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## NOTES ON SOME INDOPACIFIC SPECIES OF THE GENUS *SACCULINA*

by

**H. BOSCHMA**

For many years the species problem in the Sacculinidae has been a matter of controversies. Kossmann's (1872) paper was of fundamental importance, because in his descriptions of a great number of new species, chiefly from the Philippine Islands, he derived the specific characters from the anatomical peculiarities as well as from the excrescences of the external cuticle. Later investigators for many years dealt with European material only, in which specific characters are far less apparent than in tropical Sacculinidae, so that their opinions concerning specific differences were often based on principles instead of on facts. This applies to the papers by Giard and Bonnier (Giard, 1886, 1887, 1888; Bonnier, 1887; Giard & Bonnier, 1887, 1890), in which the description of new species was regarded as sufficiently founded by a simple indication of the host, a procedure based on Giard's conviction of the "spécificité parasitaire", resulting from investigations on the Bopyridae. Previously, Delage (1884) had proclaimed the opinion that the specific differences in the genus *Sacculina* were not sufficiently founded, and many years later Smith (1906), after remarking that he had tried in vain to find specific differences in the European forms of the genus, placed all the names of the later described species in the synonymy of *Sacculina carcini* Thomps. Guérin-Ganivet (1911) described some new species of *Sacculina* based on characters of the internal anatomy; he did not investigate the excrescences of the external cuticle, which, e.g., in his species *S. carpiliae* and *S. leptodiae*, are of comparatively large size, consisting of groups of spines united on common basal parts. In one of Guérin-Ganivet's figures (1911, Pl. I fig. 7, region of the mantle opening of *Sacculina leptodiae*,  $\times 50$ ) the excrescences of the external cuticle are faintly visible, but in the text no detail of the finer structure of the mantle is mentioned besides

the fact that the region of the mantle opening is smooth in contradistinction to the rest of the mantle. In his report on a collection of Rhizocephala, chiefly from Japan, Krüger (1912) used the one name *Sacculina carcini* Thoms. for a number of specimens from various hosts.

When examining the Sacculinidae of the Siboga Expedition, van Kampen & Boschma (1925) came to the conclusion that a fairly large number of species could be distinguished, owing to differences in the structure of the external cuticle. In this paper the tendency prevailed to unite into one species as many specimens as showed more or less corresponding characters, and to describe separate species only when their characters were distinctly different from those of other species. Though this procedure was sound in principle, it appeared afterwards that many of the species in the first Siboga report on Rhizocephala in reality were compound groups, so that a revision became necessary, in which, moreover, special attention was paid to the structure of the male organs and of the colleteric glands (Boschma, 1931 *b*). Some errors of the kind in other papers of the same period (Boschma, 1928, 1931 *a*) up till now have not yet found their corrections. The present paper deals with a few specimens that in the cited papers were misidentified as *Sacculina flexuosa* Kossmann; one of these proved to represent a new species, whilst the other specimens appeared to belong to species described a few years after the cited papers (Boschma, 1933 *b*, 1934). To avoid further misunderstanding the present paper contains notes on all the specimens belonging to the different species here dealt with.

Especially as far as concerns the description of the male organs the present paper contains data that in many cases are decidedly different from what has been remarked in previous papers in which notes appeared on the specimens here dealt with. It must be kept in mind that when these previous papers were written the author was still labouring under trial and error to establish reliable specific characters for the parasites of the group. In the course of further investigations it gradually proved that, e.g., in the species of the genus *Sacculina*, the structure of the male organs may furnish specific characters, so that even inconspicuous differences may form an important support for the distinction of species.

### ***Sacculina flexuosa* Kossmann, 1872**

4 specimens on *Grapsus grapsus* (L.) (*Grapsus strigosus* (Herbst)), from Digollorin (East coast of North Luzon, Philippine Islands), Kossmann, 1872, p. 31; external shape, Pl. I fig. 10; visceral mass and genital organs, Pl. II fig. 1 *a, b*.

1 specimen on *Grapsus grapsus* (L.) (*Grapsus strigosus* (Herbst)), from Nusa Laut (East Indies), van Kampen & Boschma, 1925, p. 49; external shape, Pl. I fig. 22; external cuticle and retinacula, fig. 37.

1 specimen on *Grapsus grapsus* (L.) (*Grapsus strigosus* (Herbst)), from Haruku (near Amboina), Boschma, 1928, p. 163; external cuticle, fig. 6*b*; retinacula, fig. 6*d*.

1 specimen on *Grapsus grapsus* (L.) (*Grapsus strigosus* (Herbst)), from unknown locality, Boschma, 1928, p. 164; external cuticle, fig. 6*c*.

*Sacculina flexuosa*, Boschma, 1931*b*, p. 50.

1 specimen on *Grapsus grapsus* (L.) (*Grapsus maculatus* (Catesby)), from Amboina, Boschma, 1933*a*, p. 520; longitudinal section with male organs and colleteric glands, fig. 41; retinacula, fig. 42.

*Sacculina flexuosa*, Boschma, 1937, p. 244; male organs, fig. 35; colleteric gland, fig. 36.

Kossmann (1872, p. 31; 1874, p. 127) describes the species as follows:

16. *S. flexuosa* n. sp. (Taf. I. Fig. 10.)

Gestalt unregelmässig, dudelsackähnlich. Mund zu einem langen cylindrischen, Mantelöffnung zu einem kurzen conischen Rüssel verlängert. Länge: 11 mm., Höhe: 20 mm.

Die Cuticula des Mantels ist von einer gleichmässigen, nicht erheblichen Dicke (0,05-0,07 mm.); sie zeigt eine feine Runzelung, welche (wenn Mund und Mantelöffnung als Pole betrachtet werden) in äquatorialer Richtung verläuft. Die Verwachsung des Mantels mit dem Körper geht vorn weit über den Mund hinaus (Taf. II. Fig. 1*a* und *b*). Der Körper ist stark seitlich zusammengedrückt, zeigt aber statt der gewöhnlich stattfindenden seitlichen Symmetrie starke Faltungen, welche an die ganz ähnlichen bei *Peltogaster* im hohen Grade erinnern. Die Öffnungen der Ovarien liegen beiderseits ziemlich in der Mitte, umgeben von den flachscheibenförmigen Eikittdrüsen. Die Hoden sind paarig retortenförmig, die Ausführungsgänge hufeisenförmig gebogen, so dass die Öffnung des Bogens nach vorne sieht. Sie liegen dicht hinter dem Munde, und zwar der Ausführungsgang dorsal von der Drüse.

Zahl der untersuchten Exemplare: 4, wovon 2 auf demselben Wohnthiere. Wohnthiere: *Grapsus strigosus* Latr. Fundort: Ostküste von Nord-Luzon (Digollorin).

