

LEPTOCEPHALUS LARVAE OF THE TRIBE CALLECHELYINI (ANGUILLIFORMES, OPHICHTHIDAE, OPHICHTHINAE) IN THE WESTERN NORTH ATLANTIC

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ABSTRACT

Larvae of *Aprognathodon platyventris*, *Callechelys bilinearis*, *C. perryae*, *C. muraena*, *C. sp. cf. springeri*, *Callechelys sp.*, *Letharchus vellifer*, a callechelyin (genus and species unknown), and a bascanichthyin (genus and species unknown) are described and figured. Larval identification is based on position of the dorsal fin, gill-arch osteology, caudal osteology, number of nephric myomeres, and total number of myomeres. Members of *Callechelyini* have the fourth hypobranchial present as larvae and adults. Two groups are recognized in *Callechelys*. Larvae of the first group are distinguished by having the fourth hypobranchial separate from the fifth ceratobranchial, gut morphology, and pigment pattern; adults have a split urohyal and two rod-shaped elements in the pectoral girdle. Larvae of the second group are characterized by having the fourth hypobranchial fused with the fifth ceratobranchial, gut morphology, and pigment pattern; adults have a simple urohyal and one or two rod-shaped elements in the pectoral girdle.

The ophichthid tribe *Callechelyini* (sensu McCosker, 1977) comprises three genera and eight nominal species in the Atlantic. Blache (1977) described larvae he identified as *Callechelys sp.* and *Callechelys leucoptera*. Fahay and Obenchain (1978) described larvae which they identified as *Letharchus vellifer*, *Callechelys sp.*, *Apterichtus kendalli*, and *A. ansp.* Leiby (1981) questioned Fahay and Obenchain's identifications of *A. kendalli* and *A. ansp.* and indicated that the larvae were probably *C. muraena* and *Callechelys sp.*

In this study, the larvae of *Aprognathodon platyventris*, *C. bilinearis*, *C. perryae*, and a *Callechelys sp.* are described for the first time. Fahay and Obenchain's (1978) description of *L. vellifer* is confirmed and expanded, but their *Callechelys sp.* larvae are considered to be an undescribed species in the tribe *Bascanichthyini* (sensu McCosker, 1977). It is demonstrated that the larvae Fahay and Obenchain (1978) described as *A. kendalli* are *C. muraena*. I identified one larval series as *Callechelys sp. springeri*, and one series of larvae as an undescribed genus and species in the tribe *Callechelyini* (sensu McCosker, 1977).

METHODS

Measurements were made to the nearest 0.1 mm using an ocular micrometer in a dissecting microscope. All counts, measurements and growth stages were defined in Leiby (1979a; b). At least four larvae of each species were stained for bone and cartilage following Dingerkus and Uhler (1977) and dissected for osteological study. Drawings were made using a camera lucida on a dissecting microscope.

Data on adult *C. perryae* and *L. vellifer* were obtained from cleared and stained specimens and from X-rays. The gill arches and hyoid arch of one adult specimen each of *A. platyventris*, *C. muraena* and *C. bilinearis* were removed, cleared and stained. Vertebral counts of adult *A. platyventris*, *C. bilinearis*, *C. muraena* and *C. springeri* were obtained from the literature, from X-rays of specimens on hand, and from X-rays provided by Mrs. Eugenia Böhlke, Academy of Natural Sciences, Philadelphia.

Larvae were identified to tribe based on dorsal-fin origin, ratio of nephric to total myomeres, gill-arch and caudal osteology and general morphology. Characters used by McCosker (1977) to separate callechelyin genera are not expressed in larvae. Consequently, larvae were identified by comparing larval total and nephric myomere number, gill-arch osteology, branchiostegal-ray number and, where pertinent, condition of the cephalic lateralis system.

Table 1. Body proportions and pectoral fin origin in eight species of callechelyin larvae and one species of bascanichthyin larvae (PFO = myomere on which pectoral fin occurs; TL = total length; PAL = preanal length; HL = head length)

Species	Development Stage	Size Range (mm TL)	# Larvae	PAL % TL	HL % TL	HL % PAL	PFO
<i>A. platyventris</i>	Engydontic	15.6–16.0	2	81.2–82.7	11.9–14.1	14.6–17.1	3–4
	Euryodontic	29.8–77.0	10	69.7–77.2	5.1–9.1	7.3–11.7	4–5
	Metamorphic	55±69.9	2	68.7	5.7	8.3	6–7
<i>C. muraena</i>	Engydontic	6.6–19.7	29	71.3–82.1	11.7–17.1	15.4–21.9	3–4
	Euryodontic	21.6–67.7	24	63.8–72.7	6.1–10.6	9.5–14.9	4
	Metamorphic	71.8	1	64.2	6.8	10.6	5
<i>C. bilinearis</i>	Engydontic	6±10±	3				3–4
	Euryodontic	28±73±	10*	66.2–70.6	6.0–7.4	8.9–10.5	4–5
	Metamorphic	67±	1				5
<i>C. perryae</i>	Engydontic	13.9–23.2	6	79.0–85.1	13.1–15.8	16.6–19.6	4
	Euryodontic	25.2–73.7	8	71.3–79.2	6.8–11.5	9.5–14.9	4–5
<i>Callechelys</i> sp.	Euryodontic	24.0–67.5	10	70.9–76.6	5.4–8.2	7.7–10.8	4
	Metamorphic	63±68.9	2	70.8	5.4	7.6	5
<i>C. springeri</i>	Engydontic	10±25±	6†	77.0–81.0	9.8–10.5	12.4–12.9	3–4
	Euryodontic	31.2–95.7	12	59.7–79.2	4.4–8.7	7.1–10.9	4–5
	Metamorphic	85±	1				6
<i>L. velliifer</i>	Engydontic	7.5–25.3	22	78.0–85.7	8.7–15.2	10.9–18.0	3–4
	Euryodontic	24.2–71.1	161	66.1–80.2	4.8–9.1	7.0–11.6	4–5
	Metamorphic	67.2–78.2	3	66.2–67.9	5.0–6.0	7.5–8.9	5–6
	Glass eel	46.3	1	63.7	12.2	19.1	11
<i>Callechelyini</i> sp.	Euryodontic	21.1–47.3	7	79.3–83.4	7.4–11.8	9.1–14.2	3–4
<i>Bascanichthyini</i> sp.	Engydontic	16.6–25.6	2	75.0–78.3	8.6–11.6	11.5–14.6	3–4
	Euryodontic	31.8–73.7	4	61.8–71.1	4.9–8.2	7.9–11.5	4–5

* Five of the ten specimens too deformed to measure; proportions given are for five specimens 37.8–65.3 mm TL.

† Three of the six specimens too deformed to measure; proportions given are for three specimens 21.0–23.1 mm TL.

Institutional abbreviations used in this study are: Academy of Natural Sciences, Philadelphia, Pennsylvania (ANSP); Florida Department of Natural Resources, Marine Research Laboratory, St. Petersburg, Florida (FSBC); Marine Biomedical Institute, Galveston, Texas (MBI); National Marine Fisheries Service, Southeast Fisheries Center, Panama City Florida (NMFS); South Carolina Wildlife and Marine Resources Department, Charleston, South Carolina (SCMRD); Florida State Museum, Gainesville, Florida (UF); Rosenstiel School of Marine and Atmospheric Science, Miami, Florida (UMML); University of Rhode Island, Kingston, Rhode Island (URI). Other abbreviations used in this study are: Basibranchials 1–4, B_{1–4}; Ceratobranchials 1–5, C_{1–5}; Epibranchial 1, E₁; Hypobranchials 1–4, H_{1–4}; Infrapharyngobranchial 2, I₂; Lower pharyngeal tooth plate, LP; Upper pharyngeal tooth plates 3–4, UP_{3–4}; Standard Length, SL; Total Length, TL.

SPECIES ACCOUNTS

Tribe CALLECHELYINI

Diagnosis

Relatively elongate, much compressed, clear larvae with moderate to pronounced gut loops (not the low gut loops seen in most *Bascanichthyini*); dorsal fin origin on anterior portion of body, near head; dorsal fin and anal fin migrate forward late in metamorphosis; branchial aperture and pectoral fin migrate posteriorly late in metamorphosis (Table 1); pectoral fin resorbed late in metamorphosis; gut expands posterior to gall bladder and liver; nephric myomeres more than 56% of total myomeres; H₄ separate from or fused to C₅; usually two (occasionally three) hypurals; pigmentation variable but distinct, not the inconspicuous patterns seen in the *Bascanichthyini*.

Table 2. Location of gut loops by myomere number in eight species of callechelyin larvae and one species of bascanichthyin larvae (Values represent maximum range of occurrence observed for each gut loop; loops are generally two to five myomeres long)

Species	Gut Loops										
	#1	#2*	#3	#4	#5	#6	#7	#8	#9	#10	#11
<i>A. platyventris</i>	11-17	21-27	32-38	42-49	52-60	62-72	73-83	84-93	94-104		
<i>C. muraena</i>	9-15	20-27	31-39	42-51	55-62	66-75	78-89				
<i>C. bilinearis</i>	14-19	26-32	39-45	52-58	65-73	78-86	91-102				
<i>C. perryae</i>	10-17	19-27	27-35	36-45	46-55	56-63	66-74	76-85	85-96	100-109	110-121
<i>Callechelys</i> sp.	11-17	22-28	30-39	40-47	50-57	59-67	68-78	78-88	89-98	98-109	
<i>C. springeri</i>	11-16	20-27	30-37	39-46	47-55	56-64	65-73	75-83	84-93	95-105	
<i>L. vellifer</i>	10-16	19-29	29-38	38-49	46-57	53-61†	59-69	67-75‡	73-85	81-95	
<i>Callechelyini</i> sp.	12-16	21-26	30-35	39-45	49-57	60-67	70-76	80-87	91-100	100-110	
<i>Bascanichthyini</i> sp.	12-19	22-27	35-41	47-53	59-66	73-77	86-91	96-102			

* Liver lies under gut loops one and two, gall bladder lies under loop two.

† Present in 10.4% of specimens examined.

‡ Present in 13.1% of specimens examined.

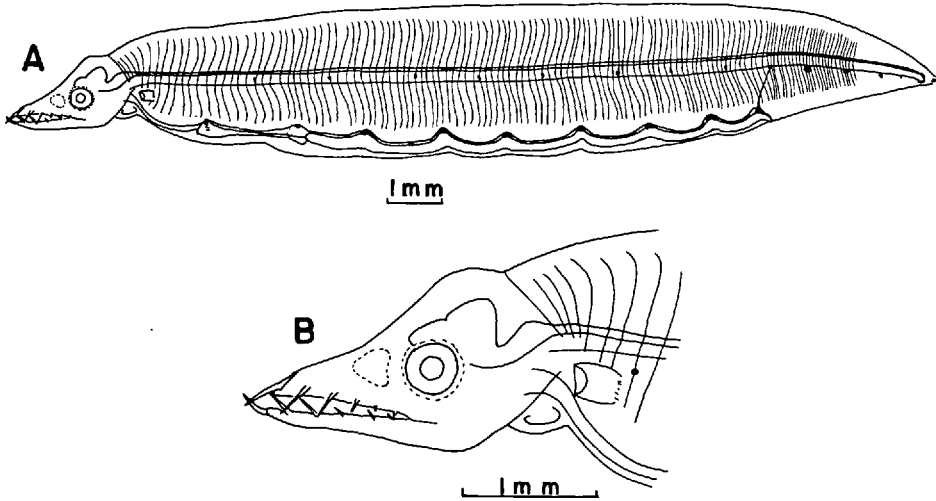


Figure 1. *Aprognathodon platyventris*, engyodontic stage: A, Leptocephalus, 15.6 mm TL; B, Head of same specimen.

