

## THE LARVAE OF THE PANDALIDAE

By Marie V. Lebour, D.Sc.

Naturalist at the Plymouth Laboratory

(Text-figs. 1-12)

Little is known of the larvae of the Pandalidae as is shown by Gurney (1939) in his Bibliography of the Larvae of Decapod Crustacea. Berkeley (1930, 1938) describes the life histories of several species of *Pandalus* and of *Pandalopsis dispar* from British Columbia, and Gurney (1937) the larvae and post-larvae of *Chlorotocella*, but beyond these the information is fragmentary. Sars' (1900) work on *Pandalus borealis* and *P. bonnieri* was formerly regarded as typical of pandalid larvae but these were proved to be *Caridion* (Lebour, 1930). Sars (1900), however, described in part in an excellent manner the larvae of *Pandalus montagui* and *Pandalina brevirostris* and Stephensen (1935) the early larvae of *Pandalus propinquus*. Whilst in Bermuda it has been possible to follow the whole larval and post-larval history of *Parapandalus richardi* and the first five larval stages of *Pandalus bonnieri* have been obtained by rearing from the egg by Dr A. G. Nicholls at Millport. These latter he has kindly given to me to describe. We have thus eight species of *Pandalus* whose larvae are known, one *Pandalina*, one *Pandalopsis*, one *Chlorotocella* and one *Parapandalus*. Besides these Gurney (1924) has described three pandalid larvae, one of which he has shown to be *Chlorotocella* (Species 2, fig. 44), one is probably some genus related to *Pandalus* (Species 1, fig. 43) and the third as will be shown below is probably a *Plesionika*.

It is interesting to compare these and to try to find the general characters of this family and those of its genera. We may with some justification place them in the following order, beginning with the most primitive:

- ? *Plesionika* sp. (larvae described by Gurney, 1924).
- Parapandalus richardi* (larva and post-larva described in the present work).
- Pandalina brevirostris* (larva described by Sars, 1900).
- Pandalus montagui* (larva described by Sars, 1900).
- P. bonnieri* (larvae described in the present work).
- P. propinquus* (larva described by Stephensen, 1935).
- P. borealis* (larvae described by Berkeley, 1930).
- P. stenolepis* (larvae described by Berkeley-Needler (= Berkeley), 1938).
- P. hypsinotus* (larvae described by Berkeley, 1930).
- P. danae* (larvae described by Berkeley, 1930).
- P. platyceros* (larvae described by Berkeley, 1930).
- Pandalopsis dispar* (larvae described by Berkeley, 1930).
- Chlorotocella* sp. (larvae described by Gurney, 1937).

The larvae of the family Pandalidae may be thus defined:

Caridea with rostrum in all stages; antennular peduncle concave on the outer margin (except sometimes in the first stage); antennal flagellum a simple rod ending in a seta with or without an accessory seta; mouth parts well developed; 5th leg never prematurely developed; none of the legs oar-shaped. No exopod on leg 5. Rostrum toothed in late stages. Legs 3-5 ending in simple dactyls. Leg 1 simple or with rudimentary chela. Leg 2 chelate in late stages.

Genus *Plesionika*(?). Early stages probably very like *Parapandalus*. Exopods on legs 1-4. Long series of larval stages(?); epipods in late stages.

Genus *Parapandalus*. No legs on hatching; antennal scale jointed at tip in first larva; flagellum unjointed: exopods on legs 1-4. Long series of larval stages. Telson with 7+7 spines in the first stage, 8+8 in the second, indented in hind margin. No epipods in late stages.

Genus *Pandalina*. No legs on hatching; antennal scale jointed at tip in first larva; flagellum unjointed; exopods on legs 1-3. Usual number of larval stages (8 or 9). Telson as in *Parapandalus*.

Genus *Pandalus*. All legs present on hatching, either rudimentary or functional; antennal scale jointed or not jointed at tip, flagellum unjointed or jointed; exopods on legs 1-2 or 1-3, never on 4 or 5. Usually 6 larval stages, probably more in *P. montagui*.

Telson as in *Parapandalus*.

The genus *Pandalus* may be divided into 2 groups:

*Group I.* Legs rudimentary on hatching; antennal scale jointed. *P. montagui*, *P. bonnieri*, *P. propinquus*.

*Group II.* Legs functional on hatching, antennal scale unjointed. *P. stenolepis*, *P. hypsinotus*, *P. danae*, *P. platyceros* (*P. borealis* has the legs rudimentary but the scale unjointed and thus comes between the two groups).

Genus *Pandalopsis*. Legs functional on hatching; exopods on legs 1-3; antennal scale unjointed; telson with 24 spines on hatching; 5 larval stages.

Genus *Chlorotocella*. No legs on hatching; exopods on leg 1 only; antennal scale jointed on hatching; telson rounded with 7+7 and 8+8 setae in first and second stages. 6 larval stages.

Pandalid, species I (Gurney, 1924), has a very long rostrum on hatching, armed with fine setae at the tip, and has no legs. It is probably not a true *Pandalus* but belongs to some closely related genus.

#### THE BRITISH SPECIES OF PANDALIDS

Four species of *Pandalus* are recorded as British: *P. montagui*, *P. bonnieri*, *P. propinquus* and *P. borealis*; three of these belong to Group I, *P. borealis* coming between the two groups; none belong to Group II. Of these *P. montagui* is the commonest and most widely distributed, occurring at times close to the shore, whilst all the others occur in more open water. *Pandalina brevirostris* is also a common form in fairly shallow water. *Pandalus*

*montagui* and *Pandalina brevirostris* are both common at Plymouth their larvae occurring abundantly in the plankton. The larvae of *P. bonnieri* have been found in plankton off the Seven Stones Light Ship.

