

# On the Parasitic Isopods of the Family Entoniscidae, especially those found in the Vicinity of Seto

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*With 15 text-figures*

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## Introduction

Our knowledge on the Entoniscidae, a family of parasitic Isopods is indebted greatly to the classical work of GIARD and BONNIER (1887). In the second part of their joint work "Contribution à l'études des Bopyriens", they published their extensive studies on the morphology and ethology of this parasite. They also reviewed the previous works, and gave monographic descriptions of all the species known to them. Since then, little has been published on this family, apart from records of a few new species, and also from ATKINS' (1934) research on the anatomy of *Pinnotherion vermiforme*.

All the species of this family hitherto known, except *Entoniscoides okadai* MIYASHITA, are from the Atlantic regions, either from the Brazilian waters or from the North Sea or the Mediterranean. MIYASHITA's record is very noteworthy, as it marks the first discovery of the family from the Pacific region, although there had been a few fragmentary accounts written in Japanese which dealt with some of the forms of Entoniscidae discovered in Japan.

In the Spring of 1935 when I was in the Seto Marine Biological Laboratory, I made some observations on the Entoniscids parasitic on the littoral crabs common in the neighbourhood. The study had been discontinued since, on account of the change of my host to the present one. In the Summer of 1938, however, I had a chance to visit the Laboratory and to supplement my previous study on this parasite. Thus altogether seven species have been discovered. All of these are apparently new to science, three representing each a new genus. The list of the species follows:

*Entoniscus japonicus* n. sp.

*Portunion flavidus* n. sp.

*Pinnotherion setoensis* n. sp.

*Cancrion deltoides* n. sp.

*Xanthion spadix* n. gen. & n. sp.

*Tiarinion fulvus* n. gen. & n. sp.

*Micippion asymmetricus* n. gen. & n. sp.

Before going farther, I wish to express my hearty thanks to Prof. T. KOMAI for his kindness in looking over the manuscript.

### Morphology

I shall give a brief account on the general structure of the Entoniscidae, before going into the descriptions of each species. The accounts are somewhat different from those given by GIARD and BONNIER (1887) and by ATKINS (1933); also some new facts left untouched by them will be shown.

The Entoniscidae live in the body cavity of crabs taking their nourishment from the body fluid of the hosts. Although they have the appearance of internal parasites, they are actually external, being enclosed by a thin membraneous sheath formed by the invagination of the host integument. The sheath is, therefore, connected with the soft lining of the wall of the branchial chamber of the host near the juncture of the skin with the epimeron. Here the sheath is folded over the pygidium of the parasite to form a more or less thickened "casque" or "calyce chitinaux" of GIARD and BONNIER (1887); its inner cavity communicates with the exterior by a small hole. The host membrane is so closely applied to the body of the parasite, that it enters all interspaces between the folds of the pleural lamellae. In some regions, however, spaces are left between the parasite and the host membrane; for instance, the thorax is separated from the host membrane on the dorsal side by a rather wide "dorsal groove". In some cases, the communication of the cavity of the sheath with the exterior is closed, as observed by GIARD and BONNIER (1888). This is found either in the very young or in the dead adult female, but never in the one with its marsupium filled with ova. The authors suggest that this closure of the external opening occurs by the moulting of the host and indicates a sexual immaturity of the individual ("forme asticot") in spite of its large size.

The Entoniscidae show a high degree of sexual dimorphism. The female is greatly deformed and lacks almost any trace of metamerism; while the male, which is a dwarf usually found within the female marsupium, retains a constitution more or less alike the typical isopod.

*Female.* The body of the adult female is curved dorsally in a V-shape, the head and thorax forming one arm and the abdomen the other (fig. 3A, etc.). It stretches from one side of the host to the other beneath the alimentary canal, directing both its ends towards the anterior. In the very young female ("forme asticot", fig. 12H), however, the body is curved

ventrally; this change of curvature occurs somewhat earlier than the time when the ovarian processes begin to develop (fig. 12G). The ventral curvature is maintained throughout its life only in the genus *Entoniscus* (fig. 1B). The female does not show any appreciable asymmetry in its body constitution except in the case of *Micippion*, in which, as will be mentioned later, the development of the dorsal ovarian process is dissimilar on each side (fig. 14D).

The cephalon, the "cephalogaster" of GIARD and BONNIER (1887), is swollen into a double sphere and is distinctly separated from the thorax (figs. 1A, 3B, etc.). The two pairs of antennae are transformed into parallel ridges and termed the external and internal antennae by the same authors (figs. 1C & 11D). The mouth part, which is formed by the closely united labrum and hypostome, is a conical elevation enclosing piercing mandibles (fig. 11D). The maxillae are absent. The maxillipeds, however, are well developed in all the genera except *Entoniscus*. They are situated at the ventral border between the cephalon and the thorax (fig. 3B, etc.), and composed of three more or less distinct parts: exopodite, endopodite, and coxopodite (after GIARD and BONNIER's terminology; fig. 11F, etc.). The exopodite, the largest of all the three parts, is lamellar, with slight concavity, and wrinkled on its surface. The coxopodite is a large protuberance situated in front of the exopodite. The endopodite is inserted between the two as a small lanceolate lobe, but its distal end is exposed on the front of the coxopodite, encircling its inner margin. GIARD and BONNIER (1887) state that the endopodite and exopodite lie respectively in front and behind the coxopodite. Nevertheless, in their fig. 25 (Pl. V; also see text-fig. 6 VIII), the relative position of these parts is completely reversed. In reality both the description and figure are incorrect; the exopodite lies behind the coxopodite and the endopodite is inserted between them.

Except for the ovarian processes to be stated below, the thorax is nearly cylindrical. The greater part of the thoracic surface represents morphologically the ventral surface in all the genera other than *Entoniscus* and its allies, the dorsal side being restricted to a narrow longitudinal area facing the abdomen. The border between the two sides can easily be made out by the line of attachment of the oostegites (figs. 8D, 11B, etc.). The thorax bears on its ventral surface conspicuous processes which contain the ovary...they may be called ovarian processes. These processes are divided into three: ventral, lateral, and dorsal. The ventral ovarian process arises from the mid-ventral line and is always unpaired, but is developed best of all (figs. 3B, 5C, 8B, 11B, & 14D). The lateral processes are paired and attached to the topographically lateral sides of the thorax (fig. 6C). They are often lacking, and, if present, only very feebly developed. The dorsal processes also are usually paired, directed dorsally, and are intermediate in their degree of development (figs. 3C, 6C, & 14D). They appear, at first sight, to originate from the dorsal side of the thorax, but in reality

this is not the case, for their bases are always ventral to the line of attachment of the oostegites. The morphological dorsal surface does not carry any process.

In *Entoniscus* and its allies, which exhibit a ventral curvature, the greater part of the circumference of the thorax is occupied by the dorsal surface, and the ventral side is reduced to a narrow longitudinal area (fig. 1B). The ovarian processes, if present, arise from the dorsal surface and are unpaired, being arranged antero-posteriorly on the mid-ventral line (fig. 1B). They are relatively smaller than the corresponding processes found in other genera. The *Entoniscus*-group is thus completely opposite to the *Entione*-group, not only in the relative extent of the two surfaces of the thorax, but also in the region from which the ovarian processes arise.

The marsupium of the *Entione*-group is formed by the overlapping consecutive oostegites which are closely applied to the host membrane (fig. 6C, etc.). It is sac-like and rather simple in shape except for having a hood (after ATKINS, 1934, = "capuchon anterieur" of GIARD and BONNIER, namely, the lobe projecting over the cephalon; cf. fig. 3A, etc.) and some small bulges corresponding to the ovarian processes. In *Entoniscus*-group, however, the marsupium is formed by the host membrane alone, and is deeply divided into secondary lobes (fig. 1A). Besides, the oostegites do not adhere to the host membrane, and are free to move so as to be a mere support to the marsupial lobes.

Five pairs of oostegites are present in most members of the *Entione*-group. The first pair are inserted immediately under the maxillipeds, and enclosed by other pairs; they are kept in constant movement agitating the water and the embryos within the marsupium when the parasite is alive. They are divided into ascendant, transverse, and recurrent lamellae, according to GIARD and BONNIER's terminology (fig. 3D, etc.). The ascendant lamella (*al*), projecting over the cephalon, is more or less deeply folded so as to divide the lumen of the hood into several sections. The transverse lamella (*tl*) is only a small fold at the base of the ascendant lamella and occasionally undifferentiated from it. The recurrent lamella (*rl*), however, is of great length, and has a somewhat crumpled appearance, being enclosed by other oostegites. The remaining four pairs are closely applied to the host membrane. GIARD and BONNIER (1887) mention them as completely fused into a pair extending along the whole length of the thorax on either side. ATKINS (1933), however, states that "the boundaries of the component oostegites cannot be distinguished in entire animal", though "in section the overlapping of consecutive oostegites may be distinguished in places (p. 329)". As a matter of fact, no one has ever made out the real state of those oostegites clearly. This is apparently due to the difficulty in separating the oostegites from the host membrane to which they closely adhere. By careful manipulation of a fine needle, I have succeeded in removing the membrane in specimens fixed with BOUIN's fluid and preserved

in alcohol. Thus I have been able to find out that all of the Japanese species, except *Micippion asymmetricus* which will be described later, have distinctly separate oostegites. It is therefore rather doubtful to me whether in *Portunion mænadis* all the pairs except the first are really fused as GIARD and BONNIER say. The oostegites in many cases meet their fellows on the opposite side at the mid-ventral line and completely surround the marsupium (fig. 3B, etc.). In some cases, however, *Tiarinion* for example, they are much reduced and leave the greater part of the mid-ventral surface of the marsupium uncovered, this part being roofed only by the host membrane (fig. 11B).

According to GIARD and BONNIER (1887) the second pair of the oostegites of the European species form a closed sac by the overlapping of their free margins on the median line, and enclose the ascendant lamellae of the first pair within. The same condition is met with in some Japanese species also (figs. 3B, 5B, & 14B), though in others like *Tiarinion*, *Xanthion*, etc., the second pair are so small that they only cover the basal part of the ascendant lamellae and do not meet each other at the median line (figs. 6B, 8B, & 11B). The second oostegites of *Portunion mænadis*, according to the named authors, form a mass of twisted folds, the "corps spongieux", on their anterior margins situated above the cephalon. ATKINS (1933) says of this body in *Pinnotherion vermiforme* as originating from the first pair of oostegites and ascribes a respiratory function to it, calling it "respiratory folds". In all of the Japanese species, neither the first pair nor the second give rise to such a structure. In the living specimen, however, one finds a whitish spongy structure corresponding exactly in appearance and location to the "folds" mentioned by those authors (figs. 3A & 5A). Dissection shows that this body is nothing but the exopodite of the maxilliped which is complicatedly folded. It is questionable whether these differences in the origin of the folds are due to the specific distinction, or merely to a mistaken idea of the previous authors on the structure.

In *Entoniscus*-group, the oostegites are separate and do not overlap one another; furthermore, they vary in number according to species (fig. 1B). They have narrow bases, but are widened and lobate distally, and end in more or less crispate margins. Unlike the species in *Entione*-group, the first pair are simple like other pairs, though much smaller in size.

The pereopoda are rudimentary, the first pair always missing. All of them, except the last two pairs, are situated close to the anterior limit of the base of the respective oostegites, and have the appearance of small processes composed of a short lanceolate lamella and a peduncle which is merely a thickened part of the oostegite (figs. 3B, 14E, etc.). GIARD and BONNIER (1887) figure two small whitish spherical sac-like structures adjoining together on either side of the thoracic end. In sections, these sacs contain corpuscles highly resembling spermatozooids and are provided with a duct opening on the seventh segment (p. 148). The above authors con-

sidered these sacs to be receptacula seminis at first (1886a), but in a later work (1887) they regarded them as seminal vesicles representing rudimentary male genital organs. ATKINS (1933), however, failed to find any such organ. Such bodies are present in the Japanese forms also, but I have never found in them any spermatozooids or leading ducts. As far as I have ascertained, these organs are merely the protuberances of the body wall, and are composed entirely of connective tissue in all stages of the development of the female. In *Portunion flavidus*, as well as in *Cancrion deltoides*, each of these protuberances issues a small lanceolate lamella very similar to the peraeopod in its appearance (figs. 3G & 6G). In view of the fact observed in the second to fifth pairs of peraeopoda, therefore, it is highly probable that these bodies and their lamellae represent the peduncle and the distal joint of the sixth and seventh peraeopoda respectively. Moreover, in young females, the primordia of these bodies are found in the form of two papillae quite separate from each other and lying in the last two thoracic segments (fig. 3I, etc.); they are much like the primordia of other peraeopoda in their appearance. The protuberances in the adult of *Tiarinion fulvus* are provided with more or less broad lamellae which remind us of the rudimentary oostegites (fig. 11G). The presence of the extra oostegites is not astonishing, for such is known in the Bopyridean genus *Pseudocryptella* also (cf. SHIINO, 1937). In *Pinnotherion setoensis* and *Micippion asymmetricus*, there are four protuberances on either side, two of which are believed to be homologous to the lamellae of the above named species (figs. 5B & 14D). In *Entoniscus*, the peraeopoda are elongate and filiform (fig. 1C).

The metamerism of the abdomen is indicated only by surface rugae, when the animal contracts. The pleural lamellae of the first four segments are complicatedly folded and crispate on their margins, exhibiting a bouquet-like appearance (fig. 4B, etc.). They gradually decrease in size as well as in the complexity of the folds from the front towards the back, always becoming simple and triangular in the fifth segment. In *Tiarinion*, *Cancrion*, and *Xanthion*, the lamellae of the third and fourth segments are also simple (figs. 6B, 8C & 11C). The pleopoda are uniramous and broadly lamellar; they are imbricate from behind forwards, and moreover overlap those on the other side (fig. 11I). GIARD and BONNIER (1887) describe the pleopoda in *Portunion maenadis* to be biramous, but ATKINS (1933) mentions them in *Pinnotherion vermiforme* as uniramous. She further points out several errors in the observations of the French authors on the structure of the abdomen. The present study has revealed the validity of her views on these points.

