

## ZOOLOGY

### FURTHER NOTES ON VARIATION IN LOXOTHYLACUS CARINATUS (KOSSM.)

BY

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In a previous paper (BOSCHMA, 1949) some details were given of Rhizocephalan parasites of various crabs, which were regarded as belonging to one species, *Loxothylacus carinatus* (Kossm.). The peculiarities of the male genital organs, the colleteric glands and the cuticular excrescences of three of these specimens are dealt with here in more detail. This is done because the three specimens among each other show differences which might indicate that they are not really conspecific. When an extensive material of specimens occurring on one species of crab is available it stands to reason that the observed variation, if within reasonable limits, is individual, as, e.g., in the specimens of *Loxothylacus variabilis* on *Chlorodiella nigra* (Forsk.) (cf. BOSCHMA, 1940). But when the specimens are parasites of different crabs and show individual variation it is open to doubt whether they are conspecific or not. The characters of the three specimens (one from unknown host, one on an unidentified Portunid, and one on *Thalamita admeta* (Herbst)) therefore are described here in some detail to form a basis for a future decision whether or not they really belong to one species. The data concerning the localities, etc., are given in the 1949 paper cited above.

In the figures of parts of sections the excrescences of the external cuticle have been omitted.

In the specimen from unknown host, from Hongkong, the visceral mass is attached to the posterior part of the body in the region from which the stalk takes its origin (fig. 1a). Here the visceral mass has shifted slightly to the right side of the posterior region, but the place of attachment is not as distinctly separated from the region of the stalk as it is typical in the genus *Loxothylacus*. In this part of the body the vasa deferentia are narrow canals running along the posterior margin of the visceral mass. In a more dorsal region the vasa deferentia gradually become wider whilst their cavities obtain an irregular inner wall as a result of numerous ridges and other prominences (fig. 1b). Farther towards the dorsal region the left vas deferens again becomes narrower, and it passes into its testis which also remains narrow. The most dorsal part of the left testis is seen in fig. 1d; here its course chiefly

is in an anterior direction. The curvature of the left testis is evident in the region of fig. 1c. The right testis is much larger than the left, it has a much thicker wall and a much wider cavity. Fig. 1c shows the right testis in the region where it is connected with its vas deferens, a slightly more dorsal section is the one of fig. 1d, whilst the terminal part of the

