PRELIMINARY OBSERVATIONS ON THE BIONOMICS, REPRODUCTION AND EMBRYONIC STAGES OF *PALAEMON IDAE* HELLER (CRUSTACEA, DECAPODA).

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INTRODUCTION.

Though a number of species of *Palaemon* have been recorded from India, some of which are of considerable economic importance, the Bionomics, Reproduction and Life-history of even the common species are unknown. The chief and probably the only contribution on the subject is a description of the larval forms of *Palaemon carcinus* and *P. rudis* by Menon (1938).

The observations reported here were made during the years 1940-1942, while I was engaged on an investigation of the Marine and Fresh water Prawn Fisheries of Travancore, at the suggestion of Dr. C. C. John, Professor of Marine Biology and Fisheries of the University of Travancore. During this investigation I found that *Palaemon idae* Heller, which is one of the commonest species of freshwater prawn in Travancore, was most suited for rearing under Laboratory conditions, owing to its hardy nature, convenient size and availability.

BIONOMICS.

Occurrence.—*P. idae* occurs in large numbers in almost all the fresh and brackish water lakes, rivers and canal systems in Travancore from June to December. These months constitute the season when this prawn is fished on a commercial scale and the catches consist mainly of adult males and ovigerous females. It continues to appear in the catches in lesser numbers till the end of February but from March onwards it is seldom seen in the hauls. The July and August collections are mainly composed of small and immature specimens. Females obtained during September to December, from the different parts of the same lake and from the different lakes in Travancore, are ovigerous and they continue to appear in lesser numbers till the end of February. Males collected during these months are very large and are mature. The breeding season for *P. idae*, therefore, appears to be a prolonged one, beginning from September and extending to the end of February.

Habits.—Like most species of *Palaemon*, *P. idae* prefers stagnant and shallow waters with a muddy bottom rich in organic matter. In their natural habitat the prawns of this species are seen to keep close to the bottom, often walking along the bed in search of food. During night, however, they swim freely and are photopositive. This habit has given the clue for one of the most popular methods of nocturnal 'prawning', which consists in fixing a light to the mouth of a net for alluring the prawns. In the aquarium they hide among aquatic weeds during day time and in the absence of weeds they generally keep to the bottom, except when food is dropped or when they are subjected to external disturbances. They either lie flat on the bottom with all their thoracic

legs folded and their pleopods flexed underneath the abdomen, remaining motionless for an indefinite period or they stand on their posterior walking legs, usually on the last three pairs, with the body almost in a horizontal position. During the latter mode of resting their chelipeds are seen to be very active, either picking up small particles of food from the bottom or removing foreign particles that might have settled on their body and antennae. Occasionally the abdomen is flexed forwards beneath the body and brought nearer to the chelipeds for a thorough cleaning. During the incubation period the female frequently stands on its walking legs and rapidly waves the pleopods, thus probably aerating the eggs in the incubation chamber.

Food and feeding habits.—The stomach contents of a large number of males and females, ranging from 1″ to 4·5″ in length, were examined, and these indicated the presence of a large percentage of decaying vegetable matter, broken bits of molluscan shells and mud in many cases. In a few of the larger examples, undigested remains of crustacean appendages were also seen. In the aquarium they readily fed on cooked and uncooked rice, Mysids, *Acetes*, non-calcarious portions of Pteropods, small Polychaetes and fish fry. On continued starvation for two or three days, they exhibited cannibalistic tendencies, the larger and stronger ones feeding on the limbs and softer portions of the body of the smaller and weaker individuals. Very often they were found to consume the appendages of their own cast-off skin.

During the breeding season the stomachs of those females in which the ovaries were fully mature and about to spawn, were seen to be empty. Specimens reared in the laboratory in which the ovaries were fully mature abstained from food, but after spawning they fed vigorously. This habit is evidently correlated with the maturation and swelling of the ovary, the increasing volume of which occupies all the available space in the cephalothoracic region. A similar tendency to starve is also noticed for two or three days before ecdysis in order to keep the stomach empty, since it is also cast off along with the outer shell during ecdysis.

Colour.—In life large males of *P. idae* are uniformly light brown in colour and their long chelipeds are of a deeper tinge in the older specimens. The females and freshly moulted males are semi-transparent, while the young ones are almost transparent, the only coloured portion of the body being the eyes, which are black.

Reproduction.

Mature males of *P. idae* vary from 70 to 110 mm. and mature females from 50 to 90 mm. in total length. The number[1] of eggs produced by a female varies from 2,000 to 20,000 according to the size of the animal.

