CLUPEIDAE *Brevoortia tyrannus* (Latrobe)

Spawning: Autumn and spring in Mid-Atlantic Bight.

Meristic features

Myomeres: 45–50
Vert : 18–19+29–30
D : 18–24
A : 18–24
Plv : 7
C : 7–9+10+9+6–7

Eggs
- Pelagic, spherical.
- Diameter: 1.30–1.95 mm.
- Shell: smooth and thin.
- Yolk: segmented.
- Perivitelline space: wide.
- Oil globules: 1.
- O.G. diameter: 0.11–0.17 mm.
- Pigmentation: 2 rows of dorsolateral spots snout to tail on late embryo.

Larvae
- Hatching occurs at 2.4–4.5 mm; eyes unpigmented.
- Body elongate, with straight gut 70–80% TL; vent always posterior to dorsal fin.
- Preanal myomeres 35 at hatching and 37–40 in larger larvae.
- Flexion occurs at 8–10 mm, and transformation at about 30 mm (in estuaries).
- Fin formation: pectoral forms first as bud but is not complete until transformation; dorsal, anal and caudal form at about 8 mm, but not complete until near transformation; pelvic forms at about 20 mm.
- Muscle-band striations obvious in posterior gut.
- Air bladder evident at about 11 mm.
- Enter estuaries after about 1 month as pelagic larvae at sizes of 10 mm and larger.
- Pigmentation: spots along entire dorsal surface of gut and along ventral surface of posterior half of gut at 5.0 mm; dorsal spots on body disappear at about 5.7 mm (see illustrations opposite).

Important characters:

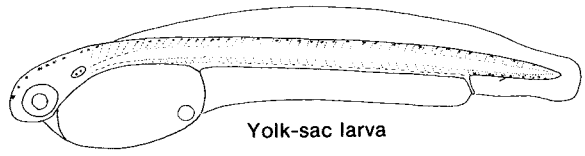
- Myomeres between dorsal and anal fins increase from 2 to 4.
- Dorsal pigment present at notochord tip in small larvae; ventral pigment also present at notochord tip.
- High dorsal and anal fin ray counts.

Note: *Brevoortia smithi* ranges from North Carolina to Louisiana; range of myomeres is 45–47, and transformation occurs at 20–24 mm.

Fig. — **A**, Kuntz and Radcliffe 1917 (redrawn); **B–E**, Mansueti and Hardy 1967 (redrawn); **F**, Lewis *et al.* 1972; **G–H**, Houde and Swanson 1975.

Brevoortia tyrannus CLUPEIDAE

A



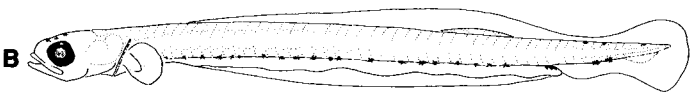
Yolk-sac larva

4.5 mm TL

Dorsal edge pigment

Few caudal spots

B



8.3 mm TL

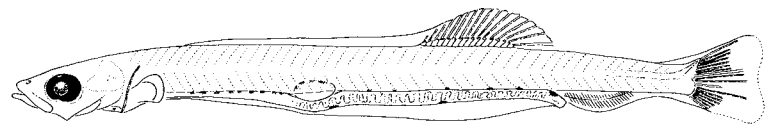
Series of spots along gut

C

10.7 mm TL

Dorsal pigment at notochord tip disappears

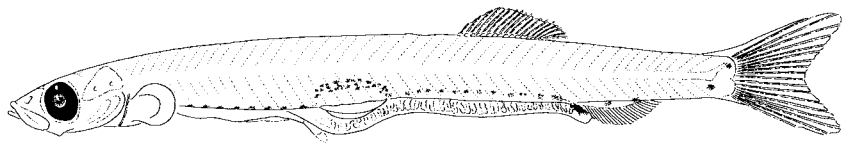
D



16.6 mm TL

Pelvic buds form at about 20 mm

E



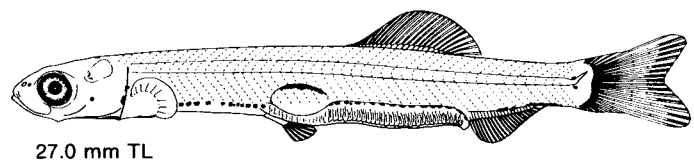
23.1 mm TL

Anal and caudal spots

Spots over air bladder

2 to 4 myomeres between end of dorsal and origin of anal fin

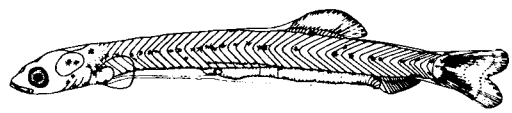
F



27.0 mm TL

Brevoortia smithi

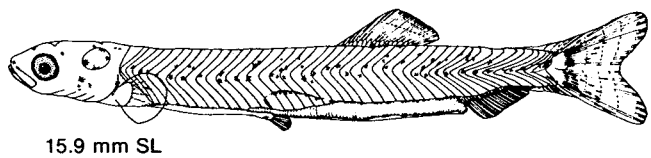
G



12.1 mm SL

Lateral pigment develops between 10 and 12 mm

H



15.9 mm SL

Fewer than 5 myomeres between end of dorsal and origin of anal fin

CLUPEIDAE *Clupea harengus* Linnaeus

Spawning: Mostly concentrated around Gulf of Maine, mainly in autumn.

