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Myctophidae: Development

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LANTERNFISHES of the family Myctophidae are found in all oceans of the world. Some 230–250 species are arranged in 36 generic/subgeneric taxa (Table 59). All nominal species are listed in Paxton (1979). Characteristic of the family is the presence of light organs or photophores on the head and body (Fig. 114). The different patterns of photophores have been used, along with meristics (Table 60), in species diagnoses and as a basis for classification within the family since the late 1800's.

Most authors have placed the Myctophidae and closely related Neoscopelidae with the families Aulopidae, Chlorophthalmidae and related families in an order or suborder variously named the Iniomi, Myctophoidea or Myctophiformes (Gosline et al., 1966; Greenwood et al., 1966; Nelson, 1976; Johnson, 1982), although Rosen (1973) separated the Myctophidae and Neoscopelidae as a restricted order Myctophiformes. Moser and Ahlstrom (1970, 1972, 1974), Ahlstrom et al. (1976) and Paxton (1972) are the most recent papers considering relationships within the family; characteristics of larvae and bones and photophores of adults were primarily utilized in the respective studies. Paxton's (1972) classification, including genera recognized subsequently, is as follows:

Subfamily Myctophinae
- Tribe Electronini
  - Genera: *Protomyctophum*, *Krefftichthys*[1], *Electrona*, *Metelectrona*[2]
- Tribe Myctophini
  - Genera: *Benthosema*, *Diogenichthys*, *Hygophum*, *Myctophum*, *Symbolophorus*
- Tribe Gonichthyini
  - Genera: *Loweina*, *Tarletonbeania*, *Gonichthys*, *Centrobranchus*

Subfamily Lampanyctinae
- Tribe Notolychnini
  - Genus *Notolychnus*
- Tribe Lampanyctini
  - Genera: *Taaningichthys*, *Lampadena*, *Bolinichthys*, *Lepidophanes*, *Ceratoscopelus*, *Stenobrachius*, *Lampanyctus*, *Triphoturus*, *Parvilux*[3]
- Tribe Diaphini
  - Genera: *Lobianchia*, *Diaphus*, *Idiolychnus*[4]
- Tribe Gymnoscopelini
  - Genera: *Lampanyctodes*, *Gymnoscopelus*, *Notoscopelus*, *Lampichthys*, *Scopelopsis*, *Hintonia*

There has not been a family revision at the species level since Fraser-Brunner's (1949) study. A large number of more recent generic revisions and regional studies are currently the primary sources for species identifications; most of these have been utilized in compiling the generic distribution limits (Table 59). The most recent zoogeographic studies are those of Backus et al.

[1] Hulley (1981).
[2] Wisner (1963).
[3] Hubbs and Wisner (1964).
[4] Nafpaktitus and Paxton (1978).

TABLE 59. GEOGRAPHIC DISTRIBUTION OF THE GENERA AND SUBGENERA OF MYCTOPHIDAE. References marked * are useful for the identification of species. The division of the Atlantic and Indian Oceans is arbitrarily taken at 20°E, the Indian-Pacific Ocean boundary at 130°E.

Genus	No. of species	Ocean	Lat. extremes	References
Krefftichthys	1	Atlantic	34°S–60°S	*Hulley (1981:12)
		Indian	43°S–66°S	*Hulley (1972:217); Andriashev (1962:224)
		Pacific	34°S–72°S	Andriashev (1962:225); McGinnis (1982:11)
Protomyctophum (*Protomyctophum*)	7	Atlantic	34°S–60°S	*Hulley (1981:29, 19)
		Indian	44°S–65°S	Hulley (1972:218); *McGinnis (1982:17)
		Pacific	40°S–70°S	*Andriashev (1962); *McGinnis (1982:16, 17)
Protomyctophum (*Hierops*)	7	Atlantic	70°N–56°S	Nafpaktitis et al. (1977:31); *Hulley (1981:36)
		Indian	35°S–52°S	*Nafpaktitis and Nafpaktitis (1969:7); *McGinnis (1982:18)
		Pacific	57°N–67°S	*Wisner (1976:20); *McGinnis (1982:18)
Electrona	5	Atlantic	55°N–70°S	*Hulley (1981:40, 46); *McGinnis (1982:21)
		Indian	2°N–68°S	Nafpaktitis and Nafpaktitis (1969:10); *McGinnis (1982:21)
		Pacific	42°N–70°S	*Andriashev (1962); Ebeling (1962:140); *McGinnis (1982:21)
Metelectrona	2	Atlantic	35°S–51°S	*Hulley (1981:53)
		Indian	35°S–47°S	*McGinnis (1982:25)
		Pacific	33°S–55°S	*Bussing (1965:200); *McGinnis (1982:25)
Benthosema	5	Atlantic	80°N–38°S	*Nafpaktitis et al. (1977:52); Hulley (1972:220); (the specimen from 55°S is possibly mislabeled, McGinnis, (1982:26, 29))
		Indian	21°N–35°S	Kotthaus (1972:18); *Nafpaktitis and Nafpaktitis (1969:11)
		Pacific	71°N–42°S	*Wisner (1976); Nafpaktitis et al. (1977:52); Robertson et al. (1978:302)
Diogenichthys	3	Atlantic	50°N–48°S	Nafpaktitis et al. (1977:58); Hulley (1981:58)
		Indian	18°N–45°S	*Nafpaktitis and Nafpaktitis (1969:15)
		Pacific	37°N–41°S	*Wisner (1976:49); Rass (1960:149)
Hygophum	9–11	Atlantic	49°N–48°S	*Bekker (1965); *Nafpaktitis et al. (1977:38); *Hulley (1981:61)
		Indian	20°N–42°S	*Bekker (1965:80); Hulley (1972:222)
		Pacific	39°N–46°S	*Wisner (1976); *Bekker (1965:94); McGinnis (1982:30)
Symbolophorus	7–9	Atlantic	59°N–51°S	*Hulley (1981:101)
		Indian	21°N–41°S	Kotthaus (1972:27); *Nafpaktitis and Nafpaktitis (1969:29)
		Pacific	50°N–59°S	*Wisner (1976); Frost and McCrone (1979:755); *McGinnis (1982:33)
Myctophum	13–14	Atlantic	65°N–40°S	*Nafpaktitis et al. (1977:62); *Hulley (1981:87)
		Indian	20°N–34°S	Nafpaktitis and Nafpaktitis (1969); *Bekker and Borodulina (1978:120); McGinnis (1982:34)
		Pacific	42°N–42°S	*Kawaguchi and Aioi (1972); *Wisner (1976); Kawaguchi et al. (1972:27); Paxton and Nafpaktitis (ms)
Loweina	3–4	Atlantic	44°N–38°S	*Nafpaktitis et al. (1977:85)
		Indian	10°S–40°S	*Bekker (1964:23); *Nafpaktitis and Nafpaktitis (1969:31)
		Pacific	32°N–40°S	*Wisner (1976); *Bekker (1964:23); McGinnis (1982:37)
Tarletonbeania	1–2	Atlantic	—	
		Indian	—	
		Pacific	50°N–30°N	*Bekker (1963:160); *Wisner (1976:82)
Gonichthys	3–4	Atlantic	47°N–40°S	Nafpaktitis et al. (1977:88); Hulley (1981:107)
		Indian	25°S–39°S	*Bekker (1964:38)
		Pacific	31°N–42°S	*Bekker (1964); *Wisner (1976:86); McGinnis (1982:36)
Centrobranchus	3–4	Atlantic	46°N–35°S	*Nafpaktitis et al. (1977:91)
		Indian	15°N–33°S	*Bekker (1964:51, 58)
		Pacific	37°N–37°S	*Bekker (1964:58)
Notolychnus	1	Atlantic	56°N–38°S	*Nafpaktitis et al. (1977:94); *Hulley (1972:222)
		Indian	11°N–40°S	Kotthaus (1972:30); McGinnis (1982:37)
		Pacific	34°N–44°S	Ebeling (1962:141); McGinnis (1982:37)
Lobianchia	2	Atlantic	61°N–51°S	*Nafpaktitis et al. (1977); Bekker (1967:98); McGinnis (1982:51)
		Indian	2°N–40°S	*Nafpaktitis (1978:7); McGinnis (1982:51)
		Pacific	32°N–47°S	*Wisner (1976:96); McGinnis (1982:51)
Diaphus	65–75	Atlantic	62°N–52°S	*Nafpaktitis et al. (1977:158); McGinnis (1982:52)
		Indian	23°N–48°S	*Nafpaktitis (1978:62, 78)
		Pacific	55°N–58°S	*Nafpaktitis (1978:62); McGinnis (1982:52)
Idiolychnus	1	Atlantic	—	
		Indian	13°S–24°S	*Nafpaktitis and Paxton (1978:495)
		Pacific	21°N	*Nafpaktitis and Paxton (1978:495–496)

TABLE 59. CONTINUED.

Genus	No. of species	Ocean	Lat. extremes	References
Lampanyctodes	1	Atlantic	19°S–34°S	*Ahlstrom et al. (1976:146); Grindley and Penrith (1965:283)
		Indian	35°S	Paxton and Nafpaktitis (in prep.)
		Pacific	34°S–51°S	*Wisner (1976:158–159); McGinnis (1982:55)
Gymnoscopelus (*Gymnoscopelus*)	4	Atlantic	34°S–66°S	*Hulley (1981:254); *McGinnis (1982:59)
		Indian	60°S–65°S	*Andriashev (1962:267); *McGinnis (1982:59)
		Pacific	40°S–72°S	*McGinnis (1982:61, 58)
Gymnoscopelus (*Nasolychnus*)	4–5	Atlantic	34°S–57°S	*Hulley (1981:261); (03°S, Fraser-Brunner (1931:224) presumably a waif)
		Indian	24°S–65°S	Smith (1933a:126); *McGinnis (1982:64)
		Pacific	40°S–70°S	*Andriashev (1962); McGinnis (1982:64)
Scopelopsis	1	Atlantic	11°S–48°S	*Hulley (1981:241)
		Indian	9°S–40°S	Legand (1967:49); McGinnis (1982:57)
		Pacific	15°S–35°S	*Wisner (1976:222); Paxton and Nafpaktitis (in prep.)
Lampichthys	1	Atlantic	30°S–48°S	Hulley (1981:242)
		Indian	35°S–40°S	McGinnis (1982:57)
		Pacific	7°S–49°S	*Wisner (1976:215); McGinnis (1982:57)
Notoscopelus (*Notoscopelus*)	5	Atlantic	65°N–60°S	*Nafpaktitis et al. (1977:254) Andriashev (1962:278)
		Indian	8°S–36°S	Nafpaktitis and Nafpaktitis (1969:35); Grindley and Penrith (1965:283)
		Pacific	50°N–37°S	*Fujkii and Uyeno (1976); Frost and McCrone (1979:755); Collins and Baron (1981:11)
Notoscopelus (*Parieophus*)	1	Atlantic	50°N–21°N	*Nafpaktitis et al. (1977:257)
		Indian	—	
		Pacific	—	
Hintonia	1	Atlantic	39°S–48°S	*Hulley (1981:239)
		Indian	47°S–51°S	McGinnis (1982:55)
		Pacific	40°S–50°S	*Wisner (1976:220); McGinnis (1982:55)
Lampadena (*Lampadena*)	8–9	Atlantic	65°N–48°S	*Krefft (1970:285); Hulley (1981:180)
		Indian	6°N–49°S	*Nafpaktitis and Paxton (1968:20, 21)
		Pacific	41°N–49°S	*Nafpaktitis and Paxton (1968:20, 21)
Lampadena (*Dorsadena*)	1	Atlantic	—	
		Indian	—	
		Pacific	45°N	*Coleman and Nafpaktitis (1972:2)
Taaningichthys	3	Atlantic	43°N–44°S	*Hulley (1981:167); *Davy (1972)
		Indian	8°N–30°S	*Nafpaktitis and Nafpaktitis (1969:40)
		Pacific	41°N–68°S	*Davy (1972:72); *Nafpaktitis et al. (1977:191)
Ceratoscopelus	3	Atlantic	52°N–45°S	*Nafpaktitis et al. (1977:243); Hulley (1981:237)
		Indian	20°N–43°S	*Bekker and Borodulina (1968:792); *Nafpaktitis and Nafpaktitis (1969:65)
		Pacific	43°N–42°S	*Wisner (1976:207); Robertson et al. (1978:302)
Lepidophanes	2	Atlantic	43°N–48°S	*Nafpaktitis et al. (1977:225); *Hulley (1981:223)
		Indian	—	
		Pacific	—	
Bolinichthys	7	Atlantic	53°N–41°S	*Nafpaktitis et al. (1977:240); *Hulley (1981:229)
		Indian	21°N–44°S	Kotthaus (1972:18); *Nafpaktitis and Nafpaktitis (1969:60)
		Pacific	31°N–43°S	*Johnson (1975:58); Nafpaktitis et al. (1977:234)
Triphoturus	3–4	Atlantic	—	Hulley (1981:205)
		Indian	8°N–14°S	*Nafpaktitis and Nafpaktitis (1969:51)
		Pacific	38°N–35°S	*Wisner (1976:165)
Stenobrachius	2	Atlantic	—	
		Indian	—	
		Pacific	57°N–30°N	*Wisner (1976:160)
Parvilux	2	Atlantic	—	
		Indian	—	
		Pacific	40°N–14°S	*Wisner (1976:163, 164)
Lampanyctus	40	Atlantic	65°N–60°S	*Nafpaktitis et al. (1977:196); *Hulley (1981:183); Zahuranec (1980)
		Indian	16°N–60°S	*Nafpaktitis and Nafpaktitis (1969); Kotthaus (1972:35); *McGinnis (1982:42); Zahuranec (1980)
		Pacific	59°N–72°S	*Wisner (1976:191); McGinnis (1982:42); Zahuranec (1980)

TABLE 60. MERISTICS OF THE GENERA AND SUBGENERA OF MYCTOPHIDAE.

