Pleuronectiformes

Meristic characters in species belonging to the order Pleuronectiformes whose adults or larvae have been collected in the study area. Classification follows Hensley and Ahlstrom (1984) and Cooper and Chapleau (1998). See caudal fin ray formulae on following pages, and species accounts for sources of other data.

Family *Species*	Vertebrae	Dorsal Fin Rays	Anal Fin Rays	Pectoral Fin Rays	Pelvic Fin Rays
Scophthalmidae					
Scophthalmus aquosus	11+23–25	63–73	46–56	11	6/6
Bothidae					
Bothus ocellatus	10+25–27	76–91	58–68	8–10 [2]	6/6
Chascanopsetta danae	16+39	125	89	14 [2]	6/6
Engyophrys senta	10+27–29	71–85	60–69	8–10 [2]	6/6
Monolene sessilicauda	10–11+35–38	92–109	76–89	11–14[2]	6/6
Trichopsetta ventralis	10+30–31	89–95	69–75	12–13	6/6
Trichopsetta orbisculus	10+30	91–92	70–73	12	6/6
Paralichthyidae					
Ancylopsetta quadrocellata	10–11+25–27	67–76	54–61	10–12	6/6
Citharichthys arctifrons	10–11+26–28	75–87	58–71	9–11	6/6
Citharichthys cornutus	10+25–26	74–83	59–66	10–11	6/6
Citharichthys dinoceros	10–11+26–29	90–95	70–76	9–10	6/6
Citharichthys gymnorhinus	10+23–24	70–77	51–61	–	5/6[1]
Citharichthys spilopterus	10+23–25	73–85	55–63	9–10	6/6
Cyclopsetta fimbriata	10+26–27	78–87	59–67	11–12	6/6
Etropus crossotus	10+25	75–87	58–68	8–10	6/6
Etropus microstomus	10+24–25	67–84	50–63	9–12	6/6
Etropus rimosus	10+24–25	74–83	57–63	8–11	6/6
Hippoglossina oblonga	11+30–31	71–86	58–72	10–12	6/6
Paralichthys albigutta	10+27	71–85	53–63	10–11	6/6
Paralichthys dentatus	11+30–31	80–96	61–73	12–13	6/6
Paralichthys lethostigma	10–11+27–28	80–95	63–74	11–13	6/6
Syacium micrurum	10+24–25	83–92	64–74	10–11	6/6
Syacium papillosum	10+25–26	79–94	62–75	11–12	6/6
Pleuronectidae					
Glyptocephalus cynoglossus	11–12+45–47	97–117	86–102	9–13	6/6
Hippoglossoides platessoides	13–14+32–35	78–98	60–79	9–12	6/6
Hippoglossus hippoglossus	16+34–35	98–106	69–84	15–17	6/6
Limanda ferruginea	10–12+30–33	73–91	51–68	10	6/6
Pleuronectes putnami	34–38	48–59	35–41	10–11	6/6
Pseudopleuronectes americanus	10+26	60–76	44–58	10–11	6/6
Reinhardtius hippoglossoides	17–19+43–45	92–104	66–80	13–15	6/6
Poecilopsettidae					
Poecilopsetta beani	10+31–32	63–68	54–56	10	6/6
Achiridae					
Achirus lineatus	25–27	47–58	35–44	4–6[2]	5/5
Gymnachirus melas	9+26–27	60–71	44–51	None[3]	5/5
Trinectes maculatus	9+19–20	50–56	36–46	None[3]	5/5
Cynoglossidae					
Symphurus billykrietei	50–53	89–95	76–84	None[3]	4[2]
Symphurus civitatium	46–50	86–93	70–78	None[3]	4[2]
Symphurus marginatus	51–56	93–104	80–89	None[3]	4[2]
Symphurus minor	41–44	69–81	55–64	None[3]	4[2]
Symphurus nebulosus	57–60	105–113	91–98	None[3]	4[2]
Symphurus plagiusa	47–51	89–97	73–81	None[3]	4[2]
Symphurus pusillus	47–49	83–88	71–75	None[3]	4[2]

[1] Five rays in left-side fin
[2] Ocular side fin only; blind-side fin lost at transformation
[3] Pectoral fins lost at transformation

Pleuronectiformes

Larval Characteristics

- Larval stage can be prolonged; some reach large size before transformation
- Midbrain typically protrudes dorsally to varying degrees
- Gut coiled, bulges out from body outline
- Preanus length usually <50% Body Length
- Dorsal and anal fins usually long-rayed and long-based, with high fin ray counts
- Dorsal fin extends from head to base of caudal fin
- Other special characters found in some taxa include elongate rays, spines on head, preopercle, opercle, scales
- Body symmetrical and compressed laterally, then a marked transformation during which one eye migrates to other side of head, gut is pulled into body outline, pectoral fin shrinks and forms rays (or is lost), and pigment increases on eyed (ocular) side

Family Differences

	Scophthalmidae Bothidae Paralichthyidae	Pleuronectidae Poecilopsettidae	Soleidae Achiridae	Cynoglossidae
Oil globules	1 to 2–3	None	Multiple	Multiple
Elongate rays	Often	None	Possible	Possible
Preanus length	About 50% TL (decreases)	About 40% TL (most)	40–50% TL	About 40% TL
Protruding midbrain	Slight (most)	Slight (most)	Prominent	Prominent
Mouth	Terminal	Terminal	Lateral	Oblique, twisted
Eye migration	Right to left	Left to right	Left to right	Right to left
Transformation size	Most <15 mm	18–35 mm[1] 7–16 mm[2]	3–5 mm	About 10 mm

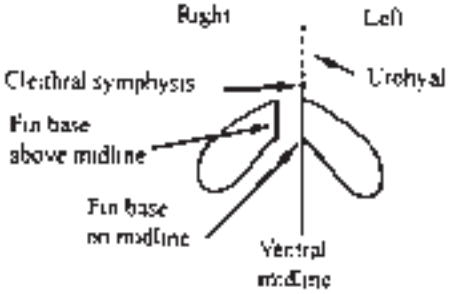
[1] Boreal-temperate species
[2] Temperate species

References: Kyle, 1913; Norman, 1934; Nichols, 1971; Fahay, 1983; Ahlstrom *et al*., 1984a; Hensley and Ahlstrom, 1984

Pleuronectiformes

Position of pelvic fins in pleuronectiform genera, beginning in flexion stage larvae

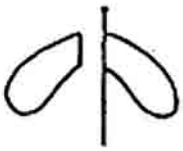
Key (ventral view)



Bothus: Left pelvic fin base longer than right; left origin on urohyal; left base on midline, right base above midline

Engyophrys, Trichopsetta, Monolene: Left pelvic fin base slightly longer than right; left origin slightly anterior to cleithral symphysis, right origin at cleithral symphysis; left base on midline, right base above midline

Cyclopsetta: Left and right pelvic fin bases equal; both origins posterior to cleithral symphysis; left base on midline, right base above midline



Symphurus: Right pelvic fin lost at transformation; left base posterior to cleithral symphysis; left base on midline

Poecilopsettidae: Same as Pleuronectidae
Scophthalmus: Both pelvic fin bases long; both origins on urohyal; left base on midline, right base above midline

Paralichthys, Hippoglossina: Left and right pelvic fin bases equal; both origins posterior to cleithral s0.300both bases above midline

Syacium, Etropus, Citharichthys: Left pelvic fin base longer than right; right origin anterior to left; both origins posterior to cleithral symphysis; left base on midline, right base above midline

Pleuronectidae (all genera): Left and right pelvic fin bases equal; both origins posterior to cleithral symphysis; both bases above midline

***Trinectes, Achirus*:** Right pelvic fin base longer than left; right origin anterior to left; right base on midline, left base above midline

References: Norman, 1934; Gutherz, 1967; Futch and Hoff, 1971; Richardson and Joseph, 1973; Futch, 1977; Hensley, 1977; Fahay, 1983

Pleuronectiformes

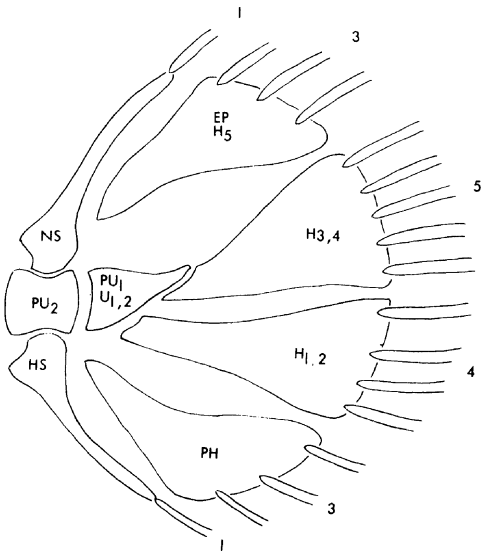
Larval characters in two left-eyed flounder families

	Paralichthyidae	Bothidae
Body	Relatively thick and short	Thin and diaphanous
Transformation size	< 15 mm	> 15 mm
Air bladder disappears	During transformation	Before transformation
Eye migrates	Anterior to dorsal fin origin (except *Cyclopsetta*)	Under dorsal fin origin (including *Cyclopsetta*)
Head spines	Opercle; sometimes post-temporals and frontals	Absent, or only urohyal, basipterygia, cleithra, otic
Elongate fin rays	0–11 anterior dorsal fin, usually in pigmented sheath	1st or 2nd dorsal fin ray; seldom in pigmented sheath
Pigment	Relatively heavy	Relatively light
Posterior basipterygium process	Short	Long, extending almost to vent

Caudal fin formulae in genera of the families Bothidae and Paralichthyidae

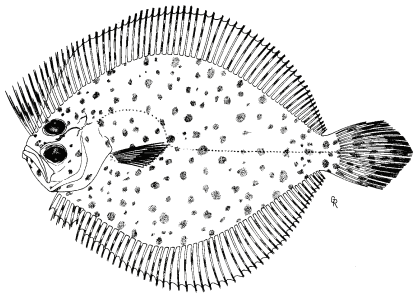
Counts are ventral to dorsal. Each number indicates number of principal rays associated with the haemal spine of PU_2 (second preural centrum), each of four hypural elements (four hypurals plus one epural in *Paralichthys* and *Hippoglossina* where the H5 and EP are not fused), and the neural spine of PU_2.

Genus	Caudal Formula
Paralichthys	1 2 5 6 2 1 1
Hippoglossina	1 3 4 5 3 1 1
Citharichthys	0 4 4 5 4 0
Etropus	0 4 4 5 4 0
Syacium	0 4 4 5 4 0
Cyclopsetta	0 4 4 5 4 0
Bothus	1 4 3 4 4 1
Engyophrys	1 3 4 5 3 1 (illustrated)
Trichopsetta	1 3 4 5 3 1 (illustrated)
Monolene	1 3 4 5 3 1 (illustrated)



References: Woolcott *et al*. 1968; Gutherz, 1970; Richardson and Joseph, 1973; Evseenko, 1977a; Futch, 1977; Hensley, 1977; Fahay, 1983

Scophthalmus aquosus (Mitchill, 1815)
Scophthalmidae
Windowpane



Range: Western North Atlantic Ocean from Gulf of St. Lawrence to Florida

Habitat: Sand or mud substrates in coastal ocean and embayments, in depths to 200m, mostly <55m

Spawning: Protracted season; spring through fall, with peak during summer on Georges Bank; split spawning season in southern part of Middle Atlantic Bight (spring and fall)

Meristic Characters

Myomeres:	34–36
Vertebrae:	11+23–25=34–36
Dorsal fin rays:	63–73
Anal fin rays:	46–56
Pectoral fin rays:	11
Pelvic fin rays:	6/6
Caudal fin rays:	17 (total)

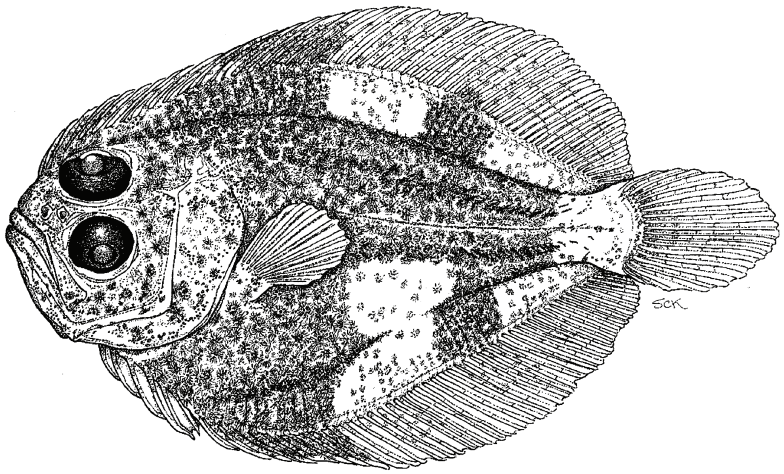
Eggs:
- Pelagic, spherical
- Diameter: 0.88–1.22 mm
- Chorion: smooth
- Yolk: homogeneous
- Oil globule: single or multiple; diameter 0.14–0.30 mm (when single)
- Perivitelline space: narrow
- Hatching length: about 2.0 mm

Larvae:
- Body deep and compressed, especially in gut area
- Preanus length <50% TL
- Flexion begins at about 5.5 mm
- Sequence of fin ray formation: C, D, A, $P_2 - P_1$
- Pelvic fins unequal in size, both bases long, with left longer; both origins on urohyal; left base on ventral midline, right base above midline
- Early larvae heavily pigmented from head to mid-tail, with posterior 1/3 unpigmented
- Later larvae form bars of pigment that extend onto fins
- Strong contrast between pigmented and unpigmented areas (compare to *Tautoga onitis* and *Hippoglossina oblonga* larvae)
- Transformation begins at about 6.5 mmTL

Position of pelvic fins

Early Juvenile:

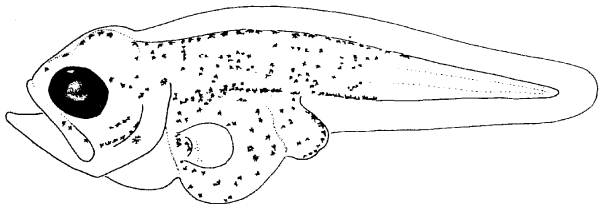
E. 12.5 mmSL



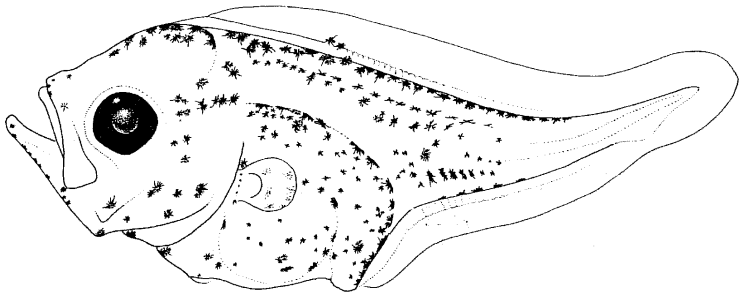
Figures: Adult: Grady Reinert (Gutherz, 1967); **A**: Perlmutter, 1939; **B–C**: Bigelow and Schroeder, 1953 (A–C redrawn); **D**: A. J. Lippson (Martin and Drewry 1978); **E**: Susan Kaiser (Able and Fahay, 1998)

References: Elliott and Jimenez 1981; Markle and Frost, 1985; Neuman and Able., 1998; Able and Fahay, 1998

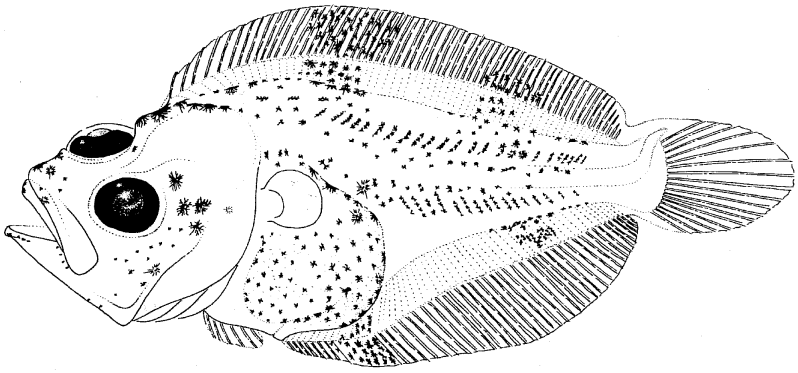
Scophthalmus aquosus



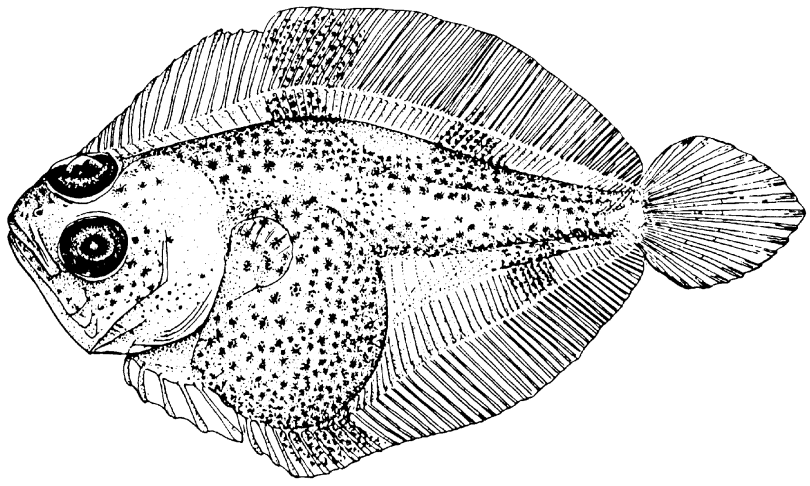
A. 2.9 mmTL



B. 5.5 mmTL

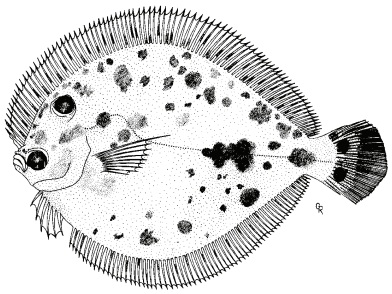


C. 8.0 mmTL



D. 13.0 mmTL

Bothus ocellatus (Agassiz, 1831)
Bothidae
Eyed flounder



Range: Western North Atlantic Ocean, in coastal waters from Long Island to Brazil, including Bermuda, the Bahamas and Caribbean Sea