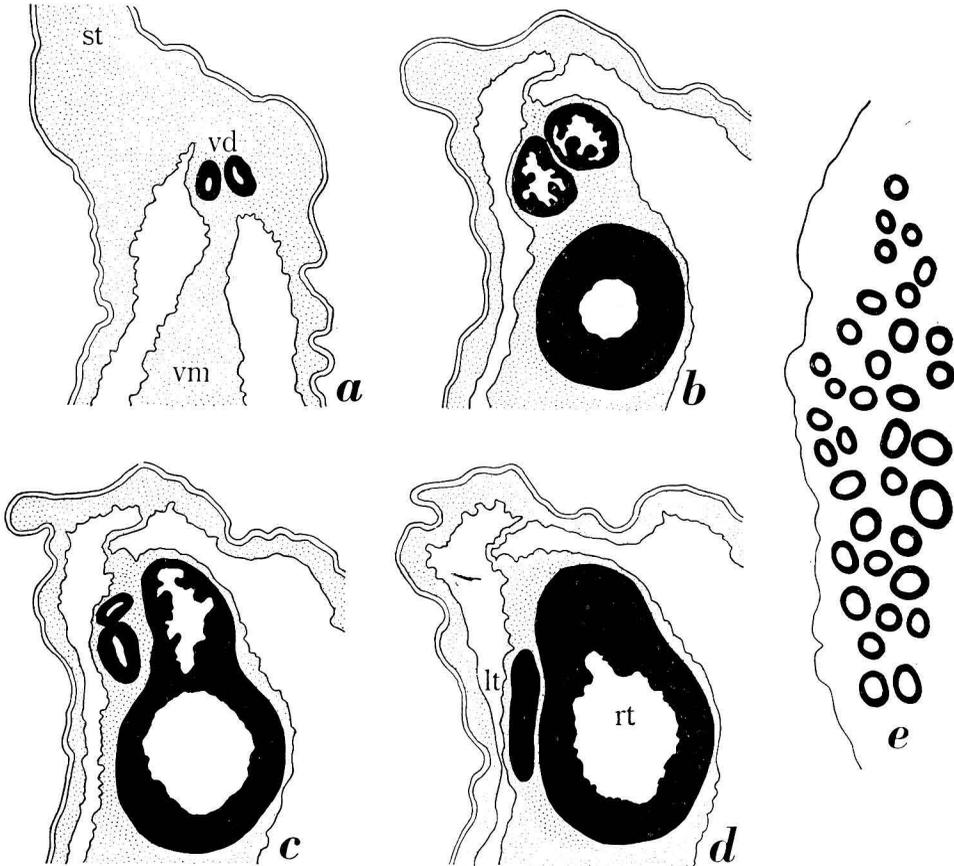


Fig. 1. *Loxothylacus carinatus*, specimen from unknown host. *a—d*, posterior parts of longitudinal sections, each following section from a more dorsal region than the preceding; *e*, longitudinal section of one of the colleteric glands. *lt*, left testis; *rt*, right testis; *st*, stalk; *vd*, vasa deferentia; *vm*, visceral mass. *a—d*,  $\times 30$ ; *e*,  $\times 107$ .

right testis, at the end of its curvature, is represented in fig. 1b. Here this terminal part is distinctly pointing in a ventral direction. In this specimen, therefore, the two male organs possess a similar, distinct curvature. Their size is so different that apparently only the right testis was functioning, the left is more or less rudimentary.

The colleteric glands occupy a not exactly central position in the lateral surfaces of the visceral mass, as they are slightly nearer to the anterior end than to the posterior extremity of the visceral mass. In a

longitudinal section of the most strongly divided part there are 35 canals (fig. 1e). In this specimen the canals of the colleteric glands do not possess chitin.

In the greater part of the mantle of the specimen from unknown host the external cuticle of the mantle is rather thin ( $9-12\ \mu$ ), in some parts it is thicker (to about  $21\ \mu$ ). Its surface is crowdedly covered with excrescences consisting of a kind of chitin different from that of the