The last segment, the pygidium, is extremely small, deeply bifurcated and curved to the ventral side. It is not certain whether the bifid tips are homologous with the uropoda or not (fig. 11I). In the genus *Entoniscus* and its allies the abdomen is very narrow and cylindrical, and retains more

distinct metamerism than in other genera (fig. 1B-D). It lacks the pleural lamellae and has filiform pleopoda at the posterior end of each segment. The heart usually lies in the third abdominal segment in the *Entione*-group, and is indicated by a slight swelling on the dorsal surface (fig. 8A, etc.); in *Entoniscus* the heart is situated at the posterior end of the thorax (fig. 1D).

*Male.* The male, which is very small in comparison with the female, is usually found in the brood-chamber or in the dorsal groove of the female. In most cases a single male accompanies a female, but in *Portunion flavidus* two or more males are sometimes found with a single female. In *Pinnotherion setoensis*, some additional males, besides the ordinary ones found in the brood-chamber, occur freely in the body cavity of the host, without having any membrane enclosing them. The male more or less has the typical constitution of an isopod, although it is degenerated in many points; its body is normally curved ventrally.

The cephalon is fused with the first thoracic segment; the two, however, are distinguishable in the lateral regions, and there is also a shallow surface groove indicating the boundary (figs. 1E, 4A, etc.). KOSSMANN (1881, in *Portunion moniezii*) and GIARD and BONNIER (1887, in *P. mænadis* and *Cancrion miser*; 1881, in *Priapion fraissei*) mention the cephalon as being separated from the thorax, whereas F. MÜLLER (1862, in *Entoniscus porcellanae*) as well as ATKINS (1933, in *Pinnotherion vermiforme*) describes it as coalesced with the thorax. As a matter of fact, owing to the ventral curvature of the body, the cephalon is concealed from view from directly above in many cases, but appears in oblique view from behind. Therefore, if the cephalon is examined in reflected light without any special care, the surface groove between it and the first thoracic segment may appear as an obscure line, and it is often difficult to decide whether the line shows a real articulation or not. It is highly improbable that the Japanese species, which belong to the same genera as those examined by GIARD and BONNIER, would be different in such an important character, since the distinctness or indistinctness of the cephalon is thought to deserve generic separation in the Bopyridae. At any rate, re-examination of the males of GIARD and BONNIER's species is desirable.

The antennules are large bosses bearing short setae (fig. 4D); the antennae, which are found in *Portunion kossmanni*, are absent in the Japanese species. The oral cone bearing the styliform mandibles is normal. The maxillulae are lacking; they are described and figured by GIARD and BONNIER (1887) as taking part in the formation of the oral cone, but this observation has been amended later by BONNIER (1900). The maxillae and maxillipeds are vestigial and sometimes missing (fig. 4D). The limbs of the first six thoracic segments are all similar, only increasing in size posteriorly (fig. 4B, etc.). They are scarcely prehensile in all cases unlike in Bopyridae; besides, there often occurs a fusion of the joints, the number of which

is five in many cases (fig. 5J, etc.). According to GIARD and BONNIER (1887), the meropodite is fused with the carpopodite to form the third joint. My observation shows, however, that the fusion may take place between the carpopodite and the propodite, the third joint being formed by the meropodite only. This view is supported by the fact that in some Epicaridean larvae, a remnant of articulation line is shown between the carpopodite and propodite, though these joints are usually completely fused (figs. 7E & 9G). The male of the *Entoniscus*-group is very different from that of the *Entione*-group in that the peraeopoda are reduced into unsegmented, tubercle-like bodies, which, nevertheless, are movable to a certain extent (fig. 1F). The last thoracic segment is limbless, but provided with protuberances bearing gonopores (fig. 4B, etc.).

Three types may be distinguished among the males of the Entoniscidae. In the first type represented by the males of *Portunion* and *Pinnotherion*, the body is very strongly curved so that it cannot be stretched flat (figs. 4A-B & 5E-F). The pleura of the thoracic segments are short, narrow, and twisted, turning their lower surface slightly backwards; the seventh segment, which lacks the pleura, is much narrower than the foregoing ones and has a cylindrical appearance. In the second type, found in *Tiarinion*, *Xanthion* and *Micippion*, the body is smaller and not so strongly curved as in the first type, but more or less extensible (figs. 9A-B, 12A-B & 15A-B); the pleura are longer, broader and not twisted, with the points of attachment of the peraeopoda greatly retreating from the segmental margin; the seventh segment has well-developed pleura and is similar in appearance to the foregoing ones. *Portunion* usually has the first type male, but sometimes the second type male, the latter type being commonly found together with a young female. *Xanthion* also has the first type male (fig. 9C) in addition to the second type males which are more usually found (fig. 9A-B). Except for the above differences, the two types of the males found in these genera are completely identical. These facts show that the distinction of the types is merely due to the difference in development rather than to that of specific significance. The third type, which has been found only in *Xanthion*, is characterized by the possession of rudimentary pleopoda (fig. 9D). This male is far smaller than that of the second type, and is apparently very young.

*Young Females.* The moulting does not seem to occur during the growth period of the females, because of the difficulty of getting rid of the shed skin in the host body. The transformation of the Cryptoniscan larva into a young female has not been observed.

The first stage (fig. 12H): The youngest stage I have found appears to be somewhat older than that described by GIARD and BONNIER (1887, "forme asticot"). It has an appearance of a caterpillar and is strongly curved ventrally, so that the cephalon almost touches the pygidium. The orientation of the parasite within the host is variable, though its pygidium



is invariably fixed to the latter's body-wall. The cephalon is the same in structure as that of the adult, with the only difference that it has eye pigments. The thorax is cylindrical, with clearer metamerism than in the adult, which is indicated by rugae on the skin. The oostegites are indicated on the side of the thorax by inconspicuous ridges, on each of which is found a tiny tubercle, the primordium of peraeopod. The pleural lamellae also are in the form of narrow lateral lobes, whose inner margins slightly project inwards; these projections indicate the primordia of pleopoda. The pygidium has already taken the definitive form. No clear specific difference is discernible in this stage.

The second stage (figs. 3I, 5K, 8I, 12G & 14H): The body is folded dorsally as in the adult, but straightens, when the parasite is taken out of the host, except for a slight ventral curvature in the thoracico-abdominal region. The orientation within the host is the same as that of the adult, both ends of the body being directed toward the anterior. The oostegites are more or less expanded, with the first pair projecting anteriorly beyond the cephalon as the rudimentary "hood". The last two pairs of peraeopoda are somewhat enlarged into lateral protuberances. The pleopoda have begun to overlap one another and the pleural lamellae have become crispate on the margins.

The third stage (figs. 3H, 5B, 8H & 12F): This is the stage directly before the first oviposition. All the organs of the body are greatly developed. The stage is characterized by the protrusion of ovarian processes, the enlargement of oostegites and the development of pleural folds. The *Cryptoniscan* larva, which is to become a male, seems to enter the female marsupium in about this stage.

*Cryptoniscan Larva* (fig. 10A-B). This is the last larval stage, and is usually found associated with a young female in about the third stage. The body is elongated and strongly convex dorsally; it is marked with diffuse and irregular double rows of large dark-brown chromatophores, of which those forming the eyes are especially large.

The cephalon has a strongly curved anterior margin. The biramous antennules are composed of four peduncular joints and two branches bearing a number of long sensory hairs (figs. 10C & 13H). The antennae are uniramous and have seven cylindrical joints, of which the distal three form a short flagellum (figs. 10D & 13H). The oral cone encloses a pair of styli-form mandibles; it is longer and more acute than in any other stage (fig. 13H). The maxillae are absent; the maxillipeds, when present, are rudimentary.

All the seven thoracic segments bear peraeopoda and well-developed coxal plates (fig. 10B). The first six pairs of peraeopoda are alike, increasing slightly in size toward the back. They are stout, strongly prehensile, and have all the joints distinct from one another (figs. 10E & 13H). The

seventh pair are considerably longer and more slender than the others (figs. 10F & 13J).

The first four peraeopoda are uniramous, lacking the endopodite; the inner distal angle of protopodite has three plumose setae and the exopodite four terminal setae (fig. 13K). The last pleopod, however, bears a short endopodite surmounted with two setae (fig. 13L). GIARD and BONNIER (1887), as well as ATKINS (1934), do not say anything of the presence of this ramus in the last pleopod. It is doubtful if this difference between the European and the Japanese forms is real or not. The uropoda are biramous, the outer ramus being shorter than the inner (figs. 10G & 13M).

*Epicaridean Larva* (fig. 13A). The first larva or the Epicaridea stage stays for some time within the mother's brood-pouch before leaving it. The larva is somewhat more slender than the corresponding larva of Bopyridae and has a strong dorsal convexity and scattered pigment patterns.

The cephalon is evenly rounded in front, bearing, on either side, a few crystallines surrounded by chromatophores. The antennules are short and two-jointed (fig. 13B), while the antenna are long and composed of six joints of which the last two form a comparatively short flagellum (fig. 13C). The oral cone encloses the usual piercing mandibles (figs. 9F & 13G). The maxillae and maxillipeds are rudimentary or absent; if present, they are merely tiny unsegmented lamellae (fig. 9F).

Of the peraeopoda, the seventh pair are lacking. The first five pairs are all similar: they are prehensile and consist usually of six joints, the pro- and carpopodite being fused into one; the coxopodite is rudimentary without expanding into a coxal plate (fig. 13E). The sixth peraeopod differs in structure from others. This is the most striking characteristic of the Epicaridea stage in the Entoniscidae. In *Entoniscus*, *Portunion* and *Pinnotherion*, this pair are slightly smaller than the foregoing pairs, the dactylopodite at the same time being highly degenerated (figs. 2F, 4H & 5L). In *Tiarinion*, *Micippion* etc., on the contrary, the sixth peraeopoda are much longer, being two or three times as long as the other pairs; besides, the propodite and dactylopodite are strongly developed; especially the former is armed with a conspicuous process which characterizes each species (figs. 7F, 9H, 13D, & 15I).

The five pairs of uniramous pleopoda are all similar in structure; the protopodite is triangular, bears two long stiff setae at its inner distal angle, and at the outer angle a quadrangular exopodite terminating in three setae (fig. 13F). *Entoniscus*, however, is an exception in having only one seta on the protopodite (fig. 2G) as well as in that the last pair are much smaller than the foregoing ones and have rudimentary setae (fig. 2H). The biramous uropoda are composed of a cylindrical peduncle and two subequal rami, all bearing terminal setae (fig. 13G).

### Taxonomy

Apart from very incomplete and erroneous statement of CAVOLINI on *Oniscus squilliformis* PALLAS (= *Grapsion cavolinii* GIARD), the first described species of the Entoniscidae was *Entoniscus porcellanae* from a *Porcellana* discovered by F. MÜLLER (1862) in Brazil. Two years later the same author reported a parasite of a crab, *Xantho* from the same locality under the name of *E. cancrorum*. Several species belonging to the genus all parasitic on the Brachyura were subsequently recorded from Europe by GIARD (1878) and FRAISSE (1878).

KOSSMANN (1882), because of the many differences in the constitution of both sexes between *porcellanae* and other species infesting Brachyura, erected a new genus *Entione* to include the latter species, confining *Entoniscus* to the former species. In 1886, GIARD and BONNIER divided KOSSMANN'S genus into three subgenera, *Cancrion*, *Portunion*, and *Grapsion*, on the basis of the characters of the female. In the next year they raised all these subgenera to the generic rank. But, instead of discarding the name *Entione* altogether, they retained it for their new species *achaei* apparently for the following reasons. When MÜLLER (1871) recorded a parasite of *Achaeus*, he referred it to the known species *cancrorum* which had originally been taken from *Xantho*, although he noticed some differences between it and the type. GIARD and BONNIER (1887), however, separated the parasite of *Achaeus* from *cancrorum* as a distinct species *achaei* because of these differences, and referred it provisionally to *Entione*. This had thrown the definition of *Entione* into a chaotic state.

GIARD and BONNIER, in their monograph in 1887, recorded all of the five genera and fourteen species then known to them. Of these, *Portunion fraissei* was subsequently removed from the original genus by the same authors to represent a new genus *Priapion*, because they found some characteristics in both sexes of the species which had previously been left unnoticed. Since then three more genera have been erected, each on the basis of a single new species, namely *Pinnotherion* GIARD and BONNIER (1889), *Synalpheion* COUTIÈRE (1908) and *Entoniscoides* MIYASHITA (1940). Of these, *Synalpheion* is noteworthy for being a parasite on a Macruran, while *Entoniscoides* is characterized by its abbreviated development as well as by being the first known Entoniscid from the Pacific. I have secured seven new species from the vicinity of Seto, of which three apparently each represent a new genus, that is, *Tiarinion*, *Micippion* and *Xanthion*.

All the genera, including the new ones, may be distinguished from one another as indicated in the following key, *Entione* being excluded on account of the incomplete diagnosis noted above.

#### Key to the Genera of the Entoniscidae

- 1) Female marsupium formed by host membrane alone, with all

oostegites not adhering to it, and freely movable; 1st oostegite not differentiated from others; pleopoda lanceolate and pleural lamellae missing. Male peraeopoda unsegmented, tuberculiform.

- A) Female without maxilliped; terminal segment of male undivided.
  - 1) Antenna of male projected laterally; 5th pleopod of Epicaridium dissimilar to others. (Parasitic on Anomura)
    - .....*Entoniscus* F. MÜLLER (5 spp.)
  - 2) Antenna of male not projected; 5th pleopod of Epicaridium similar to others. (Parasitic on Macrura)
    - .....*Synalpheion* COUTIÈRE (1 sp.)
- B) Female with maxilliped; terminal segment of male bifurcated. (Parasitic on Brachyura)
  - 3) .....*Entoniscoides* MIYASHITA (1 sp.)

