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DESCRIPTIONS OF SHRIMP LARVAE (FAMILY PENAEIDAE) OFF THE MISSISSIPPI COAST

by
C. B. Subrahmanyam[1]

INTRODUCTION

Müller (1864) showed that the penaeid egg hatches into a nauplius. Some years later studies of the metamorphosis of penaeid shrimps in the Gulf of Mexico were made (Pearson 1939, Heegaard 1953, Dobkin 1961, Cook and Murphy 1965, and Renfro and Cook 1963). The present paper treats the larvae taken in Mississippi and brings together the descriptions of the larvae scattered in the literature. The salient features of various stages of different species of the six genera studied are pointed out with the aid of drawings to facilitate easier identification. Besides the references cited above, the works of Heldt (1938), Gurney (1924, 1942), Heegaard (1966) and Cook (1966) have been consulted for this presentation.

The author is grateful to Dr. Gordon Gunter for his helpful criticisms and to Dr. Harold Howse, Gulf Coast Research Laboratory, for his generous help in photography.

MATERIALS AND METHODS

Plankton was collected simultaneously from the surface, mid-depth, and bottom at 10 m, 18 m, 36 m, 54 m, 72 m, and 90 m depths in the Gulf of Mexico. The nets used were fitted with closing devices and the netting had a mesh of 0.33 mm. After letting the plankton settle, penaeid larvae were picked out of the entire sample and preserved in buffered 5% formalin.

Photographs were taken with the aid of a microprojector. The larvae were placed in a depression slide which was mounted on the stage of the projector. The image of the specimen was directly focussed on an 8.3 x 10.2 cm photographic plate in a dark room and processed immediately. The subjects were printed on a high contrast gloss paper (Kodabromide F-5). Magnifications were measured by photographing a stage micrometer under the same setting. This method permits greater freedom for focussing and greater resolution of the objects. Pictures were drawn based on these photographs.

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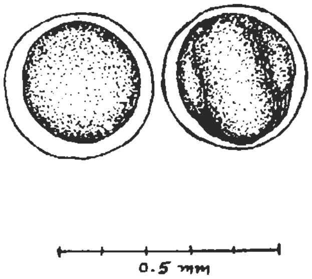

FIG. 1

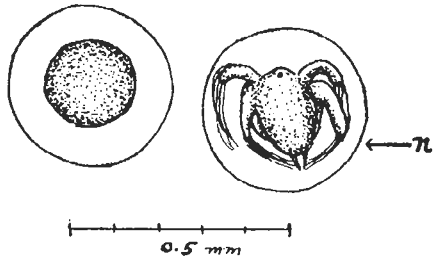

FIG. 2

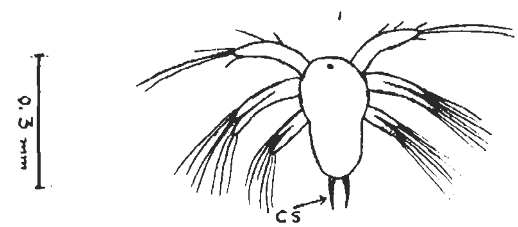

FIG. 3

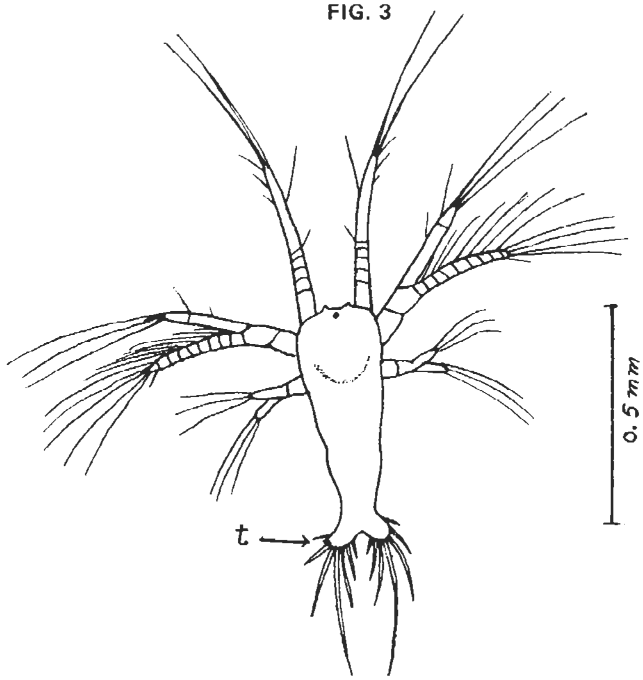

FIG. 4

The six littoral genera encountered in the samples were *Penaeus, Parapenaeus, Trachypeneus, Xiphopeneus, Sicyonia,* and *Solenocera*. Some larvae of *Gennadus* and *Artemisia* were taken one day in two years of collecting, and they are described separately (Subrahmanyam and Gunter 1970).

THE LARVAE

Eggs

Penaeus (Fig. 1). The egg measures 0.33 mm in diameter. The egg membrane is transparent. The perivitelline space is narrow and the embryo occupies almost the entire inside of the egg.

Trachypeneus (Fig. 2). Eggs with embryonic mass and nauplii inside measure 1.38 mm in diameter. They are larger than *Penaeus* eggs and the perivitelline space is wider. The nauplius, however, fills up the egg. These eggs were taken in thousands on some occasions.

Nauplius

Penaeus (Fig. 3). Only naplius V of this genus was collected. It measured 0.55 mm in body length. The oblong pear shaped body, deeply notched telson lobes, and long setae on the appendages are characteristic. These were collected mostly from 36 to 54 meter stations, and could belong to the white or brown shrimp.

Trachypeneus (Fig. 4). Only nauplius I of this genus was collected. It measures 0.28 mm in body length. The oval body and a protuberance on the dorsal side of the larva posterior to the median eye distinguish this larva. The eggs and nauplii of this genus were collected mostly at 9, 18, and 36 meter stations.

