

NOTES ON SACCULINIDAE, CHIEFLY IN THE COLLECTION OF THE UNITED STATES NATIONAL MUSEUM

by

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In a previous paper (Boschma, 1933 *b*) descriptions were given of 22 species of Rhizocephala in the collection of the United States National Museum. In the cited paper especially attention was given to the details of the external and the internal cuticle, the data concerning the structure of the male organs and the colleteric glands were briefly described but not figured. The measurements of the type specimens were noted but no description was given of the shape of the animals. In a later paper (Boschma, 1937) some more details were described of the male organs and the colleteric glands of the specimens belonging to the genus *Sacculina*, but these structures up till now remain imperfectly known in the specimens belonging to other genera of the group.

To obtain a better basis for comparison with other specimens it seemed desirable to describe the hitherto imperfectly known details of the specimens. Some of the new names in the cited paper appeared to be synonyms of other names, whilst some species proved to belong to another genus than the one in which they originally were placed. The species are arranged here in the same order as in the original paper.

In most of the drawings of sections the excrescences of the cuticle are omitted.

***Sacculina lata* Boschma (figs. 1*a*, 4*a*).**

Sacculina lata Boschma, 1933 *b*, p. 219, fig. 1 (external and internal cuticle); Idem, 1937, p. 273, fig. 55 (male organs), fig. 56 (colleteric gland).

Type specimen on *Charybdis miles* de Haan, Misaki, Japan, A. S. Pearse don., 1930 (collection U. S. N. M.).

The specimen ($21 \times 11 \times 7\frac{1}{2}$ mm) has an oblong shape with more or less pointed angles (fig. 1 *a*). The surface of the mantle is comparatively smooth with the exception of two shallow pits at each side of the median

line at the left side and of a median concavity at the right side extending from the stalk to about half-way the anterior region. These pits or grooves have arisen by pressure of the thorax and the abdomen of the host against the parasite. The mantle opening lies at the anterior margin of the left

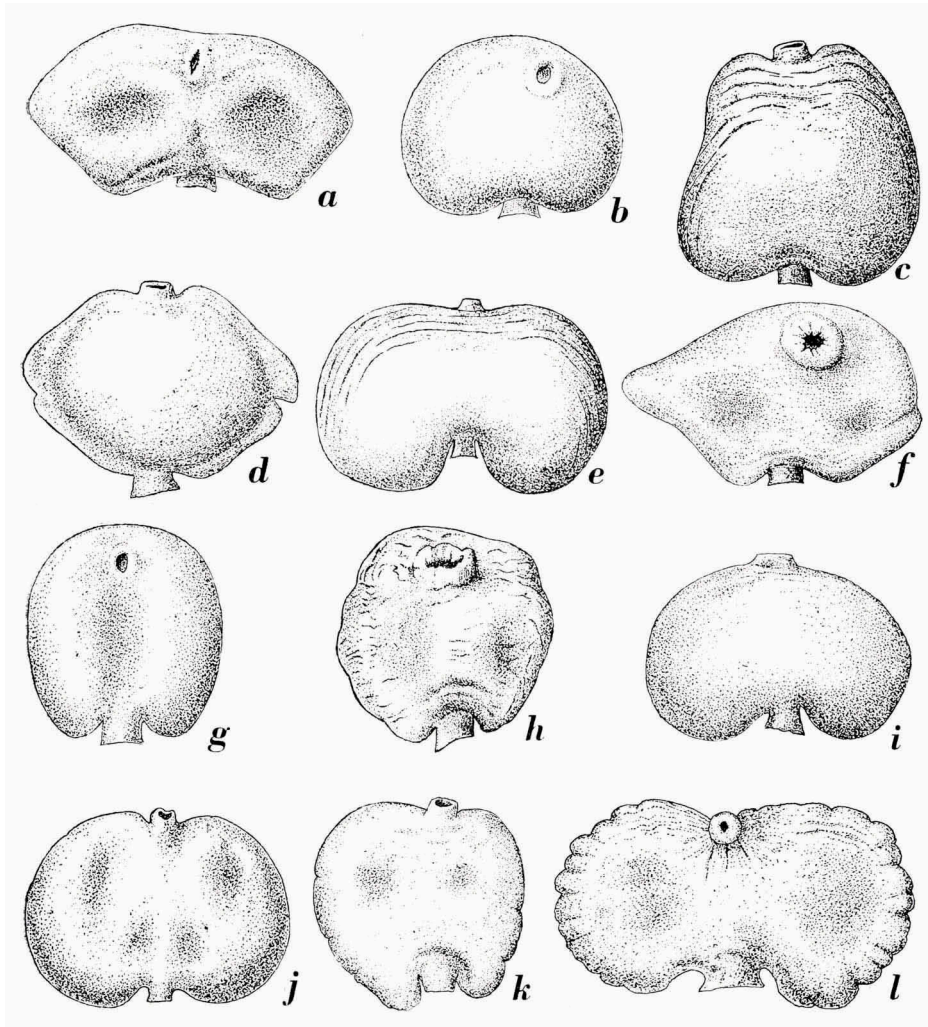


Fig. 1. Sacculinidae, left side, approximate dorso-ventral diameter (mm) in parentheses. a, *Sacculina lata* (21); b, *Loxothylacus longipilus* ($2\frac{3}{4}$); c, *Sacculina calva* ($3\frac{1}{2}$); d, *Sacculina rathbunae* ($4\frac{1}{2}$); e, *Sacculina pulchella* (5); f, *Sacculina anomala* (8); g, *Sacculina leptothrix* (2); h, *Sacculina exarcuata* (type specimen of *S. vieta*) (5); i, *Sacculina reniformis* ($4\frac{1}{2}$); j, *Sacculina senta* ($8\frac{1}{2}$); k, *Sacculina schmitti* (5); l, *Sacculina gibba* (6).

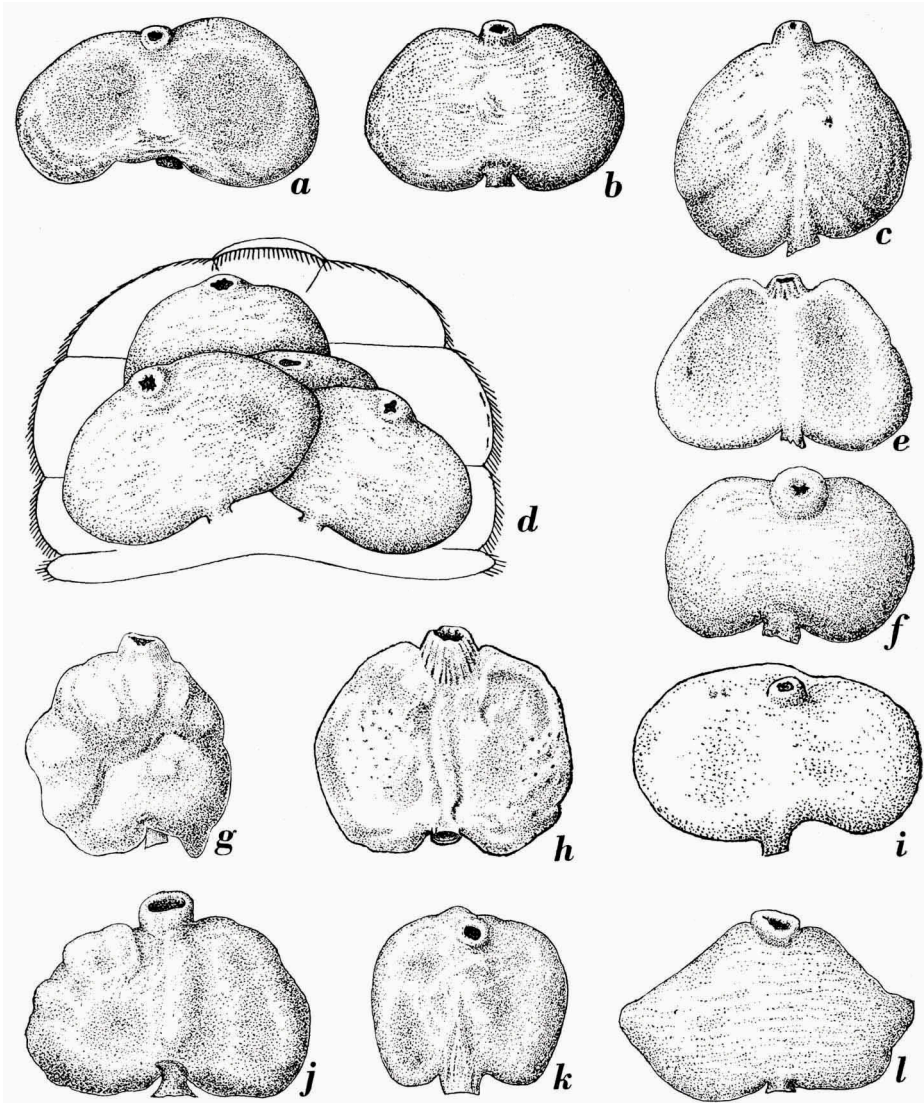


Fig. 2. Sacculinidae, left side (c, right side) approximate dorso-ventral diameter (mm) in parentheses. a, *Sacculina curvata* ($9\frac{1}{2}$); b, *Sacculina confragosa* (type specimen of *S. levis* (14); c, *Drepanorchis strigulosa* ($5\frac{1}{2}$); d, *Heterosaccus papillosus*, 4 specimens on *Charybdis japonica* (11-15); e, *Heterosaccus papillosus*, specimen on *Charybdis bimaculata* (14); f, *Drepanorchis tenuicutis* ($2\frac{1}{2}$); g, *Heterosaccus distortus* (7); h, *Heterosaccus californicus*, specimen on *Pugettia producta* (31); i, *Loxothylacus texanus*, specimen on *Callinectes sapidus* (21); j, *Loxothylacus texanus*, specimen on *Callinectes marginatus* (23); k, *Loxothylacus sclerothrix*, specimen on *Actaea boletaria* (4); l, *Loxothylacus bicorniger* (8).

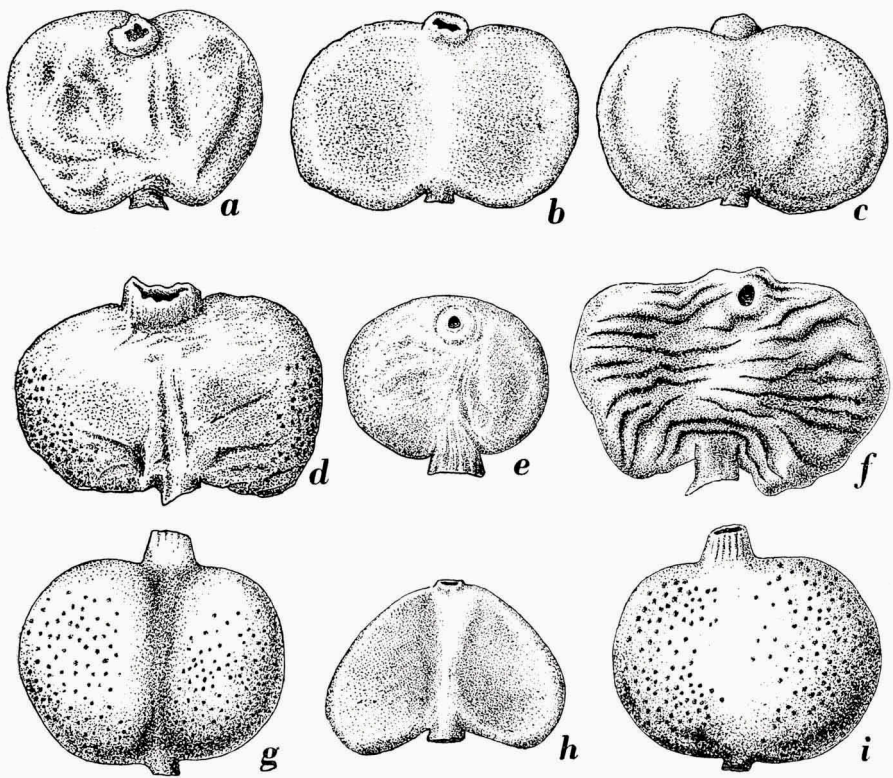


Fig. 3. Sacculinidae, left side (*c* and *g*, right side), approximate dorso-ventral diameter (mm) in parentheses. *a*, *Sacculina exarcuata*, specimen on *Actaea savignyi* (10½); *b*, *Loxothylacus texanus*, specimen on *Callinectes sapidus* (11½); *c*, same specimen; *d*, *Heterosaccus californicus*, specimen on *Loxorhynchus crispatus* (20); *e*, *Loxothylacus texanus*, specimen on *Callinectes marginatus* (6); *f*, *Loxothylacus sclerothrix*, specimen on *Carpilodes pediger* (4); *g*, *Heterosaccus californicus*, specimen on *Talipes nuttallii* (18); *h*, *Sacculina curvata*, specimen on *Uca dussumieri* (8); *i*, left side of specimen of fig. 3 *g*.

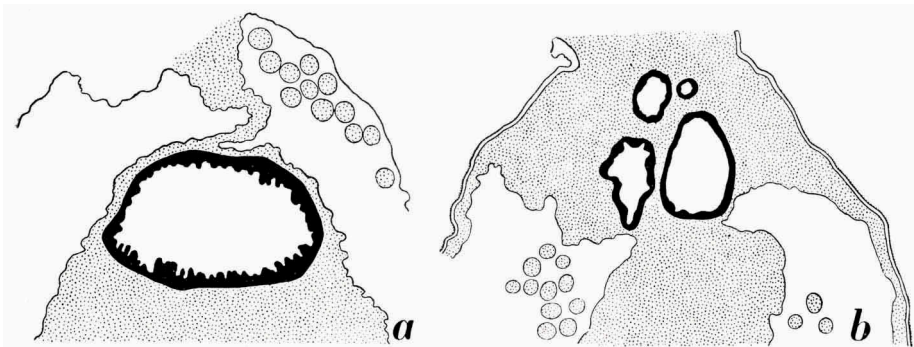


Fig. 4. *a*, *Sacculina lata*, posterior part of a longitudinal section; *b*, *Sacculina anomala*, posterior part of a longitudinal section. $\times 27$.

surface, it forms a small slit surrounded by a low wall, which does not noticeably protrude above its surroundings.

Sections of the male organs were figured in a previous paper (Boschma, 1937, fig. 55). In fig. 4 *a* of the present paper the posterior part of a longitudinal section is shown to illustrate that the male organs are found in the posterior region of the visceral mass, close to the mesentery.

***Loxothylacus longipilus* (Boschma) (figs. 1 *b*, 5).**

Sacculina longipila Boschma, 1933 *b*, p. 220, fig. 2 (external cuticle); Idem, 1937, p. 278, fig. 60 (male organs and colleteric gland).

Type specimen on *Micropanope lobifrons* A. Milne Edwards, Barbados Antigua Expedition, Barbados, British West Indies, June 5, 1918 (collection U. S. N. M.).

The specimen ($2\frac{3}{4} \times 2 \times 1\frac{1}{2}$ mm) is more or less kidney-shaped (fig. 1 *b*). With the exception of a pronounced concavity at the right side, in the vicinity of the stalk, the mantle does not possess any pits or grooves. The mantle opening lies at the anterior margin of the left side, somewhat eccentrically.

Transverse sections of the male organs were figured in a previous paper (Boschma, 1937, fig. 60). Fig. 5 in the present paper shows the situation of the male organs in the visceral mass. The first section represented here (fig. 5 *a*) shows that the visceral mass is attached to the mantle at some distance from the stalk. Here the ventral parts of the vasa deferentia are visible as rather narrow canals. They gradually pass into the testes which are of strongly unequal shape and size. The left testis (fig. 5 *b-d*) is a straight tube with a narrow cavity; the right testis shows a distinct curve, the concavity of which is turned towards the ventral surface (fig. 5 *b*, *c*). In a slightly more dorsal plane the posterior part of the curvature is seen to pass into the anterior part (fig. 5 *d*), and in a still more dorsal plane the dorsal part of the curvature is shown (fig. 5 *e*). The cavity of this large right testis is wide. Each testis is surrounded by a thin muscular layer.

The attachment of the visceral mass to the mantle at some distance from the stalk and the curvature of the right testis point to the fact that the specimen belongs to the genus *Loxothylacus*. For the species at least provisionally the name *Loxothylacus longipilus* is used here. It is not altogether certain that this species is different from *Loxothylacus panopaei* (Gissler). There are indications for peculiar specific characters of *L. longipilus* (the small size of the specimen, the narrow curve of the male organs, the extremely long hairs of the external cuticle), but the differences of the species from *L. panopaei* are of a more or less gradual kind.

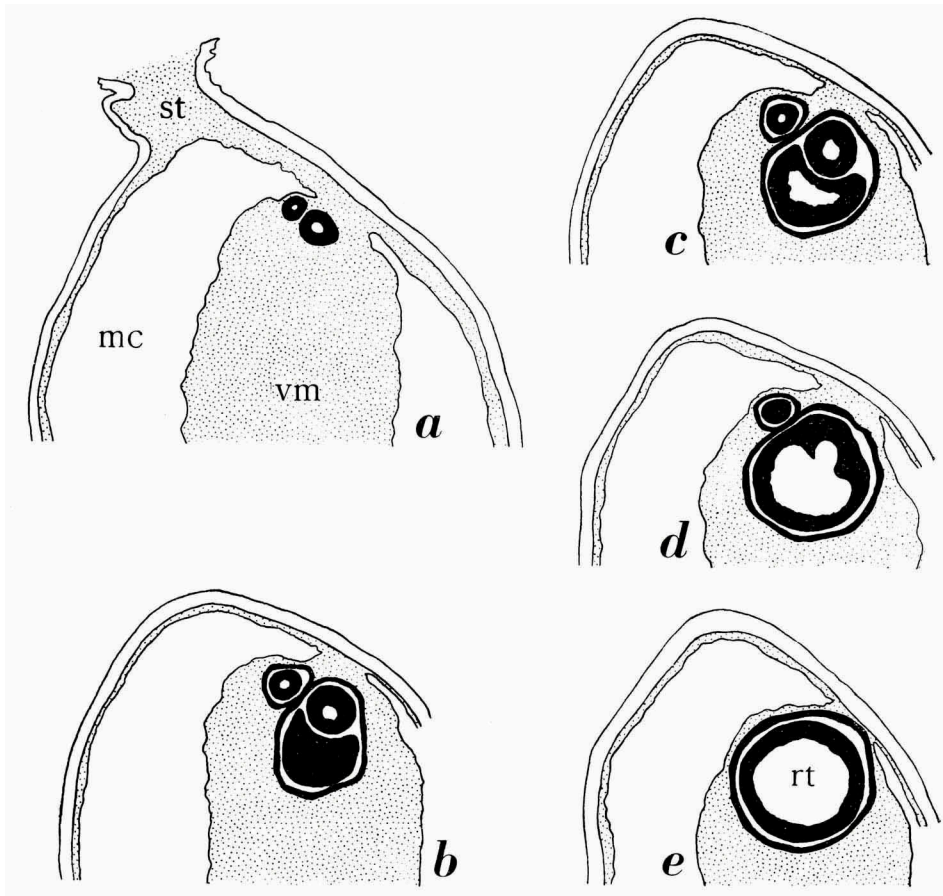


Fig. 5. *Loxothylacus longipilus*, posterior parts of longitudinal sections, each following section from a more dorsal region than the preceding. *mc*, mantle cavity; *rt*, right testis; *st*, stalk; *vm*, visceral mass. $\times 45$.

***Sacculina calva* Boschma (figs. 1 c, 6 a).**

Sacculina calva Boschma, 1933 b, p. 221, fig. 3 (external cuticle); Idem, 1937, p. 219, fig. 14 (male organs), fig. 15 (colleteric gland).

Type specimen on *Menaethius monoceros* (Latreille), Saya de Malha, Western Indian Ocean, H. M. S. "Sealark", Station C 19, 29 fms. (collection U. S. N. M.).

The specimen ($3\frac{1}{2} \times 3\frac{1}{2} \times 2$ mm) has a more or less trapezoid shape with rounded angles (fig. 1 c). The central part of the left surface is smooth, the sides and the anterior part of this surface show a quantity of rather deep grooves. At the right side the whole marginal part of the animal possesses these grooves, so that this surface has a strongly wrinkled appear-

ance. The mantle opening lies at the extremity of a short papilla in the middle of the anterior region.

