in size between the large and

the small specimens from st. 495. The head is surrounded by a well developed brim, but on the main body a brim is hardly discernible. The dorsal papillae are arranged in single or double rows along the radii. There were probably 18 tentacles, but their number can not be stated with certainty. Calcareous rods were found in a tentacle examined.

THÉEL mentions in his description of the species a transverse row of small ventral papillae just behind the tentacle crown. LUDWIG could find this row only in a few of his 25 specimens. Neither were they to be found in the specimens of the Galathea.

Benthodytes sanguinolenta is a species without very distinctive features. Maybe, as H. L. CLARK (1920) suggested, more than one species are comprised under the name. On the other hand, specimens of *B. sanguinolenta* may sometimes erroneously have been referred to *B. typica*. The species may therefore occur in the Atlantic also. At any rate, the apparently so clear indo-pacific type of distribution should be met with some doubt.

Euphronides verrucosa Ludwig 1894

Euphronides verrucosa LUDWIG 1894, pp. 44-48; pl. 3, fig. 1-6.
CLARK 1920, p. 140, pl. 1, fig. 2.
Euphronides bifurcata KOEHLER & VANEY 1905, pp. 75-76; pl. 8, fig. 1-2; pl. 12, fig. 22.

Material:
St. 495, Banda Trench, 5°26′S, 130°58′E, 7290-7250 m, clay, 3 specimens. St. 497, Banda Trench, 5° 18′S, 131°18′E, 6490-6550 m, soft clay, 1 specimen.

Previous records. *Euphronides verrucosa* was previously recorded from 4 Albatross stations in the eastern and central Pacific at 2404-4478 m. *E. bifurcata,* which is here regarded as a synonym of *E. verrucosa,* was taken in a single specimen by the Investigator in the Bay of Bengal at 3278 m.

LUDWIG's description of *E. verrucosa* is very thorough, and there is little to add. It is a very characteristic species, distinguished by having the dorsal side dotted by warts, which each contains a single large, cross-shaped spicule with strongly inwardly curved arms and a high central apophysis. Between the warts the body wall contains more unspecific, cross-shaped spicules with slightly curved, spiny arms. Moreover, in the ventral skin trifid and rod-shaped spicules are common. In the tentacles only rod-shaped spicules are found. In all these respects the specimens agree with LUDWIG's description, just as their external appearance quite concord with his figure.

The number of tentacles was 16 as in LUDWIG's and CLARK's specimens.

According to LUDWIG the species has 4 pairs of dorsal papillae. Two of Galathea's specimens lack the papillae, and the two others have only one pair, placed at about the middle of the body. They are of the same size as the warts, i. e. about 1 mm, but contrary to these they are very slender and fragile. They may easily be torn off, and no importance should therefore be attached to their absence.

The specimens were 6-7 cm long and had a dark purple colour.

E. bifurcata, which is known from a single poorly preserved specimen, is, as already supposed by H. L. CLARK, in all probability identical with *E. verrucosa*. It has similar spicules, but differs from *E. verrucosa* by its bifurcate tail, its broader lateral brim, and by the lack of dorsal papillae. The bifurcate tail has probably no taxonomic value. OHSHIMA (1915) found, within a single population of *E. depressa* Théel, all transitions between an undivided and a half divided tail. The width of the lateral brim is a rather inexact character, varying with the state of contraction of the lateral tubefeet. Finally, the absence of the dorsal papillae might be only a defect of the specimen.

ASPIDOCHIROTA

Mesothuria murrayi (Théel 1886)

Holothuria murrayi THÉEL 1886 part., pp. 185-86; pl. 10, fig. 16-18.
Mesothuria murrayi SLUITER 1901, p. 24.
FISHER 1907, pp. 683-85; pl. 71, fig. 1, 1a-h.

Material:
St. 497, Banda Trench, 5°18′ S, 131°18′ E, 6490-6550 m, soft clay, 1 specimen.

Previous records. *Mesothuria murrayi* was taken at Juan Fernandez by the Challenger, at the Hawaiian Islands and Japan by the Albatross, and in Indonesian waters by the Siboga. The specimens of the Challenger were taken at 2516 m, whereas all the other finds were from depths between 254 and 560 m.

The material consists of two fragments, probably belonging to the same specimen. One is a complete skin, the other a tentacle crown. The alimentary canal and the respiratory trees are absent.

The length of the specimen has been about 8 cm.