Meristic features

Myomeres: 52–62
Vert : 23–25+32–33
D : (16)17–19(22)
A : (15)17–19(21)
Plv : 6–10
C : 10–13+10+9+8–9

Eggs
- Demersal, adhesive.
- Diameter: 1.0–1.4 mm.
- Shell: smooth, transparent and thick.
- Yolk: segmented.
- Perivitelline space: wide
- Oil globules: none.

Larvae
- Hatching occurs at 4–10 mm TL; eyes pigmented.
- Elongate with long straight gut; vent always posterior to dorsal fin.
- Preanal length 80% TL; preanal myomeres 47, becoming 41–46 at sizes >20 mm.
- Flexion occurs at 16–17 mm, and transformation at about 30 mm.
- Fin formation: pectoral forms first as bud but is not complete until transformation; dorsal forms at about 10 mm and anal at about 16 mm, both complete at transformation; principal caudal rays complete at about 20 mm; pelvic fin forms between 20 and 30 mm, and migrates posteriorly at transformation.
- Muscle-band striations obvious in posterior gut.
- Air bladder forms at 10–15 mm, but not noticeable until about 30 mm.
- Pigmentation: (see illustrations opposite).

Important characters:

- High myomere count; 8–9 myomeres between dorsal and anal fins decrease to 4 at 30 mm.
- Dorsal pigment present at notochord tip after yolk absorption, but variable; ventral pigment present at notochord tip.
- Late anal fin ray formation.

Note: (1) High myomere count and late anal fin formation are unique for Mid-Atlantic Bight clupeids.

(2) See *Mallotus villosus* (p. 62) for note on similar larvae.

Fig. — **A–C**, **E**, Krevanovsky 1956; **D**, Ehrenbaum 1909; **F**, Fage 1920 (all redrawn).

Ref. — Russell 1976; Jones *et al.* 1978.

Clupea harengus CLUPEIDAE

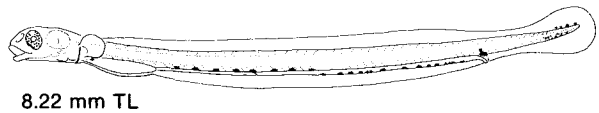
A

6.25 mm TL

Dorsal and ventral pigment at notochord tip after yolk absorption

Single streak of pigment on midline of isthmus

B



8.22 mm TL

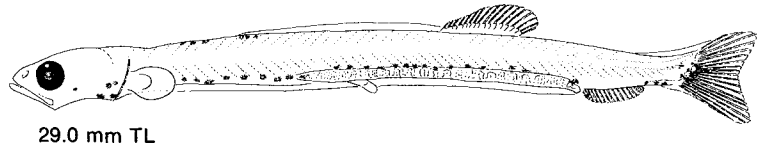
Gut pigment: dorsal spots anterior half, ventral spots posterior half (changes later to only dorsal pigment)

C

20.2 mm TL

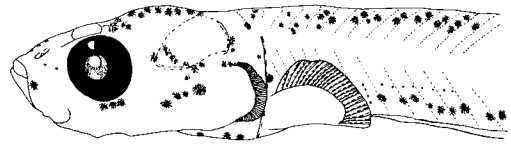
Large spots near vent and at caudal base

D



29.0 mm TL

E

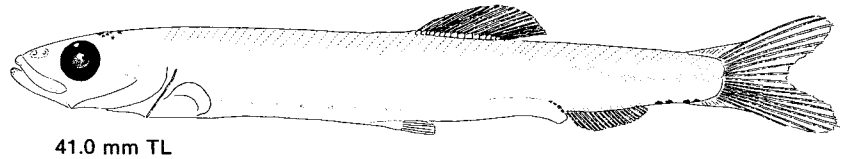


29.0 mm TL

Pigment increasing on head and dorso-lateral region

Dorsal fin origin migrates anteriorly from myomere 33 at 26 mm to myomere 25 at 55 mm

F



41.0 mm TL

A–E (eastern Atlantic material); **F** (Mediterranean specimen).

CLUPEIDAE *Etrumeus teres* (DeKay)

Spawning: Winter-spring in Gulf of Mexico.

Eggs
- Pelagic, spherical.
- Diameter: 1.17–1.53 mm.
- Shell: smooth, transparent and thick.
- Yolk: segmented.
- Perivitelline space: narrow (10% of diameter).
- Oil globules: none.

Meristic features

Myomeres: 48–50
Vert : 15–17+32–34
D : 16–22
A : 10–12
Plv : 8
C : 6–7+10+9+6

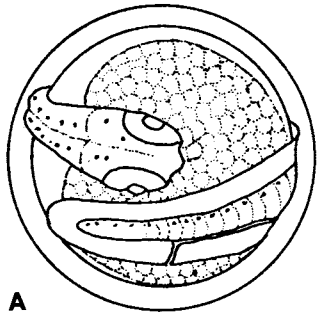
Larvae
- Hatching occurs at 3.8–4.8 mm TL; eyes unpigmented.
- Body elongate with long straight-gut; vent always posterior to dorsal fin.
- Teeth apparent at about 6 mm TL; snout long and pointed in larvae >7 mm.
- Preanal myomeres 42, predorsal myomeres 25–35.
- Flexion occurs at 8–10 mm SL, and transformation at 30–33 mm TL.
- Fin formation: pectorals present as buds very early but not complete until transformation; dorsal, anal and caudal fins form next, and dorsal migrates anteriorly; pelvic fin forms late (25–30 mm) and migrates posteriorly.
- Muscle-band striations obvious in posterior gut.
- No air bladder.
- Pigmentation: (see illustrations opposite).