Fig. 6 *a* shows a longitudinal section of the body in which one of the colleteric glands and the two closely united testes are visible, the latter in the

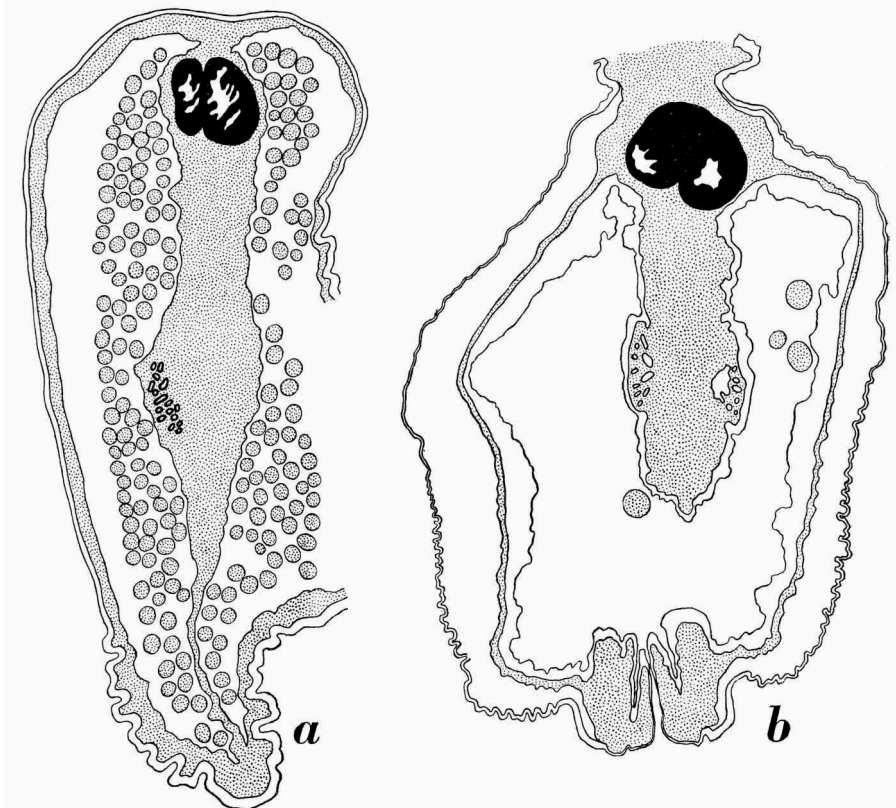


Fig. 6. *a*, *Sacculina calva*, longitudinal section; *b*, *Sacculina reniformis*, longitudinal section. $\times 30$.

posterior part of the visceral mass. Details of the structure of the male organs are given in a previous paper (Boschma, 1937, fig. 14). The figure in the present paper shows that the mantle cavity is rather crowdedly packed with eggs.

***Sacculina rathbunae* Boschma (fig. 1 *d*).**

Sacculina rathbuni Boschma, 1933 *b*, p. 222, fig. 4 (external cuticle); Idem, 1937, p. 299, fig. 74 (male organs and colleteric gland).

Type specimen on *Arachnopsis filipes* Stimpson, United States Fish Commission, Schooner "Grampus", 1889, Station 5076 (25° 34' N., 83° 28' W., West coast of Florida) (collection U. S. N. M.).

The specimen ($4\frac{1}{2} \times 3 \times 1\frac{1}{2}$ mm) is more or less lozenge-shaped (fig. 1 d). The surface of the mantle is smooth, the dorsal and ventral margins are flattened and each of these has a small notch. The mantle opening lies at the top of a small tube extending in anterior direction.

In a previous paper (Boschma, 1937, fig. 74) sections are represented containing the male organs. These form more or less straight tubes running along the posterior border of the visceral mass.

Sacculina pulchella Boschma (figs. 1 e, 7, 8).

Sacculina pulchella Boschma, 1933 b, p. 223, fig. 5 (external cuticle); Idem, 1937, p. 295, fig. 71 (male organs and colleteric gland).

Type specimen on *Huenia proteus* de Haan, Seychelles, Western Indian Ocean, H. M. S. "Sealark", Station F 8, 34 fms., October 20, 1905 (collection U. S. N. M.).

A second specimen on *Huenia proteus* de Haan, Amirante, Western Indian Ocean, H. M. S. "Sealark", Station E 11, 25-80 fms., November 10, 1905 (collection U. S. N. M.).

The two specimens are more or less similar in size and shape, the chief details of the type specimen (fig. 1 e, $5 \times 2\frac{1}{2} \times$ less than 2 mm) are: more or less kidney-shaped, antero-posterior diameter in the central part $2\frac{1}{2}$ mm, in the dorsal and ventral regions much higher. At the anterior region there are a number of small grooves which extend from there to the dorsal and ventral regions. The remainder of the surface of the mantle is smooth, except the neighbourhood of the stalk at the right side, where there is a concavity caused by pressure of the median ridge of the abdomen of the host. The mantle opening lies at the extremity of a small conical tube in the centre of the anterior region.

Details of the structure of the male organs are noted in a previous paper (Boschma, 1937, fig. 71). Fig. 7 in the present paper shows a longitudinal section. The male organs are found in the posterior part of the body, in the region of the stalk, outside the visceral mass. The colleteric glands (fig. 7) slightly protrude above the surface of the visceral mass.

The figure of the excrescences of the external cuticle of the mantle (Boschma, 1933 b, fig. 5) shows these structures as they occur in the specimen from Amirante. The excrescences of the type specimen, from the Seychelles, in every respect are similar to those of the other specimen. Some data concerning these excrescences are given here (fig. 8).

In the type specimen the thickness of the external cuticle varies from 6 to 12 μ . Its surface is crowdedly covered with excrescences which consist of a kind of chitin differing from that of the main layers. In those parts of the cuticle in which the excrescences have not yet reached their full develop-

ment the main layers, which are easily to be stained, form cylindrical small columns which at their sides and at their tops are covered with a thin layer of chitin of a hyaline structure. At the extremities of the excrescences this external layer bears a quantity of little spines, whilst at the basal region of the excrescences some root-like expansions of the hyaline layer develop. In the greater part of the mantle the excrescences have further developed. Here the basal part of the excrescences consists of hyaline chitin also; the

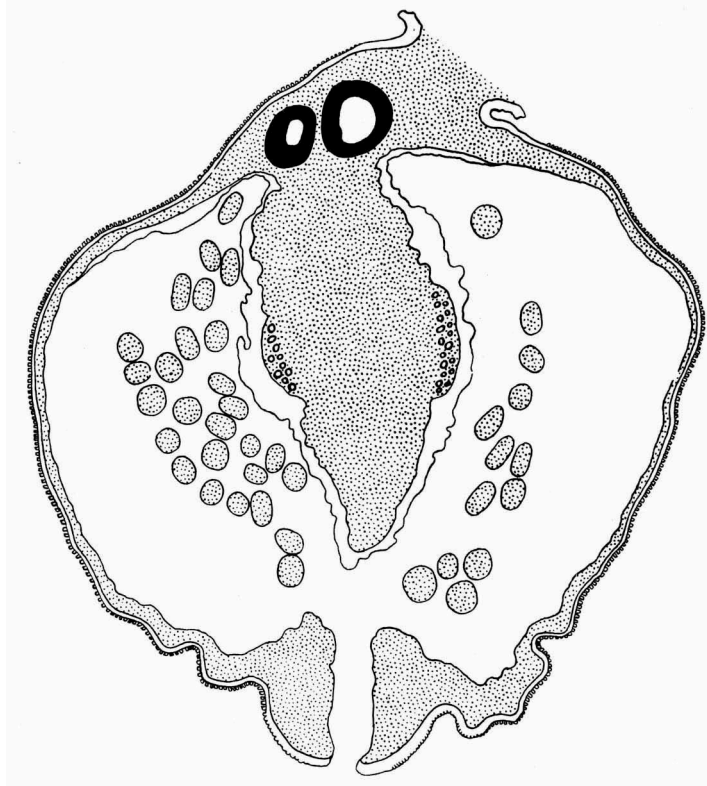


Fig. 7. *Sacculina pulchella*, longitudinal section. $\times 45$.

central part of the excrescences shows a cavity, which may be filled with a part of the stainable chitinous matter of the main layers of the cuticle. In these fully developed excrescences the spines at their tops are stronger and the roots of the basal parts are much longer. These roots are attached to the upper surface of the cuticle for the whole of their length.

When the cuticle is examined from above one obtains a different view when the upper parts of the excrescences are focussed or the lower parts. The upper parts (fig. 8a) show the spines which are distributed in great

quantities over the extremities of the excrescences. In the lower parts of the excrescences the roots which adhere to the cuticle are visible (fig. 8 *b*), and the cavity in the central part of the excrescences. These two views combined give a figure of the excrescences as that in a previous paper (Boschma, 1933 *b*, fig. 5). A section of the external cuticle is represented

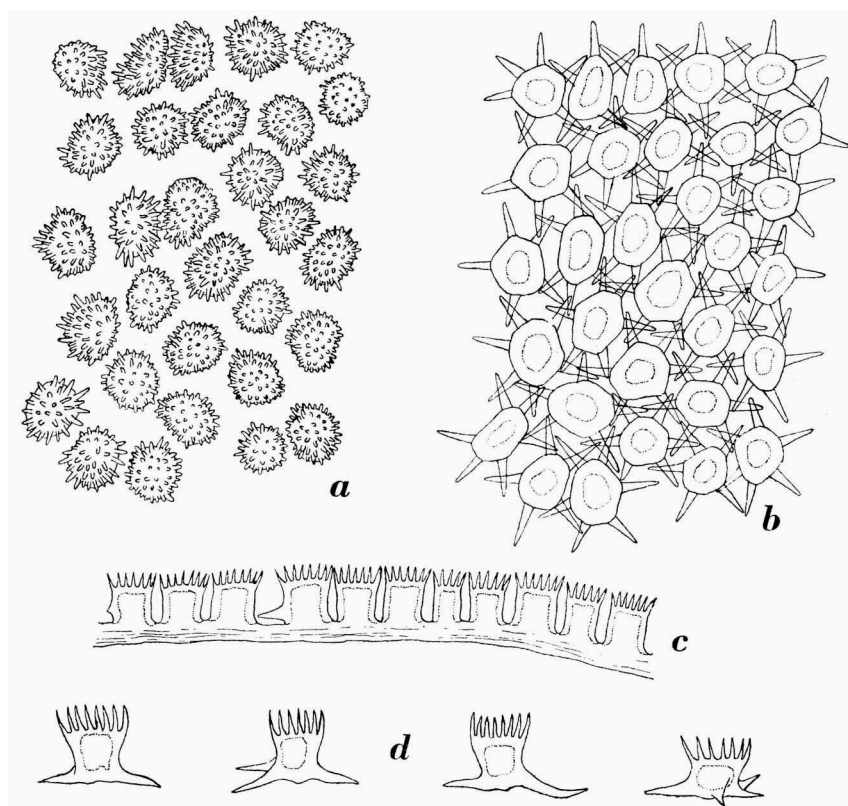


Fig. 8. *Sacculina pulchella*, type specimen, excrescences of the external cuticle. *a* and *b*, upper and lower parts of the same group of excrescences; *c*, section of the cuticle; *d*, isolated excrescences in side view. $\times 530$.

in fig. 8 *c*, a few isolated excrescences, showing the spines and the basal root-like expansions, in fig. 8 *d*.

No retinacula could be found in the parts of the internal cuticle examined for this purpose.

***Sacculina anomala* Boschma (figs. 1 *f*, 4 *b*).**

Sacculina anomala Boschma, 1933 *b*, p. 224, fig. 6 (external and internal cuticle); Idem, 1937, p. 208, fig. 5 (male organs), fig. 6 (colleteric gland); Shiino, 1943, p. 21,

fig. 2 *C* (external shape), fig. 15 (male organs, colleteric gland, external and internal cuticle) (specimen on *Charybdis bimaculata* Miers).

Type specimen on *Thalamita cooperi* Borradaile, Amirante, Western Indian Ocean, H. M. S. "Sealark", Station E 21, 30 fms., October 17, 1905 (collection U. S. N. M.).

The parasite ($8 \times 4 \times 2\frac{3}{4}$ mm) has an irregular shape, the ventral part of the mantle extends into a long blunt conical prominence, whilst the dorsal part is more evenly rounded (fig. 1 *f*). The anterior region of the body is convex, the posterior part protrudes with a small prominence at each side of the stalk. On the whole the surface of the mantle is comparatively smooth, there are a couple of shallow pits at the left surface and a median concavity next to the stalk at the right surface. The mantle opening lies in the centre of a comparatively thick wall, which, however, does not protrude strongly above the surface of the mantle; it is found at the left surface, not far from the centre of the anterior region.

Sections of the male organs are given in a previous paper (Boschma, 1937, fig. 5); fig. 4 *b* in the present paper shows the posterior part of a longitudinal section containing the dorsal part of the male organs. The figure shows that the male organs occur in the region of the stalk, outside the visceral mass.

Shiino (1943, p. 21, figs. 2 *C*, 15) described a specimen of *Sacculina anomala* parasitic on *Charybdis bimaculata*. In this specimen as well as in the type the ventral half of the body is much more pointed than the dorsal, but in other respects the external shape of the two specimens is rather different. Shiino's specimen corresponds with the type of *S. anomala* as far as concerns the structure of the male organs and of the colleteric glands. The excrescences of the external and the internal cuticle in the two specimens present rather striking differences, so that their identity is not altogether certain; it is even probable that the two specimens belong to different species.

In the type specimen of *Sacculina anomala* (cf. Boschma, 1933 *b*, fig. 6 *a, b*) the excrescences of the external cuticle are short hairs with a length of 10 to 16 μ , covered with minute lateral hairs. In the other specimen (Shiino, 1943, fig. 15 *E*) the excrescences of the external cuticle are papillae without small hairs, which have a length of about 6 μ . Moreover, the retinacula in the two specimens are entirely different. In the type specimen (Boschma, 1933 *b*, fig. 6 *c, d*) each retinaculum consists of a single barbed spindle only, with a length of 12 μ approximately. In Shiino's specimen (Shiino, 1943, fig. 15 *F*) the retinacula have two or three spindles each, here the spindles are not barbed and they have a length of 20 to 35 μ . Shiino (loc. cit., p. 21) already drew attention to these differences, but the com-

plete similarity of the male organs in the two specimens induced him to regard the two as conspecific.

***Sacculina leptothrix* Boschma (figs. 1 g, 9 b).**

Sacculina leptothrix Boschma, 1933 b, p. 225, fig. 7 (external cuticle); Idem, 1937, p. 277, fig. 59 (male organs and colleteric gland).

Type specimen on *Xenocarcinus tuberculatus* White, United States Bureau of Fisheries Philippine Expedition 1907-1910, "Albatross", Station 5145, vicinity of Jolo, February 15, 1908 (collection U. S. N. M.).

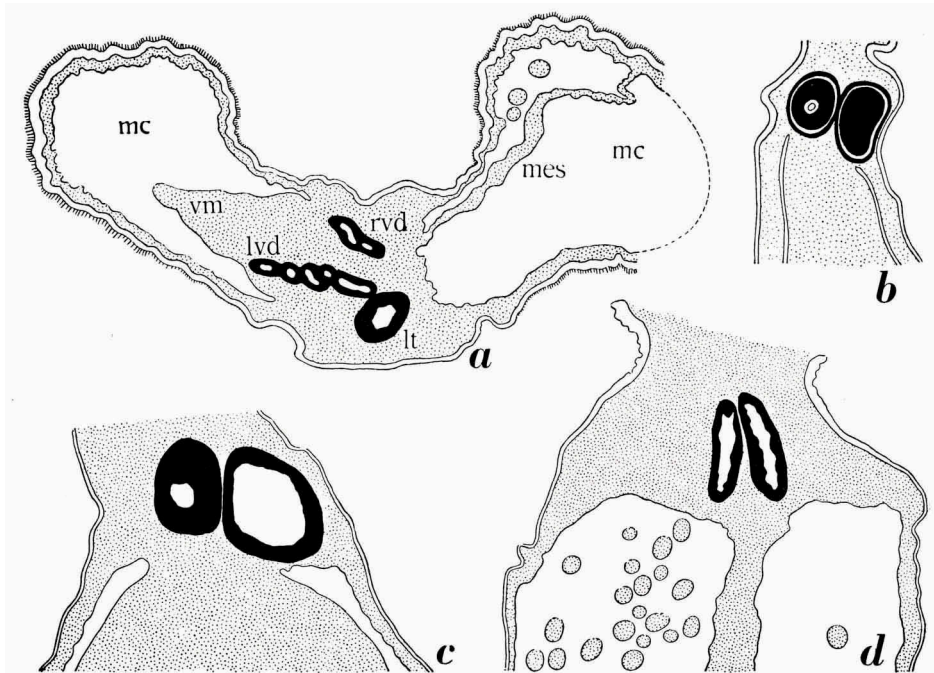


Fig. 9. a, *Sacculina exarcuata* (type specimen of *S. vieta*), transverse section of the posterior region; b, *Sacculina leptothrix*, posterior part of a longitudinal section; c, *Sacculina senta*, posterior part of a longitudinal section; d, *Sacculina curvata*, specimen on *Sesarma edwardsii*, posterior part of a longitudinal section. lt, left testis; lvd, left vas deferens; mc, mantle cavity; mes, mesentery; rvd, right vas deferens; vm, visceral mass. $\times 27$.

The parasite (greater diameter and antero-posterior diameter 2 to $2\frac{1}{2}$ mm, smaller diameter $1\frac{1}{2}$ mm) is nearly circular to slightly oval (fig. 1 g). The surface of the mantle is smooth. There is a shallow groove running in postero-anterior direction on the right side, and a corresponding very insignificant groove at the left side. The small mantle opening, at the left side near the anterior margin, does not protrude above the surface of the mantle.

Some details of the male organs are given in a previous paper (Boschma, 1937, fig. 59). Fig. 9 *b* in the present paper shows the situation of the testes in the posterior part of the body, outside the visceral mass.

As the type specimen is immature it is not certain whether it is a distinct species or a juvenile form of some other species. Even the excrescences of the cuticle may be those of a stage preceding the definite form of the species.

***Sacculina exarcuata* Kossmann (figs. 1 *h*, 3 *a*, 9 *a*, 10, 11).**

Sacculina exarcuata Kossmann, 1872, p. 33 (1874, p. 129), Pl. I (V) fig. 15 (external shape); Boschma, 1927, p. 293, fig. 1 *c* (larva); Idem, 1933 *a*, p. 507, fig. 7 *e* (external shape), fig. 26 (male organs and colleteric glands), fig. 27 (external and internal cuticle) (specimen on *Lambrus* (*Lambrus*) *validus* de Haan); Idem, 1937, p. 241, fig. 32 (male organs), fig. 33 (colleteric gland).

Sacculina vieta Boschma, 1933 *b*, p. 225, fig. 8 (external cuticle); Idem, 1937, p. 322, fig. 94 (male organs and colleteric gland).

Type specimen of *S. exarcuata* on *Cancer* spec., Lapinig Canal, Bohol, Philippine Islands.

Type specimen of *S. vieta* on *Actaea savignyi* (H. Milne Edwards), Seychelles, Western Indian Ocean, H. M. S. "Sealark", Station F 2, 31 fms., October 20, 1905 (collection U. S. N. M.).

Specimen of *S. exarcuata* on *Lambrus* (*Lambrus*) *validus* de Haan, Shanghai, Jamrach leg. (collection British Museum).

Specimen of *S. exarcuata* on *Actaea savignyi*, Hongkong, Putnam leg. (collection Museum of Comparative Zoölogy, Cambridge, Mass.).

The type specimen of *Sacculina vieta* ($5 \times 5 \times 3$ mm) has an irregular, more or less circular shape, except for the posterior part, which is concave between two conical prominences each at one side of the stalk (fig. 1 *h*). The surface of the mantle is strongly wrinkled, there are numerous small grooves and a few larger ones, especially in the posterior part of the body. At the right side there is a broad concavity caused by pressure of the median ridge of the abdomen of the crab against the parasite. The rather wide mantle opening lies at the extremity of a short, comparatively broad tube, not far from the anterior margin at the left side. This part of the body does not protrude noticeably above the surface of the mantle.

In the type specimen of *Sacculina exarcuata*, on *Cancer* spec. (Kossmann, 1872 (1874), Pl. I (V) fig. 15) the greater diameter was more than twice the antero-posterior diameter. The papilla of the mantle opening was found in the centre of the anterior region.