	Fin rays							
	Dorsal	Anal	Pectoral	Pelvic	Procurrent caudal	Vertebrae	Branchio-stegals	Gill rakers
Krefftichthys	11–14	17–19	14–16	8–9	8–9 + 7–9	36–39		6–8 + 19–23
Protomyctomphum	10–14	21*–27	14–17	8–9	7–9 + 6–9	35–41	8–10	4–7 + 14–21
P. Hierops	11–13	20–27	15–18	8	7–11 + 6–9	36–42	9–10	3–5 + 13–18
Electrona	12–16	18–22	11–17	8	6–10 + 6–9	33–41	7–8	3–10 + 12–25
Metelectrona	13–15	19–22	14–16	8	10 + 9	35–38	8	4–7 + 16–20
Benthosema	11–15	16–22	10–17	8–9	7–9 + 7–9	31–37	9	3–10 + 10–21
Diogenichthys	10–13	14–18	10–14	7–8	7–9 + 7–9	29–34	7	2–4 + 10–12
Hygophum	10–15	18–25	12–17	8–9	6–9 + 6–9	34–40	9	3–6 + 12–16
Myctophum	11–15	16–27	12–22	7–8	7–9 + 7–9	35–46	8–9	4–8 + 10–21
Symbolophorus	12–16	18–24	12–20	8	8–10 + 7–9	36–42	9	4–7 + 12–19
Loweina	10–13	13–17	9–12	7–9	6–7 + 6–7	37–39	9	2–3 + 5–10
Tarletonbeania	11–15	16–20	11–16	8	5–8 + 5–8	40–42	8	4–6 + 10–12
Gonichthys	10–13	17–24	11–18	6–8	5–6 + 5–6	38–41	9	3–6 + 7–12
Centrobranchus	9–12	16–20	11–17	8	5–7 + 5–7	35–40	7–8	0
Notolychnus	10–12	12–15	11–15	6–7	7–9 + 7–9	27–31	9–10	2 + 8–9
Lobianchia	15–18	13–15	11–15	8	5–7 + 5–6	33–35	9	4–6 + 11–16
Diaphus	10–19	11–19	9–14	8	5–8 + 5–8	31–37	8–9	4–11 + 9–21
Idiolychnus	14–15	14–16	13–15	8		34		6–7 + 14–15
Lampanyctodes	13–14	14–17	12–14	8	8–10 + 9–10	36–39	9–11	10–11 + 20–23
Gymnoscopelus	14–21	16–22	12–16	8–9	10–12 + 11–15	41–45	10	6–12 + 14–26
G. Nasolychnus	16–20	16–20	12–15	8	8–13 + 10–15	41–45	10–11	7–12 + 17–25
Scopelopsis	20–24	23–27	10–12	7–8	9–11 + 11–12	38–39	9–10	7–9 + 16–18
Lampichthys	16–18	21–23	11–15	8	10 + 12	40–41	9	4–6 + 13–16
Notoscopelus	21–27	18–21	11–14	8–9	10–14 + 10–15	35–40	10	4–10 + 9–22
N. Parieophus	23–26	18–20	12–14			37–38		8–10 + 18–20
Hintonia	14–16	12–14	13–15	8	10–11 + 13	37–39	9	6–7 + 11–14
Lampadena	13–16	12–15	13–18	8	8 + 8–9	35–40	9	3–8 + 9–18
L. Dorsadena	14–15	12–14	15–16	8–9				4–5 + 12
Taaningichthys	11–14	11–14	12–17	8	7–10 + 6–10	34–41	8–9	2–5 + 6–14
Ceratoscopelus	13–15	13–16	12–15	8	6–7 + 6–7	35–38	9	3–5 + 9–16
Lepidophanes	11–15	13–16	11–14	8–9	6–7 + 6–8	33–37	9	3–4 + 8–11
Bolinichthys	11–15	11–15	11–15	8	7 + 7–8	33–36	9	3–7 + 11–17
Triphoturus	12–16	13–18	8–10	8	5–7 + 6–7	30–36	10–11	2–4 + 8–11
Stenobrachius	12–15	14–16	8–10	8	6–8 + 7–9	35–38	9–10	5–6 + 12–14
Parvilux	14–17	15–18	10–13	8	8 + 8–9	35–38	10–11	4–6 + 11–15
Lampanyctus	10–19	14–21	0–17	8	6–8 + 6–8	30–40	8–11	3–8 + 9–19

* Incorrectly 15–27 in Paxton, 1972.

(1977) and Hulley (1981) on Atlantic species and McGinnis (1982) on Southern Ocean species.

Most lanternfishes make extensive vertical migrations from mesopelagic depths to the upper waters at night, some reaching the surface (Paxton, 1967). The fisheries potential of myctophids and other mesopelagic fishes has recently been reviewed (Gjøsaeter and Kawaguchi, 1980). Adults range in size from 20–300 mm (Krefft, 1974) and have a life span of from one year in some tropical species (Clarke, 1973) to more than five years in the few temperate species that have been studied (Smoker and Pearcy, 1970; Gjøsaeter, 1973; Kawaguchi and Mauchline, 1982).

EGGS

Myctophids are oviparous and presumably all produce planktonic eggs although such have been reported for only two species. Sanzo (1939a) indicated that mature ovarian eggs of *E. rissoi* have the following characteristics: round shape; 0.80–0.84 mm diameter; segmented yolk; single oil globule, ca. 0.28 mm diameter; smooth chorion. He illustrated a planktonic egg with similar characteristics and tentatively identified it as that of *E. rissoi*. Robertson (1977) described the planktonic egg of *Lampanyctodes hectoris* as follows: weakly oval; long axis 0.74–0.83 mm, short axis 0.65–0.72 mm; strongly segmented yolk; single oil droplet, 0.21–0.23 mm diameter; narrow perivitelline space; chorion smooth and delicate. He based his identification on the similarity of these eggs and mature ovarian eggs of running ripe *L. hectoris* captured at the same time by trawl.

We have observed planktonic eggs similar to those described by Robertson (1977) but have not found them with advanced embryos that could be matched with co-occurring yolk-sac myctophid larvae. The fact that these and other types of eggs tentatively identified as myctophids occur in relatively low abundance compared with myctophid larvae led Moser and Ahlstrom (1970) to suggest that the fragile chorion breaks in contact with plankton nets and the embryo is extruded through the mesh.

LARVAE

Moser and Ahlstrom (1970) reviewed the literature on myctophid larvae; however, numerous recent contributions have advanced our knowledge of the group and are listed in Table 61. Of the 32 recognized genera of myctophids, larvae have been described for all but *Hintonia*. The larval stages of myctophids provide sets of characters that are useful at levels of systematic analysis from species separation to hypotheses of

TABLE 61. SUMMARY OF LITERATURE CONTAINING ILLUSTRATIONS OF DEVELOPMENTAL STAGES OF MYCTOPHIDS. Frequently cited authors are abbreviated as follows: Ahlstrom (A), Belyanina and Kovalevskaya (B + K), Dekhnik and Sinyukova (D + S), Moser and Ahlstrom (M + A), Pertseva-Ostroumova (P-O), Shiganova (S), Tåning (T).

Species	Single larval stage	Multiple larval stages	Transforming stage	Juvenile stage
Benthosema				
fibulatum	M + A, 1974	P-O, 1974	—	—
glaciale	Holt, 1898; S, 1977	T, 1918; Sparta, 1951; M + A, 1974	Holt, 1898; T, 1918; Sparta, 1951	Holt, 1898; T, 1918; Sparta, 1951
panamense	—	M + A, 1970	M + A, 1970	M + A, 1970
pterota	M + A, 1974; P-O, 1974	Tsokur, 1981	—	Tsokur, 1981
suborbitale	P-O, 1964; M + A, 1974	P-O, 1974; Badcock and Merrett, 1976; S, 1977	P-O, 1974; S, 1977	S, 1977
Bolinichthys				
distofax	M + A, 1974	—	—	—
pyrsobolus	P-O, 1964	—	—	—
Centrobranchus				
andrae	P-O, 1974	—	P-O, 1974	—
brevirostris	P-O, 1964	P-O, 1974	—	—
choerocephalus	M + A, 1974	M + A, 1970	—	M + A, 1970
nigroocellatus	P-O, 1974	—	—	—
Ceratoscopelus				
maderensis	M + A, 1972; S, 1977	T, 1918; D + S, 1966	T, 1918	T, 1918; S, 1977
townsendi	M + A, 1974	—	—	—
warmingi	Miller et al., 1979; Belyanina, 1982b	S, 1977	S, 1977	—
Diaphus				
agassizii	—	P-O, 1975	P-O, 1975	P-O, 1975
holti	D + S, 1966	T, 1918	T, 1918	T, 1918
malayanus	—	Tsokur, 1975	Tsokur, 1975	Tsokur, 1975
metapoclampus	—	Sparta, 1952	Sparta, 1952	Sparta, 1952
mollis	—	S, 1977	S, 1977	S, 1977
pacificus	M + A, 1974	—	—	—
rafinesquei	—	T, 1918	T, 1918	T, 1918
theta	P-O, 1964; M + A, 1974	—	—	—
Diogenichthys				
atlanticus	P-O, 1964	T, 1918; A, 1965; M + A, 1970; P-O, 1974; S, 1977	T, 1918; M + A, 1970; S, 1977	T, 1918; M + A, 1970; S, 1977
laternatus	—	A, 1965; M + A, 1970	M + A, 1970	M + A, 1970
panurgus	—	P-O, 1974	P-O, 1974	—
Electrona				
antarctica	M + A, 1974	P-O, 1967; B + K, 1979	—	—
carlsbergi	M + A, 1974	B + K, 1979	—	—
rissoi	—	T, 1918; Sanzo, 1939a; D + S, 1966; M + A, 1970	Sanzo, 1939a	T, 1918; Sanzo, 1939a; M + A, 1970
subaspera	M + A, 1974	—	—	—
Gonichthys				
coccoi	—	T, 1918; S, 1977; D + S, 1966	—	T, 1918; S, 1977
tenuiculus	M + A, 1974	M + A, 1970	M + A, 1970	—
Gymnoscopelus				
bolini	—	S, 1977	S, 1977	S, 1977
braueri	P-O, 1964	P-O, 1977; B + K, 1979	—	—
fraseri	—	P-O, 1977	—	—
nicholsi	P-O, 1964	M + A, 1972; P-O, 1977; B + K, 1979	M + A, 1972	—
opisthopterus	—	Yefremenko, 1977	—	—
Hygophum				
atratum	—	M + A, 1970	M + A, 1970	M + A, 1970
benoiti	—	T, 1918; S, 1974	T, 1918; S, 1974	T, 1918; S, 1974
brunni	M + A, 1974	—	—	—
hanseni	—	S, 1977	S, 1977	S, 1977
hygomi	M + A, 1974	T, 1918; P-O, 1974; S, 1977	T, 1918; P-O, 1974; S, 1977	T, 1918; S, 1977

TABLE 61. CONTINUED.