Experimental.—Live specimens of *P. idae* were brought from the Veli lake and reared in table tanks, for studying the life-history. After three days of acclimatization in a large table tank 2′×1′×1′, mature

[1] Only approximate determinations of the number of eggs present in the brood have been made, following the method adopted by Cecil von Bonde (1936).

males and females were selected and reared in pairs in small glass tanks measuring 10″×6″×6″ Some aquatic weeds were introduced into each tank and the water aerated daily. Females in which the transference of the eggs from the ovary to the incubation chamber took place in the laboratory, were kept under observation and the developmental changes recorded in a general way.

All the eggs in the incubation chamber of a particular female are found to be more or less in the same stage of development at any given time. This renders possible the observation of certain general features of development by direct examination of the broods. Since a large number of eggs are present in each brood, the removal of a few eggs at regular intervals will not completely exhaust the brood before the time of hatching.

As soon as spawning[1] was over in a particular individual, it was caught by the hand and holding it under water with its head and tail gently pressed between the fingers, a few eggs were carefully detached and removed with a pippette into a watch glass for examination. The grip was then slowly loosened and the animal allowed to escape. After an interval of twenty-four hours a few more eggs were again stripped in the same way from the same individual. This process was repeated regularly at intervals of twenty-four hours.

Eggs in the early stages of development, when stripped from the pleopods and reared in petri-dishes, were found to degenerate and perish rapidly due to fungal infection even though the water was constantly aerated, but advanced eggs, six to eight hours before hatching, when detached from the brood were found to hatch in petri-dishes. Similar difficulty in the artificial rearing of young embryos of *Astacus fluviatilis* has been recorded by Reichenbach, as mentioned by von Bonde (1936).

At 6 p.m. on the 16th September 1940, the female in one of the small tanks was seen spawning. As soon as the spawning was over a few eggs were stripped from its brood for observation, and the stripping was repeated at intervals of twenty-four hours. The last stripping was done on the 30th night, even after which a good number of eggs was left in the brood. In the morning of 1st October all the remaining eggs in the brood hatched, and a number of young ones were seen attached to the illuminated surface of the glass tank.

On the 19th September at 8 p.m., the male of a second set in a different tank was observed in the act of "fencing"[2] the female. However, mating did not take place till 9 p.m. On the following morning all the eggs were seen in its brood, mating and spawning evidently having taken place during the preceding night. This individual was kept as a control for comparing the period of incubation in the undisturbed state. This brood hatched during the night of 4th October.

[1] The extrusion of eggs into the brood chamber has been referred to as "spawning".

[2] As a preliminary to mating the male is seen to "fence" the female between its long chelipeds without allowing it to escape.

With a view to varifying the period of incubation, different broods were kept under observation till the end of December, and in all cases it was seen that the period of incubation was from 14 to 16 days, most commonly 14 days, and that the daily disturbance caused by the stripping of a few eggs from the brood did not in any way hinder the natural development of the eggs still remaining in the incubation chamber or cause any appreciable variation in the period of incubation.

Development of the embryo in the brood. (*Text. figs. 1, 2a-c*).— Soon after spawning, the eggs are deep green in colour, broadly oval in shape and measure about 0·56 mm. along the long axis and 0·44 mm. along the short axis. No trace of segmentation is visible externally. The egg is enveloped in a thin membrane outside which is another thin chitinous covering, prolonged at one end into a short flexible and elastic stalk, which secures attachment to the brood. The chitinous covering is thin and transparent and is not only capable of withstanding considerable tension but also permits a slight increase in volume.

About 24 hours after spawning (Text-fig. 1 *a*) a slight increase in the size of the egg is noticed. Examination of the egg at this stage shows the presence of superficial hexagonal markings which are probably the limits of the primary yolk pyramids. Scattered all over the surface of the egg, inside the egg case, could be seen numerous oil globules.

On the second day (48 hours after spawning) a small portion at one end of the egg becomes differentiated into a thick transparent plate, the blastoderm or the ventral plate.