Protozoea

Penaeus (Fig. 5). Photozoea I measured 0.90 mm in body length. Frontal organs are present. The formula for the lateral setae on the end pod of antenna II is $2 + 2 + 1$ (Fig. 5A). The second protozoea (Fig. 5B) measures 2.04 mm in length. The rostral spine is long, veantrally curved, and measures about one third of the carapace length. Supraorbital spines are present. Protozoea III (Fig. 5C) measures 3.04 mm. The rostrum is longer. The lateral setae on the second antennal endopod retain the same formula as protozoea I.

Trachypeneus (Fig. 6). Protozoea I measures 0.91 mm in body length. It is very delicate and transparent (Fig. 6A). Protozoea II measures 1.40 mm in body length. The rostrum is

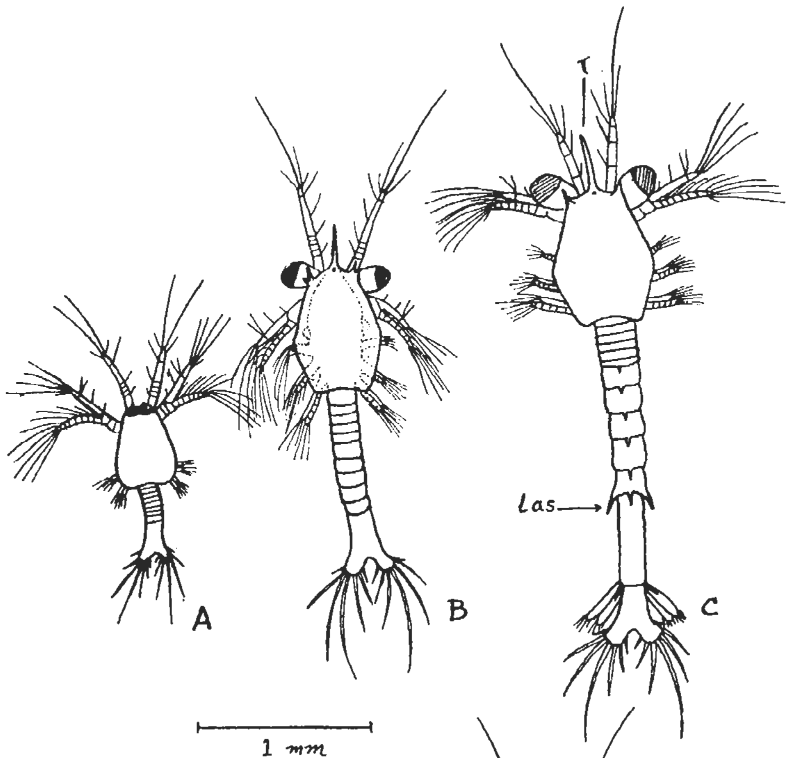

FIG. 5

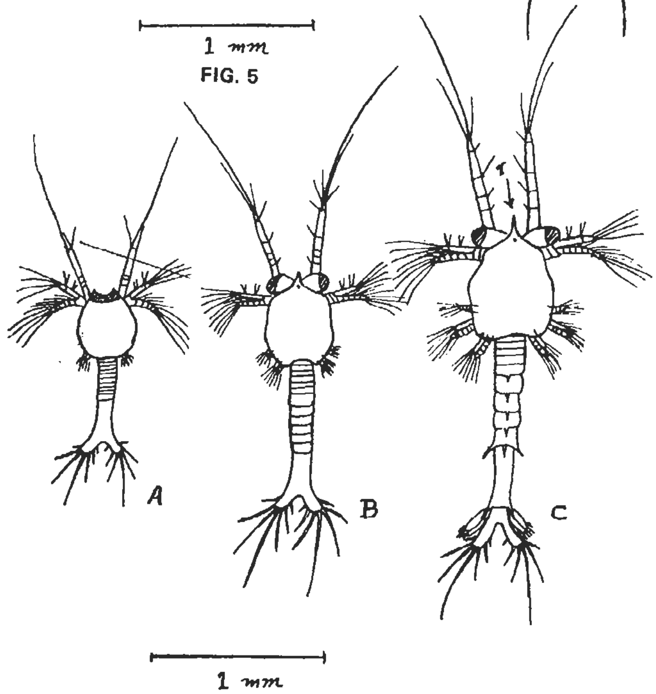

FIG. 6

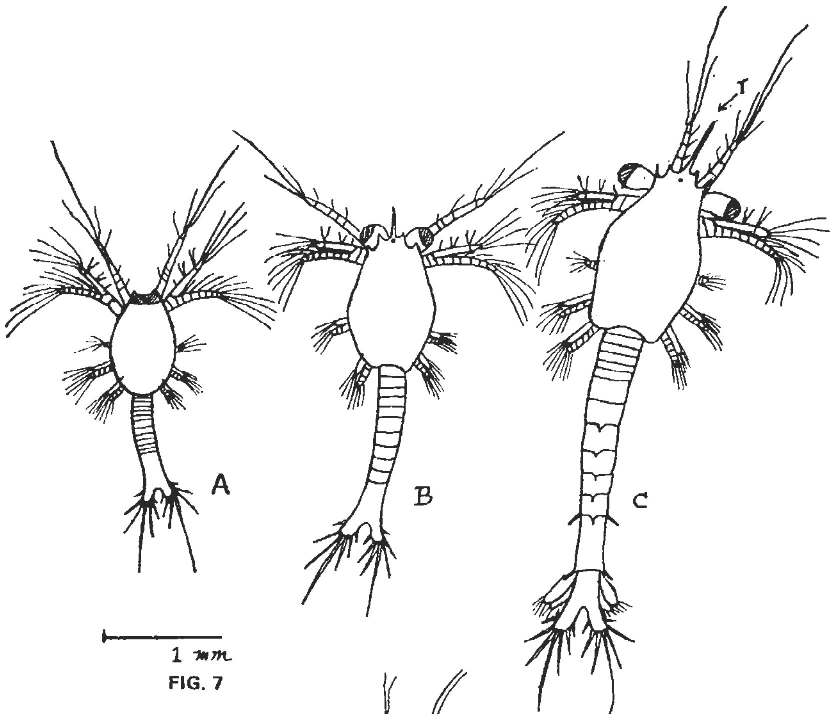

FIG. 7

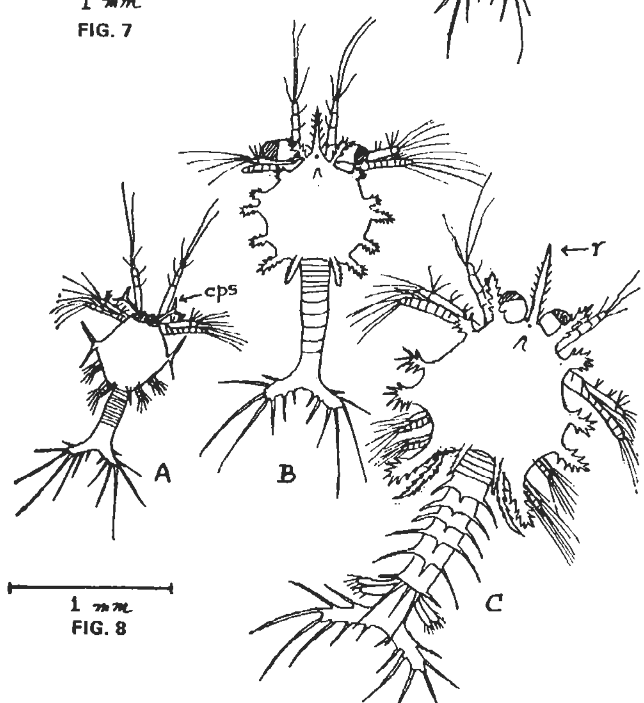

FIG. 8

short, and supraorbital spines are absent (Fig. 6B). Protozoea III measures 1.97 mm in body length. The rostrum is short (Fig. 6C). All three stages are identifiable with the setal formula of the second antennal endopod, 2 + 2, and short rostrum in second and third stages.

Xiphopeneus The protozoeal stages of this genus are identical in morphology and sizes to those of *Trachypeneus* except for one short terminal setae on the second antennal endopod.

