

Species Accounts

Acipenseriformes, Elopiformes, Albuliformes, Notacanthiformes

Selected meristic characters in species belonging to the above orders whose adults or larvae have been collected in the study area. Classification sequence follows Eschmeyer, 1990. Vertebrae and anal fin rays are generally not reported in the Notacanthiformes. Most notacanthiform larvae are undescribed. Sources: M^cDowell, 1973; Sulak, 1977; Castle, 1984; Snyder, 1988; Smith, 1989b.

Order–Family <i>Species</i>	Total vertebrae (or myomeres)	Dorsal fin rays	Anal fin rays	Caudal fin rays
Acipenseriformes-Acipenseridae				
<i>Acipenser brevirostrum</i>	60–61 myo	32–42	18–24	60
<i>Acipenser oxyrhynchus</i>	60–61 myo	30–46	23–30	90
Elopiformes-Elopidae				
<i>Elops saurus</i>	74–86	18–25	8–15	9–11+10+9+7–8
Elopiformes-Megalopidae				
<i>Megalops atlanticus</i>	53–59	10–13	17–23	7+10+9+6–7
Albuliformes-Albulidae				
<i>Albula vulpes</i>	65–72	17–19	8–10	8+10+9+6

Order–Family <i>Species</i>	Total vertebrae (or myomeres)	Dorsal fin rays	Anal fin rays	Pelvic fin rays
Notacanthiformes-Halosauridae				
<i>Aldrovandia affinis</i>	No data	11–13	No data	I, 7–9
<i>Aldrovandia oleosa</i>	No data	10–12	No data	I, 8
<i>Aldrovandia gracilis</i>	No data	10–12	No data	I, 7–9
<i>Aldrovandia phalacra</i>	No data	10–12	No data	I, 7–8
<i>Halosauropsis macrochir</i>	No data	11–13	No data	I, 9
<i>Halosaurus guentheri</i>	No data	10–11	158–209	I, 8–10
Notacanthiformes-Notacanthidae				
<i>Notacanthus chemnitzii</i>	225–239 ¹	9–12 spines	XIII–IV, 116–130	I, 8–11
<i>Polyacanthonotus challengerii</i>	242–255 ¹	36–40 spines	XXXIX–LIX, 126–142 ¹	I–II, 8–9
<i>Polyacanthonotus merretti</i>	No data	28–36 spines	No data	I–II, 6–8
<i>Polyacanthonotus rissoanus</i>	No data	26–36 spines	No data	I, 7–11
Notacanthiformes-Lipogenyidae				
<i>Lipogenys gillii</i>	228–234	9–12	116–136	II, 6–8

¹ Meristic data from California Current area (Moser and Charter, 1996a); data from western Atlantic may differ

Acipenseriformes, Elopiformes, Albuliformes, Notacanthiformes

Acipenseriformes

Sturgeons are anadromous and freshwater fishes restricted to the northern hemisphere. They usually grow to large sizes and are characterized by long snouts, inferior mouths equipped with barbels, heterocercal tails and lengthwise rows of bony scutes along the body. The 2 species included in the study area spawn in the early spring, sometimes continuing into late summer, usually in fresh or slightly brackish water. Ontogenetic information has been provided only recently. Eggs and hatching size are large, and development proceeds at a retarded rate, compared to most teleosts; one species not reaching the juvenile stage until 57–67 mmSL, the other not until a length of 116 mmSL. A review of the literature indicates that early stages are infrequently collected and most ontogenetic data derives from reared (hatchery) material.

Elopiformes

Larvae of the Elopiformes are characterized by the following (after Smith, 1989b):

- Small to moderate sized leptocephali, reaching only about 30–70 mm (in the present study area) before shrinking at transformation
- Body moderate in depth
- Gut length moderately to very long
- All have large, forked caudal fins, except very early stages
- Dorsal and anal fin bases short, with 8–29 rays, located in the posterior-most part of body
- Pectoral fins present in all stages
- Pelvic fin rays form shortly before transformation
- Head and snout short
- Pigment present along gut, sometimes laterally on body, always light
- Best characters for distinguishing the 3 species in the study area:

Character	<i>Megalops atlanticus</i>	<i>Elops saurus</i>	<i>Albula vulpes</i>
Myomeres	53–59	79–86	65–72
Dorsal fin rays	10–13	18–25	17–19
Anal fin rays	17–23	8–15	8–10
Maximum larval size	29 mm	40–50 mm	64 mm
Dorsal and anal fins	Opposite	Barely overlap	Separate

Notacanthiformes

Members of this order are found near-bottom in lower continental slope and abyssal depths. The larvae are known to include a leptocephalus stage although they have not been specifically identified. They differ from anguilliforms in the possession of well-developed pelvic fins, a short-based dorsal fin with spines in some species, and in having prominent scales. The leptocephali are greatly elongate (up to 1,800 mm) and have a thin post-caudal filament in place of a caudal fin. They also have minute pectoral fins and a long, straight gut. Myomeres are "V" shaped (not "W" shaped as in anguilliforms). Pigment typically occurs along the ventral margin, rarely along the midline. Information on vertebral and anal fin ray numbers is almost non-existent. Ontogenetic information is presented here on 3 types of notacanth leptocephali, although none has been related to a known family or species.