In the specimen on *Lambrus validus* identified as *Sacculina exarcuata* the greater diameter is 12 mm, the antero-posterior diameter 9 mm (cf. Boschma, 1933 *a*, fig. 7 *e*). Here the mantle opening lies at the top of a small tube in the centre of the anterior region.

Details of the male organs of the type specimen of *Sacculina vieta* are given in a previous paper (Boschma, 1937, fig. 94). A transverse section of the posterior part of the body is figured in the present paper (fig. 9 a) to show that the male organs are found in the posterior part of the body, outside the visceral mass.

The characters of the type specimen of *Sacculina vieta*, a parasite of *Actaea savignyi*, could be compared to those of another specimen parasitic on the same species of crab, of which a series of longitudinal sections was available. As the two specimens living on the same species of host show corresponding details it is highly probable that they are conspecific. The chief details of the second specimen on *Actaea savignyi* (from Hongkong) are:

The parasite ($10\frac{1}{2} \times 8 \times 3\frac{1}{2}$ mm) has a roundish oval, slightly panduriform shape (fig. 3 a). The mantle shows a number of shallow grooves and broad irregular wrinkles. The mantle opening is surrounded by a rather thick wall that slightly protrudes over the surface at the anterior end of the left surface. In its external shape this specimen is more or less intermediate between the specimen on *Lambrus validus* and the type specimen of *S. vieta*.

Longitudinal sections (fig. 10 b-d) show that the male organs are found in the posterior part of the body, in the region of the stalk. The vasa deferentia are narrow canals which, when passing into the more or less globular testes, show a chitinous lining on their inner wall (fig. 10 c). Fig. 10 d represents a section in which the testes reach their largest diameter.

The colleteric glands are flattened structures with a fairly large number of canals. In the figured section (fig. 10 a), from the most strongly divided region, 62 canals can be counted. In this specimen no chitin had developed in the canals so that the glandular epithelium is represented.

In the greater part of the mantle the thickness of the external cuticle is from 25 to 35 μ . Its surface is covered with small hairs which possess numerous minute lateral hairs (fig. 11 a, b). The size of these excrescences is from 15 to 27 μ .

The internal cuticle of the mantle is rather densely beset with retinacula (fig. 11 c) which each consist of a single spindle or are composed of small groups (2 or 3) of these spindles. The spindles have a slender shape, they have a length of 18 to 24 μ , and do not possess barbs.

In a previous paper (Boschma, 1933 a) the name *Sacculina exarcuata* was given to a specimen on *Lambrus validus* from Shanghai. Some further details of the male organs and the colleteric glands of this specimen are

found in another paper (Boschma, 1937, figs. 32 and 33). The characters of this specimen correspond with those of the type of *Sacculina exarcuata* as given by Kossmann (1872, 1874), though the latter are too vague to prove the specific identity of the two. For the present the identification of

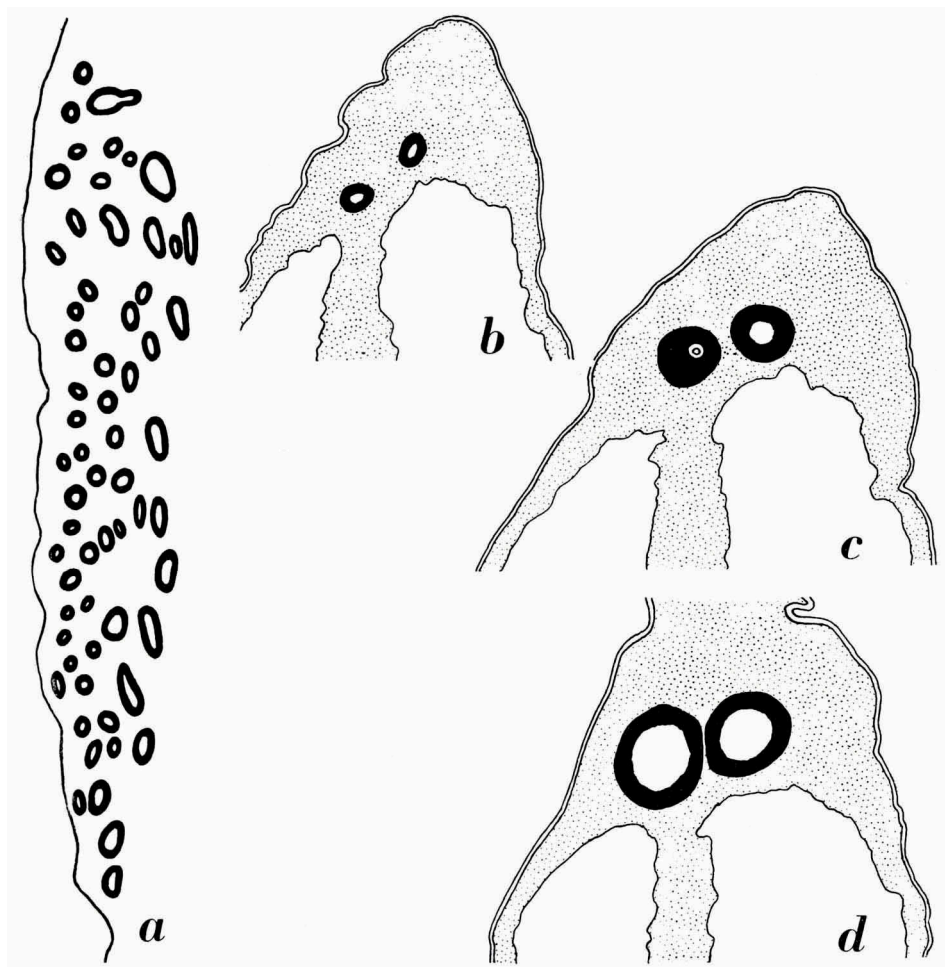


Fig. 10. *Sacculina exarcuata*, specimen on *Actaea savignyi*. *a*, longitudinal section of one of the colleteric glands; *b-d*, posterior parts of longitudinal sections, each following section from a more dorsal region than the preceding. *a*, $\times 80$; *b-d*, $\times 18$.

the specimen on *Lambrus validus* as *Sacculina exarcuata* may be assumed as correct.

The male genital organs of the specimen on *Lambrus validus*, of the specimen on *Actaea savignyi* from Hongkong, and of the type specimen of *Sacculina vieta* correspond in every detail of any importance: the testes are

more or less globular, the vasa deferentia rather narrow, and there is a chitinous tube at the place of connexion of the two parts.

The number of canals in the most strongly divided region of the colleteric glands is rather different in the three specimens. In the specimen on *Lambrus validus* the maximum number is 39; in the type specimen of *Sacculina vieta* this number is 11 (in a transverse section); in the specimen on *Actaea savignyi* from Hongkong this number is 62. It is not to be denied that these numbers are not at all of the same order.

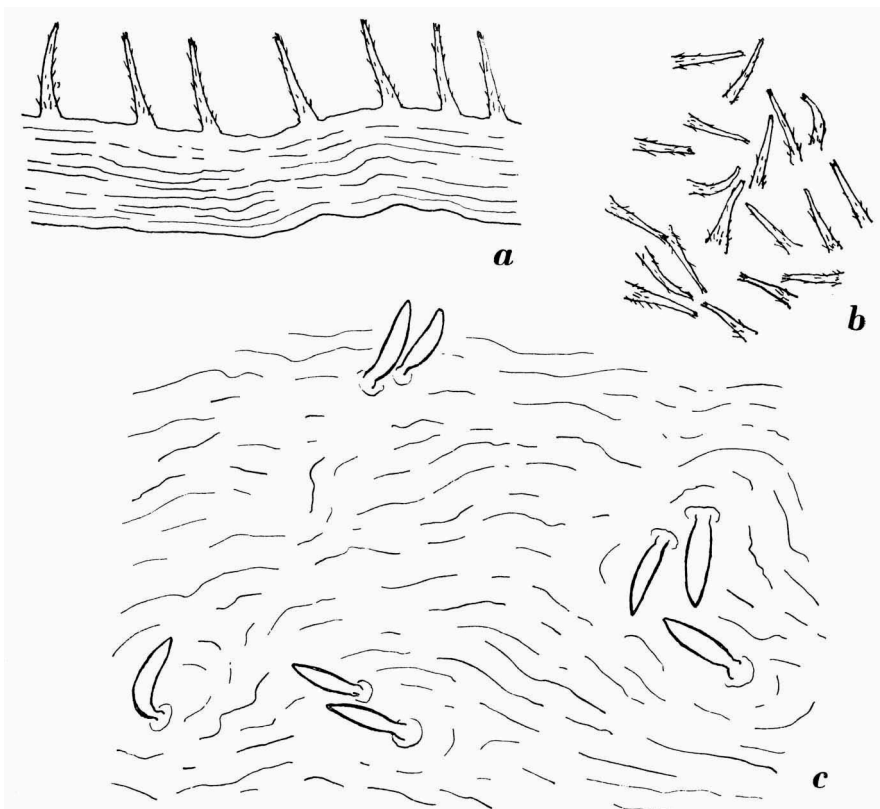


Fig. 11. *Sacculina exarcuata*, specimen on *Actaea savignyi*. a, section of the external cuticle; b, excrescences of the external cuticle; c, retinacula on the internal cuticle. $\times 530$.

In the specimen on *Lambrus validus* the thickness of the external cuticle varies from 40 to 120 μ (Boschma, 1933 a, p. 509); in the type specimen of *Sacculina vieta* the external cuticle is rather thick (about 60 μ , Boschma, 1933 b, p. 226); in the specimen on *Actaea savignyi* from Hongkong the thickness of the cuticle in the greater part of the mantle is from 25 to 35 μ .

In this respect again there are some differences, but these are not so striking that they might point to specific differences.

The retinacula of the specimen on *Lambrus validus* (Boschma, 1933 a, fig. 27 c, d) are very similar to those of the specimen on *Actaea savignyi* from Hongkong (fig. 11 c in the present paper), though in the latter specimen they are slightly larger. These structures were not found in the type specimen of *Sacculina vieta*.

Notwithstanding the rather striking differences, especially in the number of canals in the colleteric glands, I am inclined to regard the specimens on *Actaea savignyi* (the type of *Sacculina vieta* and the specimen from Hongkong) as representatives of one species. As, moreover, the characters of the specimen from Hongkong largely correspond with those of the specimen on *Lambrus validus* the three may be regarded as belonging to one species for which, at least provisionally, the name *Sacculina exarcuata* may be used.

***Sacculina reniformis* Boschma (figs. 1 i, 6 b).**

Sacculina reniformis Boschma, 1933 b, p. 225, fig. 9 (external cuticle); Idem, 1937, p. 300, fig. 75 (male organs and colleteric gland).

Type specimen on *Podochela riisei* Stimpson, United States Bureau of Fisheries, "Fish Hawk", Station 7351 (25° 09' 04½" N., 81° 18' 35" W., off Cape Sable, Florida, December 16, 1912, 3½ fms.) (collection U. S. N. M.).

The type specimen (4½ × 3 × 1½ mm) is neatly kidney-shaped (fig. 1 i). The surface of the mantle is smooth with the exception of a groove at the right side, near the stalk. The mantle opening lies at the extremity of a very short, rather wide tube in the centre of the anterior region.

In a previous paper (Boschma, 1937, fig. 75) details are given of the male genital organs and the colleteric glands. Fig. 6 b in the present paper represents a longitudinal section of the median region, showing the testes, situated in the region of the stalk, outside the visceral mass. The colleteric glands are seen to slightly protrude above the surface of the visceral mass. In the present specimen the external and internal cuticle of the mantle have detached themselves from the epithelium. The mantle cavity contains a small number of eggs.

***Sacculina senta* Boschma (figs. 1 j, 9 c).**

Sacculina senta Boschma, 1933 b, p. 227, fig. 10 (external and internal cuticle); Idem, 1937, p. 307, fig. 81 (male organs), fig. 82 (colleteric gland).

Type specimen on *Brachynotus sanguineus* (de Haan), Rikuoku, Japan, "Albatross", 1906 (collection U. S. N. M.).

The type specimen (fig. 1 *j*, $8\frac{1}{2} \times 6 \times 2\frac{1}{2}$ mm) and the other specimens (two on one crab) from the same locality (Boschma, 1933 *a*, p. 229) are more or less circular or slightly oval; in one specimen the central part of the anterior and posterior regions is slightly concave. In the solitary specimen there is a groove at the right side, in one of the two specimens from the same host there is a similar groove near the margin (these two specimens were attached each at one side of the median plane of the abdomen of the host). In the two specimens that lived on the same host the mantle opening does not protrude noticeably above its neighbourhood; in the solitary specimen it lies at the extremity of a short tube.

Remarks on the structure of the male organs are given in a previous paper (Boschma, 1937, fig. 81). The situation of the male organs in the body is shown in fig. 9 *c* of the present paper; they are found in the region of the stalk, outside the visceral mass.

***Sacculina schmitti* Boschma (figs. 1 *k*, 12 *a*).**

Sacculina schmitti Boschma, 1933 *b*, p. 229, fig. 11 (external cuticle); Idem, 1937, p. 305, fig. 79 (male organs and colleteric gland).

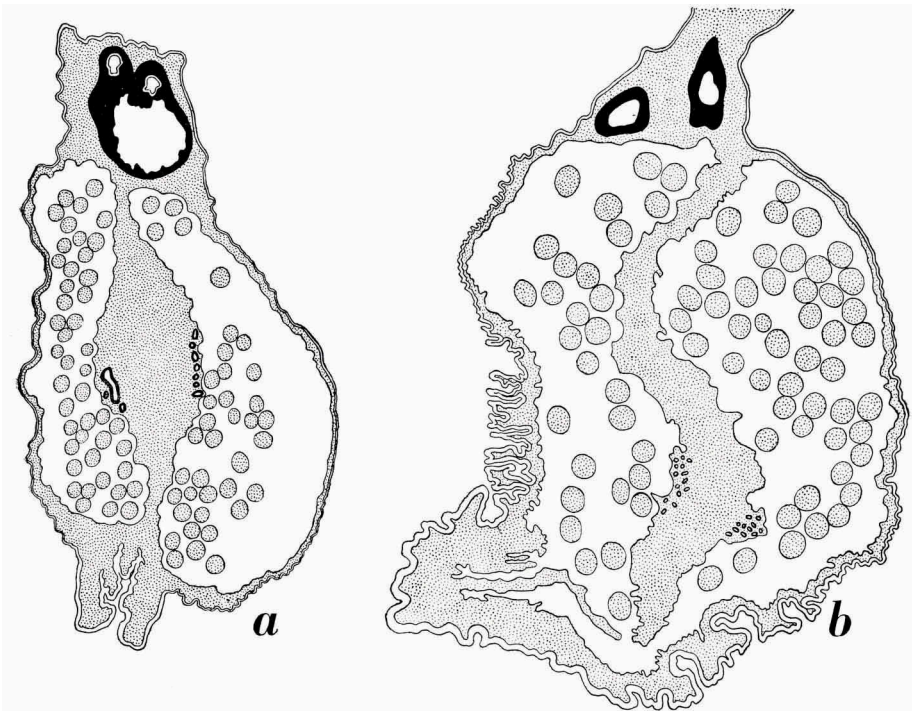


Fig. 12. *a*, *Sacculina schmitti*, longitudinal section; *b*, *Sacculina gibba*, longitudinal section. $\times 30$.

Type specimen on *Anomalothir furcillatus* (Stimpson), United States Fish Commission, Steamer "Albatross", 1885, Station 2401 (28° 38' 30" N., 85° 52' 30" W., Gulf of Mexico) (collection U. S. N. M.).

The type specimen ($5 \times 5 \times 1$ mm) is of a more or less oval shape, its lateral posterior parts extend slightly beside the stalk (fig. 1 k). The mantle shows some grooves and slight depressions. The mantle opening lies at the extremity of a small tube, in the central part of the anterior region.

Details of the structure of the male organs are found in a previous paper (Boschma, 1937, fig. 79). A longitudinal section from the median region of the body is shown in fig. 12 a of the present paper. This section shows that the male organs are confined to the posterior part of the body, they are lying outside the visceral mass. The section, moreover, shows the position of the colleteric glands, approximately in the central region of the lateral surfaces of the visceral mass. Though the canals of these glands are represented here in black they possess chitinous tubes (cf. Boschma, 1937, fig. 79 j-m).

***Sacculina gibba* Boschma (figs. 1 l, 12 b).**

Sacculina gibba Boschma, 1933 b, p. 230, fig. 12 (external cuticle); Idem, 1937, p. 248, fig. 37 (male organs and colleteric gland).

Type specimen on *Eriocheir rectus* Stimpson, Nuiwha, near Foochow, China, S. F. Light coll., August, 1923 (collection U. S. N. M.).

The specimen ($6 \times 2\frac{1}{2} \times 2$ mm) is bilobate, more or less panduriform, as the dorsal and ventral parts are stronger developed than the central region (fig. 1 l). The marginal region of the animal is divided into numerous small lobes, there are a few grooves near the mantle opening, and there is a concavity near the stalk. The remainder of the mantle has a smooth surface. The mantle opening is a narrow pore surrounded by a comparatively thick wall. It lies at the anterior margin of the left side.

In a previous paper (Boschma, 1937, fig. 37) some details are given of the structure of the male organs. A longitudinal section (fig. 12 b) shows that the male organs are situated in the posterior part of the body, outside the visceral mass. The figure, moreover, shows the place of the colleteric glands, in the anterior half of the visceral mass. The mantle cavity is filled with numerous eggs.

***Sacculina curvata* Boschma (figs. 2 a, 3 h, 9 d, 13).**

Sacculina curvata Boschma, 1933 b, p. 230, fig. 13 (external cuticle); Idem, 1937, p. 232, fig. 24 (male organs), fig. 25 (colleteric gland).

Type specimen on *Sesarma (Sesarma) edwardsii philippinensis* Rathbun, United

States Bureau of Fisheries, "Albatross" Philippine Expedition, 1907-1909, Pangauran River, Port Caltom, Busuanga Island, Philippine Islands, seine, December 16, 1908 (collection U. S. N. M.).

Specimen on *Uca dussumieri* (H. Milne Edwards), Sebatic Island, Borneo, United States Bureau of Fisheries, "Albatross" Philippine Expedition, October 1, 1909 (collection U. S. N. M.).

The specimen on *Sesarma* ($9\frac{1}{2} \times 4 \times 3$ mm) has an elongately curved shape, it is more or less sausage-like (fig. 2 a). In one half the antero-posterior diameter amounts to about 5 mm. The surface of the mantle is smooth without any conspicuous grooves or ridges. The mantle opening lies in the centre of the anterior region, it is surrounded by a comparatively

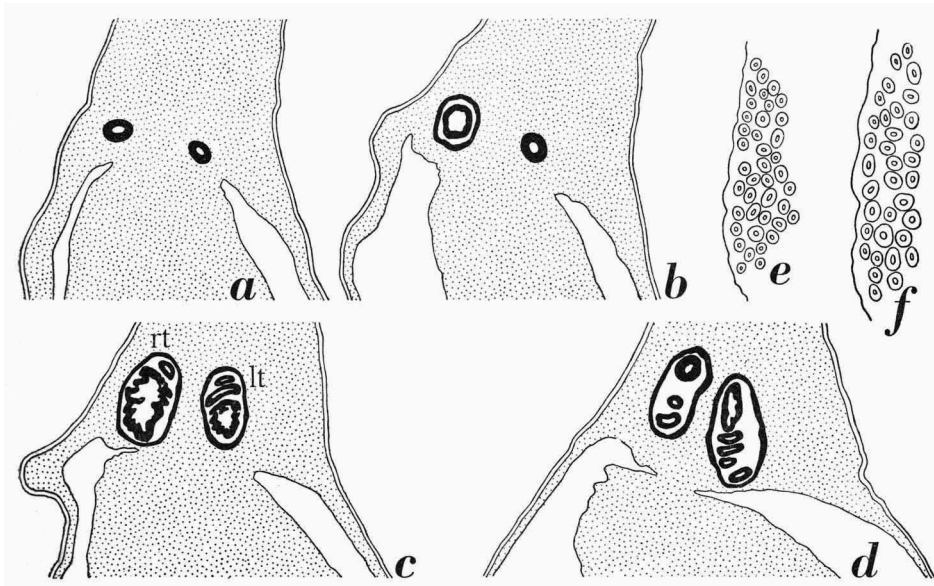


Fig. 13. *Sacculina curvata*, specimen on *Uca dussumieri*. a-d, posterior parts of longitudinal sections, each following section from a more dorsal region than the preceding; e, f, longitudinal sections of one of the colleteric glands, one from the dorsal half, the other from the ventral half. lt, left testis; rt, right testis. a-d, $\times 30$; e, f, $\times 53$.

thick wall, which does not strongly protrude above the surface. The mantle opening was directed towards the thorax of the host.