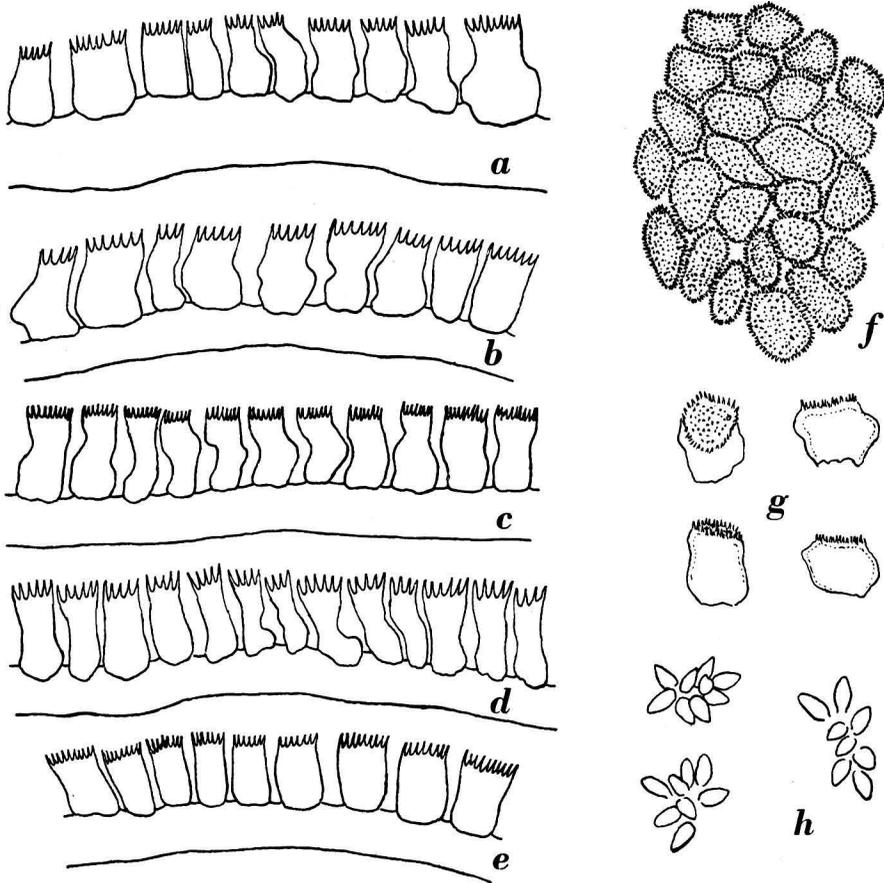


Fig. 2. *Loxothylacus carinatus*, specimen from unknown host. *a-e*, sections of the external cuticle; *f*, excrescences of the external cuticle in surface view; *g*, isolated excrescences; *h*, retinacula.  $\times 530$ .

main layers by its being of a more hyaline composition and having very little affinity for stains. These excrescences (fig. 2a-e) are more or less cylindrical bodies which with comparatively broad bases are attached to the upper surface of the cuticle and at their terminal parts bear a variable number of spines. In this specimen the excrescences do not possess root-like expansions penetrating into the main layers of the cuticle. The excrescences are of rather variable shape and size (total

height 15–26  $\mu$ ; transverse diameter 6–20  $\mu$ ), and in some parts of the mantle their spines are larger than in other parts. In surface view it appears that the larger and most conspicuous spines are found on the upper margin of the excrescences, whilst smaller spines occur in great numbers on the more or less flat upper surfaces (fig. 2*f*). Sometimes the marginal parts of the excrescences appear to have a different structure from the more internal parts (fig. 2*g*), showing that the external chitinous matter is harder than the internal.

The internal cuticle of the mantle in this specimen bears numerous retinacula which are rather regularly distributed over its surface. The basal parts of these retinacula (well developed in other specimens) are not distinct here. There are only to be seen groups of spindles, each group consisting of 7 to 10 spindles, which have a length of 6 to 9  $\mu$  and do not seem to possess barbs (fig. 2*h*).

The visceral mass of the specimen on the unidentified Portunid crab is attached to the mantle at the right side of the region of the stalk (fig. 3*a*). This situation of the visceral mass is intermediate between

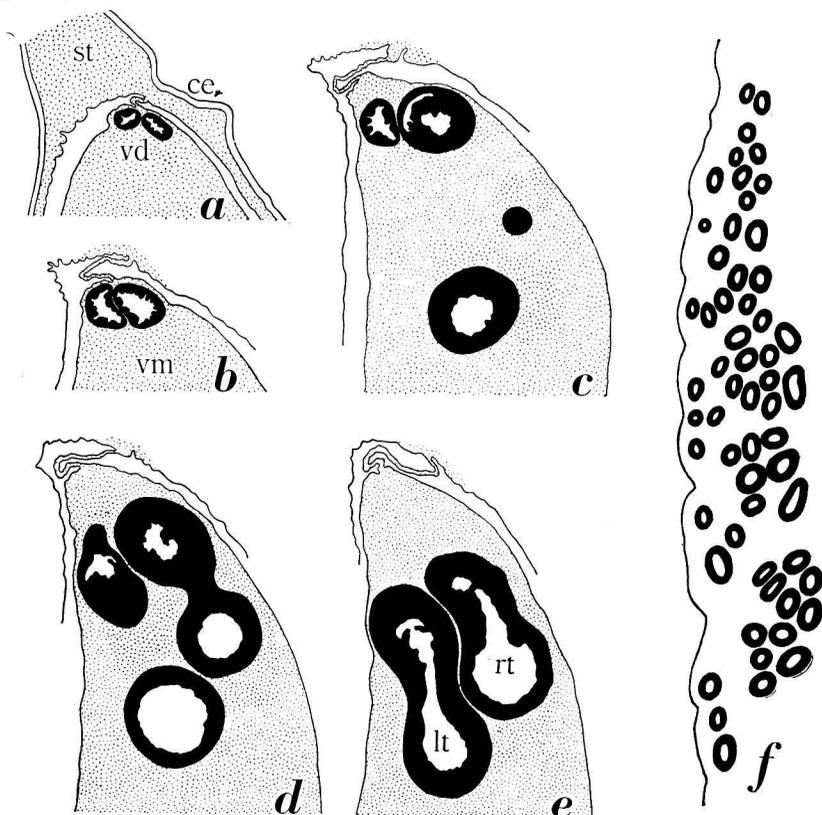


Fig. 3. *Loxothylacus carinatus*, specimen on unidentified Portunid crab. *a*–*e*, posterior parts of longitudinal sections, each following section from a more dorsal region than the preceding; *f*, longitudinal section of one of the colleteric glands. *ce*, external cuticle; *lt*, left testis; *rt*, right testis; *st*, stalk; *vd*, vasa deferentia; *vm*, visceral mass. *a*–*e*,  $\times 20$ ; *f*,  $\times 80$ .

