ANTARCTIC PARASITIC COPEPODS AND AN ASCOTHORACID CIRRIPED FROM BRITTLE-STARS

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With Plates I–II

THE Ophiuroids of the "Discovery" Expedition have been dealt with by TH. MORTENSEN (1936). During his work on the Ophiuroids Dr. Mortensen found some parasitic Crustaceans, which he mentioned in his paper. These parasites are described in detail in the present paper.

Owing to the calcareous cuticle of ophiuroids most of their parasites are endoparasitic, as a penetration of the external cuticle of the ophiuroid for nourishment of the parasite is very difficult.

Parasitic copepods are generally very sporadic in their occurrence, it is natural, therefore, that nearly all the parasitic copepods which we know today are parasites on fishes. Most of the fish parasites known have been parasitic on commercial fishes. Different publications in recent years have shown that parasitic copepods also occur on different invertebrates, even on amphibians and mammals living in the water. It is to be expected therefore that parasitic copepods are much more abundant than was previously presumed. This abundance does not apply to the specimens but only to the variety of species and hosts.

This paper deals with five new copepods only three species of which are endoparasitic, and one new cirriped all from ophiuroids, but since our present knowledge of parasitic copepods on brittle-stars is very limited even this small contribution to our knowledge may be of some interest. Further because the male of the genus *Ophioica* is described in the present paper; this proved to be so transformed that it was difficult to recognize it as a selfdependent individual. It was situated in the tissue of the female from where it gets nourishment and has been transformed so that it is only a male gonad from the female body.

I. COPEPODA ECTOPARASITIC ON OPHIUROIDS

Genus Cancerilla Dalyell.

Cancerilla ampla n. sp.

Figs. 1 a–l.

Localities: St. 170, Off Cape Bowles, Clarence Island, 342 m, 23. II. 1927, 2 specimens. St. 190, Palmer Archipelago, 315 m, 24. III. 1927, 1 specimen.

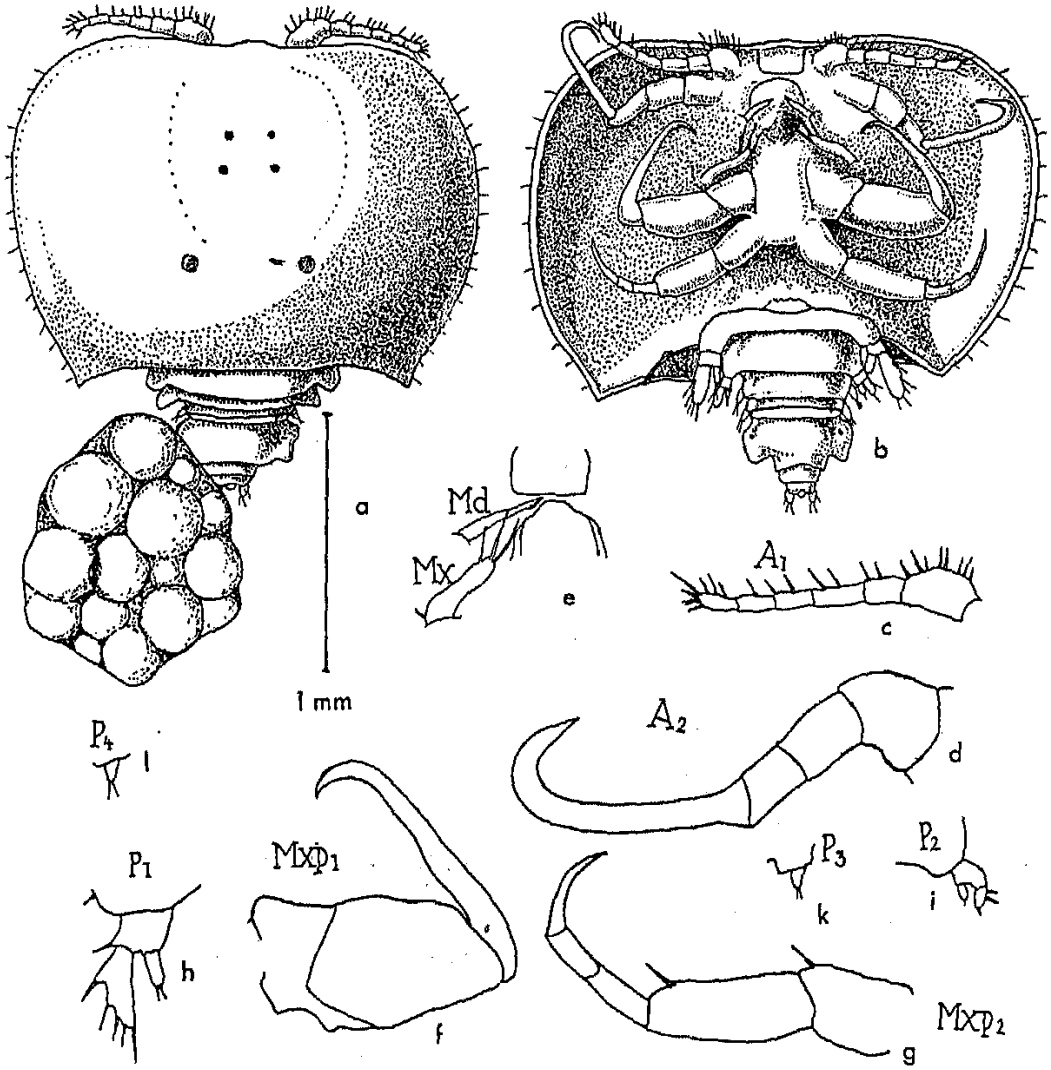
Host: The parasite at both localities was found in *Ophiacantha vivipara* Ljungman; all three specimens were females.

The genus *Cancerilla* was established in 1851 by DALYELL for the species *Cancerilla tubulata* which later on appeared to have a cosmopolitan distribution. CLAUS has further described some copepods under the name of *Caligidium* which is to be regarded as a synonym, being founded on adult males belonging to this genus, as is shown by GIESBRECHT (1897) and SARS (1918). Later STEPHENSEN (1927, 1933) described two new females, viz. *C. neozelanica* from New Zealand and *C. durbanensis* from the Indian Ocean.

Cancerilla ampla from the Antarctic differs from these species notably in the shape of the cephalic segment, which is much more flattened and broader than in any of the other species. The segments forming the cephalic shield are nearly 2 mm broad and only 1.25 mm long. The posterior margin of the cephalothorax is a little incurvated, running out laterally into two pointed wings. On the dorsal side three pairs of darker spots are seen which are placed in smaller incurvations. The two frontal pairs are the smallest, and they may look like vestiges of eyes, but are placed too much behind the rostral border as compared with *C. tubulata*, in which both males and females have eyes.

After the cephalic shield five free thoracic segments follow, after which follows the genital segment. These free segments are very small and only form an appendix to the cephalothorax. The first of the segments is almost incorporated in the cephalic shield, but those following are more movable in the links between the segments. The segments are 0.3–0.6 mm broad, and laterally they run out in to small alae or wings. After the genital segment two small abdominal segments follow. The last one is tipped with a very small pair of caudal rami, rather far apart and with short apical setae.

In front of the cephalon the rostrum is squarish and bent in underneath the shield as in the other species. The first pair of antennae (fig. 1 c) is of the usual size for the genus, i. e. comparatively small.



Figs. 1 a–l, *Cancerilla ampla*. n. sp. figs. a–b, dorsal and ventral views of female; fig. c, first antenna; fig. d, second antenna; fig. e, mouth-region mandible and second maxilla (first maxilla is lost as in most copepods, Heegaard 1947). Figs. f–g, first and second maxilliped, figs. h–l, thoracal limbs no. 1–4.

Each is composed of six joints clothed with short setae. The first joint is by far the largest one and rather broad; the terminal joint is a little broader and more flattened than the intermediate ones, and it is clothed with several setae. The terminal joint is of about the same length as the preceding ones and carries near the end a comparatively small aesthetask in addition to the setae.

The second pair of antennae (fig. 1 d) is very strong and highly

chitinized. It consists of three joints, carrying a long and strongly curved claw. In this species it is the longest and strongest clutching organ of the genus. The second pair of antennae are the agents by which the copepod clings to the brittle-star. It clings so fast that it is very difficult to remove without tearing off the antennae, which then remain embedded in the skin of the host.

The mandible (fig. 1 e) resembles that found in the *Caligidae*. The maxilla (fig. 1 e) has a single elongated lobe provided with three spreading non-ciliated setae. Both pairs of maxillipeds are very stout. The first pair consists of a thick basal part formed by the coalescence of two joints (see fig. 1 f), then follows a long, slender joint which is hook-shaped, and movable as a subchela against the basal part. The second maxilliped (fig. 1 g) is more slender, the basal part being formed of two joints, and the dactylus of three joints.

There are four pairs of thoracic appendages. The first pair (fig. 1 h) consists of a thick basal joint carrying a small bristle and two uni-articulate rami. The outer ramus is lamelliform and edged with five comparatively short, simple setae. The inner ramus is very small, cylindrical in form and tipped with two minute setae. The second pair of legs (fig. 1 i) is much smaller than the first pair, and the outer ramus carries three setae only. Both third and fourth pairs of legs (figs. 1 k–l) are extremely small and vestigial, about equal in size, and represented only by a minute bisetose joint. In *C. tubulata* the fourth pair of legs are absent.

The ovisacs are large, globular masses attached to the first abdominal or genital segment, projecting on each side and containing only a few very large eggs.