Important characters:
- Myomeres between dorsal and anal fins decrease from 5 in early larvae to 2 at transformation.
- Dorsal pigment at notochord tip absent after yolk absorption; ventral pigment at notochord tip forms early.
- Early teeth formation, and long pointed snout.
- Low anal fin ray count.

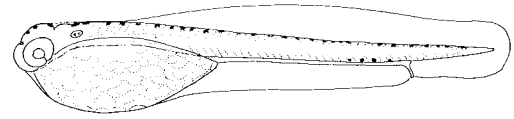
Fig. — **A**, O'Toole and King 1974; **B–C**, Mito 1961a; **D, F**, Uchida *et al.* 1958; **E**, Houde and Fore 1973; **G–H**, Hildebrand 1963 (**B**, **C**, **E**, **F** redrawn).

Ref. — E. D. Houde 1981 (pers. comm.).

Etrumeus teres CLUPEIDAE

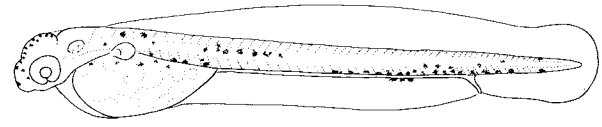


A



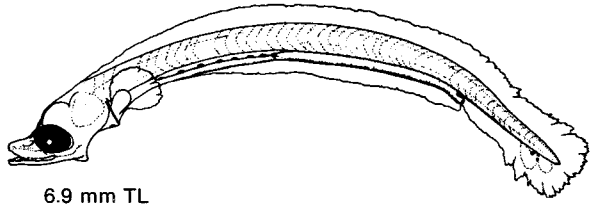
B

4.8 mm TL



C

5.7 mm TL



D

6.9 mm TL

About 8 large spots on each side of anterior gut.

E

8.5 mm TL

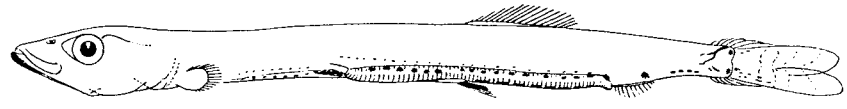
Small spots in double row on posterior gut

Spot at tip of lower jaw in some

F

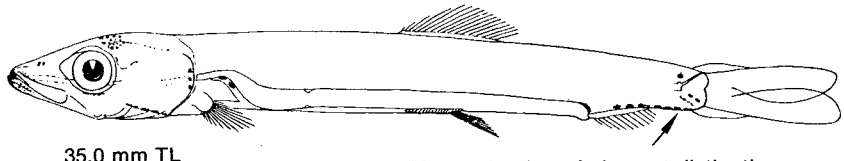
15.3 mm TL

Large spot over anus



G

27.5 mm TL



H

35.0 mm TL

Diagonal stripe of pigment distinctive

A (southeastern Atlantic); **B–D**, **F** (Pacific material).

CLUPEIDAE *Jenkinsia lamprotaenia* (Gosse)

Spawning: Unknown.

Meristic features

Myomeres: 38-(39-41)-42
Vert : 19-21+19-21
D : 10-13
A : 13-15
Plv : 8
C : 4+10+9+3

Eggs — Undescribed.

Larvae — Body elongate with long straight gut >70% SL; vent always posterior to dorsal fin.
— Preanal myomeres 32-33 at 12 mm decrease to 27 at 15 mm.
— Flexion occurs at 8-9 mm, and transformation at 12-15 mm.
— Fin formation: caudal forms first and is complete at 8-9 mm; dorsal and anal fins complete at 10 mm; pelvic fins appear at 10 mm and are complete at 15 mm; pectoral fins last to complete development.
— Muscle-band striations not well developed in hindgut.
— Pigmentation: (see illustrations opposite).

Important characters:

— Low myomere count; myomeres between dorsal and anal fins: 0 until transformation, and then 8-9.
— Dorsal pigment present at notochord tip; ventral pigment forms early at notochord tip.
— Low procurrent ray count (4 dorsal, 3 ventral), formed at 16 mm.

Note: (1) Among western North Atlantic clupeids, only *Jenkinsia* and *Harengula* (p. 34) have fewer than 44 myomeres.

(2) Ventral pigment at notochord tip forms early in *Jenkinsia* and *Etrumeus* (p. 28) but late in *Harengula* (p. 34). *Jenkinsia* lacks pointed snout and early teeth development characteristic of *Etrumeus*.

(3) *Jenkinsia* larvae have not yet been found in Mid-Atlantic Bight samples; they may be epibenthic or semi-planktonic, floating with debris.

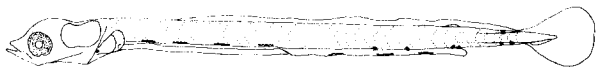
Fig. — **A-F**, Powles 1977.

