

**Zoology.** — *Three successive layers of external cuticle in Sacculina leptodiae.* By H. BOSCHMA.

(Communicated at the meeting of December 21, 1946.)

KOSSMANN (1872), who found that the excrescences of the external cuticle of the mantle may be characteristic for the species of Sacculinidae, also reported upon a case of moulting of this cuticle: in the species described by him as *Sacculina crucifera* two layers of external cuticle were present, an inner layer with well developed spinous excrescences and a much thinner outer layer without excrescences. A quite similar double external cuticle was found in a specimen of *Sacculina rotundata* Miers (VAN KAMPEN and BOSCHMA, 1925; in this paper the specimen, a parasite of *Eriphia laevimana* Latr., erroneously was identified as *Sacculina pilosa* Kossm.). A third case of a cuticle with spinous excrescences covered by a much thinner cuticle without excrescences occurs in a parasite of *Carupa laeviuscula* Heller (BOSCHMA, 1928), the latter parasite was described as *Sacculina aculeata*, but as the excrescences of the definite external cuticle have not yet fully developed it is as yet uncertain whether this form really is to be regarded as a distinct species. Similar phenomena are known in a number of other species of the family. Two layers of external cuticle have been found in specimens of *Sacculina carcini* Thomps., *S. inflata* Leuck., and *Drepanorthis neglecta* (Fraisie); here the two layers possess excrescences consisting of papillae of corresponding shape (BOSCHMA, 1927). Of *Sacculina angulata*, *S. teretiuscula*, *S. anceps* and *Heterosaccus ruginosus* specimens were described with two layers of external cuticle; here the outer layer does not show distinct excrescences whilst the inner layer in some cases has distinct papillae, in other cases a little pronounced indication of a certain differentiation of its surface (BOSCHMA, 1931). Moreover in *Sacculina setosa* two layers of external cuticle were found, both of which bear small spinous excrescences of corresponding shape (BOSCHMA, 1933).

Among specimens of a parasite on the crab *Thalamita stimpsoni* A. M. E. there are two young stages which show that in this parasite there occur three successive layers of external cuticle, each with excrescences which in their shape and size are entirely different from the other. Provisionally this parasite may be named *Sacculina leptodiae*, as its characters closely correspond with those of this species.

*Sacculina leptodiae* was described as a parasite of *Xantho exaratus* (H. M. E.) by GUÉRIN-GANIVET (1911) on material from the Gulf of Aden and from the Comoro Islands; other specimens of this parasite were collected in the Red Sea, Zanzibar and the Andaman Islands. The parasite of *Thalamita stimpsoni*, which closely corresponds with *Sacculina leptodiae*

in the shape of the male organs, that of the colleteric glands, and that of the shape and size of the excrescences of the external cuticle, was found at Singapore and at the Aru Islands. In both forms the excrescences of the external cuticle consist of small groups of hyaline spines as a rule united on a common basal part. In the type specimen of *S. leptodiae* the excrescences vary in length from 50 to 80  $\mu$ , in the two other specimens reported upon by GUÉRIN-GANIVET the excrescences have a length of 25 to 45  $\mu$  (cf. BOSCHMA, 1936).

In full grown specimens on *Thalamita stimpsoni* the excrescences of the external cuticle correspond in every detail with those of the parasite of *Xantho exaratus*. In the material from the Aru Islands, collected during the Snellius expedition in 1929, these excrescences have a length of 30 to 70  $\mu$ . In the various specimens they have slightly different shapes and sizes, the excrescences of three specimens are represented in fig. 1. In one specimen the spines are rather short and thick (fig. 1a), here the excrescences as a whole have a length of 35 to 50  $\mu$ . In a second specimen the spines are slightly longer, so that the excrescences as a whole have a length of 50 to 70  $\mu$ . In a third specimen the spines as a rule remain isolated, though they are arranged in groups on the surface of the external cuticle (fig. 1c), here they vary in length from 30 to 50  $\mu$ . In some parts of the cuticle of this specimen, however, the spines are united into distinct groups with common basal parts (fig. 1d, e), just as in the other specimens, generally the excrescences then are somewhat longer (50—60  $\mu$ ). The measurements given above hold for the excrescences of the greater part of the mantle; in some regions, e. g., near the stalk and in the vicinity of the mantle opening, there may occur excrescences of smaller size.

Among the numerous parasites of *Thalamita stimpsoni* from the Aru Islands there are two young stages which are of special interest as their external cuticle is entirely different from that in the adult stages of the same parasite.

