DESCRIPTION OF LARVAL AND JUVENILE RED SNAPPER, *LUTJANUS CAMPECHANUS*[1]

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ABSTRACT

Identification and description of the red snapper, *Lutjanus campechanus*, family Lutjanidae, were based upon the general morphology, meristic characters, head spination, and pigmentation of 18 larval and 6 juvenile specimens, 4.0-22.4 mm standard length. These 24 specimens were selected from a total of 226 larval and juvenile *L. campechanus* which were collected mainly along the Texas coast from 1975 to 1977. Lutjanids <4.0 mm lacked presently recognizable characters that are diagnostic at the species level. The key to the development of the series was a unique meristic count. Some other useful diagnostic characters were: small serrations on the anterior margin of the pelvic spine in specimens of 4.8-12.4 mm, and a long unbroken soft ray immediately adjacent to the pelvic spine in specimens of 4.8-10.6 mm. A brief comparison was made between *L. campechanus* and other lutjanid larvae and juveniles.

The red snapper, *Lutjanus campechanus* (Poey), family Lutjanidae, is one of the most important commercial and recreational fish species in the Gulf of Mexico (Bradley and Bryan 1975; Beaumariage and Bullock 1976). Numerous biological and fisheries publications concern the adult of this species. Apparantly only one short publication has dealt with the early life history of *L. campechanus* however. Arnold et al. (1978) described the spawning of this species in captivity. The primary purpose of the present paper is to describe the larval and juvenile development of *L. campechanus*.

METHODS

A total of 226 larvae and juveniles (4.0-22.4 mm SL, standard length) of the species were captured by four different methods, which are listed in Table 1. The bongo and neuston net sampling was done according to Marine Resources Monitoring, Assessment and Prediction specifications (Jossi et al. 1975) and was made at a vessel speed of 2.8 km/h (1.5 kn).

The largest specimen was preserved in 40% isopropyl alcohol. Other larvae and juveniles were preserved in buffered 5% Formalin.[3] Some larval and juvenile specimens were stained with alizarin-red to aid in measuring and in counting body parts.

A dissecting microscope with an ocular micrometer was used to make standard measurements (Laroche 1977) on 24 specimens. The level of accuracy for micrometer measurements was 0.01 mm for measurements <1 mm and 0.1 mm for measurements >1 mm. All measurements of body length refer to standard length unless otherwise noted. Standard length was defined as the distance from the tip of the snout to the posterior tip of the notochord (before hypural formation) and the tip of the snout to the posterior margin of the hypurals (after hypural formation posterior to the notochord tip).

Larvae were defined as individuals which had absorbed the yolk sac but which had not completed differentiation of adult fin spine and ray complements. Juveniles were defined as sexually immature individuals having adult fin complements of spines and rays.

We used the serial or dynamic method of tracing certain characters back from juvenile to larval specimens (Moser and Ahlstrom 1970).

IDENTIFICATION

The genus *Lutjanus* is the most speciose in the family Lutjanidae. *Lutjanus campechanus* is 1 of 10 species of that genus which occur in U.S. waters <200 m deep (Bailey et al. 1970). *Lutjanus campechanus* occurs along the continental shelf of the

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[3]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

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TABLE 1.—Catch data arranged chronologically for larval and juvenile *Lutjanus campechanus* from the Gulf of Mexico and adjacent waters.

Location	Depth range (m)	Latitude (N)	Longitude (W)	Period	Gear/tow	No. collected	Size (mm SL)	Temp. (° C)	Salinity (‰)
St. Andrew Bay, Fla.	6	30°09′	85°41′	July 1973	10.7 headrope otter trawl: 2.5 cm stretched mesh in cod end/bottom tow	1	22.4	27.0	33.7
South Texas continental shelf	42-131	27°54′ to 26°57′	96°19′ to 96°48′	Sept. 1975	1 m diameter plankton net: 0.250 mm mesh/ single oblique tow	59	4.0-12.4	19.7-29.2	33.7-36.4
		27°17′ to 26°10′	96°23′ to 96°24′						
	42-183	27°54′ to 26°57′	96°19′ to 96°48′	July-Sept. 1976	61 cm diameter bongo nets: 0.505, 0.333 mm mesh/double oblique tow	57	4.1-10.6	17.4-29.7	34.7-37.5
		27°15′ to 26°10′	96°18′ to 96°39′						
	49-131	27°30′ to 27°17′	96°44′ to 96°23′	May, July-Sept., Nov. 1977	As above	17	4.2-5.8	17.3-29.8	33.4-36.5
		to 26°10′	to 96°24′						
Buccaneer Oil Field, near Galveston, Tex.	17	28°52′	94°40′	July 1977	As above, also 1.0 × 0.5 m, 0.505 mm mesh neuston net	92	4.0-7.3	23.0-26.0	32.8-35.5

Atlantic coast of the United States and in the Gulf of Mexico (Rivas 1966). The taxonomy of this species has undergone several revisions. Three specific names have been used for the Gulf of Mexico red snapper in recent literature: *L. campechanus, L. aya,* and *L. blackfordii* (Anderson 1967). We used the American Fisheries Society (Bailey et al. 1970) nomenclature.

To date, the only lutjanid that has had its larval stages described in the literature is *Rhomboplites aurorubens* (Laroche 1977). Identification of lutjanid larvae is difficult unless a series of the larvae and juveniles is available for study.

Juveniles of only three Atlantic species of *Lutjanus* and one specimen of *Symphysanodon* have been illustrated. Illustrations of 10.5, 14.4, 19.9, and 48.5 mm juvenile *L. griseus* have been presented by Starck (1971). A 17.8 mm *L. synagris* or *L. mahogoni* was described and partially sketched by Heemstra (1974). A 14.4 mm fork length juvenile identified as *Lutjanus* sp. was illustrated by Fahay (1975). A 20 mm juvenile *Symphysanodon* was partially illustrated in Fourmanoir (1973).