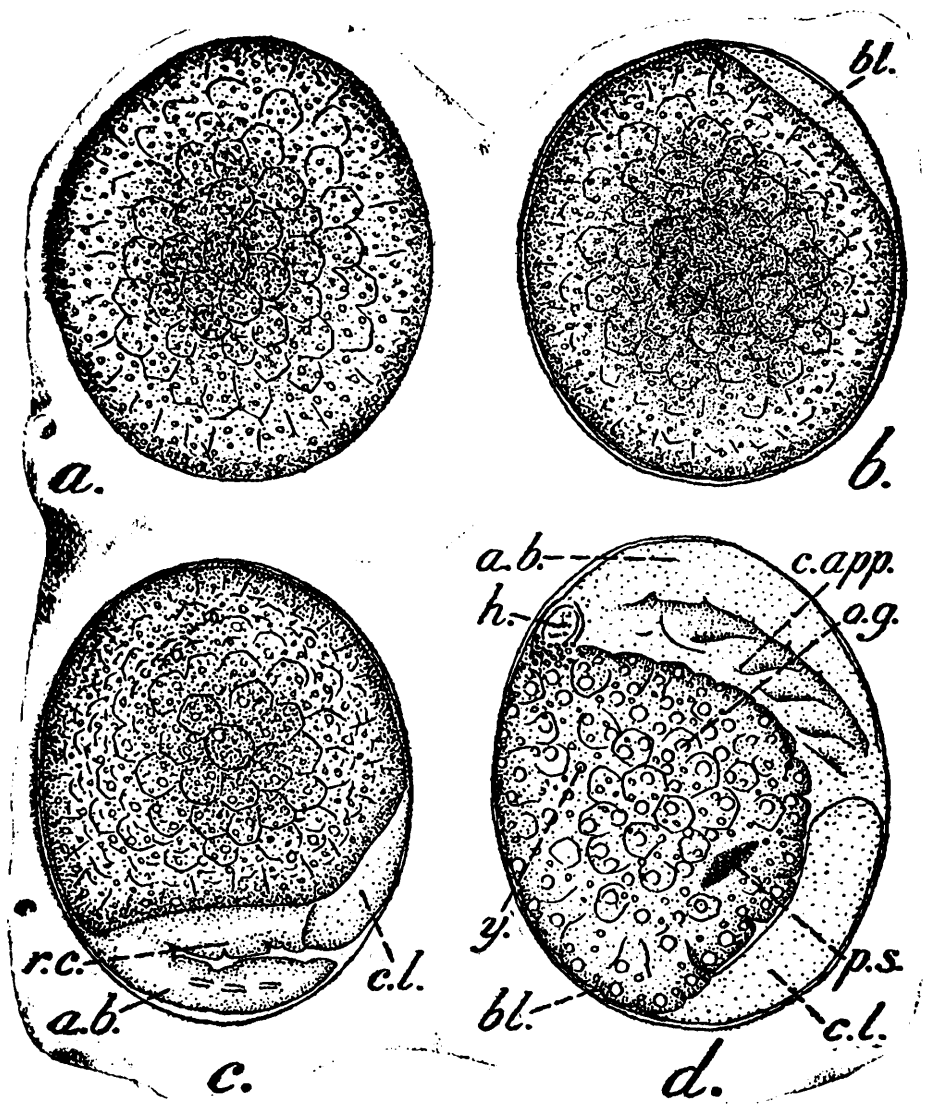
As development proceeds by the gradual assimilation of the yolk, the ventral plate becomes very distinct and on the third day (Text-fig. 2) the rudiments of the cephalic and thoracico-abdominal regions can be seen.

On the fourth day indications of the posterior or abdominal lobe is visible. The anterior region of the ventral plate is now distinguishable as a thick and rather stout rudiment of the cephalic lobe. Posteriorly the thoracico-abdominal lobe develops a forwardly directed ventral lobe which marks the beginning of the abdominal lobe. Thus at this stage the rudiments of the three regions of the body become visible, though no sign of segmentation is seen either in the cephalic or in the abdominal lobe. Between the cephalic and abdominal lobes four irregular rounded buds could be seen which represent the rudiments of the cephalic appendages.

On the fifth day (Text-fig. 1 *c*) the oil globules, which are scattered all over the yolk, become larger in size and the quantity of yolk is appreciably reduced, with the result that the deep green colour of the yolk has begun to fade slowly. The cephalic lobe has increased in size, differentiation of the cephalic appendages is more prominent and one more pair of buds has developed posteriorly. The abdominal lobe has elongated considerably and now appears like a flap overlapping the greater part of the thoracic region ventrally. Faint indications of segmentation are also visible, though the number of segments of the

abdomen cannot be counted *in situ*. The hind gut also becomes discernible as a straight narrow tube running through the middle of the abdominal lobe.

By the beginning of the sixth day the abdominal lobe has elongated considerably and approaches almost the anterior end of the cephalic lobe. The yolk has become pale green. The pigment spots of the eyes make their appearance as small dark crescentic streaks. In the posterio-dorsal region of the embryo, at the junction of the thoracic and abdominal lobes, a small oval vesicle is visible, in which an occasional gentle throbbing is noticeable. This marks the beginning of the embryonic heart.



