Beloniformes

Selected meristic characters in species belonging to the order Beloniformes whose adults or larvae have been collected in the study area. Classification sequence follows Eschmeyer, 1990 and Collette *et al.*, 1984. Sources: Bruun, 1935; Berry and Rivas, 1962; Staiger, 1965; Parin, 1986; 2002a; Collette, 2003a; 2002p; Hardy and Collette, 2003.

Family Species	Vertebrae	Dorsal Fin Ray(+finlets)	Anal Fin Rays (+ finlets)	Pectoral Fin Rays	Gill Rakers on First Gill Arch
Scomberesocidae					
Scomberesox saurus	64–70	9-12 (+5-6)	12-13 (+5-7)	12–15	34–45
Belonidae					
Ablennes hians	93–97	23–26	24–27	12-15	None
Strongylura marina	69–77	14–17	16-20	9-12	None
Tylosurus acus	90–95	22–26	20-24	13–14	None
Tylosurus crocodilus	80-84	21–23	18–22	13–15	None
Hemiramphidae					
Euleptorhamphus velox	71–73	21–24	20-24	7+1	27–35
Hemiramphus balao	54-56	11–15	10-13	10-12	31–37
Hemiramphus brasiliensis	52-55	12–15	11-15	10-12	28–33
Hyporhamphus meeki	50-53	12–16	14-18	10–13	27–40
Oxyporhamphus micropterus	49–51	13–15	13–16	11–13	30–35
Exocoetidae					
Cheilopogon cyanopterus	43–46	12–14	9–11	13–15	21–28
Cheilopogon melanurus	45–48	12–13	8-10	13-17	20–26
Cheilopogon exsiliens	43–44	13–15	8-10	13–16	16–26
Cheilopogon furcatus	44–46	11-14	8-12	14–17	18–24
Cypselurus comatus ¹	44–47	11–13	8–9	12-14	18–24
Exocoetus obtusirostris	42–45	12–14	12-14	15-17	22–29
Exocoetus volitans	43–45	13–15	12-14	14–16	29–37
Hirundichthys affinis	45–47	10-12	11–13	16–18	26–30
Hirundichthys rondeletii	45–46	10-12	11–13	16–19	24–29
Hirundichthys speculiger	45–47	10–13	11–13	17-20	21–29
Parexocoetus hillianus	36–40	9–14	10-14	11-13	26–33
Prognichthys occidentalis	42–44	10-13	8-10	15–19	20–26

¹ A tropical species (Florida to Brazil), but the original description was based on the collection of young stage "...with long mental barbel..." off New York (Mitchill, 1815).

Beloniformes

Scomberesocidae: A single species (*Scomberesox saurus*) occurs in the study area. It spawns large eggs, covered with short bristles. Larvae hatch at a large size and are heavily pigmented. A preanal finfold persists into later larval stages. Larger larvae lack greatly elongate upper or lower jaws, although the lower jaw becomes slightly longer than the upper. The presence of finlets behind the dorsal and anal fins (at sizes >20 mm) distinguish these larvae from those of other beloniform families.

Belonidae: This family is represented by 4 species in the study area. Their eggs are very large and covered with many long, threadlike, chorionic filaments. Larvae hatch at a large size, are heavily pigmented and with the urostyle already flexed and caudal fin rays formed. A preanal finfold persists into later larval stages. An elongate lower jaw "beak" forms in the early larvae of most species (during a "halfbeak stage") and this is joined by an elongate upper jaw in later larvae. The posterior portion of the dorsal fin is enlarged and darkly pigmented in larger larvae and juveniles of most species.

Hemiramphidae: This family is represented by 5 species in the study area. Eggs are moderately large and in most species are covered with many very long, threadlike, chorionic filaments. Larvae are not well described, but juveniles are fairly well known. Early stages are not as darkly pigmented as those of other families. A preanal finfold persists into later larval stages. The lower jaw elongates during ontogeny, but is not joined by an elongate upper jaw. The lower jaw "beak" is then lost in the adults of one species (*Oxyporhamphus micropterus*).

Exocoetidae: (See summary in Exocoetidae introductory pages.)

For a summary of the ontogeny of jaw formation in these families, and the phylogenetic significance of the various patterns, see Lovejoy *et al.* (2004).

Selected ontogenetic characters in beloniform families. The eggs of beloniform species in the study area lack oil globules. The number and arrangement of chorionic filaments are described in more detail in the species accounts. Sources: Mito, 1958; Imai, 1959; Parin and Gorbunova, 1964; Kovalevskaya, 1972; Berkeley and Houde, 1978; Hardy, 1978a; Collette *et al.*, 1984a; Watson, 1996k; Hardy and Collette, 2003.

Family	Egg Diameters	Egg Ornamentation	Hatching Size (mm)	First/Last Fin Rays to Form	Lower Jaw Beak
Scomberesocidae	1.5–2.5 mm (oval)	Numerous short bristles	4.0-8.5	Caudal/Pelvic	Slightly long, joined by slightly long upper jaw beak
Belonidae	3.0–4.1 mm	Long, chorionic filaments	6.8–14.4	Caudal/Pelvic	Long, joined by long upper jaw beak
Hemiramphidae	1.5–2.5 mm	Long, chorionic filaments ¹	3.0-11.0	C, D, A/Pelvic	Long, retained through adult stage
Exocoetidae	1.5–2.0 mm	Long, chorionic filaments ²	3.5-6.1	Caudal/Pectoral	Absent in most; present, then disappears in some species ³

¹ Length greatly reduced in Oxyporhamphus micropterus

² Except none in *Exocoetus*

³ In Fodiator and Parexocoetus

Scomberesox saurus (Walbaum, 1792) Scomberesocidae

Atlantic saury



Range:	Atlantic, Pacific and Indian oceans in temperate waters, mostly avoiding tropical latitudes; in the western North Atlantic from Newfoundland to Cape Hatteras, with scattered occurrences as far south as $32^{\circ}N$	Mer Myo Verte Dors
Habitat:	Epipelagic and highly oceanic, especially north and west of Gulf Stream; abundant in waters beyond continental shelf depths	Anal Pecto
Spawning:	Occurs year-round, well offshore at temperatures between $16.5^\circ C$ and $23.5^\circ C$	Cauc
Eggs:	 Moderately large, slightly oval Greatest diameter: 2.15–2.76 mm Chorion: equipped with numerous very short, rigid, uniformly spaced bristles (remnants of chorionic filaments) Yolk: homogeneous Oil globules: none 	
Larvae:	 Hatching occurs at lengths of 4–8 mm; eyes pigmented, flexion underway Body long and slender; preanus length 60–70% TL Caudal fin well-developed at hatching Sequence of fin ray formation: C – A, D – P₁, P₂ Dorsal, anal and pelvic fins located posteriorly on body Finlets form posterior to dorsal and anal fins at sizes >25 mm Note persistent preanal finfold 	

- Pelvic fin buds appear at 14-17 mm; rays form at about 20 mm
- Both jaws begin to elongate at 38-40 mm
- Pigmentation at hatching includes dense, deep blue coloring over entire body, excluding fins and yolk; later stages characterized by dark blue dorsum and silvery flanks
- Transformation occurs at about 25 mm when fin rays and finlets are complete

Juvenile:



F. 100 mmTL

Figures: Adult: H. L. Todd; Egg: Collette *et al.*, 1984a; A: Hardy and Collette, 2003; B: Sanzo, 1940a (redrawn); C: d'Ancona, 1931 (redrawn); D-F: d'Ancona, 1931 (redrawn in Hardy, 1978a)