that found typically in *Loxothylacus* and that occurring as a rule in *Heterosaccus* and *Drepanorchis*. In this region the vasa deferentia are narrow; they show already some ridges on their inner walls. In a more dorsal region the vasa deferentia become wider and their ridges become more prominent (fig. 3*b*). Gradually now the vasa deferentia pass into the testes, and from here the male organs show their curvature, which in this specimen is strongly developed. In a section of the terminal region of the testes it appears that these are found at a fairly large distance from the vasa deferentia (fig. 3*c*). In sections from a more dorsal region the transition of the vasa deferentia into the testes is visible (fig. 3*d*, *e*). The two male organs here have approximately the same shape and they are of about equal size. Especially in the dorsal region they are in close contact, but they remain completely separated.

The colleteric glands occupy the central region of each of the lateral surfaces of the visceral mass. They are more or less flattened and contain a fairly large number of canals; in a longitudinal section of the most strongly divided part (fig. 3*f*) there are 58 of these canals, which in the present specimen do not contain chitin.

In the specimen on the unidentified Portunid crab the external cuticle in various parts of the mantle has a thickness of 21 to 33  $\mu$ . Its surface is closely beset with excrescences consisting of a more or less hyaline kind of chitin, differing from that of the main layers. These excrescences are more or less cylindrical bodies that in some parts of the cuticle with their broad bases are attached to the surface layers (fig. 4*b*), whilst in the greater part of the cuticle they have well developed roots that are deeply imbedded in the main layers (fig. 4*a*, *c*, *d*). The size and the shape of the excrescences is subject to rather extensive variation. The total length of the excrescences (including the roots) is from 24 to 60  $\mu$ , the part extending above the surface of the cuticle is from 18 to 38  $\mu$ , their transverse diameter varies from 7 to 22  $\mu$ . The excrescences may be rather slender (fig. 4*d*) or broader and thicker (fig. 4*a-c*). At their extremities they bear a number of rather strong small spines. The more or less cylindrical parts extending above the cuticle often are rather contorted, as, e.g., in some of the isolated excrescences shown in fig. 4*f*. In surface view it appears that the spines chiefly are implanted on the margins of the excrescences (fig. 4*e*), the central part of the upper surface has a few smaller spines only.

On the internal cuticle of the mantle there are numerous retinacula, more or less regularly distributed over its surface. Each retinaculum (fig. 4*g*) has a well developed large basal part on the top of which there are 5 to 7 spindles. The latter have a length of 12 to 18  $\mu$ , they possess small barbs.

In the specimen on *Thalamita admeta* the visceral mass is attached to the mantle at some distance from the stalk (fig. 5*a*; the thickened part of the mantle in the upper part of the figure in a more ventral

section is connected with the region of the stalk). This section further shows the vasa deferentia, which here practically have no ridges on their inner walls, and the terminal, ventral part of the right testis. The region of transition of the right vas deferens into its testis is shown in

