THE LARVAL DEVELOPMENT OF THE SPONGE CRAB, DROMIA PERSONATA (L.) (CRUSTACEA, DECAPODA, DROMIIDEA), REARED IN THE LABORATORY

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ABSTRACT

The sponge crab, *Dromia personata* (L.), is distributed in the Mediterranean and in the western north Atlantic from the English Channel to the coast of Senegal (ZARIQUIEY ALVAREZ, 1968). The species occurs from the shore to depths of about 100 m and, although it is quite common in some areas, little is known about its biology.

There are several descriptions in the literature of zoeal stages and megalopae attributed to *D. personata* (see PIKE and WILLIAMSON, 1960), but only the first two stages have been reared previously from the egg in the laboratory (LEBOUR, 1934). Later zoeal stages and the megalopa have been obtained only from plankton samples.

Through the kindness of Dr. L. LAUBIER and Mr. A. THIRIOT of the Laboratoire Arago, Banyuls-sur-Mer we had the opportunity in 1968 of rearing the larvae from the egg through to the megalopa stage and the results of this work are presented here.

MATERIALS AND METHODS

A berried female of *D. personata* with a carapace length of 24.5 mm was taken in the Mediterranean in the region of Banyuls-sur-Mer. The specimen was flown to London on 5th August 1968 and on arrival at the British Museum (Natural History) on the morning of the 6th the eggs had begun to hatch. About 150 living larvae were obtained during the course of the 6th but many of these animals had probably hatched prematurely due to shock and few of them lived for more than a few days. These animals were not used in the rearing experiments and the results given below therefore refer only to a further 180 larvae which hatched during the following night.

These 180 larvae were placed singly in compartmented plastic trays; 10 trays, each with 18 compartments, were used. Each compartment contained about 50 ml of filtered sea-water of about 34 ‰ salinity obtained from the Plymouth Marine Laboratory. The water in four of the trays was untreated; in two it was previously autoclaved at 1 Kg/cm^2 for four minutes, and the remaining four trays were filled with autoclaved water treated with 50 i.u. of benzyl-penicillin per ml or 50 i.u. of sodium penicillin/streptomycin per ml of water. All the trays were maintained at 25-30 °C in a normal light cycle from a north facing window. One untreated tray of larvae was starved and those in the remaining nine trays were fed with freshly hatched *Artemia* nauplii. Trays were examined each morning and moulted skins and dead larvae were removed. The animals were transferred to freshly prepared trays every second day.

RESULTS

The starved animals lived for up to eight days but none of them moulted into the second stage. By contrast one third of all the fed larvae reached the megalopa stage, and there was an indication that animals did better in untreated water (42.5 % reaching megalopa) than in either sterilised water (36 % to megalopa) or sterilised and antibiotic treated water (23.5 % into megalopa). None of the megalopae moulted into the first crab stage. Each zoeal stage lasted between four and nine days (usually five or six) and the animals reached the megalopa stage between 21 and 28 days after hatching, mostly after 23-24 days.

DESCRIPTION OF THE LARVAL STAGES

As each stage of development is adequately illustrated only the more important morphological changes, from one stage to the next, are described. The changes in armature of some of the appendages through the zoeal stages are summarised in Table 1.

TABLE 1

The setal armature of the exopods of the maxilla (scaphognathite), the maxillipeds and the cheliped in the zoeal stages of Dromia personata. *The figures in parentheses following the range indicate the number of setae usually present. The figures are based on an examination of at least ten appendages in each case.*

Zoeal stage	Maxilla (scaphognathite)	Maxillipeds 1 st	Maxillipeds 2 nd	Maxillipeds 3 rd	Cheliped
I	19-21	4	4	0	0
II	22-23	5-6(6)	5-7(6)	4-6(6)	4-6(5)
III	28-31	7-8(8)	6-8(8)	7-8(8)	5-7(6)
IV	37-38	8-9(8)	8	8	6

The colour pattern remains virtually unchanged throughout all stages. The thorax and abdomen have a general diffuse orange colour with many particulate yellow and red chromatophores. This pigmentation extends into the limbs and into the telson. In the first zoea the pigmentation is absent from the 6th abdominal somite which is fused to the telson.

FIRST ZOEA. Figs. 1 (*a* & *b*), 3 (*a*), 4 (*a* & *e*), 5 (*a*, *e* & *i*).

Carapace length (tip of rostrum to the posterior margin of the carapace in the mid-line) 1.42-1.68 mm; mean (8 animals) 1.58 mm.

The carapace and eyestalks of this and all the other zoeal stages are covered in fine ridges (see Pl. 1 (*A* & *C*)). These ridges are not shown in the drawings but they are similar to those illustrated for *Dromidia antillensis* by RICE & PROVENZANO (1966, Fig. 1). The prominent postero-lateral carapace spines arise in front of the carapace margins; on each side there is a horizontal ridge

