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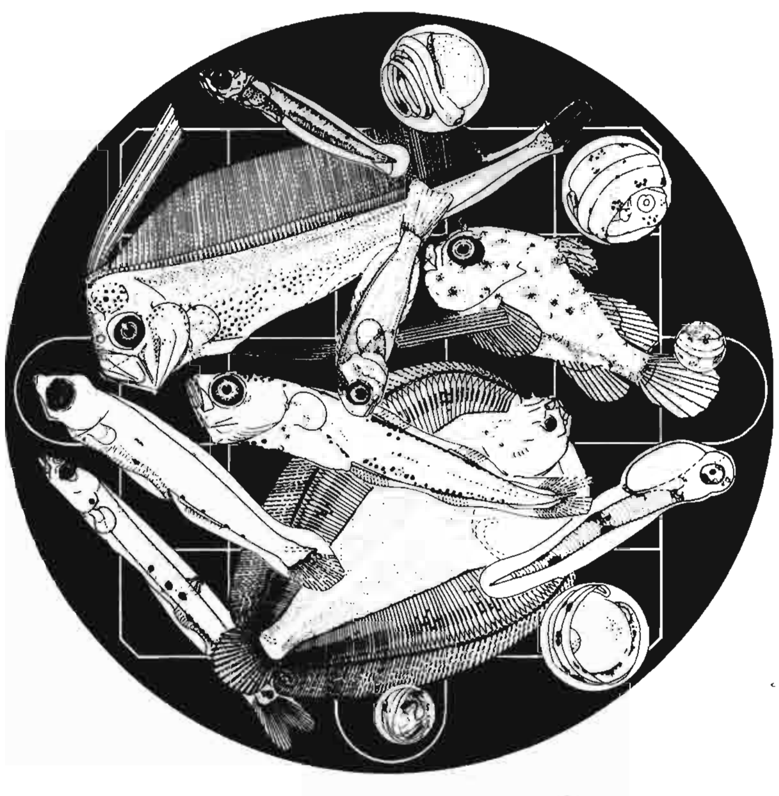
Laboratory Guide to Early Life History Stages of Northeast Pacific Fishes

Ann C. Matarese, Arthur W. Kendall, Jr.,
Deborah M. Blood, and Beverly M. Vinter



U.S. Department of Commerce

NOAA TECHNICAL REPORT NMFS

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October 1989

U.S. DEPARTMENT OF COMMERCE
Robert Mosbacher, Secretary
National Oceanic and Atmospheric Administration
John A. Knauss, Under Secretary for Oceans and Atmosphere
National Marine Fisheries Service
James Brennan, Assistant Administrator for Fisheries

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Acknowledgments

A project of this scope and magnitude always involves many people whose talents and skills were essential throughout its development and completion. This guide began as an idea in 1979 and has gradually evolved over the last 10 years with the assistance of numerous people. During the early stages, two major projects contracted with the University of Washington (UW) served as starting points. Kevin Howe, formerly of the UW, was asked to compile a checklist of fishes from Point Conception, California, north into the Arctic Ocean, and to set up a meristic database system. His assembled data form the basis of meristic sections on our taxonomic text pages and meristic tables. Kathryn Garrison, formerly of the UW, and Bruce Miller (UW) synthesized the available literature on the reproduction and early life history of Puget Sound fishes, and this enabled us to write many of our sections on life history.

During the several years we spent collecting data and examining material, a number of scientists donated specimens and/or unpublished data. We would like to thank the following people: Jeffrey Marliave (Vancouver Public Aquarium), David Misitano (NWAFC Mukilteo Laboratory), Albert Giorgi (NWAFC Coastal Zone and Estuarine Studies), Kevin Bailey (NWAFC Resource Assessment and Conservation Engineering), William Watson (Marine Ecological Consultants), Bruce Mundy (formerly Oregon State University), A. J. Paul (University of Alaska), Conrad Mahnken (NWAFC Manchester Field Station), Sally L. Richardson (deceased), and H. Geoffrey Moser (NMFS Southwest Fisheries Center). The complete files of the late E. H. Ahlstrom were kindly made available by H. Geoffrey Moser.

Throughout the planning, organizing, writing, and layout, many people contributed their special talents and we thank the following for their time: Theodore Pietsch, Kevin Howe, and Steven Leipertz, UW (meristic database); Kevin Howe and Steven Leipertz, UW, and Richard Bates, NWAFC, (literature database); Ralph Mintel, Richard Bates, and Michael McPhail, NWAFC (programming); William Rugen, NWAFC (proofreading and verification); James Peacock, NWAFC (layout, typesetting); Jack McCormick and Nancy Peacock, NMFS Scientific Publications (format and editorial assistance); William Richards, formerly NMFS Scientific Editor (editorial assistance); and Michael Fahay, NMFS Northeast Fisheries Center, who has encouraged all of us along the way and who spent several days reviewing our very preliminary first draft.

We are grateful to the following, who in reviewing sections from an earlier draft made many suggestions and corrections and generously provided us with unpublished data from their personal data files: James Allen (ecology and life history), G. David Johnson (Perciformes), Wayne Laroche (Scorpaenidae, Agonidae, Carangidae), Douglas Markle (Gadiformes, Ophidiiformes), H. Geoffrey Moser (Myctophidae, Stomiiformes, Pleuronectiformes, Scorpaenidae), Bruce Mundy (meristic data), Barbara Sumida MacCall (Carangidae, Pleuronectidae, Stromateoidei), Betsy Washington (Scorpaeniformes). James Allen, Robert Lea, and Alex Peden reviewed the adult distributions and nomenclature.

The following shared unpublished figures with us: Kathryn Garrison and Jeffrey Marliave (stichaeids); Betsy Washington (cottids); William Watson (*Atherinops* and *Atherinopsis*); and Lucy Wold and Guillermo Moreno (*Sebastes mystinus*).

The following reviewed the entire draft and made many valuable suggestions, and we thank them sincerely for their time and efforts: Michael Fahay, Jeffrey Leis, Joanne Lyczkowski-Shultz, Douglas Markle, Jeffrey Marliave, Gerald McGowen, H. Geoffrey Moser, Bruce Mundy, Muneo Okiyama, William Richards, Betsy Washington, and William Watson.

Finally, we all express a special thanks to our friend and colleague Jean Dunn for his many contributions throughout the various stages of this guide. His years of experience with the early-life-history stages of North Pacific fishes and extensive knowledge of the literature were a valuable addition to this work.

Laboratory Guide to Early Life History Stages of Northeast Pacific Fishes

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ABSTRACT

This laboratory guide presents taxonomic information on eggs and larvae of fishes of the Northeast Pacific Ocean (north of California) and the eastern Bering Sea. Included are early-life-history series, illustrations, and comparative descriptions of 232 species expected to spawn here, out of a total 627 species known to occur in marine waters of this area. Meristic and general life-history data are included, as well as diagnostic characters to help identify eggs and larvae. Most of this information has been gleaned from literature, with the addition of 200 previously unpublished illustrations.

Introduction

Background

The importance of early-life-history studies to fisheries investigations and phylogenetic research has increased dramatically during the last decade. Early-life-history stages are now routinely used in fisheries studies to investigate the interannual variation in recruitment (e.g., Wooster 1983), and in studies of the phylogeny of fishes (e.g., Moser et al. 1984b). The fact that early-life-history stages of many species remain unknown in the northeastern Pacific Ocean limits their use in these disciplines, as well as in research on ecology, behavior, and the biological effects of pollution on fishes.

At the Northwest and Alaska Fisheries Center (NWAFC), progress in the identification and understanding of early-life-history stages of marine fishes has steadily increased. Our investigations beginning in 1965 were primarily aimed at determining spawning grounds and distribution of eggs and larvae for only one target species: the Pacific hake, *Merluccius productus*. Studies in the late sixties and early seventies concentrated on ascertaining abundance and horizontal distribution of the eggs and larvae of major taxa occurring off the northeast Pacific coast and in the Gulf of Alaska and Bering Sea. In addition to baseline studies on distribution and abundance, work has increasingly emphasized the use of egg and/or larval surveys (targeted on species such as walleye pollock, *Theragra chalcogramma*) to generate estimates of spawning stock biomass and to test hypotheses concerning the multitude of possible factors involved in the stock/recruitment relationship (e.g., feeding, predation, growth, and transport). These studies require the accurate identification of all early-life-history stages, from the egg stage to newly settled juveniles and adults. The ability to make such identifications is a direct result of taxonomic studies in our laboratory, especially for the family Gadidae. These studies have enabled identification of all gadid species occurring in the Northeast Pacific Ocean and have allowed additional research on development, osteology, and systematics (e.g., Matarese et al. 1981, Dunn and Vinter 1984, and Dunn and Matarese 1984).

The primary purpose of this laboratory guide is to allow expansion of the use of early-life-history studies in fisheries research by providing descriptive information necessary to insure accurate identification of eggs, larvae, and early juveniles of marine fishes in the northeastern Pacific Ocean and Bering Sea. The guide is designed to aid in species identification; thus, it includes little of the developmental information usually found in ontogenetic descriptions. We have placed emphasis on the accuracy and quality of illustrations, whether from the literature or originals drawn for this guide. In some cases, however, when specimens were not available, we reproduced substandard figures from the literature. Diagnostic characters are included, which enable identification of early-life-history stages of closely related and/or similar-looking taxa, as are comparative tables and figures which outline similarities and differences among taxa. Detailed information is included for species where considerable early-life-history data are available. For poorly known taxa, available information is given, sometimes limited to characters of adults of the species in the study area and a description of early-life-history stages of related species from other areas.

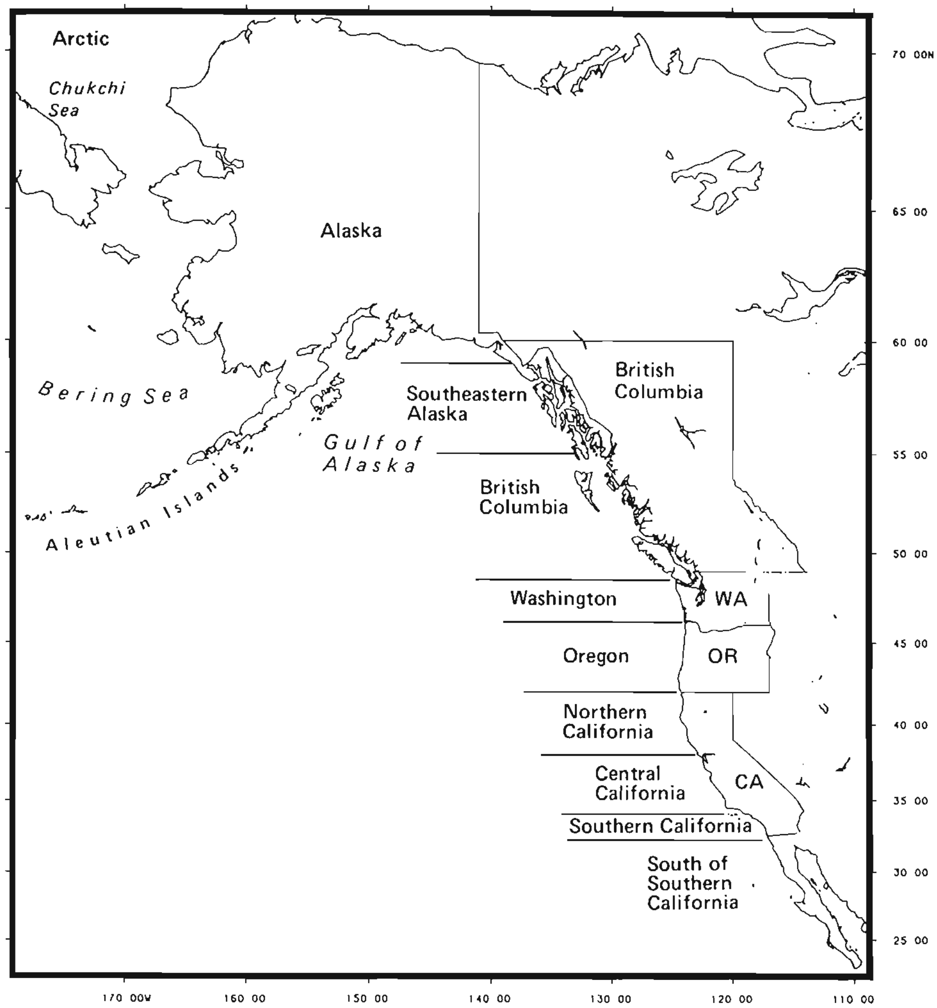


Figure 1
Study area showing geographic ranges used in species accounts.

Geographic coverage

The geographic area covered is the Pacific Ocean between approximately 38°N and 66°N and west to 180°; however, we have included only those taxa with northern limits of distribution between Oregon and the northern Bering Sea (Fig. 1). Taxa restricted to California waters or the Arctic are excluded. Because most ichthyoplankton surveys concentrate on coastal areas, usually within 200 miles (370 km) of shore, this guide emphasizes coastal, nearshore species rather than strictly oceanic species. Taxa that usually do not produce planktonic early-life-history stages are generally excluded (e.g., Embiotocidae) as are strictly freshwater and estuarine species or spawners. Sources useful in identifying early-life-history stages of freshwater and estuarine species found adjacent to our study area include Wang (1981, 1986) and Auer (1982). In general, we have based coverage on species' likelihood of spawning in the Northeast Pacific Ocean rather than on the occurrence of adults. The geographic distribution of spawning is generally more restricted than the overall range of a species. Some low-latitude oceanic species (e.g., most members of the family Scombridae) which occur off Oregon and Washington are not included because they usually spawn much further south and their eggs and larvae do not occur in our area.

Information sources

Literature In producing this guide, we first compiled meristic and life history information from the literature. This was accomplished largely through a computer-based meristic information file generated by Kevin Howe at the University of Washington, and a compendium of life history information produced under the direction of Bruce Miller, University of Washington (Garrison and Miller 1982). Information from these sources was augmented and updated as it was incorporated in this guide. The meristic database was compiled by examining specimens and original radiographs, and from the literature (original descriptions, revisions, or general sources). When possible, counts are from the left side of the body. Since Garrison and Miller (1982) is not generally available, original sources cited by them are referred to in this guide. Published early-life-history information and illustrations were used when available, supplemented when possible by data from our field collections. Among the most useful published sources were Fitch and Lavenberg (1968, 1971, 1975), Miller and Lea (1972), Hart (1973), Eschmeyer et al. (1983), Moser et al. (1984b), Ozawa (1986a), and the many papers authored or co-authored by Ahlstrom, Moser, and Richardson (see Citations). Okiyama (1988) was received too late to be fully included in this guide.

Specimens In addition to data gleaned from the literature, we have included some unpublished data and original illustrations obtained from specimens in our collections (Table 1). Specimens were from two major sources: (1) Investigations in the Kodiak Island region in the Gulf of Alaska conducted 1977-79, and (2) studies undertaken in cooperation with the U.S.S.R. beginning in 1980 to investigate the distribution and abundance of ichthyoplankton off northern California, Oregon, and Washington and in the Gulf of Alaska. Some specimens were also derived from work in the Bering Sea during 1971-72, 1976-78, and 1979. Dunn (1986) provides a list of ichthyoplankton surveys conducted by the NWAFC from which were obtained many of the specimens examined or illustrated for this guide. Occasionally specimens were obtained from other research collections or from rearing experiments conducted primarily by Jeffrey Marliave (Vancouver Public Aquarium) and David Misitano (NWAFC).

Table 1
Collection data for original illustrations by Northwest and Alaska Fisheries Center (NWAFC).[a]

Taxon	SL (mm)	Cruise	Station number	Gear[b]	Date	Location or N° W°
Thalassenchelys coheni	190.0				15 02 84	Puget Sound, WA[c]
Clupea pallasi	10.4	4MF81	G005A	6B5	20 05 81	58°19.6′, 153°54.5′
	15.0	SF7703	P-4	N	05 04 77	Str. Juan de Fuca, WA
	19.0	SF7603	13	B	18 05 76	Str. Juan de Fuca, WA
	23.8			seine	14 06 72	
Nansenia candida	5.1	1PO84	G053A	6B5	22 03 84	44°40.1′, 127°40.0′
Bathylagus milleri	15.0	2MF78	G074A	TT	02 07 78	57°07.0′, 151°01.0′
Bathylagus ochotensis	7.9	1EQ83	G056A	B	03 05 83	44°00.0′, 127°39.0′
Bathylagus pacificus	11.6	3MF79	S25A	6B5	17 06 79	54°05.2′, 170°59.0′
	17.6			6B5		Gulf of Alaska
Macropinna microstoma	11.1	1PO84	G066A	6B5	24 03 84	43°40.0′, 124°37.0′
Danaphos oculatus	22.4		M161		23 07 84	6 km W of Newport, OR
Tactostoma macropus	14.3	1PO80	G011A	6B5	03 08 80	47°18.7′, 125°13.3′
Lampanyctus regalis	5.2	1PO80	G061A	6B5	12 08 80	38°00.0′, 125°42.5′
Diaphus theta	4.6	K6703	50	1MN	08 05 67	42°00.0′, 127°35.0′
	6.3	1PO80	G085A	6B5	20 08 80	40°20.0′, 125°20.0′
	16.0	1PO80	G064A	6B5	13 08 80	42°22.5′, 126°17.5′
Stenobrachius leucopsarus	4.9	2KE72	G50A	6B5	08 05 72	57°46.0′, 149°21.0′
	6.3	1PO84	G112A	6B5	02 04 84	40°40.1′, 126°47.0′
	18.0	4DI78	G051A	TT1	13 04 78	55°26.8′, 153°53.7′
Melanonus zugmayeri	17.0	Ocean ACRE-9	9-11 N		19 03 70	32°03.0′, 64°05.0′
Boreogadus saida	16.3	*Glacier* (OCSEAP)	11	6B5	11 08 76	70°47.0′, 162°14.0′
Gadus macrocephalus	4.1	FOX86III (sample 111)	166	MOC	18 05 86	57°40.6′, 155°09.8′
Theragra chalcogramma	egg	composite				Gulf of Alaska
	3.5				— 04 82	Gulf of Alaska[d]
Ophidiidae	15.6	1EQ83	G044A	6B5	30 04 83	45°20.0′, 124°48.0′
	29.8	1EQ83	G073A	6B5	06 05 83	43°20.2′, 127°57.0′
Brosmophycis marginata	10.6					Puget Sound[e]
Gobiesox maeandricus	7.0				12 02 76	Brit. Columbia[f]
Cololabis saira	6.7	1TK80	G091	N	08 05 80	42°00.0′, 125°55.0′
	7.4	1DA81	G039A	N	02 11 81	45°37.0′, 124°52.0′
Trachipterus altivelis	9.4	K6805	30	1MN	23 10 68	45°44.0′, 124°38.0′
	24.0	1PO82	G46A	6B5	29 05 82	40°40.5′, 126°48.4′
Melamphaes sp.	3.7	1EQ83	G034A	6B5	28 04 83	46°00.0′, 128°31.0′
Sebastes brevispinis	4.6	SEI77-9	21	trawl	12 07 77	58°28.3′, 139°30.0′
Sebastes caurinus	5.1				05 07 77	Reared by C. Mahnken[g]
Sebastes jordani	4.6	*Marathon* 85-1	229	trawl	25 05 85	48°09.6′, 125°05.3′
Sebastes melanops	4.0				07 02 84	Newport, OR[h]
Sebastes polyspinis	6.1	*Poseydon* 85-1		trawl	— 07 85	Gulf of Alaska
Sebastes rufus	36.0	(Groundfish Comm. Invest.)	8	MWT	04 06 85	Farrallon Is., CA[i]
Sebastes variegatus	4.6	SEI77-9	21	trawl	12 07 77	58°28.3′, 139°30.0′
Sebastes zacentrus	4.7	SEI77-9	33	trawl	16 07 77	59°40.1′, 143°03.5′
Sebastolobus sp.	egg	1PO81	G065A	N	22 05 81	43°40.0′, 125°01.4′

Table 1 (continued)

Taxon	SL (mm)	Cruise	Station number	Gear[b]	Date	Location or N° W°
Anoplopoma fimbria	5.6	1PO84	G019B	6B5	15 03 84	46°40.5′, 124°59.0′
	8.8	MF77B-6	83(1)	N		55°40.7′, 155°23.0′
	12.0	MF77B-6	2(4)	N	15 05 77	54°22.6′, 166°42.5′
Blepsias bilobus	12.4	3MF79	V02A	N	02 06 79	56°03.5′, 166°33.9′
	16.7	3MF79	S12A	N	06 06 79	56°35.7′, 165°54.3′
	24.8	3MF79	S40A	N	21 06 79	56°31.6′, 166°42.0′
Blepsias cirrhosus	11.5				— 04 80	Friday Harbor, WA
	16.8				— 04 80	Friday Harbor, WA
Chitonotus pugetensis	3.0					Puget Sound, WA[j]
	4.9					Puget Sound, WA[j]
Gymnocanthus A	9.6	MF76A	B07	6B5	04 05 76	56°49.7′, 169°39.0′
	11.9	MF76A	B17	6B5	20 05 76	54°42.3′, 165°25.9′
Hemilepidotus jordani	10.6	1SH81	066	N	19 03 81	57°03.0′, 155°53.0′
	18.4	3MF79	V06A	N	03 06 79	56°02.8′, 166°33.6′
Myoxocephalus B	9.1	1MD82	G135A	6B5	29 05 82	54°54.1′, 158°39.0′
	12.2	1MD82	G135A	6B5	29 05 82	54°54.1′, 158°39.0′
Myoxocephalus G	8.7	2KE72	G39A	6B5	06 05 72	57°33.0′, 152°06.0′
Nautichthys oculofasciatus	8.3				— 04 80	Friday Harbor, WA
Psychrolutes paradoxus	18.0					Mukilteo, WA[j]
Synchirus gilli	10.5				15 05 79	Neah Bay, WA[k]
	16.8			N	16 05 79	Neah Bay, WA[k]
Agonidae A	4.7	1PO82	G026A	6B5	14 05 82	44°01.5′, 124°33.8′
	10.0					Gulf of Alaska
Agonomalus mozinoi	8.2	MF77B-5	3(2)	6B5	26 04 77	54°38.7′, 167°14.0′
Cyclopteridae	4.0	3MF81	G058A	5B5	01 05 81	56°55.9′, 154°55.8′
Nectoliparis pelagicus	7.9	MF77B-6	55(1)	TT	13 05 77	55°46.7′, 169°25.1′
	20.5	MF77B-6	46(1)	6B5	13 05 77	55°44.4′, 171°31.3′
Paraliparis sp.	28.5	4DI78	25	6B5	01 04 78	57°58.3′, 150°02.2′
Bathymaster A	9.0	2MF78	G35A	6B5	25 06 78	56°02.0′, 154°08.4′
	29.6	MF77B-5	2(2)	N	26 04 77	54°23.3′, 166°44.0′
Ronquilus jordani	7.7		803E		— 05 72	Newport, OR
	10.4		912E		— 05 72	
Anoplarchus purpurescens	6.1					Puget Sound, WA[j]
	9.0					Puget Sound, WA[j]
	12.0					Puget Sound, WA[j]
	12.0					Puget Sound, WA[j]
	12.0					Puget Sound, WA[j]
Bryozoichthys-Chirolophis	16.5	MF76A	10	6B5		56°29.8′, 171°34.1′
	29.0	MF77B-6	42	N	12 05 77	56°45.6′, 171°30.8′
Lumpenus sagitta	17.3	1MD82	G028A	6B5	08 04 82	56°40.0′, 155°27.0′
	35.1	4MF81	G028A	6B5	21 05 81	57°29.5′, 155°43.0′
Plectobranchus evides	9.2		1143E		24 04 73	Newport, OR
	16.9		1107E		20 04 73	Newport, OR
	31.3		933E		— 06 72	Newport, OR
Xiphister atropurpureus	8.0				20 03 78	Brit. Columbia[f]
Delolepis gigantea	17.5	1MF80	34A ?	N	27 03 80	57°52.4′, 154°38.9′
Lyconectes aleutensis	16.0	MF77B-5	8(2)	N	25 04 77	54°37.0′, 166°13.9′
Apodichthys flavidus	~15					Brit. Columbia[f]
Pholis sp.	9.2					Brit. Columbia[f]
	23.0	2MF78	G034A	6B5	25 06 78	56°33.3′, 154°51.2′
Anarhichas orientalis	21.0	MF77B-5	8(2)	N	25 04 77	54°37.0′, 166°13.9′
Ammodytes hexapterus	9.8	1SH81	177	6B5	22 04 81	55°54.0′, 156°36.0′
	32.3	1CH83	S008A	N	18 05 83	59°03.2′, 147°31.7′
Clevelandia ios	3.4			TT	04 05 82	Bohom Bay, OR
	15.0				20 01 66	Yaquina Bay, OR
Coryphopterus nicholsi	4.4				21 05 85	Dabob Bay, WA[l]
Lepidogobius lepidus	3.5			TT (midwater)		Yaquina Bay, OR
	20.8			6 ft. otter trawl	19 05 84	1 mi off Newport, OR

Table 1 (continued)

Taxon	SL (mm)	Cruise	Station number	Gear[b]	Date	Location or N° W°
Citharichthys sordidus	4.5	1EQ83	G042A		30 04 83	45°20.0′, 124°06.0′
	7.0	1EQ83	G042A		30 04 83	45°20.0′, 124°06.0′
Atheresthes stomias	10.0	MF76A-III	36	6B5	25 05 76	55°29.0′, 165°50.8′
	13.4	DE-4	14K#2	6B5	25 07 71	56°45.0′, 168°05.0′
	25.6	DE-4	16J	6B5	02 08 71	56°15.0′, 171°21.0′
Glyptocephalus zachirus	11.5	2MF78	G68A	TT	01 07 78	56°17.3′, 152°55.8′
Hippoglossoides elassodon	5.0	2MF78	G66A	TT	30 06 78	55°59.7′, 153°33.2′
	7.9	2MF78	G66A	TT	30 06 78	55°59.7′, 153°33.2′
	15.0	3MF79	S33A	6B5	19 06 79	56°16.2′, 166°29.6′
	18.0	SEI77-9	43	6B5	22 07 77	58°19.5′, 150°53.0′
Hippoglossus stenolepis	14.4	4DI78	D45C	TT	14 04 78	56°14.5′, 153°22.2′
	18.0	3MF81	G012A	6B5	27 04 81	57°57.0′, 154°13.3′
Lepidopsetta bilineata	4.3	4DI78	G009A	6B5	30 03 78	58°22.0′, 150°12.8′
	7.4	5TI79	G024A	6B5	19 05 79	56°23.7′, 155°45.0′
	10.8	DE-4	DE4#2	6B5	26 07 71	57°30.0′, 169°30.0′
	16.3	2MF78	G023A	6B5	24 06 78	57°19.5′, 152°23.9′
Lepidopsetta 2	6.3	2MF78	G044A	TT	26 06 78	57°61.1′, 151°17.4′
	9.7	2MF78	D01A	TT	28 06 78	56°42.3′, 153°33.7′
	16.4	SEI77-9	43	6B5	22 07 77	58°19.5′, 150°53.0′
Microstomus pacificus	15.0	MF84-6	B1	6B3	25 08 84	Bering Sea[m]
	26.0	1PO80	G095A	6B5	23 08 80	39°20.0′, 124°22.0′
Parophrys vetulus	4.5	K6805	32	1MN	23 10 68	45°44.0′, 124°07.0′
	10.0	6502	14F		14 05 65	46°10.0′, 124°42.0′
	17.5	SF7702	2	6B3	23 02 77	Str. Juan de Fuca, WA
Platichthys stellatus	4.8	4MF81	G029A	6B5	21 05 81	57°24.8′, 155°37.0′
	6.6				29 04 78	Str. Juan de Fuca, WA
	8.2				29 04 78	Str. Juan de Fuca, WA
	9.0				05 06 70	Puget Sound, WA
Pleuronectes quadrituberculatus	6.3	3MF79	V014A	6B5	05 06 79	57°02.9′, 165°02.8′
	7.8	3MF79	V015A	6B5	05 06 79	57°03.8′, 165°03.2′
Psettichthys melanostictus	2.5				15 02 84	Puget Sound, WA[j]
	6.9				07 03 84	Puget Sound, WA[j]
	8.1				27 03 84	Puget Sound, WA[j]
	13.9		591E		— 06 —	Newport, OR

[a]Several illustrations originally drawn for this publication and included in this table have already been published (e.g., Moser et al. 1984b, Kendall and Matarese 1987).

[b]Gear

6B5	= 60-cm bongo net, 0.505-mm mesh	1MN	= 1-m net
6B3	= 60-cm bongo net, 0.333-mm mesh	MWT	= midwater trawl
B	= 60-cm bongo net	N	= neuston net
MOC	= MOCNESS net	TT	= 1-m Tucker trawl

[c]Collected by Univ. Wash., Seattle, WA 98195.

[d]Reared by A.J. Paul, Univ. Alaska, Inst. Mar. Sci., Seward Mar. Cent., Seward, AK 99664.

[e]Reared by Steven Borton, formerly of Seattle Public Aquarium, Pier 59, Seattle, WA 98104.

[f]Reared by Jeffrey Marliave, Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8.

[g]Reared by Conrad Mahnken, NWAFC, Coastal Zone Estuarine Stud., Manchester Field Stn., P.O. Box 38, Manchester, WA 98353.

[h]Reared by George Boehlert, Southwest Fish. Cent., Honolulu Lab., Honolulu, HI 96822.

[i]Collected by Wayne Samiere, Southwest Fish. Cent., Tiburon Lab., Tiburon, CA 94920.

[j]Reared by David Misitano, NWAFC, Environ. Conserv. Div., Mukilteo Field Stn., P.O. Box 21, Mukilteo, WA 98272.

[k]Collected by Albert E. Giorgi, NWAFC, Coastal Zone Estuarine Stud., 2725 Montlake Blvd. E., Seattle, WA 98112.

[l]Collected by Bruce Frost, Univ. Wash., School Oceanogr., Seattle, WA 98195.

[m]Collected by Kevin Bailey, NWAFC, Resource Assess. Conserv. Eng., 7600 Sand Point Way N.E., Seattle, WA 98115-0070.

Species list

The following list of species found in the study area was compiled from the literature. The order of higher taxa generally follows J. Nelson (1984); genera and species are listed alphabetically within families. The list is annotated with page numbers indicating where taxa are described in the guide. Page numbers are out of sequence in instances (e.g., myctophids, cottids) where taxa are grouped according to larval similarities, rather than alphabetically. Letters in place of page numbers indicate that a species is not given individual treatment for the following reasons: A = anadromous, D = direct development, F = freshwater spawner, S = spawns south of study area, U = inadequate early-life-history information available, V = viviparous. In these cases, available meristic and ecological information is given in appropriate higher-category (e.g., order, family) accounts.

Elopomorpha	31
Notacanthiformes	
Notacanthidae	34
Notacanthus chemnitzi	U
Polyacanthonotus challengeri	U
Anguilliformes	33
Xenocongridae	34
Thalassenchelys coheni	U
Nemichthyidae	
Avocettina infans	38
Nemichthys larseni	U
Nemichthys scolopaceus	40
Cyematidae	34
Cyema atrum	U
Synaphobranchidae	34
Histiobranchus bathybius	U
Nettastomatidae	36
Venefica sp.	U
Congridae (= or includes Muraenesocidae)	36
Xenomystax atrarius	U
Serrivomeridae	36
Serrivomer jesperseni	U
Eurypharyngidae	36
Eurypharynx pelecanoides	U
Clupeiformes	43
Clupeidae	
Alosa sapidissima	A
Clupea pallasi	44
Dorosoma petenense	A
Sardinops sagax	46
Engraulididae	
Engraulis mordax	48
Salmoniformes	51
Argentinoidei	
Argentinidae	
Argentina sialis	52
Nansenia candida	54
Bathylagidae	
Bathylagus bericoides	56
Bathylagus milleri	58
Bathylagus ochotensis	60
Bathylagus pacificus	62
Bathylagus wesethi	64
Leuroglossus schmidti	66
Leuroglossus stilbius	68
Therobrommus callorhinus	U
Opisthoproctidae	
Bathylychnops exilis	70
Dolichopteryx sp.	72
Dolichopteryx longipes	72
Macropinna microstoma	74
Alepocephalidae	76
Alepocephalus tenebrosus	D
Bathylaco nigricans	D
Ericara salmoneum	D
Leptochilichthys agassizi	D
Narcetes stomias	D
Talismania bifurcata	D
Platytroctidae	77
Holtbyrnia innesi	U
Holtbyrnia latifrons	U
Maulisia argipalla	U
Pellisolus eubranchus	U
Sagamichthys abei	U
Salmonoidei	
Osmeridae	79
Allosmerus elongatus	U
Hypomesus olidus	U
Hypomesus pretiosus	U
Mallotus villosus	80
Osmerus mordax	A/F
Spirinchus starksi	U
Spirinchus thaleichthys	A
Thaleichthys pacificus	A
Salmonidae	
Coregoninae	
Coregonus laurettae	F
Coregonus nasus	F
Coregonus pidschian	F
Coregonus sardinella	F
Stenodus leucichthys	F
Salmoninae	
Oncorhynchus gorbuscha	A
Oncorhynchus keta	A
Oncorhynchus kisutch	A
Oncorhynchus nerka	A
Oncorhynchus tshawytscha	A
Parasalmo clarki	A
Parasalmo gairdneri	A
Parasalmo mykiss	A
Parasalmo penshinensis	A
Salvelinus alpinus	A
Salvelinus leucomaenis	A
Salvelinus malma	A
Stomiiformes	83
Gonostomatoidei	86
Gonostomatidae	87
Cyclothone acclinidens	88
Cyclothone atraria	88
Cyclothone pallida	88
Cyclothone pseudopallida	88
Cyclothone signata	88
Cyclothone sp.	U
Gonostoma atlanticum	90
Gonostoma gracile	90

Cyclopteropsis phrynoides	U
Eumicrotremus andriashevi	U
Eumicrotremus barbatus	U
Eumicrotremus birulai	U
Eumicrotremus derjugini	U
Eumicrotremus gyrinops	U
Eumicrotremus orbis	468
Eumicrotremus soldatovi	U
Eumicrotremus taranetzi	U
Lethotremus muticus	U
Pelagocyclus vitiazi	U
Liparidinae	470
Acantholiparis caecus	U
Acantholiparis opercularis	U
Acantholiparis sp.	U
Careproctus abbreviatus	U
Careproctus attenuatus	U
Careproctus bowersianus	U
Careproctus cameliae	U
Careproctus canus	U
Careproctus colletti	U
Careproctus cypselurus	U
Careproctus ectenes	U
Careproctus filamentosus	U
Careproctus furcellus	U
Careproctus gilberti	U
Careproctus longifilis	U
Careproctus melanurus	U
Careproctus microstomus	U
Careproctus mollis	U
Careproctus opisthotremus	U
Careproctus oregonensis	U
Careproctus ostentum	U
Careproctus ovigerum	U
Careproctus pellucidus	U
Careproctus phasma	U
Careproctus pycnosoma	U
Careproctus rastrinus	U
Careproctus scottae	U
Careproctus simus	U
Careproctus sp.	U
Careproctus spectrum	U
Careproctus zachirus	U
Crystallichthys cyclospilus	U
Crystallichthys mirabilis	U
Elassodiscus caudatus	U
Elassodiscus tremebundus	U
Gyrinichthys minytremus	U
Liparis bristolensis	U
Liparis callyodon	U
Liparis catharus	U
Liparis cyclopus	U
Liparis dennyi	U
Liparis florae	U
Liparis fucensis	U
Liparis gibbus	U
Liparis grebnitzki	U
Liparis mednius	U
Liparis megacephalus	U
Liparis micraspidophorus	U
Liparis mucosus	U
Liparis ochotensis	U

Liparis pulchellus	U
Liparis rutteri	U
Liparis tunicatus	U
Lipariscus nanus	U
Nectoliparis pelagicus	476
Odontoliparis ferox	U
Osteodiscus cascadiae	U
Paraliparis cephalus	U
Paraliparis dactylosus	U
Paraliparis deani	478
Paraliparis holomelas	U
Paraliparis latifrons	U
Paraliparis megalopus	U
Paraliparis melanobranchus	U
Paraliparis mento	U
Paraliparis paucidens	U
Paraliparis pectoralis	U
Paraliparis rosaceus	U
Paraliparis ulochir	U
Polypera beringiana	U
Polypera greeni	U
Rhinoliparis attenuatus	U
Rhinoliparis barbulifer	480
Temnocora candida	U
Perciformes	483
Percoidei	
Carangidae	
Naucrates ductor	484
Seriola lalandi	S
Trachurus symmetricus	486
Bramidae	
Brama japonicus	488
Taractes asper	U
Caristiidae	
Caristius macropus	490
Sciaenidae	
Atractoscion nobilis	S
Genyonemus lineatus	492
Seriphus politus	S
Pentacerotidae	
Pseudopentaceros sp.	494
Embiotocidae	
Amphistichus koelzi	V
Amphistichus rhodoterus	V
Brachyistius frenatus	V
Cymatogaster aggregata	V
Embiotoca lateralis	V
Hyperprosopon argenteum	V
Hyperprosopon ellipticum	V
Hypocritichthys analis	V
Phanerodon furcatus	V
Rhacochilus vacca	V
Zoarcoidei	
Bathymasteridae	496
Bathymaster caeruleofasciatus	U
Bathymaster leurolepis	U
Bathymaster signatus	U
Ronquilus jordani	U
Zoarcidae	498
Bothrocara brunneum	U
Bothrocara hollandi	U
Bothrocara molle	U

*Luvaridae is placed in the Scombroidei in J. Nelson (1984), but other studies (Leis and Richards 1984) have shown it belongs in the Acanthuroidei.

Identifying fish eggs and larvae

This guide is designed primarily to assist in identifying eggs and larvae of fishes collected by sampling plankton. This process is usually divided into two main steps: 1) Sorting fish material out of the total plankton, and 2) identifying fish eggs and larvae of interest. Sorting procedures such as outlined in Kramer et al. (1972) are usually used. Matarese and Sandknop (1984) discuss identification of fish eggs, and Powles and Markle (1984) discuss identification of fish larvae. Eggs should be fixed and maintained in 3-5% buffered formalin, whereas larvae are better preserved if transferred to 70% ethanol after fixation in 3-5% buffered formalin (see Lavenberg et al. 1984). Identification is usually accomplished using a dissecting microscope at magnifications of 7 to 70×, with lighting from above and below a clear or frosted glass stage. A calibrated ocular micrometer is needed for various measurements of eggs and larvae. Specimens are frequently examined as whole mounts in their preservation medium in dishes or watch glasses (~50 mm diameter). Fine probes and forceps can be used carefully to manipulate the specimens. A piece of white paper inserted between the specimen dish and the stage makes pigment more readily visible.

Since the larvae, and certainly the eggs, do not look like their parents, different characters are required to identify them. In practice, it is often convenient to separate the eggs and larvae in a sample into similar-appearing types, before recording specific observations or trying to identify them. Generally, it is best to identify all specimens in a sample to the lowest taxonomic level possible, even if the collection was intended for certain target species; without careful examination, other species could be misidentified as those of a target species.

In addition to characters of the eggs and larvae themselves, clues to their identity are found in information such as geographic area, depth, and date of collection.

Eggs

For pelagic fish eggs, the following identifying characters are recorded as known in this guide (see Matarese and Sandknop 1984 for more details): **Shape** (most are spherical, a few ellipsoidal); **size** (most are ~1 mm in diameter, range ~0.5-4.0 mm for pelagic eggs covered in this guide); **oil globules** (present in many species, vary in number and size); **yolk** (homogeneous or segmented); **chorion** (smooth in most, but sculptured in some); **perivitelline space** (narrow [<0.1 egg diameter] in many, but reaches one-half egg diameter in some); and **embryonic characters** (shape, pigment, gut length, early fin development, and myomere count of the embryo in late-stage eggs). Few taxonomic generalizations can be made for fish eggs; closely related species may have eggs that are as dissimilar as species in different orders (Table 2). However, the yolk is usually segmented in primitive teleosts (e.g., clupeiforms, anguilliforms, and salmoniforms) and homogeneous in more advanced forms. Also, oil globules are absent in pleuronectids covered in this guide.

Larvae

Fish larvae possess a larger suite of characters than the eggs, and may undergo dramatic changes with development. To begin to identify a larval fish, the following should be noted: **Size** (NL or SL) and **stage of development** (e.g., preflexion, flexion, postflexion, transforming [Kendall et al. 1984]) as well as its **general appearance** (e.g., long and slender, short and deep bodied, lightly or heavily pigmented). Figure 2 illustrates anatomical features and measurements used to describe larvae. With practice, it is often possible to group larvae according to order or family (Fig. 3).

Meristic characters Meristic characters are essential and should be determined, understanding that fin elements are gradually added during larval development. Myomeres are the first meristic character to stabilize, and the number usually reflects the number of adult vertebrae. The number of vertebrae varies among the fishes covered in this guide from <20 (molids) to >200 (e.g., most elopomorphs) (see Figure 4 where, for fishes occurring in the study area, vertebral counts are arranged by family in ascending order). Use of polarized light often facilitates counting myomeres. Myosepta are frequently more discernable than the myomeres, and if they are counted, one should be added to account for the myomeres anterior and posterior to the first and last myosepta.

The developing median fins contain several bits of taxonomic information. Dipping the larva in a potassium hydroxide solution and then in an Alizarin Red solution (see Hollister 1934 for solution recipes) for a few seconds, then rinsing and examining it in its preservative allows fin rays and head spines to be seen more clearly, since they stain red. However, this procedure may interfere with future attempts to clear and stain the larva. The principal caudal fin count is often an ordinal character (Table 2) and is very useful and relatively easy to determine in larvae, since it generally reaches its adult state shortly after flexion. The number, position, and order of development of the dorsal and anal fins, and their composition in terms of spines and soft rays, are important characters (Table 2). In several fishes (e.g., *Sebastes*), the final dorsal and anal spine develop first as soft rays, and change to spines during transformation. Thus, in late larvae, the median fins are different in the composition of spines and soft rays than in the adults. Fin rays that become elongate in larvae often develop precociously, otherwise second dorsal and anal soft rays generally develop concurrently when present. Spinous dorsal fins may develop before, concurrently, or after the second dorsal fin. When there is a gap between the spinous and soft-ray portions of the dorsal fin, spines generally develop after the soft rays.

In the sequence of paired fin development, the pectorals often develop early in the larval period, and the pelvics late. The pectoral fins form in the egg as larval pectoral fins, without fin rays. The fin rays generally develop much later in the larval stage. The length of the pectoral fin, as well as its number of rays, is a useful character. While the number of pectoral rays may vary within and among species in a genus, the pelvic fin position and formula are generally stable at a high level of classification (e.g., order; see Table 2). The pelvic fin is absent in anguilliforms and members of some other groups (e.g., zoarcids, ammodytids, and molids). In primitive fishes (e.g., clupeiforms, myctophiforms) it contains no spines, is abdominal, and generally contains more than five soft rays. In most perciforms and scorpaeniforms, the basic pelvic fin count is I,5, and it is thoracic in position. This count is reduced in some; notably in the northern Pacific, cottids often have fewer than five soft rays. The pelvic fin is modified into a sucking disc in gobiesociforms and in some cyclopterids.

Other meristic characters (e.g., gill rakers, secondary caudal fin rays, scales) develop too late to be generally useful in identifying larvae, but may be essential when working with pelagic juveniles.

Pigmentation Pigmentation available as taxonomic characters on larvae is limited to melanophores, since other pigment cells (e.g., xanthophores) do not retain their color in currently-used fixatives and preservatives. Melanophore patterns are very useful for identifying larval fishes. The relative size, position, and sometimes the number of melanophores in series should be noted. In some cases, pigmentation consists of a group of melanophores in a specific area; in others the pigmentation consists of an individual melanophore. Pigmentation generally changes as larvae develop. Movement of individual melanophores is rather limited, but addition or loss of melanophores is common. Usually preflexion larvae are less pigmented than later larvae, and late in the larval period, as transformation occurs, the larval pigment pattern is overgrown by the largely superficial pattern of the juvenile. Between the preflexion and transformation stages in most fish there is a definite larval pigment pattern which is relatively stable, and unique to a species in many cases. Although the position of melanophores is a species characteristic, the degree of contradiction seems to be physiologically moderated. Thus, larvae of the same species could have a different overall pigmented appearance, lighter or darker. Several species in the Northeast Pacific have heavily pigmented larvae, which are readily recognized in samples but may be confused with one another (Table 3, Fig. 5).

Morphology Larval shape can vary from stout and robust to quite slender and elongate (Table 2). Several fishes in the study area have elongate larvae which may be confused with one another (Table 4, Fig. 6). The ratio of body depth at the pectoral fin to standard length is usually sufficient to characterize overall body shape. The size and shape of the head and eye may also be important. The length of the gut, measured as the ratio of preanal to standard length, is quite useful. As with other characters, larval shape characters vary with development, so the size and stage of development should be noted when comparing shape of an unknown larva to illustrations and descriptions of known specimens.

Head spines, when present, may be more numerous and accentuated in larvae than in adults. Among Northeast Pacific fishes, larval head spines are most prevalent in cottids and scorpaenids, although they also occur in some members of groups such as perciforms and pleuronectids (Table 2).

Once the above data on an unknown specimen or group of similar specimens are assembled, actual identification becomes largely a process of eliminating species whose characters do not match the unknown specimen. Keys are not presented in this guide and generally do not work well with fish larvae, because the larvae change so much with development, and the larvae of all species in a study area are rarely known. With larvae, particularly, the first attempt should be to identify the unknown to order or family, based on meristic values, shape, and general appearance. Table 2 and the figures of larval representatives of various orders (Fig. 4) should be of assistance in this. Once an idea of the appropriate order/suborder is established, more detailed information can be obtained in the material at the beginning of each ordinal account, including general life-history characters, species represented in the study area, and meristic and early-life-history characters. Illustrations, meristics, and other information given in the individual taxon accounts in this guide should then be compared with the unknown specimens to find the most likely species. Differences between the unknown and described larvae should be noted. If an unknown specimen does not match any larval descriptions given here, check meristic tables of the most likely taxa to see if the unknown specimen fits a species whose larvae have not yet been described.

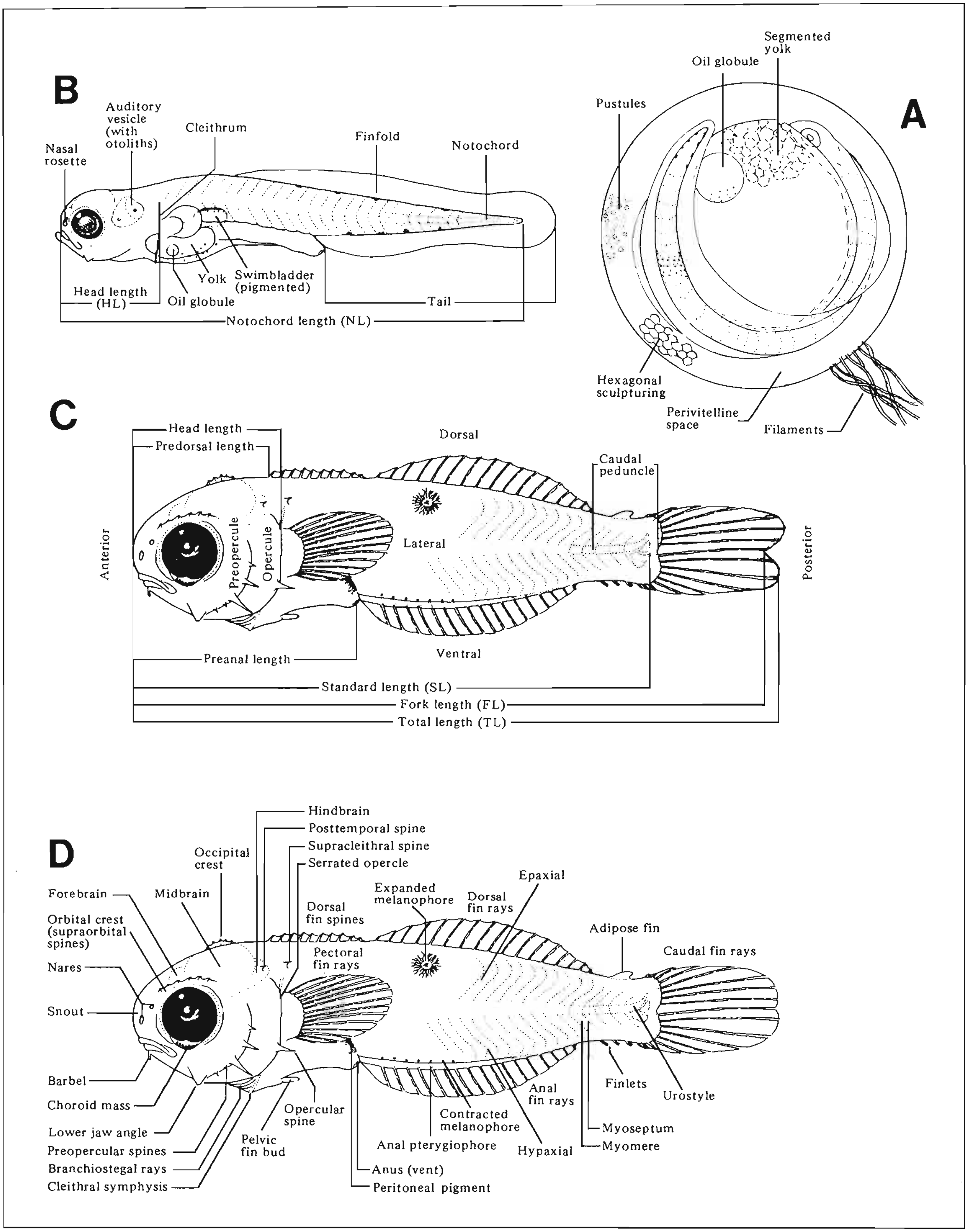


Figure 2

Examples of features used to describe early stages of fishes: A, egg; B, preflexion larva; C, late larva showing base points for measurements; D, late larva showing morphological features (B-D, after Fahay 1983).

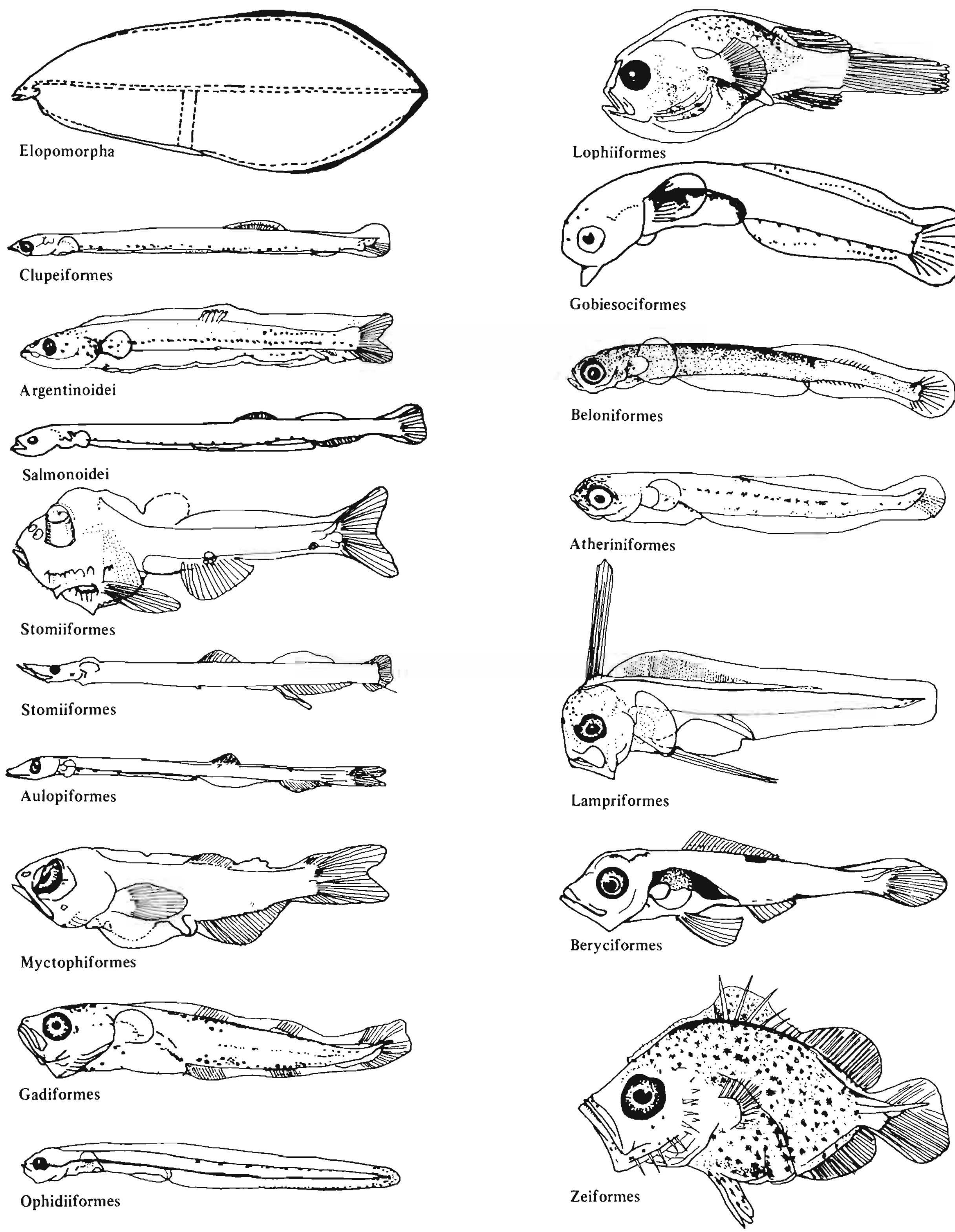


Figure 3
Representative postflexion larvae of higher categories of fishes of the Northeast Pacific Ocean.

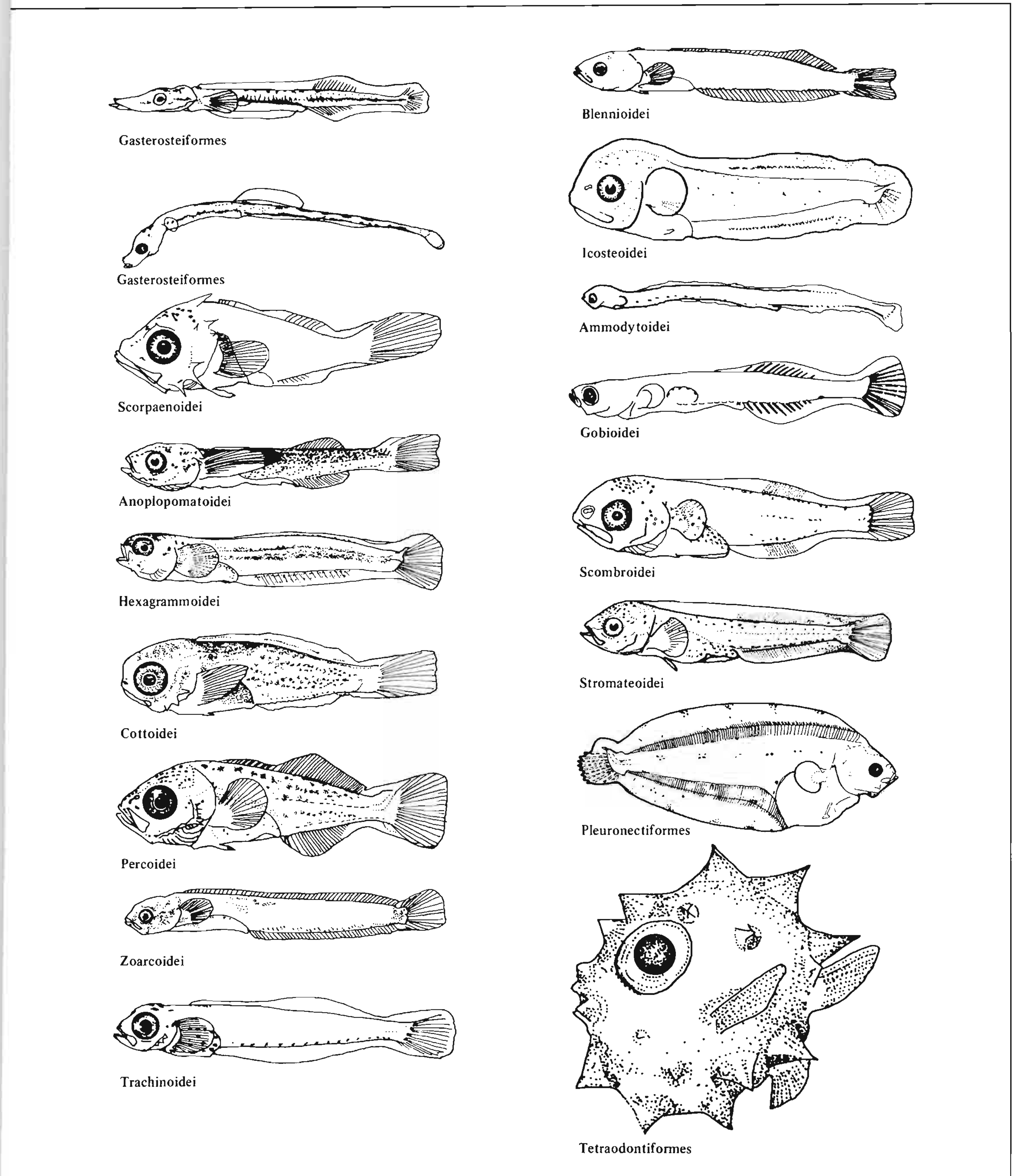


Figure 3 (continued)

Table 2

Ordinal/subordinal egg, larval, and meristic characters of Northeast Pacific fishes (Ahlstrom and Moser 1976, Fahay 1983, Leis and Rennis 1983, in part).

		Eggs																		Larvae																Meristics														
																																				Fin characters											Vertebrae	Principal caudal fin rays		
		Development site			Shape		Chorion		Yolk		Perivitelline space			Oil globule			Diameter (mm)			Shape		Preanal length (%SL)			Gut shape			Eye shape		Head spines		Transformation		Special juvenile		Spines		Pelvic fin Position				Pelvic fin Formula	No. dorsal fins		Adipose fin					
Taxon	Families in study area	Planktonic	Demersal	Internal	Spherical	Ellipsoidal	Smooth	Sculptured	Segmented	Homogeneous	Wide	Moderate	Narrow	Absent	1 Present	>1	<0.9	1.0-2.0	>2.0	Elongate	Stocky	<50	50-75	>75	Straight	Coiled	Trailing	Round	Narrowed	Absent	Present	Marked	Gradual	Present	Absent	Present	Absent	Absent	Abdominal	Thoracic	Jugular		One	Two	Present	Absent		Upper	Lower	Total
Notacanthiformes/ Anguilliformes	9	X			X		X		X		X			X	X	X			X	X			X	X	X		X	X	X	X		X			X		X	X					X			X	68-750	0-9	0-7	0-16
Clupeiformes	2	X	X[a]		X	X	X		X		X	X	X	X	X			X		X			X	X	X			X		X		X			X		X		X			6-9	X			X	43-57	10	9	19
Salmoniformes																																																		
Argentinoidei	5	X			X			X	X			X	X		X	X		X	X	X			X	X	X			X	X	X		X	X	X	X		X		X			6-12	X		X	X	34-84	10	9	19
Salmonoidei	2		X		X		X		X			X				X		X	X	X				X	X			X		X		X		X			X		X			8-11	X		X		54-75	10	9	19
Stomiiformes	6	X			X		X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X		X	X	X	X		X			X		X		X			6-17	X		X	X	35-83	10	9	19
Aulopiformes	7	X			X			X				X		X				X		X		X	X			X		X	X	X	X		X		X		X		X			8-12	X		X	X	48-87	10	9	19
Myctophiformes	2	X			X		X	X	X				X	X	X		X			X	X	X	X		X		X	X	X		X	X	X	X	X		X		X			7-10	X		X		29-42	10	9	19
Gadiformes	5	X	X		X		X	X[b]		X			X	X	X	X		X	X	X	X	X				X		X		X			X		X	X	X			X		0-17	X	X[c]		X	48-64;84-86	4-6[d]	2-4[d]	6-10[d]
Ophidiiformes	3	------ Unknown ------																		X		X				X		X		X			X		X	X					X	I,1-2	X			X	60-81	4	5	9
Lophiiformes	2	X			X		X		X	X			X	X	X		X				X			X		X		X		X		X			X		X	X					X			X	19-21	4	4-5	8-9
Gobiesociformes	1		X			X	X			X			X	X				X		X			X			X		X		X			X		X	X				X[e]		I,4	X			X	32-36	?	?	14
Beloniformes[f]	1	X	X			X		X		X			X	X				X		X			X		X			X		X			X		X		X		X			6	X			X	62-69	7	8	15
Atheriniformes	1		X		X			X		X			X			X		X	X	X		X				X		X		X			X		X	X			X			I,5-6		X		X	44-52	9	8	17
Lampriformes	2	X			X		X			X		X		X					X	X	X	X	X			X		X		X			X		X	X	X		X	X		6-7	X			X	43-46;90-94	?	?	?
Beryciformes	5	X			X		X			X			X		X		X			X	X	X	X			X		X		X	X	X	X	X	X	X		X	X	X		0-I,6-8	X			X	23-52	10	9	19
Zeiformes	1	X			X					X					X			X			X		X			X		X			X		X		X	X			X			I,6	X			X	39	6	7	13
Gasterosteiformes	3		X	X	X		X			X			X			X		X		X		X	X		X	X		X		X			X		X	X	X	X	X	X		I,1 or 4	X	X[g]		X	30-64	6-7	6	12-13
Scorpaeniformes																																																		
Scorpaenoidei	1			X	X	X	X			X			X		X	X	X	X			X	X	X			X		X			X		X	X	X	X				X		I,5	X			X	26-31	7	7	14
Anoplopomatoidei	1	X			X		X			X			X	X					X	X			X		X	X		X		X			X	X		X				X		I,5		X		X	61-66	7	7	14
Hexagrammoidei	1		X		X		X			X			X		X	X		X	X	X		X	X			X		X		X	X		X	X		X				X		I,5	X			X	36-63	7-8	6-11	13-19
Cottoidei	3[h]		X		X		X	X		X			X		X	X		X	X	X	X	X	X			X		X		X	X		X	X	X	X		X[i]		X		I,2-5[i]	X	X		X	25-71	6	5-7	11-13
Perciformes																																																		
Percoidei	6	X			X		X		X[j]	X			X		X			X		X	X	X	X			X		X		X	X		X	X	X	X				X		I,5	X			X	23-41	9	8	17
Zoarcoidei	9		X		X		X			X			X		X			X	X	X		X	X			X		X		X			X		X	X		X		X	X	0-I,0-5	X	X		X	49-150;221-250	?	?	12-15
Trachinoidei	1		X		X		X			X			X		X				X	X		X				X		X			X		X		X	X				X		I,5		X		X	44-47	?	?	13
Blennioidei	1		X		X			X		X			X		X	X				X		X				X		X		X			X		X	X				X		I,3	X			X	55-58	9	8	17
Icostoidei	1	X			X		X			X				X	X				X	X		X				X		X			X		X		X	X		X[k]	X			I,4[k]	X			X	66-68	9	8	17
Ammodytoidei	1		X		X		X			X			X		X		X			X		X			X			X		X			X		X		X	X					X			X	65-70	9	8	17
Gobioidei	1		X			X		X		X			X			X	X	X		X		X	X		X			X		X			X		X	X				X		5-6		X		X	26-38	?	?	17
Scombroidei	2	X			X		X			X			X		X			X		X	X		X			X		X			X		X		X	X				X		I,1;I,5	X	X		X	22-23;30-32;148-150	9	8	17
Acanthuroidei	1	------ Unknown ------																			X	X				X		X			X					X		X[k]		X		I,4[k]		X		X	22-23	?	?	16
Stromateoidei	3	X			X		X			X			X		X			X		X	X	X	X		X	X		X			X		X	X		X		X[l]		X		I,5	X			X	28-31;52-62	9	8	17
Pleuronectiformes	3	X	X[m]		X		X	X[n]		X		X[o]	X	X[p]	X		X	X	X	X	X	X	X			X		X		X	X	X			X		X			X	X	4-6	X			X	35-66	9-12[q]	8-11[q]	17-24[q]
Tetraodontiformes	1	X			X			X		X		X	X			X		X			X	X				X		X			X		X		X		X	X					X			X	17-18			15[r]

[a] *Clupea pallasi* eggs demersal.
[b] Macrouridae eggs sculptured.
[c] Three dorsal fins in Gadidae.
[d] Macrouridae lack caudal fins.
[e] Pelvic fin modified into a disc.
[f] J. Nelson (1984) places scomberesocids within the Cyprinodontiformes.
[g] Dorsal spines isolated from soft-rayed dorsal fin.
[h] J. Nelson (1984) considers Psychrolutidae a separate family; we include it in Cottidae.
[i] Pelvic fin absent or modified into a disc in Cyclopteridae.
[j] *Trachurus* yolk segmented.
[k] Pelvic fin present only in larvae.
[l] Pelvic fin absent in *Peprilus*.
[m] *Lepidopsetta bilineata* only species with demersal egg.
[n] *Pleuronichthys* eggs have hexagonal sculpturing.
[o] *Hippoglossoides elassodon* and *H. robustus* only species with wide perivitelline space.
[p] Pleuronectidae eggs have no oil globule.
[q] Total caudal fin rays.
[r] *Mola mola* has a pseudocaudal fin (see Tyler 1980).