Parapenaeus (Fig. 7). Protozoea I is larger than the other genera. It measures 1.28 mm in length (Fig. 7A). This stage and the following two stages show 2 + 2 + 1 lateral setae on the second antennal endopod. Protozoea I (Fig. 7B) measures 2.04 mm and is robust. The rostrum extends to the distal segment of first antenna, and two pairs of supraorbital spines are present. The third protozoea (Fig. 7C) measures 3.18 mm in body length. The rostrum is longer than that of comparable stage of *Penaeus*.

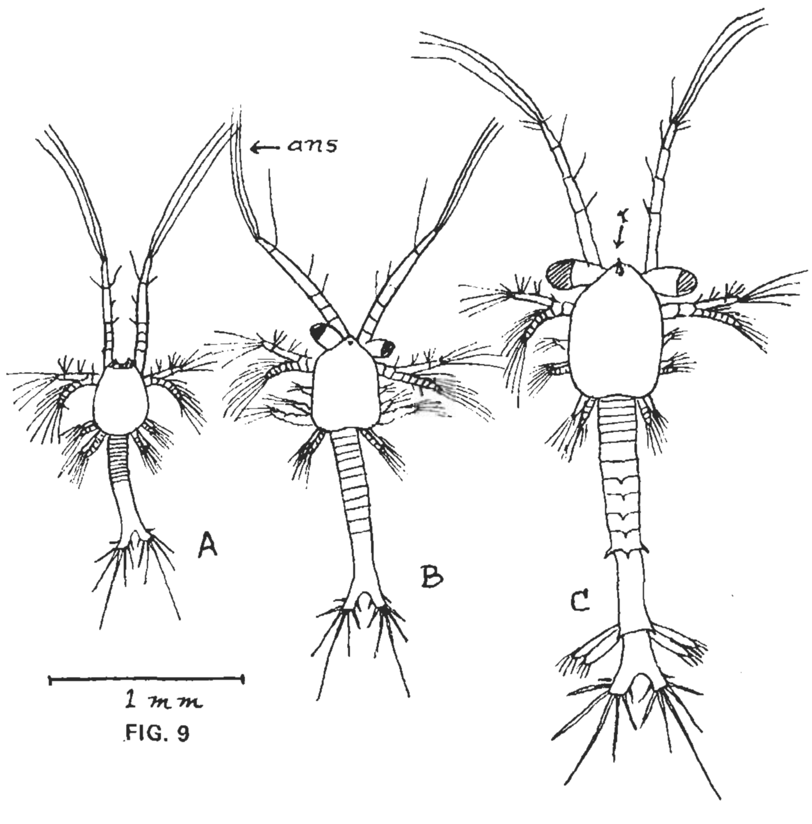

FIG. 9

Solenocera (Fig 8). Protozoea I (Fig. 8A) measures 1.0 mm in length. It has a short rostrum even at this stage. The carapace carries forked spines above the eyes, laterally and dorsally at the junction of carapace. The telson lobes are large and the notch is very shallow. The formula for the lateral setae on the second antennal endopod is 2 + 2 + 3 for all the three stages. The second protozoea (Fig. 8B) measures 1.84 mm in body length. The rostrum is spiny and as long as the first antenna. The carapace is characterized by spiny lobes. The eyes are large. The third protozoea (Fig. 8C) measures 2.66 mm in body length. It is robustly built, and the rostrum is longer than the first antenna. The supraorbital spines are large and robust. The carapace shows accentuated spiny protrusions and it is spiny all over. The salient feature is the presence of lateral spines on all the six abdominal segments. The telson carries long spines.