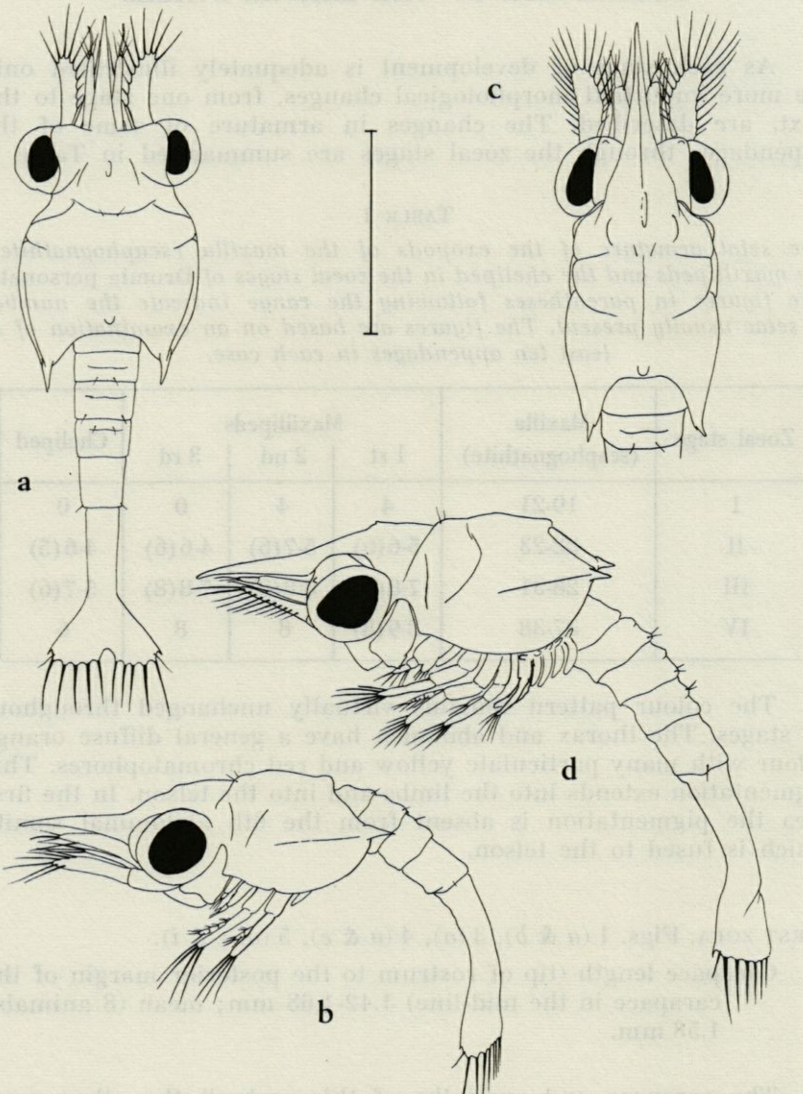

FIG. 1. — *Dromia personata.* First zoea (a and b); second zoea (c and d). Bar scale represents 1.0 mm. In this and in the other illustrations the secondary setulation is largely omitted for clarity.

running forward from the base of the spine to end behind the posterior transverse carapace furrow. The third maxilliped is not functional and the exopod is unarmed. The pereiopods are present as unarmed buds, the first one being bilobed.

SECOND ZOEA. Figs. 1 (*c & d*), 3 (*b & f*), 5 (*b, f & j*).

Carapace length 1.71-1.98 mm; mean (8 animals) 1.84 mm.

The eyes are now free, the eyestalks bear small antero-dorsal papillae (Pl. 1 (*A & B*) and the postero-lateral carapace spines are

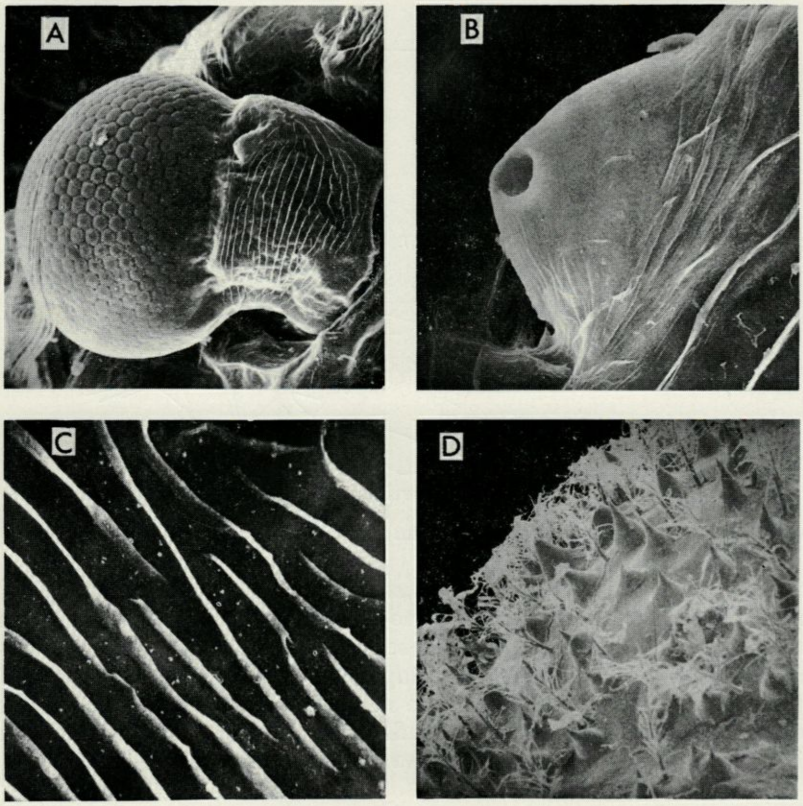

PLATE 1

Dromia personata. Scanning electron microscope photographs.