***Acipenser brevirostrum* Lesueur, 1818**
Acipenseridae
 Shortnose sturgeon



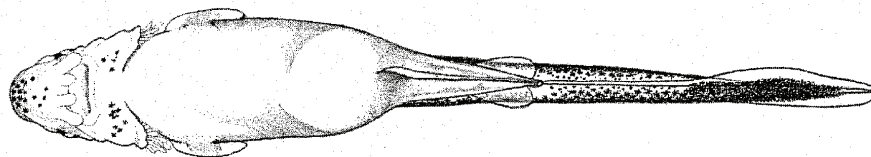
- Range:** Coastal North America from St. John River, New Brunswick to northern Florida (St. Johns River)
- Habitat:** Mostly freshwater, sometimes estuarine, rarely coastal oceanic waters; typically in deep channels; often forage in shallows (<2 m depth)
- Spawning:** Feb (Georgia), late Apr (Massachusetts), mid-May (Canada); on rocky substrates (e.g. under falls or in rapids); spawns in temperatures 9–12°C in freshwater
- Eggs:** – Benthic, adhesive; average 3.0 mm diameter
 – Bicolored, brown and grayish white
- Larvae:** – Hatching occurs at 9–10 mmSL; eyes unpigmented; yolk absorbed at about 15 mmSL
 – Mouth large in early larvae, width 66–88% of head width (see *A. oxyrinchus*)
 – After yolk absorption, inter-lip-lobe width is >25% of mouth width
 – Barbels around mouth appear at about 12 mmSL
 – Finfold long-lasting, disappears by 57 mmSL

Meristic Characters	
Myomeres:	60–61
Vertebrae:	60–61
Dorsal fin rays:	32–42
Anal fin rays:	18–24
Pectoral fin rays:	25–31
Pelvic fin rays:	17–22
Caudal fin rays:	60

– Fin Rays	Pectoral buds	Pectoral rays	Pelvic	Dorsal and anal	Caudal
Begin (mm)	12–15	21–24	24–34	21–37	24–34
Complete (mm)	36–37	41–51	51–57	>57	

- Head and tail darkly pigmented
 – Pigmentation lacking over ventro-lateral gut and base of pectoral fin; otherwise similar to larvae of *A. oxyrinchus*
 – Transformation to juvenile stage occurs at 57–67 mmSL

- Note:** 1. Best characters for distinguishing early stages of *Acipenser* include pigmentation (or lack thereof) on ventro-lateral surface of gut and lower pectoral fin bases, relative widths of mouths and inter-lip-lobes, and numbers of caudal, anal and pelvic fin rays.



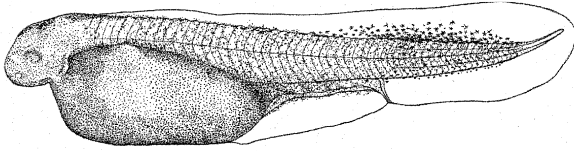
G. 15.1 mmSL

Ventral view of early larva demonstrating lack of pigment on ventro-lateral surface of gut and relatively wide mouth and inter-lip-lobe widths

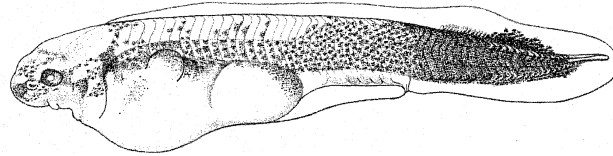
Figures: Adult: H. L. Todd; A–G: C. L. Bjork (Snyder, 1988)

References: Bath *et al.*, 1981; Buckley and Kynard, 1981; Dadswell *et al.*, 1984; Snyder, 1988; Musick, 2002