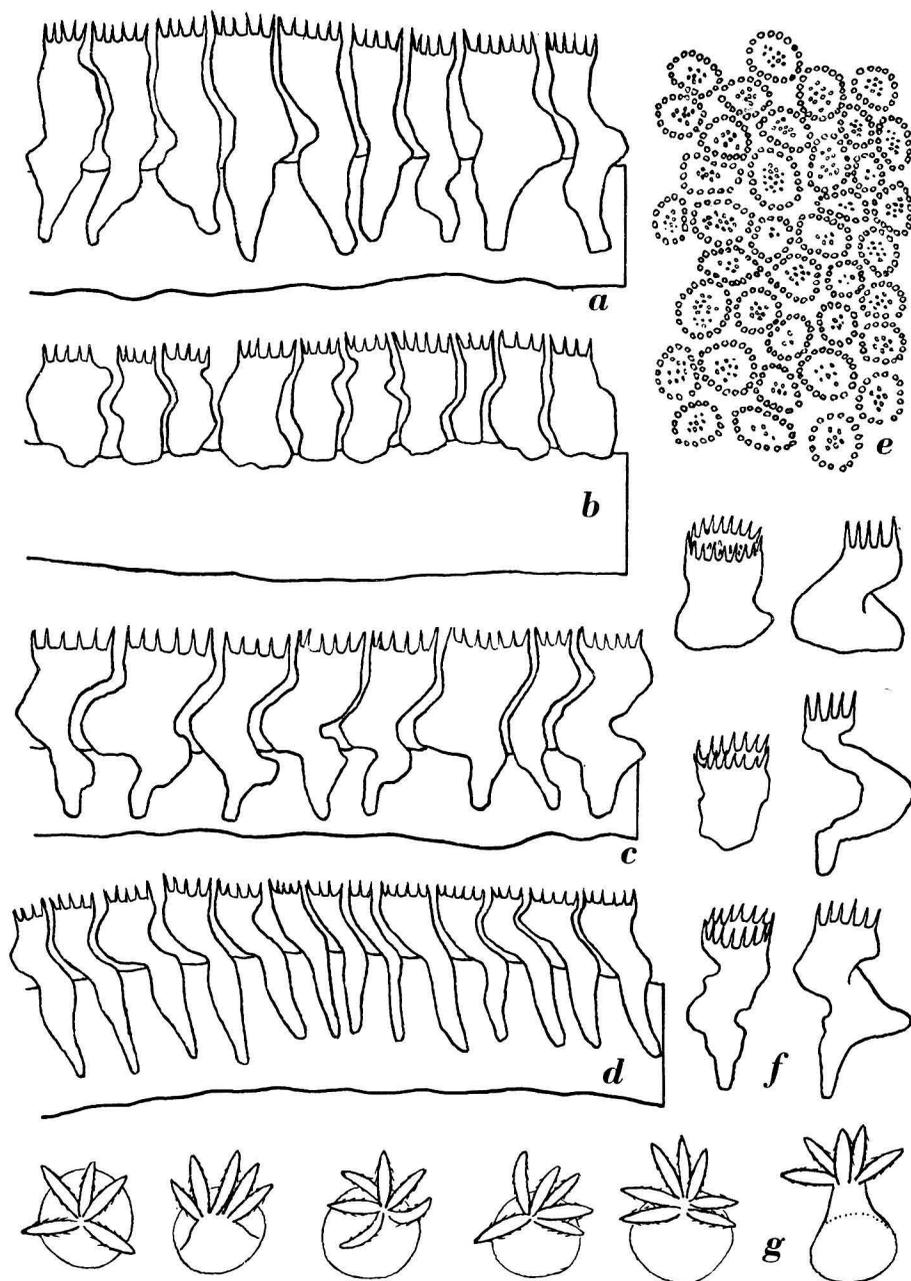


Fig. 4. *Loxothylacus carinatus*, specimen on unidentified Portunid crab. *a* — *d*, sections of various parts of the external cuticle; *e*, excrescences in surface view (basal parts of spines drawn only); *f*, isolated excrescences; *g*, retacula.  $\times 530$ .

fig. 5*b, c*; a more dorsal part of this testis is visible in fig. 5*d*. The right testis is of large size, it has a thick wall and a wide cavity. The left testis is much smaller, in its widest region (in its dorsal part, fig. 5*d*) it is not appreciably wider than the vasa deferentia. As the right testis the left shows a distinct curvature (fig. 5*c*), but it does not protrude