Sicyonia (Fig. 9). The first protozoea measures 0.93 mm in body length. The striking feature is the long first antenna (longer than the second) with three long terminal setae (Fig. 9A). The formula for the lateral setae on the endopod of second antenna is 3 + 2 + 1, which is the same for the next two

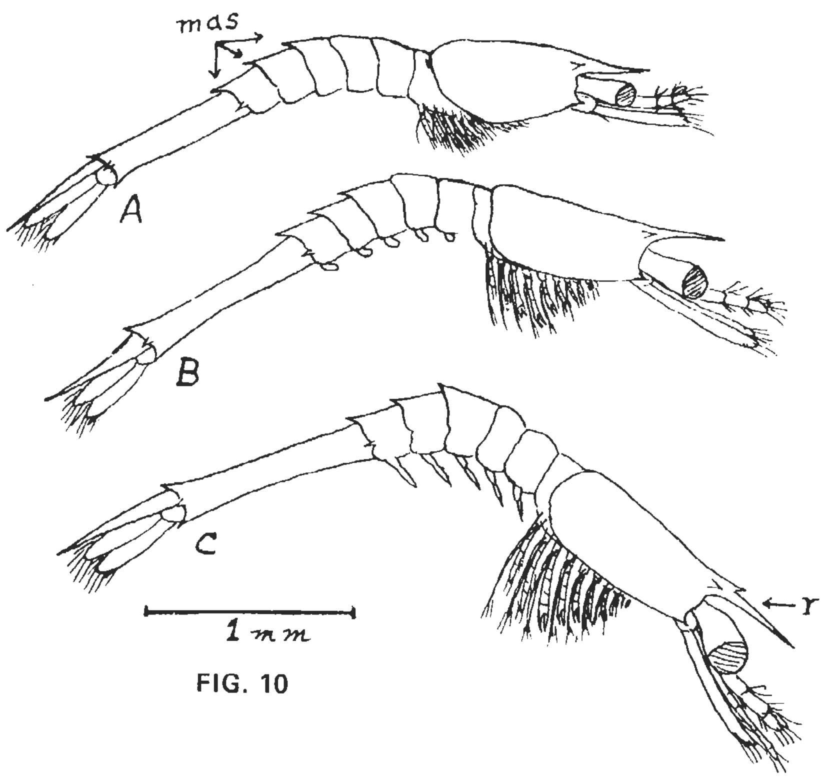

FIG. 10

stages. The notch on the telson is narrower than that of *Penaeus* and *Trachypeneus*. The second protozoea is characterized by the absence of rostrum (Fig. 9B). It measures 1.42 mm in body length. The first antennae are still the longest appendages. The third protozoea also shows no rostrum (Fig. 9C). This larva measures 2.24 mm in body length. It can be distinguished from the other genera by the three long antennal setae and the narrow notch on the telson.

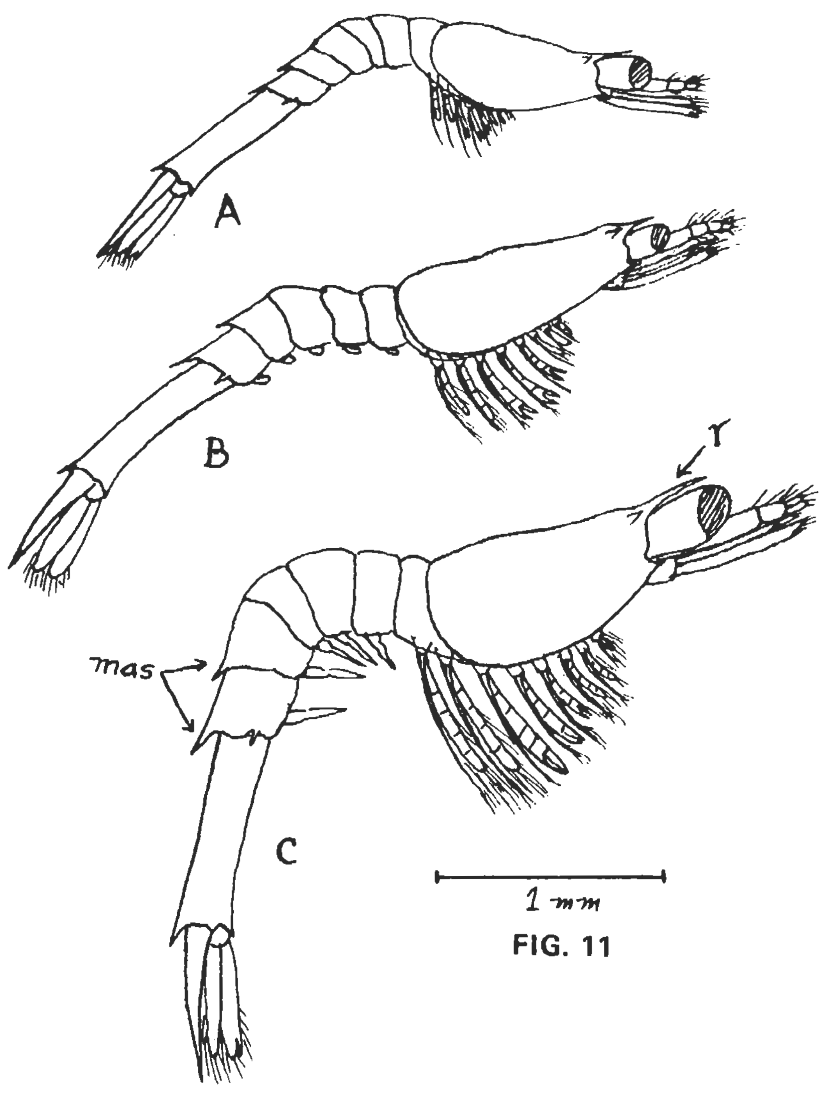

FIG. 11

Mysis

Penaeus (Fig. 10). All three mysis stages can be identified by the length of the rostrum reaching beyond the eyes, and dorsally one small spine each on the third, fourth, and fifth abdominal segment. The first mysis measures 3.47 mm in body length and is slender (Fig 10A). The second mysis measures 3.80 mm in length and shows pleopod buds (Fig. 10B). The third mysis is longer measuring 4.36 mm in length, and has one tooth on the dorsal margin of the rostrum (Fig. 10C) Pleopods are two segmented.

