A GENERIC KEY TO THE PROTOZOEAN, MYSIS, AND POSTLARVAL STAGES OF THE LITTORAL PENAEIDAE OF THE NORTHWESTERN GULF OF MEXICO [1]

HARRY L. COOK, *Fishery Biologist (Research)*, BUREAU OF COMMERCIAL FISHERIES BIOLOGICAL LABORATORY GALVESTON, TEX.

ABSTRACT

An illustrated key presenting criteria for differentiating the stages and substages of Gulf of Mexico penaeid larvae (and post larvae) from comparable stages of the more common nonpenaeids is presented. A second key permits generic identification of penaeid protozoean, mysis, and postlarval stages. All genera are illustrated, and a table of important diagnostic characters is included.

Shrimp of the Family Penaeidae which support valuable commercial fisheries in the northwestern Gulf of Mexico are being studied comprehensively by fishery scientists at the Bureau of Commerical Fisheries Biological Laboratory in Galveston, Tex. To properly manage such fisheries, it is necessary to fully understand the dynamics of the shrimp populations upon which they depend. This capability requires, in turn, as complete a knowledge as possible of the life history of the species involved.

Studies of the early (planktonic) life history of the Gulf's commercially important shrimps have been hampered by difficulties encountered in distinguishing larvae of these species from those of lesser importance. Fortunately, there has been considerable research on the description and general systematics of larval and postlarval Penaeidae both in this country and abroad. As a result, all the littoral genera known to occur in the northwestern Gulf of Mexico have had representatives—although not necessarily of indigenous species—at least partially described. The principal problem, therefore, was one of consolidating all the available information and ascertaining what portions of it might help describe the local penaeid larvae. The intent of this paper is to present criteria that will aid in distinguishing larvae and postlarvae of the genus *Penaeus* Fabricius from those of *Parapenaeus* Smith, *Sicyonia* H. Milne Edwards, *Solenocera* Lucas, *Trachypeneus* Alcock, and *Xiphopeneus* Smith, the five other littoral genera found locally.

The material made available for examination during this study was collected systematically between March 1959 and March 1960 and during January to December 1961. From January to September 1961, plankton was sampled with a Gulf-V net to depths of 45 fathoms between Cameron, La., and Freeport, Tex. In September, the sampling program was enlarged to include the area between Morgan City, La., and the mouth of the Colorado River, Tex.

Although various larval stages of several species represented in this area had been recorded, there were no established criteria for differentiating the penaeid larvae. Consequently, as new or theretofore unrecognized penaeid larvae and postlarvae were found in the plankton samples, they were assigned a code number and a reference sketch of them was made. Through the use of descriptions

NOTE.—Approved for publication Sept. 17, 1964.

[1] Contribution No. 189, Bureau of Commercial Fisheries Biological Laboratory, Galveston, Tex.

taken from the literature, and by comparison with larvae reared in the laboratory from eggs of known parentage, planktonic larvae were assigned to genera. Subsequent examination of accumulated material revealed the presence of protozoeal, mysis, and postlarval characters which remained constant within each genus. These characters were, in turn, used as criteria to construct a key to local genera. A key based for the most part on planktonic rather than laboratory-reared material has its limitations, but the scarcity of information concerning penaeid larvae from this area nevertheless justifies its presentation at this time.

Despite the fact that *Penaeus aztecus* Ives (brown shrimp); *P. duorarum* Burkenroad (pink shrimp); *Sicyonia brevirostris* (Stimpson) and *S. dorsalis* (Kingsley) (rock shrimps); *Trachypeneus similis* (Smith); and *Xiphopeneus krøyeri* (Heller) (seabob) have been reared successfully through the nauplial stage under laboratory conditions, the nauplii were found to be so similar as to defy attempts to fit them into a key. Although differences in setation are minor or absent, the lack of a dorsal protuberance (fig. 1f), as well as larger relative size, serves to distinguish nauplii of the genus *Penaeus*. In genera other than *Penaeus*, this protuberance is present on the dorsal surface of the body above the insertion of the second antennae.

Within a given developmental stage (e.g., Nauplius II, Protozoea I, etc.), the size ranges of penaeid larvae as a whole are extremely variable, although in the northern Gulf, larvae of the genus *Penaeus* are generally larger than those belonging to comparable stages of other genera. Hudinaga (1942) found that the protozoeal stages of *P. japonicus* Bate exhibited intermolt growth, the occurrence of which may also be true for other stages as suggested for nauplii of *Xiphopeneus krøyeri* by Renfro and Cook (1963). The possibility also exists that larvae (and postlarvae) of the same species grow dissimilarly at different times of the year. Since the relative size at each stage overlaps considerably between, as well as within, the various genera, it should be used with discretion for purposes of identification.

While the number of substages in each penaeid larval stage described in the literature has been found to vary, the normal situation in the northwestern Gulf of Mexico—as ascertained from material in plankton collections—seems to be five nauplial, three protozoeal, and three mysis substages. Examples of departure from this sequence are provided by the larvae of *Sicyonia brevirostris* which, when reared in the laboratory, appeared to pass through four mysis substages, and by those of *Parapenaeus* sp. which, as determined from sample material, also have at least four. Such apparent anomalies suggest that descriptions of penaeid larvae obtained either from rearing experiments or plankton samples must be viewed with caution until more is known of the effects of environmental factors on early growth and morphology.

Table 1, in addition to presenting the principal diagnostic characters included in the following key, also furnishes other valuable characters for distinguishing larvae and postlarvae.

All illustrations are intended to clarify generic characteristics and do not represent particular species.