Species	Single larval stage	Multiple larval stages	Transforming stage	Juvenile stage
macrochir	M + A, 1974	S, 1975	S, 1975	S, 1975
proximum	M + A, 1974; Miller et al., 1979	P-O, 1974	P-O, 1974	—
reinhardti	M + A, 1974	M + A, 1970; S, 1977	M + A, 1970; S, 1977	M + A, 1970; S, 1977
taaningi	M + A, 1974	—	—	—
Idiolychnus				
urolampus	M + A, 1974	—	—	—
Krefftichthys				
anderssoni	M + A, 1974	Yefremenko, 1976; B + K, 1979	Yefremenko, 1976	Yefremenko, 1976
Lampadena				
luminosa	M + A, 1974; Miller et al., 1979	—	—	—
urophaos	—	M + A, 1972	M + A, 1972	—
Lampanyctodes				
hectoris	—	Ahlstrom et al., 1976	Ahlstrom et al., 1976	Ahlstrom et al., 1976
Lampanyctus				
achirus	M + A, 1974	—	—	—
crocodilus	—	T, 1918; D + S, 1966	T, 1918	T, 1918
jordani	P-O, 1964	—	—	—
nobilis	Miller et al., 1979	—	—	—
pusillus	—	T, 1918; D + S, 1966	T, 1918	T, 1918
regalis	M + A, 1974	—	Bolin, 1939b	—
ritteri	M + A, 1974	A, 1965	—	—
Lampichthys				
procerus	—	M + A, 1972	M + A, 1972	—
Lepidophanes				
gaussi	M + A, 1974	—	—	—
guentheri	M + A, 1972	S, 1977	M + A, 1972; S, 1977	—
Lobianchia				
dofleini	M + A, 1974	T, 1918; D + S, 1966; S, 1977	T, 1918; S, 1977	T, 1918; S, 1977
gemellari	Sanzo, 1931c; P-O, 1964; M + A, 1974	T, 1918	T, 1918	T, 1918
Loweina				
rara	M + A, 1974	M + A, 1970; P-O, 1974	M + A, 1970	M + A, 1970
terminata	Belyanina, 1982b	—	—	—
Metelectrona				
ventralis	M + A, 1974	—	—	—
Myctophum				
asperum	P-O, 1964; M + A, 1974	Imai, 1958; P-O, 1974	—	Imai, 1958; P-O, 1974
aurolaternatum	M + A, 1974	—	—	—
brachygnathum	M + A, 1974	—	—	—
lychnobium	M + A, 1974; P-O, 1974	—	P-O, 1974	—
nitidulum	M + A, 1974	M + A, 1970; P-O, 1974	—	M + A, 1970
obtusirostre	M + A, 1974	—	—	—
punctatum	M + A, 1974	Sanzo, 1915b; T, 1918; S, 1977	Sanzo, 1915b; T, 1918; S, 1977	T, 1918; S, 1977
selenops	M + A, 1974	—	—	—
spinosum	M + A, 1974	P-O, 1974	P-O, 1974	P-O, 1974
Notolychnus				
valdiviae	P-O, 1964; M + A, 1974	T, 1918	T, 1918	T, 1918
Notoscopelus				
caudispinosus	Belyanina, 1982b	—	—	—
elongatus	—	T, 1918	T, 1918	T, 1918
resplendens	M + A, 1974	M + A, 1972; Badcock and Merrett, 1976; S, 1977	M + A, 1972; S, 1977	—

TABLE 61. CONTINUED.

Species	Single larval stage	Multiple larval stages	Transforming stage	Juvenile stage
Parvilux				
ingens	M + A, 1974	—	—	—
Protomyctophum				
arcticum	—	T, 1918	T, 1918	T, 1918
bolini	—	P-O, 1967; B + K, 1979	—	—
chilensis	M + A, 1974	—	—	—
crockeri	—	M + A, 1970	—	M + A, 1970
normani	P-O, 1967; M + A, 1974	—	—	P-O, 1967
parallelum	—	P-O, 1967; B + K, 1979	—	—
subparallelum	M + A, 1974	—	—	—
tenisoni	M + A, 1974	—	—	—
thompsoni	P-O, 1964	P-O, 1967; M + A, 1970	—	M + A, 1970
Scopelopsis				
multipunctatus	—	M + A, 1972; P-O, 1972	M + A, 1972; P-O, 1972; M + A, 1974	M + A, 1972
Stenobrachius				
leucopsarus	P-O, 1964; M + A, 1974	Fast, 1960; A, 1965; A, 1972b	Fast, 1960	Fast, 1960
Symbolophours				
boops	—	P-O, 1974	—	—
californiense	P-O, 1964; M + A, 1974	A, 1965; M + A, 1970; P-O, 1974	M + A, 1970; P-O, 1974	—
evermanni	P-O, 1964	P-O, 1974	P-O, 1974	P-O, 1974
veranyi	—	Sanzo, 1915b; T, 1918; D + S, 1966	Sanzo, 1915b; T, 1918	Sanzo, 1915b, T, 1918
Taaningichthys				
minimus	—	M + A, 1972	—	—
Tarletonbeania				
crenularis	P-O, 1964; M + A, 1974; P-O, 1974	A, 1965; M + A, 1970	Bolin, 1939b; M + A, 1970	M + A, 1970
Triphoturus				
mexicanus	M + A, 1974	A, 1965; A, 1972b	—	—
nigrescens	Moser, 1981	—	—	—

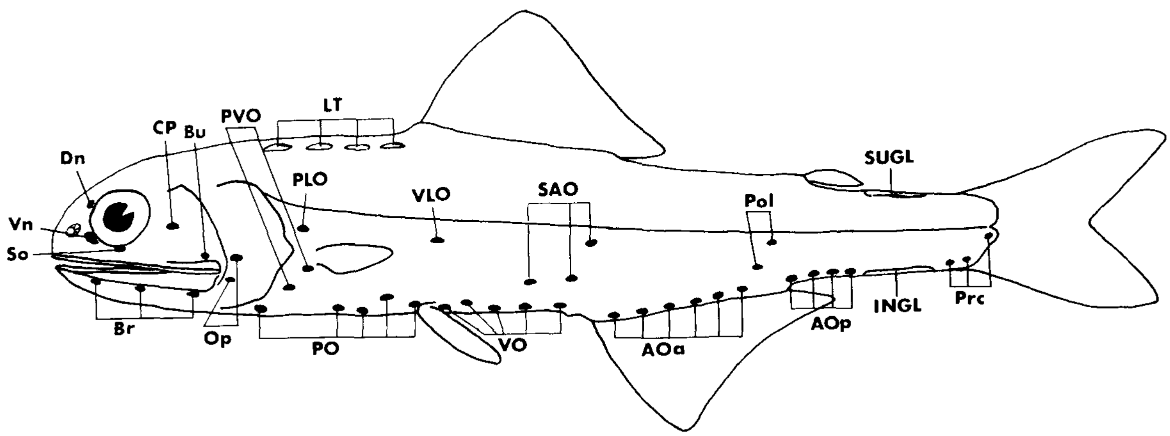


Fig. 114. Hypothetical myctophid showing photophore terminology, from Paxton (1972).

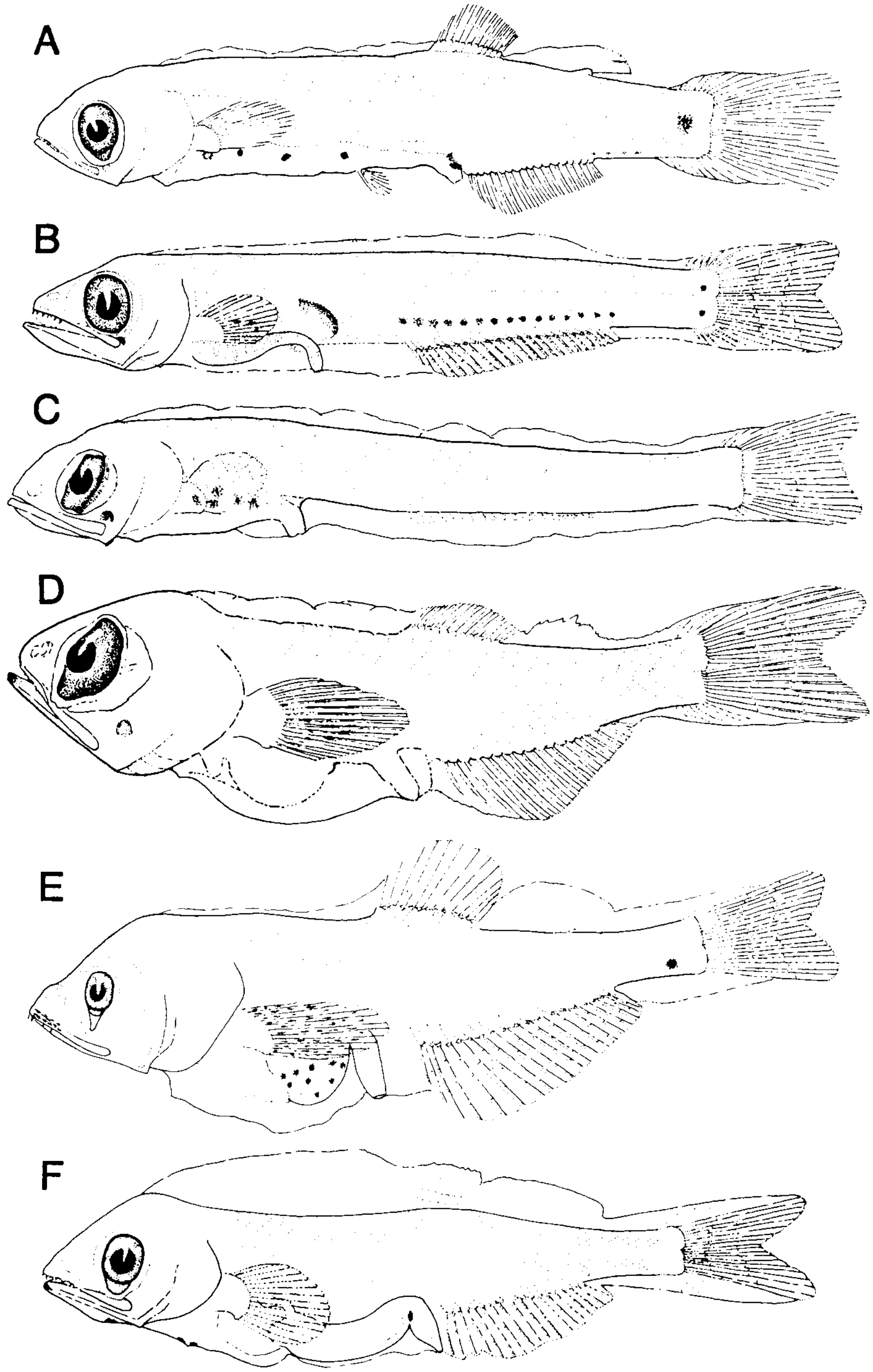


Fig. 115. Larvae of Electronini. (A) *Krefftichthys anderssoni*, 15.7 mm; (B) *Protomyctophum normani*, 15.2 mm; (C) *P. Hierops thompsoni*, 13.8 mm; (D) *Electrona rissoi*, 7.9 mm; (E) *E. antarctica*, 12.7 mm; (F) *Metelectrona ventralis*, 10.3 mm. A, B, E, F from Moser and Ahlstrom (1974); C and D from Moser and Ahlstrom (1970).

TABLE 62. SEQUENCE OF FORMATION OF PHOTOPHORES WHICH APPEAR IN FOURTEEN GENERA OF MYCTOPHIDAE. The Br_2 appear first in all genera listed. Parentheses indicate photophores appear late in larval period.