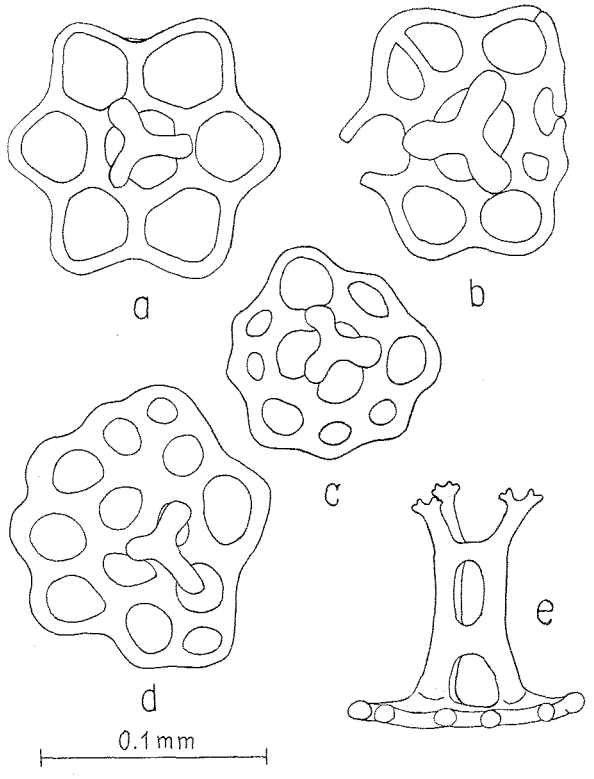

Fig. 14. *Mesothuria murrayi.* Spicules.

The tubefeet are chiefly concentrated near the ventro-lateral ambulacra and form two bands, 5-6 tubefeet broad. The central tubefeet in the band are c. 5 mm long and placed in a more or less distinct double row, while the peripheral ones are smaller and more irregularly scattered. The dorsal side has only few and small tubefeet, and on the ventral side they are completely absent. The colour of the skin is dark brown with a violet tinge. The tentacle crown has 20 peltate tentacles.

The skin contains numerous, imbricating spicules. They are somewhat varying. The most regular and original type is the 6-holed one (fig. 14a). The more or less irregular 8-holed type is, however, much more common (c). This developed from the 6-holed type, as is evident from the transitory stages present (b); the addition of 2 holes is brought about by a secondary division of 2 of the 6 large primary holes. As the number of holes increases, these become smaller, and the spicules more robust. Beside the 8-holed type, such with 7 or 9 holes are common. More rarely there develop, in addition, small peripheral holes (d). Each spicule has a tripartite spire with dichotomously branched points. In the dorsal side the 6-holed spicules are practically absent.

Mesothuria murrayi is nearly related to three species, *M. rugosa* Hérouard, *M. maroccana* Perrier, and *M. parva* Fisher. *M. rugosa* and *maroccana* are atlantic with a depth-range of 1416-3890 m and 909-3120 m, respectively. *M. parva* is a pacific species which has a depth-range of 20-780 m. The taxonomy of these species is rather intricate. *M. murrayi* was recorded also from the Atlantic, but according to DEICHMANN (1930) these records should be referred to *M. maroccana* and *rugosa,* all the safe records of *M. murrayi* being pacific. The four species are distinguished by the spicules and the distribution of the tubefeet, but both are very varying characters. In our specimen spicules similar to those of both *M. maroccana* and *rugosa* were found. *M. maroccana* has spicules as portrayed in fig. 14a (cp. PERRIER 1902, pl. 16, fig. 32-35). The spicules of *M. rugosa* are more irregular as in fig. 14c (cp. HÉROUARD 1923, pl. 1, fig. 11-21). The taxonomy of these species needs perhaps a revision, but no attempt will be made here on the basis of such small material.

Paroriza grevei n. sp.

Material:

St. 494, Banda Trench, 5°36′ S, 131°01′ E, 7280 m, clay, 1 specimen. St. 495, Banda Trench, 5°26′ S, 130°58′ E, 7290-7250 m, clay, 16 specimens. St. 497, Banda Trench, 5°18′ S, 131°18′ E, 6490-6650 m, 1 specimen.

Typelocality: St. 495. The type, 14 cm long, is preserved in the Zoological Museum of Copenhagen.

Diagnosis: *Paroriza* with the tentacles provided with cup-shaped discs, the edges of which are drawn out in four processes. The body in the larger specimens upwardly curved.

The genus *Paroriza* is nearly related to *Mesothuria.* It is distinguished by having a genital organ on either side of the dorsal mesentery, while *Mesothuria* has only one on the left side, and by the complete absence of calcareous bodies.

The specimens of *Paroriza grevei* were 8 to 20 cm long. The mouth is terminal, the anus subventral. In the larger specimens the body is characteristically upwardly curved. The tubefeet are conical and up to 5 mm long. They usually form a more or less distinct double row along each ventro-lateral radius, but outside this double row they are scattered without any serial arrangement. The papillae are filiform and up to 10 mm long. Along each dorsal radius a double row may be distinguished, but otherwise they are irregularly scattered. The ventral