Trachypeneus (Fig. 11). The mysis of this genus can be distinguished by the length of the rostrum, which just reaches the margin of the eyes. The fourth and fifth abdominal segments bear dorsal spines, of the former being the shorter of the two. The first mysis measures 2.80 mm in body length and

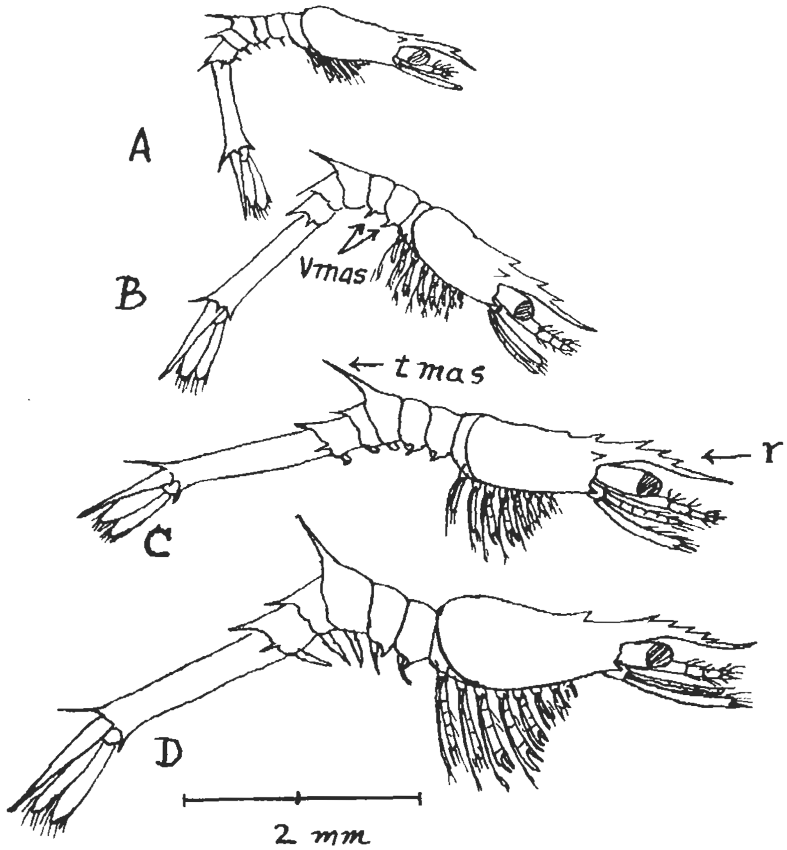

FIG. 12

is more transparent than the older larvae (Fig. 11A). The second mysis measures 3.62 mm in length and shows pleopod buds (Fig. 11B). The third mysis is not too transparent, measures 4.44 mm in length, and shows two segmented pleopods (Fig. 11C).

Xiphopeneus. The mysis stages of this genus resemble the previous genus in measurements. The only difference is the lack of lateral spines on the fifth abdominal segment.

Parapenaeus (Figs. 12 & 13). These myses are characterized by the rostrum extending beyond the eyes and a prominent spine on the third abdominal segment, followed by two shorter spines on the dorsal margins of fourth and fifth segments. The rostrum also bears teeth dorsally, and one tooth is added at each moult. The first mysis is slender, and measures 3.65 mm in length.