II) Female marsupium formed by close adhesion of oostegites to host membrane; 1st oostegite differentiated into 3 parts; pleopoda lamellar and pleural lamellae well developed. Male peraeopoda jointed. (Parasitic on Brachyura)

- A) Marsupium complete, with 2nd pair of oostegites enclosing ascendant lamellae of 1st pair; 2 ventral ovarian processes present.
  - a) Last peraeopod of Epicaridium shorter than others, with simple propodite and rudimentary dactylopodite.
    - 4) Female without dorsal ovarian process.
      - .....*Pinnotherion* G. & B. (2 spp.)
    - 5) Female with a pair of dorsal processes.
      - .....*Portunion* G. & B. (5 spp.)
  - b) Last peraeopod of Epicaridium much longer than others, with distally expanded propodite and well-developed dactylopodite.
    - i) Female with 2 pairs of dorsal ovarian processes.
      - 6) Male without penis.....*Grapsion* G. & B. (1 sp.)
      - 7) Male with penis. ....*Priapion* G. & B. (1 sp.)
    - ii) Female with an unpaired dorsal ovarian process.
      - 8) .....*Micippion* n. gen. (1 sp.)
- B) Marsupium partly uncovered, with 2nd pair of oostegites overlapping only basal part of 1st pair; ventral ovarian processes present or absent. (Last peraeopod of Epicaridium as in II, A, b)
  - a) Female with ventral ovarian process, but without dorsal one.
    - 9) With 2 ventral ovarian processes.
      - .....*Tiarinion* n. gen. (1 sp.)
    - 10) With 1 ventral ovarian process.
      - .....*Xanthion* n. gen. (1 sp.)
  - b) Female with 2 pairs of dorsal ovarian processes, but without ventral one.
    - 11) .....*Cancrion* G. & B. (4 spp.)

## Description of the New Species

*Entoniscus*-GroupGenus *Entoniscus* F. MÜLLER

1862, MÜLLER, F., Arch. Naturgesch., Jahrg. 28, p. 10.

Parasitic on Porcellanids. Female curved ventrally, with or without ovarian processes, which, if present, arise from dorsal surface. No maxilliped. Marsupium formed by host membrane alone; all pairs of oostegites independent from one another and complicatedly lobate, with crispate margins; 1st pair structurally undifferentiated from others. Peraeopoda long, filiform. Narrow, cylindrical abdomen shows more or less distinct metamorphism, and has filiform pleopoda, but lacks pleural lamellae. Male cephalon united with 1st thoracic segment; antennae discoidal, projecting laterally. Peraeopoda transformed into unsegmented, but movable bosses. Abdominal segments devoid of ventral hook. Sixth peraeopod of Epicaridium with simple propodus and dactylus rudimentary or lacking. First 4 pleopoda bear a seta at inner distal angle of protopodite and 3 setae on exopodite; 5th much smaller than foregoing ones, and with rudimentary setae.

*Entoniscus japonicus* n. sp.

*Female* (fig. 1 A-D): Marsupium stuffed with ova yellowish brown to brownish, ovary pinkish to red, cephalon and abdomen whitish. From hood to ovarian process IV ca. 5 mm, from the latter to pygidium ca. 2 mm in the largest specimen. Thorax curved dorsally at a point 2/3 of its length, and provided with 5 dorso-median ovarian processes arranged as shown in fig. 1B, as well as with 2 unequal protuberances on either side of its posterior end. Ventro-lateral margin of thorax raised into a pair of longitudinal ridges with a groove between. Four pairs of oostegites present; 1st pair attached to anterior end of thorax, very small, with notched and frilled margin; other pairs divided into narrow lobes having crispate margin and their bases crowded together in a region just anterior to point of curvature of thorax. Three pairs of filiform, posteriorly directed peraeopoda present on ventral ridges and between 1st and 2nd oostegites. Heart swelling very eminent. Abdomen curved dorsally; ventro-lateral margins of first 5 segments projected into lamellar expansions, which, with their fellows of the opposite side, enclose a ventral canal; each lamella produced backward into lanceolate pleopod, except in 1st segment; that of 3rd longest of all. Last segment cylindrical, with its posterior margin slightly notched.

*Male* (figs. 1E-F & 2A, D-E): Nearly fusiform, with a few scattered dark colour-patches besides small eye pigments; 0.83 mm long, 0.31 mm wide at 4th thoracic segment. Antennae triangular, projecting laterally beyond cephalic margin and bearing many short setae. Maxilla absent;

maxilliped oval, surmounted with a short terminal spine. Last abdominal segment short, round, but with a slight median notch.

*Epicaridium* (fig. 2B-C, F-I): 0.27 mm long, 0.148 mm wide. Maxilla absent; maxilliped with 2 short spines. Propodus of first 5 peraeopoda armed with curved, forked spines or serrated disks on the margin facing

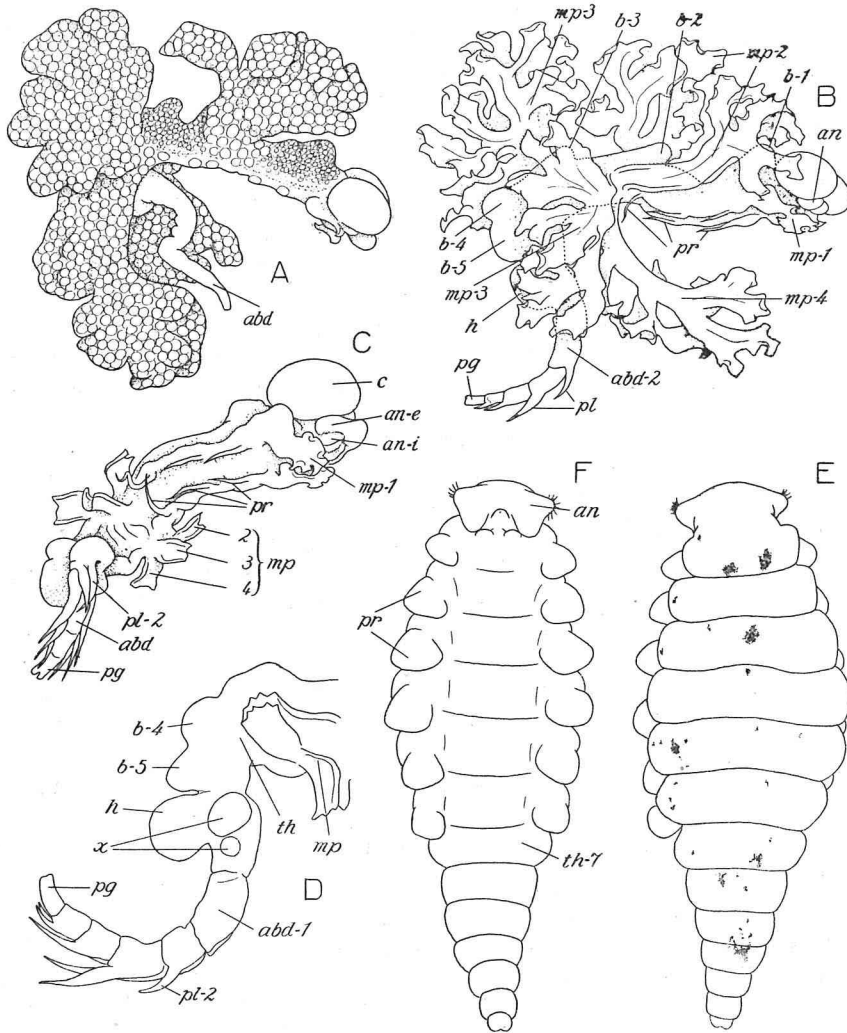


Fig. 1. *Entoniscus japonicus* n. sp.

A ♀ enclosed in host membrane; B ♀ with membrane removed; C ♀, ventral view; D ♀ abdomen; E ♂, dorsal view; F ♂, ventral view. (A, B×10, C×12, D×18, E, F×87.)

dactylus; carpus bearing a spinule at its inner distal angle. Propodus of 6th peraeopod oblong, having no armament except for rudimentary dactylus; carpus short, but expanding laterally to receive broad base of propodus.

*Remarks*: Of the 4 species of *Entoniscus* thus far known, *braziliensis* G. & B. and *creplini* G. & B. were first regarded by F. MÜLLER (1871) as falling within the specific limit of *porcellanae* F. MÜLLER previously established by him (1862). GIARD and BONNIER (1887), however, treated them as distinct species, merely on the ground that their hosts are different. It is therefore very doubtful if these species warrant recognition. The other species, *porcellanae* MÜLLER and *mülleri* G. & B. are given perfect diagnoses. The new species may be distinguished from them by the characters tabulated below:

		<i>porcellanae</i>	<i>mülleri</i>	<i>japonicus</i>
Female	Ovarian processes	0	4	5
	Oostegites	6 pairs	5 pairs	4 pairs
	Pleopoda	present in segments I-V	present in segments I-V	present in segments II-V
Male	Antenna	quadrate		triangular
	Abdominal segment VI	round, with setae		notched, without setae
Epicaridium	Dactylus of peraeopod V	absent		present

As stated above, a considerable distance separates the 1st pair of oostegites from all the others which are crowded together in the posterior region of the thorax. Although such a condition is found in *mülleri* also, there are a further pair of rudimentary oostegites close behind the 1st. The 2nd pair found in *japonicus*, therefore, appear to correspond to the 3rd pair in *mülleri*. *E. porcellanae* differs from both of these species in that the 6 pairs of oostegites (GIARD and BONNIER erroneously put them as 5 pairs) are continuous at their bases along the entire length of the thorax.

*Habitat*: Parasitic on *Petrolisthes japonicus* DE HAAN. The orientation of the parasite within the host is as follows: The body, curved like a V, lies on the dorsal side of the viscera of host for the most part, with the pygidium attached to the host's body-wall on one side at a point just behind the base of the compound eye, and the cephalon occupying the anterior part of the visceral cavity on the other side; the posterior end of the thorax is therefore situated in the hindmost part of the cavity beneath the intestine and heart. The marsupium of *E. japonicus* is divided into 4 lobes. Two of these lobes cover almost all the viscera of the host, while another submerges deeply to lie beneath the parasite's own thorax, and the rest extends into the host abdomen reaching nearly to the middle of its length.

The frequency of the parasite in both the sexes of the host is shown

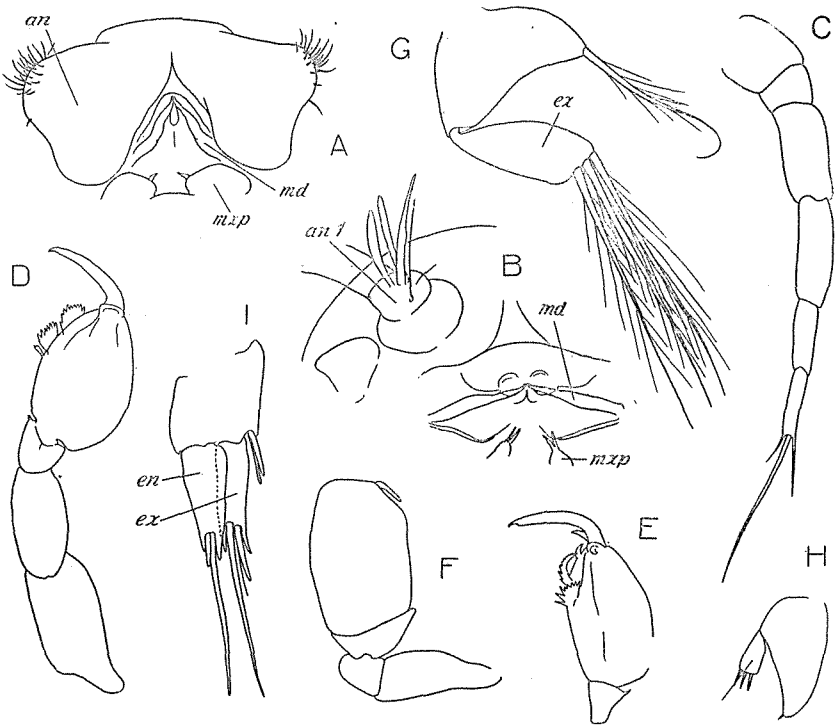


Fig. 2. *Entoniscus japonicus* n. sp.

A ♂ cephalon; B-I Epicaridium; B cephalon; C antenna; D peraeopod III; E peraeopod I; F peraeopod VI; G pleopod III; H pleopod V; I uropod. (A×240, B-I×525)

on p. 75. The occurrence of 2 of them in the same host was observed in 2 cases. In both the cases, one of the *Entoniscus* had an empty marsupium, though the other's had full of embryos. I have reported in one of my previous papers on Bopyridae (1933), that *Petrolisthes japonicus* of Seto is parasitized by 2 species of this family: *Pleurocrypta yatsui* (PEARSE) and *Pseudione petrolisthesae* SHINO. *Entoniscus* has been found associated with these Bopyrids in 3 cases. BOSCHMA (1935) describes the same host as being infested by 2 Rhizocephalans: *Lernaeodiscus cornutus* BOSCHMA and *L. okadai* BOSCHMA. Although these occur also at Seto, a simultaneous infection of *Entoniscus* and a Rhizocephalan has not been observed. At any rate, however, it is a striking fact that *P. japonicus* is infected by 5 different crustacean parasites in one and the same locality.

#### *Entione-Group*

Female, curved dorsally, has ovarian processes arising from ventral surface. Maxilliped divided into exopodite, endopodite, and coxopodite.



