

Tetraodontiformes

Selected meristic characters in species belonging to the order Tetraodontiformes whose adults or larvae have been collected in the study area. Pelvic fin absent in all taxa except *Parahollardia lineata*¹. Classification sequence and nomenclature follows Matsuura, 2002. Sources: Berry and Vogele, 1961; Miller and Jorgenson, 1973; Leis, 1978; Tyler, 1980; Matsuura, 2002

Family <i>Species</i>	Vertebrae	Dorsal Fin Rays	Anal Fin Rays	Caudal Fin Rays	Pectoral Fin Rays
Triacanthodidae					
<i>Parahollardia lineata</i> ¹	8+12=20	VI, 16	14	0+6+6+0	13
Balistidae					
<i>Balistes capriscus</i>	7+11=18	III, 26–29	23–26	0+6+6+0	13–15
<i>Balistes vetula</i>	7+11=18	III, 29–31	27–28	0+6+6+0	14–15
<i>Canthidermis maculata</i>	7+11=18	III, 23–25	20–22	0+6+6+0	13–15
<i>Canthidermis sufflamen</i>	7+11=18	III, 25–28	23–25	0+6+6+0	15–16
Monacanthidae					
<i>Aluterus heudelotii</i>	7+13=20	II, 36–41	39–44	0+6+6+0	12–14 ²
<i>Aluterus monoceros</i>	7+16=23	II, 46–50	47–52	0+6+6+0	14 ²
<i>Aluterus schoepfi</i>	7+16=23	II, 32–39	35–41	0+6+6+0	11–14 ²
<i>Aluterus scriptus</i>	7+14=21	II, 44–47	47–49	0+6+6+0	13–15 ²
<i>Cantherhines pullus</i>	7+12=19	II, 33–36	29–32	0+6+6+0	13–14 ²
<i>Monacanthus ciliatus</i>	6+13=19	II, 29–37	28–36	0+6+6+0	9–13 ²
<i>Stephanolepis hispidus</i>	7+12=19	II, 32–34	32–34	0+6+6+0	12–14 ²
<i>Stephanolepis setifer</i>	7+12=19	II, 27–30	26–30	0+6+6+0	11–13 ²
Ostraciidae					
<i>Acanthostracion polygonius</i>	9+9=18	10	10	0+5+5+0	11–12
<i>Acanthostracion quadricornis</i>	9+10=19	10	10	0+5+5+0	11–12
<i>Lactophrys trigonus</i>	9+9=18	10	10	0+5+5+0	11–13
<i>Rhinesomus triqueter</i>	9+9=18	10	10	0+5+5+0	12

¹ The pelvic fin in *Parahollardia lineata* is composed of a large, stout spine followed by 2 feeble fin rays, only one of which is visible externally.

² The pectoral fin ray counts in the Monacanthidae do not include a prominent "pectoral spine" in larvae and juveniles that becomes rudimentary in adults.

Characters of Adults and Developmental Stages in the Tetraodontiformes:

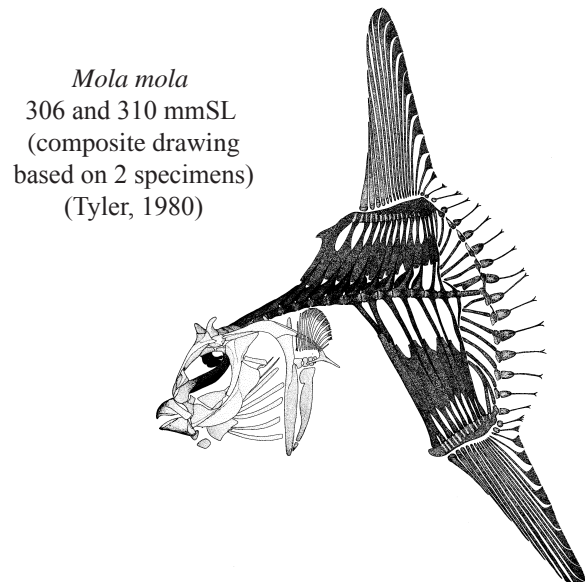
- Most exhibit extreme specializations, especially in osteology, squamation and dentition
- Many structures such as fin spines and rays, entire fins, or fin-supporting bones may be reduced or lost
- Scales are often modified into spinous scales, plates or tubercles
- Teeth are often modified into protruding incisors or beak-like plates
- Vertebral (myomere) counts are typically very low
- Fins typically lack spines; 2 families have reduced number of dorsal spines modified into locking mechanism
- Several taxa have the ability to inflate their bodies
- The flesh of many is poisonous
- Most taxa are demersal, occurring near structured habitats; very few are pelagic
- Eggs are poorly known
- Larval stages are short-lived and larvae transform into pelagic-juveniles at relatively small sizes
- Many larvae have body covering of dermal spinules that are precursors of scales in adults
- Pelagic-juvenile stage is likely to last for long period before settlement to bottom habitats

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Selected meristic characters in species belonging to the order Tetraodontiformes whose adults or larvae have been collected in the study area. Classification sequence and nomenclature follows Matsuura, 2002. Sources: Berry and Vogele, 1961; Miller and Jorgenson, 1973; Leis, 1978; Tyler, 1980; Matsuura, 2002

Family <i>Species</i>	Vertebrae	Dorsal Fin Rays	Anal Fin Rays	Caudal Fin Rays ³	Pectoral Fin Rays
Tetraodontidae					
<i>Lagocephalus laevigatus</i>	8+11=19	12–15	11–14	0+5+6+0	15–19
<i>Lagocephalus lagocephalus</i>	8+10=18	12–15	11–13	0+5+6+0	13–16
<i>Sphoeroides maculatus</i>	8+11=19	8	7	0+5+6+0	16
<i>Sphoeroides pachygaster</i>	8+10=18	8–10	7–9	0+5+6+0	15–17
<i>Sphoeroides spengleri</i>	8+9–10=17–18	8	7	0+5+6+0	13
<i>Sphoeroides testudineus</i>	8+10=18	8	7	0+5+6+0	15
Diodontidae					
<i>Chilomycterus reticulatus</i>	12+10–22	12–14	11–14	0+4+5+0	19–22
<i>Chilomycterus schoepfi</i>	10–12+8=18–20	10–12	9–11	0+4+5+0	–
<i>Diodon holocanthus</i>	12+9=21	14–15	13–14	0+4+5+0	21–23
<i>Diodon hystrix</i>	11–12+9–10=20–21	15–17	15–16	0+4+5+0	22–25
Molidae					
<i>Masturus lanceolatus</i>	8+8=16	17–20	16–19	"Clavus" ³	7–10
<i>Mola mola</i>	8+9=17	15–20	14–18	"Clavus" ³	11–13
<i>Ranzania laevis</i>	8+10=18	18–19	18–19	"Clavus" ³	13–14

³ The caudal end in molids is composed of a series of fin ray-like structures between the dorsal and anal fins. These are not supported by ural bones as they are in other teleosts. This configuration has been referred to as a "pseudocaudal" (Tyler, 1980) or "clavus" (e.g. Leis, 1984a). A caudal finfold is present in early larvae, but this is lost as a secondary formation of posterior dorsal and anal fin rays and pterygiophores occurs. The resulting array of elements shown in the accompanying figure demonstrates the total lack of ural elements, and the presence of a continuing series of pterygiophores and fin rays between the dorsal and anal fins. Similar structures in the other 2 molid species present in the study area are also present and depicted in Tyler (1980). A recent study concludes that the caudal fin is totally lost in molids, and the "clavus" is formed by modified elements of the dorsal and anal fins (Johnson and Britz, 2005).



Parahollardia lineata* (Longley, 1935)*Triacanthodidae**

Jambeau

Range: Western North Atlantic Ocean from Virginia to Mexico including Gulf of Mexico; also Baltimore Canyon (MCZ 162936)

Habitat: Demersal in continental slope waters in depths of 100–400 m. The larvae of a closely related species, illustrated in Figs. A–C, were collected in depths >2,000 m, suggesting that reproduction and development in this family occur deeper than most ichthyoplankton sampling operations.

Spawning: Undescribed

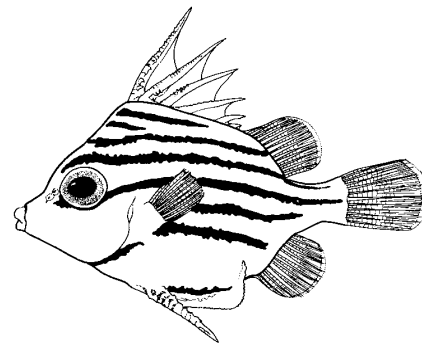
Eggs: – Undescribed

Larvae:

- Undescribed; generalizations below based on descriptions of larvae of 2 related species from the Philippines and Celebes Sea
- Body very deep and wide anteriorly, laterally compressed posterior to anus
- Preanus length 60–80% SL
- Eye large, mouth small and terminal
- Gill slit very restricted in early stages
- Sequence of fin ray formation: $D_2, A - C - P_1 - P_2 - D_1$
- Note fold of thickened membrane on dorsum in area where D_1 will form and 3 such folds on venter where P_2 spine and rays will form
- Note very long posterior portion of notochord, extending into expanded caudal finfold
- Anterior body and ventral patches over gut covered with dermal spinules in early larvae; postflexion larvae are completely covered with spinules; specialized spines are present in adults (Fig. D)
- Pigmentation undescribed; in the 2 brief descriptions available, pigmentation is reported to be absent, or is not mentioned

Note: 1. Except for references cited below, there are very few accounts of this enigmatic species. Early stages are undescribed, and details of its distribution are rare. Tyler (1968) presents a complete description, including osteological details, based on a series from 26.1 to 168.6 mmSL.

Early Juvenile: Typical adult pigmentation, composed of bold stripes, is acquired in juveniles between 23 and 26 mm. See photograph of 26.1 mmSL juvenile in Tyler (1968, fig. 23). Scales in juveniles as small as 62.2 mmSL are similar to those illustrated (Fig. D). Smaller juveniles (e.g. 20–30 mmSL) have a single spinule on each basal plate instead of the linear arrangement of 3–5 spinules (Tyler, 1968, fig. 18).

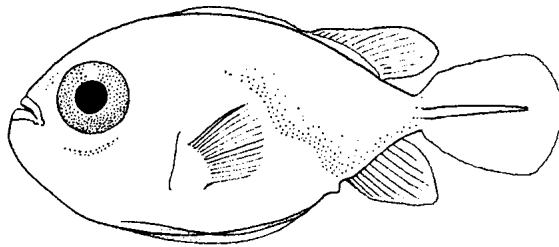
**Meristic Characters**

Myomeres:	20
Vertebrae:	8 + 12 = 20
Dorsal fin rays:	VI, 16
Anal fin rays:	14
Pectoral fin rays:	13
Pelvic fin rays:	I, 2
Caudal fin rays:	0+6+6+0

Figures: Adult: Matsuura, 2002; **A–D:** Fraser-Brunner, 1950 (A and B modified; ambiguous streaks in caudal finfold removed); **E:** Aboussouan and Leis, 1984

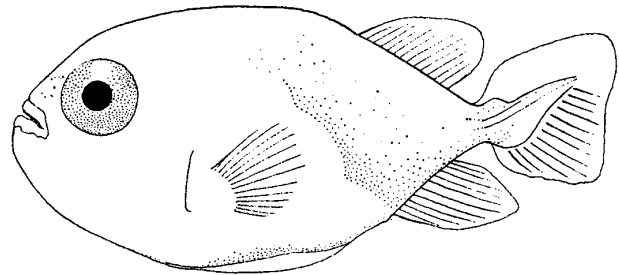
References: Fraser-Brunner, 1950; Tyler, 1968; 1980; Aboussouan and Leis, 1984; Matsuura, 2002

Parahollardia lineata

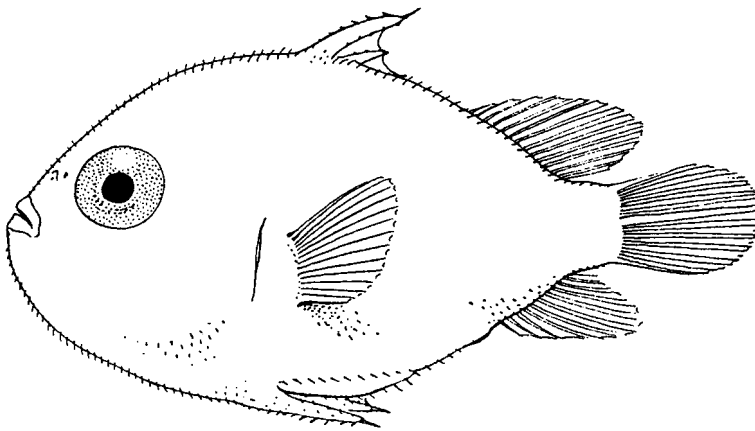


A. 2.4 mmSL

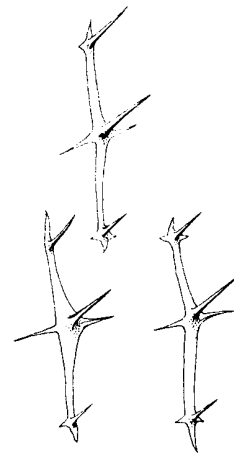
Larvae of *Parahollardia lineata* are undescribed. The larvae of 2 confamilials from the Pacific Ocean are included here to demonstrate developmental features in the family.



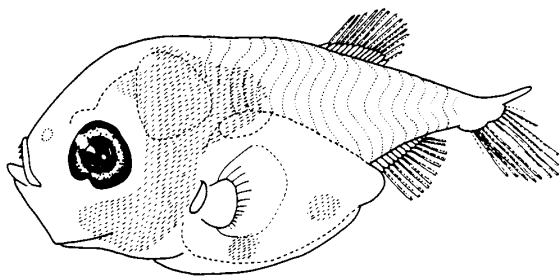
B. 3.0 mmSL



C. 6.0 mmSL



**D. Modified Scales
(Size unknown)**



**E. Composite of 3 Larvae
2.6-2.7 mmSL**

Stippled areas indicate presence of dermal spinules

Balistes capriscus* Gmelin, 1789*Balistidae****Grey triggerfish**

Range: Both sides of the Atlantic Ocean in tropical and temperate waters; in the western Atlantic from Nova Scotia to Argentina

Habitat: Demersal, often near coral or rock reefs, but also sandy or grassy bottoms near those reefs; in depths from near surface to 50 m (as deep as 106 m); juveniles primarily pelagic or neustonic

Spawning: Apr–Sep (Gulf of Mexico)

Eggs: – Demersal, small; otherwise undescribed

Larvae:

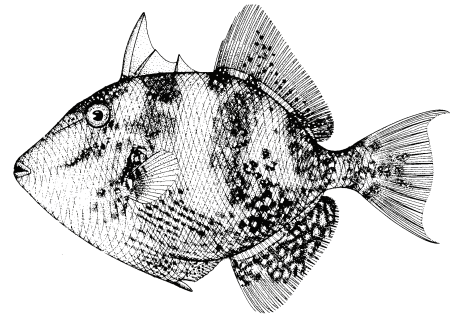
- Body very deep and wide anteriorly, tapering to narrow caudal peduncle; becomes laterally compressed during flexion
- Gut deep, coiled and compact; preanus length increases from about 55% SL to 70% SL
- Head large with small, terminal mouth; head length decreases from 55% SL to 45% SL
- Raised tuft of long spinules occurs on preopercle, beginning in preflexion larvae (Fig. F); disappears at flexion
- Sequence of fin ray formation: $D_1 - D_2, A - C - P_1$
- Dorsal fin spines develop secondary barbs
- Barbed spine forms at pelvic symphysis soon after flexion; becomes secondarily barbed
- Dermal spinules begin on ventrolateral surface of gut and head during preflexion stage; these spread to include entire head, body and fin bases in postflexion larvae; spinules are precursors to scales in adults
- Pigment in preflexion larvae includes spots on brain, in nape, over gut, internally along anal fin base, at distal tips of anal pterygiophores and on caudal finfold; pigment increases in later larvae, especially on dorsal fin membrane, on caudal peduncle, on dorsum of head and body; anterior head remains unpigmented until late postflexion

Note: 1. Ontogeny of *Balistes vetula* is undescribed, but is presumably similar to that of *B. capriscus*; slightly higher counts of fin rays should enable identification of *B. vetula* early stages. A juvenile, 36.0 mmSL, has been photographed (Moore, 1967, fig. 2C).

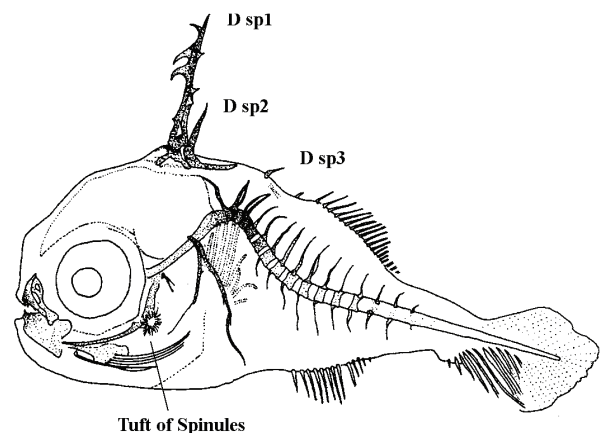
Osteology:

Note early forming dorsal spines and locking mechanism including a fused basal pterygiophore under the first 2 spines. A "supraneural element" occurs under the 3rd spine (see glossary).