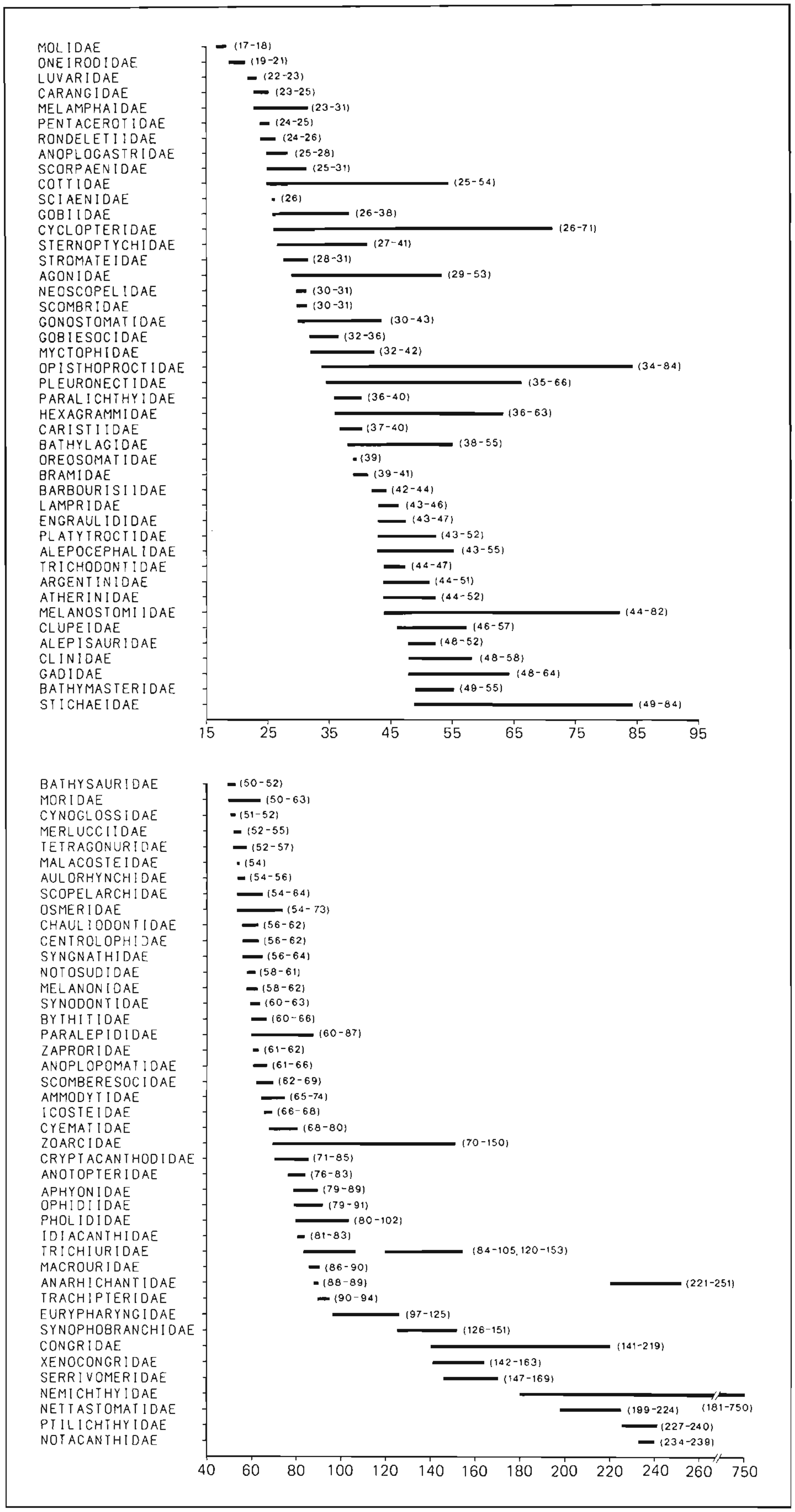


Figure 4

Ranges of total vertebral counts for families in the study area.

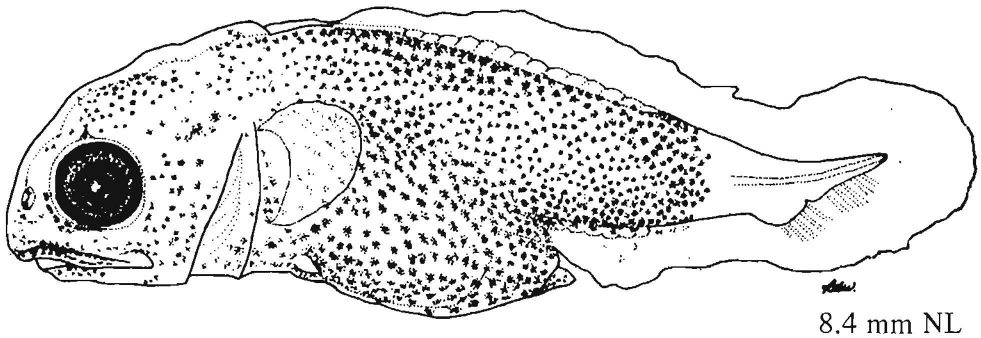
Table 3
Distinguishing features of some commonly collected heavily pigmented larvae.*

Taxon	Distribution	Total vertebrae	Description of pigment	Other diagnostic features	Page reference
Myomeres 25-50					
Rhamphocottus richardsoni	SSC-Bering Sea	26-28	Small spots, densely distributed on head, gut, and 3/4 body; absent on peduncle and tail	Subterminal mouth, deep body; after flexion head spines and prickles by 9-10 mm	366
Myoxocephalus G	Wash.-Bering Sea	34-37	Spots concentrated dorsally on head and gut, and over anterior 1/2 body; absent over gut	Head spines develop during flexion	400
Hemilepidotus spp.	SSC-SE Alaska	35-39	Spots widely distributed on head, gut, and body	Head spines develop during flexion	372
Scorpaenichthys marmoratus	SSC-SE Alaska	35-37	Dense, uniformly distributed spots over head, gut, and 3/4 body; absent on tail	Head bumps and preopercular spines develop after flexion; preanal finfold	382
Blepsias spp.	Cent. Calif.-Bering Sea	37-39	Dense, large spots evenly concentrated over dorsal head, gut, and >3/4 body; absent on tail tip	Head spines and bumps develop during flexion	448
Pleuronichthys spp.	SSC-Bering Sea	37-41	Dense spots concentrated over head, gut, and >3/4 body; dorsal and anal finfold	Slender body with wide finfolds	616
Radulinus spp.	SSC-Gulf of Alaska	38-40	Widely distributed over lateral gut surface and almost 3/4 body	Preopercular spines not prominent, gut coiled	406
Hemitripterus villosus	Gulf of Alaska-Bering Sea	39-41	Spots evenly distributed to 3/4 body and into dorsal and anal finfold	Large size at development	452
Nautichthys oculofasciatus	Cent. Calif.-Bering Sea	40-41	Large, widely distributed spots to 3/4 body; dorsal and anal finfold pigment at midbody	Long, pigmented precocious pectorals; head spines, bumps, ridges develop after flexion	454
Myomeres >50					
Hexagrammos spp./ *Pleurogrammus monopterygius*	S. Calif.-Bering Sea	50-63	Widely distributed on dorsal head and gut, above and below notochord	Gut length <50% SL	348
Ophiodon elongatus	SSC-Gulf of Alaska	56-59	Widely distributed on dorsal head and gut, more concentrated on dorso- and ventrolateral surface; chin and isthmus	Pointed snout and large terminal mouth	346
Zaprora silenus	Cent. Calif.-Bering Sea	61-62	Small spots densely concentrated over entire body, except ventrally on gut, dorsal finfold, and posterior edge of gill cover; lightly on caudal peduncle and anal finfold	Large size at development	530
Anoplopoma fimbria	SSC-Bering Sea	61-66	Widely distributed over >3/4 body	>15 mm, pectoral fins long, pigmented; gut length >50% SL; anus curves ventrad	338
Cololabis saira	SSC-Bering Sea	62-69	Small spots densely concentrated, ventral tailtip without pigment	Long preanal finfold	236
Lyconectes aleutensis	N. Calif.-Bering Sea	73-75	Heavily concentrated over >3/4 body, isthmus; lighter over gut and absent on peduncle	Large size at development	520
Delolepis gigantea	N. Calif.-Bering Sea	81-83	Widely distributed to 3/4 body, absent over gut and isthmus	Large size at development	520

*Other heavily pigmented larvae that may be less frequently encountered include the following species:
Anarhichas orientalis (p. 524)
Naucrates ductor (p. 484)
Peprilus simillimus (p. 562)
Oxylebius pictus (p. 342)
Zaniolepis (p. 344)

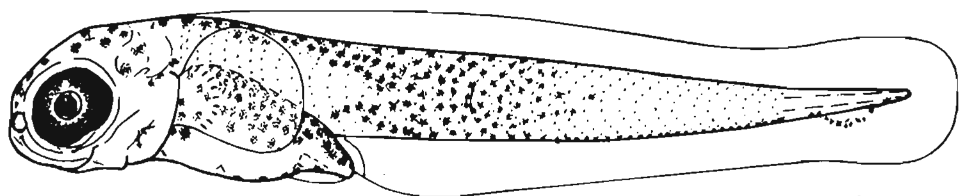
HEAVILY PIGMENTED LARVAE (MYOMERES 25–50)

A *Rhamphocottus richardsoni*



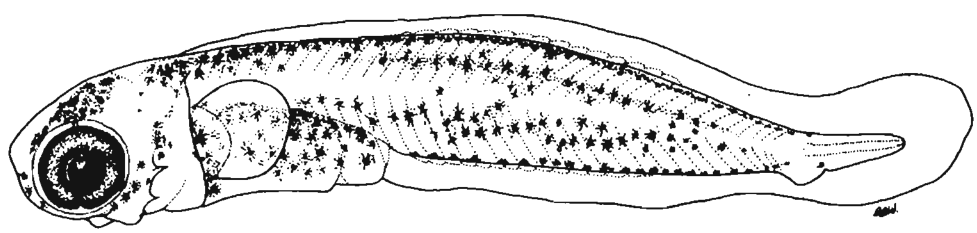
8.4 mm NL

B *Myoxocephalus* G



8.7 mm SL

C *Hemilepidotus* spp. *(Hemilepidotus spinosus)*



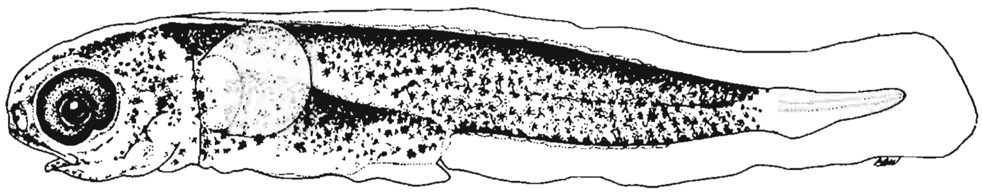
8.9 mm NL

Figures A, C, Richardson and Washington 1980; B, NWAFC original (B. Vinter).

Figure 5
Commonly collected heavily pigmented larvae with 25-50 myomeres (A-I), and >50 myomeres (J-P).

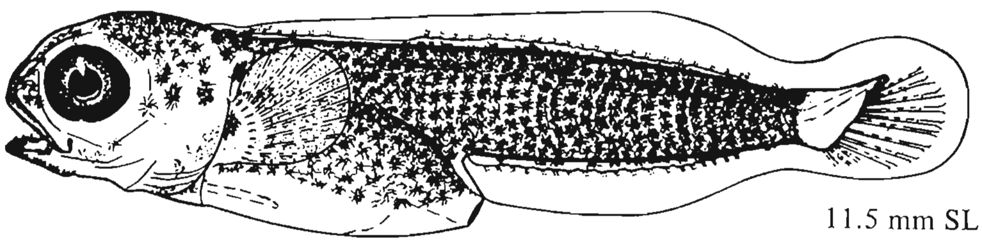
HEAVILY PIGMENTED LARVAE (MYOMERES 25–50)

D *Scorpaenichthys marmoratus*



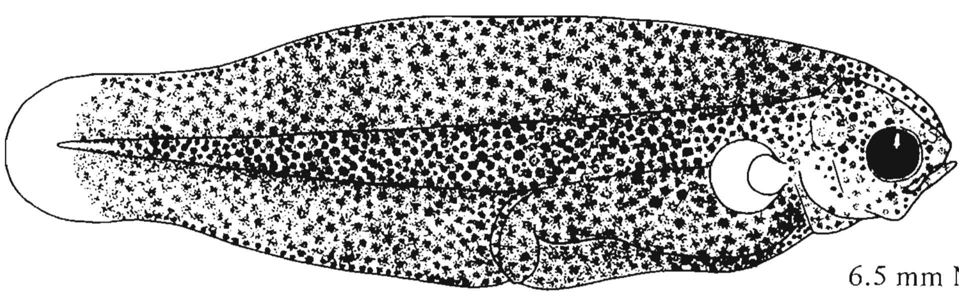
8.6 mm NL

E *Blepsias* spp. *(Blepsias cirrhosus)*



11.5 mm SL

F *Pleuronichthys* spp. *(Pleuronichthys decurrens)*



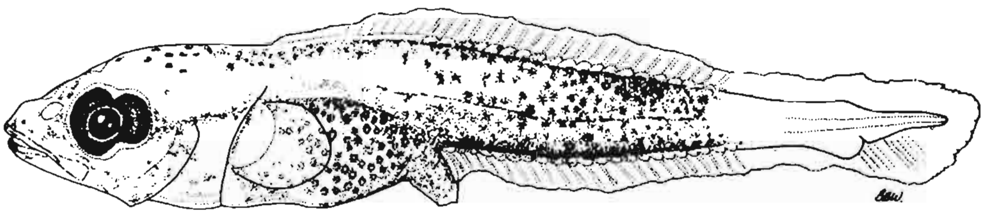
6.5 mm NL

Figure D, Richardson and Washington 1980; E, NWAFC original (B. Vinter); F, Sumida et al. 1979.

Figure 5 (continued)

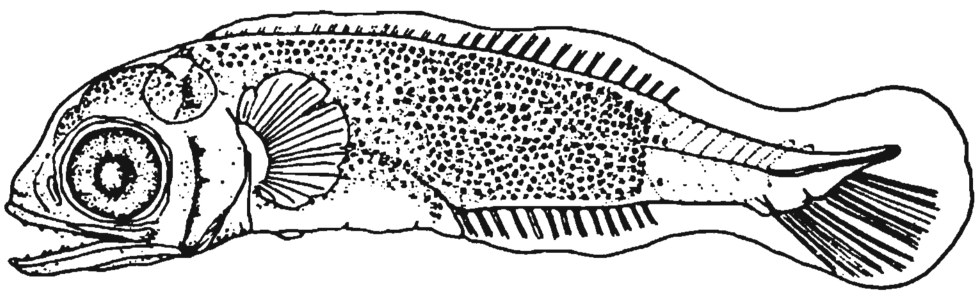
HEAVILY PIGMENTED LARVAE (MYOMERES 25–50)

G *Radulinus* spp. *(Radulinus asprellus)*



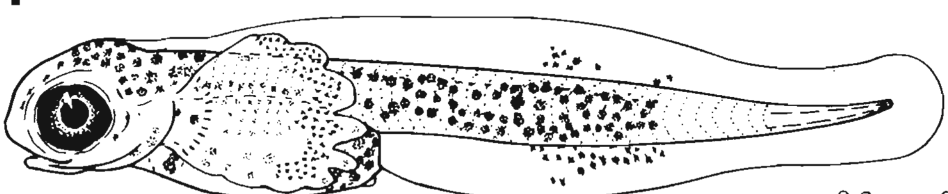
9.6 mm NL

H *Hemitripterus villosus*



14.4 mm SL

I *Nautichthys oculofasciatus*



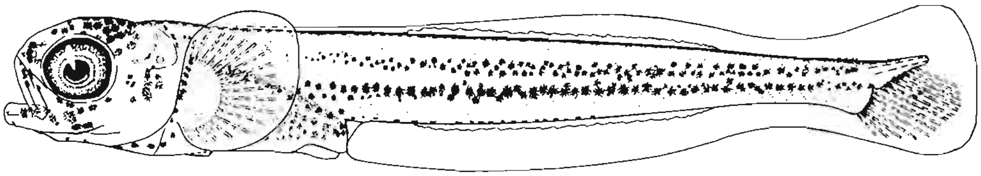
8.3 mm SL

Figure G, Richardson and Washington 1980; H, Okiyama and Sando 1976; I, NWAFC original (B. Vinter).

Figure 5 (continued)

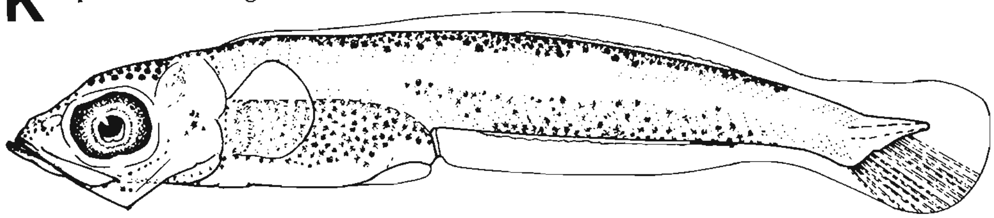
HEAVILY PIGMENTED LARVAE (MYOMERES > 50)

J *Hexagrammos* spp. *(Hexagrammos octogrammus)*



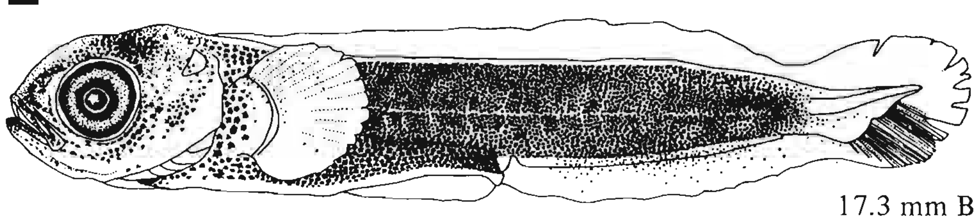
15.0 mm SL

K *Ophiodon elongatus*



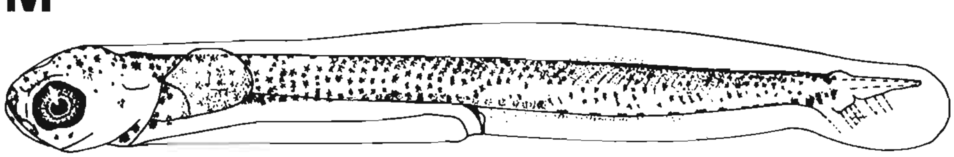
12.2 mm SL

L *Zaprora silenus*



17.3 mm BL

M *Anoplopoma fimbria*



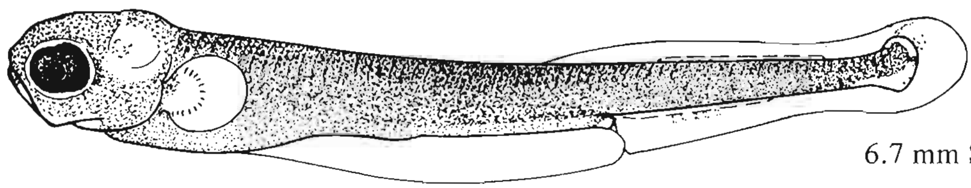
12.0 mm SL

Figures J–K, Kendall and Vinter 1984; L, Haryu and Nishiyama 1981; M, NWAFC original (B. Vinter).

Figure 5 (continued)

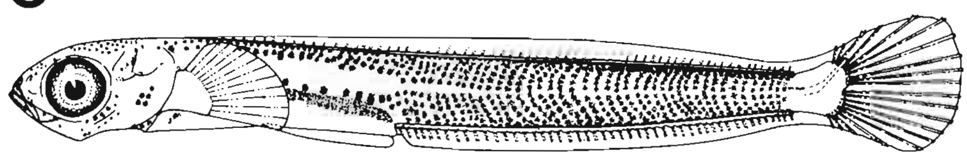
HEAVILY PIGMENTED LARVAE (MYOMERES > 50)

N *Cololabis saira*



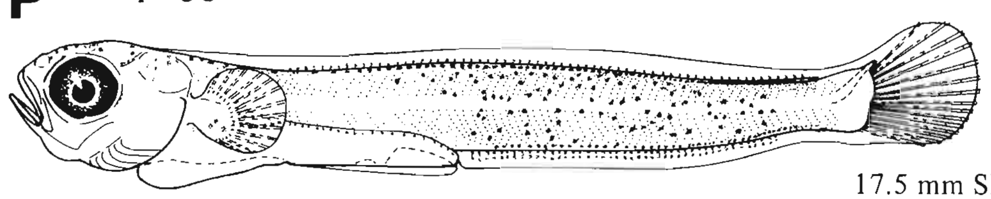
6.7 mm SL

O *Lyconectes aleutensis*



16.5 mm SL

P *Delolepis gigantea*



17.5 mm SL

Figures N–P, NWAFC originals (B. Vinter).

Figure 5 (continued)

Table 4

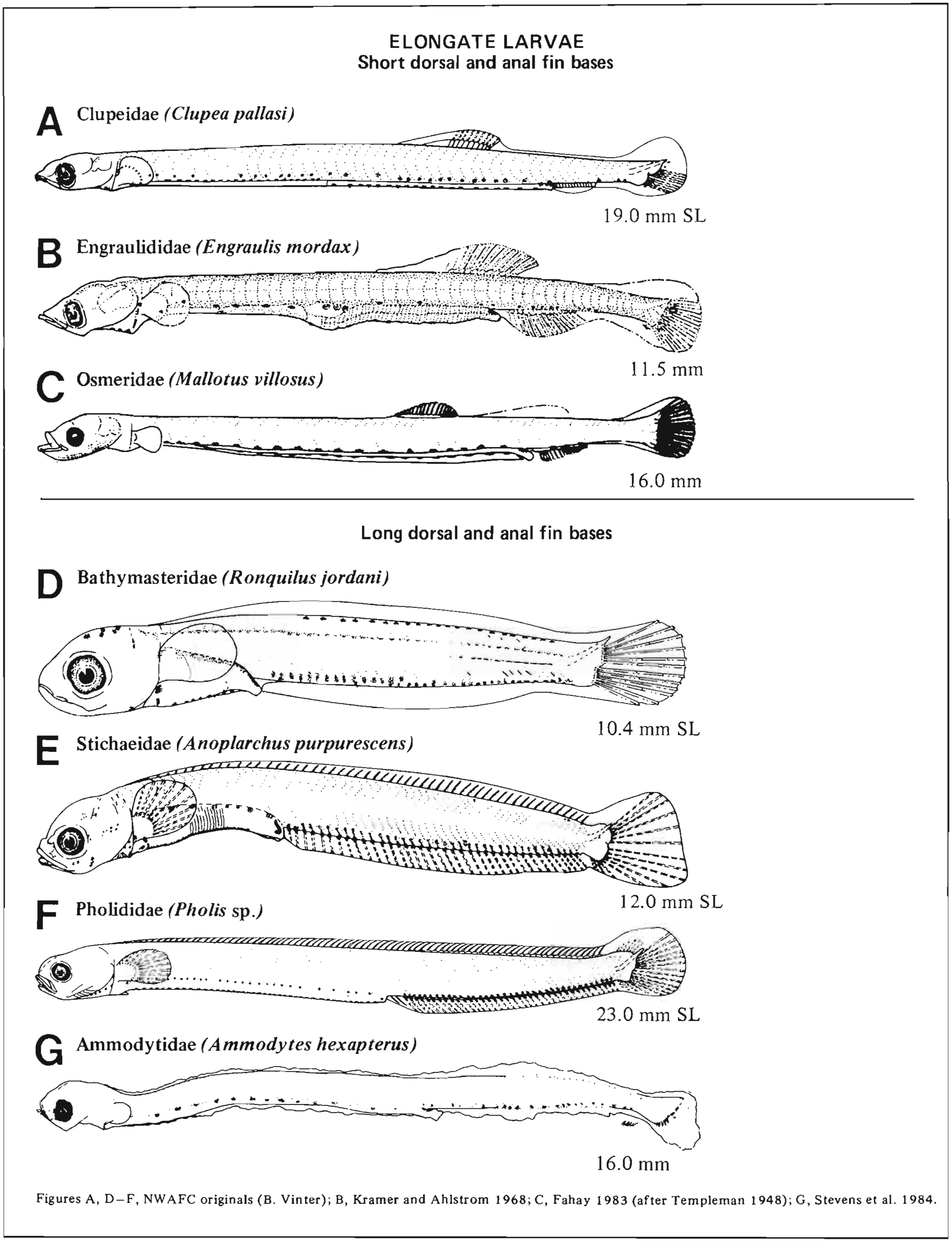
Comparison of selected diagnostic characters of some commonly collected families with similar-looking elongate larvae.

Taxon	Myomeres: Preanal	Myomeres: Postanal	Myomeres: Total	Myomeres: Number between dorsal fin insertion and anal fin origin[a] (flexion stage)	Preanal length	Presence of adipose fin	Diagnostic pigment	Page reference
Short dorsal and anal fin bases								
Clupeidae	28-32	19-23	46-57	6-8	80%	None	Gut	44
Engraulididae	24-26	19-21	43-47	0-2	67-75%	None	Isthmus, gut	48
Osmeridae[b]	—	—	54-73	9-11	80%	Yes	Single row pvm;[c] ventral gut midline	79
Long dorsal and anal fin bases								
Bathymasteridae	13-16	34-39	49-55	Overlaps	<50%	None	Urostyle or slash-like pigment along posterior hypaxial and epaxial myomeres	496
Stichaeidae	14-31	34-59	50-83	Overlaps	<50%	None	Gut, anus, pvm[c]	500
Pholididae	—	—	80-102	Overlaps	>50%	None	Gut, pvm[c]	522
Ammodytidae	40-47	23-25	65-74	Overlaps	60%	None	Double row pvm[c]	540

[a] The number of myomeres between dorsal and anal fins has been used as a taxonomic character in clupeiform larvae of certain size classes. During transformation the position of the gut and median fins shifts forward relative to myomere number (for more details, see McGowan and Berry 1984).

[b] Based on larvae of *Mallotus villosus* (except for total myomere count); other osmerids, as yet unidentified to species, are similar.

[c] pvm = postanal ventral midline melanophores.



Figures A, D–F, NWAFC originals (B. Vinter); B, Kramer and Ahlstrom 1968; C, Fahay 1983 (after Templeman 1948); G, Stevens et al. 1984.

Figure 6
Commonly collected elongate larvae.

Using this laboratory guide

Format

This laboratory guide has been designed to be practical and easy to use. Only information deemed necessary for accurate and timely identification has been included. A two-page format is provided for each taxon where sufficient early-life-history information exists. The left page includes pertinent information for identification and the right page includes illustrations, usually with notations indicating important diagnostic features. The left page is divided into two columns: Information on meristic characters and life history features is presented on the left, and developmental information on the right. Blanks within the format indicate that particular information was not available (e.g., egg size, fecundity), to point out gaps in knowledge, and allow researchers to insert new information as it becomes available. The family name appears at the top of each page for quick reference. The phylogenetic sequence generally follows J. Nelson (1984) unless otherwise indicated. Species names along with their authorities appear at the upper right corner of the left page, and common names (from Robins et al. 1980, Hubbs et al. 1979, Shiino 1976, and others) are included at the upper left corner of the right page. Nomenclature generally follows Robins et al. (1980) and Steyskal (1980) unless a more recent revision is available (usually from Moser et al. 1984b). Exceptions are noted in the text.

For taxa treated at the species level, available illustrations are arranged on the right-hand page as follows: Late-stage egg is in the upper right-hand corner, and order of larvae is shown (top to bottom) as yolksac, preflexion, flexion, postflexion, and either a transforming juvenile or special prejuvenile stage. Blank spaces indicate that stages were not available for illustration. When necessary for identification purposes, additional illustrations such as dorsal and ventral views are provided. Most illustrations were compiled from the literature; Moser et al. (1984b) provided over 100 illustrations. In a few cases, illustrations from the literature were redrawn, modified, or corrected; when this occurred, it is indicated. In addition to the published illustrations, original illustrations of 124 fish eggs and fish larvae by Beverly Vinter are included. Collection data are provided for original illustrations (Table 1).

Introductory sections are provided for each order and for taxa (usually genera or families) with difficult identification problems or for taxa that contain numerous similar species (e.g., Cottidae and *Sebastes*). Important diagnostic features are summarized, and, in some cases, tables are provided to aid in identification. In the Northeast Pacific Ocean, early-life-history stages of many species are either undescribed, incompletely described, or without adequate illustrations. For these taxa, identification material is provided at the lowest taxonomic level possible, usually family level (e.g., Osmeridae) or generic level (e.g., *Cyclothone*). Family level descriptions include a summary of available early and general life-history information, tables of meristic characters, and brief accounts of early-life-history characters from closely related taxa described from other geographic areas. For taxa where no early-life-history data are available (e.g., Cetomimoidei), life history summaries and meristic data are provided.

Meristics

Data summaries of meristic structures, except those for the caudal fin or from recently completed research, are from the NWAFC meristic database. The range (high and low value) and mode are presented for each entry. Ranges reported here generally represent the most extreme values ever recorded; in many cases, these values are not likely to be observed. These values may have been seen on specimens collected outside our study area. Thus, in using this guide more emphasis should be placed on the reported modal values. An "X" appears when data are unavailable. For fin ray counts, R = rays (soft rays) and S = spines; for gill raker counts, U = upper and L = lower. In addition to pelvic fin-ray counts, fin position is given. Position is indicated by the following descriptors: Abdominal, thoracic, jugular, absent, or modified (e.g., pelvic disc in cyclopterids). The total vertebral count given may not equal the sum of the precaudal and caudal vertebral counts in some cases, since these counts may have originated from different sources.

Data for caudal fin-ray counts have been gleaned from published material, as well as from original observations. Caudal fin-ray counts are reported in the following sequence: Upper secondary, upper principal + lower principal, lower secondary, with ranges for each when available. Total caudal fin rays or total principal caudal fin rays are reported if no other data are available. Blanks in the caudal field indicate that no data are available.

For some taxa, it was necessary to forego the standard meristic format in order to present the data or provide additional information (e.g., members of the family Gadidae have three dorsal fins and two anal fins). Departures from the standard format are either explained on the page where they occur or in introductory sections preceding species descriptions for certain taxa.

General life history

Life history data are provided as ancillary information which may aid in identification of eggs and larvae. These data were extracted from Garrison and Miller (1982) and supplemented by the general literature and original, unpublished material.

Geographic ranges are from the NWAFC meristic database and the literature. Allen and Smith (1988) provided a significant amount of new information. Range information is restricted primarily to the study area. Thus, the limits of the southern range beyond the California-Mexico border, the northern range beyond the Arctic to the north and east, and the western range beyond the Bering Sea are not specified.

The following general locations are used to approximate geographic range within the study area (abbreviations in parentheses are used hereafter in the text when necessary):

South of southern California (SSC)
Southern California, 32-34°N (S. Calif. or S. California)
Central California, 34-38°N (Cent. Calif. or Cent. California)
Northern California, 38-42° N (N. Calif. or N. California)
Oregon, 42-46°N
Washington, 46-48°30'N (Wash.)
British Columbia, 48°30'-55°N (Brit. Col.)
Southeastern Alaska, 55-59°N (SE Alaska)
Gulf of Alaska, 54-60°N
Aleutian Islands, 51-55°N (Aleutian Is.)
Bering Sea, 54-66°N
Chukchi Sea, north of 66°N
Arctic

In addition to geographic range, general ecological descriptors are incorporated in the NWAFC meristic database. The following descriptors are used.

Pelagic environment

Nearshore shelf pelagic: Extends from the shore seaward to include waters overlying an ocean bottom <200 m. Equivalent to the neritic province of Hedgpeth (1957) and other authors.

Oceanic: Waters overlying an ocean bottom >200 m. The following subdivisions based on water depth are used: Epipelagic 0-200 m; Mesopelagic 200-1000 m; Bathypelagic >1000 m.

Benthic environment

Intertidal, nearshore: Extends from high tide to low tide. Equivalent to the littoral province of many authors.

Nearshore shelf demersal: All bottom from low tide to 200 m (= epibenthal in text). Equivalent to the sublittoral zone of Hedgpeth (1957) and other authors.

Mesobenthal: Deep sea beyond the continental shelf at depths of 200-500 m. Lowest part of the shelf and upper part of continental slope (Fedorov 1973).

Bathybenthal: Deep sea along the continental slope at depths of 500-2500 m. Middle and lower sections of continental slope (Fedorov 1973).

Freshwater or anadromous: Generally the mouth and lower reaches of rivers and streams.

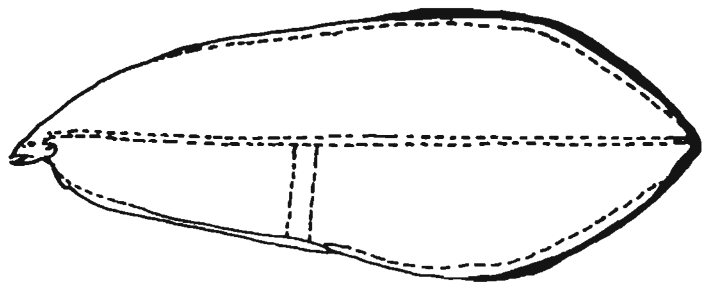
Other information under **Life History** includes reproductive mode (e.g., viviparous, ovoviviparous, oviparous) and indicates whether eggs and larvae are pelagic or demersal. Data on spawning are divided into four categories: Season, area, mode, and migration. Spawning often varies among geographic regions and populations, so care has been taken to provide as much specific geographic information as available. Fecundity values are given as counts of ripening eggs in individual females: Total ranges or (in a few cases) as a function of length in the form $F = aL^b$. Ages at first maturity and longevity values were extracted from the general literature. If available, age/length differences between sexes are noted.

Early life history

Egg and oil globule diameter measurements in millimeters are usually given as ranges (high and low values) with modal values as available in parentheses after the range. Precision varies among literature sources, but specimens used for original measurements were measured to the nearest 0.1 mm. Egg diameters on the illustrations are as they were given in the source. Incubation time, when available, is given in number of days to hatching for a specific temperature (°C). When describing embryonic pigment patterns, emphasis was placed on those characteristics which aid in identification. Diagnostic characters usually provide a summary of important features and comparisons with similar fish eggs.

Figure 2 provides examples of features used to describe and identify early stages of fishes. Original measurements of larvae are in millimeters and given in standard length (SL). Some measurements extracted from the literature were given as body length (BL), notochord length (NL), total length (TL), head length (HL), or percentages of these. Preanal length is usually expressed as a percentage of SL. If specific values are not available, preanal lengths are given as <50% SL, 50-75% SL, or >75% SL. Definitions for developmental stages are from Ahlstrom et al. (1976) and Kendall et al. (1984). Transformation is defined as acquisition of the adult complement of fin rays, and in some taxa this is accompanied by squamation. Sequence of fin development is usually described as the order in which fin rays accept alizarin stain, inferring ossification. For some taxa the sequence is determined by completion of the ossification of a fin element rather than the initiation of ossification (e.g., G.D. Johnson 1984); this is noted in the text. When three or more fins develop simultaneously, semicolons are used to separate the sequence of formation of one or more fins (e.g., dorsal; anal; caudal, pectoral, and pelvic). Otherwise, commas are used to separate fins developing individually in sequence (e.g., dorsal, anal, caudal, pectoral, and pelvic). Precocious fin development is usually noted. When describing pigment, those melanophores or patterns of melanophores important in identifying the taxon are stressed. Generally only melanophores are mentioned, since other pigment is not visible in formalin-preserved specimens. The general appearance, shape, and relative size of melanophores or groups of melanophores are indicated by imprecise descriptors such as spot, patch, or blotch. Diagnostic pigment characteristics are also indicated directly on the illustration page. The description of pigment is often brief and in telegraphic style and is not meant to be a substitute for more detailed discussions available in complete early-life-history descriptions. References are provided when more complete early-life-history descriptions are available. Under **Diagnostic Characters**, a brief summary of key features is provided which may help to distinguish a larval specimen from other similar larvae in either closely related taxa or from morphologically similar groups. When possible, comparative information is included in tables and is cross-referenced.

Data from the files of the late E.H. Ahlstrom are footnoted as "E.H. Ahlstrom notes." These files contain original lecture notes for classes conducted on ichthyoplankton taxonomy between 1971 and 1977, early-life-history data for most orders of fishes, and notes on teleost caudal fins. The files were made available to Kendall & Matarese by H. Geoffrey Moser (Southwest Fish. Cent., Natl. Mar. Fish. Serv., NOAA), as authors contributing to *Ontogeny and Systematics of Fishes* (Moser et al. 1984b).

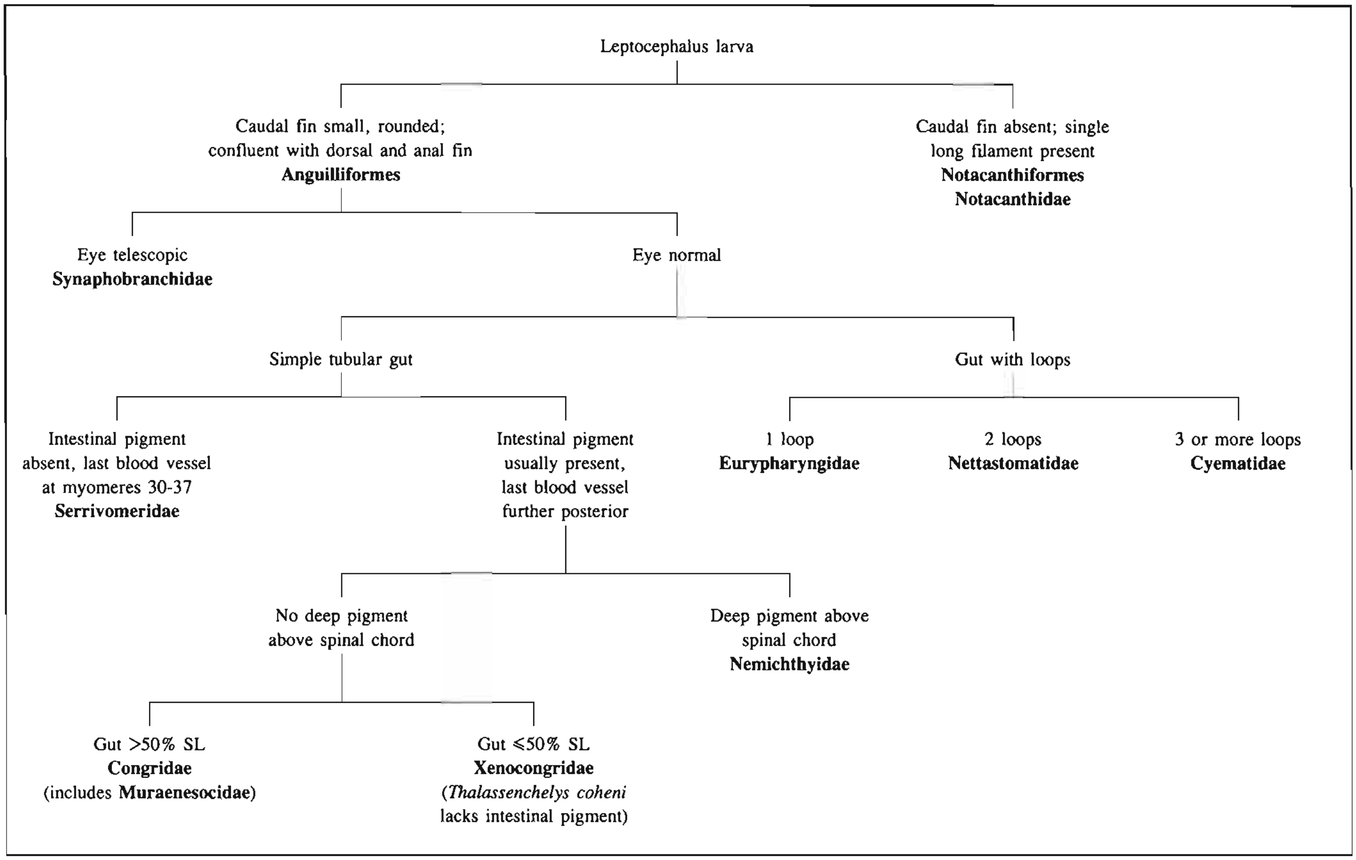


Elopomorpha: Notacanthiformes
Anguilliformes

The notacanthiform fishes (spiny eels) and anguilliform fishes (true eels) generally occur worldwide. The spiny eels are primarily a deep-sea group and are distinguished from the true eels by a number of characters including the absence or reduction of the caudal fin, the presence of well developed pelvic fins and fin spines, a short dorsal fin, and the presence in larvae of a thin postcaudal filament. According to Castle (1984), the Notacanthiformes consist of 3 families, 6 genera, and about 22 species; the Anguilliformes, a much larger order, include 21 families, 153 genera, and about 720 species.

The early life history of eels has been studied for many years primarily due to the presence of a distinctive leptocephalus larval phase, but many species remain inadequately known. Eggs are generally large, pelagic, possess segmented yolks, and have one or more oil globules. Although few larvae have been collected, at least 12 taxa from at least 9 families are thought to occur in the study area. Since early life histories are incomplete, this section (except for the nemichthyids) will be described by family.

Families in study area: **Notacanthidae**
Xenocongridae
Nemichthyidae
Cyematidae
Synaphobranchidae
Nettastomatidae
Congridae
Serrivomeridae



Key to elopomorph leptocephali in the Northeast Pacific (after Smith 1979 and Fahay 1983, in part).

Table 5
Meristic characters of superorder Elopomorpha.

Taxon	Distribution	Vertebrae: Precaudal Caudal (Total)	Fins: Dorsal	Anal	Pectoral	Pelvic	Caudal
Notacanthiformes							
Notacanthidae		(234-244)					
Notacanthus chemnitzi	Cent. Calif.[a]-Oregon	47-55	VII-X or	XI-XXV,	10-17	I-IV,	Absent
		(234-239)	IX,2-3	115-132		6-10	
Polyacanthonotus challengeri	Oregon-Bering Sea	(242-244)	XXXII-XXXV	161-162	12-13	I, 8	Reduced
Anguilliformes							
Xenocongridae		(97-163)					
Thalassenchelys coheni		67-74 83-92	280-350	218-260	Absent	Absent	Absent
		(142-163)					
Nemichthyidae		(170-400+)					
Avocettina infans	SSC-Aleutian Is.	(181-201)	300-350	265-270		Absent	Reduced
Nemichthys larseni	SSC-Oregon	79-84			10-12	Absent	
		(400-750)					
Nemichthys scolopaceus	SSC-Aleutian Is.	(293-750)	307-450	312-454	10-14	Absent	Reduced
Cyematidae		(74-108)					
Cyema atrum	SSC-Oregon	38-43	79-83	72-86	12-15	Absent	5
		(74- 80)					
Synaphobranchidae		(126-172)					
Histiobranchus bathybius	Bering Sea	(126-151)	265-302	188-203	15-17	Absent	18
Nettastomatidae		(186-290)					
Venefica sp. A	Cent. Calif.-Wash.	(199-224)	310+	325		Absent	12
Congridae		(120-261)					
Xenomystax atrarius	SSC-Brit. Col.	50-57 107-123	253-292	189-214	11-14	Absent	7-8
		(141-219)					
Serrivomeridae		(137-170)					
Serrivomer jesperseni	Brit. Col.	89-125	141-161	127-161	6-7	Absent	Reduced
		(147-169)					(6 principal)
Eurypharyngidae		(97-125)					
Eurypharynx pelecanoides	N. Calif.[b]	(97-125)	155-196	118-147	11	Absent	Absent in adult

[a]Lea and Rosenblatt (1987)
[b]One specimen collected off northern California.

Anguilliformes

Primary characters used in identifying anguilliform leptocephali are the following (Ref: E.H. Ahlstrom notes, Castle 1984, Fahay 1983, Smith 1979):

Body shape May vary from slender to deep-bodied, and the tail may be tapered or rounded.

Head characteristics Size of the head relative to the body may vary; also important are head shape (blunt, sharp, or elongate), snout shape, nasal organ (size and position), eyes (round, narrow, or telescopic), and teeth (presence/absence, fanglike if present).

Number of myomeres Usually 100-250; exceptions include *Cyema* (<100) and *Nemichthys* (>750). Preanal and predorsal counts are also useful.

Gut characteristics Gut may be a simple straight tube or more complex with loops or swellings. Relative length of gut can range from <50% SL to >90% SL, although most eels have gut lengths between 50-70% SL.

Position of vertical blood vessels Variation in the position of the last blood vessel.

Pigmentation General body pigment may be located above/below the gut, along body midline, above/below notochord internally, or along the dorsal body margin. Pigment may be in the form of fine stippling or large stellate melanophores (blotches). Head pigment also varies.

Size at transformation Maximum size before transformation can vary from <100 mm SL (most families) to ~400 mm SL (nemichthyids).

Fins Dorsal and anal fins are confluent with the caudal fin, caudal fin is usually markedly reduced with 10 or fewer rays (about 5-11 with highest numbers in synaphobranchids); pectoral fin is moderate, reduced, or lacking, and fin rays usually form late, i.e., after the leptocephalus stage. Pelvic fin is absent.

Notacanthidae (234-244 myomeres)* *Notacanthus chemnitzi* and *Polyacanthonotus challengeri* both occur in the study area but their early life histories are unknown, as is the case of most notacanthids. *Leptocephalus giganteus* (identity unknown) from outside the study area is presented for comparison only. Notacanthid larvae are easily separable from larvae of true eels. Among the most notable characters are the following: Greatly elongate shape, thin postcaudal filament, and pigment which occurs in a ventral series.

Xenocongridae (97-163 myomeres) *Thalassenchelys coheni* (142-163) may or may not belong with the xenocongrids. These larvae are quite unusual, with a short, deep body, rounded tail, and lack of pigment. They appear to be widely distributed in the northeastern Pacific from Washington to south of southern California.

Cyematidae (74-80 myomeres, most 74-78) *Cyema atrum* larvae are identified by their deep body shape, pointed head and tail, 3-4 gut loops on posterior half of gut, and low myomere count. Pigment is scattered over the lateral body surface, on the snout and lower jaw, and along the gut, especially on the loops. Other general features include gut length ~67% SL and dorsal fin origin approximately above anus. Size at transformation is 60-70 mm SL.

Synaphobranchidae (subfamily Synaphobranchinae) (126-151 myomeres) Synaphobranchinae are represented in the Northeast Pacific by *Histiobranchus bathybius* but their larvae are unknown. Larvae in other members of the subfamily are identified by their telescopic eye, general lack of pigment, and the broad white stripe formed by an opaque central area of myomeres around the notochord. The body is moderately elongate and the head is short and pointed. The dorsal fin origin is anterior to the anus. The gut is usually relatively simple, unpigmented, and about 75% SL. Some taxa have loops in the gut. Ventral pigment is lacking, and lateral pigment is restricted to the postanal body. Some genera have a prominent pigment spot laterally, near the level of the anus. Size at transformation is 130-170 mm SL.

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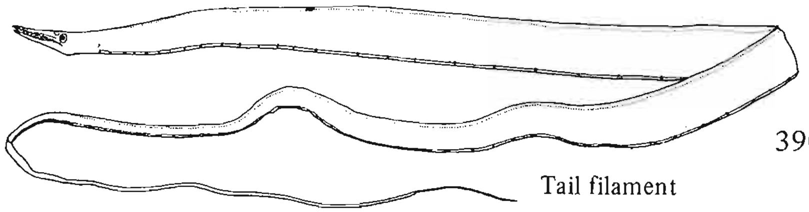
*Vertebral range is given for taxa in the study area. When no data are available, the range of counts for family is given (Table 5).

Ref: E.H. Ahlstrom notes, Castle 1984, Castle and Raju 1975, Fahay 1983.

A

NOTACANTHIDAE

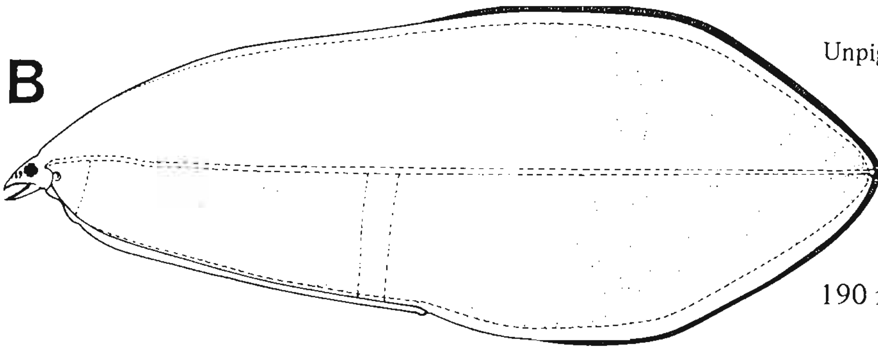
Leptocephalus giganteus



B

XENOCONGRIDAE

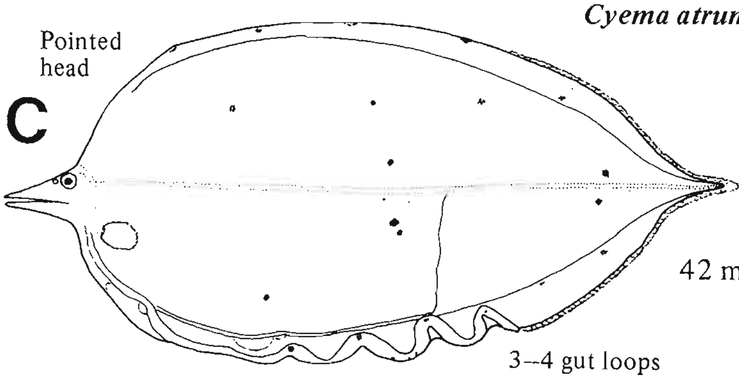
Thalassenchelys coheni



C

CYEMATIDAE

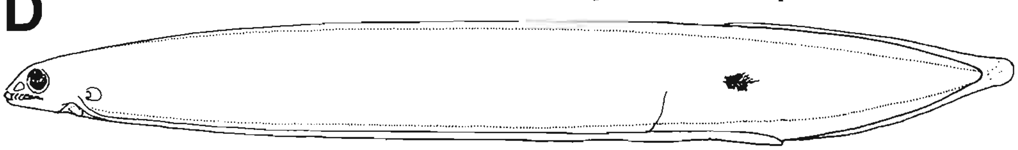
Cyema atrum



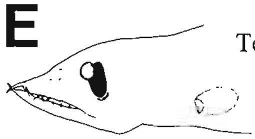
D

SYNAPHOBRANCHIDAE

Synaphobranchus sp.



E



Unidentified synaphobranchid

Figures A, D, Castle 1984; B, NWAFC original (B. Vinter); C, E, Smith 1984.

Nettastomatidae (186-290 myomeres) Nettastomatids are represented in the Northeast Pacific by *Venefica* sp., but their larvae are unknown. Larvae in the family are identified by their gut characteristics (presence of two loops and gut length <50% SL) and moderately long head. The body is deep to elongate and the tail is pointed. The dorsal fin origin is posterior to the head but well anterior, at myomeres 11-12. Ventral and lateral pigment is variable. Size at transformation is also variable but occurs between 120 and 200 mm SL.

Congridae (141-219 myomeres) Congrids are represented in the area by *Xenomystax atrarius*, a member of the subfamily Muraenesocinae (larvae unknown). *Xenomystax* is closely related to *Paraxenomystax* (Smith 1979). Members of this subfamily are sometimes considered part of a separate family. Their larvae have a moderately elongate body with the gut length about 75% SL. Pigment occurs on the head, widely spaced along the throat to anus, and below the lateral midline in the form of a row of large spots. Size at transformation is probably similar to the congrids with most at 100 mm SL but some up to 200-300 mm SL.

Serrivomeridae (147-169 myomeres) *Serrivomer jesperseni* larvae are identified by a head shape that is sharp and slightly concave, pointed tail, simple gut with a length of ~75% SL, and a small nasal organ near the eye. The dorsal fin origin is located anterior to the anus. The last blood vessel occurs between myomeres 30-37. Pigment may be located variously over the lateral body surface, but ventral pigment is lacking. Other pigment appears along the dorsal and anal fin bases and in a cluster on the orbit above the eye. Size at transformation is 60 mm SL.

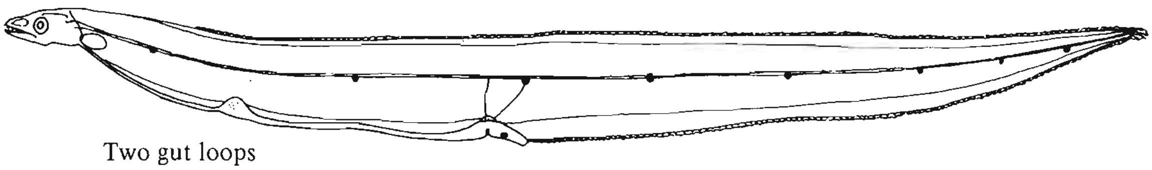
Eurypharyngidae (97-125 myomeres) *Eurypharynx* larvae are identified by their short, deep head and body, gut about 50-67% SL with one loop posteriorly, and pointed tail. Ventral pigment is limited to the gut loop. Size at transformation is 30-40 mm SL.

Ref: E.H. Ahlstrom notes, Castle 1984, Fahay 1983, Smith 1979.

NETTASTOMATIDAE

Saurenchelys sp.

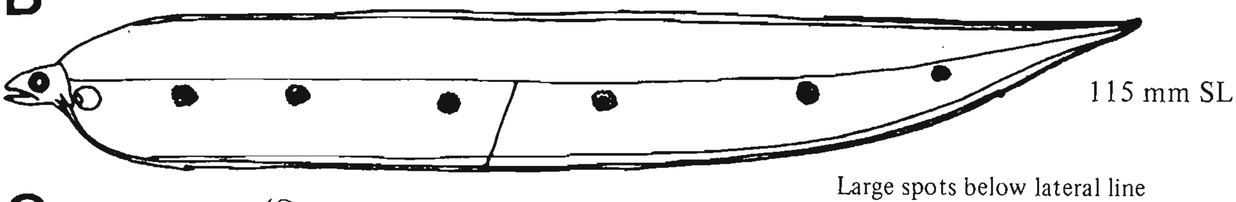
A



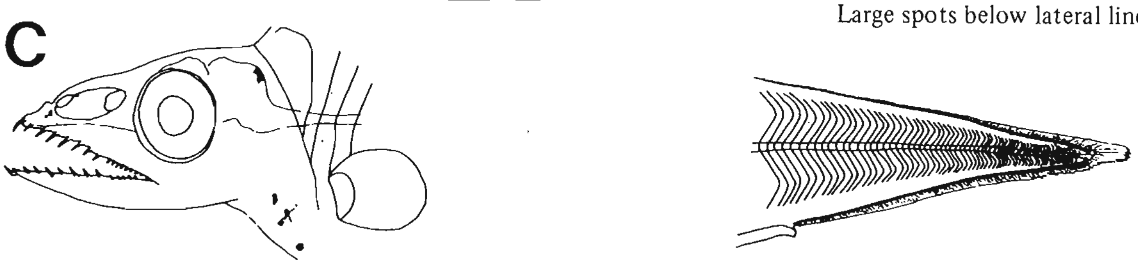
CONGRIDAE

Paraxenomystax sp.

B



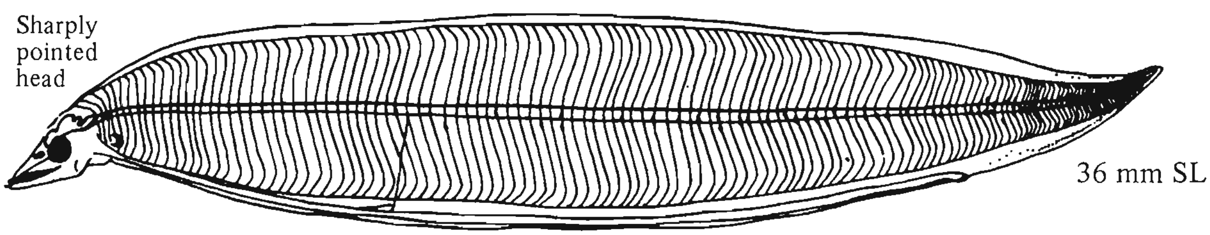
C



SERRIVOMERIDAE

Serrivomer jesperseni

D



EURYPHARYNGIDAE

Eurypharynx pelecanoides

E

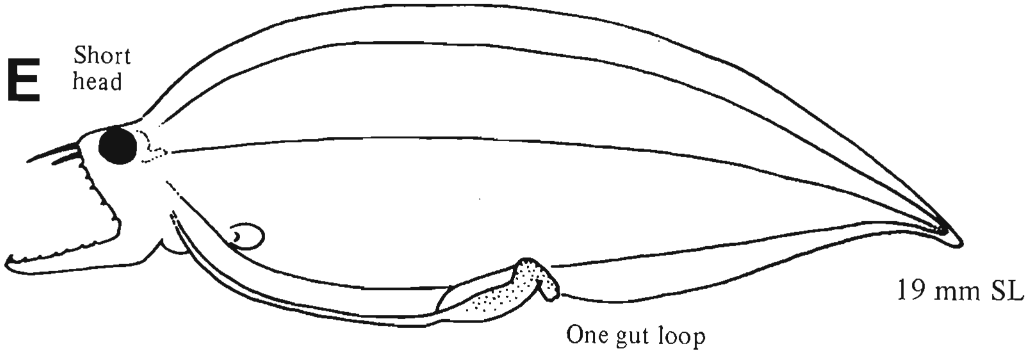


Figure A, Smith 1984; B–C, Smith 1979; D, Bauchot 1959; E, Fahay 1983 (after Smith 1979).

MERISTICS

Vertebrae	Total: 181-193-201
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	X-X-X
Caudal fin	Reduced
Pelvic fin	Absent
Dorsal fin	R: 279-339-432
	D100: 130-164-210[a]
Pectoral fin	R: 14-16-18
Anal fin	R: 240-299-372
	A100: 103-138-176[a]
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to Aleutian Is., 51-55°N
Ecology	Meso- and bathypelagic, 510-4580 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

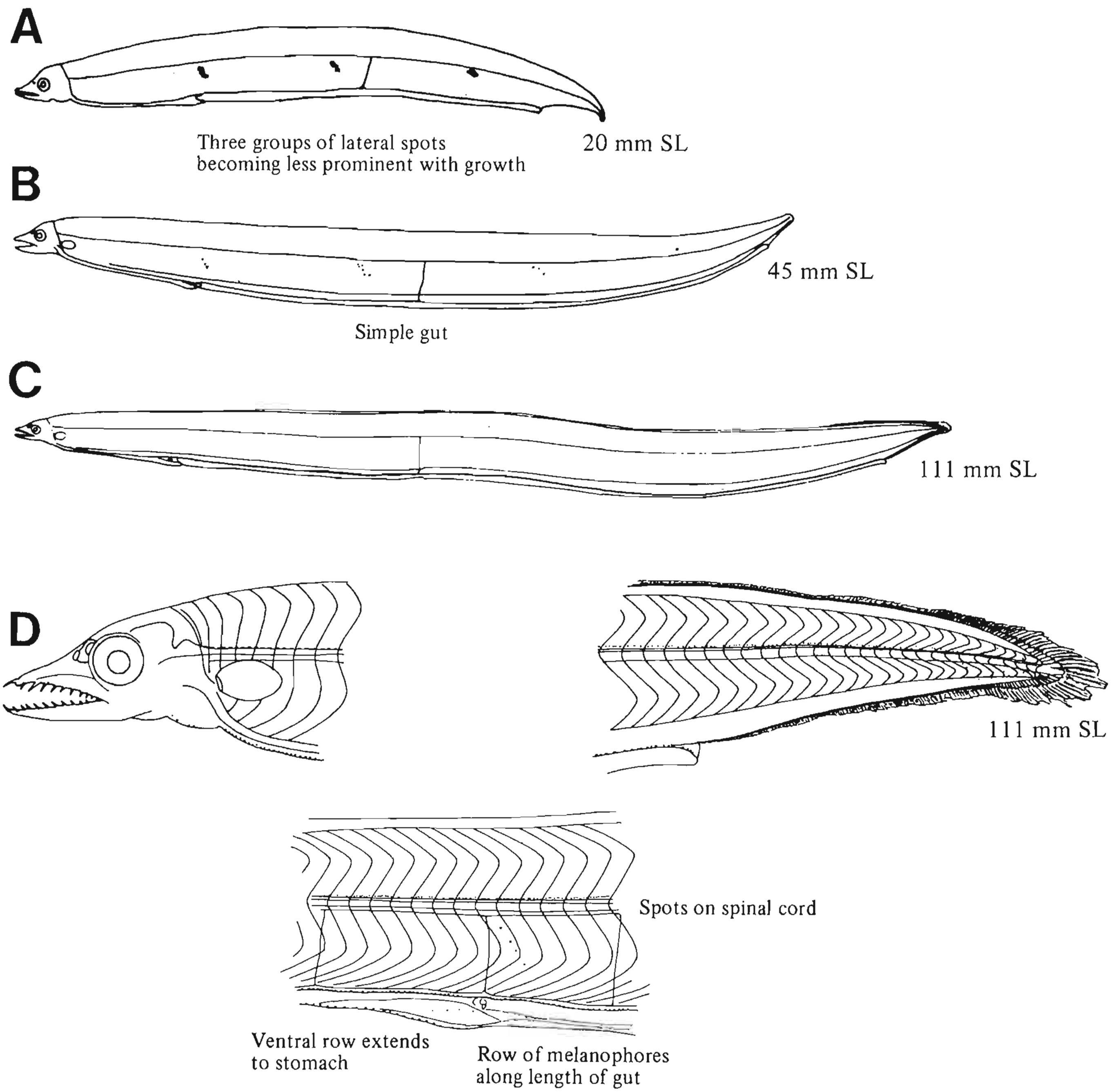
Preanal length
Length at flexion
Length at transformation
Sequence of fin development Dorsal and anal (late)
Pigment
- Small spots on top of spinal cord, at least posteriorly
- Row of spots dorsally along gut length, ventral row anterior to stomach
- Several groups (usually three) of internal spots along body subaxially—about four spots in each group[b]
- Dorsal and anal fin bases

Diagnostic characters
Distinguished from *Nemichthys* spp. by
- Body less elongate
- Caudal structure (tail more round, not filiform)
- Position of liver and last blood vessel, 30th and 70-88th myomere, respectively
- Number of myomeres (181-201)

[a]The total dorsal and anal fin ray counts and the number of lateral line pores and vertebrae are often of no value; they are not comparable because caudal parts are often missing and regeneration may have occurred. Nielsen and Smith (1978) introduced artificial lengths/counts with a greater comparative value which we employ here (see their Materials and Methods section for a complete discussion), e.g., D200, A200 = number of fin rays anterior to vertebrae no. 201.

[b]According to Smith (1979), there are three blotches of internal lateral pigment spots which become less prominent with growth.

Ref: Castle 1984, Nielsen and Smith 1978, Smith 1979.



Figures A–D, Smith 1979.