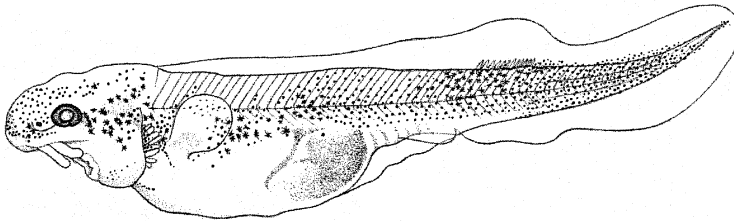
Acipenser brevirostrum



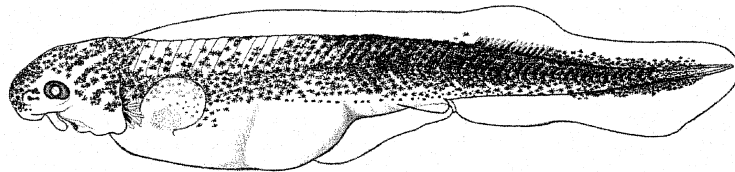
A. 10.9 mmSL



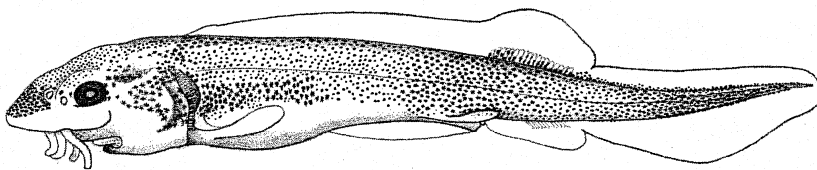
B. 12.0 mmSL



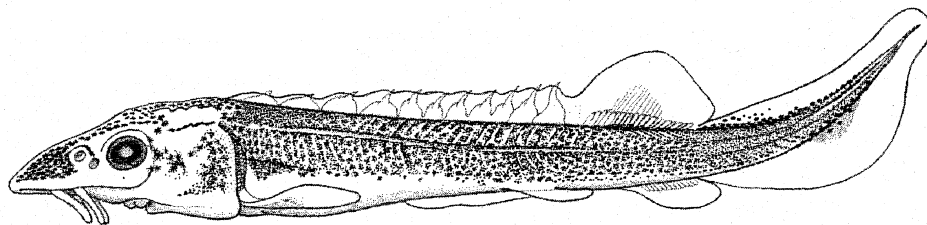
C. 13.5 mmSL



D. 15.1 mmSL

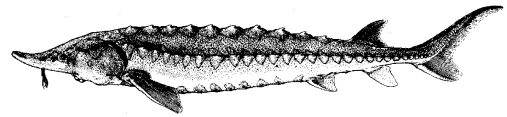


E. 17.7 mmSL



F. 24.4 mmSL

***Acipenser oxyrhynchus* Mitchill, 1814**
Acipenseridae
 Atlantic sturgeon



Range: Coast of North America from Labrador and Ungava Bay to northern Florida

Habitat: Shallow coastal waters (usually <20 m in depth), estuaries and rivers; usually move into oceanic waters during colder months, return to fresh-water when temperatures rise in spring; rarely migrate between freshwater systems (e.g. Hudson River to Chesapeake Bay)

Spawning: May–Jul in St. Lawrence River; Feb–Mar in northern Florida; on solid substrates; spawn in temperatures 13–20°C in oligohaline zone to and above tidal freshwater

Eggs: – Adhesive, often in connected strings; average 2.9 mm diameter, spherical to oval
 – Gray to brown with stellate pigment at pole

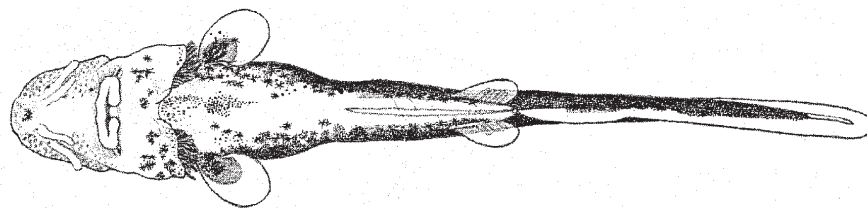
Larvae: – Hatching occurs at 7–9 mmSL; eyes unpigmented; yolk absorbed ~14 mmSL
 – Mouth small in early larvae, width 57–65% of head width (see *A. brevirostrum*)
 – After yolk absorption, inter-lip-lobe width is <20% of mouth width
 – Barbels around mouth appear at ~9 mmSL
 – Finfold long-lasting, disappears by 60–70 mmSL

– Fin Rays	Pectoral buds	Pectoral rays	Pelvic	Dorsal and Anal	Caudal
Begin (mm)	8.4	19–29	12 (buds)	19–32	21–29
Complete (mm)		39–47	47–58 (rays)	29–47	>116

– Head and tail darkly pigmented
 – Pigmentation includes melanophores over ventro-lateral gut and base of pectoral fin; with growth (30–40 mm), these become widely spaced; otherwise similar to larvae of *A. brevirostrum* (see illustrations)
 – Transformation to juvenile stage occurs at 116–136 mmSL

Note: 1. Best characters for distinguishing early stages of *Acipenser* include pigmentation (or lack thereof) on ventro-lateral surface of gut and lower pectoral fin bases, relative widths of mouths and inter-lip-lobes, and numbers of caudal, anal and pelvic fin rays

Meristic Characters	
Myomeres:	60–61
Vertebrae:	60–61
Dorsal fin rays:	30–46
Anal fin rays:	23–30
Pectoral fin rays:	40–41
Pelvic fin rays:	26–33
Caudal fin rays:	90



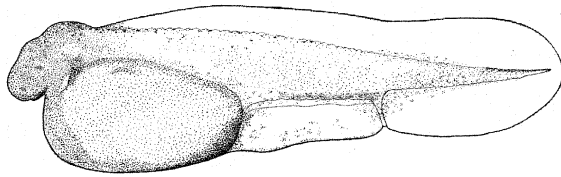
G. 14.3 mmSL

Ventral view of early larva demonstrating pigment on ventro-lateral surface of gut and relatively narrow mouth and inter-lip-lobe widths

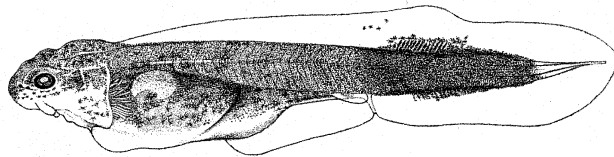
Figures: Adult: H. L. Todd; A–G: C. L. Bjork (Snyder, 1988)

References: Bath *et al.*, 1981; Buckley and Kynard, 1981; Dadswell *et al.*, 1984; Snyder, 1988; Musick, 2002