Meristic CharactersMyomeres:64-68Vertebrae:64-70Dorsal fin rays:9-12 (+5-6 finlets)Anal fin rays:12-13 (+ 5-7 finlets)Pectoral fin rays:12-15Pelvic fin rays:6Caudal fin rays:7+8 (PrC)



Scomberesox saurus



B. 7.5 mmSL







E. 48.0 mmTL

Ablennes hians (Valenciennes, 1846) Belonidae Flat needlefish



Myomeres:

Vertebrae:

Dorsal fin rays:

Meristic Characters

93-97

93-97

23-26

24-27

12-15

6

Range:	Worldwide in tropical and warm-temperate waters; in the western North Atlan- tic from Massachusetts to Brazil	
Habitat:	Epipelagic in open ocean, usually not in coastal waters	
Spawning:	Occurs in spring (at least) in offshore waters	
Eggs:	– Diameter: 3.0–3.5 mm	

- Chorion equipped with uniformly spaced tufts of filaments, 1-6 per tuft, 37–59 total; filaments longer than diameter of egg - Oil globules: none
- Anal fin rays: Pectoral fin rays: Pelvic fin rays: Caudal fin rays: 7+8 (PrC)

- Larvae: - Hatching length undescribed
 - Caudal fin formed at hatching and flexion underway
 - Body long, slender and tapered
 - Preanus length about 66% TL
 - Pectoral and pelvic fins small in size, late-forming
 - Note persistent preanal finfold
 - Dorsal and anal fins large, posteriorly placed
 - Prominent, enlarged, melanistic lobe forms in posterior part of dorsal fin
 - Note high numbers of anal fin rays (24-27) compared to other belonids
 - Early stages pass through a "half-beak stage" wherein the lower jaw elongates before the upper; note differences in relative jaw lengths between 12 and 36 mm
 - Heavy, uniform pigment forms over most of body, interrupted by 3 relatively pale 'saddles' on dorsum
- Note: 1. Vertical pigment bars and posterior, pigmented dorsal fin lobe retained in juveniles

Early Juvenile:

	With and the second second

E. 187.0 mmSL

780

Figures: Adult: Collette, 2002p; A-C: Chen, 1988; D: Mildred H. Carrington (Collette et al., 1984a); E: Collette, 2003a Fahay, 1983; Collette et al., 1984a; Chen, 1988; Collette 2003a **References**:

Ablennes hians



D. 36.1 mmSL

Strongylura marina (Walbaum, 1792) Belonidae Atlantic needlefish



Range:	Western North Atlantic Ocean from Massachusetts to Brazil; does not occur in Bahamas or West Indies	Meristic Characters Myomeres: 69–77
Habitat:	Epipelagic in oceanic and estuarine waters; also extends into freshwater habi- tats	Vertebrae: 69–77 Dorsal fin rays: 14–17
Spawning:	Occurs in bays and estuaries during spring and summer; eggs often deposited among mats of algae	Anal fin rays: 16–20 Pectoral fin rays: 9–12 Pelvic fin rays: 6
Eggs:	 Diameter: 3.5–3.6 mm Chorion: equipped with numerous filaments, distributed over the entire cho- 	Caudal fin rays: 3+7+8+3
	rion surface; filaments about equal to or <egg diameter<br="">– Oil globules: none</egg>	- HANNA
Larvae:	 Hatching occurs at 9.2–14 mm Flexion underway at hatching Body long, slender and tapered Preanus length about 66% TL Sequence of fin ray formation: C – D, A – P₁ – P₂ Note persistent preanal finfold Dorsal and anal fins large, posteriorly placed Enlarged melanistic lobe looking in dorsal fin 	
	 Pigment heavy, especially below midline of body and in 2 distinct rows on eac Early stages pass through a "half-beak stage" wherein the lower jaw elongates be er jaws are about equal in length when juveniles reach about 100 mm; note diffuse between juvenile (Fig. C) and adult 	h side of mid-dorsal line before the upper; upper and low- fferences in relative jaw lengths

Western North Atlantic Ocean from Massachusetts to Brazil; does not occur in

- Juvenile: - Growth is very fast in young-of-the-year and individuals may reach lengths of 40 cm before their first winter; juveniles occupy epi-pelagic, estuarine habitats where they swim very close to the surface; they are found in open bay waters as well as subtidal creeks and subtidal shorelines, but do not occur in intertidal creeks or in marsh-surface pools
 - Juveniles in the study area occur far upstream, often into freshwater (e.g. Chesapeake Bay); they have occurred as far up the Delaware River as Trenton, and as far up the Hudson River as the Tappan Zee Bridge
 - Juveniles apparently leave estuaries in September and spend their first winter south of the study area (Able and Fahay, 1998)

Figures: Adult: Mildred H. Carrington (Collette, 2002b); Egg: Ryder, 1882; A-B: Peni G. Lang (Hardy, 1978a); C: Collette et al., 1984a

Range:

Pelvic fin rays: Caudal fin rays:	6 3+7+8+3
AL.	

Strongylura marina



A. 12.0 mmTL



B. 14.4 mmTL



C. 23.5 mmSL

Tylosurus acus (Lacepède, 1803) Belonidae Agujon needlefish



Meristic Charac	eters
Myomeres:	90–95
Vertebrae:	90–95
Dorsal fin rays:	22-26
Anal fin rays:	20-24
Pectoral fin rays:	13-14
Pelvic fin rays:	6
Caudal fin rays:	7+8 (PrC)



Range:	Worldwide (except eastern Pacific Ocean) in tropical and subtropical waters; the subspecies <i>Tylosurus acus acus</i> occurs in the western North Atlantic from Massachusetts and Bermuda to Brazil
Habitat:	Epipelagic in oceanic waters over continental shelf depths, less commonly in coastal waters
Spawning:	Spring through summer in tropical areas; probably occurs well offshore
Eggs:	– Demersal, spherical

- Diameter: 3.2–4.0 mm
 - Chorion equipped with uniformly spaced tufts of 2–3 filaments; filaments longer than egg diameter
 - Oil globules: none

Larvae: - Hatching occurs at 10.2 mm; caudal fin formed, flexion underway

- Body long, slender and tapered; preanus length about 66% TL
- Note persistent preanal finfold
- Dorsal and anal fin rays form before hatching
- Pectoral and pelvic fins small in size, late-forming
- Prominent, enlarged, melanistic lobe forms in posterior part of dorsal fin
- Early stages pass through a weakly expressed "half-beak stage" wherein the lower jaw elongates only slightly earlier than the upper; note differences in relative jaw lengths in juveniles
- Heavy pigmentation covers body, especially dense along lower half of flanks

Early Juveniles:



H. 130 mmSL

Young stages have a light green background color and sometimes have 4 silvery bars crossing the body through the eye, just before level of pelvic fins, at the dorsal fin origin, and across the caudal peduncle

Figures: Adult: Collette, 2002p; Egg: Mito, 1958; A: Mito, 1958 (redrawn); B-F: Chen, 1988; G: Parin, 1967; H: Collette *et al.*, 1984a

Tylosurus acus



Larvae in Figs. B-F based on the subspecies Tylosaurus acus melanotus from Pacific Ocean

