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## NOTES ON RHIZOCEPHALA INFESTING SPECIES OF THE ANOMURAN GENUS GALATHEA

by

H. BOSCHMA

During the work of the Ecological Survey of the University of Cape Town a few Crustacea of various groups were collected which proved to be infested with Rhizocephalan parasites. Remarks on one of these, a parasite of *Galathea dispersa* Bate, are given in the present paper, while notes are added on the data from the literature and on the structure of some other specimens<sup>1</sup>).

The Rhizocephala occurring as parasites of species of the genus *Galathea* belong to the genera *Triangulus* and *Lernaeodiscus* (family Lernaeodiscidae) or to the genus *Galatheascus* (family Peltogastridae). Moreover, one species of the genus *Sacculina* is known as a parasite of a *Galathea*, while *Parthenopea subterranea* Kossmann, a species usually infesting *Callinassa*, has been reported as a parasite of *Galathea dispersa*. The following is a review of the literature on the parasites here dealt with, the scientific names are recorded as they were used in the cited papers.

Gerbe (1862). Records of parasites ("*Sacculina*, ou *Peltogaster*") of *Carcinus moenas*, *Xanthus floridus*, *Portunus marmoreus*, and *Galathea squamifera*, apparently from the Atlantic coast region of France. No characters noted of the adult parasites, the larvae are stated to show specific differences. Perhaps the first (unnamed) record of *Lernaeodiscus squamiferae* Pérez, 1922.

Stuxberg (1873). "*Pachybdella Carcini*" mentioned as a parasite of various Brachyura and of *Galathea squamifera*, the last record obviously based on Gerbe (1862).

Milne Edwards & Bouvier (1900). One female specimen of *Galathea squamifera* Leach "sacculinée", from Lanzarote, Canary Islands, depth 30 m; two female specimens of *Galathea intermedia* Lilljeborg "sacculinées", the one from north of the Banc d'Arguin, Mauretania, depth 235 m, the other from the Cape Verde Islands, depth 318 m. Possibly

1) I want to express my thanks to Professor J. H. Day, who kindly placed the South African specimens at my disposal, to Dr. R. Zariquiey Alvarez for the specimen of *Galatheascus minutus* from Cadaqués, and to Dr. L. B. Holthuis for the specimen of *Lernaeodiscus strigosae*.

the parasite of *Galathea squamifera* was *Lernaeodiscus squamiferae* Pérez, 1922. The parasite of *Galathea intermedia* from off the Banc d'Arguin was examined by Guérin-Ganivet (1911), and proved to be *Danalia ypsilon* Smith, 1906, a parasitic Isopod. In 1911 the other specimen, from the Cape Verde Islands, was not to be found; its identity therefore remains uncertain (*Danalia ypsilon* Smith, *Triangulus galathea* (Norman & Scott), or *Galatheascus minutus* Boschma?).

Scott (1901). Record of "*Sacculina* sp. On abdomen of *Galathea dispersa*, Clyde, 1895-1896". Probably either *Triangulus galathea* (Norman & Scott) or *Galatheascus minutus* Boschma.

Norman & Scott (1906). Description of a new species (l.c., p. 226): "*Sacculina galathea*, sp. n. We give this name to a little form found on the abdomen of *Galathea intermedia*, taken off Plymouth in 1889. There is little or no character in the species of this genus; but it can hardly be supposed that the very small form found on *G. intermedia* can be the same as that which is common on *Carcinus maenas*". The type specimen is in the collection of the British Museum. The name dates from the first part of the year 1906: "The copy of the cited book in the British Museum (Natural History) has been there since April 1906, and, as the monograph on the Rhizocephala by Smith (1906) had not appeared before August of that year, it is evident that the species should be named *Lernaeodiscus galathea* (Norman & Scott)" (Boschma, 1933, p. 546).

Smith (1906). In the genus *Lernaeodiscus* are placed besides the type species, *L. porcellanae* Müller (host "*Porcellana*" spec. from Brazil), *L. papilio* (Kossmann) (host "*Porcellana*" spec. from the Philippine Islands), and two parasites of species of the genus *Galathea*. Of the first of these the characters are: "*L. galathea*. Hosts, *Galathea dispersa* at Naples, *Galathea intermedia* from Norway. Visceral mass yellow; lappets of mantle inconspicuous and irregular. Anterior hinge of mesentery not very wide" (l.c., p. 114). The characters of the second are: "*L. strigosae*. Host *Galathea strigosa* from Naples. Visceral mass yellow; lappets of mantle inconspicuous. Anterior hinge of mesentery very wide. Much larger than *L. galathea*" (l.c., p. 114). Smith (1906, p. 115) further adds: "Remarks. Relying on the position of the mesentery, the lateral expansions of the mantle, and the nature of the host, I have placed all these forms in MÜLLER's genus *Lernaeodiscus*, but the main features of the anatomy from which the diagnosis of the genus is made, are drawn from a careful study of *L. galathea* alone, which is fairly common at Naples". Figures of the external shape and the internal organisation of *L. galathea* on *Galathea dispersa* are found on Plate 7 of the cited work.

Pérez (1908). In the Bay of Biscay, off Arcachon, at a depth of about 110 m, five specimens of *Galathea dispersa* were obtained bearing the parasite *Lernaeodiscus galathea* Smith. According to Pérez it is not certain that the parasites of *G. dispersa* and of *G. intermedia* belong to the same species; if they might prove to be different the name *L. galathea* should remain with the parasite of *G. dispersa*, the form figured by Smith.

Kollmann (1909a). Record of a specimen of *Parthenopca* on *Galathea dispersa*; probably this parasite belonged to the species later described as *Galatheascus minutus* Boschma, 1933, as a parasite of *G. intermedia* and *G. nexa*. At Saint-Vaast-la Hougue (Normandy) *Lernaeodiscus galathea* was found to occur fairly commonly on *Galathea intermedia*.

Kollmann (1909b). Note on the occurrence of *Lernaeodiscus galathea* as a parasite of *Galathea intermedia* at Saint-Vaast-la Hougue (Normandy) and at Banyuls (Pyrénées Orientales). Remarks on the internal structure of *Lernaeodiscus*, supplementing and partly correcting those of Smith (1906).

Hoek (1909). *Lernaeodiscus galathea* on *Galathea intermedia* from shallow water off the coast of Norway; data based on Smith (1906).

Stephensen (1910). Record of *Lernaeodiscus galathea* as a parasite of *Galathea intermedia* in Danish waters.

Guérin-Ganivet (1910). Note on the occurrence of *Lernaeodiscus galathea* Smith in the Bay of Biscay, according to Pérez (1908).

Guérin-Ganivet (1911). Lists specimens of *Lernaeodiscus galathea* Smith on *Galathea dispersa* from the Bay of Biscay or the adjacent part of the Atlantic Ocean, collected by the "Caudan" in 1710 and 400-500 m; moreover a specimen from Saint-Vaast-la Hougue from unknown depth, collected by Bouvier. No data on the external shape or the internal organisation of the parasites. Guérin-Ganivet examined a specimen on *Galathea intermedia* from the collections of the "Talisman", which was a parasitic Isopod (see note on Milne Edwards & Bouvier, 1900).

Smith (1915). Notes on the internal organisation of *Lernaeodiscus galathea*, in accordance with remarks by Kollmann (1909).

Pérez (1922). The name *Lernaeodiscus squamiferae* given to a parasite of *Galathea squamifera* from Villefranche-sur-Mer (Alpes Maritimes). The parasite had a wine-red colour; no other characters are noted indicating differences from *L. galathea*.