	Br_1	Br_3	Dn	Vn	OP_2	PO_1	PO_2	PO_3	PO_4	PO_5	PVO_1	PVO_2	PLO	VLO	VO_1	VO_5	AOa_1	AOa_2
Benthosema																		
suborbitale	2	2	—	—	2	1	1	3	3	3	—	—	—	—	—	—	3	3
glaciale	—	—	—	—	(1)	(1)	(1)	(1)	(1)	(1)	—	—	—	—	—	—	—	—
pterota	—	—	1	—	4	6	—	—	—	2	3	5	—	—	5	—	6	—
fibulatum	—	—	1	—	—	3	5	—	—	2	—	—	—	6	—	—	4	6
Diogenichthys																		
laternatus	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
atlanticus	—	—	—	—	—	—	1	—	—	2	—	—	—	—	—	—	3	—
Myctophum																		
spinosum	—	—	1	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—
lychnobium	—	—	1	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—
asperum	—	—	1	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—
brachygnathum	—	—	1	—	—	2	—	—	—	—	—	—	2	—	—	—	—	—
obtusirostre	—	—	1	—	—	3	—	—	—	—	—	—	2	—	—	—	—	—
selenops	—	—	1	—	—	3	—	—	—	—	—	—	2	—	—	—	—	—
Lobianchia	—	—	—	—	—	1	—	—	—	2	3	4	—	—	—	—	—	—
Diaphus																		
theta	—	—	—	—	(5)	2	(4)	(7)	(8)	1	—	—	—	(9)	(3)	(6)	—	—
pacificus	—	—	—	—	—	2	(3)	(5)	—	1	(4)	—	—	—	(6)	—	—	—
Gymnoscopelus	—	—	—	—	—	2	4	—	—	1	—	—	—	—	3	—	—	—
Lampanyctodes	—	—	—	1	—	4	—	—	—	2	—	—	3	—	—	—	—	—
Scopelopsis	—	—	—	2	—	—	—	—	—	1	—	—	—	3	—	—	—	—
Lampichthys	—	—	—	2	—	4	—	—	—	1	—	—	3	—	—	—	—	—
Notoscopelus	—	—	—	2	—	—	—	—	—	1	—	—	3	—	—	—	—	—
Lampadena	—	—	—	3	—	3	—	—	—	2	—	—	1	—	—	—	—	—
Ceratoscopelus	—	—	—	1	—	—	—	—	—	3	—	—	2	—	—	—	—	—
Lepidophanes	—	—	—	1	—	—	—	—	—	1	—	—	1	—	—	—	—	—
Bolinichthys	—	—	—	(1)	—	—	—	—	—	(1)	—	—	(1)	—	—	—	—	—

ordinal relationships. One set is the size at various developmental milestones. Myctophid larvae hatch at about 2 mm length with a yolk-sac remnant. Notochord flexion occurs in a narrow size interval (0.5–2.0 mm) and the size at mid-flexion is typically about half the maximum larval size. Size at transformation also occurs within a short length interval, usually not exceeding 2 mm. Most myctophid species transform in the length range of 12–19 mm, although some (e.g., *Electrona rissoi, Notolychnus valdiviae*) are as small as 9–10 mm at transformation and some species of *Symbolophorus* reach about 23 mm before transformation. *Gymnoscopelus nicholsi* has the largest larvae recorded, up to 28 mm.

Head, body, and gut shape are distinctive for most species and within most genera there is a similarity of shape (Figs. 115–124). While most myctophid larvae are moderately slender, body shape can range from highly attenuate (e.g., *Hygophum reinhardti*) to markedly robust (e.g., some *Myctophum* and *Lampanyctus* species). Some are deep-bodied but laterally compressed (e.g., Gonichthyini). Robust larvae and deep-bodied, laterally compressed forms tend to have large heads and jaws, while attenuate forms have flat heads.

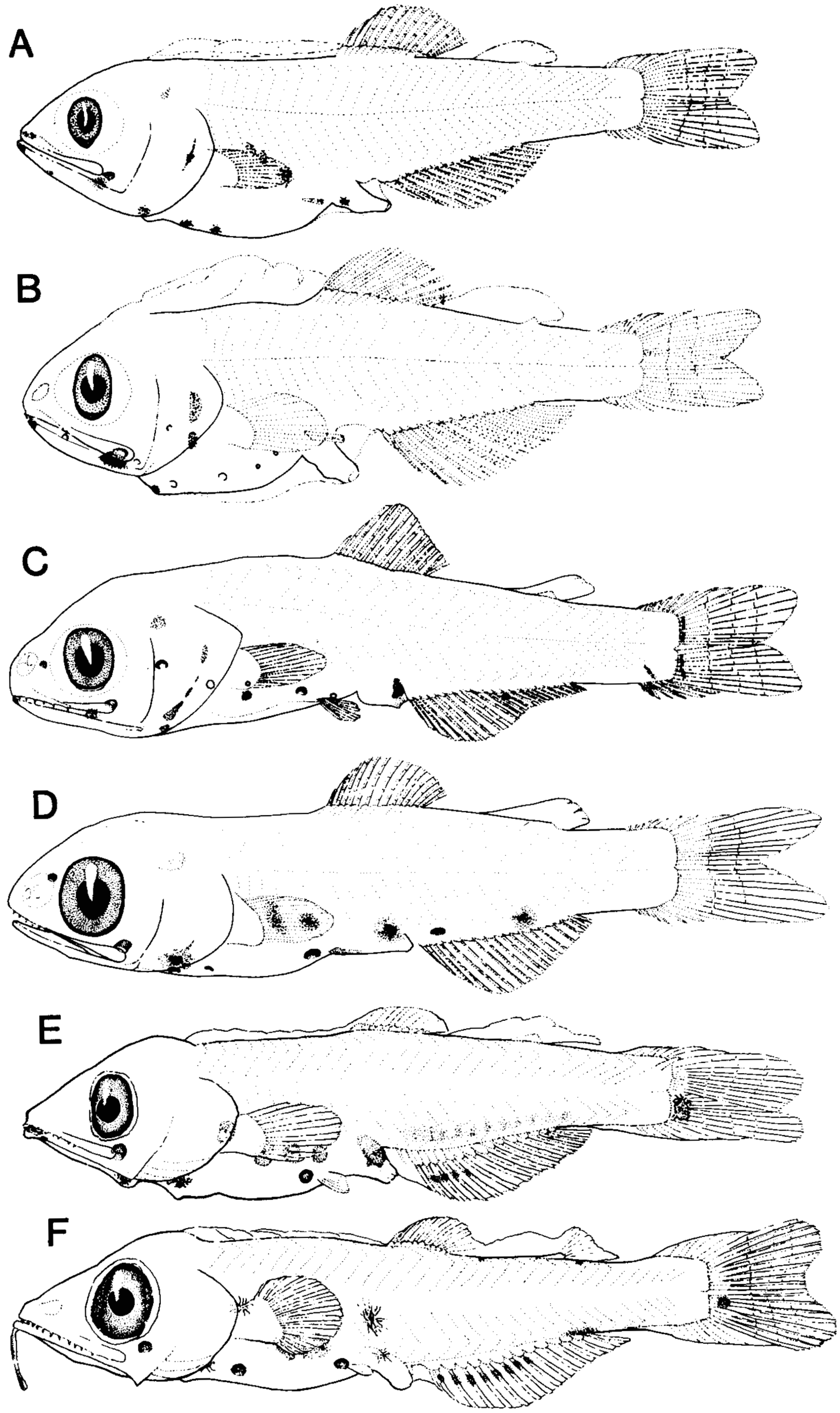
The eye is varied in size and shape and provides numerous characters. In the Myctophinae the eyes are elliptical in outline in contrast to most Lampanyctinae which have rounded eyes. Further specializations in Myctophinae are the presence of variously shaped choroid tissue on the ventral surface of the eye in most genera and eye stalks in several genera. Among lampanyctine genera eyes are sessile and only *Lobianchia dofleini* and species of *Triphoturus* have markedly narrowed eyes with choroid tissue.

The gut has distinctive transverse rugae and ranges from short, to elongate, to trailing free from the body. In most myctophids it extends to about the midpoint of the body and is slightly S-shaped. The curvature tends to be more pronounced in taxa with short guts. In two myctophine genera (*Metelectrona* and some *Hygophum* species) the anterior section of the gut is small in diameter and opens dorsally into the relatively larger posterior section.

In most myctophids, ray formation and ossification of fins proceeds in the following sequence: caudal, pectoral, anal, dorsal, and pelvic. However, in some *Symbolophorus* species the pelvic fin forms early and ossification of rays precedes that of the anal and dorsal fins. In most species the pectoral fin is relatively small, but deep-bodied and robust forms in both

→

Fig. 116. Larvae of Myctophini. (A) *Benthosema glaciale*, 10.5 mm; (B) *B. suborbitale*, 9.2 mm; (C) *B. pterota*, 8.5 mm; (D) *B. fibulatum*, 8.7 mm; (E) *Diogenichthys laternatus*, 7.7 mm; (F) *D. atlanticus*, 8.8 mm. A–D from Moser and Ahlstrom (1974); E and F from Moser and Ahlstrom (1970).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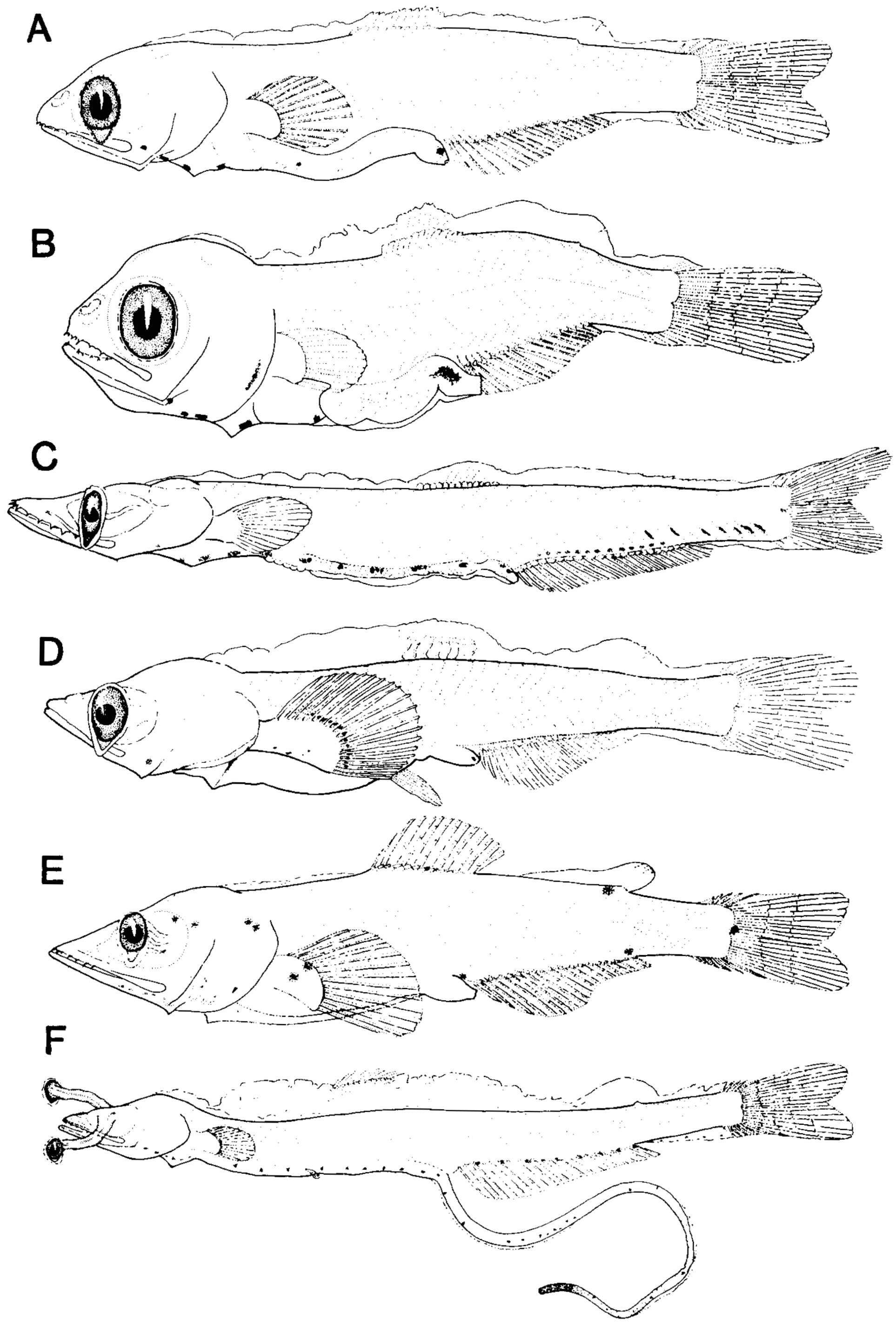

Fig. 117. Larvae of Myctophini. (A) *Hygophum proximum*, 8.9 mm; (B) *H. taaningi*, 6.8 mm; (C) *H. reinhardti*, 12.8 mm; (D) *Symbolophorus californiense*, 11.5 mm; (E) *Myctophum punctatum*, 13.6 mm; (F) *M. aurolaternatum*, 26.0 mm. A. B. E, F from Moser and Ahlstrom (1974); C and D from Moser and Ahlstrom (1970).

subfamilies have large fins and fin bases. In *Symbolophorus* the fin base is uniquely shaped and in *Lobianchia* the fin blade has a unique shape. In two genera (*Loweina, Tarletonbeania*) the lowermost pectoral ray is elongate and ornamented. The finfold is enlarged in many myctophine genera and greatly enlarged in one myctophine tribe, the Gonichthyini.