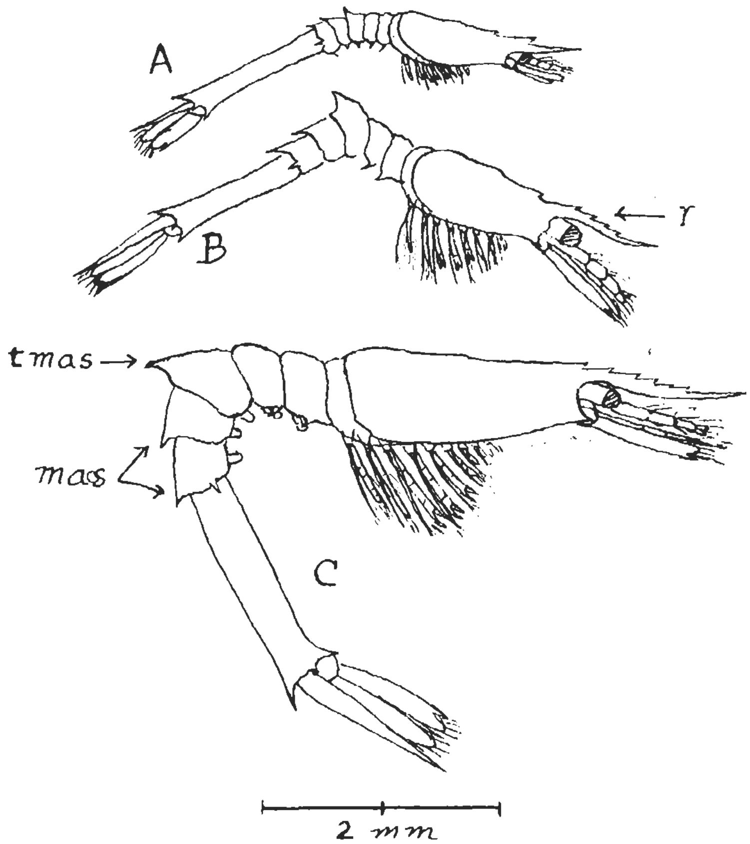

FIG. 13

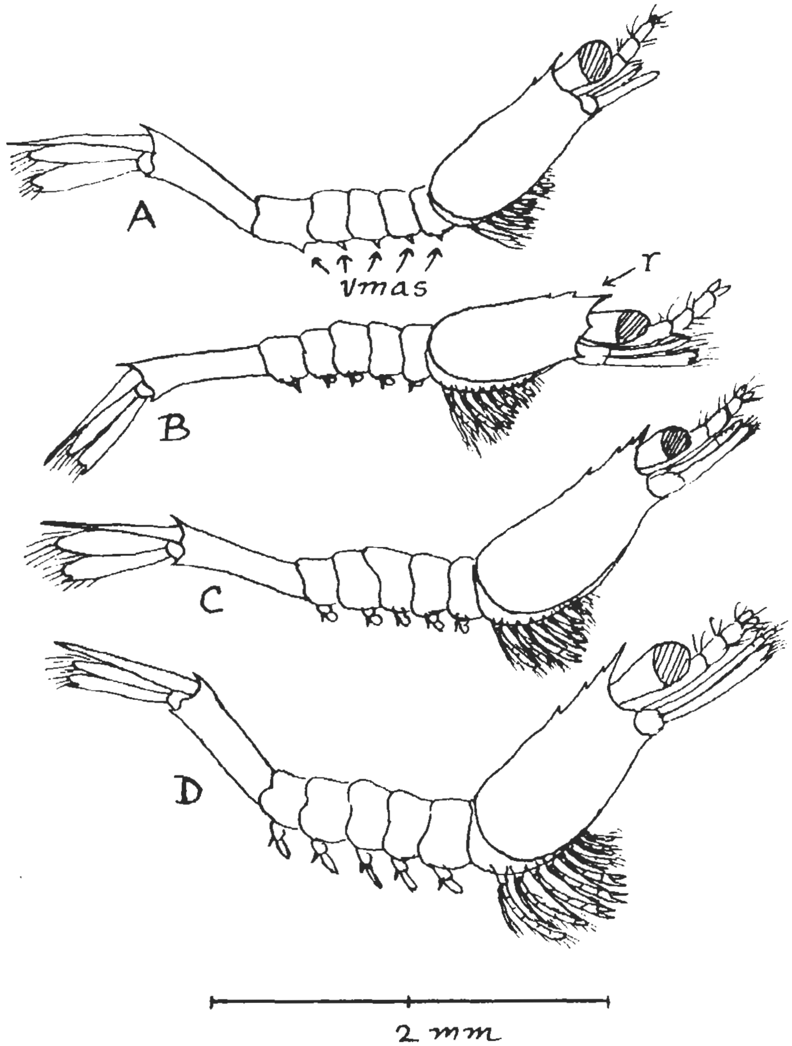

FIG. 14

The abdominal segments bear spines ventrally on the sternites of the first to fifth segments. The rostrum is decurved with two dorsal teeth (Fig. 12A). The second mysis measures 4.44 mm in length. The rostrum has three spines and the sternal spines on the third to fifth segments have disappeared (Fig. 12B). The third mysis measures 5.55 mm, has five rostral teeth, and two segmented pleopods (Fig. 12C). The characters of these larvae agree with those given by Pearson (*op. cit.*).

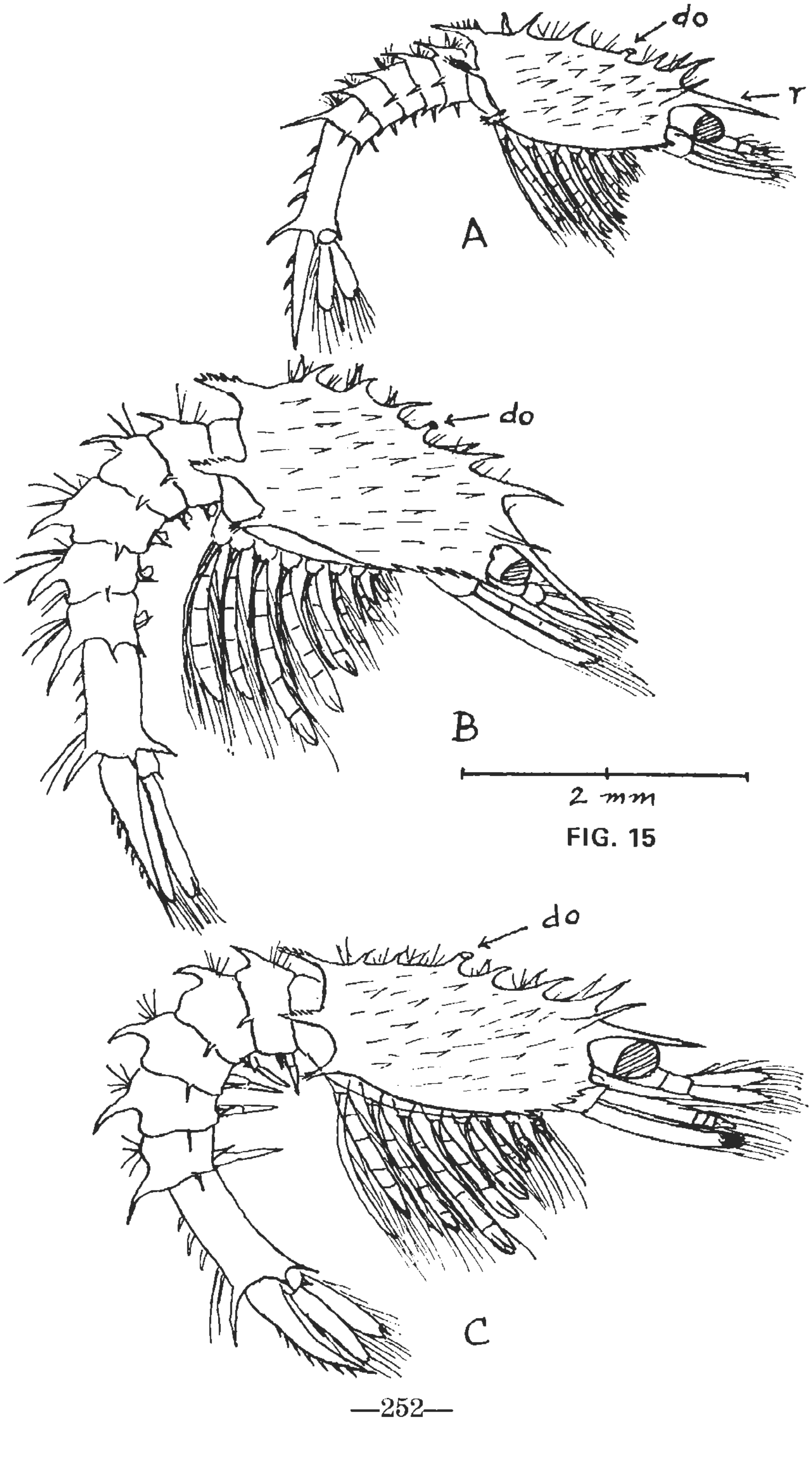

FIG. 15

Along with these mysis stages, occasionally slightly different types of myses were noticed (Fig. 13). They were generally larger and, while sharing the generic characters of the mysis described above, they have a longer rostrum with more teeth. The dorsal spine on the third abdominal segment is triangular, being broad at the base. The two short dorsal spines on the fourth and fifth segments are present. The first mysis measures 3.96 mm, the second 5.28 mm and the third mysis 8.00 mm in body length. It is obvious that these mysis are larger than those of *P. longirostris*. The rostral teeth numbered one for the first mysis, four for the second, and six for the third mysis (Fig. 13A, B, C). The fourth mysis was never caught.