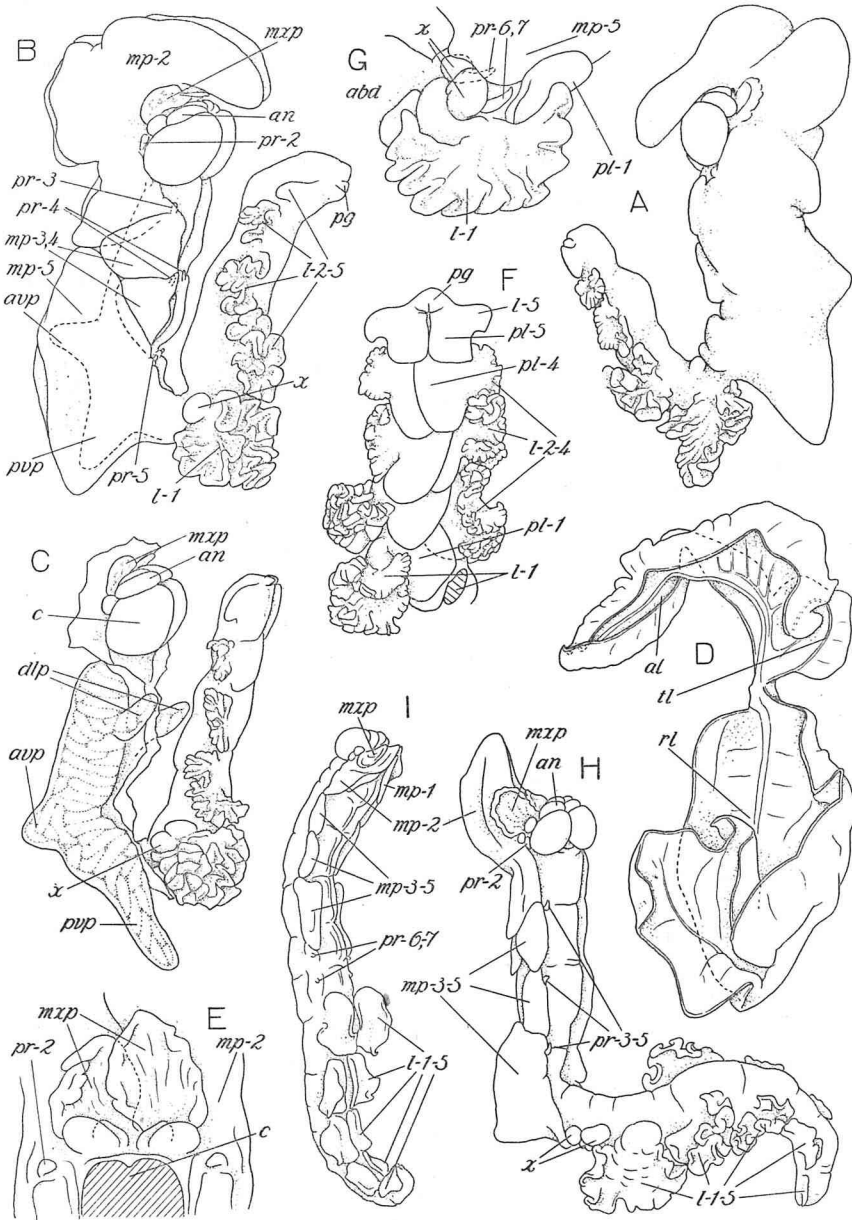


Fig. 3. *Portunium flavidus* n. sp., female

A ♀ enclosed in host membrane; B ♀ with membrane removed; C ♀ with oostegites removed; D oostegite I; E maxilliped; F abdomen; G curved part of thorax; H young ♀ of 3rd stage; I young ♀ of 2nd stage. (A×4, B, C×4.5, D, F, G×8, E×15, H, I×6)

Five pairs of oostegites usually distinctly separated; 1st pair, divided into 3 parts, concealed by other pairs which, adhering to host membrane, enclose a marsupium. Abdomen without any distinct metamerism; pleopoda uniramous and lamellar. Male peraeopoda segmented, retaining the character of a limb; 6th abdominal segment bifurcated. Pleopoda of *Epicaridium* usually all similar in having 2 setae on protopodite and 3 on exopodite.

Genus *Portunion* GIARD and BONNIER

1886, GIARD, A. and BONNIER, J., C. R. Acad. Sci., vol. 103, p. 645.

Female with 2 ventral and a pair of antero-dorsal ovarian processes. Marsupium complete; ascendant lamellae of 1st pair of oostegites entirely covered by 2nd pair. First 4 abdominal segments have folded pleural lamellae. Male cephalon fused with, or distinct from, 1st thoracic segment; abdomen bears ventro-median hooks. Sixth peraeopod of *Epicaridium* neither prehensile nor longer than others; propodus with a simple process at its tip and rudimentary dactylus.

*Portunion flavidus* n. sp.

*Female* (fig. 3): From hood to tip of posterior ventral process ca. 20 mm, abdomen ca. 12 mm in the largest specimen. Marsupium full of ova yellowish brown to dark brown, ovary lemon-yellow, abdomen whitish. Exopodite of maxilliped broad, frilled on its surface; endopodite oval, much smaller than the former. Dorsal ovarian processes arise from anterior end of thorax; of the 2 ventral processes, the anterior shorter and makes a right angle with the posterior which projects backwards. First oostegite without respiratory folds; others slightly overlap one another and meet their fellows of opposite side in the median to cover ovarian processes completely. Second to 5th peraeopoda lamellar, while last 2 lanceolate and arise from lateral protuberances of thoracic end.

*Male* (fig. 4A-E): 2.1 mm long, 0.77 mm wide at 4th thoracic segment; with scattered pigment patches. Cephalon fused with 1st thoracic segment. Antenna II absent. Maxilla and maxilliped ovate, the latter bearing a short spine. Thorax gradually narrows from 5th segment forwards, 1st being half as wide as 5th; lateral parts attenuated except in last segment which has truncate margin. Peraeopoda 5-jointed, with carpo-propodus as well as dactylus clad with many spinule-rows. Ventral spine of 1st abdominal segment hook-like and with a pointed tip, that of 2nd rudimentary; other segments lacking the spine. Bifid ends of last segment turned ventrally as well as towards each other, and more or less thorny.

*Epicaridium* (fig. 4F-H): 0.23 mm long, 0.12 mm wide. First 5 peraeopoda 6-jointed, with propodus bearing a short process at lateral end of its distal margin and merus having a very minute seta on external margin. Last peraeopod with dactylus small and directed outwards, and propodus ending in a short pointed process.

*Remarks:* Of the 4 species of *Portunion* thus far recorded, *moniezii* GIARD and *salvatoris* KOSSMANN are rather incompletely known. The new species may be distinguished from *moniezii* by that the pleural lamellae of the 1st abdominal segment are not so strongly developed as in this species. It is also different from *salvatoris* in its larger pleural lamellae as well as in the shorter and straight ventral process. The remaining two species *mænadis* G. & B. and *kossmanni* G. & B., which are both well diagnosed, differ from the new species as follows:

		<i>mænadis</i>	<i>kossmanni</i>	<i>flavidus</i>
Female	Ventral processes	both processes directed backwards	the anterior directed forwards, the posterior backwards	the anterior vertical to thorax, the posterior directed backwards
Male	Cephalon	distinct from thorax	distinct from thorax	fused with thoracic segment I
	Antenna II	present	?	absent
	Abdominal hooks	in segments I-IV	in segments I-IV	in segments I-II
Epicaridium	Dactylus of peraeopod VI	setose		not setose

GIARD and BONNIER (1887) give, in *mænadis*, the formation of the respiratory folds by the 1st pair of oostegites, the fusion of the rest pairs, the biramous pleopoda and the distinctness of the male cephalon. My own observations on these points have already been stated.

*Habitat:* Very commonly found parasitic on *Pachygrapsus crassipes* RANDALL. The incidence of the infection is strikingly frequent as shown on p. 75, the occurrence of 2 or more parasites in the same host being rather common (cf. the list on p. 75). In 2 cases I found a female accompanied by more than one male; in one of these there were 2 males and in the other 3; besides, in both of these cases, one of the additional males was located in the host viscera. BOSCHMA says that *Pachygrapsus crassipes* is infected by 2 species of *Sacculina*: *S. yatsui* BOSCHMA and *S. confragosa* BOSCHMA. At Seto also, I have secured 4 specimens of the crab bearing *Sacculina*, of which one had *Portunion* as well.

The present species sometimes also infests *Plagusia dentipes* DE HAAN. In spite of my careful examination, I have been unable to find any appreciable difference, in the characters of both the sexes as well as of the larva, between the parasite of *Pachygrapsus* and that of *Plagusia*. In *Plagusia*, however, the parasite attains a larger size than in *Pachygrapsus*, probably because of the greater size of the host, but the incidence of infection is

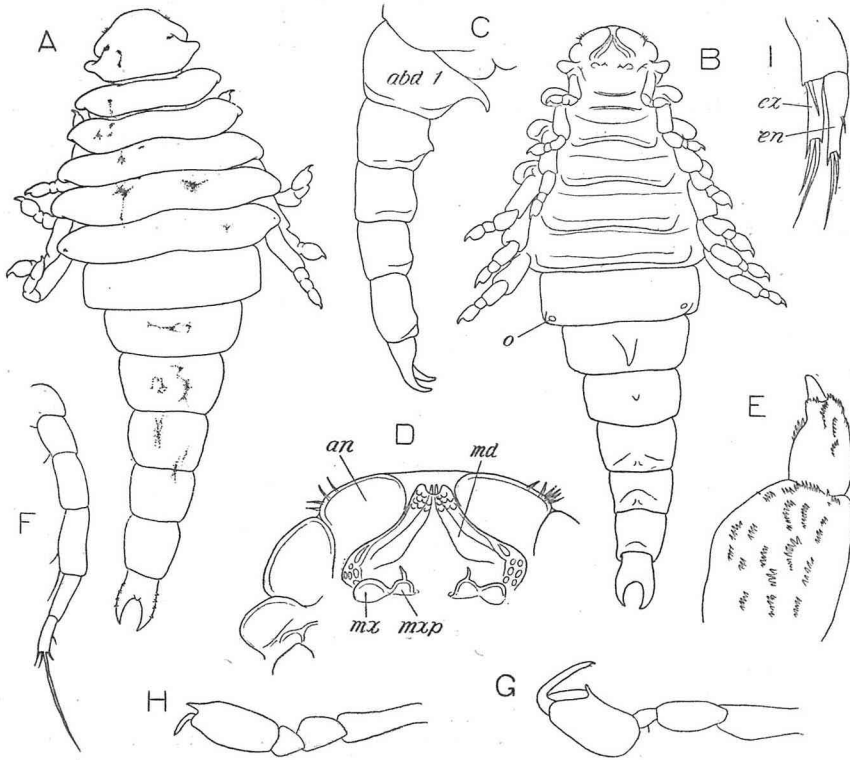


Fig. 4. *Portunio flavidus* n. sp.

A ♂, dorsal view; B ♂, ventral view; C ♂, abdomen; D ♂ cephalon; E ♂ peraeopod VI; F-I Epicaridium; F antenna; G peraeopod I; H peraeopod VI; I uropod. (A-C×40, D×215, E×450, F-I×360).

somewhat lower (cf. p. 75). The simultaneous occurrence of several parasites in the same host is also very frequent.

#### Genus *Pinnotherion* GIARD and BONNIER

1889, GIARD, A. and BONNIER, J., C. R. Acad. Sci., vol. 109, p. 914.

Female with 2 ventral ovarian processes, but without dorsal one. Marsupium closed, with 1st pair of oostegites devoid of transverse lamellae and enclosed by other pairs. Pleural lamellae folded in first 4 abdominal segments. Male cephalon fused with 1st thoracic segment; abdominal segments bear ventro-median processes. Sixth peraeopod of Epicaridium neither prehensile nor longer than others, and with rudimentary dactylus.

Although GIARD and BONNIER (1889) mention of this genus as being very near to *Grapsion*, ATKINS' description on *P. vermiforme* and the present study on the new species *setoensis* appear to indicate its affinity to

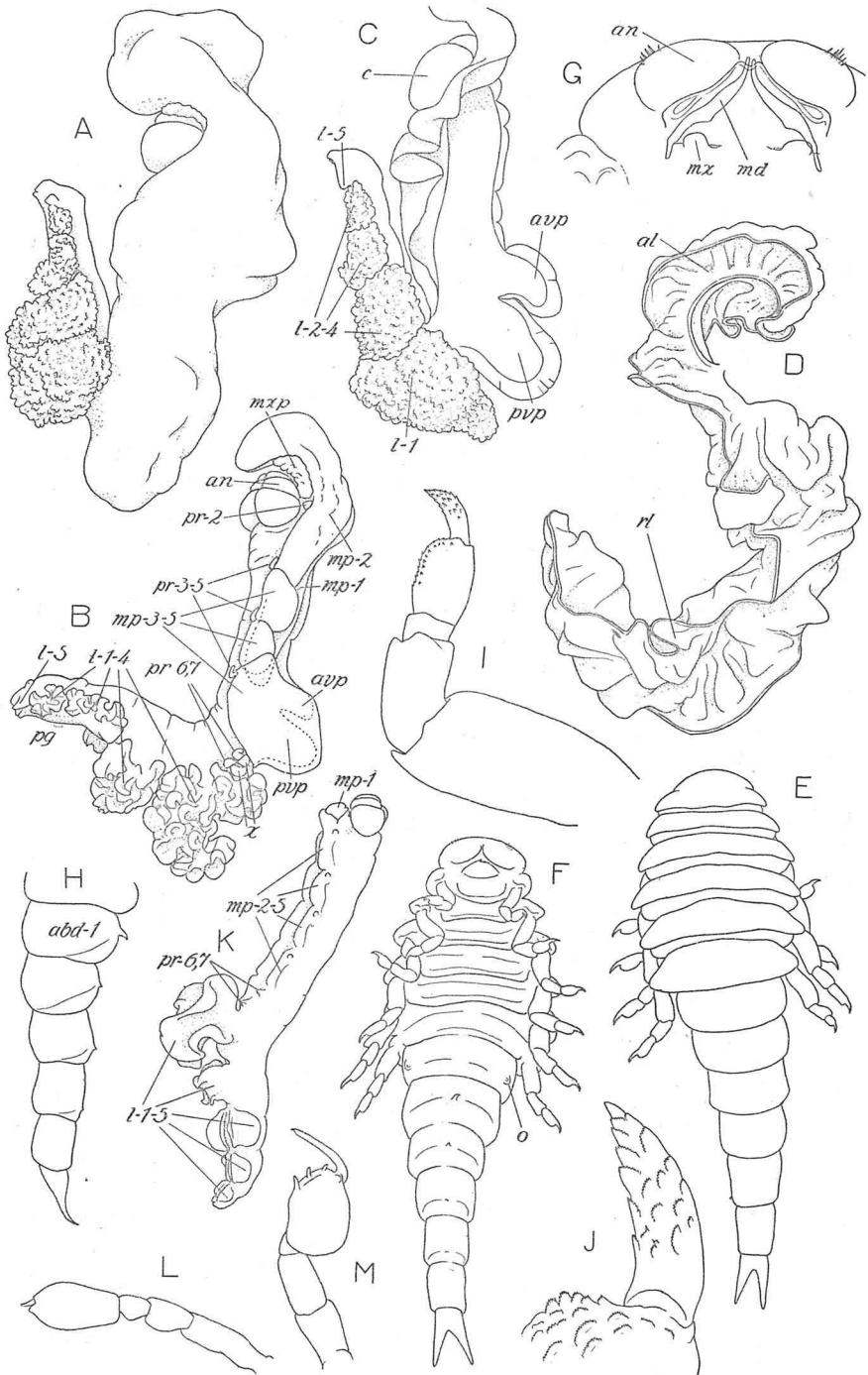


Fig. 5. *Pinnotherion setoensis* n. sp.