Habitat: Clear shallow waters over sand bottoms, or in muddy or sandy bays

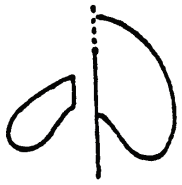
Spawning: Probably year-round with peaks in Jul and Dec, based on larvae

Eggs:
- Undescribed

Larvae:
- Blunt profile, with well-developed jaws
- Flexion occurs at 6–7 mm
- At about 14 mm, head length = 25% SL; preanus length = 26% SL; body depth = 59% SL
- First dorsal fin ray elongate at 3–13 mm
- Pigmentation: few melanophores on elongate dorsal fin ray; on caudal fin; on posterior dorsal and anal finfolds in early larvae
- No pigment (melanophores) present at sizes >10 mm
- Right eye migrates through head, under dorsal fin origin, at transformation
- Transformation occurs at sizes 9–42 mm, mostly 16–21 mm
- Larvae of this species, and those of 2 congeners, may drift north with Gulf Stream, as far as Scotian Shelf. See meristic characters for positive identification

Meristic Characters

Myomeres:	35–37
Vertebrae:	10+25–27=35–37
Dorsal fin rays:	76–91
Anal fin rays:	58–68
Pectoral fin rays:	8–10
Pelvic fin rays:	6/6
Caudal fin rays:	17 (total)

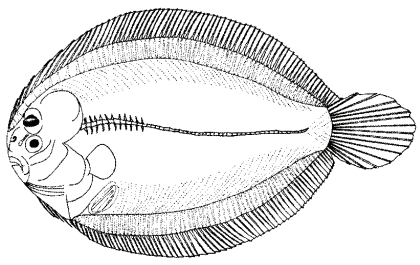


Postion of pelvic fins

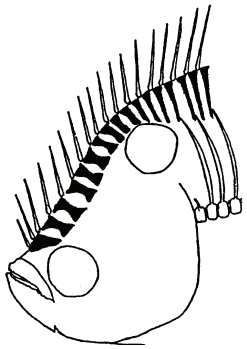
Species	Total Vertebrae	Caudal Vertebrae[1]	Dorsal Fin Rays	Anal Fin Rays	Supracranial Pterygiophores
Bothus ocellatus	35–37	26	76–91	58–68	13–15 (most 14)
Bothus robinsi	36–38	27	78–90	59–68	14–17 (most 15–16)
Bothus lunatus	40	30	91–99	71–76	–

[1] modal count

Note:
1. Characters in *B. ocellatus* and *B. robinsi* overlap broadly, but the number of supracranial pterygiophores, those situated anterior to the 1st neural spine (Fig. H), varies between these species and should be counted.



G. 19.0 mmSL (Transforming)

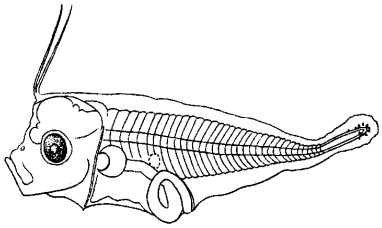


H. 79.0 mmSL

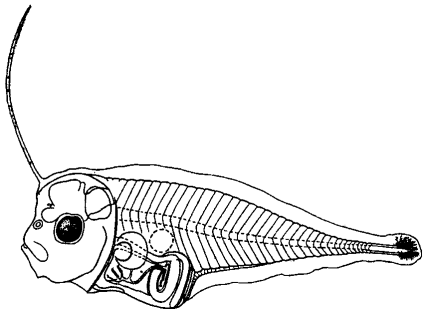
Figures: Adult: Grady Reinert (Gutherz, 1967); **A–D**, **F**: Evseenko, 1976; **E, G**: Jack Javech (Lara, 2006b); **H**: Evseenko and Nadtoka, 2003

References: Colton 1961; Evseenko, 1976; 1978; Evseenko and Nadtoka, 2003

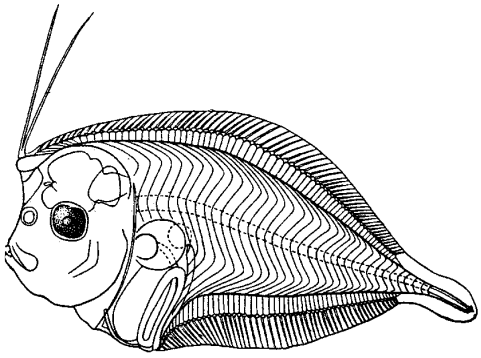
Bothus ocellatus



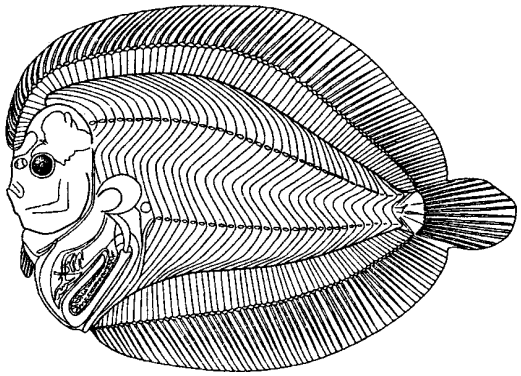
A. 3.7 mmNL



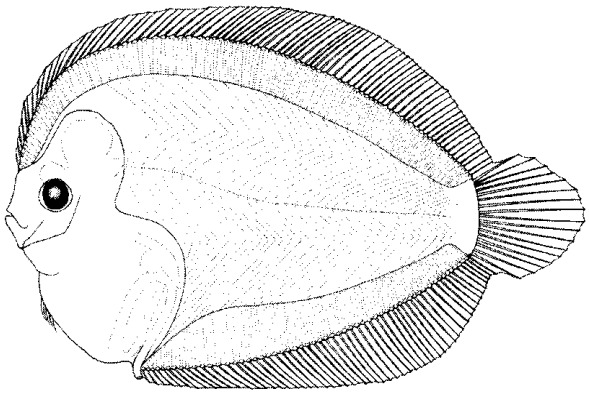
B. 4.5 mmNL



C. 5.3 mmNL

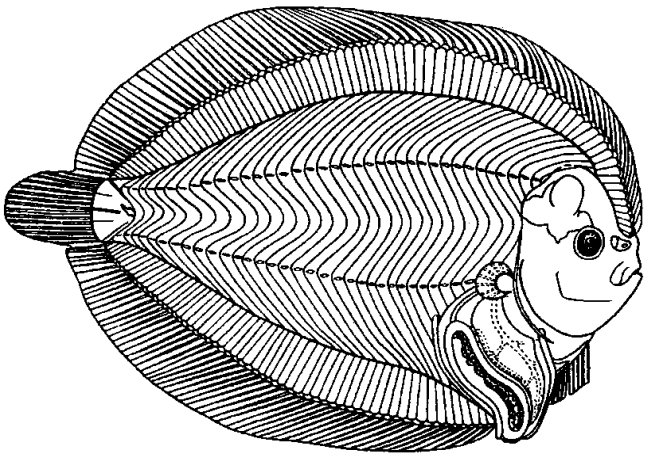


D. 11.8 mmSL



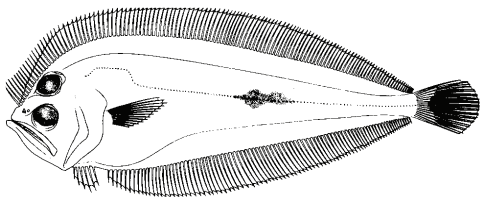
E. 14.0 mmSL

Head spines lacking



F. 16.2 mmSL
(Right Side)

Chascanopsetta danae Bruun, 1937
Bothidae
Angry pelican flounder



Range: Western North Atlantic ocean from 40°N to Straits of Florida, possibly southern part of Caribbean Sea and Antilles; replaced in Gulf of Mexico, Caribbean Sea and northeast coast of South America by *Chascanopsetta lugubris* Alcock, 1894

Habitat: Soft, muddy substrates on outer continental shelf and upper continental slope, in depths of 160–460 m

Spawning: Undescribed

Eggs: – Undescribed

Meristic Characters	
Myomeres:	55
Vertebrae:	16–18+37–39 = 54–56
Dorsal fin rays:	114–120
Anal fin rays:	80–87
Pectoral fin rays:	14
Pelvic fin rays:	6
Caudal fin rays:	17 (total)

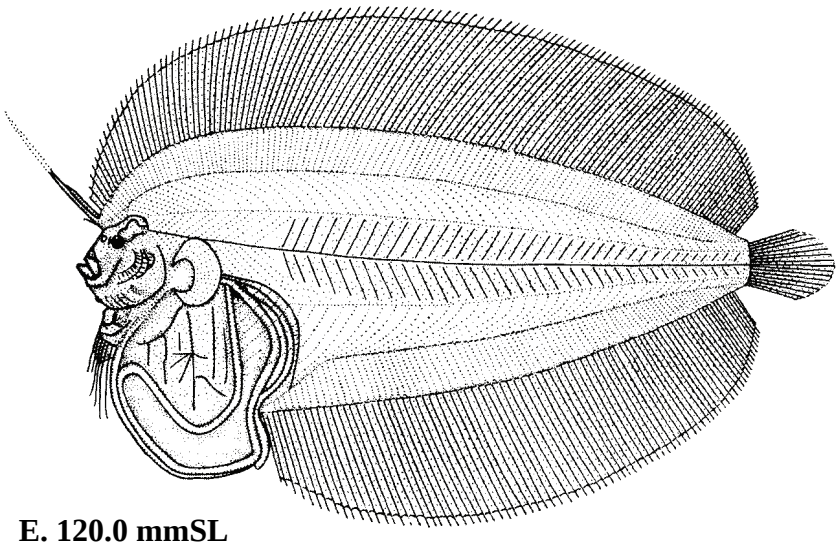
Larvae:
- Undescribed; description and illustrations based on larvae of a congener, *Chascanopsetta lugubris*, based on the assumption that they are similar to those of *C. danae*.
- Body initially elongate, gradually becoming deeper; gut tightly coiled, extends beyond ventral margin of body
- Preanus length decreases from 45% SL to 30% SL in large pelagic-juveniles
- Air bladder present on dorsum of gut in small larvae, becomes regressed at 25 mm
- Head very small
- Mouth, small, oriented obliquely
- Sequence of fin ray formation: D, A – C – P_2 – P_1
- Second dorsal fin ray elongate
- Pigmentation includes rows of small spots along bases of dorsal and anal fins; fine melanophores occur on posterior wall of gut cavity and become reduced in number from 6 to 2; fine melanophores along midline of body become embedded >15 mmSL; sheath of elongate dorsal fin ray may have few, small melanophores

Note: 1. Larvae of either species of *Chascanopsetta* may drift into the study area via the Gulf Stream. Larvae of *Chascanopsetta lugubris* have fewer dorsal fin rays (111–122) and fewer anal fin rays (76–85) than do larvae of *C. danae*.

Early Juvenile:

Note very large pre-transformation size. At 120 mm, the right eye has just begun to migrate dorsally.

There are 15 supracranial pterygiophores anterior to first neural spine

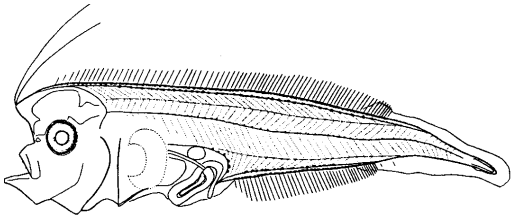


E. 120.0 mmSL

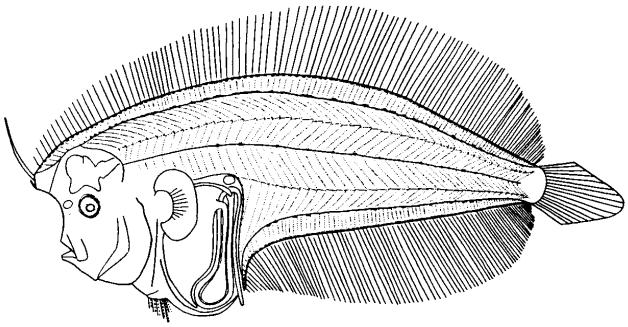
Figures: Adult: Grady Reinert (Gutherz, 1967); **A–D**: Ozawa and Fukui, 1986; **E**: Amaoka, 1971

References: Gutherz, 1967; Amaoka, 1971; Amaoka and Yamamoto, 1984; Fukui, 1997; Fukui *et al*., 2001; Munroe, 2002d; Lara, 2006b

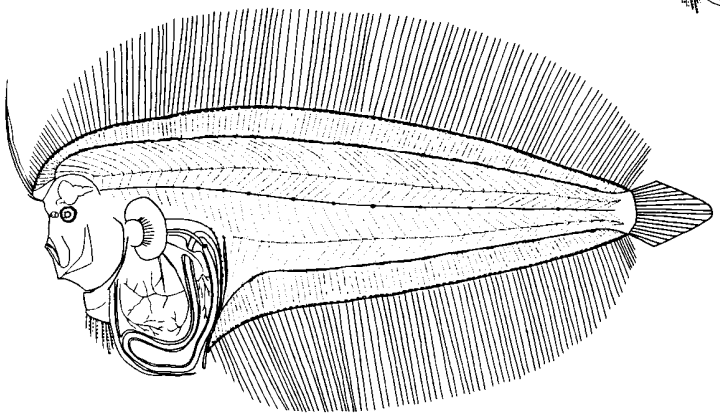
Chascanopsetta danae



A. 8.2 mmSL

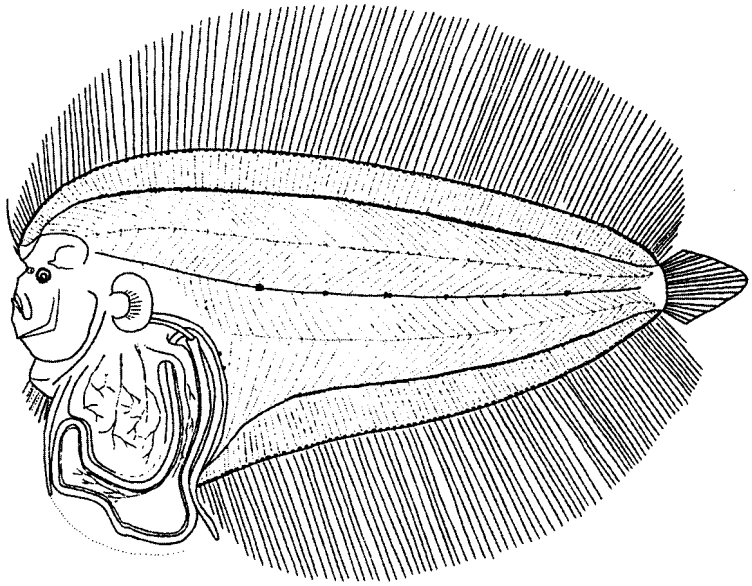


B. 16.7 mmSL



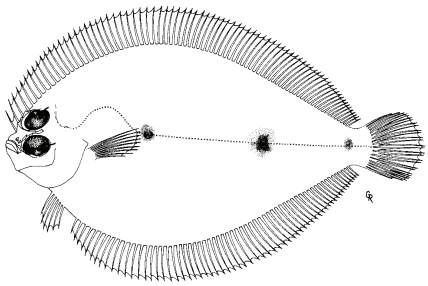
C. 40.9 mmSL

These larvae are included in the present monograph based on the possibility that they may drift into the study area via the Gulf Stream, and on a single report that the range of *Chascanopsetta danae* extends north to 40°N (Lara, 2006b). This range has not been confirmed in other reports or in museum records.