Identification of the present series of *L. campechanus* is based upon the meristic characters of the juveniles. Six juveniles (8.0-22.4 mm) had the meristic complement of adult *L. campechanus* and formed the key to the series. These counts included 24 myomeres; X, 14 dorsal fin spines and rays; III, 9 anal fin spines and rays; 9 + 8 principal caudal fin rays; 16-18 pectoral fin rays; I, 5 pelvic fin spine and rays. These counts have also been reported for *L. analis* and *L. aya* (Miller and Jorgenson 1973). However, Anderson (1967) reported that *L. analis* has a maximum of 8 anal fin soft rays. Rivas (1966) reviewed the *L. campechanus* complex of "red snappers" and stated that the species described as *Bodianus aya* by Bloch in 1790 was probably not a lutjanid. Rivas recognized only two species in the complex commonly referred to as red snappers: *L. campechanus,* from the Gulf of Mexico and the South Atlantic coast of the United States, and *L. purpureus,* from the Caribbean Sea and southeastward along the coast of the Guianas, and probably to Brazil. Rivas (1966) synonymized *L. blackfordii* with *L. campechanus*. Therefore, *L. campechanus* is the only species occurring in the northern Gulf of Mexico which has the meristic complements observed in our specimens.

DESCRIPTION

Although we collected many lutjanid larvae, only those ≥4.0 mm were identifiable as *L. campechanus*. Lutjanids <4.0 mm lacked presently recognizable characters diagnostic at the species level and, therefore, were not described. This gen-

eral lack of development has also been observed in laboratory-reared larvae of *L. campechanus* <4.0 mm (Rabalais[4]).

Pigmentation

Diagnostic melanophores occurred on various regions of the specimens (Table 2). The first melanophore to appear on the head was on the dorsal midline over the midbrain. The dorsal surface of the peritoneum was nearly covered by large melanophores in all specimens. The presence and amount of pelvic fin pigment was variable. Fading of the pigment in some specimens was probably due to the preservation and/or handling. When pelvic fin pigment was present in specimens <7.3 mm, it was located only on the fin membrane. Our undamaged specimens ≥7.3 mm had pelvic fin melanophores primarily on the most anterior soft ray (Figure 1D) and/or in the fin membrane (Figure 2B).

The largest juvenile had the most pigmentation (Figure 2C). Four vertical bars made up of small melanophores were located between the head and the caudal section. All fin membranes between the 2d and 10th posteriormost spinous dorsal rays had three melanophores between each spionous ray. The soft dorsal fin had five melanophores on the fin membranes between the 7th and 13th posteriormost rays. An additional melanophore was present near the distal end of the dorsal principal caudal rays. Unfortunately, specimens were not available to link the development of pigmentation between 12.4 and 22.4.

Fin Formation

Dorsal and pelvic fins were the first to begin development in *L. campechanus* (Figure 1A), followed by caudal, anal, and pectoral fins. The adult complement of fin spines and rays was completed in the following order: caudal (principal rays only), pelvic, pectoral, dorsal, and anal (Table 3).

Dorsal Fin

The smallest illustrated specimen had developed only the five anteriormost dorsal spinous rays (Figure 1A). Most dorsal soft rays seemed to develop simultaneously, with the exception of the posteriormost soft rays which developed last. The total adult number of dorsal fin rays (24) was present at 4.9 mm, with the 2 posteriormost dorsal

[4]N. Rabalais, University of Texas Marine Laboratory, Port Aransas, TX 78373, pers. commun. October 1978.

TABLE 2.—Number of melanophores on regions of larval and juvenile *Lutjanus campechanus*. When available, several larvae of a given size were used in determining the number of melanophores.