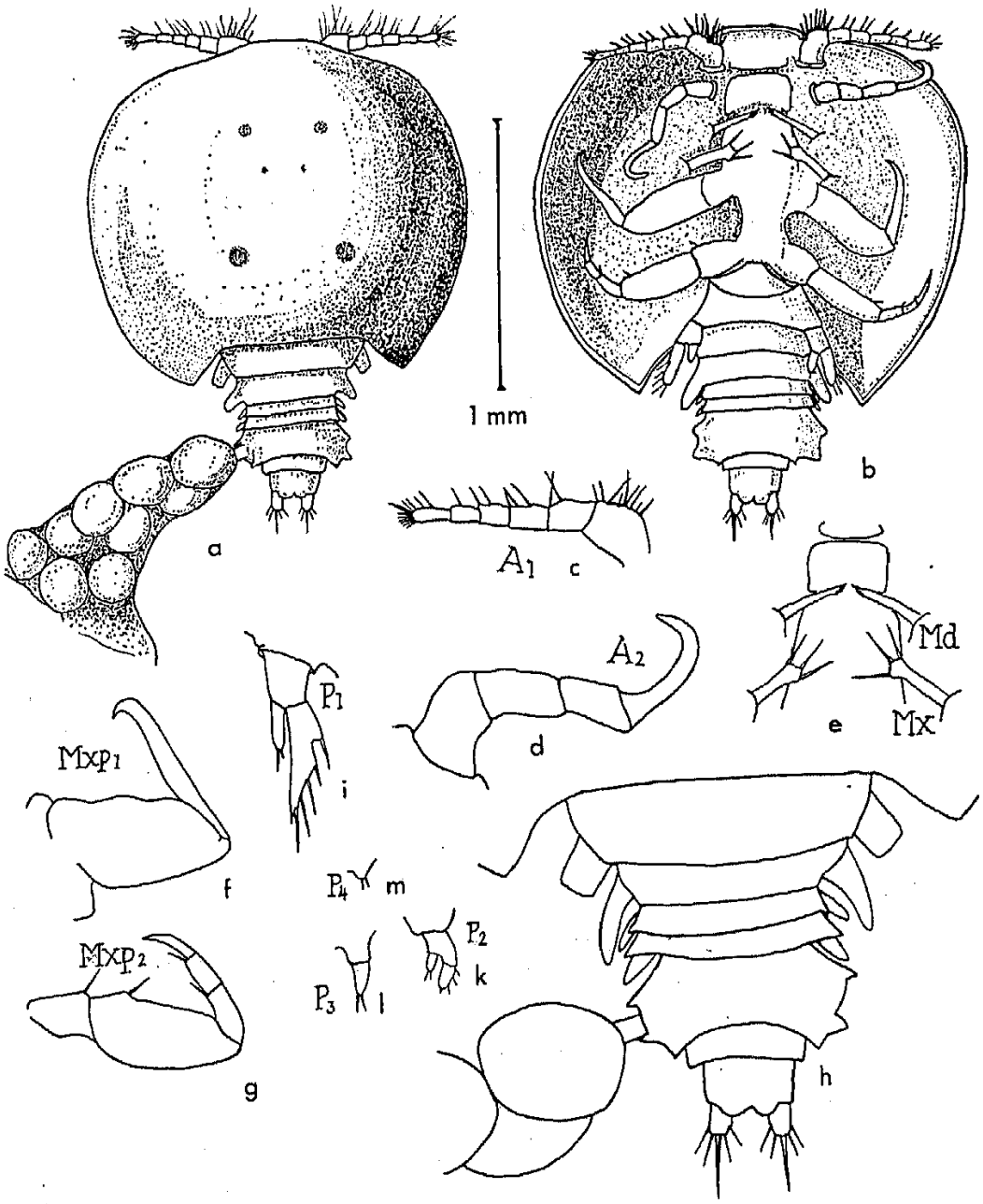
No males of the species were found.

Cancerilla alata nov. sp.

Figs. 2 a–l.

Localities: St. 170. Off Cape Bowles Clarence Island. 342 m., 23. II. 1927, 2 specimens.—St. 175. Bransfield Strait, South Shetlands, 200 m. 2. III. 1927, 1 specimen.—St. 177. Bransfield Strait, South Shetlands, 1080 m, 5. III. 1927, 2 specimens.—St. 599. Off South Georgia, 17. I. 1931, 2 specimens. All specimens were females.

Host: *Ophiacantha disjuncta* (Koehler).



Figs. 2 a–m, *Cancerilla alata* n. sp. figs. a–b, dorsal and ventral view of female, figs. c–d, first and second antennae, fig. e, mouth-region with rostrum, labrum, labium, mandible, and second maxilla, figs. f–g, first and second maxilliped, fig. h, abdomen, figs. i–m, thoracic limbs no. 1–4.

This species has a nearly circular cephalic shield, which is sharply incurved posteriorly towards the first free thoracic segment. The free thoracic segments can be more readily moved both in *Cancerilla alata* and in *Cancerilla ampla* than in *C. tubulata* and in the species described by Stephensen. On all the free thoracic segments there are comparatively large epimeral plates forming lateral wings from which the species derives its name.

The thoracic appendages, though smaller, are very nearly of the same shape as in *C. ampla*; but the terminal claw of the second antenna is shorter than in *C. ampla*, although much longer than in *C. tubulata* and *C. neozelanica*. The exopod of the first pair of legs is also more elongate than in *C. ampla* and furnished with six setae. The last abdominal segment is markedly larger, the ovisacs are more triangular in shape, not globular.

No males of the species were found.

II. COPEPODA ENDOPARASITIC IN OPHIUROIDS

Genus Ophioika Stephensen.

Ophioika tenuibrachia n. sp.

Figs. 3 a–d; Pl. I, figs. 1–4; Pl. II, figs. 1–4.

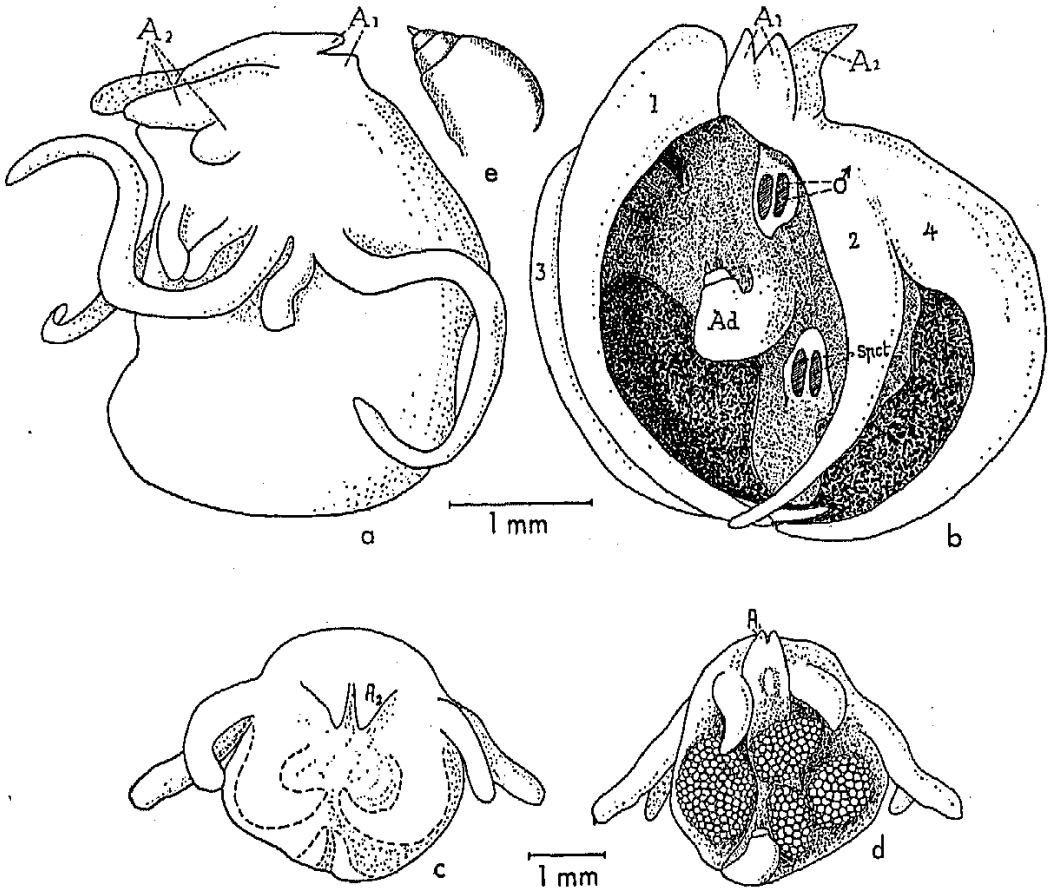
Localities: St. 27, Off South Georgia, 110 m; 25. III. 1926, 3 specimens. —St. 474, South Georgia, 199 m, 12. XI. 1930, 4 specimens.—St. 599, Off Adelaide, Graham Land, 67°08′ S., 69°06½W., 17. I. 1931, 1 specimen.

Host: *Ophiacantha vivipara* Ljungman and *Ophiacantha disjuncta* (Koehler).

This genus was established by STEPHENSEN in 1933 on a single female *O. ophiacanthae*. In 1935 he gave a more detailed description of the genus, based on further material consisting of several females of a new species *O. appendiculata*.

In the material from the "Discovery" collections a new species, *Ophioika tenuibrachia*, of this genus was found to be represented by 8 specimens from South Georgia and Graham Land. Thus the material gave an opportunity for a closer examination of the new parasite. In fig. 3 a the parasite is seen from the dorso-lateral side. The two frontal pairs of lobes can be distinctly seen, and these probably represent the first and second antennae. But behind these lobes a row of longer and shorter brachial-shaped processes are seen. They extend from the dorsal as well as from the lateral sides of the body wall, but they are free in their full length. Their number differs in the different specimens from two to four pairs as seen on figs. 3 c and d. Due to their different number and shape they can not be deformed limbs, but they may be compared with the processes found on the dorsal side of many

Chondracanthidae and on some other copepods. Only in *Ophioika* are they much longer, probably due to the fact that the animals live internally in the *Ophiura*. Probably their function in *Ophioika* is to absorb nourishment from the brittle-star and besides they may function as gills.



Figs. 3 a–d, *Ophioica tenuibrachia* n. sp. fig. 3 a, from the dorso-lateral side, fig. 3 b, from the ventral side opened through the brood-pouch. A_1, first antenna; A_2, second antenna; 1–4 the appendages forming the skeleton of the brood-pouch. Ov, ovary; Ad, abdomen ♂ and spct males with spermatocysts. figs. 3 c–d another specimen from *Ophiocantha disjuncta*, c dorsal view, d ventral view, with the brood-pouch opened showing the egg-balls and the abdomen. fig. 3 e abdomen of *Ophioica appendiculata* Stephensen.