The specimen on *Uca* ($8 \times 5 \times 1\frac{1}{2}$ mm) is more or less triangular, the sides of the triangle are convex and the base is concave, so that the animal has a more or less curved shape (fig. 3 h). The animal is very flat, in a cross section it would appear to be more or less V-shaped, for the central region of the right surface has a deep antero-posterior groove, whilst the left surface possesses a corresponding ridge. The surface of the mantle is

smooth. The mantle opening lies at the top of a very small tube, in the centre of the anterior region.

Transverse sections of the male genital organs of the specimen on *Sesarma* are figured in a previous paper (Boschma, 1937, fig. 24). These show that the testes are rather strongly compressed laterally, so that it appears as if the male organs show a tendency for a curvature in an anterior direction. A longitudinal section (fig. 9 *d*) shows that the male organs are confined to the posterior region of the body, they are lying outside the visceral mass.

The specimen on *Uca* differs in some respects from the type specimen. The chief details of its structure are given here.

The male genital organs (fig. 13*a-d*) are found in the posterior part of the body, outside the visceral mass. The vasa deferentia are narrow canals (fig. 13 *a*); they gradually pass into the testes (fig. 13 *b*), which towards the dorsal region become wider. The dorsal parts of the testes are rather irregular, showing a great number of ridges and wrinkles, so that in sections of the most dorsal region the testes appear to be divided into a great many separate parts (fig. 13 *c, d*). This probably is a result of shrinking as the muscular layers surrounding the testes in these sections have a more or less evenly oval contour.

The colleteric glands of the specimen on *Uca* are more or less flattened structures which contain a fairly large number of canals (fig. 13 *e, f*). In a longitudinal section of the most strongly divided region there are 40 of these canals. They possess a thick layer of chitin. In the specimen on *Sesarma* (cf. Boschma, 1937, fig. 25) the most strongly divided part of the glands shows 38 canals in a longitudinal section; here they do not possess a chitinous inner tube.

The external cuticle of the mantle of the specimen on *Uca* is devoid of excrescences, its surface is smooth or slightly rough on account of small grooves and other irregularities. Its thickness is about 15 μ (the cuticle of the specimen on *Sesarma* is thinner, about 10 μ). In the specimen on *Uca* the surface of the cuticle is divided into small areas with irregular contours (diameter 6 to 16 μ), just as these occur in the type specimen (cf. Boschma, 1933 *b*, fig. 13).

Retinacula were not found in the parts of the internal cuticle of the specimen on *Uca* examined for this purpose.

***Sacculina confragosa* Boschma (fig. 2 *b*).**

Sacculina confragosa Boschma, 1933 *a*, p. 494, fig. 7 *b* (external shape), figs. 16, 17 (male organs and colleteric glands), fig. 18 (external and internal cuticle); Idem, 1935, p. 151; Idem, 1937, p. 229, fig. 22 (male organs), fig. 23 (colleteric glands); Shiino,

1943, p. 24, fig. 2 *E* (external shape), fig. 17 (male organs) (specimens on *Pachygrapsus crassipes* Randall and on *Goetice depressus* de Haan).

Sacculina levis Boschma, 1933 *b*, p. 231, fig. 14 (external and internal cuticle); Idem, 1937, p. 278 (synonym of *S. confragosa*).

Type specimen of *S. confragosa* on *Pachygrapsus crassipes* Randall, Misaki, Japan, Alan V. Insole, December 23, 1921 (collection British Museum).

Type specimen of *S. levis* on unknown host, Yenosima, mouth of Bay of Jeddo, Japan, E. S. Morse coll. (collection U. S. N. M.).

The type specimen of *Sacculina levis* ($14 \times 9 \times 2\frac{1}{2}$ mm) has a more or less oval shape, with concavities at the anterior and the posterior regions, in the centres of which the mantle opening and the stalk are found (fig. 2 *b*). The surface of the mantle is smooth save for a median groove at one of the surfaces, probably the right surface. The mantle opening lies at the top of a small tube, approximately in the centre of the anterior region.

In a previous paper (Boschma, 1937, p. 278) already mention was made of the fact that the name *Sacculina levis* is a synonym of *Sacculina confragosa*. The shape of the specimen (fig. 3 *b*) is very similar to that of the type of *S. confragosa* (cf. Boschma, 1933 *a*, fig. 7 *b*) and to that of the specimen of *S. confragosa* on *Goetice depressus* figured by Shiino (1943, fig. 2 *E*).

In the description of the type specimen (Boschma, 1933 *a*, p. 494) I noted: "Testes partially united." This mistake was corrected in a later paper (Boschma, 1937, p. 229) in the following words: "Male genital organs in the visceral mass, partially close together, but their cavities completely separated." Shiino (1943, p. 25) also emphasizes the fact that in *S. confragosa* the testes are completely separated, though closely adjoining each other.

***Drepanorchis strigulosa* Boschma (figs. 2 *c*, 14).**

Drepanorchis strigulosa Boschma, 1933 *b*, p. 232, fig. 15 (external and internal cuticle).

Type specimen on *Pleistacantha moseleyi* Miers, "Albatross", Station 4895 (Eastern Sea, Ose Saki Light N. 42° E., 4.7 miles: $32^{\circ} 33' 10''$ N., $128^{\circ} 32' 10''$ E.), August 9, 1906, 95 fms. (collection U. S. N. M.).

A second specimen on *Pleistacantha moseleyi* Miers, "Albatross", Station 4839 (Eastern Sea, Ose Saki Light N. 29° E., 5.5 miles: $32^{\circ} 32'$ N., $128^{\circ} 32' 50''$ E.), August 9, 1906, 106 fms. (collection U. S. N. M.).

The type specimen ($5\frac{1}{2} \times 5 \times 2\frac{1}{2}$ mm) has a more or less circular shape (fig. 2 *c*). On the surface of the mantle there are a few shallow grooves, especially at the right side. The median groove is not more conspicuous than those found at the marginal part of the posterior region. The mantle opening is a very narrow pore which lies at the top of a kind of papilla protruding anteriorly.

The visceral mass is attached to the mantle in the region from which the stalk takes its origin. The mesentery is incomplete. These two characters, combined with the fact that the male genital organs possess a distinct curve, prove that the species belongs to the genus *Drepanorchis*.

The ventral part of the vasa deferentia is found in the visceral mass where the latter is attached to the mantle (fig. 14 a); in a more dorsal region the vasa deferentia remain in the posterior part of the visceral mass, next to the mesentery (fig. 14 b), till they pass into the testes (fig. 14 c) which gradually reach a fairly large size and continue in a ventral direction (fig. 14 b). The testes are comparatively wide and have a rather voluminous

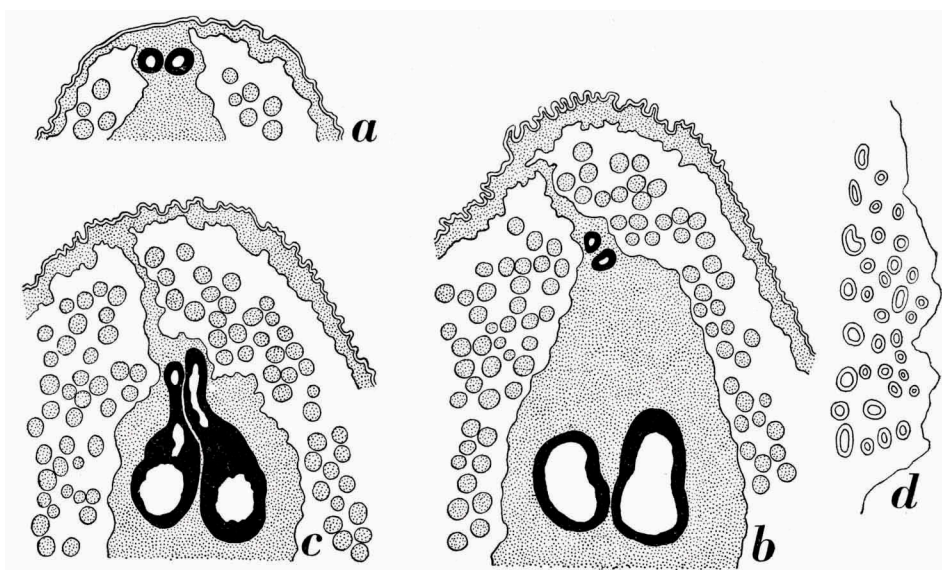


Fig. 14. *Drepanorchis strigulosa*. a-c, posterior parts of longitudinal sections, each following section from a more dorsal region than the preceding; d, longitudinal section of one of the colleteric glands. a-c, $\times 30$; d, $\times 53$.

cavity. Their terminal part lies at a fairly large distance from the vasa deferentia, so that the curvature of the male organs is rather wide (fig. 14 b).

The colleteric glands are more or less flattened structures which contain a moderate number of canals. In a longitudinal section of the most strongly divided part of one of these glands the number of canals amounts to 35 (fig. 14 d). In this specimen the canals of the colleteric glands contain well developed layers of chitin.

***Heterosaccus papillosus* (Boschma) (figs. 2 d, e, 15-18).**

Drepanorchis papillosa Boschma, 1933 b, p. 234, fig. 16 (external and internal cuticle).

Loxothylacus nierstraszi Boschma, 1938, p. 17, fig. 1 (external shape), fig. 2 (male

organs), fig. 3 (colleteric gland), fig. 4 (external cuticle), fig. 5 (internal cuticle); Idem, 1940, p. 279; Idem, 1948, p. 304.

Heterosaccus papillosus Shiino, 1943, p. 28, fig. 2 *H* (external shape), fig. 20 (male organs, colleteric gland, external and internal cuticle) (specimens on *Charybdis japonica* (de Haan)).

Type specimen of *Drepanorchis papillosa* on *Charybdis* (*Gonioneptunus*) *bimaculata* Miers, "Albatross", Station D 5369 (vicinity of Marindugue Island, Philippine Islands, Tanyabas Light (outer) N. 50° W., 8.8 miles: 13° 48' N., 121° 43' E.), February 24, 1909, 106 fms. (collection U. S. N. M.).

Type specimen of *Loxothylacus nierstraszi* on *Charybdis* (*Goniohellenus*) *truncata* Fabricius, "Gier" Expedition (probably Java Sea).

Four specimens on one specimen of *Charybdis japonica* (de Haan), Tokyo, Jordan & Snyder, 1900 (collection U.S.N.M.).

The type specimen on *Charybdis bimaculata* (14 × 9 × 3 mm) has more or less the shape of a trapezoid in which the parallel sides are slightly concave, the other sides somewhat convex (fig. 2 *e*). With the exception of a low median ridge the left surface is flat. The right surface shows a pronounced median groove running from the stalk to the mantle opening, and a quantity of irregular pits and grooves in the posterior half of the body. The mantle opening lies at the extremity of a short tube with more or less wrinkled walls, approximately in the centre of the anterior region.

The four parasites of the single specimen of *Charybdis japonica* (fig. 2 *d*) are completely covered by the abdomen of their host. They have a similar more or less oval shape and do not differ noticeably in size. The dimensions of the specimen from which sections have been made are: greater diameter 12½, antero-posterior diameter 8, and smaller diameter 3½ mm. The largest specimen (the foremost in fig. 2 *d*) has a greater diameter of 15 mm. In all the specimens the surface of the mantle is comparatively smooth, at least it does not possess conspicuous grooves or ridges. Moreover, the mantle opening is very similar in each of the four specimens. This opening is comparatively wide and protrudes very little, if at all, above the surface of the mantle.

Shiino (1943, p. 28), who examined specimens on *Charybdis japonica*, pointed to the fact that the species does not belong to the genus *Drepanorchis*, but to *Heterosaccus*, as the mesentery is very incomplete. As the original description of *Drepanorchis papillosa* is very short some more details of the structure of the specimens are given here.

In the type specimen, on *Charybdis bimaculata*, a longitudinal section from the dorsal region (fig. 15 *f*) shows that there is no mesentery at the anterior end of the visceral mass. Such a section, therefore, is very similar to one from the ventral region (fig. 15 *a*). In this specimen the visceral mass is not directly attached to the posterior region of the body from which the

stalk takes its origin, but it has shifted slightly to one side (fig. 15 *b*). In this region the vasa deferentia are found, narrow canals running along the posterior margin of the visceral mass. Towards a more dorsal region they gradually increase in size (fig. 15 *c*) and soon pass into the testes (fig. 15 *d, e*). The course of the testes is chiefly in an anterior direction, the terminal part is more or less directed towards the ventral half (fig. 15 *c*). The testes, which are surrounded by a muscular layer, in this specimen are of fairly large size. The two testes do not differ in shape or in size.

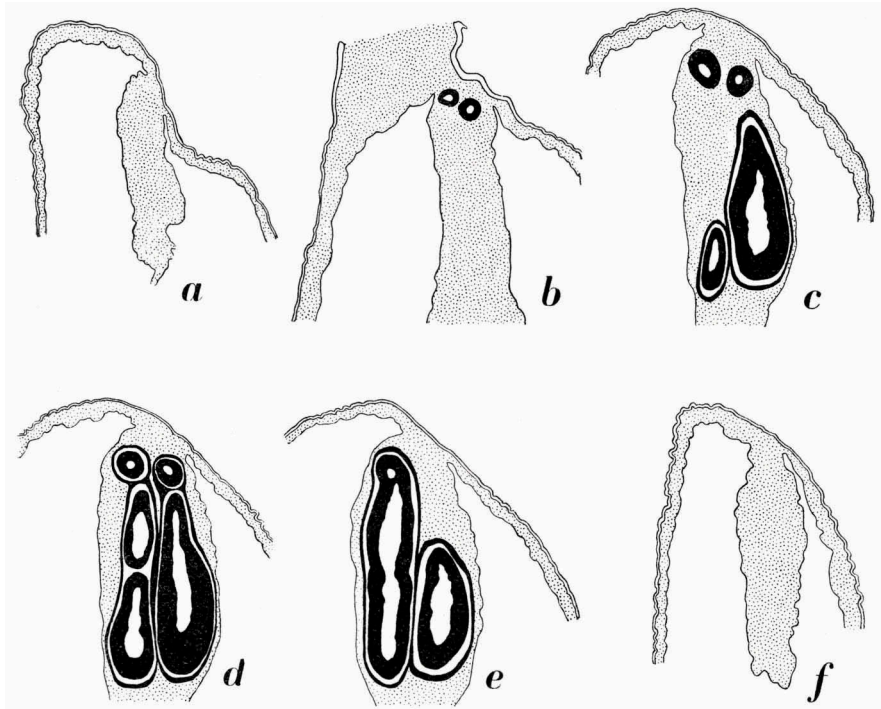


Fig. 15. *Heterosaccus papillosus*, specimen on *Charybdis bimaculata*, posterior parts (in *a* and *f* containing the whole visceral mass) of longitudinal sections, each following section from a more dorsal region than the preceding. $\times 14$.

The colleteric glands of the specimen on *Charybdis bimaculata* have a fairly large number of canals. In a longitudinal section of the most strongly divided part this number amounts to 57 (fig. 17 *a, b*). In the canals there has been secreted a distinct layer of chitin.

In the sectioned specimen on *Charybdis japonica* the visceral mass is directly attached to the posterior part of the body, the region from which the stalk protrudes (fig. 16 *a*). The mesentery is very incomplete so that a longitudinal section from the dorsal region of the body (fig. 16 *f*) does

not show a trace of the mesentery. In this specimen the male organs are comparatively small, but otherwise they are very similar to those of the type specimen. As in the latter the two testes are of approximately equal size and shape. The vasa deferentia are narrow canals (fig. 16 *b*), they gradually pass into the testes (fig. 16 *c*), which continue in a more or less anterior direction. Fig. 16 *d* represents a section in which the curvature of the testes is visible; fig. 16 *e* shows the most dorsal part of the testes. As in the type specimen the curvature of the testes is little pronounced though distinctly visible.

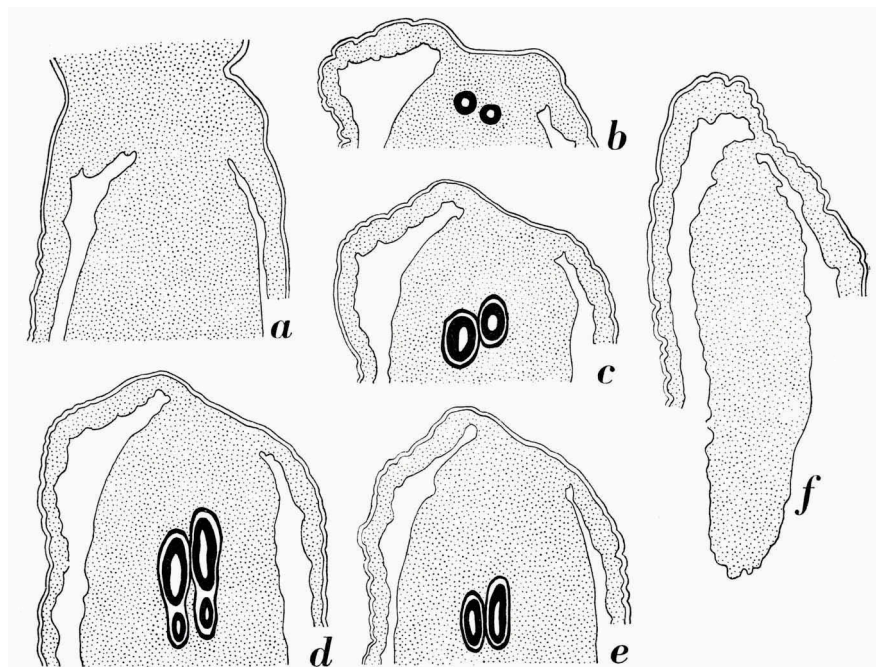


Fig. 16. *Heterosaccus papillosus*, specimen on *Charybdis japonica*, posterior parts (in *f* containing the whole visceral mass) of longitudinal sections, each following section from a more dorsal region than the preceding. $\times 14$.

The colleteric glands of the sectioned specimen on *Charybdis japonica* do not differ in any important detail from those of the type specimen. The maximum number of canals observed here in a longitudinal section is 50 (fig. 17 *c, d*). As in the type specimen the canals possess chitinous secretions.

In the four specimens occurring together on the specimen of *Charybdis japonica* the excrescences of the external and the internal cuticle of the mantle are of a similar shape, differing in minor details only from those of the type specimen. The papillae covering the external cuticle usually are

not longer than $6\ \mu$, exceptionally they may reach a size of $10\ \mu$ (fig. 18a-f). In the type specimen these papillae were found to be covered with minute lateral hairs, these were not observed in the papillae of the specimens on *Charybdis japonica*. The papillae may occur rather crowdedly (fig. 18 c, e) or more sparsely distributed (fig. 18 d, f). It is interesting that in one of the specimens the cuticle bearing the typical excrescences is covered by an older cuticle which does not possess excrescences (fig. 18 a, b).

The retinacula of the two specimens are of a similar shape. Whilst, however, in the type specimen the spindles have a length of 10 to $15\ \mu$, they are slightly smaller in the specimens on *Charybdis japonica*, where they are from 6 to $12\ \mu$ (fig. 18 g, h). As in the type specimen the spindles seem to possess no barbs.