MERISTICS

Vertebrae	Total: 300-300-300 Precaudal: 77-85-105 Caudal: X-X-X
Branchiostegal rays	7-X-15
Caudal fin	Reduced
Pelvic fin	Absent
Dorsal fin	R: 330-330-330 D200: 170-207-253[a]
Pectoral fin	R: 10-11-14
Anal fin	R: 320-320-320 A200:186-218-273[a]
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Epi-, meso-, and bathypelagic, 91-1829 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length	
Length at flexion	
Length at transformation	~200 mm SL
Sequence of fin development	Dorsal and anal (late)

Pigment
- Three prominent spots laterally below midline in small larvae (lower on body than on *Avocettina infans*)
- Above gut along length
- Above spinal cord

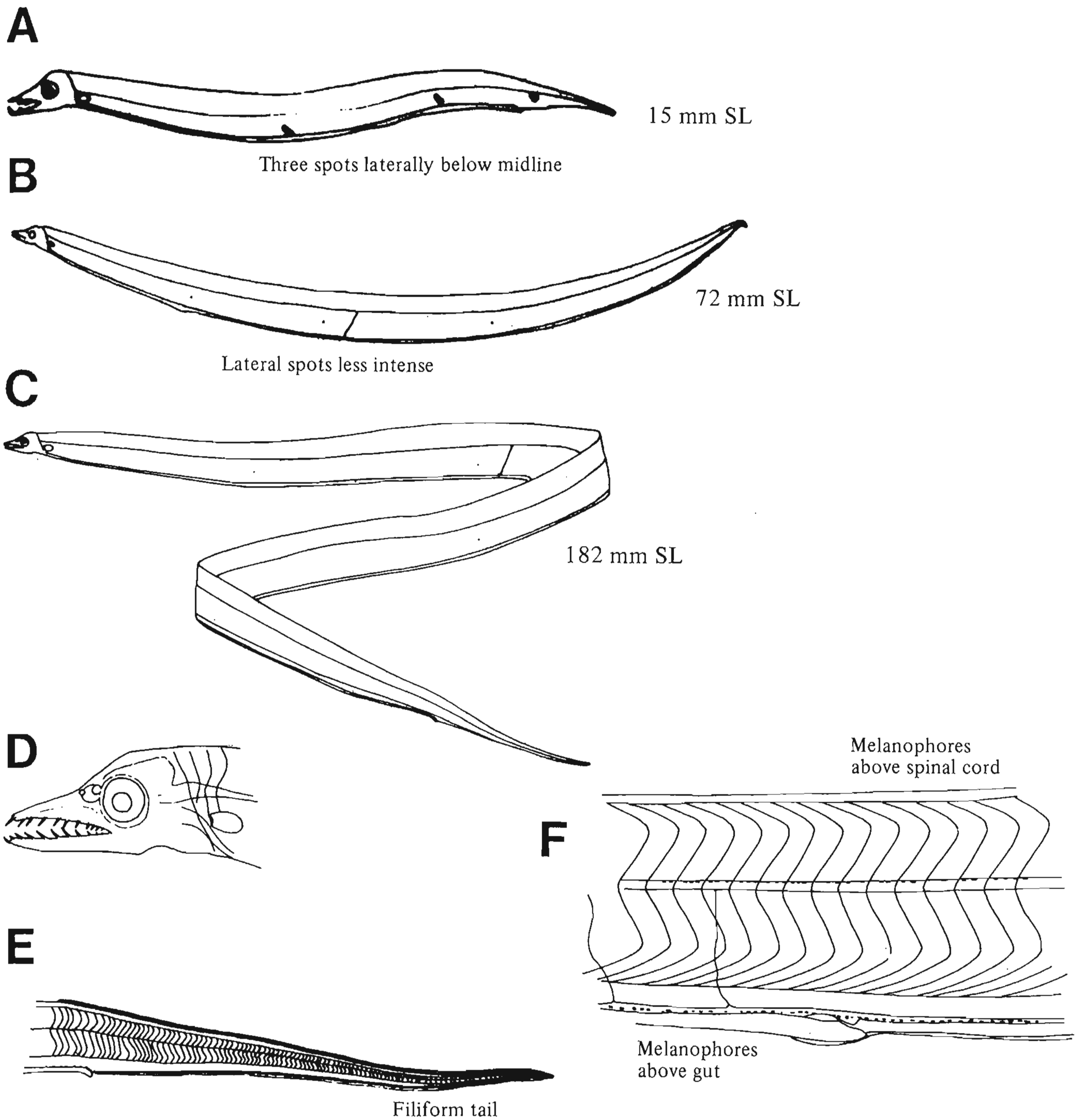
Diagnostic characters
- Elongate with filiform tail
- Number of myomeres (>300)

Distinguished from *A. infans* by
- Position of liver (myomere 40) and last vertical blood vessel (80-100th myomere)

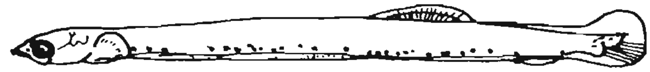
Nemichthys larseni larvae are not known but adults occur within the study area. See Table 5 for data on adults. Additional meristic characters from Nielsen and Smith (1978) are: D200, 173-205-222; A200, 164-200-208. See *A. infans* (p. 38, footnote a).

[a] See *Avocettina infans*.

Ref: Castle 1965, 1984; Nielsen and Smith 1978.



Figures A–F, Smith 1979.



Clupeiformes

The Clupeiformes (herrings, anchovies) are generally small, coastal marine fishes that occur worldwide. Most species form schools and swim near the surface in nearshore waters, feeding on plankton. They have specialized gill rakers for straining large amounts of water. The order consists of 4 families, 78 genera, and about 317 species (McGowan and Berry 1984). Clupeids generally lay demersal eggs whereas engraulidids have pelagic eggs that are sometimes ellipsoidal in shape. Larvae are elongate and similar in appearance but may be distinguished by myomere counts and pigmentation characters.

Families in study area: **Clupeidae**
Engraulididae

MERISTICS

Vertebrae	Total: 46-52-57[a]	
	Precaudal: 29-31-32	
	Caudal: 19-22-22	
Branchiostegal rays	8-X-9	
Caudal fin	9, 10+9, 8-9	
Pelvic fin	Abdominal	
	R: 9-9-9	
Dorsal fin	R: 15-18-21	
Pectoral fin	R: 17-17-17	
Anal fin	R: 13-16-20	
Gill rakers	U: 20-20-20	L: 45-45-45[a]

LIFE HISTORY

Range	South of southern California to Arctic, not specific
Ecology	Nearshore shelf pelagic, 0-137 m;[b] 475 m[c]
ELH pattern	Oviparous; demersal, adhesive attached eggs; pelagic larvae
Spawning	Season: Jan-Apr (California), Mar-June (Alaska)[d]
	Area: Demersal (usually on vegetation), nearshore[e]
	Mode: Schools[e]
	Migration: Inshore[e]
Fecundity	Range/function: 6300-41,000/ $F=0.000000436 \times L^{4.71}$, L=SL mm[f]
Age at first maturity	2-4 yr (Puget Sound)[f]
	2-6 yr (Bering Sea)[g]
Longevity	>19 yr[h]

[a] McGowan and Berry (1984) report total vertebral counts of 53-60 and lower gill raker counts of 37-52.
[b] Alaska Department of Fish and Game 1985
[c] Allen and Smith 1988
[d] Scattergood et al. 1959
[e] Schaefer 1937
[f] Katz 1942
[g] Rudomilov 1972
[h] Fitch and Lavenberg 1975

Ref: Garrison and Miller 1982, Grant 1986, McGowan and Berry 1984.

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.3-1.7 mm
No. of oil globules	None
Oil globule diameter	
Yolk	Segmented
Envelope	Smooth, clear, thick
Hatch size	5.6-7.5 mm SL (7 mm); yolk absorbed 9-10 mm SL
Incubation time/temp.	14-15 d/8.5°C
Pigment	

Diagnostic characters
- Wide perivitelline space

LARVAE

Preanal length	72% SL
Length at flexion	18 mm SL
Length at transformation	26-35 mm SL
Sequence of fin development	Caudal, dorsal, anal, pelvics, pectorals

Pigment
- Isthmus, thoracic region
- Gut: Dorsal, midventral (midventral melanophores on intestine usually paired, sometimes slightly offset)
- Caudal, hypural

Diagnostic characters (see Table 4)

Distinguished from *Engraulis mordax* (p. 48) by
- More myomeres (usually >50)
- Longer gut (consistently >70% SL)
- Placement of dorsal fin relative to anus (6-7 myomeres between dorsal and anal fins)
- Less isthmus pigment
- Prominent swimbladder in *E. mordax*
- Dorsal spots at notochord tip usually not in *E. mordax*
- Generally more pigmented

Distinguished from *Sardinops sagax* by
- Presence of posteroventral pigment on gut
- Dorsal spots at notochord tip usually not in *S. sagax*

See also *Mallotus villosus* (p. 80) and *Ammodytes hexapterus* (p. 540)

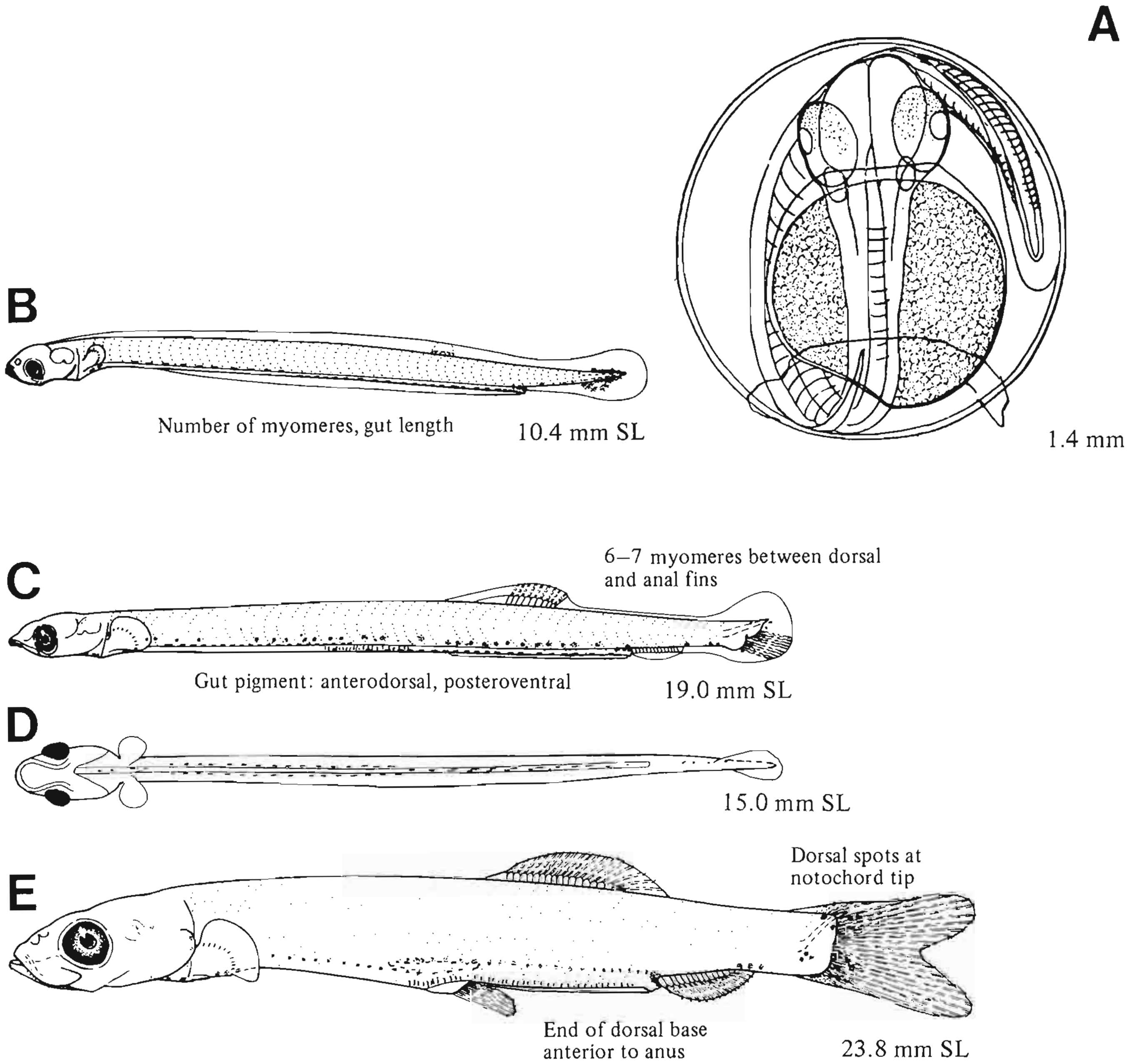


Figure A, Uchida et al. 1958; B–E (D, ventral view), NWAFC originals (B. Vinter).

MERISTICS[a]

Vertebrae	Total: 48-X-54 Precaudal: 28-29-30 Caudal: 22-22-23
Branchiostegal rays	6-X-10
Caudal fin	7-9, 10+9, 6-8
Pelvic fin	Abdominal R: 8-8-8
Dorsal fin	R: 17-X-20
Pectoral fin	R: 17-17-17
Anal fin	R: 17-X-20
Gill rakers	U: 21-X-23 L:44-X-45

LIFE HISTORY

Range	South of southern California to SE Alaska, 55-59°N
Ecology	Nearshore shelf pelagic, 0-80 m[b]
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Winter-summer[c] Area: Near surface in coastal and offshore waters[b] Mode: Pelagic, schools Migration:
Fecundity	Range/function: 30,000-65,000[c]
Age at first maturity	1-2 yr[b]
Longevity	10 yr[b], possibly 25 yr[d]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.34-2.05 mm
No. of oil globules	One
Oil globule diameter	0.16 mm
Yolk	Irregularly segmented
Envelope	Smooth, thin
Hatch size	3.5-3.75 mm SL
Incubation time/temp.	2.5 d/17°C; 2.5-4 d/ 13-16°C[e]
Pigment	

Diagnostic characters
- Wide perivitelline space

LARVAE

Preanal length	>75% SL
Length at flexion	9.0-14.0 mm SL
Length at transformation	35 mm SL
Sequence of fin development	Caudal, dorsal, anal, pelvics, pectorals

Pigment
- Row of melanophores along dorsal surface of gut and along ventral midline
- Melanophores over anterior gut appear dash-like, and those over posterior gut become larger and more intense with development

Diagnostic characters (see Table 4)
- See *Clupea pallasi* (p. 44)
- Dash-like melanophores along anterior surface of gut

Distinguished from *C. pallasi* by
- Lack of posteroventral pigment on gut

Distinguished from *Engraulis mordax* (p. 48) by
- Dorsal and anal fin placement (6-8 myomeres between fins)

[a] Meristics include information from McGowan and Berry 1984.
[b] Frey 1971
[c] Hart 1973
[d] Fitch and Lavenberg 1971
[e] Garrison and Miller 1982

Ref: McGowan and Berry 1984.

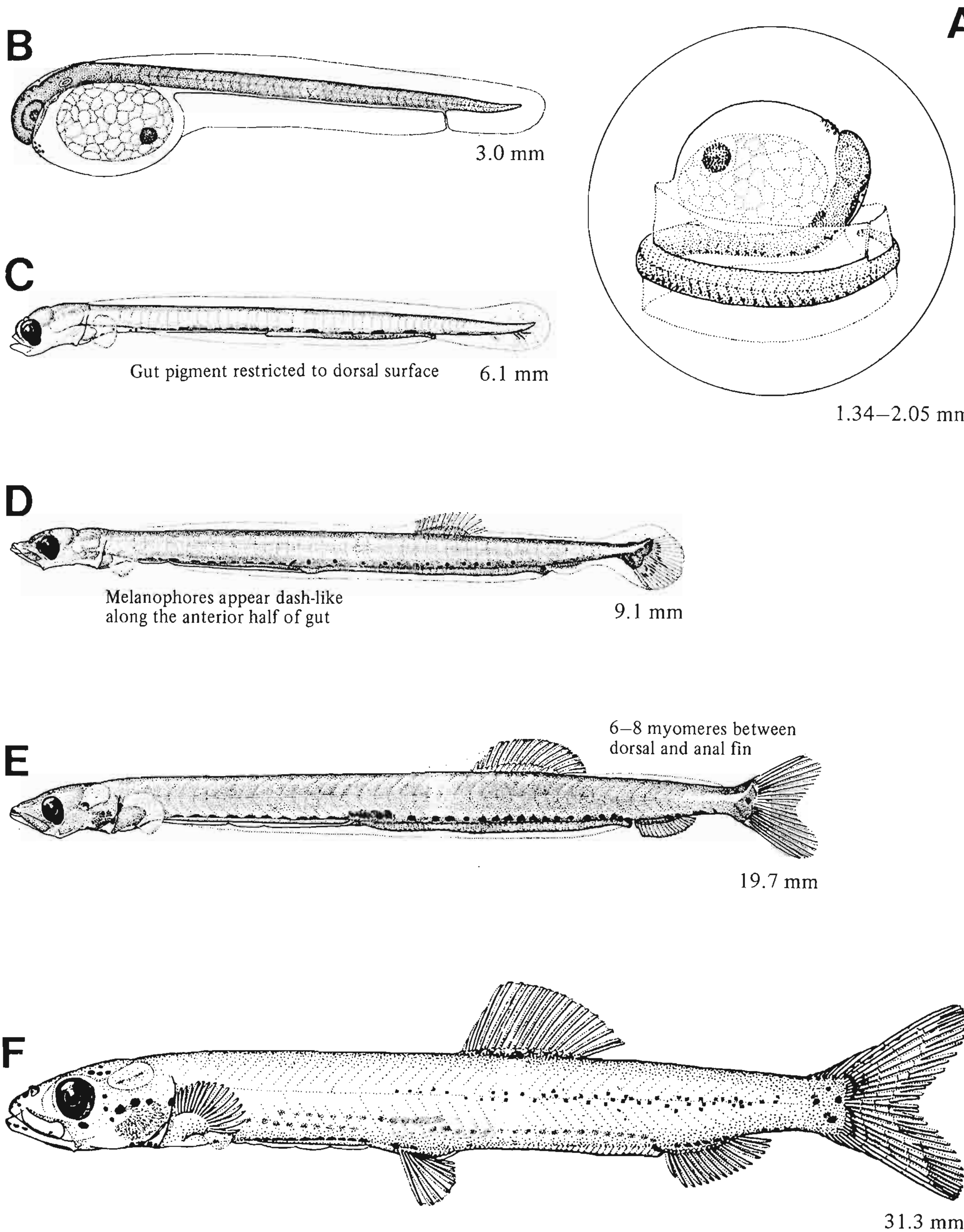


Figure A, Matarese and Sandknop 1984; B–F, Kramer 1970. Stippling in these figures is not pigment.

MERISTICS

Vertebrae	Total: 43-46-47 Precaudal: 24-25-26 Caudal: 19-20-21
Branchiostegal rays	14-14-14
Caudal fin	8-10, 10+9, 8-10
Pelvic fin	Abdominal R: 6-6-6
Dorsal fin	R: 14-X-19
Pectoral fin	R: 13-X-20
Anal fin	R: 19-X-26
Gill rakers	U: 28-X-41 L: 37-X-45

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Epi- and mesopelagic, 0-300 m[a]
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: May[b] to mid-Aug[c]; year-round (California)[d] Area: Pelagic Mode: Migration:
Fecundity	Range/function: 4025[e]-30,000[f]
Age at first maturity	1-2 yr[g]
Longevity	7 yr[h]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.23-1.55 mm × 0.6-0.8 mm
No. of oil globules	None
Oil globule diameter	
Yolk	Segmented
Envelope	Smooth, transparent
Hatch size	2.5-3.0 mm SL; yolk absorbed 3.5-4.0 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters
- Ovoid
- Narrow perivitelline space

LARVAE

Preanal length	60-66% increasing to 75% SL, decreases in postflexion larvae
Length at flexion	
Length at transformation	
Sequence of fin development	Caudal, dorsal, anal, pelvics, pectorals

Pigment
- Isthmus
- Row of melanophores along dorsal surface of gut continuing along ventral body midline
- Ventral pigment on gut beginning about midway

Diagnostic characters (see Table 4)
- See *Clupea pallasi* (p. 44)
- Isthmus pigment present
- Dorsal and anal fin placement (0-2 myomeres between fins)
- Midventral melanophores on intestine usually staggered, not single as in osmerids, and usually not as evenly paired as in *C. pallasi*

[a] Pacific Fisheries Management Council 1978
[b] Kendall and Clark 1982
[c] Blackburn 1973
[d] Lasker and Smith 1977
[e] Frey 1971
[f] Baxter 1967
[g] Clark and Phillips 1952
[h] Hart 1973

Ref: McGowan and Berry 1984, Wang 1981.

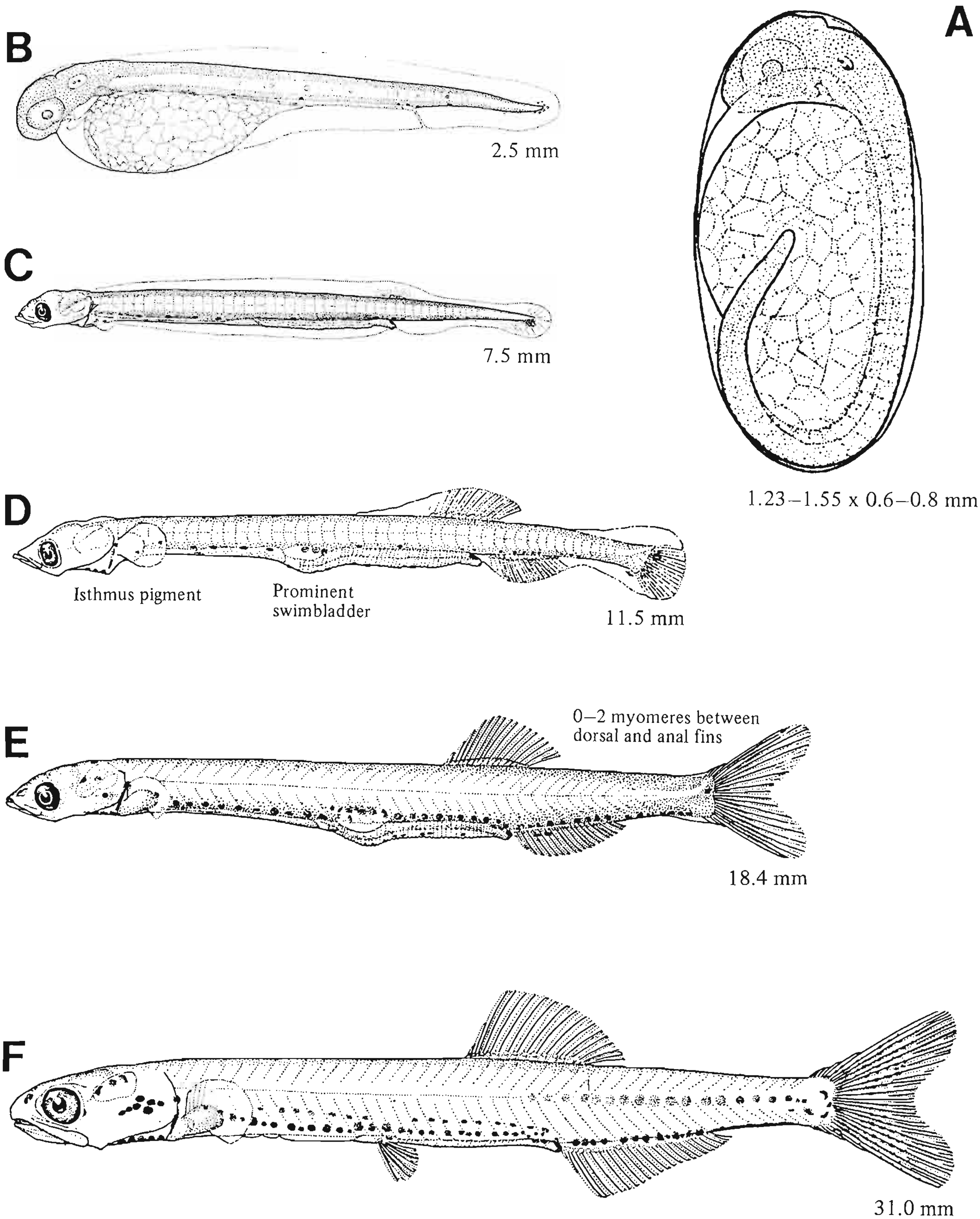
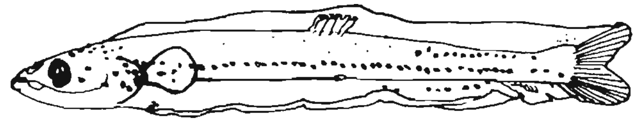
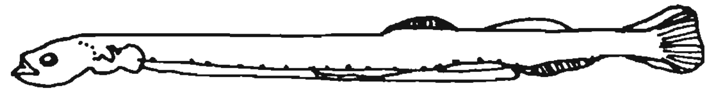


Figure A, Bolin 1936; B–F, Kramer and Ahlstrom 1968. Stippling in these figures is not pigment.





Salmoniformes

The salmoniform fishes (salmons, smelts, deep sea smelts, and others) are primarily freshwater spawners except for members of the Argentinoidei, the largest taxon of salmoniforms with marine eggs and larvae in our area. There is much disagreement as to the composition of the order (see Fink 1984). In our area, it consists of 4 suborders, 15 families, 90 genera, and about 320 species (J. Nelson 1984). The argentinoids are mostly deep-sea fishes. Eggs are pelagic and have distinctive pustules on the inner surface of the egg membranes; larvae have a variety of forms. Larval characters include presence/absence of eyestalks, unique development of median fins, and distinctive pigment patterns. Pigment patterns for bathylagids are discussed according to the categories described by Ahlstrom et al. (1984b)—species with large, isolated melanophores and those with a linear series of small melanophores.

A summary of meristic characters is included for Alepocephalidae and Platytroctidae. Although salmon parr are occasionally collected in plankton tows, they are not treated here. Information on their early life history is reviewed in Kendall and Behnke (1984).

Families in study area: **Argentinidae**
Bathylagidae
Opisthoproctidae
Alepocephalidae
Platytroctidae
Osmeridae
Salmonidae

MERISTICS

Vertebrae	Total: 47-X-51 Precaudal: 30-31-32 Caudal: 16-18-18
Branchiostegal rays	5-5-5
Caudal fin	12, 10+9, 11
Pelvic fin	Abdominal R: 10-11-12
Dorsal fin	R: 10-X-13
Pectoral fin	R: 11-X-18
Anal fin	R: 12-X-15
Gill rakers	U: 7-8-9 L:14-17-20

LIFE HISTORY

Range	South of southern California to Oregon, 42-46°N
Ecology	Epi- and mesopelagic, 11-274 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Jan-spring[a] Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	>5 yr[a]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.31-1.66 mm
No. of oil globules	One, at vegetal pole
Oil globule diameter	0.27-0.46 mm
Yolk	Segmented
Envelope	Pustules (pronounced raised bumps on inner surface)
Hatch size	
Incubation time/temp.	
Pigment	

Diagnostic characters
- Pustules more pronounced than in bathylagid eggs

LARVAE

Preanal length	76-84% SL
Length at flexion	>9 mm SL
Length at transformation	25-30 mm SL (prolonged)[b]
Sequence of fin development	Caudal, dorsal and anal, pectorals, pelvics

Pigment
- Internal head pigment
- Series of ventral trunk blotches extending from pectoral fin to end of gut
- 1-2 large blotches postanal with a large caudal blotch
- Blotches expand with development (see figure)

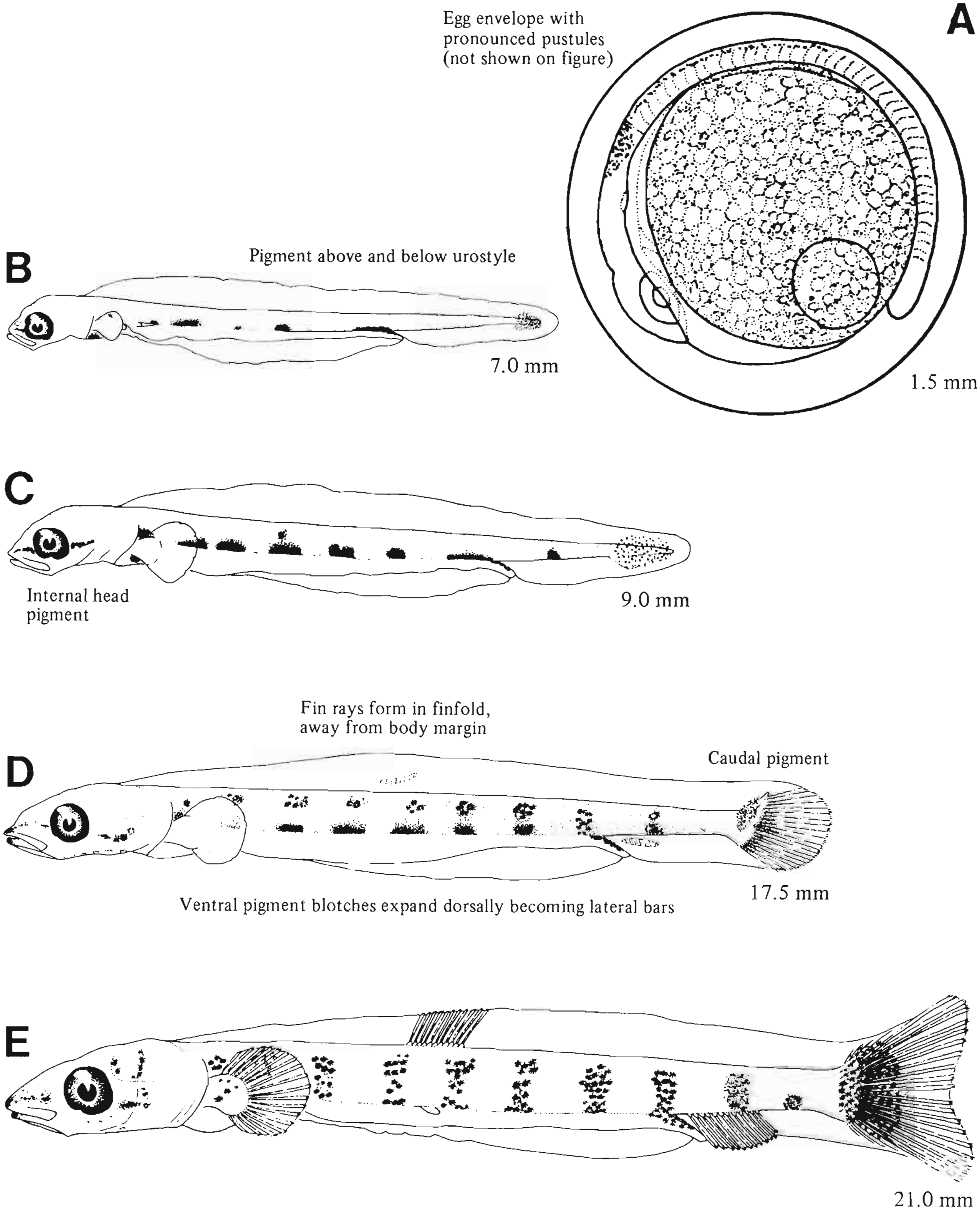
Diagnostic characters
- Transverse rugae lining gut
- Fin rays form in finfold, away from body margin

Distinguished from *Nansenia candida* by
- Presence of internal head pigment
- Caudal pigment on preflexion larvae
- Fewer spots over gut

[a] Fitch and Lavenberg 1968

[b] Transformation: Morphological changes (deepening of body, lengthening of snout, enlargement of eye) and folding of anterior gut to form stomach, along with masking of larval pigment, occur at 25-30 mm. Pelagic juveniles may occur at 50-100 mm.

Ref: Ahlstrom et al. 1984b.



Figures A–E, Ahlstrom et al. 1984b.

MERISTICS

Vertebrae	Total: 44-X-47	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	3-3-3	
Caudal fin	11, 10+9, 14	
Pelvic fin	Abdominal	
	R: 9-10-10	
Dorsal fin	R: 9-X-10[b]	
Pectoral fin	R: 9-X-11[b]	
Anal fin	R: 8-X-9	
Gill rakers	U: 12-12-12	L: 18-18-18

LIFE HISTORY

Range	South of southern California to Gulf of Alaska, 54-60°N
Ecology	Epi- and mesopelagic, 200-1000 m[c]
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.39-1.56 mm
No. of oil globules	One, at vegetal pole
Oil globule diameter	0.41-0.49 mm
Yolk	
Envelope	Pustules
Hatch size	
Incubation time/temp.	
Pigment	

Diagnostic characters
- Pustules

LARVAE

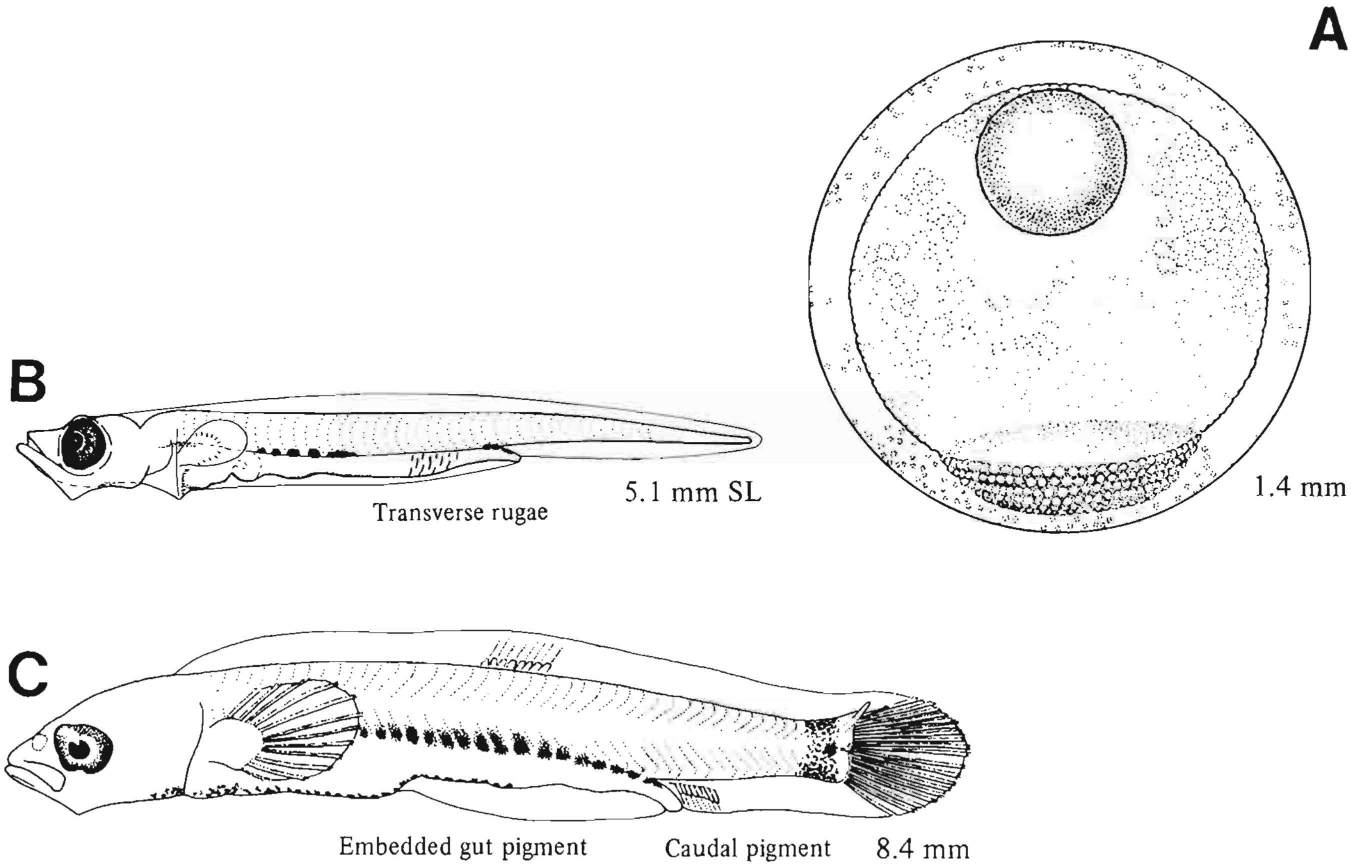
Preanal length	74-82% SL
Length at flexion	
Length at transformation	~15 mm SL
Sequence of fin development	Caudal, dorsal, anal, pectorals, pelvics

Pigment
- Embedded pigment above gut
- Superficial head pigment (>8.4 mm SL)
- With development, embedded line of melanophores running length of body
- Conspicuous caudal pigment
- Ventral pigment from isthmus along anterior 2/3 of gut

Diagnostic characters
- Transverse rugae lining gut only in posterior section, anteriorly an elongate s-shaped fold is present along with longitudinal rugae
- Fin rays form in finfold, away from body margin

[a] Referred to by Ahlstrom as northern *Nansenia* (E.H. Ahlstrom notes).
[b] Ahlstrom et al. 1984b
[c] Cohen 1958

Ref: Ahlstrom et al. 1984b.



Figures A, C, Ahlstrom et al. 1984b; B, NWAFC original (B. Vinter).

MERISTICS

Vertebrae	Total: 48-X-53 Precaudal: X-X-X Caudal: X-X-X
Branchiostegal rays	2-2-2
Caudal fin	X, 10+9, X
Pelvic fin	Abdominal R: 9-X-10[a]
Dorsal fin	R: 10-10-11
Pectoral fin	R: 10-10-12
Anal fin	R: 18-X-22[a]
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	Cent. California, 34-38°N, to Oregon, 42-46°N
Ecology	Mesopelagic, 200-1000 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length	84-89% SL
Length at flexion	
Length at transformation[b]	
Sequence of fin development	Caudal, dorsal, anal, pectorals, pelvics

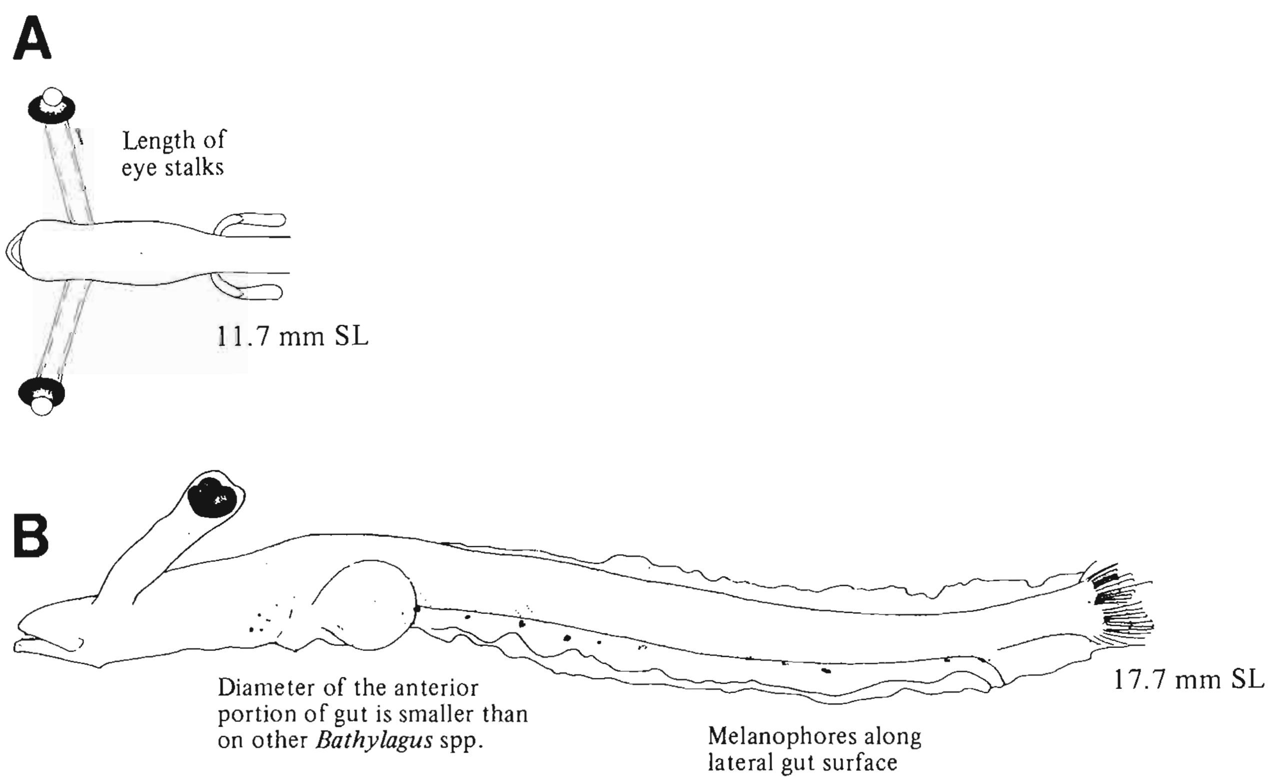
Pigment - Linear series of small melanophores
- Series of melanophores (up to 18) along lateral gut
- With development to late postflexion, additional pigment appears on lower jaw, isthmus, opercle, pectoral fin base, and lateral caudal peduncle

Diagnostic characters
- Anterior section of gut smaller in diameter compared with other species (see illustration)
- Eye stalks longer and persist into later larval stages (65% HL)
- Fin rays form in finfold, away from body margin

Distinguished from other bathylagids with eyestalks by
- Linear series of small melanophores
- *B. pacificus* has large, isolated spots, long eyestalks, and less intense pigment
- *B. ochotensis* has shorter stalks and more intense pigment

[a] Ahlstrom et al. 1984b
[b] Transformation: Direct, marked in all species; slender body becoming deeper with development, large head and eyes, gut coils and becomes covered by black peritoneal sheath.

Ref: Ahlstrom et al. 1984b.



Figures A–B, Ahlstrom et al. 1984b (North Atlantic specimen).

MERISTICS

Vertebrae	Total: 50-X-55 Precaudal: 18-X-21 Caudal: 30-X-34
Branchiostegal rays	2-2-2
Caudal fin	16-18, 10+9, 15-17
Pelvic fin	Abdominal R: 6-X-8
Dorsal fin	R: 6-X-9
Pectoral fin	R: 11-X-16
Anal fin	R: 20-X-28
Gill rakers	U: X-X-X L: 25-X-27[a]

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Epi- and mesopelagic, 60-1000 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	
No. of oil globules	
Oil globule diameter	
Yolk	Segmented
Envelope	Pustules on inner surface
Hatch size	
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	59-61% SL
Length at flexion	
Length at transformation	Larval characters visible to 50 mm SL
Sequence of fin development	Caudal, dorsal, anal, pectorals, pelvics

Pigment - Large isolated melanophores
- Preflexion larvae: Pigment on lower jaw, midgut, and tail
- Flexion larvae
  —Opposing dorsal and ventral midline melanophores
  —Large melanophores on head and pectoral fin base
  —Large lateral blotch at base of caudal fin

Diagnostic characters
- Gut shorter (usually only 50% SL) than in other species
- Eye rounder and larger than in other bathylagids (not stalked)
- Fin rays develop in finfold, away from body margin

Distinguished from other bathylagids without eyestalks by
- Large isolated spots
- *B. wesethi* has a series of melanophores along hypaxial region, large eye, and spots posteriorly along dorsal midline
- *Leuroglossus* spp. larvae have smaller eyes and no dorsal spots

[a] E.H. Ahlstrom notes

Ref: Ahlstrom et al. 1984b.

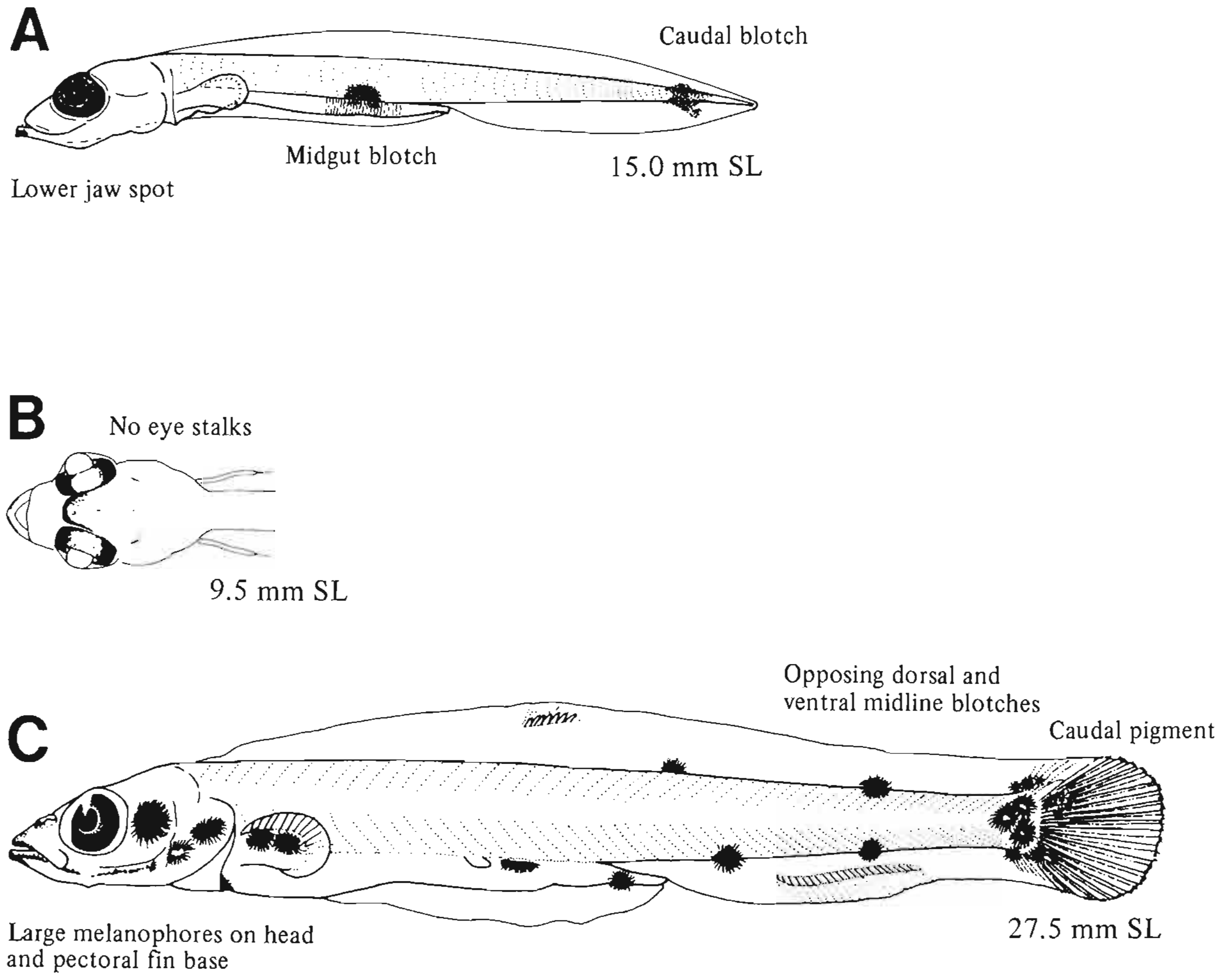


Figure A, NWAFC original (B. Vinter); B–C, Ahlstrom et al. 1984b.

MERISTICS

Vertebrae	Total: 47-X-49	
	Precaudal: 25-26-27	
	Caudal: 21-22-23	
Branchiostegal rays	2-2-2	
Caudal fin	13-14, 10+9, 15-16	
Pelvic fin	Abdominal	
	R: 9-10-10	
Dorsal fin	R: 9-11-12	
Pectoral fin	R: 9-10-11	
Anal fin	R: 12-X-15	
Gill rakers	U: X-X-X	L: 28-28-28[a]

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Epi- and mesopelagic, 49-900 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Jan-Feb[b]
	Area: Off continental slope[c]
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	0.92-1.1 mm
No. of oil globules	>10, usually coalesce to 1 in late stage[d]
Oil globule diameter	
Yolk	Segmented
Envelope	Pustules on inner surface
Hatch size	
Incubation time/temp.	

Pigment
- Unpigmented

Diagnostic characters
- Lack of pigmentation in late-stage eggs

LARVAE

Preanal length	81-90% SL
Length at flexion	
Length at transformation	
Sequence of fin development	Caudal, dorsal, anal, pectorals, pelvics

Pigment - Linear series of small melanophores
- Series of melanophores develops on hypaxial myomeres
- Epaxial melanophores limited to posterior body
- Series along posterior gut
- May occur on urostyle at sizes <7.9 mm SL

Diagnostic characters
- Eye stalks

Distinguished from other bathylagids with linear series of smaller melanophores by
- Posterior gut melanophores larger and fewer
- Anterior region of gut lacks pigment
- Epaxial myomere series limited to posterior region
- Fin rays form in finfold, away from body margin

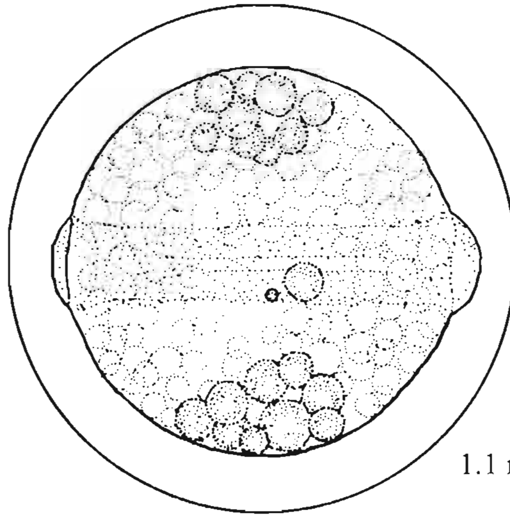
Distinguished from *B. bericoides* by
- Small *B. bericoides* larvae are unavailable but presumably eye stalks are longer at comparable stages

Distinguished from *B. pacificus* by
- Series of melanophores as opposed to isolated spots

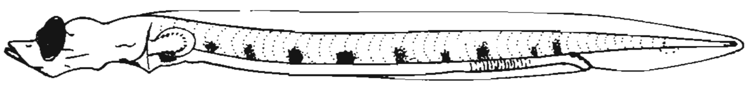
[a] E.H. Ahlstrom notes
[b] Wang 1981
[c] Ahlstrom 1965
[d] Numerous globules at vegetal pole which coalesce to one clump at each equatorial pole.

Ref: Ahlstrom et al. 1984b.

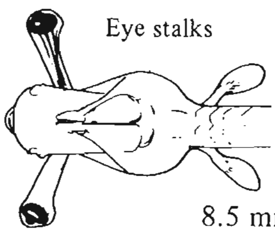
A



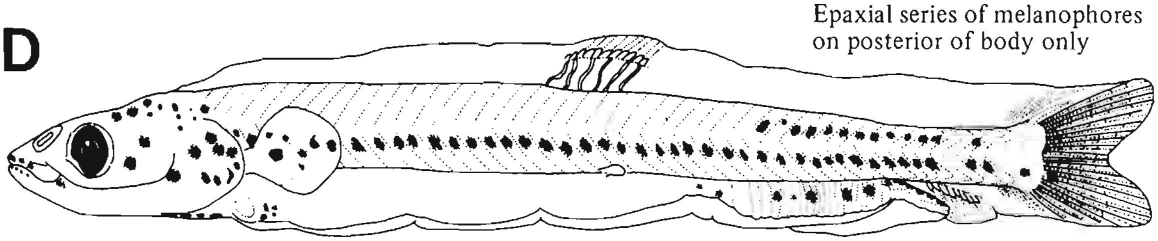
B



C



D



Figures A, C–D, Ahlstrom et al. 1984b; B, NWAFC original (B. Vinter).

MERISTICS

Vertebrae	Total: 44-X-49
	Precaudal: 18-X-25
	Caudal: 21-X-28
Branchiostegal rays	2-2-2
Caudal fin	13, 10+9, 13-14
Pelvic fin	Abdominal
	R: 7-X-10
Dorsal fin	R: 8-X-9
Pectoral fin	R: 7-X-11
Anal fin	R: 15-X-22
Gill rakers	U: X-X-X L: 28-X-32[a]

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Epi- and mesopelagic, 149-1000 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Feb-Mar;[b] spring[c]
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	
No. of oil globules	
Oil globule diameter	
Yolk	Segmented
Envelope	Pustules
Hatch size	
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	76-85% SL
Length at flexion	
Length at transformation	
Sequence of fin development	Caudal, dorsal, anal, pectorals, pelvics

Pigment - Large isolated melanophores

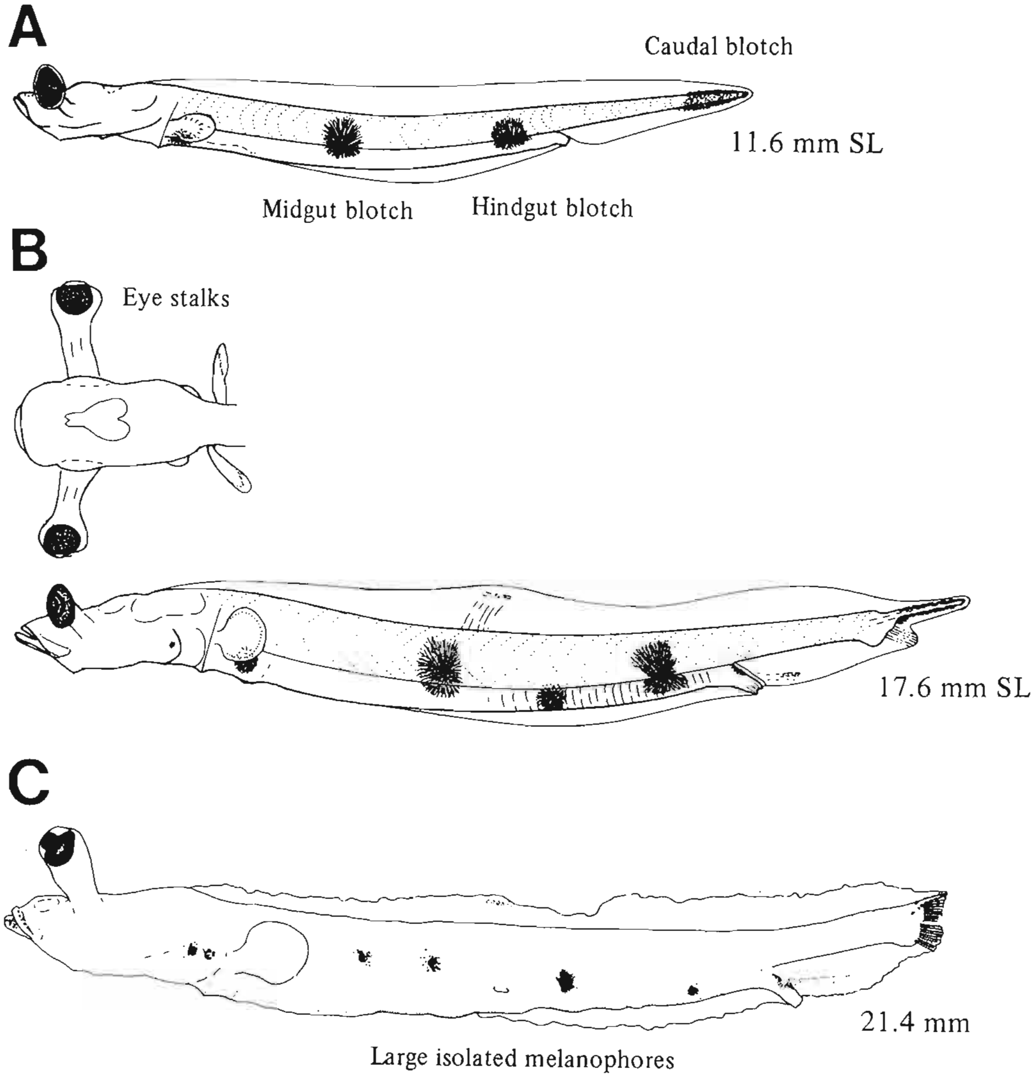
- Early larvae have large lateral blotch at midbody and another posteriad, becoming located on trunk with development
- Third blotch forms midway between and below other two blotches
- Fourth lateral trunk blotch forms in some late larval specimens between pectoral fin and large midbody blotch
- Other melanophores form lateral to liver and terminal section of gut
- Also isthmus/thoracic, dorsal gut, caudal, and two bands on body (early)

Diagnostic characters

- Stalked eyes
- Fin rays form in finfold, away from body margin
- Only bathylagid with stalked eyes and pigment consisting of large isolated spots

[a] E.H. Ahlstrom notes
[b] Wang 1981
[c] Fitch and Lavenberg 1968

Ref: Ahlstrom et al. 1984b.



Figures A–B, NWAFC original (B. Vinter); C, Ahlstrom et al. 1984b.

MERISTICS

Vertebrae	Total: 43-X-46
	Precaudal: 23-23-23
	Caudal: 22-22-22
Branchiostegal rays	2-2-2
Caudal fin	14-15, 10+9, 14-15
Pelvic fin	Abdominal
	R: 9-X-11
Dorsal fin	R: 11-12-13
Pectoral fin	R: 9-10-11
Anal fin	R: 14-X-16
Gill rakers	U: 8-8-8 L: 16-X-17

LIFE HISTORY

Range	South of southern California to Oregon, 42-46°N
Ecology	Epi- and mesopelagic, 40-1000 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	0.90-1.10 mm
No. of oil globules	12-20, subequal[a]
Oil globule diameter	
Yolk	
Envelope	
Hatch size	
Incubation time/temp.	

Pigment
- No pigment over oil globules

Diagnostic characters

LARVAE[b]

Preanal length	79-94% SL
Length at flexion	>6 mm, by 11 mm SL
Length at transformation	~25 mm SL
Sequence of fin development	Caudal, dorsal, anal, pectorals, pelvics

Pigment - Linear series of small melanophores
- Initially a series of paired spots dorsolaterally to gut extending from pectoral fin base to terminal section, becoming embedded with development (6-8 pairs developing to 7-8 pairs)
- Notochord tip (dorsal and ventral)

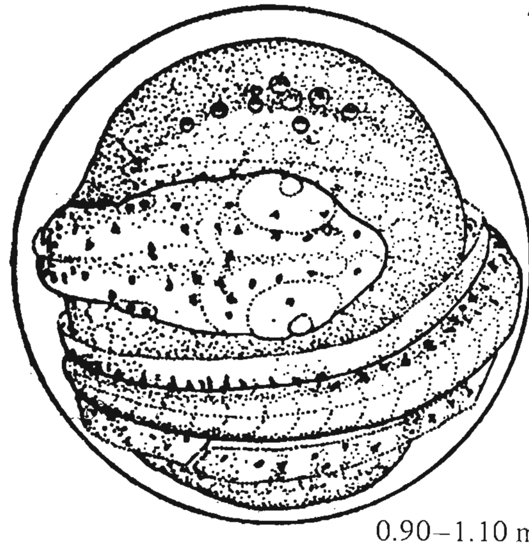
At flexion
- Series of melanophores develops along hypaxial region, and soon after a series develops along epaxial
- More lateral spots are added
- Median finfold
- Increased head pigment

Diagnostic characters
- Eyes not stalked
- Pigment pattern unique among *Bathylagus* spp. (including *Leuroglossus* spp.)
- Fin rays form in finfold, away from body margin
- Only bathylagid without stalked eyes and pigment consisting of a linear series of small melanophores

[a] Oil globules may only partially coalesce.
[b] Data on preflexion and postflexion larvae are from E.H. Ahlstrom notes. Illustrations are unavailable.

Ref: Ahlstrom 1965, 1969; Ahlstrom et al. 1984b.

A



B

C

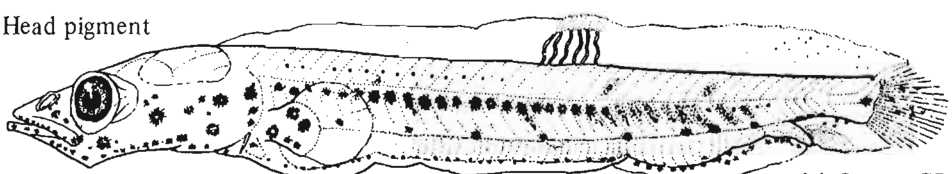


Figure A, Ahlstrom 1969; B–C, Ahlstrom et al. 1984b.

MERISTICS

Vertebrae	Total: 47-X-52
	Precaudal: 26-X-29
	Caudal: X-X-X
Branchiostegal rays	2-2-2
Caudal fin	15-17, 10+9, 15[b]
Pelvic fin	Abdominal
	R: 8-X-9
Dorsal fin	R: 10-X-11
Pectoral fin	R: 8-X-9
Anal fin	R: 11-X-14
Gill rakers	U: 8-X-9 L: 17-X-19

LIFE HISTORY

Range	Brit. Col., 48°30′-55°N, to Bering Sea, 54-66°N
Ecology	Epi-, meso-, and bathypelagic, 0-1800 m[c]
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Fall-winter;[b] summer[d]
	Area: Off continental slope[b]
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.65-1.90 mm
No. of oil globules	<5 up to 9, usually coalescing to 1[e]
Oil globule diameter	0.35-0.40 mm, 0.47 after fusion[e]
Yolk	Segmented
Envelope	Pustules
Hatch size	
Incubation time/temp.	

Pigment
- Tip of notochord

Diagnostic characters
- Egg diameter

LARVAE

Preanal length	72-78% SL
Length at flexion	13-18 mm SL
Length at transformation	31-35 mm SL
Sequence of fin development	Caudal, dorsal and anal, pectorals, pelvics

Pigment - Large isolated melanophores
- Series of 5-6 spots on posterior gut
- Midtrunk patch
- Lower trunk blotches
- 1-2 postanal lateral blotches in larger larvae

Diagnostic characters
- Eye stalks short and only in early larvae
- Fin rays form in finfold, away from body margin
- More pigmented than *L. stilbius*

Distinguished from *Bathylagus milleri* by
- Eye stalks short
- Lack of dorsal spots

[a] Placed in *Bathylagus* by Ahlstrom et al. 1984b.
[b] Dunn 1983
[c] Fedorov 1973
[d] Ahlstrom 1969
[e] Similar migrations, see *L. stilbius*.

Ref: Ahlstrom 1969, Ahlstrom et al. 1984b, Dunn 1983.

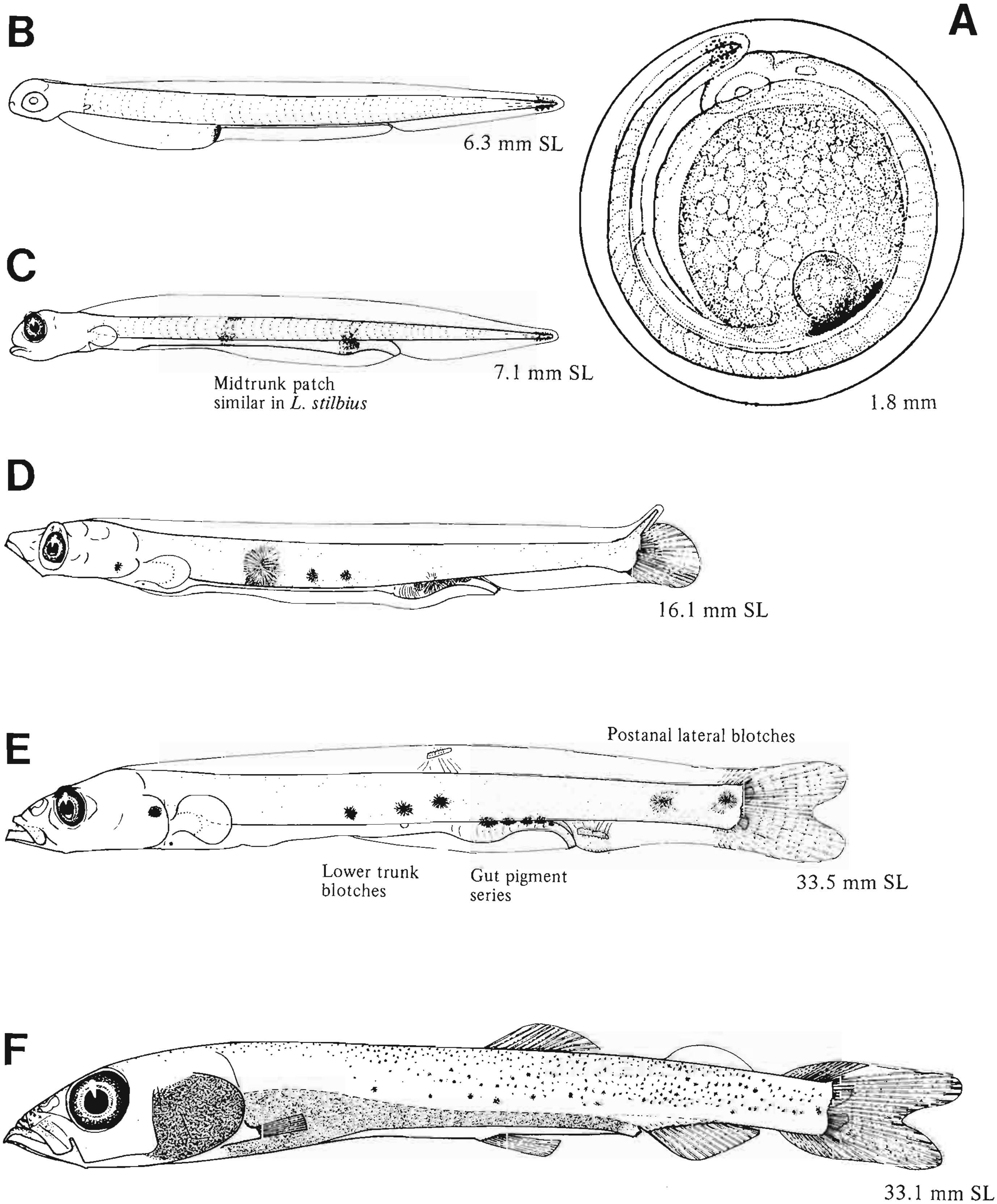


Figure A, Ahlstrom 1969; B–F, Dunn 1983.