Cuénot (1927). A reference to the occurrence of *Lernaeodiscus galathea* Smith in the Bay of Biscay (cf. Pérez, 1908).

Boschma (1927). Notes on *Lernaeodiscus galathea* Smith, based on examination of specimens on *Galathea intermedia* from the Kattegat. *L. strigosae* Smith regarded as a doubtful species.

Boschma (1928). Description and figures of specimens of *Lernaeodiscus galathea* Smith on *Galathea intermedia* from the Kattegat. Specific differences between *L. galathea* and *L. strigosae* are considered doubtful.

Boschma (1929). Description of *Galatheascus striatus* (family Peltogastridae), a parasite of *Galathea strigosa* from off Plymouth.

Boschma (1931). Description of *Sacculina flacca*, a parasite of *Galathea* spec. from Banda, East Indies. The straight dorso-ventral course of the male organs, the colleteric glands with a system of tubes, and the thin dorsal mesentery prove that the specimen belongs to the genus *Sacculina*.

Boschma (1933). *Lernaeodiscus galathea* (Norman & Scott) on *Galathea intermedia* from Plymouth (type specimen in collection Norman), on *G. nexa* from the Firth of Forth, and on *G. dispersa* from Naples (host erroneously recorded as *G. nexa*, the two names considered synonyms). *Galatheascus striatus* on *Galathea strigosa* from off Plymouth and from Port Erin, Isle of Man. Description of *Galatheascus minutus*, hosts *Galathea intermedia* from off Valentia, Ireland, and *Galathea nexa*, from Oban, Scotland.

Stephensen (1933). Record of *Lernaeodiscus galathea* Smith as a parasite of *Galathea intermedia* in Danish waters.

Brinkmann (1936). Remarks that Smith (1906) described *Lernaeodiscus galathea* as a parasite of *Galathea intermedia* and *dispersa*, and a more doubtful species, *L. strigosae*, as a parasite of *Galathea strigosa*. Brinkmann places the species *L. galathea* Smith in the genus *Triangulus*. He remarks that the parasites of *G. strigosa* which were found in later years belong to a different, unrelated genus, *Galatheascus*. In a note (l. c., p. 41) he observes that the genus *Parthenopea* probably does not belong to the family Lernaeodiscidae, as it seems to show affinities with the genus *Galatheascus* of the family Peltogastridae.

Van Baal (1937). The genus *Lernaeodiscus* restricted for the species which are internally and externally symmetrical, and have the male genital openings on either side of the ventral mesentery (*L. porcellanae* Müller, *L. ingolfi* Boschma, *L. okadai* Boschma). For the internally asymmetrical species (whether externally symmetrical or not) the genus *Triangulus* Smith is emended in so far as to include *Triangulus galathea* (Norman & Scott), in accordance with Brinkmann's (1936) views. As far as the other Lernaeodiscid parasites of species of the genus *Galathea* are concerned (*Lernaeodiscus strigosae* Smith and *L. squamiferae* Pérez) the opinion is given that the two names possibly are synonyms of *Triangulus galathea* (l. c., p. 81).

Bouvier (1940). Specific characters of *Galathea dispersa* Bate, *G. nexa* Embleton, *G. squamifera* Leach, *G. intermedia* Lilljeborg, and *G. strigosa* (Linnaeus); previously

various authors had regarded the names *G. dispersa* and *G. nexa* as synonyms. No parasites of species of the genus *Galathea* are mentioned in the cited work.

Macdonald (1941). Record of *Galatheascus striatus* from the Isle of Man.

Veillet (1943a, 1943b). Notes on the larvae of *Lernaeodiscus galathea* Norman & Scott, occurring as a parasite of *Galathea intermedia* at Sète, Mediterranean coast of France.

Veillet (1945). Elaborate notes on *Triangulus galathea* as a parasite of *Galathea intermedia* from Sète. Moreover *Triangulus galathea* is mentioned as having been found at Villefranche-sur-Mer on *Galathea squamifera* by Pérez (oral communication, l. c., p. 307), undoubtedly this record refers to the specimen named *Lernaeodiscus squamiferae* by Pérez (1922). At Sète, Veillet (l. c., p. 319) found one specimen of *Galathea dispersa* with a parasite indicated with the name *Galatheascus striatus*.

Boschma (1946). Notes on a specimen of *Lernaeodiscus squamiferae* Pérez from Norway, host *Galathea squamifera*. The parasite is externally and internally symmetrical. Perhaps it is specifically identical with *Lernaeodiscus ingolfi* Boschma, 1928, as restricted by Brinkmann (1936), known to infest three species of the genus *Munida*.

Boschma (1947). *Triangulus galathea* (Norman & Scott) on *Galathea intermedia* in the southern part of the North Sea and in the Strait of Dover. In the same region *Galatheascus minutus* occurs as a parasite of the same host.

Dahl (1949). The bathymetrical range of the species *Lernaeodiscus galathea* recorded as 0-1710 m.

Veillet (1951). Larvae of *Triangulus galathea* from Sète.

To determine the valid names of the Rhizocephala occurring on species of the genus *Galathea* the following must be taken into account.

In the Official Record of Proceedings of the International Commission on Zoological Nomenclature at its Session held in Paris in July, 1948, the Commission agreed to recommend (Conclusion 21 of Ninth Meeting): "that words should be inserted in the *Règles* to make it clear that the citation of the name of the host species of a parasitic species, unaccompanied by any other particulars does not constitute an "indication" for the purposes of Article 25 but that the provision regarding the significance of the citation of a type locality in an original description which at the meeting noted in the margin they had agreed to recommend should be inserted in the *Règles* should be expanded to cover also the citation, in the case of a parasitic species, of the name of the host species". (Bull. Zool. Nomencl., vol. 4, 1950, p. 256).

According to this conclusion it remains doubtful whether in all instances the oldest name of the parasite is nomenclatorially valid. On the base of the principle of priority the names of the species here dealt with, their typical hosts and type localities are as follows.

1. *Triangulus galathea* (Norman & Scott, 1906), typical host *Galathea intermedia* Lilljeborg, type locality off Plymouth.
2. *Lernaeodiscus strigosae* Smith, 1906, typical host *Galathea strigosa* (Linnaeus), type locality Naples.
3. *Lernaeodiscus squamiferae* Pérez, 1922, typical host *Galathea squamifera* Leach, type locality Villefranche-sur-Mer.

4. *Galatheascus striatus* Boschma, 1929, typical host *Galathea strigosa* (Linnaeus), type locality off Plymouth.

5. *Galatheascus minutus* Boschma, 1933, typical host *Galathea nexa* Embleton, type locality Oban, Scotland.

Remarks.

1. The work of Norman & Scott (April, 1906 or earlier) has priority against the work by Smith (August, 1906, or later). Norman & Scott characterize their specimen of "*Sacculina galatheae*" as a parasite of *Galathea intermedia*, adding that it can hardly be supposed that this very small form can be the same as that which is common on *Carcinus maenas*. Though the specimen later proved to be conspecific with *Lernaeodiscus galatheae* Smith, the original notes of Norman & Scott are hardly sufficient for an "indication" of specific characters, especially because the small size also applies to *Galatheascus minutus*, another parasite of *Galathea intermedia*. If the notes of Norman & Scott are considered insufficient for a specific indication the data must read "*Triangulus galatheae* (Smith, 1906), typical host *Galathea dispersa* Bate, type locality Naples". Because similar difficulties arise concerning certain species of Sacculinidae, to which specific names were given without indication of characters, the oldest name is here used.