Also note presence of tuft of spinules on preopercle

**Meristic Characters**

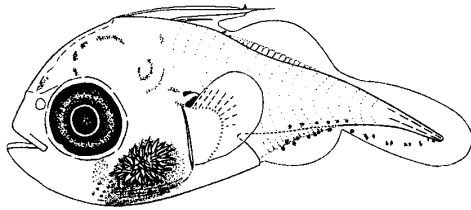
Myomeres:	18
Vertebrae:	7 + 11 = 18
Dorsal fin rays:	III, 26–29
Anal fin rays:	23–26
Pectoral fin rays:	13–15
Pelvic fin rays:	none
Caudal fin rays:	0+6+6+0

**F. 3.9 mmNL**

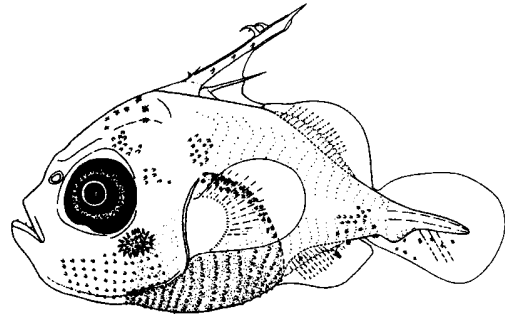
Figures: Adult: Matsuura, 2002; **A–E:** Bev Vinter and P. J. Bond (Lyczkowski-Shultz and Ingram, 2003); **F:** Matsuura and Katsuragawa, 1985 (modified)

References: Leis and Rennis, 1983; Matsuura and Katsuragawa, 1981; 1985; Matsuura, 2002; Lyczkowski-Shultz and Ingram, 2003

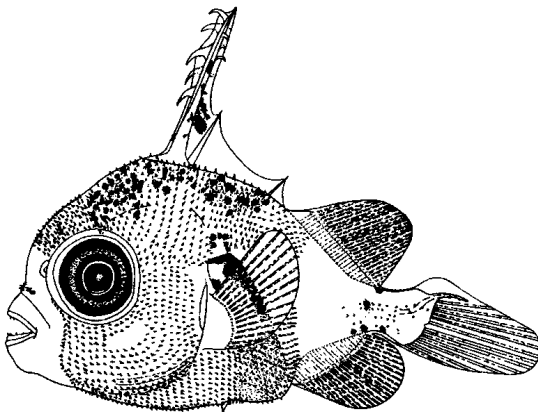
Balistes capriscus



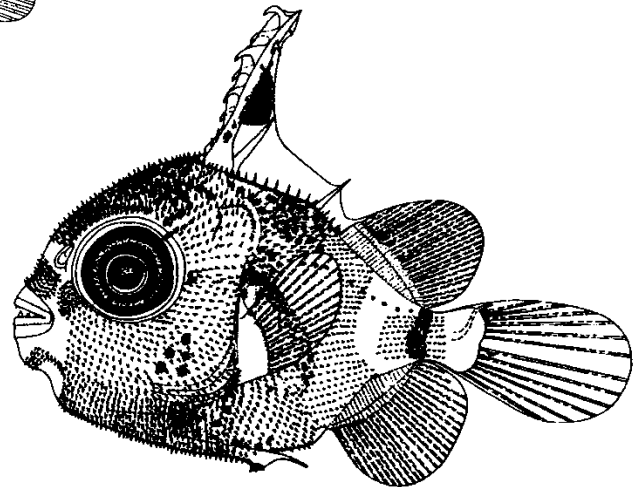
A. 2.7 mmSL



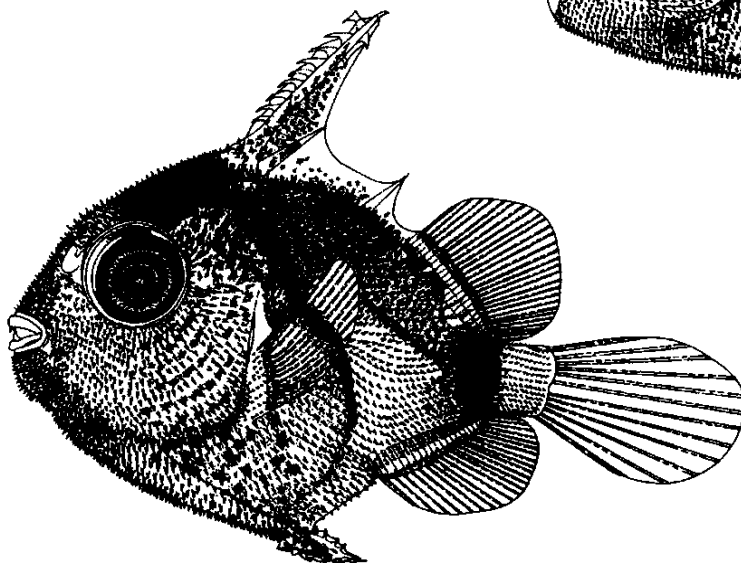
B. 3.0 mmSL



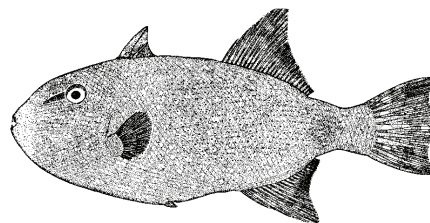
C. 3.6 mmSL



D. 4.4 mmSL



E. 6.2 mmSL

Canthidermis maculata* (Bloch, 1786)*Balistidae****Spotted oceanic triggerfish**

Range: Worldwide in temperate and tropical waters; in the western Atlantic from North Carolina to Argentina, including Gulf of Mexico and Caribbean Sea; juvenile record from New Jersey (Boston University, uncat., 59.4 mmSL, 39°44'N, 77°00'W); a few other records from southern parts of study area

Habitat: Epipelagic, often associated with floating objects

Spawning: Undescribed; larvae present in oceanic waters Apr–Oct (Gulf of Mexico)

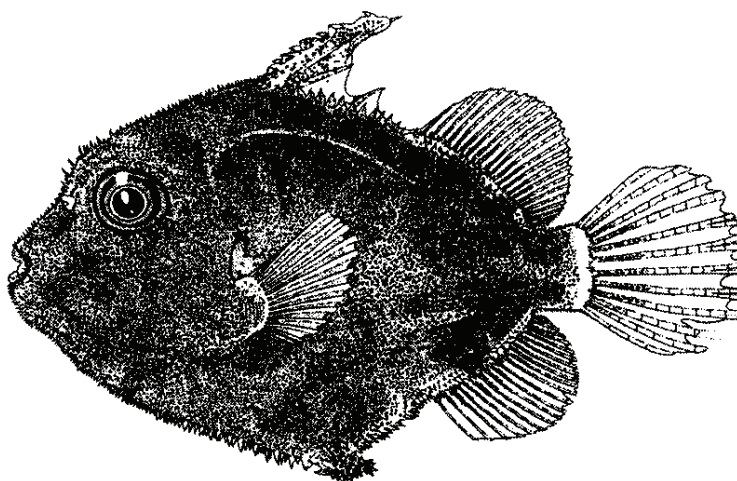
Eggs: – Undescribed

Larvae:

- Body very deep and wide anteriorly, tapering to narrow caudal peduncle; becomes laterally compressed during flexion
- Gut deep, coiled and compact; preanus length increases from about 60% SL to 70% SL
- Head large with small, terminal mouth; head length about 40–45% SL
- Raised tuft of long spinules occurs on preopercle, beginning in preflexion larvae (Fig. A); disappears after flexion
- Sequence of fin ray formation: $D_1 - D_2, A - C - P_1$
- Dorsal fin spines develop secondary barbs
- Barbed spine forms at pelvic symphysis soon after flexion; becomes secondarily barbed
- Dermal spinules begin on ventrolateral surfaces of gut and head, and top of head during preflexion stage; these spread to include entire head, body and fin bases in postflexion larvae; spinules form last on posterior body and caudal peduncle; spinules are precursors to scales in adults
- Pigment in early larvae most prominent over dorsum of gut and anterior 2/3 of body; ventral edge of branchiostegal membrane darkly pigmented; later stages very darkly pigmented, overlain with still darker pattern, e.g. 2 blotches on base of D_2 , 1 blotch on base of A fin (a second develops >16 mm); unpigmented strip at terminus of caudal peduncle

Meristic Characters

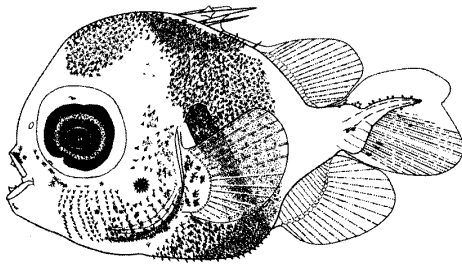
Myomeres:	18
Vertebrae:	7 + 11 = 18
Dorsal fin rays:	III, 23–25
Anal fin rays:	20–22
Pectoral fin rays:	13–15
Pelvic fin rays:	none
Caudal fin rays:	0+6+6+0

Early Juvenile:**E. 10.5 mmSL**

Figures: Adult: Matsuura, 2002; **A, B, D:** Bev Vinter and P. J. Bond (Lyczkowski-Shultz and Ingram, 2003); **C, E:** Watson, 1996f

References: Moore, 1967; Leis and Rennis, 1983; Matsuura and Katsuragawa, 1981; 1985; Aboussouan and Leis, 1984; Matsuura, 2002; Lyczkowski-Shultz and Ingram, 2003

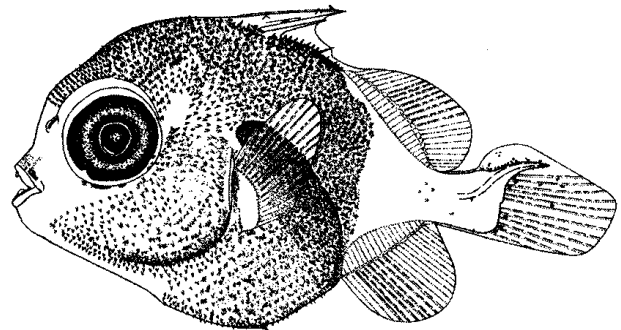
Canthidermis maculata



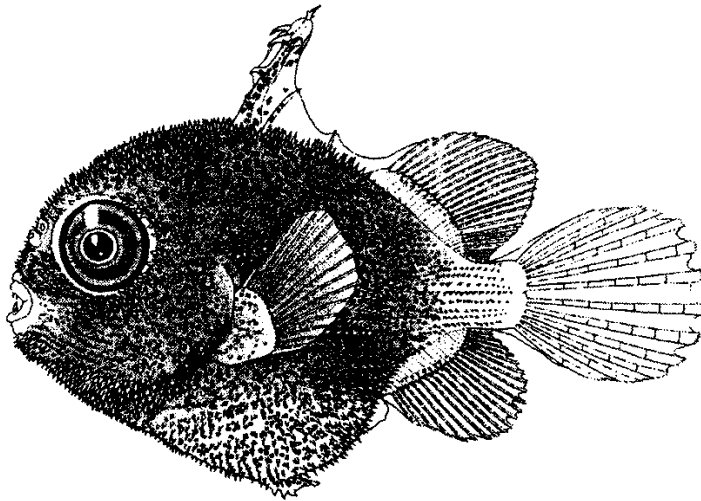
Note melanophores over upper lip

A. 3.2 mmSL

Venter of tail unpigmented;
very little pigment on
membrane of D₁ fin

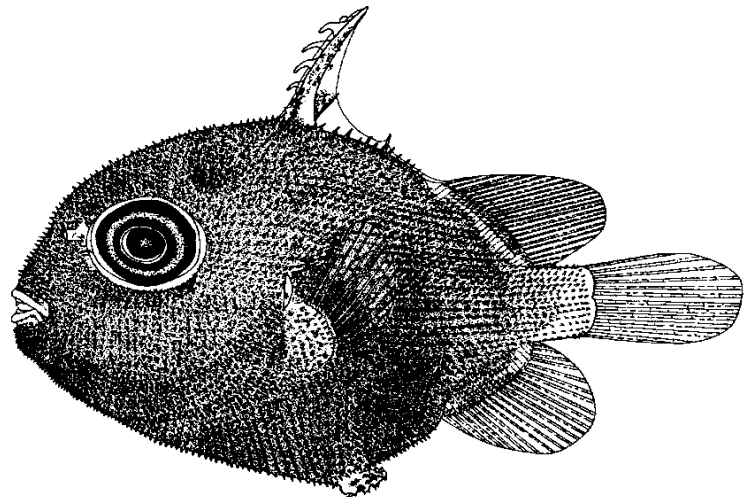


B. 3.5 mmSL

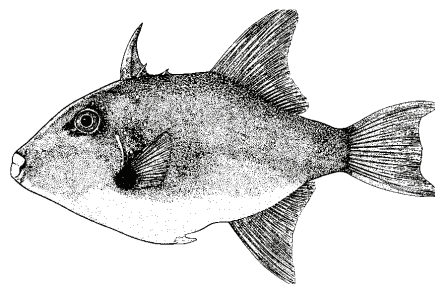


Base of pectoral fin
lightly pigmented;
caudal fin mostly unpigmented

C. 4.6 mmSL



D. 6.3 mmSL

Canthidermis sufflamen* (Mitchill, 1815)*Balistidae****Ocean triggerfish**

- Range:** Western North Atlantic ocean from Massachusetts and Bermuda to Caribbean Sea, including Gulf of Mexico where they are common
- Habitat:** Offshore reefs in clear water near drop-offs to deeper water
- Spawning:** Undescribed; larvae present in oceanic waters Apr–Oct (Gulf of Mexico)

Eggs: – Undescribed

- Larvae:**
- Body very deep and wide anteriorly, tapering to narrow caudal peduncle; becomes laterally compressed during flexion
 - Gut deep, coiled and compact; preanus length increases from about 60% SL to 70% SL
 - Head large with small, terminal mouth; head length about 40–45% SL
 - Raised tuft of long spinules occurs on preopercle, beginning in preflexion larvae (Fig. B); disappears after flexion
 - Sequence of fin ray formation: $D_1 - D_2, A - C - P_1$
 - Dorsal fin spines develop secondary barbs
 - Barbed spine forms at pelvic symphysis soon after flexion; becomes secondarily barbed
 - Dermal spinules begin on ventrolateral surfaces of gut and head and top of head during preflexion stage; these spread to include entire head, body and fin bases in postflexion larvae; spinules form last on posterior body and caudal peduncle; spinules are precursors to scales in adults
 - Pigment in early larvae most prominent over dorsum of gut; gut remains darkly pigmented in later stages; a series of small spots defines outline of notochord tip and scattered spots occur on proximal part of caudal fin; few spots on dorsum of caudal peduncle; venter of caudal peduncle not pigmented until late flexion when a few spots are present; posterior body and anterior head remain relatively unpigmented until transformation; scattered spots may occur on first D_1 spine and on pelvic tubercle

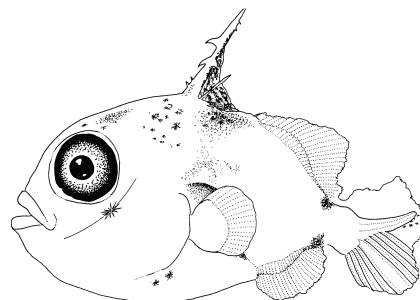
Meristic Characters

Myomeres:	18
Vertebrae:	7 + 11 = 18
Dorsal fin rays:	III, 25–28
Anal fin rays:	23–25
Pectoral fin rays:	15–16
Pelvic fin rays:	none
Caudal fin rays:	0+6+6+0

- Note:** 1. A 3.5-mm larva illustrated by Aboussouan and Leis (1984) and ascribed to this species (Fig. A) differs in several respects from the remainder of the series illustrated here. The secondary barbs on the first dorsal spine form considerably earlier, and the pigment pattern is very different than that in early stages of *C. sufflamen*. The larva depicted in Fig. A is probably *Xanthichthys ringens* (Lyczkowski-Shultz and Ingram, 2003), a species that occurs as far north as North Carolina and Bermuda (Fahay, 1975). Larvae of this species have not been reported from the study area, but might be expected to occur in Gulf Stream or Slope Sea waters. A flexion larva is illustrated in Fig. F.

Note prominent pigment on dorsal spine membrane and opposing blotches on anterior caudal peduncle

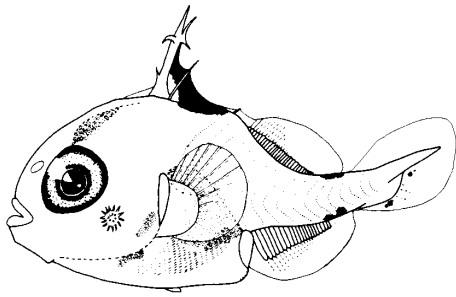
F. 3.9 mm
(*Xanthichthys ringens*)



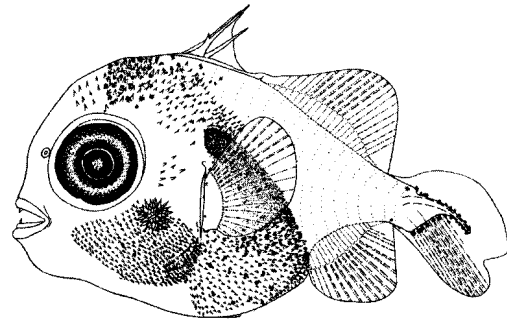
Figures: Adult: Matsuura, 2002; **A, F:** Aboussouan and Leis, 1984; **B–E:** Bev Vinter and P. J. Bond (Lyczkowski-Shultz and Ingram, 2003)

References: Moore, 1967; Leis and Rennis, 1983; Matsuura and Katsuragawa, 1981; 1985; Aboussouan and Leis, 1984; Matsuura, 2002; Lyczkowski-Shultz and Ingram, 2003

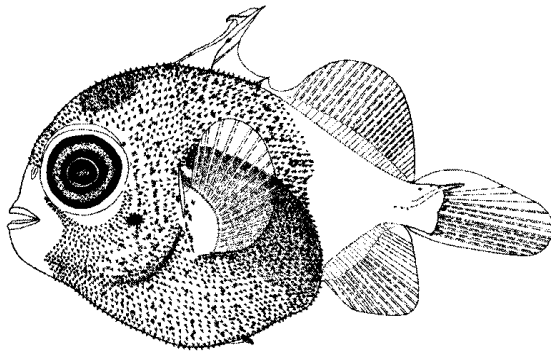
Canthidermis sufflamen



A. 3.5 mmSL
(See Note)

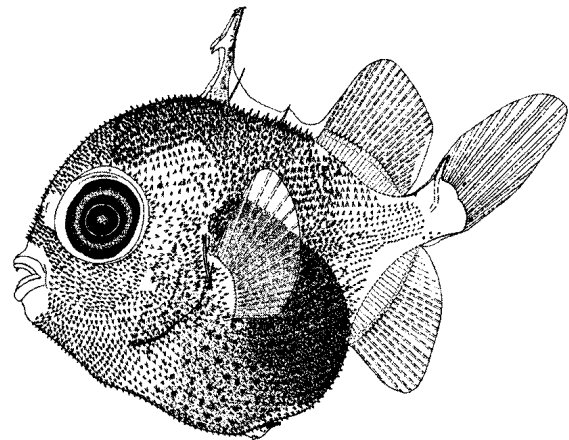


B. 3.7 mmSL

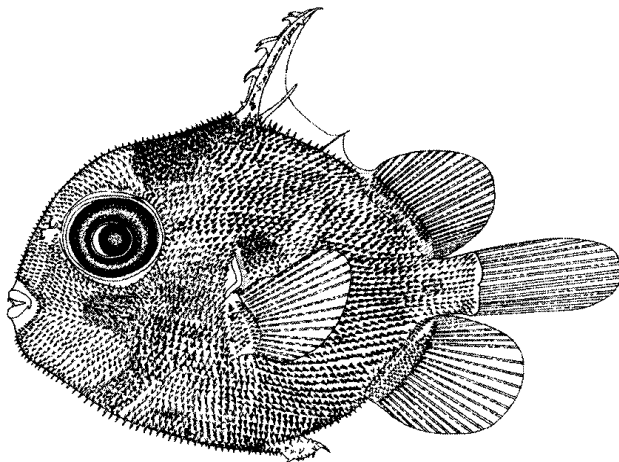


C. 4.2 mmSL

Note pigment absent over upper lip

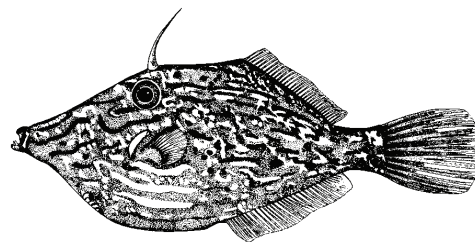


D. 5.2 mmSL



E. 6.1 mmSL

Juveniles develop numerous, fingerlike dermal papillae on venter between pelvic tubercle and anus; these are densely pigmented in juveniles >14 mm