*Pandalus montagui* Leach (Fig. 2)

Sars (1900) describes the third (as about the fifth) stage and the last larva (as the first post-larva). Miss Webb (1921) describes briefly and figures the first larva. Her drawing, however, is not quite accurate as she shows no jointing on the antennal scale, nor any flagellum. The concave margin of the antennular peduncle is also not indicated.

The larvae are very pale and transparent with a little yellowish and red on the front margin of the eye, faint pink on the last segment and yellow on the telson. The newly hatched larva measures 3-4 mm. in length. There is a short but quite conspicuous rostrum. The antennal flagellum is a strong unjointed rod terminating in a spiny seta with an accessory seta on the outer side about half-way up. There is an outer seta on the scale which bears 9 setae round the inner margin and tip and one minute one on the outside of the tip. There are no lateral spines on the fifth abdominal segment. The exopods of the maxillipedes bear 3 terminal setae and 2, 6, 6 laterals, that is to say 5, 9, 9 in all. The third stage is well figured by Sars, who however shows a pair of lateral spines on the 5th abdominal segment not present in the Millport and Plymouth specimens. Here the two last pairs of legs are still non-functional and point forwards, the supraorbital spines are well developed and there are many setae on the exopods. The telson is like that of a typical third stage carid with non-setose inner branches of the uropods. It is to be noted that this stage is much less developed than the third stage in any of the *Pandalus* larvae described by Miss Berkeley from British Columbia. *P. montagui* follows the usual carid course whilst the British Columbian forms all have their development accelerated and the third stage has all the legs functional as well as the uropods cut off from the base and the inner branch setose. The first post-larval stage described by Sars is really the last larval stage, measuring 12 mm. in length. Having regard to the backwardness of the third larva it is probable that there are the usual 8 or 9 larval stages in this species. In the last larva the rostrum projects well beyond the eyes and bears several teeth on its dorsal margin. The first leg ends in an incipient chela; the second is chelate and the carpus is not yet divided. The pleopods are well developed and bear a few setae. The telson is long with almost straight sides and bears 3 pairs of lateral teeth, the third at the outer angle, and the straight hind margin bears 10 setae.

*Pandalus* (*Dichelopandalus*) *bonnieri* Caullery (Fig. 1)

The larvae here described were hatched by Dr A. G. Nicholls at Millport and reared by him to Stage V. Stages III and IV were also obtained from plankton near the Seven Stones Light Ship. This species is an open water

form and not nearly so common as *P. montagui*. The adult retains the exopod on the third maxillipede and is in this respect more primitive than *P. montagui* and others. On hatching it is very like *P. montagui*, having a well pronounced rostrum, concave outer margin to the antennule, antennal scale jointed with 2 outer setae, and the flagellum unjointed with an accessory seta. The legs are all present but rudimentary, the first, second and third being bilobed.

*First larva.* Length 3.7–4.5 mm. The margin of the carapace is denticulate ventro-laterally. The mandible has a well developed cutting and grinding portion. The maxillule has a non-jointed setose endopod and well defined inner lobes. The maxilla has a non-jointed setose endopod and four well defined inner lobes, the exopod armed with 5 setae. The exopods of the maxillipedes bear 3 terminal and 1, 2, 2 setae, 4, 5, 5 in all. There is a conspicuous pair of lateral spines on abdominal segment 5; the telson is fairly deeply indented behind.

*Second larva.* Length 6 mm. The eyes are free and there are small supra-orbital spines. The antennal flagellum is very short, the scale segmented only at the extreme tip, which is narrowed. The proximal outer seta has disappeared. Legs 1 and 2 are functional with exopods; the carapace is still denticulated. The telson has 8+8 setae. There are 6–10 setae on the exopods.

*Third larva.* Length 8 mm. (including rostrum 1 mm.). The rostrum is slightly curved and projects well beyond the eyes and bears 3 teeth in front of the dorsal organ. The antennal scale is unjointed and bears no outer seta. There are exopods on legs 1–3, legs 4 and 5 are uniramous. There are very minute pleopods. The exopods bear 8–12 setae; the telson has the same form as in *P. montagui* with uropods not cut off at the base, the inner ramus being short and non-setose.

*Fourth larva.* Length 9 mm. (including rostrum 1.7 mm.). The rostrum has 5 teeth dorsally. All the legs are functional. There are no exopods on legs 4 and 5 which end in long simple dactyls. The carapace is still denticulate. There are antennal and pterygostomial spines. The telson is elongated with 7+7 terminal spines and 2 pairs of lateral spines. The uropods are cut off at the base and the inner uropods are setose.

*Fifth larva.* Length ca. 11 mm. There are 7 dorsal and 5 ventral spines on the rostrum. The pleopods are long and bilobed. The telson is long and nearly straight with 2 pairs of lateral spines and one at the angle and 10 terminal setae. The carapace is still denticulate. There are many setae on the exopods. Epipods are beginning to appear on legs 1–4. The second leg has a simple dactyl. From the well developed state of this larva, which corresponds in many ways with some of Miss Berkeley's penultimate stages, this seems to be the last but one. The last stage has not been seen. It is thus probable that here there are 6 larval stages, for this species is much further advanced than *P. montagui* in corresponding stages.