D. 66.8 mmSL

Engyophrys senta Ginsburg, 1933
Bothidae
Spiny flounder



Range: Western North Atlantic Ocean from Florida to Brazil, including Gulf of Mexico and Caribbean Sea; larvae may drift into study area *via* the Gulf Stream

Habitat: Demersal in depths of 35–180 m

Spawning: Spring in Gulf of Mexico

Eggs:
- Undescribed

Larvae:
- Body deep and compressed
- Head profile concave
- Head length decreases from 33% SL to 22% SL
- Preanus length decreases from 51% SL to 22% SL
- Body depth increases from 55% SL to 65% SL, then decreases to 55% SL
- Otic spines increase from 1 in early larvae to 4 in larvae >8 mm
- Cleithral spines increase from 3–4 in early larvae to 10–12
- Basipterygial spines increase from 3–6 in early larvae to 14–18
- All spines lost at transformation
- Papillae develop over eyes at about 15 mm
- Second dorsal fin ray elongate until size of about 8.5 mm
- Sequence of fin ray formation: D – A, C, P_2 – P_1
- Pigmentation: Few tiny spots on lower head, near anus and cleithral symphysis in early larvae, otherwise no pigment until transformation

Meristic Characters

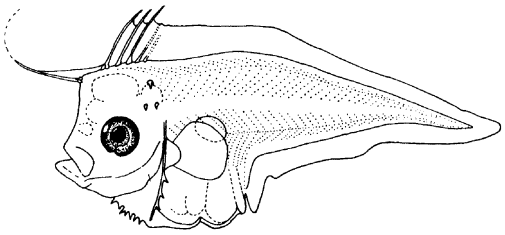
Myomeres:	37–39
Vertebrae:	10+27–29=37–39
Dorsal fin rays:	71–85
Anal fin rays:	60–69
Pectoral fin rays:	9–10
Pelvic fin rays:	6/6
Caudal fin rays:	17 (total)

Position of pelvic fins

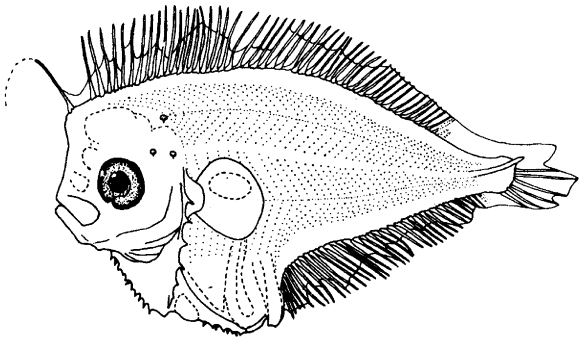
Figures: Adult: Grady Reinert (Gutherz, 1967); **A–E**: Hensley, 1977

References: Smith *et al.*, 1975; Evseenko, 1977b; Futch, 1977

Engyophrys senta

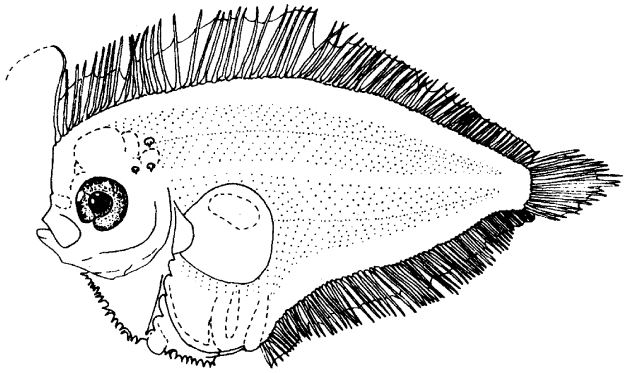


A. 3.3 mmSL

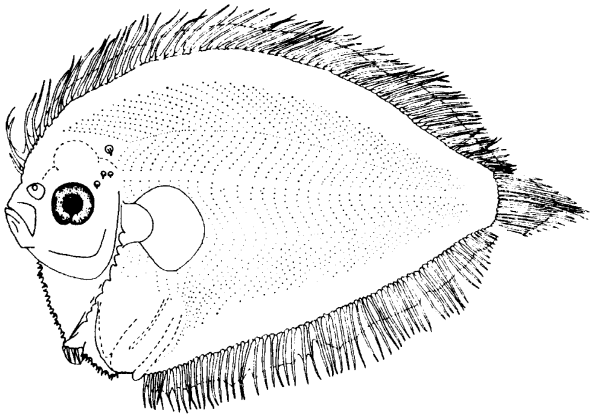


B. 4.5 mmSL

Note important series of spines on the cleithrum, otic bones, urohyal and basipterygium (lacking in *Bothus*, *Chascanopsetta* and *Monolene*)

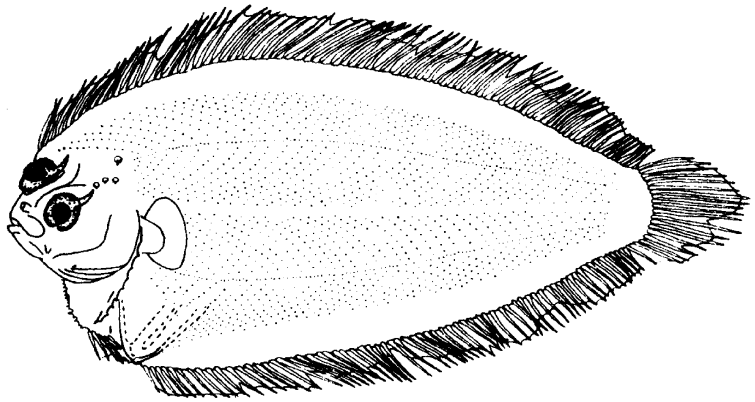


C. 6.5 mmSL



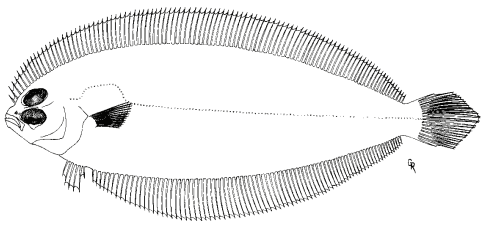
D. 12.3 MMSL

Right eye migrates through body under anterior dorsal fin



E. 19.6 mmSL

Monolene sessilicauda Goode, 1880
Bothidae
Deepwater flounder



Range: Western North Atlantic Ocean from New England to Florida and Gulf of Mexico; larvae have been collected as far north as Scotian Shelf and Newfoundland

Habitat: Outer continental shelf and upper continental slope, in depths of 100–550 m

Spawning: Probably summer, when larvae have been collected near continental shelf edge, presumably after drifting into study area *via* Gulf Stream

Meristic Characters

Myomeres:	45–46
Vertebrae:	10–11+35–38
Dorsal fin rays:	92–109
Anal fin rays:	76–89
Pectoral fin rays:	11–14 (L)
Pelvic fin rays:	6/6
Caudal fin rays:	17 (total)

Eggs:
- Undescribed

Larvae:
- Body very thin and transparent
- Head length increases from 17 to 23% SL
- Preanus length increases from 31 to 43% SL
- Body depth increases from 25 to 42% SL
- First dorsal fin ray elongate
- Flexion occurs at 8–12 mm
- Head spines lacking
- Vertebrae begin ossifying at about 7.3 mm; complete at 14.3 mm
- Sequence of fin ray formation: D, A – C – P_2 – P_1
- Right eye migrates through the head, under anterior dorsal fin
- Right side pectoral fin lost at transformation
- Pigmentation is sparse and irregular; fine melanophores on head and 1st dorsal fin ray sheath, and a few internal spots on gut
- Transformation occurs at >33 mmSL

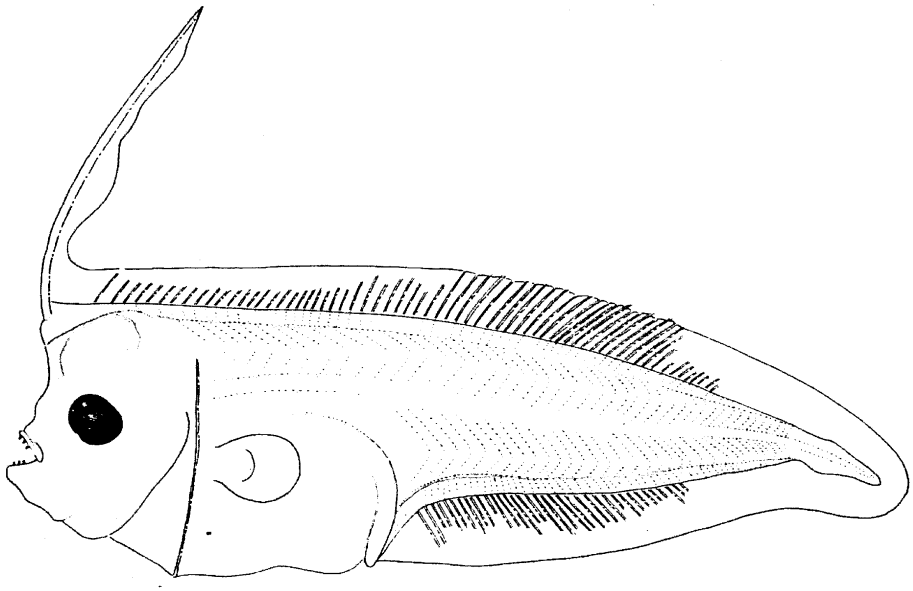
Position of pelvic fins

Note:
1. Description may include *Monolene antillarum* Norman, 1933, unless the latter species is synonymous with *M. sessilicauda* (Evseenko, 1977a); the larval evidence supports two species (D. F. Markle, 1982, pers. commun.; S. A. Evseenko, 1982, pers. comm.) but the genus is in need of revision and the larval evidence should be reanalyzed. A recent account cautions that the two species may be synonymous (Munroe, 2002d).

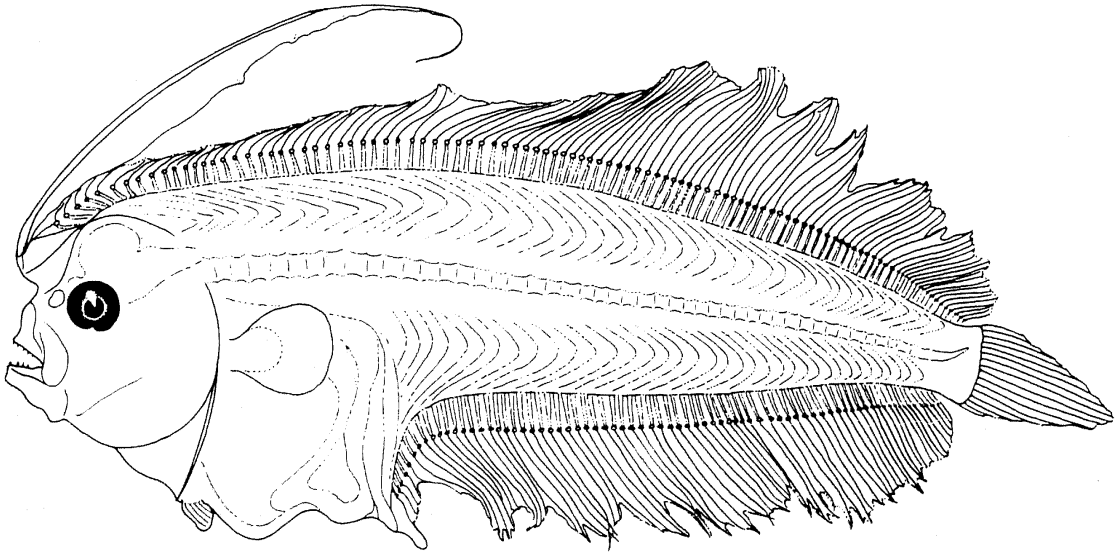
Figures: Adult: Grady Reinert (Gutherz, 1967); **A**: Futch, 1971 (redrawn); **B:** Ahlstrom *et al.*, 1984a (redrawn from Futch, 1971)

References: Colton, 1961; Smith *et al*., 1975; Evseenko, 1977a

Monolene sessilicauda

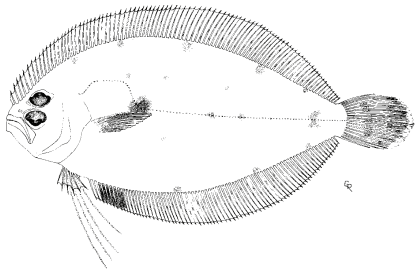


A. 7.9 mmNL



B. 14.3 mmSL

Trichopsetta ventralis (Goode and Bean, 1885)
Bothidae
Sash flounder



Range: Western North Atlantic Ocean; confined to northern and western Gulf of Mexico

Habitat: Demersal in depths of 30–110 m

Spawning: Undescribed; larvae have been collected off the northeastern United States, usually over the continental slope, presumably after drifting north in the Gulf Stream, Jul–Oct

Meristic Characters

Myomeres:	40–41
Vertebrae:	10+30–31=40–41
Dorsal fin rays:	89–95
Anal fin rays:	69–75
Pectoral fin rays:	12–13
Pelvic fin rays:	6/6
Caudal fin rays:	17 (total)

Eggs: – Undescribed

Larvae:
- Body deep and compressed
- Head profile concave
- Head length decreases from 29% SL to 19% SL
- Preanus length decreases from 50% SL to 19% SL
- Body depth increases from 39% SL to 61% SL
- Flexion occurs at 6–10 mmSL
- Otic spines increase from 2 in early larvae to 3
- Cleithral spines increase from none in early larvae to 1 at 7–9 mm, to 3–8 in larger larvae
- Urohyal spines increase from 0–10 at 10–12 mm to 10–15 in larger larvae
- Basipterygial spines increase from 2–5 at 13–20 mm to 5–15 in larger larvae
- All spines are lost at transformation
- Anterior few dorsal fin rays can be slightly elongate
- Sequence of fin ray formation: D, A, C – P_2 – P_1
- Vertebrae ossified at 26 mm
- Pigmentation: series of large melanophores form over interneurals and interhaemals and along midline (left side only). These are retained after transformation.
- Transformation occurs between 28.5 and 35.7 mmSL

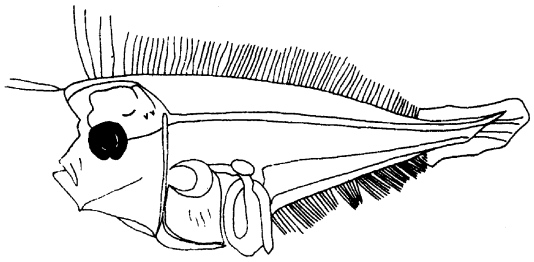
Position of pelvic fins

Note:
1. *Trichopsetta orbisculus* Anderson and Gutherz, 1967, occurs off Nicaragua and Venezuela but young stages have been taken over the Scotian Shelf (D. F. Markle, pers. comm. 1982; Scott and Scott, 1988). Lower limb gill rakers: 7–8 (cf. 9–11 in *Trichopsetta ventralis*). Larvae are undescribed.

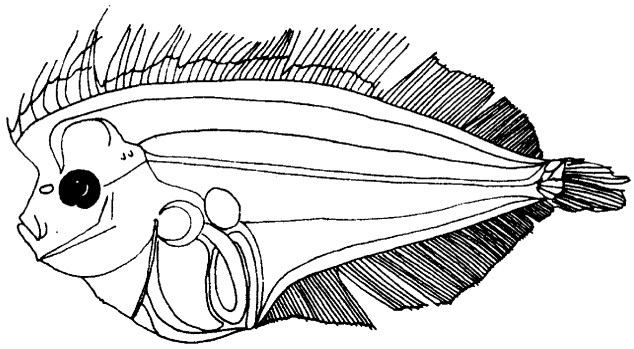
Figures: Adult: Grady Reinert (Gutherz, 1967); **A–D**: Futch, 1977

References: Anderson and Gutherz, 1967; Smith *et al*., 1975; Hensley, 1977

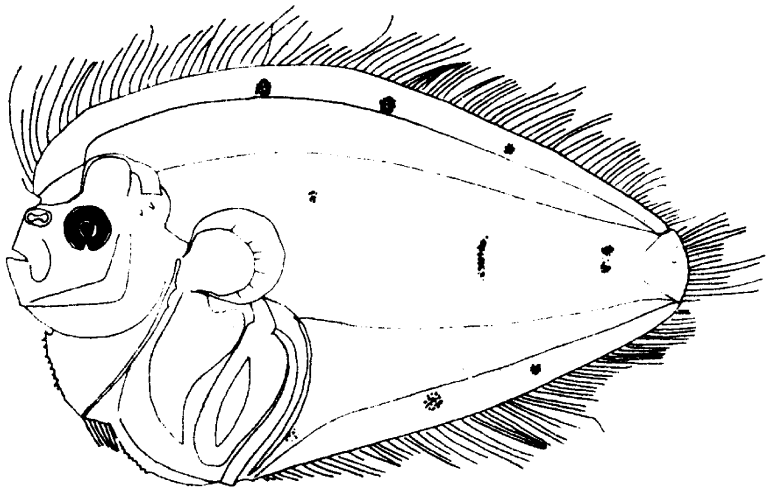
Trichopsetta ventralis



A. 6.4 mmSL



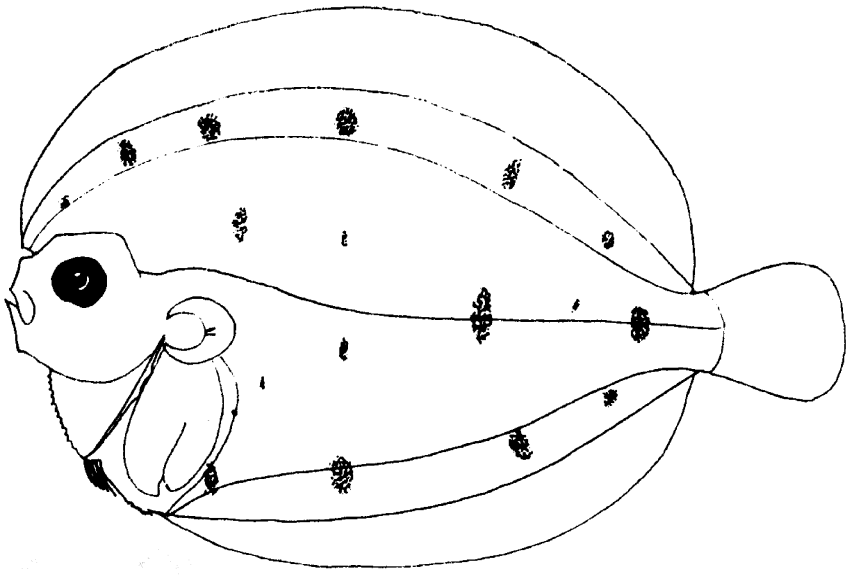
B. 9.0 mmSL



C. 20.6 mmSL

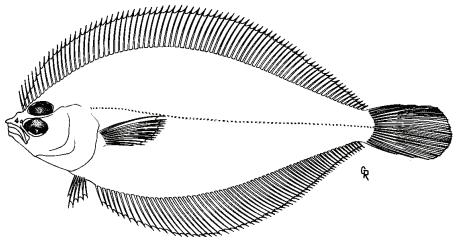
Note important series of spines on cleithrum (small), urohyal, and basipterygium (lacking in *Bothus*, *Chascanopsetta* and *Monolene*)