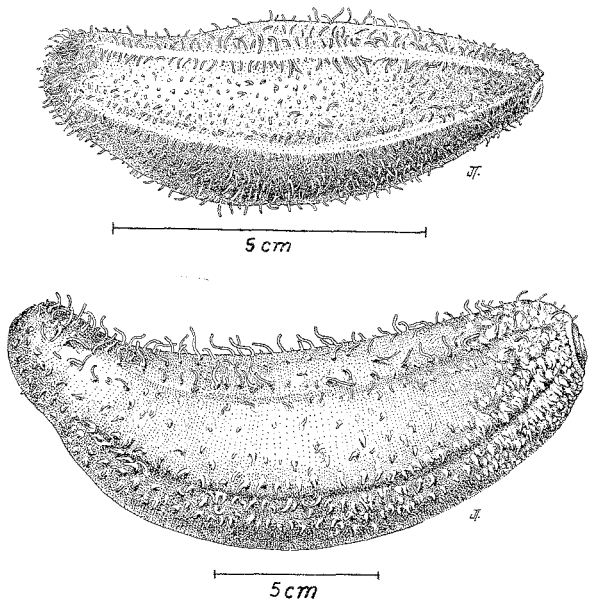

Fig. 15. *Paroriza grevei.* A small and a large specimen in lateral view. (Julie Tesch del.).

radius is naked in the larger specimens, whereas the smallest specimen have the ventral side covered by numerous small tubefeet. Even up to a size of 16 cm there are still some ventral tubefeet present. The small specimens have a greater number of tubefeet and papillae than the large ones, not only in relation to the body-size, but absolutely too. In the large specimens the bases of the tubefeet and papillae in the hindmost part of the body are very enlarged. The skin thereby gets an appearance of being made up of small mosaics, quite as described by HÉROUARD for *Paroriza prouhoi.*

When alive the specimens were brown, somewhat darker on the ventral side.

The tentacles differ from the usual aspidochirote type by the discs being more or less quadrangular, cup-shaped, with the edges drawn out in four processes (fig. 16). They are 20 in number and all of the same size.

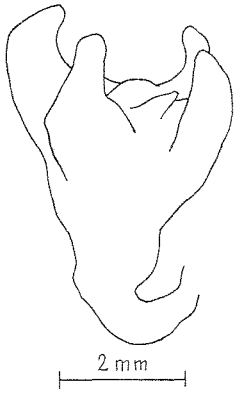

Fig. 16. *Paroriza grevei.* Tentacle.

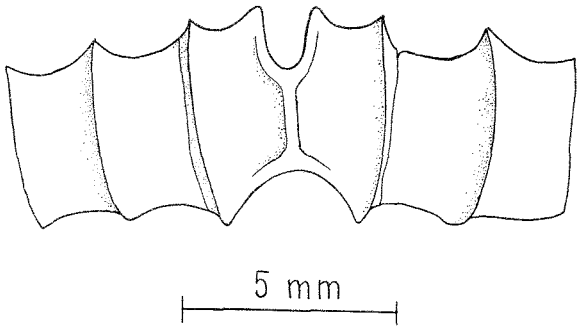

Fig. 17. *Paroriza grevei.* A radial and two interradial pieces of the calcareous ring.

The calcareous ring (fig. 17) is well developed and consists of 10 pieces. The radials carry one median and two lateral ridges. The median ridge bifurcate anteriorly. The posterior edge of the radials is markedly incurved. The interradial pieces are more regular quadratic and have a median, undivided ridge.

Two *Paroriza*-species were previously described, *P. prouhoi* Hérouard and *P. pallens* Koehler. They differ in size and distribution of the tubefeet. In *P. pallens* they are all of the same size and evenly distributed over the whole of the body. *P. prouhoi* has small and large papillae scattered among each other, and the ventral radius is completely naked. In the general appearance the larger specimens of *P. grevei* are somewhat similar to *P. prouhoi,* of which two specimens are known, both 23 cm long. *P. prouhoi,* however, lacks the upward curvature of the body, which is found in the larger specimens of *P. grevei.* Moreover, *P. grevei* is characterized by the peculiar shape of the tentacles.

The species is named after Captain Svend Greve, R. D. N., Commander of the Galathea.

Pseudostichopus villosus Théel 1886

Pseudostichopus villosus THÉEL 1886, pp. 170-71.
HÉROUARD 1902, pp. 11-13; pl. 2, fig. 1-3; pl. 7, fig. 3.
– 1923, p. 23.
DEICHMANN 1930, p. 89.
GRIEG 1921, p. 4.
Pseudostichopus globigerinae HÉROUARD 1923, pp. 23-25; pl. 4, fig. 6.

Material:

St. 651, Kermadec Trench, 32°10′ S, 177°14′ W, 6960-7000 m, brown clay with pumice, 5 specimens. St. 658, Kermadec Trench, 35°51′ S, 178° 31′ W, 6660-6720 m, brown sand with clay and stones, 30 specimens.

Pseudostichopus villosus is a cosmopolitan species, which, apart from 3 specimens taken at 896 m off Guadaloupe (DEICHMANN 1930), is only known from depths between 2615 and 5307 m. The specimens from the Kermadec Deep add nothing to the knowledge of the species, except the greater depth.