*Pandalus propinquus* G. O. Sars

This species is rare in Britain. Stephensen (1935, Figs. 21, 22) has described its early larvae, apparently stages I and II, as he figures two different telsons, one with 7+7 setae and the other with 8+8. Stage I has a jointed antennal scale with 2 outer setae, the flagellum having a large accessory seta; the rostrum is conspicuous and the antero-ventral edge of the carapace and posterior edge of the third and fourth abdominal segment fringed; there are conspicuous lateral spines on abdominal segment 5 as in *P. bonnieri*. The telson is similar to *P. montagui* and *P. bonnieri*. There are indications of exopods on legs 1-3 and the first leg is functional. It is not, however, quite clear if this belongs to stage I or II. The exopods bear 6, 8, 12, 8 setae and there are apparently 4 terminal setae.

*Pandalus borealis* Kröyer

Miss Berkeley (1930) has described fully the larvae of this cosmopolitan species from British Columbia, which are apparently the same as those described by Stephensen (1912) as *Pandalus propinquus*. It is much further advanced on hatching than the other British larvae, having a non-segmented antennal scale without outer setae and very short but unjointed flagellum with small seta; the legs are rudimentary, but the exopods of the maxillipedes bear many setae. In the second stage all the legs except the last are functional with exopods on 1-3 and the pleopods are beginning to appear; in the third stage all the legs are functional and the telson corresponds more to the usual fourth stage than to the third, the uropods being cut off at the base and the inner ramus setose. The fourth stage has an almost straight elongated telson, the fifth has epipods. The sixth stage is apparently the last larva with a few setae on the pleopods and the second leg chelate.

Thus the British species of *Pandalus* run in a series from *P. montagui* hatched in a very early state to *P. borealis* which is much further on at hatching. The latter is the only one common to the Atlantic and Pacific coasts and comes between the usually backward Atlantic forms and the usually forward Pacific forms.

*Pandalina brevirostris* (Rathke)

The only other British pandalid is *Pandalina brevirostris* whose larva closely resembles that of *Pandalus montagui*. It differs however in its much smaller size, very short rostrum and absence of legs in the first stage. Like *P. montagui* it has no lateral spines on the fifth abdominal segment.

*First larval stage* (Fig. 3). Length 1.84 mm. Very like *Pandalus montagui* but without leg rudiments. The antennule is not yet concave on its outer margin. The antennal flagellum bears a long accessory seta and the scale is segmented at the tip and bears 2 outer setae. The telson bears 7+7 spines and is deeply indented at its hind margin. The exopods of the maxillipedes bear 3 terminal setae and one lateral.