Myctophids, with the exception of *Notolychnus* and *Taaningichthys,* develop the middle branchiostegal photophore (Br_2) during the larval period. It is located posteroventral to the orbit but during transformation assumes a position beneath the orbit on the branchiostegal membrane. Three myctophine genera and 11 lampanyctine genera develop additional photophores during the larval period; however, the Br_2 is always the first to develop. The larval photophore complements and the sequence of appearance of constituent photophores are useful characters.

Myctophid species have distinct melanophore patterns, with the exception of the large genus *Diaphus,* for which only a few specific patterns have been identified. Most genera may be separated by overall similarity of pattern among their species and some have unique melanophore loci. There are no clear patterns for tribes or subfamilies although certain pigment loci are persistent in some tribes (e.g., caudal fin base spots in diaphines; dorsal midline series in gymnoscopelines).

In the following summary of key larval characters, the genera are listed for convenience as in Moser and Ahlstrom (1970, 1972, 1974) and the sequence does not necessarily imply relationship. Likewise, the species groups serve only to identify phenotypically similar larval types. Larvae of a majority of myctophid genera have a moderately slender body, a head of moderate size, with a slightly convex dorsal profile and a pointed snout of moderate length. Body and head shape are noted only when they depart from this morph. In Myctophinae eye shape is noted when it is markedly elliptical and size is noted only when larger or smaller than typical. In Lampanyctinae eye shape is noted only when it departs from the round condition and eye size only when larger or smaller than typical. Choroid tissue is described only when it is present. Gut length and shape are described only if there is a departure from the typical morph—a slightly S-shaped gut that extends to about midbody. The most persistent pigment locus in myctophid larvae is above or to the side of the free terminal section of the gut, thus only the lack of this pigment is noted. Larval photophores, in addition to the Br_2, and their sequence of appearance are shown in Table 62.

Myctophinae

Krefftichthys.—Fig. 115A; head small with short snout; conical choroid tissue; gut straight, extending beyond midbody; dorsal fin displaced posteriad; lateral gut and postanal median ventral melanophore series; large lateral hypural pigment patch.

Protomyctophum.—Fig. 115B, C; two subgenera; head small to moderate in size; gut short, wide space between anus and anal fin; head pigment lacking except in otic region of *P. Heirops chilensis*; some species may have melanophores on lateral gut, above gut on trunk, above gas bladder, in postanal ventral midline series, prominent pigment on lateral hypural region. *P. Heirops*: Fig. 115C; characters similar to *P. Protomyctophum* except eye narrower.

Electrona.—Fig. 115D, E; body moderately slender to moderatey deep; head moderately large; snout blunt or pointed; gut short, somewhat saccular, strongly S-shaped; space between anus and anal fin not as large as in *Protomyctophum*; three morphs. *E. subaspera-E. carlsbergi*: eye slightly elliptical, small lunate choroid mass in *E. carlsbergi*; pigment above gut; *E. subaspera* has pigment lateral to cleithrum. *E. rissoi*: Fig. 115D; head large, broad; eye very narrow; pigment at lower jaw symphysis, on pectoral fin blade. *E. antarctica*: Fig. 115E; body and head laterally compressed; gut mass protrudes ventrally from body profile; eye small, narrow, with bicolored elongate conical choroid mass; pigment on upper jaw, pectoral fin blade, lateral gut, lateral hypural region.

Metelectrona.—Fig. 115F; body and head laterally compressed; dorsal finfold enlarged with fin base initially separated from body; lunate choroid mass; anterior gut section with small diameter, opening dorsally into somewhat saccular posterior section; pigment below lower jaw and on isthmus.

Benthosema.—Fig. 116A–D; two morphs; photophores (Table 62). *B. glaciale-B. suborbitale*: Fig. 116A, B; eyes narrow, with small lunate choroid mass; gut moderately short in preflexion larvae with space between anus and anal fin; pigment on snout, lower jaw, hindbrain, lateral and ventral cleithral region; pigment above gut in *B. glaciale*. *B. pterota-B. fibulatum*: Fig. 116C, D; eyes less narrow than in above morph, with sliver of choroid tissue or none; gut extends to about midbody with no space between anus and anal fin; preflexion larvae with melanophore series on lateral gut and on postanal ventral midline, coalescing to a single melanophore; lateral cleithral pigment; lower jaw pigment in *B. pterota.*

Diogenichthys.—Fig. 116E, F; eyes very narrow in preflexion stage, less so in postflexion; photophores (Table 62); pigment series on lateral gut and on postanal ventral midline, increasing with development; spot at caudal fin base; pigment on tip of lower jaw in *D. laternatus*; *D. atlanticus* has spot on trunk above terminal gut flexure and pigment on symphyseal barbel.

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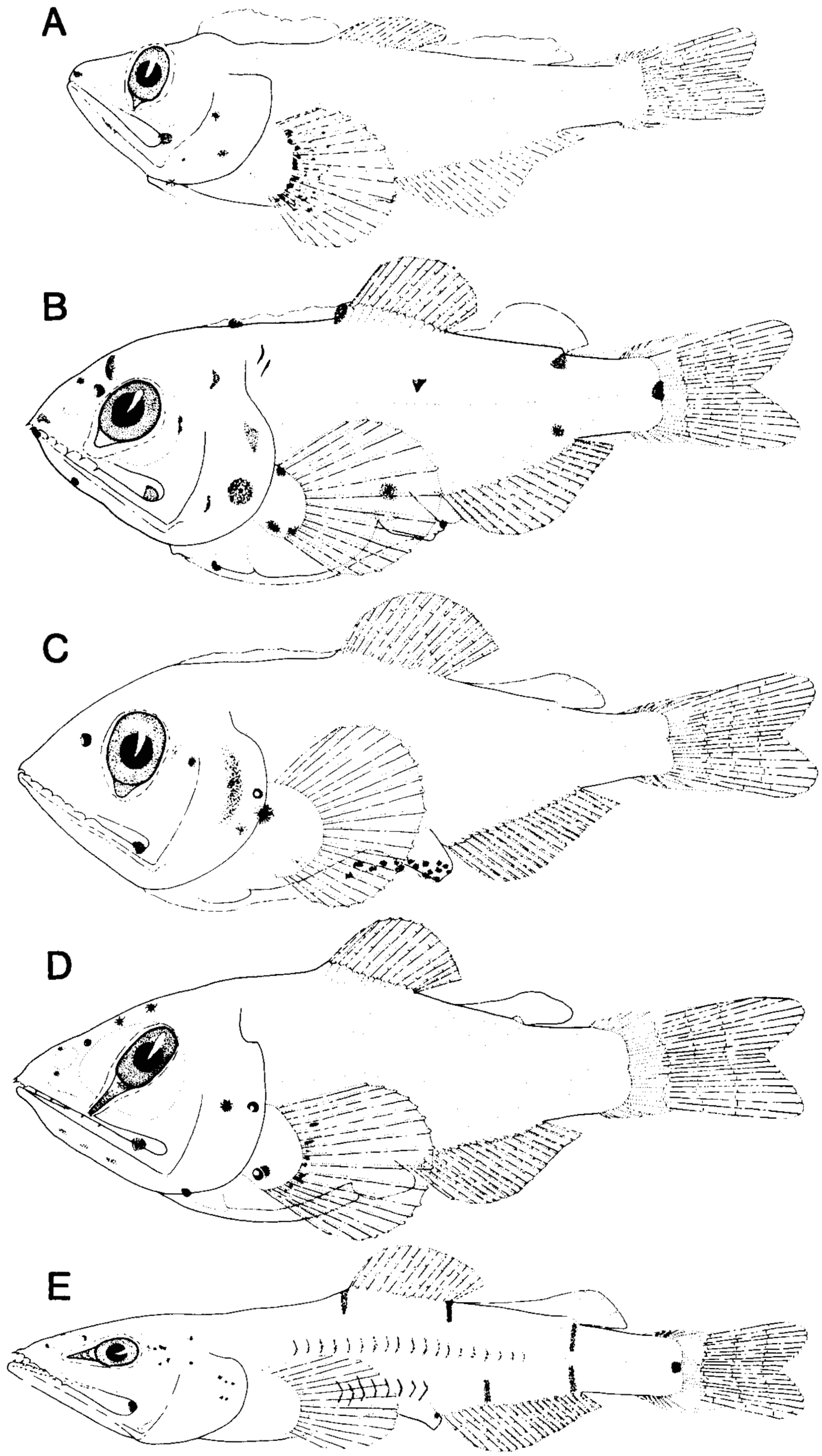
Fig. 118. Larvae of *Myctophum.* (A) *M. phengodes,* 9.8 mm; (B) *M. asperum,* 6.8 mm; (C) *M. brachygnathum,* 7.5 mm; (D) *M. selenops,* 7.8 mm; (E) *M. spinosum,* 9.0 mm. From Moser and Ahlstrom (1974).

Fig. 119. Larvae of Gonichthyini. (A) *Loweina rara,* 17.6 mm; (B) *Tarletonbeania crenularis,* 18.9 mm; (C) *Gonichthys tenuiculus,* 7.7 mm; (D) *Centrobranchus choerocephalus,* 7.3 mm. From Moser and Ahlstrom (1970).

Fig. 120. Larvae of Lampanyctinae. (A) *Notolychnus valdiviae,* 8.7 mm; (B) *Lobianchia dofleini,* 8.2 mm; (C) *L. gemellari,* 6.7 mm; (D) *Diaphus theta,* 6.9 mm; (E) *D. pacificus,* 5.2 mm; (F) *Gymnoscopelus nicholsi,* 23.5 mm. A–E from Moser and Ahlstrom (1974); F from Moser and Ahlstrom (1972).