KEY TO STAGES AND SUBSTAGES OF PENAEID LARVAE AND EARLY POSTLARVAE

1	Body simple, unsegmented; three pairs of appendages arising from anterior portion of body, first unbranched, second and third branched; paired caudal spines arise from posterior end of body (Nauplius)---------- 2
	Not as above---------- 7
2(1)	Body pear shaped; pairs of caudal spines of equal length, extending straight posteriorly; lateral setae on appendages arise singly or in pairs; appendages lack spines or processes such as would be utilized for feeding purposes; carapace present only as a close-fitting rudiment in later stages (Penaeid nauplius fig. 1)---------- 3
	One or more of the following characters present: body elliptical; pairs of caudal spines of unequal length or extending medianly, crossing one another; lateral setae on appendages arising in clusters; spines or processes such as would be utilized for feeding purposes present; a well-developed or prominent carapace present Nonpenaeid nauplius
3(2)	Five setae on exopod of second antenna; one pair of caudal spines; surface of body between insertion of caudal spines convex-- Nauplius I (fig. 1a)
	More than five setae on exopod of second antenna; one or more pairs of caudal spines; surface of body between insertion of caudal spines not convex---------- 4
4(3)	Six setae on exopod of second antenna; usually one, sometimes two, pairs of caudal spines; surface of body between insertion of caudal spines flat---------- Nauplius II (fig. 1b)

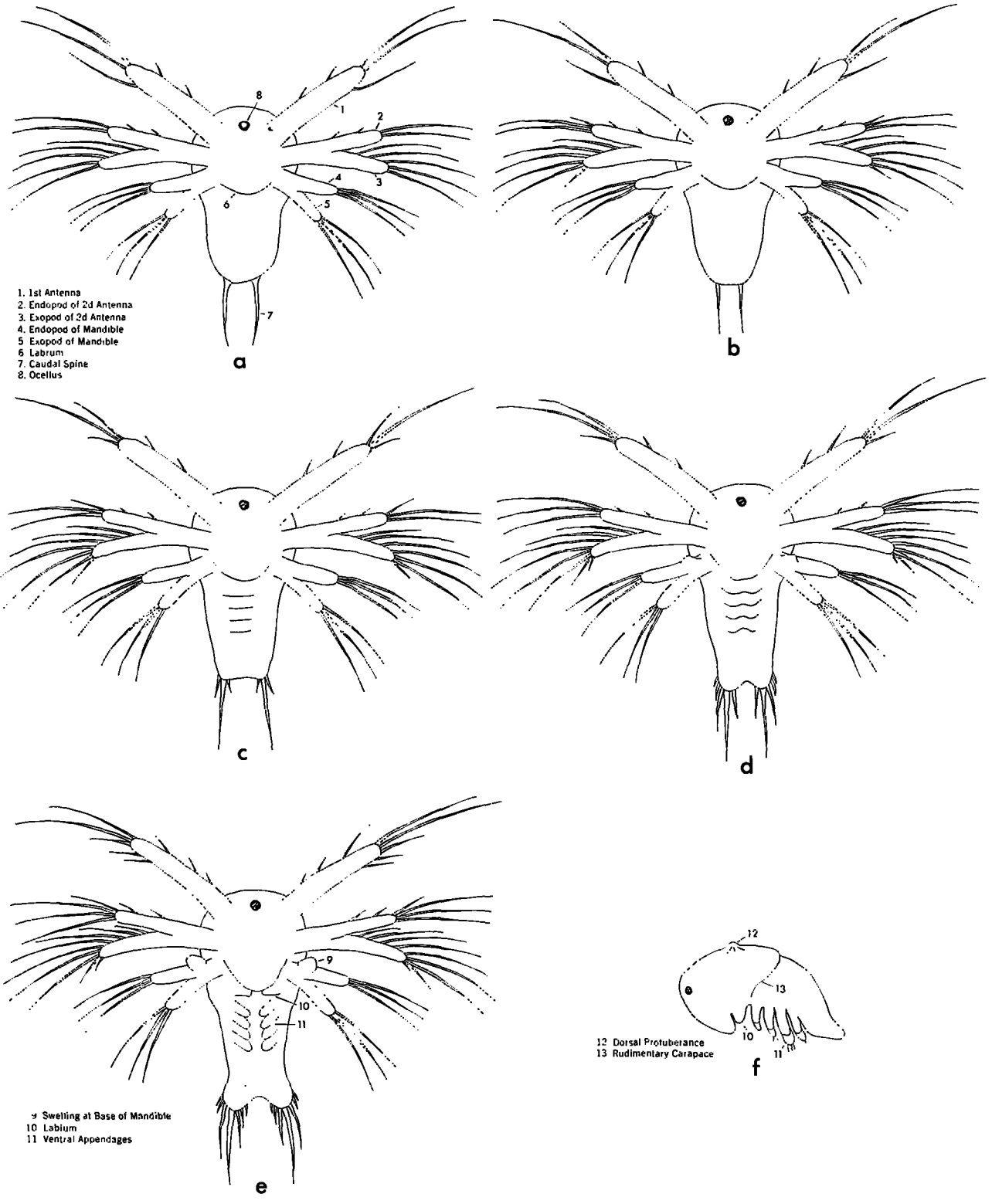

FIGURE 1.—Penaeid nauplii: *a*, Nauplius I; *b*, Nauplius II; *c*, Nauplius III; *d*, Nauplius IV; *e*, and *f*, Nauplius V.

