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DESCRIPTIONS OF THE TWO
MEGALOPAL STAGES OF LABORATORY-
REARED PINK SHRIMP, *PANDALUS JORDANI*

INFORMATION REPORT

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DESCRIPTIONS OF THE TWO MEGALOPAL
STAGES OF LABORATORY-REARED PINK
SHRIMP, PANDALUS JORDANI

This report describes for the first time, megalopal stages of the commercially important pink shrimp, Pandalus jordani, with a comparison with previously published larval studies. This will benefit future workers rearing this species' larvae and also in identification of its megalopae from plankton samples.

Published studies of P. jordani larvae have been primarily restricted to descriptions of laboratory-reared zoeal stages. Modin and Cox (1967) cultured this species through 11 to 13 zoeal stages, with only one shrimp surviving to the first postlarval (megalopal) stage. This megalopal stage was not described. Lee (1969) also reared P. jordani larvae but none survived past the eighth zoeal stage. Peter Rothlisberg (Oregon State University, Department of Zoology, Pers. Comm.) reared P. jordani through 16, not yet identified, larval stages with a few individuals surviving to become juvenile shrimp. Hosie (1975) reared P. jordani through 10 to 12 zoeal stages and 2 megalopal stages, which are discussed in this paper.

METHODS AND MATERIALS

There is confusion regarding terminology of northeastern Pacific ocean pandalid shrimp larvae. This confusion applies to use of the words stage, larva, zoea, megalopa, and postlarva. In this paper, a stage denotes the period (intermoult) between successive ecdyses (Price and Chew 1972). A larva is a young post-embryonic form, morphologically distinct from the mature adult. This term is applicable to the zoea and megalopa of P. jordani. Williamson (1969) considered a zoea to be a larva with pleopods generally absent or rudimentary and having natatory exopodites on some or all thoracic appendages. The zoea is the earliest larval form of P. jordani known to occur in nature. Lee (1969) however, reported

pre-zoea, which emerged under unfavorable laboratory conditions. Pike and Williamson (1969) defined a pandalid shrimp megalopa as the larval form in which either pleopods become functional or natatory exopodites on the pereopods are lost, or both. Their terminology has been adopted in this report. They found morphological characteristics at metamorphosis to the megalopa were not the same for all pandalid species studies. Modin and Cox (1967) and Lee (1969), used the terms postlarva or almost adult instead of megalopa for P. jordani. These names are misleading because the megalopa is a larval form morphologically distinct from juvenile and adult P. jordani. The juvenile has the characteristics of the adult, but is sexually immature.

Ovigerous P. jordani were obtained in March 1971 by shrimp trawl off Coos Bay, Oregon. These shrimp were transported to the Fish Commission of Oregon marine laboratory at Newport, Oregon. Adult shrimp were held alive in the laboratory and newly hatched larvae obtained from them.

Culture techniques were those of Hosie (1975). During April 1971, 120 newly hatched zoeae were placed into four 500-ml aerated transparent Erlenmeyer flasks (30 zoeae/flask), each containing 400 ml of water. The flasks were held in a constant water bath. Larvae were maintained until July 1971 when the experiment was terminated. At each stage larvae were measured from the anterior tip of the antennal scale to the posterior margin of the telson. Carapace lengths, from the base of the eyestalk to the posterior mid-dorsal edge, were also obtained at all stages. Measurements were made to the nearest lower 0.5 mm using a metric ruler.

Transparent exuviae and dead larvae were removed from the culture system and preserved in 5% formalin for morphological work. Megalopae were later transferred to 100% glycerin for dissection. Temporary mounts in glycerin were made of the dissected material.

Drawings of megalopae were made with the aid of a dissecting microscope and a compound microscope, both with a camera lucida attachment. Illustrations were made using a typical individual from each megalopal stage. Drawings were made of

the whole animal's lateral view, antennule, antenna, first three pereopods, second pleopod and telson. Descriptions and measurements were obtained from five first stage megalopae and four second stage megalopae.

DESCRIPTIONS OF MEGALOPAL STAGES

Measurements and spine counts (Table 1) of cultured specimens of the two megalopal stages showed some variation between individuals within a stage. However, these differences were not large.

First Megalopal Stage

The first megalopa (Fig. 1A) measures 17.5 to 18mm. It is distinguished from the last zoeal stage by lack of natatory exopodites on the first three pereopods. The most apparent larval characteristics still remaining are a telson with more than four terminal spines and a rostrum shorter than the antennal scale.

Rostrum - The rostrum (Fig. 1A) has 12 to 16 dorsal spines and 3 to 5 ventral spines.

Antennule - The outer flagellum (Fig. 1B) is still divided into 6 segments. The smaller inner flagellum bears 7 segments, one more than the preceding stage.

Antenna - The antenna flagellum (Fig. 1C) is divided into 45 to 50 segments. The antennal scale is much larger than in previous stages and is assuming the square-tipped narrow form of the adult.