In the first specimen the external cuticle of the mantle possesses distinct excrescences which consist of small papillae which at their top bear a number of minute marginal spines (fig. 2). These excrescences have a height of  $4\frac{1}{2}$  to  $7\frac{1}{2}$   $\mu$ , their thickness amounts to 4 to 9  $\mu$ . The papillae may occur rather crowdedly or more sparsely distributed. The excrescences consist of the same kind of chitin as that of the main layers of the external cuticle.

Sections of the mantle show that under this cuticle, which has a thickness of about 4 to 8  $\mu$ , the excrescences of a new cuticle are developing. It is interesting that in some parts of the mantle this process has not yet started (fig. 3a), in other parts of the mantle the first traces of these new excrescences have just appeared (fig. 3b), and in still other parts the excrescences already have a fairly large size (fig. 3c). Consequently in this specimen we can study the gradual development of the excrescences up to a certain stage.

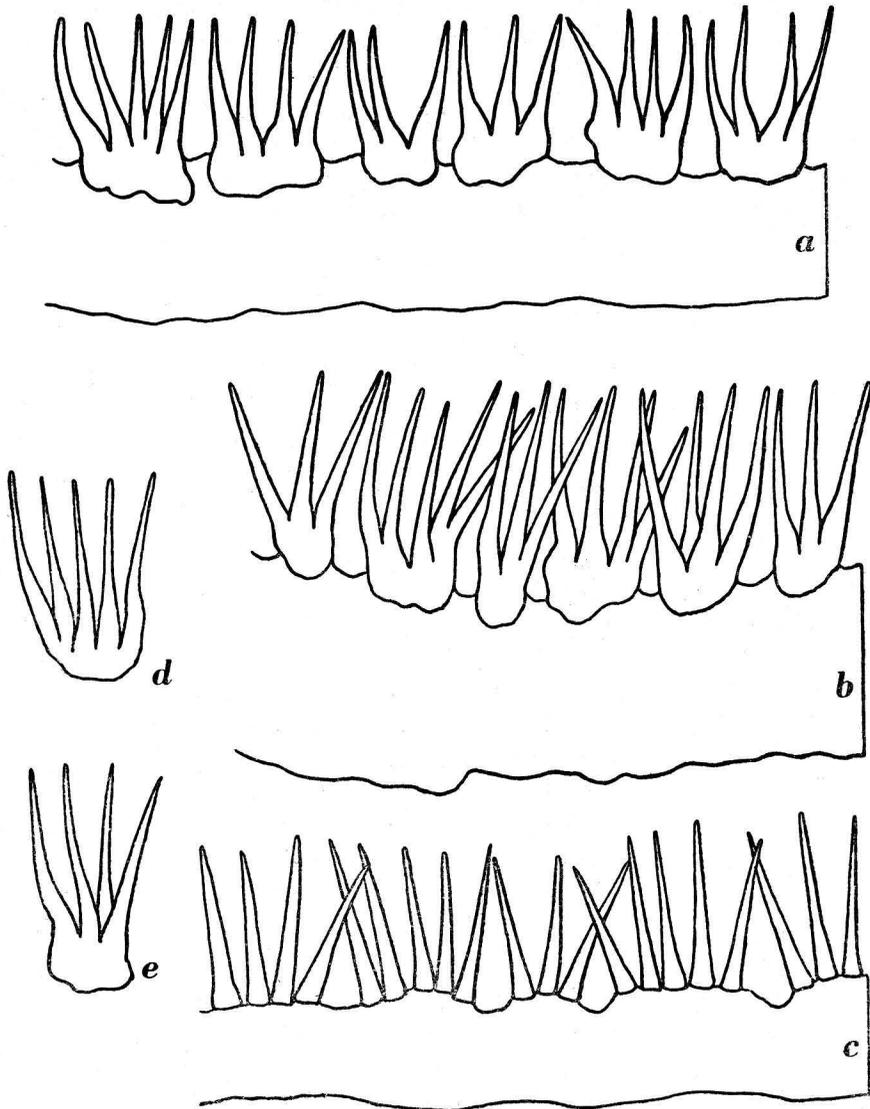


Fig. 1. *Sacculina leptodiae* from *Thalamita stimpsoni*. a—c, sections of the external cuticle of three specimens; d, e, excrescences of the external cuticle of the specimen of fig. 1 c.  $\times 530$ .