More than six setae on exopod of second antenna; usually three or more pairs of caudal spines; surface of body between insertion of caudal spines concave 5

5(4) Seven setae on exopod of second appenadge; usually three, sometimes four, pairs of caudal spines; surface of body between insertion of caudal spines slightly concave; no swelling at base of mandible ..... Nauplius III (fig. 1c)

More than seven setae on exopod of second antenna; usually more than four pairs of caudal spines; surface of body between insertion of caudal spines deeply concave; base of mandible swollen 6

6(5) Eight setae on exopod of second antenna; usually five, sometimes six, pairs of caudal spines; slight swelling at base of mandible; endopod of mandible never transparent; rudimentary ventral appendages posterior to third appendages Nauplius IV (fig. 1d)

Nine setae on exopod of second antenna; usually seven, sometimes six, pairs of caudal spines; large subconical protuberance at base of mandible; endopod of mandible frequently transparent; ventral appendages prominent Nauplius V (fig. 1e)

7(1) Large, prominent, carapace followed by a slender segmented thorax and an abdomen which may or may not be segmented; two pairs of prominent appendages arising from anterior portion of body, the first unbranched, the second branched; prominent labrum present (Protozoea) 8

Not as above 11

8(7) Carapace does not completely cover thorax; abdomen bifurcate posteriorly, with each furca bearing at least seven spines; biramous first and second maxillipeds well developed, the third absent or present only as a rudiment; usually, no spines arise from posterior half of carapace; if spines present, a dorsal organ (fig. 2d) is present (Penaeid protozoea fig. 2) 9

One or more of the following characters present: carapace completely covers thorax; abdomen not bifurcate; caudal furcae bear less than seven pairs of spines; first and second maxillipeds not well developed or third maxilliped well developed; if numerous spines arise from posterior portion of carapace, dorsal organ not present Nonpenaeid protozoea

9(8) Eyes sessile, beneath carapace; pereiopods absent; abdomen unsegmented Protozoea I (fig. 2a)

Eyes stalked; pereiopods present at least as small buds; abdomen segmented 10

10(9) Uropods not present externally, may be seen beneath cuticle; pereiopods present only as small buds; first five abdominal segments without dorsal spines ..... Protozoea II (fig. 2b)

Uropods present externally; pereiopods rudimentary, but biramous and prominent; first five abdominal segments with dorsal spines Protozoea III (fig. 2c)

11(7) Carapace closely fitting with a rostrum that extends anteriorly between the eyes; five pairs of biramous pereiopods present, with the exopods elongate and bearing numerous setae which make them appear brushlike; six-segmented abdomen followed by telson and biramous uropods; pleopods, if present, rudimentary and nonfunctional (Mysis) 12

Carapace closely fitting with a rostrum extending anteriorly between the eyes; five pairs of pereio-

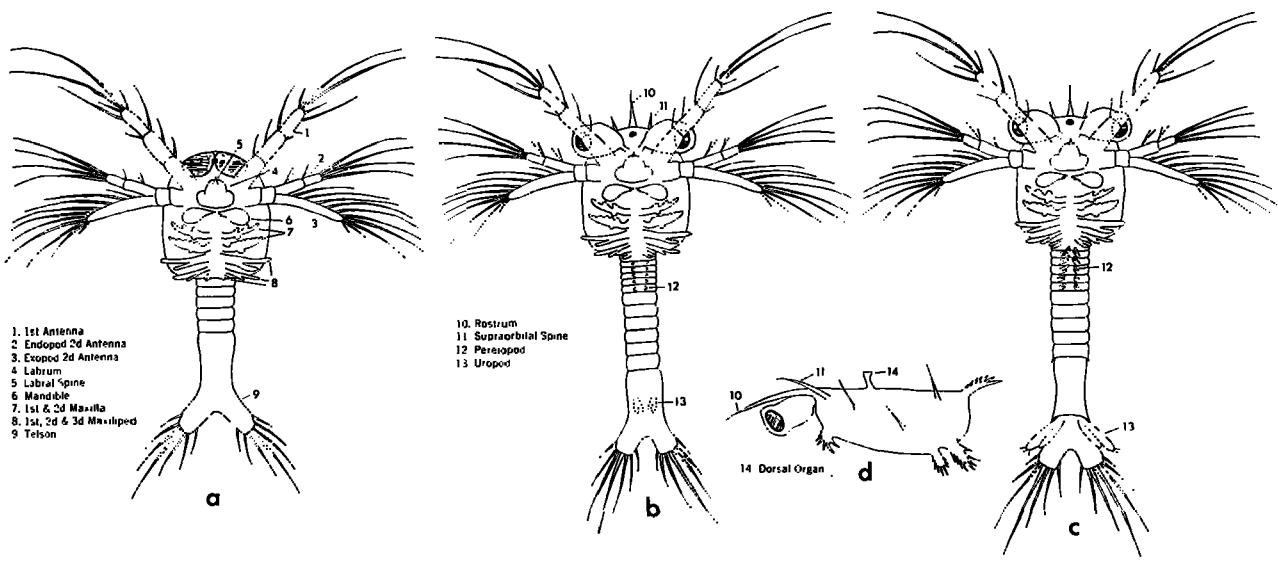

FIGURE 2.—Penaeid protozoeae: *a*, Protozoea I; *b*, Protozoea II; *c*, Protozoea III; *d*, Protozoea III, carapace.

pods present, with exopods absent or present only as rudiments; six-segmented abdomen followed by telson and biramous uropods; five pairs of setose, functional pleopods present (Postlarvae)---------- 15

12(11) First three pairs of pereiopods cleft to form rudimentary chelae; pleura of first abdominal segment overlap second; antennal blades present; pleopods develop on first five abdominal segments simultaneously although they are not necessarily of equal length; telson narrow and notched medianly; uropods without statocysts; usually, no spines originate from posterior half of carapace and margins of carapace not serrate; if spines or serrations present, a dorsal organ also present (Penaeid mysis fig. 3)---------- 13

One or more of following characters present: first three pereiopods not cleft to form rudimentary chelae; pleura of second abdominal segment overlap first; antennal blades absent; pleopods may not be present on all abdominal segments; telson broad and fan shaped or not notched medianly; uropods with statocyst; spines originate from posterior half of carapace or margins of carapace serrate, with no dorsal organ present---------- Nonpenaeid mysis