2. Smith's two species *Lernaeodiscus galatheae* and *L. strigosae* correspond in having the visceral mass yellow and the lappets of the mantle inconspicuous. While in *L. galatheae* the "anterior" hinge of the mesentery is "not very wide", this hinge is "very wide" in the much larger *L. strigosae*. Though being a character of doubtful value this difference constitutes an "indication" for a specific difference. The large parasite infesting *Galathea strigosa* is here indicated with the name *Lernaeodiscus strigosae* because the specimen dealt with in the present paper is externally and internally symmetrical (figs. 7, 8), though one of the male organs is much larger than the other.

3. In the original note on the specimen indicated with the name *Lernaeodiscus squamiferae* the colour is described as wine-red (Pérez, 1922). This single fact may serve as an "indication" of specific characters, for the two other *Lernaeodiscidae* known from the Mediterranean (*galatheae* and *strigosae*) both have the visceral mass yellow (Smith, 1906). A specimen of *Lernaeodiscus squamiferae* from Norway proved to be internally symmetrical (Boschma, 1946). Unfortunately besides the name of the host the wine-red colour is the only indication of a character for the original specimen of *L. squamiferae*. This colour might perhaps indicate that the specimen was a *Parthenopca*, which is characterized as having a red colour (Smith, 1906, p. 110), though Reverberi (1943, p. 289) describes the colour of

*Parthenopea* as bright orange ("il sacco esteriore è, invece, di colore arancio vivo"). Taking into account that Kollmann (1909a) records the occurrence of *Parthenopea* on *Galathea dispersa*, it is not altogether inconceivable that Pérez's specimen was a *Parthenopea*. In all probability, however, Kollmann identified his specimen as a *Parthenopea* because the mantle opening was found on one extremity of the body, pointing sideways in respect to the long axis of the host. To all appearance Kollmann's specimen belonged to the later described genus *Galatheascus*, known as a parasite of several species of the genus *Galathea*, and perhaps also the wine-red parasite mentioned by Pérez was a representative of this genus. On the other hand the red colour of the parasite of *Galathea squamifera* does not exclude its possible identity as a member of the Lernaediscidae, for one species of this family, *Triangulus munidae* Smith, known as a parasite of three species of the genus *Munida*, has a vividly yellowish red or red colour (Brinkmann, 1936, p. 48). The specimen from Norway identified with *L. squamiferae* had been preserved in alcohol for a long time, no data being available to determine its original colour. In the description of the specimen (Boschma, 1946, p. 733) the close resemblance to *Lernaediscus ingolfi* is noted, a species that in the living state is completely colourless or whitish (Brinkmann, 1936, p. 42).

4. The only character indicating that *Galatheascus striatus* is specifically different from the later described *G. minutus* is the large size, the type specimen having a length (antero-posterior diameter) of nearly 20 mm, and a height (dorso-ventral diameter) of about 8 mm (cf. Boschma, 1929, fig. 1). The largest known specimen of *G. minutus* has an antero-posterior diameter of  $6\frac{3}{4}$  mm (Boschma, 1947, p. 2). In the description of *G. striatus* the shallow grooves over the surface of the mantle are mentioned as a specific character; these grooves, however, also may occur in *G. minutus*, e. g., in specimen from Cadaqués (fig. 1b in the present paper). As a specific difference I further noted for *G. striatus*: "Stalk in the anterior half of the body", and for *G. minutus*: "Stalk in the median region of the body" (Boschma, 1933, pp. 475/476). As in the specimen of *G. minutus* from Cadaqués the stalk is found slightly before the middle of the body, perhaps the situation of the stalk is variable also in *G. striatus*. Retinacula are known to occur in the larger species only; this fact cannot be regarded as a specific character, for in *G. minutus* the retinacula may have escaped notice on account of the small size of the animal.

5. The only specific character of *Galatheascus minutus* is its small size, the larger diameter rarely exceeding 6 mm. The specimens identified with this name show among each other considerable variation in external appearance and in the structure of the internal organs, especially the male

genital organs. Some data in the original description of *Galatheascus minutus* need rectification. Dr. E. G. Reinhard (personal communication) detected an error that might lead to confusion: "The closed end of the testes is directed towards the posterior extremity of the body" (Boschma, 1933, p. 478); instead of "posterior" the term "anterior" ought to have been used. The description of the species contains still another error, which has already led to complications. On page 477 of the cited paper figure 2 represents a section of the small specimen on *Galathea intermedia*, figure 3 a section of the larger specimen on *Galathea nexa*, the names of the hosts having been interchanged in the captions of the figures. I was not aware of this mistake when in my 1947 paper I wanted to designate the best preserved specimen as the type of the species, and, accordingly, indicated as the type the specimen on *Galathea intermedia*. Correction of the error in the captions of the figures leads to a selection of the specimen on *Galathea nexa* as the type of the species. The specimen on *Galathea intermedia* (Boschma, 1933, fig. 2) is so poorly preserved that the male organs had become detached from their immediate surroundings. On the other hand in the specimen on *G. nexa* (l. c., fig. 3) the visceral mass, though having suffered some slight damages, as a whole has remained in its original state, enabling an examination of the male organs in situ. It stands to reason that the last mentioned specimen should be the type of the species, *Galathea nexa* then becoming the typical host, and Oban, Scotland, the type locality.

The following notes are based on an examination of four specimens of *Galatheascus minutus*, showing among each other a certain amount of variation. The data of the localities, etc., are:

Host *Galathea nexa* Embleton, locality Oban, Scotland (1877, collection Norman, British Museum), type specimen of *Galatheascus minutus*; measurements: length 5, height (dorso-ventral diameter, not including the stalk) 3, breadth 2 mm.

Host *Galathea intermedia* Lilljeborg, locality off Cape Gris-Nez, Strait of Dover (June 4, 1908, from the collection of the Brussels Museum); measurements: length 5, height and breadth about  $2\frac{1}{2}$  mm.

Host *Galathea dispersa* Bate, locality Cadaqués near Barcelona, received from Dr. R. Zariquiey Alvarez; measurements: length  $5\frac{1}{2}$ , height 2, breadth nearly 3 mm.

Host *Galathea dispersa* Bate, locality  $34^{\circ} 19.6' S$ ,  $18^{\circ} 30.5' E$ , depth 55 m (University of Cape Town Ecological Survey, TRA. 130 Q, March 10, 1957); measurements: length nearly  $6\frac{1}{2}$ , height  $4\frac{3}{4}$ , breadth about 2 mm.

The specimen from Cadaqués (fig. 1a, b) has a narrow mantle cavity without eggs; the mantle itself, especially in the ventral part, is somewhat contracted, showing a number of rather deep transverse grooves. The region of the very narrow mantle opening protrudes as a small tube at the anterior extremity. The centre of the short stalk lies at a distance of about two-fifths

of the total length from the anterior extremity (tubular mantle opening not included), the stalk is connected to an oval dorsal shield of one-third the total length of the body. Apparently owing to the contraction of the mantle its surface shows, especially in the ventral region, a fine longitudinal striation.

