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The Rhizocephalan parasites of the  
crab *Chlorodiella nigra* (Forsk.)

BY

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In the course of his studies on parasites of Crustacea GIARD expressed as his opinion that in each group of parasites every form occurring on a different species of host is a representative of a separate species. Consequently GIARD and his collaborator BONNIER gave specific names to several Rhizocephala occurring on hosts of which previously no parasites of the group had become known (GIARD, 1886, 1887, 1888; BONNIER, 1887; GIARD and BONNIER, 1890). This procedure was severely criticized by DELAGE (1884) who was convinced that *Sacculina carcini* Thomps. was the only species of the genus. SMITH (1906) in his studies on the Rhizocephala of the Gulf of Naples also came to the conclusion that all the described species of the genus *Sacculina* should be regarded as synonyms of *S. carcini*. These two authors did not sufficiently take into account the researches of KOSSMANN (1872), who demonstrated that several species of Sacculinidae may be characterized by specific peculiarities of the shape of the genital organs and of the excrescences of the external cuticle.

Even when Rhizocephala of various hosts present striking differences one might be inclined to regard these differences not as specific characters of the parasites themselves, but as peculiarities induced by the host. This might explain why in many cases closely allied species of crabs may be infested with parasites showing the same specific characters, e.g., the various European species of *Inachus* and *Macropodia*, parasitized by *Drepanorchis neglecta* (Fraisse).

When, however, a certain species of crab may be infested by more than one species of parasite it is evident that the differences of these parasites are not caused by influences of the host, but constitute definite specific characters of the parasites themselves. A striking example of a crab with four different species of Rhizocephala is that of *Chlorodiella nigra* (Forsk.). The four parasites of this crab may be defined in the following way:

*Drepanorchis villosa* (V. K. and B., 1925) (diagnosis compiled from VAN KAMPEN and BOSCHMA, 1925, and BOSCHMA, 1931b): Male genital organs distinctly curved, vasa deferentia rather narrow, testes enlarged into voluminous sacs which are in close contact, but remain completely separated. Male organs of approximately equal size. Colleteric glands with a small number of canals (less than 10 in longitudinal sections of the most strongly branched region). External cuticle densely covered with hairs or elongate papillae which have a length of 7 to 15  $\mu$ , they consist of the



same kind of chitin as that of the main layers. These excrescences possess some minute lateral hairs. Retinacula with 8 to 14 spindles on a common basal part, the spindles have a length of about  $14\ \mu$ .

Type on *Chlorodiella nigra* (Forsk.); type-locality Jiddah, Red Sea. The species is not known to occur on other hosts.

*Sacculina phacelothrix* Boschma, 1931a (diagnosis copied from BOSCHMA, 1937): Male genital organs in the posterior part of the body, outside the visceral mass, completely separated. Testes more or less globular, rather abruptly passing into the vasa deferentia; the latter are comparatively wide. Colleteric glands with few canals (less than 10 in longitudinal sections of the most strongly divided part), the canals neatly arranged in a single row parallel to the surface of the visceral mass. External cuticle of the mantle with excrescences of a hyaline kind of chitin, differing from that of the main layers of the cuticle. These excrescences are composed of groups of spines which in their basal part usually are not united, but they may be combined on a very little developed basal part. The spines have a length of 15 to  $30\ \mu$ , they may possess numerous minute lateral hairs. Internal cuticle of the mantle with retinacula which are more or less regularly distributed on its surface. Each retinaculum consists of a basal part and 3 to 5 spindles; the latter have a length of  $9\ \mu$  approximately.

Type on *Chlorodiella nigra* (Forsk.); type-locality Trincomalee, Ceylon. The species is not known to occur on other hosts.

*Loxothylacus variabilis* Boschma, 1940: Male genital organs of equal size or left small and right large. Curvature of male organs distinct, narrow or wide, or male organs slightly bent, or male organs practically straight. Colleteric glands with a moderate to fairly large number of branched canals. External cuticle densely covered with comparatively small hairs (minimum and maximum measurements 6 and  $52\ \mu$ ). Between these hairs there are larger spines in far smaller numbers (minimum and maximum measurements 30 and  $186\ \mu$ ). The excrescences have undivided tips or are irregularly divided into smaller branches. Retinacula with 1 to 5 spindles which may show barbs and vary in length from 9 to  $13\ \mu$ .