13(12) Pleopods absent---------- Mysis I (fig. 3a)

Pleopods present---------- 14

14(13) Pleopods small and unjointed-- Mysis II (fig. 3b)

Pleopods long and jointed--- Mysis III (fig. 3c)

15(11) First three pairs of pereiopods chelate; pleura of first abdominal segment overlapping second; five pairs of functional pleopods present; gills covered by carapace; antennal blades present

Penaeid postlarva (fig. 4)

One or more of the following characters present: first three pairs of pereiopods not chelate; pleura of second abdominal segment overlapping first; less than five pairs of functional pleopods present; gills extending from beneath carapace; antennal blades absent---------- Nonpenaeid postlarva

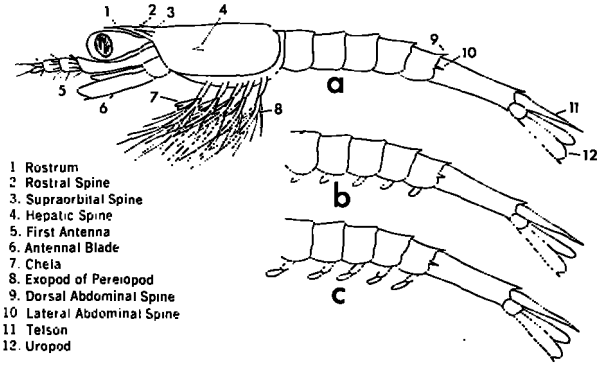

FIGURE 3.—Penaeid myses: *a*, Mysis I; *b*, Mysis II; *c*, Mysis III.

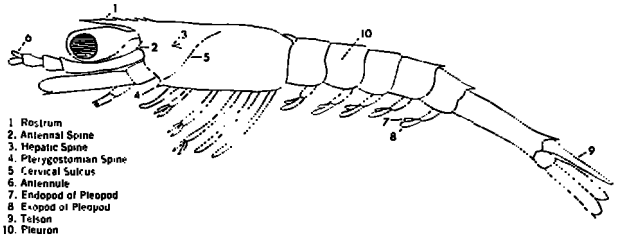

FIGURE 4.—Penaeid postlarva.

KEY TO GENERA OF PENAEID LARVAE AND POSTLARVAE

PROTOZOEAE

(Fig. 5)

1 Number of lateral setae on endopod of second appendage 1+1+2 [2]_____ *Penaeus*
Number of lateral setae on endopod of second appendage not 1+1+2_____ 2

2(1) First appendage about twice as long as second; no spine on anterior margin of labrum; number of lateral setae on endopod of second appendage 1+2+3_____ *Sicyonia*
First and second appendages of nearly equal length; a spine present on anterior margin of labrum; number of lateral setae on endopod of second appendage may be 1+2+3_____ 3

3(2) Number of lateral setae on endopod of second appendage 1+2+2, 1+2+3, or 2+2+2_ *Parapenaeus*
Number of lateral setae on endopod of second appendage not 1+2+2 or 2+2+2_____ 4

4(3) Number of lateral setae on endopod of second appendage 2+2+3_____ *Solenocera*
Number of lateral setae on endopod of second appendage 2+2_____ 5

5(4) Four long, terminal setae on endopod of second appendage_____ *Trachypeneus*
Four long and one short terminal setae on endopod of second appendage_____ *Xiphopeneus*

[2] Starting with proximal seta, the number of lateral setae at each point of insertion is recorded.