To show the situation of the colleteric glands and the male organs some transverse sections are represented in fig. 2. The first of these (fig. 2a) is

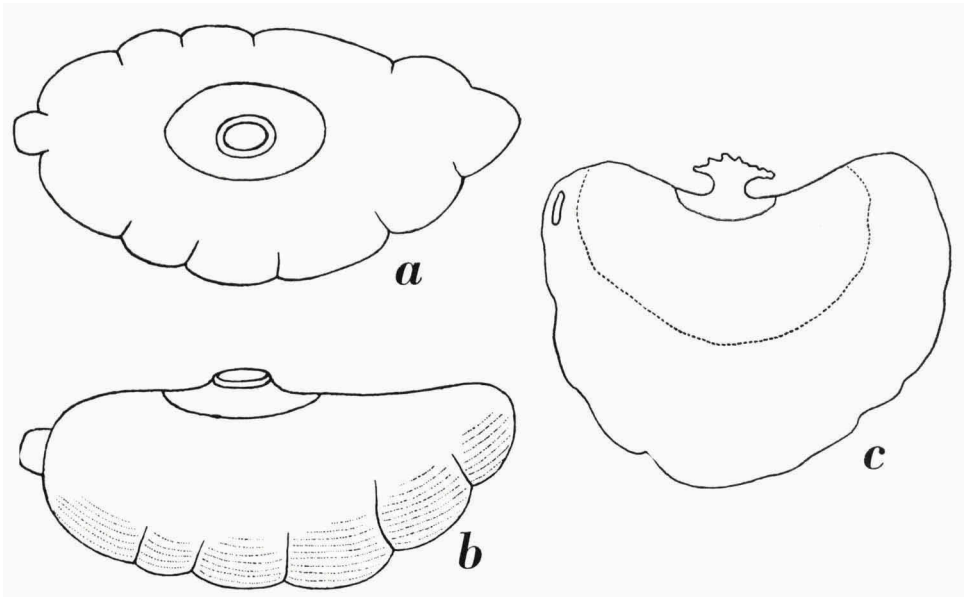


Fig. 1. *Galathecascus minutus* Boschma. a, specimen from Cadaqués, dorsal surface; b, the same specimen, right side; c, specimen from South Africa, right side. a, b,  $\times 12$ ; c,  $\times 8\frac{1}{2}$ .

from slightly before the stalk, the dorsal shield appears as a distinctly thicker part of the external cuticle; here the two colleteric glands are found, each at one side of the visceral mass. The second section (fig. 2b) contains the central part of the stalk, the terminal parts of the two testes (each enclosed in a sac, which does not continue around the vasa deferentia), and, at the left side of the figure, the extreme posterior part of one or two coils of the left vas deferens. The next section (fig. 2c), again through the stalk, contains the two testes, the coiled part of the left vas deferens just before the male opening, and one section of the anterior coil of the right vas deferens. Fig. 2d, slightly behind the previous figure, has, besides the two testes, a strongly coiled part of the left vas deferens just behind the male opening,



one section of the right vas deferens in the vicinity of the right testis, and the terminal somewhat swollen part of the right vas deferens in the immediate neighbourhood of the right male opening. Fig. 2e shows the posterior

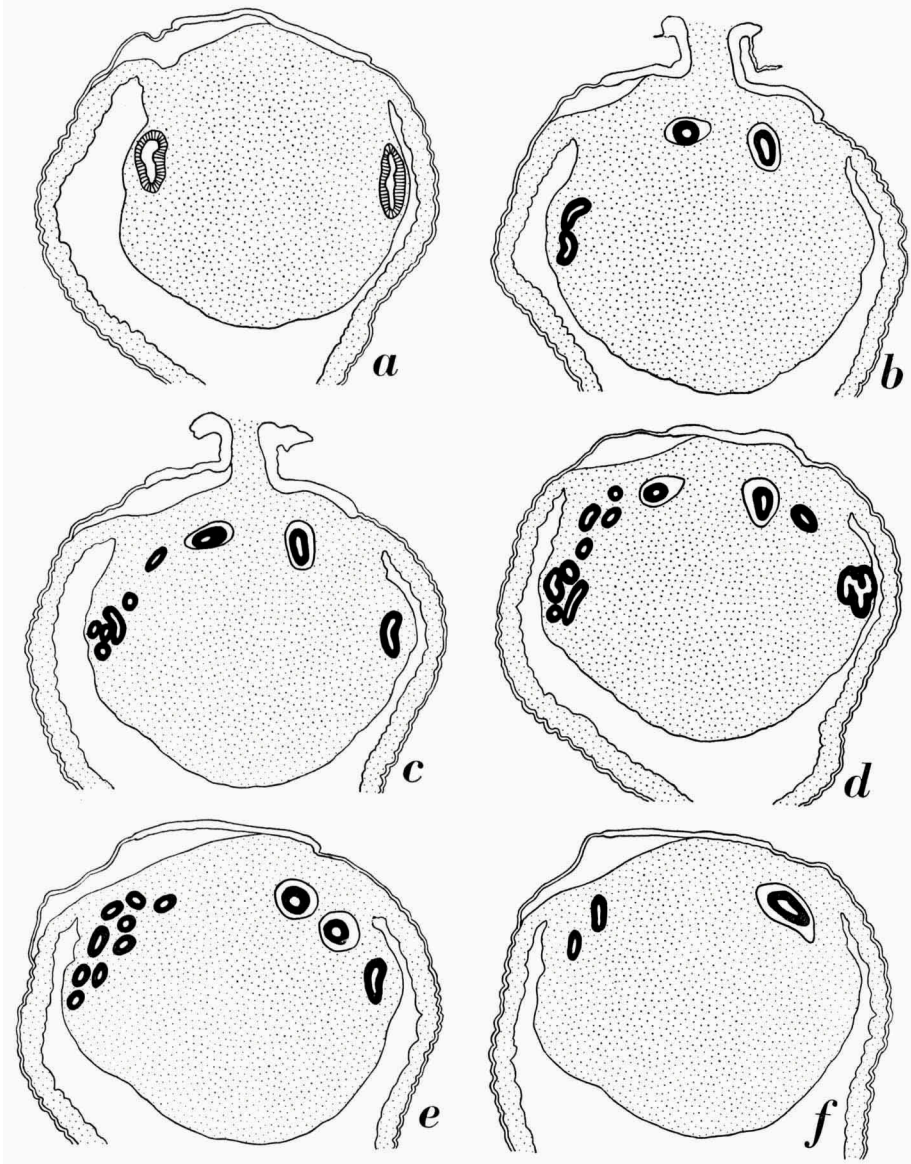


Fig. 2. *Galatheascus minutus* Boschma, specimen from Cadaqués. Transverse sections (ventral part of mantle omitted) of the region of the dorsal shield; a, from the anterior part, each following section farther posteriorly.  $\times 27$ .

part of the coiled region of the left vas deferens, two sections of the slightly curved posterior part of the right testis, and the extreme posterior part of the right vas deferens. Finally, fig. 2f shows the extreme posterior parts of the left vas deferens and of the right testis.

The figures show that the left side of the dorsal shield has become detached from the visceral mass, resulting in an artificial cavity not present in the living animal.

In the specimen from South Africa the wide mantle cavity was completely filled with eggs; these were removed before sectioning, and a drawing was made showing the visceral mass viewed by transparency through the mantle (fig. 1c). The specimen has a peculiar shape, being strongly flattened in a lateral direction, the height thereby becoming more than twice the breadth. The narrow mantle opening, which does not protrude over the surface of the mantle, lies in the dorsal part of the anterior end; the dorsal shield with the short stalk occupies the middle part of the dorsal region. When removing the eggs from the mantle cavity the dorsal shield with the stalk became detached from the rest of the body, the sections thereby in their dorsal region showing an artificial cavity (fig. 3).