Type on *Chlorodiella nigra* (Forsk.); type-locality near Koepang, Timor. The species moreover is known as a parasite of *Actaea rüppellii* (Krauss) and of another, unidentified Xanthid crab.

*Loxothylacus vepretus* nov. spec.: Male genital organs of unequal size, the one much larger than the other. The smaller testes usually is straight or slightly curved, the larger testis usually shows a more or less distinct curve but may be straight. Colleteric glands with a fairly large number of canals (25 to 50 canals in the most strongly branched region of these glands). External cuticle with excrescences consisting of spines of a hyaline kind of chitin, differing in structure from that of the main layers of the cuticle. The spines are arranged into groups, the individual spines remain isolated or are combined into compounds with a common basal part. The length of the excrescences varies from 15 to  $60\ \mu$ . Retinacula with 3 to 7

spindles united on a common basal part, the length of the spindles amounts to 9 to  $12\ \mu$ .

Type on *Chlorodiella nigra* (Forsk.), type-locality Red Sea (material collected by KOSSMANN, now in the collection of the Zoological Institute at Heidelberg). The species is not known to occur on other hosts.

A more elaborate description of the material of the new species follows here.

Five specimens of *Loxothylacus vepretus*, all of which were parasites of *Chlorodiella nigra*, were studied in some detail:

No. 1092 A (holotype). Red Sea, measurements  $6 \times 5 \times 2\ \text{mm}$ .

No. 403 A. Massaua, Red Sea, measurements  $4 \times 3 \times 2\ \text{mm}$ .

No. 720 A. Obi latoe, East Indies, measurements  $4 \times 3 \times 1\frac{1}{2}\ \text{mm}$ .

No. 720 B. Obi latoe, East Indies, measurements  $5 \times 4 \times 2\ \text{mm}$ .

No. 1092 B. Red Sea, measurements  $6 \times 5 \times 2\ \text{mm}$ .

It may be noted that in *Loxothylacus vepretus* the most striking character of the genus is well pronounced in the specimens examined, as the visceral mass is attached to the mantle at a considerable distance from the stalk, which is especially evident in longitudinal sections (figs. 1c, 2a, 3a).

The larger of the two male organs has a vas deferens which from the narrow male genital opening gradually increases in size. On its inner wall there are several ridges so that its lumen here is divided into numerous cavities. The vas deferens gradually passes into the testis which in its ventral part has a comparatively thick wall and consequently a rather narrow lumen. Towards the dorsal part of the testis its wall becomes thinner and here usually the testis shows a curve in an anterior direction. The smaller of the two male organs has a similar structure, in a less pronounced manner; usually it does not show a distinct curve in an anterior direction.