Aluterus heudelotii* Hollard, 1855*Monacanthidae****Dotterel filefish**

Range: Both sides of Atlantic Ocean; in the western North Atlantic from Massachusetts to Brazil, including Gulf of Mexico and Caribbean Sea

Habitat: Demersal on sand or mud substrates, often associated with seagrass beds; usually in shallow water, but to a maximum depth of 50 m; late larvae and juveniles commonly pelagic, often near *Sargassum* mats

Spawning: Undescribed; early stages collected spring through fall south of study area

Eggs: – Undescribed

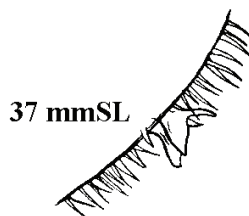
Larvae: – Undescribed, except see photograph of 5.7 mm specimen (Lyczkowski-Shultz and Ingram, 2003)

Meristic Characters

Myomeres:	20
Vertebrae:	7 + 13 = 20
Dorsal fin rays:	II, 36–41
Anal fin rays:	39–44
Pectoral fin rays:	12–14
Pelvic fin rays:	none
Caudal fin rays:	0+6+6+0

Early Juvenile: – Body shallow, but not as shallow as juveniles of *Aluterus scriptus*
 – Head rounded in early larvae, snout lengthens in late larvae and juveniles
 – Pelvic bone forms smooth, curved venter to anterior body; ends in small, barbed end
 – Spiny scales develop over body; structure similar to those of *Monacanthus* larvae and juveniles
 – Pigmentation in the form of a cryptic pattern, dark blotches alternating with light areas

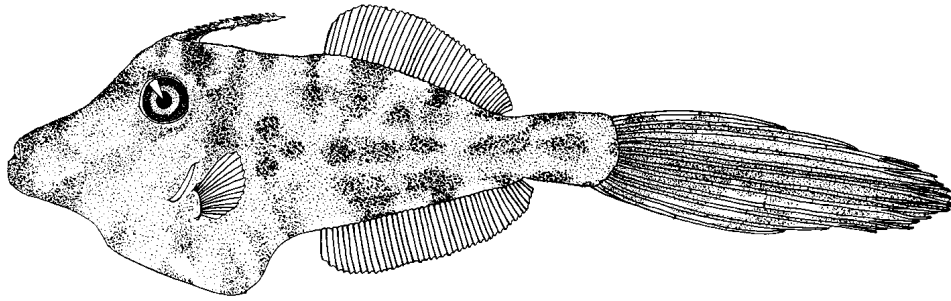
Note: 1. A barbed end on the pelvic bone, visible externally, is small and rudimentary in this species. Larvae of congeners either lack this structure, or have a rudimentary one in this location. If present, it is not articulated or movable, as it is in *Monacanthus* and *Stephanolepis*

**B. Rudimentary barbed end on pelvic bone**

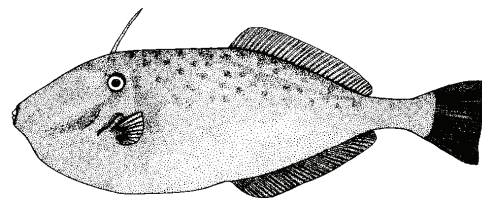
Figures: Adult: Matsuura, 2002; **A–B:** Berry and Voegelé, 1961 (B modified)

References: Berry and Voegelé, 1961; Fahay, 1975; Tyler, 1980; Aboussouan and Leis, 1984; Matsuura, 2002; Lyczkowski-Shultz and Ingram, 2003

Aluterus heudelotii



A. 30.5 mmSL

Aluterus monoceros* (Linnaeus, 1758)*Monacanthidae****Unicorn filefish**

Range: Worldwide in temperate and tropical waters; in the western North Atlantic from Massachusetts and Bermuda to Brazil, including Gulf of Mexico and Caribbean Sea

Habitat: Demersal, usually associated with reefs; early stages pelagic or neustonic, often associated with flotsam or weed mats

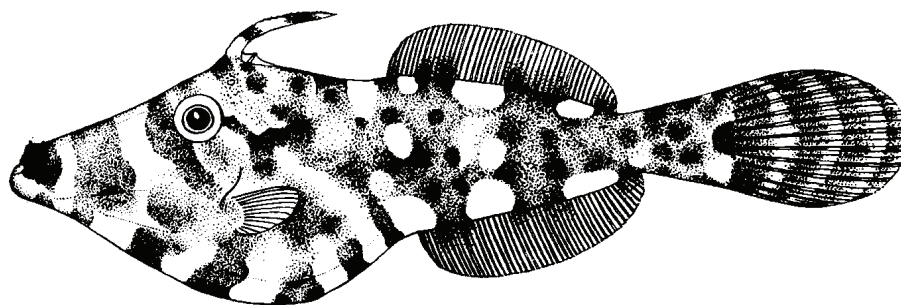
Spawning: Undescribed; juveniles collected spring-fall south of study area

Eggs: – Undescribed

Larvae:

- Body moderately elongate, with deeper head and pectoral region; unlike larvae of *Monacanthus* or *Stephanolepis*, the body does not soon deepen into a kite-shape
- Pelvic bone forms smooth, curved venter to anterior body; ends in rudimentary barbed end (similar to condition in *A. heudelotii*)
- Preanus length increases from about 35% SL to about 45% SL
- Head rounded, with blunt snout, in early larvae; snout lengthens in juveniles
- Sequence of fin ray formation: $D_1 - D_2, A - C - P_1$
- Early forming 1st Dorsal spine; 2nd spine tiny
- Spiny scales undescribed, but presumably similar to those of *Monacanthus* larvae and juveniles
- Pigmentation begins as few spots on dorsum of body and a series of spots along venter of tail; later stages develop a vague, barred pattern on body and a series of bars crossing caudal fin; note bold, cryptic pattern in juvenile

Note: Late larvae and juveniles may be distinguished from those of other monacanthids in study area by higher dorsal and anal fin ray counts

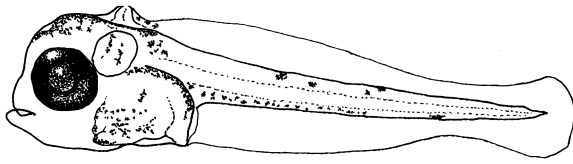
Early Juvenile:**E. 43.5 mmTL****Meristic Characters**

Myomeres:	23
Vertebrae:	7 + 16 = 23
Dorsal fin rays:	II, 46–50
Anal fin rays:	47–52
Pectoral fin rays:	14
Pelvic fin rays:	none
Caudal fin rays:	0+6+6+0

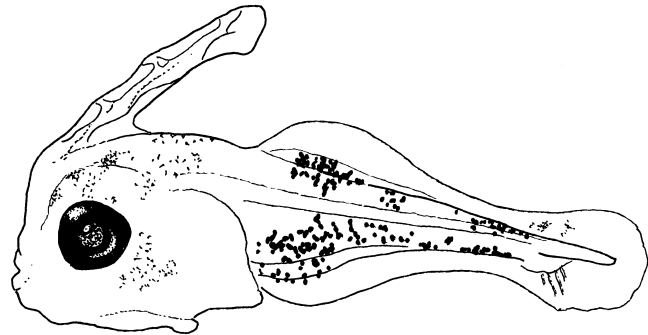
Figures: Adult: Matsuura, 2002; A–D: Okiyama, 1988 (redrawn); E: Fowler, 1944

References: Berry and Voegelé, 1961; Fahay, 1975; Tyler, 1980; Aboussouan and Leis, 1984; Okiyama, 1988; Matsuura, 2002

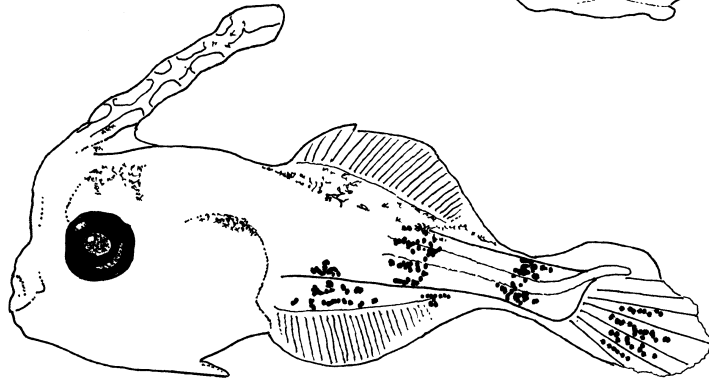
Aluterus monoceros



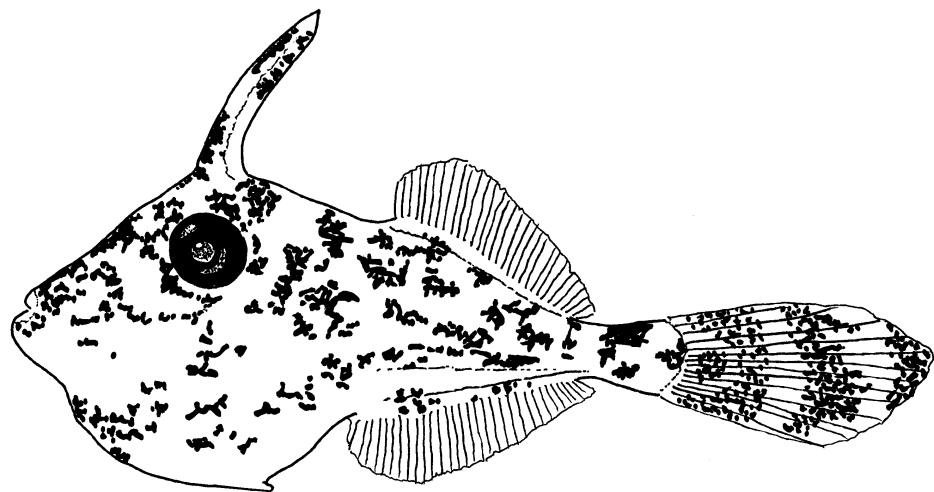
A. 3.1 mmTL



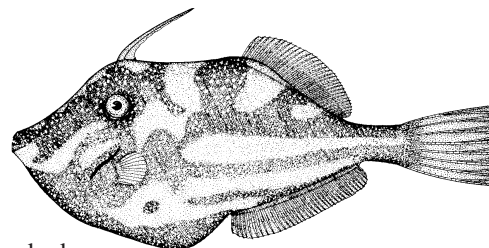
B. 5.6 mmTL



C. 7.6 mmTL



D. 31.0 mmTL

Aluterus schoepfi* (Walbaum, 1792)*Monacanthidae****Orange filefish**

Range: Western North Atlantic Ocean from Nova Scotia and Bermuda to Brazil, including Gulf of Mexico; rarely in Caribbean Sea

Habitat: Demersal on sand or mud substrates, often associated with seagrass beds; usually in shallow water, but to a maximum 50 m; late larvae and juveniles commonly pelagic, often near *Sargassum* mats

Spawning: Undescribed; early stages collected spring through fall south of study area

Eggs: – Undescribed

Larvae:

- Body moderately elongate with slightly deeper head and pectoral region; unlike larvae of *Monacanthus* or *Stephanolepis*, the body does not soon deepen into a kite-shape
- Pelvic bone forms smooth, curved venter to anterior body; does not end in a barbed end as other monacanthids
- Unique, pigmented flap of skin extends from opercular region in early larvae (Fig. A)
- Preanus length about 45% SL
- Head rounded in early larvae, snout lengthens in late larvae and juveniles
- Sequence of fin ray formation: $D_1 - D_2, A - C - P_1$
- Early forming 1st dorsal spine, secondarily barbed near tip; 2nd spine tiny, may not be visible externally
- Spiny scales develop over body; structure similar to those of *Monacanthus* larvae and juveniles
- Pigmentation begins with melanophores along the venter of tail with larger concentration near tail tip; spots on top of head and base of early dorsal spine; pigment on dorsum of gut and on opercular appendage; body pigment spreads upwards from the venter of tail, until lower half of body is darker than upper half; central caudal fin rays darker than upper and lower fin rays; in later stages, pigment becomes more widespread over head and body, followed by development of a cryptic, blotchy pattern

Note: 1. A barbed end on the pelvic bone, visible externally, is lacking in this species. Larvae of congeners may have a rudimentary structure in this location, but if present, it is not articulated or movable, as in *Monacanthus* or *Stephanolepis*.

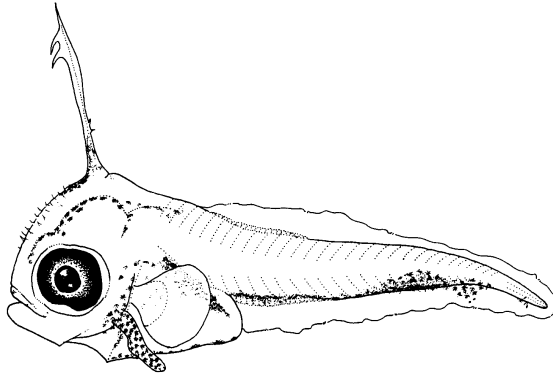
Meristic Characters

Myomeres:	23
Vertebrae:	7 + 16 = 23
Dorsal fin rays:	II, 32–39
Anal fin rays:	35–41
Pectoral fin rays:	11–14
Pelvic fin rays:	none
Caudal fin rays:	0+6+6+0

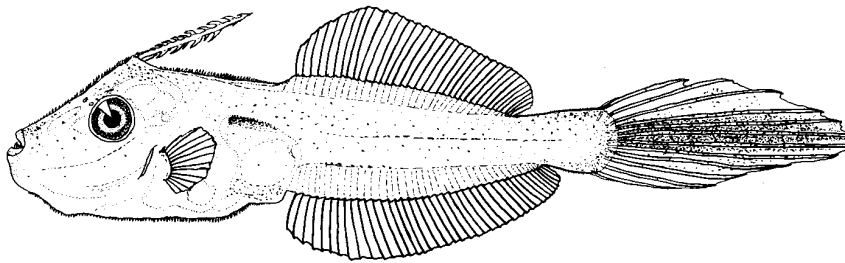
Figures: Adult: Matsuura, 2002; **A:** Aboussouan and Leis, 1984; **B–C:** Berry and Vogele, 1961

References: Berry and Vogele, 1961; Aboussouan and Leis, 1984; Matsuura, 2002

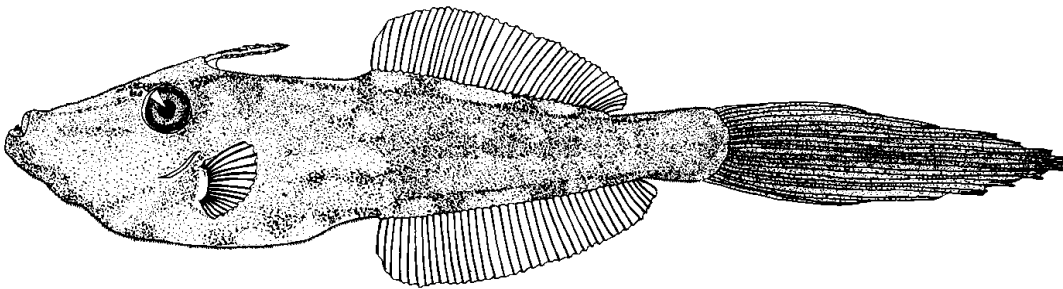
Aluterus schoepfi



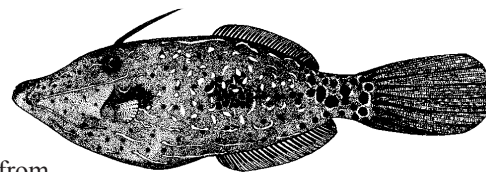
A. 2.8 mmSL
(*Aluterus* sp.)



B. 15.0 mmSL



C. 32.5 mmSL

Aluterus scriptus* (Osbeck, 1765)*Monacanthidae****Scrawled filefish**

Range: Worldwide in tropical waters; in the western North Atlantic from Massachusetts and Bermuda to Brazil, including Gulf of Mexico and Caribbean Sea

Habitat: Demersal in shallow water, to a maximum depth of 20 m; outer slopes of reefs, occasionally in lagoons; juveniles collected near surface, often associated with *Sargassum* mats

Spawning: Undescribed; early stages have been collected south of the study area spring through fall

Eggs: – Undescribed

Larvae:

- Body moderately elongate with slightly deeper head and pectoral region; unlike larvae of *Monacanthus* or *Stephanolepis*, the body does not soon deepen into a kite-shape
- Body depth remains shallow throughout development; juveniles are shallowest of congeners
- Pelvic bone forms smooth, curved venter to anterior body; ending in a rudimentary barbed end
- Unique pigmented flap of skin may extend from opercular region in early larvae as in congeners, but this structure is not described for larvae of this species (see *Aluterus schoepfi*)
- Preanus length 45–50% SL
- Head deep with small, terminal mouth in early larvae; snout lengthens in late larvae and juveniles
- Sequence of fin ray formation: $D_1 - D_2, A - C - P_1$
- Early forming 1st dorsal spine, secondarily barbed; 2nd spine tiny, may not be visible externally
- Spiny scales develop over body; structure similar to those of *Monacanthus* larvae and juveniles
- Pigmentation in early larvae includes 3 postanal aggregations of melanophores forming vague bars between the vertical fins and caudal peduncle; a weak cluster of spots on opercular region and on fin membrane posterior to dorsal spine; a weak, 3-barred pattern persists until early juvenile stage when this pattern gives way to a vague cryptic, checkered appearance

Note: 1. A prominent, barbed end is present at the tip of the pelvic bone in early larvae, but becomes rudimentary and difficult to see externally in late larvae and juveniles.