MERISTICS

Vertebrae	Total: 38-X-42 Precaudal: 20-21-22 Caudal: 19-20-21
Branchiostegal rays	2-2-2
Caudal fin	12-16, 10+9, 13-15
Pelvic fin	Abdominal R: 8-X-10[b]
Dorsal fin	R: 9-X-11
Pectoral fin	R: 8-X-11
Anal fin	R: 11-X-14
Gill rakers	U: 7-X-9 L: 18-X-20

LIFE HISTORY

Range	South of southern California to Oregon, 42-46°N
Ecology	Epi- and mesopelagic, 0-690 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Winter-spring[c] Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.10-1.21 mm
No. of oil globules[d]	
Oil globule diameter	
Yolk	Finely segmented
Envelope	Pustules
Hatch size	3 mm SL
Incubation time/temp.	

Pigment
- Yolk membrane above oil globule
- Notochord tip

Diagnostic characters
- Egg diameter: Smaller than in *L. schmidti*

LARVAE[e]

Preanal length	74-80% SL
Length at flexion	
Length at transformation	25-29 mm SL
Sequence of fin development	Caudal, dorsal and anal, pectorals, pelvics

Pigment - Large isolated melanophores
- Midtrunk patch between pectoral fin base and anus in smaller larvae is similar to *L. schmidti*
- Series of 5-6 melanophores on posterior gut

Diagnostic characters
- Eye stalks short and only in early larvae
- Fin rays form in finfold, away from body margin

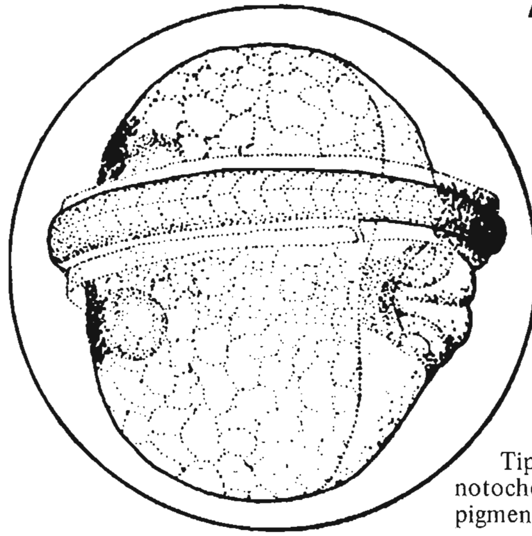
Distinguished from *L. schmidti* by
- Lack of lower trunk and postanal blotches

[a] Placed in *Bathylagus* by Ahlstrom et al. 1984b.
[b] Ahlstrom et al. 1984b
[c] Ahlstrom 1965
[d] After fertilization, 15-25 oil globules at vegetal pole; 2-5 oil globules during early stage which coalesce to 2 (sometimes 1) of equal size at opposite poles. These oil globules migrate toward and coalesce under the embryo prior to hatching.
[e] Data on preflexion and postflexion larvae are from E.H. Ahlstrom notes. Illustrations are unavailable.

Ref: Ahlstrom 1965, 1969; Ahlstrom et al. 1984b.

A

Yolk pigment above oil globules



Tip of notochord pigmented

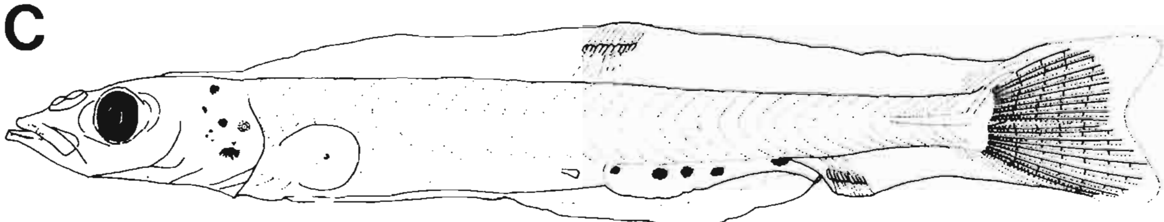
1.10–1.21 mm

B

Eye stalks short

8.5 mm SL

C



23.2 mm

5–6 melanophores on posterior gut

Figure A, Ahlstrom 1969; B–C, Ahlstrom et al. 1984b.

MERISTICS

Vertebrae	Total: 81-X-84[a]
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	2-2-2
Caudal fin	X, 10+9, X
Pelvic fin	Abdominal
	R: 7-7-8[b]
Dorsal fin	R: 13-14-16[b]
Pectoral fin	R: 10-12-13[b]
Anal fin	R: 10-12-14[b]
Gill rakers	U: 16-X-20 L: 28-X-32

LIFE HISTORY

Range	N. California, 38-42°N, to Brit. Col., 48°30′-55°N
Ecology	Epi- and mesopelagic
ELH pattern	Oviparous, eggs probably pelagic, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	(Both sexes appear to mature at 400 mm SL)[b]
Longevity	5 yr[c]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	2.2-2.6 (ripe ovarian eggs)
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	
Hatch size	
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	80-82% SL
Length at flexion	
Length at transformation	Up to 124 mm SL[d]
Sequence of fin development	Caudal, pectorals and pelvics, dorsal and anal

Pigment
- Dorsal blotches (six pairs), which extend into finfold, and ventral (eight pairs) lateral blotches; blotches alternate except for postanal ones which form a band
- Large caudal blotch
- Head heavily pigmented
- Lower gill arches heavily pigmented
- Pectoral and pelvic fin bases

Diagnostic characters
- Gut elongate
- Sac-like stomach (elongate and pointed at tip)

Distinguished from other opisthoproctids by
- Elongate snout with unique triangular flap at tip
- Round eyes (anterodorsal)
- Distinctive heavy pigment pattern
- Number of myomeres (81-84)

[a] Ahlstrom et al. 1984b
[b] Stein and Bond 1985
[c] Fitch and Lavenberg 1968
[d] Transformation (family): Marked by deepening of body and attainment of melanistic integument and large scales.

Ref: Ahlstrom et al. 1984b, Stein and Bond 1985.

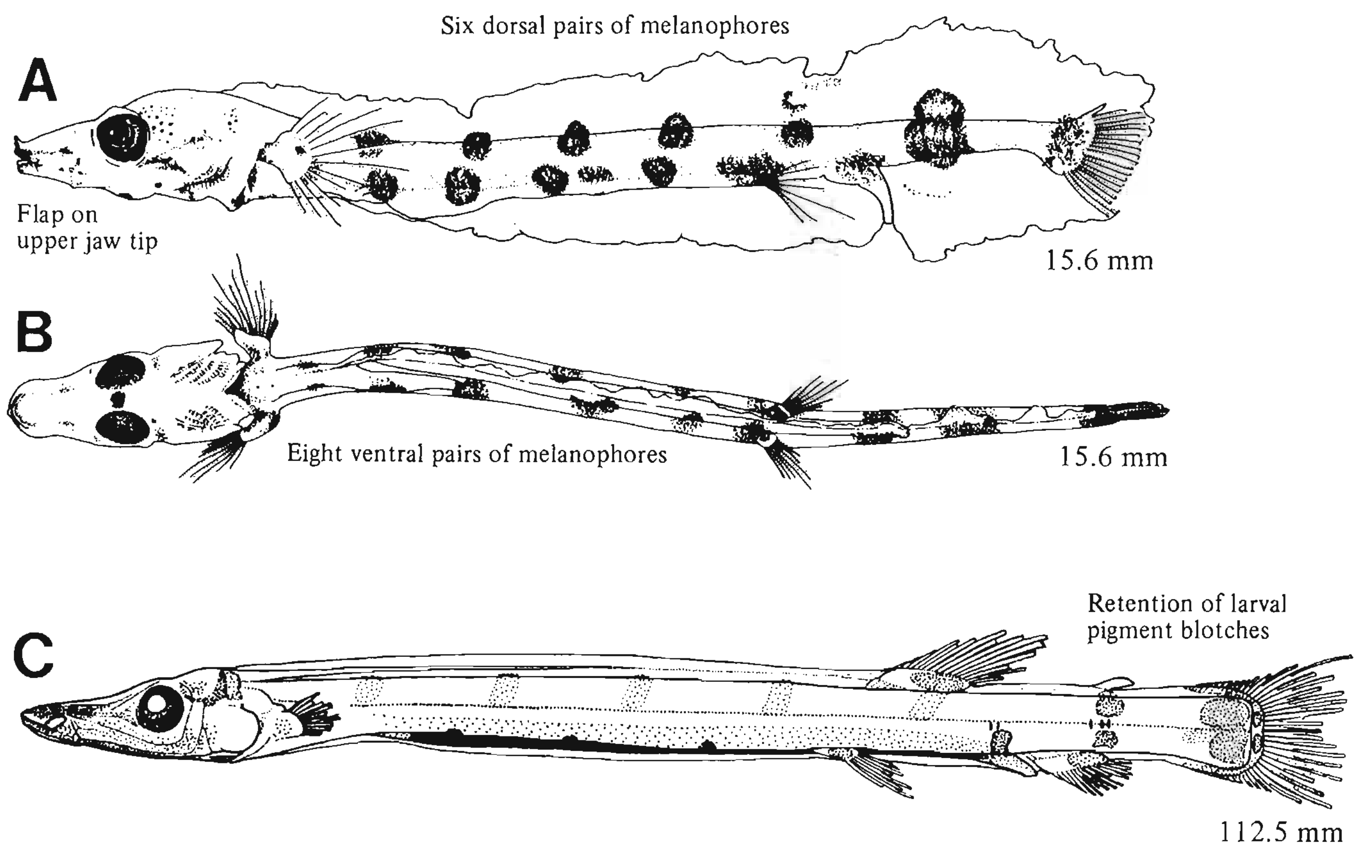


Figure A–B (B, ventral view), Ahlstrom et al. 1984b; C, Cohen 1960.

MERISTICS

Vertebrae	Total: 40-X-44
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	2-2-2
Caudal fin	X, 10+9, X
Pelvic fin	Abdominal
	R: 8-X-9
Dorsal fin	R: 10-X-11
Pectoral fin	R: 13-13-13
Anal fin	R: 8-X-9
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to Oregon, 42-46°N
Ecology	Epi- and mesopelagic, 152-457 m
ELH pattern	Oviparous, eggs probably pelagic, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	5 yr[b]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length	74-75% SL
Length at flexion	
Length at transformation	See *Bathylychnops exilis*
Sequence of fin development	Pectorals and pelvics probably right after caudal, before dorsal and anal

Pigment - Genus
- Lateral series of melanophores above gut; some species develop serial melanophores on hypaxial myomeres
- Head pigment: Jaws, internal snout, gill arches

Diagnostic characters
- Gut elongate (sac-like stomach, elongate and pointed at tip)
- Tubular eyes
- Elongate pectoral and pelvic fin rays
- Number of myomeres (40-44), less than *B. exilis* (81-84) and more than *Macropinna microstoma* (34-37)

[a] According to A.E. Peden (Brit. Col. Prov. Mus., Victoria, B.C., Canada V8V 1X4, pers. commun., 22 Jan. 1987), several species may be in the area with *D. longipes* having the more southerly distribution. Other species may occur north of Oregon and at least one form occurs off British Columbia.
[b] Fitch and Lavenberg 1968

Ref: Ahlstrom et al. 1984b.

A *Dolichopteryx binocularis*

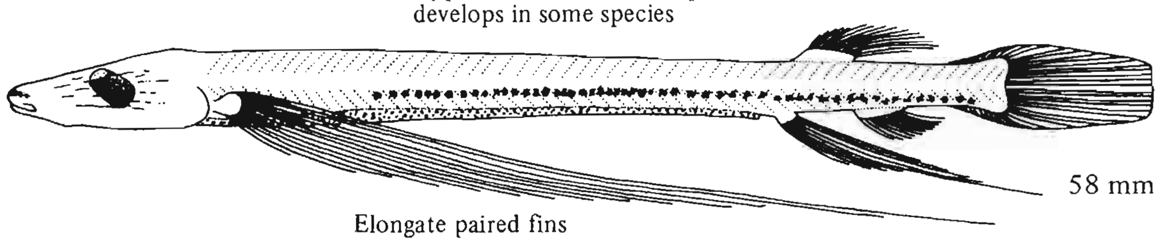


Figure A, Ahlstrom et al. 1984b (after Roule and Angel 1930, Mediterranean specimen).

MERISTICS

Vertebrae	Total: 34-X-37 Precaudal: X-X-X Caudal: X-X-X
Branchiostegal rays	3-3-3
Caudal fin	X, 10+9, X
Pelvic fin	Abdominal R: 9-X-10
Dorsal fin	R: 11-X-12
Pectoral fin	R: 17-X-19
Anal fin	R: 14-14-14
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Epi- and mesopelagic, 99-891 m
ELH pattern	Oviparous, eggs probably pelagic, pelagic larvae
Spawning	Season: Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length	59-64% SL
Length at flexion	
Length at transformation	See *Bathylychnops exilis*
Sequence of fin development	Caudal, pectorals and pelvics, dorsal and anal

Pigment
- Series of melanophores on each hypaxial myomere
- Heavy embedded blotch at pelvic fin base; expands dorsad and ventrad
- Caudal blotch
- Above terminal section on gut ventral to liver
- Lower jaw

Diagnostic characters
- Deeper body and shorter gut than *B. exilis* and *Dolichopteryx longipes*
- Head with pronounced hump or bend at nape
- Tubular eyes directed dorsally
- Number of myomeres (34-37)

Ref: Ahlstrom et al. 1984b.

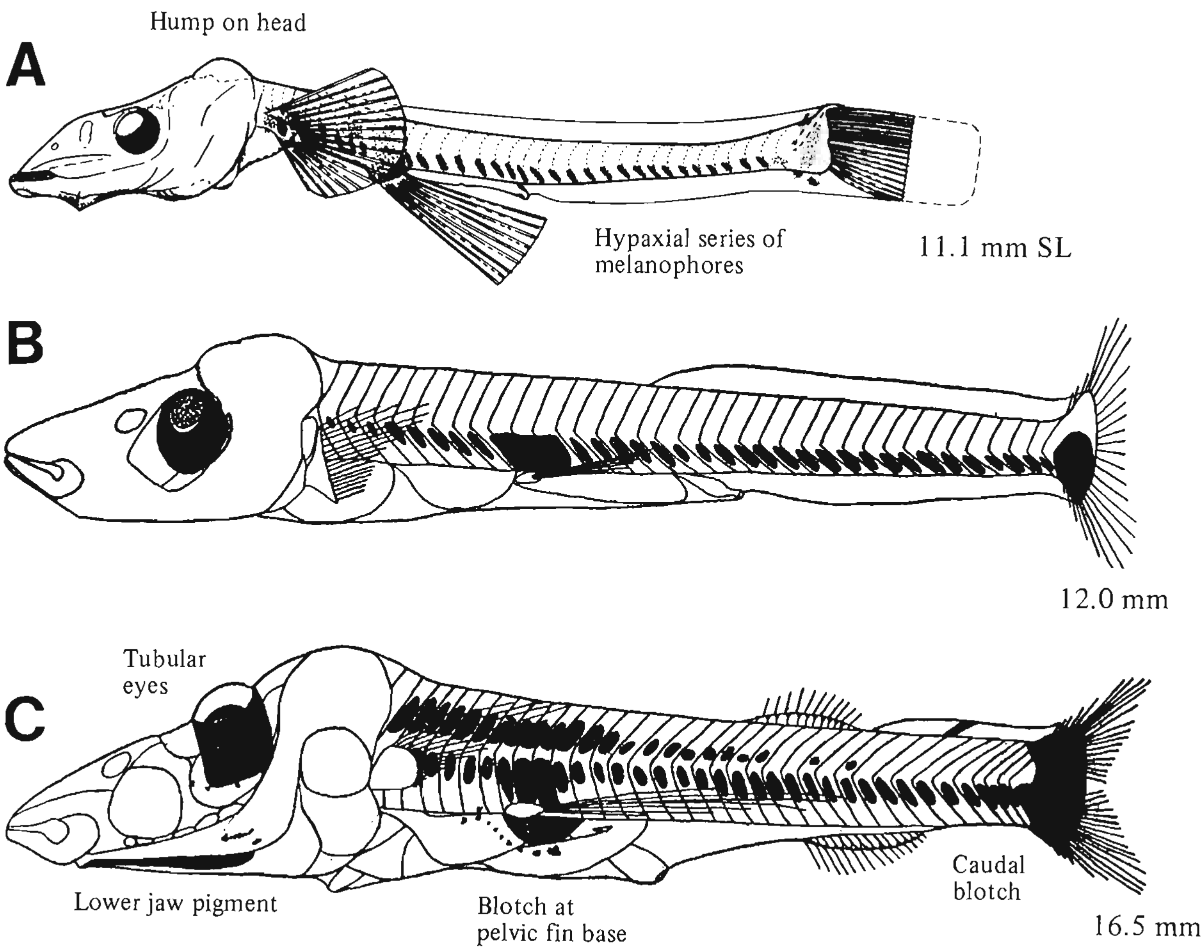


Figure A, NWAFC original (B. Vinter); B–C, Chapman 1939.

Members of the slickhead family are found worldwide in the deep sea, with six species in six genera found within the limits of this study area. Adults occur at depths of 45 to 5500 m but are primarily taken in hauls near the ocean bottom below 600 m. Juveniles occur in midwater (Fitch and Lavenberg 1968). Reproductive characteristics are unknown. Little information on alepocephalid early-life-history stages has appeared since Beebe (1933) in which they were found to hatch from large eggs (3-4 mm) and have direct development. There is no close relationship between alepocephalids and argentinoids because alepocephalids have large eggs, direct development, and share no specialized ontogenetic characters with argentinoids (Ahlstrom et al. 1984b).

Table 6
Meristic characters of family Alepocephalidae.

Taxon	Distribution	Vertebrae: Precaudal Caudal (Total)	Fins: Dorsal	Fins: Anal	Fins: Pectoral	Fins: Pelvic	Gill rakers: Upper	Gill rakers: Lower	Branchiostegals
Alepocephalus tenebrosus	Cent. Calif.-Bering Sea	(53-55)	17	17-18	10	6-7	7-8	17-18	6-7
Bathylaco nigricans	SSC-Oregon	(45-46)	17-22	11-12	6-11	6-9	3-5	8-13	9-10
Ericara salmoneum	S. Calif.-Bering Sea		17-19	4-28	12	6			6
Leptochilichthys agassizi	SSC-Oregon		14	13	11	10	8	19	13
Narcetes stomias	SSC-Wash.		17-21	14-16	10-11	8-9	3-4	12-14	8
*Talismania bifurcata**	SSC-Brit. Col.	16-17 27-28 (43-46)	22	21-23	10-12	6-7	7-8	15-18	7

*The NWAFC meristic database was updated by Sazonov 1981.

Tubeshoulders are found in all oceans, and five species in four genera are known in the Northeast Pacific Ocean and Bering Sea (Matsui and Rosenblatt 1987). Adults are commonly taken in midwater trawls but have been found at the surface (at night) to below 1000 m (Fitch and Lavenberg 1968). Little is known of their reproduction and early life history except that juveniles of *Sagamichthys abei* migrate upward at night to within 200 m of the surface to feed (Hart 1973).

Table 7
Meristic characters of family Platytroctidae.*

Taxon	Distribution	Vertebrae: Precaudal Caudal (Total)	Fins: Dorsal	Fins: Anal	Fins: Pectoral	Fins: Pelvic	Gill rakers: Upper	Gill rakers: Lower	Branchiostegals
Holtbyrnia innesi	Bering Sea	26-30 18-20 (46-48)	18-19	17	16	9	7	15-16	8
Holtbyrnia latifrons	SSC-Brit. Col.	27-28 20 (46-50)	17-20	14-16	16-20	8-9	6-8	17-19	8-9
Maulisia argipalla	SSC-Bering Sea	25-27 19-22 (46-47)	17-20	15-17	18-19	7-8	7-8	16-18	8
Pellisolus eubranchus	Oregon	20-23 20-24 (42-44)	17-19	15-16	18-21	6-8	5-6	17-18	8-9
Sagamichthys abei	S. Calif.-Brit. Col.	30-31 19-21 (50-52)	16-18	14-16	14-18	9-10	7-8	16-18	6-8

*Taxonomy and meristic data from Matsui and Rosenblatt (1987). The northernmost record of *Mirorictus taningi* (reported also as *Normichthys campbelli*) is 35°N but it may occur further north.

Smelts are confined to the Northern Hemisphere, and seven species in six genera are found in the northeastern Pacific. Some species spawn intertidally, others are anadromous. Spawning is protracted and en masse. Spent fish return to deeper water except for *Thaleichthys pacificus*, which experiences high, though not complete, mortality after spawning (Garrison and Miller 1982). Osmerid eggs are generally 0.80-1.1 mm, strong to feebly adhesive, and have numerous oil globules. The adhesive membrane results from the rupturing of an outer "chorion" during spawning which turns out and onto the substrate (Hearne 1983, 1984). In general, larval characteristics include an elongate body shape, gut 75% of standard length, subterminal mouth, conspicuous choroid fissure, stalked pectorals, no dorsal melanophores, a single row of melanophores along the ventral midline of the gut, and a single row of melanophores on the ventral midline of the tail (Hearne 1984). All osmerid larvae possess a single midventral row of melanophores below the gut. *Spirinchus starksi* larvae have a greater number of ventral melanophores than *Spirinchus thaleichthys* or *Thaleichthys pacificus* (Hearne 1983). Myomere counts may be of additional use. Osmerids are the most abundant larvae in the nearshore waters (0-20 km) off Oregon; usually >50% of the larvae collected from January through June are osmerids (B. Mundy, NMFS Southwest Fish. Cent., Honolulu Lab., Honolulu, HI 96822-2396, pers. commun., 1 Oct. 1986.). Presently, it is possible to identify only one of these larvae to genus or species. A complete developmental series of *Mallotus villosus* is known. They are common in our ichthyoplankton collections off Oregon, Washington, and in the Gulf of Alaska.

Table 8
Meristic characters of family Osmeridae.

Taxon	Distribution	Vertebrae Precaudal	Vertebrae Caudal	Fins Dorsal	Fins Anal	Fins Pectoral	Fins Pelvic	Gill rakers Upper	Gill rakers Lower	Branchiostegals
		(Total)						(Total)		
Allosmerus elongatus	S. Calif.-Brit. Col.	40-44	23-27	9-11	14-17	12-14	8	10-13	23-28	6-7
Hypomesus pretiosus	S. Calif.-Bering Sea	42-44 (62-70)	22-24	8-11	12-17	14-17	8	10-13	21-25	7-8
Mallotus villosus	Wash.-Arctic	(62-73)		10-14	16-23	16-21	9	8-13	24-35	7-8
Osmerus mordax	Brit. Col.-Arctic	(58-68)		8-11	12-16	11-14	8	8-11 (26-37)	18-24	6-8
Spirinchus starksi	S. Calif.-SE Alaska	33-36	25-29	8-11	15-21	10-11	8	8-13	24-31	7-8
Spirinchus thaleichthys	Cent. Calif.-Bering Sea	29-31 (54-61)	24-27	8-10	15-22	10-12	8	10-13	26-34	7-8
Thaleichthys pacificus	Cent. Calif.-Bering Sea	(65-72)		10-13	18-23	10-12	8	4-6	13-18	6-8

MERISTICS

Vertebrae	Total: 62-X-73 Precaudal: X-X-X Caudal: X-X-X
Branchiostegal rays	7-X-8
Caudal fin	X, 10+9, X
Pelvic fin	Abdominal R: 9-X-9
Dorsal fin	R: 10-X-14
Pectoral fin	R: 16-X-21
Anal fin	R: 16-X-23
Gill rakers	U: 8-X-13 L: 24-X-35

LIFE HISTORY

Range	Washington, 46-48°30′N, to Arctic, not specific
Ecology	Nearshore shelf pelagic, 0-200 m;[a] 750 m[b]
ELH pattern	Oviparous, demersal attached eggs, pelagic larvae
Spawning	Season: Fall (British Columbia);[c] spring (Bering Sea)[d] Area: Gravel beaches[c] Mode: Schools[c] Migration:
Fecundity	Range/function: 3000-6600 (British Columbia)[c]
Age at first maturity	2+ yr[e]
Longevity	>3 yr[f]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1 mm
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	Adhesive
Hatch size	3-6 mm
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	~75% SL
Length at flexion	After yolk absorption, ~7-8 mm SL
Length at transformation	
Sequence of fin development	Probably caudal, dorsal, anal, pelvics, pectorals

Pigment
- Single row of melanophores along ventral gut midline
- Single row of postanal ventral melanophores developing into double row (ventral view)

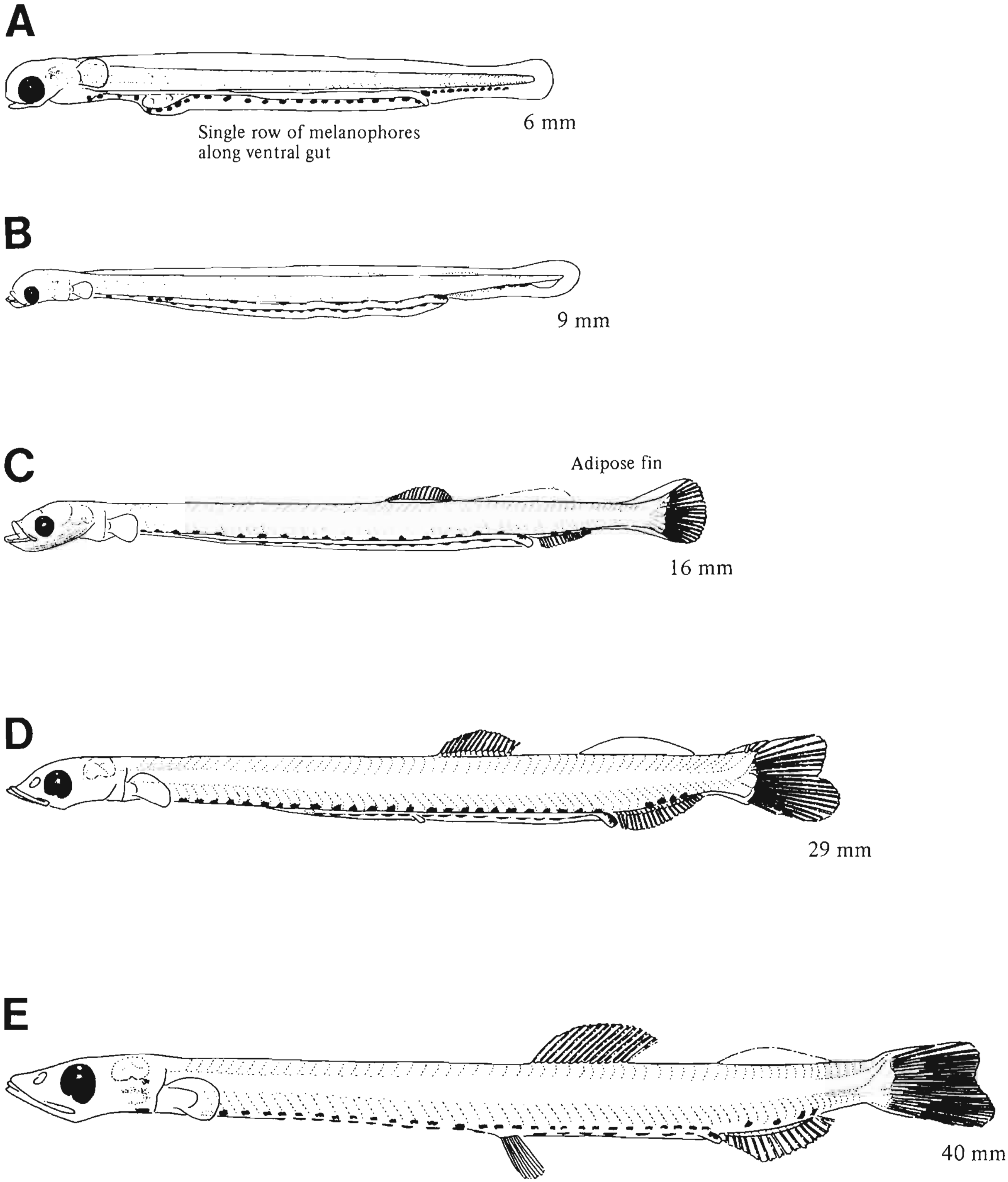
Diagnostic characters (see Table 4)

Distinguished from clupeiforms by
- Higher number of myomeres (62-73)
- Pigment: Single rather than double row of mid-ventral melanophores below gut
- Greater gut length (75% SL)
- Presence of adipose fin

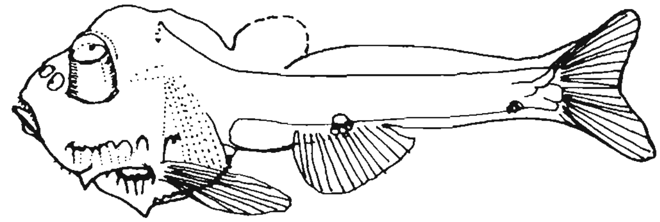
Distinguished from other osmerids by
- Combination of greater number of pectoral fin rays (16-21) and anal fin rays (16-23)

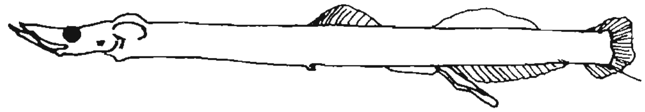
[a] Andriashev 1954
[b] Allen and Smith 1988
[c] Hart and McHugh 1944
[d] Baxter 1975
[e] Trumble 1973
[f] Hart 1973

Ref: Templeman 1948.



Figures A–E, Fahay 1983 (A, after Bigelow and Schroeder 1953; B–E, after Templeman 1948; Atlantic specimens).





Stomiiformes

Fishes of the order Stomiiformes are mostly tropical to temperate, with many being deep-sea. This highly diverse order contains 9 families, 53 genera, and about 248 species (J. Nelson 1984). A total of 6 families, 12 genera, and 22 species are found within the study area. Body forms among stomiiforms range from eel-like (idiacanthids) to deep and extremely compressed (sternoptychids). Most species have luminescent organs, teeth on both premaxilla and maxilla, mouth extending past the eye, an adipose fin, and a dark-brown or black color (primarily silver in Gonostomatidae and Sternoptychidae). Presently, there is no consensus on the relationships within the order (Weitzman 1974, Fink and Weitzman 1982, Ahlstrom et al. 1984c, Fink 1984). Herein, we treat the gonostomatids and sternoptychids together, and the chauliodontids, melanostomiids, malacosteids, and idiacanthids together. For convenience, we will call the former families the gonostomatoids, and the latter the stomioids, without phylogenetic implications. The identification of gonostomatoid larvae requires a knowledge of developmental data from larvae, juveniles, and adults (including fin rays, teeth, and photophores). Of importance are pigment patterns, position of dorsal and anal fins (caution must be used, since positions change with growth), presence of an adipose fin, and photophores (number, pattern, and sequence of development) (Ahlstrom et al. 1984c). In addition to pigment patterns and meristic and photophore characters, gut structure (trailing or not) is an important feature to consider in the identification of stomioids.

Families in study area: **Gonostomatidae**
Sternoptychidae
Chauliodontidae
Melanostomiidae
Malacosteidae
Idiacanthidae

Table 9

Definitions of alphabetical symbols used for designating photophores in deep-bodied sternoptychids and other stomiiform fishes (Ahlstrom et al. 1984c, in part).

Code	Definitions
Gonostomatoids	
SO	Symphyseal photophores (organs) located at tip of lower jaw.
Orb	Photophores associated with the eye located anterior and posterior of orbit.
Op	Photophores on opercle series generally three, coded as follows 1/(1+1).
Br (BRP)	Photophores located on the branchiostegal membranes.
Is (I)	Photophores located on the isthmus.
IP	Photophores of the ventral series found from the isthmus to the base of the pectoral fin.
PV	Photophores of the ventral series found from the pectoral fin base to the pelvic (ventral) fin base.
VAV	Photophores of the ventral series found from the pelvic (ventral) fin base to the anal fin base.
AC	Photophores of the ventral series found from the anal fin base to caudal fin base.
IC	Summary of photophores of the ventral series from the isthmus to caudal fin base (IP+PV+VAV+AC).
IV	Summary of photophores of the ventral series from isthmus to pelvic (ventral) fin base (IP+PV).
OV	Photophores of the lateral series from the opercle to pelvic (ventral) fin base.
VA (VALA)	Photophores of the lateral series from the pelvic (ventral) fin base to the anal fin base.
OAA	Summary of photophores of OV plus VA series.
OA (OAB)	Summary of lateral photophores from the opercle to anal fin base (OV+VA).
OAC (OC)	Entire lateral series on body sides just dorsal to ventral series and extending from opercular border, or just medial to it, over anal fin to caudal fin base.
ODM	Photophores (organs) found dorsal to the lateral midline (found only in *Gonostoma gracile*).
Deep-bodied Sternoptychids	
SO	Subopercle photophore which is equivalent to posteriormost photophore in opercular series of gonostomatoids.
PO	Photophore located anterior to orbit.
PTO	Photophore located posterior to orbit and may be equivalent to upper photophore of opercular series of gonostomatoids.
PRO	Preopercular photophore, used for PO photophore dorsal to ventral limb or preopercle.
Br	Same as gonostomatoid definition.
Is	Same as gonostomatoid definition.
AB	Photophores of ventral series located abdominally between pectoral fin base and pelvic fin base and equivalent to PV in gonostomatoids, plus a few posterior photophores of the IP series.
PAN	Photophores found anterior to anal fin and may be equivalent to VAV or VA in gonostomatoids.
AN	Photophores found above anal fin.
SC	Photophores found on lower (sub) caudal peduncle. Together with AN group may be equivalent to AC in gonostomatoids.
SAB	Photophores located above (supra) to the abdominal series and may be equivalent to VA in gonostomatoids.
SP	Photophores located above (supra) the pectoral fin and may be equivalent to OV in gonostomatoids.
SAN	Photophores located above (supra) to anal photophores and equivalent to part of AC series.

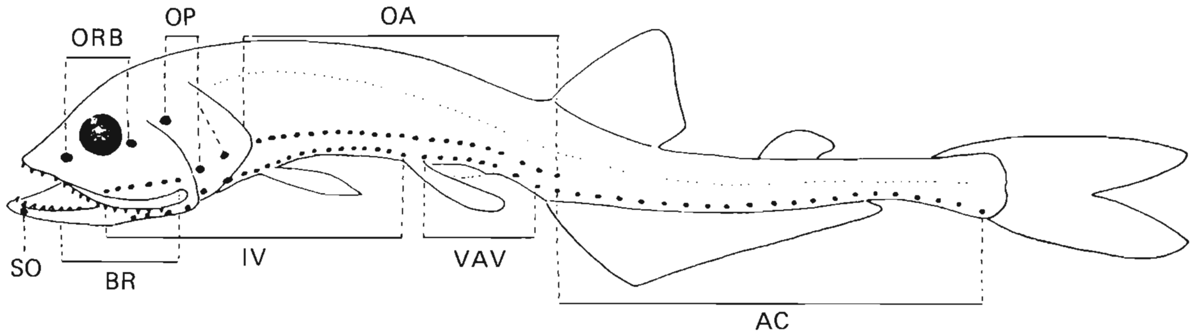
Table 10

Photophore distribution in selected gonostomatoid genera (Ahlstrom et al. 1984c, in part). See Table 9 for photophore definitions.

	No. of rows	SO	ORB	OP	BR	IS	IV	VAV	AC	Photophores in groups of glands?
Argyropelecus	2	No	2	2	6	Yes	18	4	10	Yes
Cyclothone	2	No	1	2	8-11	No	12-14	4-5	12-16	No
Danaphos	2	No	1	2-3	6	Yes	18	5	22-26	Yes
Gonostoma	2	Yes	1	2-3	9	No	11-16	3-10	15-23	No
Sternoptyx	2	No	2	2	3	Yes	15	3	7	Yes

MAJOR PHOTOPHORE GROUPS

A Gonostomatoid



B Sternoptychid

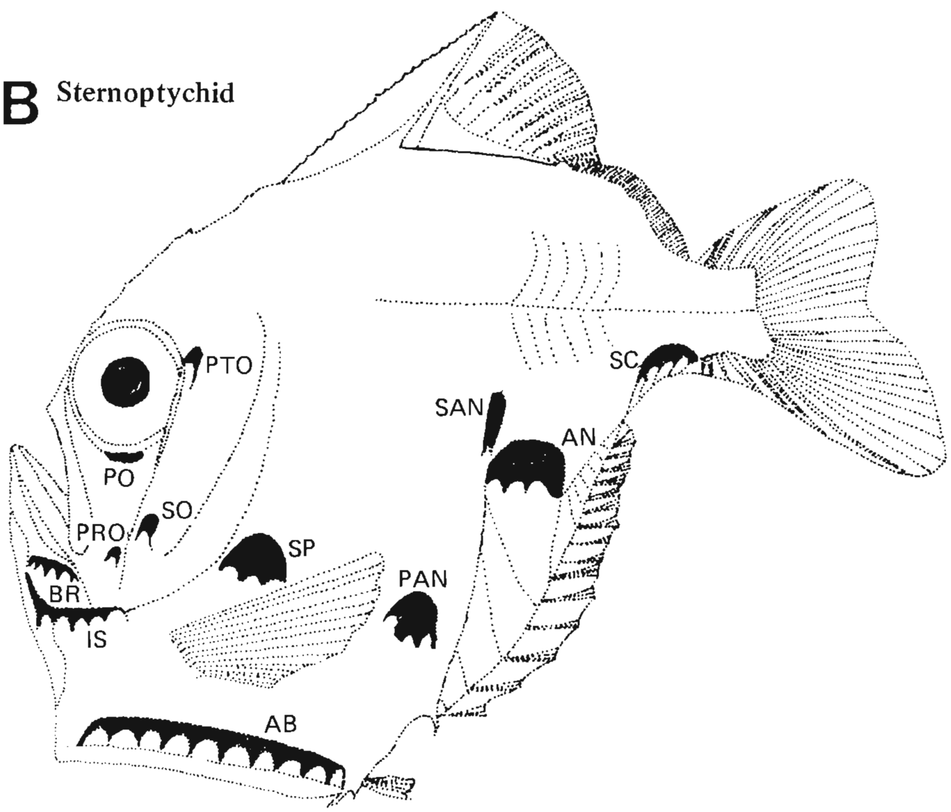


Figure A, Fahay 1983 (after Ozawa 1976); B, Badcock and Baird 1980 (redrawn).

Table 11

Fin position and condition of adipose fin in selected gonostomatoid fishes (Ahlstrom et al. 1984c, in part).

Genera	Adult	Larvae	Adipose fin
Argyropelecus	Anal origin opposite last dorsal fin ray	Anal origin behind dorsal fin	Present or absent
Cyclothone	Anal origin opposite dorsal fin or slightly behind	Same as adult	Absent
Danaphos	Anal origin behind dorsal fin	Same as adult	Absent
Gonostoma	Anal origin opposite or 3-4 rays in advance of dorsal origin	Same as adult	Present or absent
Sternoptyx	Anal origin opposite dorsal origin	Anal origin behind dorsal fin	Present

Table 12
Meristic characters of family Gonostomatidae.

		Vertebrae		Fins					Gill rakers		
Taxon	Distribution	Precaudal	Caudal (Total)	Dorsal	Anal	Pectoral	Pelvic	Caudal	Upper	Lower	Branchiostegals
Cyclothone acclinidens	SSC-Oregon	13-14	17-19	13-15	18-20	9-10	6	6,10+9,6[a]	6-9	14-17	13-15
Cyclothone atraria	SSC-Bering Sea[b]	12-13	18-20	13-15	18-21	9-10	6		6-8	13-16	12-14
Cyclothone pallida	SSC-Brit. Col.	13-14	17-21	13-15	17-19	9-11	6-7		7-10	14-18	13-15
Cyclothone pseudopallida	SSC-Bering Sea	12-13[a]	18-20[a]	13-15	18-21	9-10	6		4-6	12-14	13-15
Cyclothone signata	SSC-Gulf of Alaska	13	17-19	13-14	18-20	9-10	6	6-8,10+9,6-7[a]	3-5	10-11	12-14
Gonostoma atlanticum	SSC-Oregon	(38-39)		16-18	27-30	9-10	6-7		6-7	11	11-12
Gonostoma gracile	Gulf of Alaska-Bering Sea	18-19	22-24	9-12	22-30	8-10	6-8				11-12

[a] E.H. Ahlstrom notes
[b] Records from north of British Columbia are questionable (A.E. Peden, Brit. Col. Prov. Mus., Victoria, B.C., Canada V8V 1X4, pers. commun., 22 Jan. 1987).

This worldwide genus of lightfishes may constitute the most abundant genus of fish in the sea. These small (to 80 mm) bathypelagic fishes are found most commonly at depths of 300 m and greater and have been found as deep as 5300 m. Very little information on life history is available. The eggs are unknown but larvae are common in offshore tropical and temperate areas. *Cyclothone* spp. larvae are discussed at the generic level since only partial series are available for the five species in the study area. Gorbunova (1982a) described the larvae of eight species from the Pacific including four from the study area (all species except *C. atraria*). The descriptions of *C. acclinidens*, *C. pallida*, and *C. pseudopallida* by Gorbunova (1982a) have been questioned by Ozawa and Oda (1986) who described the larvae (>7 mm SL) of five species of *Cyclothone* (all species from the study area except *C. signata*). Since preflexion larvae and transforming larvae linking larval series to adults are generally unavailable, Ozawa and Oda (1986) discussed the need for further investigation.

Preanal length for *Cyclothone* spp. larvae is about 50% SL. Lengths at flexion and transformation are 4-5 mm SL and about 14 mm SL, respectively. Caudal and dorsal fins form first, followed in sequence by the anal, pelvic, and pectoral fins. Photophores are described in Table 10.

Pigment characters for *Cyclothone* spp., based on described species, include
- 2-3 spots along gut with posteriormost spot at anus (sometimes more spots in larger specimens)
- One spot at cleithral symphysis
- Pigment on swimbladder
- Lateral series posterior to pectoral fins, ending prior to swimbladder
- Series over anal fin base (varies from ∼5-12 spots and may or may not be evenly spaced; number and spacing of series may be species-specific)
- Some species develop dorsal series similar to anal base series
- Spots at base of anal fin pterygiophores
- Spots usually appear above and below urostyle and in hypural area

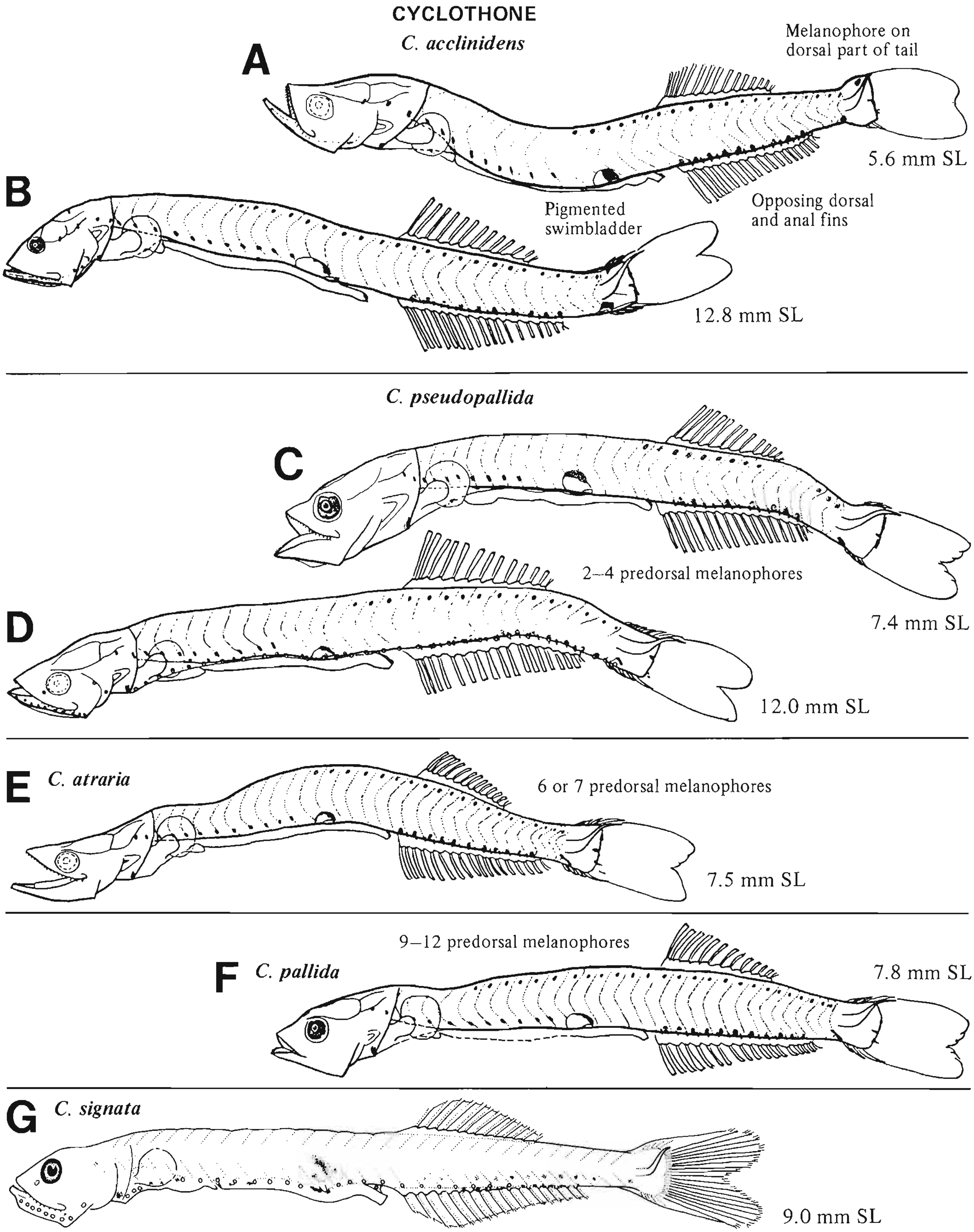
Diagnostic characters for *Cyclothone* spp. larvae include
- Distinct dark streak or intense melanophore over and parallel to parhypural on caudal fin base
- Pigmentation over gut and along ventral margin of tail
- Anal fin origin opposite dorsal fin or slightly behind (no ontogenetic movement)
- Conspicuous swimbladder
- No adipose fin
- Larvae generally elongate

Diagnostic characters for species
- *C. acclinidens* (melanophore on dorsal part of tail end)
- *C. pseudopallida* (predorsal melanophores 2-4, see figure)
- *C. atraria* (predorsal melanophores 6 or 7, see figure)
- *C. pallida* (predorsal melanophores 9-12, see figure)
- *C. signata* (no melanophore on dorsal part of tail end, and no predorsal melanophores)

Distinguish from *Gonostoma*
- See Tables 10-12
- Fewer anal fin rays (16-21 vs. 21-31)
- Fewer vertebrae (29-33 vs. 37-40)
- SO photophore absent
- Caudal pigment (present in *Gonostoma atlanticum* but not in *G. gracile*)

Larger postflexion larvae, which differ greatly from adults, undergo a metamorphic stage during which most of the photophores become pigmented simultaneously, the anterior portion of the body shortens, and the anus changes position from near the anal fin to nearer the ventral fin bases.

Ref: Ahlstrom et al. 1984c; Fahay 1983; Gorbunova 1982a; Grey 1964; Hart 1973; Jespersen and Tåning 1926; Mukacheva 1954, 1964; Ozawa and Oda 1986.



Figures A–F, Ozawa and Oda 1986; G, Ahlstrom et al. 1984c.

MERISTICS *G. atlanticum* Norman 1930

Vertebrae	Total: 38-X-39	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	11-X-12	
Pelvic fin	Abdominal	
	R: 6-7-7	
Dorsal fin	R: 16-18-18	
Pectoral fin	R: 9-X-10	
Anal fin	R: 27-28-30	
Gill rakers	U: 6-X-7	L: 11-X-11

MERISTICS *G. gracile* Günther 1878

Vertebrae	Total: 40-X-42	
	Precaudal: 18-X-19	
	Caudal: 22-X-24	
Branchiostegal rays	11-X-12	
Pelvic fin	Abdominal	
	R: 6-X-8	
Dorsal fin	R: 9-X-14	
Pectoral fin	R: 8-X-11	
Anal fin	R: 22-X-30	
Gill rakers	U: 7-8-8	L: 12-13-14

LIFE HISTORY

Range	
(*G. atlanticum*)	South of southern California to Oregon, 42-46°N
(*G. gracile*)	Gulf of Alaska, 54-60°N to Bering Sea, 54-66°N
Ecology	Meso- and bathypelagic[a]
ELH pattern	Oviparous, pelagic larvae
Spawning[b]	Season: Sept-Apr (Japan)
Age at first maturity[b]	1 yr (males - then undergo sex reversal at 70-80 mm SL)
Longevity[b]	2 yr (females)
	1 yr (males)

EARLY LIFE HISTORY DESCRIPTION

EGGS (*G. denudatum*)

Diameter	0.80-0.81 mm
No. of oil globules	One
Oil globule diameter	0.20-0.21 mm
Yolk	
Envelope	
Hatch size	
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE (*G. gracile*)

Preanal length	
Length at flexion	
Length at transformation	
Sequence of fin development	Caudal, dorsal and anal, pectorals and pelvics

Pigment
- Internal head pigment
- Swimbladder and peritoneum

Diagnostic characters

G. gracile distinguished from other *Gonostoma* spp. by
- Anal fin origin extremely in advance of dorsal fin origin

G. gracile distinguished from *G. atlanticum* by
- Lack of pigment on caudal peduncle and body surface

G. atlanticum distinguished from *Cyclothone* spp. by
- Caudal and ventral pigment
- Swimbladder position

Photophores (see Table 10)
In *G. gracile* and *G. atlanticum*, photophores develop as a group. This differs from other species of *Gonostoma* where photophores develop gradually.

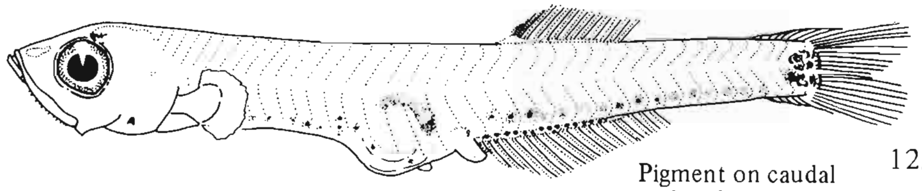
[a] *G. atlanticum* mesopelagic only.
[b] *G. gracile* only.

Ref: Ahlstrom 1974, Ahlstrom et al. 1984c, Kawaguchi and Marumo 1967, Ozawa 1986b, Sanzo 1931a.

GONOSTOMA

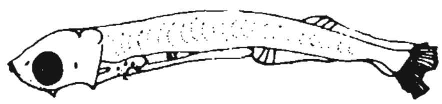
Gonostoma atlanticum

A

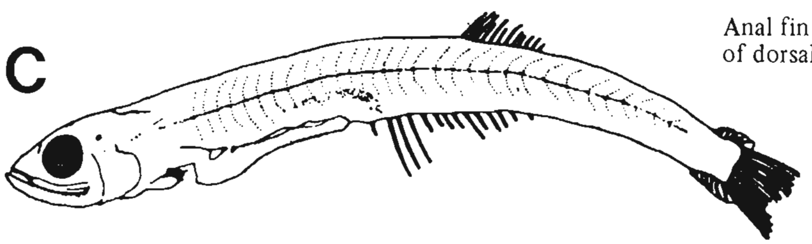


Gonostoma gracile

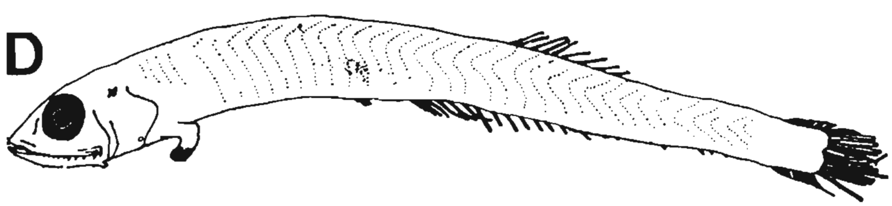
B



C



D



E

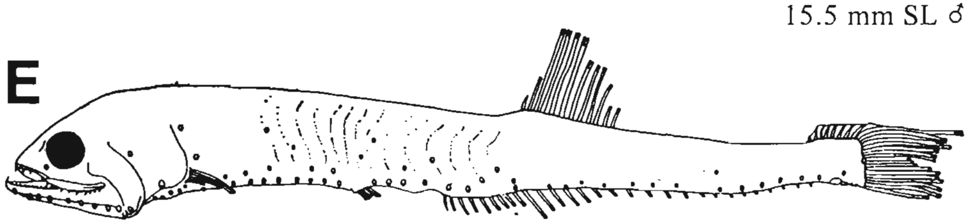


Figure A, Ahlstrom et al. 1984c (after Ahlstrom 1974); B–E, Kawaguchi and Marumo 1967 (western Pacific specimens).

STERNOPTYCHIDAE

Found in all temperate and tropical seas, hatchetfishes are represented in the northeastern Pacific by seven species in three genera. Adults are found 100-5000 m below the surface (Schultz 1961). Sternoptychid eggs and larvae are planktonic, constituting the third most abundant family in the ichthyoplankton of open ocean waters (after myctophids and gonostomatids) (Ahlstrom 1972, Loeb 1979). *Argyropelecus hemigymnus* has eggs ranging from 0.92 to 1.04 mm. The yolk is coarsely segmented and contains one oil globule (Ahlstrom 1974). Development of sternoptychids is distinctly divided into two periods (Sanzo 1935): Larval period, and the period of metamorphosis marked by a sharp reduction in body length, change in shape, and photophore and fin-ray development. Distribution and patterns of photophores, especially their sequence of development, are instrumental in larval identification. The following characters may aid in distinguishing between the three sternoptychid genera in the study area (see Tables 13-14).

	Argyropelecus	*Danaphos*	*Sternoptyx*
Anal fin rays	11-13	24-25	14-16
Pectoral fin rays	10-11	13-14	10-11
Vertebrae	34-40	38	28-31
Adipose fin	Present/absent	Absent	Absent
Photophores			
Br	6	6	3
Orb	2	1	2
IV	18	18	15
VAV	4	5	3
AC	10	22-26	7

Table 13
Meristic characters of family Sternoptychidae.

Taxon	Distribution	Vertebrae: Precaudal Caudal (Total)	Fins: Dorsal	Fins: Anal	Fins: Pectoral	Fins: Pelvic	Fins: Caudal	Gill rakers: Upper Lower (Total)	Branchiostegals
Argyropelecus affinis	SSC-Oregon	(39-41)	9	12-13	10-11	6	10-12,10+9,4	(18-22)	10
Argyropelecus hemigymnus	SSC-Wash.	(37-39)	8	11	10-11	6	10,10+9,5	(18-24)	10
Argyropelecus lychnus	SSC-Brit. Col.	(35-37)	9	12	10-11	6	9-11,10+9,6	8-9 12-14	10
Argyropelecus sladeni	SSC-Oregon	(36-38)	9	12	10-11	6	10,10+9,6	(17-21)	10
Danaphos oculatus	SSC-Brit. Col.	(38)	6	24-25	10-11		8,10+9,3	2 11-13	10
Sternoptyx diaphana	SSC-Oregon	(28-30)	9-11	13-16	10-11			6-9	6
Sternoptyx pseudobscura	SSC-Brit. Col.	(27-30)	9-11	13-15	10-11			7-9	6

Table 14
Characters useful in separating larvae of *Argyropelecus* found in the Northeast Pacific (Belyanina 1984, in part).

Character	*A. affinis*	*A. hemigymnus*	*A. lychnus*	*A. sladeni*
Photophores: SAB, PAN, AN, SC in a continuous row*	Yes	No	No	No
Caudal pigment	At or before transformation (~8 mm SL)	At or before transformation (~8 mm SL)	No	>13 mm SL
Number of postabdominal spines	2	1 (posterior one reduced)	2	2
Number of dorsal fin rays	9	8	9	9
Eye shape (telescopic)	Round	Cylindrical	Round	Round
Presence of well-developed upper preopercular spine	No	No	Yes (pointed downward)	Yes (pointed upward)
Presence of frontal crest	No	No	Yes	Yes

*See Table 9 for definitions of symbols.

MERISTICS

Vertebrae	Total: 39-X-41 Precaudal: X-X-X Caudal: X-X-X
Branchiostegal rays	10-10-10
Caudal fin	10-12, 10+9, 4
Pelvic fin	Abdominal R: 6-6-6
Dorsal fin	R: 9-9-9
Pectoral fin	R: 10-11-11
Anal fin	R: 12-X-13
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to Oregon, 42-46°N
Ecology	Epi- and mesopelagic, 100-610 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

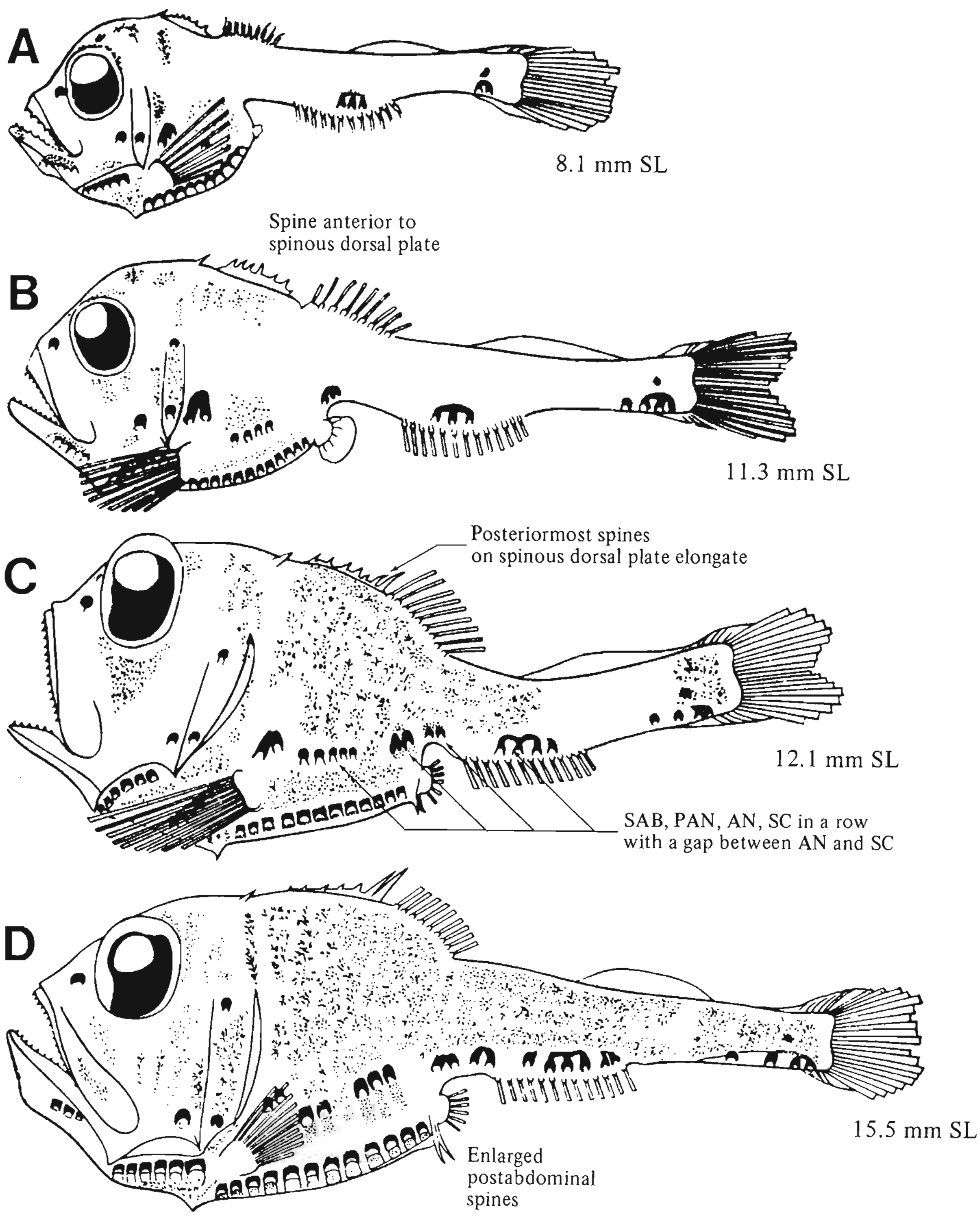
LARVAE

Preanal length	<50% SL increasing with development to ∼50% SL
Length at flexion	
Length at transformation	<8.1 mm SL
Sequence of fin development	Caudal and pectorals, dorsal and anal, pelvics

Pigment
- Initially, lightly pigmented on anterior body, increases posteriorly with development
- Characteristic spot occurs on caudal peduncle above subcaudal photophores; in larvae >11 mm SL, spot increases to a patch

Diagnostic characters
- Photophores: *A. affinis* distinguished by the location of supra-abdominal (SAB), preanal (PAN), anal (AN), and subcaudal (SC) photophores in a continuous straight line; AN and SC groups are separated by a gap
- Eyes telescopic
- Spines
  —At 8 mm SL, a spine anterior to spinous dorsal plate
  —At 11 mm SL, long posteriormost spine on spinous dorsal plate
  —At >11 mm SL, enlarged postabdominal spines

Ref: Ahlstrom et al. 1984c, Belyanina 1984.



Figures A–D, Belyanina 1984.

MERISTICS

Vertebrae	Total: 37-X-39
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	10-10-10
Caudal fin	10, 10+9, 5
Pelvic fin	Abdominal
	R: 6-6-6
Dorsal fin	R: 8-8-8
Pectoral fin	R: 10-X-11
Anal fin	R: 11-11-11
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to Washington, 46-48°30′N
Ecology	Epi- and mesopelagic, 100-731 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	0.92-1.04 mm
No. of oil globules	One
Oil globule diameter	0.26-0.28 mm
Yolk	Segmented
Envelope	
Hatch size	2.5 mm SL; yolk absorbed 4.7 mm SL
Incubation time/temp.	2-2.5 d (temperature unknown)

Pigment
- Embryo unpigmented

Diagnostic characters

LARVAE

Preanal length	<50% SL increasing with development to ~50% SL
Length at flexion	
Length at transformation	>6 mm SL; body shrinks 2-3 mm, gut shortens, head deepens, and eyes become telescopic
Sequence of fin development	Caudal and pectorals, dorsal and anal, pelvics

Pigment
- Unpigmented at hatching (except eyes) and through transformation
- After transformation, pigment appears on head in patches and on caudal peduncle

Diagnostic characters
- Elongate compressed body
- Photophores and sequence of development (~6-10 mm SL): Lower OP, BR, posterior IV, anterior IV, posterior AC, anterior AC, OA, ORB, and VAV
- SAB, PAN, AN, and SC photophores not in continuous row
- Postabdominal spines: In larvae >10-12 mm SL, anterior spine becomes thinner and elongated and bends under the posterior spine; posterior spine gradually reduces and becomes spur-shaped
- Number of dorsal fin rays (eight); other sternoptychids usually have nine
- Eye shape more cylindrical than other *Argyropelecus* spp.