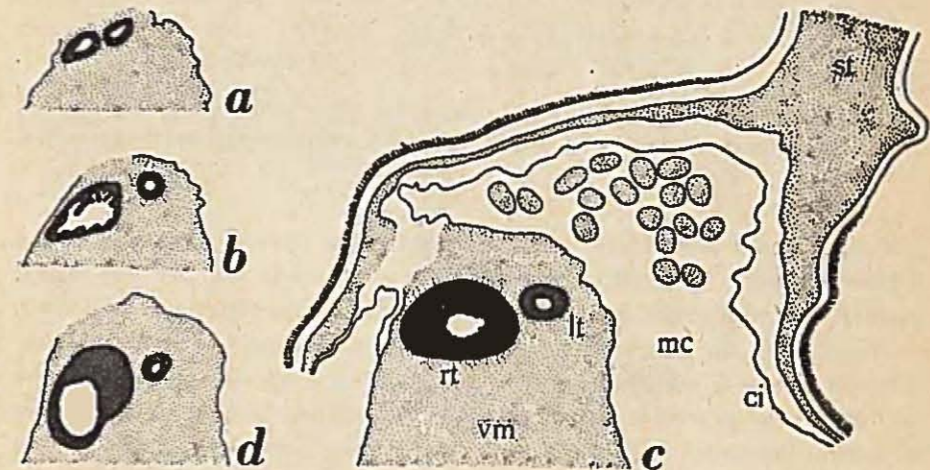


Fig. 1. *Loxothylacus vepretus*, specimen no. 1092 A, longitudinal sections; a, through the vasa deferentia, each following section from a more dorsal part. ci, internal cuticle; lt, left testis; mc, mantle cavity; rt, right testis; st, stalk; vm, visceral mass.  $\times 45$ .



As in the various specimens there is a certain amount of individual variation in the shape of the male genital organs, the chief particulars of these organs in the five specimens may be briefly described here.

No. 1092 A (longitudinal sections). In their ventral part the vasa deferentia have an approximately equal size (fig. 1a). Gradually towards a more dorsal plane the right vas deferens considerably increases in size, whilst on its inner wall there occur numerous ridges which protrude towards the centre; the left vas deferens does not become appreciably larger (fig. 1b). In the region of the stalk the vasa deferentia have passed into the testes of which the right is much larger than the left (fig. 1c). Both testes have a rather thick wall, at least for the greater part of their length. In their dorsal (closed) extremity the wall of the testes becomes thinner. In this part the right testis is slightly curved towards the anterior region of the body, whilst the left testis remains practically straight (fig. 1d).

No. 403 A. The male organs practically have the same shape and structure as those of the former specimen. Two sections, one from the ventral part of the male organs (fig. 2a) and one from the dorsal part (fig. 2b)

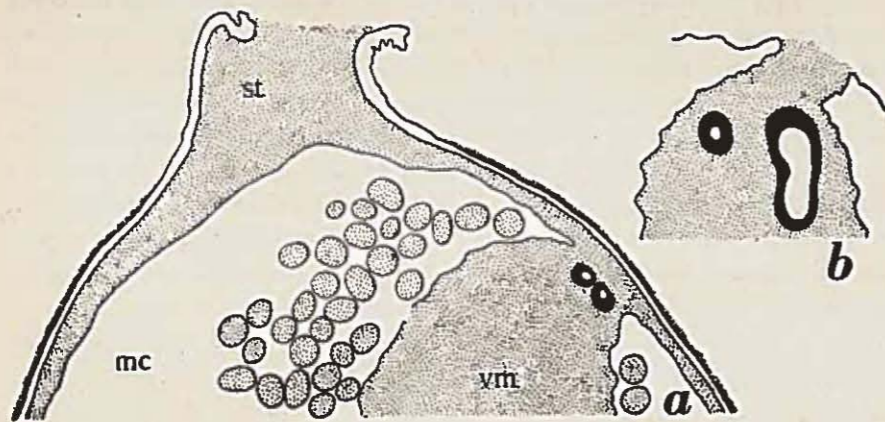


Fig. 2. *Loxothylacus vepretus*, specimen no. 403 A, longitudinal sections; a, through the stalk, b, through the dorsal part of the testes. mc, mantle cavity; st, stalk; vm, visceral mass.  $\times 45$ .

are represented here. Here again the right testis (at the right side of the figure) is much larger than the left. Its curvature in the extreme dorsal part is somewhat more pronounced than in the former specimen (fig. 2b).

No. 720 A. In this specimen the male organs have a straight course. Fig. 3a shows a section from the region of the stalk (in sections of the vicinity of the represented part the stalk inserts on the part of the mantle drawn in the upper part of the figure). Here the ventral parts of the vasa deferentia are shown. A section from a more dorsal region contains the two testes (fig. 3b), the right (at the left side of the figure) again is of much larger size than the left. The extremity of the larger testis is shown

in fig. 3c, it does not show a tendency for a curvature in an anterior direction. The smaller testis does not extend as far dorsally.