2. Larva in Fig. A based on specimen collected in eastern Pacific Ocean (Gulf of Panama)

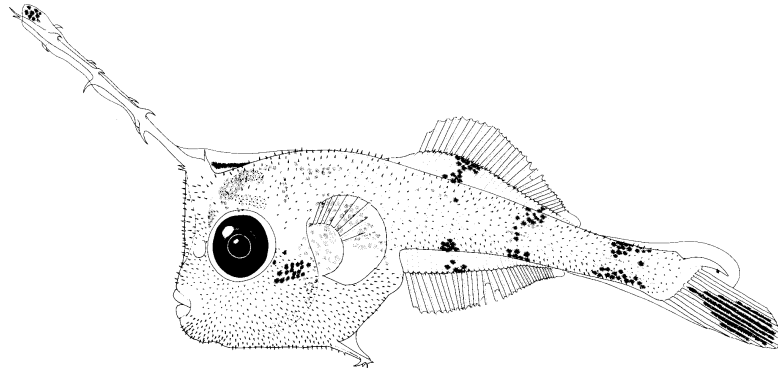
Meristic Characters

Myomeres:	21
Vertebrae:	7 + 14 = 21
Dorsal fin rays:	II, 44–47
Anal fin rays:	47–49
Pectoral fin rays:	13–15
Pelvic fin rays:	none
Caudal fin rays:	0+6+6+0

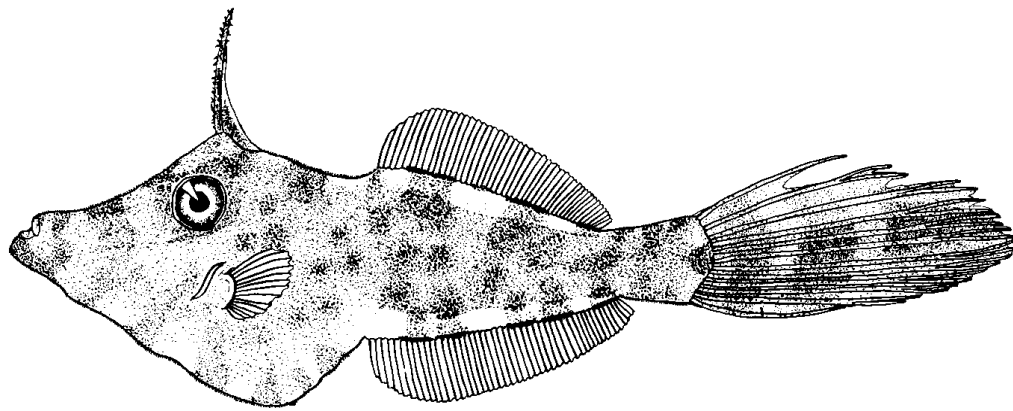
Figures: Adult: Matsuura, 2002; **A:** R. C. Walker (Watson, 1996ff); **B:** Berry and Vogeles, 1961

References: Berry and Vogeles, 1961; Fahay, 1975; Tyler, 1980; Aboussouan and Leis, 1984; Matsuura, 2002

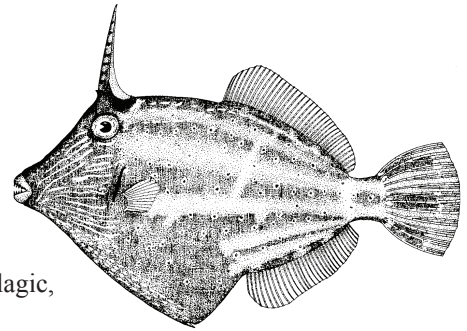
Aluterus scriptus



A. 5.7 mmSL



B. 31.0 mmSL

Cantherhines pullus* (Ranzani, 1842)*Monacanthidae****Orangespotted filefish**

Range: Both sides of Atlantic Ocean in temperate and tropical waters; in the western North Atlantic from Massachusetts and Bermuda to Brazil, including Gulf of Mexico and Caribbean Sea

Habitat: Demersal near rock or coral reefs in depths to 50 m; early stages pelagic, often near *Sargassum* mats

Spawning: Ripe females Feb–Jun (West Indies); pelagic-juveniles have been collected south of study area summer–fall

Eggs: – Undescribed

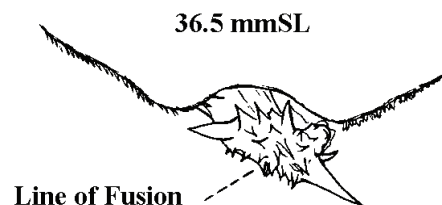
Larvae:

- Body moderately elongate with deep, blunt head in early larvae; body soon deepens into kite-shape
- Mouth small, terminal; snout elongates in later larvae
- Preanus length increases from 45% SL to about 60% SL
- Raised tuft of long spinules not observed on preopercle in known larvae; may occur in earlier stages
- Early forming 1st dorsal spine secondarily barbed; 2nd dorsal spine small, but somewhat more developed than in other taxa in study area
- Sequence of fin ray formation: $D_1 - D_2, A - C - P_1$
- Spiny scales well-developed over much of head and body; structure similar to those of *Monacanthus* larvae and juveniles
- Pigmentation not well described in larvae; juveniles develop cryptic coloration and eventually develop a series of orange spots overlying several pale, longitudinal stripes

Meristic Characters

Myomeres:	19
Vertebrae:	7 + 12 = 19
Dorsal fin rays:	II, 33–36
Anal fin rays:	29–32
Pectoral fin rays:	13–14
Pelvic fin rays:	none
Caudal fin rays:	0+6+6+0

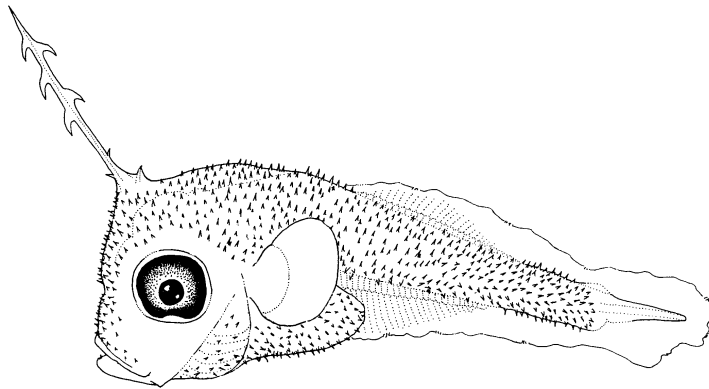
Note: 1. Pelvic bone ends in barbed end; tip is fused and immovable (Fig. C)

Early Juvenile:**C. Fused barbed end on pelvic bone**

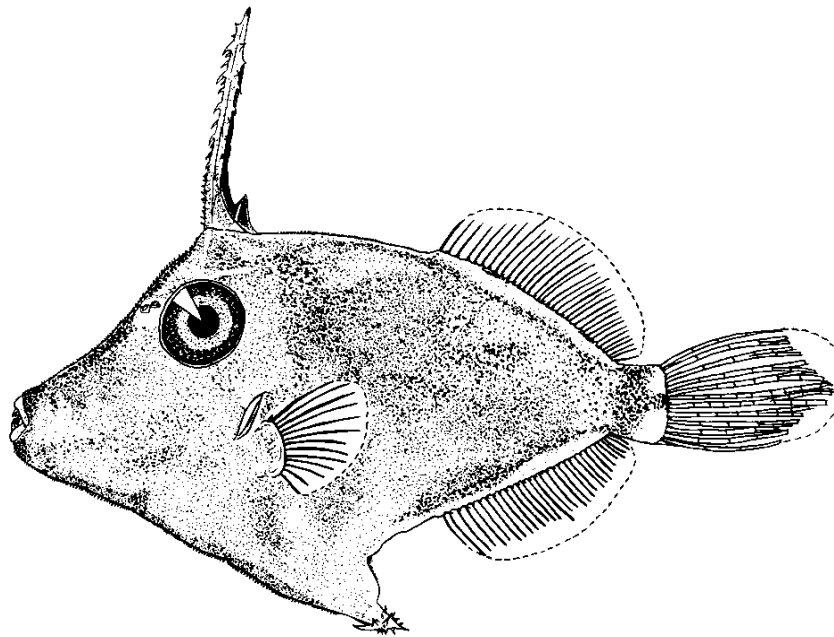
Figures: Adult: Matsuura, 2002; **A:** Betsy Washington (Aboussouan and Leis, 1984); **B–C:** Berry and Vogeles, 1961 (C modified)

References: Berry and Vogeles, 1961; Fahay, 1975; Tyler, 1980; Aboussouan and Leis, 1984; Matsuura, 2002

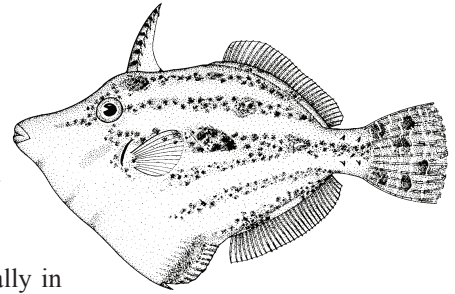
Cantherhines pullus



A. 4.0 mmSL



B. 17.5 mmSL

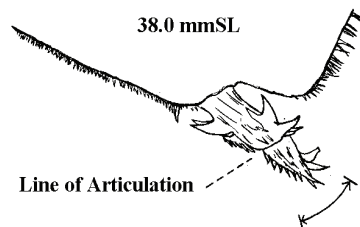
Monacanthus ciliatus* (Mitchill, 1818)*Monacanthidae****Fringed filefish**

- Range:** Both sides of Atlantic Ocean in temperate and tropical waters; in the western Atlantic from Newfoundland to Argentina, including the Gulf of Mexico and Caribbean Sea
- Habitat:** Demersal over sandy or rocky bottoms, often in seagrass beds; usually in shallow water, but to a maximum 50 m; young stages often associated with floating *Sargassum* mats
- Spawning:** Undescribed; pelagic-juveniles occur year-round in surface waters south of study area
- Eggs:** – Undescribed
- Larvae:**
- Early stages undescribed; generalizations below based on ontogeny of *Stephanolepis hispidus*
 - Body elongate with short gut at hatching, soon becomes kite-shaped
 - Head deep, with small, terminal mouth
 - Preanus length 55–65% SL
 - Raised tuft of spinules forms on preopercle in preflexion larvae, disappears at flexion
 - Early forming dorsal spines (1st and 2nd) and long pelvic bone with barbed end
 - 1st dorsal spine secondarily barbed, becoming less so in juveniles and adults; 2nd dorsal spine tiny
 - Sequence of fin ray formation: $D_1, P_2 - D_2, A - C - P_1$
 - Spiny scales develop over body at sizes <10 mmSL; begin as a single, simple spine per scale; additional simple spines are added in later stages until each scale bears multiple spines (Fig. E); compare to spiny scales in *Stephanolepis hispidus*
 - Pigmentation in early stages undescribed; late larvae and juveniles appear more lightly pigmented than similar stages of *Stephanolepis hispidus*, typically have pairs of distinct blotches on dorsum and venter of body between the dorsal and anal fins, plus a blotch on caudal peduncle; a streak along posterior midline of body becomes faint in older juveniles

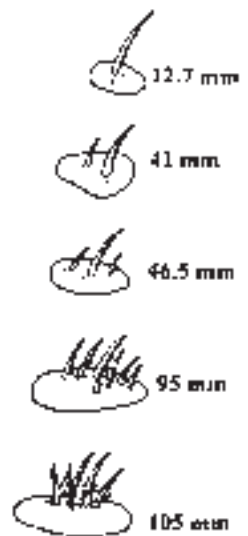
Meristic Characters

Myomeres:	19
Vertebrae:	6 + 13 = 19
Dorsal fin rays:	II, 29–37
Anal fin rays:	28–36
Pectoral fin rays:	9–13
Pelvic fin rays:	none
Caudal fin rays:	0+6+6+0

- Note:**
1. In all *Monacanthus* species over about 20 mmSL, the caudal peduncle has 2 to 4 pairs of enlarged spines (recurved in males) on each side. These are lacking in species of *Stephanolepis*.
 2. Barbed pelvic end is articulated (as in *Stephanolepis*, Fig. D); tip is movable in anterior-posterior direction



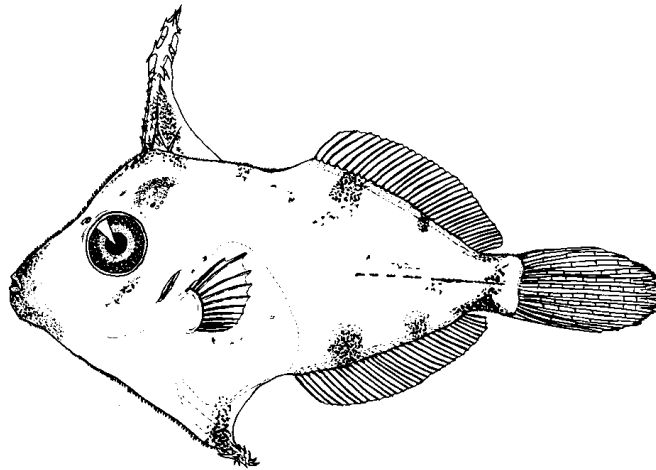
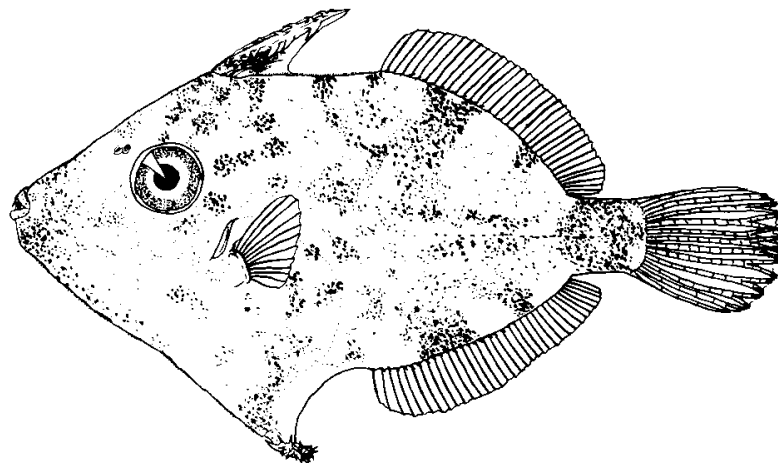
D. Articulated barbed end on pelvic bone in *Stephanolepis* (similar in *Monacanthus*)



E. Spiny Scale Development

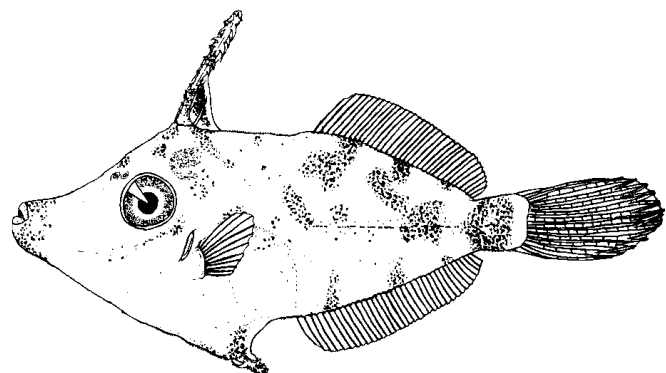
Figures: Adult: Matsuura, 2002; A–E: Berry and Voegelé, 1961 (D and E modified)

References: Berry and Voegelé, 1961; Fahay, 1975; Aboussouan and Leis, 1984; Matsuura, 2002

Monacanthus ciliatus**A. 11.0 mmSL****B. 15.3 mmSL**

Monacanthus tuckeri

This species occurs from the Carolinas and Bermuda through Florida to the Lesser Antilles. Young stages have been collected at the surface in the Gulf Stream off North Carolina during both summer and winter (Fahay, 1975) and the potential for it to occur in Gulf Stream or Slope Sea waters in the study area is high. It is best identified by its shallow body depth, compared to the deeper bodied *M. ciliatus*.