Jenkinsia lamprotaenia CLUPEIDAE

Paired, elongate pigment spots dorsal to foregut, ventral to hindgut

Dorsal peduncle pigment variable

A



5.8 mm SL

Spot at pectoral fin base remains throughout larval development

2–3 ventral spots at notochord tip develop early

Spot on hindbrain remains throughout larval development

B

8.6 mm SL

C

Dorsal spot at notochord tip throughout larval development

9.4 mm SL

Spot behind eye and pair of spots on top of head remain throughout larval development

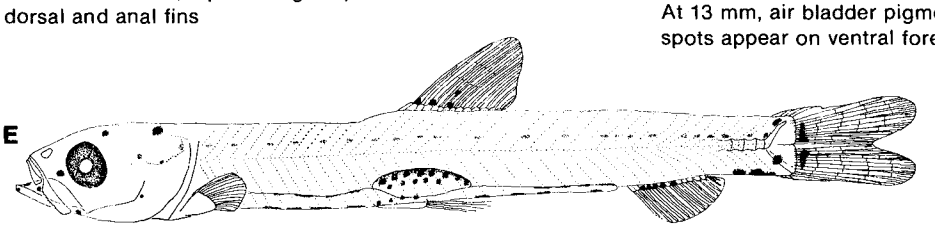
D

12.5 mm SL

At transformation, rapid change in position of dorsal and anal fins

At 13 mm, air bladder pigmented dorsally, spots appear on ventral foregut

E

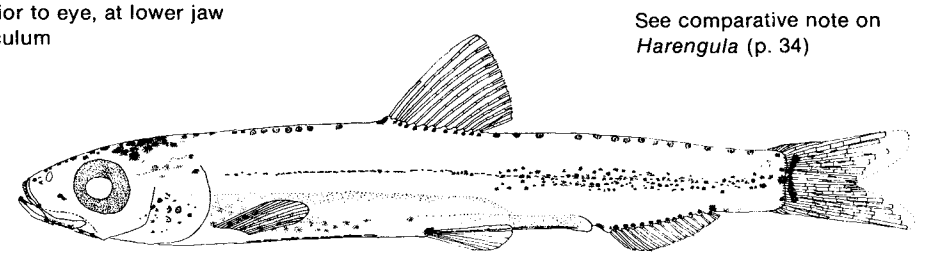


15.2 mm SL

Spots appear anterior to eye, at lower jaw angle and on operculum

See comparative note on *Harengula* (p. 34)

F



22.7 mm SL

Increase in pigment on head and opercle

CLUPEIDAE *Opisthonema oglinum* (Lesueur)

Spawning: Spring-summer off North Carolina.

Eggs
- Pelagic.
- Diameter: 1.08–1.31 mm.
- Shell: smooth, thin and clear.
- Yolk: lightly segmented.
- Perivitelline space: wide.
- Oil globules: 1.
- O.G. diameter: 0.12–0.16 mm.

Meristic features

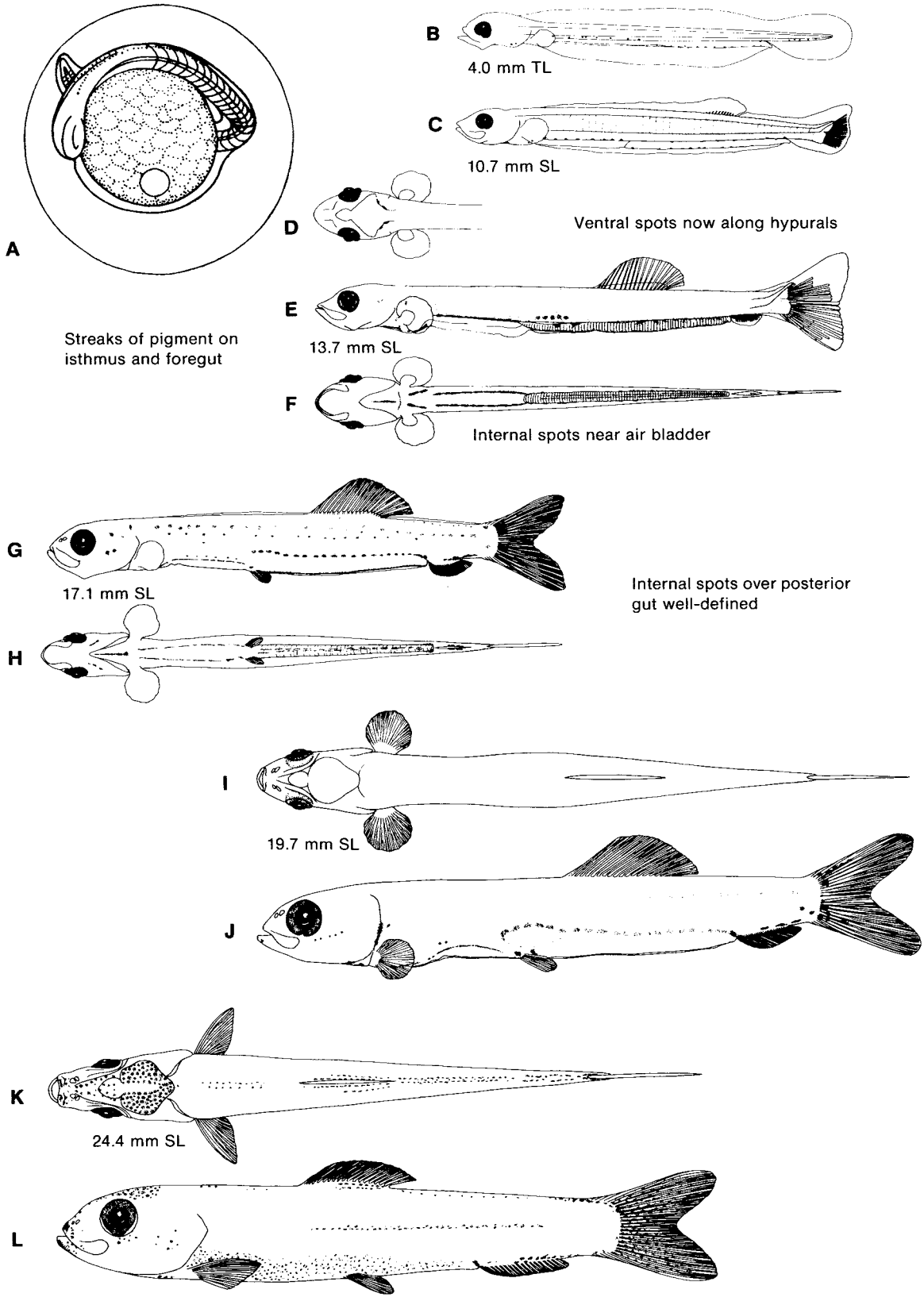
Myomeres: 45–49
Vert : 12–13+32–36
D : 17–22
A : 20–25
Plv : 8–9
C : 9+10+9+6–7