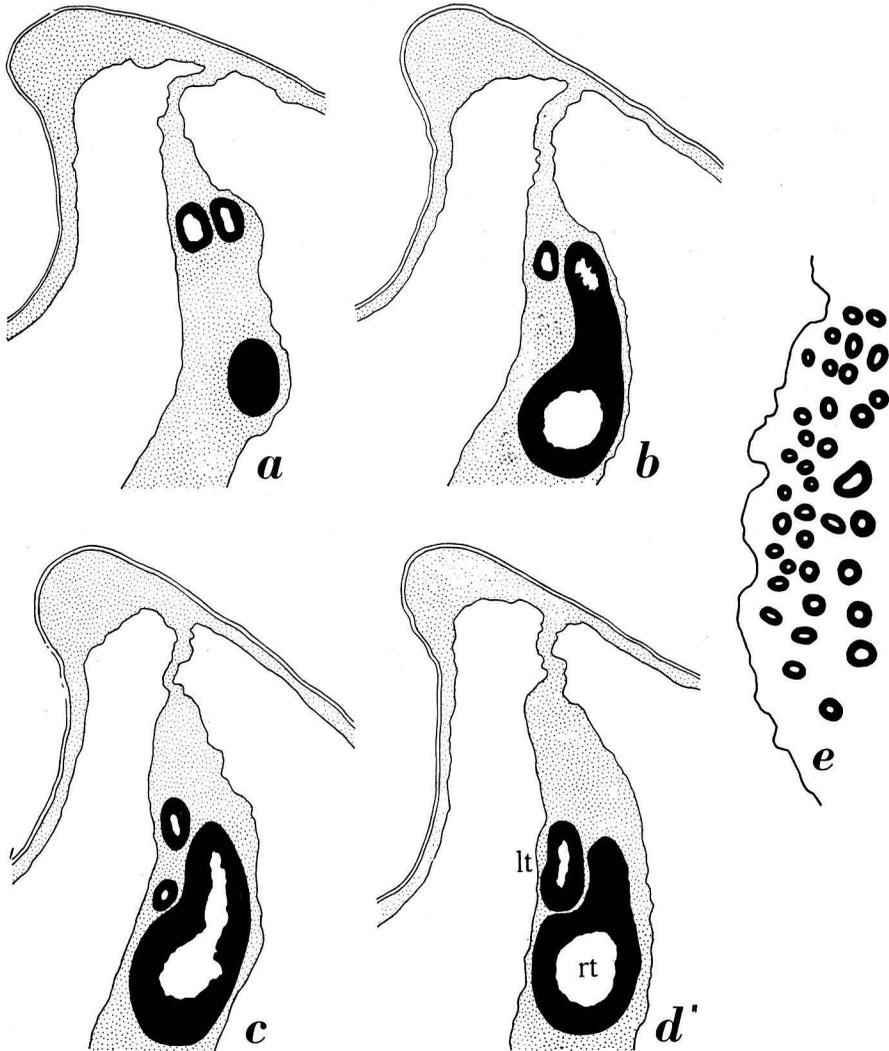


Fig. 5. *Loxothylacus carinatus*, specimen on *Thalamita admeta*. *a — d*, posterior parts of longitudinal sections, each following section from a more dorsal region than the preceding; *e*, longitudinal section of one of the colleteric glands.

*lt*, left testis; *rt*, right testis. *a — d*,  $\times 30$ ; *e*,  $\times 127$ .

as far in a ventral direction as the right. As in the specimen from unknown host the right testis of the parasite dealt with here apparently was fully functioning, the left being more or less rudimentary. The curvature of the male organs, especially that of the right, is rather wide.

The colleteric glands lie in the anterior half, at a very short distance from the centre of each lateral surface of the visceral mass. Their number of canals is not very large, in a longitudinal section of the most strongly divided region this number amounts to 36 (fig. 5e).

The external cuticle of the mantle of the specimen on *Thalamita admeta* is densely covered with excrescences which by their hyaline structure differ from the main layers of the cuticle. On the surface of the rather thin cuticle (thickness about 9 to 15  $\mu$ ) there occur more or less cylindrical bodies that with broad bases are attached to the upper layers of the cuticle; at their free extremities they bear a number of