(A) Eye of stage IV zoea showing eyestalk papilla and surface ridges (× 75); (B) Eyestalk papilla of stage IV zoea (× 625); (C) Portion of carapace surface in stage IV zoea (× 250); (D) Surface of carapace in megalopa (× 120).

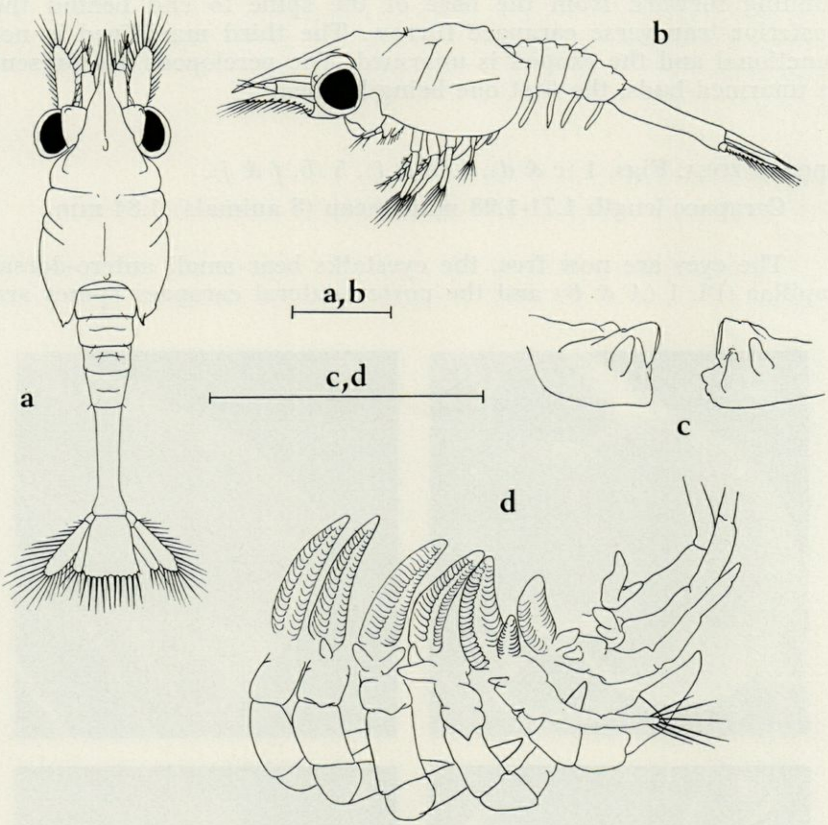

FIG. 2. — *Dromia personata.* Fourth zoea. (a) and (b) dorsal and lateral views; (c) mandibles; (d) maxillipeds, legs and associated gills of the right-hand side. Bar scales represent 1.0 mm.

smaller. The telson (Fig. 3 (*b*)) has now acquired the eighth pair of marginal processes and the postero-lateral parts of its dorsal surface are beset, on either side, with a seta and a pair of outgrowths (see also Fig. 3 (*e*)). All the appendages have added more setae. The antennal scale now has its whole margin setose (Fig. 4 (*f*)) and the third maxilliped and the chelipeds have functional exopods. Some of the gills are present as undifferentiated buds.

THIRD ZOEA. Figs. 3 (*c*), 4 (*c* & *g*), 5 (*c*, *g* & *k*).

Carapace length 2.10-2.32 mm; mean (9 animals) 2.22 mm.

The telson is now demarcated from the 6th abdominal somite and there are well developed unsegmented uropods with long setose

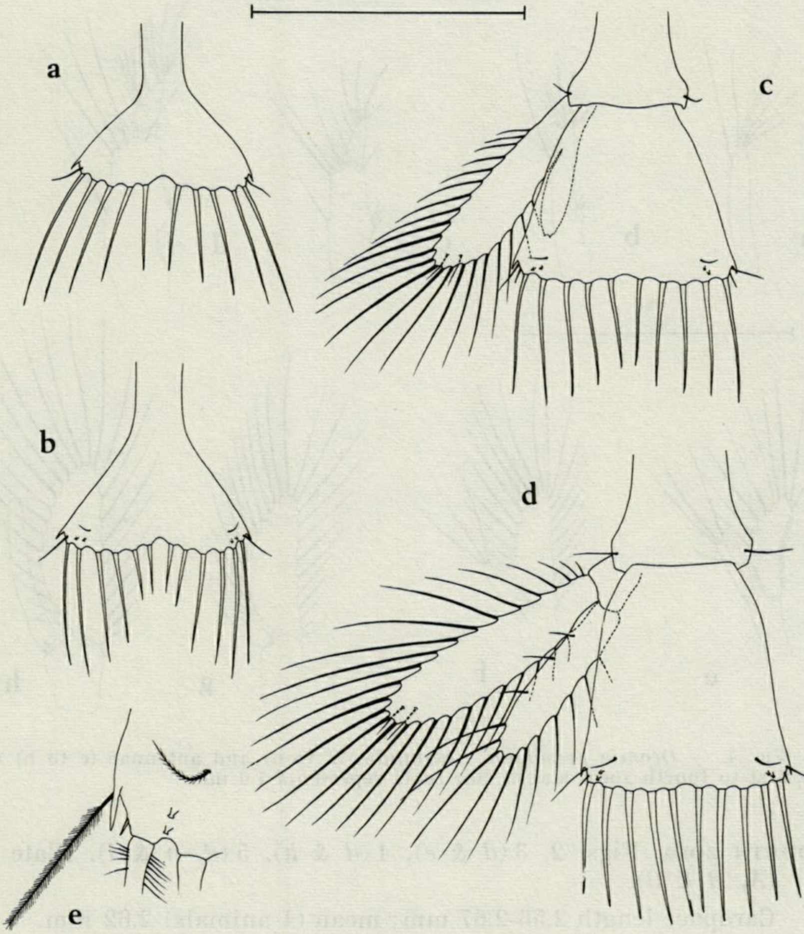

FIG. 3. — *Dromia personata.* (a to d) telsons of the first to fourth zoeal stages respectively; (e) detail of the postero-lateral angle of a stage four telson. Bar scale represents 1.0 mm for (a), (b), (c) and (d).