The left colleteric gland occurs in some sections through the anterior region of the dorsal shield (fig. 3a), the right colleteric gland lies slightly farther behind (fig. 3b). This figure further shows the terminal parts of the two testes, each enclosed in its own sac. The following drawing, representing a section through the stalk (fig. 3c), shows the posterior parts of the two testes, the anterior end of the strongly coiled left vas deferens, and the anterior part of a strongly coiled part of the right testis, two sections of this organ occurring in a common sac. The section of fig. 3d shows the same organs slightly farther towards the posterior region; in this part of the body the very tortuous left vas deferens opens into the mantle cavity; the section further contains the posterior parts of the straight portions of the two testes, each in its own sac, and a tortuous part of the right testis, the coils being enclosed in a common sac. In fig. 3e there are of the left male organ only a few coils of the vas deferens, of the right male organ a part of the testis and the anterior portion of the vas deferens. Fig. 3f is from the region in which the right vas deferens opens into the mantle cavity. In the middle of fig. 3g there is the tortuous part of the right testis, the coils enclosed in the common sac, while at each side the posterior parts of the two vasa deferentia are to be seen. The last section (fig. 3h) shows the posterior part of the right testis, occurring under the posterior end of the dorsal shield.

In this specimen the left testis is running in a nearly straight course, while in the region of fig. 3d, e it passes into the decidedly tortuous left vas

deferens. The right testis again has a nearly straight course as far as the region of fig. 3e, where it passes into a strongly tortuous part; the right vas deferens also is somewhat tortuous, but is much shorter than the left. The

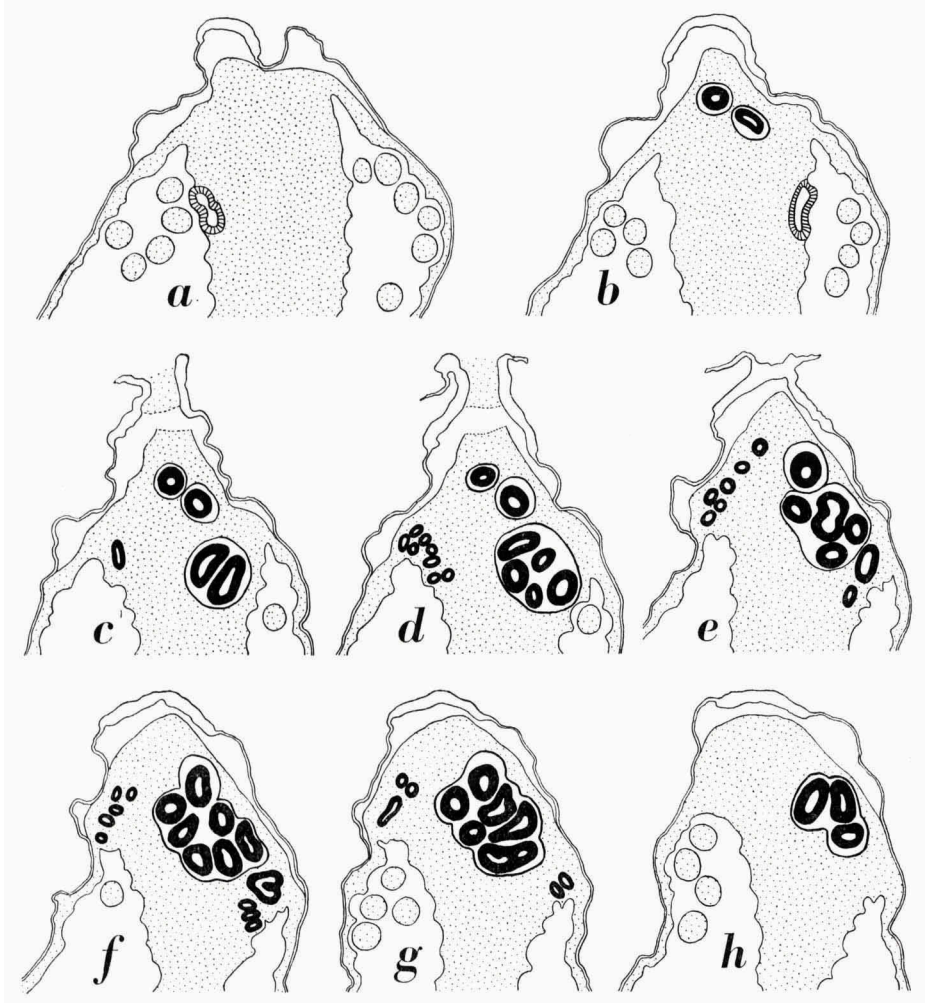


Fig. 3. *Galatheascus minutus* Boschma, specimen from South Africa. Transverse sections (ventral part not represented) of the region of the dorsal shield; a, from the anterior part, each following section farther posteriorly.  $\times 30$ .

coiling of a large part of the right testis leads to a considerable widening of the sac enveloping this testis.

The specimen from the Strait of Dover forms part of the material reported upon in a previous paper (Boschma, 1947, p. 2). It corresponds in

shape with the figured specimen (l. c., fig. 1), being broadly oval, with an inconspicuous mantle opening at the anterior end. The mantle is smooth, without grooves or wrinkles. In the sections the dorsal shield has become detached from the rest of the body. Of this specimen the series of sections

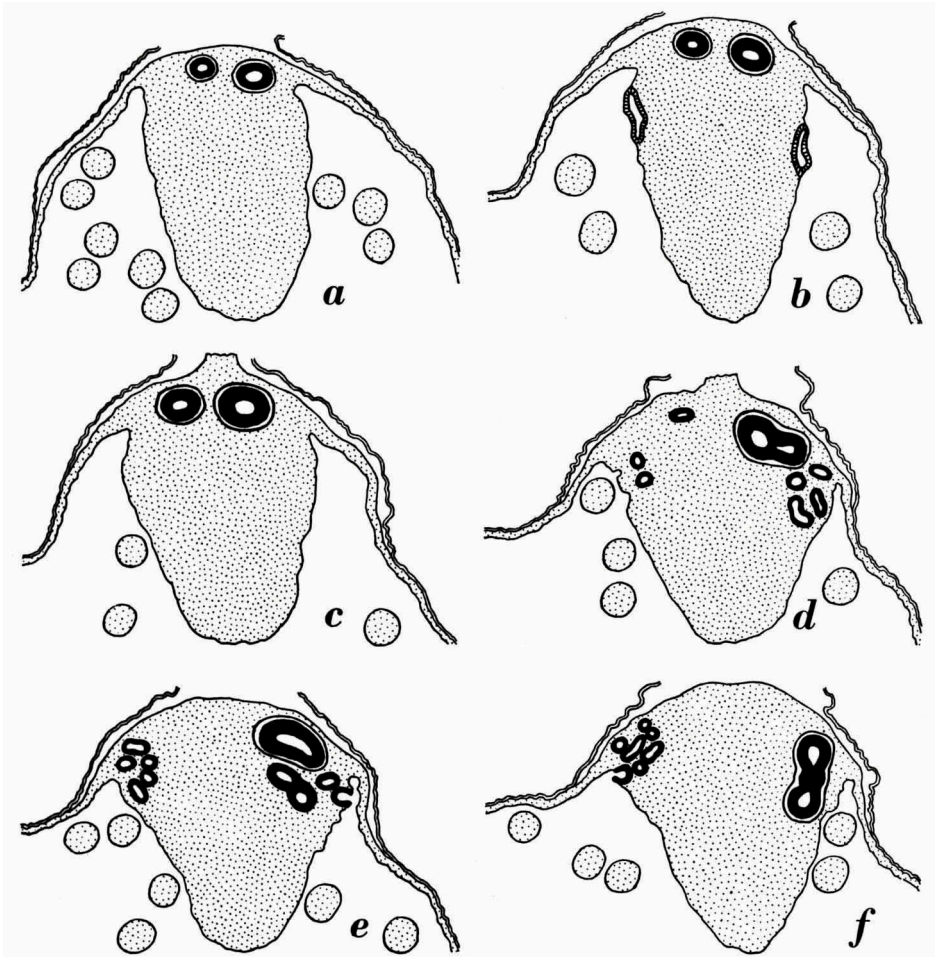


Fig. 4. *Galatheascus minutus* Boschma, specimen from off Cape Gris-Nez. Transverse sections (ventral part of mantle omitted) of the region of the dorsal shield; a, from the anterior part, each following section farther posteriorly.  $\times 36$ .