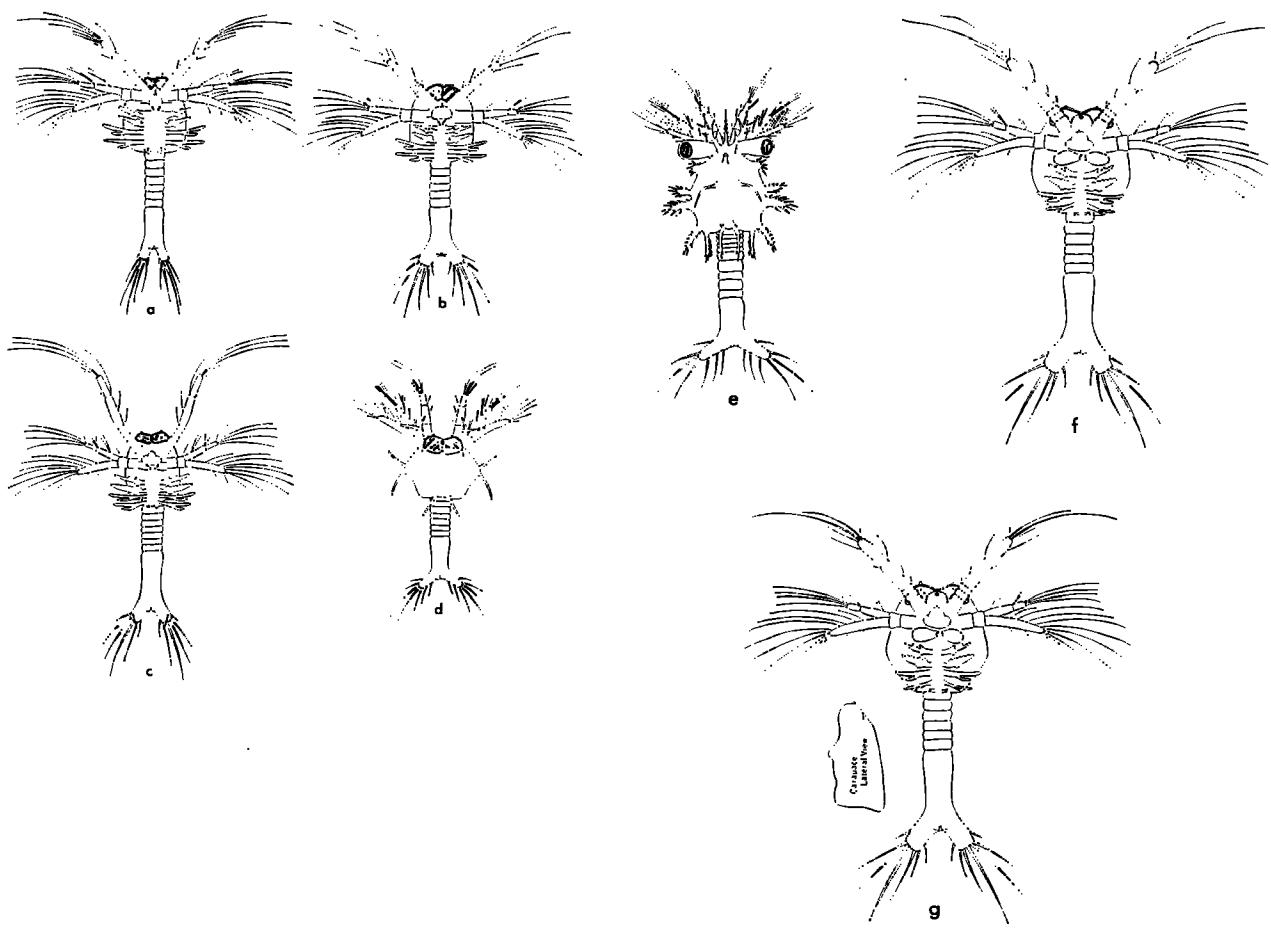

FIGURE 5.—Penaeid protozoeae: *a*, *Parapenaeus*, Protozoea I; *b*, *Penaeus*, Protozoea I; *c*, *Sicyonia*, Protozoea I; *d*, *Solenocera*, Protozoea I; *e*, *Solenocera*, Protozoea II; *f*, *Trachypeneus*, Protozoea I; *g*, *Xiphopeneus*, Protozoea I.

MYSES

(Fig. 6)

1 Carapace and abdomen with many spines; dorsal organ present on dorsal surface of carapace *Solenocera*

Carapace and abdomen without many spines; dorsal organ absent 2

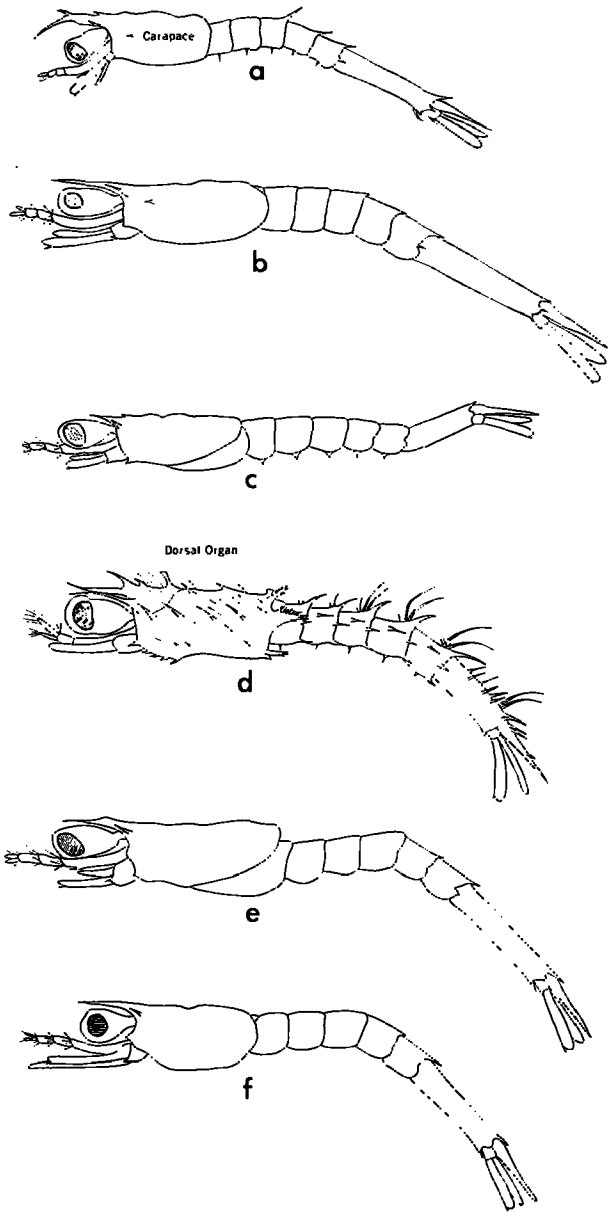

FIGURE 6.—Penaeid myses: *a*, *Parapenaeus*, Mysis I; *b*, *Penaeus*, Mysis I; *c*, *Sicyonia*, Mysis I; *d*, *Solenocera*, Mysis I; *e*, *Trachypeneus*, Mysis I; *f*, *Xiphopeneus*, Mysis I.