Larvae
- Paired dorsolateral series of spots on embryo just before hatching; eyes unpigmented.
- Body elongate with long straight gut, 86–91% SL before flexion decreasing to 75% SL in juveniles; vent always posterior to dorsal fin.
- Preanal myomeres decrease from 38 at 15 mm to 34 at 54 mm.
- Flexion occurs at 10 mm SL, and transformation at 15–25 mm SL.
- Fin formation: pectoral forms first as bud but is not complete until 23–25 mm; caudal complete at 10 mm; dorsal and anal fins complete at 25–30 mm; pelvic fin last to form at 14 mm SL and not complete until >50 mm SL.
- Muscle-band striations obvious in posterior gut.
- Air bladder present but not obvious until transformation.
- Pigmentation: in 4.0 mm larvae, spots on ventral midline under pectoral fins and posterior to anus, double row along hindgut, and dorsolateral row on each side of foregut (see illustrations opposite).

Important characters:
- Myomeres between dorsal and anal fins decrease from 8–10 in larvae <16 mm to 5–7 at 17–25 mm.
- Predorsal myomeres decrease from 25 to 15.
- Dorsal pigment absent from notochord tip, but ventral pigment present.
- High anal fin ray count.

Fig. — **A-L**, Richards *et al.* 1974.

Opisthonema oglinum CLUPEIDAE



CLUPEIDAE *Sardinella aurita* Valenciennes

Spawning: September–February off Florida.

Eggs
- — Pelagic, spherical.
- — Diameter: 0.94–1.40 mm.
- — Shell: smooth, transparent and thin.
- — Yolk: segmented.
- — Perivitelline space: moderate.
- — Oil globules: 1.
- — O.G. diameter: 0.12–0.16 mm.

Meristic features

Myomeres: 45–48
Vert : 16+29–31
D : (15)16–19(20)
A : (14)16–17(19)
Plv : 8–10
C : 8+10+9+7

Larvae
- — Hatching occurs at about 3 mm.
- — Body elongate with long straight gut; vent posterior to dorsal fin.
- — Flexion occurs at about 11 mm TL, and transformation at about 25 mm TL.
- — Last 2 anal rays become elongate in larger larvae.
- — Larvae uncommon north of Cape Hatteras.

Important characters:

- — Myomeres between dorsal and anal fins 5–8; predorsal myomeres decrease from 28 to 24.
- — Dorsal pigment absent from notochord tip, but ventral pigment present.
- — Anal fin ray count lower than in *Opisthonema* (p. 32).

Harengula jaguana Poey

Spawning: February–July off Florida

- — Pelagic, spherical.
- — Diameter: 1.55–2.00 mm (large).
- — Shell: smooth and thin.
- — Yolk: segmented.
- — Perivitelline space: wide (58% of diameter).
- — Oil globules: 1.
- — O.G. diameter: 0.07–0.10 mm (small).

Meristic features

Myomeres: 39–42
Vert : 12–14+27–29
D : 17–19
A : 17–18
Plv : 7–8
C : 8–9+10+9+7

Larvae
- — Hatching occurs at 2.4 mm; eyes unpigmented.
- — Body elongate with long straight gut; vent posterior to dorsal fin.
- — Preanal length 90% at 12 mm SL and 75% at 32 mm SL.
- — Preanal myomeres 35 at 6 mm and 27 at 22 mm; predorsal myomeres 25 at 6 mm and 10 at 22 mm.
- — Flexion occurs at about 10–11 SL, and transformation at about 22–24 mm SL.
- — Dorsal fin complete at 14–16 mm; anal fin complete at 13–15 mm.
- — Pigmentation: (see illustrations opposite).

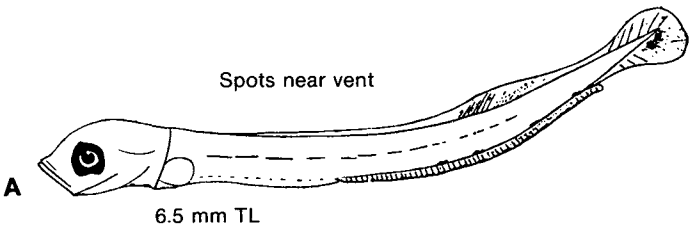
Important characters:

- — Low myomere count; myomeres between dorsal and anal fins 5–7.
- — Dorsal pigment present at notochord tip; ventral pigment at notochord tip usually forms late (later than in *Jenkinsia*) but is variable in early larvae and may be present.