**C. 15.3 mmSL**

Stephanolepis hispidus* (Linnaeus, 1766)*Monacanthidae****Planehead filefish**

Range: Both sides of Atlantic Ocean; in the western North Atlantic from Nova Scotia to Brazil, including Gulf of Mexico

Habitat: Pelagic near floating objects or weeds, or demersal over sandy, muddy or reef habitats; usually in clear water near vegetation; larger larvae and pelagic-juveniles near surface, often near Sargassum or other algal mats

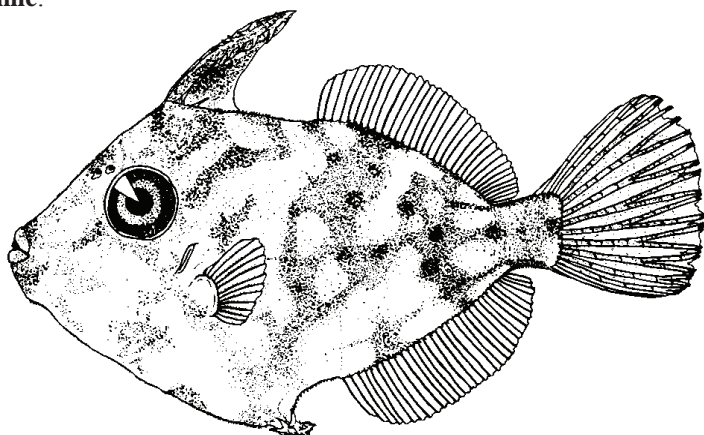
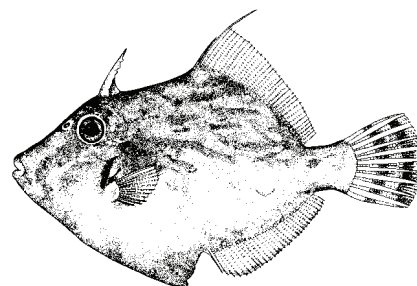
Spawning: Prolonged; possibly year-round south of study area

Eggs: – Undescribed

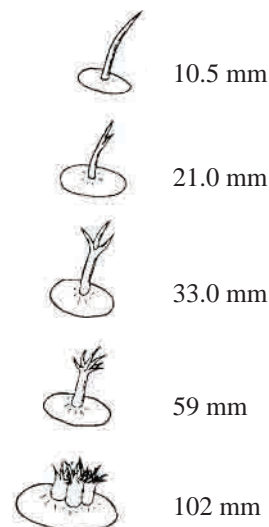
Larvae:

- Body elongate with short gut at hatching, soon becomes kite-shaped
- Head deep, with small, terminal mouth
- Preanus length 55–65% SL
- Raised tuft of spinules forms on preopercle in preflexion larvae, disappears at flexion
- Early forming dorsal spines (1st and 2nd) and long pelvic bone with barbed end
- 1st dorsal spine secondarily barbed, becoming less so in juveniles and adults; 2nd dorsal spine tiny
- Sequence of fin ray formation: $D_1, P_2 - D_2, A - C - P_1$
- Spiny scales develop over body at sizes <10 mmSL; begin as a single, simple spine per scale which later develop multiple tips; later stages add more spines per scale (Fig. G); compare to spiny scales in *Monacanthus ciliatus*
- Pigmentation in early larvae includes distinct large melanophores on top of head, on dorsum between developing D_1 and D_2 fins, on caudal peduncle and in a row along venter of tail; pigment increases in later larvae, until much of body is dark with lighter, unpigmented patches; fins unpigmented

Note: 1. Barbed pelvic end articulated; tip is movable in anterior-posterior direction (see *Monacanthus ciliatus*, Fig. D)

Early Juvenile:**F. 15.2 mmSL****Meristic Characters**

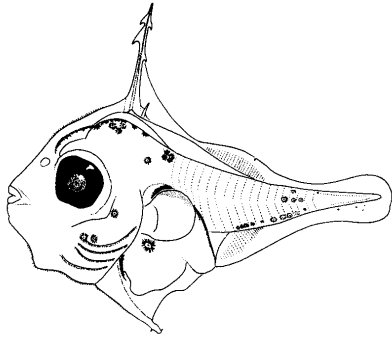
Myomeres:	19
Vertebrae:	7 + 12 = 19
Dorsal fin rays:	II, 32–34
Anal fin rays:	32–34
Pectoral fin rays:	12–14
Pelvic fin rays:	none
Caudal fin rays:	0+6+6+0

**G. Spiny Scale Development**

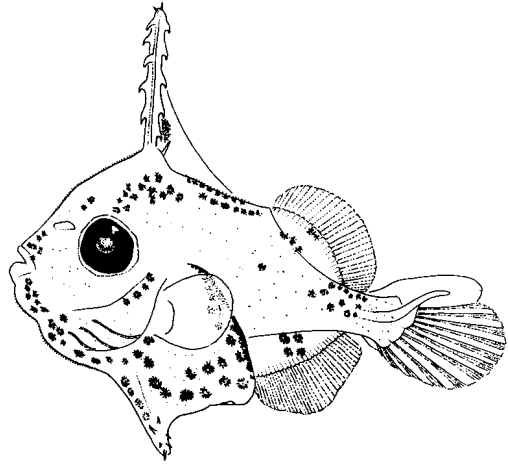
Figures: Adult: Matsuura, 2002; A–C: Aboussouan, 1966a (reversed and redrawn); D, F, G: Berry and Voge, 1961; E: Hildebrand and Cable, 1930

References: Berry and Voge, 1961; Fahay, 1975; Aboussouan and Leis, 1984; Matsuura, 2002

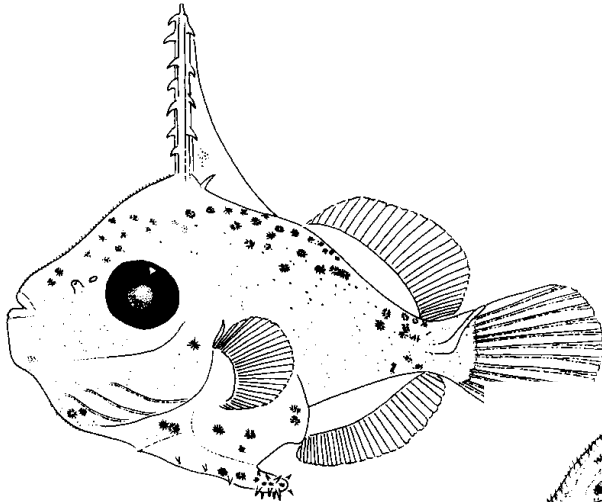
Stephanolepis hispidus



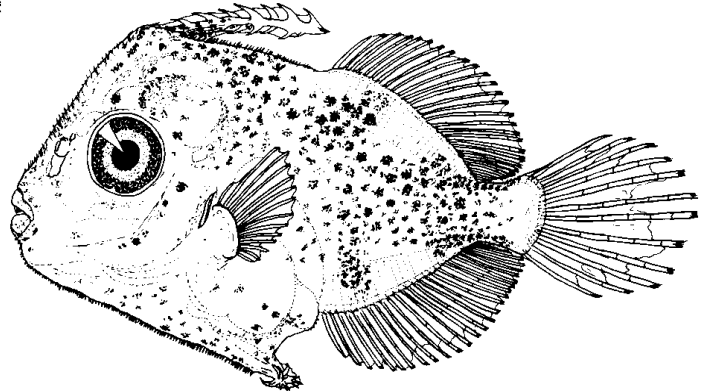
A. 3.1 mmTL



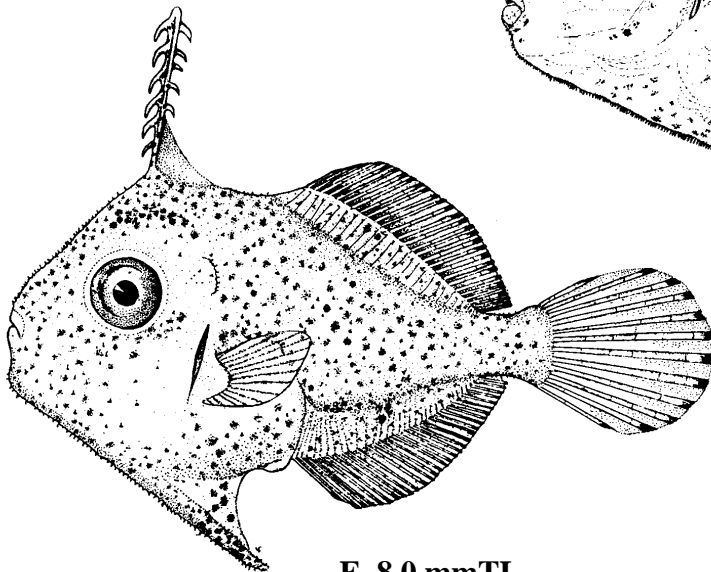
B. 5.5 mmTL



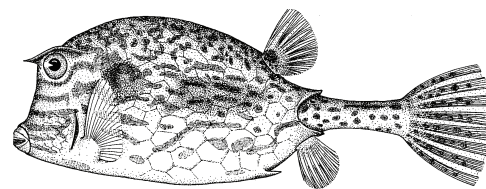
C. 6.5 mmTL



D. 6.5 mmSL



E. 8.0 mmTL

Acanthostracion quadricornis* (Linnaeus, 1758)*Ostraciidae****Scrawled cowfish**

Range: Both sides of the Atlantic Ocean in temperate and tropical waters; in the western North Atlantic from Massachusetts and Bermuda to Brazil, including Gulf of Mexico and Caribbean Sea

Habitat: Demersal in shallow water, to a maximum depth of 80 m; occurs primarily in seagrass beds; early stages pelagic; a recently-settled individual has been reported from the Hudson River (Schmidt and Lake, 2001)

Spawning: Year-round with peak in spring

Eggs:

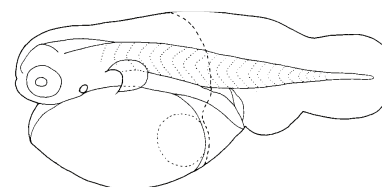
- Pelagic, spherical
- Diameter: 1.4–1.6 mm
- Chorion: ornamented with a pore
- Oil globule: single, 0.15 mm in diameter

Larvae:

- Body deep and spherical; a carapace encompasses anterior body
- Beginnings of carapace noticeable in yolk-sac larvae
- Preanus length about 65% SL
- Flexion occurs at about 4.0 mm
- Sequence of fin ray formation: P₁ – D, A – C
- Dorsal and anal fins small, opposite each other, positioned well posterior
- Caudal peduncle elongates well after transformation
- Spinous scales absent; beginning in flexion larvae, thickened areas in skin coalesce into mosaic-like armored carapace (characteristic of adults); carapace fully formed before end of flexion stage
- Pigment in preflexion larvae light and scattered over much of head and body, but weak or absent on caudal peduncle; pigment becomes dense during flexion

Meristic Characters

Myomeres:	19
Vertebrae:	9 + 10 = 19
Dorsal fin rays:	10
Anal fin rays:	10
Pectoral fin rays:	11–12
Pelvic fin rays:	none
Caudal fin rays:	0+5+5+0



Yolk-sac larva 2.6 mm

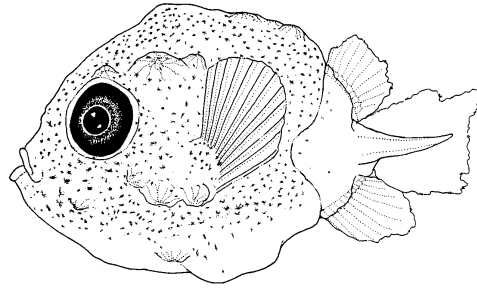
Note: 1. All ostraciids that occur in the study area share, or have broadly overlapping, meristic characters. The larvae are not well-enough described to enable accurate identification to the species level.

Early Juvenile: A recently settled juvenile (16 mmSL), collected in the Hudson River, is spherical, with a well-developed carapace composed of a honey-comb pattern of bony plates; the cross-section of the body is described as "pentagonal"; the carapace ends at the level of a short caudal peduncle; the eye is large, located high on the head; a well-developed pectoral fin is located near mid-body, adjacent to a very restricted gill slit; an adult complement of fin rays is present; over-all color is light tan with a scattering of small, black spots evenly distributed over much of the head and body; the forward-pointing carapace spines (located over each eye in adults) have not yet formed. See Schmidt and Lake (2001) for photograph.

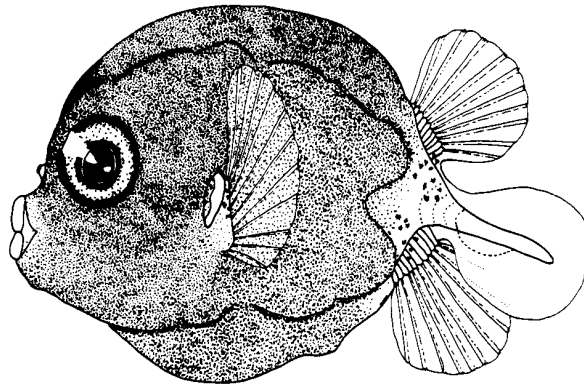
Figures: Adult: Matsuura, 2002; yolk-sac larvae and A–C: Aboussouan and Leis, 1984

References: Breder and Clark, 1947; Fahay, 1975; Tyler, 1980; Aboussouan and Leis, 1984; Matsuura, 2002

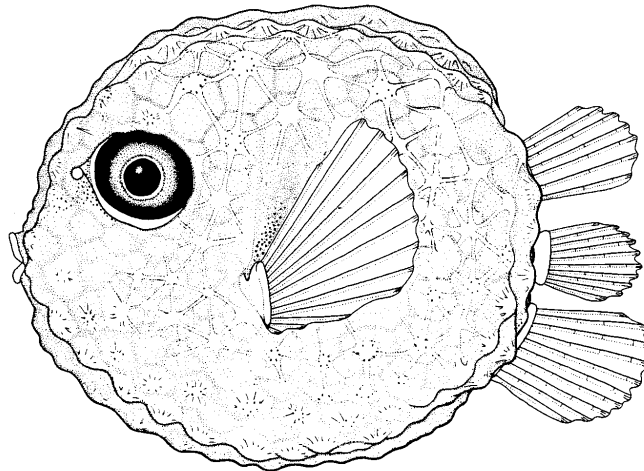
Acanthostracion quadricornis



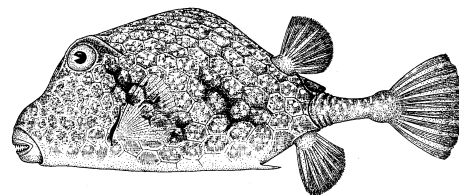
A. 2.5 mmSL



B. 3.3 mmSL



C. 6.0 mmSL

Lactophrys trigonus* (Linnaeus, 1758)*Ostraciidae****Buffalo trunkfish**

Range: Western North Atlantic Ocean from Massachusetts and Bermuda to Brazil, including Gulf of Mexico and Caribbean Sea; many references comment on occurrences in study area involving juveniles, not adults

Habitat: Demersal in seagrass beds and shallow reefs in depths to 50 m; early stages reported from eel grass (*Zostera*) beds (Woods Hole) or pelagically in Gulf Stream, under *Sargassum* mats

Spawning: Undescribed; the few early stages that have occurred in study area, have been found in summer or fall

Eggs: – Undescribed

Larvae: – Undescribed

Early Juvenile:

- Body deep, especially at level of dorsomedial ridge
- Head with moderately long snout ending in small, terminal mouth
- Dorsal and anal fins short-based, opposite each other, positioned well posterior
- Caudal peduncle beginning to elongate, but not as elongate as in adult
- Carapace has 2 spines at postero-ventral angles, anterior to anal fin; no spines anterior to eyes
- Carapace pattern is clearly composed of hexagonal "cells", each with striations radiating from center
- The cross-section of the body is described as having 4 angles, not including the dorsomedial ridge; an early, now-invalid, common name "three-angled trunk fish" obviously referred to 2 lower angles plus the dorsomedial ridge.
- Pigmentation is uniformly brownish, with a dark caudal peduncle spotted with white; fins are unpigmented

- Note:**
1. All ostraciids that occur in the study area share, or have broadly overlapping, meristic characters. The larvae are not well-enough described to enable accurate identification to the species level.
 2. The illustration (Fig. A) was provided by Fowler (1945) without accompanying written description. Characters above are interpreted from the illustration, augmented by comments by Hildebrand and Schroeder (1928).

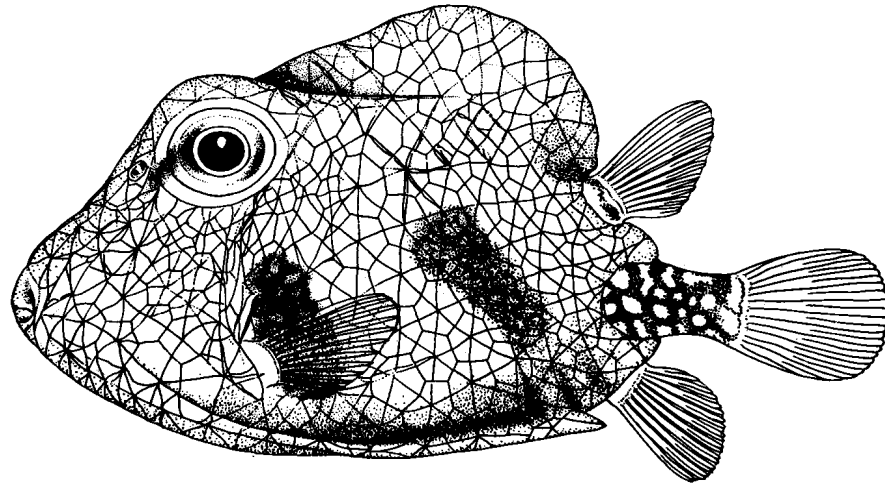
Meristic Characters

Myomeres:	18
Vertebrae:	9 + 9 = 18
Dorsal fin rays:	10
Anal fin rays:	10
Pectoral fin rays:	11–13
Pelvic fin rays:	none
Caudal fin rays:	0+5+5+0

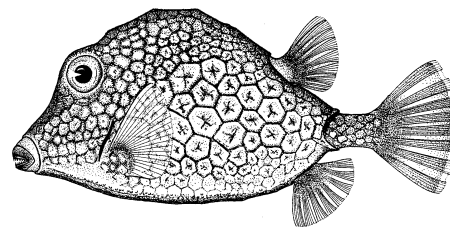
Figures: Adult: Matsuura, 2002; A: Fowler, 1945

References: Nichols and Breder, 1927; Fahay, 1975; Tyler, 1980; Aboussouan and Leis, 1984; Matsuura, 2002

Lactophrys trigonus



A. 44.5 mmSL

Rhinesomus triqueter* (Linnaeus, 1758)*Ostraciidae****Smooth trunkfish**

Range: Western North Atlantic Ocean from Massachusetts and Bermuda to Brazil, including Gulf of Mexico and Caribbean Sea

Habitat: Demersal, usually near rock or coral reefs, or sand or algal flats, to a maximum depth of about 50 m; early stages presumably pelagic, but their habitat is not well described

Spawning: Peaks between Jan and Mar (Caribbean Sea)

Eggs: – Undescribed

Larvae:

- Body deep, spherical, moderately wide, with laterally compressed tail
- Head not distinct from body; both comprise a ball-shaped unit
- Preanus length about 60% SL
- Sequence of fin ray formation: $P_1 - D, A - C$
- Dorsal and anal fins short-based, opposite each other, positioned well posterior
- Caudal peduncle elongates well after transformation
- Spinous scales absent; beginning in flexion larvae, thickened areas in skin coalesce into mosaic-like armored carapace (characteristic of adults); carapace fully formed before end of flexion stage
- Pigment in preflexion larvae is dense and uniformly scattered over head and anterior body; body between dorsal and anal fins, caudal peduncle and caudal finfold unpigmented; later larvae and juveniles remain darkly pigmented

Meristic Characters

Myomeres:	18
Vertebrae:	9 + 9 = 18
Dorsal fin rays:	10
Anal fin rays:	10
Pectoral fin rays:	12
Pelvic fin rays:	none
Caudal fin rays:	0+5+5+0

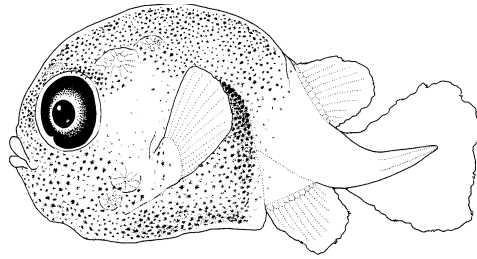
Note: 1. All ostraciids that occur in the study area share, or have broadly overlapping, meristic characters. The larvae are not well-enough described to enable accurate identification to the species level.