Besides these processes there are four more of a different type, but as the latter are coalesced with a very thin membrane so as to form the brood-pouch they are not seen at once. On Plate II, figs. 3 and 4 they are visible through the membrane of the brood-pouch and in figs. 3 b and 3 d, where this brood-pouch is opened from the ventral side. They have their origin in the frontal part of the body just behind the antennae, as can be seen in fig. 3 b. The first and second processes extend proximally from the body, and the third and fourth

follow a little farther back. Thus they are arranged in two pairs, extending more ventrally than the other processes described. Although nothing definite can be said without a knowledge of the development it seems possible that they may be deformed limbs, probably the two first pairs of thoracic limbs.

When opening the brood-pouch the body is seen to be flattened out at the bottom of the pouch, and from it a partly free abdomen extends (fig. 3 b Ad.) tipped with one free segment, the last one, with a short caudal furca. In STEPHENSEN's figures (1935) of *O. appendiculata* this free segment is only partly seen in his figures of the young specimens (fig. 10), and it is not mentioned in the text. I therefore examined his type-specimen (Stephensen fig. 8, No. 2–4), and the abdomen of this is shown here in fig. 3 e; it shows two distinct, free segments in the abdomen.

In the brood-pouch may be found four egg-shaped egg-masses (see fig. 3 d) lying free in the brood-pouch, placed with one egg-mass in each of the four spaces between the thoracic limbs.

From the ventral side of the body inside the brood-pouch two more conical processes were seen in one of the specimens, each containing sausage-shaped bodies lying side by side. These were also seen by STEPHENSEN, and in his first paper (1933, p. 205) he supposed they were mucous glands for the eggs, as he thought to have seen the genital papilla at the tip of the process. This explanation was discarded in 1935 when he found that in the abdomen there seemed to be two oviducts with their openings on either side of the apex, and further he found in one specimen that the egg-masses filled out almost the whole animal.

In 1940 PYEFINCH published a paper on a new *Ophioika*, *O. asymmetrica*, in which he found and described a male lying in a ventral groove of the female and closely applied to the surface of the latter but not coalesced with it. Mr. Pyefinch has kindly lent me some unpublished notes on the histology of his male which in many respects shows its near relation to *Ophioika quadribrachia*, except for a few points to which I shall return later.

In *Ophioika tenuibrachia* and in the species of *Ophioika* described by STEPHENSEN (1933, 1935) the conical processes extend directly from the body of the female inside the brood-pouch and superficially look as an extruded part of the female body like the several other

processes. In order to clear up the puzzle as to the nature of processes it was necessary to cut serial sections. The results of this investigation clearly showed that the two bulbs in the examined specimen were two pygmy-males of the copepod parasiting on the female.

The sections showed that the male is inserted in the female with approximately two thirds or more of its body inside the skin of the female. It is the frontal part of the body of the male which is inserted in the female. It is only what approximately may be regarded as the abdomen, which extends outside the body of the female. It is however a very degenerated male whose whole body is sausage-shaped, (see fig. 3 b) and in the one specimen examined a little wider in its frontal inserted part than in the posterior free part, the other and smaller individual was narrower in the inserted part.

Plate I and Plate II, figs. 1–2 show different sections through the male. The organs of the male are reduced in all repects except for the reproductive organs. In the frontal part of the male near the bottom of the inserted part of the male is found a large unpaired, oval to kidney-shaped testis (Pl. I, figs. 2–4; Pl. II, fig. 1). In the testis spermatogenesis was taking place as showed in Pl. I, fig. 3, which gives a detail of the testis in which all the stages in the reduction are seen from above to below: the spermatogonia (spg.), the spermatocytes (spc.) and the spermatids (spt.). At the bottom of the figure near the opening to the vas deferens the whole lumen is filled up with spermatozoa (sp.); they are better seen in figs. 2 and 4.

From the frontal part of the testis, the part towards the frontal part of the male, a long and unpaired vas deferens extends. To give space for the length of the vas deferens inside the male it is curled up in short spirals, first running anteriorly, then turning round with the spirals placed along the one side of the testis, and from there further back towards the two spermatocysts (Pl. I, fig. 1, spct.). In the beginning of the vas deferens a collection of spermatozoa (Pl. I, fig. 2, sp.) can be seen, and by the side in the same figure a curl of the vas deferens is seen. In Pl. II, figs. 1–2 the section passes through several of the spirals of the vas deferens. The vas deferens is built up of a high columnar epithelium with a distinct glandular function. It can also be seen that a secretion is filling up the lumen of the channel (Pl. II, fig. 2, s). This secretion in the preserved specimen is of a vivid yellow

colour-like yolk. The two spermatocysts at the end of the vas deferens were filled with this fluid, which gave them a strong yellow colour that could be seen through the skin (fig. 3 b, spect.), a colour which also STEPHENSEN (1935) has seen in his species. In the male specimen examined by me the spermatozoa were only beginning to fill up the first portion of the vas deferens near the testis, but when a sufficient amount of spermatozoa has been produced, they will presumably accumulate in the two spermatocysts. The yellow fluid in these, secreted by the vas deferens, must then be for nourishment of the spermatozoa during their stay in the spermatocysts.

PYEFINCH (1940) suggested that the spermatocysts may break out through the skin as no genital pore could be seen in the male of *Ophioika asymmetrica*. In *O. tenuibrachia* an unpaired genital pore is seen at the free tip of the male (Pl. I, fig. 1). This shows how the body of the male runs out into two lappets between which the genital pore can be seen.

How fertilization of the female takes place is unknown, but the males are placed inside the brood-pouch of the female near the abdomen on which the genital openings of the female are found. Therefore, a direct placing of the spermatophores at the genital openings of the female by the male can easily be effected, and must be expected as the most natural way of fertilization in the copepods.

Another problem is: what happens with the males after fertilization of the female? In the above material (fig. 3 d) as in Stephensens' collection there were females with ripe and fertilized egg-masses, but without any males, and further no eggs were found in the brood-pouch of the females with males attached to them. It is most likely therefore that the males, after discharging the spermatophores, die and are then absorbed by the female.

Along the one side, inside the male, a rudimentary intestine is found (Pl. II, fig. 1, ent.). This intestine seems to be a closed sack. It was not possible to see any gut or opening to the exterior. But as the male is placed inside the brood-pouch closed from the exterior, no nourishment can be found in this brood-pouch except that produced by the female. The intestine must therefore be only a closed sack, a vestige from free living forms, which also the relative flat epithelium in its walls suggested, as it does not seem to have any digestive function any longer. On the other hand, large blood sinuses are found in the

female along the margin towards the tissue of the male and from here a diffusion into the male may take place. In this way the male is nourished from the female through diffusion from female to male of body fluid with nourishment, partly analogous with the condition known among the fishes in some *Pediculati*.

Another remarkable abnormality of this parasite was that in most of the specimens examined by me a small polychaete of the family Eunicidae was found living in the brood-pouch and feeding on the ripe egg-masses of the copepod (Pl. II, fig. 3). As this brood-pouch is closed to the exterior by its membrane without any passage from it, the polychaetes are living internally, and probably when they are fully developed and ready for spawning, must force their own way out of the copepod. It is also unknown how the copepods' own nauplii, when hatched, can find their way out into open water and then infect another brittle-star.

The polychaetes were handed over to Dr. E. Wesenberg-Lund who will give a description of the polychaete in a separate paper.

Systematic position: Three nearly related species of *Ophioika* are described: *O. ophiacanthae* and *O. appendiculata* described by STEPHENSEN (1933, 1935) and in this paper one new species has been described: *O. tenuibrachia*. There can be no doubt about the near relation between these three species. Stephensen's figures show that both his species have the same type of male as described in this paper on *O. tenuibrachia*.

Further PYEFINCH (1940) has described an *O. asymmetrica*. This species shows so many small differences in the asymmetry of the female from the other species of *Ophioika*, but the differences are most pronounced in the male. The male of *O. asymmetrica* is not inserted in the tissue of the female as in the three other species described. Further Pyefinch's species has external processes, but above all, the testis is paired in his species, but unpaired in *Ophioika*; as Stephensen's species *Ophioika ophiacantha* is the first described species of the genus. I therefore do not think it possible to keep *O. asymmetrica* within the genus, but suggest a new genus *Ophioicodes* n. g. with *O. asymmetrica* as type species.

STEPHENSEN (1935) called attention to the near relation of *Philichthys amphiurae* Hérouard (1906) to *Ophioika*. By examining this copepod

more closely the relationship is clear, and the species is nearer to *Ophioicodes* than to *Opioika*. In *Ph. amphiurae* the male is not yet placed in the ventral groove of the female, but it has a free movable pygmy male, which is found in a number of up to four on each female according to Hérouards' description. These males cling with a pair of claws to the abdomen of the female. These claws are, as far as can be judged from Hérouard's figure, the second antenna.

The fundamental differences in the male as well as smaller differences in the female between this species and the other species described, justify in my opinion the establishment of a new genus. The genus *Philichtthys* is definitely wrong for this species, since it is much closer related to *Ophioicodes*, but I suggest a new genus *Ophioithys* n. g. with the type specimen *Ophioithys amphiurae* (Hérouard 1906).

We have therefore three points in a vestigial line in pygmy-males: *Ophioithys* with free pygmy-males, *Ophioicodes* with males placed in the ventral groove of the female imbedded in the host tissue, but not fused with it at any point. And at last the *Ophioika* male in which fusion is complete, the digestive channel being only a vestigial organ, the testis reduced to a single unpaired organ.

From *Ophioithys* the relation may go towards the true *Philichthys* as *Ph. sciænæ* Richi. (1876), but this is more uncertain and can not be determined on basis of our present knowledge, which is too sporadic yet for further conclusions.