The shape of the two figured specimens is not principally different, both are elongated in the dorso-ventral direction, in both the mantle opening lies at the top of a distinct tube (fig. 1*a, d*). The other described specimens of *Sacculina flexuosa* have a corresponding shape. Moreover all the known specimens are of an approximately equal size; the dimensions are: Kossmann's type specimen, 20 × 11 × 8 mm; specimen from Nusa Laut, 23 × 13 × 6½ mm; specimen from Haruku, 21 × 12 × 4½ mm; specimen from unknown locality, 22 × 12½ × 7 mm; specimen from Amboina, 19 × 10 × 8½ mm (the diversity in thickness is chiefly caused by the varying amount of eggs present in the mantle cavity).

Kossmann's figures of the anatomical characters of the species (fig. 2*a, b*, in the present paper) present some interesting details. These figures distinctly show the transversely folded visceral mass (cf. also Boschma, 1933*a*, fig. 41), a peculiarity not to be observed in other species of the genus. Kossmann's drawing of the male genital gland is not altogether correct (cf. fig. 2*a*): in *Sacculina flexuosa* the male opening is found at the ventral end, exactly as in other species of the genus. The male organs of *S. flexuosa* are different from those of most of the other species by being much thicker

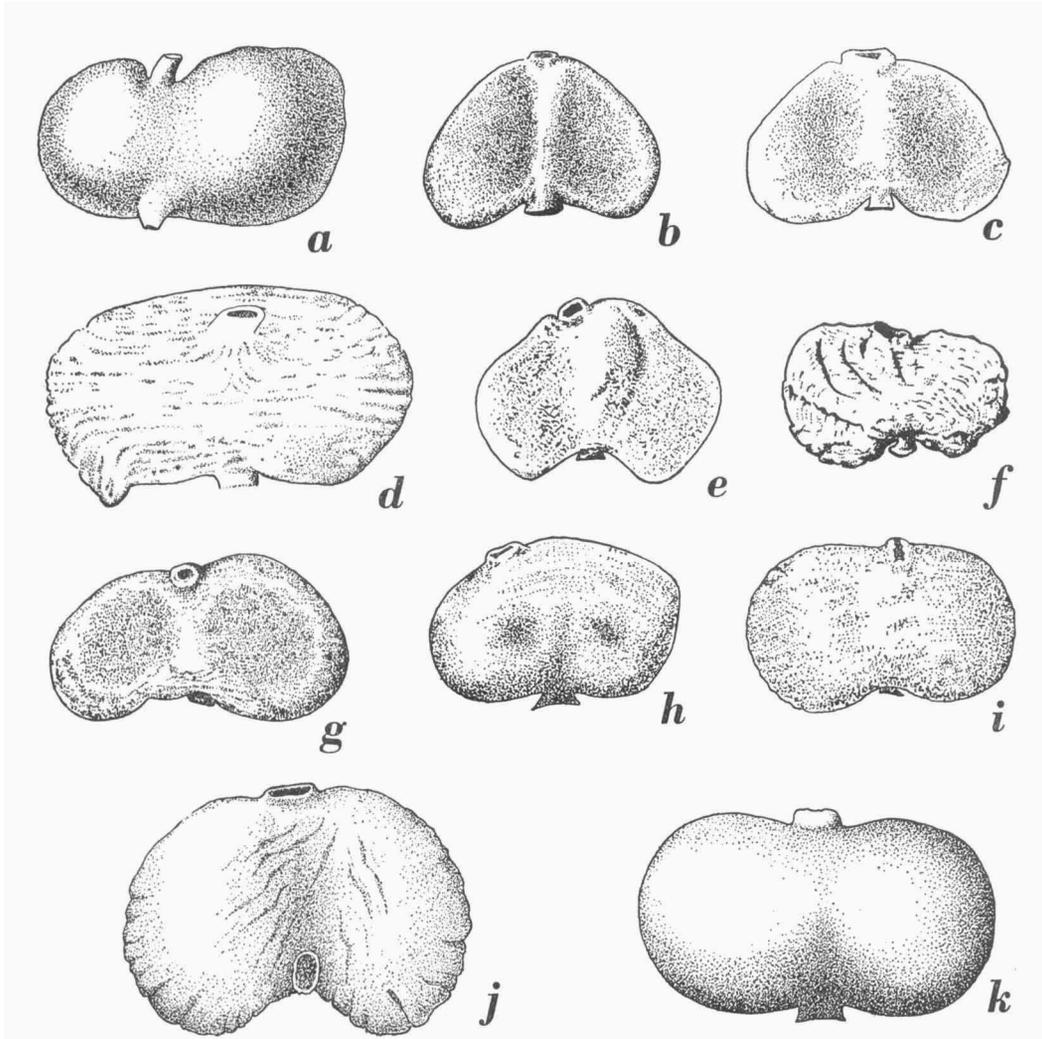


Fig. 1. Left or right side of specimens belonging to four species of *Sacculina*, in *a* mantle opening at the lower part of the figure, in *b-k* at the upper part. *a*, *S. flexuosa*, type specimen, left side (Kossmann, 1872, Pl. I fig. 10); *b*, *S. curvata* on *Uca dussumieri* (H. M. Edw.), left side (Boschma, 1950, fig. 3 *h*); *c*, *S. curvata* on *Varuna litterata* (Fabr.), left side (Boschma, 1928, fig. 1 *c*); *d*, *S. flexuosa*, left side (van Kampen & Boschma, 1925, Pl. I fig. 22); *e*, *S. curvata* on *Macrophthalmus erato* de Man, left side (Boschma, 1928, fig. 1 *d*); *f*, *S. punctata* on *Plagusia dentipes* de Haan, left side (Shiino, 1943, fig. 1 H); *g*, *S. curvata*, type specimen, left side (Boschma, 1950, fig. 2 *a*); *h*, *S. punctata* on *Plagusia depressa* (Fabr.), right side (Boschma, 1931 *a*, fig. 33 *d*); *i*, *S. punctata* on *Plagusia immaculata*, Lamk., left side (Boschma, 1928, fig. 1 *e*); *j*, *S. punctata*, type specimen, right side (original); *k*, *S. infirma*, type specimen, right side (original). *a*,  $\times 2$ ; *b*,  $\times 4$ ; *c*,  $\times 3\frac{1}{5}$ ; *d*,  $\times 2$ ; *e*,  $\times 4$ ; *f*,  $\times 1\frac{1}{2}$ ; *g*,  $\times 4\frac{1}{4}$ ; *h*,  $\times 3$ ; *i*,  $\times 2\frac{4}{5}$ ; *j*,  $\times 2$ ; *k*,  $\times 3$ .

in their ventral half than in their dorsal half; the dorsal end shows a curvature towards the anterior region of the visceral mass (fig. 2 *c*). Kossmann examined his specimen by dissection, in serial sections the exact structure becomes more easily apparent.