Ref: Ahlstrom et al. 1984c, Belyanina 1984, Fahay 1983, Sanzo 1931a.

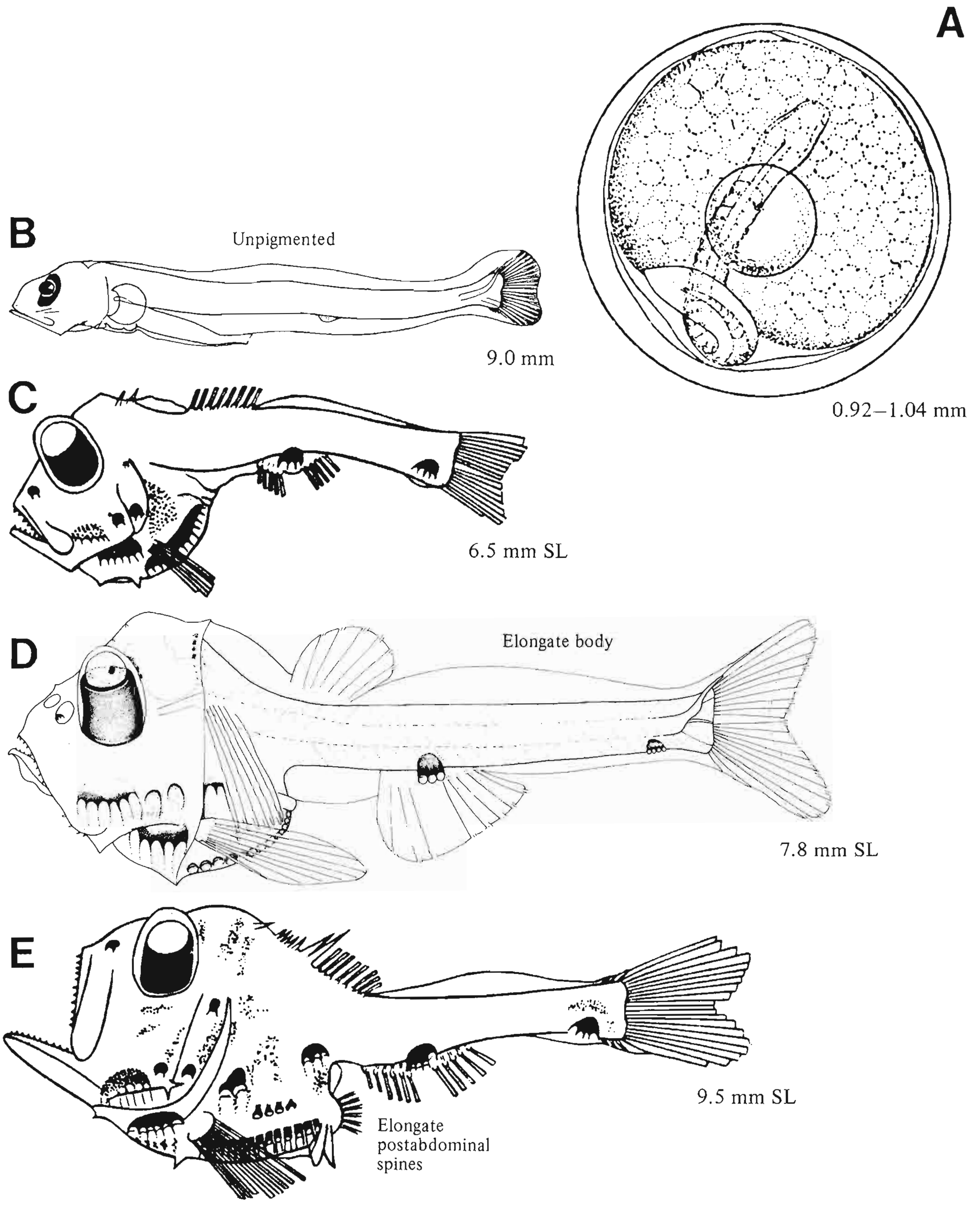


Figure A, Sanzo 1931a; B, Jespersen and Taning 1926; C, E, Belyanina 1984; D, Ahlstrom et al. 1984c (after Sanzo 1931a; A–B, D, Mediterranean specimens).

MERISTICS

Vertebrae	Total: 35-X-37
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	10-10-10
Caudal fin	9-11, 10+9, 6
Pelvic fin	Abdominal
	R: 6-6-6
Dorsal fin	R: 9-9-9
Pectoral fin	R: 10-X-11
Anal fin	R: 12-12-12
Gill rakers	U: 8-X-9 L: 12-X-14

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Epi-, meso-, and bathypelagic, 198-396 m; 4066 m[a]
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

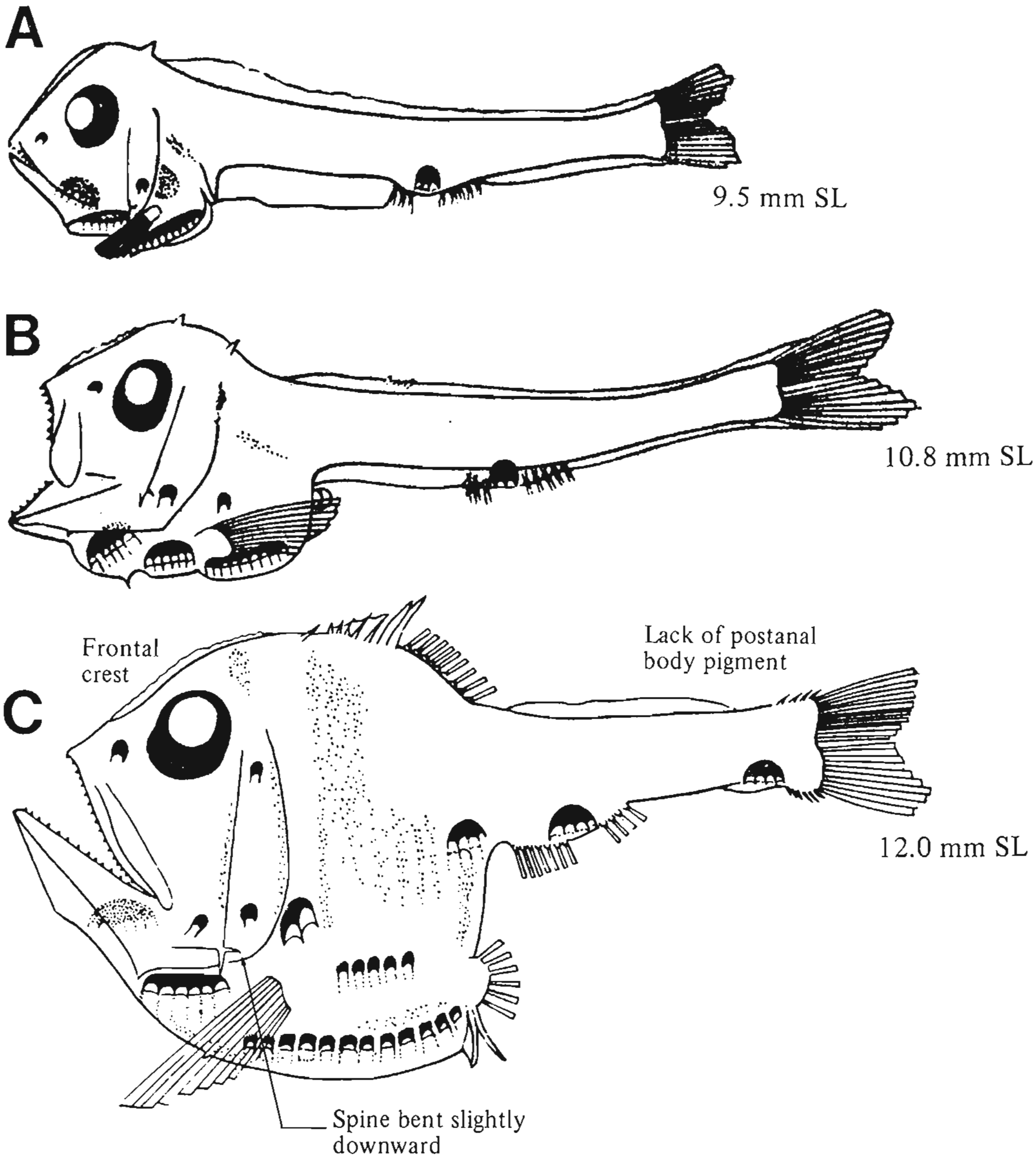
Preanal length	50-60% SL
Length at flexion	
Length at transformation	
Sequence of fin development	Caudal and pectorals, dorsal and anal, pelvics

Pigment
- Lightly pigmented, restricted to preanal body

Diagnostic characters
- Upper preopercular spine bent downward whereas same spine in *A. sladeni* is pointed slightly upward
- Pigmentation: Specimens described to 15 mm SL appear to lack pigment on postanal body, specifically in the peduncle area
- Presence of frontal crest

[a] Hart 1973

Ref: Ahlstrom et al. 1984c, Belyanina 1984.



Figures A–C, Belyanina 1984.

MERISTICS

Vertebrae	Total: 36-X-38
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	10-10-10
Caudal fin	10, 10+9, 6
Pelvic fin	Abdominal
	R: 6-6-6
Dorsal fin	R: 9-9-9
Pectoral fin	R: 10-X-11
Anal fin	R: 12-12-12
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to Oregon, 42-46°N
Ecology	Epi- and mesopelagic, 101-610 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

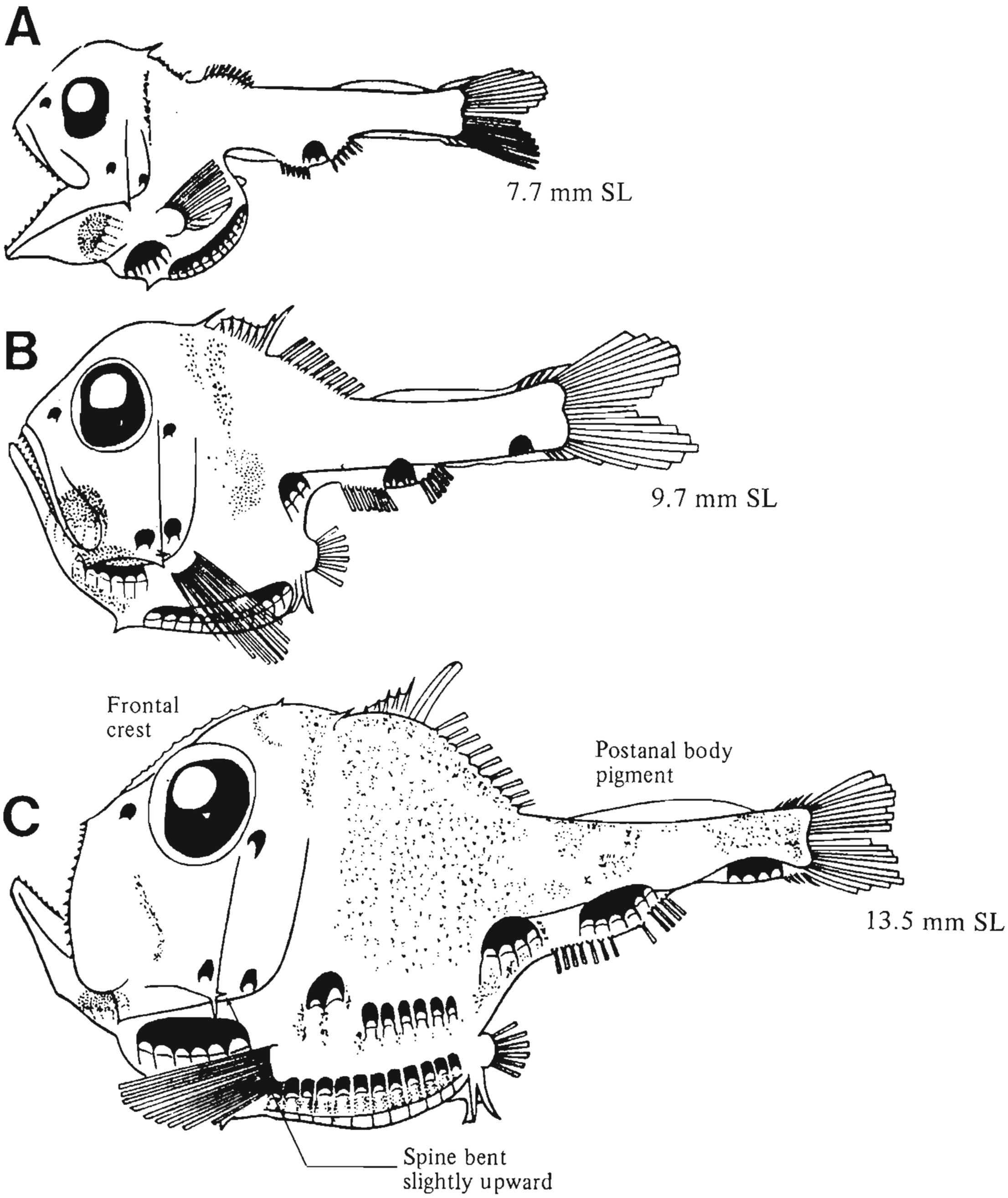
Preanal length	50-60% SL
Length at flexion	
Length at transformation	
Sequence of fin development	Caudal and pectorals, dorsal and anal, pelvics

Pigment
- Initially, appears anteriorly on body in patches and, with development, increases posteriorly
- Spot on peduncle does not appear as early as *A. affinis*, first appearing as a patch in larvae >13 mm SL

Diagnostic characters
- Spines: Upper preopercular spine is developed (pointed slightly upward) and short frontal crests are present

Distinguished from *A. affinis* and *A. hemigymnus* by
- Combination of nine dorsal spines and SAB, PAN, AN, and SC photophores not in continuous line

Ref: Ahlstrom et al. 1984c, Belyanina 1984.



Figures A–C, Belyanina 1984.

MERISTICS *S. diaphana* Hermann 1781

Vertebrae	Total: 28-29-30
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	6-6-6
Pelvic fin	Abdominal
	R: X-X-X
Dorsal fin	R: 9-10-11
Pectoral fin	R: 10-X-11
Anal fin	R: 13-14-16
Gill rakers	U: X-X-X L: X-X-X

MERISTICS *S. pseudobscura* Baird 1971

Vertebrae	Total: 27-29-30
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	6-6-6
Pelvic fin	Abdominal
	R: X-X-X
Dorsal fin	R: 9-10-11
Pectoral fin	R: 10-X-11
Anal fin	R: 13-14-15
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N[a]
Ecology	Meso- and bathypelagic
ELH pattern	Oviparous, eggs probably pelagic, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE - Genus[b]

Preanal length
Length at flexion
Length at transformation 6-14 mm SL[c]
Sequence of fin development Pectorals and caudal, anal, dorsal and pelvics
Pigment
- Head and tip of lower jaw
- Peritoneum, becoming embedded with development
- Presence/absence of pigment on caudal peduncle; according to Belyanina (1983) some specimens of *S. diaphana* have pigment whereas specimens of *S. pseudobscura* have none[d]

Diagnostic characters
- Prior to metamorphosis, larvae of the two species are indistinguishable; both with spiny ridges on frontal and parietal bones, opercular and post-temporal spines

Distinguish *S. pseudobscura* juveniles from *S. diaphana* by
- Rounder body
- Posterior anal pterygiophores longer
- SAN higher in position

Photophores (see Table 10)
Order of development in *Sternoptyx* spp. larvae: SO, Br2, AB7, I4, SP3, PTO, AN1 followed by PAN, SC, PRO, and SAN in early juveniles; finally SC.

---

[a] *S. diaphana* only to Oregon, 42-46°N.
[b] Although not well documented, geographic variation among and within species is clearly present.
[c] A dramatic change in morphology occurs at transformation. Elongate larvae become deep-bodied juveniles. Body length cannot be associated with development.
[d] Badcock and Baird (1980) cite a personal communication from E.H. Ahlstrom stating that neither of the two forms of *Sternoptyx* spp. from the study area have caudal pigment. A figure of *S. pseudodiaphana* is provided as an example of an early larva with caudal pigment.

Ref: Badcock and Baird 1980, Belyanina 1983.

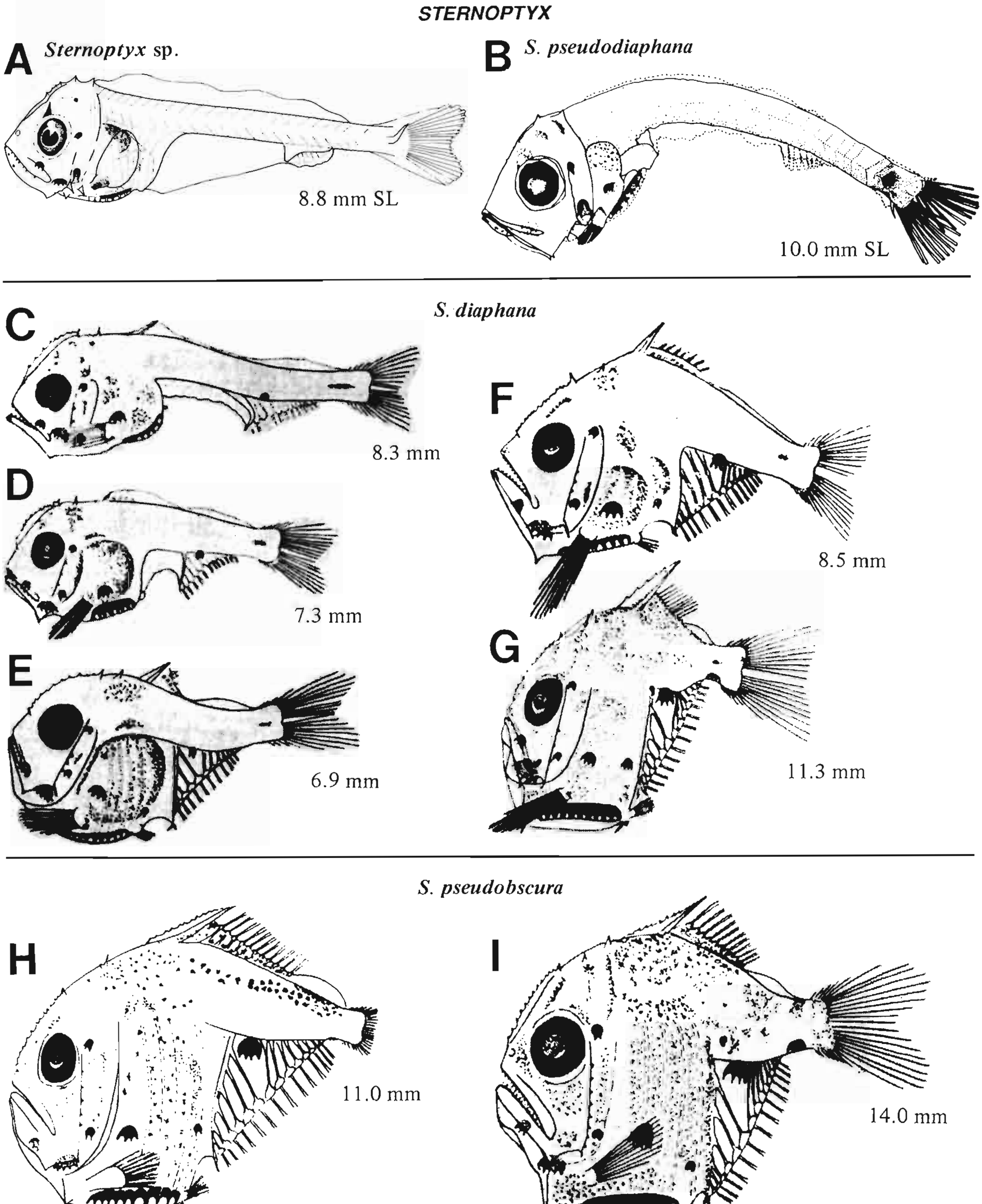


Figure A, Ahlstrom et al. 1984c; B, Badcock and Baird 1980 (eastern North Atlantic specimen); C–I, Belyanina 1984.

MERISTICS

Vertebrae	Total: 38-38-38
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	10-10-10
Caudal fin	8, 10+9, 3
Pelvic fin	Abdominal
	R: X-X-X
Dorsal fin	R: 6-6-6
Pectoral fin	R: 10-X-14
Anal fin	R: 24-X-25
Gill rakers	U: 2-2-2 L: 11-X-13

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Mesopelagic, 183-914 m
ELH pattern	Oviparous, eggs probably pelagic, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length	<50% SL (short gut)
Length at flexion	
Length at transformation	∿45-50 mm SL
Sequence of fin development	

Pigment
- Concentrated on preanal body in area below eye and over gut; smaller larvae generally unpigmented except over peritoneum

Diagnostic characters
- Larvae elongate
- Photophores begin formation ∿16.5 mm SL (see Table 15)
- Photophores in clusters with common bases
- Metamorphosis gradual with the initial formation of photophores in the BR and PV groups

Distinguished from *Argyropelecus* spp. and *Sternoptyx* spp. by
- Long anal fin (24-25 fin rays) and short dorsal fin (6 fin rays)

Ref: Ahlstrom 1974, Ahlstrom et al. 1984c.

Table 15

Development of photophores in *Danaphos oculatus* (Ahlstrom et al. 1984c).* See Table 9 for definitions of photophore groups.

Size (mm SL)	Photophore groups								
	ORB	OP	SO	BR	IP	PV	VAV	AC	OA
Adult	1	3	0	(6)	(3)+(4)	(11)	(5)	(3)+16+(4)+1	6
16.5	0	0	0	(2)	0	0	0	0	0
16.5	0	0	0	(3)	0	(3)	0	0	0
19.2	0	0	0	(4)	0	(10)	0	0	0
21.0	1	1	0	(5)	(2)+(4)	(10/11)	0	(2)+0+0+0	0
21.3	1	1	0	(4/5)	(3)+(4)	(10)	0	(3)+0+(2)+0	0
21.8	1	2	0	(5)	(3)+(4)	(11)	(2)	(3)+8+(4)+0	2
24.2	1	2	0	(6)	(3)+(4)	(11)	(2)	(3)+9+(4)+0	2

*Parenthetical numbers indicate photophores found in common glands; nonparenthetical numbers indicate photophores are single.

A

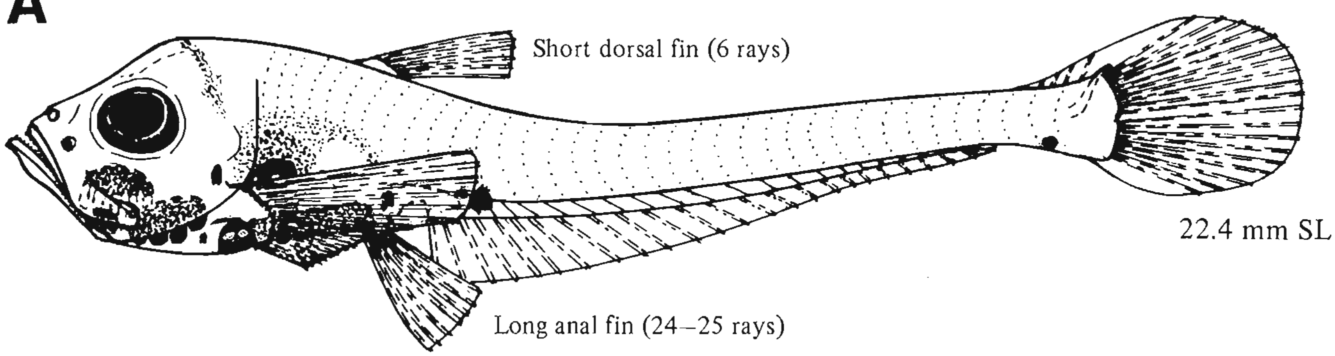


Figure A, NWAFC original (B. Vinter).

Table 16

Meristic characters of stomioid genera. Most frequent count or range is followed by overall range or infrequent count in parentheses (Kawaguchi and Moser 1984, in part).

Taxon	Vertebrae	Fin rays: Dorsal	Fin rays: Anal	Fin rays: Pectoral	Fin rays: Pelvic
Chauliodontidae					
Chauliodus	51-62	6,7 (5-7)	10-12(10-13)	12,13(11-14)	7(6-8)
Melanostomiidae					
Bathophilus	38-45(33-50)	13-16 (9-18)	15-16 (9-18)	1-37	11-16(4-26)
Eustomias	56-69	21-25(20-30)	32-46	0-13	7(6-8)
Opostomias	60	21	24	1+4	8
Tactostoma	80-82	14-16	19-22	0	8-10
Malacosteidae					
Aristostomias	44-56	18-26	24-32	6-10 (3-17)	6
Idiacanthidae					
Idiacanthus	79-85	54-74	34(33-39)	0	6

Table 17

Photophore counts of stomioid genera. Most frequent count or range is followed by overall range or infrequent count in parentheses (Kawaguchi and Moser 1984, in part). Photophore groups as defined by Ahlstrom et al. (1984c) (see Table 9).

Taxon	Photophore groups: IP	PV	VAV	AC	OV	VA
Chauliodontidae						
Chauliodus	8-11	17-23	22-30	8-13	17-21	22-29
Melanostomiidae						
Bathophilus	5(4-6)	12-18	11-13(11-17)	5-7 (5-9)	13-14(10-16)	9-11 (8-17)
Eustomias	7-8(9)	27-33(24-36)	13-17(11-21)	17-23(15-25)	26-33(24-37)	13-18(12-22)
Opostomias	4+4	27	17	16	27	17
Tactostoma	8	46	19	12	43	18
Malacosteidae						
Aristostomias	5+3	15-17(14-19)	15-18	9-11(12)	16-19(14-20)	15-17(14-18)
Idiacanthidae						
Idiacanthus	IP+PV=31-36		16-18(15)	13-18	22-25	31-35(30-36)

Table 18

Pigment characters and gut structure (NT = not trailing, T = trailing freely) in larvae and transforming specimens of stomioids (Kawaguchi and Moser 1984, in part).

Taxon	Length of larvae (mm)	Length of transforming specimens (mm)	Dorsal myomere melanophores (*n*/myomere)	Epaxial myoseptum melanophores (*n*/myoseptum)	Hypaxial myoseptum melanophores (*n*/myoseptum)	Gut structure
Chauliodontidae						
Chauliodus macouni	38-49	35-44	0	0	0	NT*
Melanostomiidae						
Bathophilus flemingi	2.9-23.8	—	1 to several	0	0	NT
Eustomias sp.	33	—	7 total	0	0	T
Eustomias sp.	13	—	7 total	0	0	T
Eustomias spp. (4 types)	6-45	—	5-11 total	0	0	T
Opostomias mitsuii	15-21	—	1	0-1 (2-3 posteriorly)	1-2 (3-5 posteriorly)	NT
Tactostoma macropus	5-44	49	0-1	0	1-3	NT
Malacosteidae						
Aristostomias scintillans	43-47	45	14 total	0	0	T
Idiacanthidae						
Idiacanthus antrostomus	4.5-71	67>	0	0	1	T

*Trails slightly.

MERISTICS

Vertebrae	Total: 56-60-62 Precaudal: 56-56-56 Caudal: 4-4-4
Branchiostegal rays	16-X-21
Caudal fin	X, 10+9, X
Pelvic fin	Abdominal R: 6-7-8
Dorsal fin	R: 5-6-7
Pectoral fin	R: 10-X-13
Anal fin	R: 10-X-13
Gill rakers	U: 3-3-3 L: 8-8-8

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Epi-, meso-, and bathypelagic, 76-4231 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	>8 yr[a]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	2.69-3.17 mm
No. of oil globules	None
Oil globule diameter	
Yolk	Segmented
Envelope	Smooth, clear
Hatch size	6-7 mm SL
Incubation time/temp.	

Pigment
- Pigment in caudal region of yolksac larvae, but soon disappears

Diagnostic characters
- Wide perivitelline space, 0.5 mm
- Yolk segmented
- Large egg size

LARVAE

Preanal length	Long, >75% SL
Length at flexion	>15 mm SL
Length at transformation	Adult ~35-46 mm SL[b]
Sequence of fin development	Dorsal, anal, and pelvics form late in postflexion larvae in adult position

Pigment
- According to Kawaguchi and Moser (1984), unpigmented except for fan-shaped caudal finfold in yolksac larvae. We have not collected any yolksac larvae and therefore have not observed this pigment. A figure of a yolksac *C. sloani* is included for comparison only.

Diagnostic characters
- Morphology: Small head, elliptical eyes, long gut, slender body
- Median finfold shape
- Lack of pigmentation
- Slightly trailing gut

[a]Fitch and Lavenberg 1968
[b]Marked shrinkage at transformation.

Ref: Kawaguchi and Moser 1984.

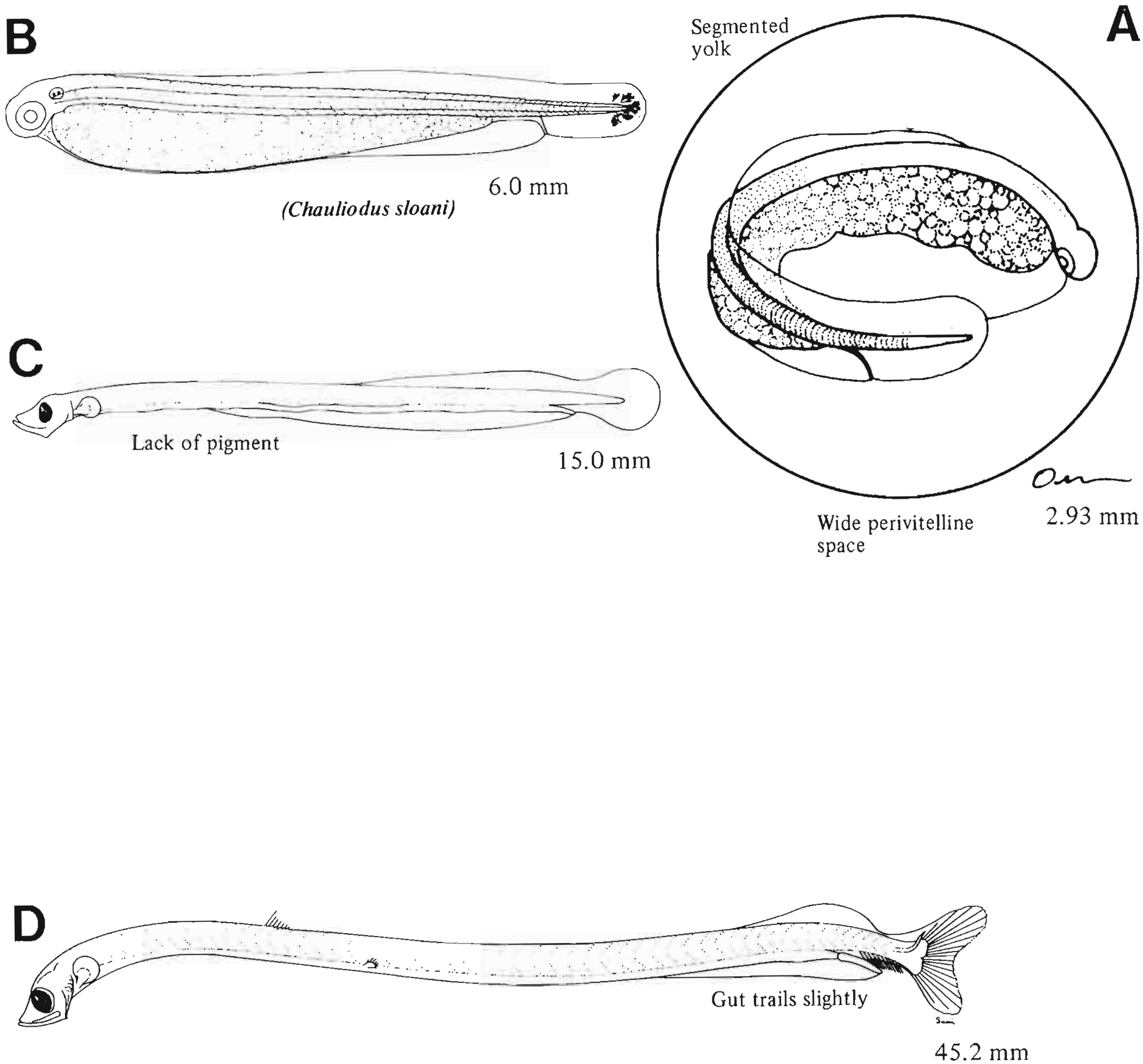


Figure A, Matarese and Sandknop 1984; B, Mito 1961 (western Pacific specimen); C–D, Kawaguchi and Moser 1984.

MERISTICS

Vertebrae	Total: 44-46-48
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	10-10-10
Caudal fin	X, 10+9, X
Pelvic fin	Abdominal
	R: 15-15-17
Dorsal fin	R: 15-15-16
Pectoral fin	R: 4-5-7, jugular
Anal fin	R: 16-17-17
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Meso- and bathypelagic
ELH pattern	Parity and eggs unknown, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

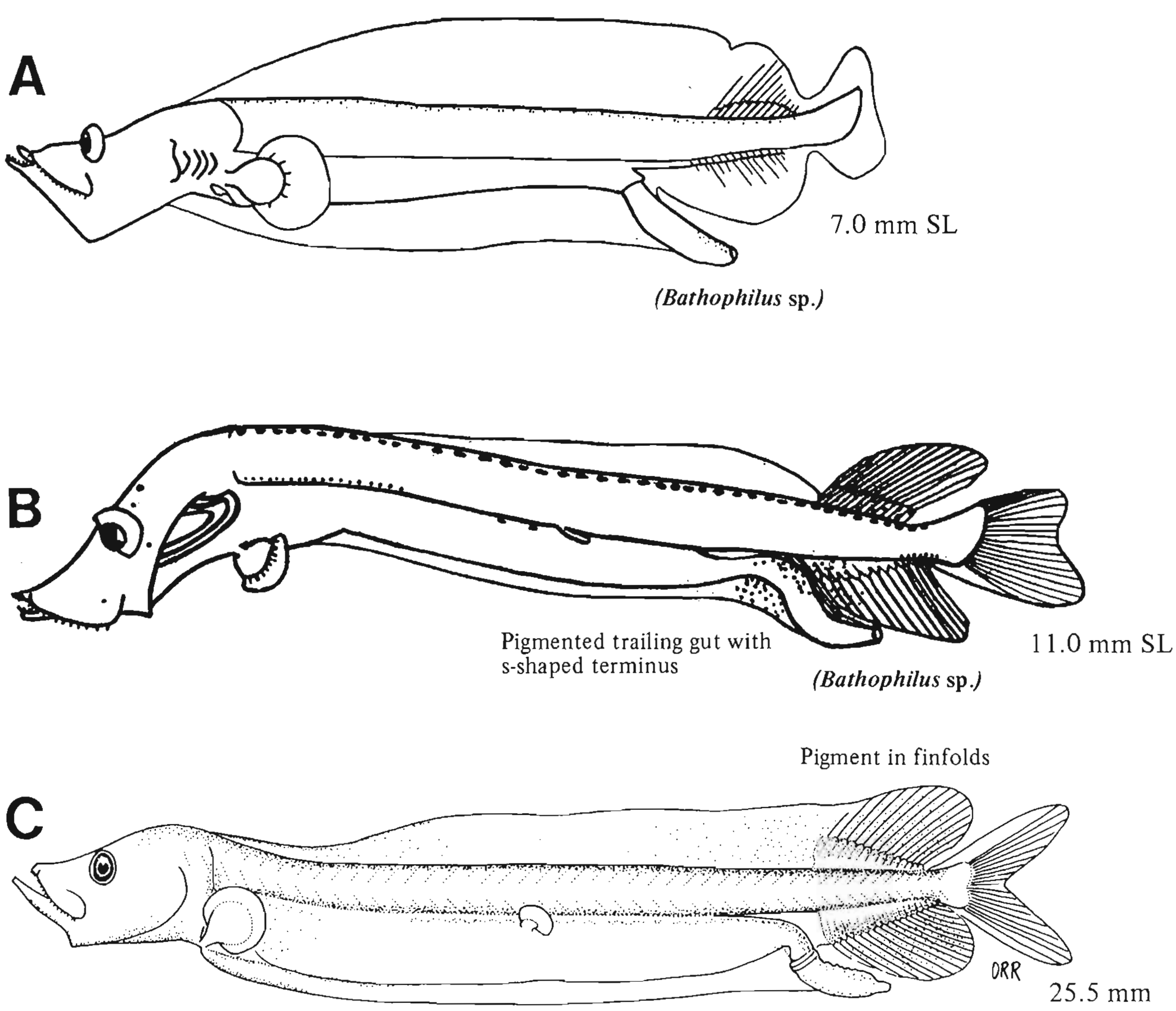
LARVAE

Preanal length	>75% SL
Length at flexion	
Length at transformation	≤25 mm SL
Sequence of fin development	Dorsal, anal, and caudal before pectorals and pelvics

Pigment
- One to several melanophores per myomere along dorsum with opposing series along ventral surface
- Head, finfolds, median fins
- Anterodorsal surface of gut and on hindgut
- Pigment more concentrated in larger specimens

Diagnostic characters
- Deep bodied
- Large head, jaws
- Gut large (highly developed trailing s-shaped terminus)
- No midlateral pigment
- Large pigmented median finfolds
- Origin of dorsal and anal fin opposite each other

Ref: Kawaguchi and Moser 1984, Ozawa and Aono 1986.



Figures A–B, Beebe and Crane 1939 (North Atlantic specimens); C, Kawaguchi and Moser 1984.

MERISTICS

Vertebrae	Total: 72-X-78
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	X-X-X
Caudal fin	X, 10+9, X
Pelvic fin	Abdominal?
	R: 6-X-8
Dorsal fin	R: 20-X-30
Pectoral fin	R: 0-X-13
Anal fin	R: 32-X-46
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	Oregon, 42-46°N
Ecology	
ELH pattern	Parity and eggs unknown, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE - Genus

Preanal length	>75% SL (trailing gut)
Length at flexion	
Length at transformation	~45 mm SL
Sequence of fin development	

Pigment
- 5-11 large melanophores along dorsal midline
- Lower jaw symphysis

Diagnostic characters
- Morphology: Slender body, head elongate and flat
- Gut: Long, slender, deflected ventrad at anal fin origin, trailing from body
- Dorsal pigment patches
- Origin of dorsal fin behind that of anal fin

Distinguished from *Aristostomias scintillans* (p. 118) by
- Unpigmented gut
- Lack of ventral body pigment
- <20 dorsal spots (5-11)

[a] Possibly 1-4 species in the area, although only one larval form has been collected.

Ref: Kawaguchi and Moser 1984, Ozawa and Aono 1986.

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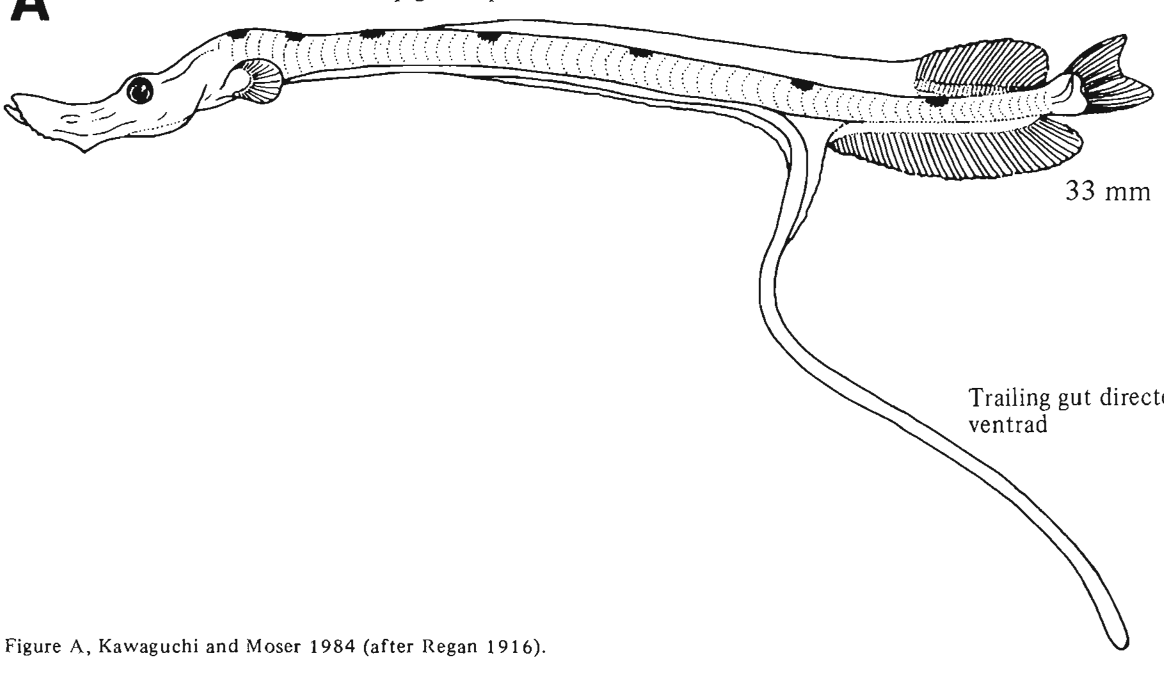

Figure A, Kawaguchi and Moser 1984 (after Regan 1916).

MERISTICS

Vertebrae	Total: X-X-X
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	10-X-15
Caudal fin	X, 10+9, X
Pelvic fin	Abdominal
	R: 7-X-8
Dorsal fin	R: 21-X-23
Pectoral fin	R: 5-5-5
Anal fin	R: 21-X-24
Gill rakers	U: 2-2-2 L: 8-8-8

LIFE HISTORY

Range	S. California, 32-34°N, to Brit. Col., 48°30′-55°N
Ecology	Epi- and mesopelagic
ELH pattern	Parity and eggs unknown, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length
Length at flexion
Length at transformation
Sequence of fin development Caudal, dorsal, and anal before pectorals and pelvics
Pigment
- One expanded melanophore per myomere along dorsum
- 1-2 melanophores on each hypaxial myoseptum
- Area under dorsal fin appears banded
- Dorsally on head
- Gill arch
- Gut terminus

Diagnostic characters
- Morphology
  —Moderately deep body
  —Large mouth
  —Large finfold
  —Elongate sloping snout
  —Eyes small
  —No trailing gut
- Pigment pattern
- Origin of dorsal fin slightly before that of anal fin
- 13-15 myomeres between pelvic and anal fins

Ref: Kawaguchi and Moser 1984, Ozawa and Aono 1986.

A

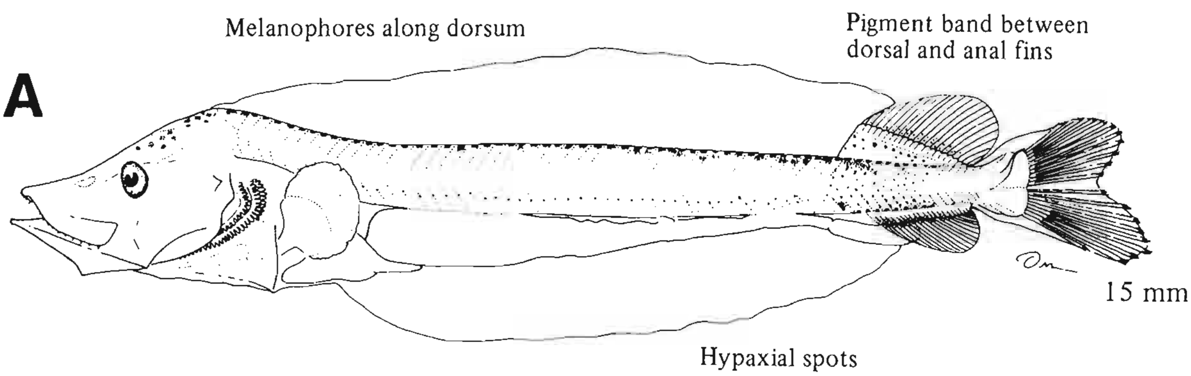

Figure A, Kawaguchi and Moser 1984 (western Pacific specimen).

MERISTICS

Vertebrae	Total: 80-X-82 Precaudal: X-X-X Caudal: X-X-X
Branchiostegal rays	13-13-13
Caudal fin	X, 10+9, X
Pelvic fin	Abdominal R: 8-9-10
Dorsal fin	R: 14-X-17
Pectoral fin	Absent in adults
Anal fin	R: 19-19-22
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Epi- and mesopelagic, 31-549 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Summer (Oregon)[a] Area: Mode: Migration:
Fecundity	Range/function: 24,000-66,000 (one spawn/year)[a]
Age at first maturity	6 yr (females)[a]
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.39-1.54 mm
No. of oil globules	One
Oil globule diameter	0.3-0.4 mm
Yolk	Segmented
Envelope	Smooth
Hatch size	5 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters
- Oil globule large and ventral
- Egg round

LARVAE

Preanal length	>75% SL
Length at flexion	
Length at transformation	44-49 mm SL
Sequence of fin development	Caudal, dorsal and anal, pectorals and pelvics

Pigment
- In early larvae, one melanophore per myomere along dorsum and 1-3 melanophores on hypaxial myosepta; postflexion larvae gradually lose the dorsal then ventral melanophores
- Lower jaw, isthmus, pectoral fin base, cleithrum, gut terminus, caudal peduncle

Diagnostic characters
- Morphology: Body elongate and flat, gut slender, finfold moderate
- Pectoral fin lost at transformation
- Decrease in pigment with development
- No trailing gut
- Finfolds unpigmented

Distinguished from *Chauliodus macouni* (p. 108) by
- Presence of pigment
- Posterior position of dorsal fin (origin of dorsal and anal fin opposite each other)

[a]Fisher and Pearcy 1983

Ref: Kawaguchi and Moser 1984, Ozawa and Aono 1986.

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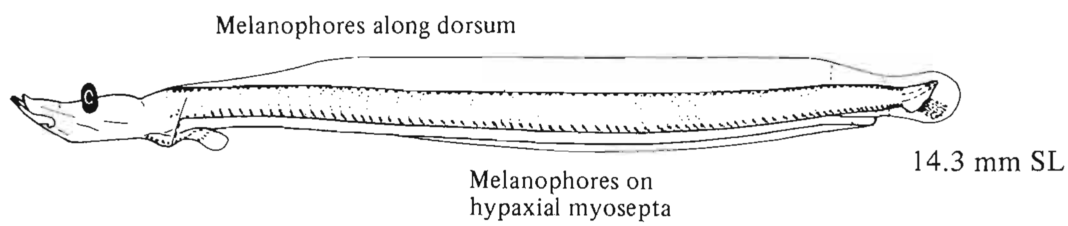

B

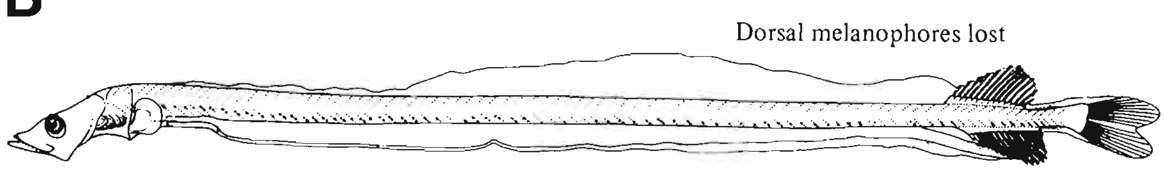

Figure A, NWAFC original (B. Vinter); B, Kawaguchi and Moser 1984.

MERISTICS

Vertebrae	Total: 54-54-54
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	8-8-8
Caudal fin	X, 10+9, X
Pelvic fin	Abdominal
	R: 6-X-7
Dorsal fin	R: 21-X-23
Pectoral fin	R: 4-X-8
Anal fin	R: 25-X-29
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Epi- and mesopelagic
ELH pattern	Parity and eggs unknown, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length
Length at flexion
Length at transformation 45 mm SL
Sequence of fin development Dorsal, anal, and caudal; pectorals, pelvics
Pigment
- Series of paired melanophores along dorsum; initially 14 pairs which increase in number with development
- Paired ventral series develops initially posteriorly and increases in number with development
- Brain, snout, lower jaw, otic region, gular-isthmus region, caudal fin, gut

Diagnostic characters
- Morphology: Body and gut slender, trailing gut, large flat head, finfold moderate

Distinguished from *Eustomias* spp. (p. 112) by
- Pigment on trailing gut
- Pigment along ventral midline

Ref: Kawaguchi and Moser 1984.

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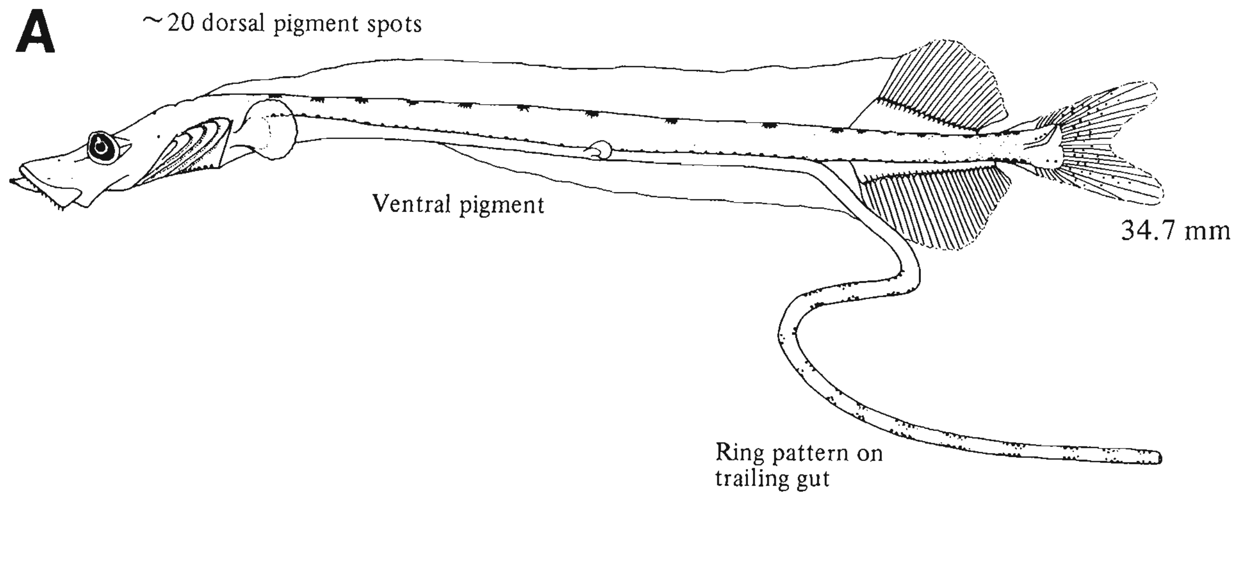

Figure A, Kawaguchi and Moser 1984.

MERISTICS

Vertebrae	Total: 81-X-83 Precaudal: X-X-X Caudal: X-X-X
Branchiostegal rays	12-X-18
Caudal fin	X, 10+9, X
Pelvic fin[a]	Abdominal R: 6-6-6
Dorsal fin	R: 54-X-66
Pectoral fin	Absent in adults
Anal fin	R: 28-X-43
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to N. California, 38-42°N
Ecology	Meso- and bathypelagic
ELH pattern	Parity and eggs unknown, pelagic larvae
Spawning	Season: Area: Mode: Migration:
Fecundity	Range/function: 14,000[a]
Age at first maturity	
Longevity	>6 yr (females)[a] <1 yr (males)[a]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length
Length at flexion
Length at transformation 35-70 mm SL
Sequence of fin development Caudal, dorsal and anal, pectorals,[b] pelvics[c]
Pigment - Genus
- Melanophore on posterior margin of each hypaxial myomere
- Isthmus
- Series along trailing gut

Diagnostic characters - Genus
- Morphology
  - —Extremely slender body
  - —Elongate flat head
  - —Elliptical eyes on stalks with cartilaginous support rods (27% BL)
  - —Trailing gut
  - —Small finfold

Distinguished from *I. fasciola* by
- Longer eye stalk and trailing gut

Since specimens are often damaged and pigment patterns are similar, the two species may be difficult to separate. In addition to the above characters, the two species differ in size at various stages of development. *I. antrostomus* larvae are 4.5-71.0 mm SL, transforming at sizes >67 mm SL. *I. fasciola* larvae are 16-28 mm SL, transforming at sizes between 35 and 48 mm SL.

[a] Fitch and Lavenberg 1968
[b] Pectoral fins lost at transformation.
[c] Pelvic fins develop in transforming females.

Ref: Kawaguchi and Moser 1984.

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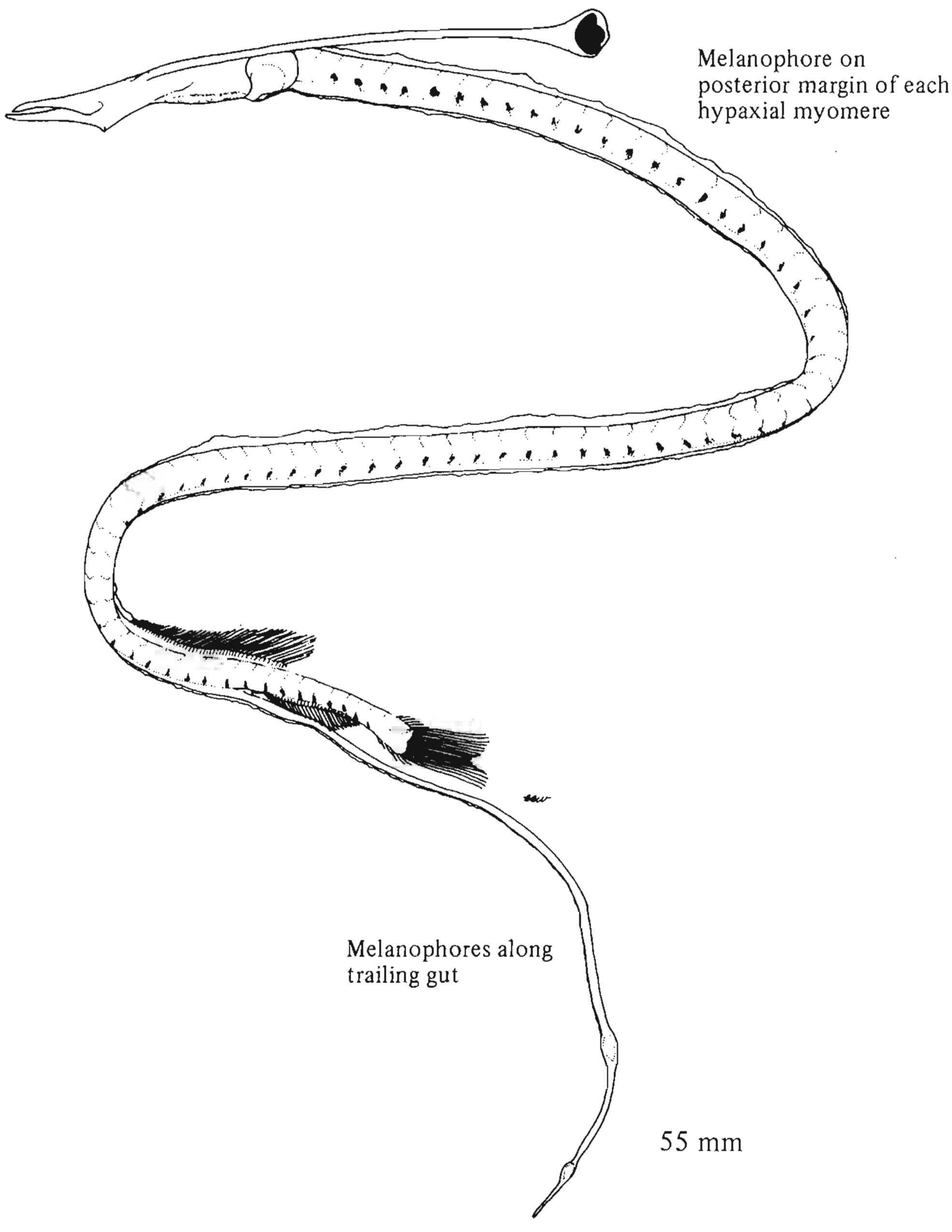


Figure A, Kawaguchi and Moser 1984.

MERISTICS

Vertebrae	Total: X-X-X Precaudal: X-X-X Caudal: X-X-X
Branchiostegal rays	12-X-18
Caudal fin	X, 10+9, X
Pelvic fin	Abdominal R: 6-6-6
Dorsal fin	R: 56-X-77
Pectoral fin	Absent in adults
Anal fin	R: 38-X-54
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to Oregon, 42-46°N
Ecology	Meso- and bathypelagic
ELH pattern	Parity and eggs unknown, pelagic larvae
Spawning	Season: Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

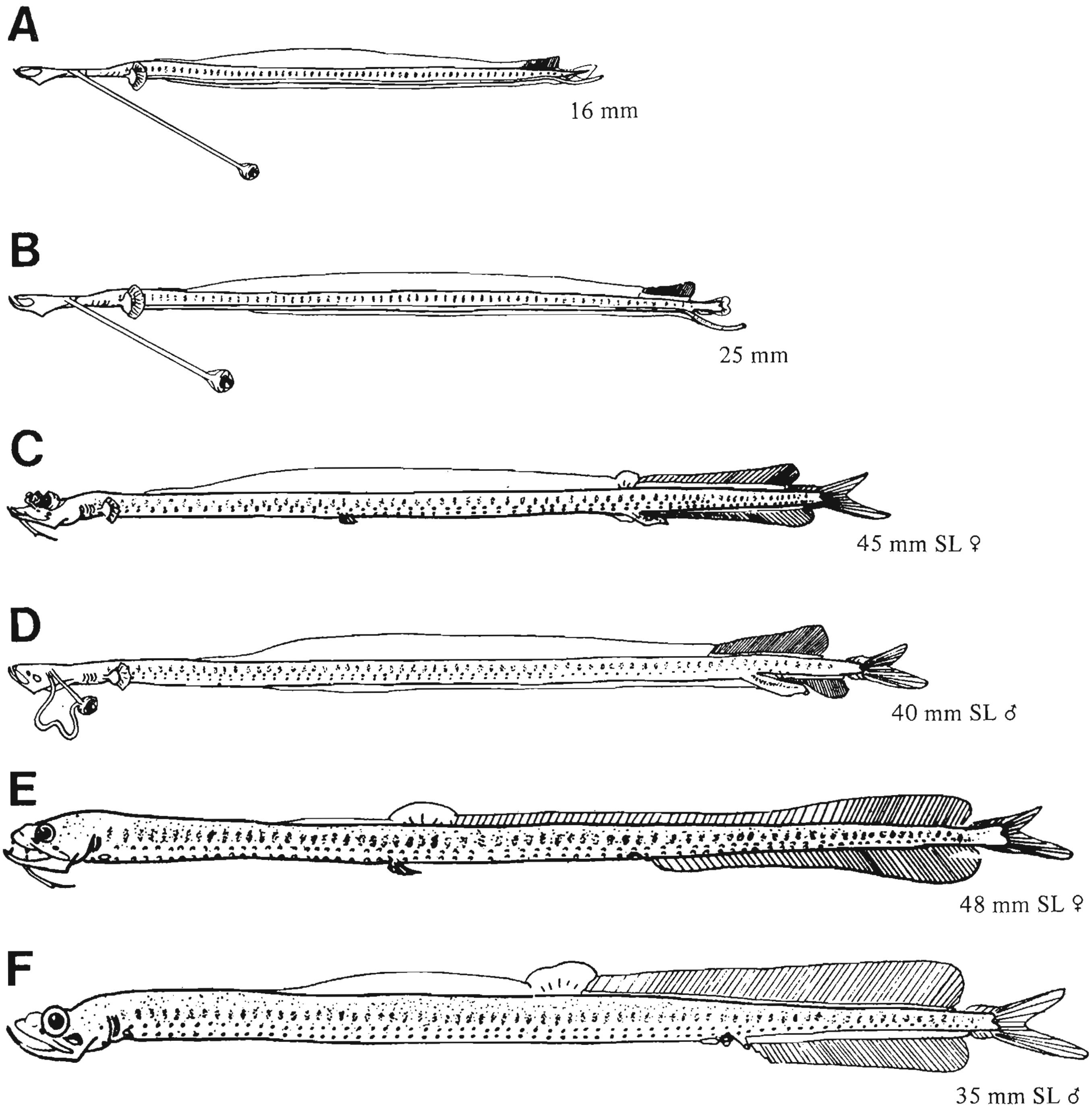
Diagnostic characters

LARVAE

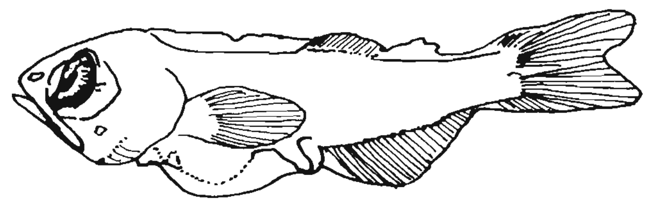
Preanal length
Length at flexion
Length at transformation 32-42 mm SL (males)
Sequence of fin development
Pigment
- See *I. antrostomus* (p. 120)

Diagnostic characters
- See *I. antrostomus*
- Depending on length of larvae, length of trailing gut may differ

Ref: Kawaguchi and Moser 1984.



Figures A–F, Beebe 1934 (North Atlantic specimens).



Scopelomorpha: Aulopiformes
Myctophiformes

The myctophiforms (Myctophidae and Neoscopelidae) and aulopiforms (J. Nelson 1984) are treated together here. According to J. Nelson (1984), these orders consist of 14 families, and about 75 genera with 429 species. Although several families are benthic (e.g., synodontids), most families consist of deep-sea, pelagic, and benthopelagic forms. Many families (not myctophids) are synchronous hermaphrodites. The diverse early-life-history stages are generally well known and can be distinguished by morphological characters (head, gut, body) and pigment patterns. Additionally, photophore patterns and development are especially helpful in myctophid fishes, while gut pigment (i.e., number and development of peritoneal patches) is an important character distinguishing some of the other families.

Families in study area: **Scopelarchidae**
Notosudidae
Synodontidae
Bathysauridae
Paralepididae
Anotopteridae
Alepisauridae
Neoscopelidae
Myctophidae

MERISTICS *B. dentata* (Chapman 1939)

Vertebrae	Total: 54-54-55
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	8-8-8
Caudal fin	X, 10+9, X
Pelvic fin	Abdominal
	R: 9-9-9
Dorsal fin	R: 6-7-8
Pectoral fin	R: 21-24-25
Anal fin	R: 17-19-21

MERISTICS *B. linguidens* (Mead and Böhlke 1953)

Vertebrae	Total: 64-64-64
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	X-X-X
Caudal fin	X, 10+9, X
Pelvic fin	Abdominal
Dorsal fin	R: 8-X-9
Pectoral fin	R: 24-X-25
Anal fin	R: 28-X-30

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N[a]
Ecology	Mesopelagic, 200-1000 m[b]
ELH pattern	Oviparous, eggs unknown, pelagic larvae
Spawning	Season:
	Area:
	Mode: Synchronous hermaphrodites[c]
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE[b]

Preanal length	Anus moves posteriad during transformation
Length at flexion	
Length at transformation	50 mm SL[d]
Sequence of fin development	Caudal; dorsal, anal, and dorsal part of pectoral; pelvics; ventral part of pectoral

Pigment
- No "accessory" pigment
- No "dermal" pigment; develops in transforming larvae and persists in adults

Diagnostic characters
- Gut expansion (in larvae, anus anterior to pelvic fin base but moves posteriad during transformation)
- Pelvic fin origin ahead of dorsal fin origin
- Adipose fin develops posterior to anal fin
- No peritoneal pigment in larvae

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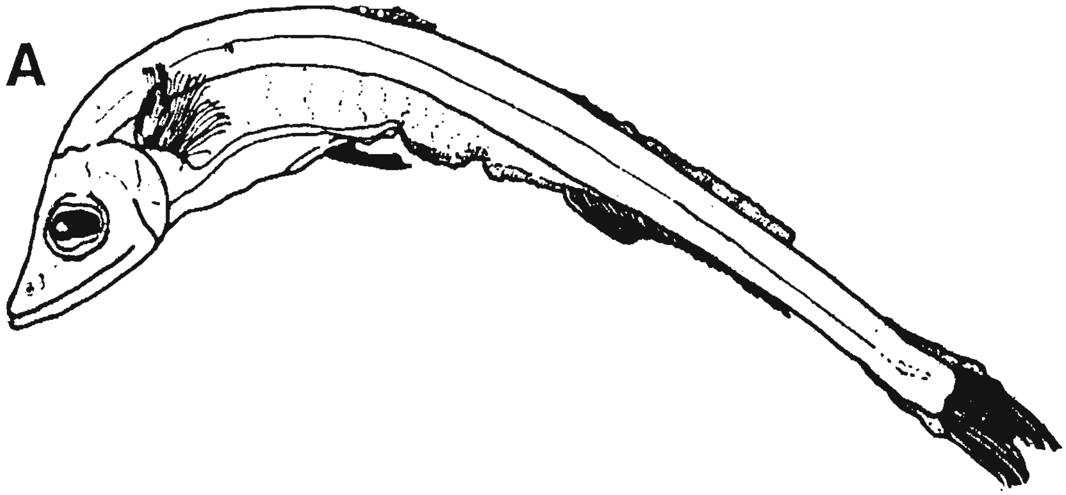
[a] *B. linguidens* only to Oregon, 42-46° N.
[b] *B. dentata* only, *B. linguidens* larvae are incompletely known.
[c] Johnson 1974a
[d] Larvae of *Benthalbella* spp. are unique among scopelarchids in achieving a large size (50-100 mm SL) while retaining a purely larval form and then exhibiting a very rapid transformation. The largest known larvae of *B. linguidens* = 85.5 mm SL, and may transform at larger sizes than *B. dentata*. Transformation is complete when peritoneal pigment first appears (uniformly in mesentary dorsal to gut from between pectoral fin bases to behind pelvic fins).