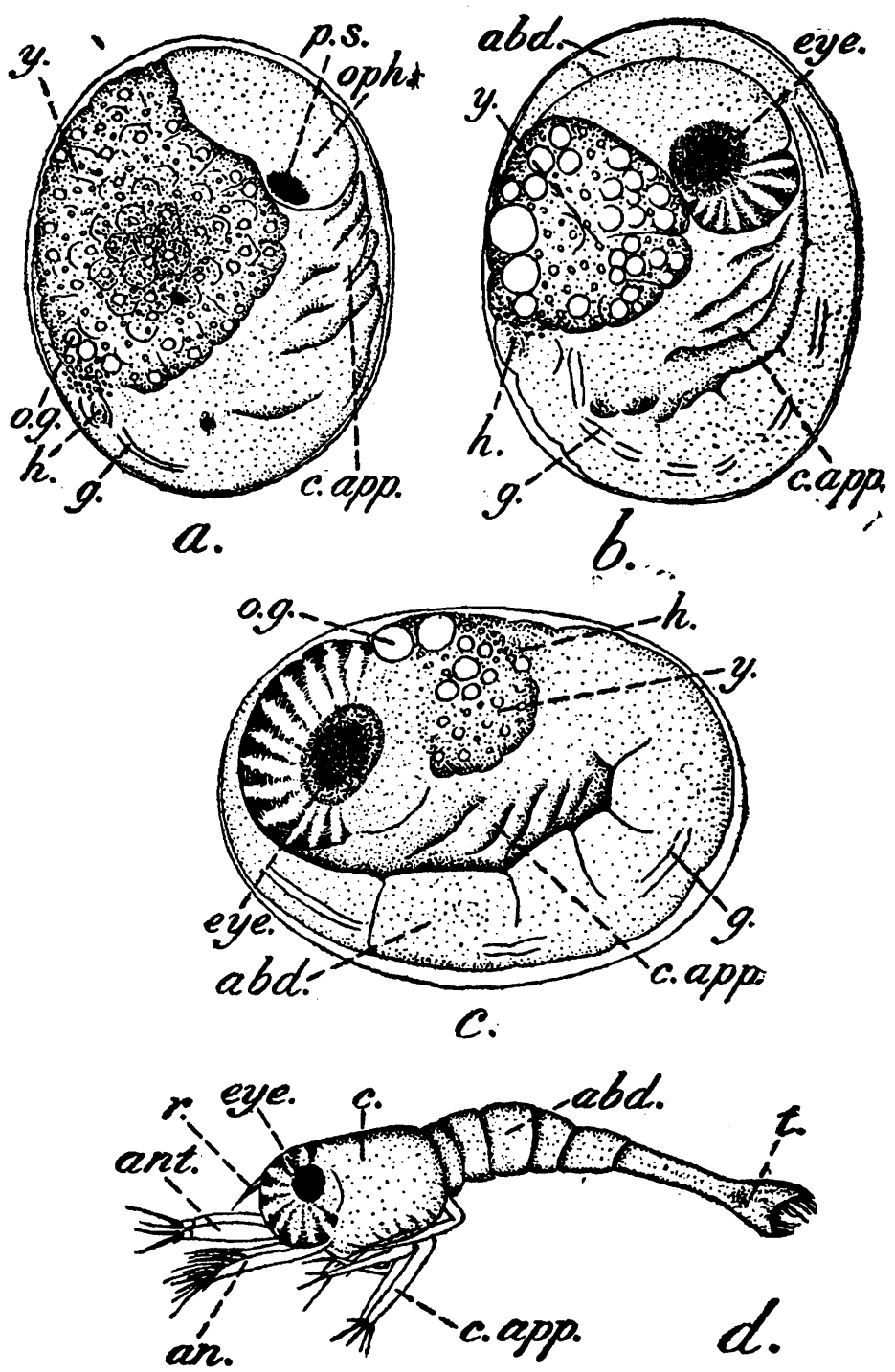
TEXT FIG. 1.—Developing embryo of *Palaemon idae* Heller.

a. 24 hours after spawning : X 86 ; *b*. third day stage ; X 86 ; *c*. fifth day stage ; *d*. seventh day stage.

a.b. abdominal lobe ; *bl*. blastoderm ; *c.app*. cephalothoracic appendage ; *cl*. cephalic lobe ; *h*. heart ; *o.g*. oil globule ; *p.s*. pigment spot of eye ; *r.c*. rudiments of cephalic appendage ; *y*. yolk.