MOLPADONIA

Ceraplectana trachyderma H. L. Clark 1908

CLARK 1908, pp. 39-40; pp. 183-84; pl. 13, fig. 5-13.
– 1920, pp. 130-31.

Material:

St. 497, Banda Trench, 5°18′S, 131°18′E, 6490-6650 m, soft clay, 5 specimens. St. 499, Banda Trench, 5° 21′S, 131°17′E, 6580 m, greenish clay, 1 specimen.

Previous records. The species was previously taken in 3 specimens at the Aleutians, and in 2 specimens off Peru, all by the Albatross. The depths were 3188 and 5173 m, respectively.

This peculiar species is unique among the holothurians by having the tentacles modified into horny claws. The specimens agree with CLARK's description both in the shape of the calcareous ring, the long tentacle ampullae, and the spicules. These were examined in 2 specimens (fig. 18). One contained numerous phosphatic bodies, as described by CLARK, the other only traces of them.

The specimens were 1.8-4.5 cm long.

The claw-shaped tentacles suggest that the species is predatory. The content of the alimentary canal was therefore examined in one of the specimens, but it was unidentifiable.

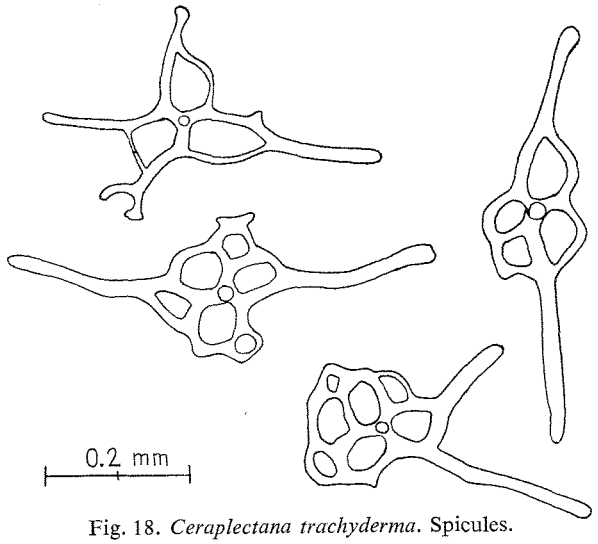

Fig. 18. *Ceraplectana trachyderma*. Spicules.

Hadalothuria wolffi n. g., n. sp.

Material:

St. 517, New Britain Trench, 6°31′ S, 153°58′ E, 8920 m, 1 specimen. St. 521, New Britain Trench, 5°59′S, 153°28′E, 8810-8940 m, clay, 13 specimens.

Typelocality: St. 521. The type, 2.7 cm long, is preserved in the Zoological Museum of Copenhagen.

Diagnosis of the genus: Gephyrothuridae without whiplash-like papillae, but with numerous, rudimentary papillae all along the dorsal and ventro-lateral ambulacra. Mouth subventral.

The peculiar family Gephyrothuridae was erected by KOEHLER and VANEY 1905 for the species *Gephyrothuria alcocki,* which was taken by the Investigator in the Bay of Bengal. Later another species, *G. glauca* (H. L. Clark), was taken in the western Atlantic (H. L. CLARK 1908). This species was originally referred to a separate genus, *Himastlephora* H. L. Clark, because it was thought, contrary to *G. alcocki,* to possess a tail. HÉROUARD (1923), however, showed that a tail is actually absent also in *Himastlephora,* which is therefore to be regarded as a synonym of *Gephyrothuria.* So far, these are the only known species of Gephyrothuridae.

The family, among other things, is characterized by the absence of a tail, the 15 tentacles without ampullae, the shape of the calcareous ring, the simple water-lungs, and the total absence of calcareous and phosphatic bodies.

All these characters are also found in *Hadalothuria wolffi.* It differs, however, from the two *Gephyrothuria*-species in two characters, which seem to be so essential that they justify the erection of a new genus. Though both genera show a development of the ambulacral appendages, which is quite unusual in the Molpadonia, these appendages are very differently developed in the two genera. *G. alcocki* and *glauca* have 4-6 pairs of long, whiplash-like papillae in the dorsal ambulacra. In *G. alcocki* no other papillae are found, while *G. glauca* possess some rudimentary ambulacral papillae both anteriorly and posteriorly. *Hadalothuria* lack the whiplash-like papillae, but has 25-30 rudimentary papillae all along the dorsal and ventro-lateral ambulacra. The second character distinguishing the genera is formed by the position of the mouth. In *Gephyrothuria* the mouth is terminal, in *Hadalothuria* subventral.