Tylosurus crocodilus (Péron and Lesueur, 1821) Belonidae Hound needlefish



Range:	Worldwide (except eastern Pacific Ocean) in tropical and warm-temperate	Meristic Charac	ters
	waters; in the western North Atlantic from North Carolina and Bermuda to	Myomeres:	80–84
	Brazii	Vertebrae:	80–84
Habitat:	Pelagic in oceanic waters over continental shelf depths; more common in coast-	Dorsal fin rays:	21–23
	al waters than Tylosurus acus	Anal fin rays:	18–22
a .		Pectoral fin rays:	13–15
Spawning:	Occurs during spring in tropical areas, possibly more protracted; eggs attached	Pelvic fin rays:	6
	to vegetation	Caudal fin rays:	7+8 (PrC)
Eggs:	– Demersal, spherical		
60	– Diameter: 4.0–4.1 mm		
	- Chorion equipped with numerous, long filaments	\Box	
	- Oil globules: none or minute, scattered	N A B B B	
Larvae:	- Hatching occurs at 10.7-12.0 mm; caudal fin formed, flexion underway		ah .
	- Body long, slender and tapered		7 77 \
	– Preanus length about 66% TL		(\mathcal{A})
	- Pectoral and pelvic fins small in size, late-forming	27F	<u> </u>
	 Note persistent preanal finfold 	$\langle \cdot \rangle$	
	- Dorsal and anal fins large, posteriorly placed		
	- Prominent, enlarged, melanistic lobe forms in posterior part of dorsal fin		
	- Early stages do not pass through a "half-beak stage" as in other belonids; upp	er jaw almost equal	in length to
	lower through development		
		1 0 110	· . •

- Heavy, uniform pigment forms over most of body, especially dark along midline; base of caudal fin with prominent black pigment

Early Juvenile:



G. 96.3 mmSL

Γ Worldwide (except eastern Pacific Ocean) in tronical and warm-temperate

Myomeres:	80-84
Vertebrae:	80-84
Dorsal fin rays:	21-23
Anal fin rays:	18-22
Pectoral fin rays:	13-15
Pelvic fin rays:	6
Caudal fin rays:	7+8 (PrC)



Tylosurus crocodilus





Euleptorhamphus velox Poey, 1868 Hemiramphidae Flying halfbeak

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

- Habitat: Epipelagic in open ocean; also around islands
- **Spawning**: Not well described; one observation of ripe female in spring (May)
- Eggs: Undescribed
- Larvae: (Based on early stages of *Euleptorhamphus viridis*; see note box opposite) - Body very long and slender
 - Preanus length about 70% SL (tip of snout to caudal fin base)
 - Lower jaw becomes very prolonged early in development
 - Caudal, dorsal and anal fin rays form early, followed by pectoral fin rays; pelvic fin rays last to form
 - Dorsal and anal fin bases long, positioned well posteriorly on body
 - Small preanal finfold persists after formation of pelvic fin
 - Lower lobe of caudal fin becomes longer than upper in late larvae and juveniles
 - Pigment includes prominent stripe along upper edge of gut, continues forward to form bar behind eye; dorsum
 of head and body well pigmented; later larvae have well-defined stripe along midline of body

Note: 1. Distinguished from other hemiramphids in study area by extremely slender body shape, high number of myomeres/vertebrae, high dorsal and anal fin ray counts and early prolongation of lower jaw

Meristic CharactersMyomeres:about 71–73Vertebrae:71–73Dorsal fin rays:21–24Anal fin rays:20–24Pectoral fin rays:7 + 1 splintPelvic fin rays:6Caudal fin rays:7+8 (PrC)

 Figures:
 Adult: Collette, 2002p; A: Watson, 1996k; B–C: Chen, 1988; D: Collette, 1965

 References:
 Collette *et al.*, 1984a; Chen, 1988; Collette, 1965; 2002p; 2003b

Euleptorhamphus velox (Euleptorhamphus viridis)



D. 135 mmSL (E. velox, juvenile)

Larvae of *Euleptorhamphus velox* are undescribed. Early stages of a closely related species from the Pacific Ocean, *E. viridis*, are included here based on the assumption that they are similar to those of *E. velox*.

Hemiramphus balao (Lesueur, 1821) Hemiramphidae Balao halfbeak



Meristic Characters

Myomeres:

Range:	Western North Atlantic Ocean from New York to Brazil, including Gulf of
	Mexico and Caribbean Sea; also eastern tropical Atlantic

- Habitat: Epipelagic in open ocean; usually not approaching coastal waters
- Spawning: Spring-early summer; females spawn daily batches
- Eggs: Demersal, spherical, attached to vegetation
 - Diameter: about 1.5–1.6 mm
 - Chorion equipped with many threadlike filaments with well-separated attachment points
 - Oil globules: none
- Larvae: Undescribed
 - Larvae of *Hemiramphus saltator* from the eastern Pacific are densely pigmented over the entire head and body; the lower jaw begins to elongate at about 14 mm; caudal, dorsal and anal fin rays form early, pectoral fins begin with formation of the upper rays at about 8.0 mm, and pelvic fin rays form last. See Watson (1996k) for illustrations and description.

Vertebrae:	54-56
Dorsal fin rays:	11-15
Anal fin rays:	10-13
Pectoral fin rays:	10-12
Pelvic fin rays:	6
Caudal fin rays:	7+8 (PrC)

about 54-56



- **Notes**: 1. In juvenile *Hemiramphus balao*, the pelvic fins acquire heavy pigment at the base of the rays (Fig. C); this contrasts with the pelvic fins of *Hemiramphus brasiliensis*, where the pigment is most dense at the tips of the rays, and *Hyporhamphus meeki*, where pelvic fin pigment is absent.
 - 2. Body pigment bars are typical in the juveniles of *Hemiramphus*, but these are retained in sizes >175 mm in *H. balao*; these bars are lost in *H. brasiliensis* at sizes smaller than 120 mmSL and are absent in juveniles of *Hyporhamphus*. Body pigment bars are also absent in juveniles of *Euleptorhamphus velox* and *Oxyporhamphus micropterus*.

Hemiramphus balao



Hemiramphus brasiliensis (Linnaeus, 1758)





Range:	Western North Atlantic Ocean from Massachusetts to Brazil, including Gulf of Mexico and Caribbean Sea; also eastern tropical Atlantic; absent from Bermuda
Habitat:	Epipelagic in oceanic waters, often in large schools; also inshore near sea grass beds
Spawning:	Spring through summer; eggs attached to submerged aquatic vegetation
Eggs:	 Demersal, spherical, attached to vegetation Diameter: about 2.4 mm Chorion equipped with many threadlike filaments originating from all points of egg surface, but with tips congregating at one end Oil globules: none
Larvae:	 Hatching occurs at 5–7 mmSL Body long, slender, not tapered Preanus length about 66–75% of SL Note persistent preanal finfold Sequence of fin ray formation undescribed Dorsal and anal fins small and positioned posteriorly Lower jaw begins to elongate at about 30–40 mmSL

- Posterior dorsal fin rays become elongate and pigmented; posterior anal fin rays also become pigmented, but are only slightly elongate
- Pigment light until a length of 13 mmSL; 2 rows of small spots form along dorsal edge; dorsal and ventral rows of pigment give way to a bold stripe along midline of body; pigment bars form across body in juveniles, but are lost at about 120 mmSL (cf: Hemiramphus balao).