Right eye migrates through body under anterior dorsal fin



D. 28.5 mmSL

Citharichthys arctifrons Goode, 1880
Paralichthyidae
Gulf Stream flounder



Range: Western North Atlantic Ocean from Scotian Shelf to Yucatan Peninsula

Habitat: Sandy bottoms on continental shelf and upper slope, in depths of 22–682 m (mostly 46–365 m), rarely shallower

Spawning: Summer through fall, mostly Jul–Oct

Eggs: – Undescribed

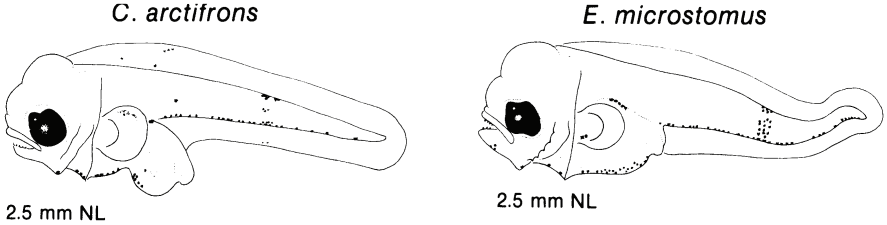
Meristic Characters

Myomeres:	34–35
Vertebrae:	10–11+26–28
Dorsal fin rays:	75–87
Anal fin rays:	58–71
Pectoral fin rays:	9–11
Pelvic fin rays:	6/6
Caudal fin rays:	17 (total)

Larvae:
- Head length increases from 19–25% SL in early larvae to 26–30% SL at transformation
- Preanus length increases from 36–42% SL in early larvae to 35–40% SL at transformation
- Body depth increases from 18–25% SL in early larvae to 34–39% SL at transformation; relative body depth less than in comparably sized *Etropus microstomus*
- Flexion occurs at 5–9 mm
- No preopercle spines; 3 anterior dorsal fin rays elongate in larvae 4.5–12.0 mmSL
- Sequence of fin ray formation: C – D, A, – P_2 – P_1
- Vertebrae begin ossification at 6–7 mm; complete at 10+ mm
- Pigmentation: 3 horizontal bars form on body anterior to caudal peduncle at 4–5 mmSL; internal pigment on notochord near these bars >5 mmSL; irregular row of melanophores along ventral edge of body.
- Transformation occurs at 13–15 mm
- Pigment comparison in early stages:

Position of pelvic fins

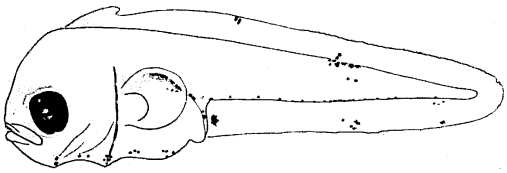
Pigment Location	*Citharichthys arctifrons*	*Etropus microstomus*
Lower jaw	Absent	Present
Air bladder	Present	Present
Ventral edge	Present	Present
Finfold	May be present	Absent
Mid-tail	3 bars at about 3 mm	2–3 bars at <3 mm
Ventral gut anterior to anus	Absent	Present
Lower pectoral base	Usually absent	Usually present



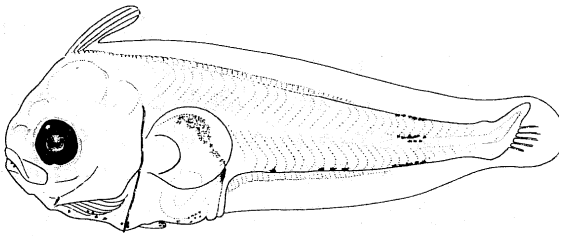
Figures: Adult: Grady Reinert (Gutherz, 1967); early larvae: Richardson and Joseph, 1973 (redrawn); **A–F**: Richardson and Joseph, 1973 (redrawn)

References: Markle *et al.*, 1980; Tucker, 1982

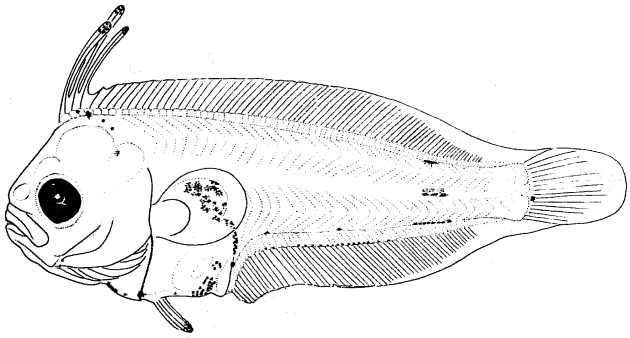
Citharichthys arctifrons



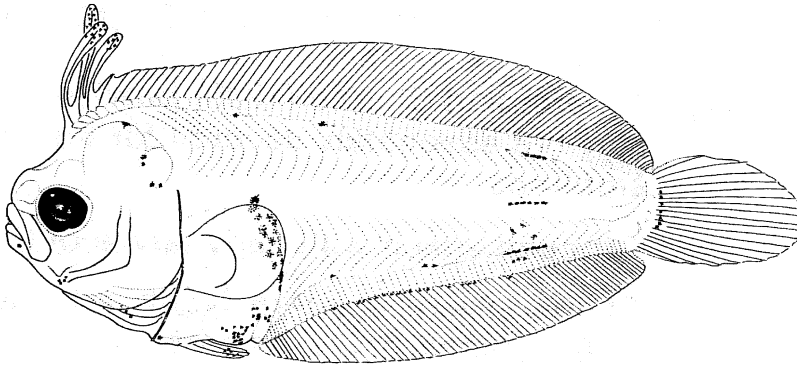
A. 4.5 mmNL



B. 5.9 mmSL

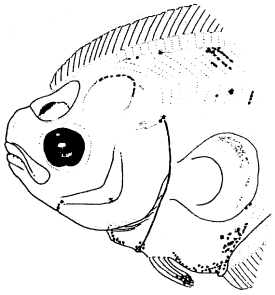


C. 8.3 mmSL



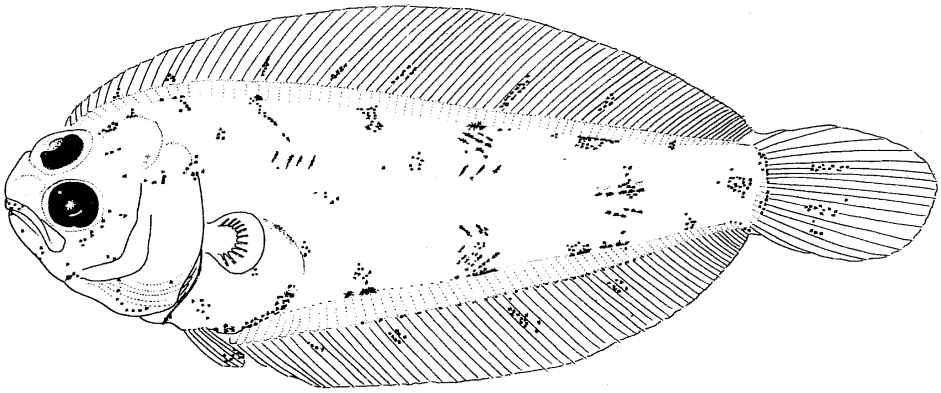
D. 11.2 mmSL

Important characters include lack of pectoral fin base melanophore, internal pigment restricted to notochord just anterior to caudal peduncle, 3 elongate anterior dorsal fin rays



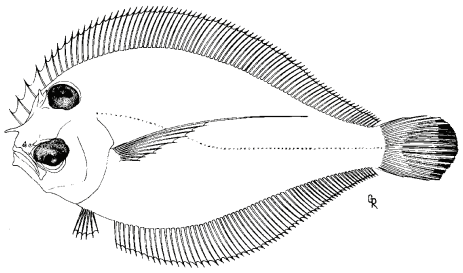
E. 13.8 mmSL

Note eye migration anterior to dorsal fin origin



F. 14.4 mmSL

Citharichthys cornutus (Günther)
Paralichthyidae
Horned whiff



Range: Western North Atlantic Ocean; range usually reported as Georgia to Brazil, including Gulf of Mexico and Caribbean Sea, but adults are fairly common as far north as Cape Hatteras and Hudson Canyon; larvae collected as far north as Georges Bank

Habitat: Demersal on sand-mud substrates, usually deeper than 137 m.

Spawning: No data. Larval occurrences in Middle Atlantic Bight and Georges Bank Jan through May; off southeastern U.S. from Oct through May

Meristic Characters

Myomeres:	35–36
Vertebrae:	10 + 25–26 = 35–36
Dorsal fin rays:	74–83
Anal fin rays:	59–66
Pectoral fin rays:	10–11
Pelvic fin rays:	6/6
Caudal fin rays:	17 (total)

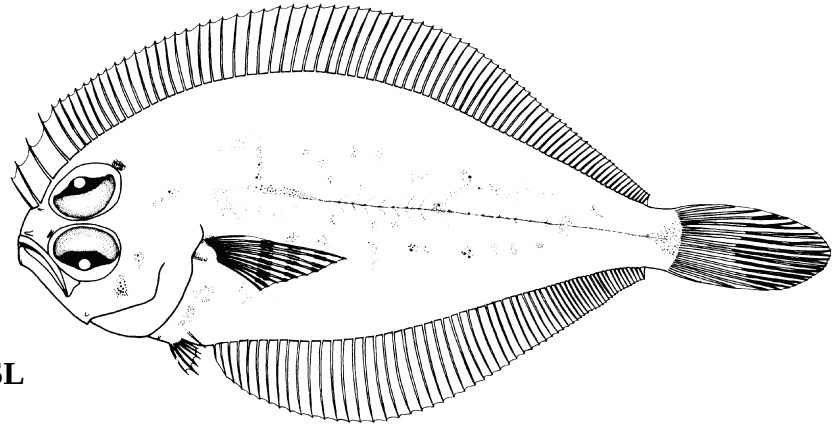
Eggs:
- Undescribed

Larvae:
- Preopercle spines present in preflexion (14), flexion (31) and postflexion (22) larvae
- 3 elongate dorsal fin rays; 1st and 2nd pelvic fin rays elongate before transformation
- Eye diameter larger than in *Citharichthys arctifrons* larvae
- Length at flexion: 9–10 mm
- Sequence of fin ray formation: P_2 – D, A, C – P_1
- Gill rakers on lower limb of first arch: 10–15
- Notochord pigment restricted to caudal area; no melanophore on pectoral fin base;pigment accumulations along dorsal and ventral edges of body; heavy lateral pigment before transformation; prominent pigment patches on air bladder, gut and lateral tail
- Before transformation, pigment develops on select myosepta
- Snout spine present (in males) at transformation
- Length at transformation: about 18 mm

Position of pelvic fins

Note: 1. Males develop a horizontally directed spine on snout at about 35 mm; eyes farther apart in males than in females or juveniles

Early Juvenile:

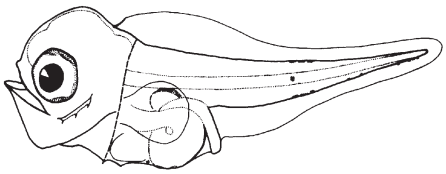


F. 37.2 mmSL

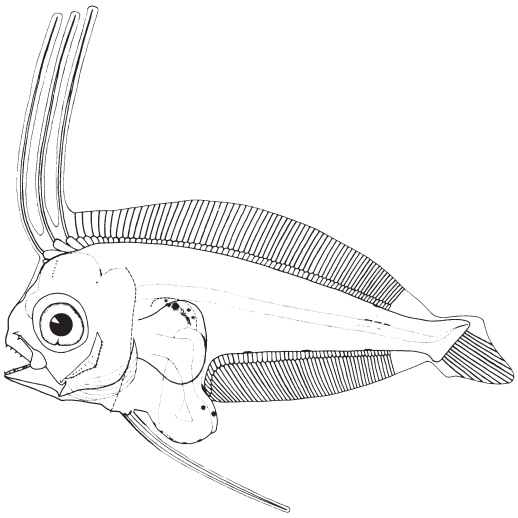
Figures: Adult: Grady Reinert (Gutherz, 1967); **A–F**: Tucker, 1982

References: Parr, 1927; Gutherz, 1967

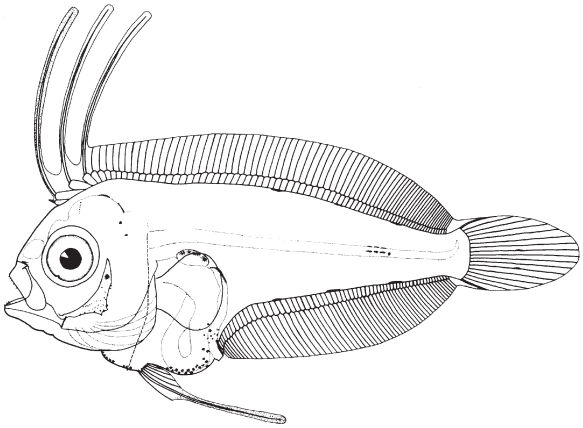
Citharichthys cornutus



A. 2.2 mmNL

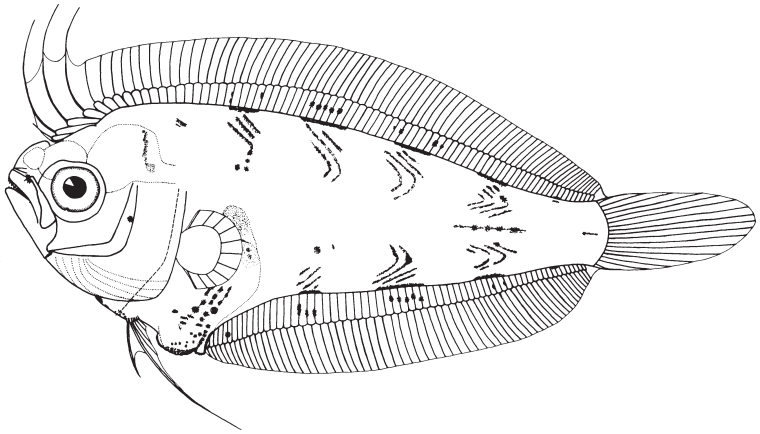


B. 6.9 mmSL

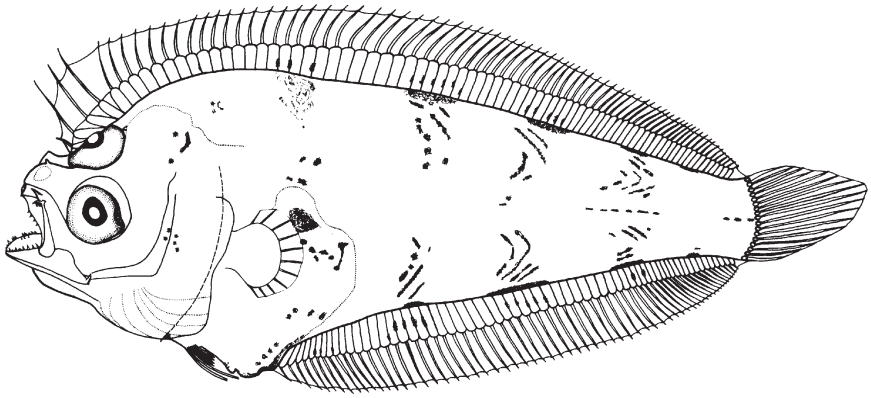


C. 8.2 mmSL

Important characters include lack of pectoral fin base melanophore, internal pigment restricted to notochord just anterior to caudal peduncle, 3 elongate anterior dorsal fin rays, and heavy lateral pigmentation before transformation.