Fig. 121. Larvae of Lampanyctinae. (A) *Lampanyctodes hectoris,* 13.0 mm; (B) *Scopelopsis multipunctatus,* 13.4 mm; (C) *Lampichthys procerus,* 14.5 mm; (D) *Notoscopelus resplendens,* 11.2 mm; (E) *Lampadena luminosa,* 12.8 mm; (F) *Taaningichthys minimus,* 14.4 mm. A from Ahlstrom et al. (1976); B, C, F from Moser and Ahlstrom (1972); D and E from Moser and Ahlstrom (1974).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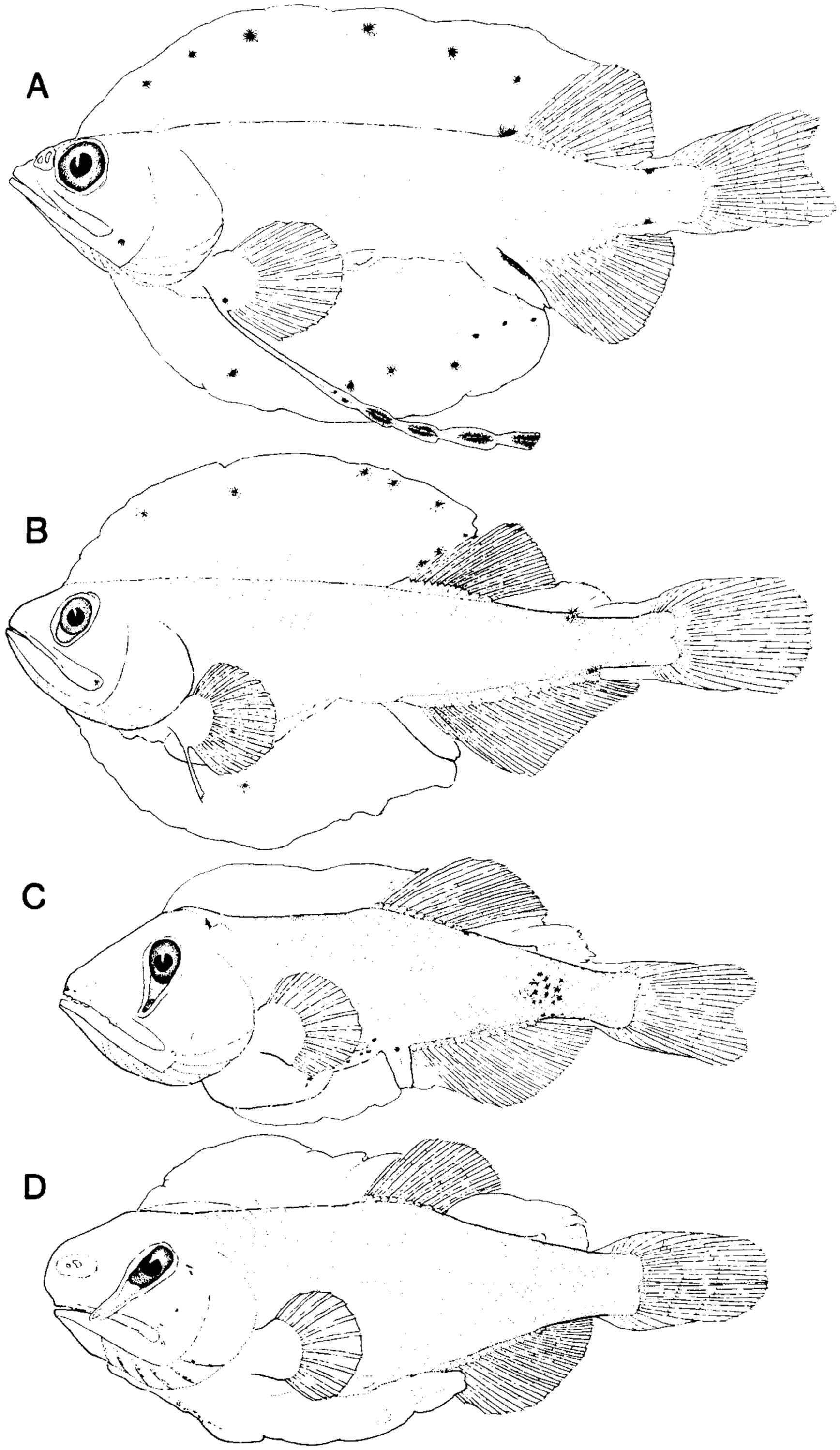
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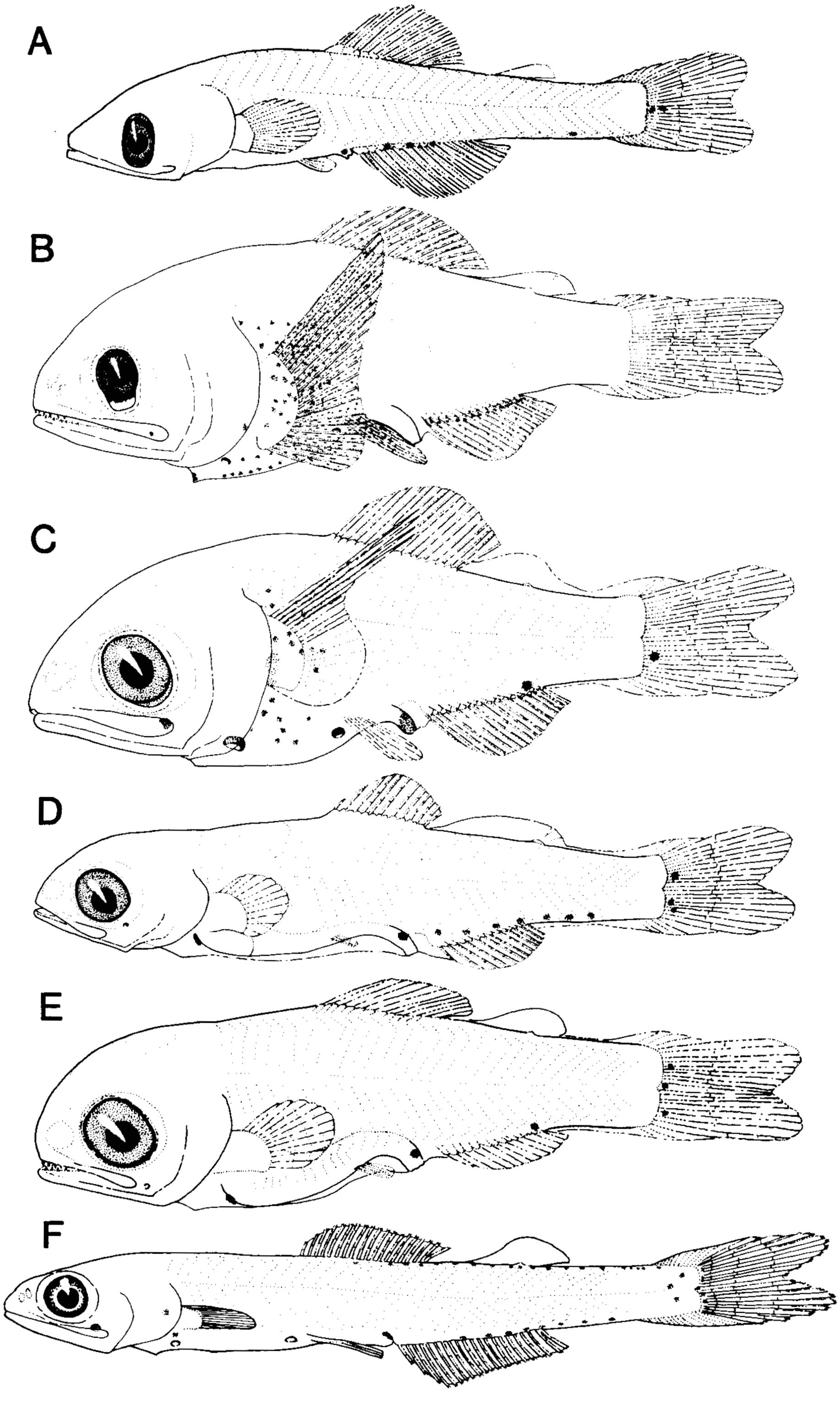
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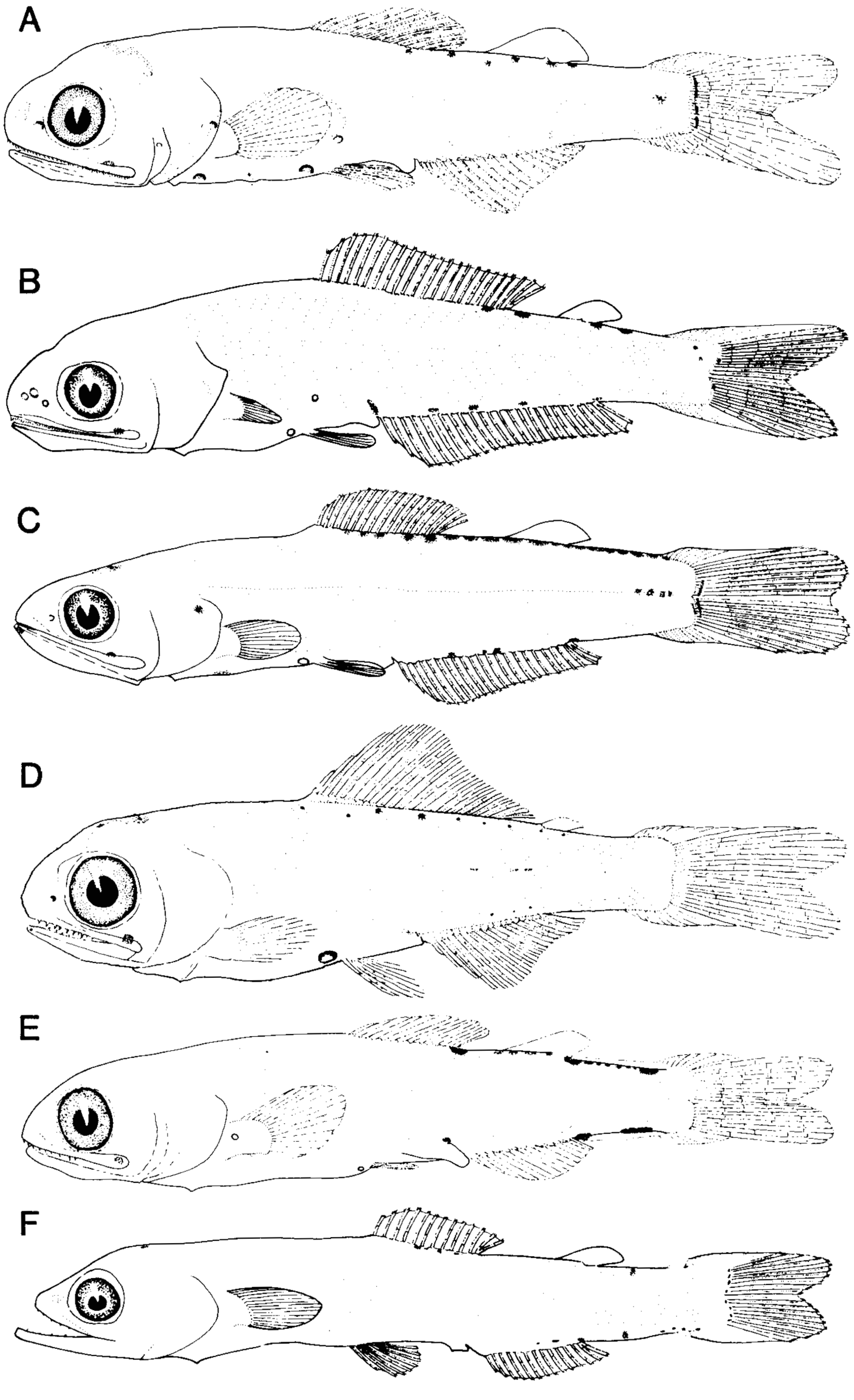
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Hygophum.—Fig. 117A–C; diagnostic pattern of melanophores at the cleithral symphysis and isthmus region consisting of paired pigment dashes that form a median line as the series extends forward on the isthmus; Br_2 photophore forms late in larval period; three morphs. *H. proximum-H. hygomi-H. benoiti-H. hanseni-H. brunni*: Fig. 117A; eye moderately narrow with conical choroid tissue; pigment sparse in most species with some lateral gut spots in all species; some species may have pigment on hypaxial myosepta, jaws, lateral cleithral region, base of caudal rays. *H. atratum-H. reinhardti*: Fig. 117C; body very slender; head flat; eyes very narrow, on short stalks; elongate conical choroid mass; gut almost straight, small diameter; pigment series along lateral gut and hypaxial myosepta; pigment at caudal fin base; pigment on lower jaw symphysis in *H. atratum*. *H. macrochir-H. taaningi*: Fig. 117B; body and head deep and laterally compressed; eyes large, relatively wide; no choroid tissue; anterior gut section narrow in diameter, opening dorsally into somewhat saccular posterior section; *H. macrochir* has pigment on upper and lower jaw and a patch of melanophores on posterior gut section; *H. taaningi* has pigment on gular region and lateral surface of cleithrum.

Symbolophorus.—Fig. 117D; head broad, somewhat flat; eyes slightly stalked, conical choroid mass; pectoral fin large with supernumerary rays, base wing-shaped, rays ossify early; pelvic fin large, early-forming in some species; dorsal finfold well developed with fin base forming in it; pigment series on lateral gut and postanal ventral midline in preflexion larvae; pigment on snout, hindbrain, lateral cleithral region, isthmus, paired fins.