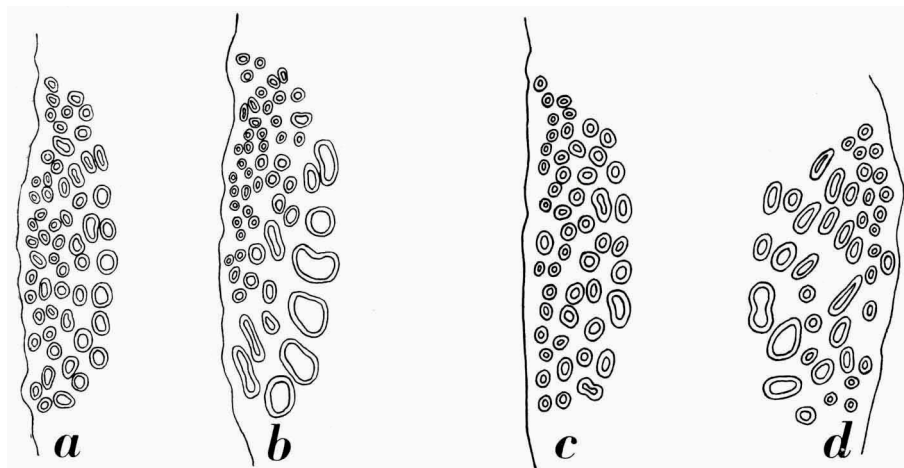


Fig. 17. *Heterosaccus papillosus*. a, b, specimen on *Charybdis bimaculata*, longitudinal sections of one of the colleteric glands, b from a more central region than a; c, d, specimen on *Charybdis japonica*, longitudinal sections of the two colleteric glands. $\times 45$.

The type specimen of *Loxothylacus nierstraszi* (cf. Boschma, 1938) has an incomplete mesentery and, therefore, belongs to the genus *Heterosaccus*. In this specimen the visceral mass is attached to the mantle at some distance from the stalk (loc. cit., fig. 2 a), which explains the mistake of placing the specimen in the genus *Loxothylacus*. As far as concerns this character the type specimen of *Heterosaccus papillosus* is intermediate between the sectioned specimen on *Charybdis japonica* and the type specimen of *Loxothylacus nierstraszi*. The male organs of the latter specimen and its colleteric glands are of a similar shape as those of the other specimens, the number of canals in a longitudinal section of the most strongly divided region amounting to 60 (loc. cit., fig. 3 c).

The excrescences of the external cuticle of the mantle of the type specimen of *Loxothylacus nierstraszi* (loc. cit., fig. 4) are exactly alike to those of the specimens on *Charybdis japonica* (fig. 18 a-f). The retinacula of the type specimen of *Loxothylacus nierstraszi* (loc. cit., fig. 5) in every respect are entirely corresponding to those of the type specimen of *Heterosaccus papillosus* (cf. Boschma, 1933 b, fig. 16 c, d).

All these peculiarities show that the specimen described as *Loxothylacus*

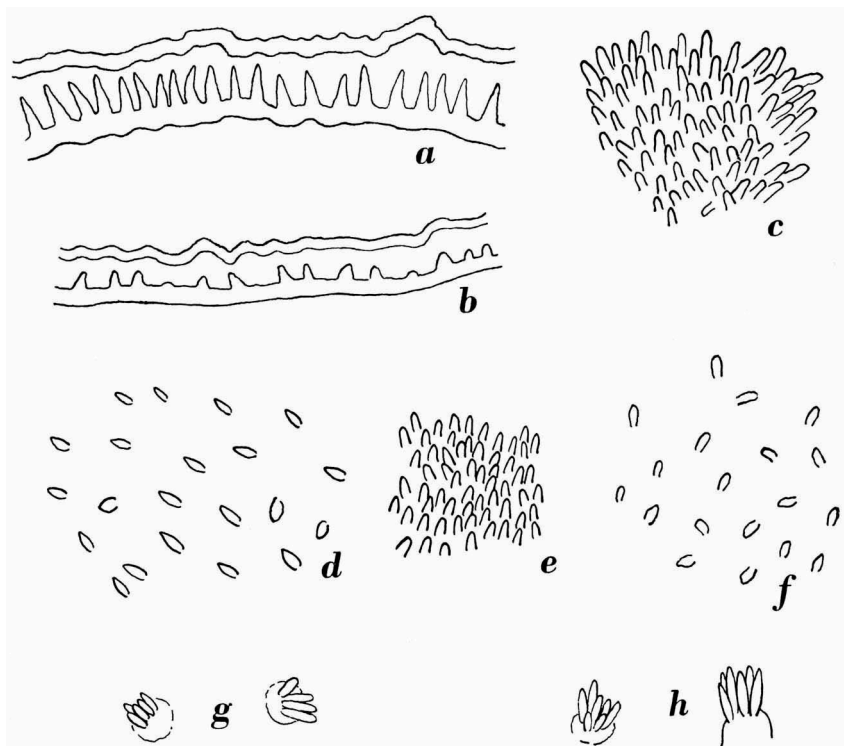


Fig. 18. *Heterosaccus papillosus*, specimens on *Charybdis japonica*. a, b, sections of the external cuticle of one specimen; c, excrescences of the external cuticle of the same specimen; d-f, excrescences of the three other specimens; g, h, retinacula of two of the specimens. $\times 530$.

nierstraszi is nothing else but a specimen of *Heterosaccus papillosus* in which the visceral mass has a rather aberrant manner of attachment.

Shiino's specimens of *Heterosaccus papillosus* on *Charybdis japonica* correspond with those on the same species of host dealt with above. The curvature of the testes is highly similar, the papillae of the external cuticle are of the same shape, without lateral hairs (length to about 7μ , cf. Shiino, 1943, fig. 20 F). In Shiino's specimens the retinacula (loc. cit., fig. 20 G)

have spindles of a length of 9 to 14 μ , and here they possess barbs. The colleteric glands of Shiino's specimens show a larger maximum number of canals (surpassing 85, loc. cit., p. 28) than in the specimens dealt with above. These differences, however, may be regarded as the results of individual variation.

***Drepanorchis tenuicutis* Boschma (figs. 2 f, 19).**

Drepanorchis tenuicutis Boschma, 1933 b, p. 234, fig. 17 (external and internal cuticle).

Type specimen on *Aepinus indicus* (Alcock), Amirante, Western Indian Ocean, H. M. S. "Sealark", Station E 10, October 11, 1905 (collection U. S. N. M.).

The parasite ($2\frac{1}{2} \times 1\frac{1}{2} \times 1$ mm) has an oval shape (fig. 2 f). It is more or less constricted at its posterior part and the right side shows a deep median groove, so that the animal especially at the right side has a more or less bilobate appearance. The surface of the mantle does not possess any marked furrows or ridges, with the exception of the groove mentioned above. The narrow mantle opening, surrounded by a well developed wall, lies at the anterior margin of the left side. This part slightly protrudes above the surface of the mantle.

The visceral mass is attached to the region of the stalk (fig. 19 a), the mesentery does not reach the mantle opening, the male organs are distinctly curved, so that without any doubt the parasite belongs to the genus *Drepanorchis*.

The vasa deferentia are narrow canals extending along the posterior border of the visceral mass (fig. 19 b, c). In their most dorsal part they bend towards the anterior region (fig. 19 d) and pass into the testes. The two testes are of a highly different shape. The left does not become wider than its vas deferens (fig. 19 c), the right is strongly enlarged and is composed of a wide sac which towards its terminal region reaches its largest size (fig. 19 b). The two testes are distinctly curved, the convex part of the curvature being turned towards the dorsal half of the visceral mass.

The colleteric glands, in the original description (Boschma, 1933 b, p. 234) stated to be situated in the anterior half of the visceral mass, really are nearer to the anterior extremity of the visceral mass than to its posterior end, but the glands are not far from the central region of the visceral mass (fig. 19 a). They have very few canals, which in the type specimen do not show secretions of chitin.

In the description of the type specimen it was observed that the specimen, though being very small, is not immature, as the mantle cavity contains eggs. These are shown in the sections represented in fig. 19.

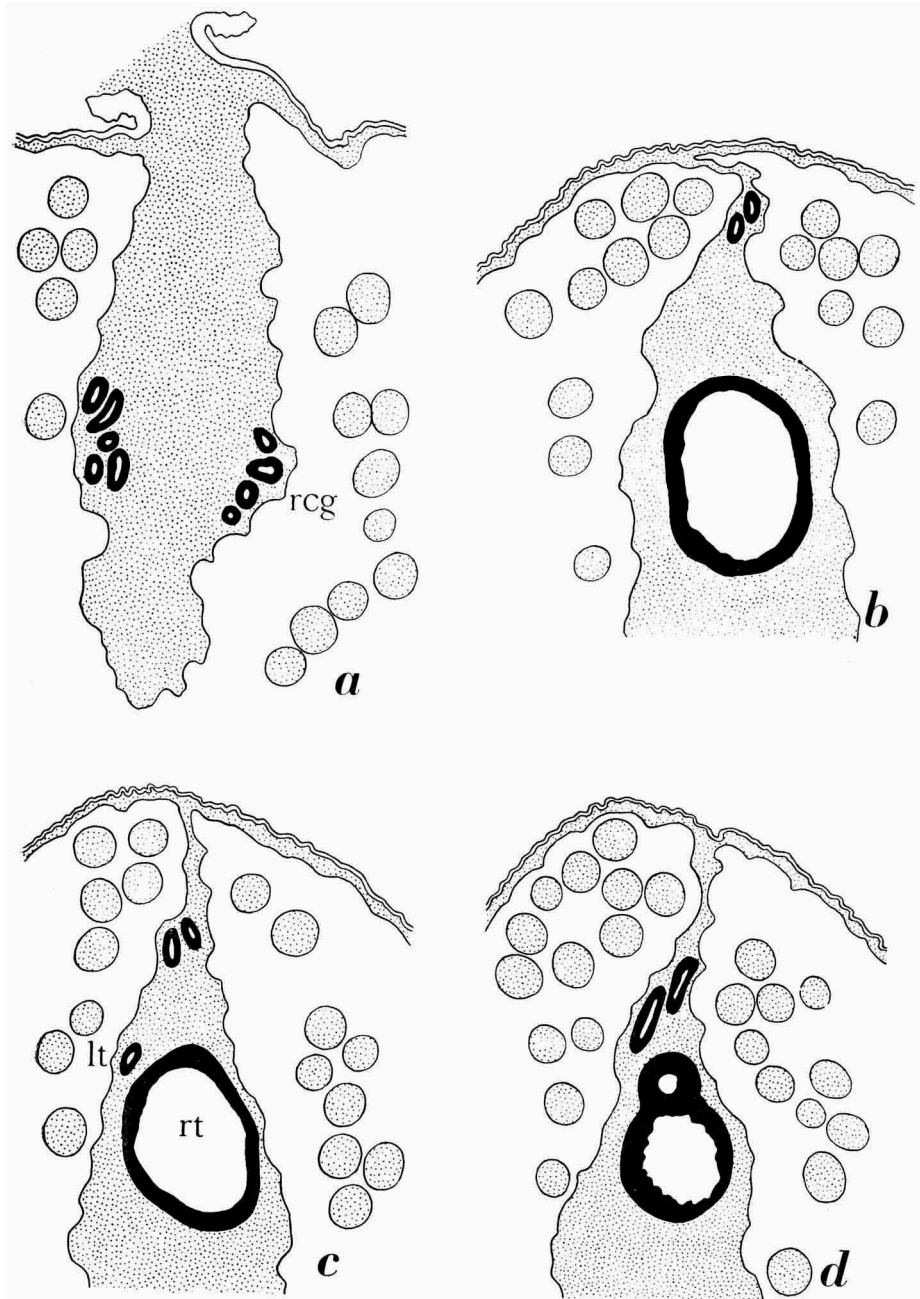


Fig. 19. *Drepanorchis tenuicuttis*, longitudinal sections (*b-d*, posterior parts), each following section from a more dorsal region than the preceding. *lt*, left testis; *rcg*, right colleteric gland; *rt*, right testis. $\times 80$.

Heterosaccus distortus Boschma (figs. 2 *g*, 20).

Heterosaccus distortus Boschma, 1933 *b*, p. 235, fig. 18 (external and internal cuticle).

Type specimen on *Schizophrys aspera* (H. Milne Edwards), United States Bureau of Fisheries Philippine Expedition 1907-1910, "Albatross", Station 5145, vicinity of Jolo, February 15, 1908 (collection U. S. N. M.).

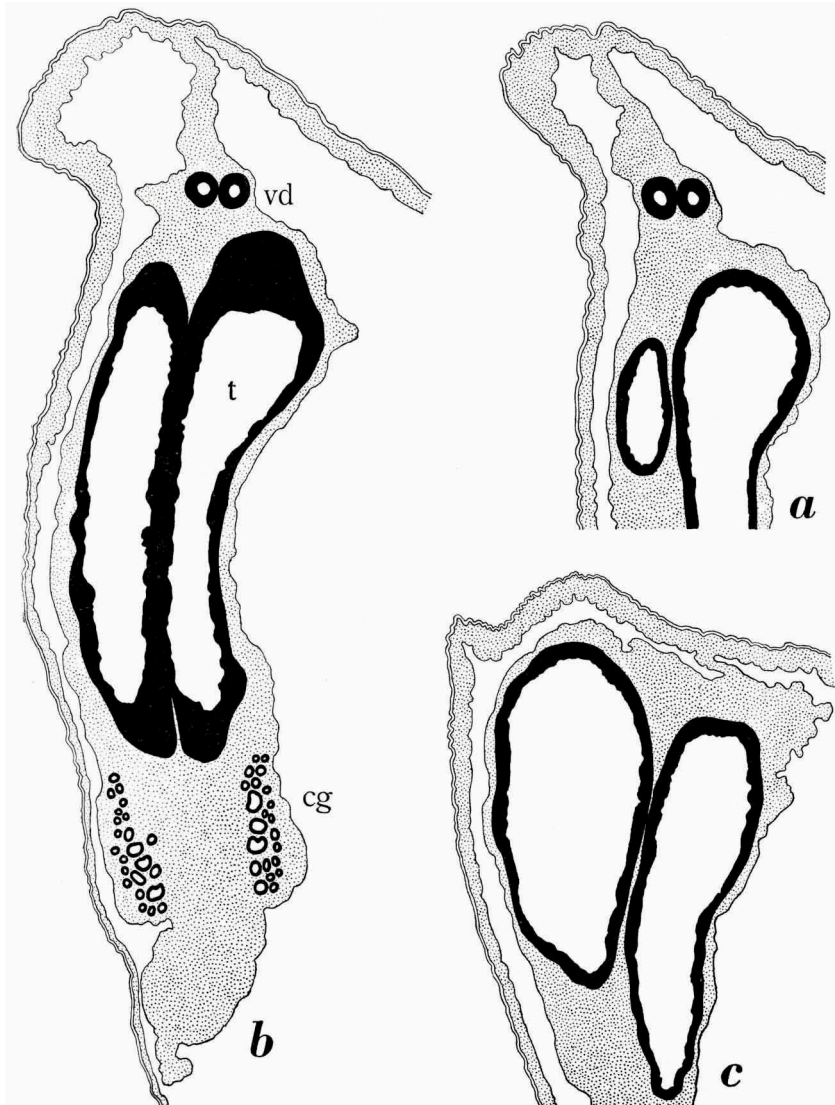


Fig. 20. *Heterosaccus distortus*. *a*, posterior part of a longitudinal section; *b*, longitudinal section from a more dorsal region; *c*, posterior part of a longitudinal section from a still more dorsal region. *cg*, colleteric gland; *t*, testis; *vd*, vas deferens. $\times 30$.

The specimen ($7 \times 6 \times 3$ mm) has an irregular shape caused by a Bopyrid parasite which takes up the greater part of the mantle cavity, and by which the latter consequently is strongly distorted (fig. 2g). Through the thin, more or less transparent mantle the shape of the Bopyrid is dimly visible, and, at the surface which was turned towards the thorax of the host (the left side) the visceral mass and the colleteric gland of this side. The mantle opening is comparatively wide, it lies at the top of a short tube in the central part of the anterior region.

The vasa deferentia are narrow canals running along the posterior margin of the visceral mass (fig. 20 a, b), the testes are comparatively wide sacs, chiefly extending in an anterior direction (fig. 20 a-c). The two male organs are of approximately equal size, their thickness is largest in the dorsal region (fig. 20 c). The male organs show a distinct curve resulting in continuing their course in an anterior direction; the terminal part is not so strongly curved that it points in a ventral direction. The two testes are of about equal size; they are in rather close contact (pressure of the Bopyrid?), but their cavities remain completely separated.

The colleteric glands (fig. 20 b) are found in the anterior part of the visceral mass. They contain a moderate number of canals. In the figured section one of these glands shows 23 canals, the other 22. In the only available specimen the canals of the colleteric glands do not possess chitin.

Heterosaccus californicus Boschma (figs. 2 h, 3 d, g, i, 21-26).

Heterosaccus californicus Boschma, 1933 b, p. 236, fig. 19 (external and internal cuticle); Ricketts & Calvin, 1948, p. 317.

Sacculina, Ricketts & Calvin, 1948, pp. 81, 240 et seq.; MacGinitie & MacGinitie, 1949, p. 261, fig. 117 (photograph of specimen on *Loxorhynchus grandis* Stimpson).

Type specimen on *Pugettia producta* (Randall), Santa Cruz, California, J. L. Kingsley coll. (from Boston Society of Natural History) (collection U. S. N. M.).

Specimen on *Loxorhynchus crispatus* Stimpson, Monterey Bay, "Albatross", Station 4551, 46-56 fms., June 7, 1904 (collection U. S. N. M.).

Specimen on *Taliepus nuttallii* (Randall), San Diego, California, Henry Hemphill leg., received April 15, 1874 (collection Museum of Comparative Zoölogy, Cambridge, Mass.).

The specimen on *Pugettia producta* (the type specimen, $31 \times 22 \times 9$ mm) has a more or less roundish shape (fig. 2 h). Its surface shows a number of smaller and larger grooves and pits, for a large part arisen as a result of pressure of parts of the body of the host against the parasite. The wide mantle opening lies at the top of a tubular structure in the central part of the anterior region. The sides of this protruding part of the mantle show a number of longitudinal grooves. At the right side there is a median

groove running from the stalk in anterior direction, caused by pressure of the abdomen of the host against the parasite.

The specimen on *Loxorhynchus crispatus* ($20 \times 13 \times 8$ mm) has a more or less oval shape (fig. 3 *d*). In comparison to the large size of the parasite the mantle is very thin (it is covered by a thin cuticle also); it shows, therefore, many irregular grooves and furrows, which for the greater part have arisen as a result of the pressure of parts of the host against the parasite. The most conspicuous concavity is that at the median part of the right surface. Besides this one the latter surface shows a number of smaller grooves more or less perpendicular to the main axis. The left surface also possesses a number of grooves, chiefly in the posterior half. Especially in the dorsal and ventral regions of the body the mantle is strongly wrinkled on a smaller scale, resulting in the numerous small grooves and ridges as they are represented in fig. 24 *a*. The mantle opening is extremely wide, it lies at the top of a short tube with a thin wall, which has a greater diameter of 5 mm (at the base). This tube lies in the centre of the anterior region.

The specimen on *Taliepus nuttallii* ($18 \times 13 \times 10$ mm) has a more or less circular to slightly oval contour (fig. 3 *g, i*). With the exception of a broad furrow on the right side, running in antero-posterior direction, and caused by pressure of the median ridge of the abdomen of the host against the parasite, the mantle does not show any pronounced grooves or wrinkles. The surface, however, appears to be profusely pitted with small shallow depressions. When slightly enlarged it appears that each of these pits forms the centre of a system of more or less radially arranged grooves, as shown in fig. 26 *d*. The mantle opening lies at the extremity of a well developed tubular expansion of the mantle, which exteriorly shows a number of longitudinal grooves. This expansion of the mantle occupies the central part of the anterior region of the body.

In the specimen on *Pugettia producta* the visceral mass is attached to the mantle not exactly in the region of the stalk, but slightly to one side (fig. 21 *a*). In this region the vasa deferentia are narrow canals running along the posterior margin of the visceral mass (fig. 21 *a, b*). Towards a more dorsal plane they become wider and at the same time obtain a more or less contorted course (fig. 21 *c, d*), which still continues in the region in which they are passing into the testes (fig. 21 *e-g*). The male organs show a distinct curvature, so that the terminal part of the testes is distinctly pointing in an anterior direction (fig. 21 *b-d*). The two male organs have approximately the same shape and the same dimensions.

The colleteric glands occupy approximately the central part of the lateral

surfaces of the visceral mass (fig. 21 *d, e*), they contain a considerable number of canals. A longitudinal section of the most strongly branched region of these glands appears to contain 130 canals (fig. 22 *a*). In many parts of the gland a number of canals are surrounded by a common thin layer of tissue, so that the structure of the glands in this specimen is more or less similar to those of *Heterosaccus setoensis* (cf. Shiino, 1943, fig.