The specimens measure from 20 to 35 mm. The skin is brownish and a thin layer of mud adheres to

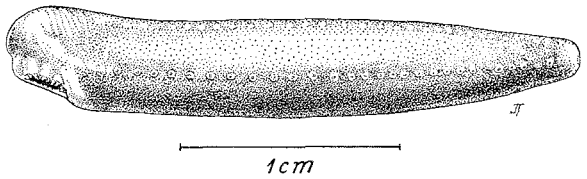

Fig. 19. *Hadalothuria wolffi.* (Julie Tesch del.).

it. The anterior end of the body is dominated by the strongly developed calcareous ring. The width of the body decreases more or less regularly from the head to the anal opening. In a few of the specimens the posterior third or so of the body is rather abruptly set off from the rest, but this is apparently due to contraction, and a tail is never present. The anal opening is terminal.

Along the dorsal and ventro-lateral ambulacra a single row of papillae is found. Each row continues from the head to the anal opening and comprises about 25-30 papillae. They are extremely rudimentary and usually only seen as small white spots when the adhering layer of mud is removed. They are most distinct in the hindmost part of the body; in the anterior part they are only visible in a few of the specimens. The ventro-lateral papillae are better developed than the dorsal ones. The ventral ambulacrum is devoid of papillae.

The calcareous ring is not as usual in the Molpadonia placed vertical to the longitudinal axis of the animal, but has an oblique or even horisontal position. The mouth is consequently placed more or less ventrally. It is partly covered from behind by a fold of the ventral skin. The 15 tentacles (fig. 20) bear a pair of well developed end-digits, and mostly also a pair of rudimentary, proximal papillae. Tentacle ampullae are absent. There is one ventrally placed polian vesicle.

There are 10 firmly united pieces in the calcareous ring (fig. 21). The anterior edge of the ring is provided with 15 pointed processes, the radial pieces carrying 2, the interradial pieces 1 each. The size of the processes and the intervals between them are the same all the ring round, giving the ring a quite regular appearance. The posterior edges of both the radials and the interradials are slightly incurved.

The genital organ consists of a long canal bearing

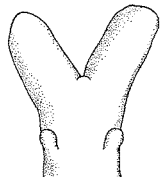

Fig. 20. *Hadalothuria wolffi.* Tentacle.

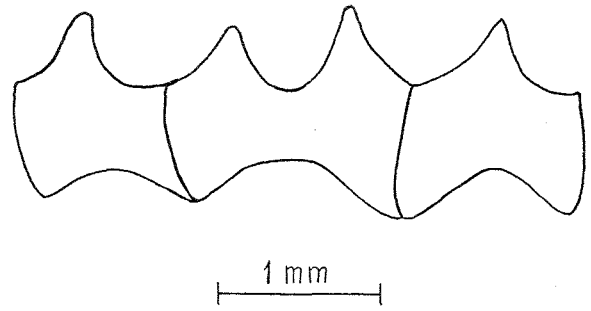

Fig. 21. *Hadalothuria wolffi.* A radial and two interradial pieces of the calcareous ring.

in its posterior part a series of undivided ampullae on each side of the dorsal mesentery. The canal follows the dorsal mid-line and opens anterior to the calcareous ring. The length of the canal is about one fourth of the body-length. No genital papillae are present.

The water lungs form a pair of slender, undivided tubes. They measure about one third of the body length.

The longitudinal muscles are undivided.

Calcareous and phosphatic bodies are completely absent.

The species is named after Torben Wolff, M. Sc., First Zoologist of the Galathea Expedition.

APODA

Myriotrochus bruuni n. sp.

Material:

St. 418, Philippine Trench, 10°13′ N, 126°43′ E, 10190 m, clay with gravel and stones, 96 specimens. St. 419, Philippine Trench, 10°19′ N, 126° 39′ E, 10160-10210 m, clay, 4 specimens. St. 424, Philippine Trench, 10°28′ N, 126°39′ E, 10120 m, brownish clay covering blackish green sand, 1 specimen. St. 517, New Britain Trench, 6°31′ S, 153°58′ E, 8920, 3 specimens.

Typelocality: St. 517. The type, 12 mm long, is preserved in the Zoological Museum of Copenhagen.

Diagnosis: *Myriotrochus* with 10 tentacles and 10 pieces in the calcareous ring. Spicules exclusively wheels, which are scattered all over the body-wall. Number of spokes and teeth in the wheels 12-18 and 25-32, respectively. The spokes without wing-like distensions.

The 9 hitherto known species of *Myriotrochus* may be divided into two groups, one with 12, the other with 10 tentacles. *M. bruuni* belongs to the latter,

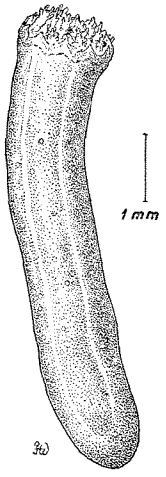

Fig. 22. *Myriotrochus bruuni.* A specimen from the Philippine Trench (Poul H. Winther del.).

together with only two other species, *M. théeli* Østergren (ØSTERGREN 1905a) and *M. minutus* Østergren (ØSTERGREN 1905b).