Aprognathodon platyventris Böhlke
Figures 1–5; Tables 1–3

General Morphology. — Fourteen larvae examined, 15.6–77.0 mm TL. Total myomeres 149–159; nephric myomeres 96–102; preanal myomeres 97–104; predorsal myomeres in euryodontic and early metamorphic larvae 5–10. Dorsal-fin rays 493; anal-fin rays 183–211. Branchiostegals 27. Nine moderate gut loops (Table 2, Figs. 1–3). Nephros terminates 1–2 myomeres anterior to anus. Body proportions during stages of development given in Table 1.

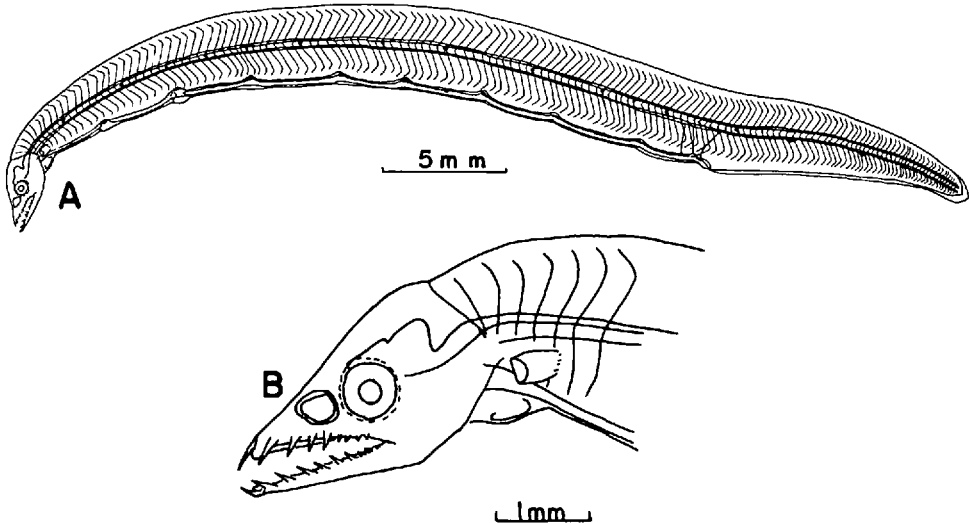


Figure 2. *Aprognathodon platyventris*, euryodontic stage: A, Leptocephalus, 43.1 mm TL; B, Head of same specimen.

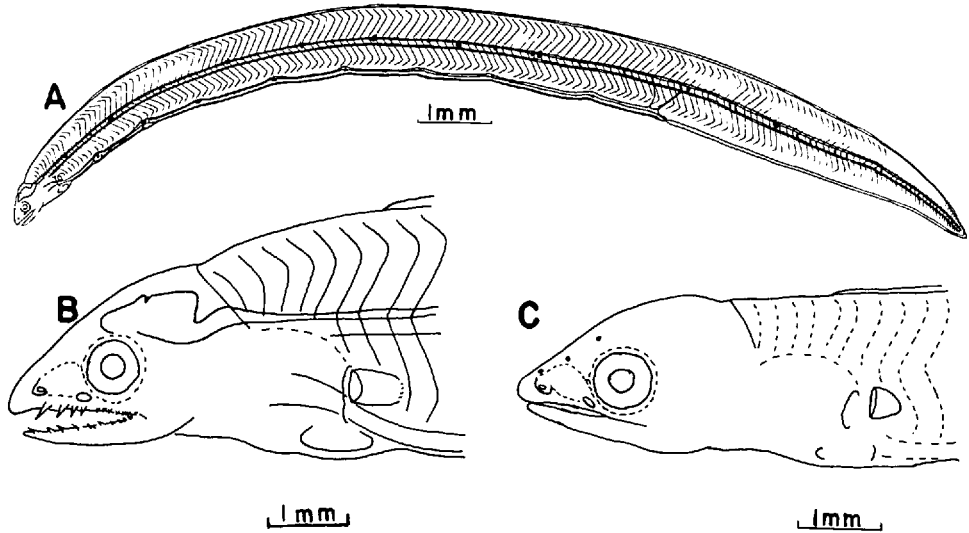


Figure 3. *Aprognathodon platyventris*, metamorphic stage: A, Leptocephalus, 69.9 mm TL; B, Head of same specimen; C, Head of 54.7 mm TL late metamorphic specimen.

Pigmentation.—No apparent pigment on head. Midline pigment complex: major group of pigment approximately every tenth myomere; minor group every fourth to sixth myomere between major groups; subcutaneous pigment on tail just ventral to aorta. Major groups consist of pigment on notochord, streak of pigment on

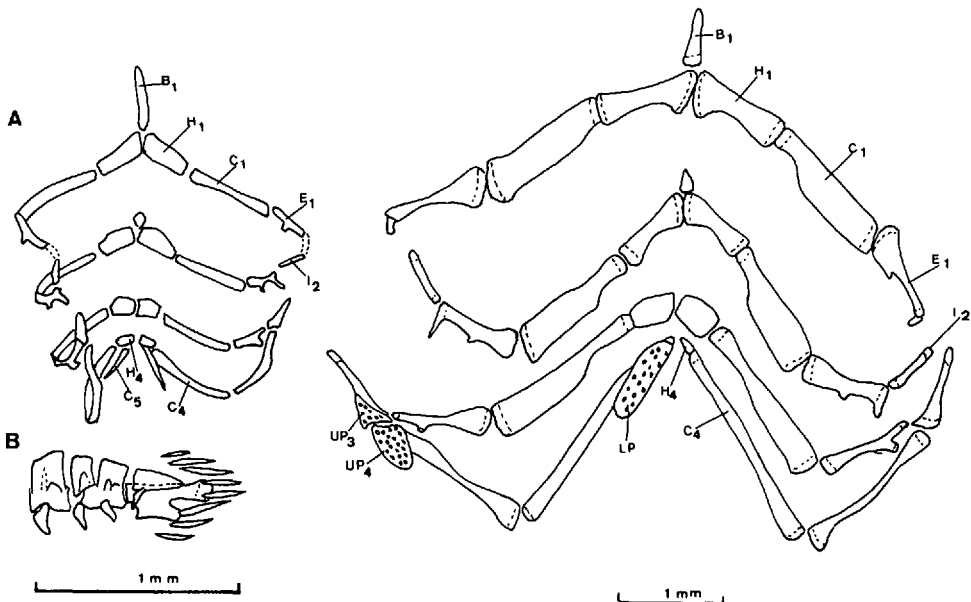


Figure 4. (Left) A, Gill arches of *Aprognathodon platyventris* from a 69.9 mm TL early metamorphic specimen; B, Caudal skeleton of same specimen.

Figure 5. (Right) Gill arches of a 220 mm TL adult *Aprognathodon platyventris*.

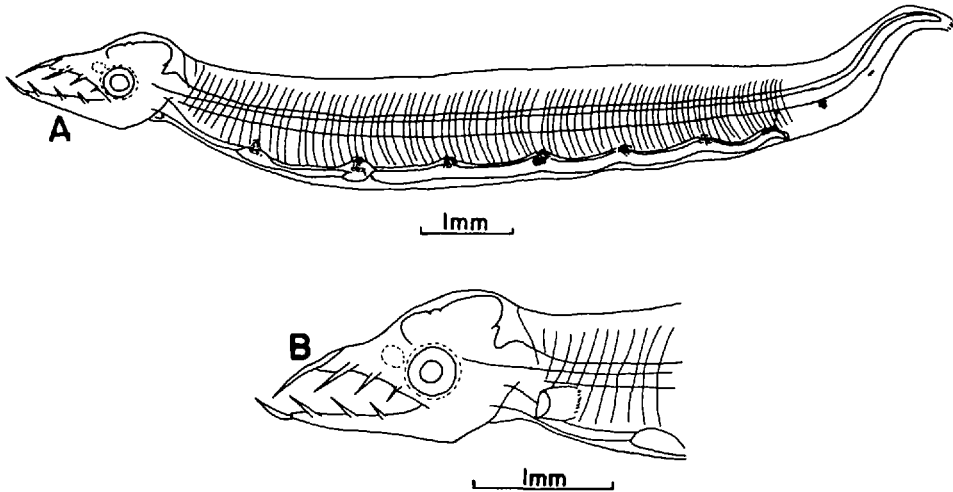


Figure 6. *Callechelys muraena*, engyodontic stage: A, Leptocephalus, 9.6 mm TL; B, Head of same specimen.

myoseptum, groups of occasionally stellate chromatophores in body wall flanking myoseptal pigment. Minor groups consist of spots or streak of pigment on myoseptum. Ventral margin pigment consists of pigment on esophagus near base of pectoral fin, on each gut loop between nephros and gut, on surface of gut generally midway between each gut loop, occasionally stellate chromatophores in body wall lateral to each gut loop. No pigment on anal-fin pterygiophores.

Remarks.—The only known Atlantic callechelyin with meristics comparable to the meristics of these larvae is *Aprognathodon platyventris*. Gill-arch comparison between these larvae (Fig. 4A) and adult *A. platyventris* (Fig. 5) supports the larval identification.

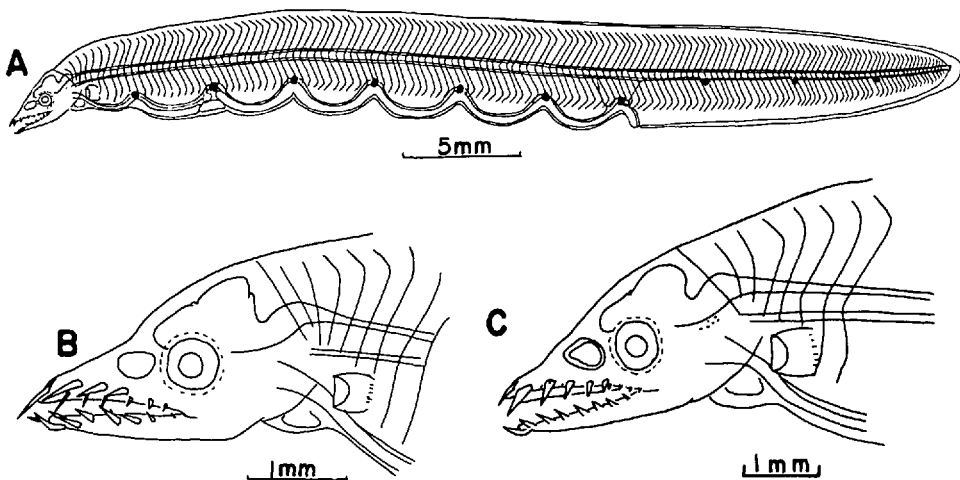


Figure 7. *Callechelys muraena*, euryodontic stage: A, Leptocephalus, 40.4 mm TL; B, Head of early euryodontic specimen (33.1 mm TL) showing replacement teeth; C, Head of 40.4 mm TL specimen.