Early Juvenile: Fowler (1945) reports on the collection of 2 juveniles from Massachusetts and New Jersey (Figs. B and C) and provides illustrations, but without a verbal description. The figures clearly indicate a patterned carapace, with striations radiating from the centers of each "cell", and the eventual formation of a rigid shell encompassing the entire head and body, with the exception of the caudal peduncle and caudal fin. Color is not described in these specimens, but has been reported to be light green with greenish blue spots (Smith, 1907). Color probably varies in these stages. Juveniles and adults are triangular in cross-section.

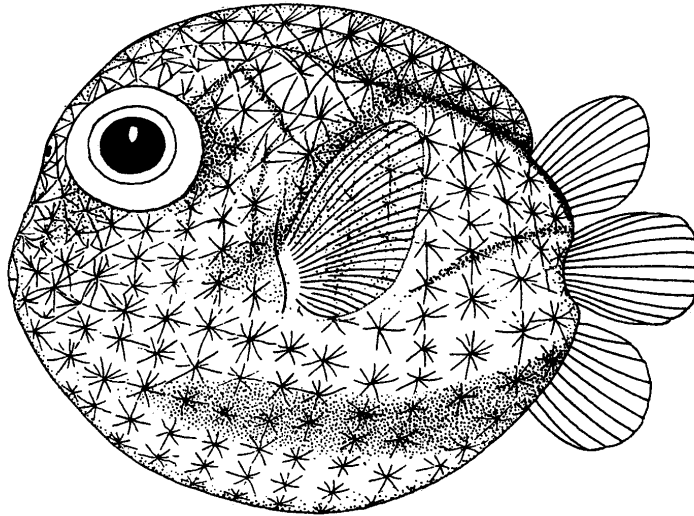
Figures: Adult: Matsuura, 2002; **A:** Betsy Washington (Aboussouan and Leis, 1984); **B–C:** Fowler, 1945

References: Fahay, 1975; Tyler, 1980; Aboussouan and Leis, 1984; Matsuura, 2002

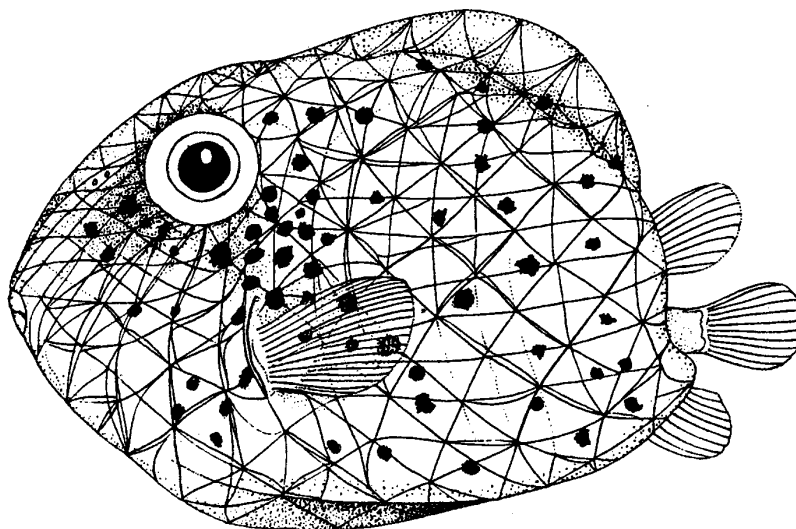
Rhinosomus triqueter



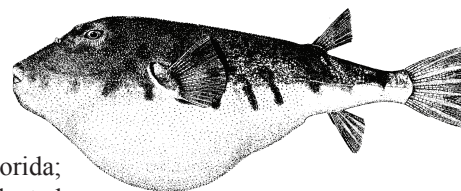
A. 2.8 mmSL



B. 15.5 mmSL



C. 20.0 mmSL

Sphoeroides maculatus* (Bloch and Schneider, 1801)*Tetraodontidae****Northern puffer**

Range: Western North Atlantic Ocean from Newfoundland to northern Florida; adults abundant in study area; larvae and juveniles are commonly collected in most bays and estuaries in study area

Habitat: Bays, estuaries and coastal waters to a maximum depth of 60 m; over a variety of substrates, often associated with piers or other structured habitats; also commonly found in surf zone; occur in dense aggregations, but only juveniles form schools; winters in deeper water in the southern part of the study area

Spawning: May–Aug (as late as Oct) in coastal waters and estuaries

Eggs:

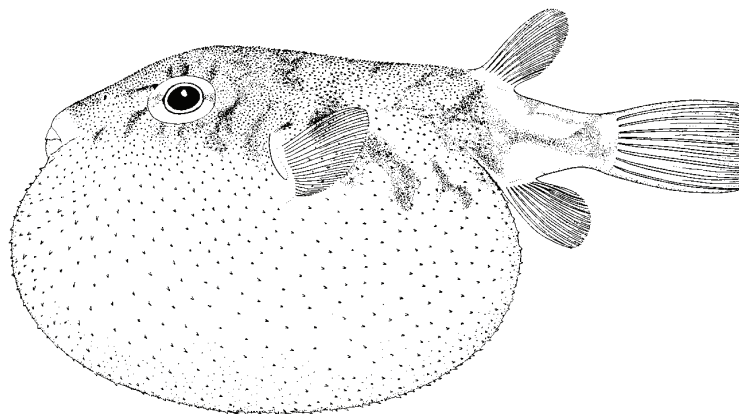
- Demersal, spherical, adhesive; deposited in circular depression in substrate
- Diameter: 0.85–0.91 mm
- Chorion: reticulated
- Oil globules: numerous, average diameter 0.034 mm

Larvae:

- Hatching occurs at about 2.4 mm, eyes unpigmented, mouth unformed
- Body (preflexion) stocky, with blunt, rounded head profile
- Small tubercles present over body
- Sequence of fin ray formation: P₁ – D, A – C
- Caudal fin rays last to form (unusual for teleosts)
- All fin rays complete at about 7.4 mm
- Capable of inflating bodies as small as 7.0 mm
- Early juveniles have small, terminal mouth, eyes situated near dorsal outline
- Dermal prickles begin to form over body at about 10 mm
- Pigment becomes heavy over-all, except for posterior third, which remains unpigmented until transformation

Juvenile:

Pelagic-juveniles are abundant in surface waters south of study area (Fahay, 1975) but are not identifiable to species. Most of these exhibit pelagic-juvenile coloration with dark blue dorsum and silvery sides. This stage also occurs in Slope Sea and Gulf Stream collections in study area in May–Jun (Hare *et al.*, 2001) and may result from spawning south of Cape Hatteras



G. 26.0 mmTL
(estimate from scale bar)

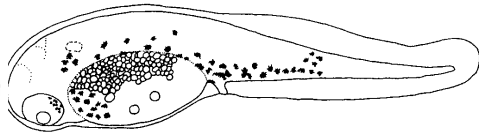
Meristic Characters

Myomeres:	19
Vertebrae:	8 + 11 = 19
Dorsal fin rays:	8
Anal fin rays:	7
Pectoral fin rays:	16
Pelvic fin rays:	none
Caudal fin rays:	0+5+6+0

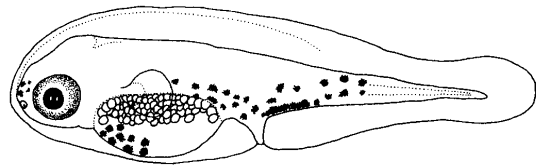
Figures: Adult: W. S. Haines (Klein-M^{ac}Phee, 2002v); **A–D:** P. J. Bond (Lyczkowski-Shultz, 2003) (redrawn from Welsh and Breder, 1922); **E:** Welsh and Breder, 1922; **F:** Susan Kaiser (Able and Fahay, 1998); **G:** Fowler, 1945

References: Welsh and Breder, 1922; Shipp and Yerger, 1969; Fahay, 1975; Tyler, 1980; Aboussouan and Leis, 1984; Able and Fahay, 1998; Matsuura, 2002

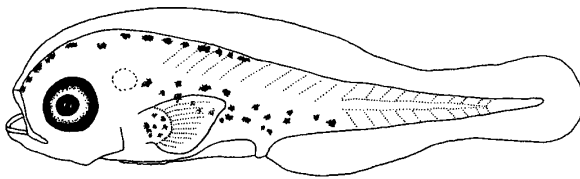
Sphoeroides maculatus



A. 2.4 mmTL

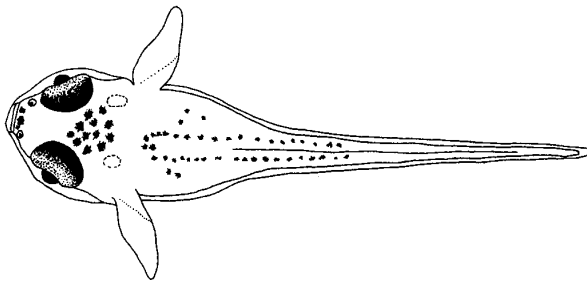


B. 2.5 mmTL

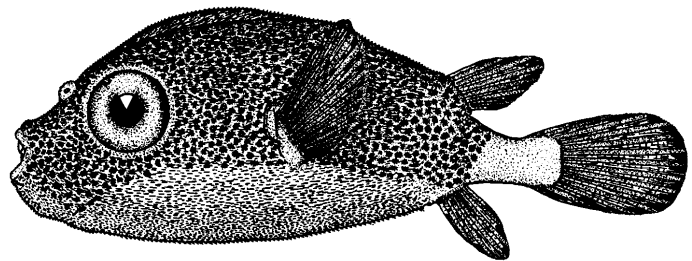


C. 2.6 mmTL

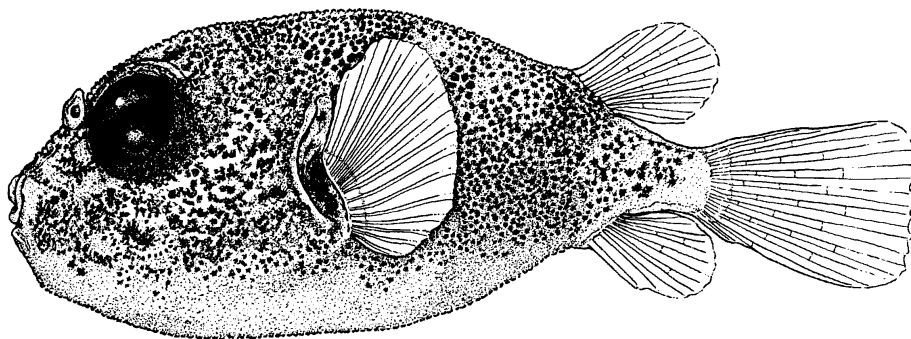
Illustrations in Figs. C and D do not represent the same larva



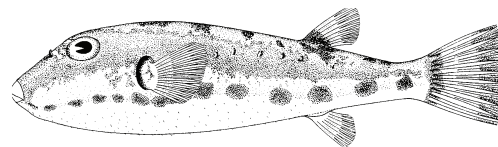
**D. 2.6 mmTL
(Dorsal View)**



E. 7.4 mmTL



**F. 9.7 mmSL
(Transformed Juvenile)**

Sphoeroides spengleri* (Bloch, 1785)*Tetraodontidae****Bandtail puffer**

Range: Western North Atlantic Ocean from Massachusetts and Bermuda to Brazil, including Gulf of Mexico and Caribbean Sea

Habitat: Demersal near reefs or submerged aquatic vegetation in depths of 10–40 m; juveniles often in seagrass beds interspersed with bare, sandy flats

Spawning: Undescribed

Eggs: – Undescribed

Larvae: – Undescribed

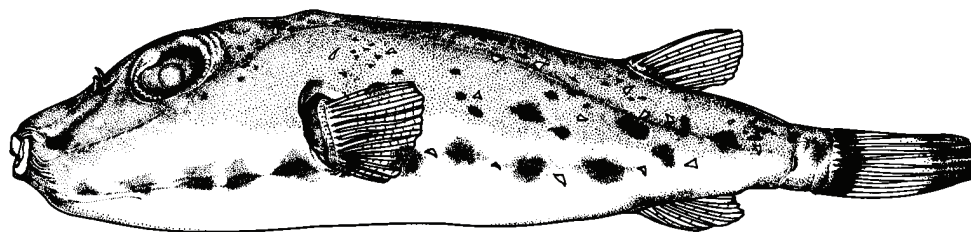
Meristic Characters

Myomeres:	17–18
Vertebrae:	8 + 9–10 = 17–18
Dorsal fin rays:	8
Anal fin rays:	7
Pectoral fin rays:	13
Pelvic fin rays:	none
Caudal fin rays:	0+5+6+0

Early Juvenile:

- The early to late juveniles illustrated were apparently identified on the basis of the uninterrupted, even series of 11–14 blotches along the lower side, a diagnostic character for the species
- Fleshly lappets are also present on lower back and upper sides
- In adults, dermal prickles cover small portion of upper sides and belly
- Also note small pectoral fins, and small dorsal and anal fins, opposite each other and situated well posteriorly

Note: 1. Place of capture and disposition of the specimens illustrated in Figs. A–C unknown.

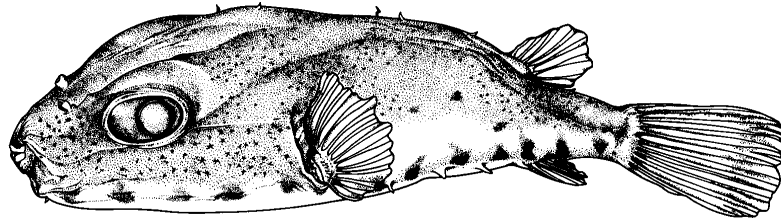


C. 80.0 mmSL

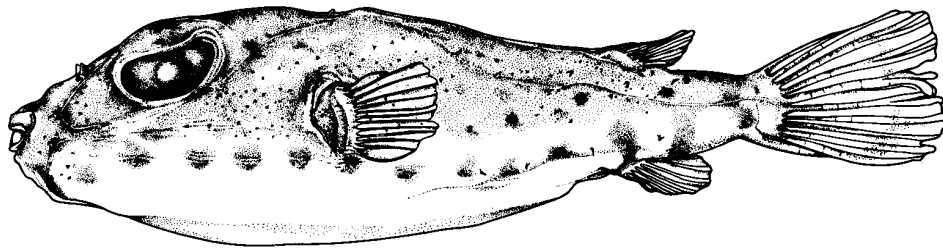
Figures: Adult: Matsuura, 2002; A–C: Elizabeth Ray Peters (Martin and Drewry, 1978)

References: Martin and Drewry, 1978; Fahay, 1975; Tyler, 1980; Aboussouan and Leis, 1984; Matsuura, 2002

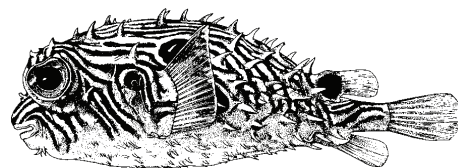
Sphoeroides spengleri



A. 15.0 mmSL



B. 21.0 mmSL

Chilomycterus schoepfi* (Walbaum, 1792)*Diodontidae****Striped burrfish**

Range: Western North Atlantic Ocean from Nova Scotia to the Bahamas, Cuba and Belize, including northern Gulf of Mexico

Habitat: Demersal in seagrass beds or on soft substrates, in relatively shallow waters; also estuaries; a presettlement stage (the "lyosphaera") is pelagic until reaching a size of about 20 mm

Spawning: Not well described, possibly early spring through Jul (or later); spawning reportedly occurs well offshore

Eggs:

- Pelagic, non-adhesive, transparent
- (Unfertilized eggs are demersal)
- Diameter: 1.8 mm (average)

Larvae:

- Undescribed
- Most likely has body partially enclosed in a "shell" or "vesicular dermal sac" as in other diodontids
- Body width exceeds body depth in early stages

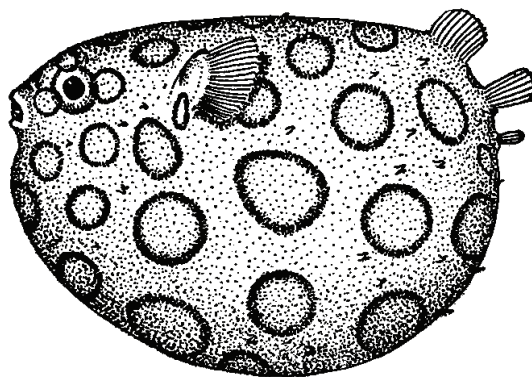
Early Juvenile:

- A specialized pelagic- juvenile stage (the "lyosphaera") differs from larvae and juveniles of *Diodon* and certain other species in *Chilomycterus*, in lacking elongate spines covering the body. In this stage, elongate papillae develop, but these fail to form spines (= specialized scales) in their interiors. Instead, some of these papillae enlarge enormously, but body spines do not form until after the pelagic-juvenile settles to demersal habitats.
- Pelagic-juveniles are further characterized by the body width exceeding the body depth
- Eye very large, mouth small and terminal; (the early adult stage illustrated above still has a proportionately large eye; the eye in fully grown adults is much smaller; see Klein-M^{ac}Phee (2002v))
- Pigment includes circular pigment aggregations surrounding each fleshy papilla
- See photograph of "lyosphaera" stage in Böhlke and Chaplain, 1968 (or Böhlke and Chaplain, 1993). In both editions the photograph appears on p. 694. Also refer to Heck and Weinstein (1978).
- See Humann (1996) for color photograph of "lyosphaera" stage *in situ*

Meristic Characters

Myomeres:	18–20
Vertebrae:	10–12 + 8 = 20
Dorsal fin rays:	10–12
Anal fin rays:	9–11
Pectoral fin rays:	about 20
Pelvic fin rays:	none
Caudal fin rays:	0+4+5+0