A ♀ enclosed in host membrane; B somewhat younger ♀ with membrane removed; C ♀ with oostegites removed; D ♀, oostegite I; E-J ♂; E dorsal view; F ventral view; G cephalon; H abdomen; I peraeopod VI; J tip of peraeopod; K young ♀ of 2nd stage; L Epicaridium, peraeopod VI; M same, peraeopod IV. (A, C×3.5, B, K×6, D×10, E, F, H×20, G×86, I×110, J, L, M×360)

*Portunio*. It is, however, distinguished from *Portunio* by the absence of the paired dorsal ovarian processes.

*Pinnotherion setoensis* n. sp.

*Female* (fig. 5A-D, K): From hood to posterior end of marsupium 21 mm, abdomen 11 mm in largest specimen. Marsupium full of ova, ranging from yellowish brown to brown, ovary pale reddish brown, abdomen whitish. Exopodite of maxilliped frilled on its surface. Thorax comparatively longer than in type species *vermiforme*. Ventral ovarian processes rather thick and closely adjoining at thoracic end; posterior process larger than anterior but not so long as in type species. Third and 4th oostegites small, hardly meeting their fellows of the opposite side in the median; 5th large, completely covering ovarian processes. Second peraeopod lamellar, 3rd to 5th dactyliform, whereas the last 2 are tuberculiform and adhere to lateral protuberances of thoracic end. Pleural folds more complicated than in *vermiforme*.

*Male* (fig. 5E-J): 3.4 mm long, 1.2 mm wide at 5th thoracic segment. No pigment, no eye. Maxilla semicircular, maxilliped absent. Thorax widest in 5th segment, from which it gradually narrows forward; 1st segment rounded on margin, while the succeeding 5 are attenuated and the 7th is abruptly narrower than 6th, more or less cylindrical, and resembles the abdominal segment in its appearance. Dactylus and propodus of peraeopoda beset with numerous serrated scales. Very rudimentary ventro-medial spines present in first 4 abdominal segments; that of 1st segment largest, though smaller than in usual cases. Bifid ends of last segment somewhat curved ventrally.

*Epicaridium* (fig. 5L-M): 0.22 mm long, 0.106 mm wide. Propodus of first 5 peraeopoda has 3 spines on its margin facing the dactylus. Last peraeopod shorter than others, with propodus bearing a small process at its distal end and rudimentary dactylus, slightly extending beyond terminal process of propodus.

*Remarks*: *Pinnotherion* is thus far known on a single species *vermiforme* G. & B. The new species may be distinguished from this by the characters mentioned below:

		<i>vermiforme</i>	<i>setoensis</i>
Female	Thorax	short	long
	Postero-ventral ovarian process	long and curved	short and straight
Male	7th thoracic segment	with a ventro-medial process	without process
	Abdominal hook	only in segment I, large	in segments I-IV, rudimentary

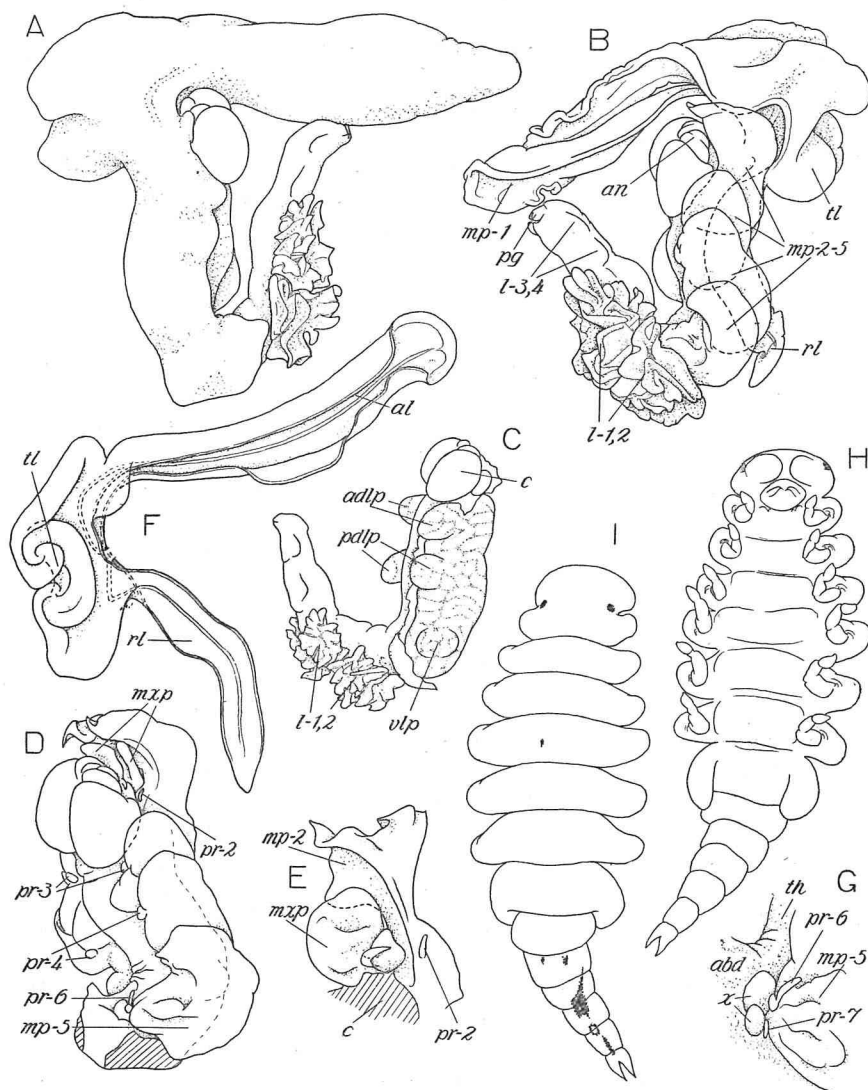


Fig. 6. *Cancrion deltoides* n. sp.

A ♀ enclosed in host membrane; B ♀ with membrane removed; C ♀ with oostegites removed; D ♀ thorax, dorso-lateral view; E ♀ maxilliped; F ♀, posterior part of thorax; G ♀, posterior part of thorax; H ♂, ventral view; I ♂, dorsal view. (A×6, B, F×8, C×5, D×10, E, G×18, H, I×45)

ATKINS (1933) is of the opinion that the respiratory folds arise from the anterior margin of the 1st oostegites. As stated before, they are nothing but the exopodite of the maxilliped in the Japanese species.

*Habitat*: Commonly parasitic on *Camposcia retusa* LATREILLE taken from a depth of several fathoms. Although more than 30 specimens of the parasite are now in my hand, I am unable to give any exact account on the incidence of infection, for the record is accidentally missing. According to my observation in March 1935, however, 4 out of 29 individuals of the crab were infected. The infection of more than one female upon a host as well as the occurrence of a supernumerary male within the host viscera, were rather commonly observed as shown in the list inserted on p. 75.

Genus *Cancrion* GIARD and BONNIER

1886, GIARD, A. and BONNIER, J., C. R. Acad. Sci., vol. 103, p. 646.

Female provided with 2 pairs of dorsal ovarian processes, but without a ventral one; a pair of lateral ones present or absent. Marsupium incompletely closed, with 2nd pair of oostegites covering merely basal part of 1st pair. Pleural lamellae folded in first 2 abdominal segments, folded or simple in succeeding 2. Male cephalon distinct or fused with 1st thoracic segment; abdomen without ventro-median spine. Sixth peraeopod of Epicaridium much longer than others, strongly prehensile, and with propodus bearing well-developed terminal process.

*Cancrion deltooides* n. sp.

*Female* (fig. 6A-G): From hood to posterior end of thorax 8.7 mm, abdomen 5.5 mm in largest specimen. Marsupium full of ova, yellowish brown, ovary yellow to orange-yellow, cephalon and abdomen whitish. Hood prolonged dorsally as a conspicuous lobe which exceeds thoracic length; its posterior part bilobed. Except for this, outline of marsupium simple. Exopodite of maxilliped neither wrinkled nor forming respiratory folds. Two pairs of dorsal ovarian processes arise one from anterior end of thorax and the other from about its middle, both pairs being short and subequal in size. Lateral processes very low, lying on either side of posterior part of thorax. Ascendant lamella of 1st oostegite, an elongated and narrow lobe, makes a right angle with much shorter recurrent lamella; both of them simple in structure, while transverse lamella is characteristically folded and larger than in usual cases. Remaining 4 pairs of oostegites more or less oval, overlapping from behind forwards, but lamellae of one side not meeting their fellows of opposite side, leaving a wide longitudinal area of marsupium uncovered. Second peraeopod dactyliform, 3rd to 5th tubercular, while the last 2 are lanceolate and arise from lateral protuberances on the side of the thorax. Pleural lamellae of first 2 abdominal segments folded but not so complicatedly as in other species; those of last 3 simple.

*Male* (figs. 6H-I & 7A-B): 1.58 mm long, 0.54 mm wide at 4th thoracic segment. Besides somewhat large eye pigments, dark colour-patches present on abdomen. Cephalon fused with 1st thoracic segment. Maxilla oval;



maxilliped small, tuberculiform, with 2 apical setae. Thorax widest in 4th segment from which it gradually narrows towards both ends; lateral parts of last segment turned ventro-posteriorly as oval lobes. Peraeopoda with joints distal to merus fused into one; distal part of this composite joint thickly beset with spinules and setae and its proximal part has a short transverse line on the external margin, indicative of the border between the merus and carpus; ischium also spiny. Abdominal segments have no ring of tubercles such as present in *C. miser*; bifid ends of last segment pointed.

*Epicardium* (fig. 7C-G): 0.345 mm long, 0.183 mm wide. Maxilla ovate; maxilliped 2-jointed, with distal joint elongated, bearing 2 setae. Border between carpus and propodus in first 5 peraeopoda indicated by a short suture line on external side; propodus spinose on its margin facing the dactylus. All joints of 6th peraeopod much longer than in others, having carpus and propodus completely fused into a triangular joint; outer distal angle of this joint bears a process composed of a narrow, setaceous

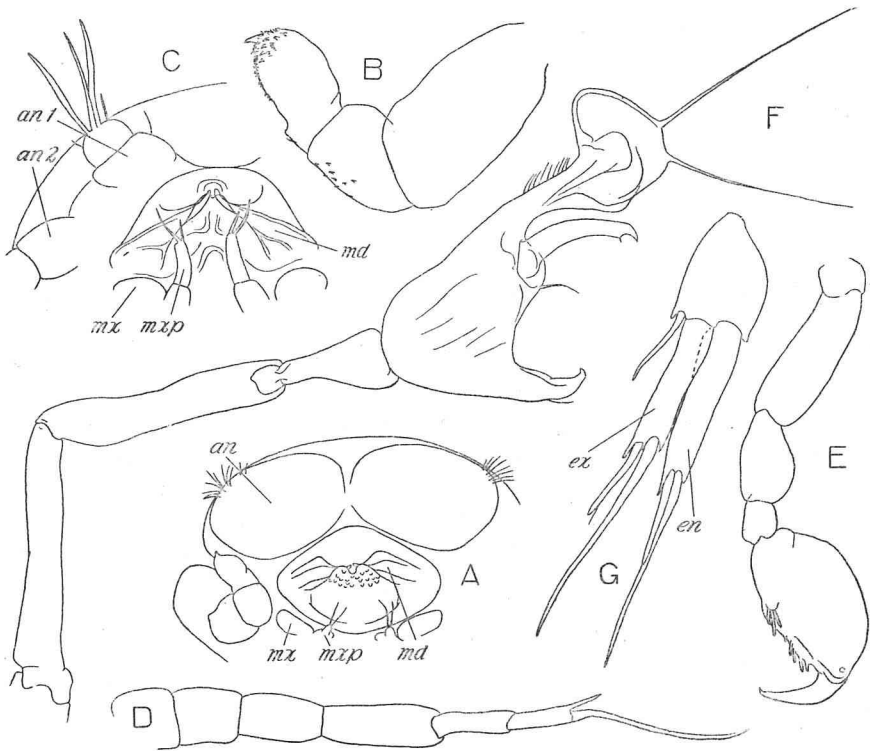


Fig. 7. *Cancrion deltooides* n. sp.

A ♂ cephalon; B ♂ peraeopod VI; C-G Epicardium; C cephalon; D antenna; E peraeopod V; F peraeopod VI. (A×115, B×310, C-G×410)

stalk and a terminal expansion, irregularly ridged on its surface and having 2 very long, stiff, diverging apical setae; inner distal angle of the joint produced into a sharp, inwardly curved process, against which strong dactylus acts.

*Remarks:* Of the 3 species of the genus thus far known, *cancrorum* (MÜLLER) and *floridus* G. & B. are rather incompletely defined. The new species, however, may be distinguished from the former by the constitution of the 6th peraeopod of the Epicaridium and from the latter by the great development of the hood. Differences between the new species and *miser* G. & B. may be tabulated as follows:

		<i>miser</i>	<i>deltoides</i>
Female	Ascendant lamella of 1st oostegite	short	very long
	Lateral ovarian processes	absent	present
	Pleural lamellae of abdominal segments III-IV	folded	simple
Male	Cephalon and thoracic segment I	separated	fused
	Abdominal segment VI	slightly bifid, with blunt tips	deeply bifid, with pointed tips
	Peraeopoda	4-jointed	3-jointed

As for the male cephalon in GIARD and BONNIER's species, my view has already been indicated. The authors state, further, that the marsupium is closed in the adult, but I am doubtful if this statement is based on actual observation.

*Habitat:* Parasitic on *Pilumnus vespertilio* FABRICIUS. The frequency of infection is shown in the table inserted on p. 75. The occurrence of 2 or more parasites in a host has not been observed. The females always have a single male each and are never associated with a male living free within the host viscera. The orientation of the female in the host body-cavity is very characteristic: the thorax and abdomen forming a V as usual, the long hood of marsupium runs along the anterior border of the host carapace and its distal end comes in contact with the pygidium; thus the entire body of the parasite describes a  $\Delta$  (Delta) to which the specific name is referred. The parasite causes a slight swelling of the host carapace on the side where its marsupium lies.