The specimens from the Philippine Trench are all 7-8 mm long. The specimens from the New Britain Trench are larger, but only one, the type specimen, is complete. This is 12 mm long. The two other specimens lack the posterior end, but since their calcareous rings are of the same size as in the complete specimen, their body-lengths were probably also about 12 mm.

The calcareous ring (fig. 23) consists of 10 pieces, each with an anterior crest and a slightly inwardly curved posterior margin. The crests are a little higher on the radials than on the interradials, but apart from this all the pieces of the ring are similar. The diameter of the ring is 1.9 mm in the small specimens, and 2.9 in the large ones.

There is a single, large polian vesicle.

The spicules are exclusively developed as wheels (fig. 24), which are evenly scattered over the whole of the body-wall. They are placed rather densely together, but do not overlap. Their number is difficult to state, since they are easily rubbed off. The small specimens usually have about 50 wheels; the large, complete specimen from the New Britain Trench has about 250. The wheels measure 0.09-0.10 mm in diameter, both in the small and the large specimens. The rim of the wheel is provided with 25-32 centripetally directed teeth. The number of spokes is 12-18.

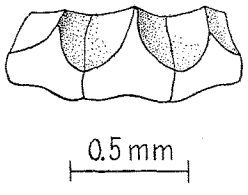

Fig. 23

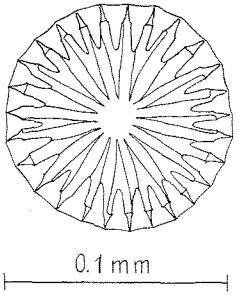

Fig. 24

Fig. 23. *Myriotrochus bruuni.* A radial and two interradial pieces of the calcareous ring from a specimen from the Philippine Trench.

Fig. 24. *Myriotrochus bruuni.* Spicule.

The tentacles are rather robust and bear 4-8 digits on either side. Their shape is very varying with the state of contraction. The fully outstreched tentacle has no end-digit, but on the less outstretched ones the digits form a continuous row from one side to the other.

Myriotrochus bruuni is clearly distinguished from the most nearly related species. *M. théeli* has wing-like, lateral distensions on the spokes, while these are quite circular in cross-section in *M. bruuni.* Moreover, the wheels in *M. théeli* are much more numerous and placed in layers. The number of spokes and teeth in the wheels can not be used to distinguish the species. They are in *M. théeli* 12-15 and 24-30, respectively.

M. minutus is distinguished from all other species of the genus by having calcareous rods in the tentacles. Besides, the wheels are divided into two size-groups and have rudiments of wing-like distensions on the spokes. The number of spokes and teeth is 13-16 and 18-26, respectively.

The species is named after Dr. Anton Fr. Bruun, Scientific Leader of the Galathea Expedition.

GENERAL REMARKS

The material of holothurians collected by the Galathea in the deep sea trenches is of considerable ecological-zoogeographical interest. But also from a purely taxonomical point of view some general conclusions may be drawn from the material.

Taxonomical remarks. The great number of specimens in some of the species gives valuable information concerning the variability of some characters much used in holothurian taxonomy. This was already mentioned under the respective species. Here should again be stressed the variability of the dorsal veil and of the calcareous bodies. The different forms of the veil of *Periamma naresi* (fig. 8) prove that this character should be used with great care in the taxonomy of the holothurians. Similarly, the study of the spicules in numerous specimens of

Peniagone vedeli and *Elpidia glacialis* revealed a great variability in this character also, in *E. glacialis* with a tendency to geographical differentiation. Generally, a greater amount of intraspecific variation should be allowed to the calcareous bodies, than has often been the case. Not a few species of holothurians were undoubtedly separated on the basis of too small differences in their spicules.

Zoogeographical remarks. The zoogeography of the deep sea is subject to fairly divergent opinions. EKMAN (1953) suggests that a cosmopolitan distribution is the exception even for the extremely abyssal species and proposes the division of the deep sea into an atlantic and an indo-pacific region. MADSEN (1951a, 1951b), on the contrary, finds that the distribution of the deep sea Asteroidea and Ophiuroidea rather suggests the division into an atlanto-indian and a pacific region. The Holothurioidea, according to MADSEN (1953), does not clearly support either of these opinions.

The few species dealt with in this paper do not add much to the discussion. Nevertheless, it might be justified to undertake a critical review of these species in regard to their taxonomy and zoogeography.

A thorough taxonomical knowledge of an animal group is a necessary basis of any zoogeographical conclusion. Of the deep sea holothurians a third of the species is known in one specimen only, and few are known in so many specimens and localities that their taxonomical relations are definitely settled. Many endemisms have falsely been indicated by too few finds. A better knowledge of the deep sea holothurians may reveal many synomyms among them and prove that many of them have a cosmopolitan distribution.