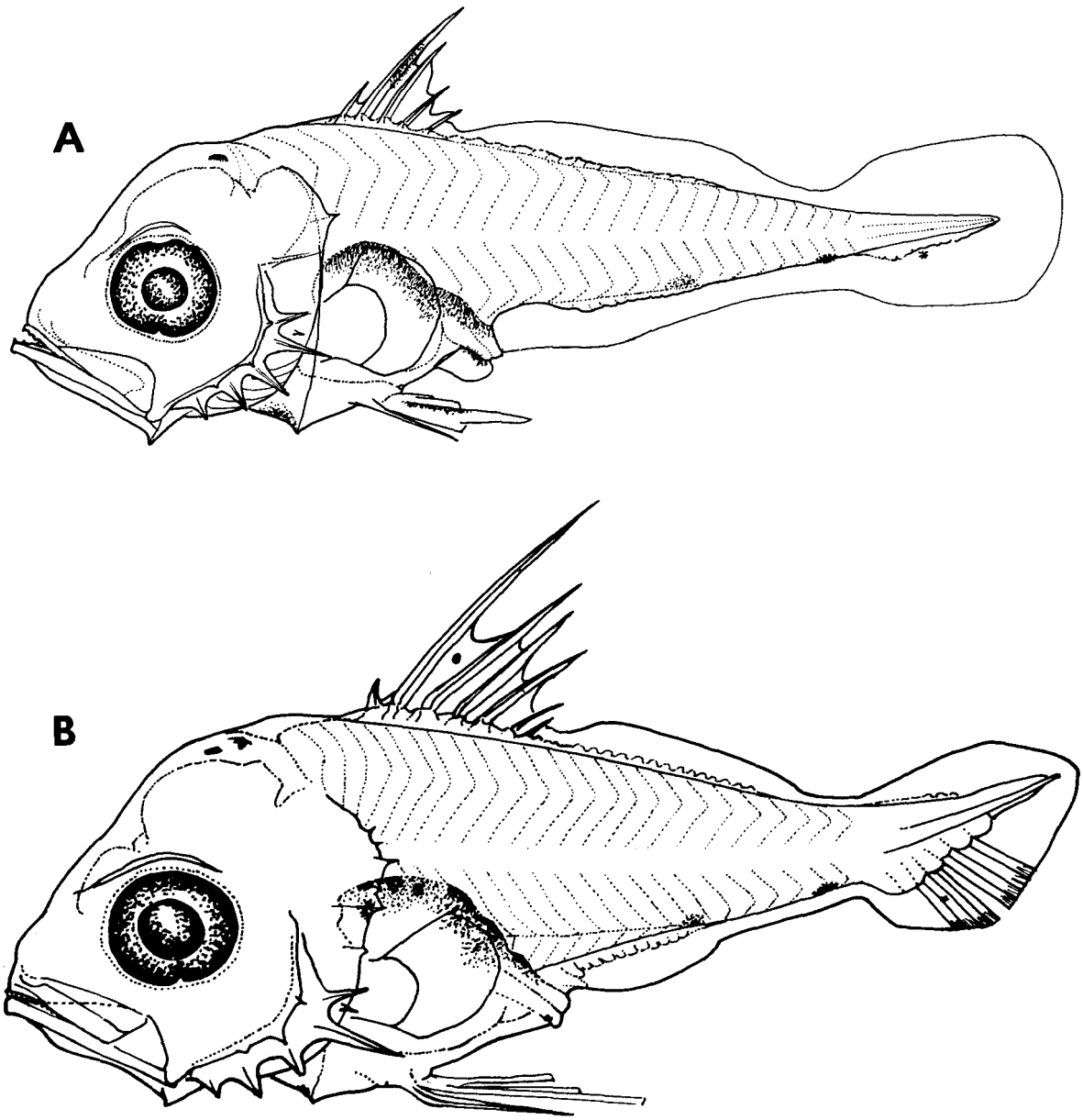
	Head				Gut		Dorsal and pelvic		Caudal			
SL (mm)	Over fore-brain	Over mid-brain	On oper-culum	On ventral midline anterior to ventral tip of cleithrum	Internal, over dorsal surfaces of peritoneum	On ventral midline just anterior to anus	Fin membrane between 2d and 3d dorsal spines	On anterior portion of pelvic fin	Internal, near posterior base of anal fin	On ventral midline of myomere no. 22-25	On ventral principal caudal rays	Internal, lateral to notochord and anterior to point of flexion
4.0	0	1	0	1	5-10	1	1-2	1-2	1	1	1	0
4.2	0	1-2	0	1	5-10	1	1-2	0-2	1	1	1	0
4.6	0	1	0	1	5-10	1	2	0-2	1	1	1	0
4.7	0	2	0	1	5-10	1	2	0-2	1	1	1	0
4.8	0	2	0	1	5-10	1	3-7	1-2	1	1	1	0
4.9	0	1-2	0	1	5-15	0-1	3-6	0-2	1	1	1	0
5.4	0	1	0	1	5-15	0-1	1-8	0-1	1	1	1	0
5.5	0	1-2	0	1	5-15	0	3-5	0-3	1	1	1	0
6.1	0	2-3	0	1	5-15	0	2-8	2-3	1	1	1	0-1
6.2	0	3-5	0	1	5-15	0	3-8	1-2	1	1	1	0-1
6.3	0	1-2	0	1	5-15	0	3-8	1-2	1	1	1	0-1
6.4	0	1-6	0	1	5-15	0	3-8	0-2	1	1	1	0-1
6.5	0	1-3	0	1	5-15	0	3-8	1-3	1	1	1	(1)
6.6	0	3-4	0	1	5-15	0	1-8	0-8	1	1	1	0-1
7.3	0	2	0	1	5-15	0	12-20	14	1	1	1	1
7.4	1	6	2	1	5-15	0	2	(1)	1	1	1	1
7.5	3	9	2	1	5-15	0	1	3	1	1	1	1
7.6	(1)	(1)	(1)	(1)	5-15	0	3-8	(1)	1	1	1	1
[2]8.0	1	13	1	1	5-15	0	3	(1)	1	1	1	1
[2]9.0	3	17	2	0	5-15	0	3-8	(1)	1	1	1	1
[2]9.5	6	30	2	0	5-15	0	3-8	3-8	1	1	1	1
[2]10.6	3	34	3	0	5-15	0	3-8	3-8	1	1	1	1
[2]12.4	7	36	1	0	5-15	0	10	6	1	1	1	1
[2]22.4	ca. 30	ca. 100	2	0	ca. 20	0	3	(1)	1	3	4	2

[1]Specimen was damaged and no count was taken.
[2]Juvenile.

spines represented by 2 soft rays (Table 3). At 5.4 mm the anteriormost soft ray became a spine. All specimens ≥7.5 mm had X, 14 dorsal fin spines and rays. The second dorsal spine was the longest ray in the dorsal fin in specimens 4.0-12.4 mm. In the 22.4 mm specimen, all dorsal fin rays except the first spine were about equal in length (Figure 2C). Serrations did not appear on the dorsal spines of *L. campechanus* between 4.0 and 22.4 mm.