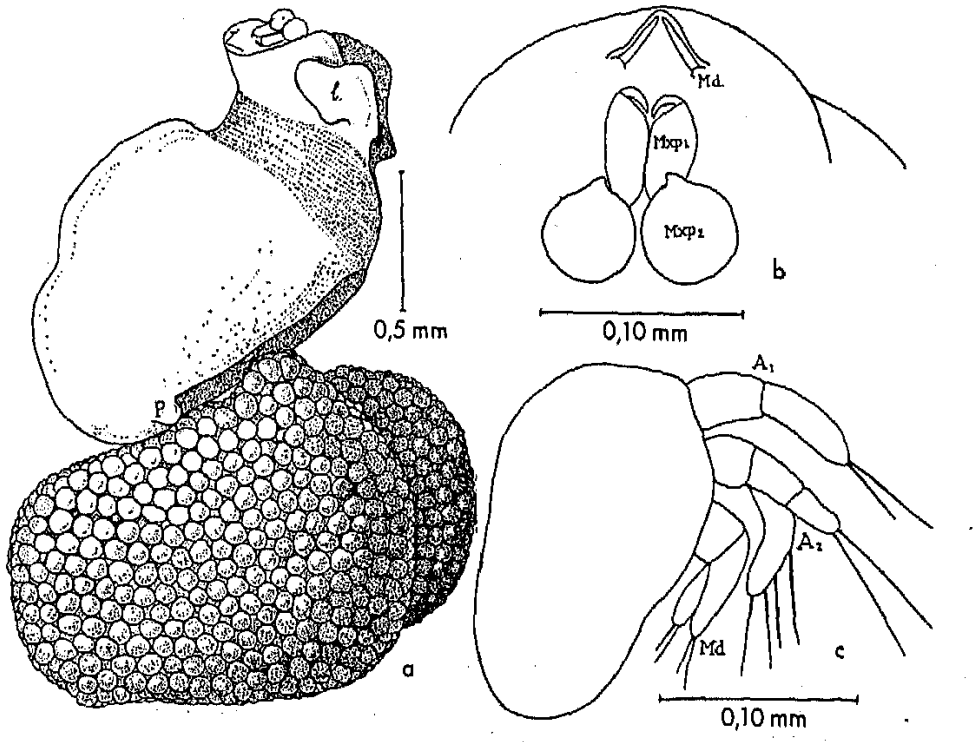
At St. 182 (Palmer Archipelago 278–500 m, 14. III. 1927) a parasite was found in a specimen of *Ophiurolepis partita* (Koehler) which should be assigned to a new genus near *Ophioika*, but as the specimen was badly damaged and gone to pieces, when I received it, it has not been possible to give a proper description of it. I think it better therefore only to refer to its existence for the attention of future collectors of brittle-stars in the Antarctic.

Lernaeosaccus ophiacanthae n. g. n. sp.

Figs. 4 a–c.

Locality: St. 190, Palmer Archipelago, 278 m, 14. III. 1927, 1 specimen.
Host: Endoparasitic in *Ophiacantha disjuncta* (Koehler).
This small parasite with a body only about 1.5 mm in length, but

with two huge egg-sacs, was only found in a single specimen. The body is simply a bag without any definite thorax or abdomen. The head is in one end of the bag, with a short mouth cone inside on which there is a pair of mandibles. Neither the first and second pair of antenna nor the maxillae could be seen. Behind the mouth cone two pairs of mouth appendages were visible which in shape remind one of the



Figs. 4 a–c, *Lernaeosaccus ophiacanthae* n. g. n. sp. fig. 4 a, female from the lateral side, l lateral wings; P right genital process with right genital aperture. fig. 4 b, head of female; md. mandible, Mxp_1 first maxilliped; Mxp_2 second maxilliped. Fig. 4 c, partly undeveloped nauplii from the eggs.

two pairs of maxillipedes in the *Lernaeopodidae*. The first limb was two-jointed with a stout basal joint and a smaller distal joint, which was very weak and did not seem to be movable in its connection with the basal joint. Behind this pair of limbs there was a second pair, nearly globular in shape and with a small tooth on each pointing forward, probably the vestige of a second joint. Judging by their shape these two pairs of limbs represent the first and second pairs of maxillipeds, but they are both very weakly developed.

Close behind the "head" is a pair of lateral processes (l in fig. 5 a). These may be the vestigial remains of the thoracic appendages, or they may only be processes from the body and not limbs; they are

so deformed that it is not possible to say anything definite about them except that they are placed in the right position on the body for limbs. Farther behind on the ventral side of the body there are two more processes, and these are the genital processes with the genital openings on their tips (fig. 5 a, P).

Among the immense number of eggs there were some with nauplii (fig. 5 c), but they were all so undeveloped that nothing could be ascertained except that they were copepod-nauplii.

As to the systematic position, the parasite must be closely related to the *Lernaeopodidae*, and presumably forms its own family. This new family has no bulla, and the two pairs of maxillipeds are more like the maxillipeds in the male than in the female of the *Lernaeopodidae*; this however is only natural as the first pair of maxillipeds are more deformed in the female than in the male of the *Lernaeopodidae*. But so long as only a single specimen, a female of this new genus, is known I do not think it right to establish a new family. This will have to wait till we have a better knowledge of the genus or some other genera which can be united with this new genus into a new family.

Codoba discoveryi n. g. n. sp.

Figs. 5 a–g, Pl. II, fig. 4.

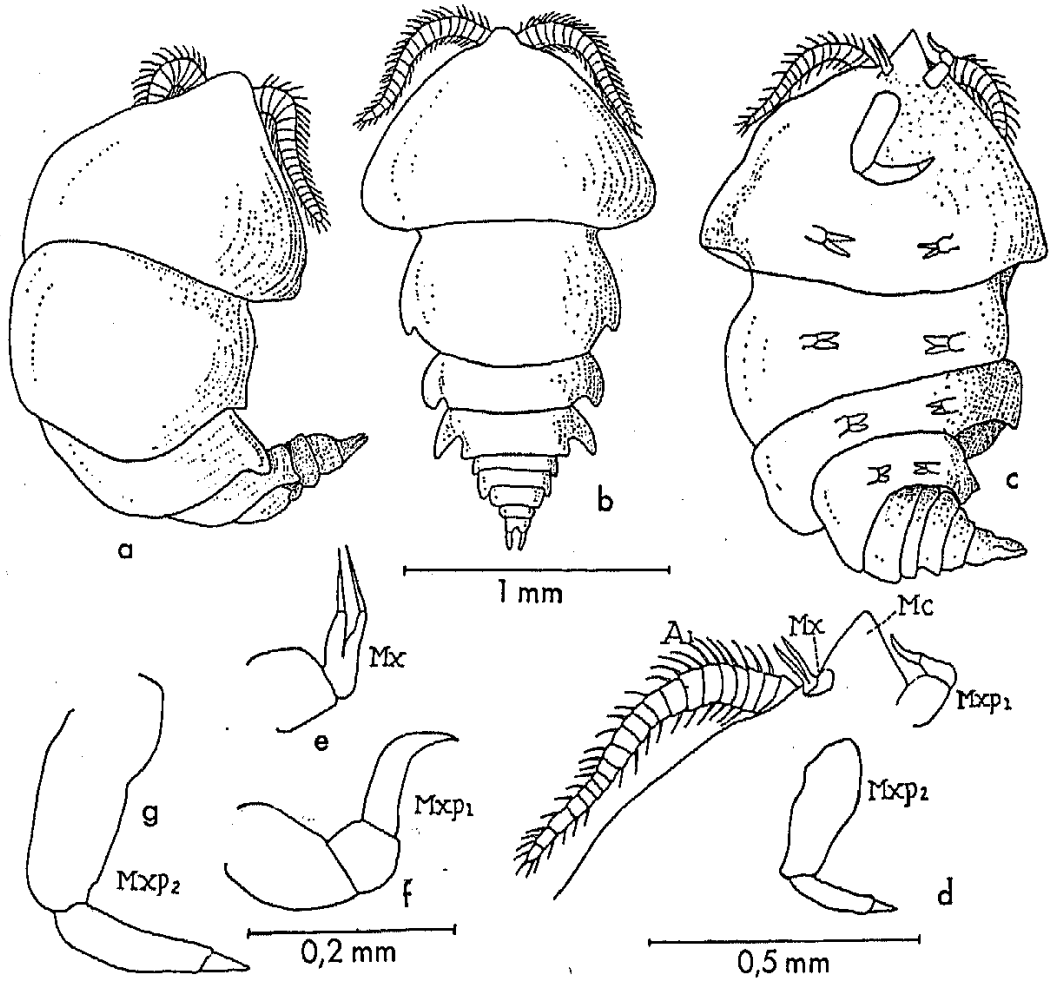
Localities: St. 123, Off South Georgia, 100 m, 25. III. 1926, 1 specimen St. 152. Off South Georgia, 245 m, 17. I. 1927, 1 specimen, St. 156. Off South Georgia, 236 m, 20. I. 1927, 1 specimen.

Host: *Ophiura meridionalis* (Lyman).

Plate II, fig. 5, shows how this copepod was lodged in the brittle-star. In the first place the latter had produced a gall to protect itself from the parasite. That this gall was produced from the echinoderm could be seen from the fact that calcareous bodies were imbedded in the tissue of the gall wall. In Plate II, fig. 5 this exterior layer has been removed. Underneath the gall-layer there was a thin membrane, and this can be seen in the figure. Inside the membrane a copepod was visible on one side (c), surrounded by its own eggs. These eggs were not—as usual—gathered in one or two egg-balls; they were absolutely loose, and only held together by the membrane which also covered the female itself.

Another interesting point is that the eggs were nearly as large as the adult copepod itself and therefore only few in number.

The female of the copepod is seen in figs. 5 a–g, and in this species no males were found. The head of the female is coalesced with the



Figs. 5 a–g, *Codoba discoveryi* n. g. n. sp. figs. 5 a–c, female from lateral, dorsal and ventral sides. fig. 5 d, frontal part from ventral side. A_1 first antenna; Mc. mouth-cone; Mx, second maxilla; Mxp_1 and Mxp_2 first and second maxilliped. figs. 5 e–g, mouth-appendages, detail.

first thoracic segment; then follow five thoracic and three abdominal segments. The cephalothorax and the following free thoracic segment are of about equal size and represent the largest part of the animal; from there the segments rapidly taper in size towards the last abdominal segment. In front there is a small rounded rostrum, as can be seen in figs. 5 a–b viewed from the dorsal side. The cephalothorax is nearly triangular with the rostrum as one corner in the triangle. The next segment is not as wide as the previous one, but it is provided with two lateral alae as can be seen in fig. 6 b. In the following two segments

these alae become larger and larger, although the segments themselves decrease in size from front to rear. After these four larger segments two smaller thoracic segments follow, and then three abdominal segments. On the two last thoracic segments the lateral alae are very small, and on the abdominal segments they are absent. The last abdominal segment is tipped with a caudal furca, but this furca has no setae.

The first antenna is long, slender and many-jointed, and provided with so many setae that the whole antenna has a shaggy appearance.