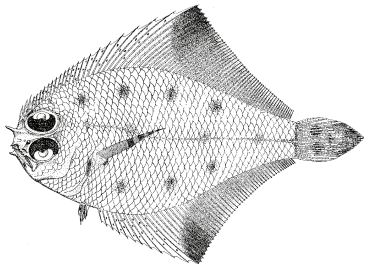


D. 14.2 mmSL



E. 17.4 mmSL

Citharichthys gymnorhinus Gutherz and Blackman, 1970
Paralichthyidae
Anglefin whiff



Range: Western North Atlantic Ocean from Florida through the Caribbean Sea to Guyana

Habitat: Deeper continental shelf waters, 37–201 m

Spawning: Possibly year-round; larvae have been collected in study area north of Cape Hatteras Jan–Nov, with a peak in Aug–Sep

Eggs:
- Undescribed

Larvae:
- Morphology similar to larvae of *Citharichthys cornutus*
- Preopercle spines present in preflexion (17), flexion (22), and postflexion (31) larvae
- 2nd–4th dorsal fin rays elongate and early forming
- Internal pigment on notochord restricted to caudal area
- Eye diameter slightly smaller than in *C. cornutus*
- Flexion complete at 7–8 mm SL
- Sequence of fin ray formation: D, P_2 – A – C – P_1
- Unique among paralichthyids in having only 5 pelvic fin rays on left side
- Snout spine present in males at transformation
- Gill rakers on lower limb of first arch: 9–14
- Pigment includes a patch of melanophores on air bladder; no pigment on pectoral fin base; lateral pigment sparse
- Transformation occurs at sizes < 15–18 mmSL

Meristic Characters

Myomeres:	33–34
Vertebrae:	10+23–24
Dorsal fin rays:	70–77
Anal fin rays:	51–61
Pectoral fin rays:	8–11
Pelvic fin rays:	5/6
Caudal fin rays:	17 (total)

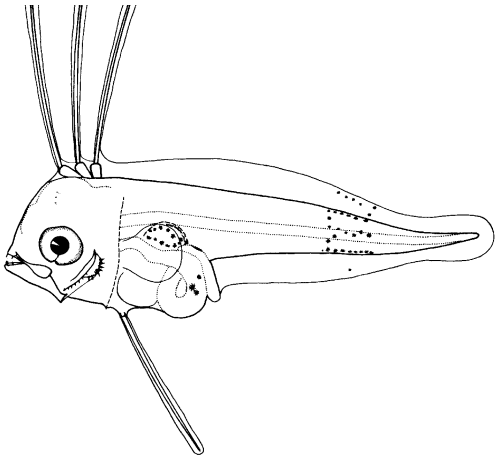
Position of pelvic fins

Note:
1. This is a dwarf species, seldom exceeding 55 mm in length; a fully transformed specimen of 15 mm has been described and sexual maturity is reached by 30 mm (Topp and Hoff, 1972)

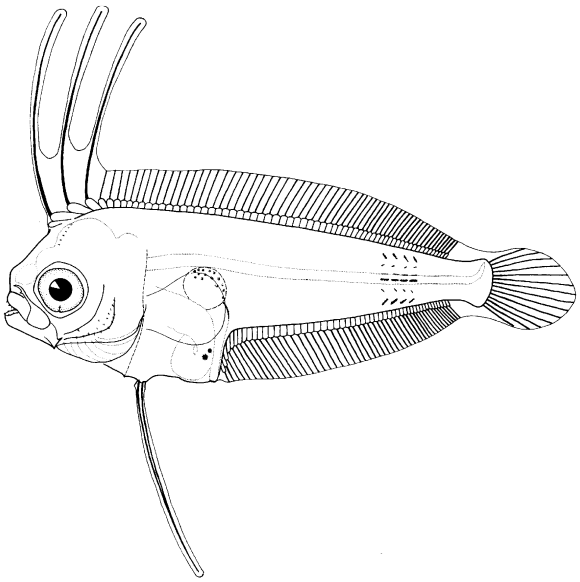
Figures: Adult: Topp and Hoff, 1972; **A–D**: Tucker, 1982

References: Gutherz and Blackman, 1970

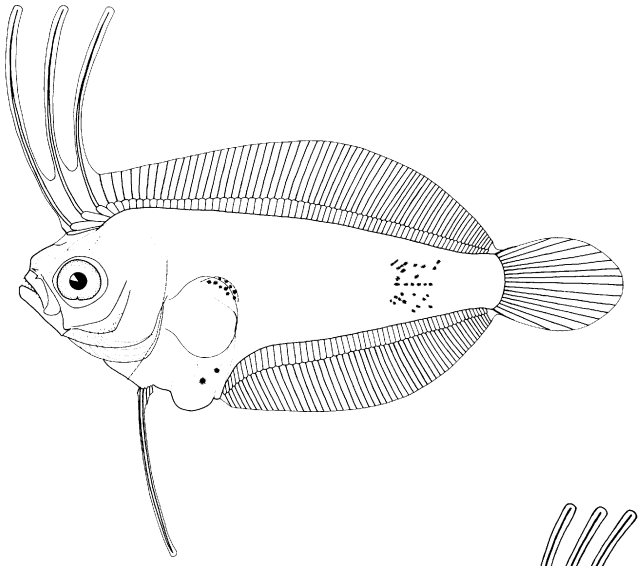
Citharichthys gymnorhinus



A. 4.6 mmNL



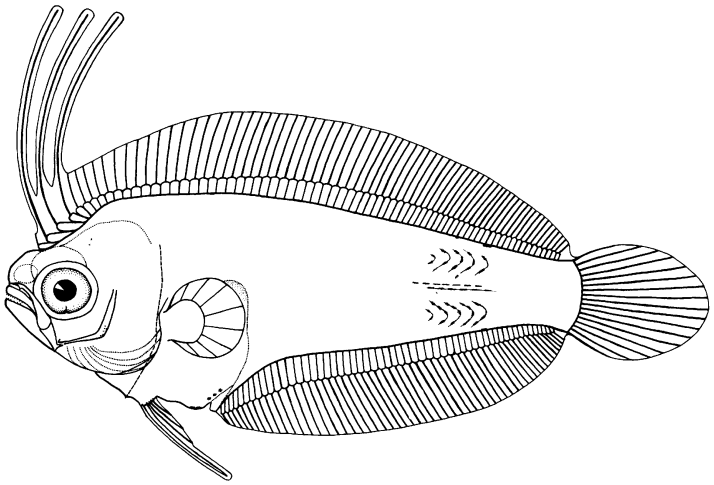
B. 6.7 mmSL



C. 9.6 mmNL

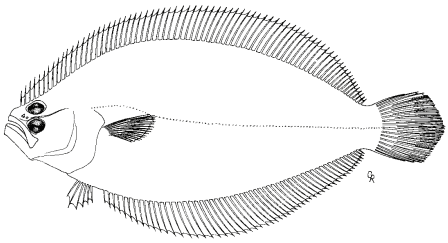
Note: There are 6 fin rays in the right pelvic fin; 5 in the left

Important characters include lack of pectoral fin base melanophore, internal pigment restricted to notochord just anterior to caudal peduncle, 3 elongate anterior dorsal fin rays, and pigment forming a band across the posterior mid-line of the body



D. 12.6 mmSL

Citharichthys spilopterus Günther, 1862
Paralichthyidae
Bay whiff



Range: Western North Atlantic Ocean from Virginia (rarely New Jersey) to Brazil, including Gulf of Mexico and Caribbean Sea

Habitat: Demersal in coastal waters to a depth of 73 m

Spawning: Undescribed; larvae present off southeastern United States Sep–Apr

Eggs:
- Undescribed

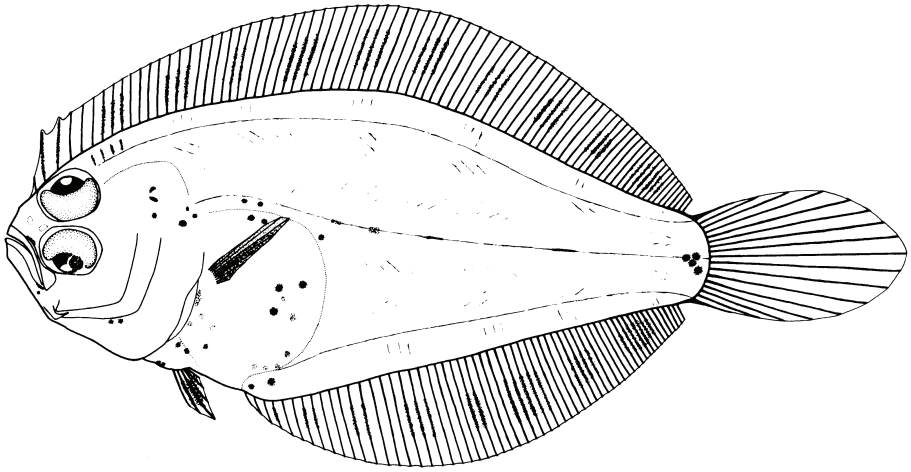
Larvae:
- Preopercle spines present in preflexion (31), flexion (31) and postflexion (16) larvae
- 2 elongate dorsal fin rays present preflexion through transformation
- Flexion occurs at lengths of 7–9 mm
- Sequence of fin ray formation: D, C, P_2 – A – P_1
- Notochord pigment restricted to caudal area; 2 pigment accumulations possible on ventral edge of body, with 4 added to dorsal edge at transformation; relatively light lateral pigment in larvae, becomes heavier in juveniles; 1 or 2 prominent melanophores over left side of air bladder
- Length at transformation: 9–11 mmSL

Meristic Characters

Myomeres:	33–35
Vertebrae:	10+23–25=33–35
Dorsal fin rays:	75–84
Anal fin rays:	56–63
Pectoral fin rays:	9–10
Pelvic fin rays:	6
Caudal fin rays:	17 (total)

Position of pelvic fins

Early Juvenile:

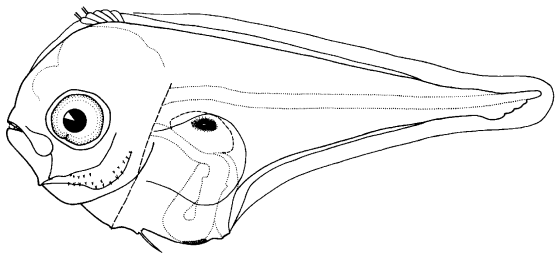


F. 16.6 mmSL

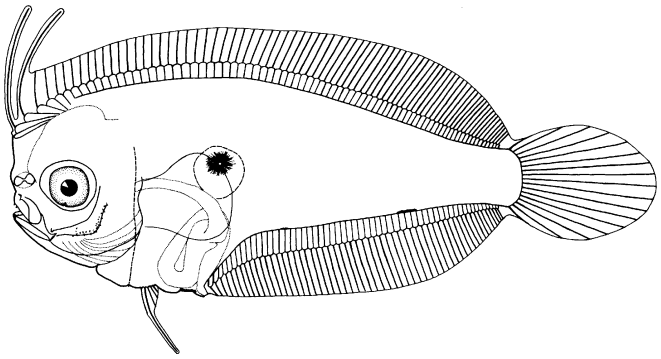
Figures: Adult: Grady Reinert (Gutherz 1967); **A–F**: Tucker, 1982
References: Tucker, 1982

Citharichthys spilopterus

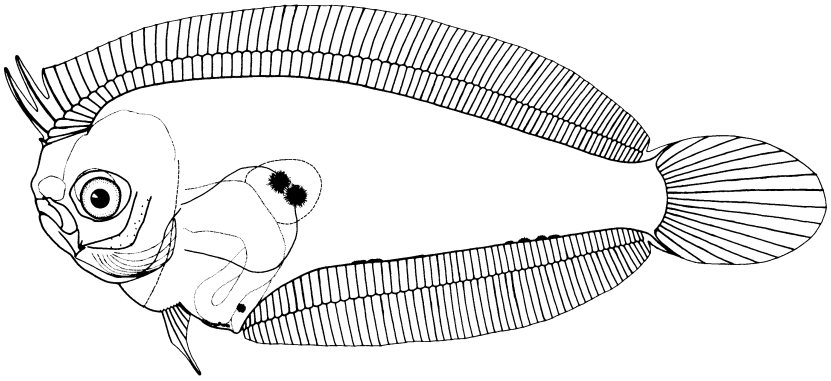
Important characters include
lack of pectoral fin base melanophore,
internal pigment restricted to notochord
just anterior to caudal peduncle,
2 elongate anterior dorsal fin rays,
prominent pigment over air bladder



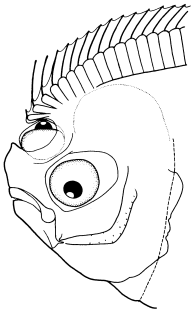
A. 3.7 mmNL



B. 6.7 mmSL

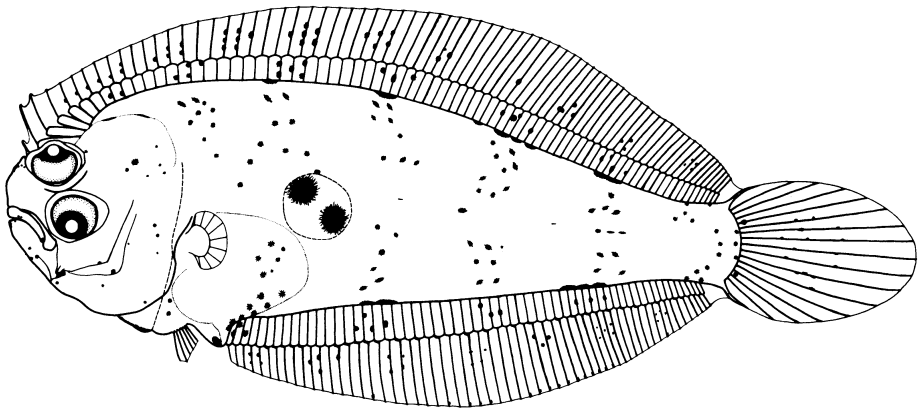


C. 9.9 mmSL



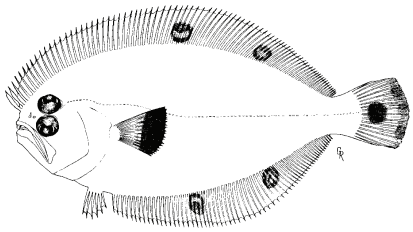
D. 9.9 mmSL

Note eye migration
anterior to dorsal fin
origin



E. 10.7 mmSL

Cyclopsetta fimbriata (Goode and Bean, 1885)
Paralichthyidae
Spotfin flounder



Range: Western North Atlantic Ocean from North Carolina to Guyana including northern Gulf of Mexico

Habitat: Demersal in depths of 18–228 m

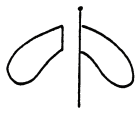
Spawning: Apr–Oct (south of Cape Hatteras); larvae drift north in Gulf Stream and have been collected off the northeastern United States and Scotian Shelf

Meristic Characters

Myomeres:	36–37
Vertebrae:	10+26–27=36–37
Dorsal fin rays:	78–87
Anal fin rays:	59–67
Pectoral fin rays:	11–12
Pelvic fin rays:	6/6
Caudal fin rays:	17 (total)

Eggs: – Undescribed

Larvae:
- Hatching size unknown
- Head length increases from 27% SL to 34% SL
- Preanus length decreases from 50% SL to 40% SL
- Body depth increases from 30% SL to 42% SL
- Flexion occurs at 5–8 mm
- Cranial spines (1 per side, small) present until transformation
- Preopercle spines 4–6; smaller than those in *Syacium*; spine at preopercle angle develops spur
- Anterior 3 dorsal fin rays elongate in early larvae, then anteriormost 8–11 rays remain elongate from flexion through transformation stages
- Sequence of fin ray formation: D – P_2 – C, A – P_1
- 3 pelvic fin rays elongate at about 3.0 mm, then rays form on right side
- Pigmentation: 3 dorsal and 2 ventral clusters of melanophores at 3.0 mm; 1 dorsal and 1 ventral cluster added at about 5.0 mm; 1 dorsal cluster added at about 7.0 mm
- Right eye moves under dorsal fin at transformation
- Transformation occurs at 14–15 mmSL

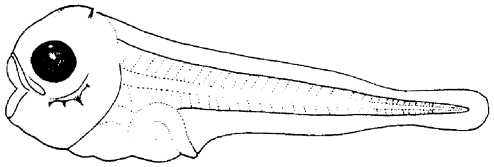


Position of pelvic fins

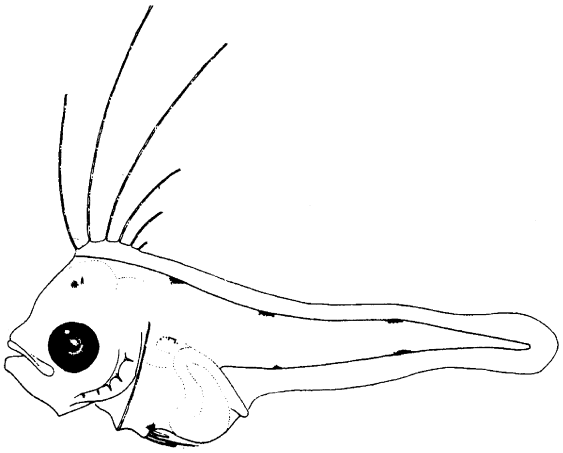
Figures: Adult: Grady Reinert (Gutherz, 1967); **A–D**: Gutherz, 1970 (A–C redrawn)

References: Gutherz, 1970; Evseenko, 1979

Cyclopsetta fimbriata



A. 1.9 mmNL

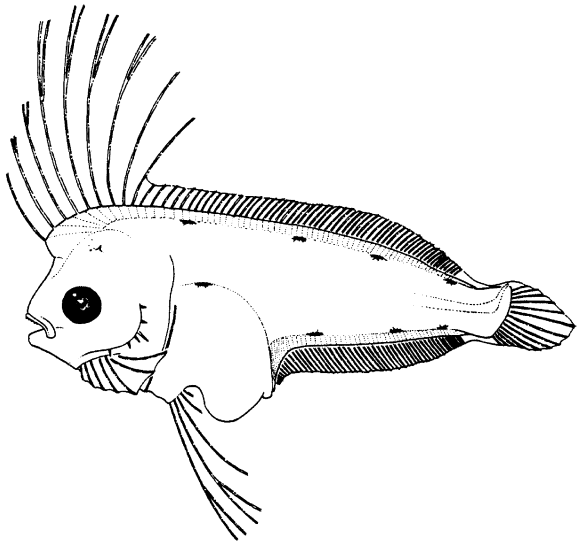


B. 3.0 mmNL

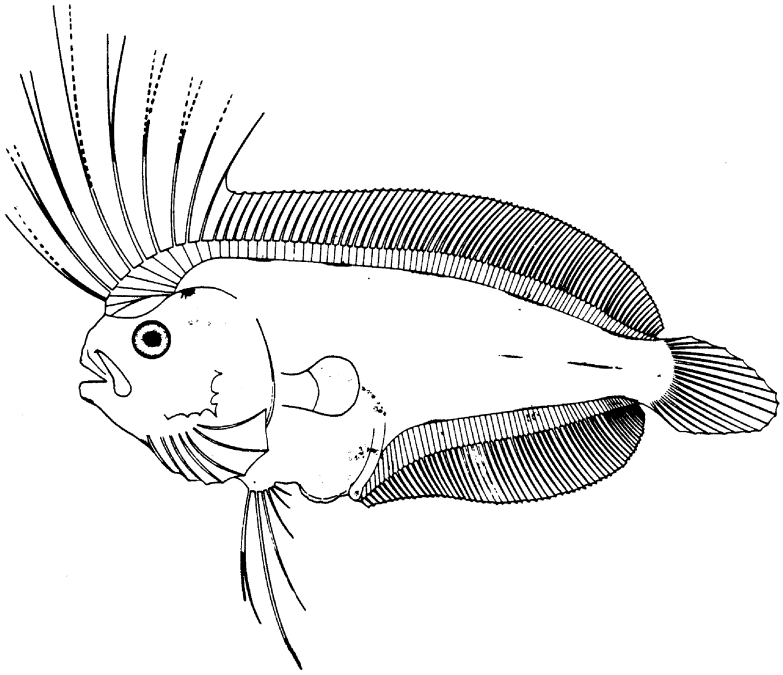
Ventral row of small spots anterior to anus