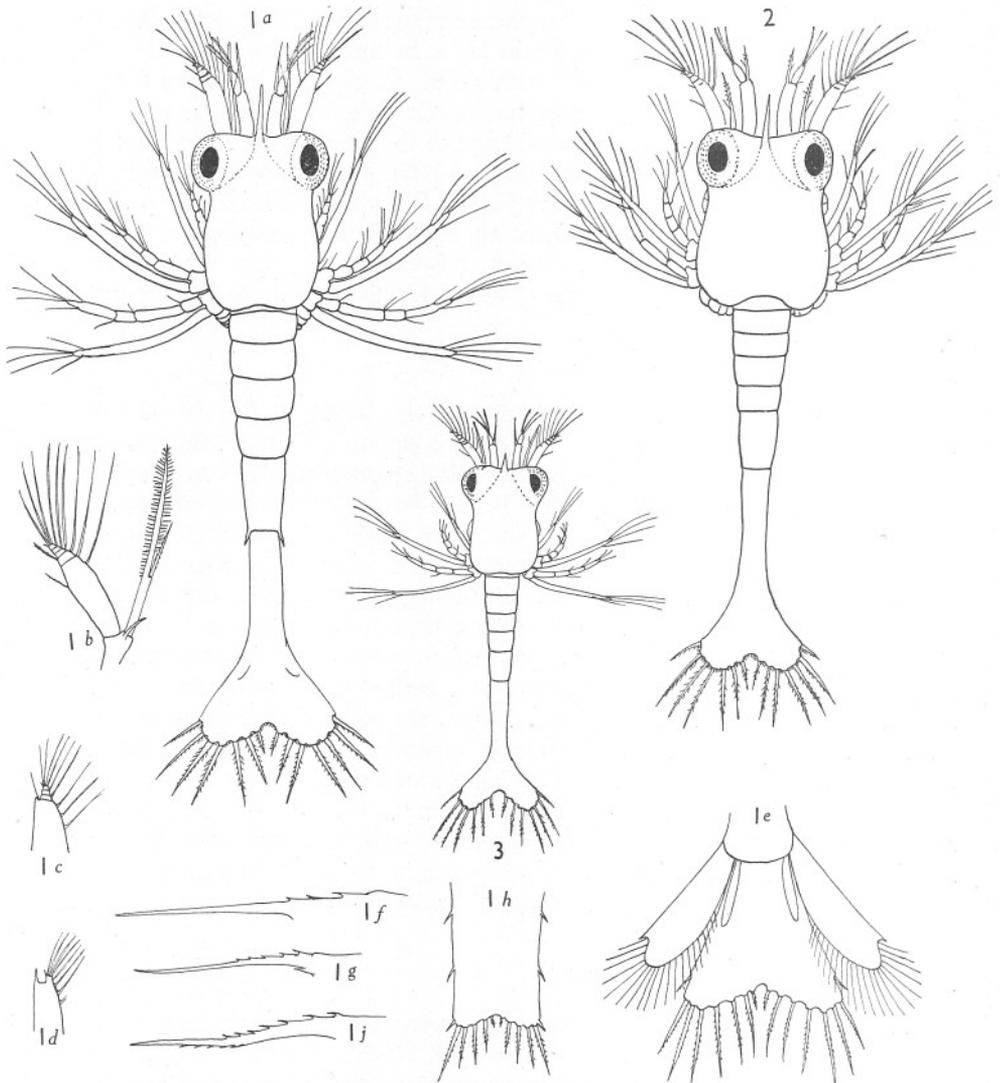


Fig. 1. *Pandalus bonnierii*. *a*, dorsal view, first larva, 3.7 mm. long; *b*, antenna of same; *c*, tip of antenna of second larva; *d*, tip of antenna of third larva; *e*, telson of third larva; *f*, rostrum of third larva; *g*, rostrum of fourth larva; *h*, telson of fifth larva; *j*, rostrum of fifth larva.

Fig. 2. *Pandalus montagui*, 3 mm. long.

Fig. 3. *Pandalina brevirostris*, 1.8 mm. long.

This species is very common at Plymouth, its larva occurring with that of *Pandalus montagui* in fairly shallow water. The antenna of the first stage is figured by Gurney (1926) and the fifth stage by Sars (1900). It almost certainly has 8 or 9 larval stages.

*Parapandalus* (*Stylopandalus*) *richardi* (Coutière)  
*Pandalus* (*Stylopandalus*) *richardi* Coutière (1905)  
*Parapandalus richardi* (Cout.) de Man (1920)

(Figs. 4-12)

This species has so far not been recorded from Bermuda but it was obtained there in the adult stage in 1939 and the larvae are very common in the outside tow-nets. A male, 45 mm. long, was obtained by the "Culver" about 5 miles off Bermuda at a depth of about 750 metres and a female in berry 55 mm. long at about 800 metres (June 13 1939). The larvae occur almost anywhere outside from near the surface to about 350 metres or more.

The first and second stages were, rarely, also taken in shallow water from tow-nets let down from the Swing Bridge over the Reach, near the Biological Station. The later stages were always from outside. The first and second stages occurred from August to October; this species must therefore breed at least from June to October, later larvae occurring at any time of year. This is the first time that any larva of *Parapandalus* has been described.

In general form the early larvae are rather like those of *Chlorotocella* sp. described by Gurney (1937) from the Red Sea, but they differ in detail, notably in the third abdominal segment, which is not humped at all in *Parapandalus*, and in the telson. In the later stages, however, they differ considerably and the series of larval stages are not comparable as there are far more in *Parapandalus* which must have a very much prolonged larval life.

The eggs measured  $0.64 \times 0.48$  mm. and were nearly ready to hatch, but unfortunately both parent and eggs died. The last larva changed to a post-larva in a bowl in the Laboratory and several moults were obtained in the later stages.

It is interesting that in the post-larva there are two large red organs on each side of the thorax, probably luminous, in the same position as those in *Chlorotocoides* (see Kemp, 1925, p. 277). These organs closely resemble, in colour, size and position, the organs of Pesta in some of the Sergestids. Dr Kemp kindly allows me to quote from his manuscript notes on this species: "the patches of red pigment on the pleopods may be luminous organs and it appears very probable that two pairs of large organs on the carapace have this function. Of the latter, one pair is situated at the base of the mandible, beneath the carapace, and one pair postero-dorsally underlying both the posterior edge of the carapace and the ligament of the first abdominal somite."

There appear to be more than the usual nine larval stages in this species, for after the first six stages, which progress normally, there may be about

four ranging from 7 to 10 mm. in length which are all much alike and only differ in the length of rostrum, pleopods and slight changes in the limbs. The rostrum in these is rather short and the telson usually bears 10 terminal spines (rarely 12). Following these is an anti-penultimate stage with fairly long and very slender pleopods, measuring about 12.5 mm., a penultimate stage of about 15 mm. and a last larval stage of about 17.5 mm. or more. It is probable, however, that some of these are alternative. A still later stage, which seemed to be between the ordinary last stage and the post-larva, moulted from a larva similar to the form which changed to a post-larva. In this specimen the exopods were twisted and still setose, the pleopods were very setose and well developed like those of the post-larva and the terminal setae of the telson were reduced to 2 pairs and 2 long inner setae but with no central tooth.

It seems that after the pleopods have appeared and all the legs are developed the number of larval stages may vary.

The larvae are extremely transparent and glass-like with rose-red chromatophores scattered on the body and appendages. In the early larvae there is a little yellow mixed with a large red patch in the thorax, and red chromatophores on both endopod and exopod of the third maxillipede. The post-larva has very little colour, but has scattered rose-red chromatophores on the antennule, antenna and legs and the above-mentioned round red organs on the thorax.