2(1) Dorsomedian spines not present on first five abdominal segments ..... *Sicyonia*
Dorsomedian spine present on at least fourth and fifth abdominal segments 3

3(2) Dorsomedian spine not present on third abdominal segment 4
Dorsomedian spine present on third abdominal segment 5

4(3) Lateral spine present on fifth abdominal segment; rostrum shorter than eye ..... *Trachypeneus*
Lateral spine not present on fifth abdominal segment; rostrum as long as or shorter than eye *Xiphopeneus*

5(3) Dorsomedian spine on third abdominal segment elongate ..... *Parapenaeus*
Dorsomedian spine on third abdominal segment not elongate ..... *Penaeus*

POSTLARVAE

(Fig. 7)

1 Total length 6.0 mm. or less [3] 3
Total length greater than 6.0 mm 2

2(1) Total length 6.0 mm. to 12.0 mm 5
Total length 12.0 mm. to 25.0 mm 10

3(1) No terminal spines on telson ..... *Sicyonia*
Terminal spines present on telson 4

4(3) Medioterminal spines of telson longer than those adjacent to it ..... *Trachypeneus*
Medioterminal spine of telson equal in length to those adjacent to it ..... *Penaeus*

5(2) First abdominal segment with dorsal anteromedian spine ..... *Sicyonia*
First abdominal segment without dorsal anteromedian spine 6

6(5) Pterygostomian spine present; pleopods of fifth abdominal segment with exopods and endopods of equal length 7
Pterygostomian spine absent; pleopods of fifth abdominal segment with endopods inferior to exopods 8

7(6) Antennules round; no cervical sulcus on carapace; rostrum curved ..... *Parapenaeus*
Antennules flattened; well-defined cervical sulcus present on carapace; rostrum straight ..... *Solenocera*

8(5) Antennal spine absent or minute; if present, subrostral teeth also present ..... *Penaeus*
Antennal spine very prominent; no subrostral teeth 9

9(8) Rostrum shorter than eye ..... *Trachypeneus*
Rostrum longer than eye ..... *Xiphopeneus*

10(2) Rostrum usually with ventral teeth and shallowly compressed ..... *Penaeus*
Rostrum without ventral teeth and broadly compressed 11

11(10) Pterygostomian spine present 12
Pterygostomian spine absent 13

[3] Early *Xiphopeneus* postlarvae probably fall in the <6.0-mm. category, but none in this size range was noted during the study.

12(11) Antennules flattened; cervical sulcus present; sixth abdominal segment short and slightly curved ..... *Solenocera*
Antennules round; cervical sulcus absent; sixth abdominal segment long and straight ..... *Parapenaeus*

13(11) Rostrum longer than eye ..... *Xiphopeneus*
Rostrum shorter than eye 14

14(13) First abdominal segment with anteromedian spine on dorsal surface; sixth abdominal segment short ..... *Sicyonia*
First abdominal segment without anteromedian spine on dorsal surface; sixth abdominal segment elongate ..... *Trachypeneus*