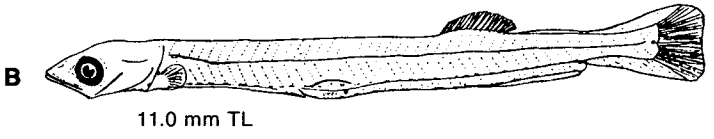
Fig. — **A–C**, Fage 1920; **D–F**, Houde *et al.* 1974 (all redrawn).

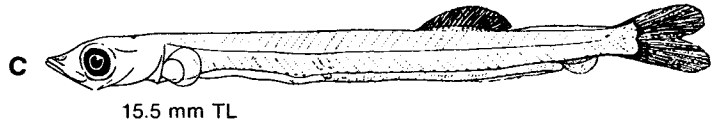
Ref. — Simpson and Gonzalez 1967; Gorbunova and Zvyagina 1975; Matsuura 1972, 1975; E. D. Houde 1981 (pers. comm.).

Sardinella aurita — CLUPEIDAE



In young larvae, ventral spots at notochord tip





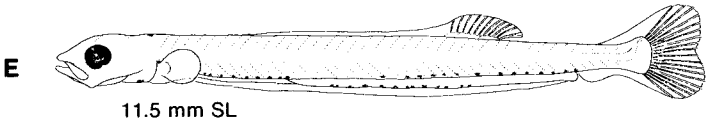
Harengula jaguana

Head pigment sparse at less than 15 mm

Dorsal spots at notochord tip, lacking in *Opisthonema oglinum*, *Etrumeus teres* and *Sardinella aurita*

Spots at cleithral symphysis retained throughout larval development

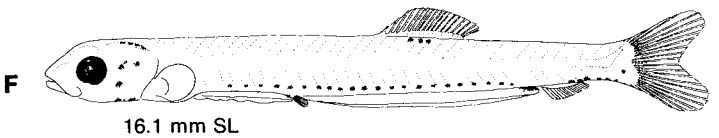
2 spots form near vent, from which an internal row of pigment develops dorsal to hindgut



Spots on caudal ray bases

Gut pigment: dorsal surface of foregut, ventral surface of hindgut

Spots on dorsal and anal bases and on postanal ventral midline, form later than similar spots in *Jenkinsia lamprotaenia* (p. 30)



Spot at base of pelvic fin

A-C (Mediterranean material)

ENGRAULIDAE *Anchoa hepsetus* (Linnaeus)

Spawning: Spring-summer.

Eggs
- Pelagic elliptical.
- Diameter: long axis 1.20–1.66 mm, and short axis 0.70–0.94 mm.
- Sheli: smooth and transparent.
- Perivitelline space: narrow.
- Oil globules: none.

Meristic features

Myomeres:	40–44
Vert :	21–22+20–21
D :	13–17
A :	18–23
P :	13–17
C :	7+9+10+9+7–8

Larvae
- Hatching occurs at 3.6–4.0 mm.
- Body long and slender, with vent under dorsal fin.
- Yolk tapers posteriorly.
- Mouth large, terminal, extends to middle of eye; becomes subterminal.
- Flexion occurs between 5 and 10 mm.
- Fin formation: caudal, dorsal and anal fins develop at same time; pectoral forms early as a bud but is not complete until late; pelvic forms late.
- Gut with muscle-band striations posteriorly.
- Little pigment.
- Overlapping dorsal and anal fins (good character after ray formation).

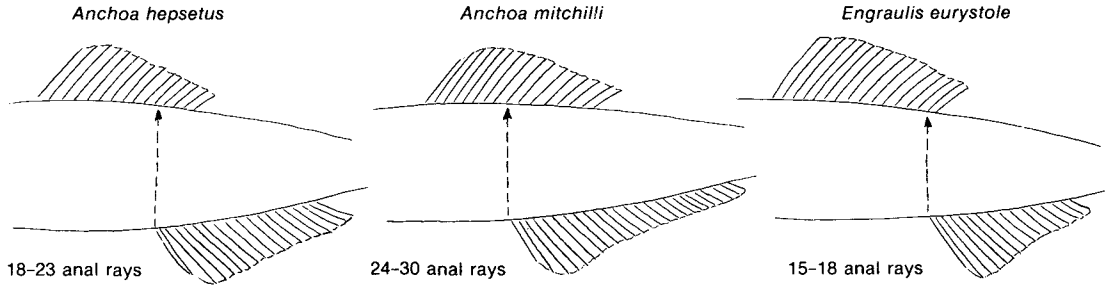
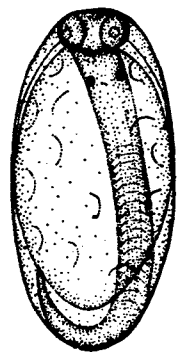


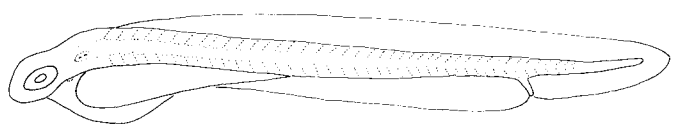
Fig. — **A–C**, Hildebrand and Cable 1930; **D**, Lippson and Moran 1974 (**B–D** redrawn).