*First larval stage* (Fig. 4 *a-d*). Length 1.7 mm. The rostrum is sharp, reaching slightly beyond the eyes. The carapace is denticulated antero-ventrally. There is a dorsal organ and a papilliform organ dorsally at the posterior end of the carapace. There are no abdominal spines. The telson (*c*) is fairly deeply indented in the centre of the hind margin and bears the usual 14 setae. The antennule is unjointed, with an internal thin seta, the internal flagellum being represented by a very thick seta, the outer thick with 3 aesthetes (*d*). The antenna has a flagellum nearly as long as the scale, the latter being jointed at the tip and bearing an outer seta and 10 setae round the tip and margin. The maxillipedes are well developed with 4 setae on the exopods. There is a red chromatophore on each branch of the second maxillipede and 3 on the endopod and one on the exopod of the third maxillipede (*b*). There are no legs. A first stage changed to the second in a small glass dish.

*Second larval stage* (Fig. 5 *a-c*), reared from first. Length 2 mm. The colouring is like the first stage and the structure closely similar, except for the eyes, which are on long stalks, and the extra pair of spines on the telson (*c*). There is a very small pair of supra-orbital spines. There are now 6 setae on the exopods of the maxillipedes, the antennal scale is no longer segmented and the flagellum is longer than the scale. There are no traces of legs.

*Third larval stage* (Fig. 6 *a-e*). Length 3 mm. The antennule has 2 segments and the peduncle is concave on its outer margin. The antennal flagellum is

much shorter and thicker at the base. The exopods of the maxillipedes have 6 setae. There are rudiments of the first and second legs. The carapace is still denticulate antero-ventrally and the spine on the angle distinct. The telson is triangular, the greatest width equal to the length, the hind margin conspicuously indented, the inner ramus of the uropods short with 2 setae. The mandible (*c*) has a cutting and grinding portion, the maxillule (*d*) has an unsegmented endopod with 3 terminal and 2 lateral setae, the inner lobes well developed. The maxilla (*e*) has an unsegmented endopod with one terminal and 3 lateral setae and 4 inner lobes.

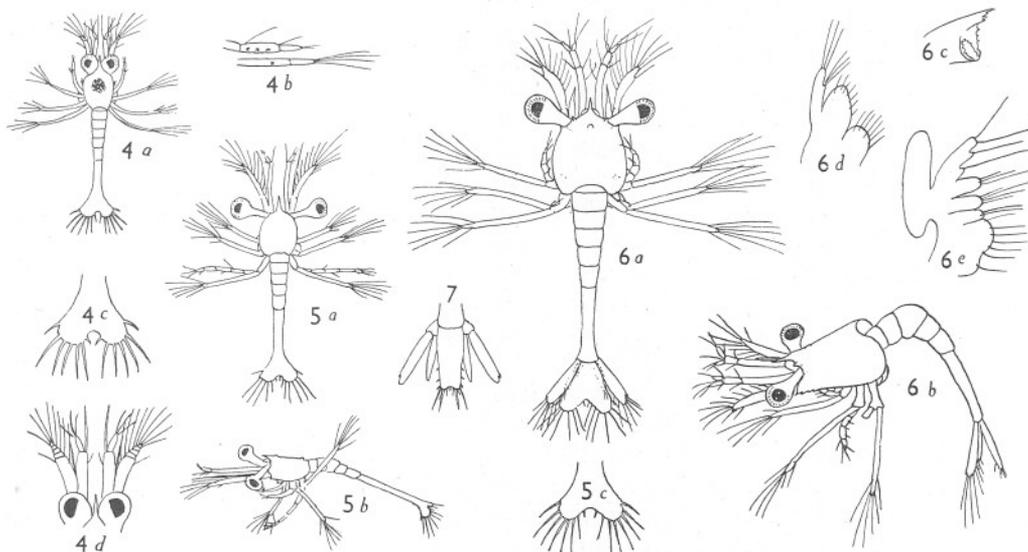


Fig. 4. *Parapandalus richardi*. *a*, first larval stage, 1.7 mm. long; *b*, tip of endopod and exopod of third maxillipede; *c*, telson; *d*, head region.

Fig. 5. *Parapandalus richardi*. *a*, second larval stage, 2 mm. long, dorsal; *b*, side view; *c*, telson.

Fig. 6. *Parapandalus richardi*. *a*, third larval stage, 3 mm. long, dorsal; *b*, side view; *c*, mandible; *d*, maxillule; *e*, maxilla.

Fig. 7. *Parapandalus richardi*. Fourth larval stage 3.5 mm. long, telson.

*Fourth larval stage* (Fig. 7). Very like stage III. Length *ca.* 3.5 mm. Legs 1 and 2 longer, 3-5 small rudiments. The telson is elongated with 3 pairs of lateral spines and 10 terminal setae, the hind margin slightly indented.

*Fifth larval stage* (Fig. 8 *a-c*). Length 4.5 mm. No pleopods. The rostrum is very short. The eyes are long, the antennular flagella are thick and nearly equal. The antennal scale has no outer seta and is long and narrow with a terminal tooth. The endopod of the second maxillipede has 6 setae, of the third 6, of the first leg 8, of the second leg 10, of the third leg 8 and of the fourth leg 4. The last leg is uniramous and is still rudimentary and bent forward under the abdomen. The telson (*c*) has a pair of dorso-lateral spines

in front of the first half, two pairs of lateral spines, a spine at each angle and 10 terminal setae, the first of which is much the largest, the inner pair very small. The hind margin is still indented.