The second antenna could not be found. Just behind the rostrum the mouth-cone is formed in the usual way from the upper and lower lip. At its base is the second maxilla (fig. 6 e), which consisted of a basal joint and two branches; each branch is tipped with a seta. The first maxilliped was found close behind the mouth-cone (figs. 6 d–f). It consists of three joints: a stronger basal joint, then a shorter joint which is tipped with a long sickle-shaped claw. The second maxilliped is both longer and more strongly built than the first maxilliped, but it is also three-jointed, with a long and strong basal joint and a shorter second joint. The distal joint is formed as a short conical claw.

As to the systematic position of this copepod it is obvious that these copepods parasitic on echinoderms for the greater part form their own families and so long we only know about half a dozen parasitic copepods from echinoderms, it is premature to establish different families, we must wait until our knowledge of this copepod group has become greater.

III. AN ASCOTHORACIC CIRRIPED ENDOPARASITIC IN OPHIUROIDS

Genus Ascothorax Djakonow.

Ascothorax bulbosus nov. sp.

Figs. 6 a–e, fig. 7.

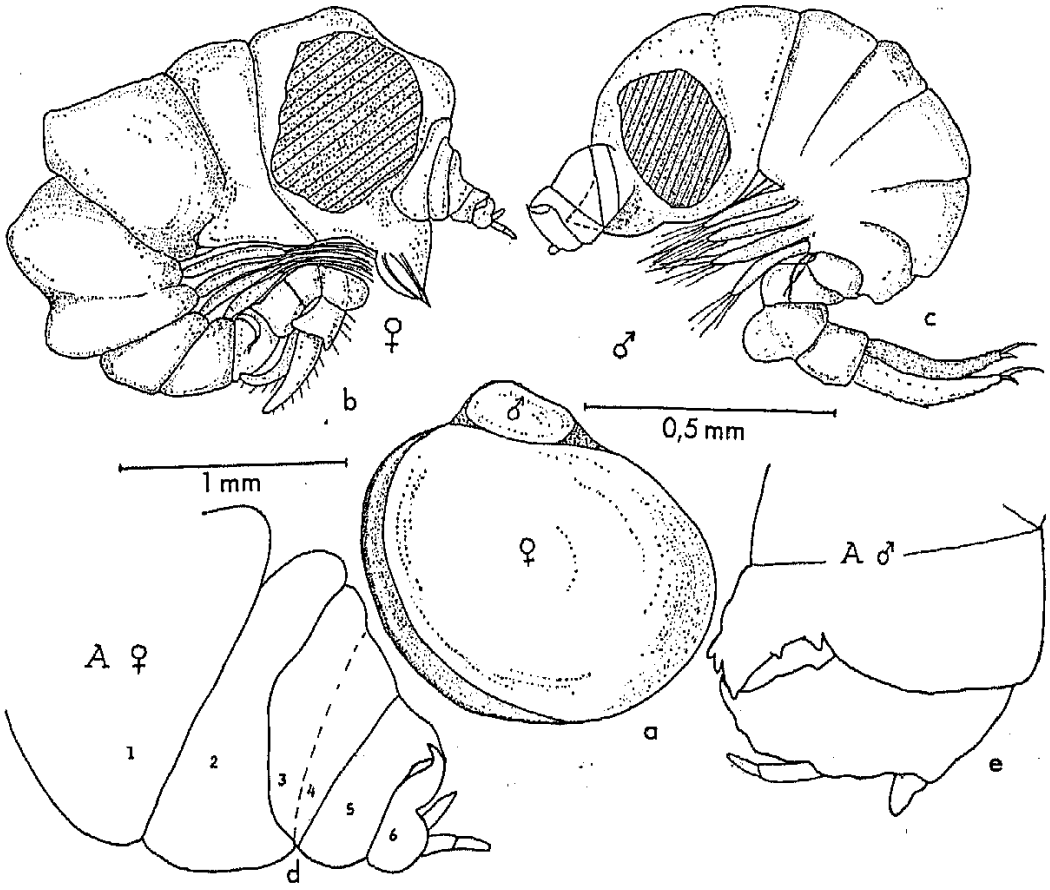
Localities: St. 27. Off South Georgia, 100 m, 25. III. 1926, 1 specimen. St. W. S. 42. Off South Georgia, 175 m, 7. I. 1927, 1 specimen.

Host: *Amphiura belgicae* Koehler and *Amphiura microplax* Mortensen.

The parasite lies in the bursa of the host; only one specimen was found in each host, and in both specimens a complementary male

was placed dorsally to the female underneath the cuticle of the female, as shown in fig. 6 a.

The body of both the male and the female is more or less regularly globular; it is totally covered with a large leathery shell, corresponding to the shell of the cypris stage. The two halves of the shell are comple-



Figs. 6 a–e, *Ascothorax bulbosus*, n. sp. fig. 6 a, female and male, fig. 6 b, female with the "shells" removed, fig. 6 c, male with "shells" removed. figs. 6 d–e, antenna of female and male.

tely coalesced at the dorsal side and here the male is found lying on its side and forming an angle of 90 degrees with the body of the female. The free margins of the shell are bent inwards and lie close to each other. In the female the shells is filled up with the eggs of the parasite.

The thorax is fixed to the shell by a bundle of strong muscles. The body (figs. 7 b–c) is strongly curved and when the shell is removed it may remind one of an amphipod. The frontal part is rather heavy and without any distinct segmentation, and the abdomen is formed by four segments. STEPHENSEN (1935) in *A. ophioctenis* found 5 abdo-

minal segments in the female, and 4 in the male. I can only find 4 abdominal segments in both sexes, for the segment which appears

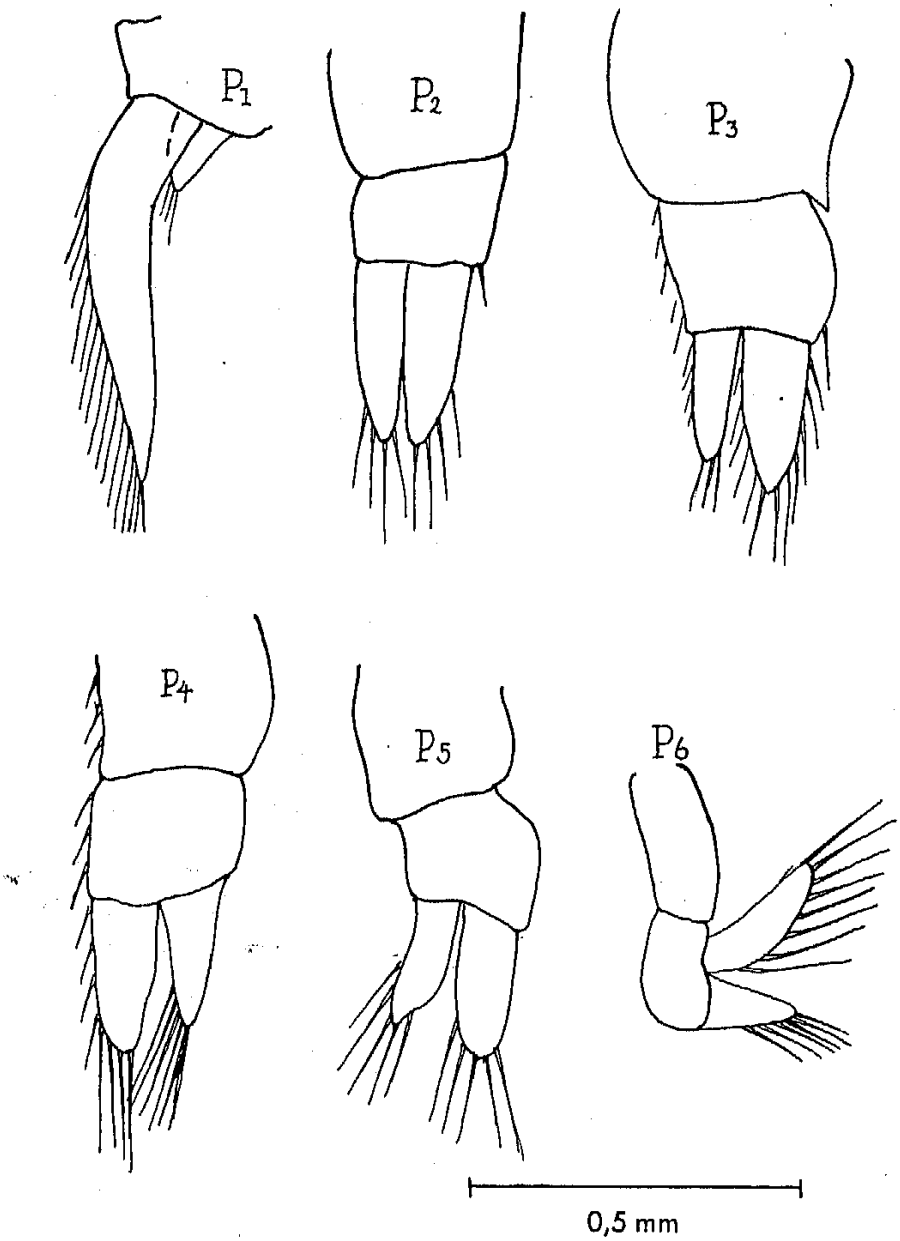


Fig. 7. *Ascothorax bulbosus* n. sp. Thoracic appendages no. 1–6 of female.

to be the first one without appendages in reality bears the small sixth pair of curved thoracic limbs.

On examining my specimen I first thought that it was *A. ophioctenis* Djakonow, for no difference could be seen externally. But on dissecting out the appendages I found (fig. 7) that they differed from those figured by Stephensen. In his figures there is a remarkable reduction

in the limbs. There are no setae on one branch of legs number 2, 3, and 6, and the other branch is two-jointed in all the limbs except in the first one. Neither this reduction nor this articulation are found in my specimens. The first pair of legs (fig. 7) has an unjointed sympod and a long and slender exopod which extends towards the mouth cone and may have the function of a maxilliped. The endopod is only short and rudimentary. DJAKONOW (1914), according to his description, only found the exopod, and in Stephensen's figure the exopod is broken so that only the basal part of it is shown. The four following pairs of legs are very flat and broad, lying one after the other as leaves in a book. The sympod is divided into two joints, the coxa and the basis, and the exopod as well as the endopod is unjointed, but tipped with long marginal setae. The sixth pair of legs also has a two-jointed sympod. The two branches, the exopod and the endopod, are turned to one side and placed in a dorsal direction along the side of the body segment as shown in fig. 7.