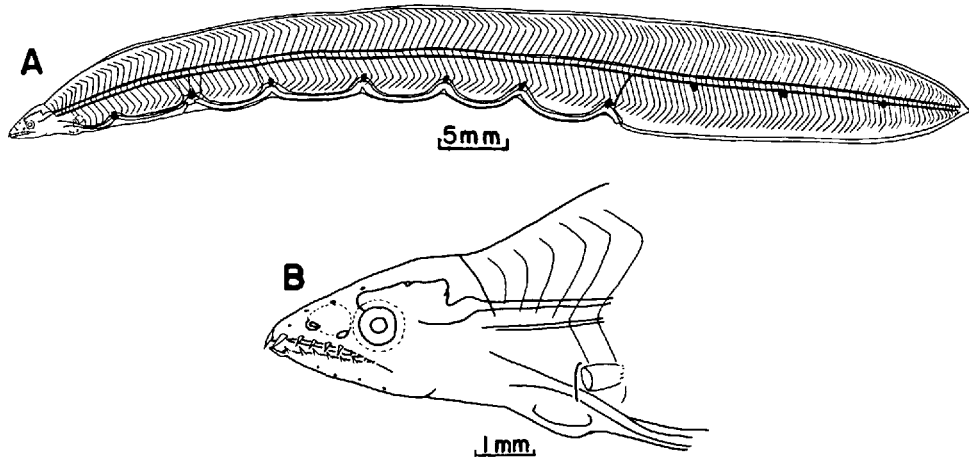


Figure 8. *Callechelys muraena*, metamorphic stage: A, Leptocephalus, 71.8 mm TL; B, Head of same specimen.

Material Examined.—Catalogued specimens: ANSP 105792 (1, 55 ± mm TL); FSBC 11562L (1, 77.0); FSBC 11563L (1, 64.2); FSBC 11564L (2, 16.0–29.8); FSBC 11565L (1, 76.7). Uncatalogued specimens: MBI (4, 43.1–52.5); UMML (4, 15.6–69.9). Collection locations: Caribbean near Cayman Islands; Yucatan Channel; Florida Straits; Bahamas.

Callechelys muraena Jordan and Evermann
Figures 6–10; Tables 1–4

General Morphology.—Fifty-four larvae examined, 6.6–71.8 mm TL. Total myomeres 138–148; nephric myomeres 81–88; preanal myomeres 82–89; predorsal

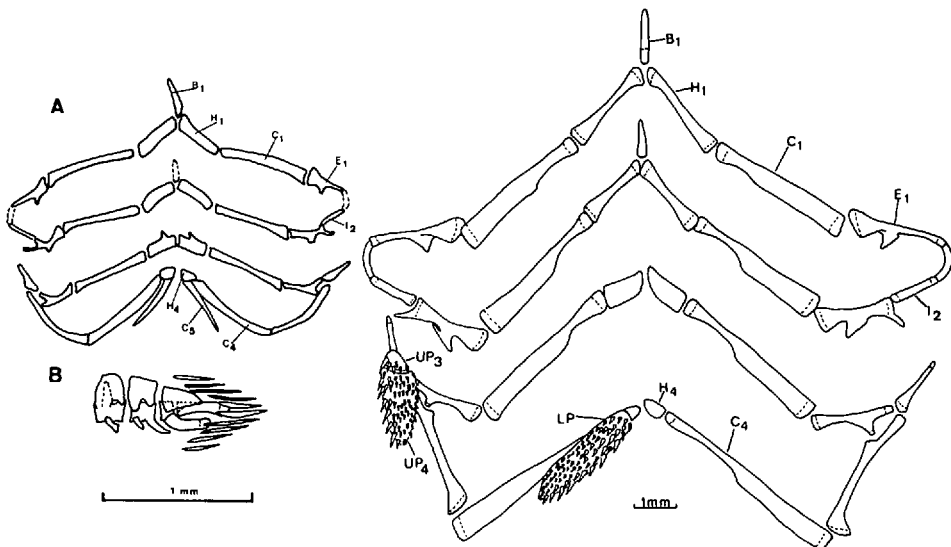


Figure 9. (Left) A, Gill arches of *Callechelys muraena* from a 71.8 mm TL early metamorphic specimen; B, Caudal skeleton of same specimen.

Figure 10. (Right) Gill arches of 295 mm TL adult *Callechelys muraena*.

Table 3. Meristic characters of eight species of callechelyini and one species of bascanichthyini larvae

Species	Total Myomeres			Nephric Myomeres			Preanal Myomeres		
	Range	\bar{x}	N	Range	\bar{x}	N	Range	\bar{x}	N
<i>A. platyventris</i>	149-159	153.2	13	96-102	98.7	14	97-104	100.0	13
<i>C. muraena</i>	138-148	142.5	30	81-88	84.4	45	82-89	85.5	46
<i>C. bilinearis</i>	158-165	162.7	11	95-100	97.2	14	97-102	99.4	14
<i>C. perryae</i>	174-184	177.1	11	111-120	114.8	14	114-121	116.2	14
<i>Callechelys</i> sp.	154-163	158.2	12	100-107	103.1	12	100-109	103.1	12
<i>C. springeri</i>	171-181	176.0	16	97-105	100.3	19	97-105	101.1	19
<i>L. vellifer</i>	133-145	139.5	168	82-91	86.9	176	85-95	89.9	176
<i>Callechelyini</i> sp.	148-154	151.0	7	102-109	104.3	7	103-110	105.6	7
<i>Bascanichthyini</i> sp.	180-186	184.2	5	99-104	102.2	6	100-106	102.8	6
	Predorsal Myomeres			Dorsal Rays			Anal Rays		
	Range	\bar{x}	N	Range	N		Range	\bar{x}	N
<i>A. platyventris</i>	5-10	8.0	12	493	1		183-211		
<i>C. muraena</i>	9-16	12.6	21	468	1		147-203	175.7	5
<i>C. bilinearis</i>	11-15	13.0	10	487	1		160-197	177.2	9
<i>C. perryae</i>	6-10	7.5	7				231		7
<i>Callechelys</i> sp.	7-11	9.2	9	489	1		172-207		1
<i>C. springeri</i>	15-19	17.9	11	746	1		220-279		4
<i>L. vellifer</i>	8-13	10.0	130	435-495	2		165-227	185.4	23
<i>Callechelyini</i> sp.	11-13		2				172		1
<i>Bascanichthyini</i> sp.	15-17		4				306		1

* Nine loops occurred in 12.6% of specimens examined; 10 loops occurred in 5.0% of specimens examined.

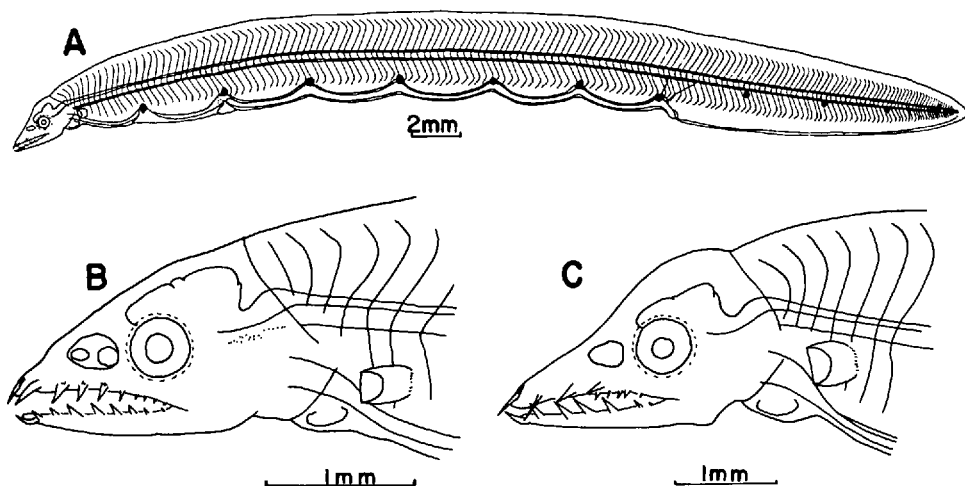


Figure 11. *Callechelys bilinearis*, euryodontic stage: A, Leptocephalus, 37.8 mm TL; B, Head of late euryodontic specimen, 67.4 mm TL; C, Head of early euryodontic specimen, 37.8 mm TL.

myomeres in euryodontic and early metamorphic larvae 9–16. Dorsal-fin rays 468; anal-fin rays 147–203. Branchiostegals 24–26. Seven pronounced gut loops (Table 2, Figs. 6–8). Nephros terminates 0–2 myomeres anterior to anus. Body proportions during stages of development given in Table 1.

Pigmentation.—Little or no pigment visible on head in early stages; by mid-euryodontic stage, small, scattered pigment spots on upper jaw at base of teeth; group of small spots on side of head lateral to medulla. No midline pigment anterior to anus. Postanal midline pigment consists of small dots or streaks on few myosepta; three round patches in body wall lateral to three pronounced, round, subcutaneous patches ventral to aorta on tail. Ventral margin pigment consists of patches on surface of each gut loop and pronounced, round patches in body wall lateral to each gut loop. No pigment patches between gut loops or on anal pterygiophores.

Remarks.—The only known *Callechelyini* with meristics consistent with the meristics of these larvae are *C. muraena* and *Letharchus vellifer*. *L. vellifer* has four supraorbital pores, *C. muraena* three. *L. vellifer* has 28–32 branchiostegal rays, *C. muraena* 23. One late metamorphic specimen in this larval series had three supraorbital pores; two larvae had 24 and 26 branchiostegals. The larvae are best identified with *C. muraena*. Gill-arch comparison between these larvae (Fig. 9A) and an adult *C. muraena* (Fig. 10) supports this identification.

Blache (1977) and Fahay and Obenchain (1978) identified larvae as *Apterichtus kendalli*. The data provided in Leiby (1982) and this paper demonstrate that Blache's (1977) and Fahay and Obenchain's (1978) larvae were *C. muraena*.

Material Examined.—Catalogued specimens: FSBC 11566L (2, 9.1–10.8); FSBC 11567L (12, 11.7–26.4); FSBC 11568L (1, 38.2); FSBC 11569L (4, 8.2–16.9); FSBC 11570L (1, 31.2); FSBC 11571L (1, 41.1); FSBC 11572L (2, 12.7–19.7); FSBC 11573L (3, 24.5–40.4); FSBC 11574L (1, 25.4); FSBC 11575L (1, 15.3); FSBC 11576L (1, 41.0); FSBC 11577L (2, 14.9–15.2); FSBC 11578L (1, 57.8); FSBC 11579L (1, 55.7); FSBC 11580L (1, 67.7); FSBC 11581L (1, 26.7); FSBC 11582L (1, 26.7); FSBC 11583L (1, 32.0); FSBC 11584L (14, 6.6–16.8); FSBC 11585L (1, 12.7); FSBC 11657L (1, 46.8); FSBC 11658L (1, 38.0). Uncatalogued specimens: MBI (1, 50.0); UMML (3, 51.6–71.8). Collection locations: Yucatan Channel; Florida Straits; northeast Gulf of Mexico; Bahamas; Gulf Stream off Georgia.