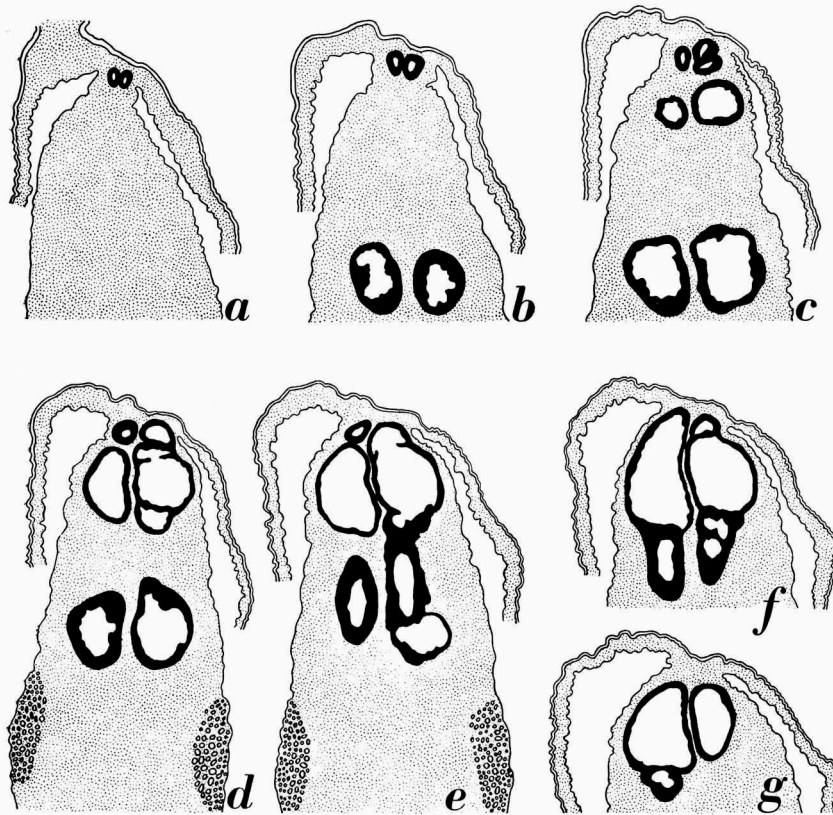


Fig. 21. *Heterosaccus californicus*, specimen on *Pugettia producta*, posterior parts of longitudinal sections, each following section from a more dorsal region than the preceding. $\times 6$.

22 *G*). In the specimen described by Shiino, however, the colleteric glands contain well developed tubes of chitinous matter, so that here the occurrence of a number of chitinous tubes in one canal with a distinct epithelium might point to the fact that the chitinous matter of the glands was partially withdrawn from the places where it had been formed. In the specimen on *Pugettia producta* the colleteric glands do not possess chitin, the regular

occurrence of a number of tubes in common larger cavities cannot be explained in the manner outlined above.

In the specimen on *Loxorhynchus crispatus* the visceral mass is attached to the posterior part of the body in the region of the stalk.

The sections of the male organs represented in fig. 23 were selected in such a way that from fig. 23 *a* to fig. 23 *e* the distance of two sections

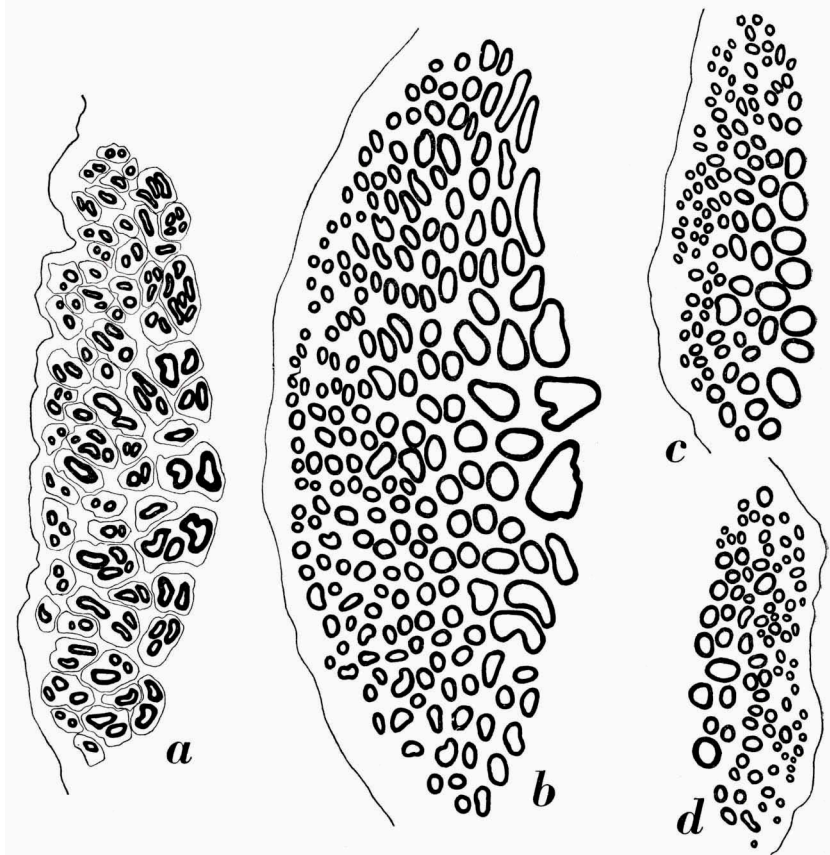


Fig. 22. *Heterosaccus californicus*, longitudinal sections of colleteric glands of three specimens. *a*, on *Pugettia producta*; *b*, on *Taliepus nuttallii*; *c*, *d*, on *Loxorhynchus crispatus* (sections of the two glands). *a*, *c*, *d*, $\times 30$; *b*, $\times 53$.

always is $150\ \mu$, and that from fig. 23 *e* to fig. 23 *m* the distance of two sections always is $75\ \mu$. Fig. 23 *a* shows the parts of the male organs protruding into the most ventral region, these are the closed extremities of the two testes. In a more dorsal region the ventral parts of the vasa deferentia appear (fig. 23 *b*); in this section the testes already have a wide cavity. In the next section (fig. 23 *c*) the cavities of the testes have reached their

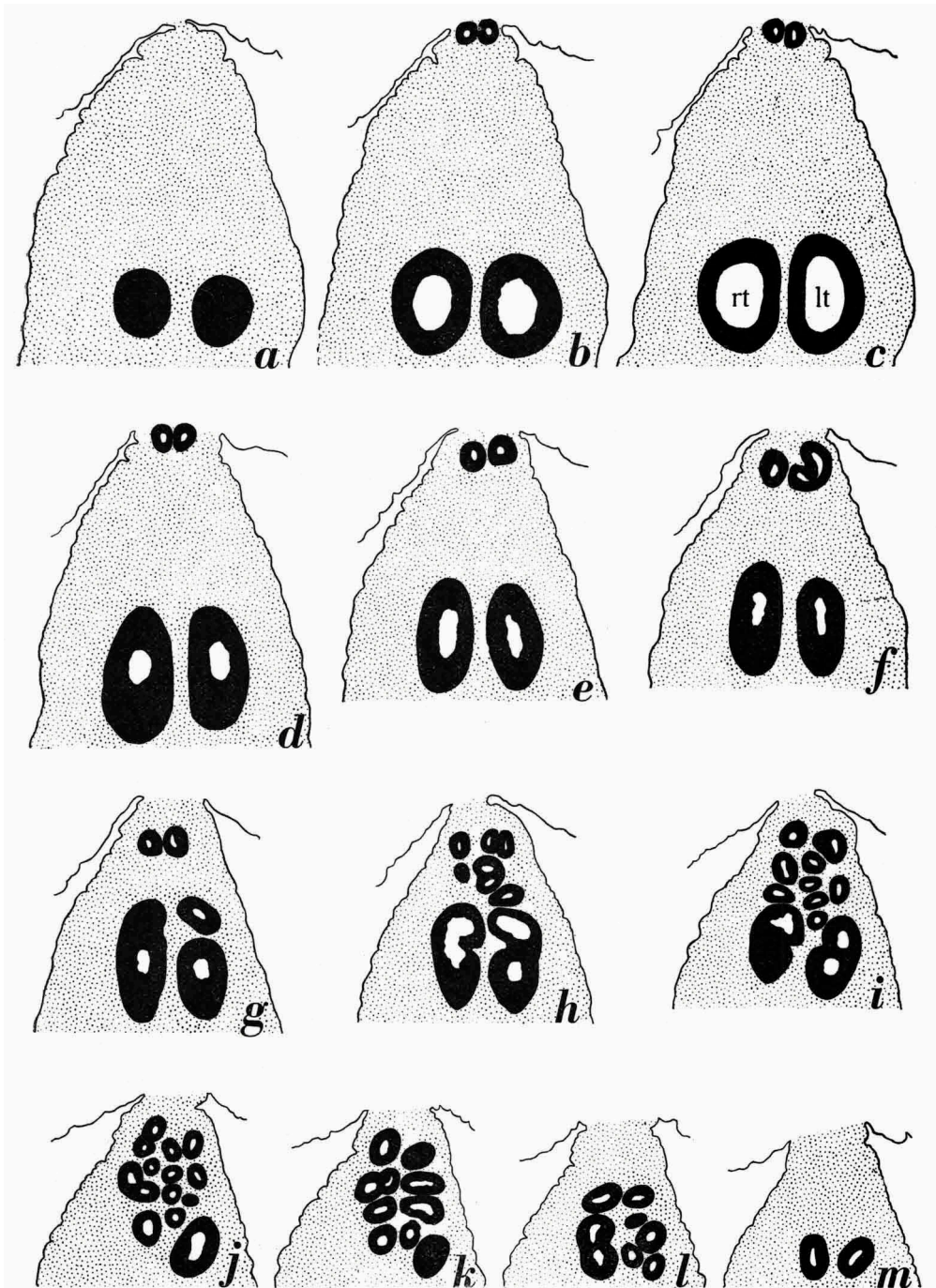


Fig. 23. *Heterosaccus californicus*, specimen on *Loxorhynchus crispatus*, posterior parts of longitudinal sections, each following section from a more dorsal region than the preceding. *lt*, left testis; *rt*, right testis. $\times 12$.

maximum width; towards a more dorsal region (fig. 23 *d-f*) the cavities of the testes become narrower. Fig. 23 *g* shows a section in the region of the transition of the vasa deferentia into the testes, the male organs have become somewhat contorted, a process which in a still more dorsal region (fig. 23 *h-l*) becomes very pronounced. The farthest dorsal part of the male organs is shown in fig. 23 *m*. The two male organs are of the same size and have approximately the same shape; one of the vasa deferentia (the left) is still more contorted than the other.

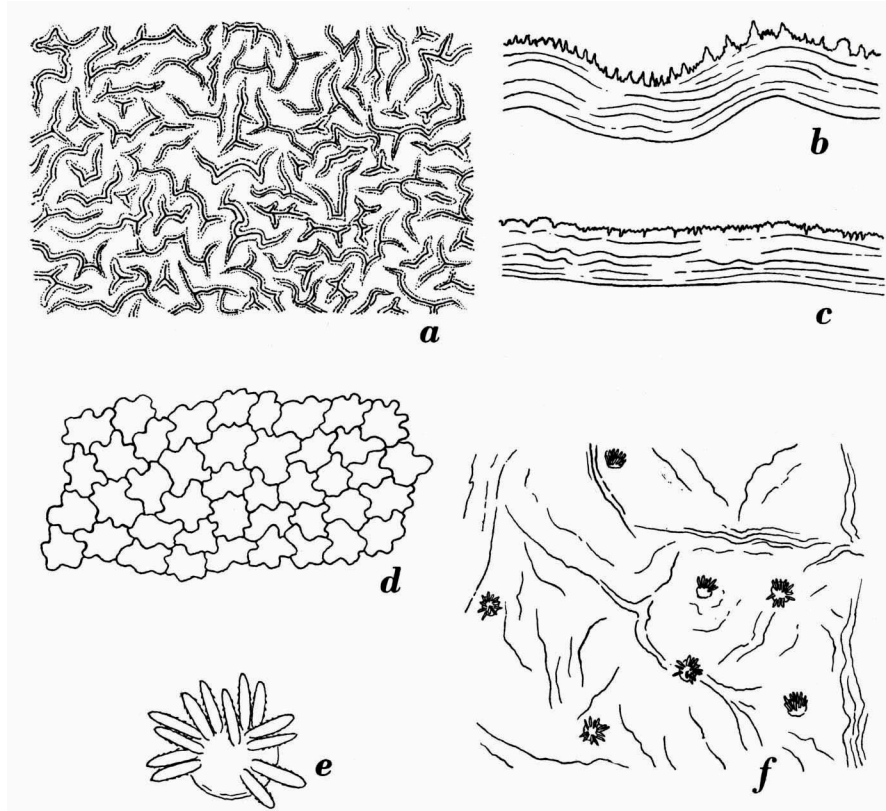


Fig. 24. *Heterosaccus californicus*, specimen on *Loxorhynchus crispatus*, *a*, surface view of the external cuticle; *b* and *c*, sections of the external cuticle; *d*, surface view of the external cuticle; *e*, retinaculum; *f*, surface view of the internal cuticle with reticula. *a*, $\times 29$; *b-e*, $\times 530$; *f*, $\times 100$.

The colleteric glands are found in the central region of the lateral surfaces of the visceral mass. They contain a large number of canals. In a longitudinal section from the most strongly divided part of one of these glands 106 canals are present (fig. 22 *c*), in a corresponding section of the other gland there are 88 canals (fig. 22 *d*).

The external cuticle of the mantle shows a great number of short irregular grooves so that it has a more or less wrinkled appearance (fig. 24 *a*). The cuticle does not possess excrescences. As a rule its surface is not altogether smooth but shows some irregular rugosities (fig. 24 *b, c*). In many parts of the cuticle the surface is seen to be divided into small areas with more or less sinuous contours (fig. 24 *d*), which have a diameter of 7 to 15 μ .

Retinacula occur in large numbers on the surface of the internal cuticle (fig. 24 *f*). Each retinaculum consists of a fairly large basal part and about 10 to 15 spindles (fig. 24 *e*). The latter are barbed, they have a length of 12 to 15 μ .

In the specimen on *Taliepus nuttallii* again the visceral mass is attached to the region of the stalk. The male organs (fig. 25) are similar to those of

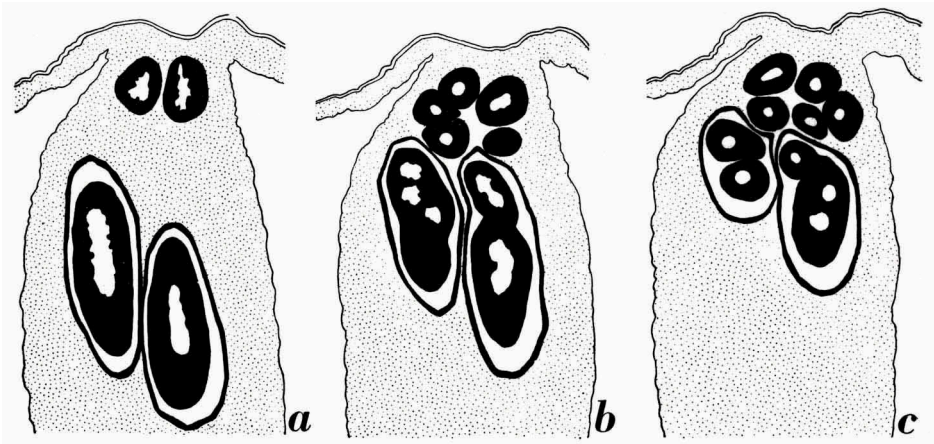


Fig. 25. *Heterosaccus californicus*, specimen on *Taliepus nuttallii*, posterior parts of longitudinal sections; *a* from a more ventral region than *b*, *c* from a more dorsal region than *b*. $\times 5\frac{1}{2}$.

the specimen on *Loxorhynchus*. In the figures the muscular layer is shown that is distinctly developed around the testes and not, or far less pronouncedly, around the vasa deferentia. Fig. 25 *a* shows the vasa deferentia and the ventral part of the testes. Fig. 25 *b* is from a more dorsal region; here the cavities of the testes are divided into several parts, showing that here the testes too have a slightly contorted shape, similar to that of the vasa deferentia. Fig. 25 *c* is a section from the region of the transition of the vasa deferentia into the testes, the twisted appearance of this part of the male organs is evident here. The two male organs in the specimen on *Taliepus nuttallii* have an approximately equal size and have a similar shape.

In this specimen the colleteric glands have a very large number of canals.

In a longitudinal section of the most strongly divided region of one of these glands 212 canals were counted (fig. 22 *b*). They form a compact mass; as a matter of fact the smaller canals are most abundant in the peripheral region. As in the two other specimens of *Heterosaccus californicus* dealt with here the canals do not happen to contain chitin.

In comparison to the size of the parasite the external cuticle of the mantle is extremely thin. In many parts of the mantle this cuticle has a thickness of about 20 μ (fig. 26 *b*), but in other parts it is still thinner (fig. 26 *a*, 5 to 7 μ). The cuticle does not possess excrescences, its surface as a rule shows slight rugosities (fig. 26 *b*), which also appear in surface view (fig. 26 *c*). The surface of the cuticle is divided into small areas with sinuous contours which have a diameter of 7 to 15 μ (fig. 26 *c*). Already with the naked eye the surface of the mantle is seen to be more or less grooved or pitted. This results into a number of grooves and furrows as shown in fig. 26 *d*.

The internal cuticle of the mantle is covered with numerous retinacula, which as in the other specimens dealt with here, consist of a fairly large basal part and numerous spindles (fig. 26 *e*). The spindles are barbed and have a length of 12 to 15 μ .

The specimen on *Pugettia producta*, that on *Loxorhynchus crispatus*, and that on *Taliepus nuttallii* (all these hosts belong to the family Maiidae) undoubtedly belong to the same species. In the three specimens the characters of the external and the internal cuticle correspond closely, whilst the colleteric glands, though presenting differences in the number of canals, in the three specimens have an entirely similar structure. The observed differences must be a result of individual variation. In the specimens on *Loxorhynchus* and on *Taliepus* the male organs are pronouncedly contorted; in the specimen on *Pugettia* this contortion occurs to a much lesser degree. Here too the differences undoubtedly are a result of individual variation. In all the three specimens the two male organs are of pronouncedly similar shape and size, whilst the two male organs constantly remain completely separated.

The occurrence of a Rhizocephalan parasite on *Pugettia producta* has also been noted by Ricketts & Calvin (1948, as *Sacculina* on p. 81 and on p. 240 et seq.; on p. 317 as *Heterosaccus californicus*). Interesting are the following remarks (loc. cit., p. 241): "*Sacculina* afflicts European crabs heavily, but for some reason it is not known on our Atlantic coast. On the California coast usually less than 10 per cent but more than 1 per cent of the kelp crabs examined will be found to be infected. With increase in latitude, rhizocephalans become more abundant; at Sitka even the tide-pool

crabs may be afflicted." In this connexion it may be observed that rather common Sacculinidae of the Atlantic coastal waters of America are *Heterosaccus occidentalis* and *Loxothylacus panopaei* (cf. Boschma, 1928), and *Loxothylacus texanus*, the latter dealt with in the present paper.