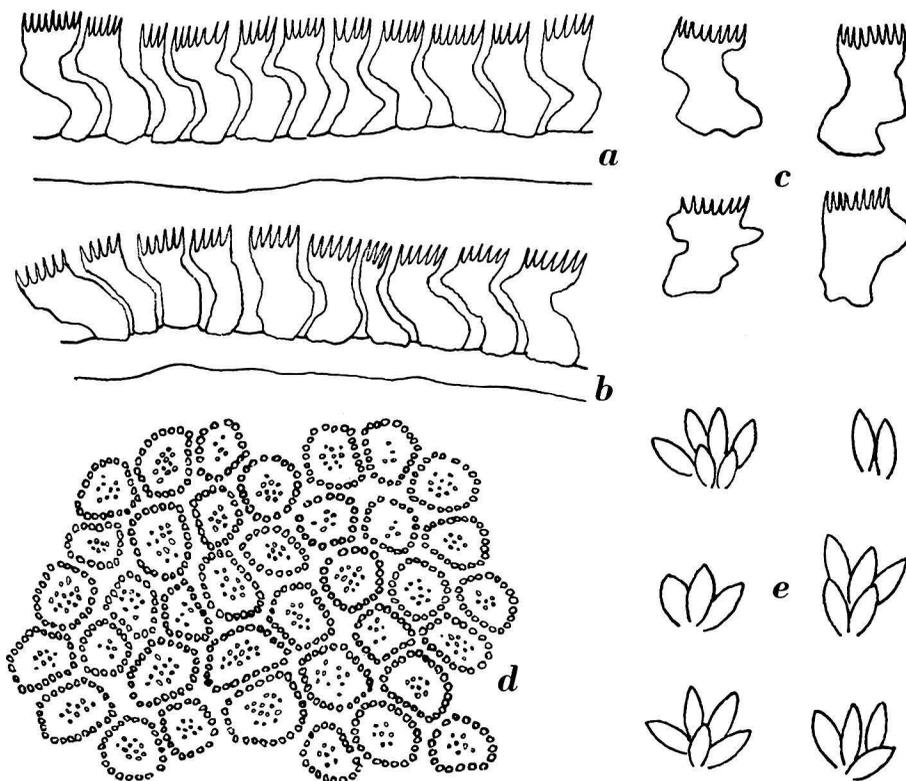


Fig. 6. *Loxothylacus carinatus*, specimen on *Thalamita admeta*. a, b, sections of the external cuticle; c, isolated excrescences; d, excrescences of the external cuticle in surface view (basal parts of spines drawn only); e, retinacula.  $\times 530$ .

small spines (fig. 6a, b). The cylindrical bodies often have a more or less contorted shape: their total height varies from 22 to 33  $\mu$ , their transverse diameter from 7 to 23  $\mu$ . On their flat upper surfaces they show a few smaller spines within the outer row of stronger spines (fig. 6d). No excrescences were found here that penetrated with root-like expansions into the main layers of the cuticle.

The surface of the internal cuticle of the mantle bears numerous

retinacula in more or less regular distribution. No basal parts as they occur in most of the other specimens were to be found here; each retinaculum seems to consist of a group of spindles only (fig. 6e). The spindles are arranged in groups of 2 to 6 (as a rule 4 or 5), they have a length of 12 to 16  $\mu$  and do not show barbs.

In a previous paper (BOSCHMA, 1949) attention was drawn to the similarity of the excrescences of *Sacculina cuspidata* to those of *Loxothylacus carinatus*. In this paper it was noted that the colleteric glands of *S. cuspidata* are found near the anterior extremity of the visceral mass. As in *L. carinatus* these glands as a rule have a more or less central position in the lateral surfaces of the visceral mass, this difference may serve as an additional character for distinguishing the two species. In fig. 7 longitudinal sections of the median part of the body are drawn of six specimens of *Loxothylacus carinatus* (fig. 7a—d, g, h) and of two