The antenna was described as six-jointed by Djakonow, but Stephensen could only see five joints. In the female specimen of *A. bulbosus* the antenna can be said to have six joints, for a weak suture showed a coalescense of joints number 3 and 4, which is indicated as the dotted line in fig. 6 d. This line of coalescense could only be found in the female. I was not able to recognise it in the male, since the other joints of the antenna were more coalesced than in the female.

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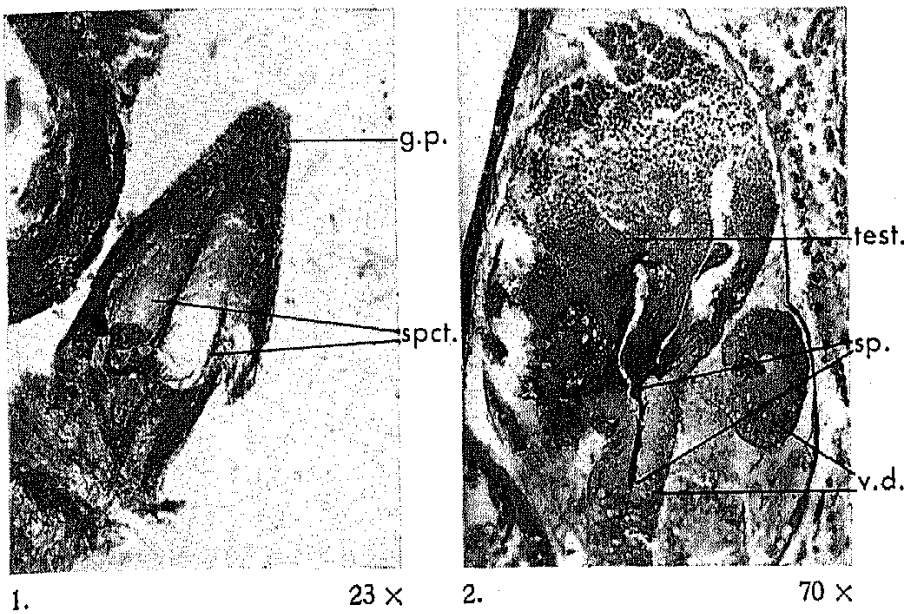
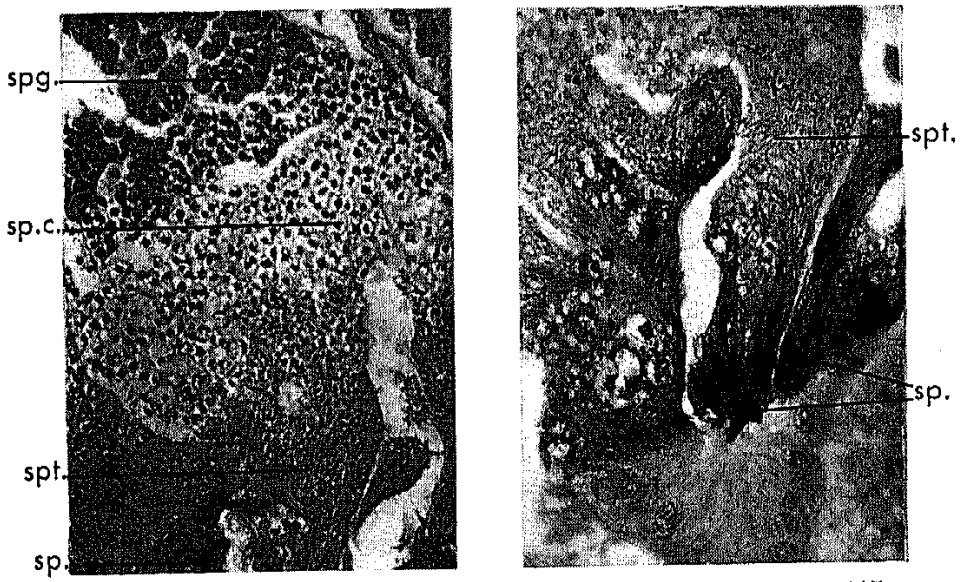
(Særtrykkene udkommet den 23. Juli 1951)



1. 23 × 2. 70 ×



3. 215 × 4. 215 ×

Sections of *Ophioika tenuibrachia* male. Fig. 1 nearly longitudinal section through frontal free part of male. g. p. genital pore; spct. spermatocysts.

Fig. 2. Section through the testis with a short part of the vas deferens; test. testis; sp. spermatozoa; v. d. vas deferens.

Fig. 3. Enlarged part of the testis showing the different stages of spermatogenesis; spg. spermatogonia; spc. spermatocytes; spt. spermatids; sp. spermatozoa.

Fig. 4. Detail with spermatids and spermatozoa. Lettering as in previous figures. (A. Øye phot.)

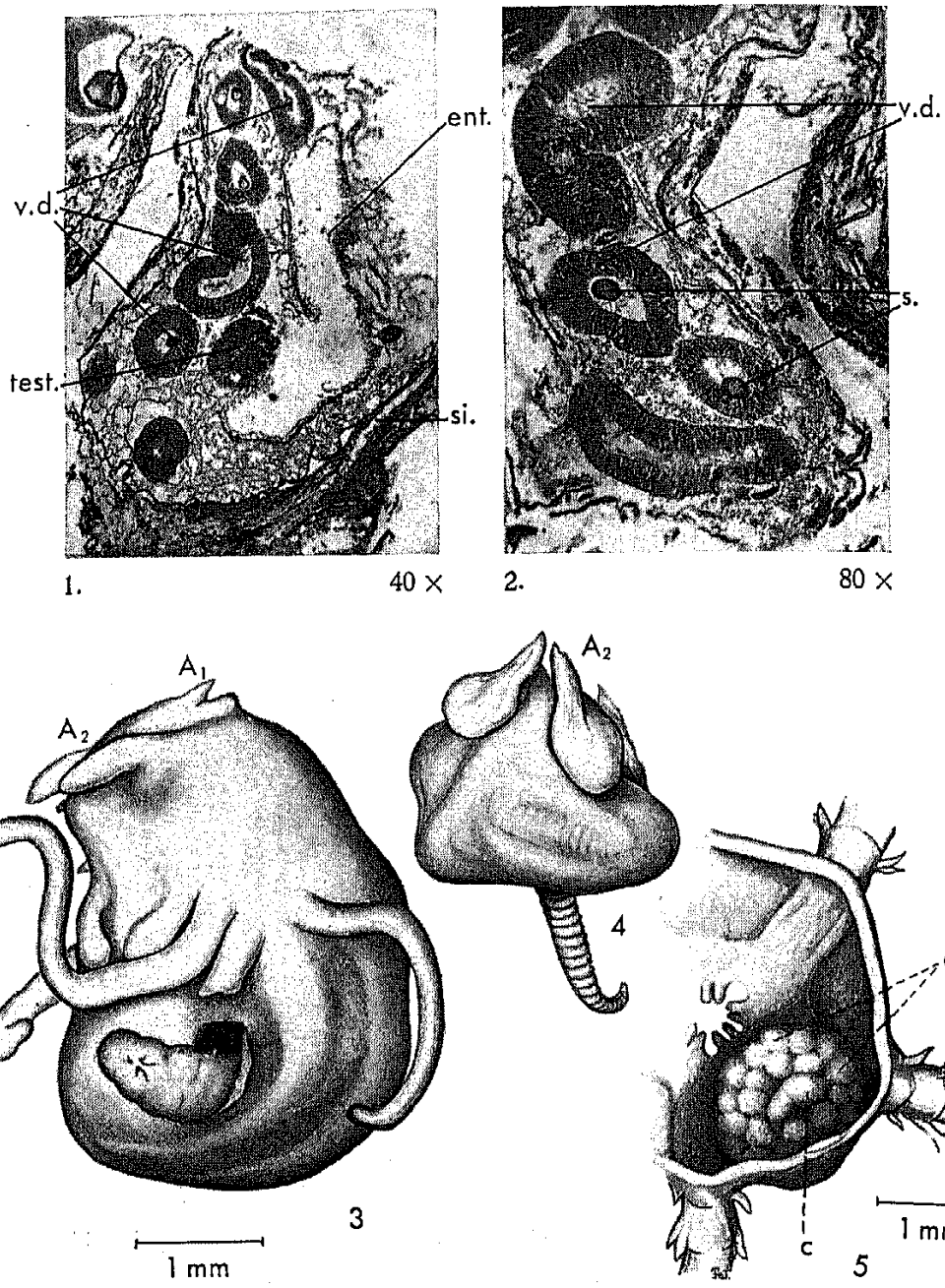


Fig. 1–2. Sections of *Ophioika tenuibrachia* male. Showing the *curls* of the vas deferens, a part of the testis and the intestine by the side fig. 1; ent.; Si. sinus; and S. secretion from the cylindrical epithelium of the vas deferens lying in the lumen of the duct.

Fig. 3. *Ophioika tenuibrachia* female with an artificial opening in the brood-pouch through which one of the parasitic *Eunicidae* Extrudes.

Fig. 4 same from dorsal.

Fig. 5. A specimen of *Ophiura meridionalis* with its dorsal part removed showing the parasitic copepod *Codoba discoveryi* n. g. n. sp. together with its eggs. — c. copepod; e. eggs.

(Fig. 1, 2. A. Øye phot., fig. 3–5. P. Winther del.).

THE 3rd DANISH EXPEDITION TO CENTRAL ASIA

Zoological Results 5.

BOMBIDAE (INSECTA) FROM AFGHANISTAN

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I am much indebted to Mr. Niels Haarløv (the collector of nearly all the specimens) and to Dr. S. L. Tuxen, of the Zoological Museum of Copenhagen University, for the opportunity to study this interesting collection. Apart from a short paper by REINIG (1940), very little is known of the Bombidae of Afghanistan. The collection is probably too small to allow any far-reaching conclusions to be drawn and it is unnecessary to add anything to what Reinig has already said (l. c., p. 231; also 1930) on the fauna of the region.

Unless otherwise stated, all specimens bear the data "Afghanistan, N. Haarløv", in addition to the information cited.

Bombus Latz.

Subgenus *Lapidariobombus* Vogt, 1911.

The females and workers of this subgenus can be distinguished from those of *Cullumanobombus* Vogt and *Pratobombus* Vogt, even when the colour pattern is almost identical, by the dense pale pectinate pubescence on the outer side of the third basitarsus.