To emphasize the striking differences from those of the other species dealt with in the present paper, a number of transverse sections of the male organs in the British Museum specimen from Amboina are drawn in fig. 3. The first section (fig. 3 *a*) shows the most ventral part of one of the male glands, the other begins at a slightly farther dorsal region. In this ventral region the cavity of the vas deferens is of a rather complicated structure,

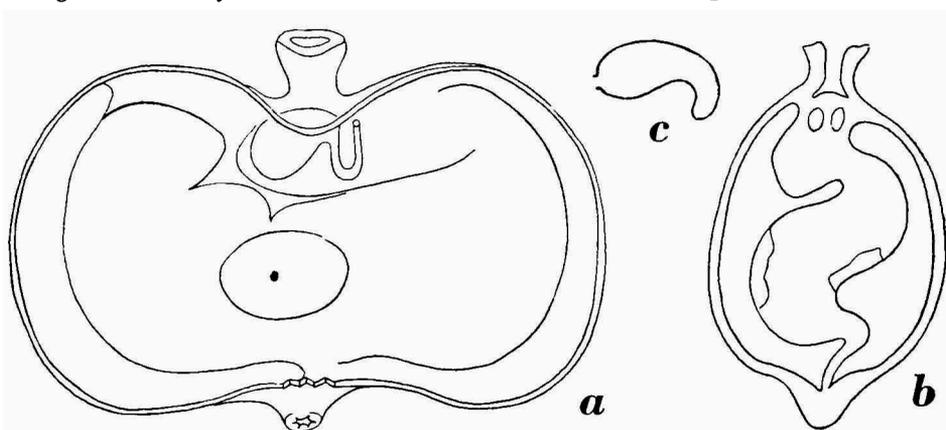


Fig. 2. *a, b*, *Sacculina flexuosa*, type specimen (Kossmann, 1872, Pl. II fig. 1 *a, b*). *a*, left side, mantle removed; *b*, longitudinal section. The figures show the folds in the visceral mass, the male genital and colleteric glands. Some details omitted.  $\times 4$ . *c*, diagrammatic reconstruction of a male genital gland as shown in the sections of fig. 3.

as it is divided into several partitions by comparatively high ridges extending from the wall. This condition remains for some distance (fig. 3 *b*), but gradually the central canal becomes more apparent (fig. 3 *c-e*). At about the middle of their length the male organs become narrower, whilst continuing their course as a curvature directed towards the anterior region of the visceral mass (fig. 3 *f-h*). Because there is not a narrow canal with chitinous inner wall connecting the two parts of the male organs, the region of transition of the vas deferens into the testis is not sharply delimited.

In fig. 3 *i* the canals are shown as they occur in a longitudinal section of one of the colleteric glands from the region in which the system of canals is the most widely extended. In the figured section there are 92 canals.

The external cuticle of the mantle does not possess excrescences, nor does it in other respects show peculiarities to be regarded as specific

characters. On the other hand the retinacula yield an important specific character: they occur in large numbers, and were found in all the specimens examined for these structures; their 3 to 5 spindles varying in size from 12 to 15  $\mu$  are slightly larger than those of most of the species of the genus.

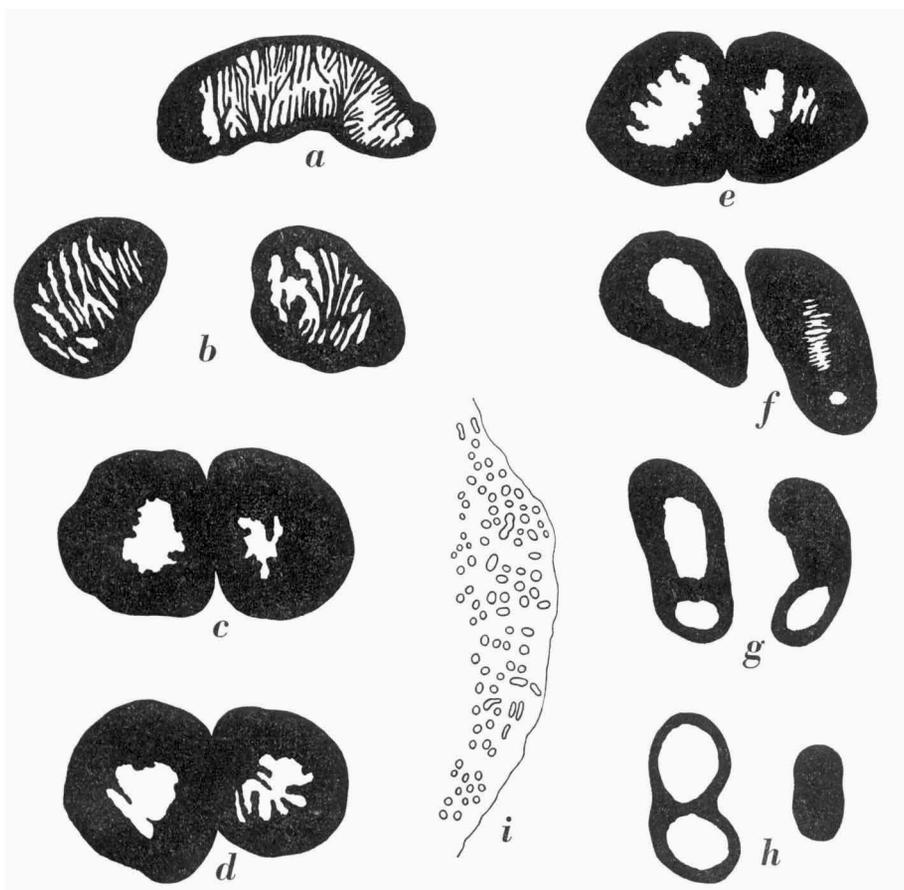


Fig. 3. *Sacculina flexuosa* Kossmann, specimen from Amboina, collection British Museum (Natural History). *a-h*, transverse sections of the male organs; *a*, from the ventral part, each following section 300  $\mu$  farther to the dorsal region; *i*, longitudinal section of one of the colleteric glands.  $\times 23$ .

They are strikingly different from the isolated spindles as they occur in *Sacculina punctata*.

At present three species of the genus *Sacculina* are known as parasites of crabs of the genus *Grapsus*, viz., *S. flexuosa* Kossmann, *S. plana* Boschma, 1933 *a*, and the new species described in the present paper. These three

species have the common peculiarity of an external cuticle that is devoid of excrescences. The retinacula of *S. flexuosa* are of the compound type, each bearing three or more spindles, those of *S. plana* consist of isolated spindles, whilst in the new species they are unknown. The male organs of the three species present striking differences: in the new species these organs are remarkable by their lack of definite peculiarities, in *S. plana* there is one testis with two vasa deferentia, whilst the most striking feature in the male organs of *S. flexuosa* is the multidivided lumen of the vasa deferentia.

### **Saccolina punctata** Boschma, 1934

1 specimen on *Plagusia immaculata* Lamk., from unknown locality (p. p. *Saccolina flexuosa*), Boschma, 1928, p. 166; external shape, fig. 1 e; longitudinal section with testes, fig. 5 d; external cuticle, fig. 6 h.