First pereopod - the first pereopod (Fig. 1D) bears only a rudimentary bud-like exopodite.

Second pereopod - This thoracic appendage (Fig. 1E) has 6 segments, with 1 joint appearing on the carpus of the chela for the first time. It also possesses a rudimentary exopodite.

Third pereopod - This pereopod (Fig. 1F) has grown larger than in the preceding stage and lacks a functional natatory exopodite.

Pleopods - These swimming structures (Fig. 1G) are essentially adult, being longer and more setose than the preceding stage.

Telson - The telson (Figure 1H) bears 6 to 8 large spines on its convex terminal

margin and 18 small, simple spines along the lateral margin. This compares to 10 terminal spines and 14 lateral spines described by Modin and Cox (1967) for the last zoeal stage. The uropods are well developed and densely fringed with about 60 large, heavily plumose natatory setae.

Second Megalopal Stage

The second megalopa (Fig. 2A) is 18.0 to 18.5 mm long and can easily be separated from previous stages by a rostrum extending to the tip of the antennal scale. This stage, however, is still a larval form. In post-larval juvenile and adult P. jordani the rostrum extends beyond the antennal scale and is, according to Rathbun (1904), about 1.75 times longer than the carapace. Also the second megalopae still have the larval characteristic of rudimentary exopodites on the first 3 pereopods.

Rostrum - The rostrum (Fig. 2A) has 15 to 19 dorsal spines, 1 near the tip, and 6 to 8 ventral spines. It now projects as far as the tip of the antennal scale.

Antennule - The outer flagellum (Fig. 2B) is divided into 10 segments. The smaller inner flagellum bears 8 segments.

Antenna - The antenna flagellum (Fig. 2C) is divided into over 100 segments and is essentially adult, being almost as long as the body. The antenna scale is similar to the first megalopal stage.

First pereopod - This thoracic appendage (Fig. 2D) has 5 segments. This is one more segment than the first megalopa. A rudimentary exopodite is still present.

Second pereopod - The left second pereopod (Fig. 2E) has an essentially adult chela with 10 to 14 joints on the carpus. A bud-like exopodite is still present. The right second pereopod has 5 to 7 carpus joints.

Third pereopod - (Fig. 2F) has 6 segments, one more than found on first megalopae, and a rudimentary exopodite.

Pleopods - The pleopods (Fig. 2G) are essentially adult, being unchanged from the preceding first megalopae.

Telson - The telson (Fig. 2H) has 4 to 6 large terminal spines and 18 lateral

spines. The uropods are essentially adult, being little changed from the first megalopae.

DISCUSSION

Results of the study showed a larger size (Table 2) than Modin and Cox (1967) and Lee (1969). Lengths of zoeae increased from 6.25 mm at stage 1 to 17.25 mm at stage 10. Zoeae reared by Modin and Cox (1967) were 5.25 mm at stage 1 and 14.75 mm at stage 10. Lee (1969) used a criterion for measuring growth not comparable to this study (Table 17). Duration of larval stages in the two previous studies averaged 6 to 7 days, a shorter time than the 10 to 25 days found in this study. First stage megalopae achieved a mean length of 18.75 mm and megalopae II, 18.75 mm. Carapace lengths of larvae increased from 1.25 mm at zoeal stage 1 to about 3.5 mm in the second megalopal stage.

The morphology of zoeae reared in this study were similar to those reported by Modin and Cox (1967) and Lee (1969). Differences in growth, as well as morphological discrepancies, were probably caused by a combination of factors, including differing populations of shrimp and contrasting rearing conditions. (Table 3).

The 10 to 12 zoeal stages and two megalopal stages found may be atypical for this species. Pike and Williamson (1964) cultured European pandalid shrimp and reported more larval stages than in natural conditions. The number of larval stages has also been found to vary for pandalid shrimp in nature (Karata 1964, Pike and Williamson 1964). This variation in moulting among decapod larvae has been suggested by Broad (1957a, 1957b) to be governed by external factors independent of rate of development. Hence, the stages of laboratory-reared P. jordani larvae should not be thought of as inflexible, natural steps through which all individuals pass.

It was not possible to determine if lengths of most P. jordani larval stages cultured were similar to those in nature. However, carapace lengths of second megalopal stage shrimp possibly were close to those in the ocean. Cultured larvae at this stage has carapace lengths with a mode of 3.5 mm at 95 days of age. Lukas and

Hosie (1973) found 3.5 to 5.5 mm (mode 4.5 mm) carapace lengths for approximately 75 to 90 day old juvenile P. jordani collected from off northern Oregon in early June 1970.

The descriptions of these megalopal stages of P. jordani may prove valuable in future plankton larval studies for identification of megalopae of this species. I recommend that these descriptions be used only as guidelines because of known differences between laboratory and natural populations of larvae of other species of pandalid shrimp.

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