The species from the deep sea trenches seem already to point in this direction. Leaving out of account the new species, their distributions are as follows:

Elpidia glacialis. Cosmopolitan, with preponderance in the North Polar Basin and some of the deep sea trenches.
Periamma naresi. Outside the Sunda Trench known only in one specimen south of Australia.
Scotoplanes globosa. Cosmopolitan. Known from the Pacific, the Antarctic Sea south of the Indian Ocean, from south-west of Cape of Good Hope, and from off the Gold Coast.
Benthodytes sanguinolenta. Known from several stations in the Pacific and Indian Ocean. The specific delimitation of the species is not quite clear, and some specimens from the Atlantic previously recorded as *B. typica* might belong to *B. sanguinolenta*.
Euphronides verrucosa. Known from four stations in the eastern and central Pacific, from the Banda Trench, and from the Bay of Bengal. This species is well-defined and may for the present be regarded as the safest indo-pacific species among those dealt with in this paper.
Mesothuria murrayi. According to DEICHMANN (1930) a pacific species. It is, however, not very clearly distinguished from the atlantic species *M. maroccana* and *M. rugosa*.
Pseudostichopus villosus. Cosmopolitan.
Ceraplectana trachyderma. Outside the Banda Trench recorded from only 2 stations in the Pacific.

As will be seen from the list most of the species are not very suited for drawing zoogeographical conclusions. *Benthodytes sanguinolenta* and *Mesothuria murrayi* are too insufficiently known in regard to their taxonomy, and *Ceraplectana trachyderma* and *Periamma naresi* are known from too few localities, to allow any safe conclusion as to their distributions. Of the remaining 4 species, *Euphronides verrucosa* seems to be indo-pacific, while *Elpidia glacialis, Scotoplanes globosa,* and *Pseudostichopus villosus* seem to be cosmopolitan, the two latter with the exception of the arctic basin.

Vertical distribution. Whether the deep sea trenches in their faunas possess endemic elements, is a question of considerable interest, both from an ecological and a zoogeographical point of view. It is, however, very difficult to answer on the basis of the scarce knowledge which we have as yet of the deep sea fauna. We can not safely conclude that the new species taken by the Galathea in the trenches are restricted to these. A better knowledge of the general abyssal fauna might prove that they are found at lower depths also.

Of the 8 species which were previously taken outside the trenches, 5 were known from depths less than 1000 m, thus showing a strikingly wide vertical distribution. *Elpidia glacialis* was found in shallow water only in the Arctic. Similarly, the finds of *Scotoplanes globosa* at 545 and 970 m were from high latitudes, off the northern Japan at temperatures of 1°,6-2°,2 C. These two species may be regarded as examples of the wellknown equatorial submergence

The holothurians taken by the Galathea Expedition at depths exceeding 6000 m

Species	Philippine Trench				Sunda Treneh		Banda Trench				New Britain Trench		Kermadec Trench				
	St. 418 10190 m	St. 419 10160–10210 m	St. 424 10120 m	St. 435 9790 m	St. 465 6930–7000 m	St. 466 7130–7160 m	St. 494 7280 m	St. 495 7250–7290 m	St. 497 6490–6650 m	St. 499 6580 m	St. 517 8920 m	St. 521 8810–8940 m	St. 649 8210–8300 m	St. 650 6620 m	St. 651 6960–7000 m	St. 653 6140–6160 m	St. 658 6660–6720 m
Elpidia glacialis	–	–	–	–	7	c. 3000	–	–	–	–	14	63	c. 1800	1	–	–	–
Periamma naresi	–	–	–	–	–	114	–	–	–	–	–	–	–	–	–	–	–
Scotoplanes globosa	–	–	–	–	–	–	–	–	–	–	–	–	–	31	–	1	17
Scotoplanes galatheae	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–
Peniagone vedeli	–	–	–	–	–	–	–	–	–	–	–	–	160	260	6	1	c. 600
Benthodytes sanguinolenta	–	–	–	–	–	–	–	5	3	–	–	–	–	–	–	–	–
Euphronides verrucosa	–	–	–	–	–	–	–	3	1	–	–	–	–	–	–	–	–
Mesothuria murrayi	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
Paroriza grevei	–	–	–	–	–	–	1	16	1	–	–	–	–	–	–	–	–
Pseudostichopus villosus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5	–	30
Ceraplectana trachyderma	–	–	–	–	–	–	–	–	5	1	–	–	–	–	–	–	–
Hadalothuria wolffi	–	–	–	–	–	–	–	–	–	–	1	13	–	–	–	–	–
Myriotrochus bruuni	96	4	1	–	–	–	–	–	–	–	3	–	–	–	–	–	–

of cold-water animals. On the other hand, *Benthodytes sanguinolenta, Pseudostichopus villosus,* and *Mesothuria murrayi* were taken at depths less than 1000 m in the tropical seas.

The remaining 3 previously known species were only recorded from the abyssal part of the ocean. *Periamma naresi* was taken at 3292 m, *Euphronides verrucosa* at 2404-4478 m, and *Ceraplectana trachyderma* at 3188 and 5173 m.