(fig. 4) commences at the anterior end, so that the left side of the body is on the right side of the figures.

Fig. 4a shows the terminal parts of the two testes. Slightly farther posteriorly (fig. 4b) the two colleteric glands are to be found, both in the dorsal half of the left and right surfaces of the visceral mass. When the testes reach

the region of the stalk they show a slight increase in size (fig. 4c). In the section of fig. 4d the right vas deferens is present, the wide left testis here makes a slight turn, and parts of the somewhat tortuous left vas deferens are to be seen. Fig. 4e shows the left male opening, fig. 4f the right male opening (the chitinous plugs filling these openings omitted). The last coils of the left testis form the extreme posterior part of the left male organ. The width of the sacs enveloping the testes is slightly exaggerated in the figures, in many parts these sacs are closely adhering to the testes.

The parasite from Oban, Scotland, the type specimen of *Galatheascus minutus*, host *Galathea nexa*, has an oval shape, the anterior part being much thicker than the posterior part (Boschma, 1933, fig. 1b). One section of the visceral mass, from the region of transition of the right testis into its vas deferens, has been figured (l. c., fig. 3); to show the situation and the course of the internal organs parts of some sections are represented in fig. 5.

The first section (fig. 5a) contains the anterior part of the left vas deferens and the left colleteric gland. Slightly farther posteriorly the left male opening occurs in the sections (fig. 5b), in the male opening there is a plug of chitin connected with the internal cuticle of the mantle (this cuticle is omitted in the other figures). Next to the male opening there is a section of the terminal coil of the left vas deferens. The following section (fig. 5c) contains a rather tortuous part of the left vas deferens. Fig. 5d shows from left to right two sections through the left vas deferens, the closed terminal part of the left testis enveloped in its sac, and the corresponding part of the right testis. In fig. 5e the same parts are visible, each of the two testes here showing a rather wide cavity. Fig. 5f represents from left to right the transition of the left testis into its vas deferens, the right testis, and the right colleteric gland. In the left half of fig. 5g there is the posterior part of the left male organ, showing the wall of the vas deferens and of the testis, the lumen having disappeared, the sac enveloping the testis still being distinct; in the right half of the figure two sections of the right testis are visible. Fig. 5h is the section figured in a previous paper (Boschma, 1933, fig. 3); it shows the tortuous part of the right testis with its enveloping sac, and the likewise tortuous right vas deferens. Slightly farther posteriorly the right male opening occurs (fig. 5i), the figure also shows the chitinous plug connected with the internal cuticle of the mantle; next to the mantle opening parts of the tortuous right vas deferens and two sections of the right testis are visible. The last section (fig. 5j) contains the posterior part of the right male organ.



Among each other the four sectioned specimens show rather striking differences in the situation and in the structure of the internal organs.

In the first place the colleteric glands do not have a fixed position in regard

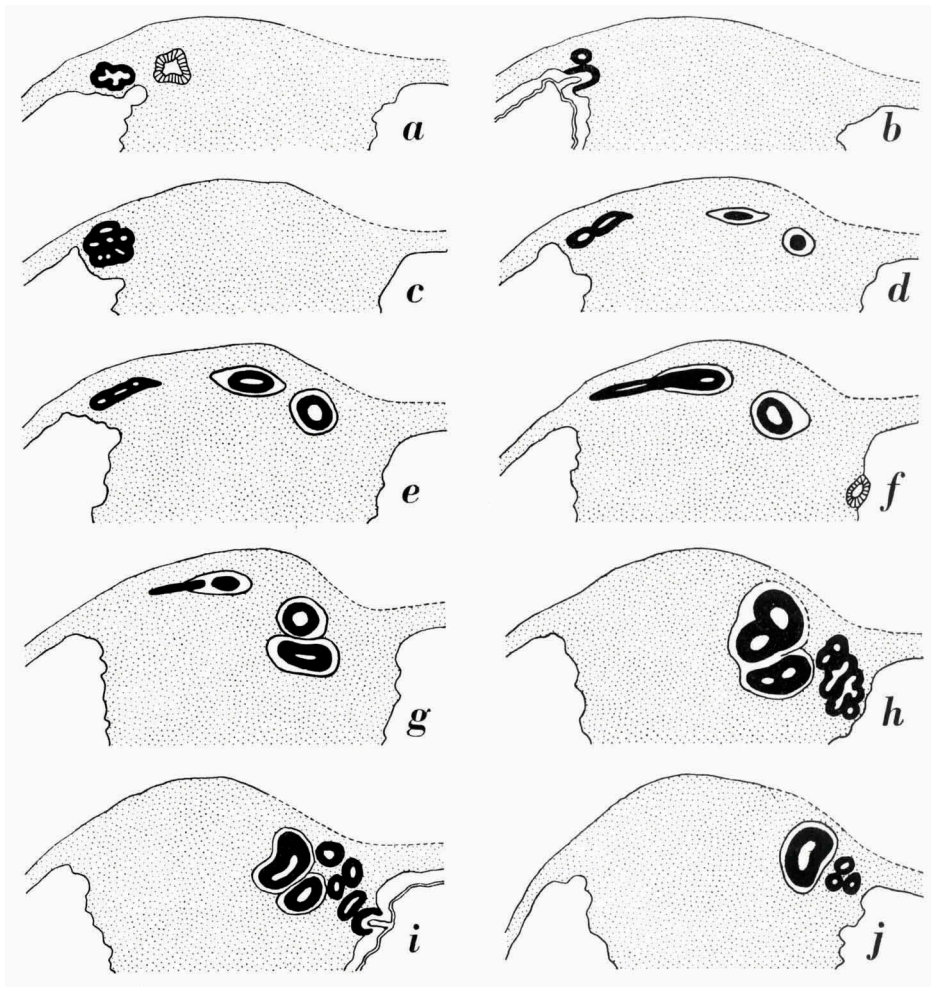


Fig. 5. *Galatheascus minutus* Boschma, type specimen, from Ohan. Transverse sections (ventral part not represented) of the region of the dorsal shield; a, from the anterior part, each following section farther posteriorly.  $\times 32$ .

to the male organs. In the specimen from Cadaqués (fig. 2a) the colleteric glands occur before the closed ends of the testes. In the specimen from South Africa (fig. 3a, b) the closed ends of the testes lie between the two colleteric glands. In the specimen from the Strait of Dover (fig. 4a, b) the testes extend anteriorly distinctly beyond the colleteric glands. In the spec-

imen from Oban the left colleteric gland lies near the anterior end of the left male organ (fig. 5a), the right colleteric gland distinctly farther posteriorly (fig. 5f).