Pelvic Fin

The smallest larva had not yet developed pelvic fin soft rays but had developed the pelvic spine (Figure 1A). The pelvic spine was smooth on the anterior margin on 4.0 and 4.7 mm specimens. Between 4.7 and 4.8 mm this spine developed ~30 fine serrations along its anterior margin. All larvae and juveniles 4.8-12.4 mm had these serrations. The number of serrations generally in-



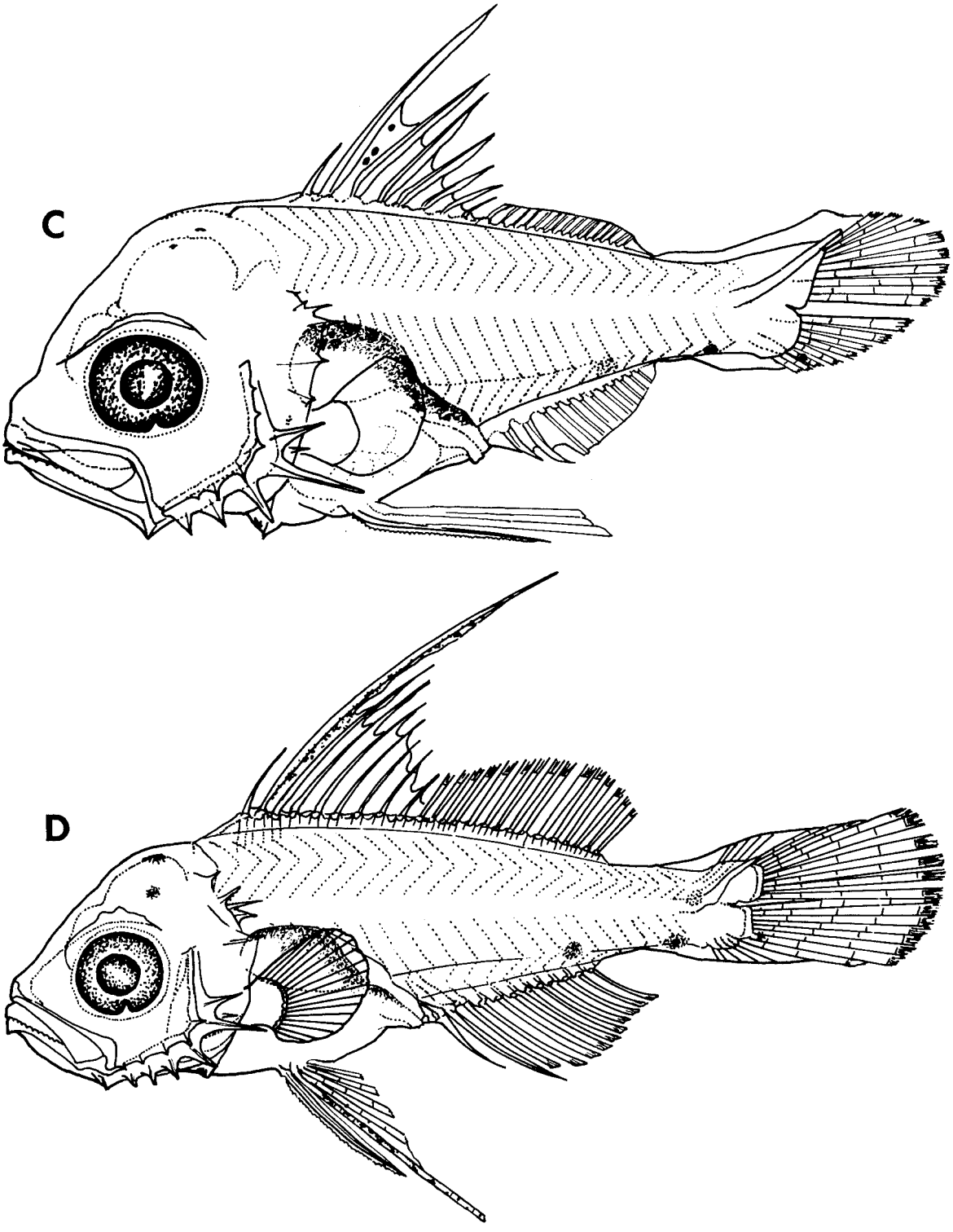


FIGURE 1.—Developmental stages of the red snapper, *Lutjanus campechanus*, larvae drawn using a camera lucida: A, 4.0 mm SL;B,4.2 mm; C, 4.9 mm; D, 7.3 mm.

creased with specimen size between 4.8 and 12.4 mm. The 12.4 mm juvenile had ~60 fine serrations on the anterior margin of each of its pelvic spines. Between 12.4 and 22.4 mm these serrations were lost.

Three distinct pelvic rays appeared on the 4.2 mm larva in the anterior portion of the previously undifferentiated finfold (Figure 1B). Between 4.6 and 5.5 mm the pelvic fin attained the adult complement of 1 spine and 5 soft rays (Table 3).