Anchoa hepsetus ENGRAULIDAE

A



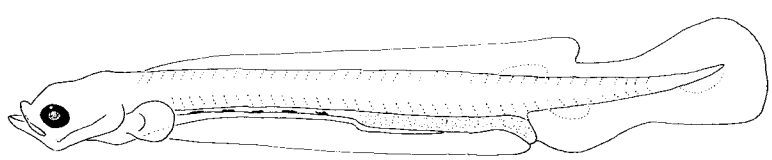
B



3.6 mm TL

No pigment

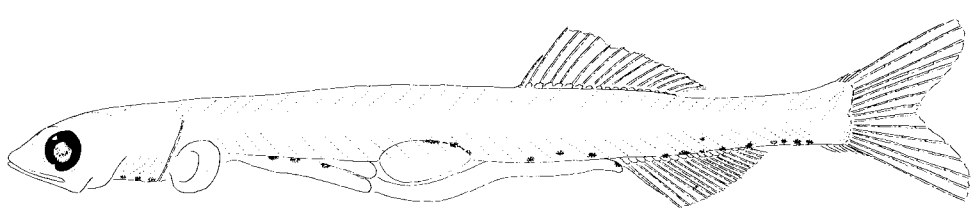
C



5.6 mm TL

5 elongate spots on gut

D



15.0 mm TL

Few ventral spots

Ventral spots behind anal base

ENGRAULIDAE *Anchoa mitchilli* (Valenciennes)

Spawning: Late April to September in Mid-Atlantic Bight.

Eggs
- Pelagic, barely elliptical.
- Diameter: long axis 0.84–1.11 mm.
- Shell: smooth and transparent.
- Yolk: segmented.
- Perivitelline space: narrow.
- Oil globules: none.

Meristic features

Myomeres:	38–44
Vert :	19+21–22
D :	13–17
A :	24–30
P :	10–13
C :	9+10+9+7–8

Larvae
- Hatching occurs at 1.8–2.7 mm (smaller than other engraulids).
- Body long and slender, with vent under dorsal fin.
- Yolk tapers posteriorly.
- Mouth large, terminal, extends to middle of eye; becomes subterminal.
- Flexion occurs at 7–8 mm, and transformation at about 20 mm.
- Fin formation: caudal, dorsal and anal fin develop at same time; pectoral forms as a bud but is not complete until late; pelvic forms late.
- Gut with muscle-band striations posteriorly.
- Little pigment, but somewhat more extensive than shown in illustrations opposite.
- Overlapping dorsal and anal fins (good character after ray formation).

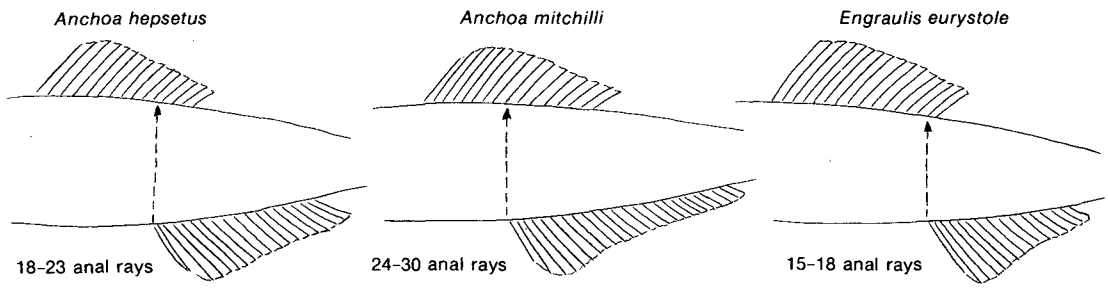
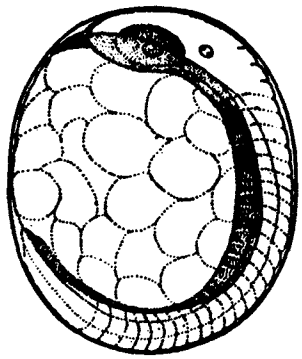


Fig. — **A**, **B**, **D**, Kuntz 1915; **C**, Lippson and Moran 1974; **E**, Mansueti and Hardy 1967; **F**, Fowler 1945 (**B–F** redrawn).

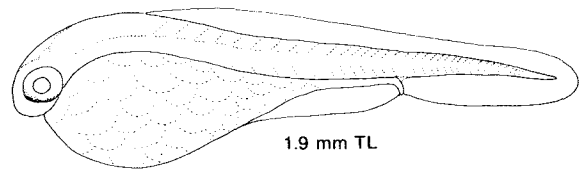
Ref. — E. D. Houde 1982 (pers. comm.)