exopods and shorter, unarmed endopods (Fig. 3 (*c*)). The third telson process is reduced to a small seta and is considerably shorter than the 2nd process. The antennule (Fig. 4 (*c*)) has an incipient ventral flagellum. The antennal endopod (Fig. 4 (*g*)) is now unarmed and the mandible bears a very small palp. The pereiopods are larger proportionally than in the second zoea and show the beginnings of segmentation. Abdominal somites 2-5 now bear unsegmented bilobed pleopod buds.

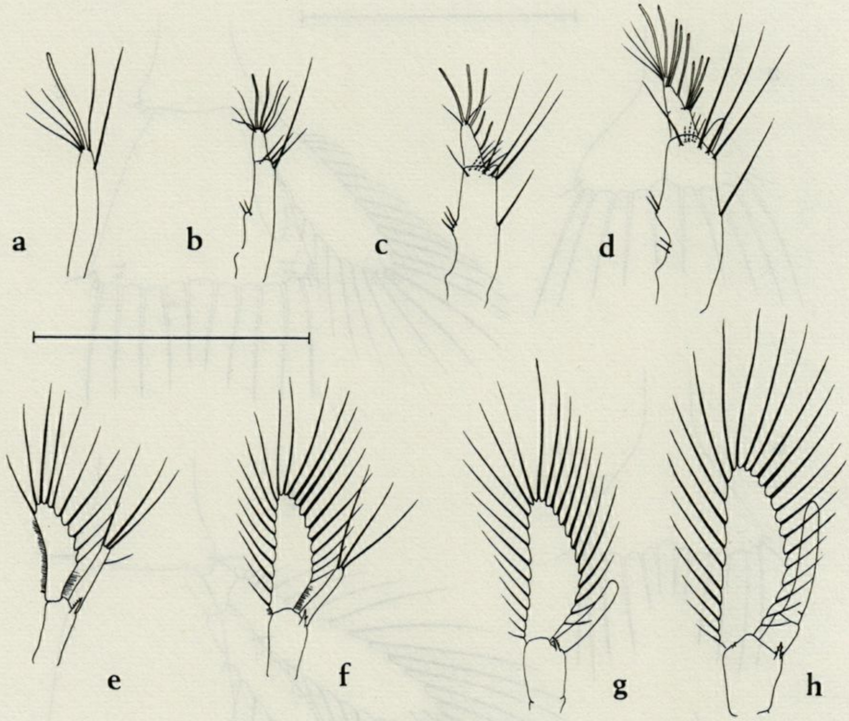

FIG. 4. — *Dromia personata.* Antennules (a to d) and antennae (e to h) of the first to fourth zoeal stages. Bar scale represents 1.0 mm.

FOURTH ZOEA. Figs. 2, 3 (*d* & *e*), 4 (*d* & *h*), 5 (*d, h* & *l*). Plate 1 (*A, B* & *C*).

Carapace length 2.56-2.67 mm; mean (4 animals) 2.62 mm.

The postero-lateral carapace spines are now very small and there is a pair of small supra-orbital outgrowths at the base of the rostrum. Both branches of the uropods are articulated with the protopodite and the endopods are now setose. The telson (Fig. 3 (*d*)) is relatively much narrower than in the previous stage but its armature is essentially unchanged. The endopod of the antenna (Fig. 4 (*h*)) is now two-segmented. The mandibular palp (Fig. 2 (*c*)) is larger than that of the third zoea but is still unsegmented and unarmed. The endopod of the second maxilliped (Fig. 5 (*h*)) is now divided into five segments and that of the third maxilliped (Fig. 5 (*l*)) is divided into two segments. The segmentation of the pereiopods is now complete and there are exopod buds on pereiopods