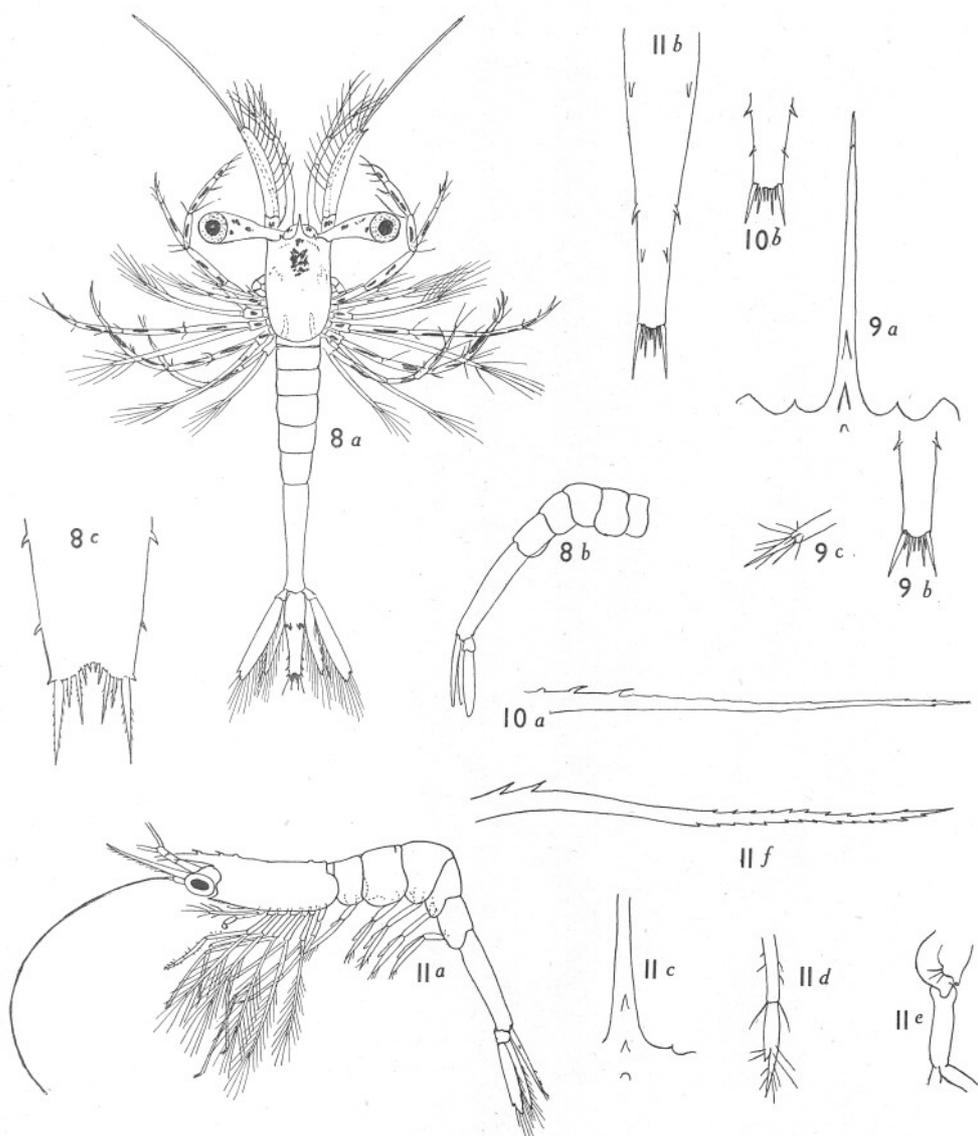
*Sixth larval stage.* Length *ca.* 5.5–6 mm. All the legs are long and functional. There is no exopod on the last leg. The rostrum is beginning to lengthen and reaches nearly half way along the eyes. Pleopods are beginning as minute buds. There is still a spine at each angle of the telson and 10 terminal setae, but the hind margin is hardly indented.

From this stage up to a length of 10 mm. (including rostrum), the stages are difficult to distinguish and are probably alternative. The rostrum rapidly elongates and acquires two posterior teeth immediately in front of the dorsal organ. One of these is on the carapace. There is an antennal spine more or less developed and a distinct pterygostomial spine. One specimen of 8 mm. still had 10 terminal teeth plus the spines at the angles of the telson, but most of them had 8 setae and the hind margin is no longer indented but slightly convex. There is a pair of dorso-lateral spines proximally and two pairs of lateral spines on the distal half. The pleopods are small.

*Antipenultimate larva* (Fig. 9 *a-c*). Length *ca.* 12.5 mm. including rostrum, 3 mm. long projecting far beyond the eyes (*a*). The pleopods are small and slender. The rostrum is armed with 2 large teeth just in front of the dorsal organ and one very small one near the tip. The supra-orbital spines have become very small. The telson (*b*) bears 8 terminal setae, the tooth on the angle having disappeared. The hind margin is rounded. The second leg ends in a pointed dactyl. This changed to the penultimate stage.

*Penultimate larval stage* (Fig. 10 *a, b*). Length *ca.* 15 mm. The pleopods are long but not setose. The telson is like the previous stage (*b*). The rostrum is much longer, 4 mm. in length, and besides the 2 large basal teeth it has indications of teeth along its length dorsally, 1 or 2 being distinct near the tip, and there are also indications of teeth ventrally and one distinct near the tip. This changed to a last larva.