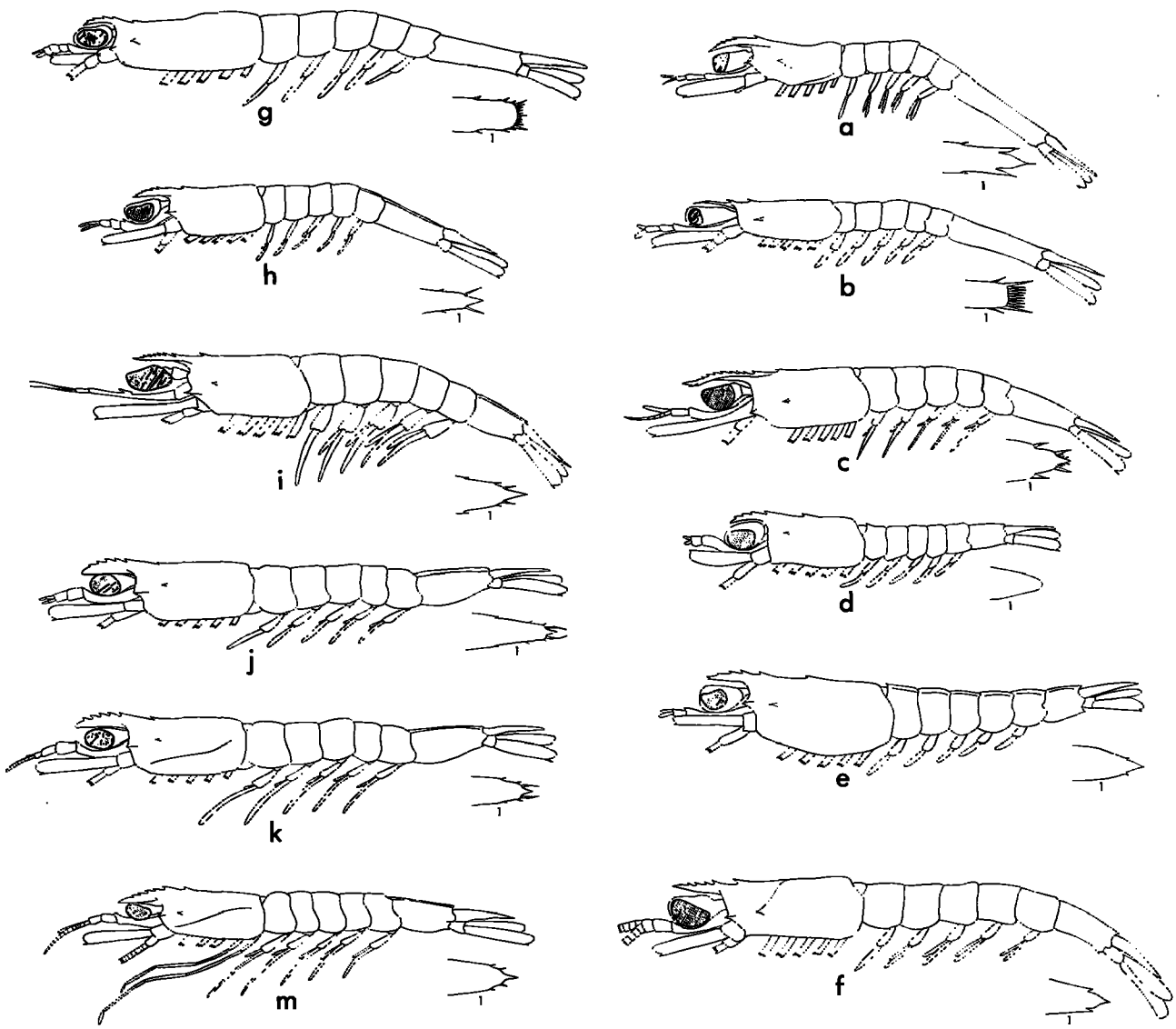

FIGURE 7.—Penaeid postlarvae: *a*, *Parapenaeus* postlarva, 8.0 mm.; *b*, *Penaeus* postlarva, 6.0 mm.; *c*, *Penaeus* postlarva, 15.0 mm.; *d*, *Sicyonia* postlarva, 5.0 mm.; *e*, *Sicyonia* postlarva, 14.0 mm.; *f*, *Solenocera* postlarva, 7.0 mm.; *g*, *Trachypeneus* postlarva, 6.0 mm.; *h*, *Trachypeneus* postlarva, 10.0 mm.; *i*, *Trachypeneus* postlarva, 25.0 mm.; *j*, *Xiphopeneus* postlarva, 6.0 mm.; *k*, *Xiphopeneus* postlarva, 7.5 mm.; *m*, *Xiphopeneus* postlarva, 12.0 mm.; *l*, Tip of telson.

TABLE 1.—*Characters of diagnostic importance in distinguishing genera during the early life history stages of the littoral Penaeidae occurring along the northern Gulf coast*

Stage and structure	*Parapenaeus*	*Penaeus*	*Sicyonia*	*Solenocera*	*Trachypeneus*	*Xiphopeneus*
PROTOZOEAE–GENERAL						
Relative lengths of 1st and 2d appendages.	Approximately equal.	Approximately equal.	First about twice as long as second.	Approximately equal.	First about 1½ as long as second.	First about 1½ as long as second.
Spine on labrum	Small	Small	Absent	Very long	Small	Small.
Telson	Narrow and deeply notched.	Medium width and notch.	Medium width and notch	Wide and shallowly notched.	Medium width and notch.	Medium width and notch.
Dorsal surface of carapace	Smooth	Smooth	Small hump	Spines and dorsal organ.	Small hump	Small hump.
Setation of endopod of second appendage.	Variable	1+1+2 lateral	1+2+3 lateral	2+2+3 lateral	2+2 lateral, 4 terminal.	2+2 lateral, 5 terminal.
PROTOZOEAE I						
Projection on front of carapace.	Pointed	Round	Round	Pointed	Round	Round.
Third maxilliped	Small, biramous, no setae.	Absent or present as small uniramous bud.	Small, biramous, no setae.	Small, biramous, with setae.	Small, biramous, with setae.	Small, biramous, with setae.
Spines on carapace	None	None	None	Four pairs	None	None.
PROTOZOEAE II						
Rostrum	Long	Long	Short	Long	Long	Long.
Supraorbital spines	Two pairs	One pair	Absent	One pair with many branches.	Absent	Absent.
PROTOZOEAE III						
Rostrum	Long	Long	Short	Long	Long	Long.
Supraorbital spines	One pair	One pair	Absent	One pair	Absent	Absent.
Dorsomedian spines of abdomen.	Present on six segments.	Present on first five segments.	Present on first five segments.	Present on first five segments.	Present on first five segments.	Present on first five segments.
Posterolateral spines of abdomen.	Present on fourth, fifth, and sixth segments.	Present on fifth and sixth segments.	Present on fifth segment.	Present on sixth segment	Present on fifth and sixth segments.	Present on fifth and sixth segments.
Ventrolateral spine on sixth segment.	One pair	One pair	One pair	One pair	Two pairs	Two pairs.
MYSIS						
Rostrum	Elongate, toothed, broadened at base.	Elongate, smooth, not broadened at base.	Short, toothed, not broadened at base.	Elongate, toothed, not broadened at base.	Elongate, toothed, not broadened at base.	Elongate, toothed, not broadened at base.
Superaorbital spine	Present	Present	Present	Present	Present	Present.
Hepatic spine	Present	Present	Absent	Present	Absent	Absent.
Ventromedian spines of abdomen.	Present	Absent	Present	Present	Absent	Absent.
Posterolateral spines of abdomen.	Present on fifth and sixth segments.	Present on fifth and sixth segments.	Absent	Present on first five segments.	Present on fifth segment.	Absent.

TABLE 1.—*Characters of diagnostic importance in distinguishing genera during the early life history stages of the littoral Penaeidae occurring along the northern Gulf coast*—Continued