Anchoa mitchilli ENGRAULIDAE

A

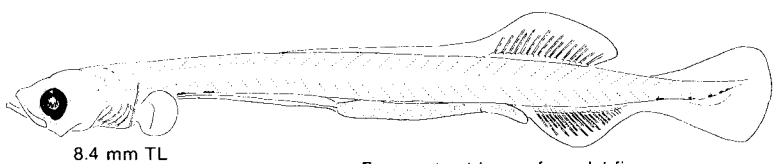


B



1.9 mm TL

C



8.4 mm TL

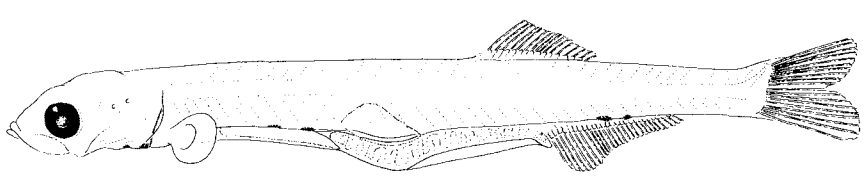
Few spots at base of caudal fin

D

10.0 mm TL

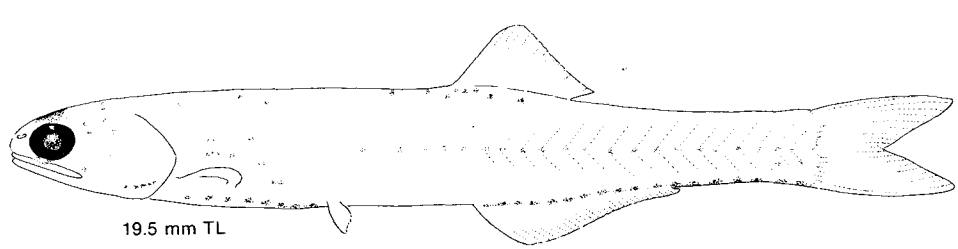
Few ventral spots

E



12.0 mm TL

F



19.5 mm TL

ENGRAULIDAE *Engraulis eurystole* (Swain and Meek)

Spawning: July and August.

Meristic features

Myomeres: 43–45
Vert : 26+18
D : 13–16
A : 15–18
P : 14–16
C : 10+9

Eggs
- Pelagic, elliptical.
- Diameter: long axis 1.02–1.25 mm, and short axis 0.50–0.80 mm.
- Shell: smooth and transparent.
- Yolk: segmented.
- Perivitelline space: narrow.
- Oil globules: none.

Larvae
- Hatching occurs at 2–3 mm TL.
- Body long and slender, with vent under dorsal fin.
- Yolk tapers posteriorly.
- Mouth large, terminal, extends to middle of eye; becomes subterminal.
- Fin formation: caudal, dorsal and anal fins develop early and at the same time; pectoral forms early as a bud but is not complete until late; pelvic forms late.
- Gut with muscle-band striations posteriorly.
- Air bladder prominent in larger sizes (not illustrated).
- Pigment increases with development (see illustrations opposite).
- Overlapping dorsal and anal fins (good character after ray formation).

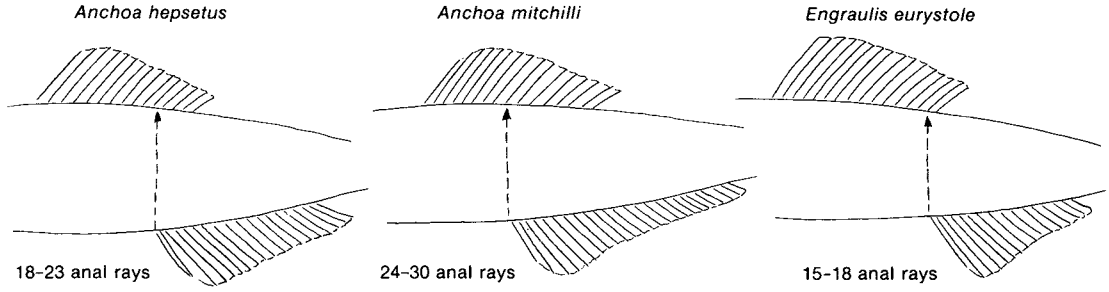
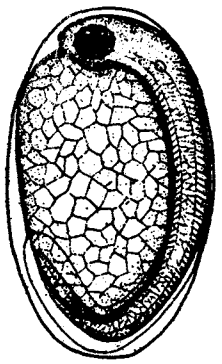


Fig. — **A–D**, Kuntz and Radcliffe 1917; **E**, Lippson and Moran 1974 (**B–E** redrawn).

Ref. — Markle *et al.* 1980.

Engraulis eurystole ENGRAULIDAE

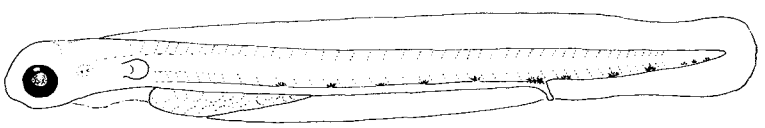
A



B

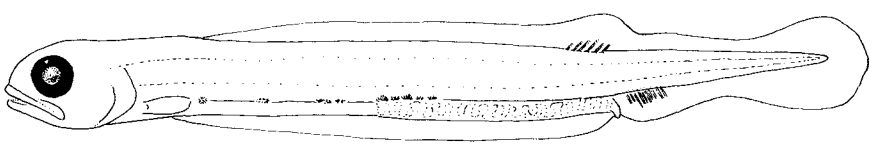
3.2 mm TL

C



3.4 mm TL

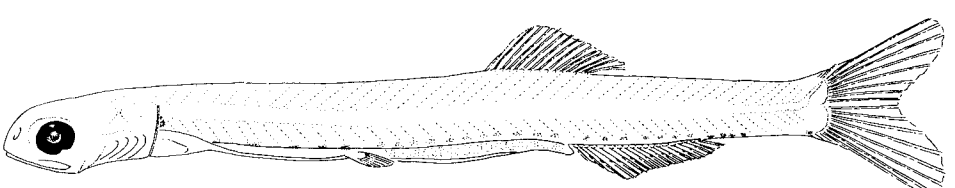
D



5.2 mm TL

Row of elongate spots forms medially on isthmus

E



22.8 mm TL

In larger specimens, spots form on head, along lateral midline, on caudal rays and dorsal peritoneum.