Sicyonia (Fig 14). The mysis is characterized by a short rostrum (shorter than the eye), absence of dorsal spines on the abdominal segments, and presence of ventro-mediam spines on all the five abdominal segments. The larvae are also more robust. The first mysis measures 2.45 mm (Fig. 14A) and shows the ventro-median spines clearly. The second mysis measures 2.90 mm and shows rudiments of pleopod buds (Fig. 14B). The third mysis measures 3.20 mm in length, and shows small two-segmented pleopods (Fig. 14C). The fourth mysis measures 3.35 mm in length and shows prominent and two segmented pleopods. The features of these larvae are in general agreement with those given by Cook and Murphy (1965).

Solenocera (Fig. 15). The myses are the easiest to be identified by the spiny nature of the whole body. The rostrum is long, and the carapace as well as the abdomen carry long spines. The dorsal organ is the salient feature of *Solenocera* mysis, the function of which is disputed. The first mysis measures 4.42 mm in length and bears ventro-median spines (Fig. 15A). The second mysis measures 6.85 mm in length and bears strong spines dorsally on the abdominal segments. The pleopods are beginning to show (Fig. 15B). The third mysis measures 6.95 mm in body length, and bears dorsal abdominal spines and two segmented pleopods (Fig. 15C). These larvae were particularly abundant in waters deeper than 54 meters.

Postlarvae

Postlarvae of *Penaeus, Parapenaeus, Trachypeneus, Sicyonia*, and *Solenocera* were collected during the present study. Only the postlarvae of *Penaeus* and *Trachypeneus* are described here. These were most commonly taken in the plankton.

Penaeus (Fig. 16). The postlarvae are distinguished by long and slender bodies, thin rostrum, and long sixth abdominal segment. The post-larvae were identified with the aid of the key worked out by Williams (1959). In Figure 16, the first and the third postlarvae of *Penaeus fluviatilis* are given. The first postlarva is slender, and measures 4.5 mm in body length. The ros-

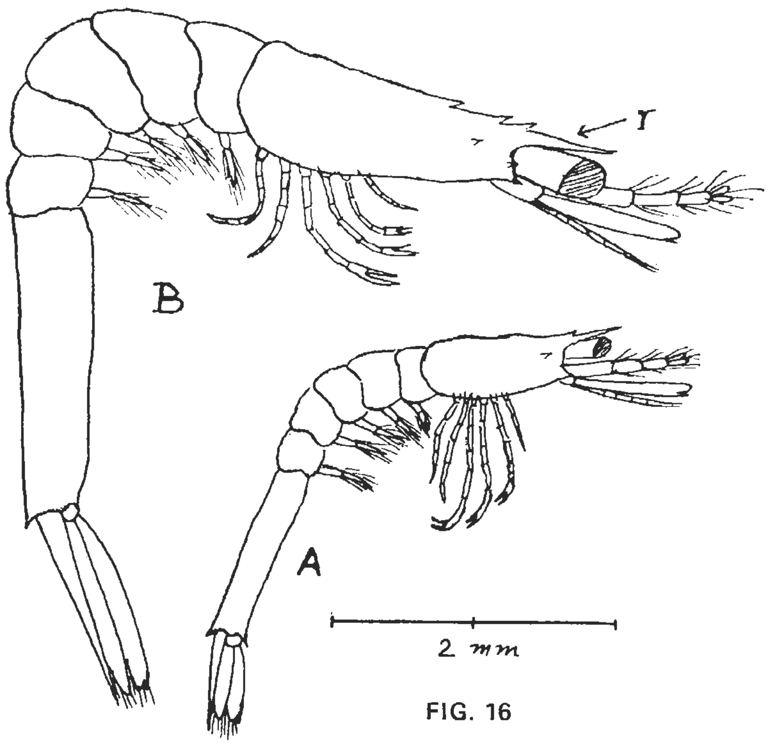

FIG. 16

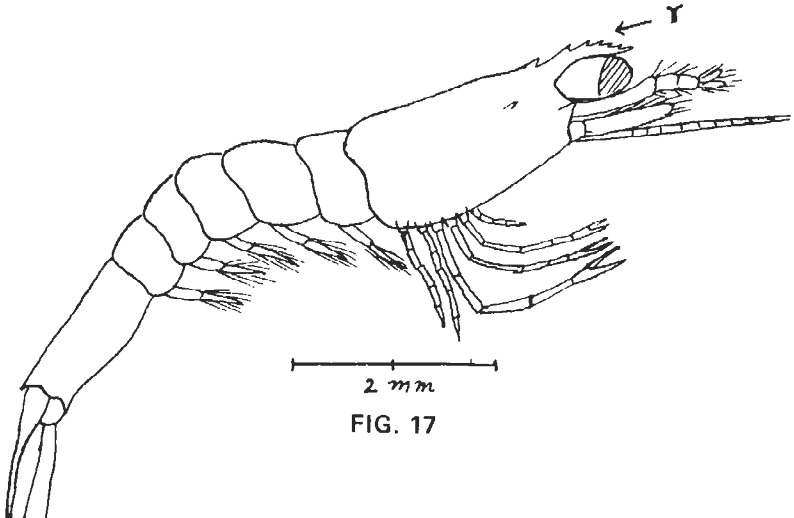

FIG. 17

trum evens with the margin of the eye, and bears one dorsal tooth (Fig. 16A). The third postlarva measures 8.38 mm in length and has three rostral teeth. The rostrum just reaches the margin of the eye (Fig. 16B). Though the postlarvae of brown shrimp were taken, they are not described here. Pink shrimp postlarvae were least abundant of the three species.

Trachypeneus (Fig. 17). The postlarva is thick and the sixth abdominal segment is not as long as in *Penaeus*. The rostrum does not reach up to the margin of the eye, and it bears seven dorsal teeth. It measures 8.45 mm in body length, and judging from its size and the number of rostral teeth it is the fourth postlarval stage. Younger postlarvae were not common in the plankton samples.