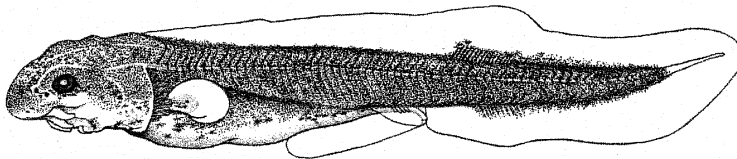
Acipenser oxyrinchus



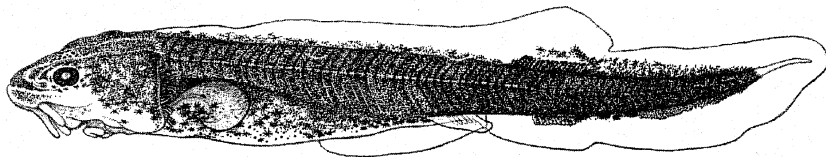
A. 7.4 mmSL



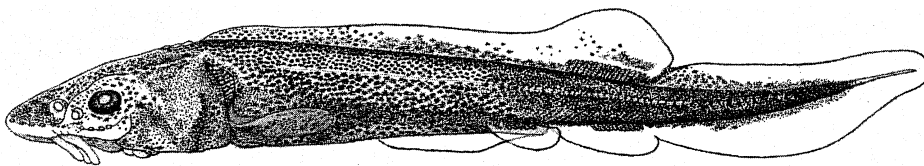
B. 11.5 mmSL



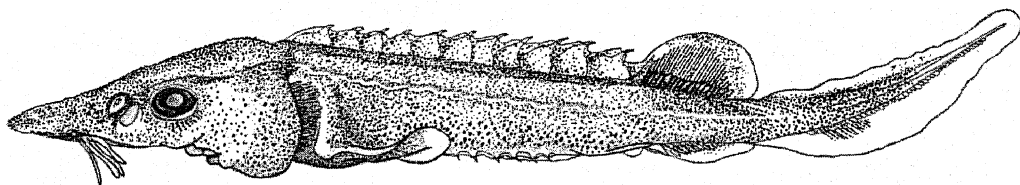
C. 12.9 mmSL



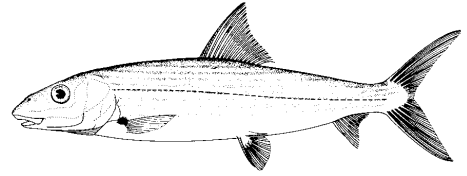
D. 14.3 mmSL



E. 17.0 mmSL



F. 28.9 mmSL

Albula vulpes* (Linnaeus, 1758)*Albulidae****Bonefish**

Range: Worldwide in tropical seas; in the western North Atlantic from Massachusetts (rare) to Brazil, including the Bahamas and Bermuda

Habitat: Shallow sand and mud flats; mangroves

Spawning: Prolonged, but seasonality unclear; leptocephali rarely collected in study area, Jul–Nov; a single, rare occurrence of juveniles on Long Island (Schaefer, 1967)

Eggs: – Undescribed

Larvae: – Leptocephalus-like with forked caudal fin and small head
 – Gut very long (ends at caudal peduncle); preanus length 97–98% SL
 – Period of larval growth, followed by shrinkage and thickening of body, then resumption of growth to juvenile stage
 – Teeth obvious in smaller larvae, lost at transformation
 – Flexion occurs before 17 mm

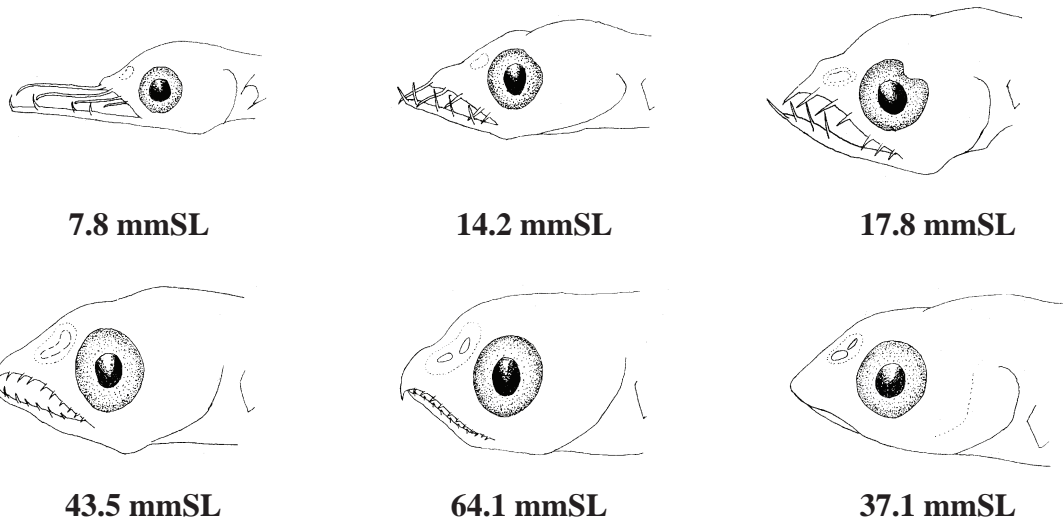
Meristic Characters

Myomeres:	(65)67–69(72)
Vertebrae:	69–74
Dorsal fin rays:	17–19
Anal fin rays:	8–10
Pectoral fin rays:	15–17
Pelvic fin rays:	9–10
Caudal fin rays:	8+10+9+6

- Fin Rays

	Dorsal and anal	Caudal	Pelvic
Begin (mm)	30		65
Complete (mm)	64	43	
- Dorsal fin origin moves from myomere 55 to 29; anal fin moves from myomere 66 to 57
- Note relative positions of dorsal and anal fins
- Pigment restricted to dorsal gut until transformation, then few spots added to caudal fin base and over eye
- Maximum size before transformation about 64 mm

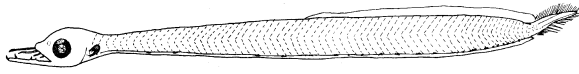
Note: 1. Note change in morphology of head, teeth, jaws through ontogeny (below):