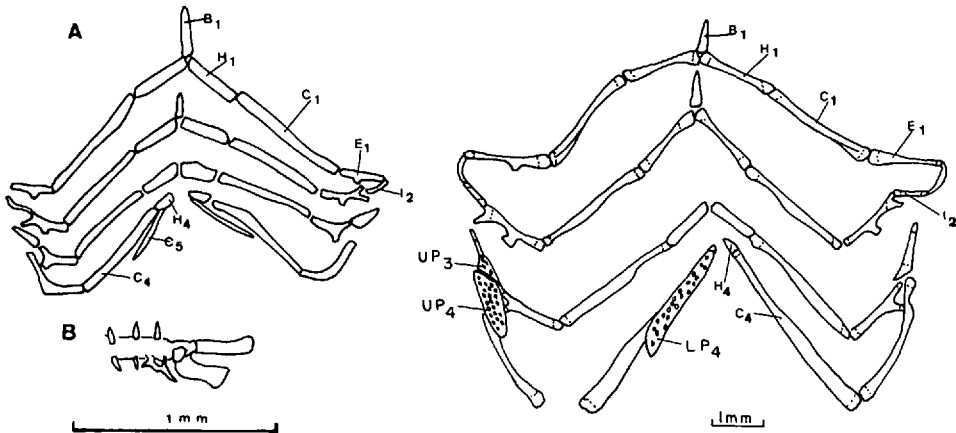


Figure 12. (Left) A, Gill arches of *Callechelys bilinearis* from a 73.3 mm TL euryodontic specimen; B, Caudal skeleton of same specimen.

Figure 13. (Right) Gill arches of 280 mm TL adult *Callechelys bilinearis*.

Callechelys bilinearis Kanazawa

Figures 11–13; Tables 1–4

General Morphology.—Fourteen larvae examined, $6\pm 73\pm$ mm TL. Total myomeres 158–165; nephric myomeres 95–100; preanal myomeres 97–102; predorsal myomeres in euryodontic and early metamorphic larvae 11–15. Dorsal-fin rays 487; anal-fin rays 160–197. Branchiostegals 28. Seven pronounced gut loops (Table 2, Fig. 11). Nephros terminates 0–3 myomeres anterior to anus. Body proportions during stages of development given in Table 1.

Pigmentation.—Pigmentation essentially as in *Callechelys muraena*.

Remarks.—The only known Atlantic *Callechelys* with meristics consistent with the meristics of these larvae are *C. bilinearis* in the western Atlantic and *C. leucoptera* in the eastern Atlantic. *C. leucoptera* larvae have fewer nephric myomeres than the larvae in this series, and have been described by Blache (1977). Comparison of meristics and gill arches (Figs. 12A, 13) between these larvae and adult *C. bilinearis* confirms the larval identification.

Material Examined.—Catalogued specimens: FSBC 11656L (1, 56.0). Uncatalogued specimens: MBI (11, $6\pm 73\pm$); UMML (2, $62.5\text{--}67\pm$). Collection locations: Yucatan Channel; Campeche Shelf; east-central Gulf of Mexico; Bahamas.

Callechelys perryae Storey

Figures 14–17; Tables 1–4

General Morphology.—Fourteen larvae examined, 13.9–73.7 mm TL. Total myomeres 174–184; nephric myomeres 111–120; preanal myomeres 114–121; predorsal myomeres in euryodontic and early metamorphic larvae 6–10. Dorsal-fin rays not countable in my specimens; anal-fin rays 231. Branchiostegals not countable in my specimens. Eleven moderate gut loops (Table 2; Figs. 14–15). Nephros terminates 0–3 myomeres anterior to anus. Body proportions during stages of development given in Table 1.

Table 4. Comparison of five selected characters among fifteen species of adult *Callechelys*. Data for each character comes from: 1, McCosker and Rosenblatt (1972); 2, McCosker (1977); 3, this study. Postanal length in thousandths of total length. F = forked urohyal; S = simple urohyal; + = present; - = absent

Species	Postanal Length			Scapula			Urohyal			Branchiostegal Rays			Epiphyal Ray Broadening		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
<i>C. nebulosus</i>	408	408		+	+				S		29			yes	
<i>C. springeri</i>	350	350			+				S		25?			yes	
<i>C. bilinearis</i>	364	364	368	+	+	+			F		27	28		no	no
<i>C. cliffi</i>	434	434		+	+				F		26			no	
<i>C. galapagensis</i>	444	444		+	+				F		26			no	
<i>C. luteus</i>	415	415		+	+				F		27			no	
<i>C. muraena</i>	385	385	397	+	+	+			F		23?	23		no	yes
<i>C. perryae</i>	310-328	319	323		-	+			S		24	21-25		no	yes
<i>C. marmoratus</i>	345	345		-	-				S		29			no	
<i>C. eristignus</i>	295	295		-	-				S	31	31			no	
<i>C. melanotaenius</i>	282	282		-	-				S		29			no	
<i>C. leucopterus</i>	431-475	453													
<i>C. striatus</i>	304	304			-				S					no	
<i>C. holochromus</i>	333	333			-				S					no	
<i>C. bitaeniatus</i>	385	385									26				

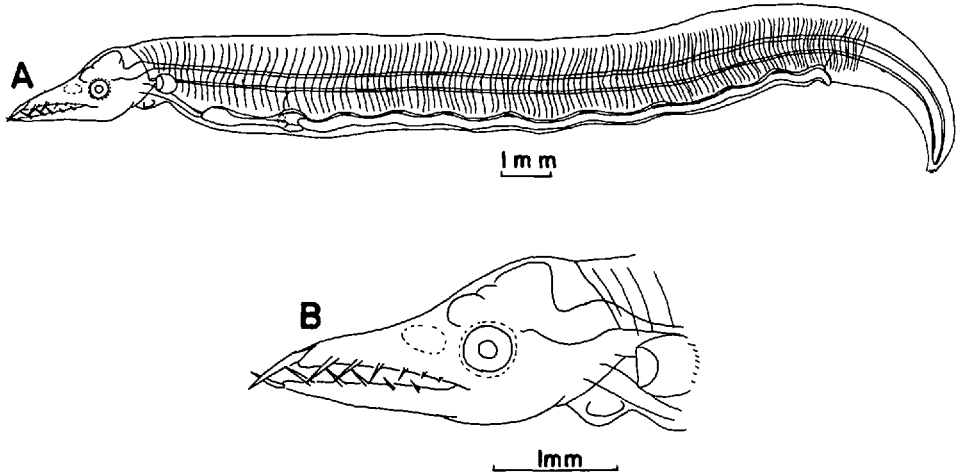


Figure 14. *Callechelys perryae*, engyodontic stage: A, Leptocephalus, 19.2 mm TL; B, Head of same specimen.

Pigmentation.—Little or no pigment on head in early stage; by euryodontic stage, head pigment consists of several small patches on side of head lateral to medulla; occasionally a few stellate chromatophores on side of head lateral to notochord and occipital arch; subcutaneous pigment ventral to notochord at chondrocranium. Midline pigment (every 7–11 myomeres), of dark streaks on myosepta, some pigment in body wall flanking pigmented myosepta, subcutaneous pigment on dorsal surface of notochord beneath pigmented myosepta, four irregular, subcutaneous patches on tail just ventral to aorta. Ventral margin pigment on esophagus near base of pectoral fin, on each gut loop between nephros and gut, on surface of gut generally midway between each gut loop, small patch on surface of gut beneath urinary bladder, near anus, some body wall pigment lateral to each gut loop. Eight or nine evenly spaced, round or saddle-shaped patches of pigment in

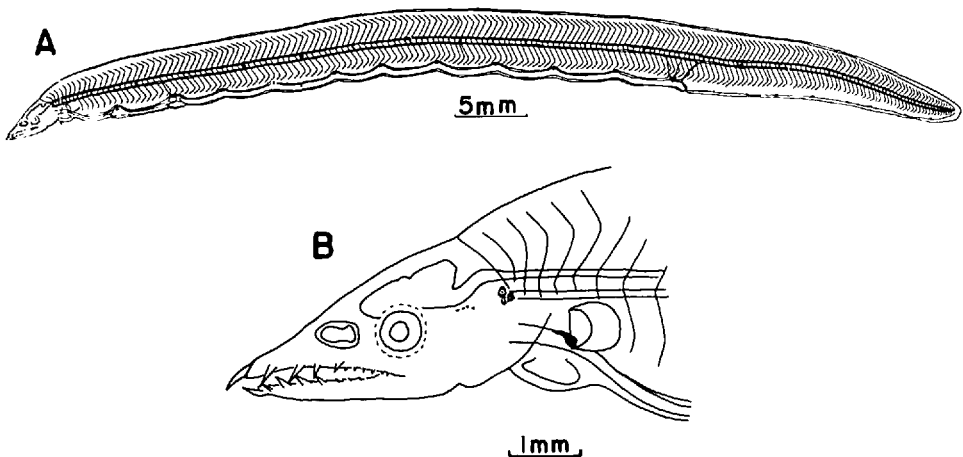


Figure 15. *Callechelys perryae*, euryodontic stage: A, Leptocephalus, 66.4 mm TL, B, Head of same specimen.

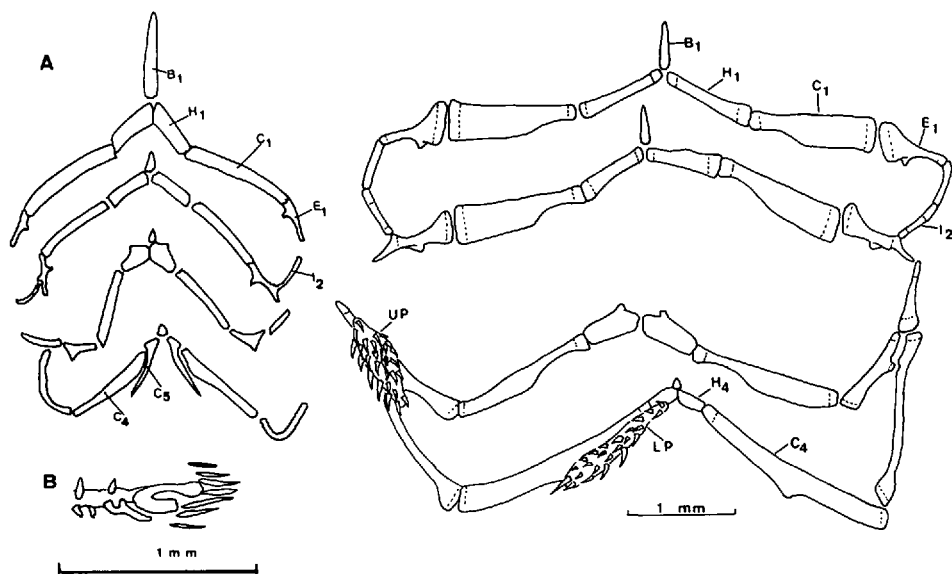


Figure 16. (Left) A, Gill arches of *Callechelys perryae* from a 73.7 mm TL euryodontic specimen; B, Caudal skeleton of same specimen.

Figure 17. (Right) Gill arches of 238 mm TL adult *Callechelys perryae*.

body wall on ventral margin of tail, occasionally extending onto a few anal pterygiophores.

Remarks.—Comparison of meristics and gill arches (Figs. 16A, 17) between these larvae and adult *C. perryae* confirms the identification of these larvae. Gill-arch development in larvae of *C. perryae* is variable. In five late euryodontic larvae examined, two had a reduced B₃, three did not. The B₃ was absent in the gill arches of two adult *C. perryae*. Presumably, B₃ is lost during development in those larvae which have it early in development.

Material Examined.—Catalogued specimens: FSBC 11586L (1, 19.2); FSBC 11587L (1, 68.6); FSBC 11588L (2, 36.2–50.2); FSBC 11589L (2, 13.9–15.4); FSBC 11590L (1, 21.4); FSBC 11591L (1, 54.7); FSBC 11592L (1, 28.8). Uncatalogued specimens: MBI (4, 17.0–66.4); UMML (1, 73.7). Collection locations: Yucatan Channel; southwest and northeast Gulf of Mexico.