Melanophore near cranial spine; internal pigment on air bladder

Melanophore near pelvic fin base (3-5 mm)



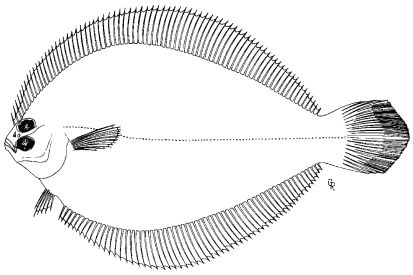
C. 6.9 mmSL
(Pectoral fin inadvertently omitted in Figs. A-C)



D. 12.9 mmSL

Midline pigment appears

Etropus crossotus Jordan and Gilbert, 1882
Paralichthyidae
Fringed flounder



Range: Western North Atlantic Ocean from Chesapeake Bay (rarely New Jersey) to Brazil, including Gulf of Mexico

Habitat: Estuaries and inner continental shelf from 1 to 86 m, usually <33 m; often found in very low salinities, on substrates of mud, silt, and organic detritus

Spawning: Probably spring–summer, based on presence of larvae in estuaries and continental shelf

Eggs: – Undescribed

Larvae:
- Morphology similar to larvae of *Etropus microstomus*
- Preopercle spines present in preflexion (17), flexion (20), and post-flexion (11) larvae
- 1st and 2nd anterior dorsal fin rays early forming and elongate
- Internal pigment occurs along entire length of notochord
- Flexion occurs at 9–10 mm
- Mouth and eye remain small throughout larval period
- 3–4 tiny spines on frontal-sphenotic part of head
- Vertebrae complete ossification by 6.2 mm
- Sequence of fin ray formation: D – C, P_2 – A – P_1
- Gill rakers on lower limb of first arch: 6–9
- Pigment includes a melanophore on the lower base of pectoral fin, dense pigment on air bladder, heavy lateral pigment before transformation, and clusters of spots along dorsal and ventral edges of the body
- Transformation occurs at 10–12 mmSL

Meristic Characters

Myomeres:	34–36
Vertebrae:	10+24–26=34–36
Dorsal fin rays:	75–87
Anal fin rays:	58–68
Pectoral fin rays:	8–10
Pelvic fin rays:	6/6
Caudal fin rays:	17 (total)

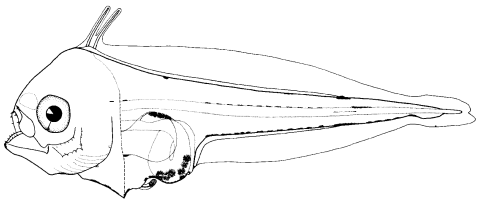
Position of pelvic fins

Note: 1. Larvae transform in shallow waters then settle onto sandy substrates, late-spring through summer

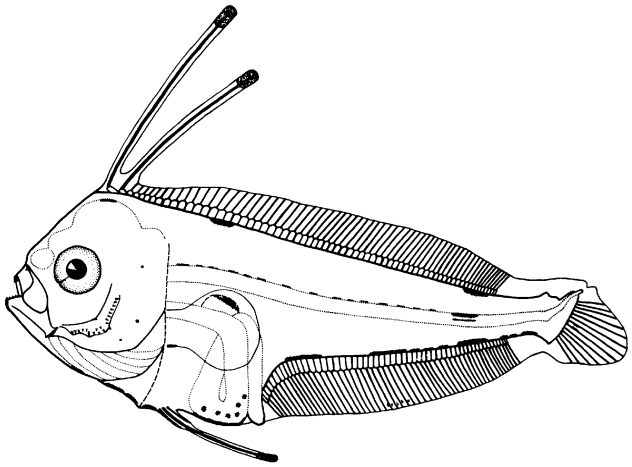
Figures: Adult: Grady Reinert (Gutherz, 1967); **A–D**: Tucker, 1982

References: Topp and Hoff, 1972; Reichert and Van de Veer, 1991

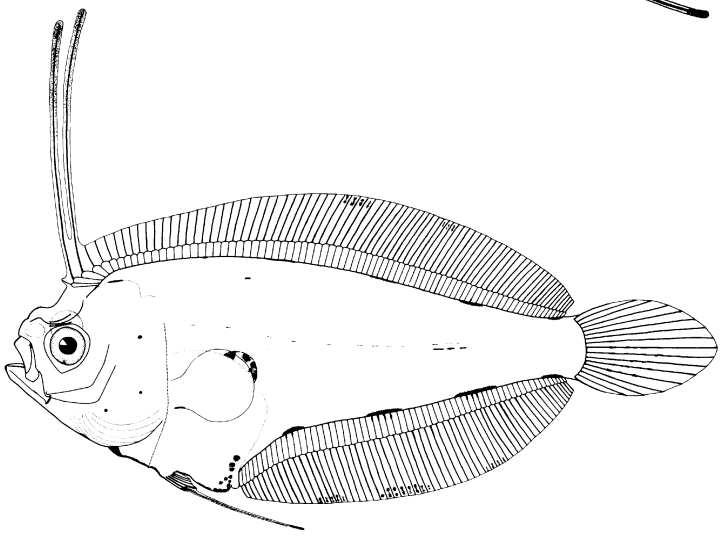
Etropus crossotus



A. 4.6 mmNL

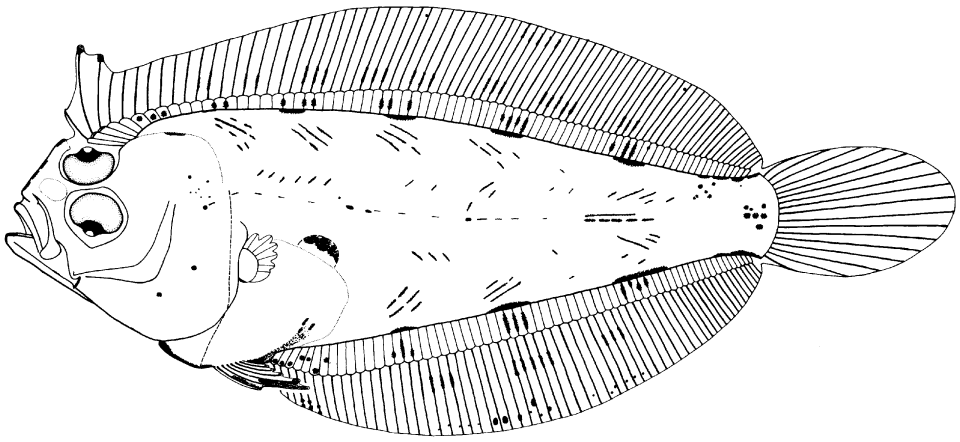


B. 6.0 mmSL



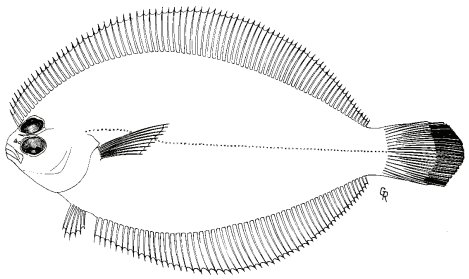
C. 10.5 mmSL

Important characters include melanophore on base of pectoral fin, internal pigment along length of notochord, 2 elongate anterior dorsal fin rays, and heavy lateral pigment before transformation



D. 10.3 mmSL

Etropus microstomus (Gill, 1864)
Paralichthyidae
Smallmouth flounder



Range: Western North Atlantic ocean from southern New England to South Carolina

Habitat: Estuaries, bays and coastal ocean; generally to depths of 35 m

Spawning: Summer through early fall in inner continental shelf waters

Eggs:
- Pelagic, spherical (see note 1)
- Diameter: 0.56–0.74 mm
- Chorion: transparent, unsculptured
- Oil globule: single, 0.05–0.16 mm in diameter

Meristic Characters

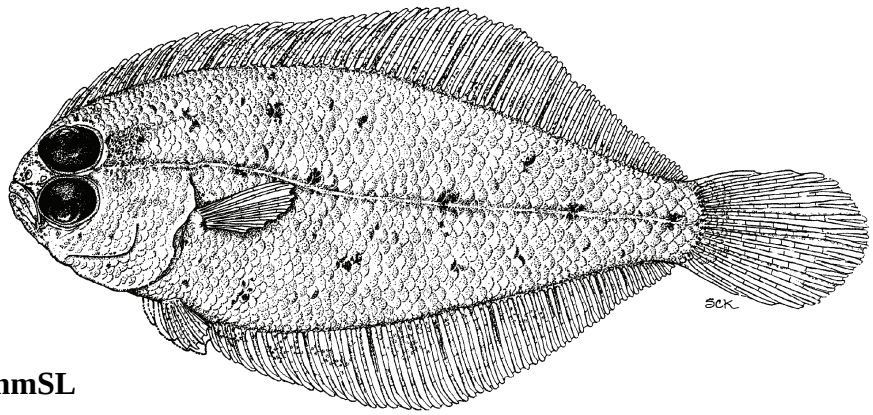
Myomeres:	31–33
Vertebrae:	10+24–25=34–35
Dorsal fin rays:	67–84
Anal fin rays:	50–63
Pectoral fin rays:	9–12
Pelvic fin rays:	6/6
Caudal fin rays:	17 (total)

Larvae:
- Hatching size: 1.4 mmNL
- Preanus length decreases from 36–43% SL in early larvae to 33–35% SL at transformation
- Body depth increases from 20–26%SL in early larvae to 36–41%SL at transformation
- Preopercle spines prominent in larvae 2.5–8.0 mm; disappear by 10 mm
- Pelvic fins in same position as *Citharichthys arctifrons*
- Vertebrae begin to ossify at 5 mm; complete at 9 mm
- Flexion occurs at 5–7 mm
- Sequence of fin ray formation: C, D, A – P_2 – P_1
- Pigmentation: internal melanophores along length of notochord; 1–2 melanophores on pectoral fin base; 3 horizontal bars anterior to caudal peduncle; 2 prominent ventral edge clusters between anus and horizontal bars; larger larvae develop pigment under hindbrain, on septa of interhaemal musculature, on myosepta, on opercle, and scattered on fins
- Transformation occurs at 10–12 mm

Position of pelvic fins

Note:
1. Description of egg development (Scherer and Bourne, 1980) may not adequately account for presumably similar egg of *Citharichthys arctifrons*, although the latter species probably spawns on outer continental shelf or upper continental slope, in water deeper than the spawning range of *Etropus microstomus*.
2. See *Citharichthys arctifrons* for comparisons between early larvae of the two species

Early Juvenile:

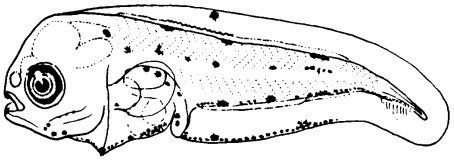


G. 19.9 mmSL

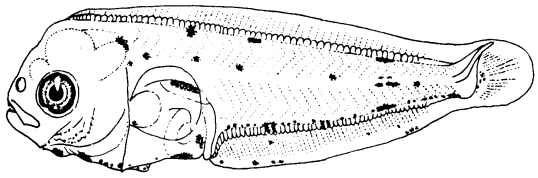
Figures: Adult; Grady Reinert (Gutherz, 1967); **A–F**: Barbara Sumida M^{ac}Call (Redrawn from Richardson and Joseph, 1973); **G**: Susan Kaiser (Able and Fahay, 1998)

References: Tucker, 1982

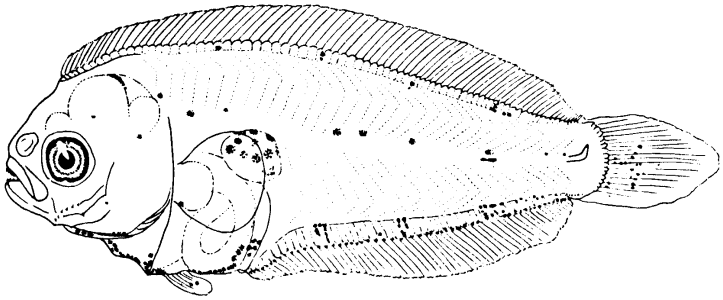
Etropus microstomus



A. 4.5 mmNL

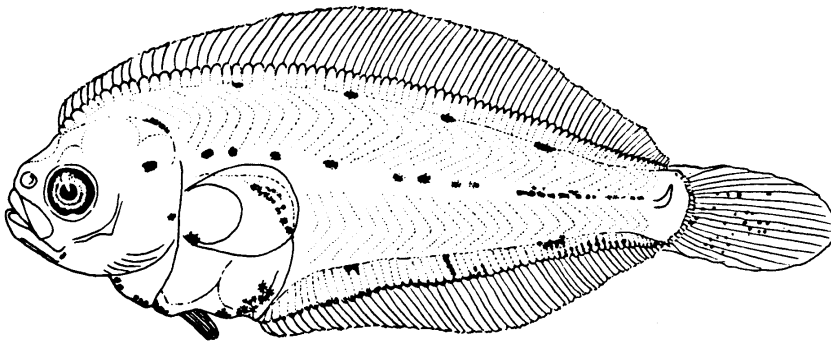


B. 5.9 mmSL

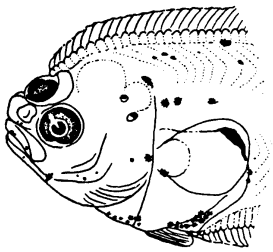


C. 8.3 mmSL

Important characters include melanophore on base of pectoral fin, internal pigment along length of notochord

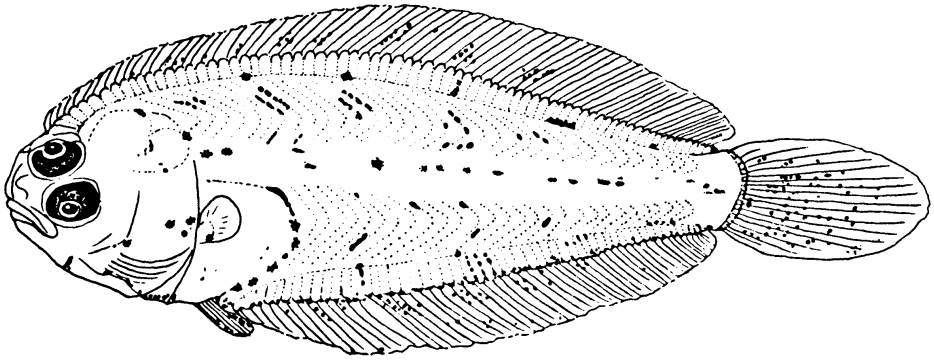


D. 10.6 mmSL



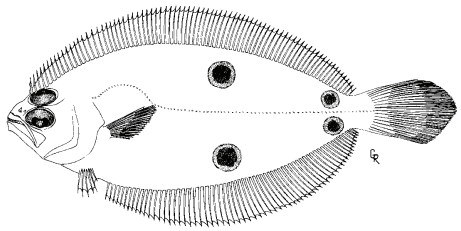
E. 10.9 mmSL

Note eye migration anterior to dorsal fin origin



F. 11.4 mmSL

Hippoglossina oblonga (Mitchill, 1815)
Paralichthyidae
Fourspot flounder



Range: Western North Atlantic Ocean from Massachusetts Bay and Georges Bank to southern Florida; rarely farther north to coast of Maine and Bay of Fundy

Habitat: In northern part of range, occurs in bays, estuaries and inner continental shelf to about 30 m; also southern flank of Georges Bank; off North Carolina in depths of 36–91 m; off Florida in depths >275 m

Spawning: Summer into fall

Meristic Characters

Myomeres:	41–42
Vertebrae:	11+30–31
Dorsal fin rays:	71–86
Anal fin rays:	58–72
Pectoral fin rays:	10–12
Pelvic fin rays:	6/6
Caudal fin rays:	18–19 (total)

Eggs:
- Pelagic, spherical
- Diameter: 0.79–1.01 mm (most 0.84–0.97 mm)
- Chorion: smooth
- Yolk: homogeneous
- Oil globules: single, 0.10–0.20 mm in diameter
- Perivitelline space: narrow