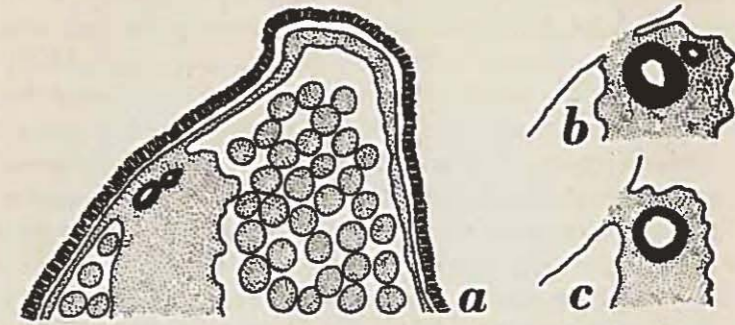


Fig. 3. *Loxothylacus vepretus*, specimen no. 720 A, longitudinal sections; a, through the vasa deferentia, each following section from a more dorsal part.  $\times 45$ .

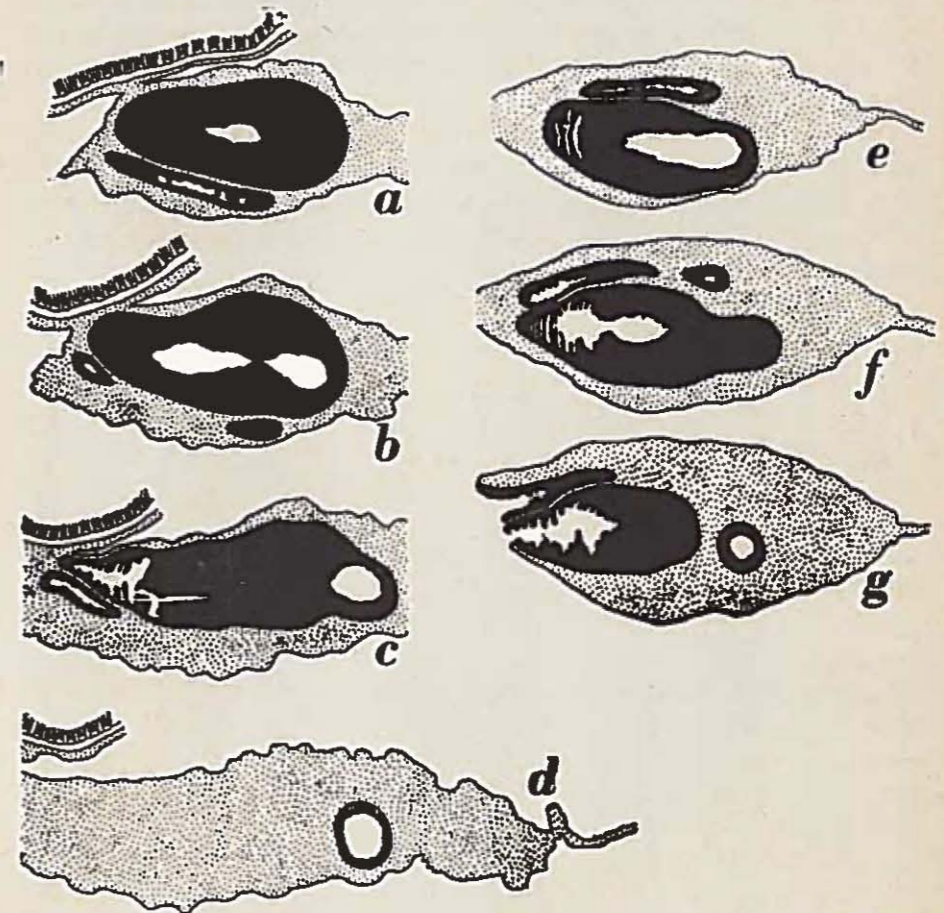


Fig. 4. *Loxothylacus vepretus*, transverse sections; a-d, specimen no. 720 B; e-g, specimen no. 1092 B. a and e, from the posterior part of the body, each following section from a more anterior part.  $\times 45$ .