Meristic Characters		
Myomeres:	about 52–55	
Vertebrae:	52-55	
Dorsal fin rays:	12-15	
Anal fin rays:	11-15	
Pectoral fin rays:	10-12	
Pelvic fin rays:	6	
Caudal fin rays:	7+8 (PrC)	



Hemiramphus brasiliensis



D. 119 mmSL

Hyporhamphus meeki Banford and Collette, 1993 Hemiramphidae Meek's halfbeak



Dongo	Western North Atlantic Occup from Cone Cod to Elevide, northern Gulf of		
Kange.	Mexico and Yucatan Peninsula	Meristic Characters	
Habitat:	Strongly surface oriented in coastal ocean and estuarine waters; often over sandy substrates near submerged vegetation	Myomeres: about 50–53 Vertebrae: 50–53 Dorsal fin rays: 12–16	
Spawning:	Summer (Chesapeake Bay); eggs attached to floating eel grass blades	Anal fin rays: 14–18 Pectoral fin rays: 10–13	
Eggs:	Demersal, spherical, attached to vegetationDiameter: 2.0 mm	Pelvic fin rays: 6 Caudal fin rays: 7+8 (PrC)	
	 Chorion equipped with several very long filaments Oil globules: none 		
Larvae:	 Hatching occurs at sizes <3.0 mm Body long, slender, not tapered Preanus length about 66% of TL Note persistent preanal finfold Dorsal and anal fins small and positioned posteriorly; posterior dorsal fin rays do not elongate Lower jaw begins to elongate at about 10–15 mmSL Lower lobe of caudal fin not elongate Dorsal pigment heavy at small sizes; 2 rows of large, dorsal spots almost merge posteriorly (Fig. E); row of melanophores forms along gut; line of pigment present along base of anal fin 		
Note:	1. Records of Hyporhamphus unifasciatus (Ranzani, 1841) in the present study	y area probably refer to Hypor-	

Ν refer to Hyporhamphus meeki. The range of H. unifasciatus includes tropical waters from southern Florida to Venezuela, where it occurs in inshore waters (including estuaries) along coasts and around islands in the Caribbean Sea. It also occurs in Bermuda, but it is unlikely that it drifts very far into oceanic waters, and there are no records of its young stages occurring north of 35°N.

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Hyporhamphus meeki



E. 15.8 mmSL (Dorsal View)

Oxyporhamphus micropterus Bruun, 1935 Hemiramphidae





Meristic Characters

about 49-51

49-51

13-15

13-16

11-13

6

7+8 (PrC)

Myomeres:

Dorsal fin rays:

Pectoral fin rays:

Pelvic fin rays:

Caudal fin rays:

Anal fin rays:

Vertebrae:

Range:	Atlantic Ocean in tropical and subtropical waters; in the western North
	Atlantic from 40°N to equator, including Gulf of Mexico and eastern Carib-
	bean Sea; a different subspecies occurs in the Indo-Pacific Ocean

Habitat: Epipelagic in oceanic waters, usually far from coast

Spawning: Undescribed

- Pelagic, spherical, pinkish-brown
 - Diameter: 1.8-2.1 mm
 - Chorion equipped with 74-120 very short attachment filaments
 - Oil globules: none

Larvae: - Hatching occurs at about 3.0 mmSL; body moderately long with bulging yolk mass, weakly pigmented eye, mouth well-formed, caudal fin rays formed

- Preanus length about 70% SL
- Note persistent preanal finfold after all fin rays are formed
- Caudal, dorsal and anal fin rays form early, followed by pectoral and pelvic fin rays
- Dorsal and anal fins short-based, located far posteriorly; pectoral fins moderately elongate
- Lower lobe of caudal fin begins to elongate soon after acquisition of fin rays
- Early stages pass through a "half-beak stage" wherein the lower jaw elongates before the upper; note increase in lower jaw length during larval and early juvenile stage, followed by loss of elongate lower jaw in late juvenile stage (at about 70–100 mmSL)
- Pigment includes dense line of melanophores along dorsum of body and top of head; cluster of spots present along dorsal surface of gut; patch of pigment spots on opercle

Early Juveniles:



I. 70.0 mmSL

(Note pigment on dorsal and anal fins)

 Figures:
 Adult: Collette, 2002p; Egg1: Imai, 1959; Egg2: Kovalevskaya, 1980; A: Nancy Arthur (Watson, 1996k); B, C: Kovalevskaya, 1963 (redrawn); D–F: Chen, 1988; G, I: Collette, 2003b; H: Kovalevskaya, 1963

References: Imai, 1959; Kovalevskaya, 1963; 1980; Fahay, 1983; Collette et al., 1984; Watson, 1996k; Collette, 2002p; 2003b

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Eggs:



G. 38.6 mmSL

Exocoetidae

Exocoetidae: The early stages of 12 species of flyingfishes may be encountered in the study area. Some of these may only occur in Gulf Stream or northern Sargasso Sea waters. Eggs are only moderately large and most have a uniform covering of long, threadlike, chorionic filaments, or filaments grouped into specific areas of the chorion. Species in one genus (*Exocoetus*) lack ornamentation on the egg surface. Eggs of most species are not buoyant, but their chorionic filaments are used to attach to floating objects such as *Sargassum*, floating sea grass, driftwood, straw, feathers, coconuts, empty bottles, drifting nets. The eggs of some may be deposited on benthic substrates, or may sink when their point of attachment becomes water-logged.

Larvae hatch at large sizes, although smaller than those of other beloniforms. Pigmentation is typically heavy. The preanal finfold does not persist into later larval stages. Early stages lack elongate upper or lower jaws, but species in 2 genera (not included here) go through a "halfbeak stage" wherein an elongate process forms on the lower jaw, and then is lost at transformation. Barbels form on the mandible tip of many species during the juvenile stage, but they are absent in some species.

Species	Jaw "Beak"	Mandibular Barbels	Pectoral/Pelvic Length	Pelvic Fin Origin	Dorsal Fin Height	Pectoral Fin Pigment
Cheilopogon cyanopterus	None	Paired, very long	Long/Long	Closer to anal fin	High, uniformly dark	Dark upper and outer rays
C. exsiliens	None	Paired, moderate	Long/Long	Closer to anal fin	High, patterned	Bands and 2 spots
C. furcatus	None	Paired, short- moderate	Long/Long	Closer to anal fin	Moderate, sparse pigment anteriorly	Strongly barred pattern
C. melanurus	None	Short	Long/Long	Between pectoral and anal fins	Moderate, few blotches	Several large blotches, pale background
Cypselurus comatus	None	Single, long	Long/Long	Closer to anal in	Not high, pigment absent	Uniformly pigmented
Exocoetus obtusirostris	None	None	Long/Short	Closer to pectoral fin	Not high, spot posteriorly	Usually clear
E. volitans	None	None	Long/Short	Closer to pectoral fin	Not high, unpigmented	Unpigmented
Hirundichthys affinis	None	None	Long/Long	Closer to anal fin	Moderately high, black distally	Mottled, dark spot and bands
H. rondeletii	None	None	Long/Long	Closer to anal fin	Moderately high, black distally	Dark with clear edge
H. speculiger	None	None	Long/Long	Closer to anal fin	Low, black edged	Mottled with band
Parexocoetus hillianus	Small, on lower jaw	Paired, moderate	Moderate/Short	Closer to anal fin	Very high, black	Weak pigment
P. occidentalis	None	None	Long/Long	Closer to anal fin	Moderate, dark	Very dark

Characters in larval and juvenile stages of flyingfishes occurring in the study area

Exocoetidae

Key to larval and juvenile exocoetids expected to occur in study area (modified after Cotten and Comyns, 2006)