#### Genus *Xanthion* n. gen.

Female has a ventral process only. Marsupium incompletely closed with ascendant lamella of 1st oostegite largely uncovered by 2nd. Pleural

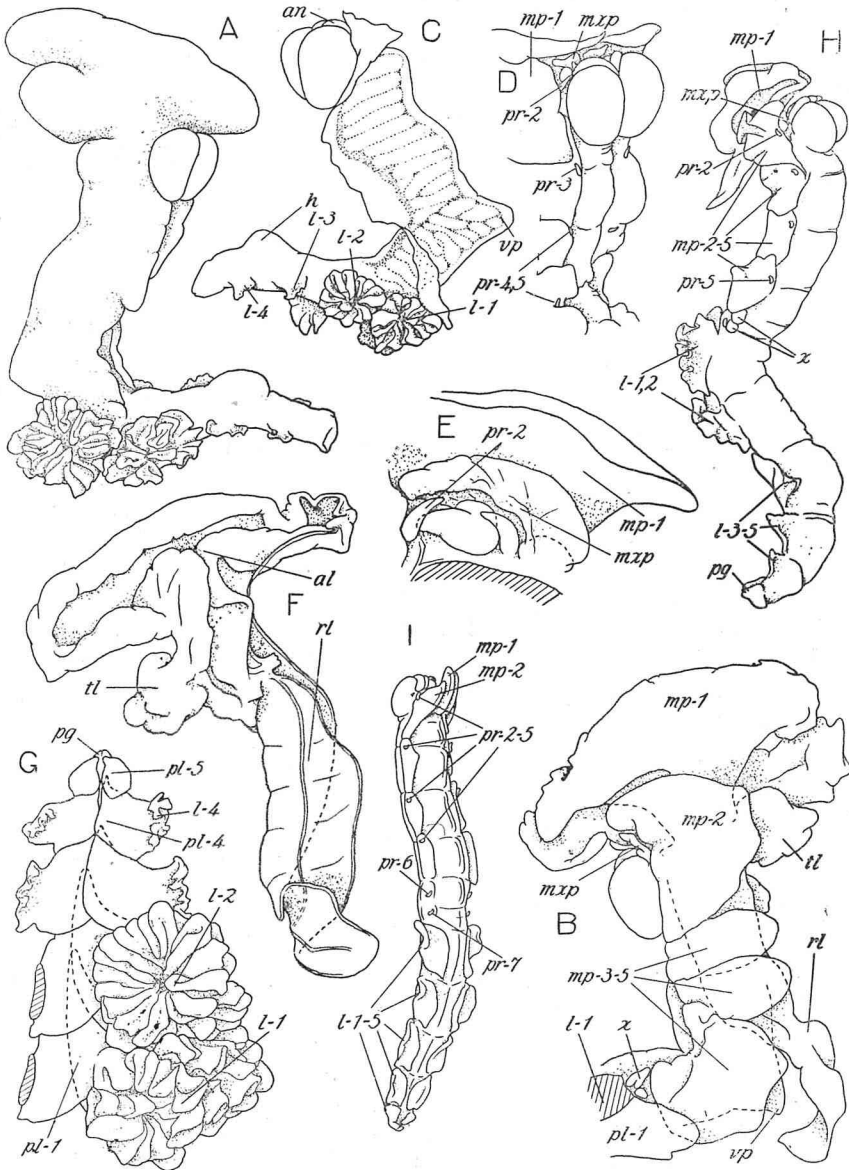


Fig. 8. *Xanthion spadix* n. gen. & n. sp., female

A ♀ enclosed in host membrane; B ♀ with host membrane removed; C ♀ with oostegites removed; D thorax; E maxilliped; F oostegite I; G abdomen; H young ♀ in 3rd stage; I young ♀ in 2nd stage. (A, C, D×5, B, F×9, E×20, G, I×10, H×7)

lamellae of first 4 abdominal segments folded. Male cephalon coalesced with 1st thoracic segment; abdomen without ventro-median spine. Sixth peraeopod of *Epicaridium* much longer than others, strongly prehensile, and with propodus bearing a well-developed terminal process.

The genus may be distinguished from other genera above all by having a single ventral process and by lacking the dorsal one. It is somewhat closer to *Cancrion*, *Grapsion*, *Tiarinion* etc. than to *Portunion* and *Pinnotherion* in that the 6th peraeopod of *Epicaridium* is very strongly developed.

*Xanthion spadix* n. sp.

*Female* (fig. 8): From hood to posterior end of thorax 10 mm, from top of ventral process to pygidium 7 mm. Marsupium full of ova, yellow to yellowish brown, ovary chestnut-coloured, cephalon and abdomen whitish. Marsupium rather simple in outline, except for having a small and posteriorly bilobed hood. Maxilliped with exopodite folded, more or less wrinkled on its surface, and with exopodite somewhat elongated laterally. Thorax curved at the region 2/3 of its length, where it bears a rudimentary ventral ovarian process. Ascendant lamella of 1st oostegite projects dorsally as well as ventrally, and largely uncovered by 2nd; transverse lamella well developed. Remaining 4 pairs of oostegites small and scarcely overlapping. Peraeopoda of 2nd to 5th dactyliform; lateral protuberances of thoracic end irregular in shape and devoid of limb rudiment. Pleural lamellae of first 2 abdominal segments large, complicatedly folded, but those of succeeding 2 small and folded only on margin.

*Male* (fig. 9A-E): 1.9 mm long, 0.66 mm wide at 5th thoracic segment. Eye pigments as well as scattered colour-patches present. Maxilla and maxilliped absent. Lateral parts rounded and somewhat directed posteriorly in increasing degree from 3rd segment backwards. Peraeopoda small, and largely concealed under body segments; merus, carpus and propodus fused into one, but a notch on inner margin indicating border between the first 2; dactylus, distal parts of propodus and of ischium beset with comb-like scales. First 2 abdominal segments with an oval marking of chitin on either side of ventral side.

Besides the above described and most commonly found male, there are two other types of males, one apparently older and the other younger (fig. 9C-D). As for the characters of these males see p. 44. Measurements: younger male 0.9 mm, older male 3.1 mm.

*Epicaridium* (fig. 9F-I): 0.36 mm long, 0.16 mm wide. Maxilla oval; maxilliped composed of a short basal joint and an elongated distal one, terminating in 2 setae. Carpus and propodus in first 5 peraeopoda incompletely fused, with line of suture distinct for some distance from both outer and inner margins; margin of propodus facing dactylus as well as distal angle of carpus spinose, merus with a strong spine at its outer angle. All joints of last peraeopod long, carpus and propodus completely fused; outer

distal part of this composite joint elongate forming a large, flattened, lanceolate, setaceous lobe, and inner part bearing fine setae on its margin facing curved, strong dactylus, and projecting a sharp, inwardly bent process; spine of merus short.

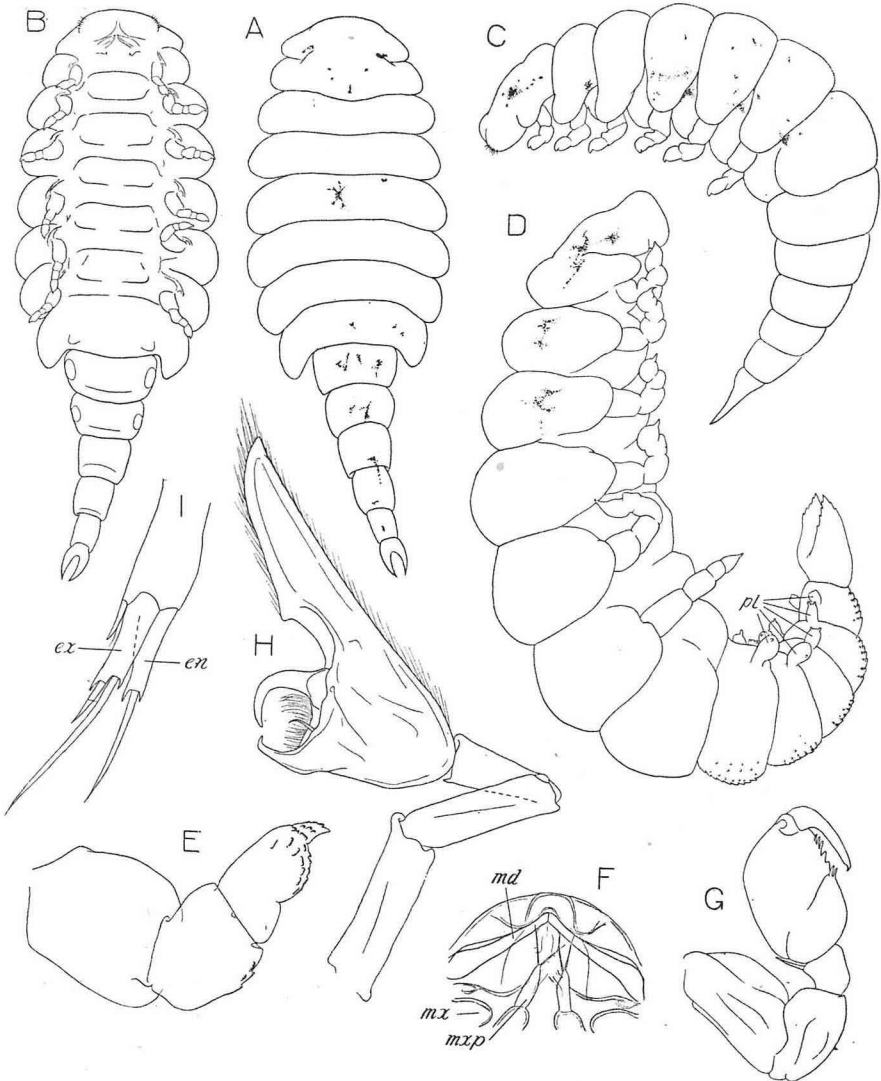


Fig. 9. *Xanthion spadix* n. gen. & n. sp.

A ♂, dorsal view; B ♂, ventral view; C ♂ older than A; D ♂ younger than A; E ♂ peraeopod IV; F-H Epicaridium; F oral cone; G peraeopod I; H peraeopod VI; I uropod. (A, B×40, C×35, D×118, E×360, F×310, G-I×435)

*Cryptoniscium* (fig. 10): 0.64 mm long, 0.184 mm wide. Body wider anteriorly than posteriorly; dorsal surface of all segments as well as of coxal plates traversed by parallel streaks. Eye pigments indistinguishable from other scattered colour-patterns. Basal 2 joints of antennule denticulate on their posterior margins, and furnished with stiff setae and small tubercles on surface; 3rd joint narrow, bearing 2 bundles of long sensory hairs; 4th still narrower, surmounted with 2 very thin rami, each of which terminates in sensory hairs. No maxilla, no maxilliped. Coxal plates entire in posterior border. Propodus of first 6 peraeopoda more or less crenate on its distal margin, carpus very thin, tipped with a short spine, and merus with a long, sharp spine. All joints of last peraeopod more slender than

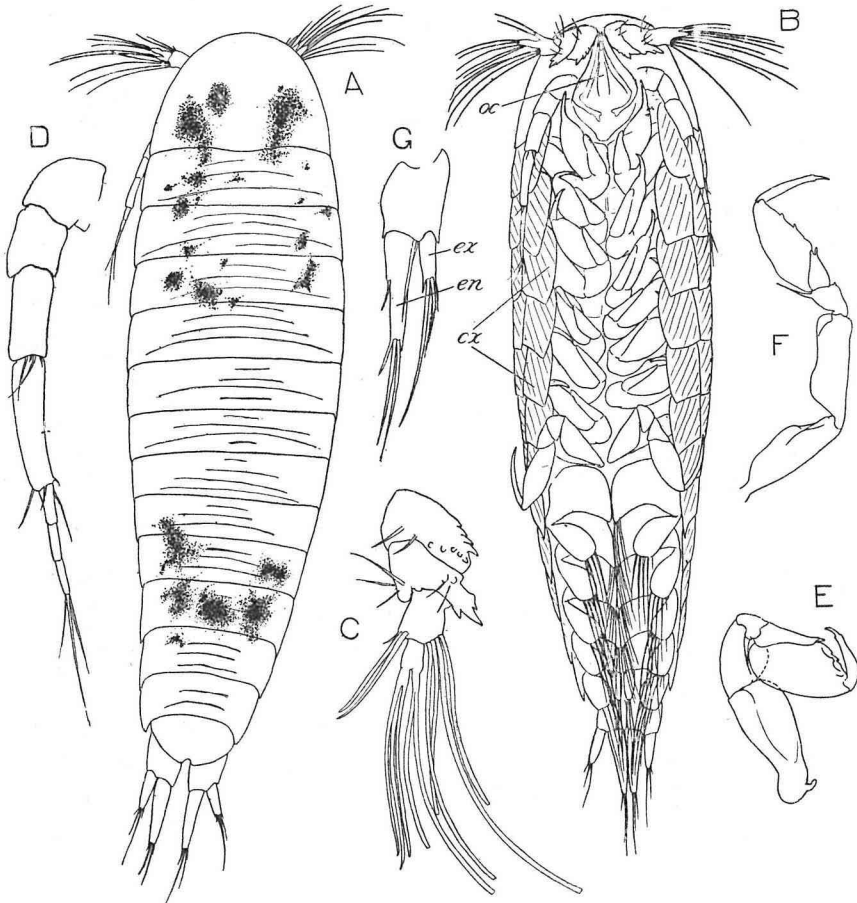


Fig. 10. *Xanthion spadix* n. gen. & n. sp., *Cryptoniscium*

A dorsal view; B ventral view; C antennule; D antenna; E peraeopod III; F peraeopod VII; G uropod. (A, B×310, C, D×360, E-G×245)

in foregoing limbs. First to 4th pleopoda with protopodite nearly quadrate, bearing 3 long plumose setae and a short non-plumose seta at inner distal