Stage and structure	*Parapenaeus*	*Penaeus*	*Sicyonia*	*Solenocera*	*Trachypeneus*	*Xiphopeneus*
PROTOZOEAE—Continued						
MYSIS—Continued						
Dorsomedian spines of abdomen.	Present on third, fourth, fifth, and sixth segments. Spine of third segment elongate.	Present on third, fourth, fifth, and sixth segments.	Present on sixth segment only.	Present on six segments.	Present on fourth, fifth, and sixth segments.	Present on fourth, fifth, and sixth segments.
POSTLARVAE						
First TO 6.0-MM. POSTLARVAE:						
Rostrum	[First postlarva begins at about 8.0 mm.]	Straight	Curved	[First postlarva begins at about 7.0 mm.]	Curved	None examined.
Anteromedian spine on first abdominal segment.		Absent	Present		Present	
Sixth abdominal segment		Elongate	Short		Elongate	
6.0- TO 12.0-MM. POSTLARVAE:						
Anteromedian spine of first abdominal segment.	Absent	Absent	Present	Absent	Absent	Absent.
Length of pleopods	All equal	All equal	Fifth pleopod shorter than first.	Fifth pleopod shorter than first.	All equal	All equal.
Relative lengths of endopod and exopod of fifth pelopod.	Approximately equal.	Endopod absent or inferior.	Endopod absent	Approximately equal.	Endopod inferior	Endopod inferior, exopod elongate.
Pterygostomian spine	Present	Absent	Absent	Present	Absent	Absent.
Antennal spine	Present	Absent	Present	Present	Present	Present.
Antennules	Round	Round	Round	Flattened	Round	Round.
Sulcae of carapace	Absent	Absent	Absent	Cervical sulcus	Absent	Branchio-cardiac sulcus.
Rostrum	Curved, elongate	Straight, elongate	Straight, short	Straight, short	Curved, short	Curved, elongate.
Sixth abdominal segment	Elongate, straight	Elongate, straight	Short, straight	Medium, curved ventrally.	Medium, straight	Medium, straight.
12.0- TO 25.0-MM. POSTLARVAE:						
Rostrum	Curved, elongate, subrostral teeth absent.	Curved, elongate, subrostral teeth present.	Straight, short, subrostral teeth absent.	Straight, medium, subrostral teeth absent.	Curved, medium, subrostral teeth absent.	Curved, elongate, subrostral teeth absent.
Pterygostomian spine	Present	Absent	Absent	Present	Absent	Absent.
Antennules	Round	Round	Round	Flattened	Round	Round.
Sulcae of carapace	Absent	Absent	Absent	Cervical sulcus	Absent	Branchio-cardiac sulcus.
Sixth abdominal segment	Elongate, straight	Elongate, straight	Short, straight	Medium, curved ventrally.	Medium, straight	Medium, straight.
Anteromedian spine on first abdominal segment.	Absent	Absent	Present	Absent	Absent	Absent.

ACKNOWLEDGMENT

Ray S. Wheeler and Robert F. Temple offered many helpful suggestions during the course of this study, and Daniel Patlan assisted with the drawings.

BIBLIOGRAPHY

ANDERSON, WILLIAM W., AND MILTON J. LINDNER.
1945. A provisional key to the shrimps of the family Penaeidae with especial reference to American forms. Transactions of the American Fisheries Society, vol. 73, for the year 1943, pp. 284–319.

BERKELEY, ALFREDA A.
1930. The post-embryonic development of the common Pandalids of British Columbia. Contributions to Canadian Biology and Fisheries, being Studies from the Biological Stations of Canada, N.S., vol. 6, No. 6, pp. 81–163.

BROAD, ALFRED CARTER.
1957. The relationship between diet and larval development of *Palaemonetes*. Biological Bulletin, vol. 112, No. 2, pp. 162–170.

BROOKS, W. K.
1882. *Lucifer:* a study in morphology. Philosophical Transactions of the Royal Society, vol. 173, pp. 57–137.

DOBKIN, SHELDON.
1961. Early developmental stages of pink shrimp, *Penaeus duorarum*, from Florida Waters. U.S. Fish and Wildlife Service, Fishery Bulletin 190, vol. 61, pp. 321–349.

GURNEY, ROBERT.
1924. Crustacea. Part 9–Decapod Larvae. British Antarctic ("Terra Nova") Expedition, 1910. Natural History Report, Zoology, vol. 8, No. 2, pp. 37–202.
1943. The larval development of two penaeid prawns from Bermuda of the genera *Sicyonia* and *Penaeopsis*. Proceedings of the Zoological Society of London, series B, vol. 113, pp. 1–16.
1960. Bibliography of the larvae of Decapod Crustacea [and] Larvae of Decapod Crustacea. [Authorized reprints.] H. R. Engelmann, Weinheim, 429 pp. Original: Ray Society, London, No. 125, 1939; No. 129, 1942.

HELDT, JEANNE H.
1938. La reproduction chez les Crustacés Décapodes de la famille des Pénéides. Annales de l'Institut Océanographique de Monaco, vol. 18 (fasc. 2), pp. 31–206.

HILDEBRAND, HENRY H.
1954. A study of the fauna of the brown shrimp (*Penaeus aztecus*, Ives) grounds in the western Gulf of Mexico. Publications of the Institute of Marine Science, University of Texas, vol. 3, No. 2, pp. 231–366.

HUDINAGA, MOTOSAKU.
1942. Reproduction, development and rearing of *Penaeus japonicus* Bate. Japanese Journal of Zoology, vol. 10, No. 2, pp. 305–393, 46 plates. Tokyo.

PEARSON, JOHN C.
1939. The early life histories of some American Penaeidae, chiefly the commercial shrimp, *Penaeus setiferus* (Linn.). Bulletin of the U.S. Bureau of Fisheries, Bulletin No. 30, vol. 49, pp. 1–73.

RENFRO, WILLIAM C., AND HARRY L. COOK.
1963. Early larval stages of the seabob, *Xiphopeneus krøyeri* (Heller). U.S. Fish and Wildfife Service, Fishery Bulletin, vol. 63, No. 1, pp. 165–177.

VOSS, GILBERT L.
1955. A key to the commerical and potentially commercial shrimp of the family Penaeidae of the western North Atlantic and Gulf of Mexico. Florida State Board of Conservation, Technical Series No. 14, pp. 1–23.

WILLIAMS, AUSTIN B.
1953. Identification of juvenile shrimp (Penaeidae) in North Carolina. Journal of the Elisha Mitchell Scientific Society, vol. 69, No. 2, pp. 156–160.
1959. Spotted and brown shrimp postlarvae (*Penaeus*) in North Carolina. Bulletin of Marine Science of the Gulf and Carribean, vol. 9, No. 3, pp. 281–290.