1 specimen on *Plagusia depressa* (Fabr.), from Jap (Caroline Islands) (*Saccolina flexuosa*), Boschma, 1931 a, p. 344; longitudinal section with testes and colleteric glands, fig. 34; external cuticle, fig. 35 a, b.

1 specimen on *Plagusia depressa* (Fabr.), from unknown locality (*Saccolina flexuosa*), Boschma, 1931 a, p. 344; external shape, fig. 33 d (erroneously indicated as the specimen from the Caroline Islands); external cuticle, fig. 35 c.

Type specimen on *Plagusia dentipes* de Haan, from Kaseda, Satuma, Japan, Boschma, 1934, p. 286; longitudinal sections of male organs, fig. 1; external cuticle and retinacula, fig. 2.

*Saccolina punctata*, Boschma, 1937, p. 296; male organ and colleteric gland, fig. 72.

3 specimens on *Plagusia dentipes* de Haan, from Tomioka, Japan, Shiino, 1943, p. 14; external shape, fig. 1 H; male organs fig. 10 A; external cuticle, fig. 10 B.

Three of the specimens previously identified as *Saccolina flexuosa* proved to belong to *S. punctata*, so that at present seven specimens of *S. punctata* have become known. The figured specimens (fig. 1 f, h, i, j) do not present striking differences as far as concerns their shape, they are broadly oval, comparatively smooth or somewhat wrinkled, fairly symmetrical (fig. 1 j) or rather asymmetrical (fig. 1 h). The shape of the mantle opening is remarkably constant: it occurs on a very short tube slightly extending over the surrounding parts of the mantle. The size of the known specimens of *S. punctata* is rather variable, the Japanese specimens being the largest: type specimen,  $23 \times 16 \times 6$  mm; Shiino's largest specimen,  $21\frac{1}{2} \times 12\frac{1}{2} \times 6$  mm. The dimensions of the other specimens are: on *Plagusia immaculata*,  $12\frac{1}{2} \times 8 \times 4$  mm; on *P. depressa* from the Caroline Islands,  $12 \times 8 \times 3$  mm; on *P. depressa* from unknown locality,  $11 \times 6\frac{1}{2} \times 3$  mm.

Transverse sections of the male organs in the specimen on *Plagusia immaculata* are shown in fig. 4. The vasa deferentia (fig. 4 a, b, right half of c-e) are comparatively wide, they contain a few rather high ridges dividing the cavities into partitions. The vas deferens is connected with the testis by means of a narrow canal with a thick inner lining of chitin;

this region of transition of the vas deferens into the testis is shown for one of the male organs in fig. 4 *c, d*, for the other in fig. 4 *f*. In this specimen one of the testes remains rather narrow (greatest width in fig. 4 *f*), the

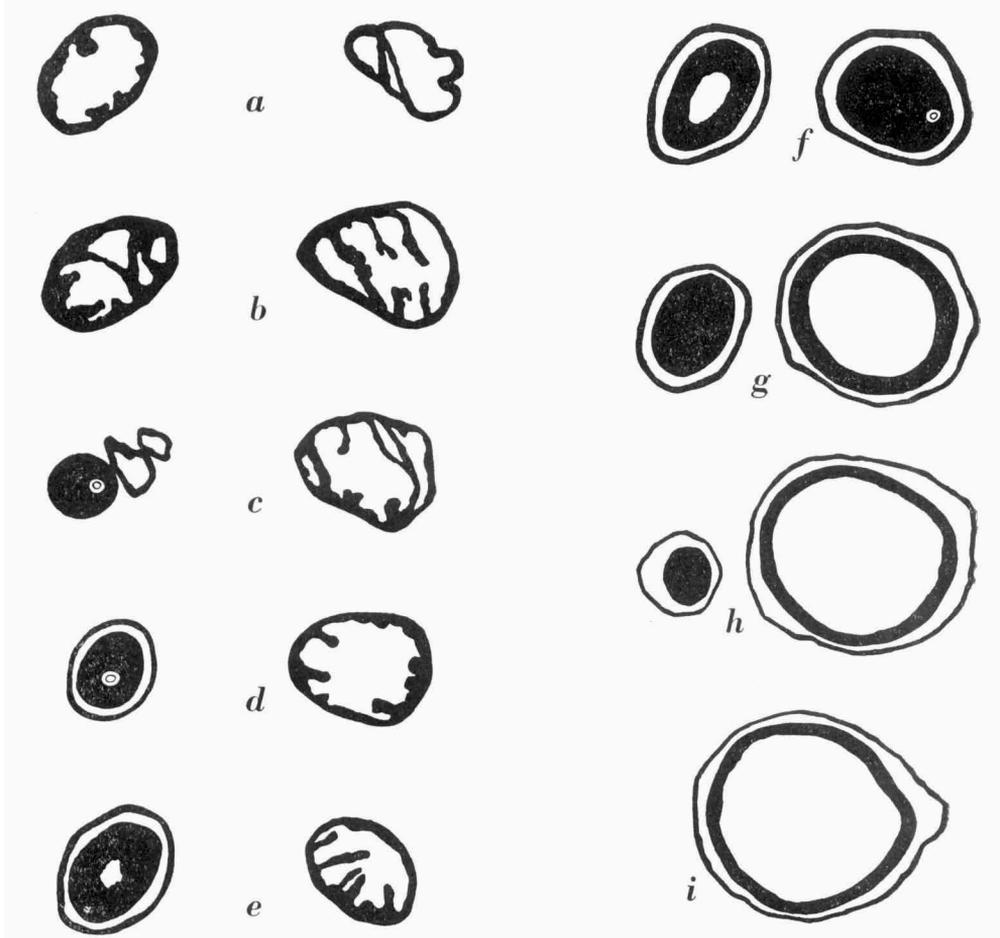


Fig. 4. *Sacculina punctata* Boschma, specimen on *Plagusia immaculata* Lamk., transverse sections of the male organs; *a*, from the ventral part, each following section  $150 \mu$  farther to the dorsal region.  $\times 30$ .

other testis becomes much wider (fig. 4 *g-h*); the narrower testis has a more ventral position than the wider.

In the specimen on *Plagusia depressa* from the Caroline Islands the male organs have a structure similar to that of the specimen dealt with above; here again one of the testes is larger and wider than the other. Two transverse sections of the male organs, showing the region of transition of the

vas deferens into the testis, are represented in fig. 5*b, c*; the peculiarities of these organs correspond in every respect with those of the specimen dealt with above.

In these two specimens the male organs are comparatively straight, as in Shiino's figure (1943, fig. 10 A) of the male organs of a large specimen on *Plagusia dentipes* from Japan. On the other hand in the type specimen (of large size, on *Plagusia dentipes* from Japan) the dorsal part of the vasa deferentia extends over the ventral part of the testes (cf. Boschma, 1934, fig. 1).