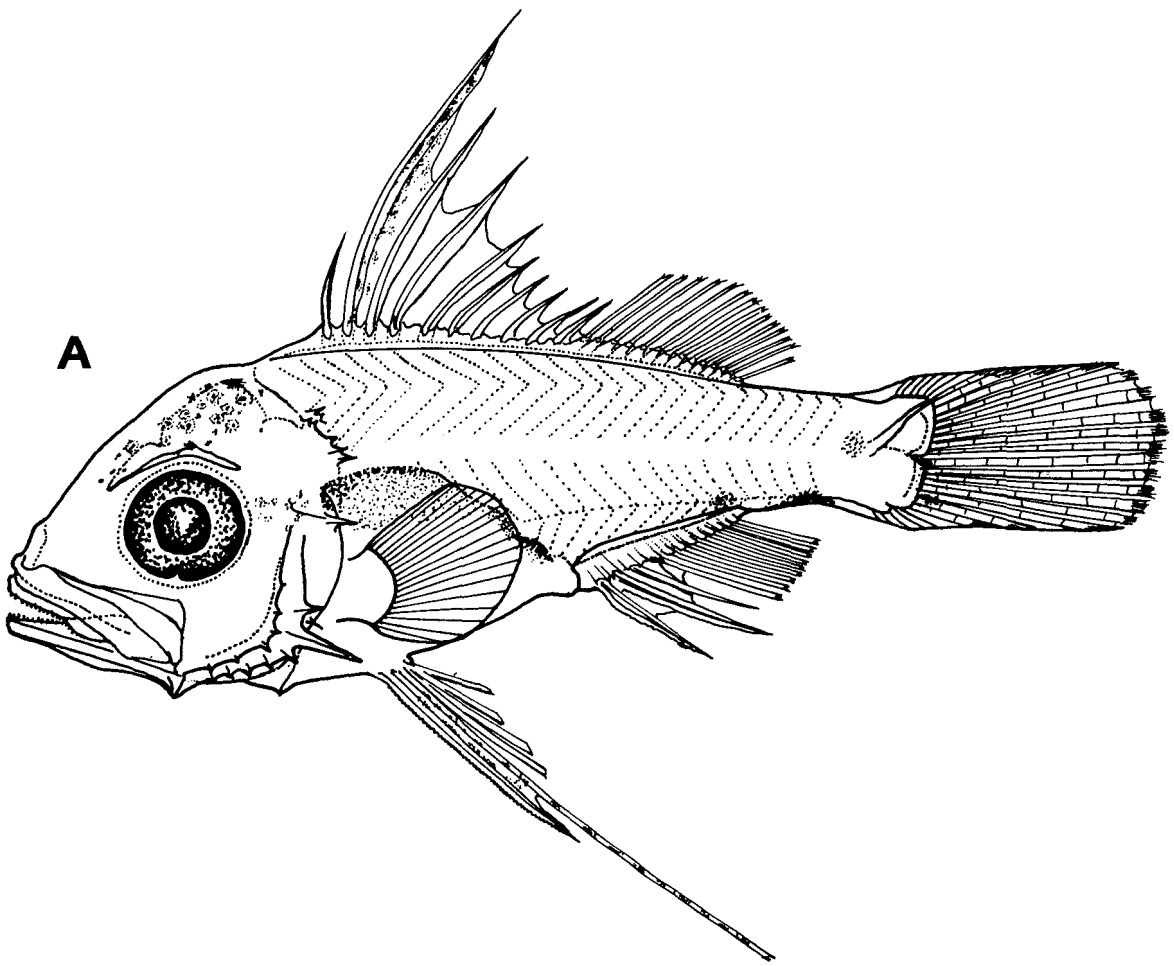
The pelvic spine was long. It extended to or beyond the anus in all but the smallest and largest specimens, 4.0 and 22.4 mm, respectively (Figures 1, 2). The pelvic soft ray closest to the pelvic spine was always the longest pelvic fin ray. Apparently this longest ray may be easily broken off during collection and handling. Approximately half of all specimens had this ray broken off. The unbroken, anteriormost pelvic ray in specimens 4.8-10.6 mm extended at least to the center of the anal fin base (Figure 1C). Specimens of 6.4, 7.3, and 9.5 mm had an unbroken ray that extended posteriorly beyond the center of the anal fin base (Figures 1D, 2A).

Caudal Fin

Caudal fin formation began at ~4.2 mm (Figure 1B, Table 3). The most ventral principal rays and those near the tip of the urostyle were the last to develop. Between 4.2 and 4.7 mm the adult complement of 17 (9 dorsal and 8 ventral) principal caudal rays developed. Notochord flexure occurred between 4.7 and 4.9 mm (Table 3).

Anal Fin

At 4.7 mm, 8 anal rays were present as 2 spines and 6 soft rays in the anteriormost part of the fin (Table 3). The posteriormost rays formed last. By 4.9 mm the adult complement of 12 rays was pres-