1. *B. semenovianus* (Skorikov, 1914).

♀☿ Black; the whole thorax with bright ochreous-yellow pubescence; abdominal tergites 4–6 deep red. Wings a little infuscate at tip and just beyond the marginal cell. Pubescence very short. ♀ length forewing 18.0 mm., hamuli 25.

♂ Black; a few yellow hairs in the tuft of vertex; whole thorax bright ochreous-yellow; abdominal tergite 1 yellow except for sides and a narrow posterior lunule; tergite 2 with an anterior lunule somewhat black mixed, or anterior third, yellow; a very few hairs on hind tibia and basitarsus, yellow. Pubescence short. Wings a little darkened. Fore-wing 13.5, 14.0 mm.; hamuli 20, 23.

Specimens examined:— ♀ Unai Kohal, 10. *vi.* '49. 2♀ Paghman, 17 miles W. of Kabul, 8000 ft., *vi.* 1939. (J. L. Chaworth-Musters) (Brit. Mus.); Marak, Koh-i-Baba, 2♂ 14. *viii.* '48, and 5☿, 16. *viii.* '48; Surta, ☿ 11. *viii.* '48.

The species has already been recorded from Afghanistan by REINIG (1940: 226) and its range extends to Kashmir. It seems to vary very little in colour.

2. *B. keriensis* Morawitz, 1886 subsp. *meridialis* (Skorikov, 1914).

♀☿ Black; broad mesonotal collar, scutellum except anterior quarter, whole pleuron, whole of abdominal tergites 1–2, white; a few pale hairs at posterior margin of tergite 3, especially at sides; tergites 4–6 pale red, becoming whitish at sides; hind femora with many whitish hairs, corbicular hairs red. Black interalar band very little broader than collar, usually rather broader in ☿ than in ♀. Wings a little darkened along the veins, especially the costa. Pubescence moderately short. ♀. Length fore-wing 17.0, 17.5 mm.; hamuli 26, 27.

♂ Black; labrum, clypeus, many hairs round base of antennae, tuft of vertex, mesonotal collar, scutellum except a few anterior hairs, mesopleuron, abdominal tergites 1–2, light ochreous-yellow; tergites 4–7 moderately dark red, paler at sides. Legs with pale hairs, becoming reddish on tibiae. Venter almost entirely pale. Black interalar band about as broad as collar. Wings hyaline. Length of fore-wing 12.5 mm.; hamuli 20.

Specimens examined:— 2♀ 1♂ 10☿ Ghilzai, Koh-i-Baba, 5. *viii.* '48; ☿ Surta, Koh-i-Baba, 9. *viii.* '48.

In one worker, the black interalar band is much broader than the collar and the pleuron has a considerable intermixture of black hairs. The white in the workers is slightly yellow-tinged but in the female snow-white. The subspecies was described from the Western Himalayas, R. Sindu, above Sonomarga, 2400–3000 m.

Subgenus *Cullumanobombus* Vogt, 1911.

3. *B. serrisquama* Morawitz, 1888.

♀☿ Black; broad mesonotal collar, almost as broad as interalar black band, scutellum except a few hairs along anterior margin, mesopleuron except a few black hairs mixed on posterior third, abdominal tergites 1–2, pale ochreous-yellow; tergites 4–6 rather pale red; some pale hairs at apex of mid and fore coxae. Wings lightly infuscate. Pubescence short. ♀ Length fore-wing 15.0–16.0, mean 15.4 mm.; hamuli 19–24, mean 21.0.

♂ Black; clypeus, most hairs round base of antennae, tuft of vertex, mesonotum except a small discal patch, mesopleuron, abdominal tergites 1–2, long hairs of legs except a few on two front pairs, pale ochreous-yellow. Tergites 4–7 rather light red. Entire venter pale. Mandibular beard reddish-brown. Wings almost hyaline. Pubescence moderately short. Length fore-wing 11.5 mm.; hamuli 18.

Specimens examined:— 5♀ 1☿ Ghilzai, Koh-i-Baba, 5. *viii.* '48; ♀ Panjao, Koh-i-Baba, 19. *viii.*, ☿ Panjao, 18. *viii.* '48; ♂☿ Marak, Koh-i-Baba, 16. *viii* '48; ♀ no locality, 1948.

Four of the females have a few paler hairs round the base of the antennae and three of these also have a few pale hairs in the corbicle. The worker from Panjao has all coxal hairs black and the worker from Marak has a brown Meloid larva attached to the left hind femur. These specimens appear to constitute the most eastern record of the species whose range extends to Hungary and Poland.

Subgenus *Pratobombus* Vogt, 1911.

4. *B. kotzschi* Reinig, 1940.

☿ Black; a few hairs round bases of antennae, a few of shorter hairs in vertical tuft, mesonotum except for a few black hairs mixed in on disc, scutellum, whole pleuron, abdominal tergites 1–2 except a few hairs in centre of posterior margin of 2, bright ochreous-yellow (as in *B. semenovianus* Skor.); tergites 4–6 moderately pale red; most long hairs on coxae, femora and vertex pale. Wings a little infuscate. Pubescence moderately long, about as in *B. pratorum* (L.).

Specimen examined:— 1☿ Pashki, Nuristan, 28. *viii.* '48 (K. Paludan). This species was described from a single male, Afghanistan,

Anderab. The above worker may well belong to the same species though in the male the second abdominal tergite has black hairs.

5. *B. leucurus* Bischoff and Hedicke, 1931.

♀ Black; some hairs round bases of antennae, mesonotal collar, rather broader than black interalar band, scutellum, whole pleuron, abdominal tergites 1–2, ochreous-yellow; tergites 4–6 white; many pale hairs on coxae and femora; corbicular hairs half reddish. Wings very little infuscate. Pubescence rather short. Length of fore-wing 14.5 mm.; hamuli 22.

☿ Like ♀, but some pale hairs at posterior margin of tergite 3, and some reddish hairs at anterior margins of tergites 4–5.

♂ (1) Almost entirely yellow; some longer hairs on sides of face and on vertex, black; anterior three-quarters of tergite 3, mainly black; rest of tergite 3 and whole of 4–7 white. Wings subhyaline. Pubescence rather long. Length fore-wing 11.0 mm.; hamuli 21.

(2) Like (1), but a few black hairs on posterior part of disc of mesonotum; posterior margin of tergite 3, and tergite 4, slightly pinkish; fore-wing 11.0 mm.; hamuli 22.

(3) Like (1), but a moderate patch of black hairs on posterior part of mesonotal disc, very few pale hairs on tergite 3, those of tergite 4 pinkish; fore-wing 12.0 mm.; hamuli 20.

(4) Like (1), but a few black hairs mixed on mesonotal disc, tergite 4 distinctly red, 5–7 pale red and white mixed; fore-wing 11.5 mm.; hamuli 22.

(5) Like (1), but two or three long black hairs on mesonotal disc, pale hairs of tergites 3–4 pink tinged; fore-wing 9.5 mm.; hamuli 18.

(6) Like (1), but posterior part of mesonotal disc with a considerable mixture of black hairs, tergite 3 and anterior quarter of tergite 4 black, rest of tergite 4 distinctly pink, tergites 5–7 faintly pink-tinged. Fore-wing 11.0 mm.; hamuli 20.

Specimens examined: —♀ Herat, 10. *vi.* '48; 4 ♂ (1–4) Ghilzai, Koh-i-Baba, 5. *viii.* '48; ☿ 2 ♂ (5–6) Surta, Koh-i-Baba, 11. *viii.* '48.

This species is very variable and perhaps not yet fully understood. It is widely distributed in C. Asia.

Subgenus *Sibiricobombus* Vogt, 1911.

The females of the two species of this subgenus are distinguished from those of *Hortobombus* Vogt which have an equally long head and similarly spinose mid basitarsi, by the ocelli which are separated from the eyes by not more than two diameters instead of fully two and a half. In the males, the eyes are clearly swollen, the ocelli being separated by only one diameter, and the genitalia are distinctive.

6. *B. asiaticus* Morawitz, 1875.

♀☿ Black; broad mesonotal collar, about as broad as interalar black band, scutellum, pleuron, abdominal tergites 1–2, bright ochreous yellow; posterior three-quarters of tergite 4 white with a faint pink tinge, tergites 5–6 white, a few corbicular hairs pale tipped. Wings slightly infuscate. Pubescence rather short. ♀ Length fore-wing 14.0, 15.5, 16.5 mm.; hamuli 24, 27, 25.

♂ Abdominal sternite 6 (fig 1 a) distinctly emarginate. Lacinia (parameral spine) of genitalia (fig. 2 a) considerably narrowed to the tip where there is a considerable projection. Black; clypeus, shorter hairs round antennae, much of tempora, about half of hairs in tuft of vertex, broad mesonotal collar, as wide as interalar band which is somewhat yellow mixed, scutellum, whole pleuron and sternum, abdominal tergites 1–2, bright ochreous yellow; posterior margin of tergite 4 narrowly white with a slight pinkish tinge, tergites 5–7 white; nearly all hairs of coxae, trochanters and femora pale, except dorsal side of femora 3; tibiae mainly with dark hairs except along dorsal side of hind pair; abdominal sternites mainly pale. Wings slightly infuscate. Pubescence rather short. Length of fore-wing 12.0–13.5, mean 12.8 mm.; hamuli 19–22, mean 20.7.

Specimens examined:— 3♀ 3☿ 1♂ Ghilzai, Koh-i-Baba, 5. *viii.* '48; ☿♂ Surta, Koh-i-Baba, 10. *viii.* '48; ♂ Marak, Koh-i-Baba, 14. *viii.*, ♂ Marak, Koh-i-Baba, 16. *viii.* '48; ♂ Tarapas, Koh-i-Baba, 22. *viii.* '48; ♂ Puistagoli, Koh-i-Baba, 2. *viii.* '48.

Variation. In one female only half of tergite 4 is pale haired and in two workers the pale hairs of this tergite are not pink tinged; another worker has tergite 4 almost entirely pale. The male from Puistagoli has the interalar band one and a half times as wide as the collar and the posterior half of tergite 4 is quite deep pink. In the male from

Ghilzai, the very few pale hairs on tergite 4 are white; in the Surta ♂ they are also white but more numerous. In the Marak ♂ the interalar band is strongly pale mixed and tergite 3 as well as 4 has some pale hairs at the posterior margin.