Transverse sections of the body very distinctly show the differences in shape and size of the male genital organs. It appears from these sections that not only the larger testis may have a pronounced curve in an anterior direction but that also the smaller testis has a not altogether straight course.

No. 720 B. Especially in the larger male organ the vas deferens has a great number of ridges on its inner wall, resulting in a rather irregular cavity (fig. 4c). The larger testis for the greater part of its extent has a very thick wall (fig. 4a, b), towards its dorsal region the wall becomes thinner (fig. 4c), whilst the organ shows a pronounced curve in an anterior direction so that it penetrates for some distance into the visceral mass (fig. 4d). The smaller male organ has an irregular lumen (fig. 4a), its extreme ventral and dorsal parts are slightly bent in an anterior direction (fig. 4b).

No. 1092 B. The shape and the course of the male genital organs correspond in every detail with those of the former specimen. Fig. 4e shows a section through the posterior part of the male organs, fig. 4f and g represent slightly more anterior parts. The male genital openings are shown in fig. 4g, in which also the curved anterior part of the larger testis is to be seen. The smaller male organ has a similar slight curve as that of the former specimen (fig. 4f).

Fig. 5 shows sections of the colleteric glands of three specimens. The canal system is well developed, in the most strongly branched region of these glands in the three specimens the number of canals amounts to 40 (fig. 5a), 25 (fig. 5b) and 50 (fig. 5c). The canals form a rather compact mass, they are not arranged in rows.

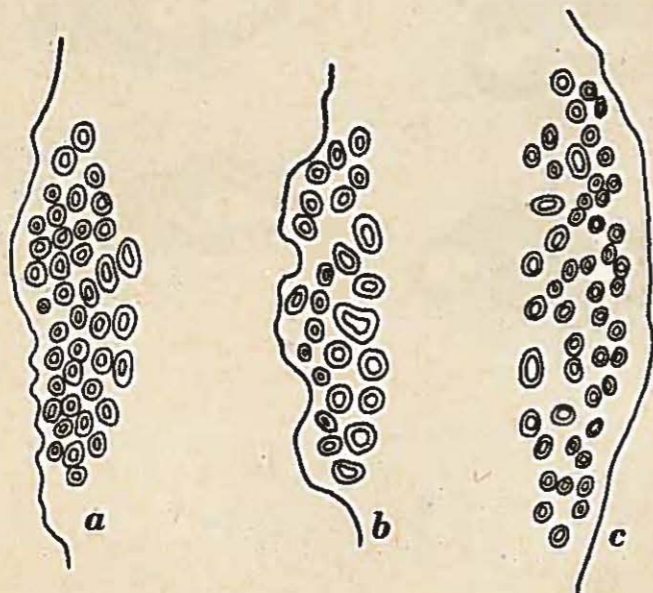


Fig. 5. *Loxothylacus vepretus*, longitudinal sections of colleteric glands of three specimens showing the most strongly branched region. Posterior part in the upper side of the figures. a, specimen no. 403 A, b, specimen no. 720 A, c, specimen no. 1092 A.  $\times 128$ .

The excrescences of the external cuticle of the mantle in each specimen vary to a certain degree as in some parts of the mantle they have a different size and structure from that in other regions. On the whole they consist of groups of spines which may be united on a common basal part. The chitin of the excrescences differs from that of the main layers of the cuticle by its being more hyaline and harder.

In the specimens 1092 A and B the excrescences of the external cuticle are rather small and slender, their length varies from 20 to 40  $\mu$  (fig. 6 a-d). In these specimens many spines remain isolated though there is a tendency to form small groups of 2 to 3 spines each. In specimen 720 A the excrescences may reach a length of 60  $\mu$ , then they form groups of spines united on a basal part (fig. 6 e-f). In some parts of the mantle the spines remain more or less isolated (fig. 6g), then they also are somewhat smaller (length