In a previous paper the canal system in longitudinal sections of one of the colleteric glands in the type specimen was figured (Boschma, 1937, fig. 72 *b, c*); the number of canals in the most strongly branched part appeared to be 147. In the smaller specimens the number of canals of the colleteric glands is not as large: in the specimen on *Plagusia immaculata* a longitudinal section of the most strongly branched region contains 97 canals (fig. 5 *a*); a corresponding section of the specimen on *Plagusia depressa* from the Caroline Islands shows 109 canals (fig. 5 *d*). The lesser number apparently is determined by the smaller size of the gland in the smaller specimens.

The external cuticle of the mantle does not show peculiarities of a constant character that may be regarded as of specific value. In the type specimen the cuticle shows small areas of varying shape, as a rule each with a small central column of chitin of a more hyaline structure penetrating towards the deeper layers (Boschma, 1934, fig. 2 *a-d*). The specimen on *Plagusia immaculata* has the small areas, but does not have the central columns of hyaline chitin (Boschma, 1928, fig. 6 *h*); the specimens on *Plagusia depressa* do not show the small areas, but have inconspicuous verrucae occurring in patches on the surface of the cuticle (Boschma, 1931*a*, fig. 35). Shiino (1943, p. 14, fig. 10 B) describes and figures small papillae on the external cuticle of his specimens on *Plagusia dentipes*, which do not show the small areas as they occur in the type specimen. It stands to reason that this variation in the minute structure of the external cuticle leads to the simple but rather vague definition "external cuticle devoid of excrescences".

Retinacula have been found in the type, not in the other specimens. They occur as broad bands of isolated spindles on which no barbs were observed. The spindles have a length of 7 to 12  $\mu$ . As retinacula occurring as isolated spindles are a rather exceptional feature among the species of the genus *Sacculina*, the peculiarities of these structures form an important character of the species.

All the specimens of *Sacculina punctata* that up till now have become known were parasites of various species of the genus *Plagusia*; moreover, it is the only species of rhizocephalan parasites known to infest these Grapsid crabs. As observed on a previous page, *Sacculina flexuosa* is the

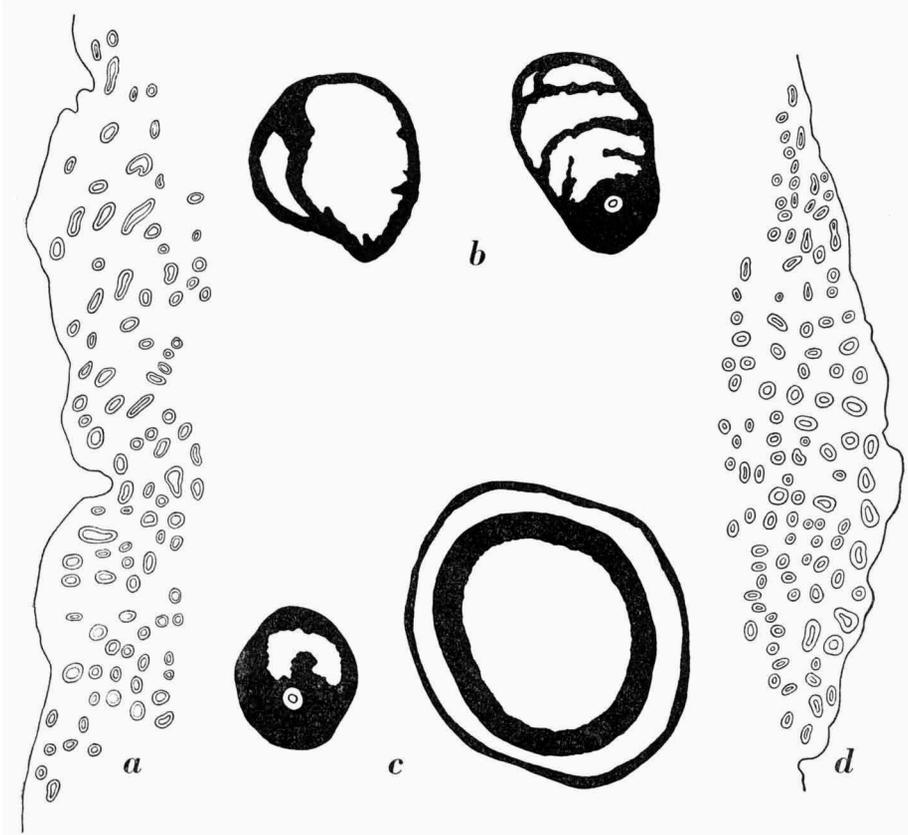


Fig. 5. *Sacculina punctata* Boschma. *a*, longitudinal section of one of the colleteric glands of the specimen on *Plagusia immaculata* Lamk.; *b*, *c*, transverse sections of the male organs of the specimen on *Plagusia depressa* from the Caroline Islands; *d*, longitudinal section of one of the colleteric glands of the same specimen.

*a*,  $\times 63$ ; *b*, *c*,  $\times 53$ ; *d*,  $\times 85$ .

most common parasite of the crabs of the genus *Grapsus*. These preferences for a certain host, or at least for a host belonging to a certain genus point to an at least partial validity of Giard's theory of the specific differences of the parasites of different hosts.

#### ***Sacculina curvata* Boschma, 1933 *b***

1 specimen on *Varuna litterata* (Fabr.) from Alkmaar Island (Bay of Batavia) (p. p. *Sacculina flexuosa*), Boschma, 1928, p. 164; external shape, fig. 1 *c*; longitudinal section with testes, fig. 5 *a*; external cuticle, fig. 6 *g*, *i*.

2 specimens on *Macrophthalmus erato* de Man, from South coast of Madura (East Indies) (p. p. *Sacculina flexuosa*), Boschma, 1928, p. 165; external shape, fig. 1 *d*; longitudinal section with testes, fig. 5 *b*; external cuticle, fig. 6 *e, f, k*.

Type specimen on *Sesarma (Sesarma) edwardsii philippinense* Rathbun, from Pangauran River, Busuanga Island, Philippine Islands, Boschma, 1933 *b*, p. 230; external cuticle, fig. 13.

1 specimen on *Uca dussumieri* (H. M. Edw.), from Sebatik Island, Borneo, Boschma, 1933 *b*, p. 231.

*Sacculina curvata*, type specimen, Boschma, 1937, p. 232; male organs, fig. 24; colleteric gland, fig. 25.

*Sacculina curvata*, type specimen, Boschma, 1950, p. 21; external shape, fig. 2 *a*.

*Sacculina curvata*, specimen on *Uca dussumieri* (H. M. Edw.), Boschma, 1950, p. 22; external shape, fig. 3 *h*; male organs and colleteric gland, fig. 13.