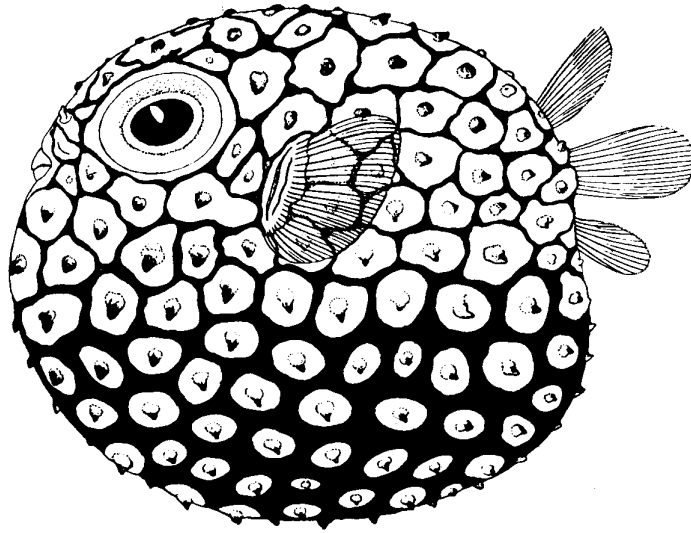
B. size unknown
(Described as <1.25")
"Lyosphaera globosa"



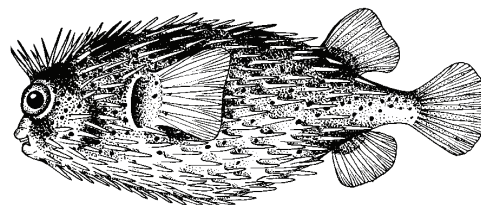
Figures: Adult: Matsuura, 2002; **A:** Fowler, 1945; **B:** Evermann and Kendall, 1898

References: Nichols and Breder, 1927; Leis, 1978; Martin and Drewry, 1978; Tyler, 1980; Aboussouan and Leis, 1984; Klein-M^{ac}Phee, 2002v; Matsuura, 2002

Chilomycterus schoepfi



A. 14.0 mmSL

Diodon holocanthus* Linnaeus, 1758*Diodontidae****Long-spine porcupinefish**

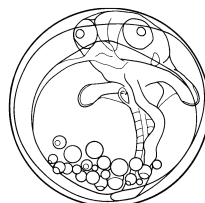
Range: Worldwide in tropical waters; in the western North Atlantic from Florida and the Bahamas to Brazil; a single larva has been collected in study area at 38°03'N, 68°35'W (MCZ 91390)

Habitat: Demersal in a variety of habitats ranging from shallow reefs to open, soft substrates in depths to 100 m; young stages pelagic until a size of about 60–90 mm

Spawning: Spring through fall (Gulf of Mexico)

Eggs:

- Pelagic, spherical
- Diameter: 1.7–1.8 mm
- Chorion: clear, unornamented
- Yolk: homogeneous
- Oil globules: 10–30, yellowish, 0.05–0.25 mm in diameter
- Perivitelline space: narrow

**Meristic Characters**

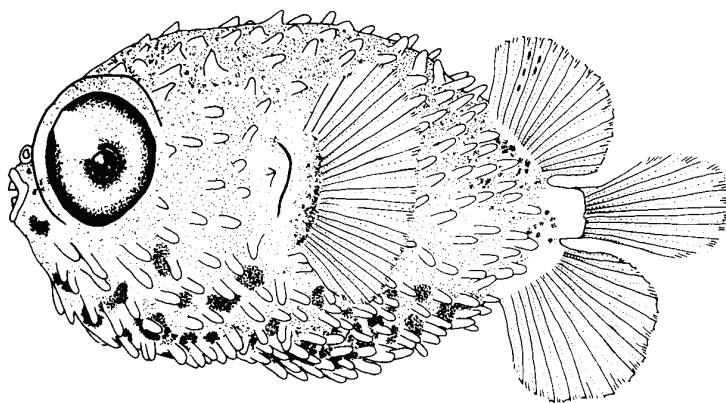
Myomeres:	21
Vertebrae:	12 + 9 = 21
Dorsal fin rays:	14–15
Anal fin rays:	13–14
Pectoral fin rays:	21–23
Pelvic fin rays:	none
Caudal fin rays:	0+4+5+0

Larvae:

- Hatching occurs at 1.9–2.1 mm with well-pigmented eyes and well-formed mouth
- Body width exceeds body depth (see dorsal views), with thinner, compressed tail tip
- Note partial enclosure of body in a "shell" or "vesicular dermal sac"
- Sequence of fin ray formation: P₁ – D, A – C
- Pigment in early larvae composed of dense pigment on dorsum of head and body, but pigment does not extend past the mid-point of developing dorsal and anal fins and the tail tip is unpigmented; in later stages, a scattering of large spots covers much of the venter of the body
- Transform to spiny juvenile stage at sizes <5.0 mmSL (as small as 3.0 mmSL); body becomes covered with low tubercles, covered with sheath-like tissue, which develop into longer spines; these spines are totally lacking on the caudal peduncle

Early Juvenile:

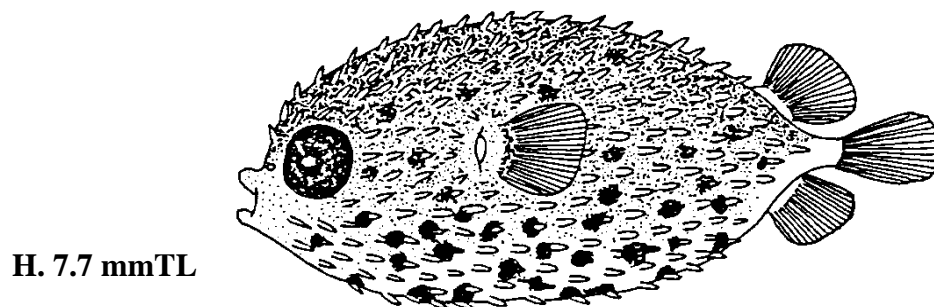
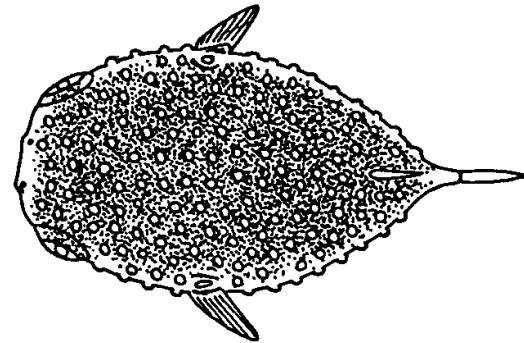
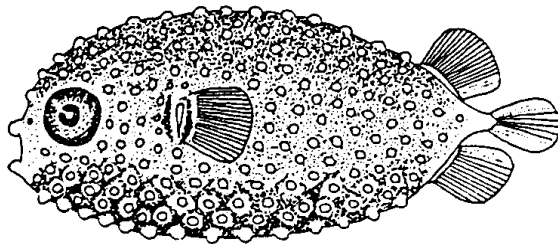
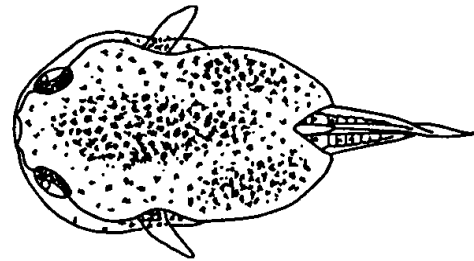
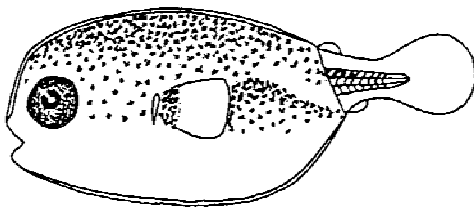
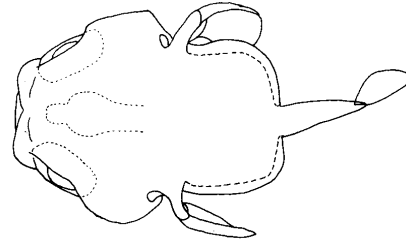
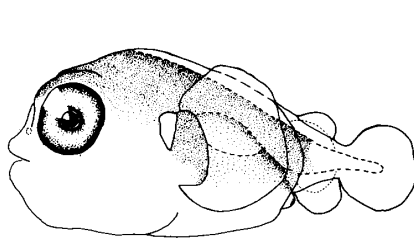
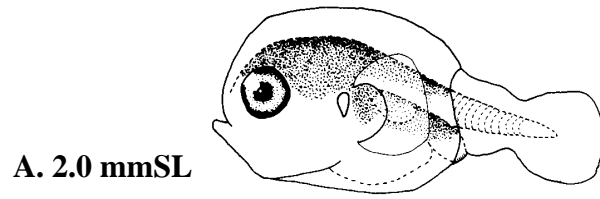
At this size, the morphology is basically that of a miniature adult. A nasal tentacle is present on each nostril, with 2 small openings near tip; a single opening is present at the end of each at sizes of 6.0 mmSL. Spines lengthen and the eye becomes proportionately smaller in larger sizes

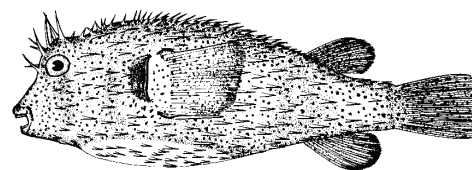
**I. 4.8 mmSL**

Figures: Adult: Matsuura, 2002; egg: Leis, 1978; **A–C, I:** Leis, 1978; **D–H:** Sakamoto and Suzuki, 1978

References: Leis, 1978; Martin and Drewry, 1978; Sakamoto and Suzuki, 1978; Tyler, 1980; Aboussouan and Leis, 1984; Matsuura, 2002

Diodon holocanthus



Diodon hystrix* Linnaeus, 1758*Diodontidae****Porcupine fish**

Range: Worldwide in tropical waters; in the western North Atlantic from Massachusetts and Bermuda to Brazil, including Gulf of Mexico

Habitat: Demersal near reefs in depths to 50 m; young stages pelagic until a size of about 180 mm; juveniles often occur under *Sargassum* mats, in Gulf Stream waters

Spawning: Ripe females found Feb–Mar (Caribbean Sea)

Eggs:

- Pelagic, spherical
- Diameter: 1.9–2.1 mm
- Chorion: clear, unornamented
- Yolk: unsegmented
- Oil globules: multiple, 0.03–0.15 mm in diameter
- Perivitelline space: narrow

**Meristic Characters**

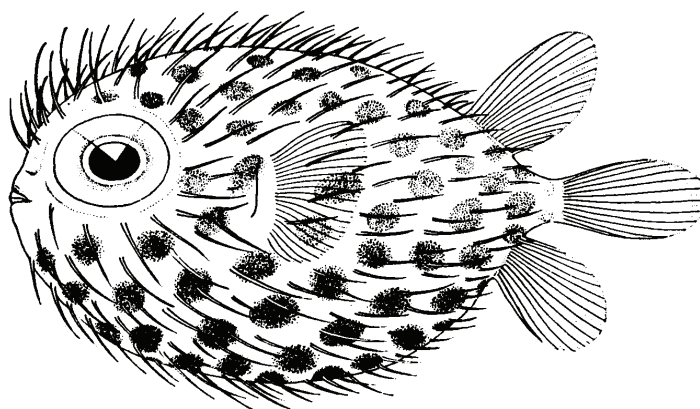
Myomeres:	20–21
Vertebrae:	11–12+9–10=20–21
Dorsal fin rays:	15–17
Anal fin rays:	15–16
Pectoral fin rays:	22–25
Pelvic fin rays:	none
Caudal fin rays:	0+4+5+0

Larvae:

- Larvae at hatching have partially pigmented eyes, non-functional mouth
- Body width exceeds body depth in early stages
- Note partial enclosure of body in a "shell" or "vesicular dermal sac"
- Sequence of fin ray development: P₁ – D, A – C
- Pigment in early larvae scattered over dorsal parts of head, trunk and tail; dorsal pigment extends posterior to dorsal and anal fin bases
- Transform to a spiny juvenile stage at sizes <5.0 mmSL; 2 or more small spines present on dorsal or dorsolateral surface of caudal peduncle

Putative Early Juvenile:

Juveniles are reported to have shorter spines than juveniles of *Diodon holocanthus*, and to have a more darkly pigmented snout (Leis, 1978)

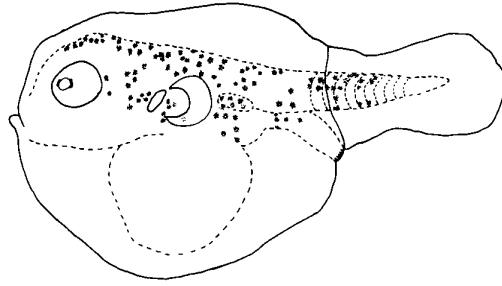
**C. Length unknown**

(Ostensibly a juvenile *Diodon hystrix*, but diagnostic characters are not indicated and identity is therefore in doubt. Collection location of this specimen is also unknown.)

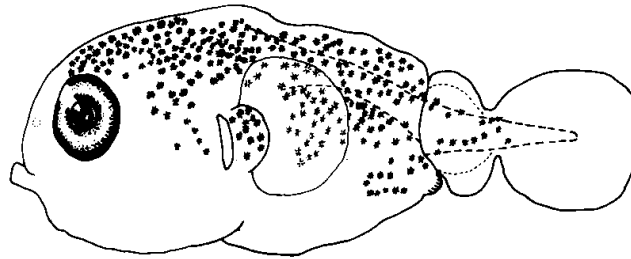
Figures: Adult: Matsuura, 2002; egg (tentative): Watson and Leis, 1974; **A–B**: Leis, 1978; **C**: Fowler, 1928

References: Leis, 1978; Martin and Drewry, 1978; Tyler, 1980; Aboussouan and Leis, 1984; Matsuura, 2002

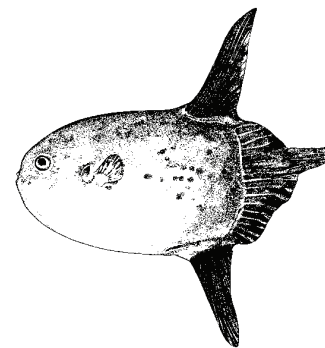
Diodon hystrix



A. 2.57 mmSL



B. 2.60 mmSL

Masturus lanceolatus* (Liénard, 1840)*Molidae****Sharptail mola**

Range: Worldwide in temperate and tropical waters, except absent from eastern Pacific and Mediterranean Sea; in the western North Atlantic from North Carolina (rarely Nova Scotia and Massachusetts Bay) to Brazil; early stages may occur in Gulf Stream or Slope Sea waters of study area

Habitat: Epipelagic, although there are records of collections from depths of 37 m or deeper. Young stages often collected from stomachs of large predators (e.g. *Thunnus*, *Coryphaena*, *Acanthocybium*).

Spawning: Probably near centers of subtropical gyres; season unknown

Eggs:

- Pelagic, spherical
- Diameter: 1.8 mm
- Oil globules: about 40

Larvae:

- Partial enclosure of body in a "shell" or "vesicular dermal sac" probable in hatchlings, but not described for this species
- Body deeper than wide with compressed tail; body becomes more compressed after about 5.0 mmNL
- Head and body covered by series of large dermal spines; bases of these spines supported by lengthwise- and cross-ribs (not present in spines of *Ranzania laevis* larvae)
- 5 dermal spines become very elongate at about 3.5 mmNL: these are located at rostral, dorso-medial, ventro-medial and 2 ventro-lateral positions
- Gill opening reduced to pore
- Sequence of fin ray formation: P₁ – D, A – "pseudocaudal" or "clavus"; (see glossary)
- Notochord tip and caudal finfold shrink with development, eventually disappear
- A claval filament is present in some specimens >12 mm; this structure may be easily lost during collection
- Pigment is uniform over much of body and gut except for unpigmented areas on bases of P₁, D and A fins; heavily spotted over much of body after spines become elongate; forms a counter-shaded pattern in juveniles

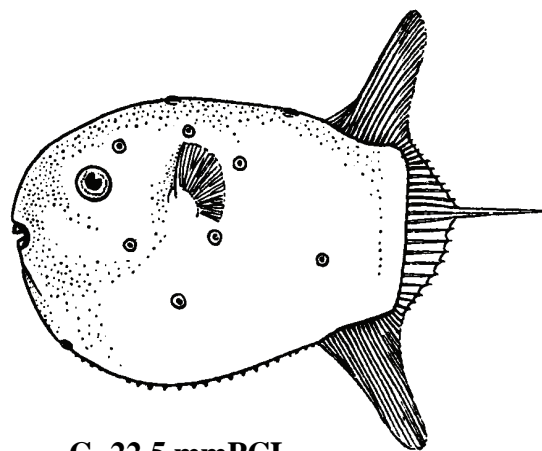
Meristic Characters

Myomeres:	16
Vertebrae:	8 + 8 = 16
Dorsal fin rays:	17–20
Anal fin rays:	16–19
Pectoral fin rays:	7–10
Pelvic fin rays:	none
Caudal fin rays:	"clavus"

Note:

1. At transformation, large body spines gradually reduce in length and become small, round, wart-like; juveniles gradually assume near-adult appearance after assuming a very deep body with ventral keel. This stage termed "*Molacanthus*" by some authors. Compare to transforming larvae of *Ranzania*.