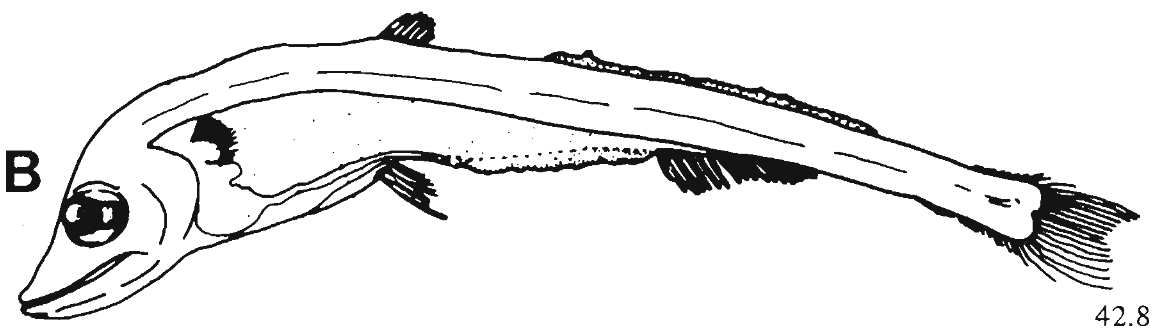
Ref: R.K. Johnson 1984.

B. linguidens

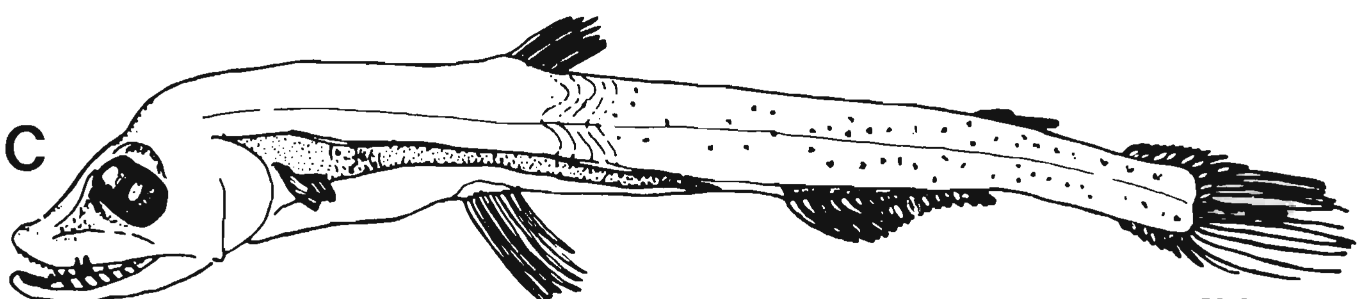


49.0 mm SL

B. dentata



42.8 mm SL



53.0 mm SL

Figures A–C, Johnson 1974a.

MERISTICS

Vertebrae	Total: 58-X-61
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	10-10-10
Caudal fin	X, 10+9, X
Pelvic fin	Abdominal
	R: 9-X-10
Dorsal fin	R: 10-X-12
Pectoral fin	R: 10-X-14
Anal fin	R: 16-X-19
Gill rakers	U: 2-2-2 L: 17-X-19

LIFE HISTORY

Range	S. California, 32-34°N, to Aleutian Is., 51-55°N
Ecology	Mesopelagic, 500-800 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season:
	Area:
	Mode: Synchronous hermaphrodites[a]
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	Probably small
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	
Hatch size	
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	<50% SL
Length at flexion	
Length at transformation	25-45 mm SL
Sequence of fin development	Caudal, anal, dorsal, pectorals, pelvics (family)

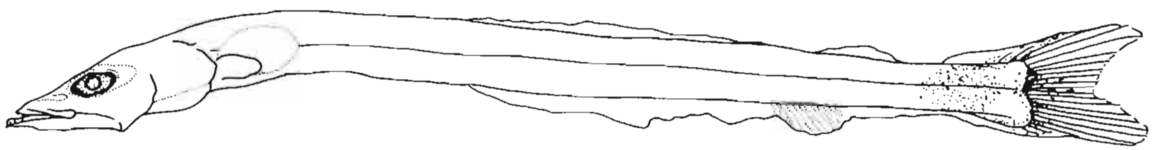
Pigment
- Restricted to tail along hypural region

Diagnostic characters—Family
- Hypural pigment: Exact distribution of pigment on the hypural region is diagnostic for species within the family
- Long body, becoming compressed toward tail
- Depressed head
- Posteriorly protruding lobes in brain (corpus cerebelli)
- Conical mass of choroid tissue around narrowed eye; long axis of the narrow eye is horizontal rather than vertical or oblique as it is in most other narrow-eyed larvae
- Anus at midbody; widely separated from anal fin
- Maxillary teeth

[a] Okiyama 1984

Ref: Okiyama 1984, Ozawa 1978.

A

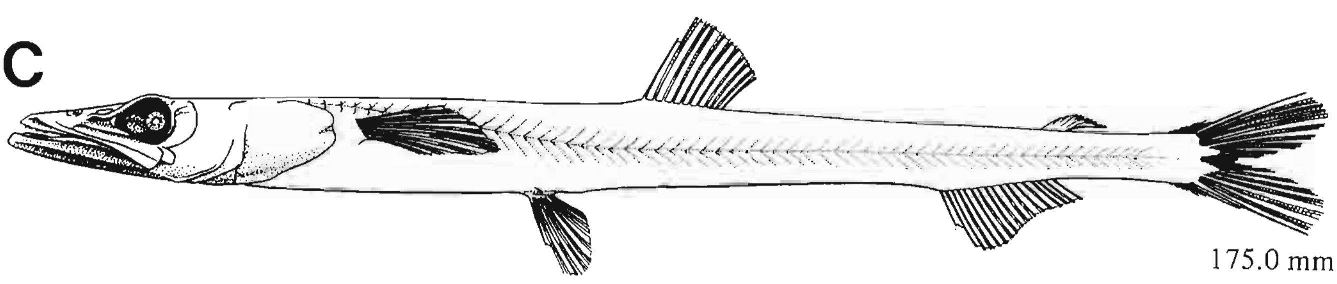


(Scopelosaurus smithii) 13.4 mm SL

B

27.3 mm

C



175.0 mm

Figure A, Okiyama 1984 (southwestern Pacific specimen); B–C, Bertelsen et al. 1976 (North Atlantic specimens).

MERISTICS

Vertebrae	Total: 50-X-52 Precaudal: X-X-X Caudal: X-X-X
Branchiostegal rays	8-8-8
Caudal fin	7, 10+9, 6
Pelvic fin	Abdominal R: 8-8-8
Dorsal fin	R: 15-X-17
Pectoral fin	R: 16-X-17
Anal fin	R: 11-13-13
Gill rakers	U: 5-X-6 L: 14-X-16

LIFE HISTORY

Range	South of southern California to Oregon, 42-46°N
Ecology	Bathybenthal
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Area: Mode: Synchronous hermaphrodites[a] Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	Ovarian eggs of *B. ferox* 1.2 mm[b]
Number of oil globules	
Oil globule diameter	
Yolk	
Envelope	
Hatch size	
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE[c]

Preanal length	70% SL
Length at flexion	
Length at transformation	>83 mm SL (gradual)[d]
Sequence of fin development	

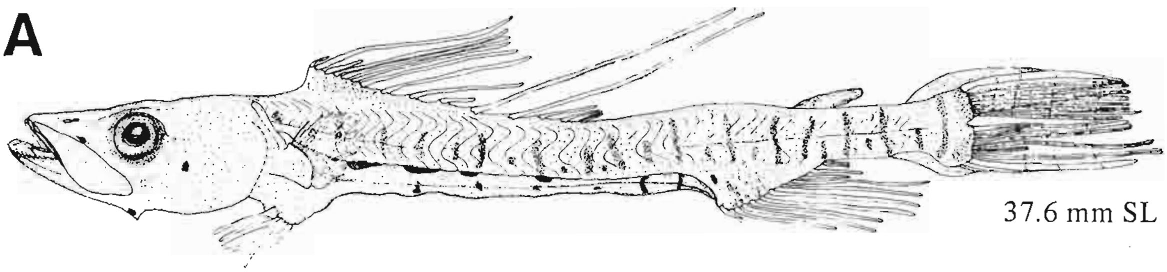
Pigment
- Peritoneal patches, about five; about six short bars laterally on gut
- About 17 vertical bars along body, 8 shorter bars in interspaces between vertical bars
- Several spots on head and fin rays

Diagnostic characters—Family
- Elongate fins
- Anterior placement of dorsal and pelvic fins
- Raised dorsal and anal fin bases
- Long gut terminating in front of anal origin
- Pigment: Peritoneal (5-6 sections) and lateral bars

[a] Okiyama 1984
[b] Wenner 1978
[c] *B. mollis* larvae originally described as "*Macristium*" larvae (Johnson 1974b). An illustration of *B. ferox* is provided for comparison and to show fin rays intact.
[d] Changes at transformation include shortening of fins, expansion of gape, backward shift of dorsal fin origin, and darkening of body surface, oral cavity, and peritoneum. According to Sulak et al. (1985), the large sizes attained by these larvae suggest a long oceanic existence prior to transformation.

Ref: Johnson 1974b, Okiyama 1984, Sulak et al. 1985.

A



B *Bathysaurus ferox*

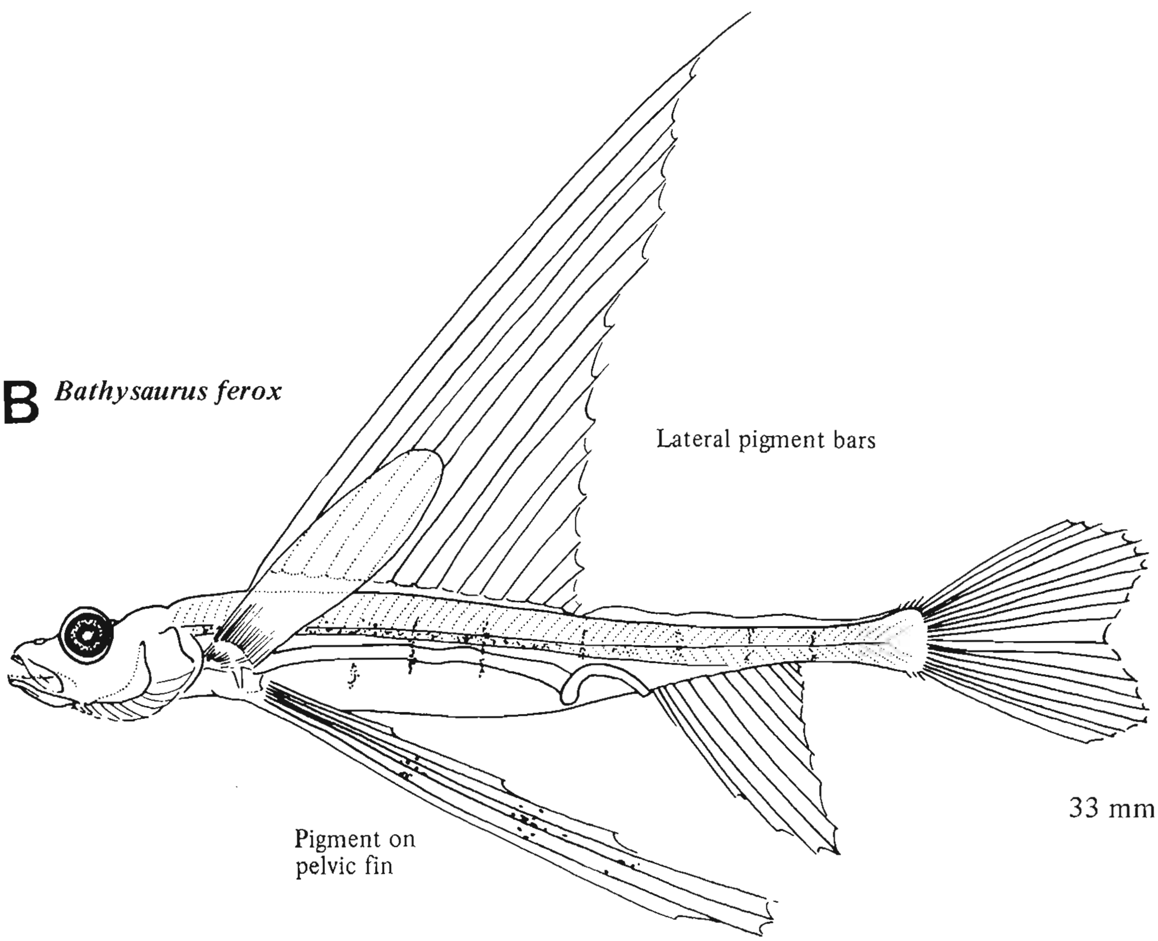


Figure A, Johnson 1974b (Gulf of Mexico specimen); B, Marshall 1960 (Atlantic specimen).

MERISTICS

Vertebrae	Total: 60-62-63	
	Precaudal: 49-52-54	
	Caudal: 8-10-11	
Branchiostegal rays	18-18-18	
Caudal fin	X, 10+9, X	
Pelvic fin	Abdominal	
	R: 8-8-8	
Dorsal fin	R: 11-X-13	
Pectoral fin	R: 13-X-14	
Anal fin	R: 12-X-14	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	South of southern California to N. California, 38-42°N[a]
Ecology	Epi- and mesodemersal
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.33-1.44 mm
No. of oil globules	None
Oil globule diameter	
Yolk	
Envelope	Hexagonal surface
Hatch size	<4.7 mm SL
Incubation time/temp.	

Pigment
- Unpigmented until late stage of development when pigment first appears along dorsal midline
- Few scattered yolksac spots
- Late-stage embryo resembles newly hatched larva with distinctive pigment along gut

Diagnostic characters
- Hexagonal surface similar to *Pleuronichthys coenosus* (p. 616) except hexagons are wider (0.047 mm vs. 0.035 mm) and irregularly arranged[b]

LARVAE[c]

Preanal length	>50% SL
Length at flexion	~10.5 mm SL
Length at transformation	
Sequence of fin development	Caudal, anal, dorsal, pectorals, pelvics

Pigment
- Seven evenly spaced pairs of "peritoneal patches" which form gradually
- Spot on postanal ventral midline midway between anus and tail
- Spot in area where hypurals are forming

Diagnostic characters
- Distinctive peritoneal patches (seven)
- Preanal finfold
- Deeper body than other *Synodus* spp.

[a] During "El Niño" years, adults occur as far north as Puget Sound, Washington. Postflexion larvae were collected off Oregon during the strong El Niño summer of 1982 (B. Mundy, NMFS Southwest Fish. Cent., Honolulu Lab., 2570 Dole St., Honolulu, HI 96822, pers. commun., 1 Oct. 1986).
[b] See Sumida et al. 1979.
[c] Data on preflexion and postflexion larvae are from E.H. Ahlstrom notes. Illustrations are unavailable.

Ref: Okiyama 1974, 1984; Ozawa 1986c; Sumida et al. 1979.

A

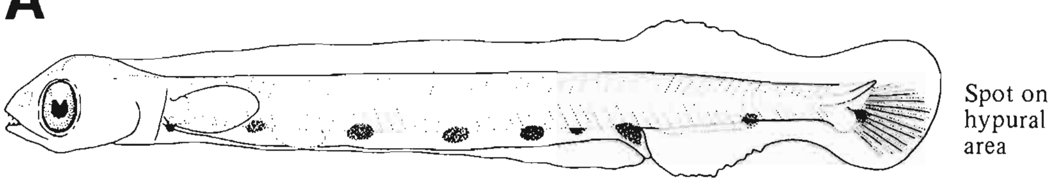


Figure A, Okiyama 1984.

MERISTICS

Vertebrae	Total: 84-X-87 Precaudal: 41-41-41 Caudal: X-X-X
Branchiostegal rays	8-8-8
Caudal fin	13, 10+9, 13
Pelvic fin	Abdominal R: 8-10-11
Dorsal fin	R: 9-12-12
Pectoral fin	R: 11-11-12
Anal fin	R: 26-26-33
Gill rakers	U: 3-X-9 L: 21-X-31

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Epi-, meso-, and bathypelagic
ELH pattern	Oviparous, eggs unknown, pelagic larvae
Spawning	Season: Area: Mode: Synchronous hermaphrodites[a] Migration
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length	<50% SL, increasing with development
Length at flexion	
Length at transformation	~45 mm SL
Sequence of fin development	Caudal, anal, dorsal, pectorals, pelvics (family)

Pigment
- Tip of jaw, two dorsal and one ventral midline spot
- Peritoneal patches increase during development to about seven
- With development, head, dorsal and anal fin bases, and caudal peduncle

Diagnostic characters - Family
- Pigment, especially peritoneal patches[b]
- Elongation of gut with development
- Morphology[c]

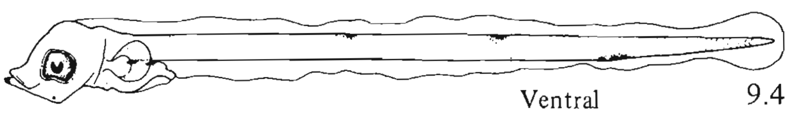
Distinguished from *Notolepis rissoi* and *Paralepis atlantica* by

	Lestidiops	*Notolepis*	*Paralepis*
No. peritoneal patches			
(flexion larvae)	3	1	2
(postflexion larvae)	7	12	3
No. myomeres	84-87	72-74	76-83

[a] Okiyama 1984
[b] Peritoneal pigment patches are sequentially formed with gradual lengthening of the gut. The number of patches (called "sections" by Okiyama 1984) may be species-specific. In general, these patches develop by 5-10 mm SL and persist until 15-45 mm SL. Other characteristic paralepidid pigment may include dorsum of body, caudal peduncle, and caudal and pectoral fins.
[c] General morphological characters in paralepidids are a long compressed body, short gut increasing in length with development, head increasing in relative size with development, elongate snout, well-developed preanal finfold, and eyes initially ovoid, becoming round with development.

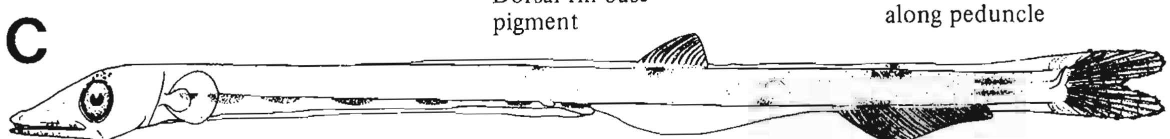
Ref: Okiyama 1984.

A



B

C



Figures A, C, Okiyama 1984; B, Moser 1981.

MERISTICS

Vertebrae	Total: 72-X-74	
	Precaudal: 37-X-39	
	Caudal: 39-X-41	
Branchiostegal rays	8-8-8	
Caudal fin	X, 10+9, X	
Pelvic fin	Abdominal	
	R: 8-X-12	
Dorsal fin	R: 9-X-13	
Pectoral fin	R: 10-X-13	
Anal fin	R: 29-X-34	
Gill rakers	U: 3-X-9	L: 18-X-36

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Epi-, meso-, and bathypelagic
ELH pattern	Oviparous, eggs unknown, pelagic larvae
Spawning	Season:
	Area:
	Mode: Synchronous hermaphrodites[a]
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

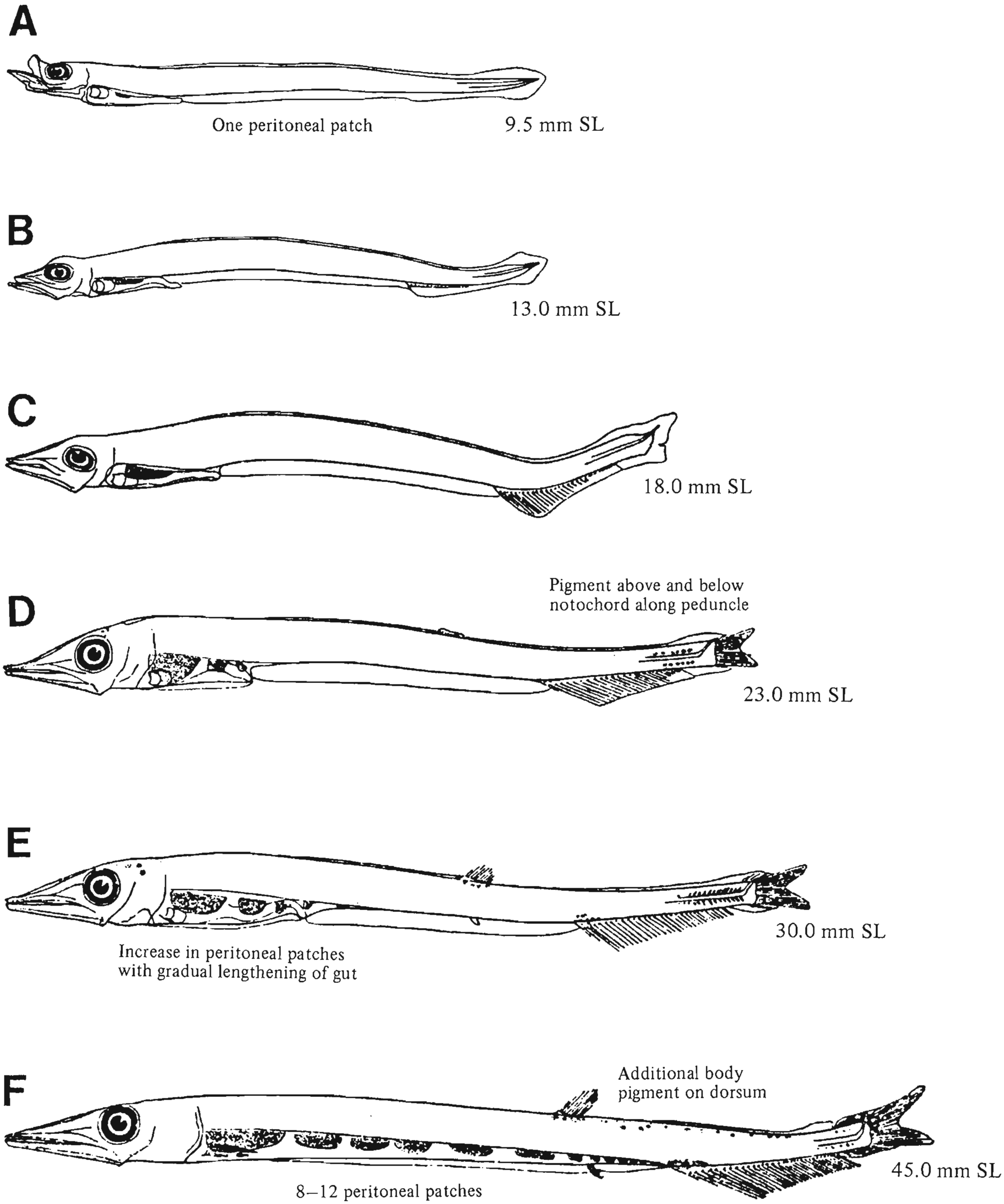
Preanal length	<50% SL, increasing with development
Length at flexion	~13-18 mm SL
Length at transformation	~45 mm SL
Sequence of fin development	Caudal, anal, dorsal, pectorals, pelvics (family)

Pigment
- Peritoneal patches, 1 increasing with development to 12 (see *Lestidiops ringens*)
- Above and below notochord on caudal peduncle
- Additional pigment along dorsum from dorsal fin origin to tail with development

Diagnostic characters
- See *L. ringens* (p. 134)
- Pigment, peritoneal patches
- Morphology

[a] Okiyama 1984

Ref: Okiyama 1984.



Figures A–F, Rofen 1966a (North Atlantic specimens).

MERISTICS

Vertebrae	Total: 60-67-69 Precaudal: 38-40-41 Caudal: X-X-X
Branchiostegal rays	8-8-8
Caudal fin	X, 10+9, X
Pelvic fin	Abdominal R: 9-X-10
Dorsal fin	R: 9-X-12
Pectoral fin	R: 15-X-18
Anal fin	R: 20-X-23
Gill rakers	U: 7-X-9 L: 26-X-32

LIFE HISTORY

Range	South of southern California to SE Alaska, 55-59° N
Ecology	Epi-, meso-, and bathypelagic
ELH pattern	Oviparous, eggs unknown, pelagic larvae
Spawning	Season: Area: Mode: Synchronous hermaphrodites[a] Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

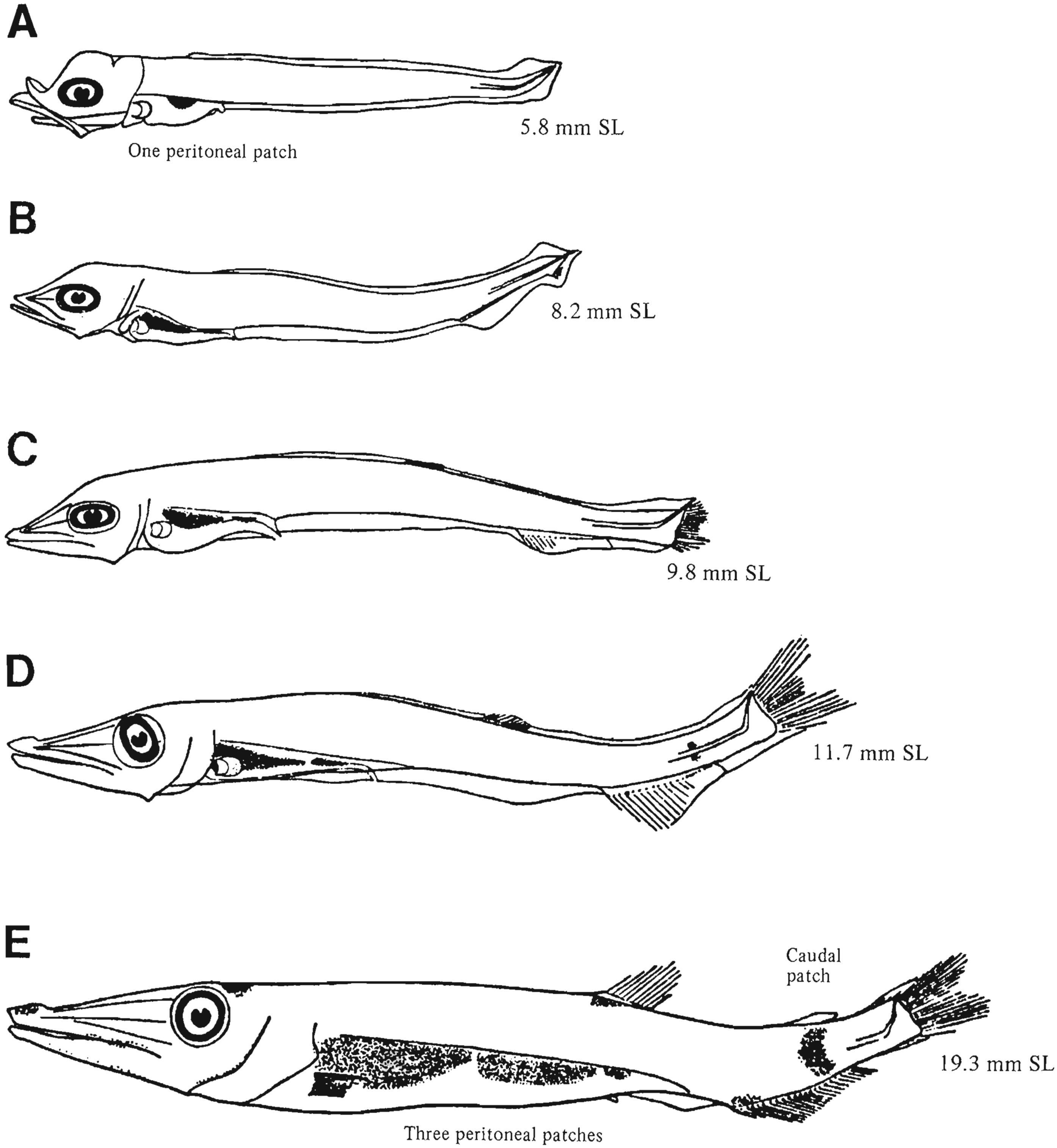
LARVAE

Preanal length
Length at flexion
Length at transformation
Sequence of fin development Caudal, anal, dorsal, pectorals, pelvics (family)
Pigment
- Peritoneal patches, one increasing with development to three (see *Lestidiops ringens*, p. 134)
- Few spots above and below notochord in caudal peduncle region which, with development, form a patch
- Patch at base of dorsal and anal fin, on cranium, on upper jaw (late in development)

Diagnostic characters
- See *L. ringens*
- Pigment, peritoneal patches
- Morphology

[a] Okiyama 1984

Ref: Okiyama 1984.



Figures A–E, Rofen 1966a (North Atlantic specimens).

MERISTICS

Vertebrae	Total: 76-80-83
	Precaudal: 48-52-54
	Caudal: 27-29-31
Branchiostegal rays	7-7-7
Caudal fin	14-15, 10+9, 14
Pelvic fin	Abdominal
	R: 9-X-11
Dorsal fin	Absent
Pectoral fin	R: 12-X-16
Anal fin	R: 14-X-17
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Epi- and mesopelagic
ELH pattern	Oviparous, eggs unknown, pelagic larvae
Spawning	Season:
	Area:
	Mode: Synchronous hermaphrodites[a]
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE[b]

Preanal length	>50% SL
Length at flexion	
Length at transformation	<50 mm SL
Sequence of fin development	Only pectoral anlagen present at 14.2 mm SL

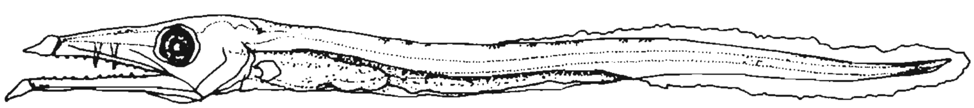
Pigment
- No peritoneal pigment patches, instead uniform peritoneal pigment
- Snout, jaw
- Dorsal midline
- Tail tip

Diagnostic characters
- Morphology: Long slender body, large head, pointed snout
- Fleshy prolongation at jaw tips
- Two large canine teeth
- Gut extending to midbody

[a]Okiyama 1984
[b]Data are from one larva.

Ref: Okiyama 1984.

A



B

Figure A, Okiyama 1984; B, Rofen 1966b (North Atlantic specimen).

MERISTICS

Vertebrae	Total: 48-50-52 Precaudal: 19-23-26 Caudal: 24-27-31
Branchiostegal rays	8-8-8
Caudal fin	X, 10+9, X
Pelvic fin	Abdominal R: 8-X-10
Dorsal fin	R: 30-X-45
Pectoral fin	R: 12-X-15
Anal fin	R: 14-X-17
Gill rakers	U: 2-X-6 L: 16-X-24

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Epi-, meso-, and bathypelagic, 0-1829 m
ELH pattern	Oviparous, eggs unknown, pelagic larvae
Spawning	Season: May (California)[a] Area: Mode: Synchronous hermaphrodites[b] Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE[c]

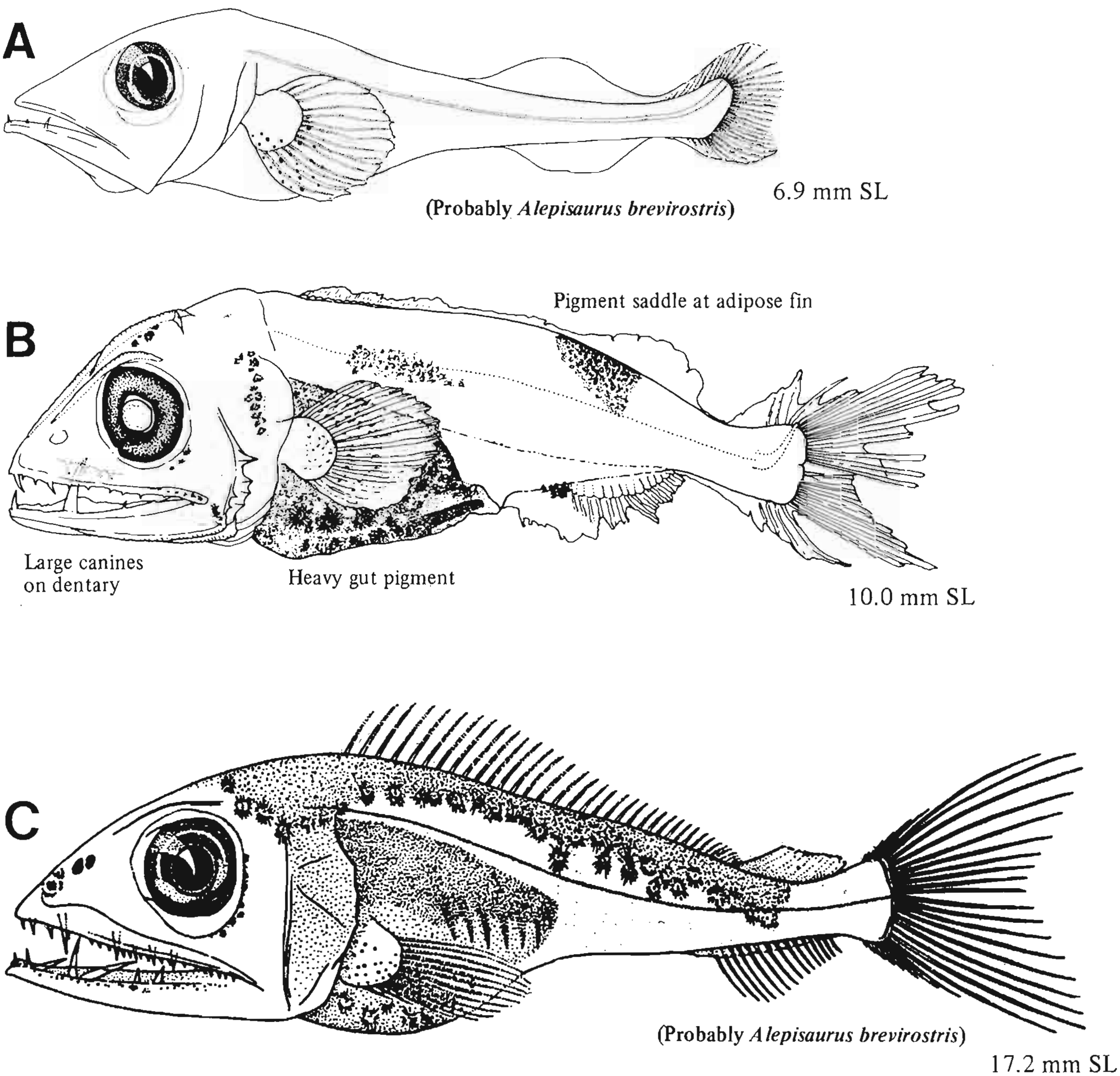
Preanal length
Length at flexion
Length at transformation[d]
Sequence of fin development Pectorals, caudal, dorsal, anal, pelvics
Pigment
- Genus: Preflexion larvae appear to be unpigmented except for pectoral fins
- Postflexion
  —Heavy gut pigment
  —Pigment patch at anal fin origin
  —Pectoral fins
  —Saddle in area of adipose fin
  —Patch along midline over gut

Diagnostic characters
Distinguished from other species of *Alepisaurus* by
- Four preopercular spines
- Bony ridges on head
- Pigment patch at anal fin base

For family
- Large head and mouth
- Prominent canines on dentary
- Small fins
- Short gut

[a] Fitch and Lavenberg 1968
[b] Okiyama 1984
[c] Illustrations of preflexion and postflexion *A. brevirostris* are provided for comparison.
[d] Transformation is gradual.

Ref: Okiyama 1984.



Figures A, C, Rofen 1966c (specimens collected off Bermuda); B, Okiyama 1984 (Hawaiian specimen).

MERISTICS

Vertebrae[a]	Total: 30-X-31 Precaudal: X-X-X Caudal: X-X-X
Branchiostegal rays	8-8-8
Caudal fin	6-8, 10+9, 5-7
Pelvic fin	Abdominal R: 8-8-8
Dorsal fin	R: 11-X-13
Pectoral fin	R: 18-X-19
Anal fin	R: 10-X-13
Gill rakers[b]	U: 3-3-3 L: 8-8-8 (T: 10-X-12)

LIFE HISTORY

Range[c]	Brit. Col., 48°30′-55°N
Ecology	Mesopelagic, 300-800 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS (Ripe ovarian)

Diameter	0.83-0.98 mm
No. of oil globules	One
Oil globule diameter	0.39-0.61 mm
Yolk	
Envelope	
Hatch size	
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE (Postflexion only)

Preanal length	~70% SL
Length at flexion	
Length at transformation	Fin rays formed by 10.0 mm SL
Sequence of fin development	Pectorals, dorsal, anal, caudal, pelvics

Pigment
- Small dorsal patches on peritoneum and hindgut

Diagnostic characters
- Pigment patch over hindgut (not solid as in other myctophiforms)
- Small preopercular spines

Distinguished from most myctophiforms by
- Lack of peritoneal pigment patches

For family
- Morphology
  - —Deep body
  - —Large head
  - —Large pectoral fin
- Round eye without choroid tissue
- Lightly pigmented

[a] Genus vertebral range 29-35.
[b] Gill raker counts vary geographically.
[c] Peden and Hughes (1986); previously only off Japan and Hawaii.

Ref: Maruyama 1970; Nafpaktitis 1977; Okiyama 1974, 1984.

Neoscopelus sp.

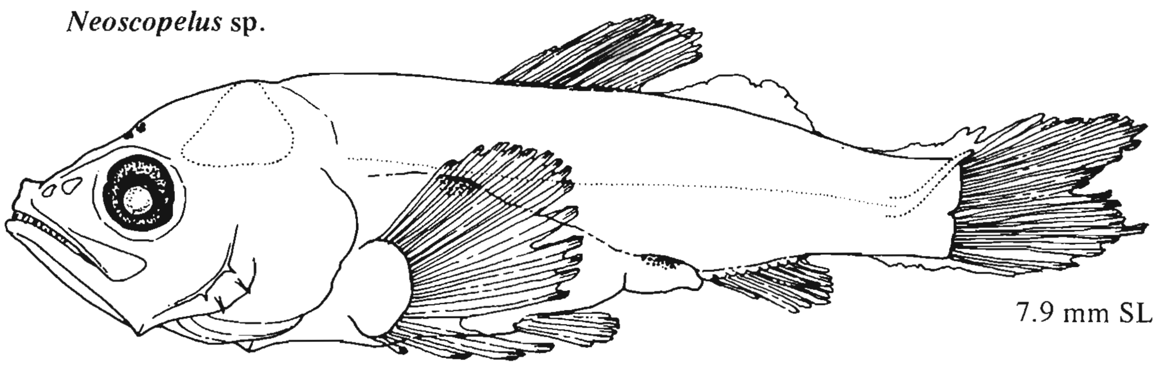


Figure A, Okiyama 1984 (southwestern Japan specimen).

Lanternfishes are worldwide in distribution, having 32 genera with 235 species found from the Arctic to the Antarctic. Myctophids generally have large eyes, large terminal mouths, photophores, and a black body color. In the Northeast Pacific, 20 species occur within two subfamilies: Myctophinae and Lampanyctinae. Most of the species (13) are members of the Lampanyctinae.

Myctophids are oviparous and presumably all produce planktonic eggs (Moser et al. 1984a). Eggs of only two species have been described: *Electrona rissoi* by Sanzo (1939) and *Lampanyctodes hectoris* by Robertson (1977). Eggs of both species are small (<1.0 mm), possess a single large oil globule, segmented yolk, smooth chorion, and at least *Lampanyctodes* eggs possess a fragile chorion. We have identified several types of myctophid eggs with these characteristics, in particular a fragile chorion. At least two of these types are probably *Diaphus* and *Stenobrachius* (based on egg characters and the presence of yolksac larvae of those species in the same samples).

The larval photophore complements and the sequence of appearance of photophores are useful characters. Most myctophids develop the Br2 during the larval period (in the Northeast Pacific the only exception is *Taaningichthys*). The Br2 is located posteroventral to the orbit but during transformation assumes a position beneath the orbit on the branchiostegal membrane. Three myctophine genera and eleven lampanyctine genera develop additional photophores during the larval period, with the Br2 always first to appear (Moser et al. 1984a). Of these 14 genera, only 4 are represented in our study area: *Ceratoscopelus*, *Lampadena*, *Diaphus*, and *Notoscopelus*.

The taxonomic section on myctophids here is arranged according to the intrafamilial classification of the group (Table 19), since certain larval characters reflect this classification (e.g., larval eye shape).

Table 19
Myctophid taxa in the Northeast Pacific Ocean
(see Moser et al. 1984a, Paxton 1972 [tribes], J. Nelson 1984).

Subfamily Myctophinae			(Eyes elliptical)
	Tribe Electronini		
		Electrona rissoi	
		Protomyctophum crockeri	
		Protomyctophum thompsoni	
	Tribe Myctophini		
		Symbolophorus californiensis	
	Tribe Gonichthyini		
		Loweina rara	
		Tarletonbeania crenularis	
		Tarletonbeania taylori	
Subfamily Lampanyctinae			(Eyes mostly rounded)
	Tribe Lampanyctini		
		Ceratoscopelus townsendi	
		Dorsadena (?=*Lampadena*) *yaquinae**	
		Lampadena urophaos	
		Lampanyctus fernae	
		Lampanyctus jordani	
		Lampanyctus regalis	
		Lampanyctus ritteri	
		Parvilux ingens	
		Stenobrachius leucopsarus	
		Stenobrachius nannochir	
		Taaningichthys bathyphilus	
	Tribe Diaphini		
		Diaphus theta	
	Tribe Gymnoscopelini		
		Notoscopelus resplendens	

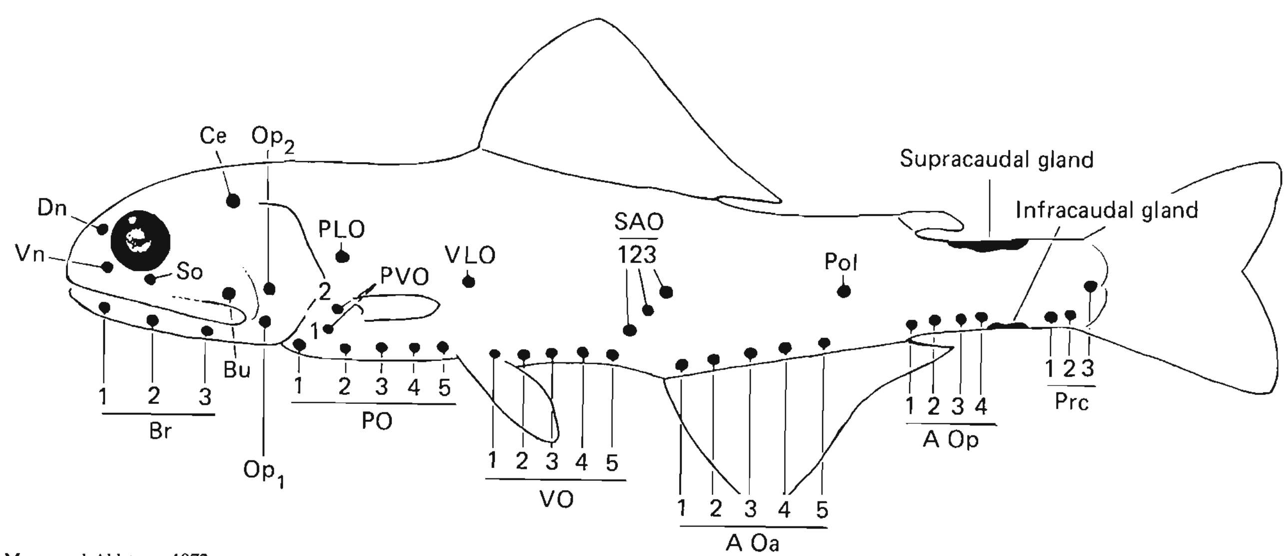
*See Moser et al. (1984a); larvae are unknown.

Table 20
Meristic characters of the genera of Myctophidae (Moser et al. 1984a).

		Fins						Gill rakers		
						Caudal*				
Taxon	Vertebrae	Dorsal	Anal	Pectoral	Pelvic	Upper	Lower	Upper	Lower	Branchiostegals
Myctophinae										
Electrona	33-41	12-16	18-22	11-17	8	6-10	6-9	3-10	12-25	7-8
Protomyctophum	35-41	10-14	21-27	14-17	8-9	7-9	6-9	4-7	14-21	8-10
Symbolophorus	36-42	12-16	18-24	12-20	8	8-10	7-9	4-7	12-19	9
Loweina	37-39	10-13	13-17	9-12	7-9	6-7	6-7	2-3	5-10	9
Tarletonbeania	40-42	11-15	16-20	11-16	8	5-8	5-8	4-6	10-12	8
Lampanyctinae										
Ceratoscopelus	35-38	13-15	13-16	12-15	8	6-7	6-7	3-5	9-16	9
Dorsadena		14-15	12-14	15-16	8-9			4-5	12	
Lampadena	35-40	13-16	12-15	13-18	8	8	8-9	3-8	9-18	9
Lampanyctus	30-40	10-19	14-21	0-17	8	6-8	6-8	3-8	9-19	8-11
Parvilux	35-38	14-17	15-18	10-13	8	8	8-9	4-6	11-15	10-11
Stenobrachius	35-38	12-15	14-16	8-10	8	6-8	7-9	5-6	12-14	9-10
Taaningichthys	34-41	11-14	11-14	12-17	8	7-10	6-10	2-5	6-14	8-9
Diaphus	31-37	10-19	11-19	9-14	8	5-8	5-8	4-11	9-21	8-9
Notoscopelus	35-40	21-27	18-21	11-14	8-9	10-14	10-15	4-10	9-22	10

*Principal caudal fin ray count is 10+9. Only secondary fin ray counts are given.

PHOTOPHORE GROUP TERMINOLOGY



Moser and Ahlstrom 1972.

MERISTICS

Vertebrae	Total: 32-X-34 Precaudal: X-X-X Caudal: X-X-X
Branchiostegal rays	8-8-8
Caudal fin	6-8, 10+9, 6-7
Pelvic fin	Abdominal R: 8-8-8
Dorsal fin	R: 13-X-15
Pectoral fin	R: 13-X-16
Anal fin	R: 18-19-20
Gill rakers	U: 8-X-9 L: 18-X-21

LIFE HISTORY

Range	South of southern California to Oregon, 42-46°N
Ecology	Epi- and mesopelagic
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	0.80-0.84 mm
No. of oil globules	One
Oil globule diameter	0.28 mm
Yolk	Segmented
Envelope	Smooth, fragile
Hatch size	
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

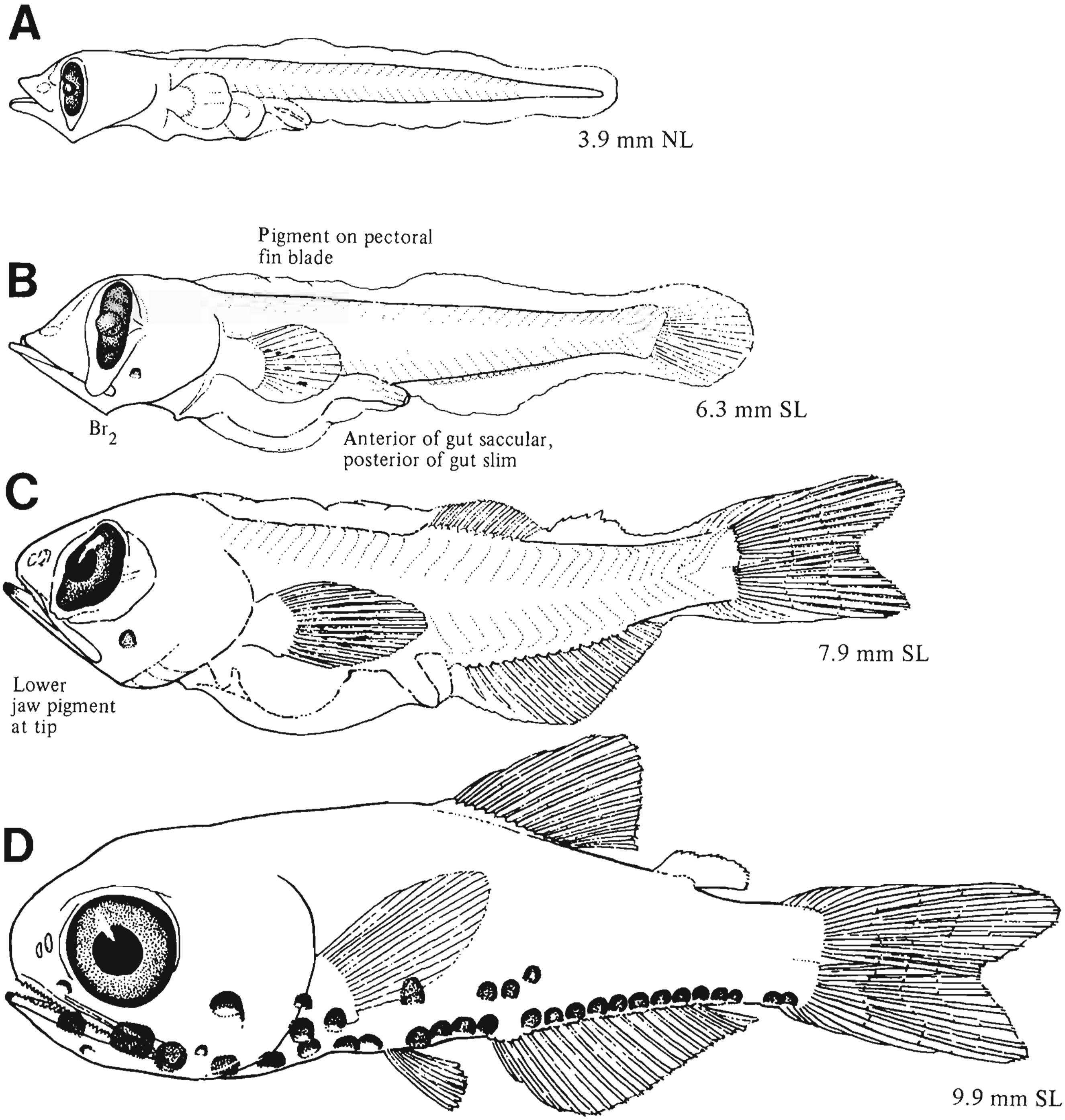
Preanal length	50% SL, with development 50-75% SL
Length at flexion	6.2-7.0 mm SL
Length at transformation	~10 mm SL
Sequence of fin development	Caudal, pectorals, anal, dorsal, pelvics

Pigment
- Lower jaw symphysis (see 7.9 mm)
- Pectoral fin blade (see 6.3 mm)

Diagnostic characters
- Photophores: Early Br2, usually forms at transformation in other species
- Morphology: Body moderately slender, head large
- Gut saccular, s-shaped
- Space between anus and anal fin origin but not as large as in *Protomyctophum* spp.
- Eyes very narrow
- Transforms earlier than most myctophids (9-10 mm SL)

Distinguished from other myctophids with elliptical eyes by
- Pigment on lower jaw tip and pectoral fin
- Lack of pigment on postanal body

Ref: Fahay 1983, Moser and Ahlstrom 1970, Moser et al. 1984a, Sanzo 1939, Tåning 1918.



Figures A–D, Moser and Ahlstrom 1970.

MERISTICS

Vertebrae	Total: 36-X-37 Precaudal: X-X-X Caudal: X-X-X
Branchiostegal rays	8-X-12
Caudal fin	7-9, 10+9, 7-8
Pelvic fin	Abdominal R: 8-8-8
Dorsal fin	R: 11-12-13
Pectoral fin	R: 13-16-17
Anal fin	R: 19-22-24
Gill rakers	U: 4-5-6 L: 14-16-18

LIFE HISTORY

Range	South of southern California to Washington, 46-48°30′N[a]
Ecology	Epi- and mesopelagic, 0-500 m
ELH pattern	Oviparous, eggs probably pelagic, pelagic larvae
Spawning	Season: Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length	<50% SL
Length at flexion	7.2-8.8 mm SL
Length at transformation	12-15 mm SL, as large as 18 mm SL
Sequence of fin development	Caudal, pectorals, anal, dorsal, pelvics

Pigment
- Preflexion larvae unpigmented
- Large melanophore over gut
- Postanal ventral melanophores in juveniles

Diagnostic characters
- Single spot over gut and lack of pigment elsewhere (flexion and postflexion larvae)

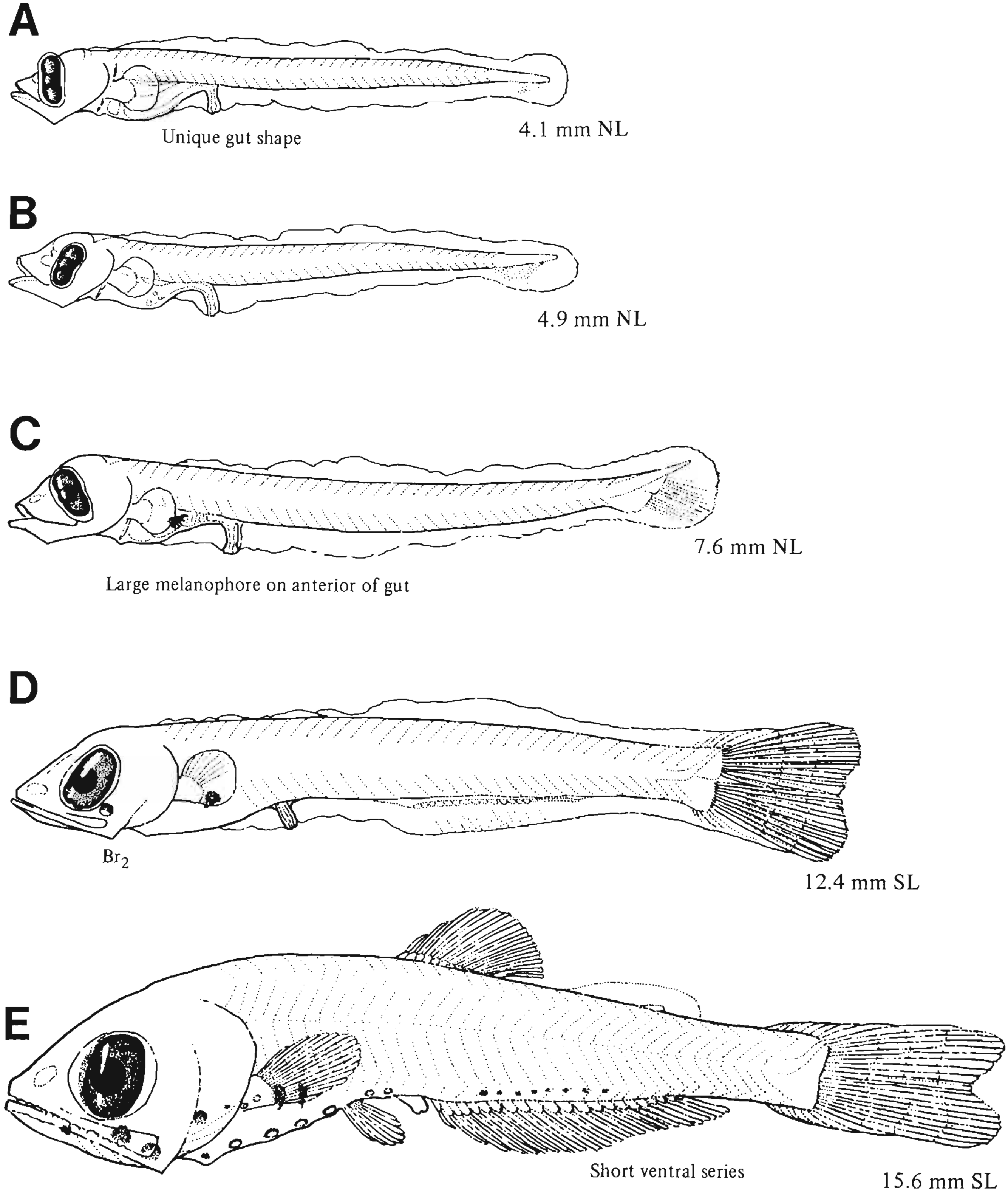
For Genus

Distinguished from other myctophids with elliptical eyes by
- Head small, body slender
- Gut short
- Wide space between anus and anal fin
- Larvae relatively lightly pigmented
- Eyes moderately narrow
- No enlarged fins

Distinguished from *P. thompsoni* by
- Lack of postanal ventral melanophores in preflexion larvae and presence of only one spot over the gut in larger larvae

[a] Wisner 1974

Ref: Moser and Ahlstrom 1970, Moser et al. 1984a.



Figures A–E, Moser and Ahlstrom 1970.

MERISTICS

Vertebrae	Total: 37-38-39
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	8-X-12
Caudal fin	7-9, 10+9, 6-8
Pelvic fin	Abdominal
	R: 8-8-8
Dorsal fin	R: 11-12-13
Pectoral fin	R: 14-15-17
Anal fin	R: 21-23-25
Gill rakers	U: 3-4-4 L: 13-14-16

LIFE HISTORY

Range	Cent. California, 34-38°N[a] to Bering Sea, 54-66°N
Ecology	Epi- and mesopelagic
ELH pattern	Oviparous, eggs probably pelagic, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

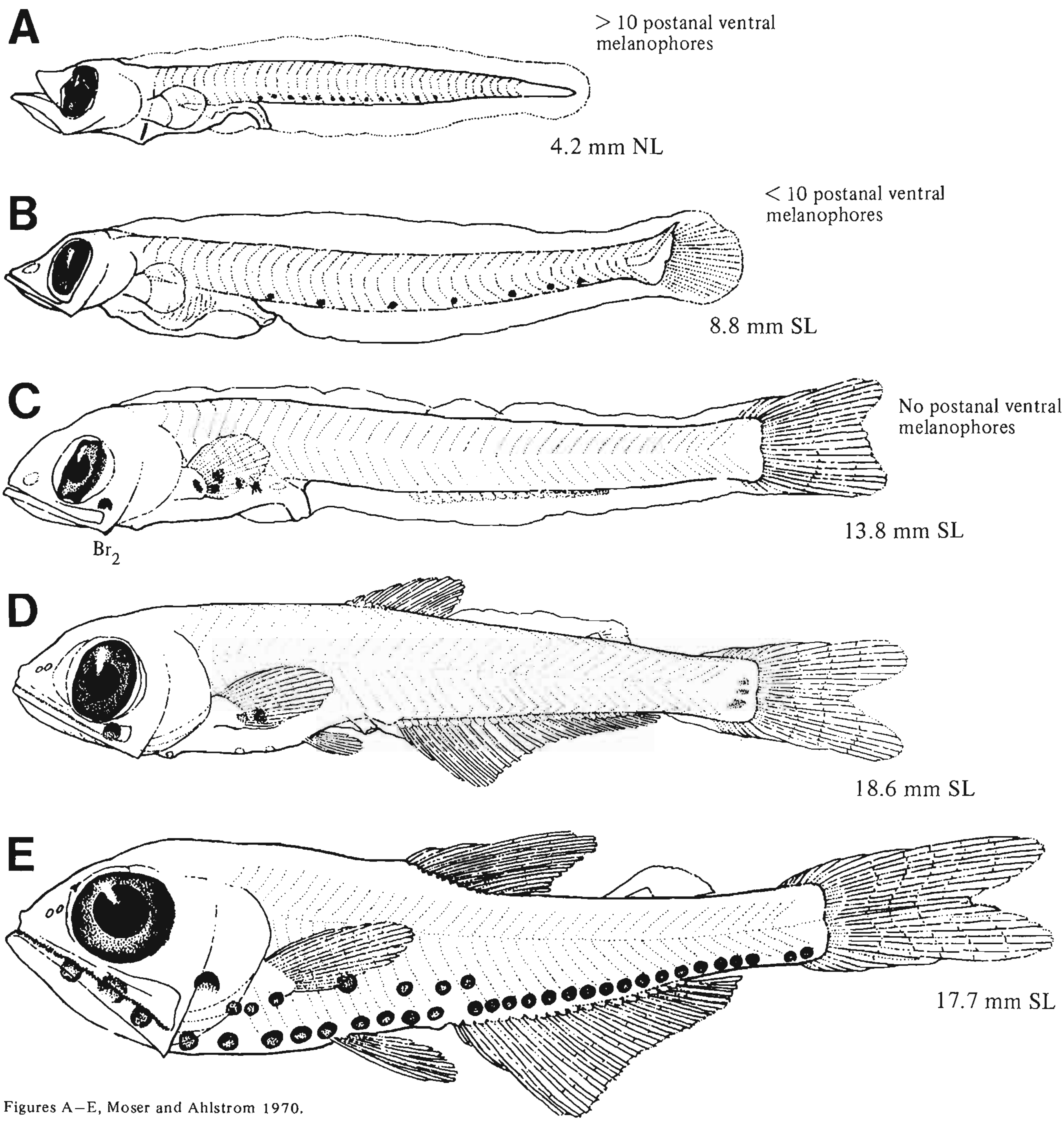
Preanal length	<50% SL
Length at flexion	7-10.0 mm SL
Length at transformation	14-17 mm SL
Sequence of fin development	Caudal, pectorals, anal, dorsal, pelvics

Pigment
- Postanal ventral melanophores >10 in preflexion larvae decreasing to <10 in flexion larvae; not present in postflexion larvae
- Dorsolateral surface of gut in postflexion larvae

Diagnostic characters
- See *P. crockeri* (p. 150)
- Narrow eye
- Postanal ventral melanophore pattern

[a]R.N. Lea, Calif. Dep. Fish Game, 2201 Garden Road, Monterey, CA 93940, pers. commun., 19 Feb. 1987.

Ref: Moser and Ahlstrom 1970.



Figures A–E, Moser and Ahlstrom 1970.