1a	Body depth 10.5–13.0% SL when >5.0 mm; 50–51 vertebrae; pigment rows concentrated dorsally and ventrally; very light lateral pigment	rus
1b	(see Hemiramphid Body depth >14.0 %SL; 38–49 vertebrae	ae) 2
2a 2b	Body lightly pigmented Body darkly pigmented	3 4
3a	13–15 dorsal fin rays; no internal row of pigment spots over notochord; chin barbels not visible until about 8.5–10.0 mm	ens
3b	12–14 dorsal fin rays; internal pigment present along notochord; chin barbels visible by 4.3 mm	rus
4a	Body uniformly covered with small melanophores giving appearance of brown background;	5
4b	Body speckled with larger melanophores; guanine only partially covers body in fresh specimens	7
5a 5b	Tip of lower jaw forms a protruding, sharp, "jaw beak" >18.0 mm	1US 6
6a 6b	Pelvic fin rays develop pigment by 4.3 mm	tris ans
7a 7b	10–13 dorsal fin rays and 11–13 anal fin rays 12–14 (rarely 11 or 15) dorsal fin rays and 9–10 (rarely 7 or 11) anal fin rays	8 .10
8a 8b	Predorsal and preanus length 60.5–65.5 %SL; prepelvic length 49.0–50.5 %SL	<i>etii</i> 9
9a 9b	Pigment absent on snout and jaws	ger Inis
10a 10b	Body short and thick; prepelvic length 50.0–52.5%SL	<i>tus</i> . 11
11a 11b	 Small melanophores scattered over caudal fin Dash-like pigment spots along 3–4 lowest caudal fin rays; 12 (rarely 10, 11 or 13) dorsal fin rays; 9 (rarely 8 or 10) anal fin rays; 15–19 pectoral fin rays	.12 alis
12a 12b	11–13 dorsal fin rays; 8–9 anal fin rays; a single, median chin barbel forms >11.0 mm	tus
	develops in juveniles 46 (rarely 44, 45 or 47) vertebrae Cheilopogon melanut	rus

Cheilopogon cyanopterus (Valenciennes, 1847) Exocoetidae Marginated flyingfish



Meristic Characters

Pectoral fin rays: 13–15

Caudal fin rays: 7+8 (PrC)

about 43-46

43-46

12 - 14

9-11

6

Myomeres:

Vertebrae:

Dorsal fin rays:

Anal fin rays:

Pelvic fin rays:

Range:	Worldwide in Atlantic, western Pacific and Indian oceans; in the western
	Atlantic found between 40°N and 20°S; northernmost occurrences are
	juveniles in the Gulf Stream

- Habitat: Epipelagic in open ocean waters; primarily a neritic species
- Spawning: Summer (at least), perhaps more protracted; not well described
- **Eggs**: Undescribed, demersal; ovarian eggs are 1.2 mm in diameter and have uniform arrangement of attachment filaments over their chorion
- Larvae: Hatching length undescribed; body moderately long with rounded head, terminal mouth
 - Mandibular barbels begin forming in early larvae
 - Fin rays form early; pectoral fin rays last to form
 - Pectoral and pelvic fin rays long; dorsal and anal fins positioned posteriorly on body, dorsal typically longerrayed than anal until adult stage
 - Lower lobe of caudal fin longer than upper; begins to form early in development
 - Pigment in early larvae includes scattered melanophores across dorsum of body, top of head and along dorsal surface of gut; juveniles acquire characteristic pattern on pectoral and pelvic fins
 - Dorsal fin in juveniles usually uniformly pigmented
 - Paired mandibular barbels very long in juveniles 20-80 mmSL; barbel length may exceed body length
- Note: 1. See box for comments on pectoral and pelvic fin pigment

Early Juvenile:

Pigment is acquired on the upper corner of pectoral fin, spreads to include entire length of upper 7 or 8 rays; in later juveniles, this pigment is interrupted by pale spots near base of fin. Pelvic and caudal fins acquire pattern of alternating dark and pale blotches.



E. 82.6 mmSL

Figures: Adult: Parin, 2002a; A–B, D: T. N. Steyker (Kovalevskaya, 1977); C: Chen, 1987; E: Howard E. Hamman (Gibbs and Staiger, 1970)

References: Gibbs and Staiger, 1970; Kovalevskaya, 1977; Parin, 2002a

Cheilopogon cyanopterus



Cheilopogon exsiliens (Linnaeus, 1771) Exocoetidae Bandwing flyingfish

- **Range**: Widespread Atlantic Ocean; in the western Atlantic from 40°N (in the Gulf Stream) to 25°S, including Gulf of Mexico, but absent or rare in Caribbean Sea
- Habitat: Epipelagic in open ocean waters
- Spawning: Undescribed
- Eggs: Pelagic; characters undescribed
- Larvae: Hatching length undescribed; body moderately long with rounded head, terminal mouth
 - Mandibular barbels begin forming in early larvae
 - Fin rays form early; pectoral fin rays last to form
 - Pectoral and pelvic fin rays long; dorsal and anal fins positioned posteriorly on body, dorsal typically longer-rayed than anal until adult stage
 - Lower lobe of caudal fin longer than upper; begins to form early in development
 - Dorsal fin pigment begins as light scattering on outer margin; pattern develops in juveniles
 - Pigment in early larvae includes scattered melanophores across dorsum of body and top of head; stripe of melanophores extend anteriorly from caudal peduncle; fins lightly peppered; later juveniles develop series of blotches along body and patterns develop on fins
 - Upper lobe of caudal fin remains very lightly pigmented throughout development; lower lobe develops 2 large pigment spots
 - Paired mandibular barbels present, moderately long and fleshy, grey with darker margins
- Note: 1. See box for comments on pectoral and pelvic fin pigment

Pectoral Fin Patterns



Pigment on pectoral fin begins as light scattering of spots over distal part; these consolidate into bands that cross fin, then bands with 2 prominent spots near end of 1st ray and on upper corner of fin; pelvic fin only lightly pigmented throughout stage.



Meristic Characters		
Myomeres:	about 43–44	
Vertebrae:	43–44	
Dorsal fin rays:	13-15	
Anal fin rays:	8-10	
Pectoral fin rays:	13-16	
Pelvic fin rays:	6	
Caudal fin rays:	7+8 (PrC)	
Caudai III Tays.	/+0(110)	

Cheilopogon exsiliens



Cheilopogon furcatus (Mitchill, 1815) Exocoetidae

Worldwide in tropical waters; in the western Atlantic Ocean from 44°N (in Range: the Gulf Stream) to 18°S Habitat: Epipelagic in highly oceanic waters; seldom, if ever, found close to land Spawning: Year-round, with a possible low ebb during early fall, based on collections of young stages (Breder, 1932; Staiger, 1965) - Demersal, attached to drifting algae or other floating objects Eggs: - Diameter: 1.7-1.9 mm; no other information Larvae: - Hatching length undescribed, <4.2 mmTL - Head large, mouth oblique, body robust and compressed - Mandibular barbels begin to form between 12 and 18 mmTL - Fin rays in all fins begin to form at sizes <5.0 mmTL - Pectoral and pelvic fin rays become elongate at about 12 mmTL - Lower lobe of caudal fin noticeably longer than upper at 7.7 mmTL

- Dorsal fin pigment sparse, mostly on anterior half of fin
- Pigment includes scattering of melanophores on head and body, especially dorsally; 6 vague bars cross body during juvenile stage
- Paired mandibular barbels about 50% head length at 36 mmTL; (fully as long as head in 32.0 mmSL juvenile described by Parin and Belyanina, 1998, Fig. E)

Early Juvenile:



Pigment on pectoral fin begins at 16.4 mmSL with a blotch covering the base of fin and a band, with straight anterior edge, crossing the fin near its tip; tip of fin becomes covered with alternating light and dark areas; pelvic fin begins with few sooty strips on pale background, becomes very densely dark.