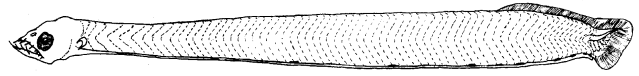
Figures: Adult: D. G. Smith, 2002c; Heads: Alexander, 1961; A–I: Alexander, 1961

References: Alexander, 1961; Eldred, 1967b; Richards, 1984a; Smith, 1989b

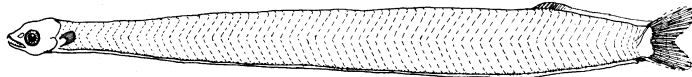
Albula vulpes



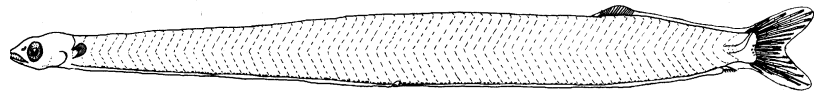
A. 7.8 mmSL



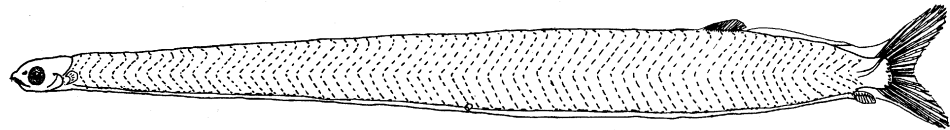
B. 17.8 mmSL



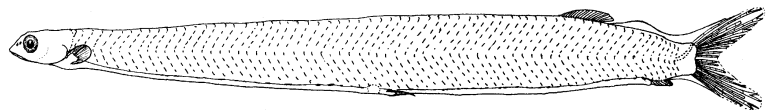
C. 29.1 mmSL



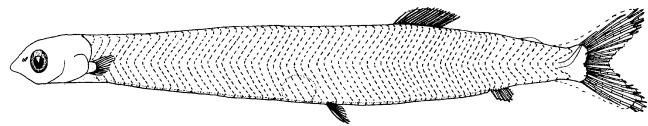
D. 43.5 mmSL



E. 64.2 mmSL

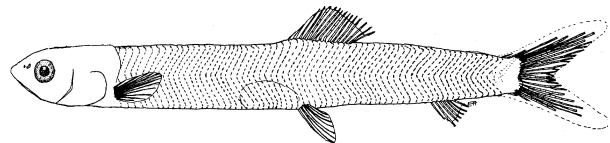


F. 46.1 mmSL

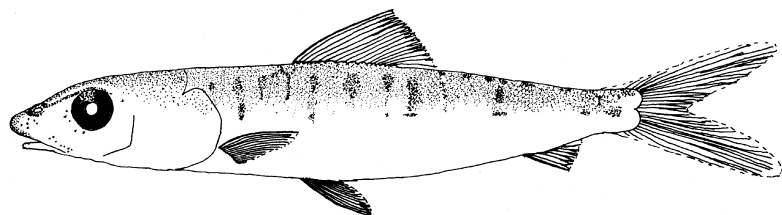


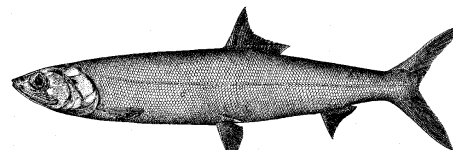
G. 31.6 mmSL

H. 28.5 mmSL



I. 51.2 mmSL
(Juvenile)



Elops saurus* Linnaeus, 1766*Elopidae****Ladyfish**

Range: Western North Atlantic Ocean from Cape Cod and Bermuda through northern Gulf of Mexico to Brazil; rare in study area

Habitat: Bays, lagoons and mangroves

Spawning: Prolonged, probable peak in fall; location undescribed, presumably offshore; larval duration is about 6 months; 2 kinds of larvae (see below) have occurred as far north as Virginia in May–Jul; the low-count form may represent an undescribed species

Eggs – Undescribed

Larvae:

- Leptocephalus-like with forked caudal fin and small head; head length 8–9% SL
- Gut long, preanus length 80–94% TL
- Flexion occurs at about 10–15 mmSL
- Period of larval growth followed by shrinkage and thickening of body during transformation, then resumption of growth to juvenile stage
- Dorsal and anal fin ray counts usually complete at about 25 mm (after transformation)
- Note relative positions of dorsal and anal fins
- Pigmentation includes spots on dorsal gut, a series along mid-lateral body from head to level of anus, spaced at about every 3rd myomere, along anal fin base and dorsal margin of eye
- Series of small spots on lower angle of myosepta between anus and caudal fin base
- Internal pigment occurs on dorsal surface of air bladder after transformation
- Maximum size before transformation about 43 mmSL

Note:

1. Myomere counts above are for both low-count and high-count forms of leptocephalus; either form may reach as far north as Virginia
2. See M^cBride and Horodysky (2004) for details of distribution of 2 forms of leptocephali

Meristic Characters

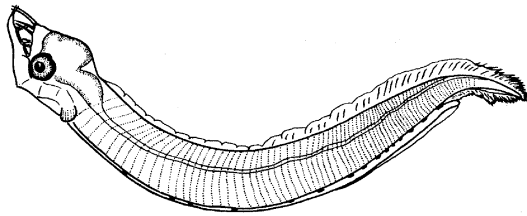
Myomeres:	74–78 or 79–86
Vertebrae:	55–56+24
Dorsal fin rays:	18–25
Anal fin rays:	8–15
Pectoral fin rays:	16–17
Pelvic fin rays:	14–15
Caudal fin rays:	9–11+10+9+7–8