The figured specimens (fig. 1 *b, c, e, g*) show that the parasite has a tendency towards a more or less triangular shape, the region of the mantle opening forming the top of the triangle (the least apparent in the type specimen, fig. 1 *g*, in which, in contradistinction to the other specimens, the antero-posterior diameter is less than half as long as the dorso-ventral diameter, so that the triangular shape has changed into a broadly oval form). In comparison to the here figured other specimens those representing *Sacculina curvata* have their largest dimension far more towards the posterior region. One of the specimens on *Macrophthalmus erato* (not figured) has a different shape: this specimen is almost globular though parts of the mantle are somewhat irregularly protruding; it was, however, on account of its much smaller size, not yet fully developed. The dimensions of the parasites are: specimen on *Uca*,  $8 \times 5 \times 1\frac{1}{2}$  mm; specimen on *Varuna*,  $11 \times 6\frac{1}{2} \times 2$  mm; larger specimen on *Macrophthalmus*,  $8 \times 5 \times 1\frac{1}{2}$  mm; smaller specimen on *Macrophthalmus*,  $3\frac{1}{2} \times 3 \times 2\frac{1}{2}$  mm; specimen on *Sesarma*,  $9\frac{1}{2} \times 4 \times 3$  mm. A common feature of the specimens is that the mantle opening but slightly protrudes above its surroundings.

The notes on the male organs, as given in previous papers (Boschma, 1933 *b*, 1937, 1950) need some corrections. At present four sectioned specimens, on four different hosts, could be examined; it proved that the male organs of the four specimens are similar in almost every detail. The course of the male organs is in a dorso-ventral direction, they do not show a curve towards the anterior region, though one gets the impression of such a curve because the dorsal parts of the testes are flattened sideways. In all the specimens the curious fact presents itself of a chitinous layer covering the inner wall of the entire testis and at least part of the vas deferens. If such a layer of chitin is of constant occurrence in the species it is difficult to explain how the testis can perform its function notwithstanding interiorly being covered by an impenetrable layer of chitin. If on the other hand such a layer of chitin occurs during a certain period in the life history of the

parasites only, it remains a curious coincidence that this layer of chitin is present in a corresponding manner in all the four specimens investigated. Because in all the specimens the layer of chitin has at least partly detached itself from the inner wall of the testis, the conclusion seems indicated that this layer is being removed previous to a period of functioning of the testis; but if this explanation is correct, it remains incomprehensible why all the four examined specimens happen to show the same condition.

The here mentioned layer of chitin is visible in some previously published figures (Boschma, 1928, fig. 5 *a*, specimen on *Varuna*; *ibid.*, fig. 5 *b*, specimen on *Macrophthalmus*), but as yet no attention was paid to this uncommon structure. In the figures of the male organs of the type specimens of *Sacculina curvata* (Boschma, 1937, fig. 24) the chitinous layer

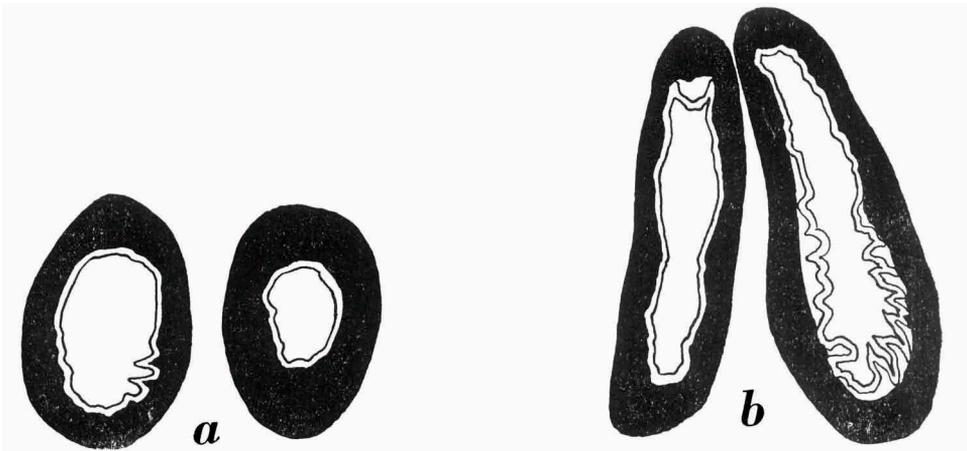


Fig. 6. *Sacculina curvata* Boschma, type specimen. Transverse sections of the male organs; *a*, from the ventral half; *b*, from the dorsal half.  $\times 107$ .

in the testes was omitted; in the corresponding figures of the specimen on *Uca* (Boschma, 1950, fig. 13) the inner black lines in the male organs represent this layer of chitin; the outer black line is the wall of the testis itself, not the muscular layer surrounding the testis. In this specimen the chitinous layer has detached itself from the wall of the testis, it is strongly shrivelled, so that in sections, especially in those of the dorsal region, it appears to be divided into several component parts (*l.c.*, fig. 13 *d*).

Two transverse sections of the male organs of the type specimen of *Sacculina curvata* are here represented (fig. 6), the one (fig. 6 *a*) from the ventral half, the other (fig. 6 *b*) from the dorsal half of these organs. In this specimen the chitinous layer is still united with the inner wall of the testes, except in the dorsal region.

Sections of the male organs of the specimen on *Varuna*, at equal distances from each other, are shown in fig. 7. The vasa deferentia (fig. 7 *a, b*) are rather narrow tubes, the testes at first have a more or less circular contour (fig. 7 *c, d*), gradually they become laterally compressed (fig. 7 *e-i*). There is a distinct layer of chitin in the vasa deferentia as well as in the testes; at