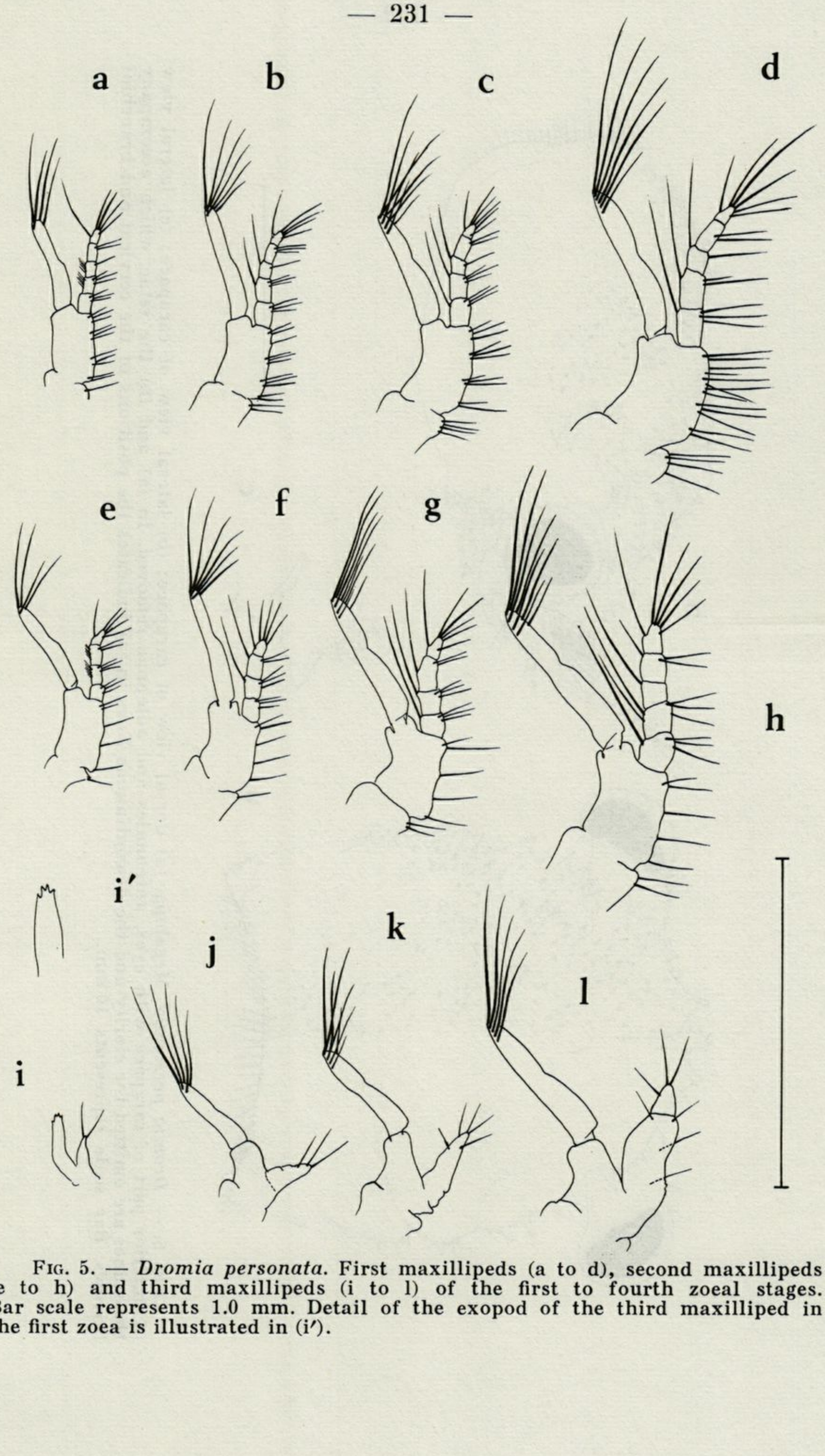

Fig. 5. — *Dromia personata.* First maxillipeds (a to d), second maxillipeds (e to h) and third maxillipeds (i to l) of the first to fourth zoeal stages. Bar scale represents 1.0 mm. Detail of the exopod of the third maxilliped in the first zoea is illustrated in (i′).

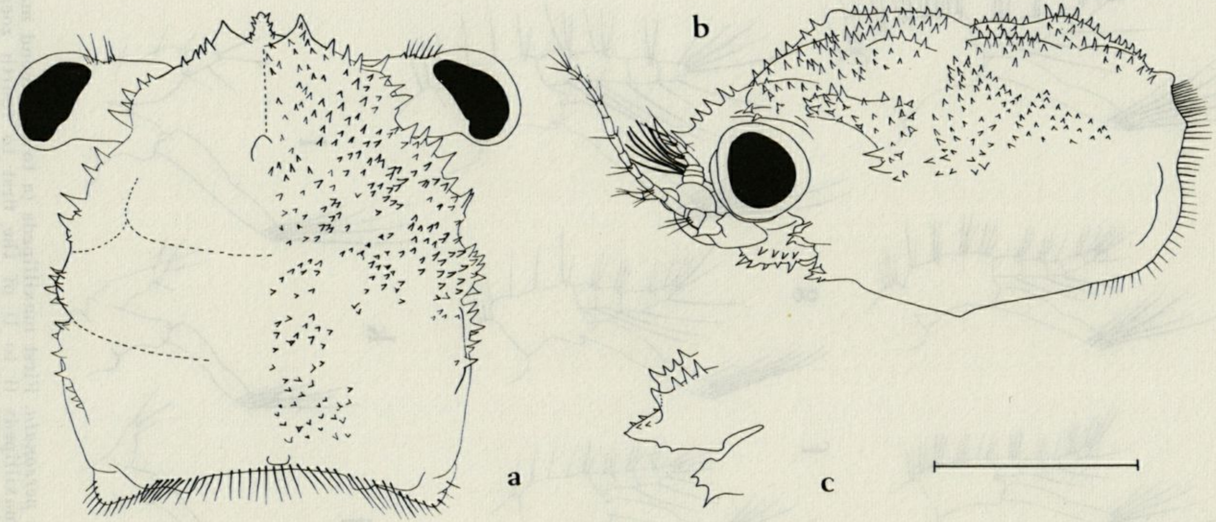

Fig. 6. — *Dromia personata.* Megalopa. (a) dorsal view of carapace; (b) lateral view of carapace; (c) lateral view of anterior part of carapace with eyes, antennules and antennae removed. In (a) and (b) the setae which accompany the spines are omitted for clarity and the discontinuous lines in (a) indicates the positions of the cervical and branchial furrows. Bar scale represents 10 mm.