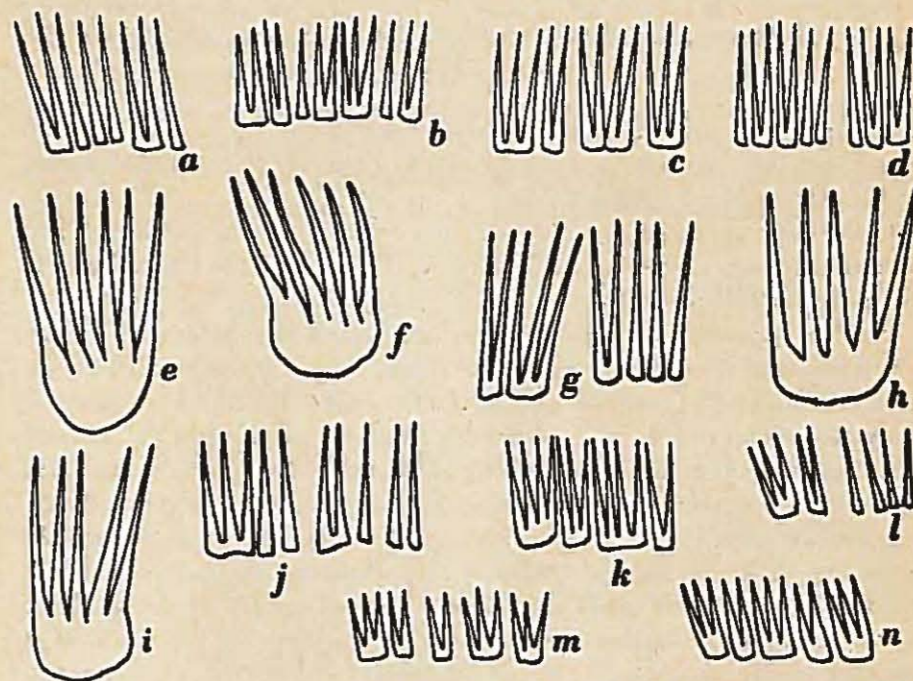


Fig. 6. *Loxothylacus vepretus*, excrescences of the external cuticle. a-b, specimen no. 1092 A; c-d, specimen no. 1092 B; e-g, specimen no. 720 A; h-j, specimen no. 720 B; k-n, specimen no. 403 A.  $\times 530$ .

about 38  $\mu$ ). Specimen 720 B has excrescences of similar structure and size. Here again the larger spines are united on common basal parts (fig. 6 h-i), the length of these is about 60  $\mu$ . When the excrescences are smaller (fig. 6 j, about 30  $\mu$ ) the spines usually remain more or less isolated. In specimen 403 A the excrescences are smaller and more slender than those of the former specimens. They vary in size and in shape in a corresponding manner, here again the spines may be united into compounds



with a common basal part, or may remain more or less isolated (fig. 6 k-n). In this specimen the length of the excrescences varies from 15 to 30  $\mu$ .

In specimens 1092 A and B the internal cuticle of the mantle bears distinct retinacula (fig. 7). These excrescences are more or less regularly

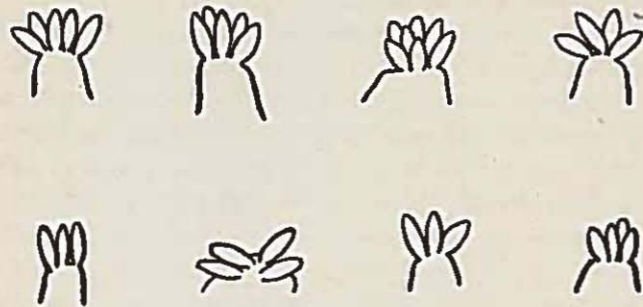


Fig. 7. *Loxothylacus vepretus*, retinacula. Upper row, specimen no. 1092 A; lower row, specimen no. 1092 B.  $\times 530$ .

distributed over the surface of the cuticle, they consist of a basal part and 3 to 7 spindles, which have a length of 9 to 12  $\mu$ . No barbs could be seen on the sides of these spindles.

In the other specimens undoubtedly also retinacula occur on the internal cuticle; they were, however, not found on the parts of the internal cuticle examined for this purpose.