Callechelys species Figures 18–19; Tables 1–3

General Morphology.—Twelve larvae examined, 24.6–68.9 mm TL. Total myomeres 154–163; nephric myomeres 100–107; preanal myomeres 100–109; predorsal myomeres in euryodontic and early metamorphic larvae 7–11. Dorsal-fin rays 489; anal-fin rays 172–207. Branchiostegals 28. Ten pronounced gut loops (Table 2; Figs. 18A, C). Nephros terminates 0–2 myomeres anterior to anus. Body proportions during stages of development given in Table 1.

Pigmentation.—No head pigment present in any specimens examined. Midline pigment consists of streaks on approximately every tenth myoseptum; five irregular, subcutaneous patches on tail just ventral to aorta; patches of stellate chromatophores in body wall lateral to first four subcutaneous tail patches. Ventral

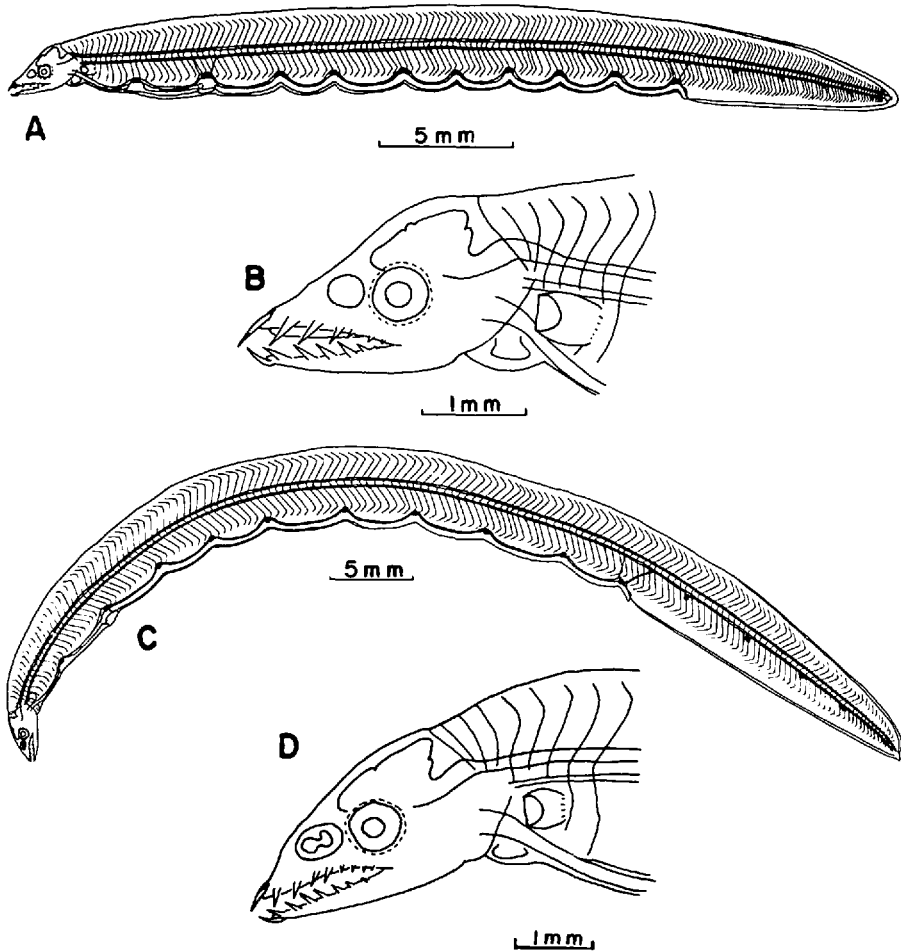


Figure 18. *Callechelys* sp., euryodontic stage: A, Early euryodontic leptocephalus, 32.7 mm TL; B, Head of same specimen; C, Late euryodontic leptocephalus, 66.6 mm TL; D, Head of same specimen.

margin pigment consists of: pigment on each gut loop between nephros and gut; circular patches of stellate chromatophores in body wall lateral to each gut loop; pigment on approximately every fifth anal pterygiophore in posterior half of fin.

Remarks.—Gill-arch and caudal osteology (Fig. 19) and larval morphology place this series of larvae in the genus *Callechelys*. The only known Atlantic *Callechelys* with meristics consistent with the meristics of these larvae is *C. bilinearis*. A series of 14 larvae was identified as *C. bilinearis* earlier in this paper. Meristics and gill-arch condition of the earlier described series and this series are both consistent with the meristics and gill-arch condition of adult *C. bilinearis*. Based on these data, either series could reasonably be identified as *C. bilinearis*. McCosker (1977) indicated that *C. bilinearis*, *C. cliffi* and *C. muraena* are closely related. Consequently, the first series of larvae was identified as *C. bilinearis* because of similarities in gut morphology and pigment pattern between it, *C. muraena*, and the larval pigmentation retained in a recently transformed *C. cliffi* (Böhlke and Briggs, 1954), which indicate a closely related species complex. The larvae of *C. muraena*,

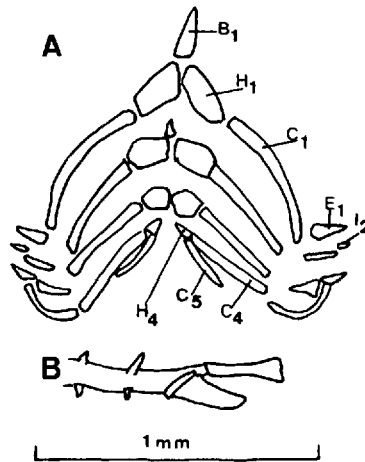


Figure 19. A, Gill arches of *Callechelys* sp. from a 66.2 mm TL euryodontic stage specimen; B, Caudal skeleton of same specimen.

C. bilinearis, and, presumably, *C. cliffi* have seven pronounced gut loops and three (*C. bilinearis* and *C. muraena*) or four (*C. cliffi*) postanal subcutaneous pigment patches marked by round pigment patches in the body wall. The larvae described in this section have ten pronounced gut loops and five postanal pigment patches consisting of subcutaneous and body wall pigment. *C. muraena* and *C. bilinearis* larvae have pigment of the side of the head, lack pigment on preanal myosepta, have little or no pigment on postanal myosepta, and lack anal pterygiophore pigment. This series of larvae lacks head pigment, has pigment on every tenth myoseptum, and has some anal pterygiophore pigment. If, as suggested by McCosker (1977), *C. bilinearis* is closely related to *C. cliffi* and *C. muraena*, it seems reasonable to assume that the larval form most similar to them is *C. bilinearis*. Since the larvae described in this section are not *C. bilinearis*, but clearly are *Callechelys* larvae, they can only be the larvae of an undescribed species of *Callechelys*.

Material Examined.—Catalogued specimens: FSBC 11623L (1, 42.7); FSBC 11624L (1, 34.4); FSBC 11625L (1, 32.7); FSBC 11626L (1, 51.9); FSBC 11627L (1, 67.5). Uncatalogued specimens: MBI (3, 31.5–66.2); UMML (3, 24.0–68.9); URI (1, 63±). Collection locations: Southwest and northeast Gulf of Mexico; Florida Straits; Bahamas.

Callechelys species cf. *springeri* (Ginsburg)
Figures 20–22; Tables 1–4

General Morphology.—Nineteen larvae examined, 10±–95.7 mm TL. Total myomeres 171–181; nephric myomeres 97–105; preanal myomeres 97–105; predorsal myomeres in euryodontic and early metamorphic larvae 15–19. Dorsal-fin rays 746; anal-fin rays 220–279. Branchiostegals 31. Ten moderate gut loops (Table 2; Figs. 20–21). Nephros terminates 0–2 myomeres anterior to anus. Body proportions during stages of development given in Table 1.

Pigmentation.—Pigment on head consists of numerous small chromatophores at base of teeth on upper jaw, 1–3 spots lateral to the Meckel's cartilage/quadratojuncture on lower jaw. Midline pigment consists of occasionally stellate chromatophores or streaks of pigment on most myosepta beginning midway between

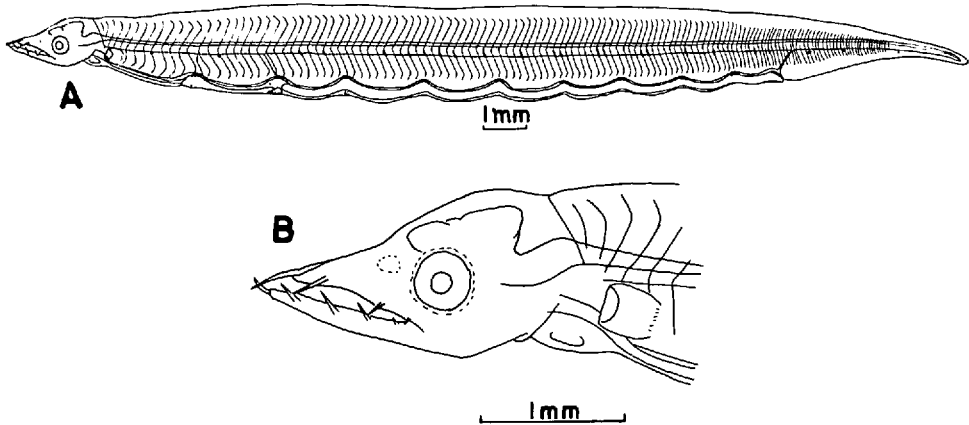


Figure 20. *Callechelys springeri*, engyodontic stage: A, Leptocephalus, 21.0 mm TL; B, Head of same specimen.

head and first liver lobe, 1–3 irregular, subcutaneous pigment patches on tail just ventral to aorta in engyodontic larvae, 6–7 patches in euryodontic and metamorphic larvae. Ventral margin pigment on esophagus near base of pectoral fin, on dorsal surface of each gut loop, small patches on dorsal surface of gut generally midway between each gut loop, body-wall pigment ventral to liver and occasionally under some gut loops, and pigment on ventral surface of most anal pterygiophores.

Remarks.—Identification of this series of larvae to tribe, genus, and species is problematical. The advanced dorsal fin position and high nephric to total myomere ratio place the larvae in the tribe Callechelyini or the tribe Bascanichthyini. Data from gill-arch osteology, caudal osteology, gut morphology, and pigmentation do not definitively place these larvae in either tribe.

The gill arches of an early metamorphic specimen (Fig. 22A) had expansions of the anterior end of C_5 which are probably reduced H_4 's fused with C_5 . These

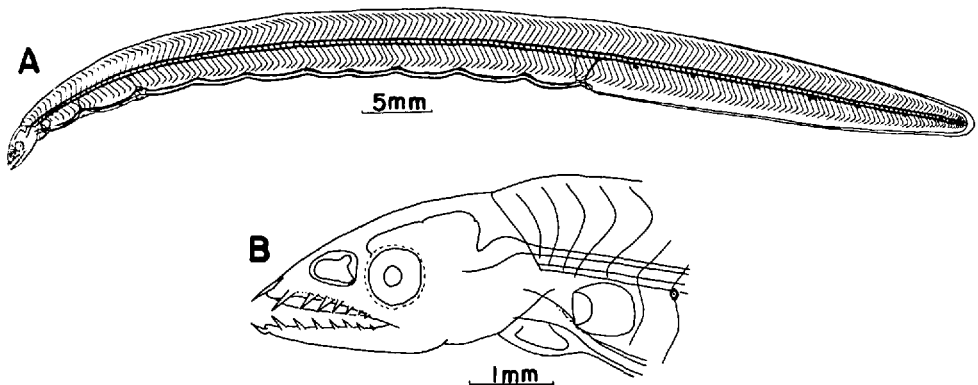


Figure 21. *Callechelys springeri*, euryodontic stage: A, Leptocephalus, 77.3 mm TL; B, Head of same specimen.