MYCTOPHIDAE *Symbolophorus californiensis* (Eigenmann and Eigenmann 1889)

MERISTICS

Vertebrae	Total: 37-X-40
	Precaudal: 16-16-17
	Caudal: 22-23-23
Branchiostegal rays	8-X-12
Caudal fin	8-9, 10+9, 8-9
Pelvic fin	Abdominal
	R: 8-8-8
Dorsal fin	R: 13-14-15
Pectoral fin	R: 15-17-19
Anal fin	R: 19-20-22
Gill rakers	U: 6-6-7 L: 15-16-17

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Epi- and mesopelagic, 0-762 m
ELH pattern	Oviparous, eggs probably pelagic, pelagic larvae
Spawning	Season: Spring-summer[a]
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	7 yr[a]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length	
Length at flexion	8.0-10.0 mm SL
Length at transformation	23.0-24.0 mm SL
Sequence of fin development	Pectorals, pelvics, caudal, anal, dorsal: pectoral fin base large and wing-shaped with supernumerary rays developing first

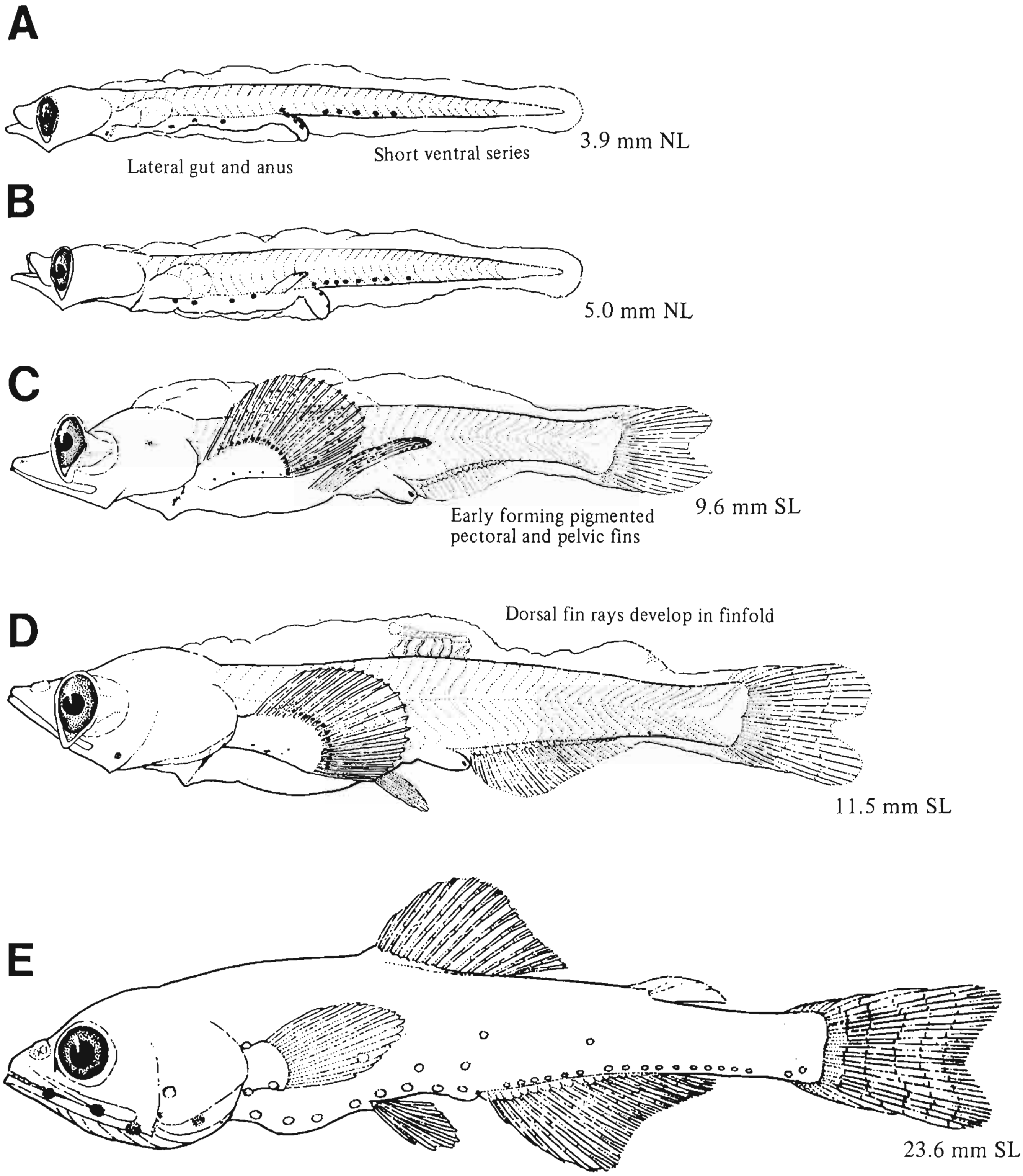
Pigment
- Paired fins
- Lateral gut and anus
- Postanal ventral melanophores (preflexion)
- Also on snout, hindbrain, cleithral region, isthmus (lower jaw)

Diagnostic characters

Distinguished from other myctophids with elliptical eyes by
- Broad head
- Eyes slightly stalked with conical choroid mass (narrow)
- Early pectoral fin development, pectorals large with wing-shaped base
- Early pelvic fin development (unusual for myctophids)
- Dorsal fin rays develop in finfold
- Slightly enlarged median finfold
- Pigment on paired fins

[a] Fitch and Lavenberg 1968

Ref: Moser and Ahlstrom 1970, 1974; Moser et al. 1984a.



Figures A–E, Moser and Ahlstrom 1970.

MERISTICS

Vertebrae	Total: 37-X-39
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	9-9-9
Caudal fin	6-7, 10+9, 6-7
Pelvic fin	Abdominal
	R: X-X-X
Dorsal fin	R: X-X-X
Pectoral fin	R: 16-X-18 (larvae)[a]
	R: 9-X-12 (adults)
Anal fin	R: X-X-X
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range[b]	South of southern California to N. California, 38-42°N,[c] and Oregon, 42-46°N[d]
Ecology	Unknown
ELH pattern	Oviparous, eggs unknown, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length	55% SL increasing with development to 80% SL
Length at flexion	8.0-11.0 mm SL
Length at transformation	>20.0 mm SL
Sequence of fin development	Pectorals, caudal, anal and dorsal, pelvics

Pigment
- Preflexion and flexion larvae
  - —Dark band of pigment between olfactory and optic lobes of the brain
  - —Blotch develops medially to each pectoral fin base
  - —Two blotches on dorsal surface of gut merging into one with development
  - —Three postanal body blotches
  - —Median finfold, lower pectoral ray
  - —Dorsal and ventral margins of caudal peduncle

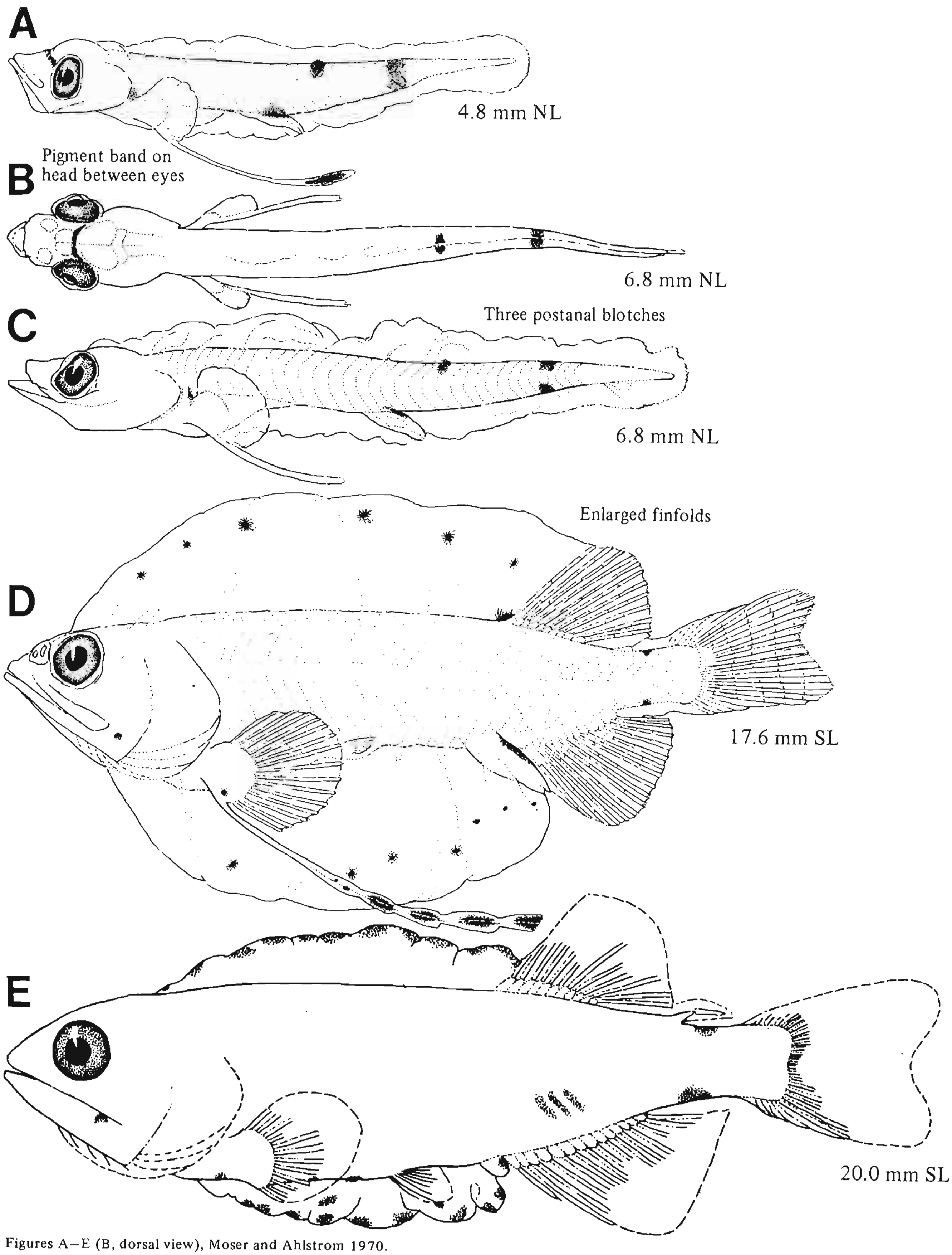
Diagnostic characters
- Among largest myctophid larvae at transformation (>20.0 mm SL)
- Morphology: Early larvae slender but relative body depth doubles in later stages
- Only Br2 develops during larval period

Distinguished from all other myctophids except *Tarletonbeania crenularis* by
- Enlarged median finfolds

Distinguished from *T. crenularis* (p. 158) by
- Eye moderately narrow, no choroid tissue on ventral surface of eye
- Pigment: Band on head between eyes

[a] Larvae have six more pectoral fin rays than adults.
[b] Range for larvae; adults widespread.
[c] Moser and Ahlstrom 1970
[d] Richardson and Pearcy 1977

Ref: Moser and Ahlstrom 1970.



Figures A–E (B, dorsal view), Moser and Ahlstrom 1970.

MERISTICS

Vertebrae	Total: 39-41-42
	Precaudal: 17-17-19
	Caudal: 22-23-24
Branchiostegal rays	8-9-11
Caudal fin	5-7, 10+9, 5-7
Pelvic fin	Abdominal
	R: 7-8-9
Dorsal fin	R: 11-12-14
Pectoral fin	R: 11-13-15
Anal fin	R: 17-18-20
Gill rakers	U: 4-5-6 L: 10-11-12

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Epi- and mesopelagic, 0-832 m
ELH pattern	Oviparous, eggs probably pelagic, pelagic larvae
Spawning	Season: Winter-spring;[a] Nov-Feb[b]
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length	50% SL at hatching, 70% SL at 13-14 mm SL, ⩾50% SL at transformation
Length at flexion	7.5-10.5 mm SL
Length at transformation	~19-21 mm SL
Sequence of fin development	Caudal, pectorals, anal, dorsal, pelvics

Pigment
- Preflexion: Postanal band located at posteriormost 4-5 myomeres, on anus, and over gut
- Flexion: Head, finfold, 1-2 postanal melanophores
- Postflexion: Dorsal midline anterior to fin

Diagnostic characters

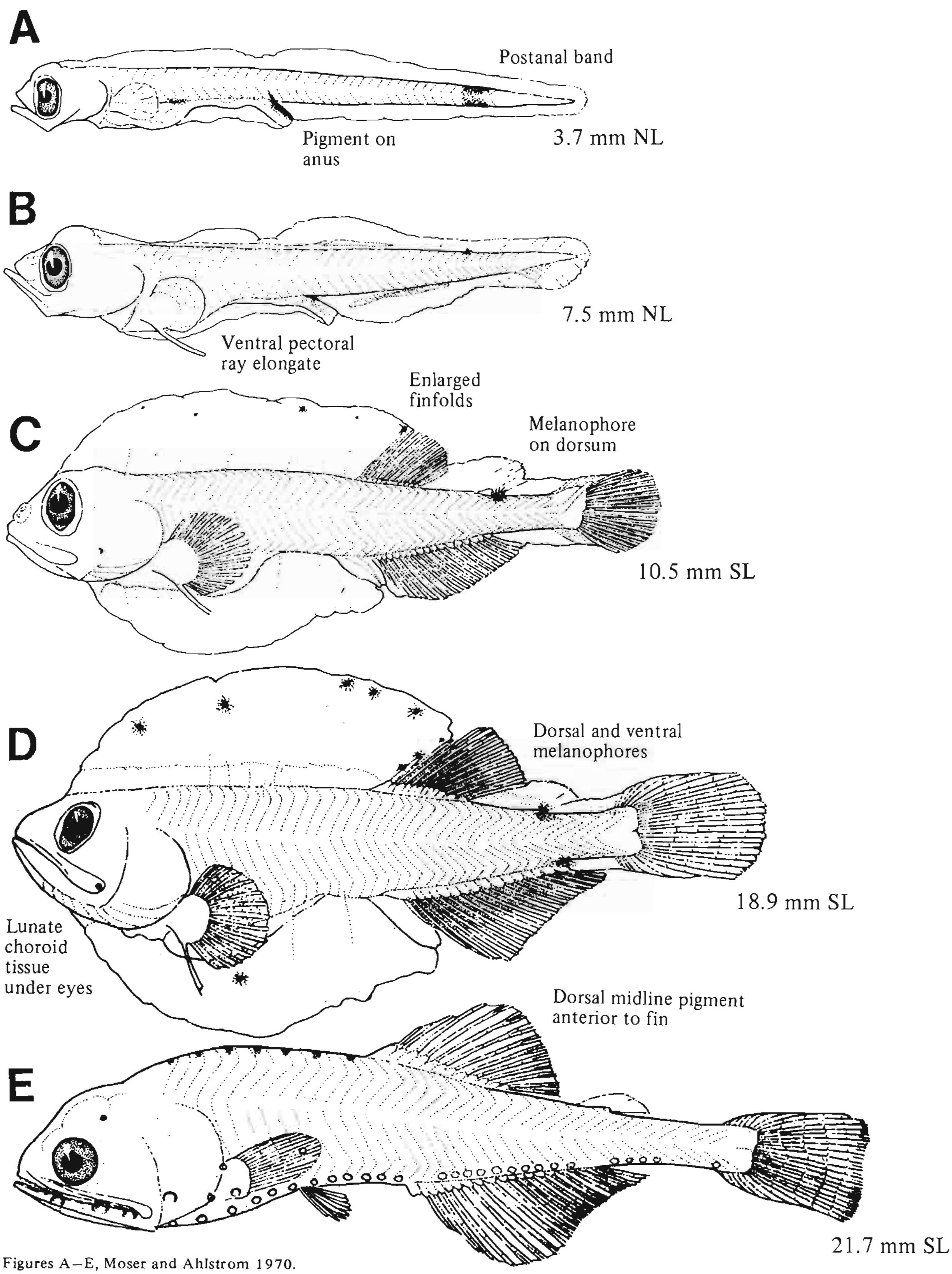
Distinguished from *Loweina rara* (p. 156) by
- See *L. rara*

Distinguished from all other myctophids except *L. rara* by
- Finfold: Dorsal and ventral finfolds greatly enlarged and conspicuously pigmented (more on dorsal)
- Eyes narrow with lunate choroid mass
- Only Br2 develops during larval period
- Enlarged ventral pectoral fin ray (lost during transformation)
- Postanal pigment band

Note: *T. taylori* adults occur in the area but their larvae are inadequately known. Pertseva-Ostroumova (1964) illustrated a 12-mm SL larva as *T. crenularis taylori*, but it has no features that distinguish it from *T. crenularis*.

[a] Ahlstrom 1965
[b] Wang 1981

Ref: Moser and Ahlstrom 1970, 1974; Moser et al. 1984a.



Figures A–E, Moser and Ahlstrom 1970.

MYCTOPHIDAE *Ceratoscopelus townsendi* (Eigenmann and Eigenmann 1889)

MERISTICS

Vertebrae[a]	Total: 35-36-38	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	8-X-12	
Caudal fin	6, 10+9, 6-7	
Pelvic fin	Abdominal	
	R: 8-X-9	
Dorsal fin	R: 13-14-15	
Pectoral fin	R: 12-X-14	
Anal fin[a]	R: 13-X-14	
Gill rakers[a]	U: 4-4-5	L: 10-11-12

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Epi- and mesopelagic
ELH pattern	Oviparous, eggs probably pelagic, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE[b]

Preanal length	46% SL, with development 58-61% SL
Length at flexion	6.2-7.0 mm SL
Length at transformation	16.6-21.0 mm SL (may be larger)
Sequence of fin development	Caudal, pectorals, anal, dorsal, pelvics

Pigment
- Generally light pigment
- Pair of melanophores at each side of gut at point of divergence of the free terminal section (retained throughout but becoming embedded with development)
- Series (∼11) of postanal ventral melanophores in early larvae, with development usually coalescing to a single spot in postflexion larvae

Diagnostic characters
- Photophores: Br2 (7.0 mm SL); Vn (7.8 mm SL); PLO (8.7 mm SL; develop and remain at pectoral fin base throughout larval period but at transformation they migrate dorsally to just below the lateral line); PO5 (9.0 mm SL); during transformation the remaining photophores develop sequentially

Distinguished from other myctophids with round eyes by
- Eye elliptical in preflexion larvae (although not perfectly round, the eye is easily differentiated from the narrow eyes of larval Myctophinae)
- Single spot at anus
- Preflexion larvae with ∼11 postanal ventral melanophores

---

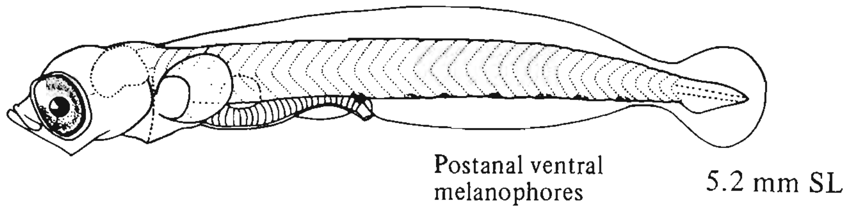
[a] Peden and Hughes (1986) report counts for the following meristic characters:

Precaudal vertebrae	16
Caudal vertebrae	20
Anal fin rays	15
Gill rakers	6−7+1+15

[b] H.G. Moser, NMFS Southwest Fish. Cent., P.O. Box 271, La Jolla, CA 92038, pers. commun., 9 Jan. 1984. Illustrations of small larvae are unavailable. A figure of a preflexion larva of *C. warmingi* is included for comparison.

Ref: Moser and Ahlstrom 1974, Moser et al. 1984a.

A



(Ceratoscopelus warmingi)

B

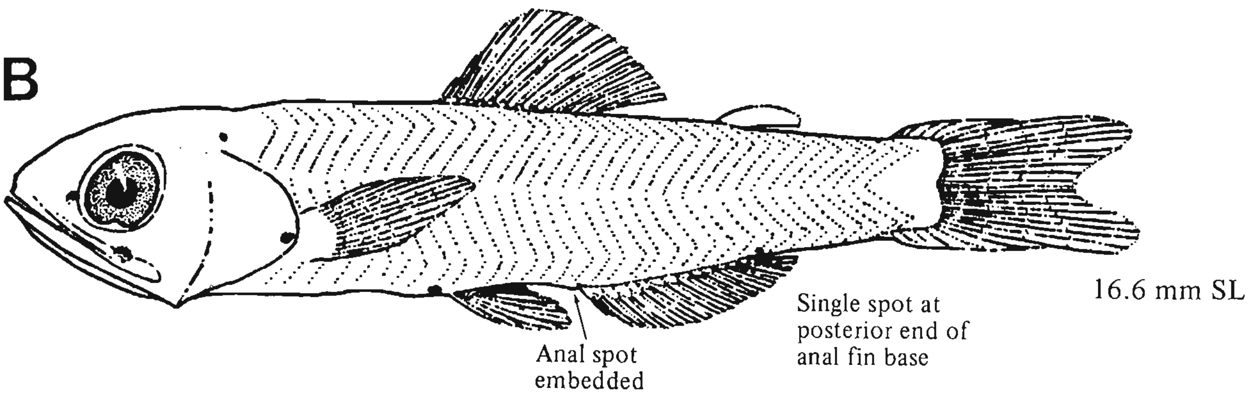


Figure A, Miller et al. 1979 (Hawaiian specimen); B, Moser and Ahlstrom 1974.

MERISTICS

Vertebrae[a]	Total: 35-36-36
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	9-X-10
Caudal fin	8-9, 10+9, 8-9
Pelvic fin	Abdominal
	R: 8-8-8
Dorsal fin	R: 14-15-16
Pectoral fin	R: 15-16-17
Anal fin	R: 13-13-14
Gill rakers[a]	U: 3-4-5 L: 9-X-11

LIFE HISTORY

Range	South of southern California to Washington, 46-48°30'N
Ecology	Epi- and mesopelagic
ELH pattern	Oviparous, eggs probably pelagic, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length	50% SL
Length at flexion	By 5-6 mm SL
Length at transformation	19.6 mm SL
Sequence of fin development	Caudal, pectorals, anal, dorsal, pelvics

Pigment - Genus[b]

(Pigment for *L. urophaos* more restricted to dorsal and ventral midline)

- Brain, nape, gut, swimbladder
- Double row of large melanophores along dorsal midline with an opposing double row of postanal ventral midline melanophores
- Some with more numerous dorsal and ventral melanophores and internal pigment above the notochord

Diagnostic characters

- Photophores: Br2, PLO, PO5, and Vn+PO1 develop during larval period

Distinguished from other myctophids with round eyes by

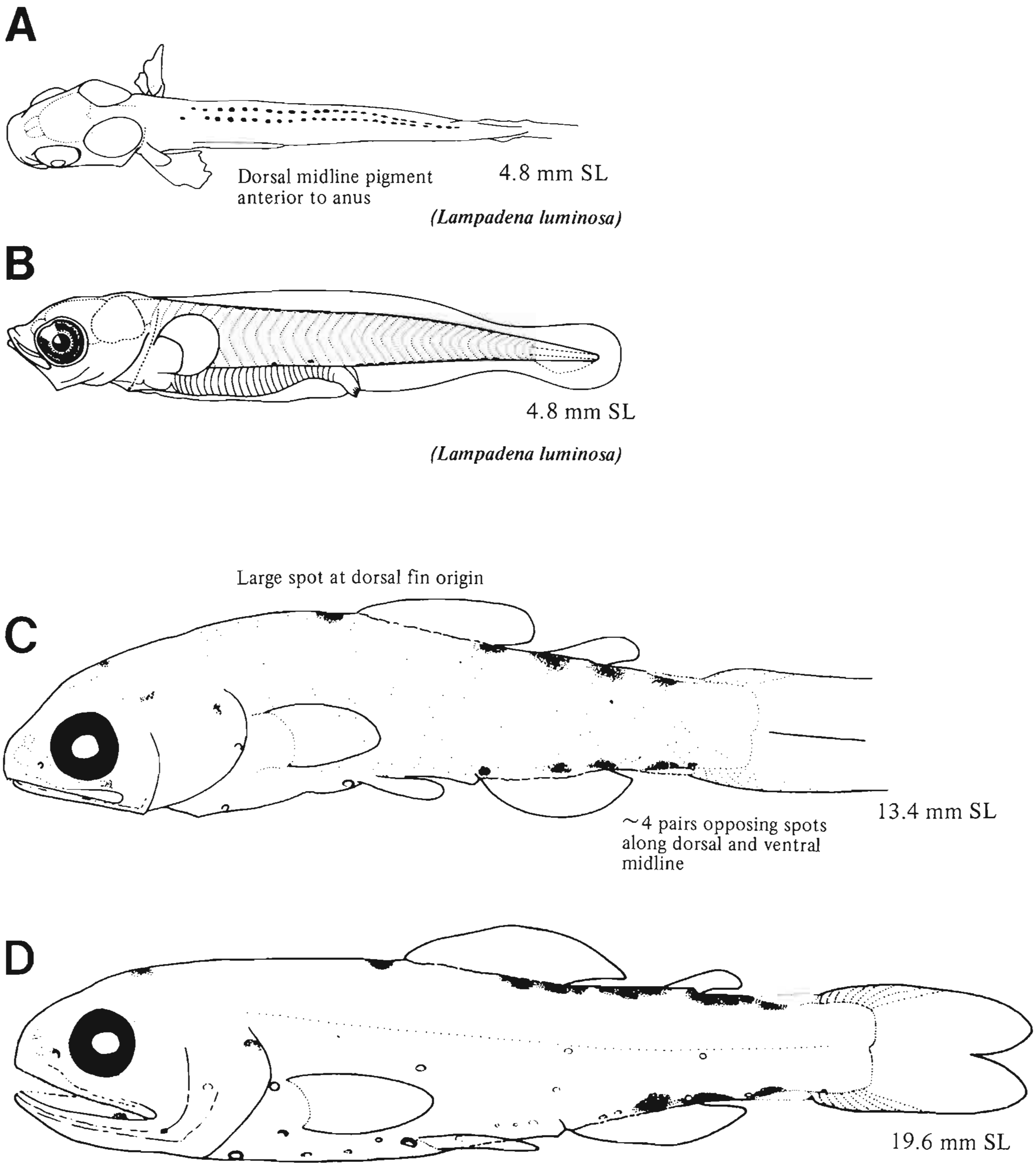
- Dorsal midline pigment anterior to anus

[a] Peden and Hughes (1986) report counts of the following meristic characters:

Total vertebrae	38
Precaudal vertebrae	17
Caudal vertebrae	21
Gill rakers	5+1+12

[b] Discussion of pigment is based on genus, since illustrations of small larvae of *L. urophaos* are not available. Figures of a preflexion larva of *L. luminosa* are included for comparison.

Ref: Moser and Ahlstrom 1972; Moser et al. 1984a; H.G. Moser, NMFS Southwest Fish. Cent., P.O. Box 271, La Jolla, CA 92038, unpubl.



Figures A–B (A, dorsal view), Miller et al. 1979 (Hawaiian specimens); C–D, Moser and Ahlstrom 1972.

Of the four *Lampanyctus* species found in the study area, we can identify larvae of only *L. regalis* and *L. ritteri*. Generic characters include:

- Pigment above brain
- Myoseptal trunk pigment increasing during postflexion to cover most of anterior trunk at transformation
- Slender body; deepens and becomes robust in some species
- Deep head
- Gut short in early preflexion larvae; with development lengthens to midbody

The following meristic information may aid in identifying the four *Lampanyctus* species.

			Fins			
Species	Distribution	Vertebrae	Dorsal	Anal	Pectoral	Pelvic
Lampanyctus fernae	N. Calif. - Oregon	36-38	12-14	16-18	12-14	8
Lampanyctus jordani	S. Calif. - Bering Sea	38-40	10-12	17-20	14-17	8
Lampanyctus regalis	SSC - Bering Sea	36-39	14-16	17-19	12-14	8
Lampanyctus ritteri	SSC - Bering Sea	35-38	12-15	16-19	10-13	8-9

MERISTICS

Vertebrae	Total: 36-X-39 Precaudal: X-X-X Caudal: X-X-X
Branchiostegal rays	9-9-9
Caudal fin	6-8, 10+9, 6-8
Pelvic fin	Abdominal R: 8-8-8
Dorsal fin	R: 14-15-16
Pectoral fin	R: 12-13-14
Anal fin	R: 17-17-19
Gill rakers	U: 4-4-4 L: 9-10-10

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Epi- and mesopelagic
ELH pattern	Oviparous, eggs probably pelagic, pelagic larvae
Spawning	Season: Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE[a]

Preanal length	38% SL preflexion, 54% SL at flexion, 67% SL postflexion
Length at flexion	>4 mm SL, <7 mm SL
Length at transformation	>10 mm SL, <28 mm SL
Sequence of fin development	Caudal, pectorals, anal, dorsal, pelvics (pelvics may form early)

Pigment
- Preflexion larvae are unpigmented except for spots on lower jaw tip and snout
- Head: Jaw tips, internal along snout, postorbital, opercle
- Pectoral and pelvic fins
- Large spot at adipose fin

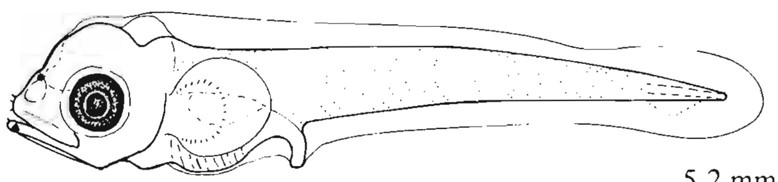
Diagnostic characters
- Photophores: Only Br2 develops during larval period (7.8 mm SL); remaining photophores develop synchronously at end of transformation period

Distinguished from other myctophids with round eyes by
- Morphology: Initially slender with a small head; with development a deep broad head and body with elongate snout develops; pectorals moderately large
- Jaws large with teeth
- Pigment: Large spot at adipose fin

[a] H.G. Moser, NMFS Southwest Fish. Cent., P.O. Box 271, La Jolla, CA 92038, pers. commun., 9 Jan. 1984.

Ref: Moser et al. 1984a; Moser, unpubl.

A



B

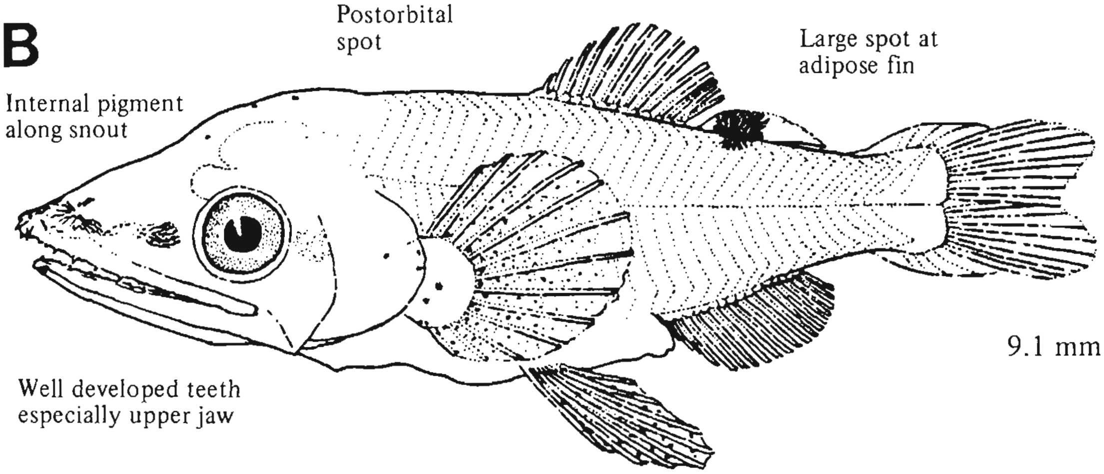


Figure A, NWAFC original (B. Vinter); B, Moser and Ahlstrom 1974.

MERISTICS

Vertebrae	Total: 35-36-38	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	9-9-9	
Caudal fin	7-8, 10+9, 7-8	
Pelvic fin	Abdominal	
	R: 8-X-9	
Dorsal fin	R: 12-13-15	
Pectoral fin	R: 10-11-13	
Anal fin	R: 16-18-19	
Gill rakers	U: 4-4-4	L: 9-10-11

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Epi-, meso-, and bathypelagic, 20-1098 m
ELH pattern	Oviparous, eggs probably pelagic, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE[a]

Preanal length	<50% SL in preflexion, with development 50% SL
Length at flexion	>4 mm SL, ~6 mm SL
Length at transformation	>10 mm SL
Sequence of fin development	Caudal, pectorals, anal, dorsal, pelvics

Pigment

- Head: Snout, lower jaw, opercle; several spots anterodorsal to eye persist throughout development
- Dorsal and ventral midline on tail
- Anteroventral to liver

Diagnostic characters

- See *L. regalis* (p. 166)
- Photophores: Only Br2 develops during larval period; remaining photophores develop synchronously at end of transformation period

Distinguished from other myctophids with round eyes by

- See *L. regalis*

Distinguished from *L. regalis* by

- Morphology: Body and head moderately deep; jaws, teeth, and pectorals moderate in size

[a] H.G. Moser, NMFS Southwest Fish. Cent., P.O. Box 271, La Jolla, CA 92038, pers. commun., 9 Jan. 1984.

Ref: Ahlstrom 1965; Moser and Ahlstrom 1974; Moser, unpubl.

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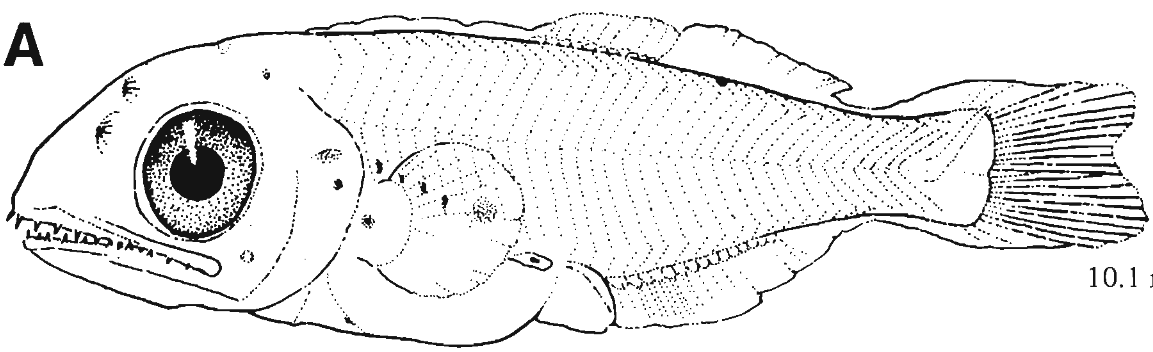

Figure A, Moser and Ahlstrom 1974.

MERISTICS

Vertebrae	Total: 36-37-38
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	8-X-12
Caudal fin	8, 10+9, 8
Pelvic fin	Abdominal
	R: 8-8-8
Dorsal fin	R: 14-X-17
Pectoral fin	R: 10-X-13
Anal fin	R: 15-X-18
Gill rakers	U: 4-5-6 L: 12-13-15

LIFE HISTORY

Range	South of southern California to Oregon, 42-46°N
Ecology	Epi- and mesopelagic
ELH pattern	Oviparous, eggs probably pelagic, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length	<50% SL, with development increasing to 50% SL
Length at flexion	
Length at transformation	
Sequence of fin development	Caudal, pectorals, anal, dorsal, pelvics

Pigment
- Early preflexion larvae probably unpigmented with pigment developing by flexion stage
- Postflexion larvae have pigment above brain, internally above otic region, lateral to cleithrum, and in anteroventral region of liver
- Postanal body with 1-2 dorsal midline melanophores and 1 ventral midline melanophore at caudal peduncle

Diagnostic characters
- Photophores: Only Br2 forms during the larval period

Distinguished from other myctophids with round eyes by
- Dorsal midline melanophores restricted to 1-2 spots posterior to adipose fin
- Head and eyes large with the body tapered

Ref: Moser and Ahlstrom 1974; Moser et al. 1984a; H.G. Moser, NMFS Southwest Fish. Cent., P.O. Box 271, La Jolla, CA 92038, unpubl.

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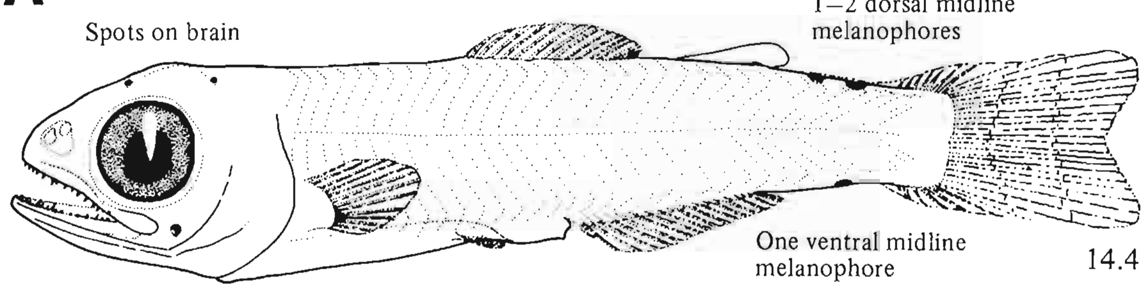


Figure A, Moser and Ahlstrom 1974.

MYCTOPHIDAE *Stenobrachius leucopsarus* (Eigenmann and Eigenmann 1890)

MERISTICS

Vertebrae	Total: 36-37-38
	Precaudal: 14-15-16
	Caudal: 20-21-22
Branchiostegal rays	8-X-12
Caudal fin	6-8, 10+9, 7-8
Pelvic fin	Abdominal
	R: 8-8-8
Dorsal fin	R: 12-X-14
Pectoral fin	R: 9-X-11
Anal fin	R: 14-15-16
Gill rakers	U: 5-5-6 L: 12-13-14

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Epi-, meso-, and bathypelagic, 0-2896 m
ELH pattern	Oviparous, eggs probably pelagic, pelagic larvae
Spawning	Season: Winter-spring (Oregon);[a] Nov-Aug (Calif.);[b] Dec-Feb (Moss Landing, Calif.)[c]
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	3 yr (California)[b]
	4 yr (Oregon)[a]
Longevity	3-4 yr[b]

[a] Smoker and Pearcy 1970
[b] Fast 1960
[c] Wang 1981

Ref: Ahlstrom 1965, 1972; Moser and Ahlstrom 1974.

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length	<50% SL
Length at flexion	>5.3 mm SL, ~6-7 mm SL
Length at transformation	>12.5 mm SL; 10-19 mm SL[b]
Sequence of fin development	Caudal, pectorals, anal, dorsal, pelvics

Pigment
- Gut melanophores: Early preflexion, lateral spots at pectoral fin base, midgut, and anus
- Series of postanal ventral melanophores (>15) in preflexion larvae which coalesce to 2 or 3 spots in postflexion larvae
- Postflexion: Above brain, nape, and embedded in trunk myosepta on each side of dorsal midline (not shown)

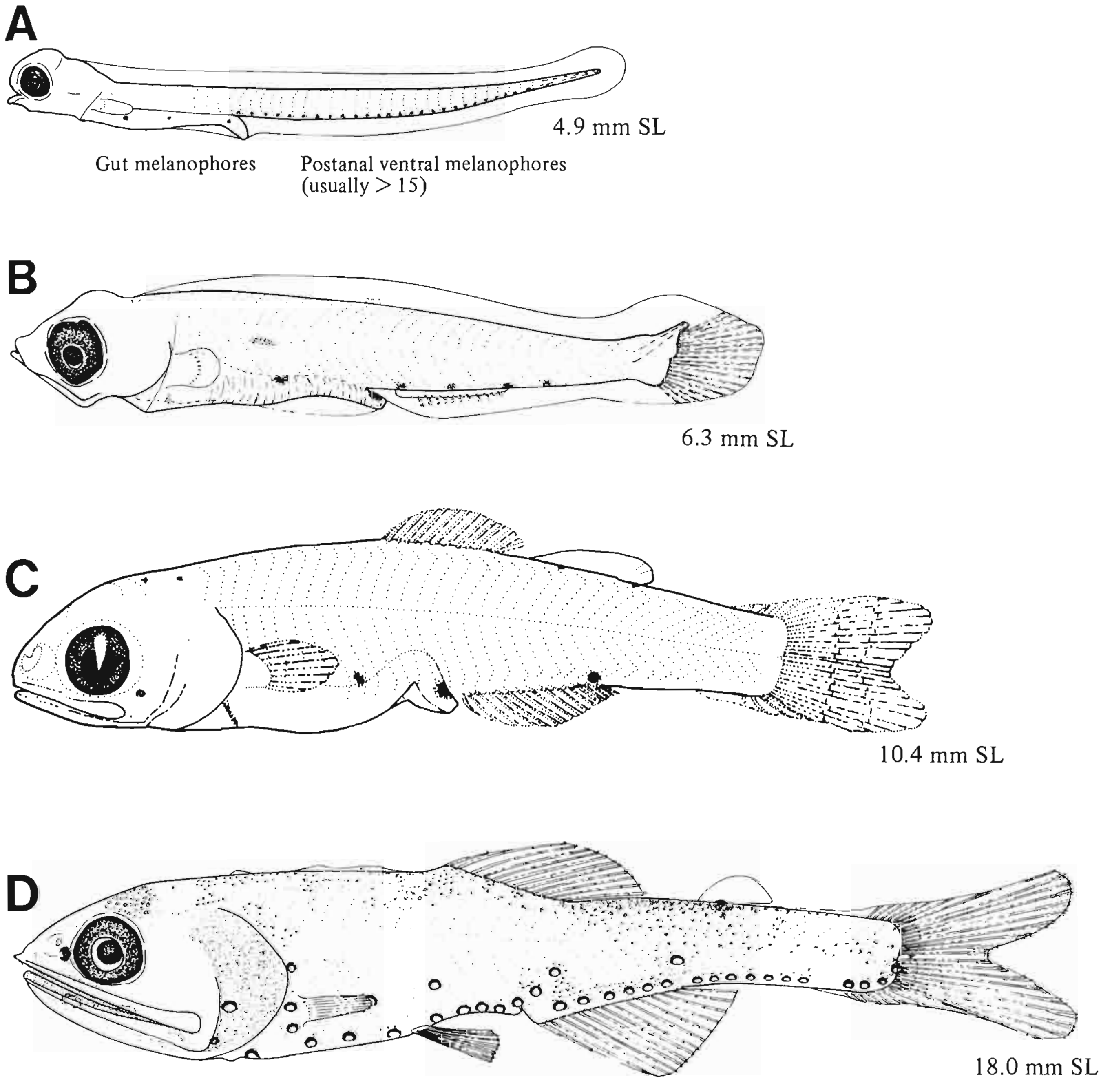
Diagnostic characters
- Photophores: Only Br2 forms in the larval period

Distinguished from other myctophids with round eyes by
- Gut pigment: Three spots in preflexion larvae (pectoral fin base, midgut, and anus); with development spots are retained, although their position shifts posteriorly
- Series of postanal ventral melanophores (>15) in preflexion larvae

Distinguished from *Diaphus theta* (p. 176) by
- Lack of pigment at caudal base
- Number of postanal ventral melanophores (>15): Preflexion larvae usually have >20; postanal ventral midline melanophores appear more embedded in *D. theta* (see figure)

S. nannochir larvae are unknown. The following meristic information may aid in identification.

Total vertebrae	36-38
Dorsal fin rays	13-14
Anal fin rays	14-16
Pectoral fin rays	9-10
Pelvic fin rays	8



Figures A–B, D, NWAFC originals (B. Vinter); C, Moser and Ahlstrom 1974.

MERISTICS

Vertebrae	Total: 34-X-36
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	8-X-12
Caudal fin	X, 10+9, X
Pelvic fin	Abdominal
	R: 8-8-8
Dorsal fin	R: 11-X-14
Pectoral fin	R: 12-X-14
Anal fin	R: 12-13-14
Gill rakers	U: 3-3-3 L: 6-X-10

LIFE HISTORY

Range	Cent. California, 34-38°N,[a] to Oregon, 42-46°N
Ecology	Meso- and bathypelagic
ELH pattern	Oviparous, eggs probably pelagic, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length
Length at flexion
Length at transformation
Sequence of fin development Caudal, pectorals, anal, dorsal, pelvics

Pigment - Genus[b]
- Above brain, otic region
- One to several opposing melanophores at postanal dorsal and ventral midline
- Late postflexion larvae may develop melanophores along each side of dorsal midline
- Base of caudal rays
- Series of embedded melanophores above spinal column

Diagnostic characters - Genus
- No photophores in larvae

Distinguished from other myctophids with round eyes by
- Morphology: Body slender, lower jaw projects beyond upper jaw
- Embedded melanophores above spinal column
- Opposing dorsal and ventral melanophores on caudal peduncle

[a] Wisner 1974
[b] Information on *T. minimus* larvae is provided for comparison since *T. bathyphilus* larvae are unknown.

Ref: Moser et al. 1984a; H.G. Moser, NMFS Southwest Fish. Cent., P.O. Box 271, La Jolla, CA 92038, unpubl.

Taaningichthys minimus

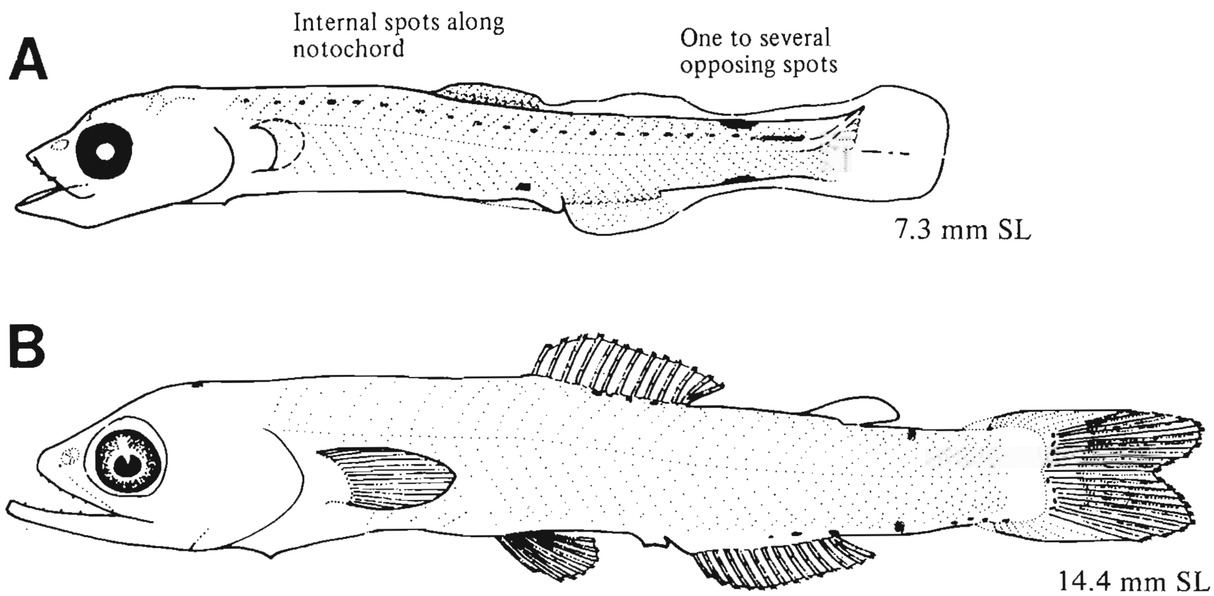


Figure A–B, Moser and Ahlstrom 1972 (southwestern Pacific specimens).

MERISTICS

Vertebrae	Total: 34-35-36
	Precaudal: 15-16-16
	Caudal: 18-19-20
Branchiostegal rays	9-9-9
Caudal fin	6-8, 10+9, 6-8
Pelvic fin	Abdominal
	R: 7-X-8
Dorsal fin	R: 11-13-15
Pectoral fin	R: 10-X-12
Anal fin	R: 12-X-14
Gill rakers	U: 5-X-7 L: 12-15-16

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Epi- and mesopelagic, 0-792 m
ELH pattern	Oviparous, eggs probably pelagic, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length	
Length at flexion	<6.9 mm SL
Length at transformation	
Sequence of fin development	Caudal, pectorals, anal, dorsal, pelvics

Pigment

- Head unpigmented
- Anteroventral surface of liver, midgut, base of caudal fin rays, swimbladder
- Postanal ventral melanophores in preflexion: Numerous (<15)

Diagnostic characters

- Number of photophores in larvae[a]

Distinguished from other myctophids with round eyes by

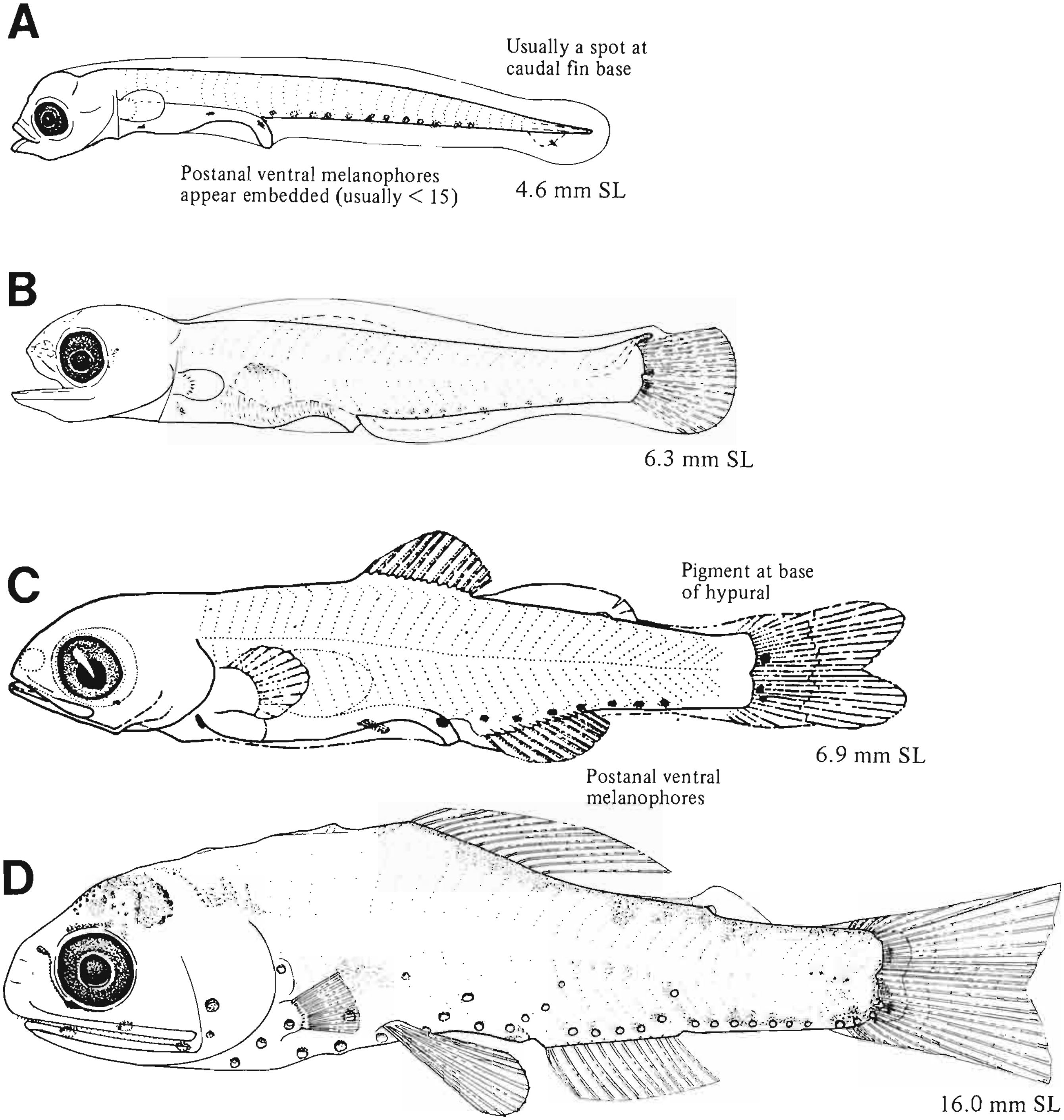
- Body moderately slender
- Head moderate in size, unpigmented
- Postanal ventral melanophores (<15)
- Melanophores at base of caudal fin rays

Distinguished from *Stenobrachius leucopsarus* (p. 172) by

- See *S. leucopsarus*

[a] Sequence of formation of photophores: Br2, PO5, PO1 [VO1, PO2, OP2, VO5, PO3, PO4, VLO] (photophores in brackets appear in late larval period).

Ref: Moser and Ahlstrom 1974.



Figures A–B, D, NWAFC originals (B. Vinter); C, Moser and Ahlstrom 1974.

MERISTICS

Vertebrae	Total: 35-37-38
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	9-9-9
Caudal fin	11-14, 10+9, 10-14
Pelvic fin	Abdominal
	R: 8-X-9
Dorsal fin	R: 21-22-23
Pectoral fin	R: 11-12-13
Anal fin	R: 18-19-20
Gill rakers	U: 6-6-7 L: 13-14-15

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Epi- and mesopelagic
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS - Genus

Diameter	0.26 mm
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	
Hatch size	
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE[b,c]

Preanal length	<50% SL preflexion, with development 50% SL
Length at flexion	
Length at transformation	
Sequence of fin development	Caudal, pectorals, anal, dorsal, pelvics

Pigment
- Preflexion: Jaw tips, above brain and swimbladder, lateral cleithral
- Postflexion: Lower jaw, hindbrain, nape, double row of melanophores along dorsal midline beginning at midbody, series along anal fin base, caudal fin base, pelvic and anal fin, internal notochord pigment on trunk

Diagnostic characters
- Photophores: Br2, PO5, Vn, and PLO develop during larval period

Distinguished from other myctophids with round eyes by
- Morphology: Body moderately deep, head and eyes large
- Midlateral and dorsal fin base pigment in postflexion larvae
- Highest dorsal fin ray count among myctophids in study area (21-23)
- Head pigment: Jaw tips, snout, opercle and brain

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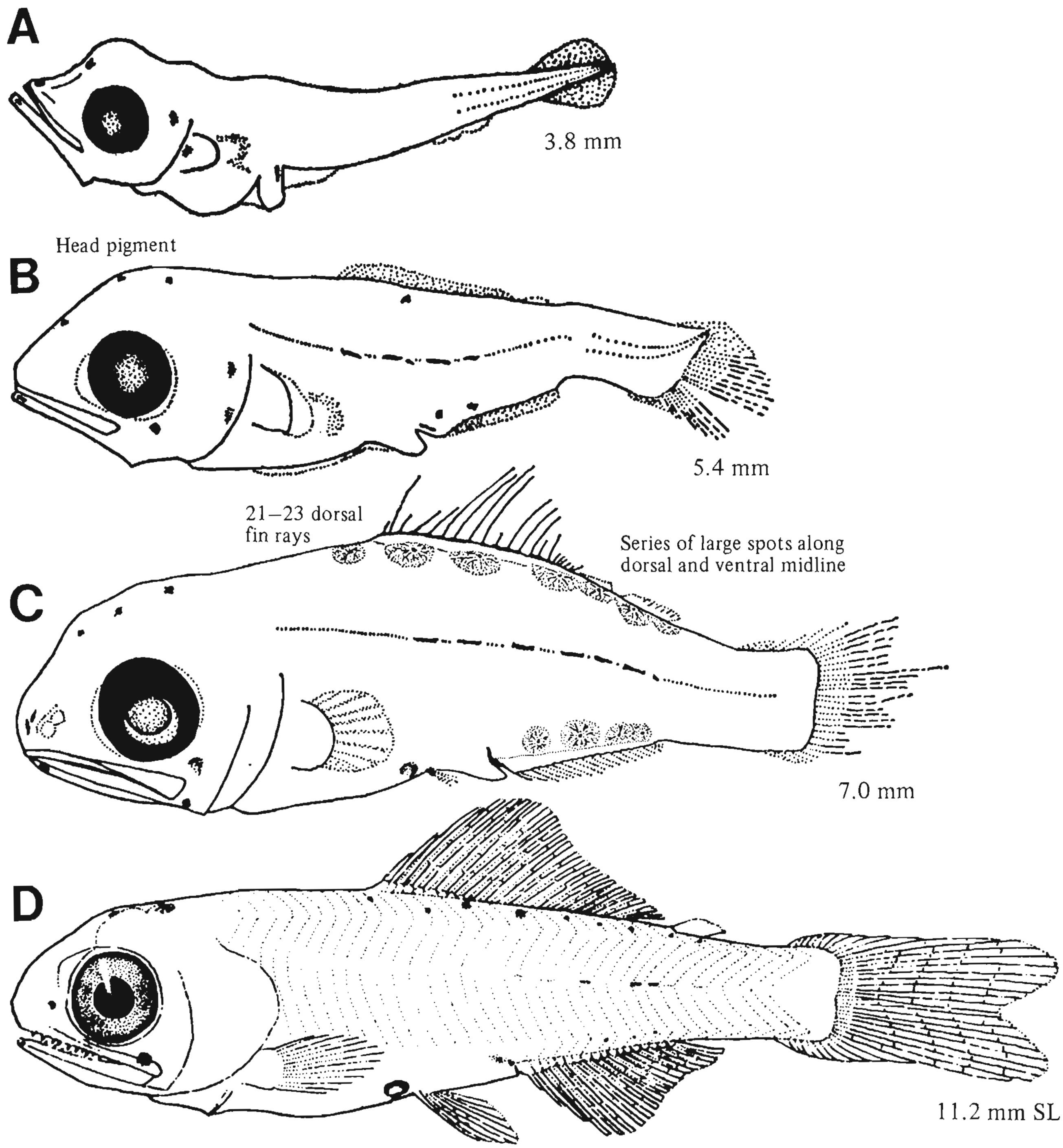
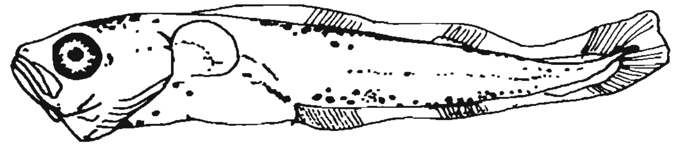
[a] According to Peden and Hughes (1986) northern records of *N. resplendens* are probably *N. japonicus*.
[b] H.G. Moser, NMFS Southwest Fish. Cent., P.O. Box 271, La Jolla, CA 92038, pers. commun., 9 Jan. 1984.
[c] Both *N. resplendens* and *N. japonicus* are described and illustrated in Ozawa (1986d). Specimens from the eastern Atlantic are figured here, but, according to Ozawa (1986d), they may differ in pigmentation and in photophore development from specimens found in the Pacific.

Ref: Badcock and Merrett 1976; Moser and Ahlstrom 1972; Ozawa 1986d; Moser, unpubl.



Figures A–C, Badcock and Merrett 1976 (eastern Atlantic specimens); D, Ahlstrom and Moser 1974.



Gadiformes

Gadiform fishes include some of the most commercially important coldwater marine species in the world: the codfishes and their relatives. The order contains between 7 and 13 families, depending on the source, and well over 400 species. Fishes of this order are found worldwide and are generally bathypelagic (except for one freshwater species). Most species are elongate with some having long dorsal and/or anal fins. Pelvic fins are thoracic or jugular, and chin barbels are present in many. Although they are easily recognized and well studied, evolutionary relationships are poorly understood and most recent authors now propose a multiple origin for at least the Gadidae (Markle 1989). The early-life-history stages are well known, especially for the gadids and merlucciids, and have been studied for well over 100 years (Fahay and Markle 1984). Most eggs are pelagic, spherical, and have a single oil globule (lacking in some gadids). Larvae are commonly identified by their distinctive pigment patterns, coiled gut, and general tadpole shape. Morids, melanonids, and macrourids are less well known.

Families in study area: **Moridae**
Melanonidae
Merlucciidae
Gadidae
Macrouridae

MORIDAE

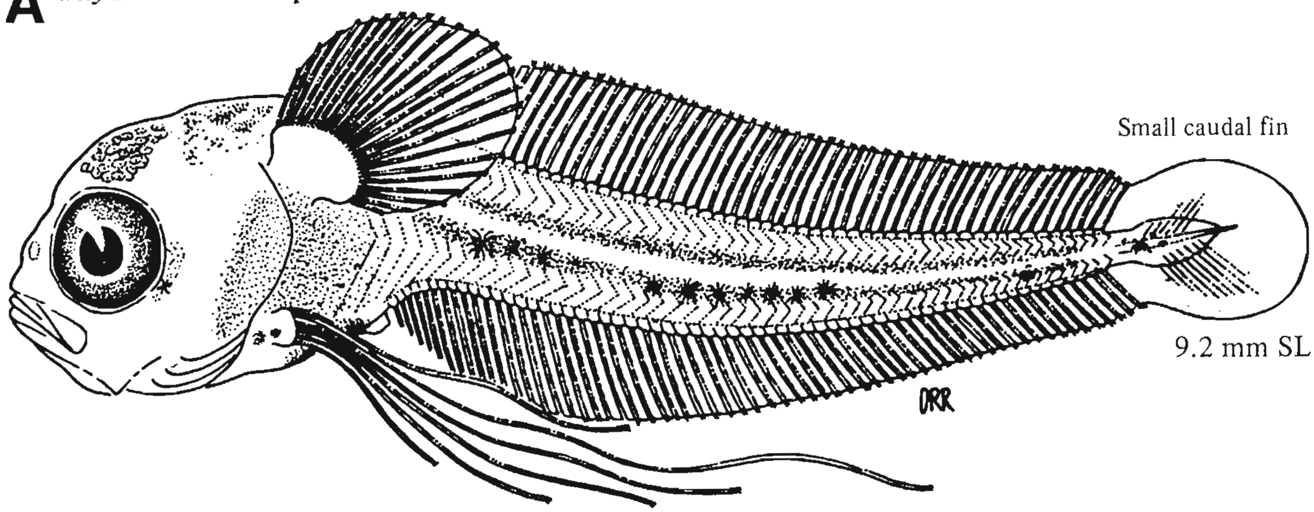
Morids are benthopelagic fishes distributed throughout the world's oceans and are represented by two species in two genera in the study area. Very little is known of the early life history of the codlings. For the few species described, eggs are 0.52-1.16 mm in diameter, have one oil globule, and a smooth chorion (Fahay and Markle 1984). The scarcity of small fish in bottom trawls indicates the very young, and perhaps eggs, are pelagic (Iwamoto 1975). Most morids have precocious pelvic fin ray development. Usually the pelvic fin rays are elongate and probably undergo some ontogenetic reduction. Figures of larvae of *Physiculus nematopus* and *Laemonema* sp. are provided for comparison, since larvae of species in our area are unknown.

Table 21
Meristic characters of family Moridae.

Taxon	Distribution	Vertebrae Precaudal	Vertebrae Caudal (Total)	Fins First Dorsal	Fins Second Dorsal	Fins Anal	Fins Pectoral	Fins Pelvic	Fins Caudal (Total)	Gill rakers Upper	Gill rakers Lower	Branchiostegals
*Antimora**		24-25	33-35 (57-61)	4-7	48-56	36-49	17-25	5-7				
Antimora microlepis	SSC - Bering Sea	24-25	33	4-5	50-55	37-42	20	6-7	14,5+4,12	5	15	7
*Laemonema**		15-17	42-45 (50-63)	5-6	48-75	45-72	15-26	1-3 (usually 2)				
Laemonema longipes	Bering Sea		(51)	6	50-52	45-50	15-17	2-3	(22-25)	5-7	19-20	6

*Data are from Fahay and Markle (1984).

A *Physiculus nematopus*



B *Laemonema* sp.

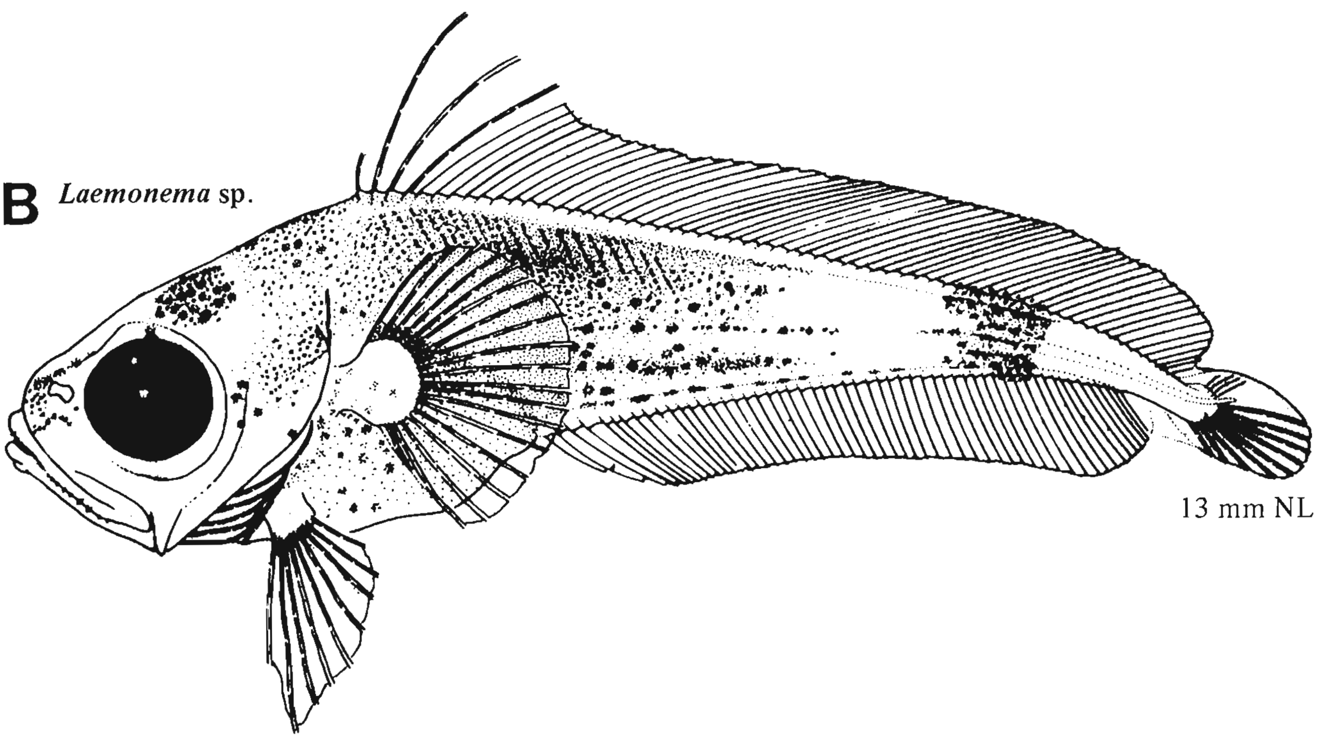


Figure A, Fahay and Markle 1984; B, Fahay 1983 (North Atlantic specimen; identification is tentative).