In fig. 3a a complete section of the mantle has been drawn. This section shows the chief elements described by DELAGE (1884, pl. XXVII fig. 51 and other figures). The cells of the epithelium (e) adhere with their flat extremities perpendicularly to the external cuticle which has been secreted by them. Towards the middle region of the mantle the epithelium cells are prolonged into muscular or connective elements which are united with the corresponding elements of the other surface of the mantle. The cells of the epithelium are arranged in groups of a more or less conical shape, the

bundles of muscular or connective elements forming the tops of the cones. These bundles traverse the muscular layers in the middle region of the mantle, two of which (*m*) are visible in the figure, one in transverse, the other in more or less longitudinal section. The remaining elements of the

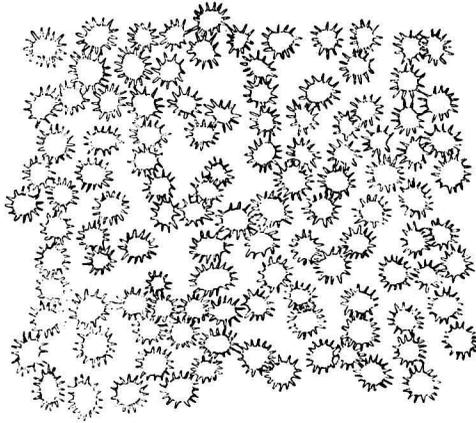


Fig. 2. *Sacculina leptodiae* from *Thalamita stimpsoni*, young specimen. Surface view of the excrescences of the external cuticle.  $\times 530$ .

mantle (lacunae, etc.) are represented in the figure by dotting. The thin internal cuticle (*ci*), to which the innermost row of epithelium cells adheres, does not show any important particulars.

In fig. 3*b* and *c* the external parts of sections of the mantle are drawn.

Fig. 3*b* shows a region of the mantle in which the external cuticle (*ce*) is found at a slight distance from the epithelium cells (*e*). On the top of each of these cells there is a little cone of chitin (length about  $6\mu$ ), apparently of the same kind as that of the external cuticle, as it stains in the same manner. These cones (*ex*) form the beginning of the external cuticle as it is found in the adult animal. As yet the little cones form a continuous row of small spines, the only arrangement in groups is that of the cells of the epithelium.

A further development of the excrescences is shown in fig. 3*c*, where there is a considerable distance between the external cuticle (*ce*) and the cells of the epithelium (*e*), apparently on account of further growth of the excrescences (*ex*) of the new cuticle, which have a length of about  $18\mu$ . Here the excrescences still consist of chitin of a comparatively weak kind, as they are stained in the same degree as the old external cuticle. In this figure again the arrangement in groups is apparent in the cells of the epithelium only.

The second young specimen too has two layers of external cuticle, but here the inner layer is covered with papillae with a peripheral row of minute spines (fig. 4). This inner layer (*ce*) has a thickness of 4 to  $8\mu$ , its excrescences have a height of  $4\frac{1}{2}$  to  $8\mu$  and a thickness of 2 to  $4\frac{1}{2}\mu$ . In all important details these excrescences correspond with those of the outer

layer of cuticle in the former specimen. In this specimen the outer layer of the external cuticle (*cu*), apparently the original external cuticle, is