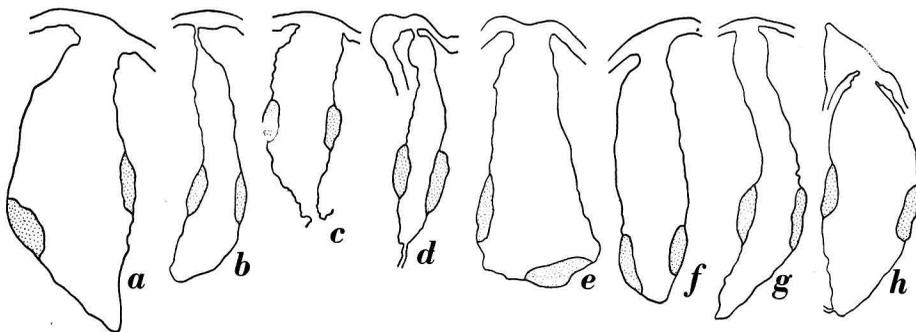


Fig. 7. Longitudinal sections of the visceral mass (with the colleteric glands, stippled) of various specimens of *Loxothylacus carinatus* (a — d, g, h) and *Sacculina cuspidata* (e, f). a, on *Thalamita prymna*; b, on *Neptunus hastatooides*; c, on *Lissocarcinus polybioides*; d, from unknown host; e, on *Pseudozizus caystrus*; f, on *Chlorodopsis* spec.; g, on *Thalamita admeta*; h, on unidentified Portunid crab. a — d,  $\times 8$ ; e, g,  $\times 13$ ; f,  $\times 20$ ; h,  $\times 7$ .

specimens of *Sacculina cuspidata* (fig. 7e, f). In the latter the colleteric glands are found in the vicinity of the anterior extremity of the visceral mass (in fig. 7e this extremity is pointing to one side), whilst in the specimens of *Loxothylacus carinatus* these glands occupy the central region of the visceral mass (fig. 7a, c, h) or have a slightly more anterior position (fig. 7b, d, g).

It is by no means certain that the parasites identified here as *Loxothylacus carinatus*, viz., the three specimens dealt with in a previous paper (BOSCHMA, 1949) and the three specimens of which the characters are described in the present paper, are conspecific. The same uncertainty holds for the specimen on *Caphyra levis* mentioned in the cited paper; of the latter specimen the structure of the excrescences of the cuticle is known, but that of the male organs and of the colleteric glands is unknown.

In three specimens of *Loxothylacus carinatus* (on *Thalamita prymna*, on *Lissocarcinus polybioides*, and on the unidentified Portunid) the two male organs are of equal size; in the three other specimens (on *Neptunus hastatoides*, on unknown host, and on *Thalamita admeta*) the right testis is much larger than the left. This difference, however, not necessarily points to a specific distinction, as in other species of *Loxothylacus* a corresponding difference may occur as individual variation (e.g., in *L. variabilis*, cf. BOSCHMA, 1940).

The colleteric glands in the six specimens show a large degree of similarity. The number of canals is somewhat different, but these differences are not pointing to specific distinction.

The chief characters of the external and the internal cuticle of the mantle of the seven specimens may be summarized as follows:

Specimen on *Caphyra levis* (VAN KAMPEN & BOSCHMA, 1925, fig. 24): excrescences of the external cuticle with well developed roots; retinacula with basal part and 2 to 4 barbed spindles.

Specimen on *Thalamita prymna* (VAN KAMPEN & BOSCHMA, 1925, fig. 25): excrescences of the external cuticle with well developed roots; retinacula with basal part and 2 to 4 barbed spindles.

Specimen on *Neptunus hastatoides* (BOSCHMA, 1931, fig. 51b, c): excrescences of the external cuticle with small though distinct roots; retinacula with basal part and 4 to 6 barbed spindles.

Specimen on *Lissocarcinus polybioides* (BOSCHMA, 1931, fig. 51a): excrescences of the external cuticle without distinct roots; retinacula unknown.

Specimen from unknown host (fig. 2 in the present paper): excrescences of the external cuticle without roots; retinacula without basal part, consisting of 7 to 10 spindles without barbs.

Specimen on unidentified Portunid crab (fig. 4 in the present paper): excrescences of the external cuticle as a rule with well developed roots; retinacula with basal part and 5 to 7 barbed spindles.

Specimen on *Thalamita admeta* (fig. 6 in the present paper): excrescences of the external cuticle without roots; retinacula without basal part, consisting of 2 to 6 spindles without barbs.

Especially on account of the peculiar shape of the retinacula (without basal part and without barbs) the specimens on unknown host and on *Thalamita admeta* might be regarded as a distinct species, different from *Loxothylacus carinatus*. It is interesting that in these two specimens the right testis is much larger than the left. But in the third specimen showing this enormous difference in the size of the male organs (the specimen on *Neptunus hastatoides*) the retinacula have basal parts and possess barbs.

Though there are indications for specific distinctions the material up till now available is too scanty to justify a definite decision. For the present all the specimens dealt with above may be regarded as belonging

to the one species *Loxothylacus carinatus*. The details of the individual specimens described here may serve as a means to reach a better solution of the difficulties when more material becomes available.

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