Spotfin flyingfish

Note: 1. See box for comments on pectoral and pelvic fin pigment

Adult: D. R. Harriott (Scott and Scott, 1988); A-D: Hildebrand and Cable, 1930 (modified); E: Parin, 2002a Figures: Staiger, 1965; Shiganova and Kovalevskaya, 1991; Parin and Belyanina, 1998; Parin, 2002a **References**:



Meristic Characters		
Myomeres: about 44–46		
Vertebrae: 44–46		
Dorsal fin rays: 11–14		
Anal fin rays: 8–12		
Pectoral fin rays: 14–17		
Pelvic fin rays: 6		
Caudal fin rays: 7+8 (PrC)		



The series of larvae and juveniles collected off North Carolina and described by Hildebrand and Cable (1930) was apparently identified (as Cypselurus furcatus = Cheilopogon furcatus) based on the relative lengths of pelvic fins and on fin ray counts of 13 or 14 dorsal and 9 or 10 anal. The young stages of congeners reported to occur off North Carolina also have elongate pelvic fin rays, and dorsal and anal fin ray counts broadly overlap in all four species. Therefore those characters (considered alone) are of dubious value in identifying young stages of Cheilopogon. However, mandibular barbels in the young of two of these congeners are either extremely elongate (in C. cyanopterus) or flap-like, branched and darkly pigmented (in C. exsiliens). The barbels in C. melanurus, however, have been described as being very similar to those in the Hildebrand and Cable series, and much shorter than those in C. furcatus juveniles (Gibbs and Staiger, 1970; Parin, 2002a).

Furthermore, a juvenile (32.0 mmSL) C. furcatus described by Parin and Belyanina (1998) (repeated in Parin, 2002a and shown here as Fig. E) has barbels that are considerably longer than those indicated in the Hildebrand and Cable series. Hildebrand and Cable (1930) also mention the presence of a "pearly-white spot near the base of the ventrals" in adults of C. furcatus. This character has not since been mentioned by students of the group, nor is it of any apparent value in the young stages. The juveniles of both C. furcatus and C. melanurus have been described as having 6 dark, transverse bars on a pale body (Parin, 2002a). Given the foregoing *caveats*, therefore, the identification of the present series should be considered putative until diagnostic characters can be described to separate the young stages of all the species contained in Cheilopogon. Cheilopogon melanurus (Valenciennes, 1847) Exocoetidae Atlantic flyingfish

Western Atlantic Ocean from 42°N to Trinidad, including Gulf of Range: Mexico and Caribbean Sea; strays into Gulf of Maine; also coast of Brazil from Equator to 30°S Habitat: Neritic species strongly associated with coastal waters; found offshore only in area between Gulf Stream and Bermuda Spawning: Summer (at least); young stages collected year-round, southern United States Eggs: - Demersal, spherical - Diameter up to 1.9 mm - Chorion equipped with uniform covering of attachment filaments Larvae: - Early larvae undescribed - Hatching length undescribed - Pectoral and pelvic fin rays long; dorsal and anal fins positioned posteriorly on body, dorsal fin typically longerrayed than anal fin in juvenile and adult stage - Lower lobe of caudal fin longer than upper; begins to form early in development - Dorsal fin in juveniles either uniformly pale, or pale with several dark blotches - Juvenile pigment includes series of bars crossing body and a stripe extending forward from caudal peduncle - Paired mandibular barbels present, but not exceedingly long (cf. Cheilopogon cyanopterus)

- Note: 1. See box for comments on pectoral and pelvic fin pigment
 - 2. Previously widely reported as *Cheilopogon heterurus*, which is now understood to be restricted to eastern Atlantic and Mediterranean Sea, with a disjunct population close to shore off Bermuda

Juvenile:



Figures: Adult and A, B, D: Parin and Belyanina, 2000; C: Gibbs and Staiger, 1970 Staiger, 1965; Gibbs and Staiger, 1970; Fahay, 1975; Parin and Belyanina, 2000; Parin, 2002a **References**:

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Meristic Characters		
Myomeres:	about 45-48	
Vertebrae:	45-48	
Dorsal fin rays:	12-13	
Anal fin rays:	8-10	
Pectoral fin rays:	13-17	
Pelvic fin rays:	6	
Caudal fin rays:	7+8 (PrC)	

Pigment on juveniles' pectoral fins begins with uniform dense shading with clear, unpigmented center. Larger juveniles have spot at upper corner of fin, plus pattern of bars and stripes (Figs. B and D). Pelvic fin initially shaded, then develops cross-banding pattern.

Cheilopogon melanurus



A. 21.0 mmSL



B. 38.3 mmSL

Two juveniles (23 and 28 mm) collected in the eastern tropical Atlantic and described as *Cheilopogon melanurus* by Gibbs and Staiger (1970) were identified as *C. milleri*, an eastern Atlantic species by Parin and Belyanina (2000). The 28.0 mm specimen is shown here (Fig. C). Juveniles of *C. milleri* differ from *C. melanurus* in morphology of mandibular barbel, dorsal fin height and shape, and pigment patterns on the pectoral and dorsal fins.

> C. 28.0 mmSL (Cheilopogon milleri)



Cypselurus comatus (Mitchill, 1815) Exocoetidae Clearwing flyingfish



- **Range**: Tropical western Atlantic Ocean; most common off Florida, the Bahamas, Antilles and Caribbean Sea; rarely in Gulf of Mexico or off Brazil; holotype (a juvenile) collected off New York
- **Habitat**: Epipelagic in neritic waters; a juvenile has been reported from just south of study area at 34°17.03'N, 75°47.22'W (Quattrini *et al.*, 2004) and others might be expected to occur in study area in Gulf Stream or Slope Sea waters
- Spawning: Feb–Apr (West Indies)
- Eggs: Demersal, attached to floating objects
 - Diameter: 1.20-1.45 mm
 - Chorion: attachment filaments uniformly distributed
 - Oil globule: none
- Larvae: Hatching occurs at 5.0 mm; body moderately long
 - No elongate jaw "beaks"
 - Fin rays form early
 - Pectoral and pelvic fin rays elongate
 - Lower lobe of caudal fin longer than upper; begins to elongate at about 10 mm
 - Dorsal fin pigment lacking

Meristic Charact	ers
Myomeres:	44–47
Vertebrae:	44–47
Dorsal fin rays:	11–13
Anal fin rays:	8–9
Pectoral fin rays:	12-14
Pelvic fin rays:	6
Caudal fin rays:	7+8 (principal)



- Pigment in earliest larvae undescribed; pigment in later stages includes uniform scattering of large spots over head and body; gut darkly pigmented in later larvae; few, large spots on base of pectoral fin; caudal fin is only pigmented fin through most of development, until P₁ and P₂ fins acquire pigment at about 8.0 mm
- Note:
- 1. The presence of a single, median, mandibular barbel on chin is diagnostic. Juveniles of other exocoetids have paired chin barbels or none.