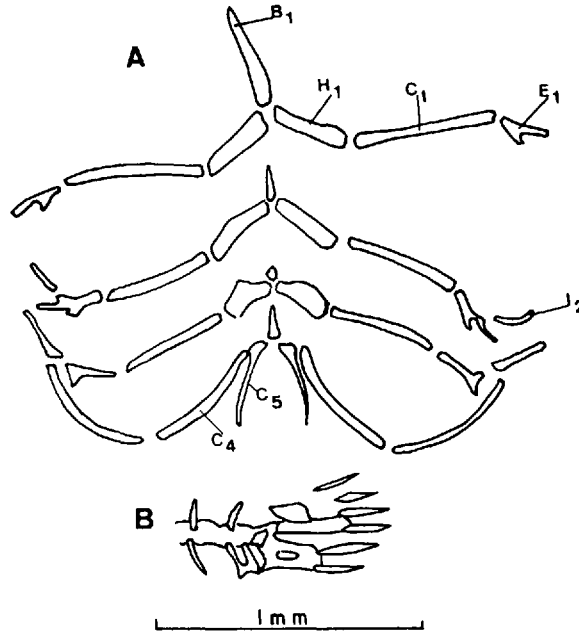


Figure 22. A, Gill arches of *Callechelys springeri* from an 85.4 mm TL early metamorphic specimen; B, Caudal skeleton of same specimen.

fused H_4 's are not as well developed as they are in *C. perryae* (Fig. 16A) or *L. vellifer* (Fig. 26A), but they are not known at all in the Bascanichthyini I have examined. This expanded condition is not present in two euryodontic larvae of this species (81.5 mm TL, 95.7 mm TL) but is present in one euryodontic specimen (82.1 mm TL) and the metamorphic specimen ($85 \pm$ mm TL). All four larvae had a reduced B_3 which may or may not be present in adults. Species having a reduced B_3 as larvae, but lacking it as adults, occur in both the Callechelyini and the Bascanichthyini. The caudal-fin support of these larvae is composed of three hypurals on one and one half terminal centra. This condition occurs in the larvae of all the known Bascanichthyini I have examined. All of the Callechelyini I have examined, except for the species described later in this paper and provisionally placed in the tribe Callechelyini, have two hypurals. Gut morphology of these larvae is similar to that of *C. perryae*, but pigmentation is close to bascanichthyin larval pigmentation.

While none of the larval characters definitively place this series of larvae in the Bascanichthyini or the Callechelyini, the rudimentary H_4 and the gut morphology suggest that they are allied with the Callechelyini, but that they are closer to the Bascanichthyini than the other callechelyin species examined in this study.

The only known callechelyin with meristics approaching the meristics of these larvae is *C. springeri*. Data on adult *C. springeri* are limited, and agreement between adult and larval data is weak. *C. springeri* adults have 167–175 total ($n = 4$) and 109 precaudal ($n = 2$) vertebrae. These larvae have 171–181 total ($\bar{x} = 176.0$; $n = 16$) and 97–105 nephric ($\bar{x} = 100.3$; $n = 19$) myomeres. Since the adults examined generally had fewer total body segments than the larvae while having more nephric segments, my identification of these larvae as *C. springeri* is tentative

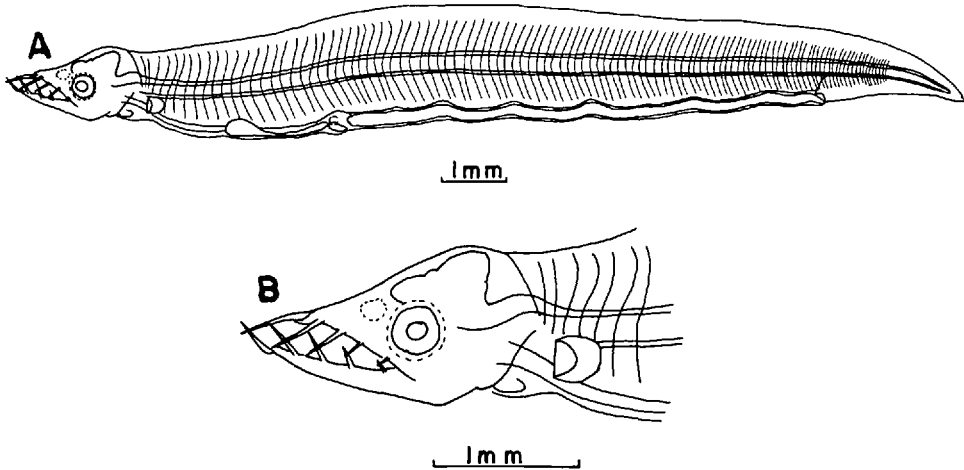


Figure 23. *Letharchus vellifer*, engyodontic stage: A, Leptocephalus, 13.3 mm TL; B, Head of same specimen.

at best. It is still possible that the larvae described in this section are an undescribed bascanichthyin (e.g., *Ethadophis*) in which H_4 has not been completely lost as it has in other western Atlantic Bascanichthyini.

Material Examined.—Uncatalogued specimens: MBI (10, 23.1–81.5); NMFS (4, 10±–22.5); UMML (5, 44.3–95.7). Collection locations: off northern Brazil; French Guiana; Colombia; Panama; Belize; western Gulf of Mexico.

Letharchus vellifer Goode and Bean
Figures 23–27; Tables 1–3

General Morphology.—One hundred eighty-six larvae, 7.5–78.2 mm TL, and one glass eel, 46.3 mm TL, examined. Total myomeres 133–145; nephric myomeres

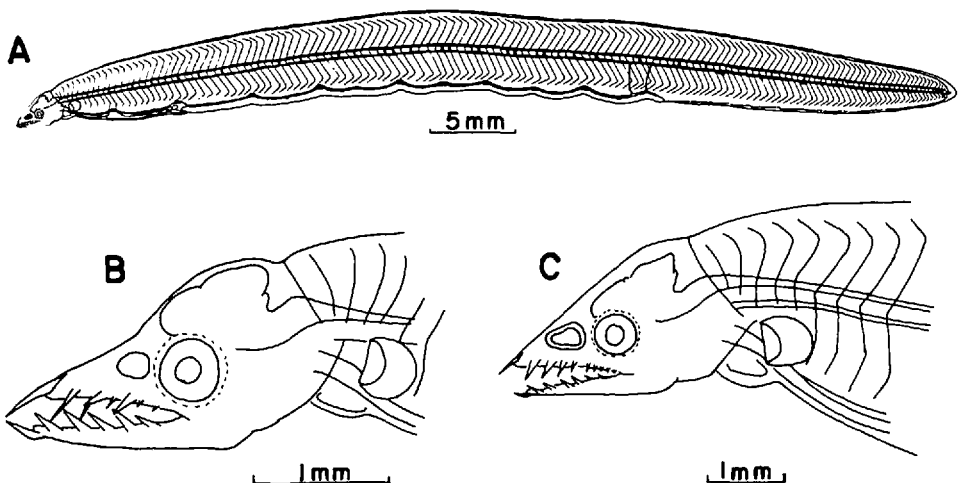


Figure 24. *Letharchus vellifer*, euryodontic stage: A, Leptocephalus, 58.4 mm TL; B, Head of early euryodontic specimen (25.2 mm TL) showing replacement teeth; C, Head of 58.4 mm TL specimen.

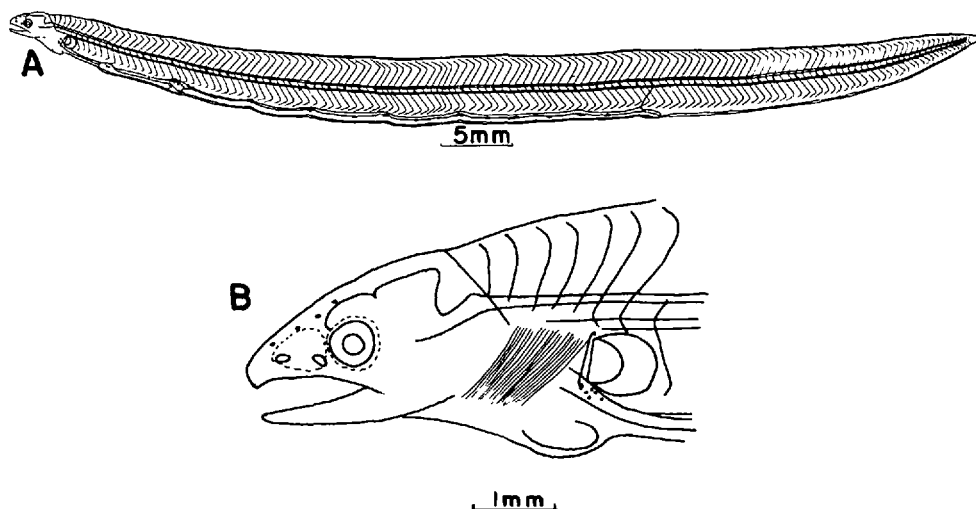


Figure 25. *Letharchus vellifer*, metamorphic stage: A, Leptocephalus, 67.2 mm TL; B, Head of same specimen.

82–91; preanal myomeres 85–95; predorsal myomeres in euryodontic and early metamorphic larvae 8–13. Dorsal-fin rays 435–495; anal-fin rays 165–227. Branchiostegals 28–31. Eight to occasionally 10 low to moderate gut loops (Table 2; Figs. 23–25). Nephros terminates 1–4 myomeres anterior to anus. Body proportions during stages of development given in Table 1.

Pigmentation.—Head pigment, when present, consists of a few small patches at base of teeth on anterior portion of upper jaw. Midline pigment consists of: spots or streaks of pigment on every second to fifth myoseptum, from midway between branchial aperture and liver, to tail tip; 3–4 irregular, subcutaneous patches on tail just ventral to aorta. Ventral margin pigment on esophagus near base of pectoral fin, on dorsal surface of each gut loop, 1–3 patches on dorsal surface of gut between each gut loop, occasionally some light pigment in body wall lateral to each gut loop, and pigment on ventral surface of anal-fin pterygiophores occurring in groups of 2–6 pigmented pterygiophores alternating with groups of 2–5 unpigmented pterygiophores.

Remarks.—These larvae were identified by comparing larval and adult meristics, gill arches (Figs. 26A, 27), and cephalic lateralis systems.

Fahay and Obenchain (1978) described a series of 57 larvae as *L. vellifer*. While I generally agree with their identification and description, there are differences worth noting. Fahay and Obenchain gave the total myomere range as 137–150 (\bar{x} = 143.5; n = 54); I found 133–145 total myomeres (\bar{x} = 139.5; n = 168); adult vertebral range is 134–144 (\bar{x} = 139.1; n = 39). A range of 18 myomeres in larval Ophichthinae with so few total myomeres is unusual.

Fahay and Obenchain's larvae had 10 gut loops. I found 10 distinct gut loops in 5% of my larvae, nine in 12.7%, and eight in 82.3% (Table 2). This variability in number of observed gut loops is unusual in species with moderately developed loops.