In the specimen from Cadaqués the two male organs are of about equal shape (fig. 2), though the right testis is larger than the left, while the left vas deferens is more tortuous than the right, thereby becoming much longer. In the specimen from South Africa (fig. 3) the right testis is much larger than the left, showing a strongly tortuous part which is entirely absent in the left testis. Here again the left vas deferens is strongly tortuous, thereby attaining a much greater length than the inconspicuously tortuous right vas deferens. In the specimen from the Strait of Dover (fig. 4) the left testis is distinctly larger than the right, while the right vas deferens is somewhat more coiled and is consequently distinctly longer than the left. In the specimen from Oban the right male organ (fig. 5d-j) is similar to that of the specimen from South Africa, though being distinctly less tortuous. In the specimen from Oban the left male organ (fig. 5a-g) is altogether different from that in all other specimens. The chief course of the left testis is sideways, not posteriorly as in the other specimens, the vas deferens even turning anteriorly instead of running in a posterior direction. In this specimen the left male opening lies before the closed end of the left testis, in contradistinction to the situation found in all the other male organs of the specimens examined, which show a pronouncedly posterior course.

In the two parasites of *Galathea dispersa* (figs. 2 and 3) the right male organ is larger than the left, the difference being most striking in the specimen from South Africa. In the parasite of *Galathea nexa* (fig. 5) again the right male organ is larger than the left; the shape of the right male organ in this specimen is more or less intermediate between those of the two parasites of *G. dispersa*. On the other hand in the parasite of *Galathea intermedia* (fig. 4) the left male organ is distinctly larger than the right.

The peculiarities of the left male organ in the specimen from Oban are altogether unusual, an anterior course of a male organ only occurring on one side of one of the specimens examined. Apparently this abnormal condition is quite exceptional in the species.

The male organs of *Galatheascus striatus* are very similar to those of *G. minutus*. Parts of transverse sections of the type specimen of *G. striatus* showing the right and left male organs in the region of their greatest number of convolutions are represented in fig. 6. The most strongly developed part of the left testis (fig. 6b) is from a region slightly before that of the most strongly developed part of the right testis (fig. 6a). In this specimen both

testes are tortuous, though the right distinctly more so than the left. Each testis is enclosed in a sac which does not continue around the vas deferens.

As remarked above, the only character indicating a specific difference in the two species of *Galatheascus* is the striking dissimilarity in size, *G. striatus* being at least three times as long as the largest specimen known of *G. minutus*. The longitudinal striation of *G. striatus*, which in the description of the species was considered a specific character, is perhaps a result of contraction of the mantle. In *G. minutus* the external cuticle of the mantle as a rule is

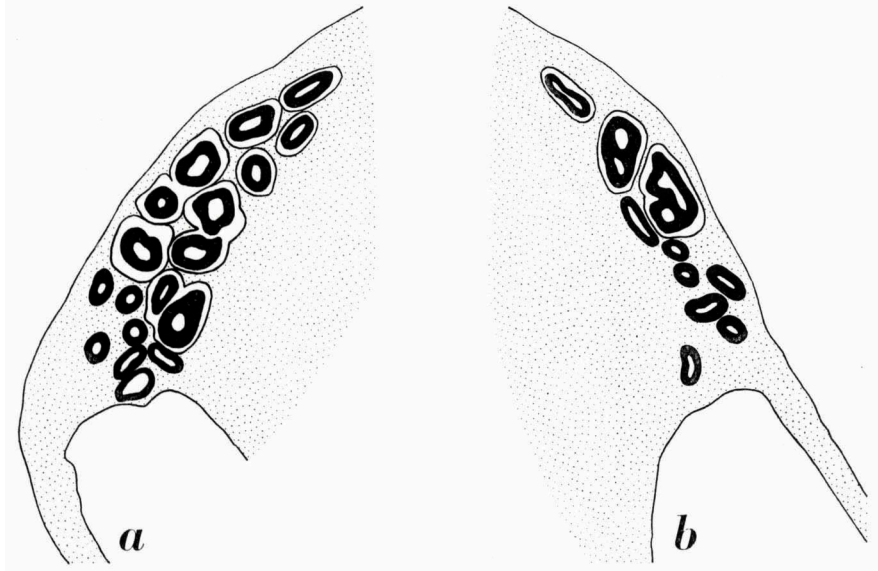


Fig. 6. *Galatheascus striatus* Boschma, type specimen. Parts of transverse sections, showing the most strongly convoluted parts of the right (a) and the left (b) male genital organ.  $\times 27$ .

smooth, without grooves; in one specimen (fig. 1b) there are grooves of a similar appearance as those of *G. striatus*. The different position of the stalk, in the anterior half in *G. striatus*, in or about in the middle in *G. minutus*, perhaps may constitute another specific character; because the exact position of the stalk is known in one specimen of *G. striatus* only it is not certain that in this species the stalk has a fixed position. In some other species of Peltogastridae, however, the position of the stalk is an important diagnostic character, *Peltogasterella subterminalis* Reinhard differing from *P. socialis* Krüger in the first place by having the stalk at about one-fifth of the length from the posterior extremity, not terminal as in *P. socialis* (cf. Reinhard, 1944). On account of this character the two species of the



genus *Peltogasterella* are distinct from *Chlorogaster sulcatus* (Lilljeborg), which has the stalk in or near the middle of the body.

As remarked on a previous page, Smith (1906) gave the name *Lernaeodiscus galathea* to a parasite occurring on *Galathea dispersa* at Naples, and on *G. intermedia* in Norway; he further gave the name *Lernaeodiscus strigosae* to a parasite of *Galathea strigosa* from Naples. Smith examined the structure and the situation of the internal organs in the species *L. galathea* (present name *Triangulus galathea*), and noted as peculiarities of *L. strigosae* the much larger size and the very wide "anterior" hinge of the mesentery. This "anterior" hinge is the dorsal mesentery in the orientation as proposed in a previous paper (Boschma, 1928, p. 18).

The following notes are based on an examination of a specimen of *Lernaeodiscus strigosae* Smith, of which the data of collecting, etc., are:

Host *Galathea strigosa* (Linnaeus), locality Bay of Cadaqués, Northeast Spain, collected by fishermen, August 3-17, 1955, received from Dr. L. B. Holthuis; measurements: larger diameter (breadth) 21, antero-posterior diameter (length) 11, dorso-ventral diameter (thickness) 5 mm.

The specimen (fig. 7a) is nearly twice as broad as long, of more or less trapezoidal shape, the posterior part being much broader than the anterior region. The wide mantle opening with its thick muscular margin is turning towards the dorsal surface, the same holds for the stalk, which is oval in cross section. The stalk lies in the centre of an irregularly polygonal shield, a part of the external cuticle that is more than twice as thick as on other parts of the mantle. At the ventral surface there is a broad median groove running from the stalk to nearly half-way the distance to the mantle opening, agreeing in position to the ventral mesentery; at the dorsal surface there is a much narrower groove running from the shield to the mantle opening.

The specimen was transversely sectioned. The sections show that the dorsal surface of the visceral mass is very broadly attached to the mantle, thereby forming the very wide dorsal mesentery (fig. 7b), the lateral parts of the visceral mass at each side very little extending beyond the margin of the mesentery. On the other hand in *Triangulus galathea* the dorsal mesentery is about two-thirds the breadth of the entire visceral mass (cf. Boschma, 1928, fig. 9b, c). These differences confirm the observations by Smith (1906: the "anterior" hinge of the mesentery very wide in *L. strigosae*, not very wide in *L. galathea*).

The left and right male organ occur each on one side of the median plane. The specimen in this respect is internally symmetrical, though one of the male organs (the right) is much more strongly developed than the other.

As in its external appearance (fig. 7a) the specimen is regularly symmetrical, the chief characters point to the fact that it belongs to the genus *Lernaeodiscus*.