Juvenile:



Cypselurus comatus



A. 11.2 mmSL



B. 17.2 mmSL

Exocoetus obtusirostris Günther, 1866 Exocoetidae Oceanic two-wing flyingfish

Tropical Atlantic Ocean; in the western North Atlantic as far north as Range: 40°N, including Gulf of Mexico and Caribbean Sea Habitat: Epipelagic in open ocean waters Spawning: Eggs spawned in small batches (420–890 eggs per batch)

- Pelagic, spherical - Diameter: 2.8-2.9 mm - Chorion lacks attachment filaments
- Larvae: - Hatching occurs at <4.0 mm
 - Body slender, head large with blunt "forehead"
 - No elongate jaw "beaks", no mandibular barbels on lower jaw
 - Fin rays form early; pectoral fin rays last to form
 - Pectoral fin rays begin to elongate at about 10 mm
 - Pelvic fin origin far forward; pelvic fin rays do not elongate
 - Lower lobe of caudal fin longer than upper; begins to form <10 mm
 - Dorsal fin pigment light; few spots form on posterior part of fin
 - Pigment includes dense scattering of spots over much of head and body in early larvae; pigment becomes more dense on dorsum in later stages; pectoral fins lightly pigmented
- 1. Juveniles are evenly pigmented on the body, without bold bars; dorsal and anal fins have black smudge pos-Note: teriorly; pelvic fins mostly blackish, origin closer to pectoral fin than to anal fin; pectoral fins transparent

Early Juvenile:



E. Size unknown



Meristic Characters		
Myomeres:	about 42–45	
Vertebrae:	42–45	
Dorsal fin rays:	12-14	
Anal fin rays:	12-14	
Pectoral fin rays:	15-17	
Pelvic fin rays:	6	
Caudal fin rays:	7+8 (PrC)	

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Eggs:

Exocoetus obtusirostris



Exocoetus volitans Linnaeus, 1758 Exocoetidae Tropical two-wing flyingfish



Myomeres:

Dorsal fin rays:

Pelvic fin rays:

Anal fin rays:

Vertebrae:

Meristic Characters

Pectoral fin rays: 14–16

Caudal fin rays: 7+8 (PrC)

about 43-45

43-45

13 - 15

12-14

6

Range:	Worldwide in tropical waters; in the western North Atlantic Ocean as
	far north as 35° 57'N, 73° 13'W; very abundant in open ocean waters,
	rare in Gulf of Mexico

Habitat: Epipelagic in open ocean waters; rarely neritic

Spawning: Year-round; eggs spawned in small batches (330-420 eggs per batch); spawns well offshore, based on distribution of small larvae

- **Eggs**: Pelagic, spherical
 - Diameter: 1.7–2.0 mm
 - Chorion lacks attachment filaments

Larvae: - Hatching occurs at about 3.5 mm, flexion underway, fin rays formed

- No elongate jaw "beaks", no mandibular barbels on lower jaw
- Fin rays form early; pectoral fin rays last to form
- Pectoral fin rays begin to elongate at about 10 mm
- Pelvic fin origin far forward; pelvic fins do not elongate
- Lower lobe of caudal fin longer than upper; begins to form at about 10 mm
- Dorsal fin pigment absent through development
- Pigment includes scattering of spots over much of head and body in early larvae, with a more dense accumulation of pigment forming across the body between dorsal and anal fins in larger stages; dense cluster of pigment forms over distal part of pectoral fin
- Transformation occurs at 13-16 mm, when all fin rays are formed and pectoral fin is elongate
- Note:
 Juveniles are pale with about 4 darker bars crossing body; dorsal and anal fins have dark smudge on posterior parts; pectoral fins are dusky with clear edge; pelvic fins are clear; pelvic fin origin much closer to pectoral fin than to anal fin

Juvenile:



H. 79.2 mmSL

Figures: Adult: Parin, 2002a; Egg: Parin and Gorbunova, 1964; A, D: Kovalevskaya, 1964 (redrawn); B,C,E,F: Chen, 1987; G: Kovalevskaya, 1964; H: Kovalevskaya, 1980

References: Kovalevskaya, 1964; 1982; Collette et al., 1984a; Hunte et al., 1995; Parin and Shakhovskoy, 2000; Parin, 2002a

Exocoetus volitans



Hirundichthys affinis (Günther, 1866) Exocoetidae Fourwing flyingfish



Range:	Western Atlantic Ocean as far north as 35°N; abundant in Caribbean Sea
	and Gulf of Mexico; also eastern tropical Atlantic (see Note 2); target of
	important commercial fishery in eastern Caribbean Sea

Habitat: A neritic, or neritic-oceanic, epipelagic species

Spawning: Year-round with peak Mar–Jul; maturity reached at about 190 mm

Eggs: – Demersal, attached to floating objects or on benthic substrates

- Diameter: 1.6–1.9 mm (ovarian)
- Chorion equipped with 8–11 long attachment filaments originating at one pole of egg (with a central, thicker filament reaching 40 mm long) and a bundle of shorter, finer filaments at opposite pole

Meristic Characters		
Myomeres:	about 45–47	
Vertebrae:	45–47	
Dorsal fin rays: 10–12		
Anal fin rays:	11–13	
Pectoral fin rays:	16–18	
Pelvic fin rays:	6	
Caudal fin rays:	7+8 (PrC)	

- **Larvae**: Hatching occurs at <4.0 mm, caudal fin rays formed
 - No elongate jaw "beaks"
 - Fin rays form early
 - Pectoral and pelvic fin rays elongate
 - Lower lobe of caudal fin longer than upper; begins to elongate at about 12-14 mm
 - Dorsal fin pigment light; dark edged in larger juveniles
 - Pigment in early stages includes heavy covering of distinct melanophores over head and body; more extensive
 pigment over gut; opercle pigmented, but no separate, distinct spots as in larvae of *Hirundichthys speculiger*;
 pigment on underside of head light, few spots near lower jaw tip; late larvae develop pigment on edges of pectoral and pelvic fins

Note:

- 1. Juveniles pale; pectoral and pelvic fins crossed by bands; pelvic fins long, with origin closer to anal fin than to pectoral fin; dorsal fin not particularly high, outer margin dark
 - 2. This species just reaches southern limit of study area; juveniles possible in Gulf Stream north of 35°N

Juvenile:



H. Size Unknown

Figures: Adult and H: Parin, 2002a; A–G: Belyanina, 1994

References: Bruun, 1935; Breder, 1938; Evans, 1961; Lewis *et al.*, 1962; Belyanina, 1994; Oxenford *et al.*, 1995a; 1995b; Hunte *et al.*, 1995; Parin, 2002a

Hirundichthys affinis



Hirundichthys rondeletii (Valenciennes, 1846) Exocoetidae Blackwing flyingfish



Meristic Characters		
Myomeres:	about 45-46	
Vertebrae:	45-46	
Dorsal fin rays:	10-12	
Anal fin rays:	11-13	
Pectoral fin rays:	16-19	
Pelvic fin rays:	6	
Caudal fin rays:	7+8 (PrC)	





Range: Worldwide in Atlantic, Pacific, Indian oceans and Mediterranean Sea; in the western North Atlantic between 42°N and 28°N; also northern parts of Gulf of Mexico