Fahay and Obenchain's smallest larvae (18.0–20.0 mm TL) had three pigment spots along the anterodorsal margin of the body. I did not observe this in any of

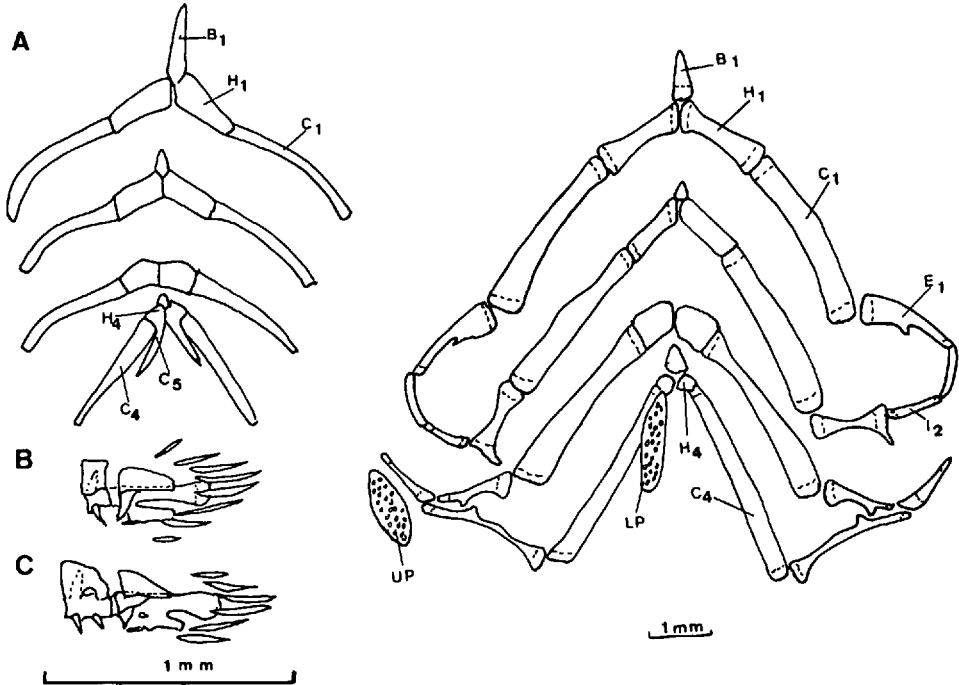


Figure 26. (Left) A, Gill arches of *Letharchus vellifer* from a 78.2 mm TL early metamorphic specimen; B, Caudal skeleton of same specimen; C, Caudal skeleton of 68.3 mm TL metamorphic specimen showing gap between hypurals beginning to close.

Figure 27. (Right) Gill arches of a 296 mm TL adult *Letharchus vellifer*.

my small (7.5–25.3 mm TL) larvae. I have a series of 11 larvae of uncertain affinity which have 10–11 low to moderate loops, 142–154 total myomeres, 89–98 preanal myomeres, and pigmentation along the dorsal body margin. It is possible their small larvae actually belong in this group.

Material Examined.—Catalogued specimens: FSBC 5980 (1, 46.3); FSBC 11593L (1, 13.3); FSBC 11594L (1, 10.9); FSBC 11595L (3, 7.5–13.7); FSBC 11596L (1, 21.6); FSBC 11597L (17, 34.4–64.7); FSBC 11598L (3, 10.8–23.6); FSBC 11599L (1, 63.5); FSBC 11600L (3, 47.1–59.0); FSBC 11601L (1, 54.7); FSBC 11602L (1, 69.8); FSBC 11603L (1, 71.1); FSBC 11604L (1, 58.4); FSBC 11605L (3, 13.5–25.2); FSBC 11606L (88, 25.3–68.8); FSBC 11607L (1, 11.9); FSBC 11608L (1, 17.5); FSBC 11609L (39, 19.4–65.8); FSBC 11610L (3, 39.8–50.2); FSBC 11611L (1, 67.2); FSBC 11612L (1, 14.8); FSBC 11613L (2, 68.3–78.2); FSBC 11614L (4, 42.2–65.8); FSBC 11615L (2, 22.7–48.8); FSBC 11616L (1, 26.4); FSBC 11617L (1, 18.7); FSBC 11618L (1, 50.2). Uncatalogued specimens: UMML (2, 56.2–58.0); NMFS (4, 7.7–12.3). Collection locations: northeast Gulf of Mexico; Florida Straits; Gulf Stream to North Carolina.

Tribe Callechelyini genus and species unknown

Figures 28–29; Tables 1–3

General Morphology.—Seven larvae examined 21.1–47.3 mm TL. Total myomeres 148–154; nephric myomeres 102–109; preanal myomeres 103–110; predorsal myomeres in euryodontic larvae 11–13. Anal-fin rays 172; dorsal-fin rays and branchiostegals not sufficiently developed to count. Ten moderate gut loops (Table 2, Figs. 28A, C). Nephros terminates 0–2 myomeres anterior to anus. Body proportions given in Table 1.

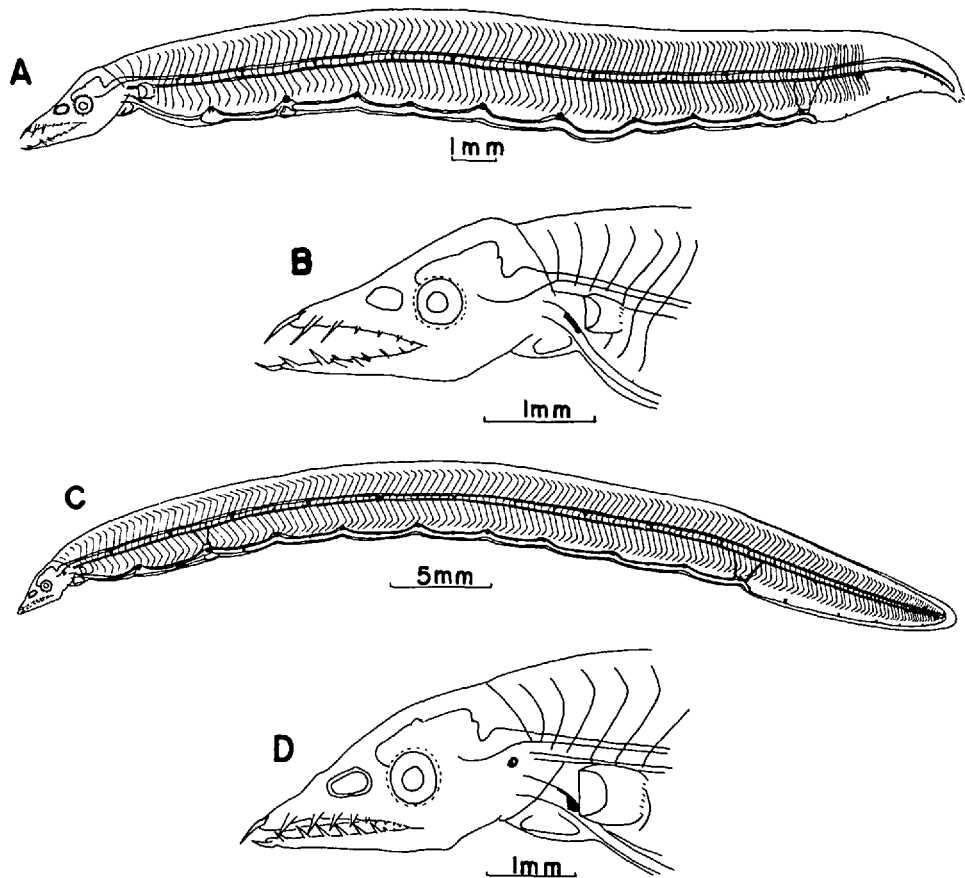


Figure 28. Callechelyini gen. et sp. unknown, euryodontic stage: A, Early euryodontic leptocephalus, 21.1 mm TL; B, Head of same specimen; C, Leptocephalus, 47.3 mm TL; D, Head of same specimen.

Pigmentation.—Head pigment consists of a few small spots on anterior portion of upper jaw, a few, occasionally stellate, subcutaneous patches on side of head lateral to notochord and occipital arch. Midline pigment, occurring approximately every tenth myomere, consists of: dark streaks on myosepta, some pigment in body wall flanking pigmented myosepta, subcutaneous pigment on dorsal surface of notochord beneath pigmented myosepta; four clumps of pigment on tail formed by irregular, subcutaneous patches just ventral to notochord, flanked by pigment in body wall. Ventral margin pigment on esophagus near base of pectoral fin, on each gut loop flanked by pigment in body wall, on surface of gut generally midway between each gut loop, 5–6 (possibly more in larger larvae) round or saddle-shaped patches of pigment in body wall on ventral margin of tail and occasionally extending onto fin membrane and pterygiophores. Dorsal margin pigment consists of 4–5 small patches on edge of body, extending slightly onto fin membrane (confined to tail in larvae examined, but number of patches may increase with growth and may extend more anteriorly).

Remarks.—Identification of this series of larvae to tribe is problematical. The advanced dorsal-fin position and high nephric to total myomere ratio places the

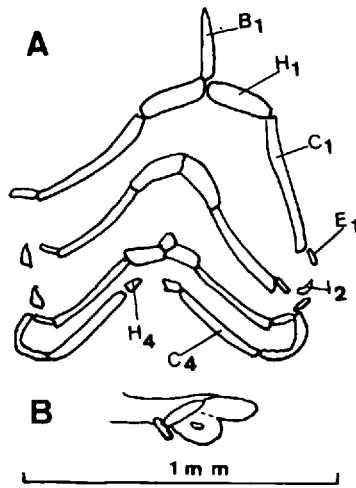


Figure 29. A, Gill arches of *Callechelyini* gen. et sp. unknown, from a 47.3 mm TL euryodontic specimen; B, caudal skeleton of same specimen.

larvae either in the tribe *Bascanichthyini* or *Callechelyini*, but evidence from gill-arch osteology, caudal osteology, gut morphology, and pigmentation is inconclusive.

The gill arches have a distinct H_4 and B_3 , but lack B_2 , B_4 and C_5 (Fig. 29A). Except for the H_4 , which is typically callechelyin, the gill arch condition of these larvae differs trenchantly from gill arch conditions in all larval and adult ophichthids for which gill-arch data are available. These larvae have three rudimentary hypurals (Fig. 29B), not the two seen in most of the *Callechelyini* described earlier in this paper. Gut morphology of these larvae approaches that of *Bascanichthys scuticaris* (Leiby, 1981), but is also similar to gut morphologies of *A. platyventris* and *C. perryae* larvae (Figs. 1–3, 14–15, 28). Pigmentation of these larvae differs trenchantly from any known bascanichthyin larva, but is similar to the pigmentation of *A. platyventris* and *C. perryae* larvae (Figs. 1–3, 14–15, 28).

There are no known adult *Bascanichthyini* or *Callechelyini* in the Atlantic which have meristics consistent with the meristics of these larvae. Consequently, based on the presence of an H_4 in these larvae, and the similarity of their gut morphology and pigmentation to the gut morphologies and pigmentation of two known callechelyins, I am provisionally assigning these larvae to the tribe *Callechelyini*. Because of their unique gill arch and caudal osteology, I am unable to assign them to genus and conclude that they are the larvae of an undescribed genus and species.