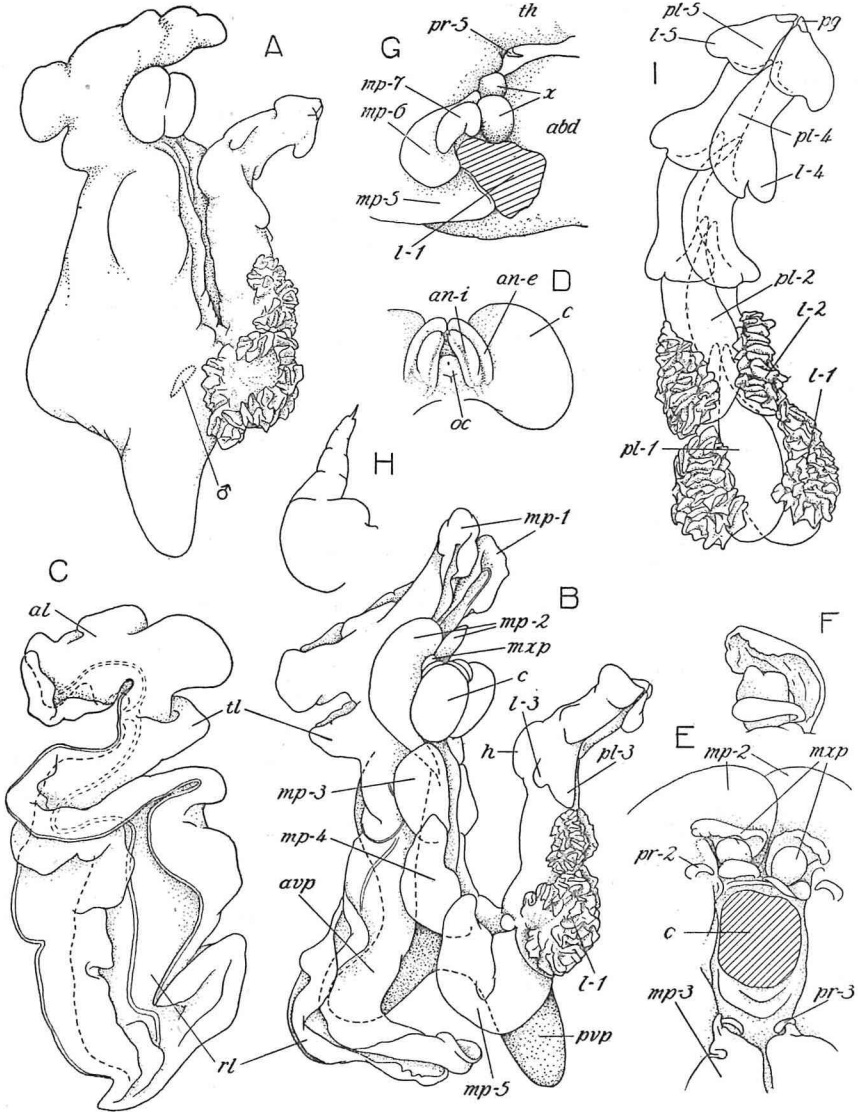


Fig. 11. *Tiarinion fulvus* n. gen. & n. sp., female

A ♀ enclosed in host membrane; B ♀ with membrane removed; C oostegite I; D cephalon; E anterior part of thorax with cephalon removed; F maxilliped; G curved part of body; H peraeopod V; I abdomen. (A×5, B, C×6, D, I×10, E×9, F×12, G×15, H×105)

angle and 2 simple setae at inner proximal angle; exopodite fringed with 4 long plumose and a short simple setae. Triangular protopodite of 5th pleopod with endopodite bearing 2 setae.

*Habitat*: Parasitic on *Xantho* (*Leptodius*) *exaratus* (MILNE-EDWARDS). The frequency of infection and the cases of the occurrence of 2 or more parasites in a host are given on page 75. The parasite causes a slight swelling of the host carapace on the side where its marsupium is located.

#### Genus *Tiarinion* n. gen.

Female with 2 ventral processes, but without dorsal one. Marsupium very incompletely closed; 1st pair of oostegites with ascendant lamellae largely uncovered by 2nd pair; very rudimentary 6th and 7th oostegites present. Pleural lamellae folded in first 2 abdominal segments, simple in others. Male cephalon fused with 1st thoracic segment; abdomen armed with ventro-median hooks. Sixth peraeopod of Epicaridium much longer than others, strongly prehensile, propodus bearing well-developed terminal process.

The new genus appears, at first sight, to be very close to *Pinnotherion* and *Portunion* in the possession of 2 ventral processes. But it differs from these, above all, in the well-developed 6th peraeopod of the Epicaridium which is highly degenerated in those genera.

#### *Tiarinion fulvus* n. sp.

*Female* (figs. 11 & 12F-H): From hood to tip of postero-ventral ovarian process 16 mm, abdomen 12 mm in the largest specimen. Marsupium full of ova, yellow to yellowish brown, cephalon whitish, ovary orange-yellow, abdomen pale greenish. Exopodite of maxilliped concave with its surface wrinkled, but not forming respiratory folds. Two ventral ovarian processes well developed; anterior process slightly shorter and nearly vertical to posterior one which is directed backward. Ascendant lamella of 1st oostegite comparatively small but complicatedly folded, transverse one distinct, and recurrent one broad. Other oostegites very slightly overlapping antero-posteriorly, but the lamella of one side does not meet its fellow of opposite side, leaving a large central area of marsupium uncovered; rudimentary 6th and 7th attached to lateral protuberances of thoracic end and concealed beneath 1st pleopod. Second to 4th peraeopoda lanceolate, while the 5th is dactyliform and indistinctly articulated.

*Male* (fig. 12A-E): 1.94 mm long, 0.67 mm wide at 5th thoracic segment; besides eye pigments, scattered dark colour-patches present. Maxilla crescentic; maxilliped semicircular, surmounted with a short hair. Thorax widest in 5th segment, from which it gradually narrows towards both ends; lateral parts rounded in first 6 segments, slightly turned backwards and ending in angular tip in 7th. Points of attachment of peraeopoda retreat from segmental margin; propodus and dactylus covered by many



short rows of spinules. Each of first 2 abdominal segments bears a sharp, curved ventro-median spine and a pair of oval markings of chitin; spine rudimentary in 3rd segment, absent in others. Bifid ends of last segment thorny.

*Epicaridium* (fig. 13A-G): 0.365 mm long, 0.144 mm wide. No maxilla, no maxilliped. Carpo-propodus of first 5 peraeopoda bearing setae besides a spine on inner margin, and merus has a spine on outer side. Last peraeopod with much elongated joints; setaceous outer margin of carpo-propodus

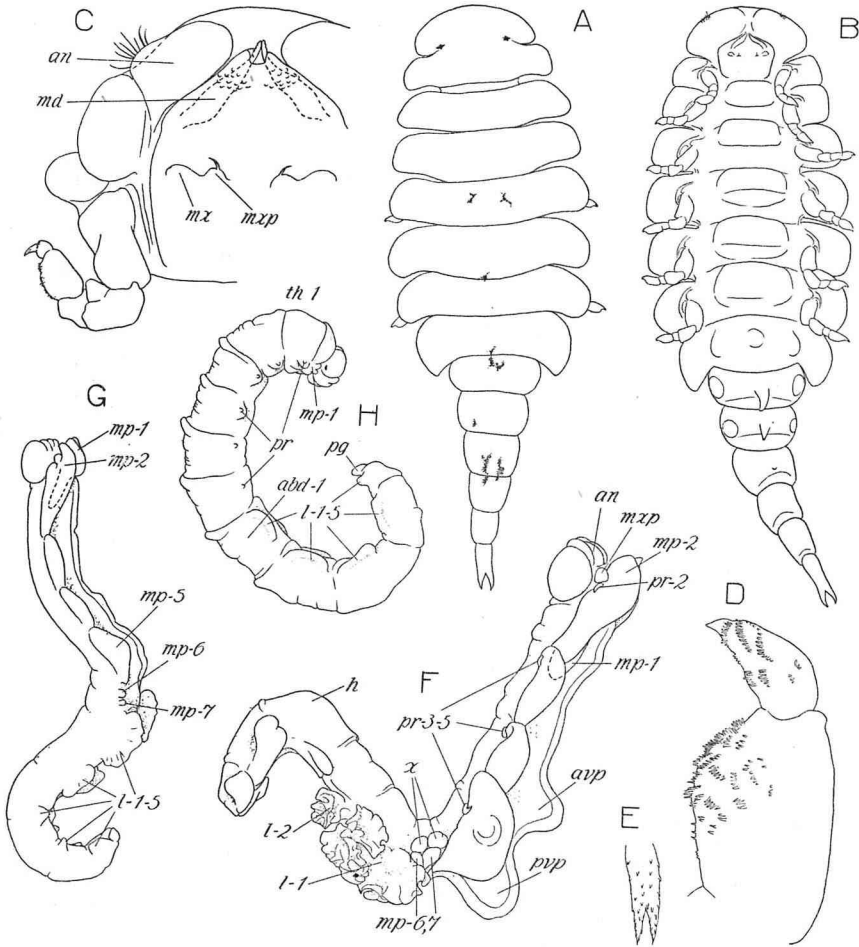


Fig. 12. *Tiarinion fulvus* n. gen. & n. sp.

A-E ♂; A dorsal view; B ventral view; C cephalon; D peraeopod VI; E abdominal segment VI; F-H young ♀; F 3rd stage; G 2nd stage; H 1st stage. (A, B×40, C×155, D×360, E×80, F×5, G×6, H×13)

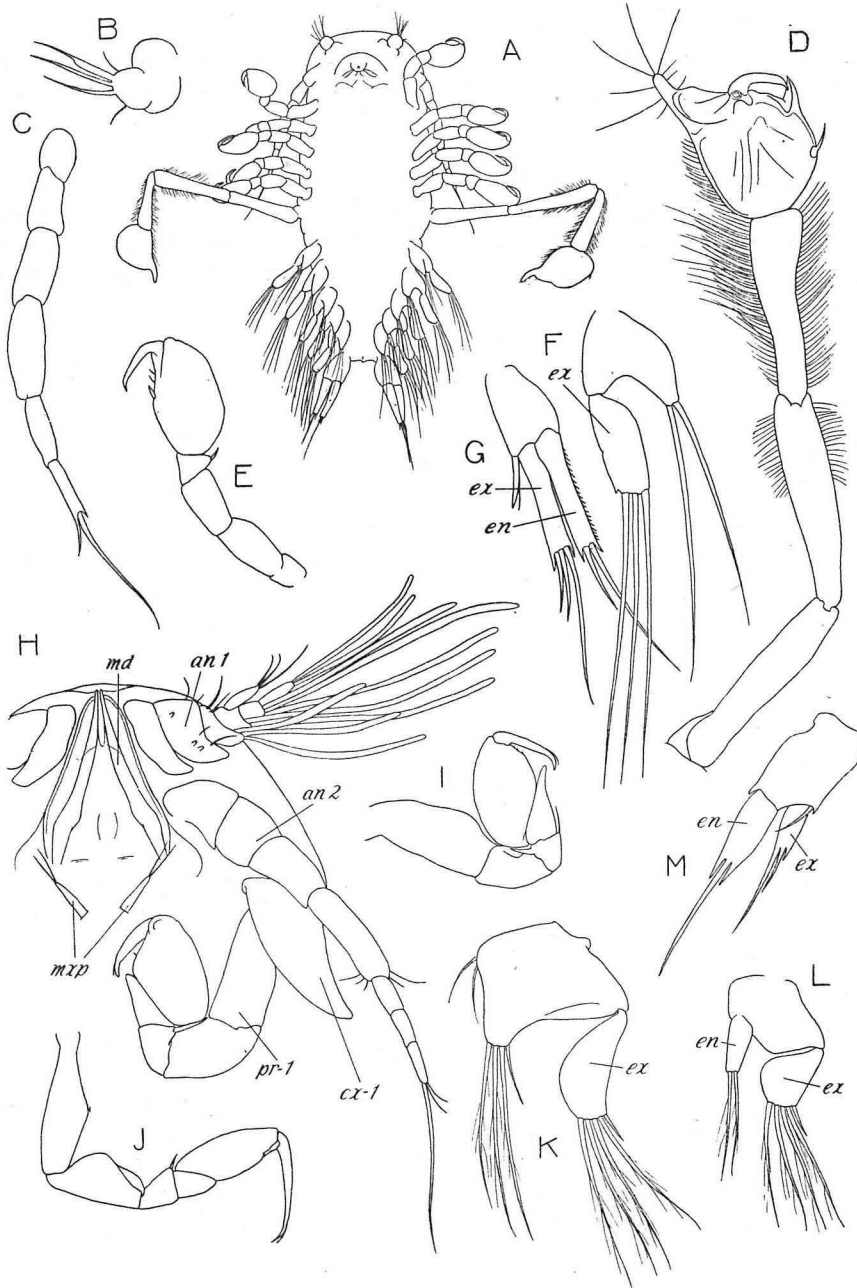


Fig. 13. *Tiarinion fulvus* n. gen. & n. sp.  
 A-G Epicaridium; A ventral view; B antennule; C antenna; D peraeopod VI; E peraeopod II; F pleopod III; G uropod; H-M Cryptoniscium; H cephalon; I peraeopod VII; J peraeopod VII; K pleopod I; L pleopod V; M uropod. (A×122, B-M×310)

has a terminal process having blunt tip and radiating long, stiff hairs; inner margin has a spine in the middle of its length and ends in a sharp process against which strong dactylus closes; merus as well as distal half of ischium fringed with rows of long setae along both margins.

*Cryptoniscium* (fig. 13H-M): 1.00 mm long, 0.37 mm wide. General body characters much like those of *Xanthion*. Antennule 6-jointed, having a non-articulated branch issuing from 4th joint; basal 3 joints produced postero-externally into linguiform lobes with entire margin, 2nd of these bearing tubercles and setae; 3rd to 6th joints provided with bundles of long sensory hairs. Filiform and setose maxilliped present. Merus of first 6 peraeopoda with a spine on outer side and a seta on inner side. Median notch of last segment shallower than in *Xanthion*.

*Habitat*: Parasitic on *Tiarinia cornigera* LATREILLE. The rate of infection is much higher in spring than in summer as shown on p. 75. The infection of 2 parasites upon a host was observed 4 times, but no male living free within the host viscera has been found. I (1934) have reported a Bopyrid parasitic on *Tiarinia* under the name of *Portunicepon tiariniae* SHIINO. During the course of my present study, I have met with 2 cases of simultaneous parasitism of *Portunicepon* and *Tiarinion*, in one of them the host carried 2 couples of the Bopyrid.