Myctophum.—Figs. 117E, F and 118A–E; at least five distinct morphs, all but *M. aurolaternatum* with enlarged fan-shaped pectoral fins, some with supernumerary rays and early ossification; conical choroid mass. *M. aurolaternatum*: Fig. 117F; body very slender; head somewhat flat; eyes small, on elongate stalks; gut straight, at midbody becomes trailing, extending to well beyond caudal fin; dorsal finfold well developed, fin base forms at its margin; pigment series on lateral gut, evenly distributed on trailing section, except heavier near terminus; pigment on jaws, isthmus, opercle, branchiostegal membrane, pectoral fin, anal fin base, caudal fin. *M. nitidulum-M. punctatum*: Fig. 117E; body moderately slender to slightly deep; head broad, somewhat flat in preflexion stage; eyes on short stalks; numerous small melanophores on snout, jaws, brain, isthmus, branchiostegal membrane; two rows of melanophores on ventral surface of gut; opposing melanophores on postanal dorsal and ventral midline; pigment on pectoral fin base and blade and at base of caudal rays. *M. phengodes*: Fig. 118A; body and head moderately deep; similar to *M. nitidulum*, except pigment sparse and eyes not stalked; pigment at base of pectoral fin rays. *M. spinosum-M. lychnobium*: Fig. 118E; head with convex dorsal profile and long snout giving the larva a fusiform appearance; long axis of eye rotated towards horizontal; photophores (Table 62); head heavily pigmented on jaws, brain, postorbital and opercular regions; pigment above gut on trunk, embedded in myosepta in *M. spinosum*; opposing dorsal and ventral midline blotches, larger and more deeply embedded in *M. spinosum* with embedded myoseptal pigment along horizontal septum; blotch at base of caudal rays. *M. asperum-M. brachygnathum-M. obtusirostre-M. selenops*: Fig. 118B–D; body deep, robust; head broad, deep with convex dorsal profile and large snout; eye relatively larger than in other morphs; choroid tissue broadly conical, except in *M. selenops* where it is elongate and pigmented at tip; photophores (Table 62); head pigment similar to *M. spinosum*; most species have heavy pigment lateral to cleithra and on pectoral fin bases; all species lack trunk and tail pigment, except *M. asperum* which has extensive embedded myoseptal and dorsal/ventral midline blotches.

Loweina.—Fig. 119A; body and head moderately deep, laterally compressed; dorsal and anal fins displaced far posteriad; dorsal and ventral finfolds greatly enlarged and conspicuously pigmented to produce a disc-shaped profile; eyes large; gut with expanded anterior section and enlarged terminal section; pectoral fin large with lower-most ray elongate, ornamented with pigmented spatulations; interorbital pigment band; pigment at lateral cleithral surface, dorsal fin origin, and opposing midline blotches at caudal peduncle region.

Tarletonbeania.—Fig. 119B; similar to *Loweina*, except median fins displaced less posteriad; eye narrower and with lunate choroid mass; four melanophores on periphery of brain, two melanophore series on ventrum of gut.

Gonichthys.—Fig. 119C; body and head deep and laterally compressed, leaf-like; snout large, angulate in profile; eye small with elongate conical choroid mass, pigmented at tip; enlarged dorsal and ventral finfolds; pectoral fins moderately large; pigment on snout, jaws, midline of brain, postorbital and opercular regions; pigment on lateral hindgut and on trunk above gut; series of embedded blotches on dorsal midline of body, opposing blotches on postanal ventral midline; large pigment patch on lateral caudal peduncle region in *G. tenuiculus*; heavy embedded pigment streak along horizontal septum in *G. coccoi*.

Centrobranchus.—Fig. 119D; morphology similar to *Gonichthys* except snout markedly blunt and rounded and terminal gut flexure less acute; two morphs. *C. choerocephalus-C. brevirostris-C. nigroocellatus*: Fig. 119D; eye very narrow with unpigmented choroid mass that exceeds it in length; pigment sparse; some at postorbital-opercular region, branchiostegal membrane, ventral surface of liver. *C. andrae*: eye wider than in above morph and with short conical choroid mass; pigment extensive, on snout, upper jaw, dorsal brain, opercle, branchiostegal membrane, lateral hindgut, ventral surface of liver, pectoral fin base; embedded spots along dorsal midline with opposing spots along postanal ventral midline; embedded spots along horizontal septum in caudal peduncle region.

LAMPANYCTINAE

Notolychnus.—Fig. 120A; head relatively large with moderately elongate snout; eyes usually narrow, often irregular in shape; gut short, more so in preflexion stage; no photophores, even Br_2 lacking; pigment on lateral hindgut, gas bladder, base of caudal rays; a persistent but sparse postanal ventral midline series.

Lobianchia.—Fig. 120B, C; body deep, robust; head broad with large snout; pectoral fins large; blade wing-shaped with upper rays longer than others; photophores (Table 62); head unpigmented; pigment on trunk, on gut below pectoral fin base, on pectoral fin base and blade, embedded in gut region anterior to pectoral fin base, along anal fin base, and at base of caudal rays; embedded melanophores in myosepta above pectoral fin becoming extensive in postflexion stage; two morphs. *L. dofleini*: Fig. 120B; eye small, narrow, with lunate to squarish choroid

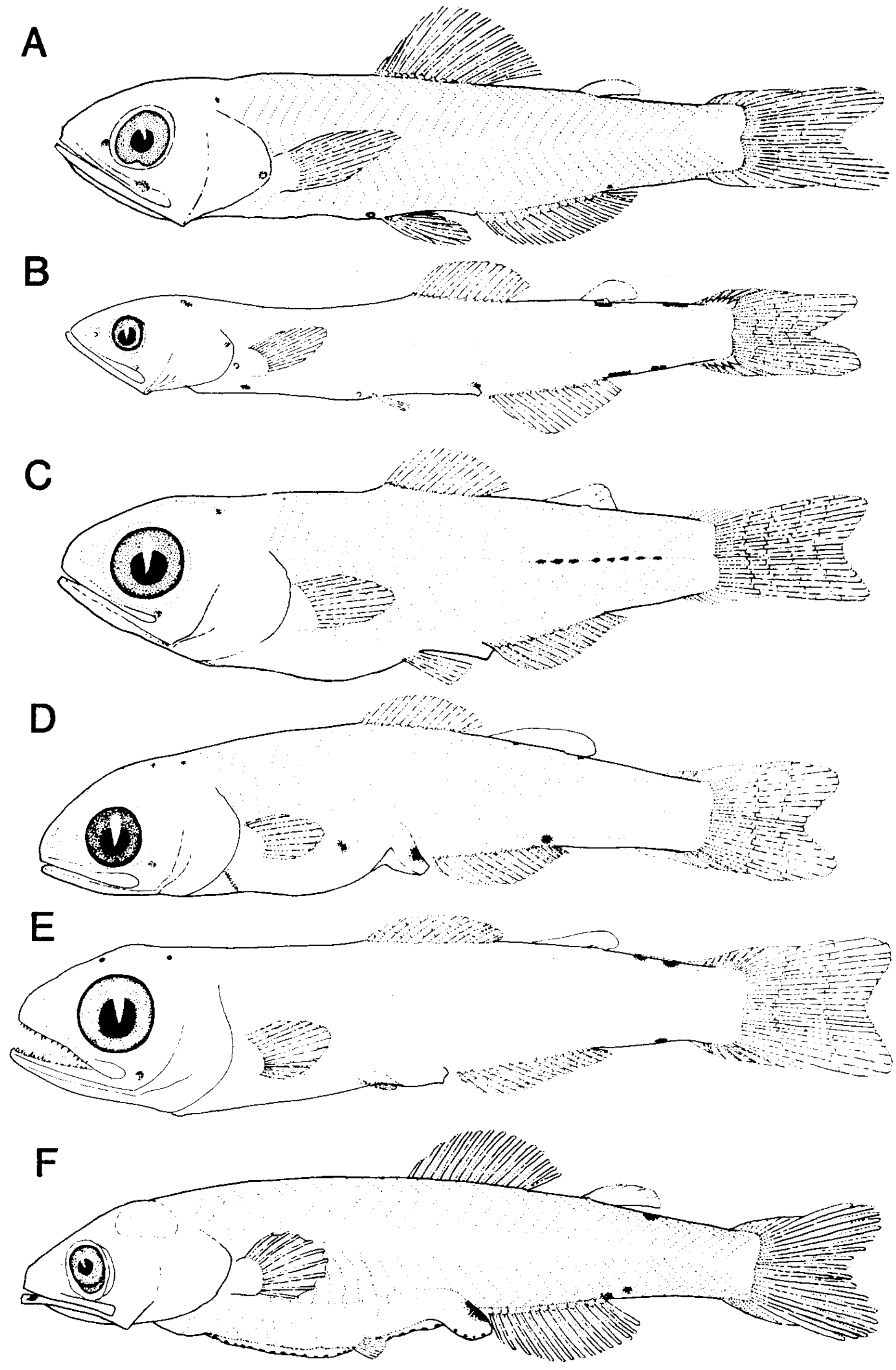

Fig. 122. Larvae of *Lampanyctinae*. (A) *Ceratoscopelus townsendi*, 16.6 mm; (B) *Lepidophanes gaussi*, 13.5 mm; (C) *Bolinichthys distofax*, 9.4 mm; (D) *Stenobrachius leucopsarus*, 10.4 mm; (E) *Parvilux ingens*, 14.4 mm; (F) *Triphoturus mexicanus*, 10.5 mm. A–E from Moser and Ahlstrom (1974); F from Ahlstrom (1972b).

mass; gradual transition from lower pectoral rays to longer upper rays. *L. gemellari*: Fig. 120C; eye large, almost round, choroid mass a lunate sliver; abrupt transition between lower pectoral rays and long upper rays.

Diaphus.—Fig. 120D, E; pigment lacking on head; melanophore at anteroventral surface of liver, one or more at midgut region, one or more at base of caudal rays; gas bladder pigmented; two morphs. *D. theta*: Fig. 120D; body moderately slender; head moderate in size; photophores (Table 62); numerous melanophores in postanal ventral midline series, persisting into postflexion stage. *D. pacificus*: Fig. 120E; body moderately deep, somewhat robust; head moderately large; photophores (Table 62); a few melanophores in postanal ventral midline series, usually coalescing to one before flexion stage.

Gymnoscopelus.—Fig. 120F; photophores (Table 62); pigment above brain, at lateral cleithral region, above midgut, above gas bladder; postanal ventral midline series present but, in some species, restricted to caudal peduncle region; melanophore series on each side of dorsal midline, in most species extending between caudal and dorsal fins, in others extending forward to dorsal fin origin, and in others restricted to caudal penduncle region; pigment at base of caudal rays; some species have pigment on lateral hypural region; lateral pigment patch at caudal peduncle in *G. opisthopterus*, which also has embedded melanophores above vertebral column.

Lampanyctodes.—Fig. 121A; photophores (Table 62); pigment above brain, at anteroventral surface of liver, above gas bladder; a postanal ventral midline series and a series on each side of dorsal midline between dorsal and caudal fins; pigment at base of caudal rays and at lateral hypural region.

Scopelopsis.—Fig. 121B; photophores (Table 62); pigment similar to *Lampanyctodes* except additional melanophores on hindbrain, nape, lateral cleithral region; pigment rows along dorsum irregular.

Lampichthys.—Fig. 121C; photophores (Table 62); pigment similar to *Scopelopsis* except dorsal rows consist of large closely-spaced melanophores which at maximal development extend from caudal fin to dorsal fin origin; a short melanophore series along horizontal septum on caudal peduncle in late postflexion stage.

Notoscopelus.—Fig. 121D; photophores (Table 62); body moderately deep; head moderately large; eye large; snout becomes somewhat bulbous at flexion stage; gut short in early preflexion stage, elongates to about midbody by late preflexion; pigment at tips of jaws, above brain, above gas bladder and at lateral cleithral region in early postflexion larvae; additional pigment develops below lower jaw, on hindbrain and nape; series of melanophores on each side of dorsal midline, beginning at midbody and gradually developing along entire dorsum; series along horizontal septum and along anal fin base; pigment on base of caudal rays and on pelvic and anal rays in some species at late postflexion stage; extensive embedded myoseptal pigment on trunk or tail in postflexion stages of some species.

Lampadena.—Fig. 121E; photophores (Table 62); pigment above brain, nape, gut, gas bladder; most species have large melanophores along dorsal midline, with opposing postanal ventral midline melanophores; some species with smaller, more numerous melanophores in dorsal and ventral series; embedded pigment above spinal column in some species.

Taaningichthys.—Fig. 121F; body slender; lower jaw projects beyond upper; no photophores, even Br_2 lacking; pigment above brain, in otic region, one to several opposing melanophores at postanal dorsal and ventral midline; late postflexion larvae may develop minute melanophores along each side of dorsal midline; pigment at base of caudal rays; series of embedded melanophores above spinal column.

Ceratoscopelus.—Fig. 122A; eye elliptical in early larvae; photophores (Table 62); pigment above gut; postanal ventral midline series in early larvae, coalesces to a single spot in postflexion larvae; *C. maderensis* has short series at dorsal and ventral midline in caudal peduncle region; embedded pigment above posterior region of spinal column in some species.

Lepidophanes.—Fig. 122B; eye small; photophores (Table 62); usually two melanophore pairs at dorsal midline in caudal peduncle region and one or two ventral midline melanophores; *L. gaussi* has median melanophore above hindbrain and median ventral melanophore below pectoral fin base.