The number of new species in the material is remarkably high, even if we take into account the limited knowledge we have of the deep sea fauna. Moreover, it is remarkable that the new species especially were found at the greatest depths. The two species from the Philippine Trench were both new to science, and one of them, *Myriotrochus bruuni,* was furthermore refound in the New Britain Trench, here living together with another new species. The relatively many new species together with the preponderance of these at the greatest depths, seems to indicate a certain endemism in the trenches.

On the other hand, the distribution of *Elpidia glacialis* is very instructive. This species, which is a dominating one in the Sunda, Kermadec, and New Britain Trenches, was so rarely found outside the arctic basin that the records were doubted. It has now proved to be a cosmopolitan species, which under the extreme conditions in the deeps, as well as in the arctic basin, develops as a type species.

Something similar is possibly the case with some of the new species from the deeps: They may be widely distributed and only be especially abundant in the deeps. The faunas of the trenches might then be endemic to a less degree, and should rather be regarded as an extract of the general abyssal fauna. Only few abyssal species are able to penetrate into the trenches, but the few which do, as a consequence attain a great abundance in individuals.

As appears from the table, most of the species were taken at more than one station. *Elpidia glacialis* and *Myriotrochus bruuni* were even common to different deeps. The refind of the same species in different localities indicates that the species taken by the Galathea form an essential fraction of the total number of species in the deeps. Similarly, the richness in number of specimens of several of the species indicates a low total number of species; the number of specimens and the number of species may be supposed to be inversely correlated.

If it holds good that only a part of the abyssal fauna is able to subsist in the trenches, these might in consequence in the course of time develop endemic elements. A species, which becomes extinct in the general abyssal fauna, may survive in the deeps on account of the absence of competitors. Later, the species isolated in this way might evolve adaptations to the life at the great depths, so that not only competitional conditions, but also special adaptions to the life in the trenches will prevent them from leaving these.

An isolation of a species in different deeps may be supposed to be followed by a geographical subspeciation. On the other hand, clear morphological differences between the populations of different

deeps may probably occur without any isolation. *Elpidia glacialis* shows subspecific differences between the populations of the Sunda, Kermadec, and New Britain Trenches. But the subspecies from the Sunda Trench was nevertheless found south of Australia also, and, moreover, the subspecies from the Tasman Sea is as well characterized as those from the trenches.

No differences were found between the *Myriotrochus bruuni* from the Philippine Trench and that from the New Britain Trench.

To sum up, it is not possible at present to decide, whether the deep sea trenches contain species, which are not found outside these. But the investigations of the Galathea Expedition proved nevertheless that the trench faunas are well characterized as against the general abyssal fauna, and, moreover, that the faunas of different trenches have some features in common.

Postscript

In a small, preliminary paper from a Russian deep sea expedition to the north-western part of the Pacific P. V. Uschakov (Isutschenie glubokovodnoi fauni, Priroda no. 6, pp. 100-102, 1952) among other animals mentions two species of holothurians taken in the south-eastern part of the Kurile Trench in 1949 at a depth of 8100 m.

One of them was *Elpidia glacialis,* taken in about a hundred specimens. The specimens are not described in the text, except that they are stated to be up to 5 cm long. A portrayed specimen, reproduced here, shows, however, four pairs of small, fairly regularly distributed dorsal papillae. The similarity to the specimens from the New Britain and especially to those from the Kermadec Trench is striking. *Elpidia glacialis kermadecensis* had usually five, but occasionally four or six pairs of papillae. It would be interesting to know the number of papillae in the rest of the specimens from the Kurile Trench.

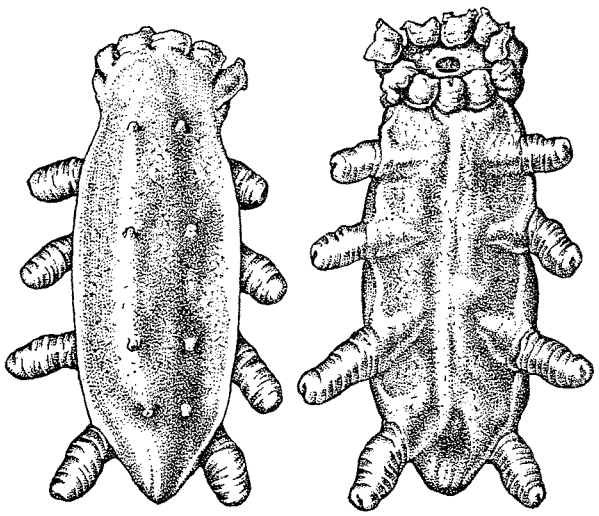

Fig. 25. *Elpidia glacialis.* (From Uschakov 1955).

Besides *E. glacialis* three specimens of an unidentified species of *Pseudostichopus* was taken. In the Galathea material this genus was represented by *P. villosus* which occurred in the Kermadec Trench down to a depth of 7000 m.

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