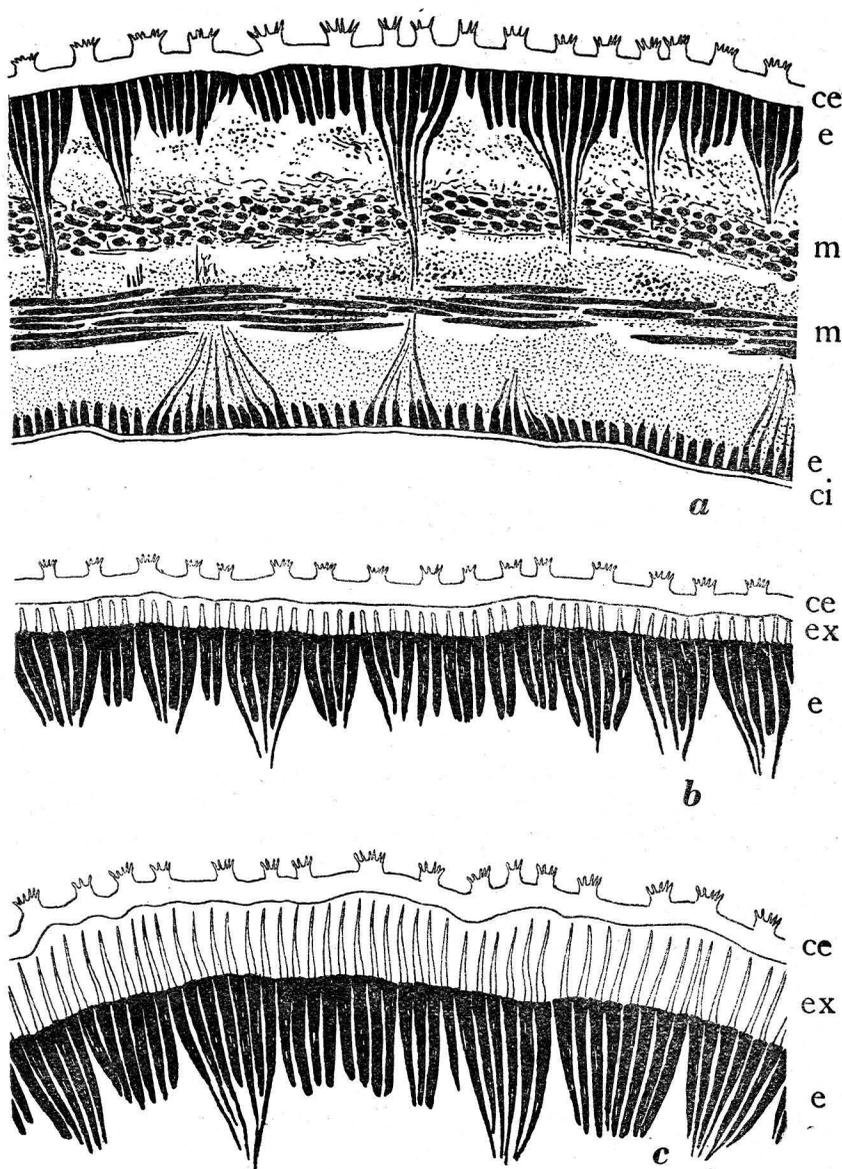


Fig. 3. *Sacculina leptodiae* from *Thalamita stipsoni*, young specimen. a, section of the mantle; b, c, sections of the external part of the mantle. ce, second external cuticle; ci, internal cuticle; e, epithelial cells; ex, excrescences of the third external cuticle; m, muscles of the mantle.  $\times 530$ .

extremely thin (1 to  $1\frac{1}{2}\mu$ ); it may be quite smooth (fig. 4a) or may possess minute excrescences in the shape of small pointed spines of a height of  $1\frac{1}{2}\mu$  or less (fig. 4b).

The two young parasites undoubtedly belong to the same species as the specimens of which excrescences are represented in fig. 1. The excrescences indicated with *ex* in fig. 3c show already a similar arrangement as those

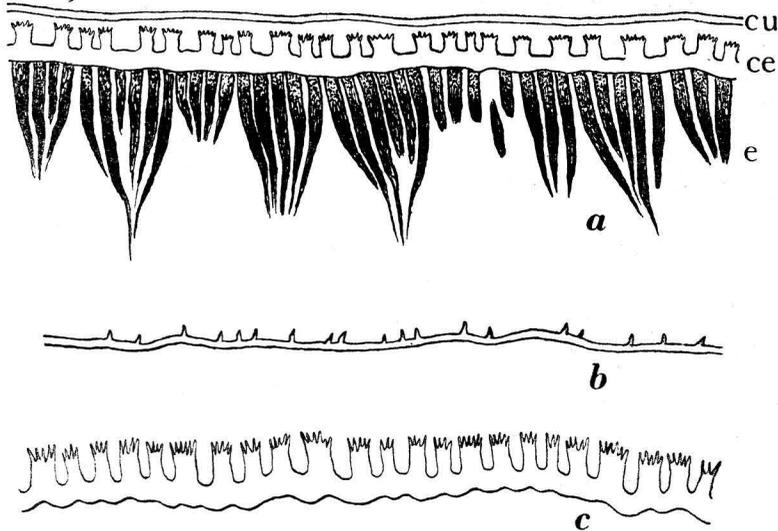


Fig. 4. *Sacculina leptodiae* from *Thalamita stimpsoni*, young specimen. *a*, section of the external part of the mantle; *b*, section of the first external cuticle; *c*, section of the second external cuticle. *ce*, second external cuticle; *cu*, first external cuticle; *e*, epithelial cells.  $\times 700$ .

of fig. 1c. As yet they do not consist of the hyaline kind of chitin which is characteristic of the excrescences of *Sacculina leptodiae*, but during further development gradually the spines would have changed into this harder kind of chitin, a process which begins at the tops and proceeds towards the lower parts of the spines. In the specimens of *Sacculina rotundata* and *S. aculeata* mentioned above this process is already much farther advanced than in the specimen described here.

The occurrence of three successive layers of external cuticle in *Sacculina leptodiae* emphasizes the fact that immature specimens of species of Sacculinidae may show characters of this cuticle which erroneously might be mistaken for definite specific characters. Especially the excrescences of the second layer (fig. 3a, fig. 4c) are of a so well defined shape that they show more distinct peculiarities than the typical excrescences of many other species of the family.

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