The sections of fig. 8 show the male organs from the anterior extremity of the ventral mesentery (fig. 8a) to the region of the stalk (fig. 8d). In the first section (fig. 8a) to the left of the median plane the terminal part of the left vas deferens is to be seen, to the right of the median plane the

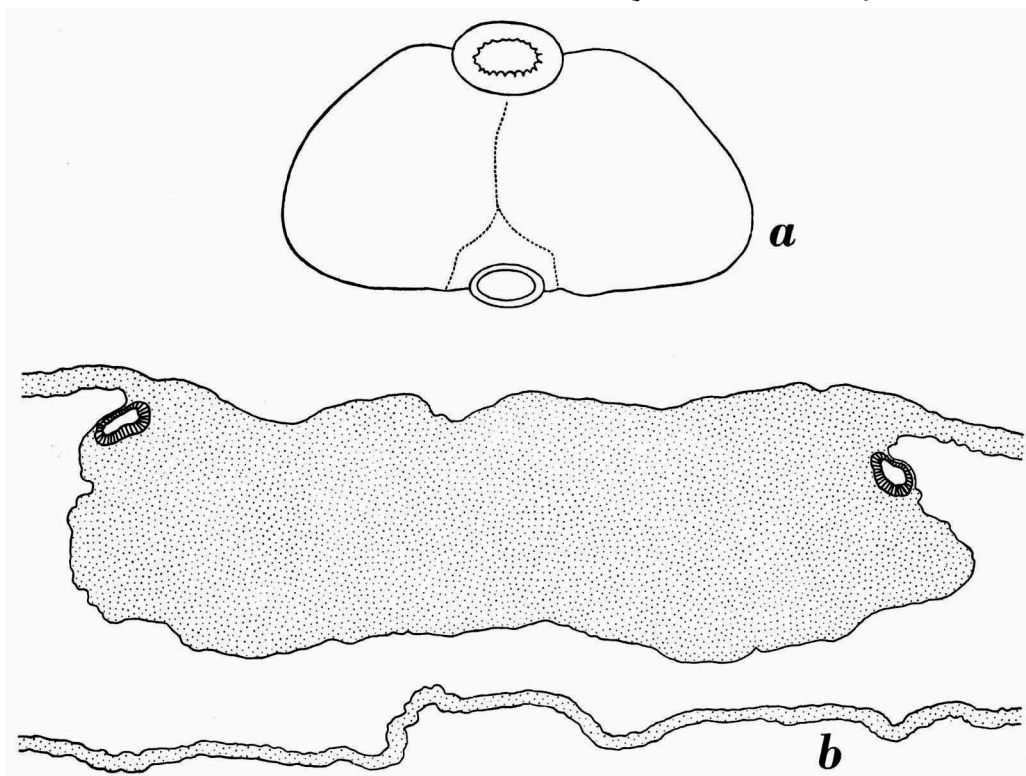


Fig. 7. *Lernaeodiscus strigosae* Smith, specimen from Cadaqués. a, dorsal surface; b, transverse section of the middle region of the body, containing the colleteric glands (lateral parts of the mantle omitted). a,  $\times 3$ ; b,  $\times 12$ .

terminal part of the right vas deferens and, probably, the right male opening. Unfortunately the connexion between the two parts represented in black in the right half of fig. 8a could not be traced; the topmost canal certainly is the anterior part of the right male organ, but it is not altogether certain that the horseshoe-shaped figure represents the male opening, the sections not being without defects. The next figured section (fig. 8b) shows the slightly tortuous left vas deferens and two sections of the right testis, each

enclosed in a sac. In the left half of fig. 8c there is the left vas deferens, and the left testis enclosed in a sac; the right half shows the much larger right testis with its surrounding sac. Finally fig. 8d shows the posterior parts of the left vas deferens and of the right testis. The closed ends of the two

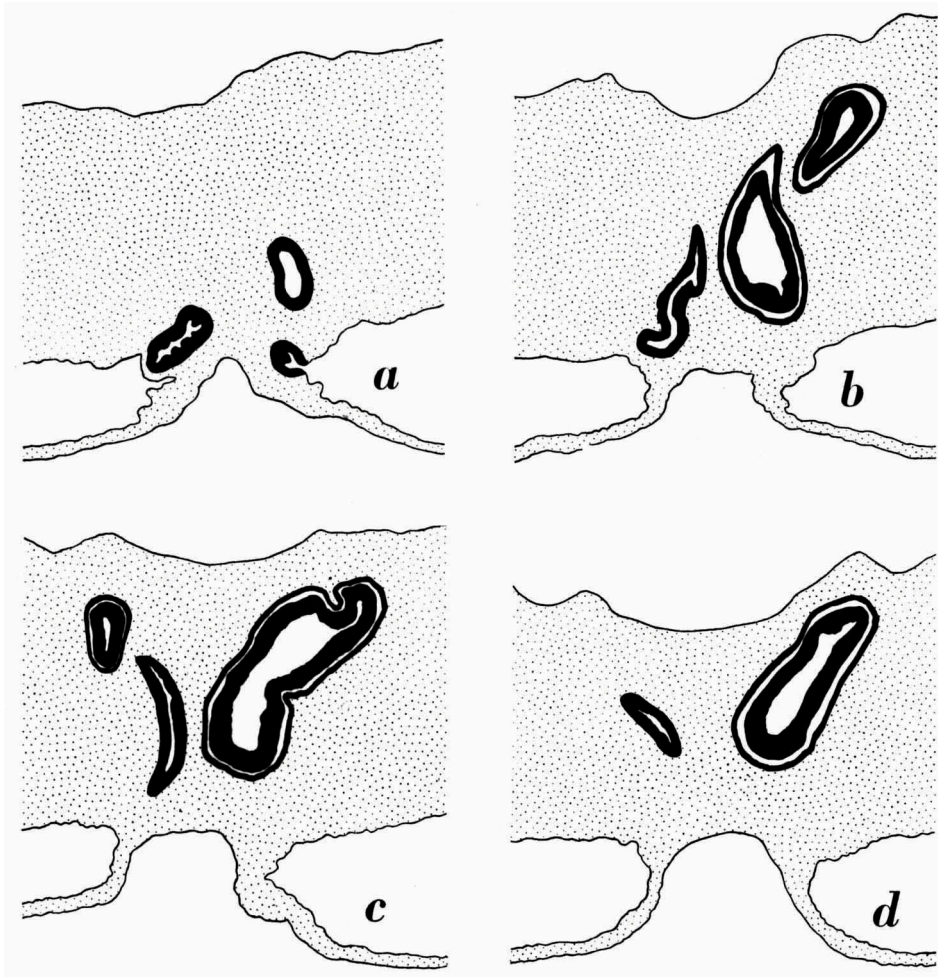


Fig. 8. *Lernaeodiscus strigosae* Smith, specimen from Cadaqués. Central parts of transverse sections from the posterior half of the body.  $\times 12$ .

testes are to be found in the dorsal part of the visceral mass, not far from the large mesentery. The male organs continue their course in a posterior direction, and then turn again anteriorly to terminate in the vicinity of the anterior extremity of the small ventral mesentery.

The colleteric glands (fig. 7b) occur slightly anteriorly to the anterior end of the ventral mesentery, each at one side of the visceral mass in the region of the margin of the wide dorsal mesentery. The colleteric glands are simple cavities surrounded by high epithelium, especially on their inner sides.

The external cuticle of the mantle, a thin layer of chitin except the part constituting the shield, had become loose from its epithelium; this cuticle (and the much thinner internal cuticle of the mantle) has not been drawn in the figures.

The specimen which is here identified with *Lernaeodiscus strigosae* Smith distinctly shows the characters of symmetry assigning to it its generic position. The male organs, of which the one is much larger than the other, perhaps indicate that the specimen in this respect is of an abnormal structure. Examination of future specimens must show whether the difference in size of the male organs is a constant character of the species.

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