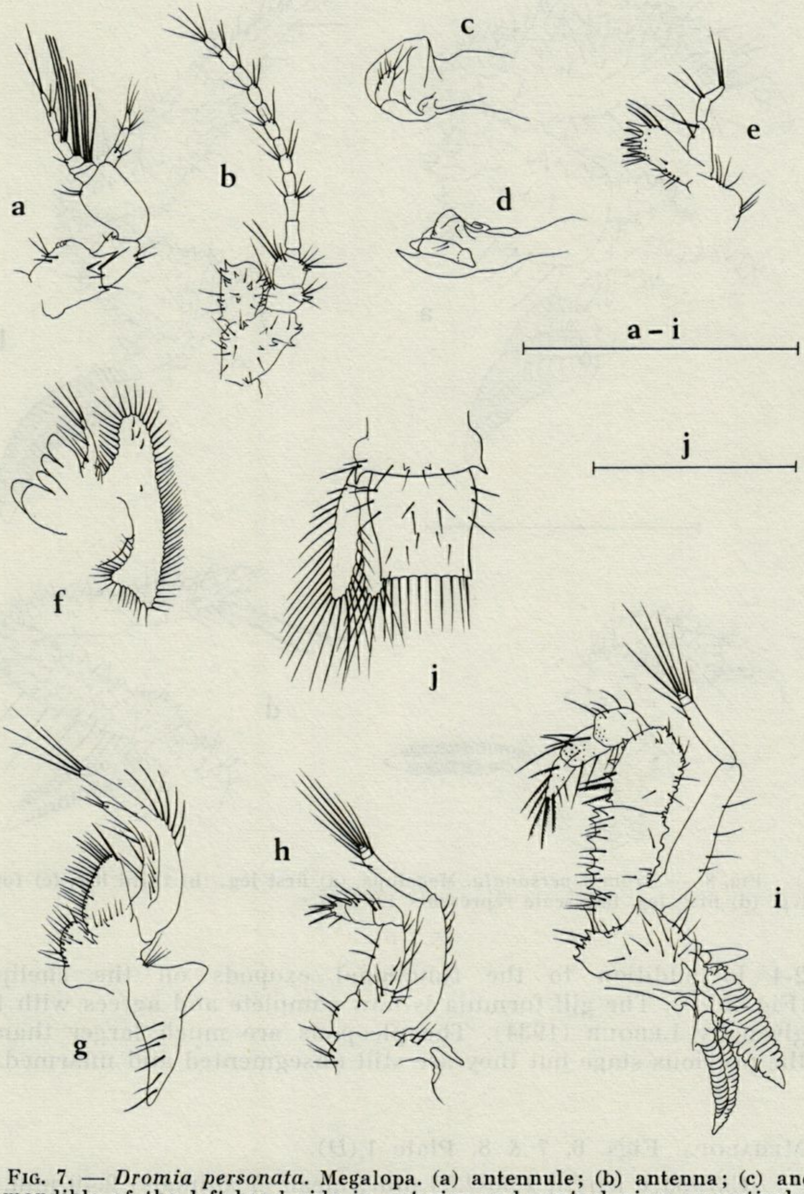

Fig. 7. — *Dromia personata*. Megalopa. (a) antennule; (b) antenna; (c) and (d) mandible of the left-hand side in anterior and ventral view respectively; (e) maxillule; (f) maxilla; (g), (h) and (i) first, second and third maxillipeds; (j) telson. Bar scales represent 1.0 mm.