Bolinichthys.—Fig. 122C; moderately deep-bodied; snout blunt; eye large; photophores (Table 62); sparse pigment; midline spot above brain, embedded otic spot, embedded pigment above gut; some species with a sparse postanal median ventral series that coalesces to a single melanophore; *B. distofax* has a short series on horizontal septum; embedded pigment above posterior region of spinal column in some species.

Triphoturus.—Fig. 122F; eye elliptical with choroid mass; pigment at tip of lower jaw, at angular region of jaw, at lateral cleithral region; early preflexion larvae have paired lateral gut spots near pectoral fin base and at midgut; anterior pair coalesces to a median position anteroventral to liver, the posterior pair becomes dorsal to gut; pigment above gas bladder; early preflexion larvae have postanal median ventral series that coalesces to one or two spots; pigment along margin of preanal finfolds; a single dorsal spot at adipose fin in *T. mexicanus*; a series of pigment dashes on horizontal septum in *T. nigrescens*.

Stenobrachius.—Fig. 122D; gut melanophores and postanal median ventral series similar to *Triphoturus*; pigment above brain and nape in postflexion stage; late postflexion larvae have embedded melanophores in trunk myosepta and melanophore series on each side of dorsal midline.

Parvilux.—Fig. 122E; head, eyes large; tapered body; gut short

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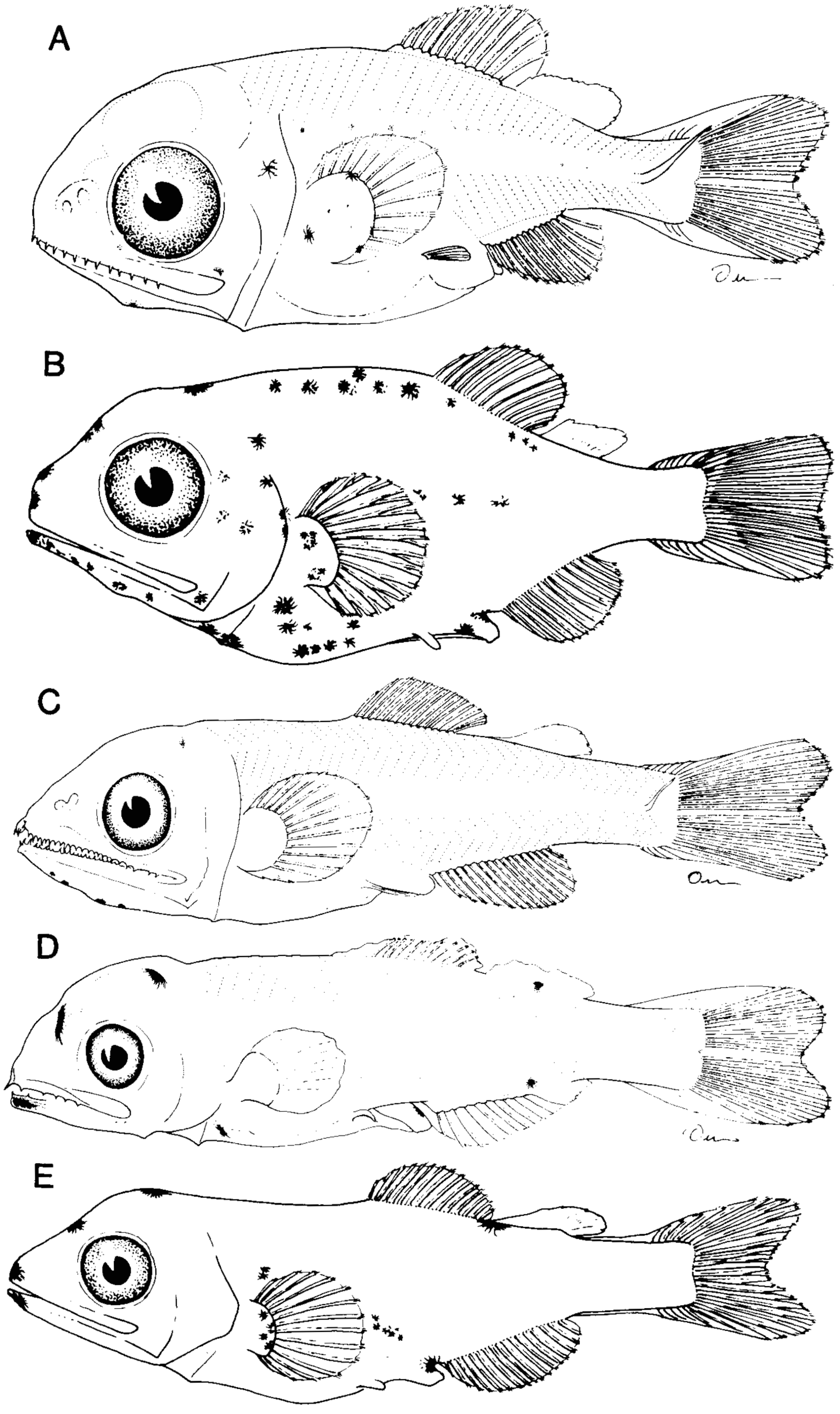
Fig. 123. Larvae of *Lampanyctus*. (A) *L. steinbecki*, 6.6 mm; CalCOFI Sta. 70.200; (B) *L. pusillus*, 7.7 mm; redrawn from Taaning (1918); (C) *L. nobilis*, 9.6 mm; SEFC, OR II 7343 Sta. 98; (D) *L. parvicauda*, 7.5 mm, SWFC, Eastropac Op Sta. 023; (E) *L. crocodilus*, 11.5 mm, redrawn from Tåning (1918).


A
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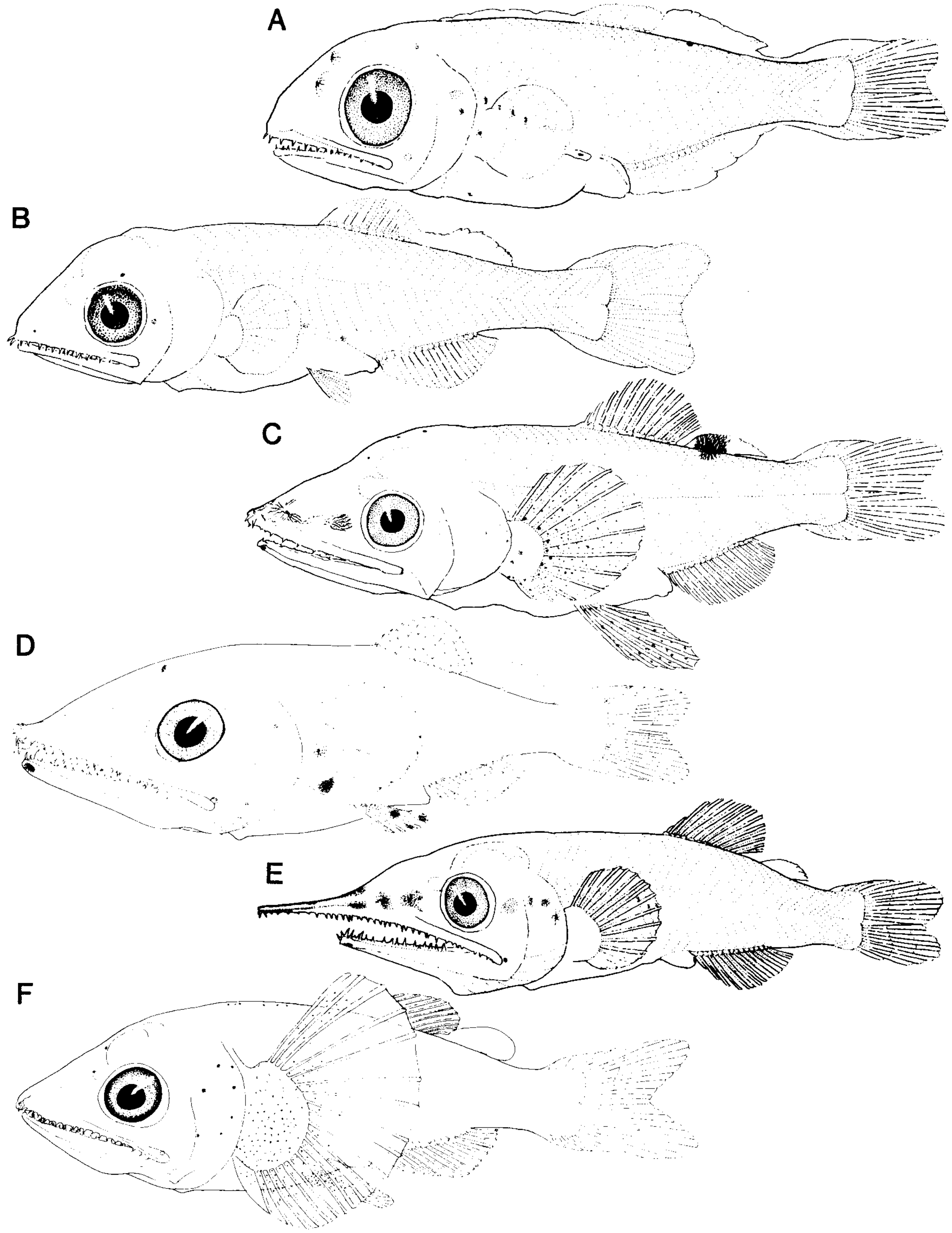

Fig. 124. Larvae of *Lampanyctus.* (A) *L. ritteri,* 10.1 mm; (B) *L. idostigma,* 7.2 mm, CalCOFI 6002 Sta. 133.45; (C) *L. regalis,* 13.0 mm; (D) *Lampanyctus* sp., 8.7 mm; (E) *L. achirus,* 13.4 mm; (F) *Lampanyctus* sp., 9.4 mm. A, C, D, E from Moser and Ahlstrom (1974); F from Moser (1981).

in early preflexion stage, elongates to midbody by flexion stage; in postflexion stage pigment above brain, embedded in otic region, lateral to cleithrum, at anteroventral region of liver; one to several dorsal median melanophores and one ventral median melanophore at caudal peduncle.

Lampanyctus.—Figs. 123, 124; body slender; head deep; gut short in early preflexion stage; during preflexion stage gut lengthens to midbody, body deepens and becomes somewhat robust in most species; pigment above brain in most species; postflexion larvae develop trunk myoseptal pigment that increases to cover most of the anterior trunk at transformation; at least 6 morphs. *L. nobilis-L. parvicauda-L. omostigma-L. crocodilus-L. ritteri-L. idostigma*: Figs. 123C–E, 124A, B; body and head moderately deep; eyes, jaws, pectoral fins moderate in size; pigment may be present at snout, lower jaw, opercle, above gut, anteroventral surface of liver, at dorsal or ventral midline on tail. *L. pusillus-L. steinbecki*: Fig. 123A, B; deep, broad body and head, very robust; snout blunt; eyes large; dorsal and anal fins displaced posteriad; pectoral fins moderately large; *L. pusillus* heavily pigmented on head, body, pectoral fin base; series along horizontal septum; *L. steinbecki* with pigment below lower jaw, on opercle, pectoral fin base; series along horizontal septum and embedded pigment on tail in postflexion larvae. *L. regalis-L. ater*: Fig. 124C; deep, large head and body; snout elongate, jaws large, teeth well developed, especially at tip of upper jaw; preopercular spines in some species; dorsal and anal fins displaced posteriad; pectoral fins moderate to large; pigment may be present at tips of jaws, embedded in snout, at postorbital and opercular regions, pectoral and pelvic fins; spot at adipose fin in *L. regalis*; one or two dorsal spots in *L. ater*. Information on *L. ater* from H. Zadoretsky (Dept. Zoology, Univ. of Rhode Island, pers. comm.). *L. achirus*: Fig. 124E; body moderately deep; head and jaws large with snout produced into toothy rostrum; dorsal and anal fins displaced posteriad; pectoral fins moderately large; pigment on tips of jaws, embedded in snout, and present at postorbital and opercular regions. *L. lineatus-L. cuprarius*: body moderately elongate; snout elongate, jaws large; head pigment as in *L. achirus*; *L. lineatus* pigment consists of numerous melanophores along dorsum and ventrum and at base of caudal rays; *L. cuprarius* has pigment above gut and an irregular bar below dorsal fin. Information from H. Zadoretsky (pers. comm.).

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