Habitat: Epipelagic in open ocean waters

Spawning: Winter-spring in Pacific; undescribed in Atlantic

- Eggs: Demersal, attached to floating objects or vegetation – Diameter: 1.4–1.5 mm
 - Chorion equipped with 90–100 attachment filaments arising from one pole, a single filament arising from opposite side of egg
- **Larvae**: Hatching occurs at <4.0 mm
 - No elongate jaw "beaks", no mandibular barbels
 - Fin rays form early
 - Pectoral fin rays begin to elongate at about 6.0 mm
 - Lower lobe of caudal fin longer than upper; begins to elongate at about 12.0 mm
 - Dorsal fin pigment absent until juvenile stage
 - Pigment in early larvae includes scattering of spots over much of head and body; later larvae develop few vague bars across body
- Note: 1. Juveniles pale with few, vague bars crossing body; dorsal fin black at tips of rays; pectoral fin mostly black, with clear edge; pelvic fins long and mottled, with origin closer to anal fin than to pectoral fin

Juvenile:



Figures: Adult: Bruun, 1935; A, B, E, F: Kovalevskaya, 1980; Eggs and C: Kovalevskaya, 1972; D: Okiyama, 1988
References: Kovalevskaya, 1972; 1980; Okiyama, 1988; Collette *et al.*, 1984a; Amaoka *et al.*, 1992; Watson, 1996k; Parin, 2002a

Hirundichthys rondeletii



Hirundichthys speculiger (Valenciennes, 1846) Exocoetidae Mirrorwing flyingfish



Range:	Worldwide in Atlantic, Pacific and Indian oceans; in the western North
	Atlantic as far north as 40°N, not including Gulf of Mexico or western
	Caribbean Sea

- Habitat: Epipelagic in open ocean waters
- Spawning: Year-round
- Demersal, attached to floating objects Eggs:
 - Diameter: 1.53-1.87 mm (maximum: 2.2 mm)
 - Chorion equipped with cluster of 7-20 attachment filaments arising from one pole, a single, long, thick filament arising from opposite pole
- Larvae: - Hatching occurs at about 3.6 mm
 - No elongate jaw "beaks", no mandibular barbels
 - Fin rays form early
 - Pectoral and pelvic fin rays begin to elongate at sizes <10 mmSL
 - Lower lobe of caudal fin longer than upper; begins to elongate at about 10 mmSL
 - Dorsal fin pigment absent in larval stages
 - Pigment in early stages includes light scattering of spots over body, with circular cluster on top of head; 3 prominent spots on opercle; cluster of spots on middle of caudal peduncle; late larvae develop pigment on edges of pectoral and pelvic fins

Meristic Characters		
about 45–47		
45–47		
10-13		
11-13		
17-20		
6		
7+8 (PrC)		



Note: 1. Juveniles pale; pectoral and pelvic fins mottled with dark spots and bands; pelvic fins long, with origin closer to anal fin than to pectoral fin; dorsal fin low, outer margin darkly pigmented

Juvenile:



G. 58.0 mmSL

Figures: Adult: Bruun, 1935; Egg: Parin and Gorbunova, 1964; A-F: Chen, 1987; G: Kovalevskaya, 1980 Kovalevskaya, 1972; Collette et al., 1984a; Chen 1987; 1988; Amaoka, et al., 1992; Belyanina, 1994; Parin, 2002a **References**:

Hirundichthys speculiger



F. 21.4 mmSL

Parexocoetus hillianus (Gosse, 1851) **Exocoetida**e Sailfin flyingfish



Dorsal fin rays:

Pectoral fin rays:

Pelvic fin rays:

Caudal fin rays:

Anal fin rays:

about 36-40

36-40

9–14

10 - 14

11-13

6

7+8 (PrC)

Atlantic Ocean, mostry in tropical waters, in the western North Atlantic	-0	×
from 40°N to northern Brazil; very common in Caribbean Sea and Lesser		
Antilles, less common in Gulf of Mexico, Gulf Stream, and western Sar-	Meristic Char	acters
gasso sea	Myomeres:	abo
Epipelagic in open ocean waters	Vertebrae:	

- Habitat: Epipelagic in open ocean waters
- Much of year off coast of U.S.; in 2 pulses (Mar-Aug and Sep-Jan) in Spawning: Caribbean Sea; may spawn close to shore
- Eggs: - Demersal, attached to floating objects
- Larvae: -Hatching occurs at <4.0 mm; fin rays form early
 - No elongate jaw "beaks" (except Parexocoetus brachypterus brachyp*terus* forms small, lower jaw beak by 18 mm, Figs. J, K)
 - Pair of short, mandibular barbels form in larvae; length about equal to eye diameter in late larvae, longer in older juveniles (Fig. I)
 - Pectoral fins become moderately elongate; pelvic fins do not
 - Lower lobe of caudal fin longer than upper; begins to elongate at about 9 mm
 - Dorsal fin pigment begins as shading in mid-fin, spreads to include most of fin
 - Pigment in early stages includes scattered spots that follow myosepta outlines
- Note: 1. This species is treated as *Parexocoetus brachypterus hillianus* (or simply *P. brachypterus*) by recent authors, but most recently as *P. hillianus* by Parin (2002a). It is very closely related to the Pacific form, *P. brachypterus brachypterus*, therefore the early stages of the latter subspecies are included for comparison.

Juvenile:



I. Size unknown

Note very high, darkly pigmented dorsal fin, moderate sized pelvic fin originating closer to anal fin than to pectoral fin

- Figures: Adult: Parin, 2002a; A-D: Chen, 1987; E-H: Hildebrand and Cable, 1930; I: Parin, 2002a; J-K: Betsy Washington (Collette et al., 1984a)
- Hildebrand and Cable, 1930; Imai, 1959; Lewis, 1961; Fahay, 1975; Collette et al., 1984a; Okiyama, 1988; Oxenford et al., **References**: 1995b

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Range:

Parexocoetus hillianus



Series described as Parexocoetus brachypterus brachypterus (Chen, 1987)

Prognichthys occidentalis Parin, 1999 Exocoetidae Western bluntnose flyingfish

southern United States

Undescribed



Meristic CharactersMyomeres:about 42–44Vertebrae:42–44Dorsal fin rays:10–13Anal fin rays:8–10Pectoral fin rays:15–19Pelvic fin rays:6Caudal fin rays:7+8 (PrC)

Undescribed
Small juveniles occur in dark and light forms

Primarily neritic, avoiding open ocean

Pectoral and pelvic fins moderately elongate

40°S, including Gulf of Mexico and Caribbean Sea

- Lower lobe of caudal fin longer than upper
- Pigment in both forms very dense; both pectoral and pelvic fins almost black

Western Atlantic Ocean between 40°N (juveniles in Gulf Stream) and

Undescribed; small juveniles occur year-round off the coast of the

- Juveniles are heavily pigmented on head, body and fins; pectoral fins in larger juveniles black, often with pale cross-bands
- Note: 1. Collections of this species off the coast of the United States have been referred to as *Prognichthys gibbifrons* (e.g. Fahay, 1975) a name applied to a valid species restricted to the eastern tropical Atlantic (Parin, 1999).
 - 2. A congener, *Prognichthys glaphyrae* Parin, 1999, occurs mostly in the cores of central oceanic gyres, including the North Atlantic, where it has been collected as far north as 32°N. Larvae and juveniles have been described by Parin (1999).

Juvenile:



F. Size unknown (illustration possibly based on same specimen as depicted in Fig. E)

 Figures:
 Adult: Parin, 2002a; A–E: Parin, 1999; F: Parin, 2002a

 References:
 Parin, 1999; 2002a

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Range:

Habitat:

Eggs:

Larvae:

Spawning:

Prognichthys occidentalis