Character	<i>Elops saurus</i> (high-count)	<i>Elops</i> sp. (low count)
Total myomeres	79–86	74–78
Preanal myomeres	76–80	68–72
Predorsal myomeres	66–71	61–66
Last vertical blood vessel at myomere #	55–58	50–55

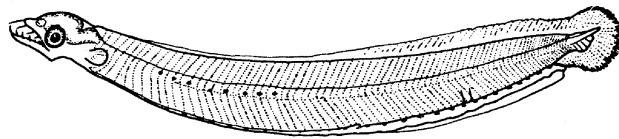
Figures: Adult: H. L. Todd; A–F: Gehringer, 1959a

References: Eldred and Lyons, 1966; Fahay, 1974; Govoni and Merriner, 1978; Richards, 1984a; Smith, 1989b; Crabtree, 2002; M^cBride and Horodysky, 2004

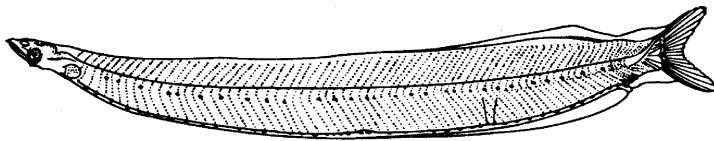
Elops saurus



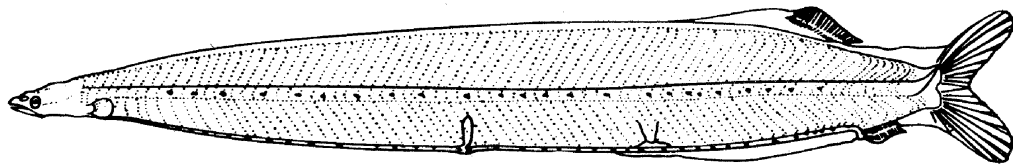
A. 5.3 mmSL



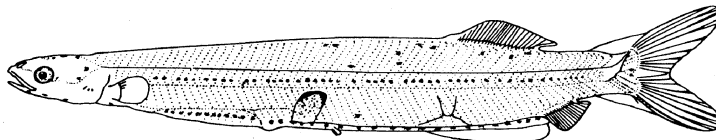
B. 11.2 mmSL



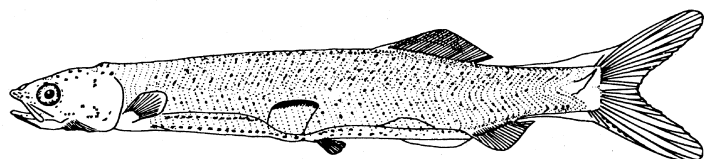
C. 22.4 mmSL



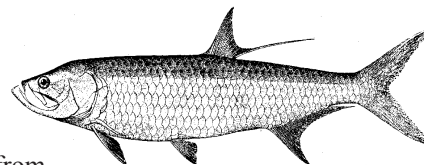
D. 43.3 mmSL



E. 21.5 mmSL



F. 24.7 mmSL (Transforming)

Megalops atlanticus* Valenciennes, 1847*Megalopidae****Tarpon**

Range: Tropical and subtropical Atlantic Ocean; in the western North Atlantic from Virginia (rarely farther north) to Brazil, including the Gulf of Mexico and Caribbean Sea

Habitat: Coastal and inshore waters including freshwater lakes, rivers, estuaries; young-of-the-year in stagnant pools, sloughs, mangroves, *Spartina* marshes as far north as North Carolina; often in areas with low dissolved oxygen levels; can survive very high temperatures and salinities

Spawning: Oceanic waters off Florida May–Aug, peak Jun–Jul; usually coincides with new and full moon phases; larval duration estimated to be 2–3 months; larvae very rarely collected north of 35°N, Aug

Eggs: – Undescribed

Larvae:

- Leptocephalus-like with forked caudal fin, small head, short snout
- Gut long, preanus length about 75% TL (longer in early larvae); preanal myomeres 39–47; esophagus separated from intestine by gastric region (stomach, liver, gall bladder)
- Flexion occurs at 10–11 mmSL
- Predorsal myomeres 39–44; last vertical blood vessel at myomere 44
- Teeth prominent in early larvae (lost at transformation)
- Period of larval growth followed by shrinkage and thickening of body during transformation, then resumption of growth to juvenile stage
- Caudal fin rays form at flexion; dorsal and anal fin rays form about 16 mm (before transformation) and are complete at 17–20 mm (after transformation); pectoral and pelvic fin rays develop later
- Note relative positions of dorsal and anal fins
- Air bladder conspicuous after flexion
- Pigmentation includes melanophores on dorsal edge of gut, along anal fin base, and over eye; larger larvae have series of oblique streaks on myosepta below mid-line; pigment becomes scattered with growth
- Maximum size before transformation about 29 mmSL

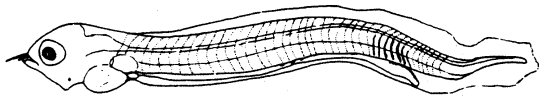
Meristic Characters

Myomeres:	53–59
Vertebrae:	53–57
Dorsal fin rays:	10–13
Anal fin rays:	17–23
Pectoral fin rays:	13–14
Pelvic fin rays:	–
Caudal fin rays:	7+10+9+6–7

Figures: Adult: H. L. Todd; **A–B:** Smith, 1980; **C, H:** Wade, 1962, **C** redrawn); **D, G:** Eldred, 1967c; **E:** Gehringer, 1959b; **F:** Richards, 1969; **I:** Harrington, 1958