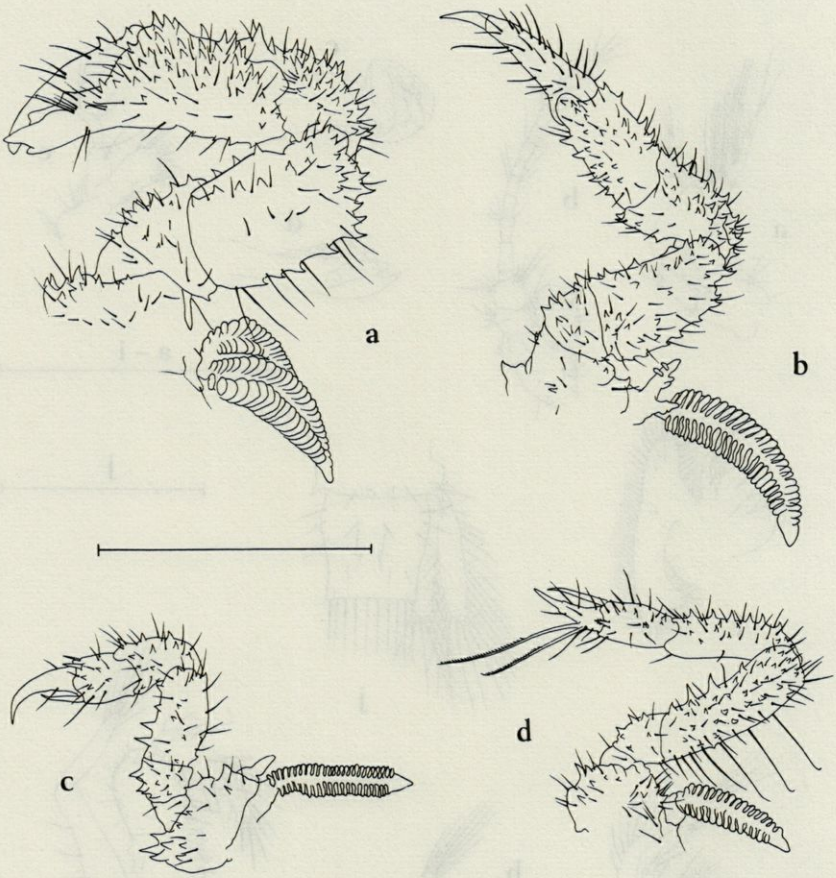

FIG. 8. — *Dromia personata.* Megalopa. (a) first leg; (b) third leg; (c) fourth leg; (d) fifth leg. Bar scale represents 1.0 mm.

2-4 in addition to the functional exopods on the chelipeds (Fig. 2 (*d*)). The gill formula is now complete and agrees with that given by LEBOUR (1934). The pleopods are much larger than in the previous stage but they are still unsegmented and unarmed.

MEGALOPA. Figs. 6, 7 & 8. Plate 1 (*D*).

Carapace length 2.30-2.55 mm; mean (7 animals) 2.49 mm.

The globose carapace has a very furry appearance owing to the liberal covering of spines and plumose setae (Pl. 1 (*D*)). These spines and setae are absent from the sides of the carapace but are fairly evenly distributed over the dorsal surface except for two naked postero-lateral areas and the well-marked cervical and branchial furrows. The eyestalk papillae of the zoeal stages have each been replaced by two or three spines and a few setae. The telson (Fig. 7 (*j*)) is truncate, with very small spines at the postero-lateral angles and an almost straight posterior margin with either eight or ten terminal processes. These terminal processes are usually subequal, but in some examples with ten processes the outermost on each side are reduced to less than half the length of the remainder. The pereiopods are short and stout, with many spines and setae (Fig. 8). The dactylus of each of the last two pairs of legs apparently closes against a strong spine on the distal margin of the propodus. The exopod of the cheliped is now very rudimentary and in most specimens is unarmed, but in one case it still retains the six terminal setae present in the last zoea. The exopods of each of the pleopods are fringed with about 24 setae and the endopods are beset with a row of coupling hooks.

DISCUSSION

There have been previous descriptions of larval stages undoubtedly attributable to *Dromia personata* *. Gourret (1884) and Cano (1893) both described the first zoeal stage hatched from Mediterranean adults and Cano also described plankton caught last zoea and megalopa stages. Pike and Williamson (1960) described the first three zoeal stages collected by townetting in the Bay of Naples, while Lebour (1934) reared the first two zoeae at Plymouth and also described a terminal zoea taken in the Channel and the megalopa into which it moulted. Where comparisons are possible these descriptions are all very similar except that Pike and Williamson described a series of small denticles on the postero-lateral margins of the carapace which were not mentioned in the other accounts. This suggests that there might be some geographical variation in the larvae of this species. This first description of the complete larval series from one locality tends to confirm this suggestion of variability in morphology and also in the size and number of zoeal stages.

* The larvae described by Boas (1880) and attributed to *D. personata* by Pike and Williamson are unlikely to belong to this species as they were taken in the Yellow Sea.

Although she did not have access to a complete larval series, LEBOUR stated that there are five zoeal stages in the development of *D. personata,* a conclusion apparently based on GURNEY's (1924) description of the second, third and fourth zoeal stages of a dromiid which seemed to bridge the gap between LEBOUR's stage two and terminal zoeae. This reasoning is not valid since GURNEY's larvae do not belong to the same species and probably not to the same genus (see RICE and PROVENZANO, 1966). Nevertheless, the increase in size between LEBOUR's second zoea (total length 3.2 mm) and her terminal zoea (total length 6.4 mm) could hardly be accomplished in less than three moults, so that there certainly seem to be at least five zoeal stages in the development of *D. personata* at Plymouth, compared with the four stages noted here in the Banyuls specimens. Unfortunately, the length of CANO's terminal zoea from the Bay of Naples is not given and an estimate of the number of moults between this stage and PIKE and WILLIAMSON's third zoea is therefore not possible.

The Banyuls larvae differ from those described by PIKE and WILLIAMSON in being smaller, lacking denticles on the postero-lateral carapace margins and having rather more advanced maxillipeds and first legs in the third stage. The Banyuls larvae are also smaller than LEBOUR's and have much less prominent postero-lateral carapace spines. PIKE and WILLIAMSON noted the reduction of the third telson process to a short naked seta and in LEBOUR's illustration of the telson of the terminal zoea this process has completely disappeared. This third telson process was still present in the last zoeal stages from Banyuls and did not disappear until the moult to the megalopa. None of the previous descriptions of larvae of *Dromia* mentioned the eyestalk papillae but they had probably been overlooked.

LEBOUR's description and illustration of the megalopa are very poor and detailed comparison with the Banyuls megalopae is therefore not possible. However, she specifically mentions that the hair-like second telson process is still present in the megalopa, a feature which was not seen in the Banyuls specimens. LEBOUR mentions the sickle-shaped dactyls of only the last pair of legs, whereas the fourth pair must certainly have been similar and like those illustrated above.