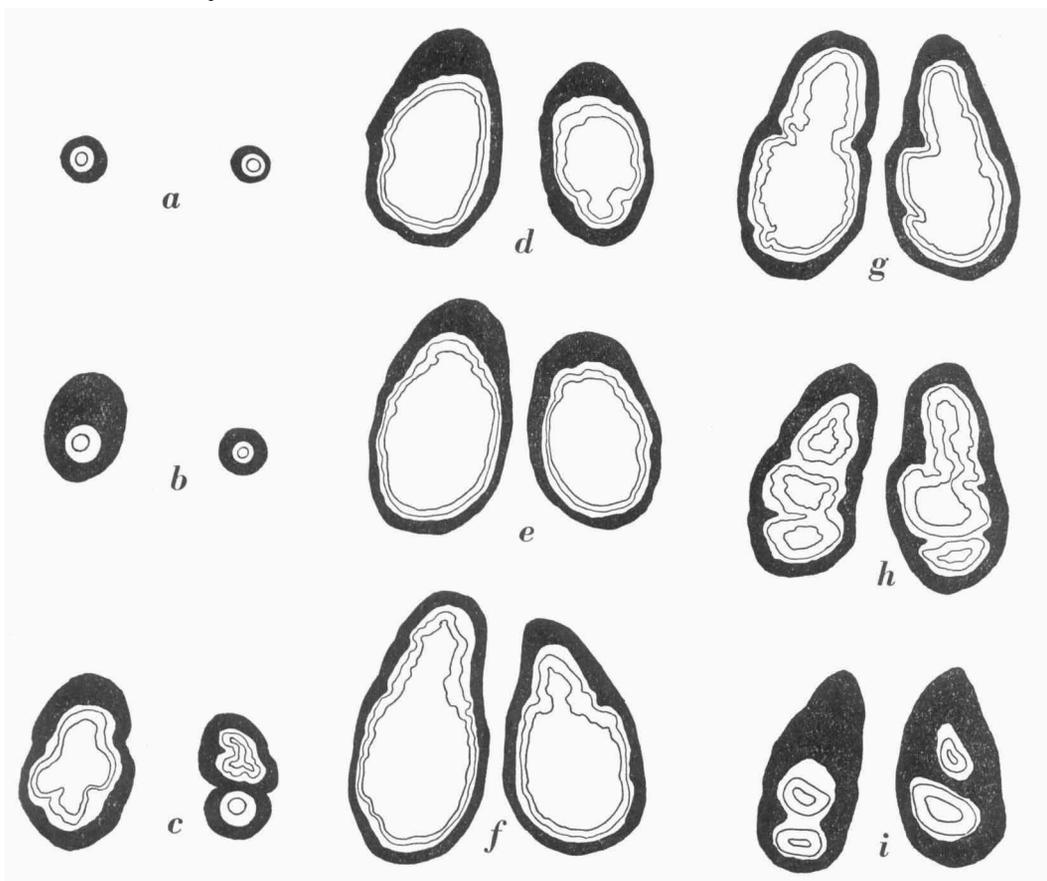


Fig. 7. *Saccolina curvata* Boschma, specimen on *Varuna litterata* (Fabr.), transverse sections of the male organs; *a*, from the ventral part, each following section 50  $\mu$  farther to the dorsal region.  $\times 53$ .

first this layer is adhering to the inner wall of the male organs, but gradually it detaches itself, and towards the extreme dorsal region it becomes strongly wrinkled, so that separate protruding parts often occur in one section (fig. 7 *h, i*).

The male organs of the larger specimen on *Macrophthalmus* (fig. 8) are similar to those of all the other specimens. Here the chitinous layer is present

in the testes; in the vasa deferentia it is not apparent. The chitinous layer has completely loosened itself from the inner wall of the testes, it is strongly

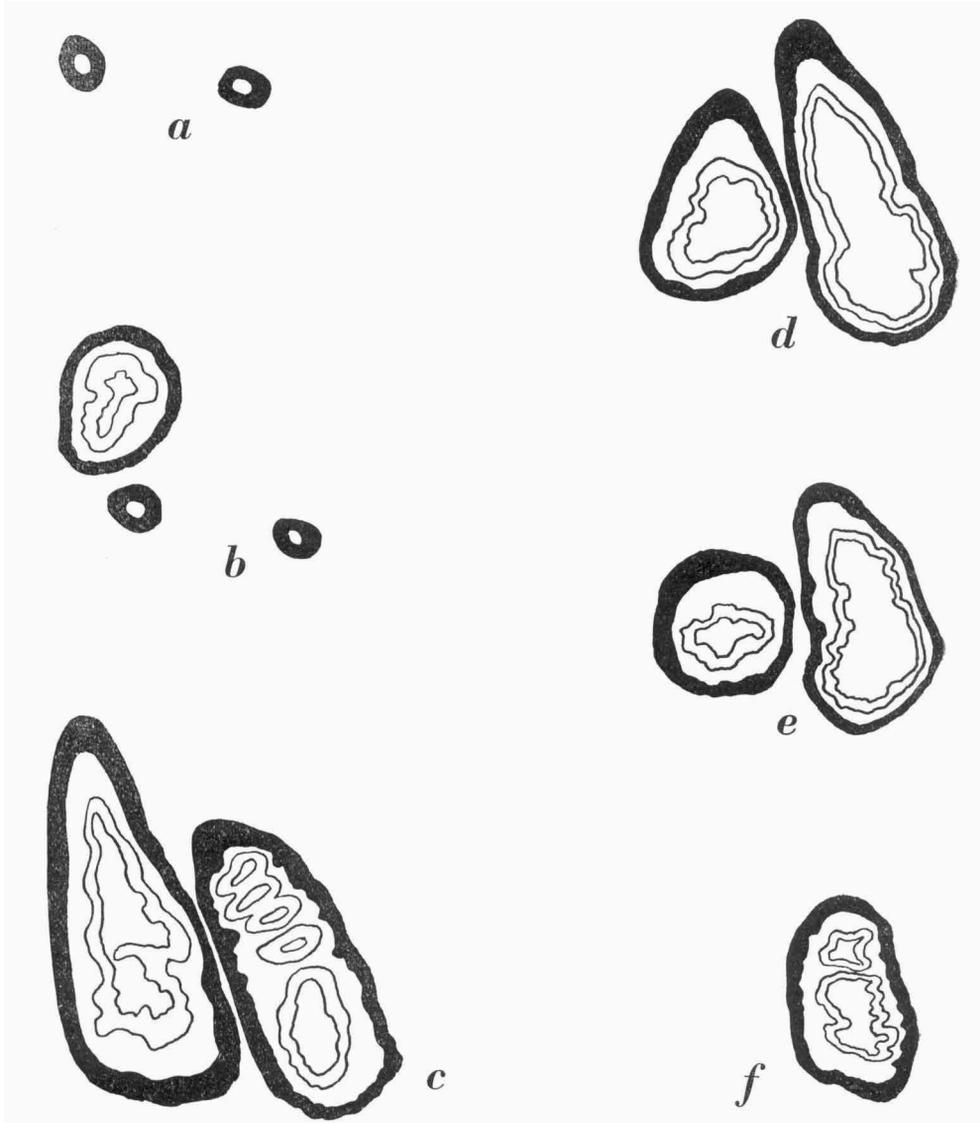


Fig. 8. *Sacculina curvata* Boschma, specimen on *Macrophthalmus erato* de Man, transverse sections of the male organs; *a*, from the ventral part, each following section  $50\ \mu$  farther to the dorsal region.  $\times 96$ .

wrinkled and folded, so that in many sections a number of separate folds are shown (fig. 8 *c*, *f*). In this specimen too the testes are distinctly flattened

laterally; here one of the testes has a more ventral position than the other.

The number of canals in a longitudinal section of the most strongly branched region of the colleteric glands is somewhat variable in the different specimens. In the type specimen, on *Sesarma* (Boschma, 1937, fig. 25) the number of canals amounts to 43, in the specimen on *Uca* (Boschma, 1950, fig. 13 *e, f*) to 40. On the other hand the specimen on *Macrophthalmus* has a larger number of canals, the figured section (fig. 9 *a*) showing 98. In the



Fig. 9. Longitudinal sections of colleteric glands. *a*, *Sacculina curvata* on *Macrophthalmus erato* de Man; *b*, *S. curvata* on *Varuna litterata* (Fabr.); *c*, *S. infirma*.  $\times 53$ .

specimen on *Varuna* the number of canals is smaller, the figured section (fig. 9 *b*) showing 32 canals, slightly less than in the first mentioned specimens. In the four specimens the distribution of the canals in the colleteric glands is similar, though in some specimens they are wider apart than in others.