MacGinitie & MacGinitie (1949, p. 261) state: "*Sacculina* parasitizes several species of crabs. The crab most often parasitized by *Sacculina* on our Southwest Coast is *Loxorhynchis grandis*, farther north it is the kelp

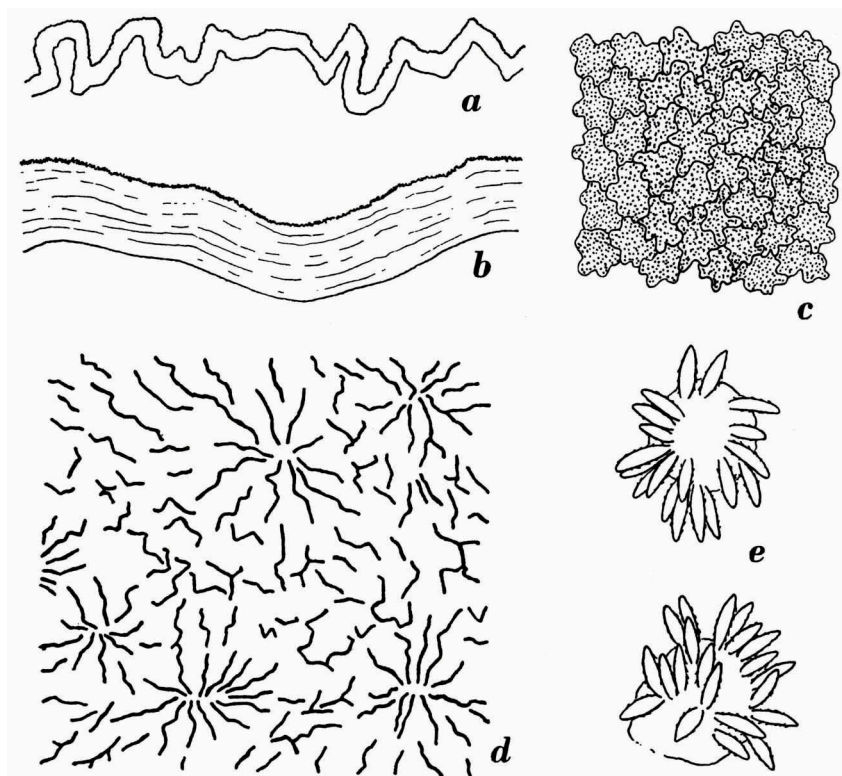


Fig. 26. *Heterosaccus californicus*, specimen on *Talipes nuttallii*. a, b, sections of the external cuticle; c, d, surface of the external cuticle; e, retinacula. a-c, e, $\times 530$; d, $\times 29$.

crab *Pugettia producta*, and in the Puget Sound region it is the rocky tide-pool crab *Lophopanopeus bellus*. On the East Coast *Sacculina* parasitizes *Carcinides maenas*." Fig. 117 in the cited work shows "A parasitic barnacle, *Sacculina* sp. On the crab *Loxorhynchus grandis*. $\times \frac{1}{2}$." This figured specimen is of rather large size, the greater diameter amounting to about 35 mm. In all probability the parasite of *Loxorhynchus grandis* is conspecific with the parasite of *L. crispatus* dealt with above. As far as concerns

the statement regarding the occurrence of *Sacculina* on *Carcinides maenas* on the East coast of America it must be remarked that a lapsus has occurred here. Rathbun (1930), when listing an abundant material of *C. maenas* from the East coast of the United States, does not mention a single specimen with a Rhizocephalan parasite, though she records a specimen from Cowes, England, bearing a parasite of the group.

Loxothylacus texanus Boschma (figs. 2 *i, j*, 3 *b, c, e*, 27-31).

Loxothylacus texanus Boschma, 1933 *b*, p. 237, fig. 20 (external and internal cuticle); Idem, 1940, p. 278.

Type specimen on *Callinectes sapidus* Rathbun, Metagorda Bay, near Indianola, Texas, J. D. Mitchell coll. (collection U. S. N. M.).

Specimen on *Callinectes sapidus* Rathbun, San Antonio Bay, Texas, J. D. Mitchell, 1898 (collection U. S. N. M.).

Specimen on *Callinectes sapidus* Rathbun, Galveston, Texas, W. M. Wheeler coll. (collection American Museum of Natural History, New York).

Specimen on *Callinectes marginatus* (A. Milne Edwards), Toro Point, Canal Zone, Meek & Hildebrand, January 25, 1912 (collection U. S. N. M.).

Specimen on *Callinectes marginatus* (A. Milne Edwards), Porto Bello, River of Panama, Meek & Hildebrand, March 19, 1912 (collection U. S. N. M.).

The shape of the parasites is rather variable. A specimen on *Callinectes sapidus*, from San Antonio Bay (fig. 2 *i*, $21 \times 13 \times 5\frac{1}{2}$ mm) is irregularly oval with the mantle opening at the top of a short tube, on the left surface, at a slight distance from the anterior region. In this specimen the mantle does not show any pronounced grooves except the one at the right surface running in an antero-posterior direction. The greater part of the specimens on *Callinectes sapidus* have the shape of the animal from Galveston shown in fig. 3 *b, c* ($11\frac{1}{2} \times 7 \times 4\frac{1}{2}$ mm). Here the dorsal and ventral halves at the left side are more or less flattened, whilst the right side is more convex. The right side always shows a pronounced median groove in an antero-posterior direction, caused by pressure of the median ridge of the abdomen of the host, and usually a few more grooves caused by pressure of appendages of the host. In the figured specimen from Galveston the mantle opening, at the top of a short tube, has a more central anterior position.

Specimens on *Callinectes marginatus* on the whole have a shape corresponding with that of the parasites of *C. sapidus*. A full grown parasite of *C. marginatus*, from Toro Point, is the one of fig. 2 *j* ($23 \times 15 \times 6$ mm). It has an irregular triangularly oval shape, whilst the comparatively wide mantle opening is found at the top of a rather broad tube, in the central part of the anterior region. In this specimen the mantle is more or less uneven, mostly on account of pressure by parts of the body of the host.

The other figured parasite of *Callinectes marginatus* (fig. 3 e, $6 \times 4\frac{3}{4} \times 2$ mm) is a juvenile specimen of more or less circular shape in which the

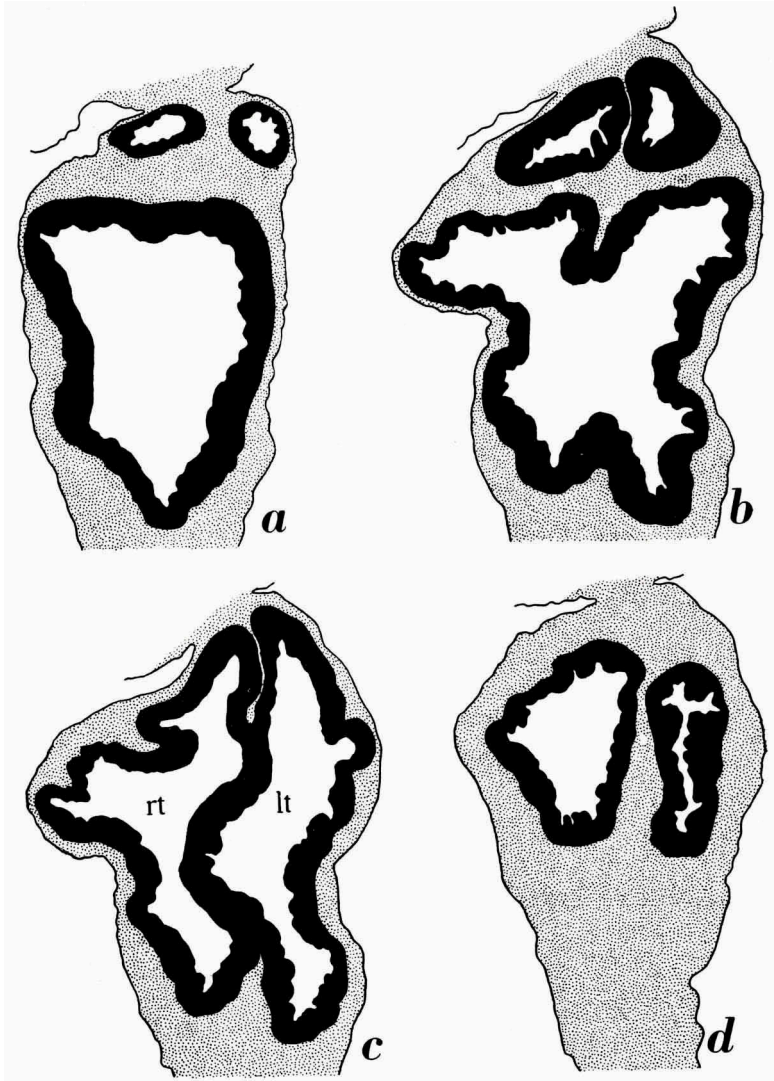


Fig. 27. *Loxothylacus texanus*, specimen on *Callinectes sapidus*, posterior parts of longitudinal sections, each following section from a more dorsal region than the preceding. *lt*, left testis; *rt*, right testis. $\times 30$.

mantle opening does not yet protrude above its surroundings. Here the mantle is irregularly grooved and wrinkled.

There is no direct correlation between the size of the parasites and the size of their hosts. In the collection of the American Museum of Natural History there is a comparatively large number of crabs belonging to *Callinectes sapidus* bearing specimens of *Loxothylacus texanus*, all from one locality, Galveston, Texas. In a number of specimens the carapace breadth of the crabs (including the large lateral spines) was measured together with the greater diameter (dorso-ventral diameter) of the parasite occurring on each of these measured crabs. The results are given below, where the crabs are arranged according to the carapace breadth, and the greater diameter of the parasite is recorded in parentheses:

59 (20); 58 (22); 55 (17½); 55 (17); 54 (19½); 53 (18); 53 (16); 50 (15½); 49 (20); 48 (12); 46 (15); 45 (20); 44 (17); 44 (16½); 41 (15).

In the various specimens the male organs show a great deal of individual variation.

In the type specimen, on *Callinectes sapidus*, from Metagorda Bay, the visceral mass is somewhat shrunk as it apparently recently had discharged its eggs. In comparison to the remainder of the visceral mass the male organs consequently have a rather large size. The ventral parts of the vasa deferentia (fig. 27 *a*) are rather narrow canals showing some ridges on their inner walls. In a more dorsal region (fig. 27 *b*) the vasa deferentia increase in size, they pass into the testes which in their most dorsal part are entirely separated (fig. 27 *d*), whilst more ventrally they are in close contact though at first the cavities remain separated (fig. 27 *c*). Still more ventrally the cavities of the two testes are united into a common wide sac (fig. 27 *b*) which still shows that it is composed of two parts. In their terminal, most ventral part the two testes are so completely united that they form a single organ of more or less oval contour (fig. 27 *a*).

In the specimen on *Callinectes sapidus* from San Antonio Bay the ventral parts of the vasa deferentia are narrow canals (fig. 28 *a*). Towards a more dorsal region they become wider and a number of ridges develops on their inner walls (fig. 28 *b*). In a farther dorsal region the vasa deferentia pass into the testes which here chiefly extend in an anterior direction (fig. 28 *c*). The same holds for the extreme dorsal part of the testes (fig. 28 *d*). The closed ends of the testes point in a ventral direction (fig. 28 *a, b*). In this specimen the two testes remain completely separated for the whole of their extent. The two male organs here are of approximately equal shape and size.

In the sectioned specimen on *Callinectes sapidus* from Galveston the vasa deferentia from a ventral region to a more dorsal part of the body again

gradually increase in size (fig. 29 *a-c*). They pass into the testes (fig. 29 *d*) which in their most dorsal region chiefly have an antero-posterior direction. In this dorsal region the two testes remain completely separated (as far as their cavities are concerned), and still remain separated in the same manner in the part where they begin to show a curvature towards the ventral region (fig. 29 *c*). In a more ventral region the united median walls of the testes

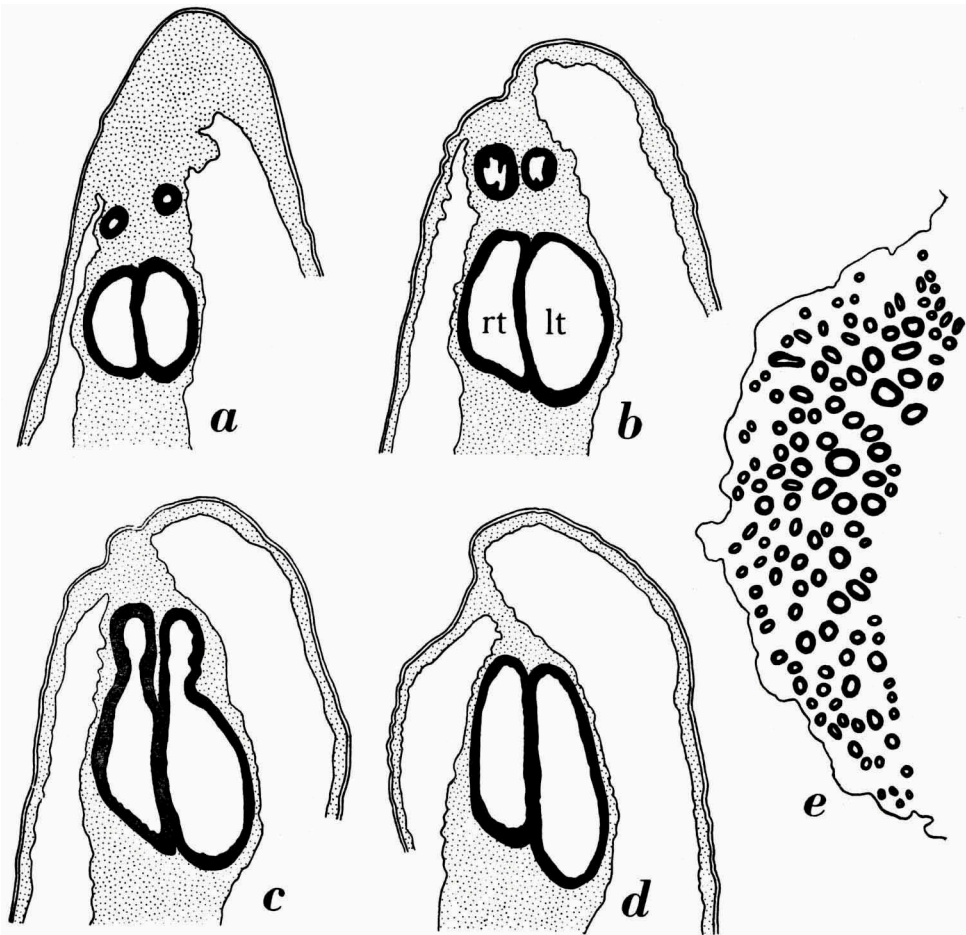


Fig. 28. *Loxothylacus texanus*, specimen on *Callinectes sapidus*. *a-d*, posterior parts of longitudinal sections, each following section from a more dorsal region than the preceding; *e*, longitudinal section of one of the colleteric glands. *lt*, left testis; *rt*, right testis. *a-d*, $\times 9$; *e*, $\times 45$.

become incomplete (fig. 29 *b*) so that the cavities are largely communicating. In a still more ventral region this common wall has completely vanished, so that the two united testes here form a single wide sac (fig. 29 *a*).

In the specimen on *Callinectes marginatus* from Toro Point the ventral parts of the vasa deferentia show a rather strong development of ridges on their inner walls (fig. 30 *b*). Gradually they slightly increase in size (fig. 30 *c, d*) and in a more dorsal region they pass into the testes, which here

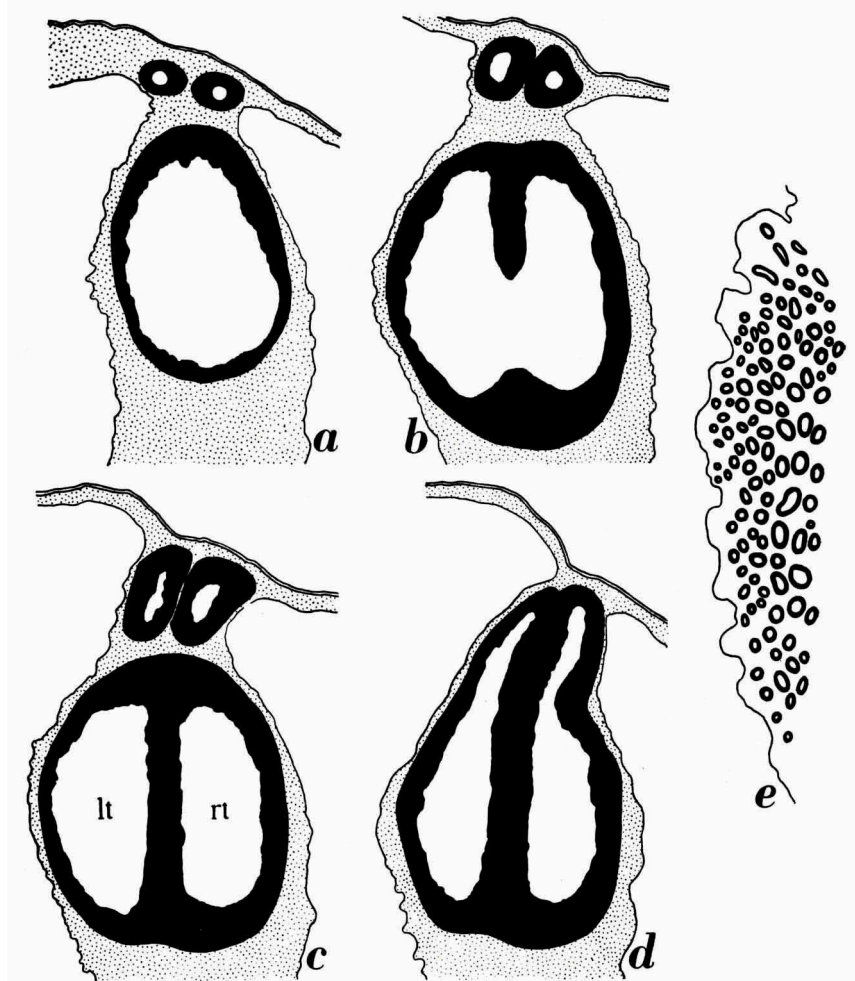


Fig. 29. *Loxothylacus texanus*, specimen on *Callinectes sapidus*. *a-d*, posterior parts of longitudinal sections, each following section from a more dorsal region than the preceding; *e*, longitudinal section of one of the colleteric glands. *lt*, left testis; *rt*, right testis. *a-d*, $\times 20$; *e*, $\times 53$.

already are completely united into one wide common sac (fig. 30 *e*). This common sac protrudes in the visceral mass in a ventral direction (fig. 30 *c, d*).

The specimen on *Callinectes marginatus* from Porto Bello is immature. Its vasa deferentia are narrow canals (fig. 31 *a, b*). In the dorsal region of the male organs the vasa deferentia pass into the testes (fig. 31 *c, d*). The testes have very thick walls, their cavities remain completely separated, though the walls are united in the median plane of the body. The terminal part of the united testes penetrates towards the ventral region (fig. 31 *a, b*).

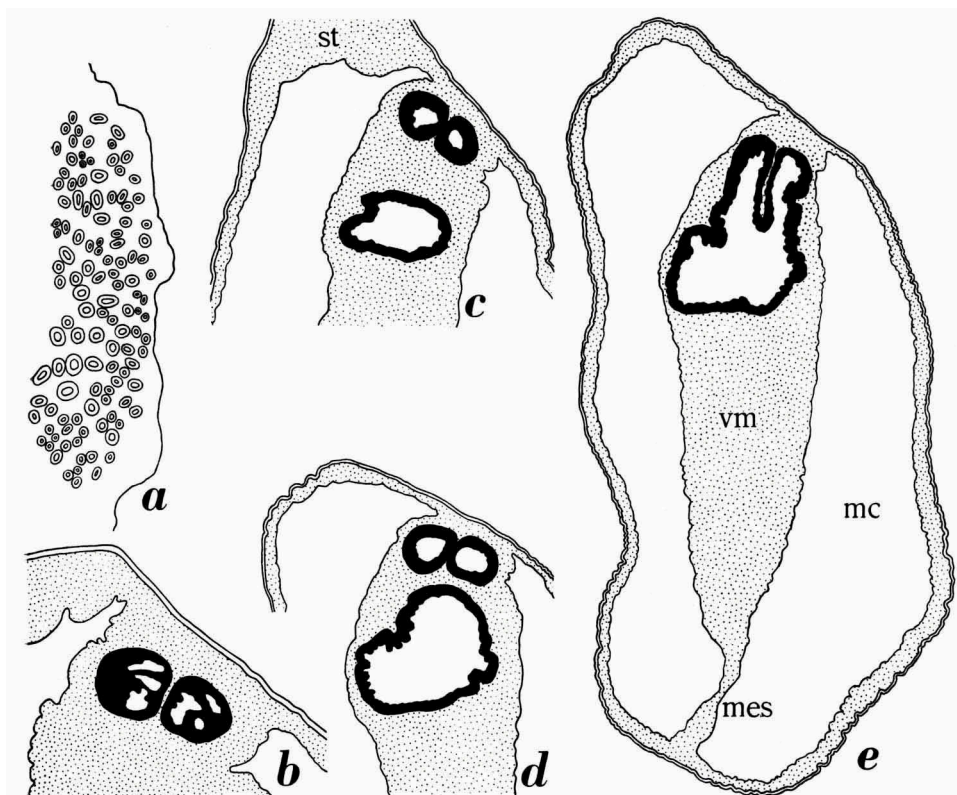


Fig. 30. *Loxothylacus texanus*, specimen on *Callinectes marginatus*. *a*, longitudinal section of one of the colleteric glands; *b-d*, posterior parts of longitudinal sections, each following section from a more dorsal region than the preceding; *e*, longitudinal section from a more dorsal part than *d*. *mc*, mantle cavity; *mes*, mesentery; *st*, stalk; *vm*, visceral mass. *a*, $\times 30$; *b*, $\times 12$; *c-e*, $\times 6$.