*Last larval stage* (Fig. 11 *a-f*). 17.5 mm. long including rostrum which was broken (*c*). The rostrum of another specimen measures 4.5 mm. in length. The pleopods are long and have a few setae. The rostrum besides the 2 large basal teeth had 10 teeth dorsally and 14 ventrally. It was slightly curved twice (*f*) and is very like the adult. The antennal flagellum is rather longer than the body. The supra-orbital spines have almost disappeared. The antennal spine is more or less distinct. The telson (*b*) is like the penultimate stage. The exopods of the second and third maxillipedes and legs have many setae and are very long. The second leg is chelate (*d*) but the carpus is not divided. There is an anal spine. The mandible has a minute rudiment of a palp. The maxillule has a simple endopod with a bilobed tip and distinct inner lobes. The maxilla has an unsegmented endopod and the third inner lobe has almost disappeared. The first maxillipede has a large epipod, the second a large gill (podobranch) and the third a plate-like epipod and two arthro-



- Fig. 8. *Parapandalus richardi*. a, fifth larval stage, 4.5 mm. long; b, abdomen; c, telson.  
 Fig. 9. *Parapandalus richardi*. a, anti-penultimate stage, 12.5 mm. long, rostrum and front of carapace; b, telson; c, end of second leg.  
 Fig. 10. *Parapandalus richardi*. a, penultimate stage, 15 mm. long, rostrum; b, telson.  
 Fig. 11. *Parapandalus richardi*. a, last larva, 17.5 mm. long (rostrum broken); b, telson of cast skin (into post-larva); c, rostrum; d, end of second leg; e, proximal end of third leg; f, rostrum of another specimen.

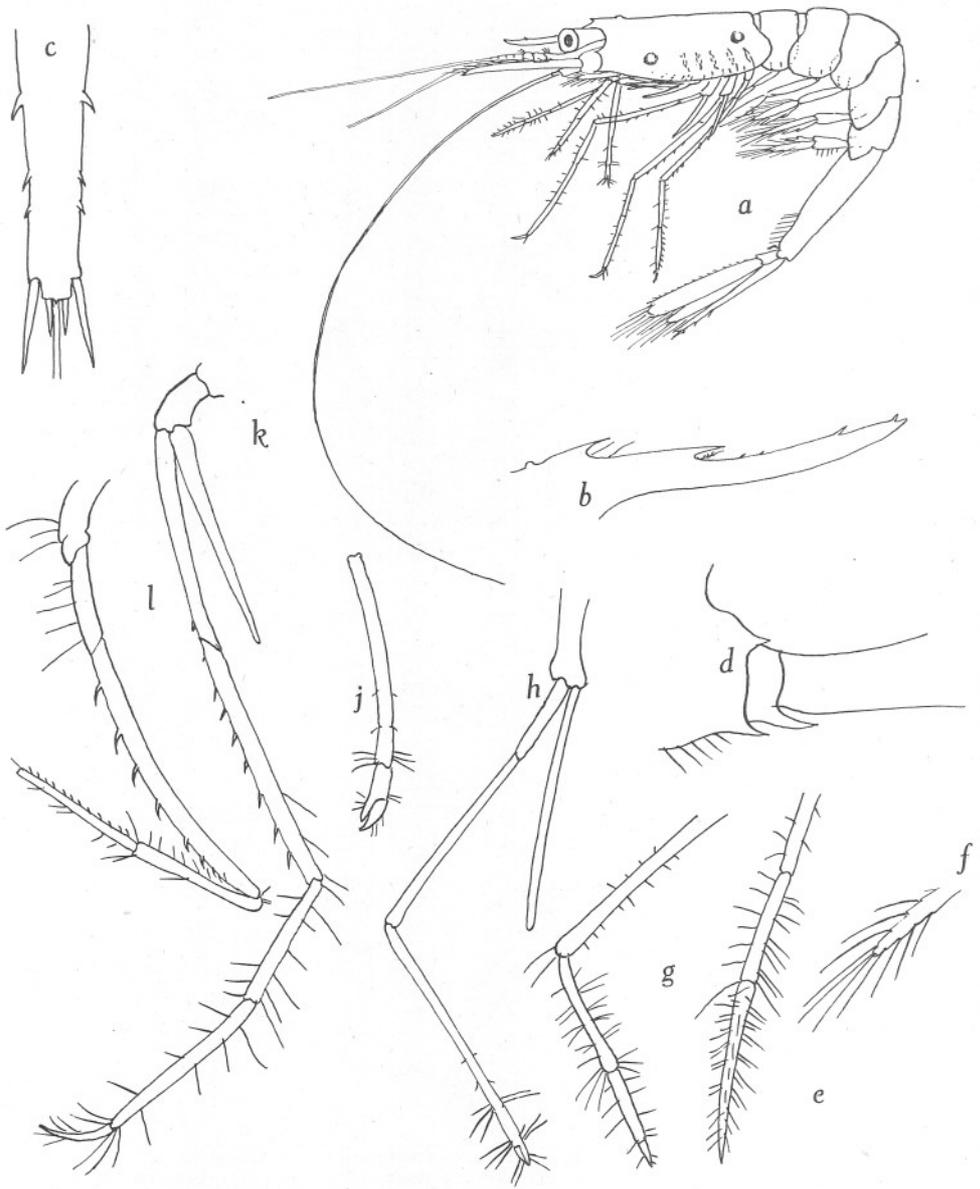


Fig. 12. *Parapandalus richardi*. a, post-larva from last larva; b, rostrum; c, telson; d, front end of carapace and base of antenna; e, third maxillipede; f, tip of exopod of same; g, first leg; h, second leg; j, end of same; k, fourth leg; l, last leg (dactyl broken off).

branches. There is an arthrobranch and a pleurobranch on legs 1-4 and a pleurobranch on leg 5. The gill formula is thus complete as in the adult. On the third maxillipede and legs 1-4 in the cast skin there were seen small processes with 3 setae on the base. These appear to be rudiments of the epipods which disappear. The second maxillipede closely resembles the adult.