REMARKS

The diagnostic characters of different larval stages of various species of the six genera have been pointed out to facilitate easier identification. Plankton samples collected from any level of a water column (of the area sampled) and from any depth invariably contain a mixture of stages and species, and it is possible to identify these larvae with the help of the drawings presented as far as the Gulf of Mexico genera are concerned. It appears to be a general feature with crustaceans that their larval stages occur together in any area. The proportions of stages and species, however, exhibit seasonal variations. This has been observed by Gurney (1924, 1942), Pearson (1939), and Eldred *et al.* (1965). Gurney (1924) remarks that crustacean larvae have the power of keeping together or collecting at a suitable locality and may not be at the mercy of the currents as much as it is generally supposed. The correspondence between the bathymetric distribution of the larval species and the adults appears to lend support to this surmise.

It has been found that the identical stages of any species are not uniform in size, and identification based on the size alone is liable to be misleading. That within an instar the body size of the larvae may differ has been pointed out by Hudinaga (1942) and again by Renfro and Cook (1963). Though growth has been known to occur only at each molting in crustaceans it is interesting that size differences within an instar are noticeable.

It is difficult to separate the three species of *Penaeus, P. fluviatilis, P. aztecus,* and *P. duorarum,* based on larval morphology or morphometry. The white shrimp and the pink shrimp are relatively shallow water species and the brown shrimp is known to occur in deeper waters (Burkenroad 1939). Therefore, the larvae caught in deeper waters may belong to the brown shrimp, and those in shallower waters may belong to either white or pink shrimp, depending on the geographical locality. However, this is complicated by the offshore movements of all the species into deeper waters with the temperature decline as has been shown in the case of *P. fluviatilis* (Weymouth, Lindner and Anderson 1933). The eggs of Penaeus can be distinguished by the narrow perivitelline space.

The two common species of *Trachypeneus* in the Gulf of Mexico are *T. similis* and *T. constrictus,* and their ranges overlap (Burkenroad 1939). No descriptions of the larvae of *T. similis* are available, and it is hard to distinguish the larvae of these two species. Similarly, the protozoea of *Xiphopeneus* resembles *Trachypeneus* but for one small seta on the second endopod and many times this is lost, making it difficult to separate the protozoeae of the two genera. The mysis of *Trachypeneus* can be easily identified by the lateral spines on the fifth segment, though Cook (1966) says that the rostrum can be used for this purpose. However rostral length, in my experience, is not a dependable character. Pearson (1939) described only two mysis stages of *T. constrictus* and his second mysis appears to be the third mysis because of two segmented pleopods. Also, the lack of lateral spines on the fifth abdominal segment casts a doubt that his larvae could belong to *Xiphopeneus.* Unfortunately, there is no information on the development of other *Trachypeneus* species since Pearson's work.

The present larvae of *Parapenaeus* agree with the descriptions of Pearson (1939) and Heldt (1938). It has been noticed that the mysis stages may differ slightly in morphology within the species. The dorsal spine on the third abdominal segment looks different in some larvae as well as the rostral length and shape (Figs. 12 and 13). This has been pointed out earlier by Heldt (1938). The most common species in the Gulf of Mexico is *P. longirostris* (Williams 1965). *P. americanus* is relatively a deep water species (Springer and Bullis 1956).

Both *Sicyonia dorsalis* and *S. brevirostris* occur in depths from inshore to the continental shelf (Williams 1965). *S. stimpsoni* is a shallow water species confined to the inside of 90 m contour (Lunz 1957). During the present investigation *S. dorsalis* was most commonly taken. The larval stages of *S. brevirostris, S. stimpsoni,* and *S. wheeleri* have been described and it is possible to distinguish these species based on the lateral setal formulae (Cook and Murphy 1965). Again, the short seta on the endopod is often lost, and the present larvae could belong to *S. brevirostris* (1 + 2 + 3) or *S. dorsalis* (1 + 2 + 2). The life history of *S. dorsalis* has not been described.

The three species of *Solenocera* known to occur in the Gulf of Mexico are *S. vioscai, S. atlantidis,* and *S. necopina.* These species inhabit waters 18 to 329 m deep and *S. necopina* occurs in shallow waters as well (Williams 1965). The mysis can be distinguished from the sergestid mysis by the presence of the dorsal organ. The different species are identified based on the length and shape of the rostrum and the structure of the spines on the carapace (Heegaard 1966). There is practically no information on the *Solenocera* from the Gulf of Mexico. The most common species on the Louisiana and Mississippi coasts is *S. vioscai* (Burkenroad 1936), and the present larvae could belong to this species.

The significant point during the present investigation has been the correspondence between the bathymetric distribution of the larval genera and the known ranges of the species of the six genera. *Penaeus* larvae were obtained in depths from 10 to 90 m, *Trachypeneus* larvae mostly from 10 to 54 m, *Xiphopeneus* larvae from 10 to 90 m, *Parapenaeus* larvae mostly from 36 to 90 m, *Sicyonia* larvae from 10 to 72 m mostly, and *Solenocera* larvae from 18 to 90 m. The adult ranges are: Pink shrimp 0-109 m, white shrimp 0-78 m, brown shrimp 0-180 m; *P. longirostris* 25-145 m; *T. constrictus* 20-37 m; *T. similis* 5-55 m; *X. kroyeri* 5-36 m; *S. dorsalis* 5-85 m; *S. brevirostris* 5-85 m; *S. vioscai* 36-72 m; *S. atlantidis* 18-329 m; and *S. necopina* 5-183 m; (Burkenroad 1936, 1939 and Williams 1965). From regular observations on the distribution and seasonal abundance of these larvae, it has been possible to gain an understanding of the breeding areas of the species belonging to the six genera. The life histories of species of *Trachypeneus*, *Xiphopeneus*, and *Solenocera* need to be worked out. It is a matter of conjecture whether the larvae of the species of one genus (except *Sicyonia*) can be distinguished by morphological characters alone, or whether one has to investigate at the biochemical or molecular level.

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