Regular rhythmic pulsation of the heart is observed on the seventh day. At the same time the rudiments of the cephalothoracic appendages have elongated considerably and as many as six pairs of stump-like appendages can be seen in a side view (Text-fig. 1*d*). The tip of the abdominal lobe is marked off as the tail region, from which the uropod of the adult is developed at a later stage.

On the eighth day, the anterior part of the cephalic lobe is differentiated into the ophthalmic lobe by the appearance of a shallow constriction between it and the more posterior part of the cephalic lobe. A pericardial sinus envelops the heart, in which rhythmic pulsation is clearly seen.



Text Fig. 2.—Developing embryo of *Palaemon idae* Heller.

a. ninth day stage : X 86 ; *b.* twelveth day stage ; *c.* fourteenth day stage ; *d.* newly hatched larva : X 32.

abd. abdomen ; *an.* antenna ; *ant.* antennule ; *c.app.* cephalothoracic appendage ; *eye.* eye ; *g.* gut ; *h.* heart ; *o.g.* oil globule ; *oph.* ophthalmic lobe ; *p.s.* pigment spot of eye ; *r.* rostrum ; *t.* tail ; *y.* yolk.

On the ninth day (Text-fig. 2 *a*) the pigmented eyes become more prominent. The yolk hts dwindled to a third of its original volume and

is still pale green. The ophthalmic lobe is more distinct and the cephalothoracic appendages have elongated considerably. The embryo lies bent up, with the ophthalmic lobe directed forwards, the yolk occupying the middle region, and the elongated abdomen curving round and overlapping the cephalothoracic region.

On the tenth day the remaining yolk is almost semi-transparent. The region between the cephalic and ophthalmic lobes is marked off by a short constriction.

On the eleventh and twelfth days (Text-fig. 2 *b*) the abdominal lobe elongates further. The tip of the tail lies flat over the basal region of the ophthalmic lobe. The abdominal segments are clearly marked.

By this time all the embryonic structures have been developed and the yolk disappears gradually. Jerky movements of the embryo, which are occasionally noticed even earlier, become more frequent on the thirteenth day. On the fourteenth day (Text-fig. 2 *c*) the embryo hatches as a tiny larva.

Hatching.—As a result of the jerky movements of the embryo the inner and the outer chitinous coverings break and the larva emerges out. All the eggs in the brood are not hatched simultaneously. Hatching takes place in batches of twos and threes. There is a regular sequence in the process of hatching; the first spawned eggs, which lie towards the periphery of the incubation chamber, hatch first, while those lying more internally follow in succession. Generally hatching takes place at night and the time taken depends upon the number of eggs present in the brood.

Dispersal.—Dispersal of the newly hatched larvae is brought about by the currents set up by the rapid movements of the pleopods. As soon as the larvae are liberated in the water, they make a few jerky movements by bending and straightening their abdomen. After some time the larvae begin to swim with the help of their thoracic appendages towards the side of the glass tank facing the window. Reaching this surface they attach themselves to the sides of the glass by the thoracic appendages, with the tail directed upwards. This reversed posture of the larvae is indicative of the relative weight of the anterior portion of the body. On being disturbed they make a few jerky movements and scatter themselves temporarily in all directions.

During the day the larvae are seen attached to the more illuminated surface of the glass tank, but during night they scatter themselves in all directions. However, when a light is placed at one side of the tank, all the larvae move towards that side and attach themselves to the surface opposite the source of light. When the light is slowly moved to the left or right, the larvae also follow the source of illumination and if the light is switched off, slowly they scatter themselves in all directions.

The freshly hatched larvae of another species, *viz. Palaemon dolychodactylus* Hilgendrof, were seen to behave likewise in the laboratory. Lyon (1906-7) observed a similar phenomenon in the larvae of *Palaemonetes*.

THE LARVA.

The newly hatched larvae are transparent and measure about 1·60 mm. to 2·00 mm. from the tip of the rostrum to the end of the tail. The carapace is produced anteriorly into a long and slender rostrum, reaching to about three quarters the length of the antennular peduncle. The cephalothoracic region possesses a pair of large sessile eyes, a pair of antennules, a pair of antennae, a pair of mandibles, two pairs of maxillae, three pairs of maxillipeds and large biramous rudiments of the first two pairs of peraeopods. The abdomen is long and slender and is devoid of any appendage. The telson is longer than broad, with a concave outer margin bearing seven pairs of spines, the innermost pair being the shortest. The larva is practically identical with stage 1 of the larvae of *P. rudis* and *P. carcinus* (Menon 1938).

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