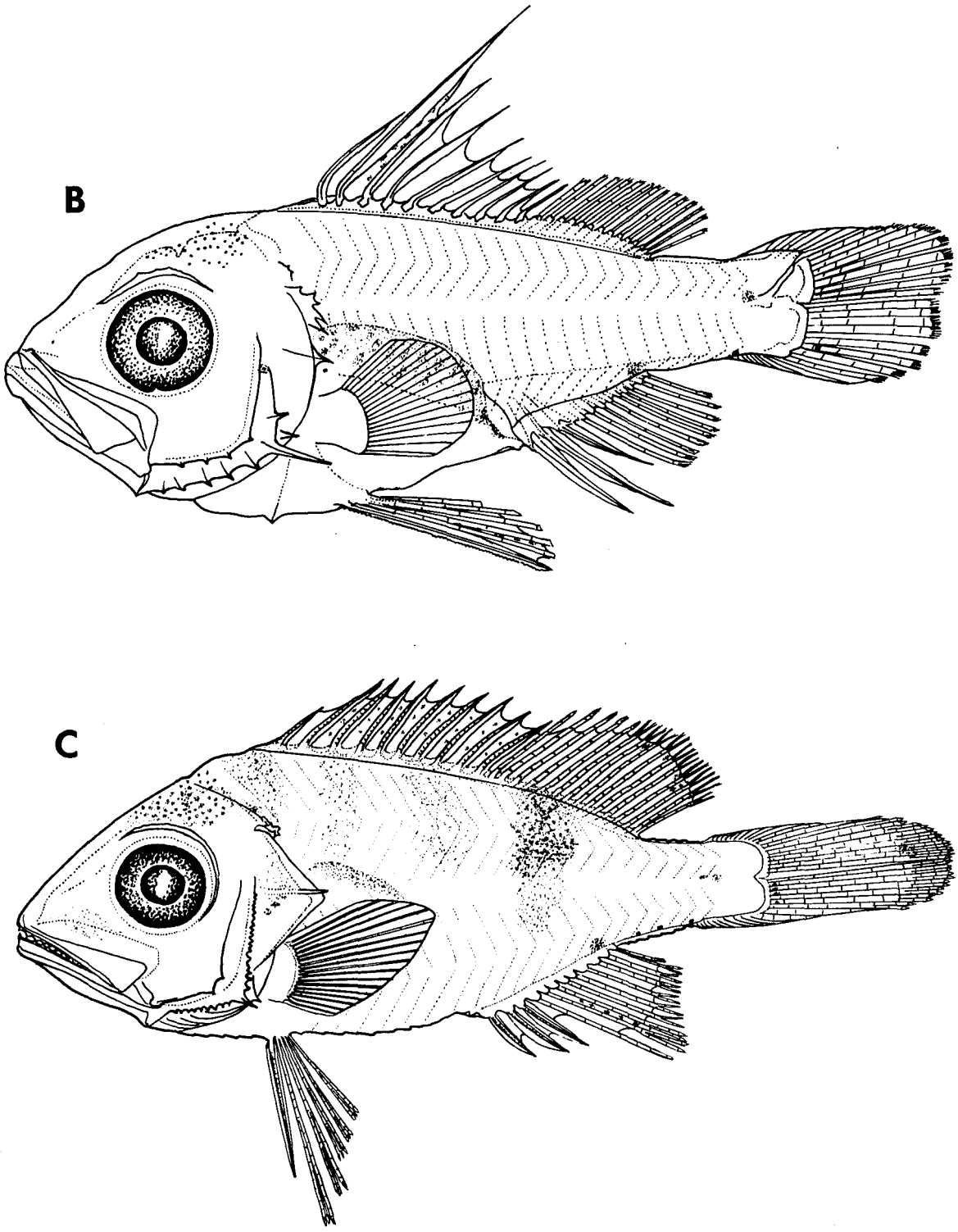


FIGURE 2.—Developmental stages of the red snapper, *Lutjanus campechanus*, juveniles drawn using a camera lucida: A, 9.5 mm SL; B, 12.4 mm; C, 22.4 mm.

TABLE 3.—Meristic characters and notochord flexure of larval and juvenile *Lutjanus campechanus*.

SL (mm)	Principal caudal fin rays		Dorsal fin		Anal fin		Pectoral fin	Pelvic fin		Notochord
	Upper	Lower	Spines	Rays	Spines	Rays	Rays	Spines	Rays	
4.0	0	0	V	0	0	0	0	I	0	Straight
4.2	4	4	VII	0	0	0	(1)	I	3	Straight
4.6	5	5	VI	0	0	0	(1)	I	3	Straight
4.7	9	8	VII	8	II	6	(1)	I	4	Flexed
4.8	9	8	VIII	11	II	8	(1)	I	4	Straight
4.9	9	8	VIII	16	II	10	(1)	I	(1)	Flexed
5.4	9	8	IX	15	II	10	(1)	I	(1)	Flexed
5.5	9	8	IX	15	II	10	(1)	I	5	Flexed
6.1	9	8	IX	15	II	10	(1)	I	5	Flexed
6.2	9	8	IX	15	II	10	(1)	I	5	Flexed
6.3	9	8	IX	15	II	10	(1)	I	5	Flexed
6.4	9	8	IX	15	II	10	(1)	I	5	Flexed
6.5	9	8	IX	15	II	(1)	(1)	I	5	Flexed
6.6	9	8	IX	15	II	10	14	I	5	Flexed
7.3	9	8	IX	15	II	10	16	I	5	Flexed
7.4	9	8	IX	15	II	10	17	I	5	Flexed
7.5	9	8	X	14	II	(1)	16	I	5	Flexed
7.6	9	8	X	14	II	10	17	I	5	Flexed
[2]8.0	9	8	X	14	III	9	17	I	5	Flexed
[2]9.0	9	8	X	14	III	9	18	I	5	Flexed
[2]9.5	9	8	X	14	III	9	18	I	5	Flexed
[2]10.6	9	8	X	14	III	9	18	I	5	Flexed
[2]12.4	9	8	X	14	III	9	18	I	5	Flexed
[2]22.4	9	8	X	14	III	9	17	I	5	Flexed

[1]An accurate count was not possible.
[2]Juvenile

ent in the form of 2 spines and 10 soft rays (Figure 1C). The transformation of the anteriormost soft ray into the third anal spine occurred between 7.6 and 8.0 mm and marked the end of the larval period. Anal spines were not serrated.

Pectoral Fin

The 4.0 mm larva had only a pectoral finfold (Figure 1A). Between 4.0 and 6.5 mm ray development began, but ossification was not completed and the exact number of rays was difficult to determine. The 6.6 mm larva had 14 pectoral rays, and 2 more rays were added by 7.3 mm. The 16 rays on the 7.3 mm specimen were within the 16-18 range for adult pectoral rays (Rivas 1966). The number of pectoral rays on specimens 7.3-22.4 mm varied from 16 to 18 (Table 3).

Squamation

Scales were present on the 22.4 mm specimen only. An accurate lateral line scale count was not possible.

Head

The head of the larval and juvenile *L. campechanus* was large, ranging between 32.5 and 44.9% SL (Table 4). Head size (head length as percent of SL) generally increased in larvae and decreased in juveniles. The smallest and largest specimens had the smallest head proportions, 32.5% on the 4.0 mm larva and 34.8% on the 22.4 mm juvenile. The head was proportionally largest, 44.9 and 44.4%, on the 4.9 and 5.4 mm larvae, respectively. Head length was about equal to body depth in all specimens. Head length ranged from 32.5 to 44.9% SL and body depth from 32.5 to 43.9% SL.