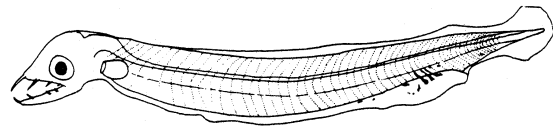
References: Gehringer, 1959b; Wade, 1962; Eldred, 1967c; 1968d; 1972; Richards, 1984a; Smith, 1989b; Crabtree, 2002

Megalops atlanticus

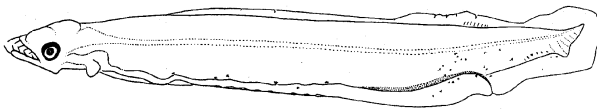


A. 5.7 mmNL

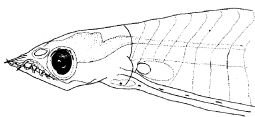
Small larvae have prominent swelling at end of gut



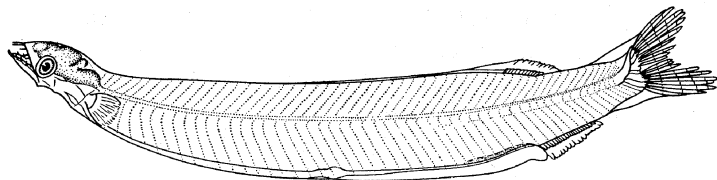
B. 6.3 mmNL



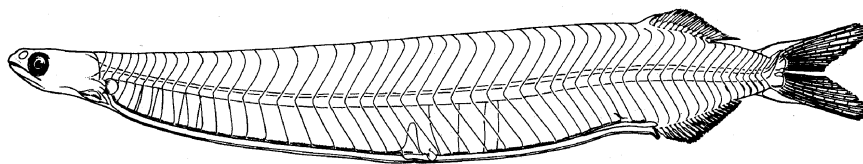
C. 11.7 mmSL



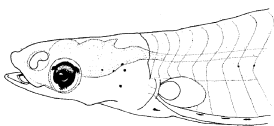
**D. 17.1 mmSL
(Head detail)**



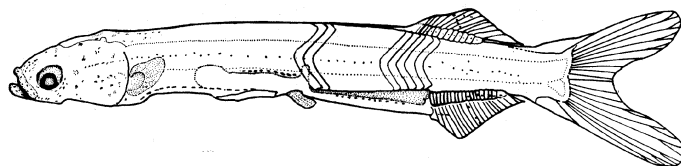
E. 18.0 mmSL



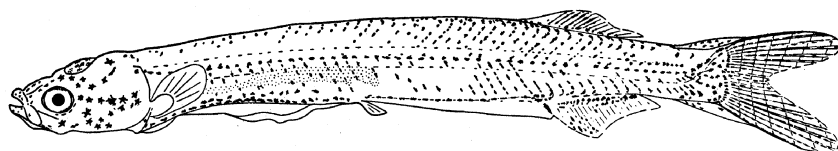
F. 22.8 mmSL



**G. 16.9 mmSL
(Head detail, transforming)**



**H. 13.8 mmSL
(Transforming)**



I. 16.0 mmSL

Notacanthiformes leptocephali**Halosauridae, Notacanthidae**

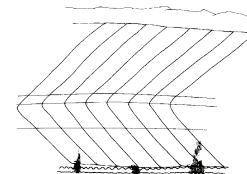
No common name

Meristic Characters

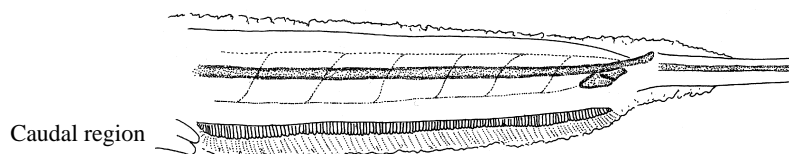
See Introductory Table

- Range:** Worldwide; rarely collected in study area
- Habitat:** Deep continental shelf, continental slope and abyssal regions
- Spawning:** Undescribed; presumably all members of the order have a leptocephalus-like, pelagic larva; (MCZ collections)
- Eggs:** – Undescribed
- Larvae:** – Leptocephalus-like, large to very large (up to 2 m); body elongate
 – Body deepest in anterior half, thence narrowing to very thin caudal end
 – Myomeres "V" shaped (not "W" shaped) and very numerous (300+)
 – Gut long, simple, preanus length 90% or more of total length
 – Caudal fin absent, replaced by filamentous structure (not associated with hypural elements or the notochord); intact filament has leaf-like, pigmented appendages

Evidence suggests halosaurids reduce length drastically at transformation



Myomeres at body mid-section



- Dorsal fin short-based, with 8–10 rays, origin located in anterior 20% of body length
- Anal fin occupies short space between anus and end of notochord
- Small pectoral fin located at about level of myomere #2–4; tiny pelvic fins on large specimens only, anterior to level of dorsal fin; fin formation sequence: P₁, D, A, P₂, C
- Head with long or stubby snout; eye round or vertically elongate
- Pigment typically includes melanophores along gut length, sometimes on myosepta on side of body
- 3 basic types:

"*Tilurus*" (most likely a notacanthid) has short, stubby head and round eye; about 300 myomeres; 45–46 predorsal myomeres; predorsal length 16% SL; preanal length 99% SL; head length 2% SL; series of spots along ventral margin at every 2–3 myomeres; each spot comprised of many small spots superimposed on larger spots; maximum reported length 309 mm.