The species has already been recorded by REINIG (1940) from Afghanistan and it is widespread in C. Asia. The emargination of the

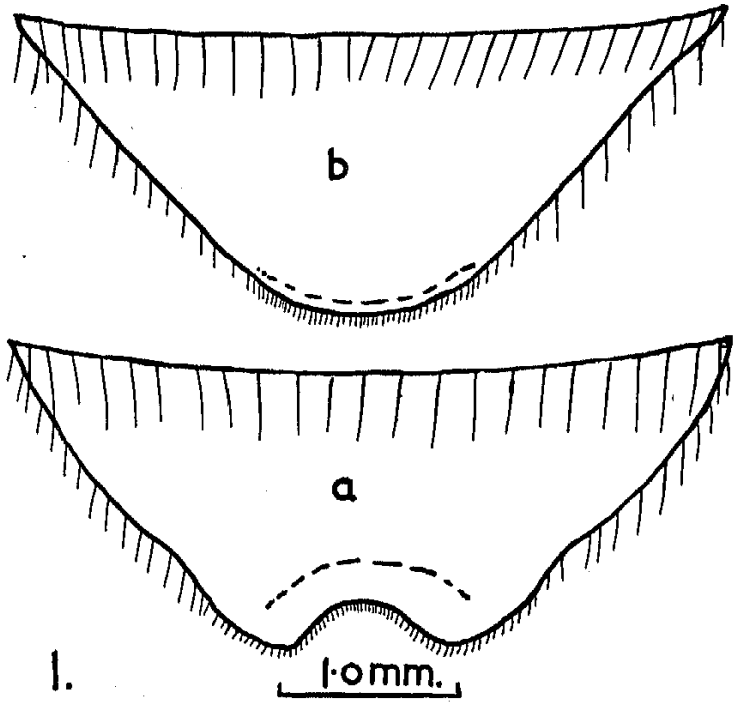

Fig. 1. Sixth (morphological seventh) abdominal sternite, in ventral view. a. *B. asiaticus* Mor. b. *B. obtusus* sp. n.

sixth sternite was described by MORAWITZ (1894) in his amplification of the description of *B. regeli* Morawitz, 1880, a synonym of the present species. It has not been mentioned by any of the more recent authors and it is possible that not all the forms ascribed to this species are really conspecific.

7. *Bombus obtusus* n. sp.

♂ Pubescence rather short, black; the shorter and some of the longer hairs of the clypeus, hairs round bases of antennae, more than half hairs of tuft of vertex, broad anterior collar on mesonotum, scutellum, whole pleural region, abdominal tergites 1–2, bright ochreous yellow. Hairs of tergites 5–7 white. Majority of long hairs of coxae, trochanters and femora yellow, those of hind tibia reddish. Venter

of abdomen mainly pale haired. Black interalar band somewhat narrower than the collar and considerably yellow mixed. Wings little infuscate. Wing-length (from centre of tegula to tip) 14.0 mm.

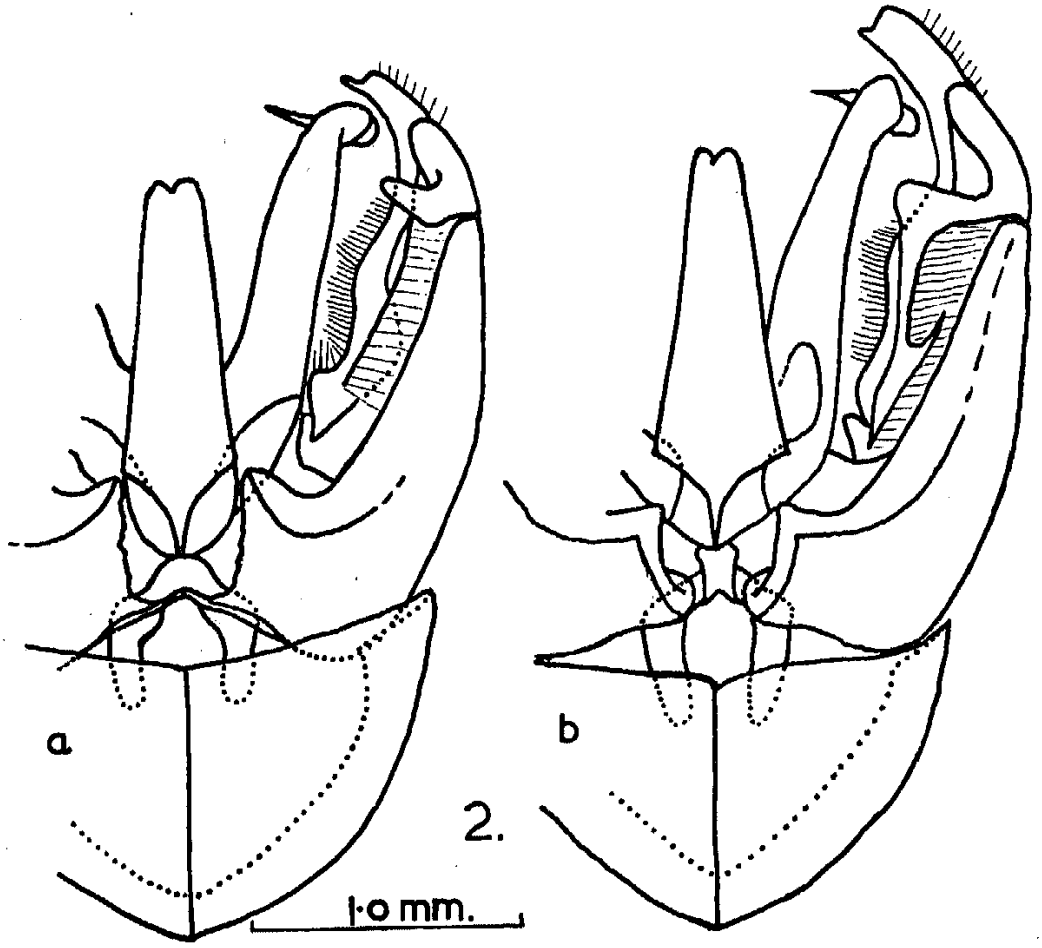

Fig. 2. Left half of male genitalia, dorsal view. a. *B. asiaticus* Mor. b. *B. obtusus* sp. n.

Malar space a little longer than broad, with many punctures. Antennae elongate, segments 3–5 together as long as scape, 3 as long as 5, almost three times as long as broad, 4 almost twice as long as broad, distal segments a little longer than 5. Eyes swollen, posterior ocelli separated from them by a little less than one diameter. Mid basitarsus about five times as long as broad, postero-distal angle not produced, surface with dense short pubescence. Posterior tibia convex, shining, with sparse large punctures, dorsal hair-fringe dense, distally as long as tibial width. Posterior basitarsus parallel-sided, three and a half times as long as broad, postero-distal angle hardly less than a right angle, surface shining with moderately close short hairs, posterior fringe sparse, as long as width of tarsus. Sixth (true seventh) abdominal

sternite with margin obtusely curved, hardly truncate in centre (fig. 1 b). Genitalia (fig. 2b) with sagittae ending in a hook whose external flange is a little broader than in *B. asiaticus* F. Mor.; squama more deeply emarginate than in that species and more strongly produced forwards over the volsella; lacinia distally parallel-sided with a short straight distal projection which is a direct prolongation of the inner margin.

Female (one worn specimen). Pubescence short, black; broad mesonotal collar (as wide as interalar black band), scutellum, mesopleuron and abdominal tergites 1–2, bright ochreous yellow. Abdominal tergite 5 and long hairs of tergite 6, white. Wings rather strongly infuscate. Wing-length 17.0 mm.; hamuli 26. Structurally apparently identical with *B. asiaticus* F. Mor. and only differing in that all the hairs of abdominal tergite 4 are black.

Worker. Pattern the same as in the female. Out of sixteen specimens, five have a narrow band of black pubescence at the base of tergite 5, and one has the anterior half of tergite 5 black-haired. One of these dark specimens has the bases of all the pale hairs on tergite 5–6 brownish-red.

Type ♂ Puistagoli, Koh-i-Baba, 2. *viii.* Allotype ♀ Marak, Koh-i-Baba, 16. *viii.* Paratypes 3 ♂, Marak, Koh-i-Baba, 14. *viii.* '48; 5 ☿ Marak, Koh-i-Baba, 16. *viii.* '48; ☿ Puistagoli, Koh-i-Baba, 2. *viii.* '48; 4 ♀ Ghilzai, Koh-i-Baba, 5. *viii.* '48; ☿ Surta, Koh-i-Baba, 9. *viii.* '48; 4 ☿ Panjao, Koh-i-Baba, 18. *viii.*, 2 Panjao, Koh-i-Baba, 25. *vii.* '48; 1 ☿ Tarapas, Koh-i-Baba, 22. *vii.* '48.

Variation in male:—in two paratypes the anterior quarter of tergite 5 has an intermixture of black hairs; in one the black hairs of the interalar band are much fewer. Wing-length 13.5, 14.0, 14.0, 14.0 mm.; hamuli 20, 21, 21, 24.

The type, allotype, and fifteen paratypes are in the collection of the Zoological Museum of Copenhagen University; 1 ♂ and 3 ☿ paratypes are in my collection.

Owing to failure to mention structural details in some previous accounts, it is uncertain whether this species may not have been recorded as a colour-form of *B. asiaticus* Mor., e. g. var. *ataeniatus* Reinig, 1930. It would probably be impossible to recognise the species in the absence of males.

Subgenus *Subterraneobombus* Vogt, 1911.

8. *B. melanurus* Lepeletier, 1836.

♀ Black; mesonotum, scutellum, dorsal third of mesopleuron, abdominal tergites 1–2 ochreous yellow. Wings rather dark. Pubescence short.

♂ Black; shorter hairs of face, tuft of vertex, whole thorax, abdominal tergites 1–2, ochreous yellow; some pale hairs beneath femora 1 and 2. Wings rather dark. Pubescence short. Length of fore-wing 14.5–17.5, mean 16.0 mm.; hamuli 22–29, mean 24.7.

Specimens examined:— 6 ♂ 1 ♀ Ghilzai, Koh-i-Baba, 5. *viii.* '48; 1 ♀ Marak, Koh-i-Baba, 16. *viii.* '48.

The range of this species extends from Syria and Russia to C. Asia and the present specimens are quite typical.

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