Besides *Loxothylacus vepretus* four species of the genus are known which possess excrescences of a similar shape, viz., *L. aristatus*, *L. setaceus*, *L. desmothrix*, and *L. strandi* (cf. BOSCHMA, 1936). By their characters of the male genital organs and of the excrescences of the mantle three of these are easily to be distinguished from *L. vepretus*, the fourth, *L. aristatus*, in its characters shows a great deal of resemblance to *L. vepretus*. In the only known specimen of *L. aristatus* the male organs are of approximately equal size. As in the known specimens of *L. vepretum* the male organs are decidedly unequal this might constitute a distinct specific character. It is, however, not quite certain that this peculiarity may be regarded as a constant specific character as in another species of the genus, *L. variabilis*, there occur specimens with male organs of equal size and structure and specimens with highly different male organs (BOSCHMA, 1940). The excrescences of the external cuticle of the mantle in the two species show differences which really may be considered as of specific value. In *L. vepretus* these excrescences consist of a small number of spines, whilst their size does not exceed 60  $\mu$ ; in *L. aristatus* the excrescences in their most fully developed form consist of numerous spines, they may have a length of 85  $\mu$ . Especially the fact that in the latter species the excrescences may form compounds consisting of a great number of spines united on a well developed basal part points to a specific distinction between *L. aristatus* and *L. vepretus*.

The four species of *Rhizocephala* known to infest *Chlorodiella nigra* have quite different characters.

*Loxothylacus variabilis* is distinct from all other Sacculinidae by its peculiar excrescences of the external cuticle: very long spines on a surface densely covered with much shorter spines.

*Drepanorchis villosa* differs from the three other species by the excrescences of the external cuticle which consist of rather long papillae not differing in structure from the chitin of the main layers. Its retinacula have numerous spindles of a very slender shape. Moreover the male organs differ from those of the other species as the testes are enlarged into rather wide sacs with thin walls. Not too much stress may be laid on the generic characters, as the available specimens are no more in an altogether excellent state of preservation.

*Sacculina phacelothrix* has excrescences of the external cuticle of a shape and size as they may occur in *Loxothylacus vepretus*. Here the generic distinction already shows that the two species are distinct. In a previous paper (BOSCHMA, 1940) I could show that specimens of certain species of *Loxothylacus* may present characters regarded as generic characters of *Sacculina* (more or less straight male genital organs), but *Sacculina phacelothrix* undoubtedly is a representative of the latter genus. In this species the male genital organs are found outside the visceral mass (fig. 8). Here

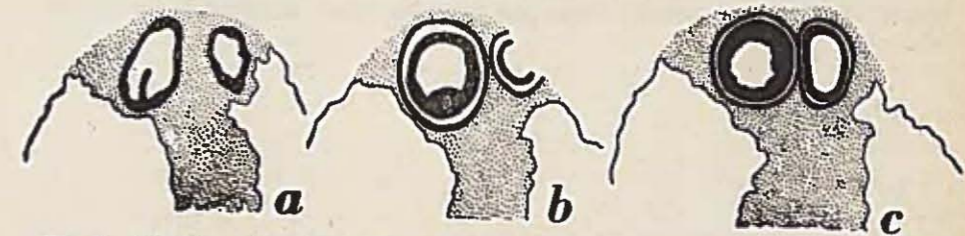


Fig. 8. *Sacculina phacelothrix*, type specimen, longitudinal sections; a, through the vasa deferentia, each following section from a more dorsal part.  $\times 45$ .

the vasa deferentia are comparatively wide and possess a few ridges only on their inner wall (fig. 8a), each vas deferens is connected with its testis by a narrow canal with a chitinous wall (fig. 8b, this canal is visible in the wall of the testis which is surrounded by a muscular layer), the two testes are not strongly differing in size (fig. 8c). In *Loxothylacus vepretus* the male genital organs have a completely different structure, so that already on this account the two species can be easily distinguished.

As the four species of Sacculinidae occurring on *Chlorodiella nigra* show specific characters in a so strongly different manner we may safely conclude that these characters are not influenced by the host but are inherent to the species.

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