RICE and PROVENZANO (1966) compared the larvae of *Dromidia antillensis* with what was known of the development of *Dromia personata* at that time. A few of the apparent differences between these species can now be amended. Thus, the eyestalk papillae present in *D. antillensis* from the second zoea are now known to be present in *D. personata* also. Differences in the armature of the third maxillipeds of the first stage zoeae in the two species were given but it was suggested that LEBOUR and PIKE and WILLIAMSON (from whom the data were taken) had confused the parts of this appendage. This mistake has now been confirmed and this distinction between the species no longer applies. Finally, the similarity of the dactyls of the fourth legs to the anterior ones rather than to those of the last pair in *D. personata* was also listed as a difference from *D. antillensis*; this also no longer applies.

The only other published account of a reared member of the Dromiidea is that for *Conchoecetes artificiosus* (Fabr.) by SANKOLLI and SHENOY (1968). This species passes through only two zoeal stages and apart from the features connected with this relatively abbreviated development, such as the presence of pleopods in the first stage, the larvae are generally quite similar to those of *D. personata* and *D. antillensis*. However, they are distinguishable from both these species in lacking both supra-ocular and postero-lateral carapace spines in the zoeal stages, having no exopods on any of the legs, and in having uniramous uropods and a deeply notched telson in the megalopa stage.

In its small number of zoeal stages, absence of exopods on the legs and uniramous uropods, *Conchoecetes artificiosus* is more advanced than either *Dromia* or *Dromidia*. A somewhat intermediate condition occurs in *Hypoconcha arcuata* Stimpson (KIRCHER, pers. comm.). This species has three zoeal stages, it develops exopods only on the chelipeds and although the uropods are biramous they do not have setose endopods until the megalopa stage. There is thus considerable variation in the possession of 'advanced' and 'primitive' characters by larvae of the Dromiidea, although all of them show much greater affinity with the Anomura than with the Brachyura.

However, WILLIAMSON (1965) pointed out that the characters of the larvae of *Dromia* and *Dromidia* placed them at an evolutionary level comparable to that of the Thalassinidea and more primitive than that of the Anomura. The more advanced larvae of *Conchoecetes* and *Hypoconcha* tend to bridge this gap between the more primitive dromiids and the Anomura, while some of their characters, such as the tendency towards uniramous uropods, are even more advanced than in most anomurans.

ACKNOWLEDGMENTS

Our thanks are due to Miss Ann B. KIRCHER for allowing us to see her unpublished work on *Hypoconcha*.

SUMMARY

Larvae of the sponge crab, *Dromia personata*, have been hatched from the egg in the laboratory and reared to the megalopa stage for the first time. The four zoeal stages and the megalopa are described and compared with previous descriptions of larvae attributed to this species. There is some variation in larval morphology and possibly also in the number of zoeal stages over the geographical range of the species.

RÉSUMÉ

Les larves de *Dromia personata* ont été obtenues à partir des œufs au laboratoire et élevées, pour la première fois, jusqu'au stade mégalope. Les quatre zoés et la mégalope sont décrites, et comparées avec les descriptions antérieures de larves attribuées à cette espèce. Il y a une certaine variabilité de la morphologie larvaire et peut-être aussi du nombre des stades zoés dans l'aire de répartition géographique de l'espèce.

ZUSAMMENFASSUNG

Larven von *Dromia personata* konnten erstmals im Laboratorium vom Ei bis zum Megalopastadium aufgezogen werden. Die vier Zoea-Stadien und die Megalopa werden beschrieben und mit früheren Beschreibungen von Larven, die der vorliegenden Art zugerechnet werden, verglichen. Unterschiede in der Morphologie der Larven und möglicherweise auch in der Zahl der Zoeastadien erstrecken sich über das gesamte Verbreitungsgebiet der Art.

ADDENDUM

Since this paper was submitted for publication we have had an opportunity to examine more larval material of *Dromia perso-*

nata. Dr. A. THIRIOT kindly sent us first zoea larvae obtained from two laboratory hatchings at Banyuls and also first, second and third stage zoeae collected from the plankton in the same region.

The only morphological differences between these larvae and those described above are that, unlike ours, the zoeae from one of the laboratory hatchings have denticles on the postero-lateral carapace margins similar to, but smaller than, those described by PIKE and WILLIAMSON (1960), while the single third stage zoea from the plankton has relatively larger postero-lateral carapace spines than ours.

However, the larvae from the various sources show interesting differences in size. Thus, the mean carapace length of 40 stage I zoeae from our hatchings was 1.56 mm (range 1.42-1.68 mm), compared with mean carapace lengths of 1.58 mm (range 1.52-1.62 mm) and 1.46 mm (range 1.36-1.51 mm) for similar samples from the two laboratory hatchings at Banyuls. These larvae are smaller than the previously reported plankton caught specimens and are also smaller than zoeae caught off Banyuls which had a mean carapace length of 1.64 mm (range for four specimens 1.57-1.73 mm). Similarly, the stage II and stage III larvae from the plankton are larger than our reared examples.

There are at least two possible explanations for these size discrepancies. It is possible that the laboratory conditions, perhaps unnaturally high temperatures, under which the ovigerous females were kept prior to hatching the eggs, resulted in smaller larvae than would be produced in the sea. Alternatively, it may be that the size of the eggs, and consequently of the resulting larvae, is related to the size of the female from which they come. There are insufficient data available to show whether either of these explanations is correct.

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Reçu en mai 1969