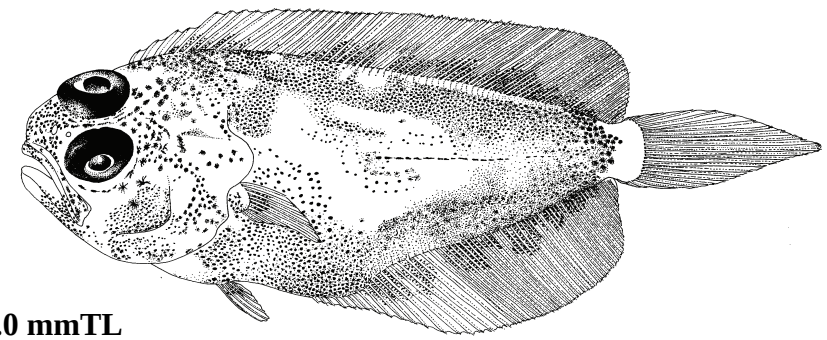
Larvae:
- Hatching occurs at about 2.9 mm; eyes unpigmented
- Preanus length about 50%TL at hatch; anus shifts anteriorly in later larvae
- Head and gut deep and compressed
- Few serrations appear on preopercle edge at 4.2 mm, disappear by about 7.0 mm
- Flexion occurs between 6 and 8 mm
- Anterior dorsal fin rays may be slightly elongate
- Vertebrae completely ossified at about 9 mm
- Sequence of fin ray formation: D, A – C – P_2 – P_1
- Pigmentation: early larvae have light scattering of spots over head, trunk and yolk sac; no pigment posterior to a mid-tail bar that extends onto finfold; in late larvae, the mid-tail bar is limited to body and spreads anteriorly and posteriorly; unpigmented areas remain at caudal fin base and in a zone on the side above the pectoral fin
- Transformation begins at about10 mm, complete at >12 mm; right eye migrates over mid-dorsal ridge, dorsal fin origin moves anteriorly and is deflected toward the right side
- At transformation, round, ocellated spots form on body, posterior to anus

Position of pelvic fins

Note: 1. This species is referred to as *Paralichthys oblongus* by some authors

Early Juvenile:

Note pigment pattern unique to early settlement stage; unpigmented areas are opaque white

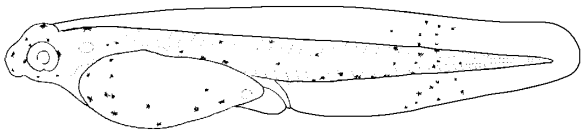


F. Ca. 25.0 mmTL

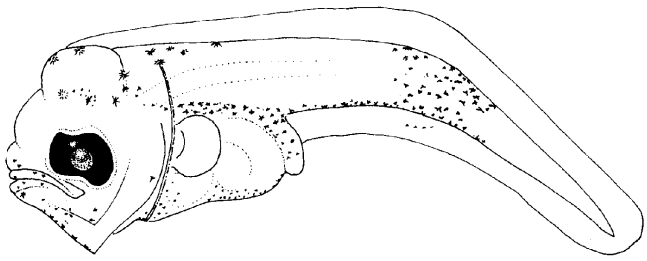
Figures: Adult: Grady Reinert (Gutherz, 1967); **A**: Miller and Marak, 1962; **B–E**: Leonard, 1971; (A–E redrawn) **F**: Nancy Arthur (original)

References: Leonard, 1971; Sullivan *et al*. 2000; Klein-M^{ac}Phee, 2002u

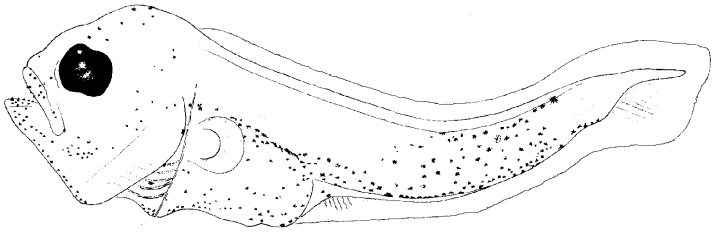
Hippoglossina oblonga



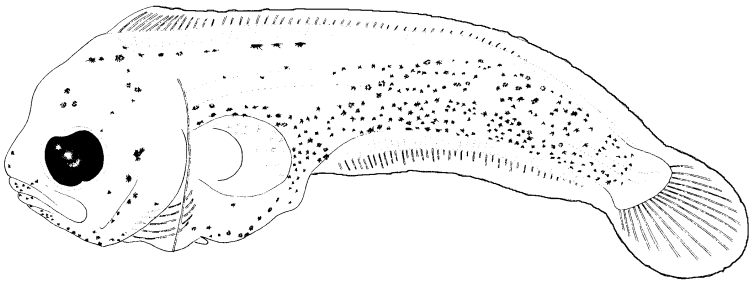
A. 3.1 mmTL



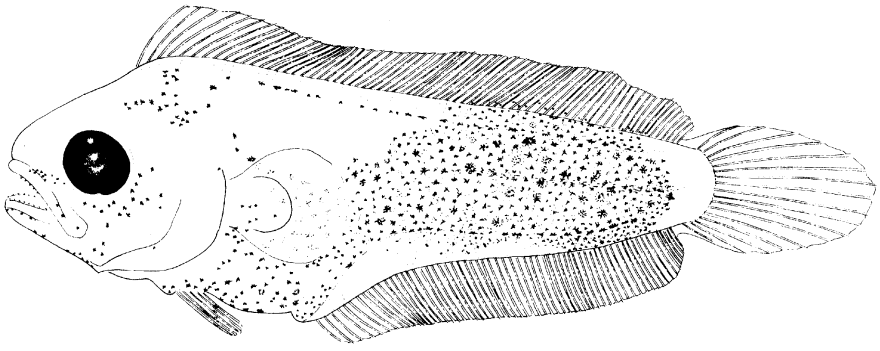
B. 4.2 mmNL



C. 6.3 mmNL

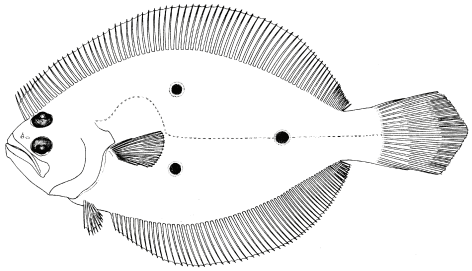


D. 7.7 mmSL



E. 10.5 mmSL

Paralichthys albigutta Jordan and Gilbert, 1882
Paralichthyidae
Gulf flounder



Range: Western North Atlantic Ocean from North Carolina to Texas

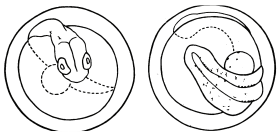
Habitat: High-salinity waters of bays, inlets and inner continental shelf

Spawning: Oct–Feb off southeastern U.S. and Gulf of Mexico; larvae infrequently collected in southern part of study area

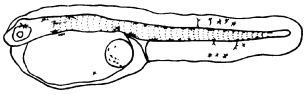
Meristic Characters

Myomeres:	37
Vertebrae:	10+27
Dorsal fin rays:	71–85
Anal fin rays:	53–63
Pectoral fin rays:	10–12
Pelvic fin rays:	6/6
Caudal fin rays:	18–19 (total)

Eggs:
- Pelagic and spherical
- Diameter: 0.84–0.90 mm
- Chorion: smooth and transparent
- Yolk: homogeneous
- Oil globule: single, 0.17–0.19 mm in diameter
- Perivitelline space: narrow



Larvae:
- Hatching occurs at 1.8–2.2 mmNL, eyes unpigmented, mouth parts unformed, oil globule posterior in yolk
- Yolk-sac larvae have scattering of pigment on mid-tail and finfold, and on body over yolk; a few spots occur on oil globule
- Weak preopercle spines (4–5 plus a larger one at angle) decrease in number with increasing size; disappear by 8.5 mmSL
- Cranial spines tiny, never more than 2; disappear before postflexion stage
- Sequence of fin ray formation: C, D – A – P_2 – P_1
- Pigmentation includes mid-dorsal and mid-ventral series of melanophores that are nearly, but not quite, paired and contiguous; internal pigment on notochord extends anteriorly through the eye; both finfolds have a scattering of pigment; melanophores cover the gut surface; a single spot occurs on the lower pectoral fin-base
- Pigment increases during transformation, including patches on dorsal and anal fins, base of caudal fin, and on body, aligned with myosepta



Yolk-sac larva

Position of pelvic fins

Note: Meristic characters in 4 congeners

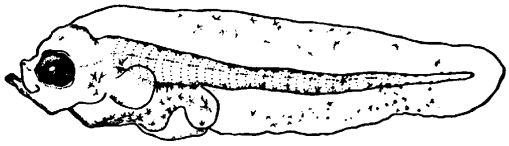
Species	Vertebrae	Dorsal Fin Rays	Anal Fin Rays
Paralichthys albigutta	10+27	71–85	53–63
Paralichthys dentatus	11+30–31	80–96	61–73
Paralichthys lethostigma	10–11+27–28	80–95	63–74
Paralichthys squamilentus[1]	10+27–29	76–85	59–65

[1] Not recorded from study area

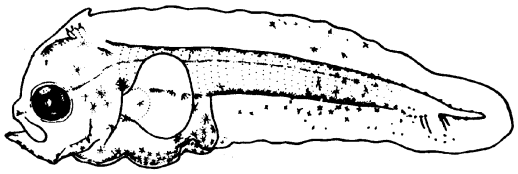
Figures: Adult: Grady Reinert (Gutherz, 1967); Eggs, yolk-sac larva, and **A–F**: Powell and Henley, 1995

References: Deubler, 1958; Rothschild and Deubler, 1960; Powell and Henley, 1995

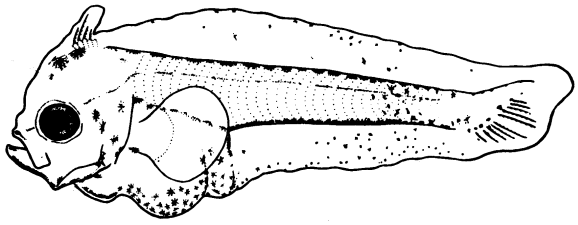
Paralichthys albigutta



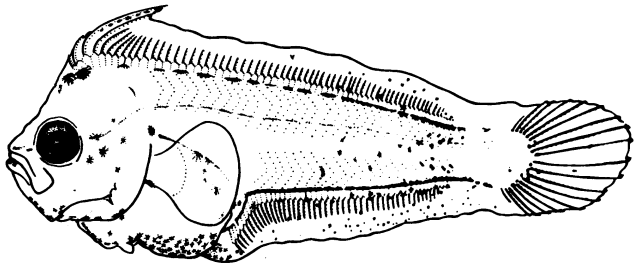
A. 3.5 mmNL



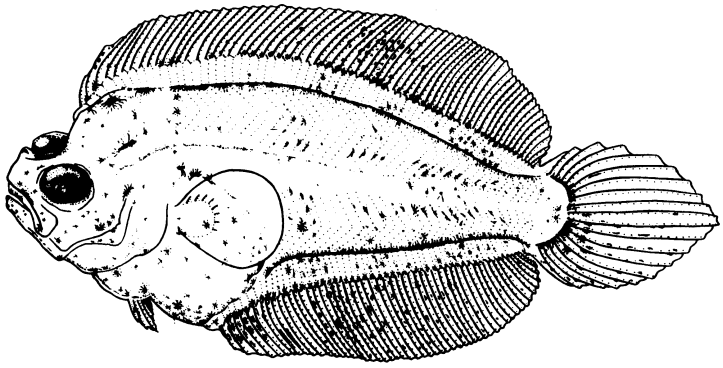
B. 5.8 mmNL



C. 6.2 mmNL



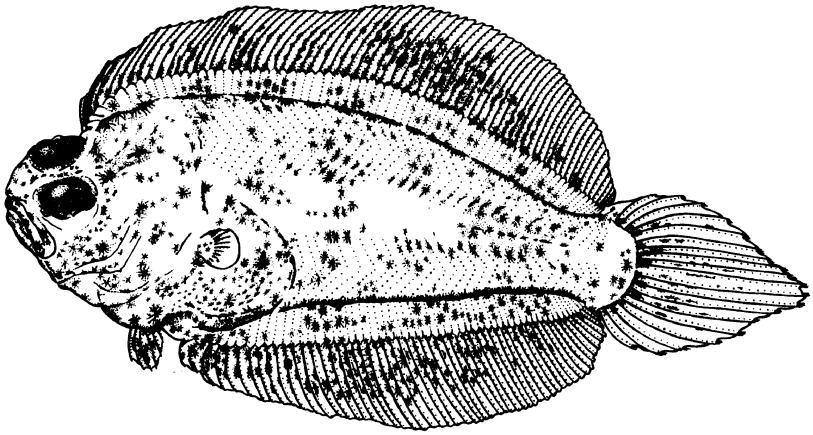
D. 7.1 mmSL



19-31 postanal ventral melanophores, uniform in size and spacing. (*P. dentatus* larvae have 10-13 melanophores, not uniform in size or spacing.)

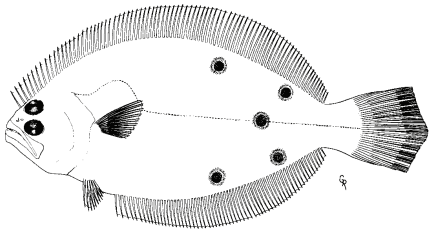
E. 8.2 mmSL

Based on lab-reared specimens; field-collected larvae tend to be less intensely pigmented



F. 9.0 mmSL

Paralichthys dentatus (Linnaeus, 1766)
Paralichthyidae
Summer flounder



Range: Western North Atlantic Ocean from Nova Scotia to northern Florida; most common south of Cape Cod

Habitat: Continental shelf on sand or mud substrates; also found in estuaries with seagrass beds on muddy or silty bottoms; usually offshore in winter, in depths to 155 m

Spawning: Mostly during the fall, while migrating offshore for the winter; minor spawning also occurs in southern part of Middle Atlantic Bight during spring

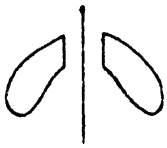
Meristic Characters

Myomeres:	41–42
Vertebrae:	11+30–31
Dorsal fin rays:	80–96
Anal fin rays:	61–73
Pectoral fin rays:	12–13
Pelvic fin rays:	6/6
Caudal fin rays:	18–19 (total)

Eggs:
- Pelagic, spherical
- Diameter: 0.95–1.03 mm
- Chorion: smooth and transparent
- Yolk: homogeneous
- Oil globule: single, 0.17–0.23 mm
- Perivitelline space: narrow

Yolk-sac larva

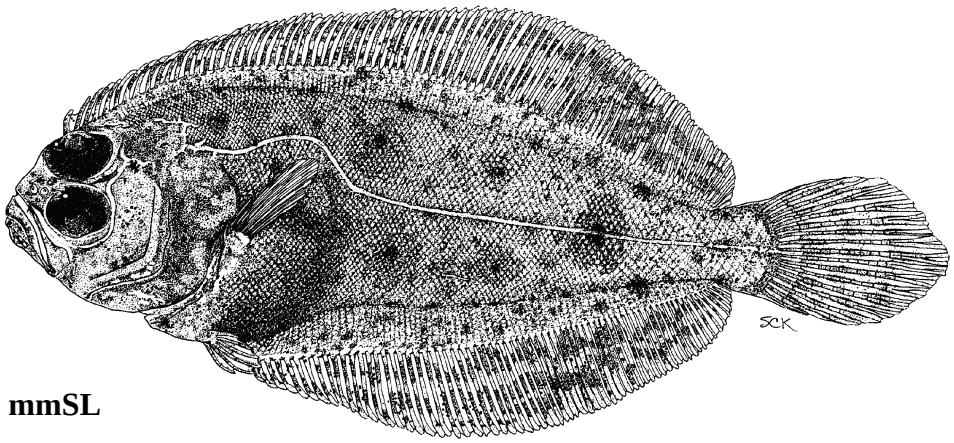
Larvae:
- Hatching occurs at 2.4–2.8 mmNL; eyes unpigmented, mouth parts unformed; oil globule posterior in yolk
- Preanus length decreases from 48%NL to 30% SL; body depth increases from 14% NL to 45% SL
- Head length ranges from 23–27%SL through development
- Teeth first visible and vertebrae ossified at about 9.5 mmSL
- Flexion occurs at 9–10 mmSL
- Spines: 1 cranial spine on each side at hatching, increase to 2–3 per side, directed anteriorly; 5–7 preopercle spines at 4.5–9.5 mmSL; 2–5 opercle spines at 8.6–9.5 mmSL; all spines disappear during transformation
- Sequence of fin ray formation: D – C – A – P_2 – P_1
- Pigmentation: in early larvae, anterior 2/3 of body and finfold with scattered melanophores; later larvae have row of 10–13 melanophores along ventral edge of body, and 6–8 separated melanophores along dorsal edge



Position of pelvic fins

Early Juvenile:

Transformation occurs between 9.5 and 12–13 mmSL

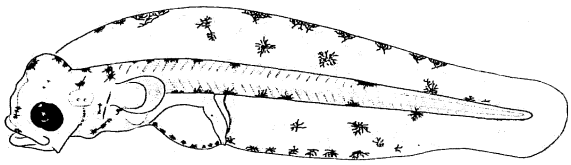


F. 27.0 mmSL

Figures: Adult: Grady Reinert (Gutherz, 1967); Yolk-sac larva and **A–D**: Smith and Fahay, 1970 (redrawn); **E–F**: Susan Kaiser (Able and Fahay, 1998)