Early Juvenile:

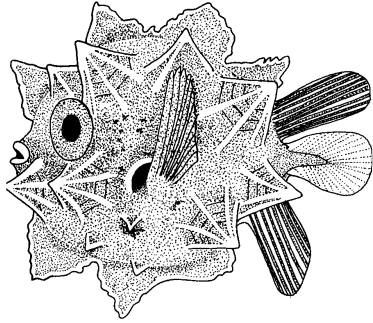


G. 22.5 mmPCL

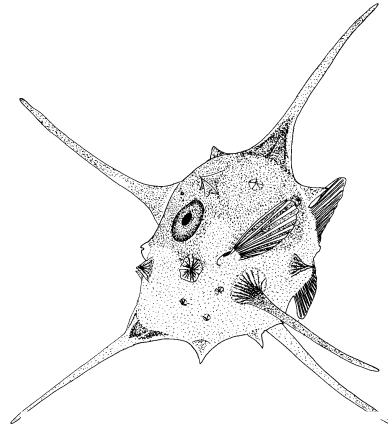
Figures: Adult: Matsuura, 2002; **A:** Gudger, 1935; **B, D:** Schmidt, 1921; **C, G:** Gudger, 1937; **E:** Sokolavskaya and Sokolovskiy, 1975 (modified); **F:** Yabe, 1953

References: Schmidt, 1921; Sokolavskaya and Sokolovskiy, 1975; Leis, 1977; 1984a; Martin and Drewry, 1978; Tyler, 1980; Aboussouan and Leis, 1984; Collette and Hartel, 1988; Watson, 1996ff; Klein-M^{ac}Phee, 2002v; Matsuura, 2002

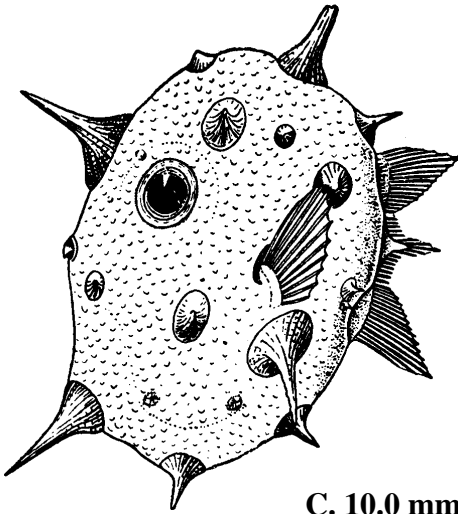
Masturus lanceolatus



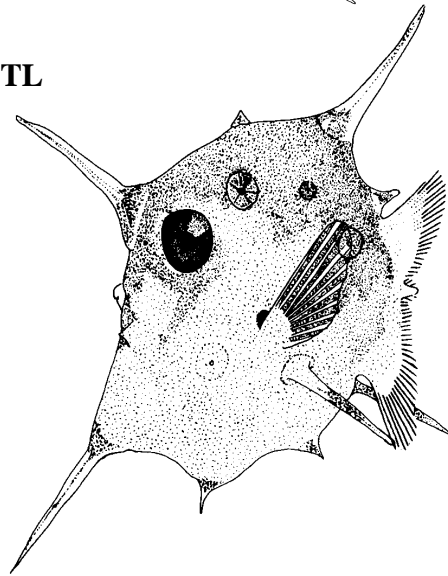
A. 2.8 mmTL



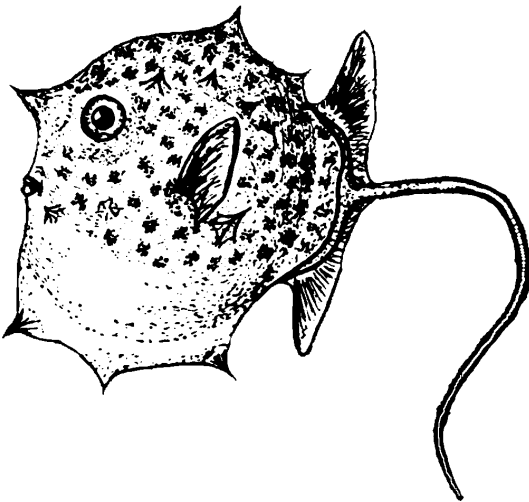
B. 5.5 mmTL



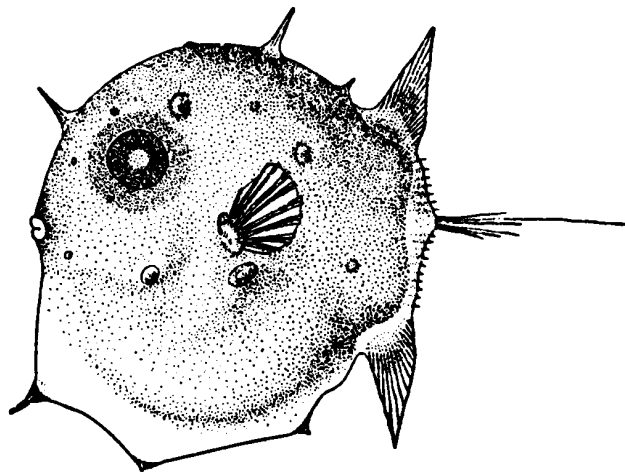
C. 10.0 mmTL



D. 10.5 mmTL



E. 12.0 mmPCL



F. 22.5 mmPCL

PCL = preclavus length

Mola mola* (Linnaeus, 1758)*Molidae****Ocean sunfish**

Range: Worldwide in temperate and tropical waters; in the western Atlantic from Newfoundland to Argentina

Habitat: Epipelagic in oceanic waters, but also sporadically in coastal waters or bays and estuaries; young stages in Gulf Stream or Slope Sea waters in study area

Spawning: Season undescribed; presumed to occur in outer perimeter of temperate Atlantic Ocean, based on distribution of young stages

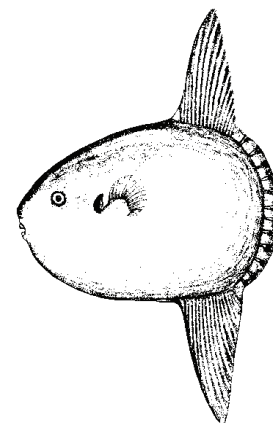
Eggs: – Undescribed

Larvae:

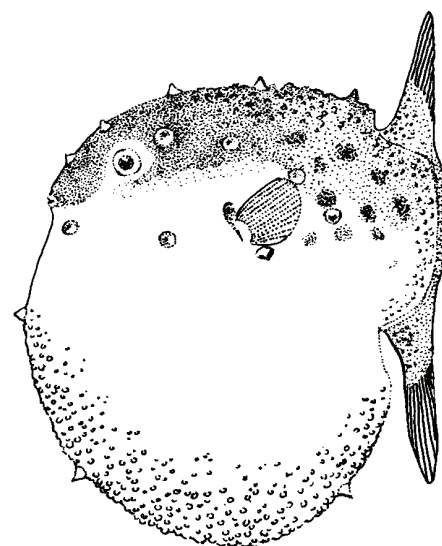
- Partial enclosure of body in a "shell" or "vesicular dermal sac"
- Body deeper than wide with compressed tail; body becomes more compressed after about 5.0 mmNL
- Head and body covered by series of large dermal spines; bases of these spines supported by lengthwise- and cross-ribs (not present in spines of *Ranzania laevis* larvae)
- Extreme elongation of dermal spines not described for larvae of this species (see *Masturus lanceolatus*)
- Gill opening reduced to pore
- Sequence of fin ray formation: P₁ – D, A – "pseudocaudal" or "clavus"; (see glossary)
- Notochord tip and caudal finfold shrink with development, eventually disappear
- A claval filament has not been described in this species (see *Masturus lanceolatus*)
- Pigment is uniform over much of body and gut except for unpigmented areas on bases of P₁, D and A fins and around mouth; pigment becomes concentrated into spots of varying size after resorption of notochord tip; venter of body may remain unpigmented; forms a counter-shaded pattern in juveniles

Note: 1. At transformation, large body spines gradually reduce in length and become small, round, wart-like; juveniles gradually assume near-adult appearance after assuming a very deep body with ventral keel. This stage termed "*Molacanthus*" by some authors. Compare to transforming larvae of *Ranzania*.

Early Juvenile:

**Meristic Characters**

Myomeres:	17
Vertebrae:	8 + 9 = 17
Dorsal fin rays:	15-20
Anal fin rays:	14-18
Pectoral fin rays:	11-13
Pelvic fin rays:	none
Caudal fin rays:	"clavus"

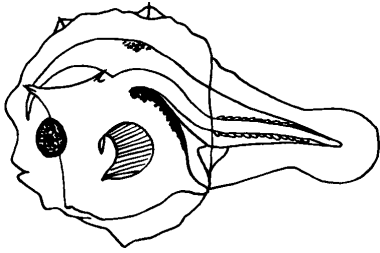


F. 31 mmTL

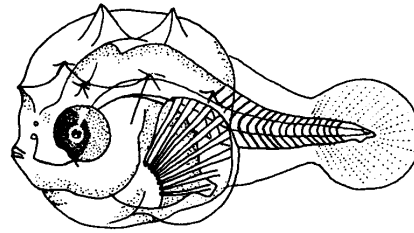
Figures: Adult: Matsuura; **A:** Aboussouan, 1969; **B, F:** Joan Ellis (Martin and Drewry, 1978) (redrawn after Tortonese, 1956 and Sanzo, 1939); **C, E:** Schmidt, 1926; **D:** Steenstrup and Lütken, 1898

References: Leis, 1977; 1984a; Martin and Drewry, 1978; Tyler, 1980; Aboussouan and Leis, 1984; Watson, 1996ff; Klein-M^{ac}Phee, 2002v; Matsuura, 2002

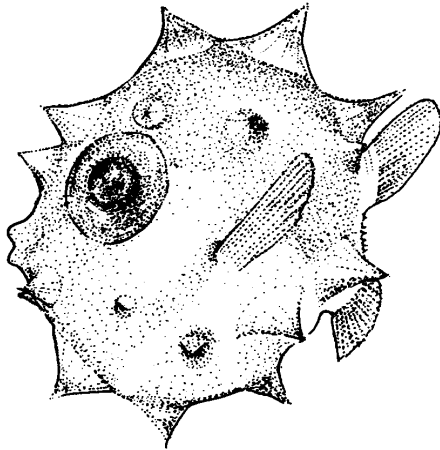
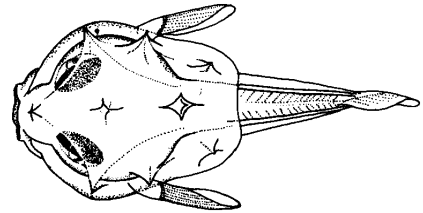
Mola mola



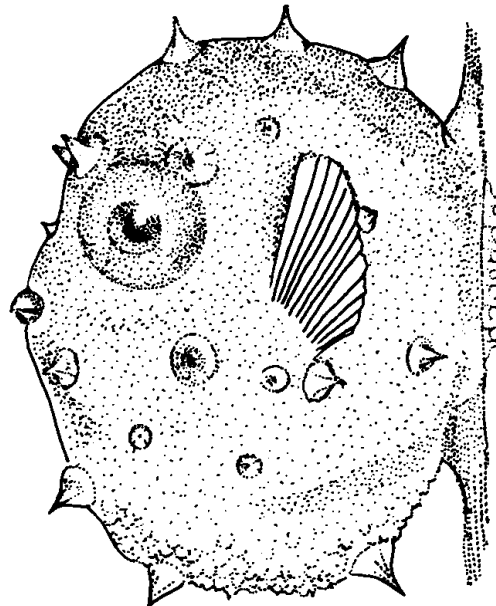
A. 1.4 mmTL



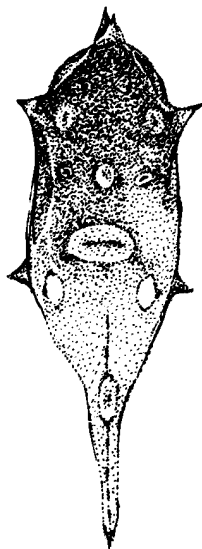
B. 1.8 mmTL
(Lateral and Dorsal)



C. 5.0 mmTL



D. 15.0 mmTL



E. 19.5 mmTL
(Anterior View)

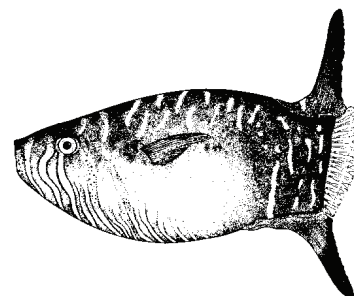
Ranzania laevis* (Pennant, 1776)*Molidae****Slender mola**

Range: Worldwide in tropical waters; in the western North Atlantic from Florida to Brazil; young stages may occur in study area, especially in Gulf Stream

Habitat: Epipelagic in oceanic waters; young stages may occur closer to coast

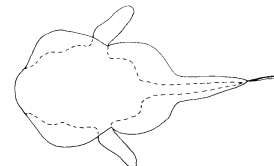
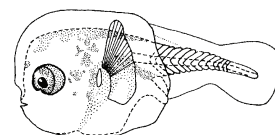
Spawning: Probably near centers of subtropical gyres

- Eggs:**
- Pelagic, spherical
 - Diameter: 1.4–1.7 mm
 - Chorion: clear, smooth
 - Yolk: homogeneous
 - Oil globules: 20–30, 0.05–0.16 mm in diameter
 - Perivitelline space: narrow

**Meristic Characters**

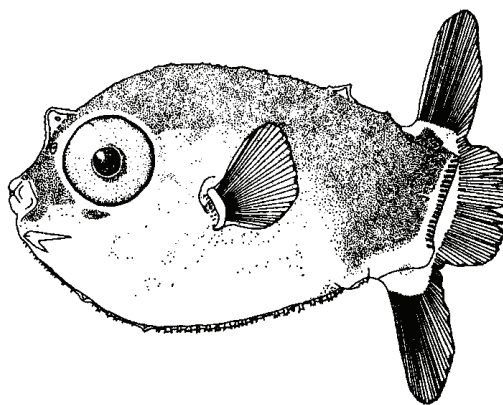
Myomeres:	18
Vertebrae:	8 + 10 = 18
Dorsal fin rays:	18–19
Anal fin rays:	18–19
Pectoral fin rays:	13–14
Pelvic fin rays:	none
Caudal fin rays:	"pseudocaudal"

- Larvae:**
- Hatching occurs at <2.0 mmNL, eyes pigmented, mouth well formed
 - Note partial enclosure of body in a "shell" or "vesicular dermal sac"
 - Body deeper than wide with compressed tail; compare dorsal view to that of diodontids
 - Gill opening reduced to pore
 - Sequence of fin ray formation: P₁ – D, A – "pseudocaudal" or "clavus"
 - Few P₁ fin rays ossified at hatching
 - Notochord tip shrinks with development, eventually disappears
 - Several series of large, serrated spines form over head and body
 - As large spines decrease in size, smaller spines form on ventral keel
 - Pigment is heavy on dorsum of body and over gut; forms a counter-shaded pattern at relatively small sizes 1.8 mmNL; shortly after hatching; lateral and dorsal



1.8 mmNL; shortly after hatching; lateral and dorsal

- Note:** 1. At transformation, larvae lose large body spines fairly quickly and juveniles soon assume near-adult appearance. Compare to transforming larvae of *Mola* and *Masturus*.

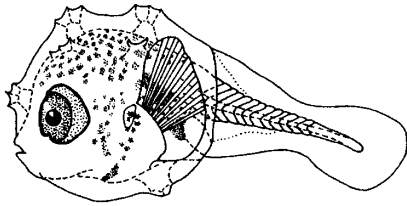
Early Juvenile:

G. 11.0 mmPCL

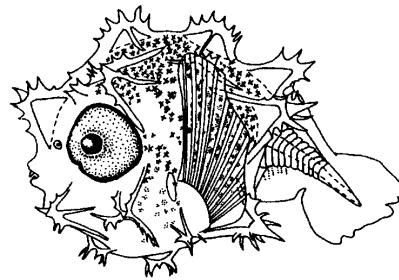
Figures: Adult: Matsuura, 2002; Egg, hatchling and A–G: Leis, 1977

References: Leis, 1977; 1984a; Martin and Drewry, 1978; Tyler, 1980; Aboussouan and Leis, 1984; Watson, 1996ff; Klein-M^{ac}Phee, 2002v; Matsuura, 2002

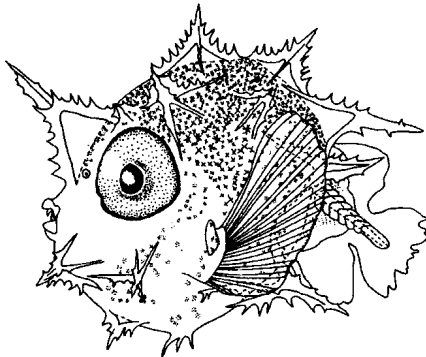
Ranzania laevis



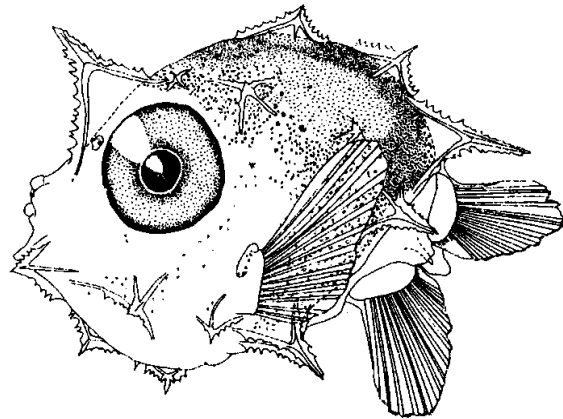
A. 2.0 mmNL



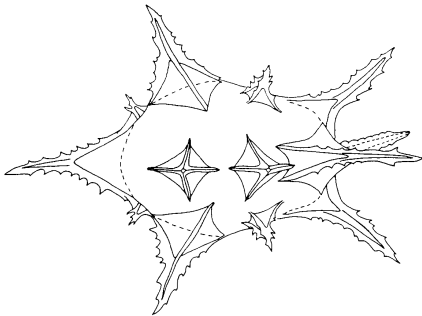
B. 2.0 mmNL



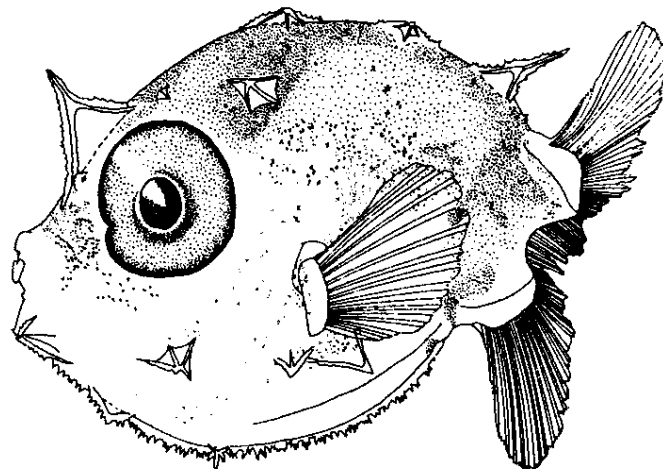
C. 2.5 mmNL



D. 3.9 mmNL



**E. 2.5 mmNL
(Dorsal View,
Pigment and Fins
Deleted)**



F. 6.0 mmPCL

PCL = preclavus length