#### Genus *Micippion* n. gen.

Female has 2 ventral ovarian processes and an unpaired dorsal one. Marsupium complete, with 1st pair of oostegites enclosed by 2nd pair which is completely fused with 3rd; 4th and 5th separate. Pleural lamellae of first 4 abdominal segments folded. Male cephalon fused with 1st thoracic segment; abdomen has ventro-median hooks. Sixth peraeopod of Epicaridium well developed and with propodus bearing terminal process.

In possessing 2 ventral and a dorsal ovarian processes, *Micippion* is similar to *Portunium*, but differs from it in that the dorsal process is unpaired, as well as in having only 4 pairs of oostegites. Besides, the fact that the 6th peraeopod of Epicaridium is well developed in the former, whereas it is rudimentary in the latter, does not appear to suggest any relationship between the two genera. The dorsal ovarian process develops only on the side which is uppermost when the parasite is in situ; namely, if the parasite is fixed with its abdomen to the wall of the right branchial cavity of the host, the left side of its thorax which is turned upwards develops the process, but if it is fixed to the left branchial cavity, the process is formed on the right side.

#### *Micippion asymmetricus* n. sp.

*Female* (fig. 14): From hood to posterior end of thorax 14 mm, abdomen 7 mm in the largest specimen. Marsupium full of ova yellowish red

to orange-red, ovary vermilion-red, cephalon and abdomen whitish. Outline of marsupium uneven, having a projecting lobe corresponding to dorsal

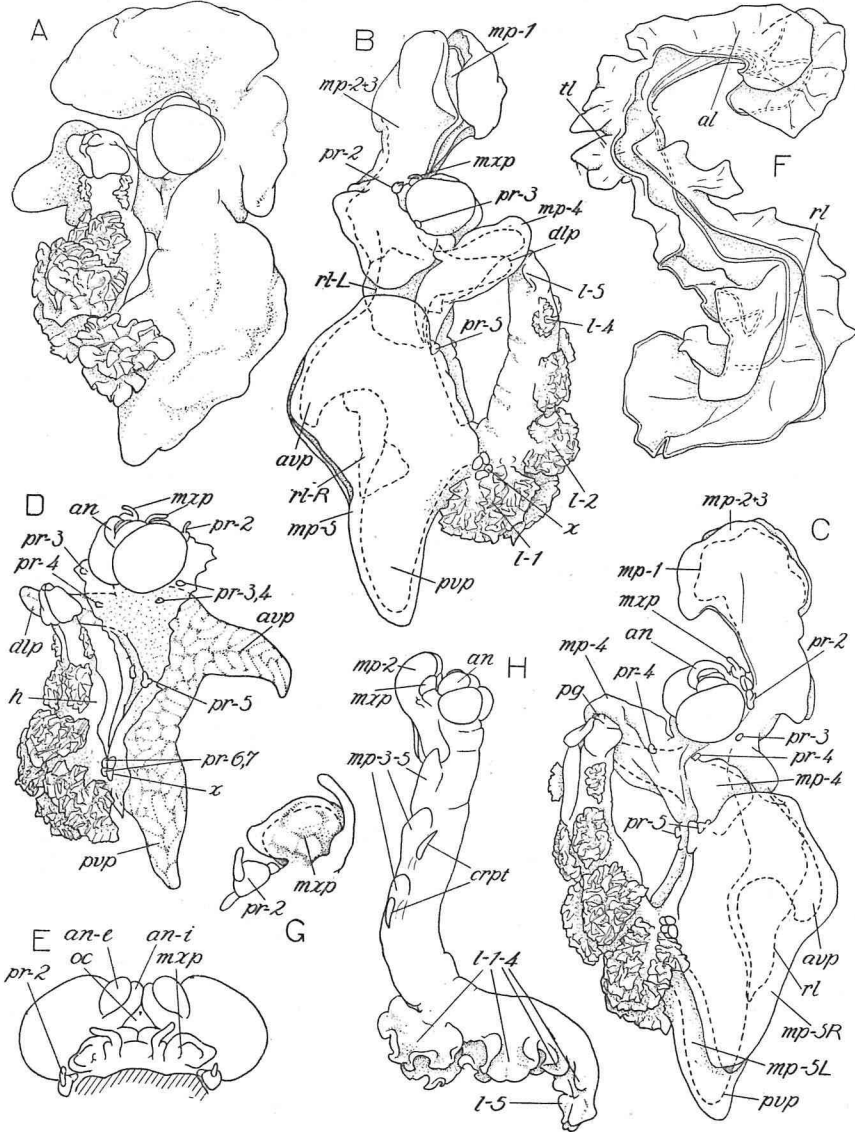


Fig. 14. *Micippion asymmetricus* n. gen. & n. sp., female

A ♀ enclosed in host membrane; B ♀ with host membrane removed (upper side); C same (lower side); D ♀ with oostegites removed; E cephalon; F oostegite I; G maxilliped; H young ♂ in 2nd stage. (A, D  $\times 4.5$ , B, C  $\times 5$ , E  $\times 10$ , F  $\times 8$ , G  $\times 20$ , H  $\times 9.5$ )

ovarian process, besides a large irregularly shaped hood. No respiratory folds. Exopodite of maxilliped comparatively small, and not frilled on its surface; endopodite well developed and represented by a long, curved process. Antero-ventral process directed obliquely backwards, curved slightly at its tip; postero-ventral one longer, thicker, and projecting straight backwards. Dorsal process, much smaller than ventral one, develops at anterior end of thorax only on upper side. Ascendant lamella of 1st oostegite com-

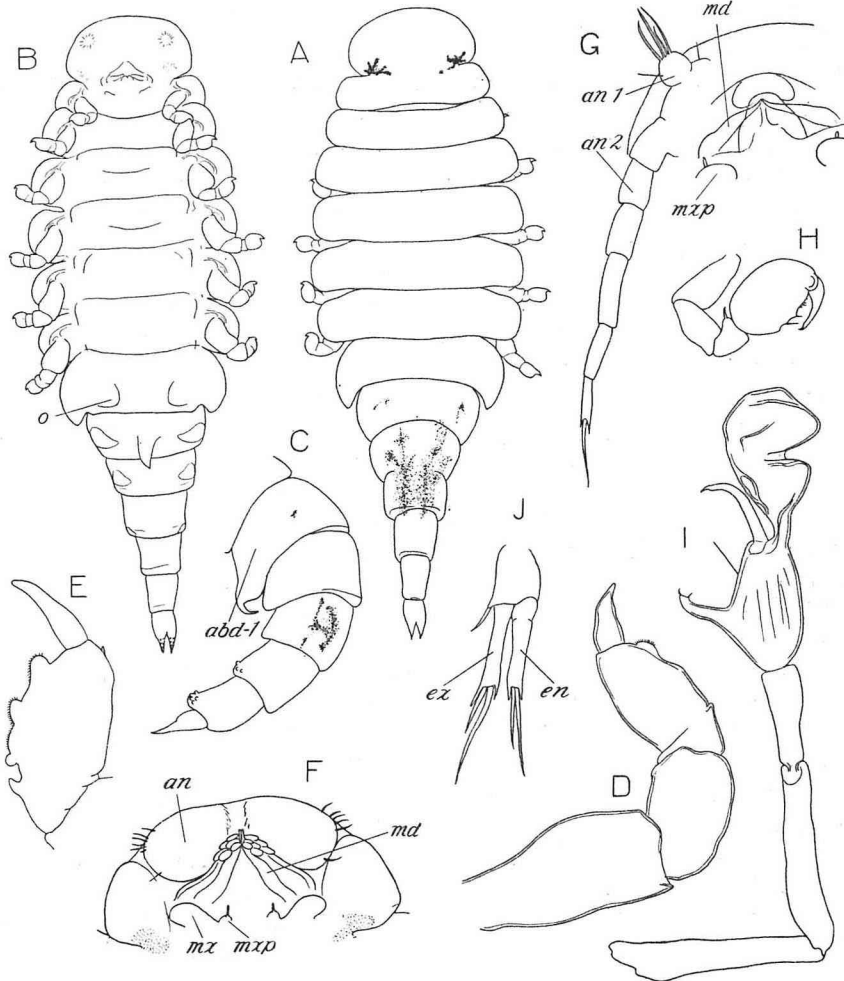


Fig. 15. *Micippion asymmetricus* n. gen. & n. sp.

A-F ♂; A dorsal view; B ventral view; C abdomen; D peraeopod VI; E peraeopod I; F cephalon; G-J Epicaridium; G cephalon; H peraeopod III; I peraeopod VI; J uropod. (A, B×60, C×80, D, E×310, F×140, J×360)

plicatedly folded; recurrent one of lower side freely trailing backwards, whereas that of upper side irregularly folded from being confined within projecting lobe of marsupium which covers dorsal process. Second and 3rd oostegites fused into a single large lamella which, together with its fellow of the opposite side overlaps ascendant lamella. Fourth pair dissimilar, lamella of lower side being small, triangular, the other sac-like, enclosing dorsal ovarian process. Fifth pair greatly expanded to cover ventral process completely. Second peraeopod composed of a tubercular base and a dactyliform process; 3rd to 5th tubercular, 6th and 7th located close to dorsal side of lateral protuberances of thoracic end.

*Male* (fig. 15A-F): 1.43 mm long, 0.475 mm wide at 5th thoracic segment. Besides irregularly shaped eye pigment groups, dark colour-patterns present in anterior segments of abdomen. Maxilla ovate; maxilliped smaller and tipped with a short seta. First 6 thoracic segments more or less rounded in lateral parts, while these parts of 7th turn backwards to form a pair of pointed lobes. Peraeopoda with merus, carpus, and propodus coalesced into one; demarcation between the first 2 indicated by a short suture line on outer side and by a notch on inner side; dactylus comparatively well developed, propodus with rounded, ciliated tubercles. First abdominal segment with a sharp, strongly curved ventro-median hook; this segment as well as succeeding 2 bears a pair of crescent markings on ventral side respectively. Posterior borders of 4th and 5th segments tuberculated. Bifid tips of last segment thorny.

*Epicaridium* (fig. 15G-J): 0.23mm long, 0.10mm wide. Maxilla absent; maxilliped ovate, with a short apical spine. First 5 peraeopoda with merus bearing a short spine at outer angle, and with propodus ciliated on inner margin. Joints of last peraeopod much longer than in foregoing limbs; inner distal angle of propodus produced into a narrow columnar process curved inwards at its tip; outer distal angle bears a large, swollen expansion, having a deep incision at the middle of the outer margin, irregular rugae on its surface and a narrow short stalk; dactylus well developed and strongly curved. Exopodite has 3 setae in first 4 pleopoda, while only 2 in 5th.

*Habitat*: Parasitic on *Micippa philyra* (HERBST). The frequency of the infection is shown on p. 75. The occurrence of 2 adult parasites in a host was observed in 2 cases; in each of these the female had their marsupium filled with ova. I have obtained a young female carrying 2 Cryptoniscan larvae, but the adult female is always accompanied by a single male.

Table 1. Frequency of the infection

Parasites	Hosts		August, 1938				March, 1935	
			♂	♀	total	%	♂ + ♀	%
<i>Entoniscus japonicus</i>	<i>Petrolisthes japonicus</i>	uninfected	308	320	628	94.6		
		infected	18	18	36	5.4		
<i>Portunio flavidus</i>	<i>Pachygrapsus crassipes</i>	uninfected	10	13	23	81.1	12	80.0
		infected	2	3	5	17.9	3	20.0
<i>Cancrion deltoides</i>	<i>Pilumnus vespertilio</i>	uninfected	100	17	117	97.5	65	97.0
		infected	3	0	3	2.5	2	3.0
<i>Xanthion spadix</i>	<i>Xantho exaratus</i>	uninfected	31	16	47	64.4	24	92.3
		infected	19	7	26	35.6	2	7.7
<i>Tiarinio fulvus</i>	<i>Tiarinia cornigera</i>	uninfected	53	54	107	90.7	18	51.4
		infected	3	8	11	9.3	17	48.6
<i>Micippion asymmetricus</i>	<i>Micippa philyra</i>	uninfected	145	105	250	95.1	78	96.3
		infected	9	4	13	4.9	3	3.7

Table 2. List of the host individuals, showing the number of parasites found in each of them.

Parasites ( <i>Portunio flavidus</i> )	Hosts	<i>Pachygrapsus crassipes</i>										<i>Plagusia dentipes</i>			
		I	II	III	IV	V	VI	VII	VIII-IX	X-XI	I	II	III	IV	
Adult female with embryos		1		2					2	1		1	3	1	2
Adult female without embryo		1			1	3		2					1	1	
Young female		1	5		1		4		1	1		2			
Dead adult female			1										1		

Parasites ( <i>Pinnotherion setoensis</i> )	Hosts	<i>Camposcia retusa</i>			
		I	II	III	IV
Adult female with embryos		1	1	1	
Adult female without embryo					3
Young female			2	1	
Free male		3	2	1	

Parasites ( <i>Xanthion spadix</i> )	Hosts	<i>Xantho exaratus</i>				
		I	II	III	IV	V
Adult female with embryos		2	2	1		1
Adult female without embryo				1		
Young female					3	3

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## List of abbreviations used in figures.

*abd* abdominal segment, *adlp* anterior dorsal ovarian process, *al* ascendant lamella, *an* antenna, *an 1* antennule, *an 2* antenna, *an-e* external antenna *an-i* internal antenna, *avp* anterior medio-ventral ovarian process, *b* ovarian boss, *c* cephalon, *cx* coxal plate, *dlp* dorsal ovarian process, *en* endopodite, *ex* exopodite, *h*, heart, *l* pleural lamella, *md* mandible, *mp* oostegite, *mx* maxilla, *mxp* maxilliped, *o* gonopore, *oc* oral cone, *pdlp* posterior dorsal ovarian process, *pg* pygidium, *pl* pleopod, *pr* peraeopod, *pvp* posterior medio-ventral ovarian process, *rl* recurrent lamella, *th* thoracic segment, *tl* transverse lamella, *vlp* lateral ovarian process, *vp* medio-ventral ovarian process, *x* lateral protuberance of thorax.