Summarizing it may be remarked that the two male organs in the young, immature specimen (fig. 31) remain separated, at least as far as the cavities are concerned, whilst in nearly all the adult specimens the testes are largely united and at least ventrally have a common cavity. In two specimens the two testes are still separated in their dorsal region (figs. 27, 29); in one specimen the two testes have a common cavity for about the whole of their

extent (fig. 30). The specimen of fig. 28 is full grown and still has testes which remain completely separated. It obviously forms an exception to the rule prevailing in the species.

In the various specimens the colleteric glands show a corresponding shape and structure. As a rule they do not protrude noticeably above the surface of the visceral mass. They possess a more or less compact mass of canals, usually these occur in fairly large numbers. In the most strongly divided part of a longitudinal section of one of the colleteric glands of the

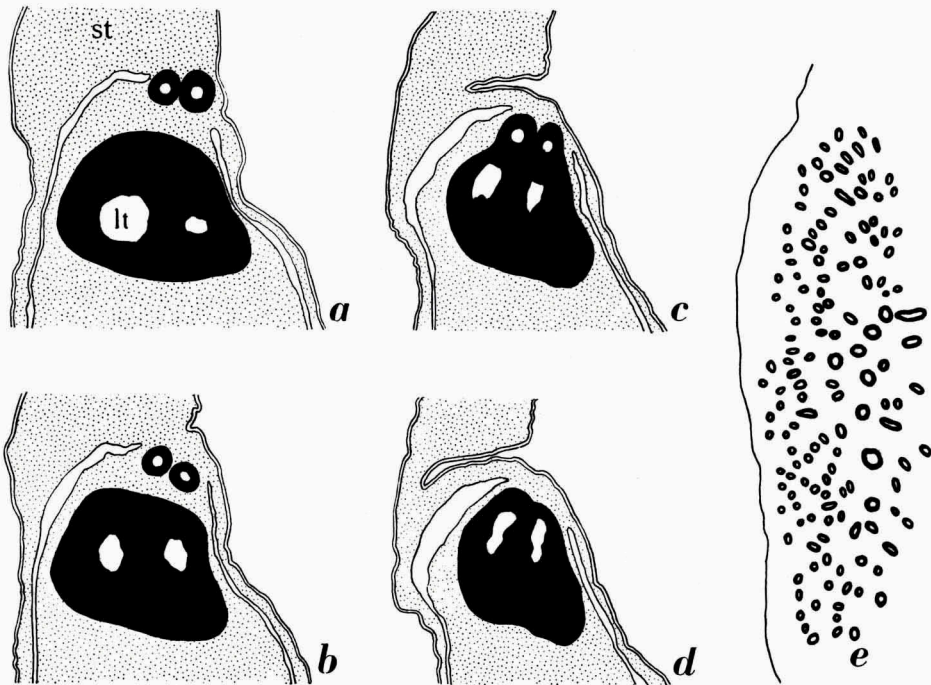


Fig. 31. *Loxothylacus texanus*, specimen on *Callinectes marginatus*. a-d, posterior parts of longitudinal sections, each following section from a more dorsal region than the preceding; e, longitudinal section of one of the colleteric glands, lt, left testis; st, stalk. a-d, $\times 14$; e, $\times 64$.

specimen on *Callinectes sapidus* from San Antonio Bay the number of canals is 125 (fig. 28 e); in the specimen on *Callinectes sapidus* from Galveston (fig. 29 e) this number is 115; in the specimen on *Callinectes marginatus* from Toro Point (fig. 30 a) this number is 118; in the specimen on *Callinectes marginatus* from Porto Bello (fig. 31 e) this number is 143. It is an unexpected fact that here the largest number occurs in the immature specimen. In the specimen of fig. 30 the colleteric glands have well developed chitinous tubes, in the other specimens no chitin was present.

The excrescences of the external and the internal cuticle of the specimens on *Callinectes sapidus* and on *C. marginatus* dealt with above do not show differences of any importance from those described in the type specimen (cf. Boschma, 1933 *b*, p. 237, fig. 20).

Loxothylacus panopaei (Gissler), occurring in the same region as *L. texanus*, differs from the latter by its smaller size, by having completely separated testes, and by having excrescences of the cuticle of a different shape. The excrescences of the external cuticle in *L. panopaei* are much larger, the retinacula are much smaller than those of *L. texanus*.

***Loxothylacus sclerothrix* Boschma (figs. 2 *k*, 3 *f*, 32-34).**

Loxothylacus sclerothrix Boschma, 1933 *b*, p. 238, fig. 21 (external and internal cuticle); Idem, 1940, p. 278, p. 367, fig. 62 (male organs), fig. 63 (colleteric gland), fig. 64 (external cuticle), fig. 65 (internal cuticle) (specimen on *Xantho sanguineus* (H. Milne Edwards)); Idem, 1947, p. 1037, 5 *b* (external shape of type specimen); Idem, 1948, p. 304.

Type specimen on *Actaea boletaria* Rathbun, Amirante, Western Indian Ocean, H. M. S. "Sealark", Station E 11, 25-80 fms., October 11, 1905 (collection U. S. N. M.).

Specimen on *Carpilodes pediger* Alcock, Amirante, Western Indian Ocean, H. M. S. "Sealark", Station E 11, 25-80 fms., October 11, 1905 (collection U. S. N. M.).

The specimen on *Actaea boletaria* ($4 \times 3 \times 1\frac{1}{2}$ mm) is more or less circular with somewhat enlarged posterior lobes at each side of the stalk (fig. 2 *k*). The left surface does not show any pronounced grooves or ridges, the other surface has a median groove extending from the stalk to some distance from the anterior region. At each side of this groove there is a shallow concavity. The region of the mantle opening does not protrude above the surface of the mantle. This opening is narrow, it lies at the left side near the anterior margin.

In the type specimen the vasa deferentia do not possess ridges on their inner walls (fig. 32 *a*, *b*). From the region in which the vasa deferentia pass into the testes (fig. 32 *c*) the latter (a common wide sac) extend somewhat farther in a dorsal direction (fig. 32 *d*), and in its most dorsal part this combined testis is divided into the two component parts (fig. 32 *e*). Ventrally the two united testes still extend for some distance (fig. 32 *b*).

The colleteric glands of the specimen on *Actaea boletaria* have rather few canals; in a longitudinal section of the most strongly divided region of one of these glands there are 26 canals (fig. 32 *f*).

The excrescences of the external and the internal cuticle of the mantle are described and figured in a previous paper (Boschma, 1933 *b*, p. 238, fig. 21).

The specimen on *Carpilodes pediger* ($4 \times 2\frac{1}{2} \times 1\frac{1}{2}$ mm) has an irregular oval shape (fig. 3 f). With the exception of the dorsal and ventral margin the surface of the mantle shows numerous strong folds and grooves which chiefly run in a dorso-ventral direction. The animal hereby obtains a highly wrinkled appearance. The narrow mantle opening is surrounded by a kind of wall which, however, does not protrude noticeably above the

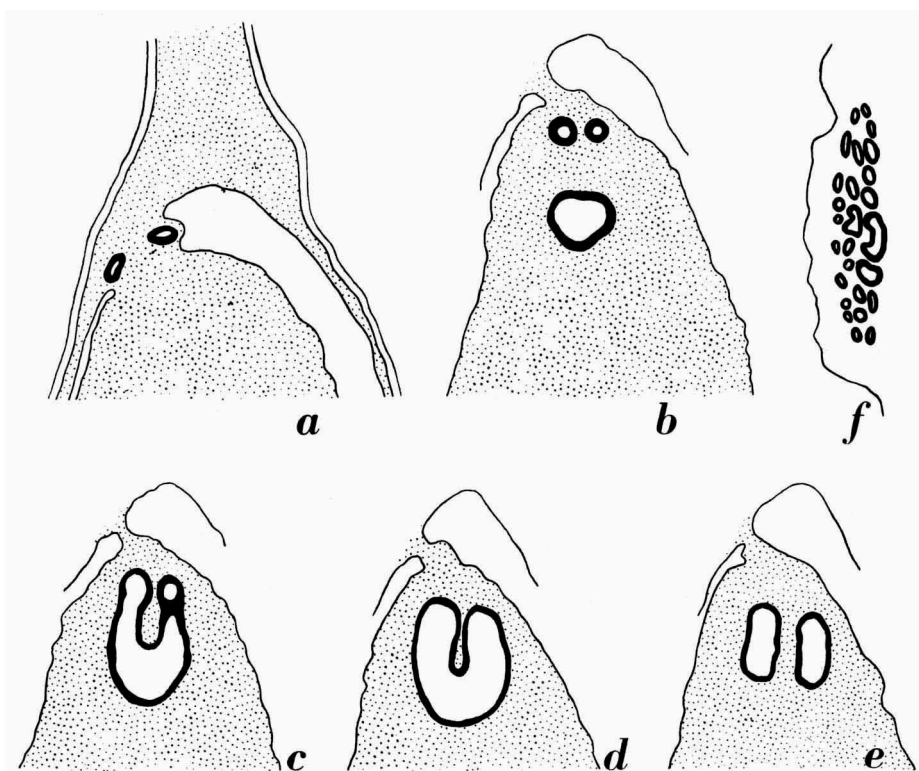


Fig. 32. *Loxothylacus sclerothrix*, specimen on *Actaea boleteria*. a-e, posterior parts of longitudinal sections, each following section from a more dorsal region than the preceding; f, longitudinal section of one of the colleteric glands. a-e, $\times 39$; f, $\times 69$.

surface of the mantle. The mantle opening lies in the anterior region of the surface of the parasite which was turned towards the thorax of the host (the left side).

In their ventral region the vasa deferentia have a number of ridges on their inner walls (fig. 33 b, d), partly they are completely separated, partly they are lying close together (fig. 33 c). In their most dorsal part the two testes are wholly separated (fig. 33 g, h), gradually the anterior part of

their common inner wall vanishes (fig. 33 *f*), and in the region in which the vasa deferentia are passing into the testes these already are largely united (fig. 33 *e*). In a slightly more ventral region there is still a notch at the posterior border of the common testis (fig. 33 *d*), but in the terminal part,

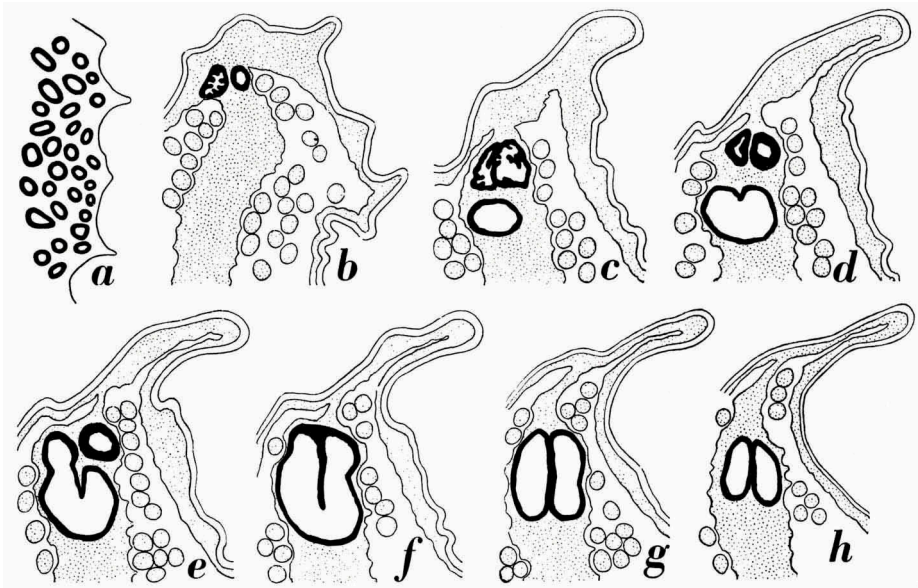


Fig. 33. *Loxothylacus sclerothrix*, specimen on *Carpilodes pediger*. *a*, longitudinal section of one of the colleteric glands; *b-h*, posterior parts of longitudinal sections, each following section from a more dorsal region than the preceding. *a*, $\times 48$; *b-h*, $\times 27$.

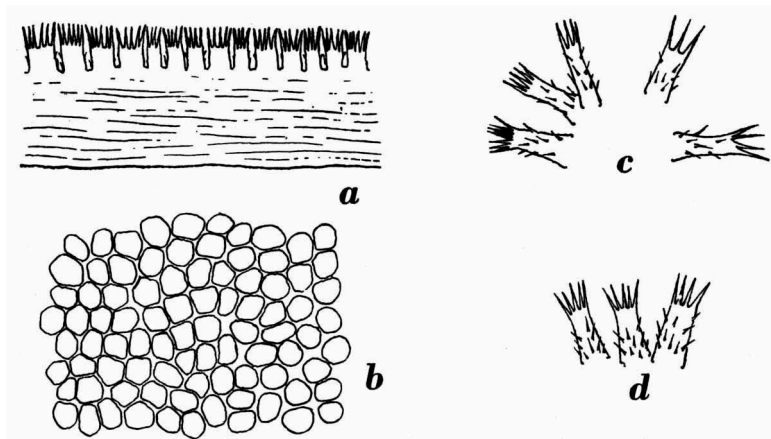


Fig. 34. *Loxothylacus sclerothrix*, specimen on *Carpilodes pediger*. *a*, section of the external cuticle; *b*, basal parts of excrescences on the external cuticle; *c* and *d*, isolated excrescences. $\times 530$.

the most ventral region of the testes, the two male organs are united into one common cavity (fig. 33 c).

In their most strongly divided region the colleteric glands of the specimen on *Carpilodes pediger* show 31 canals in a longitudinal section (fig. 33 a). In this specimen the colleteric glands do not contain chitin.

The external cuticle of the mantle of the specimen on *Carpilodes pediger* has a thickness of 20 to 30 μ . Its surface is covered with dense masses of excrescences (fig. 34) which have the shape of short thick hairs or elongate papillae covered with small spines which are most conspicuous and strongest developed at the top. The excrescences have a length of 10 to 25 μ , the thickness of their basal part is 3 to 8 μ .

Retinacula have not been found on the internal cuticle of the specimen.

The two specimens of *Loxothylacus sclerothrix* dealt with above correspond in every important detail with the specimen on *Xantho sanguineus* described in a previous paper (Boschma, 1940, p. 367 et seq.).

***Loxothylacus bicorniger* Boschma (figs. 2 l, 35).**

Loxothylacus bicorniger Boschma, 1933 b, p. 240, fig. 22 (external and internal cuticle); Idem, 1940, p. 279.

Type specimen on *Portunus ventralis* (A. Milne Edwards), Hog Island, Nassau, Bahamas, June 20, 1903, B. A. Bean coll. (collection U. S. N. M.).

In the type specimen ($8 \times 5 \times 2\frac{1}{2}$ mm) the dorsal and ventral parts of the body are elongated into pointed prominences, giving the animal a more or less lozenge-shaped appearance (fig. 2 l). The surface of the mantle is smooth. On the right side there is a broad concavity in the vicinity of the stalk, caused by pressure of the abdomen of the host against the parasite. The mantle opening is found in the central part of the anterior region. It lies at the extremity of a short tube with a well developed wall.

The male organs are found in the posterior region of the visceral mass. The vasa deferentia (fig. 35 a) gradually pass into the testes (fig. 35 b, the male organs in this section are considered to be the testes as they are surrounded by a muscular layer). Here the right testis is already smaller than the left. The right testis is running in a dorsal direction, slightly turning towards the anterior region, but does not show a curvature (fig. 35 c, d). On the other hand the left testis, which is much larger than the right, shows a distinct curve (fig. 35 c), which is still visible in a more dorsal region (fig. 35 d). Towards a still more dorsal region the left testis has a very wide cavity.

The colleteric glands have a moderate number of canals (fig. 35 f-h). In longitudinal sections of the most strongly divided region of these glands

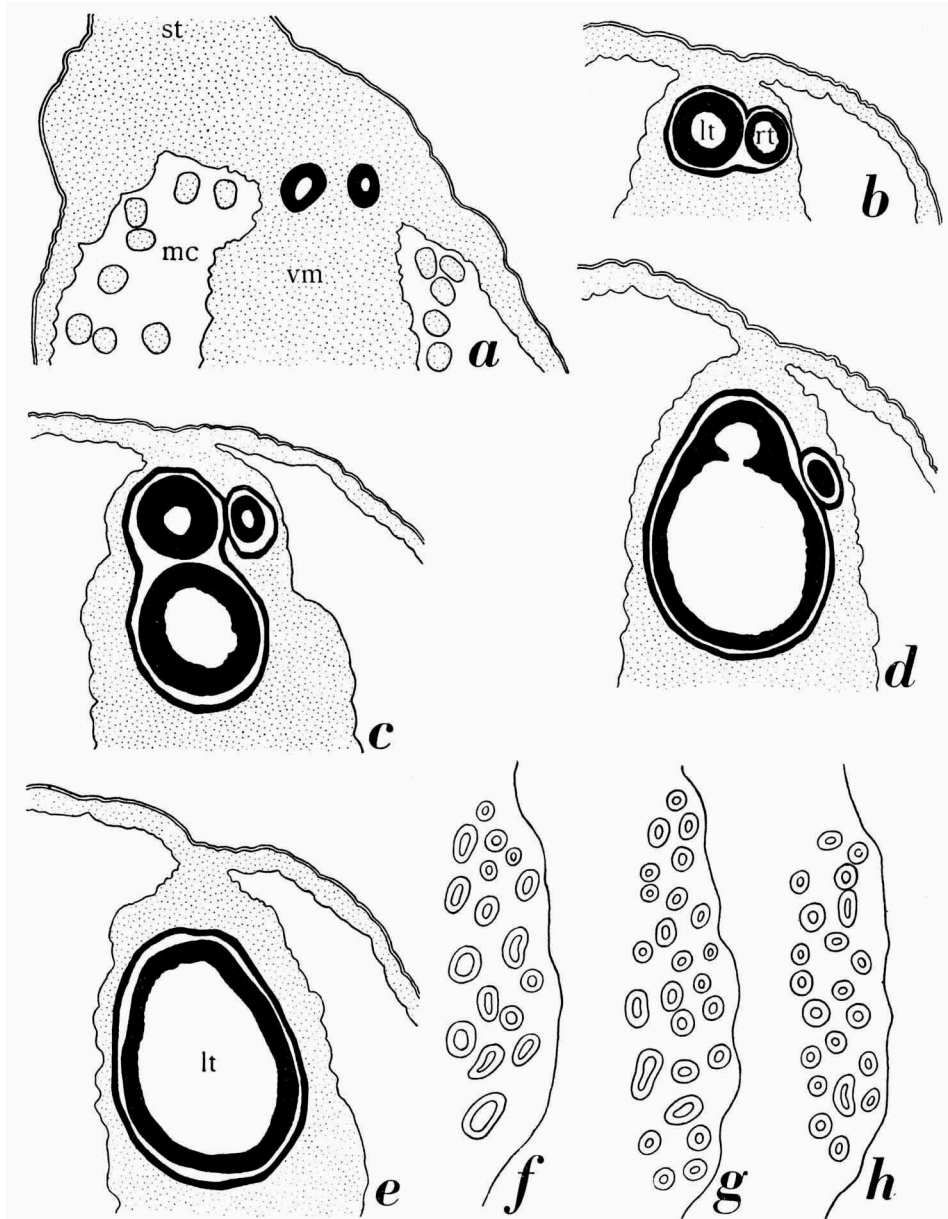


Fig. 35. *Loxothylacus bicorniger*. *a-e*, posterior parts of longitudinal sections, each following section from a more dorsal region than the preceding; *f-h*, longitudinal sections of one of the colleteric glands, each following section from a more peripheral part than the preceding. *lt*, left testis; *mc*, mantle cavity; *rt*, right testis; *st*, stalk; *vm*, visceral mass. *a-e*, $\times 36$; *f-h*, $\times 96$.

the number of canals may amount to 21. The canals show a well developed inner layer of chitin.

Loxothylacus bicorniger is the only species of the genus in which the external cuticle of the mantle does not possess excrescences.

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