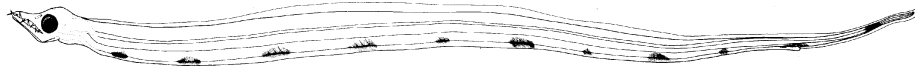
"*Tiluroopsis*" (most likely a halosaurid) has short head and vertically elongate eye; 229–331 myomeres; 45–50 predorsal myomeres; predorsal length 15–23% SL; preanal length 95–99% SL; head length 2–8% SL; a paired series of small spots along ventral edge of entire length of body, with larger spots superimposed over these; maximum reported length 456 mm.

Leptocephalus giganteus (an unknown notacanthiform) has elongate head and snout with round eye; 300–486 myomeres; predorsal myomeres 41–55; predorsal length 14–17% SL; preanal length 99% SL; head length 2% SL; ventral pigment includes series of mostly longitudinally elongate spots from heart region to anus, merging to single line posteriorly; maximum reported length 1,840 mm. May be the larva of *Notacanthus chemnitzii* (see Moser and Charter, 1996a).

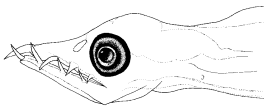
Figures: Caudal region: D. G. Smith, 1984; midsection myomeres and C: Barbara Sumida M^{ac}Call (Moser and Charter, 1996a); A–B: Mary Vona (Moser and Charter, 1996a); D–G: Castle, 1984

References: Smith, 1970; 1989b; Moser and Charter, 1996a

Notacanthiform leptocephali

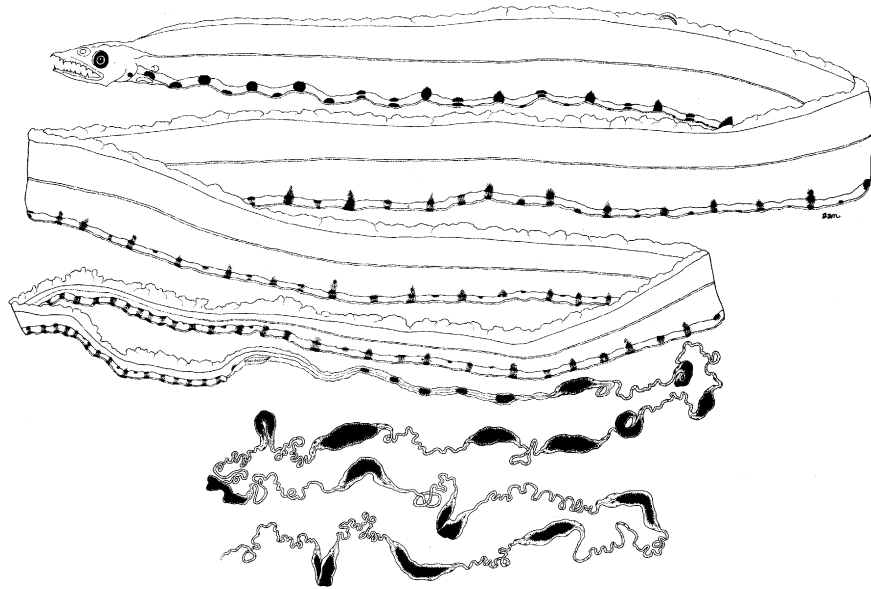


A. 22.0 mmSL (*Leptocephalus giganteus*)

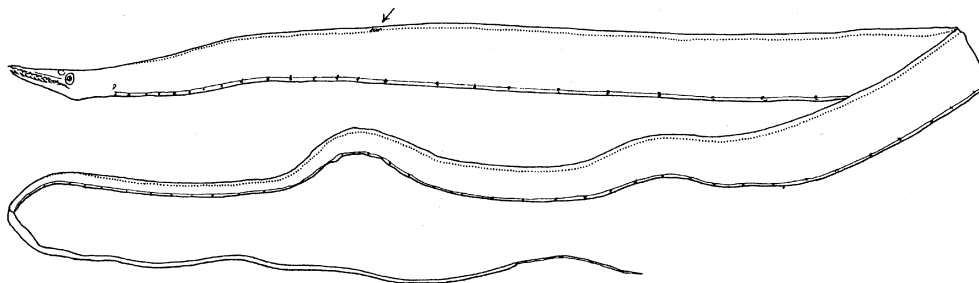


**B. Head detail
22.0 mmSL**

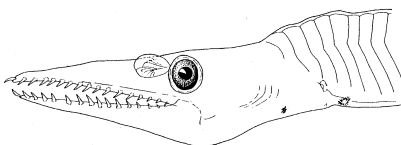
Larger specimens have paired, lateral 'pouches' along gut



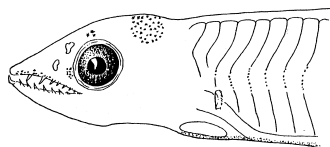
**C. 314.0 mmSL
(*L. giganteus*)**



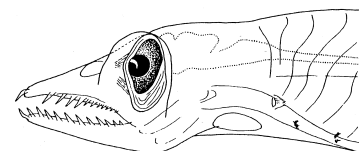
D. 390 mmTL (*L. giganteus*) (Larvae from different regions differ in structure and pigment)



**E. Head detail
(*L. giganteus*)**



**F. Head detail
"Tilurus"**



**G. Head detail
"Tiluropsis"**