The four different hosts of *Sacculina curvata* belong to two families: *Sesarma* and *Varuna* to the Grapsidae, *Uca* and *Macrophthalmus* to the

Ocypodidae. These families are closely allied, both belonging to the Catometopa, so that the known occurrence of the species is restricted to mutually related hosts.

**Sacculina infirma** nov. spec.

1 specimen (holotype) on *Grapsus grapsus* (L.) (*Grapsus strigosus* (Herbst)), from "Indian Ocean" in Rijksmuseum van Natuurlijke Historie, Leiden (p. p. *Sacculina flexuosa*), Boschma, 1928, p. 161; longitudinal section with male organs, fig. 5c; external cuticle, fig. 6a.

Specific characters. Male organs in the region of the stalk, outside the visceral mass, forming narrow, slightly flattened canals, completely separated; testes not wider than vasa deferentia, the two parts without distinct region of transition. Colleteric glands with a moderate number of canals (32 in a longitudinal section of the most strongly branched region). External cuticle of the mantle without excrescences. Retinacula unknown.

The species differs from all other species of the genus by its lack of distinct characters.

The specimen (fig. 1k) is of a more or less panduriform shape. The mantle does not show any pronounced grooves or wrinkles. The mantle opening lies at the top of a short tube in the middle of the anterior surface. The dorso-ventral diameter is 15½ mm, the antero-posterior diameter 7½ mm, and the thickness 5 mm.

The serial sections are not altogether perfect, but the chief details of the internal organs could be examined with sufficient accuracy, especially the male organs. In comparison to those in other species of *Sacculina*, the male organs of *S. infirma* are of a very simple structure. The vasa deferentia are slightly flattened canals, each with an almost undivided cavity (fig. 10a, b). Gradually the vasa deferentia pass into the testes; there is not a sharply delimited region of transition between the two parts of the male organs. The widest part of the testes (fig. 10g-i) is not appreciably wider than the vasa deferentia; towards their dorsal ends the testes gradually diminish in width (fig. 10j-l). The two male organs remain separated from each other for the whole of their extent, the left and right male organ do not show striking differences in width or in position.

The colleteric glands contain a moderate number of canals (fig. 9c). In a longitudinal section of the most strongly branched part the number of canals amounts to 34. The canals are not evenly distributed, but often form patches that are more or less separated from each other. In the single available specimen the canals of the colleteric glands do not have a layer of chitin.

The external cuticle of the specimen was described in a previous paper (Boschma, 1928, p. 163). It does not possess excrescences, nor does it show

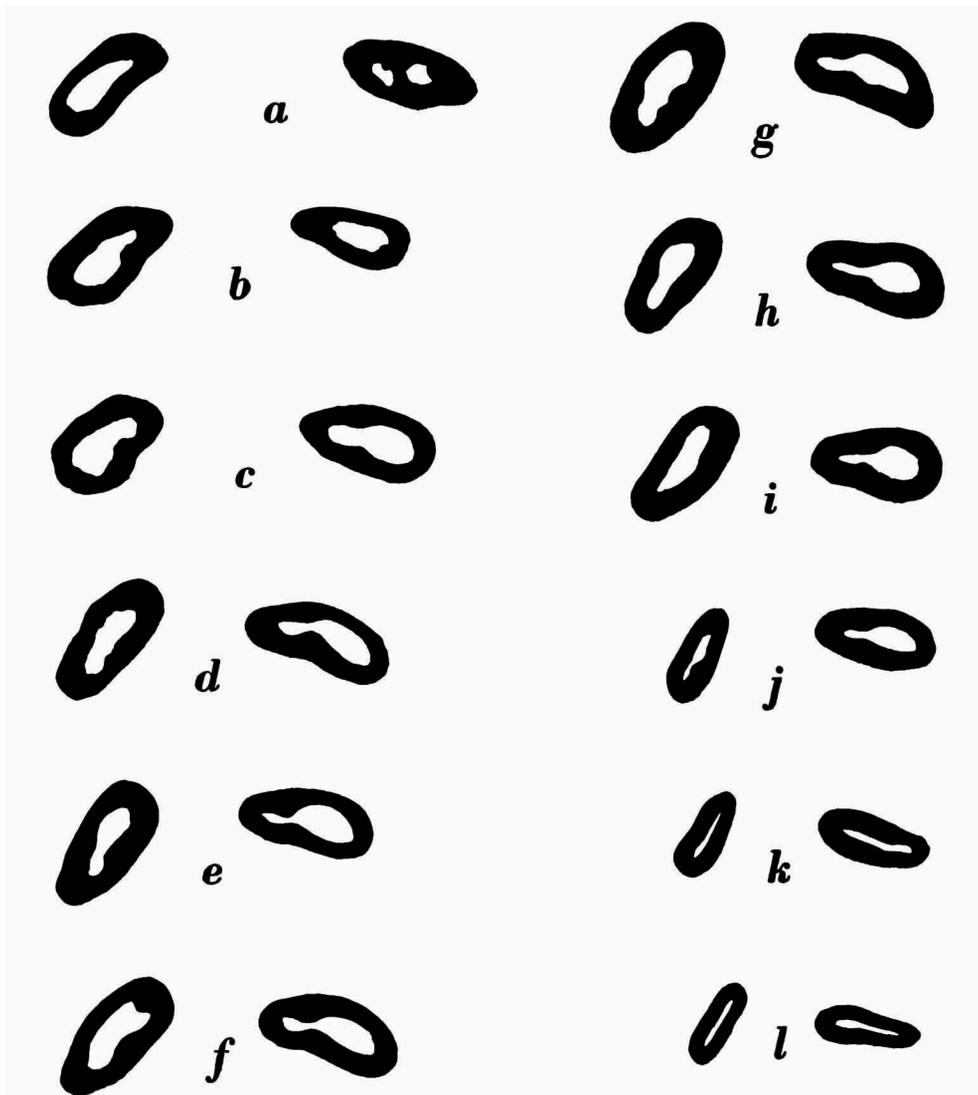


Fig. 10. *Sacculina infirma* nov. spec., transverse sections of the male organs; *a*, from the ventral part, each following section  $75 \mu$  farther to the dorsal region.  $\times 54$

the small areas as they often occur in species with a smooth external cuticle. When strongly enlarged the external cuticle appears to be minutely wrinkled and granular.

Retinacula are not present in the parts of the internal cuticle examined for this purpose.

Attempts to place the new species in the (artificial) key of the species in a previous paper (Boschma, 1937, pp. 197-202) lead to the species *anceps* and *bicuspidata*. In both of these the testes are much wider than the vasa deferentia, in contradistinction to the here described new species. The same character holds for the species with a cuticle without excrescences that were described in later years. Accordingly *Sacculina infirma* must be regarded as a separate species, ill-defined as it may be on account of its lack of distinct characters.

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