One of the penultimate stages changed to a form which was intermediate between the true last larva and the post-larva, having exopods on the legs which were still setose although much curled up and the pleopods being quite as much developed as they are in the post-larva. In this specimen the telson has 6 thick setae on the hind margin and an inner pair of long very thin feathered setae.

*Post-larval stage* (Fig. 12 a-l). The post-larva from the first larva is 16 mm. long, but the rostrum is abnormal owing to its being broken in the last larva and is much shorter than it should be (b). This approaches the adult in form. The antennal and pterygostomial spines are distinct but the supra-orbitals have disappeared. The antennal flagellum is slightly longer than the body. The second leg has the carpus divided once (with indications of a second division) distally, therefore its segmentation is not nearly complete (h, j). The first leg ends in a simple pointed dactyl (g). The remains of the exopods are unusually long. The telson has 3 pairs of lateral spines and ends in a straight narrow portion with a minute central tooth. There are 4 stout setae terminally and a long hair-like seta on each side of the central spine. There are no epipods on the legs. The red round organs, in a similar position to the organs of Pesta in Sergestids, are conspicuous.

The pandalid larva III described by Gurney (1924, Figs. 45 and 46) is very like that of *Parapandalus* but the last larva has epipods, which fact shows that it cannot belong to that genus. It therefore almost certainly belongs to the closely related *Plesionika*. It is thus very probable that all the larvae known as *Icotopus* described by Bate (1888) and Coutière (1907) belong to *Plesionika*.

All these pandalid larvae appear to be closely related to *Processa* and the Hippolytidae, especially *Caridion* and *Spirontocaris*, in sharp contrast to the Alpheidae and Palaemonidae. *Parapandalus* larvae agree fairly closely with some of the Hoplophoridae (*Acanthephyra* and relatives), but never have an exopod on the last leg and in other ways are less primitive.

#### REFERENCES

- BATE, C. SPENCE, 1888. Report on the scientific results of the exploring voyage of H.M.S. *Challenger*, 1873-1876. Crustacea Macrura. *Voy. H.M.S. "Challenger"*, Zoology, Vol. xxiv, pp. 1-942.
- BERKELEY, A., 1930. The postembryonic development of the common Pandalids of British Columbia. *Contrib. Canad. Biol.*, N.S., Vol. vi, pp. 1-85.
- 1938. The larval development of *Pandalus stenolepis*. *Journ. Fish. Res. Board Canada*, Vol. iv, pp. 88-95.

- COUTIÈRE, H., 1905. Note préliminaire sur les Eucyphotes recueillis par S.A.S. le Prince de Monaco à l'aide du filet à grande ouverture. *Bull. Mus. Océanogr. Monaco*, No. 48, pp. 1-35.
- COUTIÈRE, H., 1907. Sur quelques formes larvaires énigmatiques d'Eucyphotes, provenant des collections de S.A.S. le Prince de Monaco. *Bull. Mus. Océanogr. Monaco*, No. 104, 70 pp.
- GURNEY, R., 1924. Decapod larvae. *Nat. Hist. Rep. "Terra Nova" Exped. Zoology*, VIII. Crustacea, pp. 37-202.
- 1926. The protozoal stage in decapod development. *Ann. Mag. Nat. Hist.*, Ser. (9), Vol. XVIII, pp. 19-27.
- 1937. Notes on some decapod and stomatopod Crustacea from the Red Sea. III-V. III. The larvae of *Gonodactylus glabrous* Brooks, and other Stomatopoda. IV. The larva of *Callianassa*. V. The larvae of *Chlorotocella* Balss. *Proc. Zool. Soc. Lond.*, Ser. B, 1937, pp. 319-36.
- 1939. Bibliography of the larvae of decapod Crustacea. *Ray Society*, pp. 1-123.
- KEMP, S., 1925. Notes on Crustacea Decapoda in the Indian Museum. XVII. On various Caridea. *Rec. Ind. Mus.*, Vol. xxvii, Pt IV, pp. 249-343.
- LEBOUR, M. V., 1930. The larval stages of Caridion, with a description of a new species, *C. steveni*. *Proc. Zool. Soc. Lond.*, 1930, pp. 181-94.
- DE MAN, J. G., 1920. The decapoda of the Siboga Expedition. Part IV. *Siboga Expedition*, xxxixA, pp. 1-318.
- SARS, G. O., 1900. Account of the post-embryonal development of *Pandalus borealis*, with remarks on the development of other Pandali, and descriptions of the adult *Pandalus borealis*. *Rep. Norweg. Fish. Invest.*, Vol. 1, No. 3, 45 pp.
- STEPHENSEN, K., 1912. Report on the Malacostraca collected by the "Tjalfe" expedition. *Vidensk. Medd. Naturh. Foren. Købg.*, Bd. LXIV, pp. 57-134.
- 1935. The Godthaab Expedition, 1928. Crustacea Decapoda. *Medd. Grønland*, Bd. LXXX, No. 1, 94 pp.
- WEBB, G., 1921. The larvae of the Decapoda Macrura and Anomura of Plymouth. *Journ. Mar. Biol. Assoc.*, Vol. XII, pp. 385-417.