Material Examined.—Catalogued specimens: FSBC 11628L (1, 39.3); FSBC 11629L (1, 23.1). Uncatalogued specimens: MBI (3, 21.1–47.3); UMML (2, 28.3–45.6). Collection locations: southwest and eastcentral Gulf of Mexico; Florida Straits.

Tribe *Bascanichthyini* genus and species unknown Figures 30–31; Tables 1–3

General Morphology.—Six larvae examined, 16.6–73.7 mm TL. Total myomeres 180–186; nephric myomeres 99–104; preanal myomeres 100–106; predorsal myomeres in euryodontic larvae 15–17. Anal-fin rays 306; dorsal-fin rays and branchiostegals not countable in my specimens. Eight pronounced gut loops (Table 2;

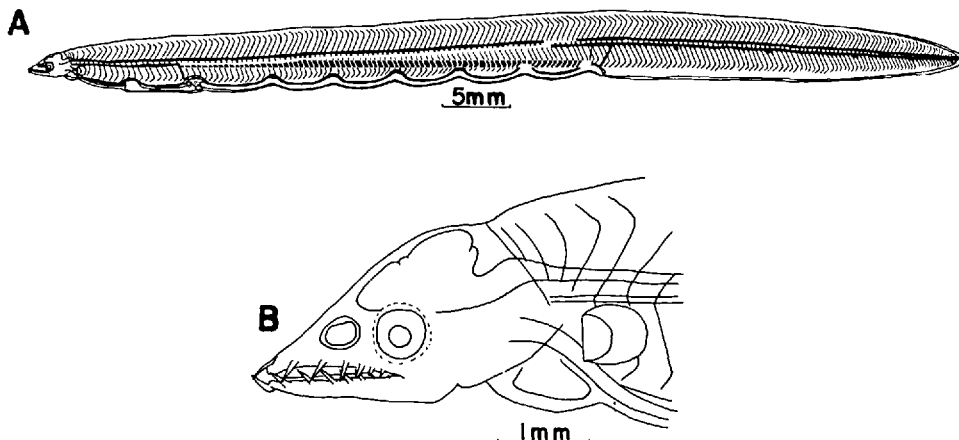


Figure 30. Bascanichthyini gen. et sp. unknown, euryodontic stage: A, Leptocephalus, 71.5 mm TL; B, Head of same specimen.

Fig. 30). Nephros terminates 0–2 myomeres anterior to anus. Body proportions during stages of development given in Table 1.

Pigmentation.—Head pigment a few small spots at base of teeth on upper jaw. Midline pigment consists of light streaks on approximately 65% of myosepta (more pigmented myosepta in posterior half of body than in anterior half), four irregular, subcutaneous patches on tail. Ventral margin pigment on esophagus near base of pectoral fin, dense patches on surface of each gut loop, light pigment in body wall ventral to first two gut loops, small spot on ventral surface of every fifth to tenth anal pterygiophore.

Remarks.—Identification of this series of larvae to tribe is problematical. The advanced dorsal fin origin and high nephric to total myomere ratio places the larvae either in the tribe Bascanichthyini or Callechelyini, but evidence from gill-arch and caudal fin osteology, gut morphology, and pigmentation is inconclusive. Gill-arch and caudal osteology are typically bascanichthyin (Fig. 31; Leiby, 1981), but their pronounced gut loops are typically callechelyin. The pigment pattern of these larvae is not typically callechelyin or bascanichthyin, but is closer to the lightly pigmented Bascanichthyini (Leiby, 1981) than to the distinctively pigmented Callechelyini.

There are no known adult Bascanichthyini or Callechelyini in the Atlantic which have meristics consistent with the meristics of these larvae. Consequently, based on gill arch and caudal osteology, I am provisionally assigning these larvae to the tribe Bascanichthyini, but I am unable to assign them to genus. I conclude that they are either members of an undescribed genus, or of a genus which has not yet been found in the Atlantic.

Fahay and Obenchain (1978) described two larvae they identified as *Callechelys* sp. Their larvae are clearly the same species as the larvae described in this section. They assigned their larvae to *Callechelys* based on head, gut, and liver structures, myomere ranges and pigment pattern. Superficially, these larvae do look like callechelyins; however, similar head and liver structures are found in the Ophichthini (Blache, 1977; Leiby, 1979a; b; 1982), the Bascanichthyini (Blache, 1977; Leiby, 1981), and the Sphagebranchini (Blache, 1977: 286 only; Leiby, 1982) as

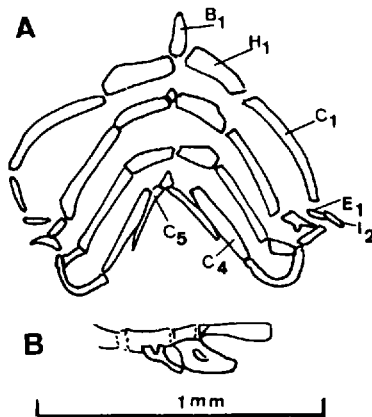


Figure 31. A, Gill arches of *Bascanichthyini* gen. et sp. unknown, from a 71.5 mm TL euryodontic specimen; B, Caudal skeleton of same specimen.

well as the *Callechelyini*. A gut with pronounced loops is found in some *Ophichthini* (Blache, 1977; Leiby, 1981) and possibly in some *Sphagebranchini* (Blache, 1977: 286 only). The myomere range of these larvae match adult *Callechelyini* vertebral ranges, but they also match adult *Bascanichthyini* vertebral ranges. Contrary to Fahay and Obenchain's (1978) assertion, the pigment pattern of these larvae is not identical to the pigment pattern of the recently transformed *C. cliffi* described by Böhlke and Briggs (1954). The pigment pattern in the juvenile *C. cliffi* is left over from the body wall pigment which overlies the gut loops and subcutaneous tail patches of the larvae (see pigmentation discussion of *C. muraena*). Fahay and Obenchain's larvae, and the larvae described in this section, have no body wall pigment flanking the gut loops or the subcutaneous tail spots.

Material Examined.—Catalogued specimens: FSBC 11619L (1, 31.8); FSBC 11620L (1, 71.5); FSBC 11621L (1, 25.6); FSBC 11622L (1, 16.6). Uncatalogued specimens: MBI (1, 73.7); SCMRD (1, 43.7). Collection locations: Southwest and northeast Gulf of Mexico; Gulf Stream off South Carolina.

DISCUSSION

McCosker and Rosenblatt (1972) and McCosker (1977) discussed lineages within the genus *Callechelys*. In the course of this study I obtained specimens of adult *Callechelys* not available to McCosker and Rosenblatt. This new data on adult and larval *Callechelys* allows a refinement of their proposed lineages.

McCosker and Rosenblatt (1972) recognized two major groups in *Callechelys*. One group, characterized by two rod-shaped pectoral elements and a posteriorly split urohyal, contained *C. cliffi*, *C. muraena* and *C. bilinearis*. The second group, characterized by a simple urohyal and a single rod-shaped pectoral element, contained *C. eristigmus*, *C. marmoratus* and *C. melanotaenius*. They apparently did not have specimens of *C. perryae* available; however, based on descriptions of its external morphology, they suggested that it was most closely related to the eastern Pacific *C. eristigmus*. McCosker (1977) tentatively recognized a third group, containing *C. springeri* and *C. nebulosus*, characterized by relatively few branchiostegals (those along the epihyal broadened), two rod-shaped elements in the pectoral girdle, a simple urohyal and a shorter trunk than other species of *Callechelys*.

Table 4 shows branchiostegal counts for 12 species of *Callechelys*. Only one of these has more branchiostegals than *C. nebulosus*, two have the same number, and seven have fewer. Two adult specimens of *C. perryae*, and two adult *C. muraena* examined for this study all have the branchiostegals along the epihyal broadened. Clearly, a moderate number of branchiostegals with those on the epihyal broadened is not a character limited to *C. nebulosus* and *C. springeri*. Both adult *C. perryae* had two rod-shaped elements in the pectoral girdle and a simple urohyal. This combination of characters is also not limited to *C. nebulosus* and *C. springeri*. Based on available data (Table 4) four species of *Callechelys* have a shorter trunk than *C. nebulosus* and eight species have a shorter trunk than *C. springeri*. If one were to accept McCosker's (1977) third *Callechelys* group, it would have to contain *C. nebulosus*, *C. springeri*, and *C. perryae*, and its differentiation would have to rest solely on the possession of a simple urohyal (a generalized ophichthine condition) and two rod-shaped elements in the pectoral girdle (a primitive *Callechelys* condition).

The larval evidence (H_4 fused to or separate from C_5 , gut morphology, pigmentation patterns) and the available data on adult specimens support McCosker and Rosenblatt's (1972) recognition of two groups in *Callechelys* with some modifications. As recognized in this study, group one contains *C. muraena*, *C. bilinearis*, *C. cliffi* (?=*Leptocephalus decimpunctatum* Fowler, 1938), Fowler's (1944) *Leptocephalus caribbeus* (identified by Fahay and Obenchain [1978] as *Apterichtus ansp*, but actually a *Callechelys* sp.), the larval *Callechelys* sp. described in this paper, and, presumably, *C. luteus* and *C. galapagensis*. The known adults of this group have a split urohyal and two rod-shaped elements in the pectoral girdle. The larvae of this group which were examined for this study have pronounced gut loops (Figs. 6-8, 11, 18); H_4 not fused to C_5 (Figs. 9A, 12A, 19A); most or all of the myosepta without pigment; most or all of the anal pterygiophores without pigment; no pigment on the esophagus; pigment on the dorsal surface of each gut loop but no pigment on the gut between gut loops; pronounced, round pigment patches in the body wall lateral to each gut loop; and three to five pronounced, circular, postanal pigment patches which consist of subcutaneous and body-wall pigment. The second group contains *C. nebulosus*, *C. springeri*, *C. eristigmus*, *C. marmoratus*, *C. melanotaenius* and *C. perryae*, and, presumably, *C. leucoptera*, *C. bitaeniatus* and *C. striatus*. The adults of this group have a simple urohyal and one or two rod-shaped elements in the pectoral girdle. The larvae of this group examined for this study have low to moderate gut loops (Figs. 14-15, 20-21), H_4 fused with C_5 (Figs. 16A, 22A); dark pigment on every third to eleventh myoseptum, or light pigment on every myoseptum; round or saddle-shaped patches of pigment in the body wall on the ventral margin of the tail extending onto the anal pterygiophores, or pigment on every anal pterygiophore but none in the ventral body wall; pigment on the esophagus, on the dorsal surface of each gut loop, and between each gut loop; occasionally some body wall pigment lateral to each gut loop; four to seven irregular, subcutaneous pigment patches on tail, usually not flanked by body-wall pigment.

ACKNOWLEDGMENTS

J. E. Böhlke (ANSP), D. G. Smith (MBI), J. Finucane (NMFS), B. Stender (SCMRD), C. R. Gilbert (UF), C. R. Robins (UMML) and W. H. Kreuger (URI) loaned me specimens used in this study. I am grateful. I thank E. B. Böhlke (ANSP), who generously provided X-rays and other data on adult *Callechelys*. The final version of this manuscript was greatly improved by the thoughtful comments on and criticism of an earlier version by J. E. Böhlke (ANSP) and J. E. McCosker (Steinhart Aquarium, San Francisco, Calif.). I especially thank my wife Judy Leiby for her encouragement, patient under-

standing and considerable help during the course of this study, and for her help in revising and editing this manuscript.

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DATE ACCEPTED: August 17, 1982.

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