TABLE 4.—Measurements and body part proportions for larval and juvenile *Lutjanus campechanus*.

SL (mm)	Head length		Snout to anus length		Body depth		Eye diameter	
	(mm)	(% SL)	(mm)	(% SL)	(mm)	(% SL)	(mm)	(% SL)
4.0	1.3	32.5	1.9	47.5	1.3	32.5	0.44	11.0
4.2	1.6	38.1	2.3	54.8	1.5	35.7	0.51	12.1
4.6	1.7	37.0	2.3	50.0	1.5	32.6	0.53	11.5
4.7	1.9	40.4	2.6	55.3	1.8	38.3	0.59	12.6
4.8	1.8	37.5	2.8	58.3	1.9	40.0	0.66	13.8
4.9	2.2	44.9	3.0	61.2	2.0	40.8	0.56	11.4
5.4	2.4	44.4	3.3	61.1	2.3	42.6	0.77	14.3
5.5	2.3	41.8	3.4	61.8	2.1	38.2	0.70	12.7
6.1	2.4	39.3	3.6	59.0	2.3	37.7	0.78	12.8
6.2	2.6	41.9	3.9	62.9	2.4	38.7	0.79	12.7
6.3	2.6	41.3	3.8	60.3	2.5	39.7	0.79	12.5
6.4	2.4	37.5	3.8	59.4	2.6	40.6	0.79	12.3
6.5	2.6	40.0	4.1	63.1	2.7	41.5	0.83	12.8
6.6	2.8	42.4	4.3	65.1	2.9	43.9	0.87	13.2
7.3	2.7	37.0	4.3	58.9	2.8	38.4	0.95	13.0
7.4	3.1	41.9	4.7	63.5	3.1	41.9	0.93	12.6
7.5	3.0	40.0	4.7	62.7	3.1	41.3	0.97	12.9
7.6	3.1	40.8	4.7	61.8	3.0	39.5	0.98	12.9
[1]8.0	3.2	40.0	5.1	63.8	3.3	41.3	0.99	12.4
[1]9.0	3.3	36.7	5.8	64.4	3.3	36.7	1.2	13.3
[1]9.5	3.5	36.8	5.9	62.1	3.4	35.8	1.2	12.6
[1]10.6	4.0	37.7	6.7	63.2	4.0	37.7	1.2	11.3
[1]12.4	4.8	38.7	7.9	63.7	4.7	37.9	1.4	11.3
[1]22.4	7.8	34.8	15.1	67.4	8.1	36.2	2.7	12.1

[1]Juvenile.

Spines were found on the preopercle, posterodorsal margin of the operculum, posttemporal, and supracleithrum. Serrations developed on the supraocular crest.

The preopercular spines developed in two rows, one anterior to the preopercular margin and one along the preopercular margin (Figures 1, 2). Both rows had vertical and horizontal segments. The vertical segments were situated approximately perpendicular to the body midline, and the horizontal segments were situated approximately parallel to the body midline of the fish. The anteriormost row had 3-6 spines (1-3 vertically and 2-3 horizontally) in the 4.0-22.4 mm specimens. The number of anterior row spines decreased in the largest specimens. The row along the preopercular margin had 5-27 spines (2-18 vertically and 3-9 horizontally) in the 4.0-22.4 mm specimens. The number of both vertical and horizontal preopercular margin spines increased between 12.4 and 22.4 mm. Vertical spines increased by 16 and horizontal spines increased by 4 along the preopercular margin between these two lengths.

A small spine was present on the interopercle of all specimens. A larger spine was also present on the posterodorsal margin of the opercle of all specimens. (Figures 1, 2). The spine at the angle of the preopercle was the largest spine on the head. No serrations developed on this or any other preopercular spine.

A spine on the posttemporal was first present on the 7.3 mm larva. A second spine developed on this bone by 9.5 mm. These 2 posttemporal spines were greatly reduced in the two largest specimens. A supracleithral spine was present on the smallest larva (4.0 mm). Three spines were present by 4.2 mm, and 5 spines had developed by 9.5 mm (Figures 1A, B; 2A). The 2 most ventral supracleithral spines were longer in the 12.4 mm specimen than in smaller specimens. The 22.4 mm juvenile had all of the supracleithral spines, but these spines were much smaller (Figure 2C).

Two serrations developed on the supraocular crest by 7.3 mm (Figure 1D), and two more by 12.4 mm. The 22.4 specimen had no serrations on the supraocular crest (Figure 2C).

Eye diameter was 11.0-14.3% SL (Table 4). The eye was almost spherical, and the iris had a ventral cleft in all but the largest specimen (Figures 1, 2).

Teeth were present in all specimens on the dentary and premaxillary bones. In addition, the two largest specimens (12.4 and 22.4 mm) had vomerine and palatine teeth. The vomerine teeth in these two specimens were arranged in a V-shaped pattern with the angle pointed anteriorly.

TABLE 5.—Predictive linear regressions of body measurements on standard length for 24 larval and juvenile *Lutjanus campechanus* over the size range 4.0-22.4 mm SL.

Measurement	Slope	Intercept	$S_{y \cdot x}$	r
Head length	0.341	0.350	0.177	0.991
Body depth	0.699	-0.601	0.159	0.998
Snout to anus length	0.359	0.197	0.181	0.992
Eye diameter	0.118	0.050	0.054	0.993

Body Growth

Measurements of four body parts are given in Table 4. The growth of these parts in relation to standard length is described by linear regressions (Laroche 1977; Sokal and Rohlf 1969), the statistics for which are presented in Table 5. All relationships have high correlation coefficients of ≥ 0.991.