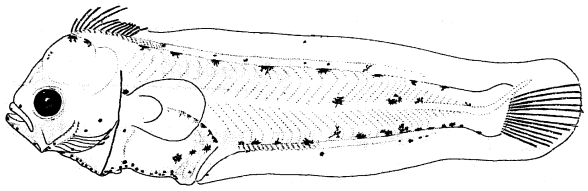
References: Deubler, 1958; Rothschild and Deubler, 1960; Gutherz, 1967; Woolcott *et al*., 1968; Morse, 1981; Able *et al*., 1990; Able and Fahay, 1998

Paralichthys dentatus



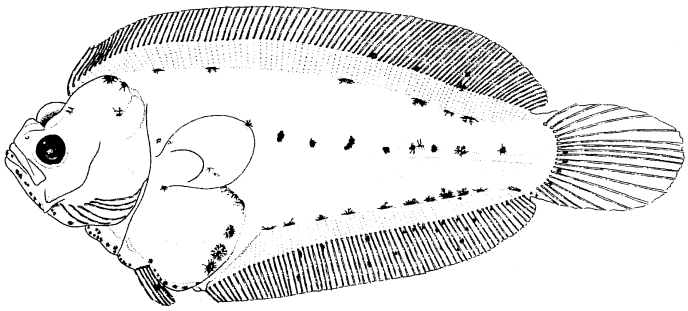
A. 3.2 mmNL

Edge of preanal finfold pigmented



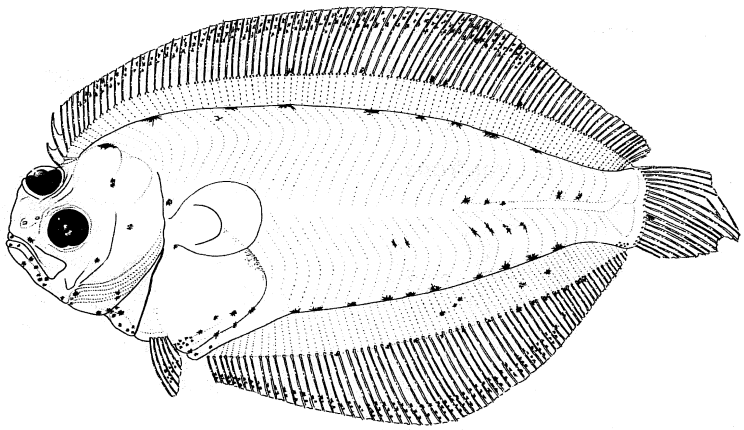
Note anteriorly directed cranial spines

B. 9.5 mmNL



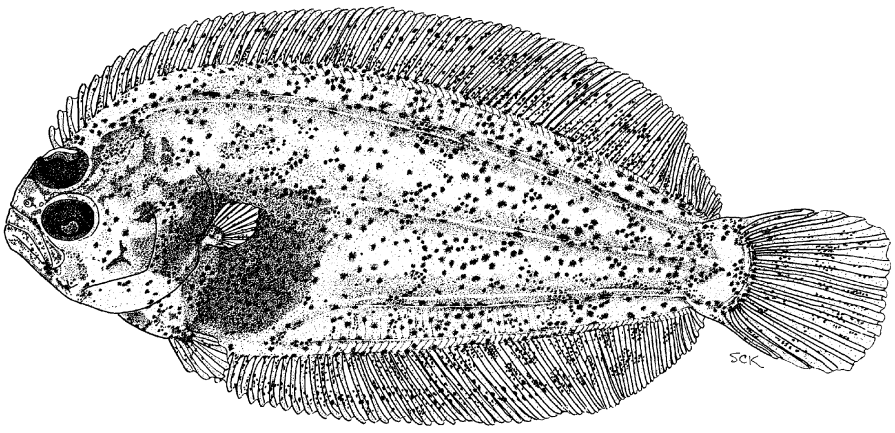
Note 3 melanophores on posterior midline, and a row of internal melanophores along notochord

C. 12.1 mmSL



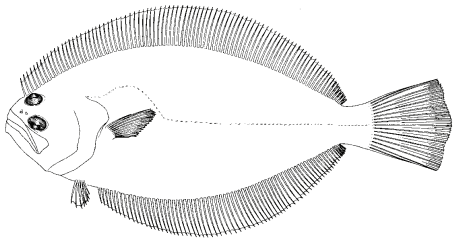
Melanophores form on margins of dorsal and anal fins

D. 12.6 mmSL



E. 18.0 mmSL

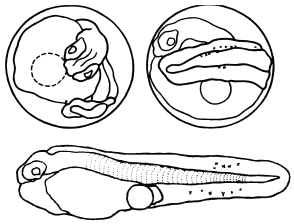
Paralichthys lethostigma Jordan and Gilbert 1884
Paralichthyidae
Southern flounder



Range: Western North Atlantic Ocean from North Carolina to Texas, except southern Florida

Habitat: Bays, inlets and inner continental shelf; often occurs in brackish or fresh water

Spawning: Fall and winter as spawners move offshore Oct–Dec; larvae infrequently collected in southern part of study area



Yolk-sac larva

Meristic Characters

Myomeres:	37–39
Vertebrae:	10–11+27–28
Dorsal fin rays:	80–95
Anal fin rays:	63–74
Pectoral fin rays:	11–13
Pelvic fin rays:	6/6
Caudal fin rays:	18–19 (total)

Eggs:
- Pelagic, spherical
- Diameter: 0.84–0.96 mm
- Chorion: Smooth and transparent
- Yolk: homogeneous
- Oil globule: single, 0.16–0.20 mm in diameter
- Perivitelline space: narrow

Position of pelvic fins

Larvae:
- Hatching occurs at 2.0–2.2 mmNL, eyes unpigmented, mouth parts unformed, oil globule posterior in yolk
- Yolk-sac larvae have scattering of pigment on mid-tail and finfold; the oil globule is unpigmented
- Weak preopercle spines (4–5 plus a larger one at angle) decrease in number with increasing size; disappear by 8.5 mmSL
- 3 tiny, cranial spines; disappear before postflexion stage
- Sequence of fin ray formation: D – C – A – P_2 – P_1
- Pigmentation includes mid-dorsal and mid-ventral series of melanophores that are nearly, but not quite, paired and contiguous; internal pigment on notochord; both finfolds have a scattering of pigment, but in later larvae this is not as dense as it is in *P. albigutta*; gut pigment is also not as dense as it is in *P. albigutta*; a single spot occurs on the lower pectoral fin-base.
- Pigment increases during transformation, including patches on dorsal and anal fins, base of caudal fin, and on body, but not aligned with myosepta

Note: Meristic characters in 4 congeners

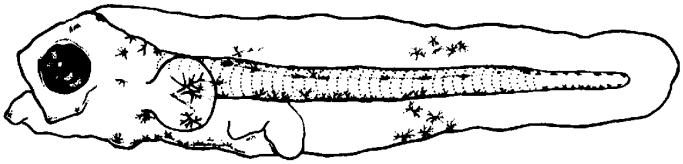
Species	Vertebrae	Dorsal Fin Rays	Anal Fin Rays
Paralichthys albigutta	10+27	71–85	53–63
Paralichthys dentatus	11+30–31	80–96	61–73
Paralichthys lethostigma	10–11+27–28	80–95	63–74
Paralichthys squamilentus[1]	10+27–29	76–85	59–65

[1] Not recorded from study area

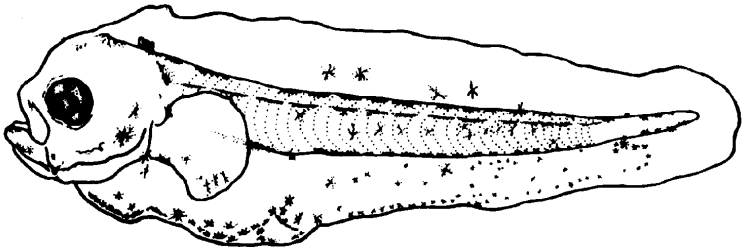
Figures: Adult: Grady Reinert (Gutherz, 1967); Eggs, yolk-sac larva and **A–D**: Powell and Henley, 1995

References: Deubler, 1958; Rothschild and Deubler, 1960; Powell and Henley, 1995

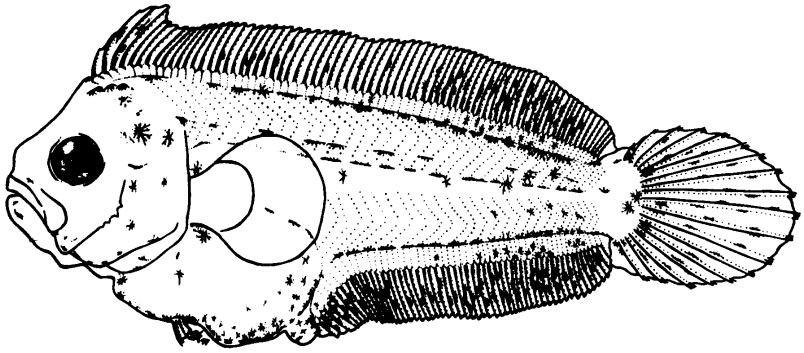
Paralichthys lethostigma



A. 3.3 mmNL



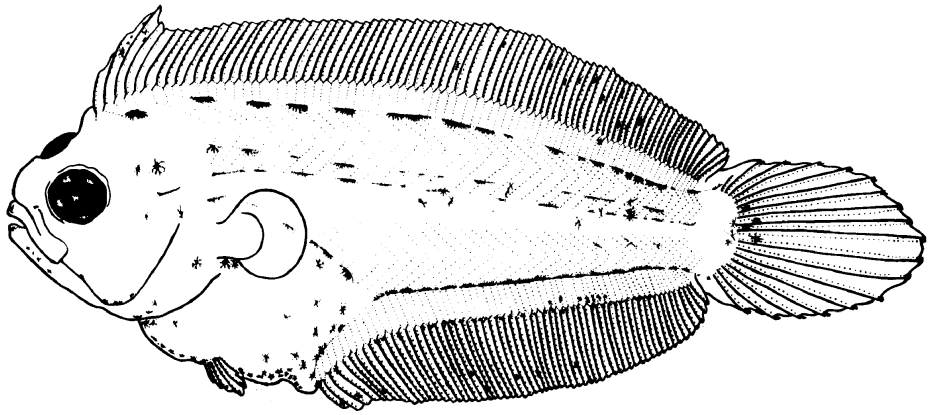
B. 6.4 mmNL



19-31 postanal ventral melanophores; uniform in size and spacing. (*P. dentatus* larvae have 10-13 melanophores, not uniform in size or spacing.)

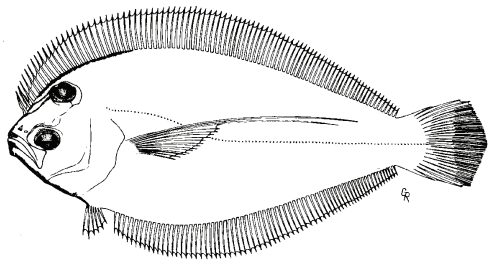
C. 7.7 mmSL

Based on lab-reared specimens; field-collected larvae tend to be less intensely pigmented



D. 9.1 mmSL

Syacium papillosum (Linnaeus, 1758)
Paralichthyidae
Dusky flounder



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

Habitat: Inner continental shelf; 9–137 m (usually < 90 m)

Spawning: Undescribed; larvae occur in study area spring through fall, with a peak Jul–Sep

Eggs:
- Undescribed

Larvae:
- Teeth visible early (at about 3 mm NL)
- Bulge in forehead profile 4–6 mmSL
- Head length increases from 26 to 34% SL
- Preanus length decreases from 48–39% SL
- Body depth increases from 24–43% SL
- Cranial spines (1 per side) at 2–8 mmSL
- Preopercle spines 4–7; large spine at preopercle angle develops a spur
- Anterior 5–8 dorsal fin rays elongate (form at about 3 mm)
- Pelvic fin rays not elongate, but left fin longer than right until transformation
- Flexion occurs at 5–7 mmSL
- Vertebrae completely ossified at 6 mmSL
- Sequence of fin ray formation: D – A, P_2, C – P_1
- Pigmentation: note pigment on distal 1/3 of pelvic fin; melanophore near cranial spine; row of melanophores along ventral edge in early larvae; most myomeres have single spot at dorsal and ventral margin; 5 groups of melanophores along dorsal edge; 3–4 groups along ventral edge; midline pigment forms in larger larvae
- Transformation occurs at 15–22 mmSL

Meristic Characters

Myomeres:	33–36
Vertebrae:	10+25–26
Dorsal fin rays:	79–94
Anal fin rays:	62–75
Pectoral fin rays:	11–12
Pelvic fin rays:	6/6
Caudal fin rays:	17 (total)

Position of pelvic fins

Note:

1. A congener, *Syacium micrurum*, occurs in coastal waters from Florida to Brazil. Adults are best distinguished by number of lateral line scales (57–69, cf. 44–57 in *S. papillosum*) and by subtle differences in body shape and proportion (Murakami and Amaoka, 1992). The larvae of this species are undescribed, but probably resemble those of *S. papillosum*.

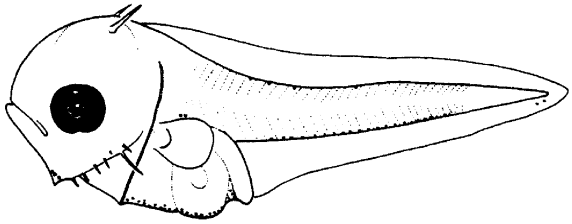
2. Another congener, *Syacium gunteri*, occurs in coastal waters from Florida to French Guiana. Adults are best distinguished by deeper bodies and wider inter-orbital spaces than in *S. micrurum* or *S. papillosum*. The larvae of this species are also undescribed.

3. If reproduction of *Syacium micrurum* or *S. gunteri* occurs off the coast of Florida, the resulting larvae of either species may drift north *via* the Gulf Stream and might be subject to collection in the study area.

Figures: Adult: Grady Reinert (Gutherz, 1967); **A–D**: Futch and Hoff, 1971 (all redrawn)

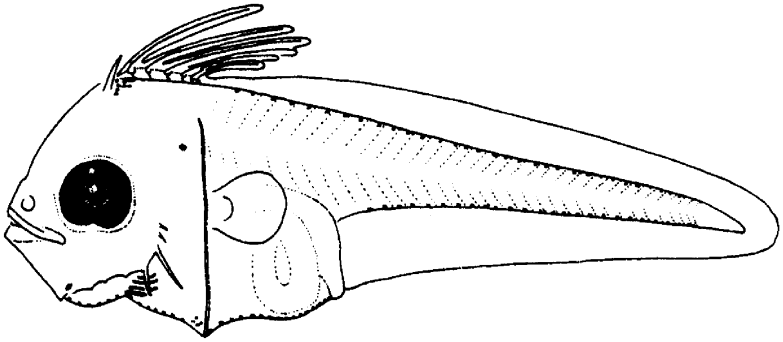
References: Futch and Hoff, 1971; Evseenko, 1979; Murakami and Amaoka, 1992

Syacium papillosum

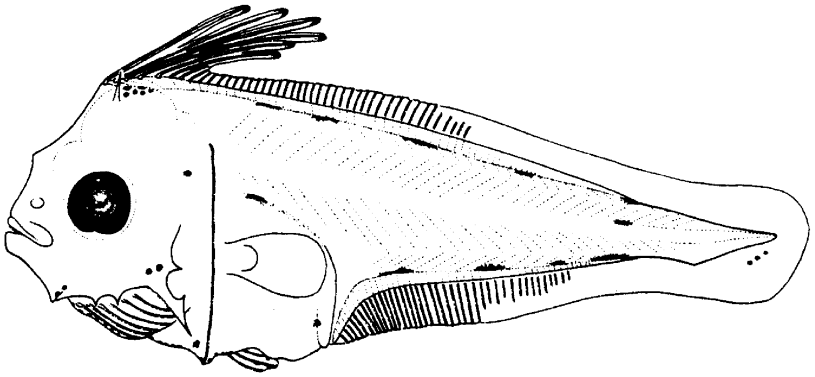


A. 2.3 mmNL

Note cranial spine

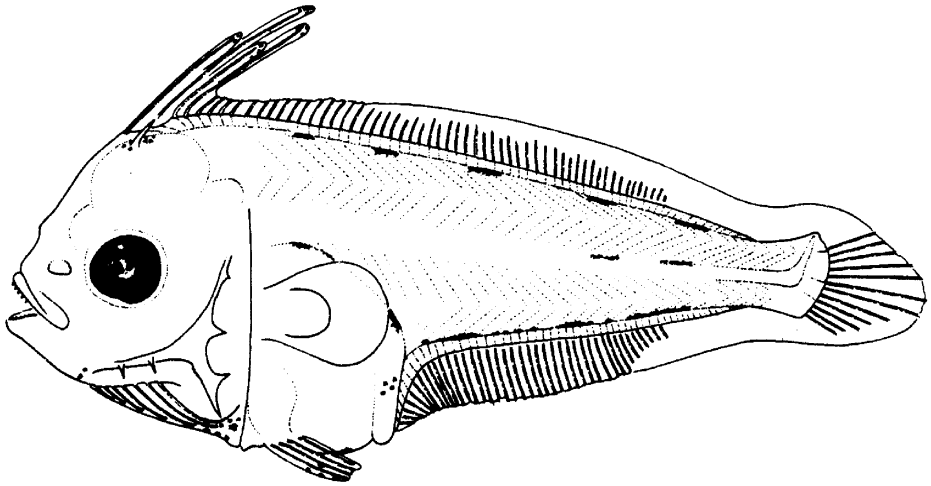


B. 3.3 mmNL



Large spine at preopercle angle develops a spur

C. 5.5 mmSL



D. 6.0 mmSL