Comparison With Other Lutjanid Larvae and Juveniles

As stated earlier, *R. aurorubens* is the only lutjanid to have previously had its larval and juvenile stages described. The two snappers are easily separated as follows: In specimens ≥4.0 mm, *R. aurorubens* has serrations on the largest spine at the preopercular angle. Figure 1A in Laroche (1977) did not show the serrations on this spine, however, the text stated that, "A large, stout, and serrated spine occurs at the preopercular angle in all specimens." Laroche[5] confirmed this. In addition, large serrations develop on the anterior and posterior margins of the dorsal and pelvic spines in larval *R. aurorubens* ≥4.7 mm. None of the 4.0-4.7 mm *L. campechanus* had serrated preopercular, dorsal, or pelvic spines. Both species have serrated pelvic spines in specimens >4.8 mm, but *R. aurorubens* has large serrations on the anterior and posterior margins while *L. campechanus* has small serrations on just the anterior margin. The total number of rays in the dorsal and anal fins also separates these two snappers at sizes ≥5.0 mm. *Rhomboplites aurorubens* has 22 or 23 dorsal and 11 anal rays while *L. campechanus* has 24 dorsal and 12 anal rays. *Rhomboplites aurorubens* is the only lutjanid to have an adult complement of

[5]W. A. Laroche, School of Oceanography, Oregon State University, Corvallis, OR 97331, pers. commun. June 1978.

12 dorsal spines. All other members of the Lutjanidae have 10 spines. Finally, the head length of *R. aurorubens* is greater than the body depth (Laroche 1977), while in *L. campechanus* head length is about equal to body depth (Table 4).

Identification of the larvae and juveniles of other lutjanid species is more difficult than that of *L. campechanus* and *R. aurorubens*, since the meristic characters are very similar in most other species of lutjanids. At the present time, field-collected lutjanid larvae <4.0 mm can be identified only to family. Laboratory rearing presents the most likely solution to the larval and juvenile lutjanid taxonomic problem.

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LITERATURE CITED

ANDERSON, W. D., JR.
1967. Field guide to the snappers (Lutjanidae) of the western Atlantic. U.S. Fish Wildl. Serv., Circ. 252, 14 p.

ARNOLD, C. R., J. M. WAKEMAN, T. D. WILLIAMS, AND G. D. TREECE.
1978. Spawning of red snapper (*Lutjanus campechanus*) in captivity. Aquaculture 15:301-302.

BAILEY, R. M., J. E. FITCH, E. S. HERALD, E. A. LACHNER, C. C. LINDSEY, C. R. ROBINS, AND W. B. SCOTT.
1970. A list of common and scientific names of fishes from the United States and Canada. Am. Fish. Soc., Spec. Publ. 6, 149 p.

BEAUMARIAGE, D. S., AND L. H. BULLOCK.
1976. Biological research on snappers and groupers as related to fishery management requirements. *In* H. R. Bullis, Jr. and A. C. Jones (editors), Proceedings: Colloquium on snapper-grouper fishery resources of the western central Atlantic Ocean, p. 86-94. Fla. Sea Grant Rep. 17. FSUS-76-R-17.

BRADLEY, E., AND C. E. BRYAN.
1975. Life history and fishery of the red snapper (*Lutjanus campechanus*) in the northwestern Gulf of Mexico: 1970-1974. Gulf Caribb. Fish. Inst., Proc. 27th Annu. Sess., p. 77-106.

FAHAY, M. P.
1975. An annotated list of larval and juvenile fishes captured with surface-towed meter net in the South Atlantic Bight during four RV *Dolphin* cruises between May 1967 and February 1968. U.S. Dep. Commer., NOAA Tech. Rep. NMFS SSRF-685, 39 p.

FOURMANOIR, P.
1973. Notes ichthyologiques (V). Cah. O.R.S.T.O.M. Sér. Oceanogr. 11:33-39.

HEEMSTRA, P. C.
1974. On the identity of certain eastern Pacific and Caribbean postlarval fishes (Perciformes) described by Henry Fowler. Proc. Acad. Nat. Sci. Phila. 126:21-26.

JOSSI, J. W., R. R. MARAK, AND H. PETERSON, JR.
1975. At-sea data collection and laboratory procedures. MARMAP survey I manual. National Marine Fisheries Service, Wash., D.C., 115 p.

LAROCHE, W. A.
1977. Description of larval and early juvenile vermilion snapper, *Rhomboplites aurorubens*. Fish. Bull., U.S. 75:547-554.

MILLER, G. L., AND S. C. JORGENSON.
1973. Meristic characters of some marine fishes of the western Atlantic Ocean. Fish. Bull., U.S. 71:301-312.

MOSER, H. G., AND E. H. AHLSTROM.
1970. Development of lanternfishes (family Myctophidae) in the California Current. Part I. Species with narrow-eyed larvae. Bull. Los Ang. Cty. Mus. Nat. Hist. Sci. 7, 145 p.

RIVAS, L. R.
1966. Review of the *Lutjanus campechanus* complex of red snappers. Q. J. Fla. Acad. Sci. 29:117-136.

SOKAL, R. R., AND F. J. ROHLF.
1969. Biometry. The principles and practice of statistics in biological research. W. H. Freemen and Co., San Franc., 776 p.

STARCK, W. A., II.
1971. Biology of the gray snapper, *Lutjanus griseus* (Linnaeus), in the Florida Keys. *In* W. A. Starck II and R. E. Schroeder, Investigations on the gray snapper, *Lutjanus griseus*, p. 11-150. Stud. Trop. Oceanogr. (Miami) 10.