MERISTICS

Vertebrae	Total: 58-X-62
	Precaudal: 13-13-13
	Caudal: 47-47-47
Branchiostegal rays	7-7-7
Caudal fin	23-25, 6+3, 22-25
Pelvic fin	Thoracic
	R: 5-X-7
Dorsal fin	R: 67-X-80[a]
Pectoral fin	R: 12-X-16
Anal fin	R: 52-X-61[a]
Gill rakers	U: 3-X-4 L: 6-X-11

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Mesopelagic, 200-1000 m
ELH pattern	Parity and eggs unknown, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE[b]

Preanal length
Length at flexion
Length at transformation
Sequence of fin development
Pigment

Diagnostic characters

- Large number of secondary caudal fin rays (23-25 upper and 22-25 lower)

[a] D. Markle, Dep. Fish. Wildl., Oregon State Univ., Corvallis, OR 97331-3803, pers. commun., 8 May 1986.
[b] Specimens <17 mm SL have not been identified.

Ref: Fahay and Markle 1984.

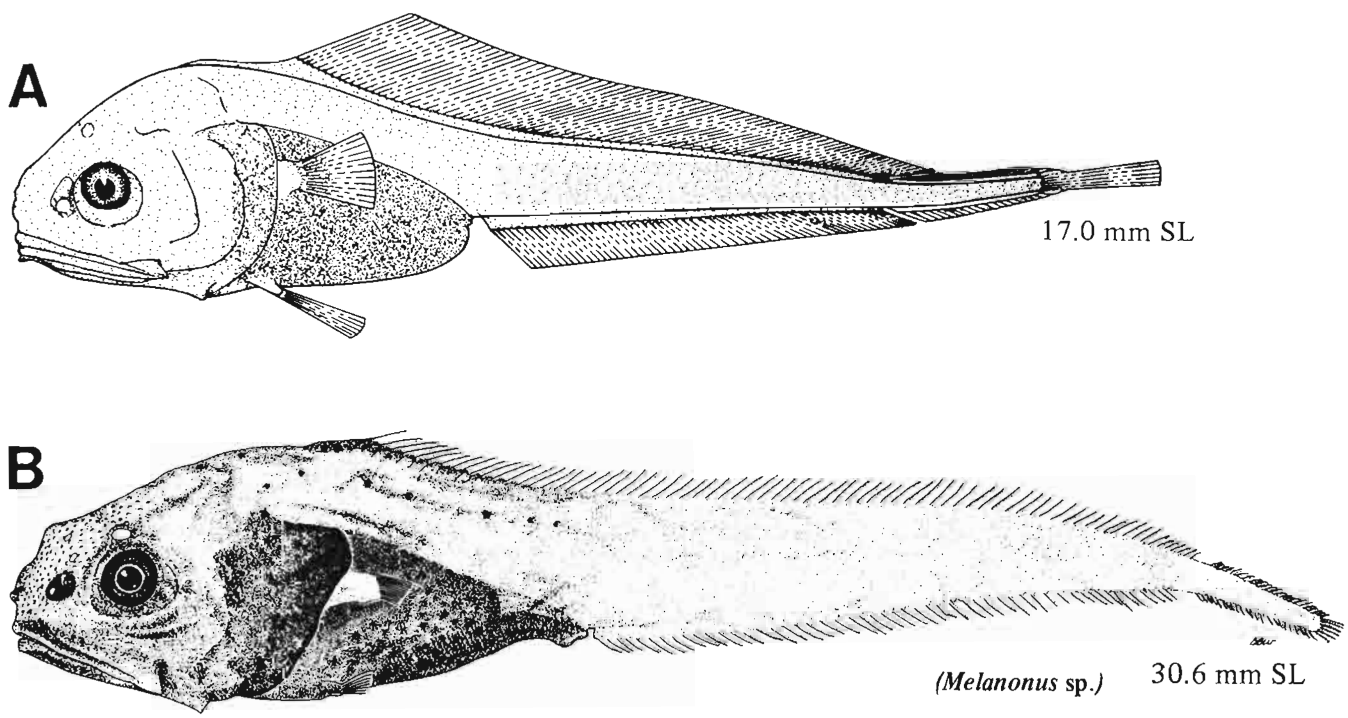


Figure A, NWAFC original (B. Vinter, Atlantic specimen); B, Fahay and Markle 1984 (South Atlantic specimen).

MERISTICS

Vertebrae	Total: 52-53-55 Precaudal: 23-24-25 Caudal: 29-29-30
Branchiostegal rays	7-7-7
Caudal fin	16-18, 6+2-3, 14-17
Pelvic fin	Thoracic R: 6-X-8
Dorsal fin	1st: 10-11-13 2nd: 37-40-44
Pectoral fin	R: 14-16-16
Anal fin	R: 37-40-44
Gill rakers	U: 4-X-5 L: 13-16-18

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Epi- and mesopelagic, 0-914 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Jan-June[a] Area: Offshore pelagic;[b] 130-500 m[c] Mode: Schools[d] Migration: South and offshore to spawn (southern subpopulation); within Puget Sound and Straits of Georgia (northern subpopulation)[b]
Fecundity	Range/function: 3419[e]-496,000[f]
Age at first maturity	2 yr[d]-4 yr[g]
Longevity	17 yr[h]

[a] Hart 1973
[b] The main offshore population spawns offshore off southern California (Francis and Bailey 1983). Disjunct populations in the Puget Sound-Straits of Georgia area spawn in restricted areas within these regions.
[c] Bailey et al. 1982
[d] Kimura and Milliken 1977
[e] MacGregor 1971
[f] MacGregor 1966
[g] Best 1963
[h] Beamish 1979

Ref: Ahlstrom and Counts 1955, Fahay and Markle 1984.

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.07-1.18 mm (1.12 mm)
No. of oil globules	One
Oil globule diameter	0.27-0.34 mm
Yolk	May appear granular
Envelope	Clear, smooth
Hatch size	2.4 mm NL
Incubation time/temp.	3.1 d/16.6°C

Pigment
- On yolk
- Characteristic late-stage patches on embryo

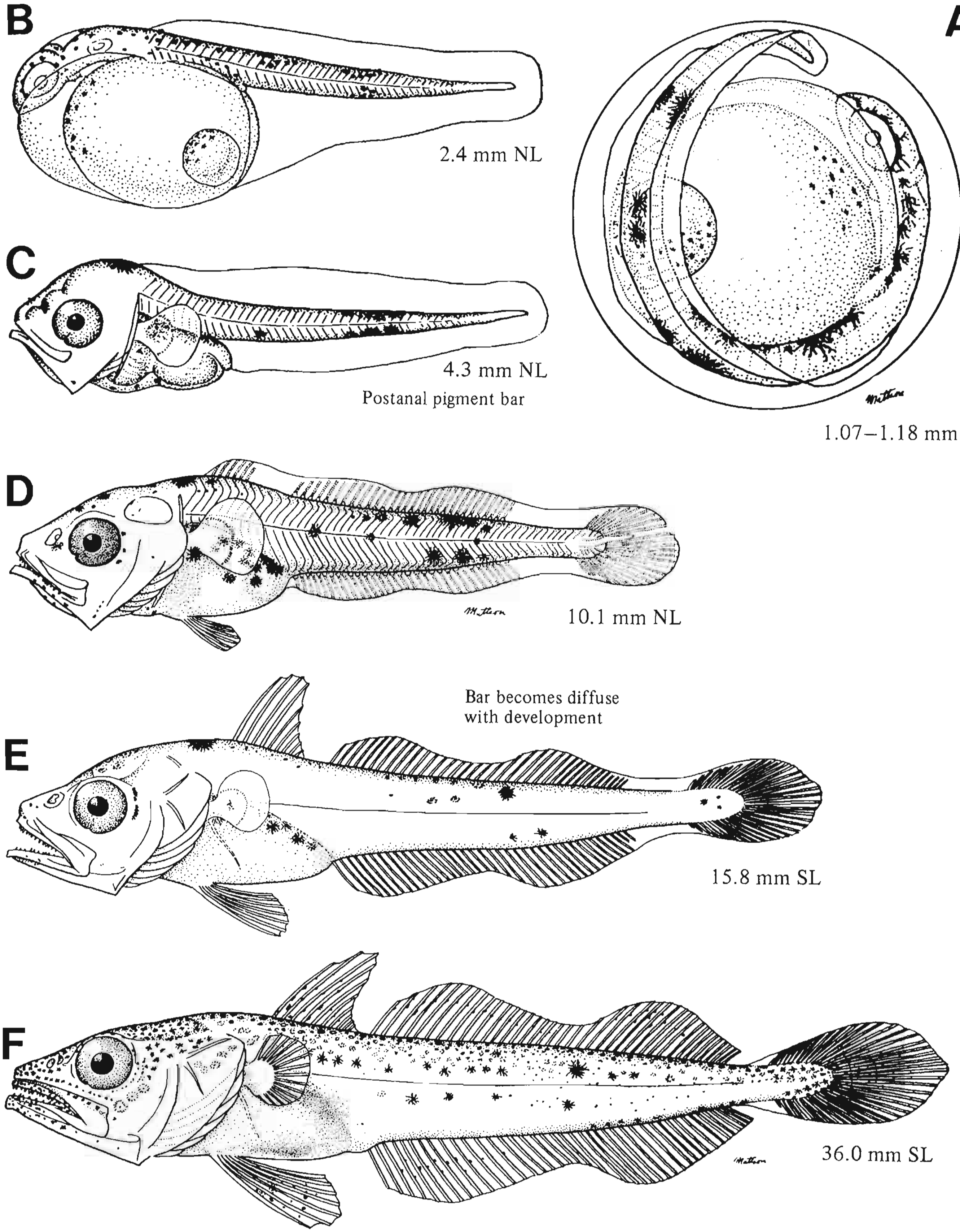
Diagnostic characters
- Pigment pattern
- Presence of oil globule
- Eye forms early during embryonic development

LARVAE

Preanal length	<50% SL
Length at flexion	~10 mm SL
Length at transformation	~30-35 mm SL
Sequence of fin development	Caudal, pelvics, 1st dorsal, 2nd dorsal and anal, pectorals

Pigment
- Preflexion larvae: One postanal bar, one large dendritic spot several myomeres posterior to anus; with development, bar becomes diffuse, postanal body pigment increases, especially dorsolaterally
- On head, crown, and snout; increasing with development
- Dorsolaterally on gut

Diagnostic characters
- Gadoid shape but absence of >1 distinct postanal pigment bar
- Two dorsal fins and one anal fin
- Specimens from Puget Sound and Straits of Georgia have pigmented pectoral rays



Figures A–F, Ahlstrom and Counts 1955.

The family Gadidae is represented in the Northeast Pacific Ocean and Bering Sea by five species: Walleye pollock, *Theragra chalcogramma*; Pacific cod, *Gadus macrocephalus*; Pacific tomcod, *Microgadus proximus*; saffron cod, *Eleginus gracilis*; and Arctic cod, *Boreogadus saida*. Identification of gadid larvae prior to 1980 was not possible. Gadid larvae collected during ichthyoplankton studies were routinely reported as "Gadidae." Recent taxonomic studies have continued since 1980 and have allowed the specific identification of all five species in the area (e.g., Matarese et al. 1981 and Dunn and Vinter 1984). Identification is based primarily on differences in pigmentation patterns and meristic characters. The available knowledge of the general early life histories of these five species was recently reviewed by Dunn and Matarese (1987).

Table 22

Characters useful in separating larvae of *Eleginus gracilis*, *Boreogadus saida*, *Gadus macrocephalus*, *Theragra chalcogramma*, and *Microgadus proximus* at specific size ranges (Dunn and Vinter 1984, in part).

Character	Size range (mm SL)	*E. gracilis*	*B. saida*	*G. macrocephalus*	*T. chalcogramma*	*M. proximus*
Pigment						
Preanal region						
Ventral gut	4.4-13.5	Double row of small melanophores	Absent in larvae <10mm; spots present anterior to pectoral fins in larvae >10 mm	Large melanophores medially	Relatively few scattered spots, more anterior than posterior	Large melanophores present, more anterior than posterior
Line of lateral pigment	10-18	Begins anterior to anus	Begins under second dorsal fin	Begins anterior to anus	Begins under second dorsal fin	Begins just anterior to anus
Postanal region						
Length of ventral stripes (based on no. of melanophores)	4-6	Both longer than dorsal stripes	Both shorter than dorsal stripes	Anterior stripe longer than dorsal stripe (<5.3 mm)	Posterior stripe longer than dorsal stripe	Anterior stripe longer than dorsal stripe (<5 mm)
No. of myomeres from vertical end of anus to anterior end of first ventral pigment stripe	4-6	4-6	5-7	1-3 (reaches vent by ~5.3 mm)	4-5	1-3 (reaches vent by ~5.0 mm)
Length at which dorsal pigment forms a continuous line	4-15	~10 mm	~7 mm	~5-6 mm	~13 mm	~13 mm
Length at which ventral pigment forms a continuous line	4-10	~7 mm	~10 mm	~5-6 mm	Never merge	~5-6 mm
On ventral margin of body	10-15	In double row on each side of midline	Pigment on midline and scattered on each side	Single row on each side of midline	Pigment on midline and a single row on each side	Single row on each side of midline anteriorly, single row on midline posteriorly
Morphologic						
Position of vent relative to dorsal fins	15-20	Under second dorsal	Under second dorsal	Under second dorsal	Between first and second dorsal	Between first and and second dorsal (ultimately under first dorsal)
Meristic						
No. of rays on superior hypural	>13	5	4	4	4	5

MERISTICS

Vertebrae	Total: 53-X-58 Precaudal: 18-X-20 Caudal: 35-X-39
Branchiostegal rays	7-7-7
Caudal fin	21-25, 4+2, 21-25
Pelvic fin	Thoracic R: 6-6-6
Dorsal fin	1st: 10-X-17 2nd: 11-X-18 3rd: 16-X-24
Pectoral fin	R: 18-X-19
Anal fin	1st: 13-X-21 2nd: 17-X-23
Gill rakers	U: 8-X-9 L: 29-X-34

LIFE HISTORY

Range	Bering Sea, 54-66°N, to Arctic, not specific
Ecology	Epi- and mesopelagic, 0-731 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Oct-Mar[a] Area: Nearshore[b] Mode: Schools[b] Migration: Nearshore to spawn[b]
Fecundity	Range/function: 9000-21,000[a]
Age at first maturity	3 yr (females)[b] 2-3 yr (males)[b]
Longevity	7 yr[b]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.53-1.90 mm
No. of oil globules	None
Oil globule diameter	
Yolk	Homogeneous
Envelope	Smooth
Hatch size	6 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	<50% SL
Length at flexion	11-17 mm SL
Length at transformation	17-30 mm, pelagic until 30-45 mm SL
Sequence of fin development	Caudal, dorsals and anals, pectorals, pelvics

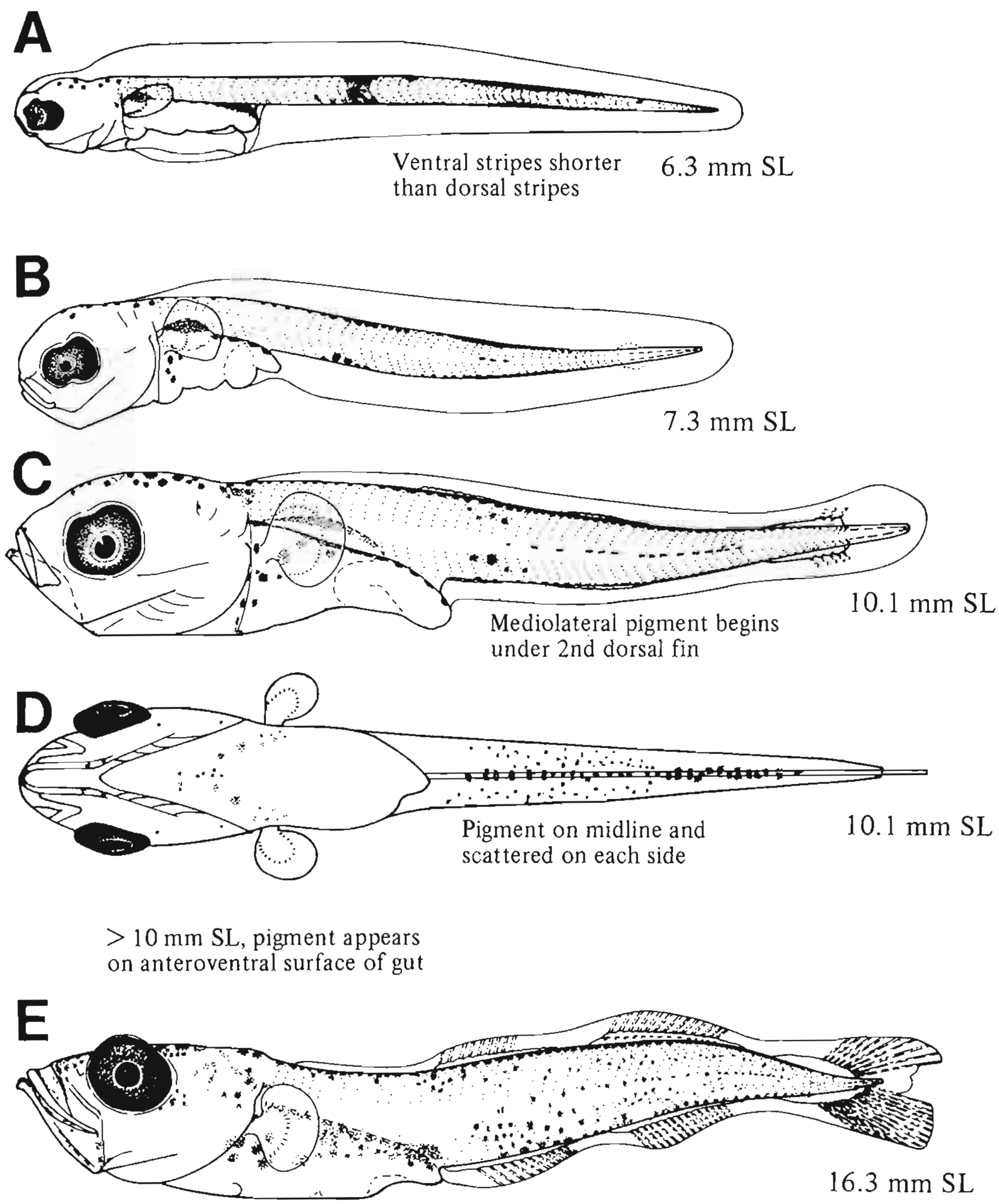
Pigment
- Presence of bars
- Shorter ventral stripes
- Mediolateral pigment

Diagnostic characters (see Table 22)
- Ventral pigment on midline and scattered on each side
- Rays on superior hypural = 4

Distinguished from *Theragra chalcogramma* by
- Ventral pigment on midline and scattered on each side. In *T. chalcogramma*, ventral pigment consists of a row along midline and a single row on each side.

[a] Bain and Sekerak 1978
[b] Craig et al. 1982

Ref: Dunn and Matarese 1984, Dunn and Vinter 1984.



Figures A–D (D, ventral view), Dunn and Vinter 1984; E, NWAFC original (B. Vinter).

MERISTICS

Vertebrae	Total: 57-62-64	
	Precaudal: 21-X-24	
	Caudal: 37-X-41	
Branchiostegal rays	7-7-7	
Caudal fin	22-25, 5+2, 23-26	
Pelvic fin	Thoracic	
	R: 6-6-6	
Dorsal fin	1st: 11-X-16	2nd: 15-X-23
	3rd: 18-X-21	
Pectoral fin	R: 18-X-21	
Anal fin	1st: 20-X-24	2nd: 19-X-22
Gill rakers	U: 2-X-3	L: 17-X-20

LIFE HISTORY

Range	Gulf of Alaska, 54-60°N, to Arctic, not specific
Ecology	Nearshore shelf pelagic, 2-75 m
ELH pattern	Oviparous, demersal eggs, pelagic larvae
Spawning	Season: Winter[a]
	Area: Shallow nearshore (2-10 m)[a]
	Mode:
	Migration: To shallow water for spawning[a]
Fecundity	Range/function: 28,900-190,700[a]
Age at first maturity	2 yr[a]
Longevity	9 yr[a]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.0-1.7 mm (1.3-1.7 mm)
No. of oil globules	None
Oil globule diameter	
Yolk	Homogeneous, dense
Envelope	Smooth, thick
Hatch size	3.5 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

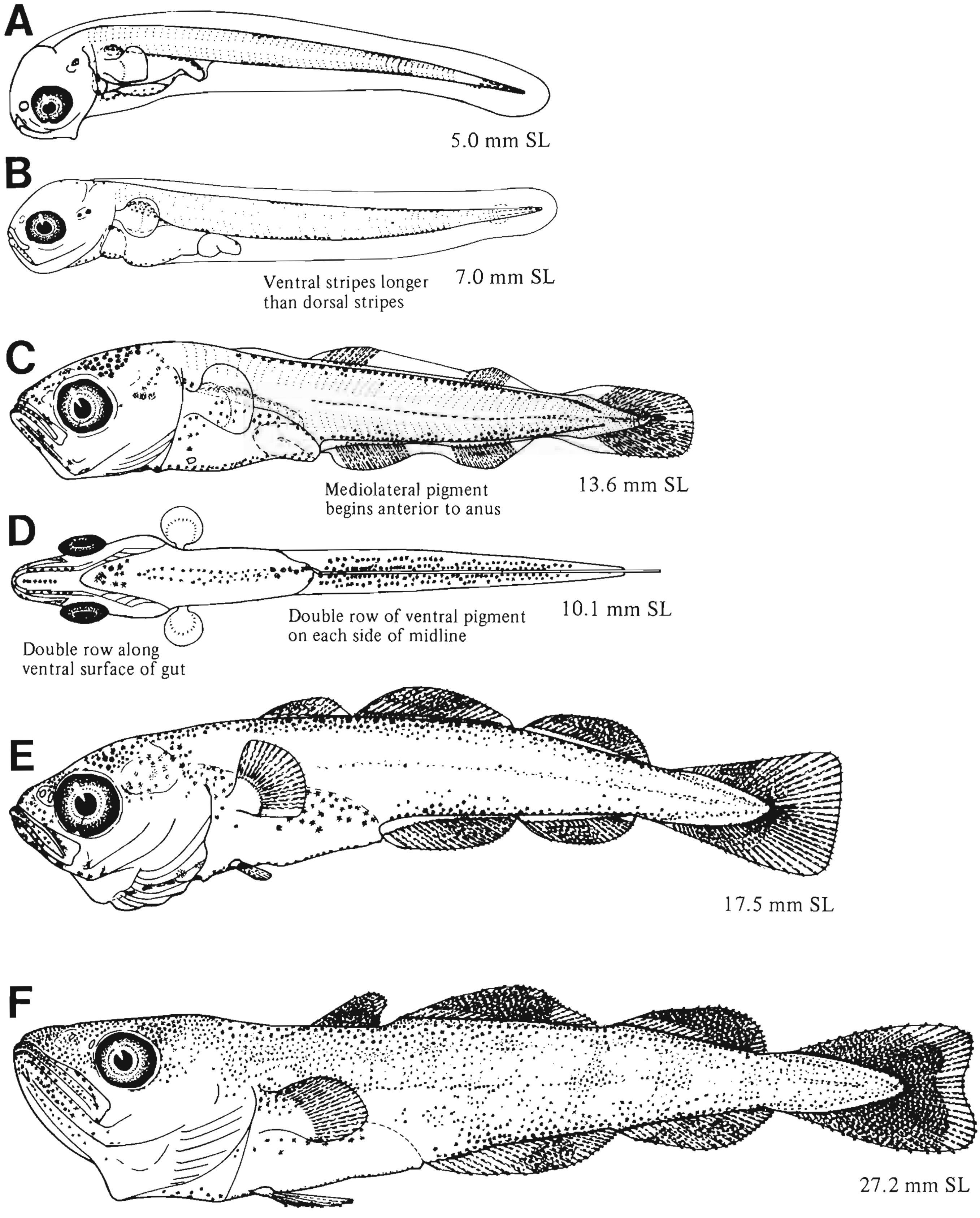
Preanal length	<50% SL
Length at flexion	11-17 mm SL
Length at transformation	24-27 mm SL
Sequence of fin development	Caudal, dorsals and anals (nearly simultaneous), pelvics, pectorals

Pigment
- Presence of bars
- Ventral stripes longer than dorsal stripes
- Ventral pigment in double row on each side of midline
- Mediolateral pigment begins anterior to anus
- Double row of melanophores along ventral surface of gut

Diagnostic characters (see Table 22)
- Pigment
  - —Double row of melanophores along ventral surface of gut
  - —Double row of ventral pigment on each side of midline
- Rays on superior hypural = 5

[a] Wolotira 1985

Ref: Dunn and Matarese 1984, Dunn and Vinter 1984.



Figures A–F (D, ventral view), Dunn and Vinter 1984.

MERISTICS

Vertebrae	Total: 49-54-56 Precaudal: 18-X-21 Caudal: 31-X-35
Branchiostegal rays	7-7-7
Caudal fin	23-24, 4+2, 21-22
Pelvic fin	Thoracic R: 6-X-7
Dorsal fin	1st: 10-12-16 2nd: 11-15-22 3rd: 10-X-21
Pectoral fin	R: 19-20-22
Anal fin	1st: 16-18-27 2nd: 12-17-25
Gill rakers	U: X-X-X L:X-X-X

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Epi-, meso-, and bathybenthal
ELH pattern	Oviparous, demersal eggs, pelagic larvae (small larvae demersal)[a]
Spawning	Season: Jan[b]-July[c] Area: Semi-demersal (73-265 m)[c] Mode: Schools[b] Migration: To deepwater[d]
Fecundity	Range/function: 228,000[e]-3 million[f]/ $F=12.024\times L^{2.959}$[g]
Age at first maturity	2 yr[d]
Longevity	13 yr[f]

[a] Walters (1984) reported small larvae are demersal whereas Rugen and Matarese (1988) reported newly hatched larvae quickly rise to above 50 m.
[b] Miller et al. 1978
[c] Hirschberger and Smith 1983
[d] Ketchen 1961
[e] Thompson 1962
[f] Andriashev 1954
[g] Karp 1982

Ref: Dunn and Matarese 1984, 1987; Dunn and Vinter 1984; Matarese et al. 1981; Walters 1984.

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	0.98-1.08 mm (1.02 mm)
No. of oil globules	None
Oil globule diameter	
Yolk	Homogeneous, dense
Envelope	Smooth, thick
Hatch size	3-4 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	<50% SL
Length at flexion	10-17 mm SL
Length at transformation	25-35 mm SL
Sequence of fin development	

Pigment
- Presence of bars
- Ventral gut with large melanophores (in larvae >20 mm SL, small spots occur in two rows along ventral surface of gut)
- Stripe continuity (~5-6 mm SL)
- Mediolateral pigment begins anterior to anus (~5-6 mm SL)

Diagnostic characters (see Table 22)
- Pigment
  - —Large melanophores medially along length of gut
  - —Single irregular row of pigment on each side of ventral midline
  - —Ventral pigment begins at anus after yolksac absorption
- Rays on superior hypural = 4

Distinguished from *Theragra chalcogramma* at yolksac stage by
- Less lateral pigment within bars
- Posterior bar longer, extending closer to tail
- Presence of about 2-6 spots in the ventral caudal region
- More pigment in snout area and on mouth

Distinguished from *T. chalcogramma* at later stages by
- Generally more pigmented, especially on head and gut

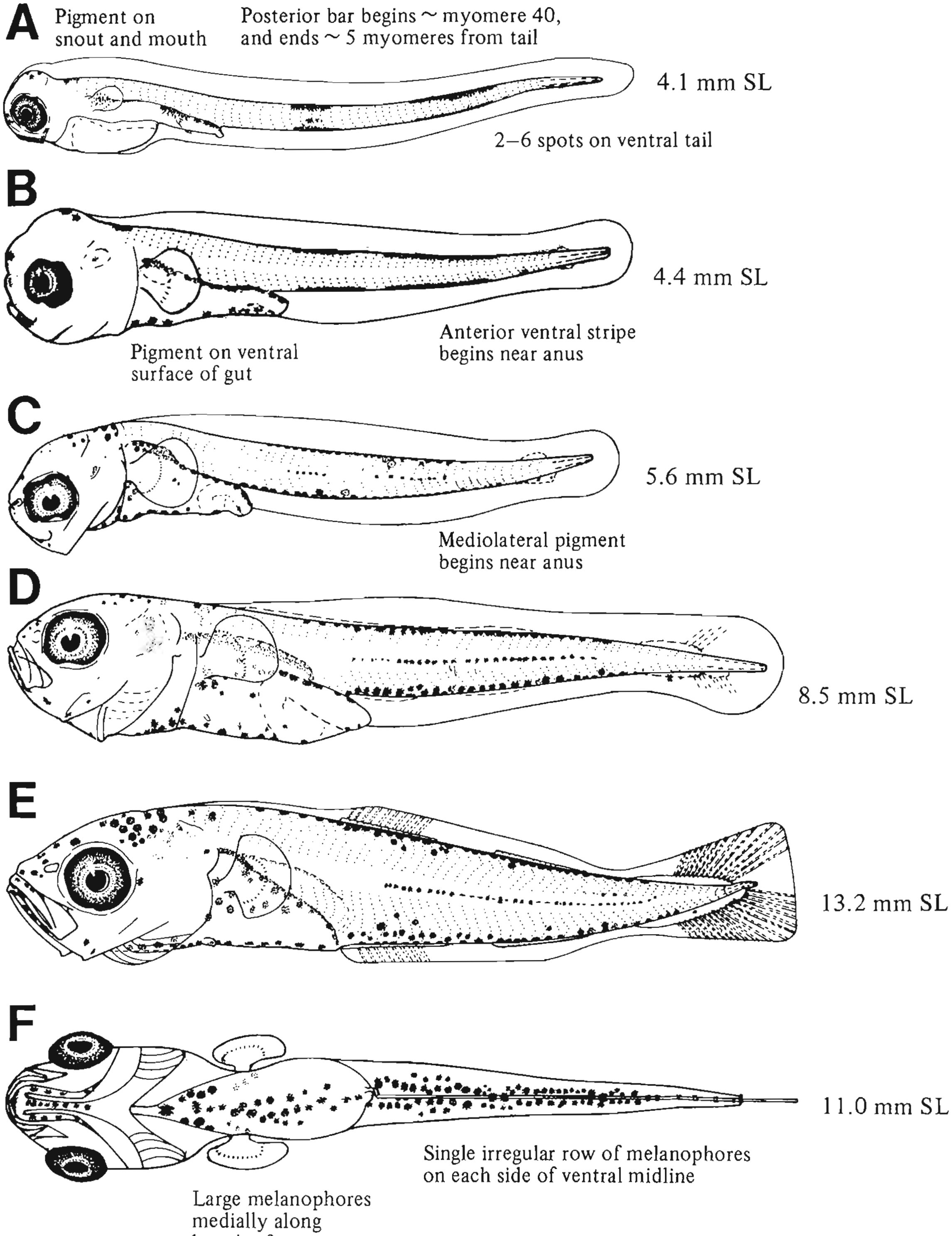


Figure A, NWAFC original (B. Vinter); B, E–F (F, ventral view), Dunn and Vinter 1984; C–D, Matarese et al. 1981.

MERISTICS

Vertebrae	Total: 53-56-60 Precaudal: 17-20-21 Caudal: 33-37-40
Branchiostegal rays	6-X-8
Caudal fin	22-26, 5+2, 20-24
Pelvic fin	Thoracic R: 6-X-7
Dorsal fin	1st: 9-X-15 2nd: 16-X-21 3rd: 17-X-24
Pectoral fin	R: 19-19-19
Anal fin	1st: 20-X-29 2nd: 18-X-28
Gill rakers	U: 3-X-5 L: 18-X-23

LIFE HISTORY

Range	Cent. California, 34-38°N, to Bering Sea, 54-66°N[a]
Ecology	Epi- and mesobenthal, 0-275 m
ELH pattern	Oviparous, demersal eggs, pelagic larvae
Spawning	Season: Winter-spring[b] Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	
No. of oil globules	Probably none
Oil globule diameter	
Yolk	Homogeneous
Envelope	
Hatch size	3 mm SL
Incubation time/temp.	
Pigment	
Diagnostic characters	

LARVAE

Preanal length	<50% SL
Length at flexion	8-15 mm SL
Length at transformation	22-28 mm, pelagic from 28-45 mm SL
Sequence of fin development	Caudal; 1st anal; 2nd anal; 3rd, 2nd, and 1st dorsal (nearly simultaneously); pelvics; pectorals

Pigment
- Presence of bars
- Single row on each side of ventral midline anteriorly and a single row along ventral midline posteriorly
- Large melanophores scattered on ventral surface of gut

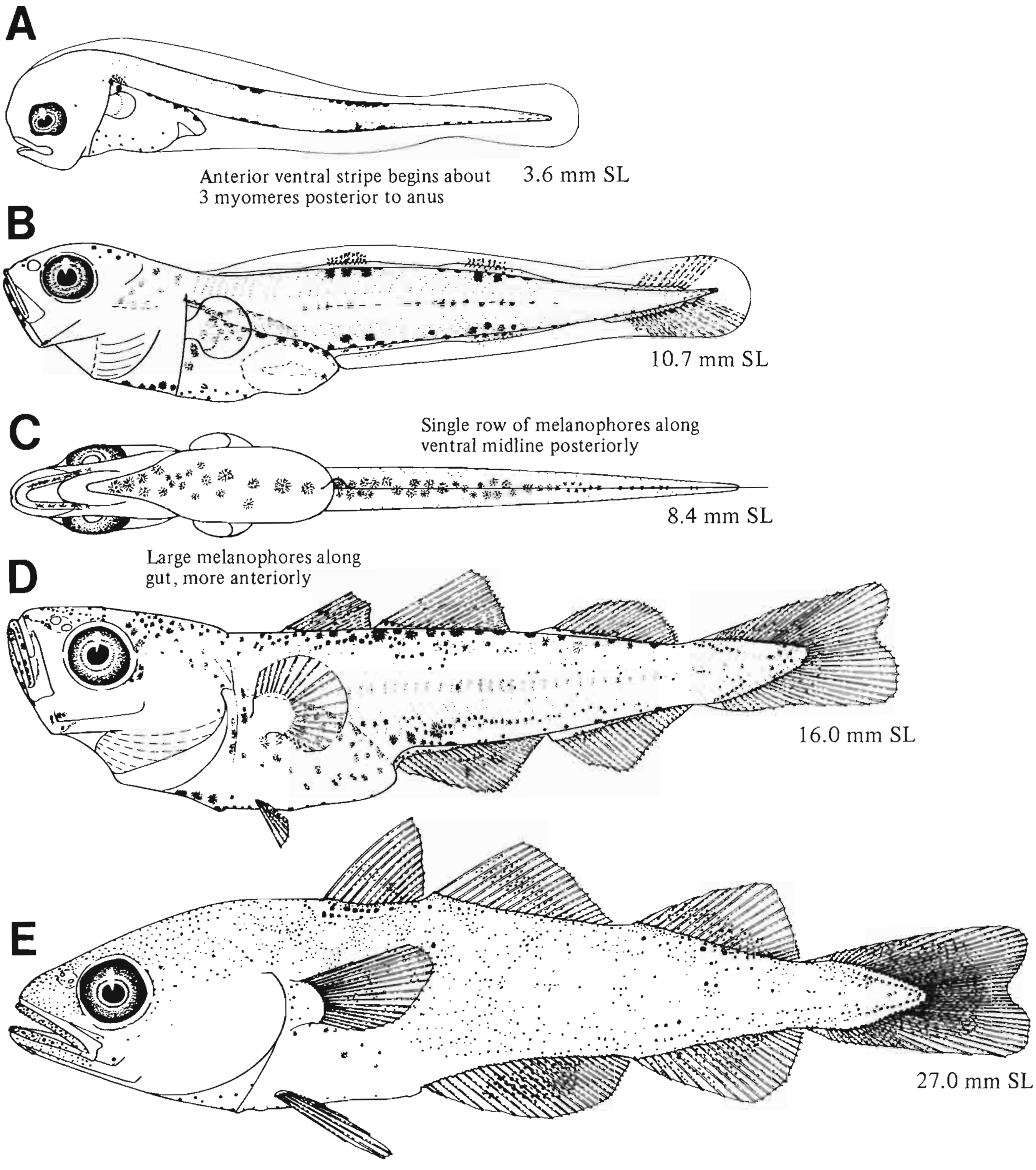
Diagnostic characters (see Table 22)
- Pigment
  - —Single row on each side of ventral midline anteriorly and a single row along ventral midline posteriorly
  - —Large melanophores scattered on ventral surface of gut
- Anterior placement of bars
- Rays on superior hypural = 5

Distinguished from *Gadus macrocephalus* by
- Dorsal pigment separated in specimens <13 mm SL, bars not continuous

Distinguished from *Theragra chalcogramma* by
- Anterior bar begins closer to anus

[a]The presence of *M. proximus* larvae in the Bering Sea remains a question.
[b]Richardson 1977

Ref: Dunn and Vinter 1984, Matarese et al. 1981.



Figures A–E (C, ventral view), Matarese et al. 1981.

MERISTICS

Vertebrae	Total: 48-51-53 Precaudal: 18-X-20 Caudal: 31-X-34
Branchiostegal rays	6-X-8
Caudal fin	21-24, 4+2, 19-22
Pelvic fin	Thoracic R: 6-X-7
Dorsal fin	1st: 10-12-14 2nd: 12-14-18 3rd: 14-17-21
Pectoral fin	R: 17-20-22
Anal fin	1st: 15-18-22 2nd: 15-18-23
Gill rakers[a]	U: 5-X-7 L: 25-X-34

LIFE HISTORY

Range	Cent. California, 34-38°N, to Chukchi Sea, north of 66°N
Ecology	Epi-, meso-, and bathypelagic, 0-975 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Feb-Aug[a] Area: Pelagic (50-460 m)[a] Mode: Schools[b] Migration: Bering Sea, offshore to outer and upper slope;[c] Gulf of Alaska to Shelikof Strait[d]
Fecundity	Range/function: 91,633-1,200,000/ $F=0.1719\times L^{3.6046}$, L=FL cm;[e] 96,216-1,079,540/ $F=1.2604\times L^{3.2169}$, L=FL cm[f]
Age at maturity	3-4 yr[g]
Longevity	17 yr[g]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.35-1.45 mm (1.2-1.8)
No. of oil globules	None
Oil globule diameter	
Yolk	Homogeneous
Envelope	Smooth, clear
Hatch size	3-4 mm SL
Incubation time/temp.	15 d/5°C

Pigment
- Late-stage embryo develops bar pattern

Diagnostic characters
- Late-stage embryo with pigment

LARVAE

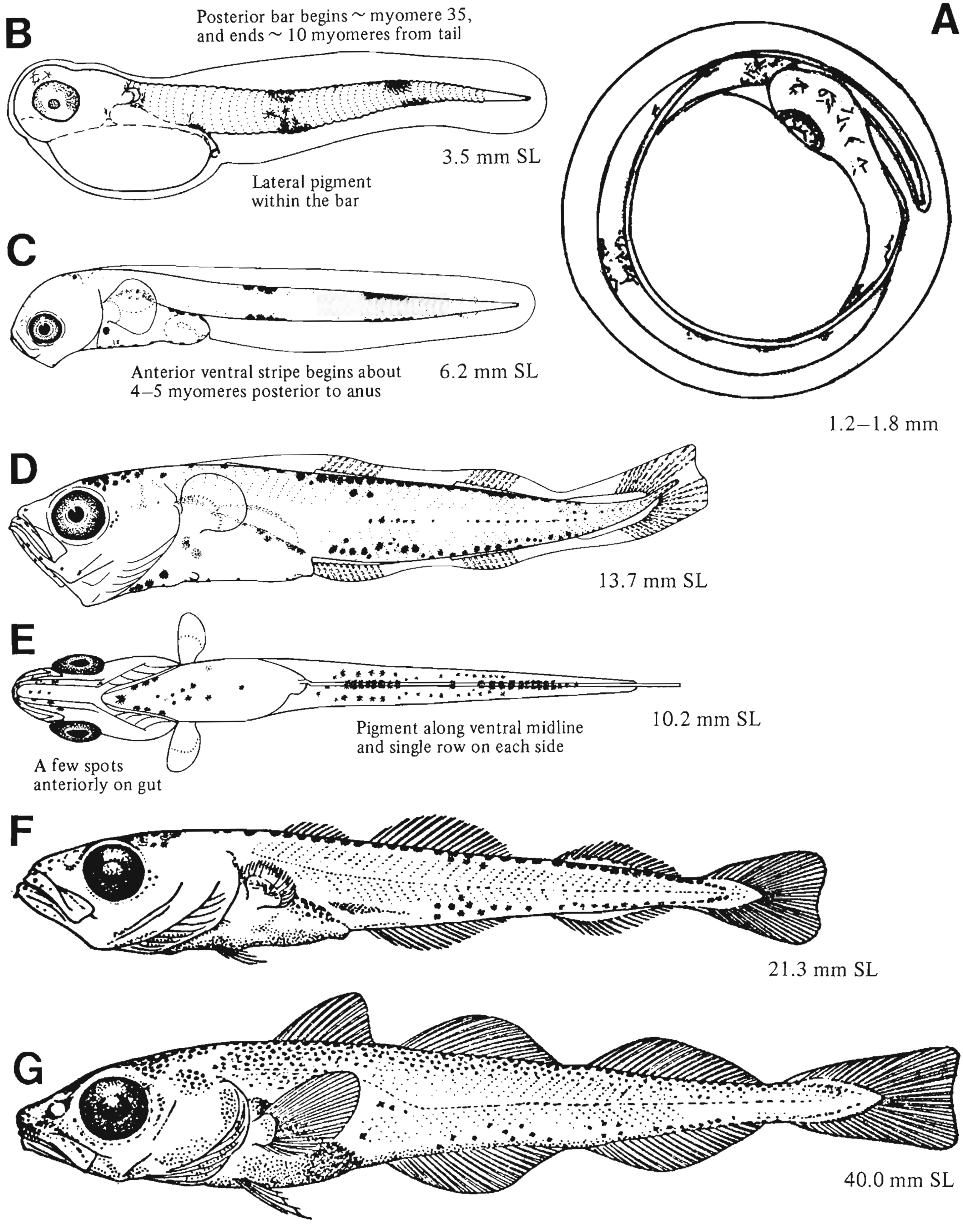
Preanal length	<50% SL
Length at flexion	10-17 mm SL
Length at transformation	30-40 mm SL
Sequence of fin development	Caudal, 1st anal, 2nd anal, 3rd dorsal, 2nd dorsal, 1st dorsal, pelvics, pectorals

Pigment
- Presence of bars
- A few melanophores scattered on ventral surface of gut
- Pigment along ventral midline and a single row on each side

Diagnostic characters (see Table 22)
- See *Gadus macrocephalus* (p. 194)
- Pigment
  - —A few melanophores scattered on ventral surface of gut
  - —Pigment along ventral midline and a single row on each side
- Rays on superior hypural = 4

[a] Hirschberger and Smith 1983
[b] Takahura 1954
[c] Serobaba 1968
[d] Dunn and Matarese 1987
[e] Hinckley 1986 (Bering Sea specimens only)
[f] Miller et al. 1986 (Shelikof Strait specimens only)
[g] Salveson and Alton 1976a

Ref: Dunn and Matarese 1984, 1987; Dunn and Vinter 1984.



Figures A–B, NWAFC originals (B. Vinter); C–E (E, ventral view), Dunn and Vinter 1984; F–G, Gorbunova 1954.

Among the most common of all deep-sea bottom-living fishes, grenadiers are found in all the world's oceans. They have long, tapering bodies and elongate dorsal and anal fins continuous with the tail. A chin barbel is usually present. In the Northeast Pacific there are ten species in three genera. Adults have been found in water as shallow as 100 m but are more commonly collected at depths greater than 300 m (Fitch and Lavenberg 1968). Little is known of their early life history. Macrourid eggs are generally 1-2 mm, have a single oil globule, and some species have honeycomb ornamentation on the chorion. Larvae are characterized by an elongate tail, lack of caudal fin, and an elongate pectoral fin peduncle. The transition from larva to juvenile is rapid. The most important morphological change is the loss of the pectoral fin peduncle. Other morphological differences occurring at transformation include small changes in head length, mouth orientation changing from oblique to horizontal, snout becoming more distinct, and the stomach (gut) becoming reduced in prominence (decreasing depth of posterior trunk). The occurrence of juveniles of increasing size at increasing depth suggests an ontogenetic migration of subadults to a benthic existence (Stein 1980a). Some species remain pelagic throughout a prolonged juvenile period (Hubbs and Iwamoto 1977).

Table 23
Meristic characters of family Macrouridae.

		Vertebrae		Fins					Gill rakers		
Taxon	Distribution	Precaudal (Total)	Caudal	First* Dorsal	Second Dorsal	Anal	Pectoral	Pelvic	Upper (Total)	Lower	Branchiostegals
Albatrossia pectoralis	SSC - Bering Sea	13-14		9-11	126	131	16-21	6-8		5-7 (5-7)	6
Coryphaenoides acrolepis	SSC - Bering Sea	13-16	70	10-13	138-153	123-135	19-22	7-9		5-7 (5-7)	6
Coryphaenoides armatus	SSC - Bering Sea	13-15		10-12		77	18-22	10-12	1	6-9 (7-9)	6
Coryphaenoides cinereus	Oregon - Bering Sea	13-14		12-16			17-23	8-10	1	9-11 (9-12)	6
Coryphaenoides filifer	S. Calif. - Bering Sea	(84)		13-16			18-23	9-10	(8-10)		6
Coryphaenoides leptolepis	SSC - SE Alaska	12		10-12			18-22	9-11	1	8-10 (8-11)	6
Coryphaenoides liocephalus	Brit. Col.	(84)		11	114	113	20	10			6
Coryphaenoides longifilis	Aleutian Is. - Bering Sea	14-15		14-16			15-19	9-10	2-3	12-13	6
Coryphaenoides yaquinae	Cent. Calif. - Oregon			9-12			16-22	8-11	(11-12)		
Nezumia stelgidolepis	SSC - Brit. Col.	13	73-77	10-13			20-26	8-11	(8-12)		7

*First dorsal fin count includes two spinous rays.

Table 24

Morphological characters useful in identifying macrourid larvae likely to occur off the coast of Oregon (Stein 1980a).

	Albatrossia pectoralis	*Coryphaenoides*				
		C. acrolepis	*C. armatus*	*C. cinereus*	*C. filifer*	*C. leptolepis*
Larval body pigment	Unknown	Melanophores on dorsum and venter, absent on last 20% of tail and on midline	Unknown	Unknown	Melanophores widely scattered on dorsum around dorsal fin only	Melanophores on trunk and head, closely spaced, not posterior to anal fin ~10th ray
First dorsal fin rays	7-9	9.11	8-10	10-12	11-15	8-10
Pelvic fin rays	6-8	8-9	10-11	8-10	9-10	9-10
Pyloric caeca	12-16	12-14	10-13	5-7	8-12	11
Rostral scutes[a]	Absent	Strong	Absent	Strong	Strong	Absent
Size at which pectoral fin peduncle is reduced	—	9.4-9.8 mm HL[b]	18.2 mm HL	—	14.1-14.6 mm HL	6.2-15.0 mm HL
Precaudal vertebrae	13-14	14-15	13-15	13-14	—	12
Gas glands[a,c]	2	4	5-6	4	4	6
Retia[a,c]	2	4	5-6	4	4	6

[a] Adult/juvenile characters.
[b] Since macrourid larvae often have damaged tails, body lengths are generally described by head lengths (HL).
[c] The swimbladder in postlarvae and juveniles can be examined by making an incision in the side of the abdominal cavity.

MERISTICS

Vertebrae	Total: 86-86-86 Precaudal: 14-X-15 Caudal: 70-70-70
Branchiostegal rays	6-6-6
Caudal fin	Absent
Pelvic fin	Thoracic R: 8-X-9
Dorsal fin[a]	1st: 9-X-11 2nd: 138-X-153
Pectoral fin	R: 19-20-22
Anal fin	R: 123-X-135
Gill rakers	U: X-X-X L: 5-6-7

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Meso- and bathybenthal
ELH pattern	Oviparous, eggs probably pelagic, pelagic larvae
Spawning	Season: Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	Ripe eggs 2 mm
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	
Hatch size	
Incubation time/temp.	
Pigment	

Diagnostic characters

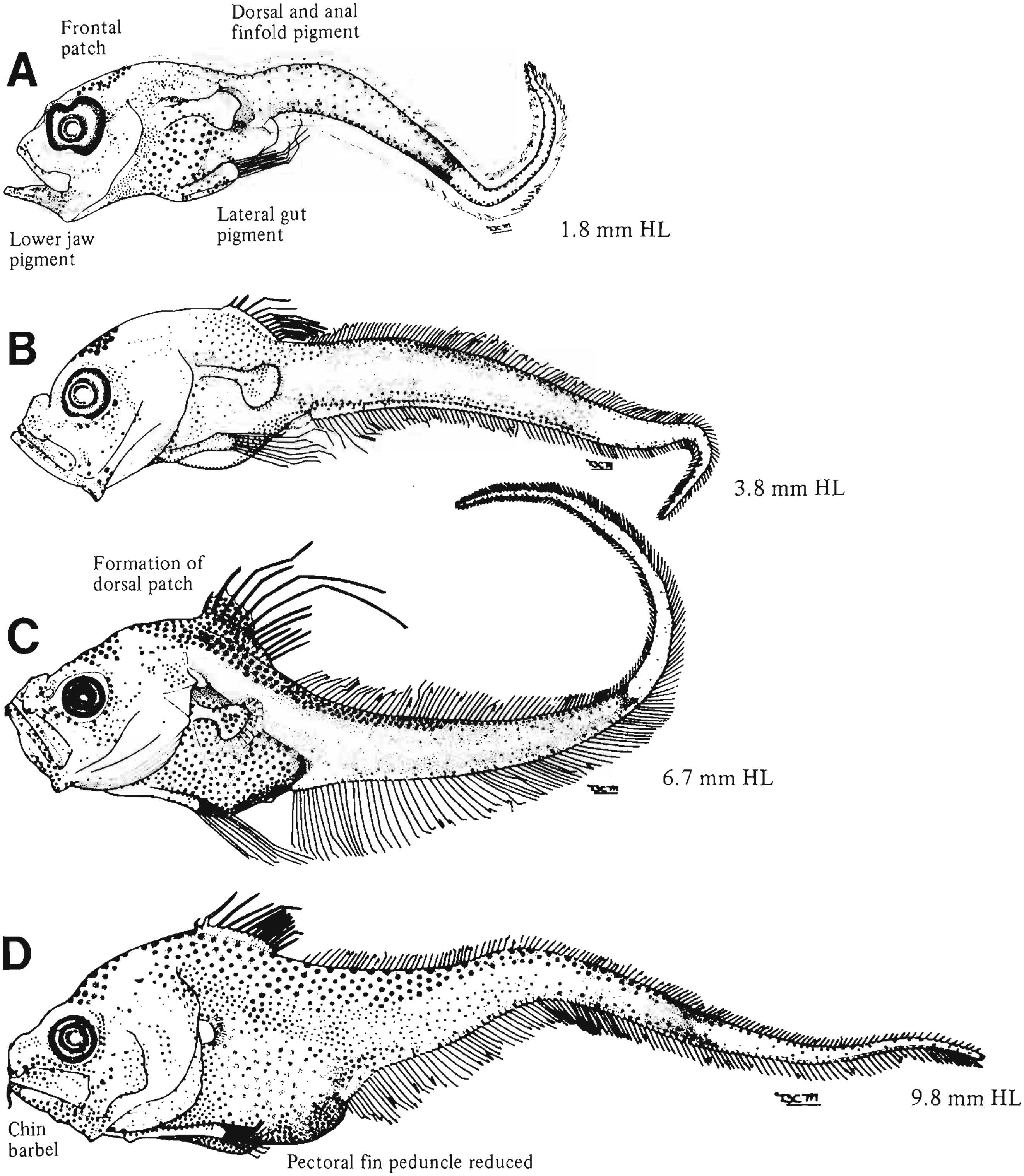
LARVAE

Preanal length
Length at flexion
Length at transformation
Sequence of fin development
Pigment
- Melanophores on dorsal and ventral body surface
- Lateral pigment absent on posterior 20% of body

Diagnostic characters (see Table 24)
- Number of first dorsal fin rays (9-11)
- Pelvic fin rays (8-9)
- Number of gas glands (four)
- Presence of rostral scutes in juveniles >16 mm HL

[a] Range of counts for the first dorsal does not include "spines."

Ref: Stein 1980a.



Figures A–D, Stein 1980.

MERISTICS

Vertebrae	Total: 84-84-84 Precaudal: X-X-X Caudal: X-X-X
Branchiostegal rays	6-6-6
Caudal fin	Absent
Pelvic fin	Thoracic R: 9-9-10
Dorsal fin[a]	1st: 11-X-15 2nd: X-X-X
Pectoral fin	R: 18-22-23
Anal fin	R: X-X-X
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Bathybenthal
ELH pattern	Oviparous, eggs probably pelagic, pelagic larvae
Spawning	Season: Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

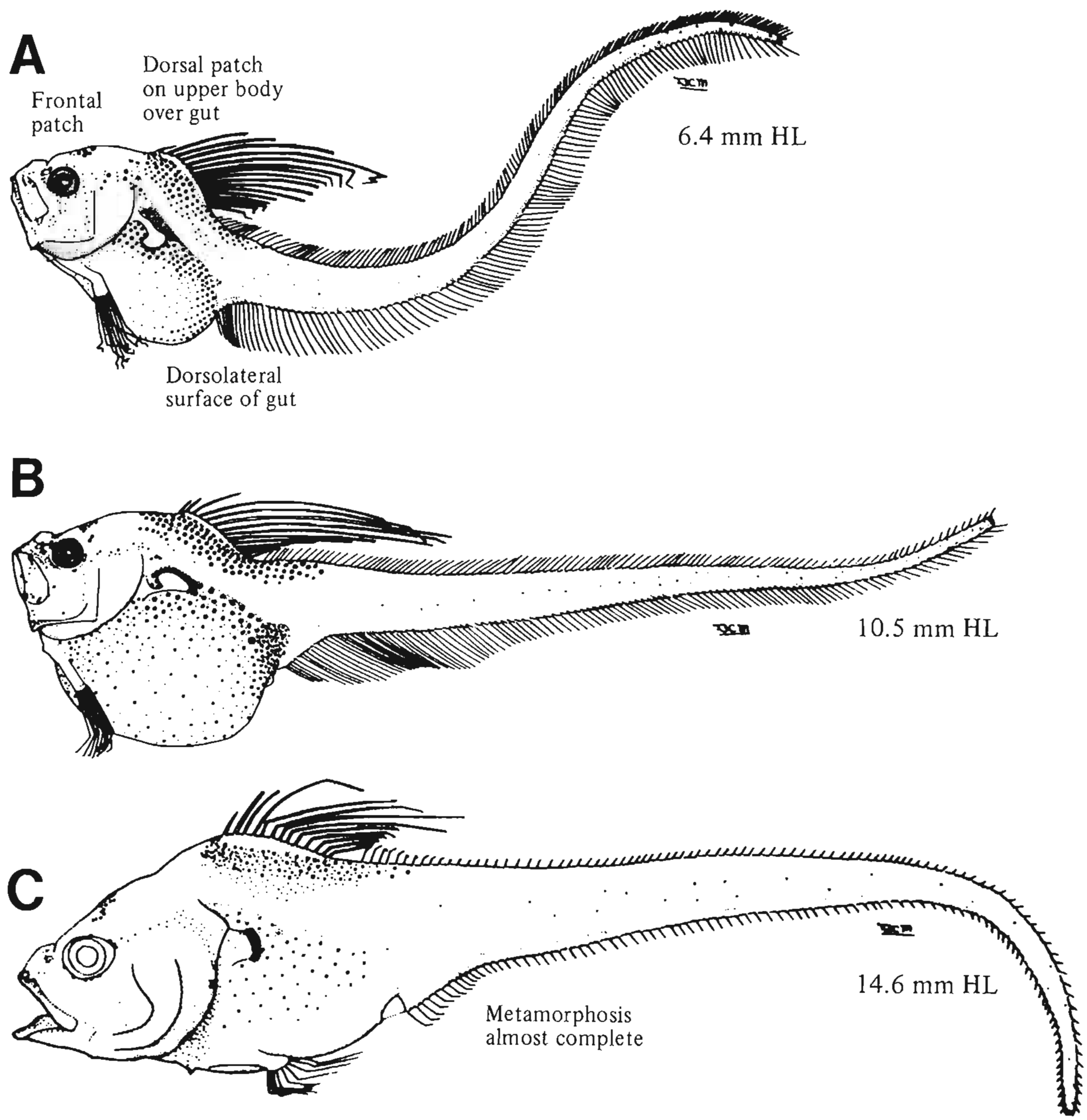
LARVAE

Preanal length
Length at flexion
Length at transformation
Sequence of fin development
Pigment
- Melanophores widely scattered on upper dorsal body around dorsal fin

Diagnostic characters (see Table 24)
- Number of first dorsal fin rays (11-15)
- Pelvic fin rays (9-10)
- Number of gas glands (four)
- Pigment pattern: Fine pigment spots under first dorsal fin

[a]Range of counts for the first dorsal does not include "spines."

Ref: Stein 1980a.



Figures A–C, Stein 1980. Figure C is a composite drawn from two specimens. The head has been reconstructed.

MERISTICS

Vertebrae	Total: X-X-X
	Precaudal: 12-12-12
	Caudal: X-X-X
Branchiostegal rays	6-6-6
Caudal fin	Absent
Pelvic fin	Thoracic
	R: 9-X-10
Dorsal fin[a]	1st: 8-X-10 2nd: X-X-X
Pectoral fin	R: 18-19-22
Anal fin	R: X-X-X
Gill rakers	U: 1-1-1 L: 8-X-10

LIFE HISTORY

Range	South of southern California to SE Alaska, 55-59°N
Ecology	Bathybenthal
ELH pattern	Oviparous, eggs probably pelagic, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length
Length at flexion
Length at transformation
Sequence of fin development
Pigment

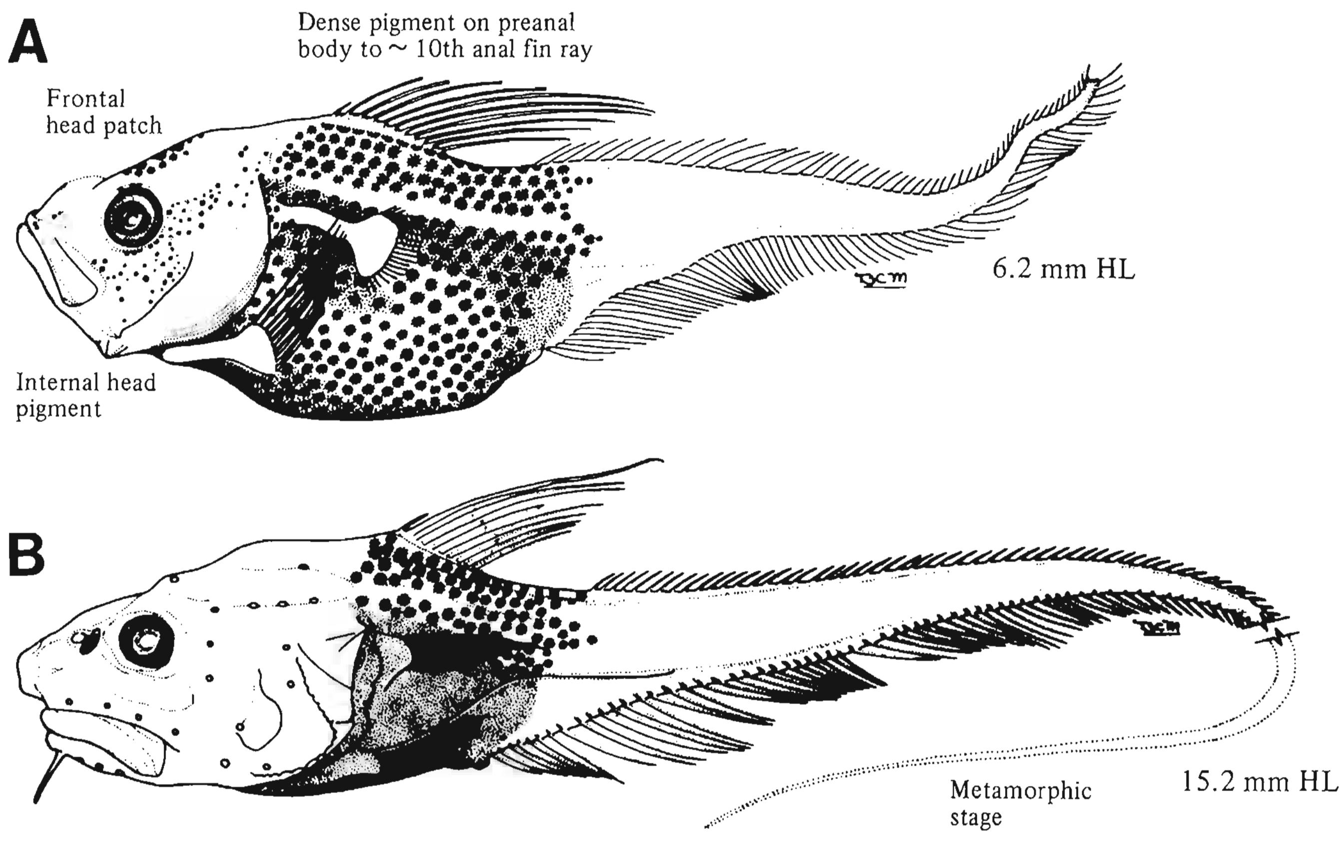
- Melanophores on trunk, gut, and head dense, but not present posterior to anal fin (~10th ray)[b]

Diagnostic characters (see Table 24)

- Pigment pattern: Pigment to 10th anal fin ray
- Number of gas glands (six)
- Number of first dorsal fin rays (8-10)

[a]Range of counts for the first dorsal does not include "spines."
[b]According to Stein (1980a), this pattern may be similar in *C. armatus*.

Ref: Stein 1980a.



Figures A–B, Stein 1980.

MERISTICS

Vertebrae	Total: 86-X-90
	Precaudal: 13-13-13
	Caudal: 73-X-77
Branchiostegal rays	7-7-7
Caudal fin	Absent
Pelvic fin	Thoracic
	R: 8-X-11
Dorsal fin	S: 10-X-13 R: X-X-X
Pectoral fin	R: 20-X-26
Anal fin	R: X-X-X
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Epi- and mesobenthal
ELH pattern	Oviparous, eggs unknown, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE - Genus

Preanal length <30% SL
Length at flexion
Length at transformation
Sequence of fin development
Pigment
- Frontal patch
- First dorsal fin patch
- Heavy over entire gut
- Ventral midline series and double lateral spots approximately first half of postanal body

Diagnostic characters
- Lateral pigment on postanal body appears to be distinctive perhaps at generic level, but whether it appears in other macrourine larvae cannot be determined at this time

Ref: Fahay and Markle 1984.

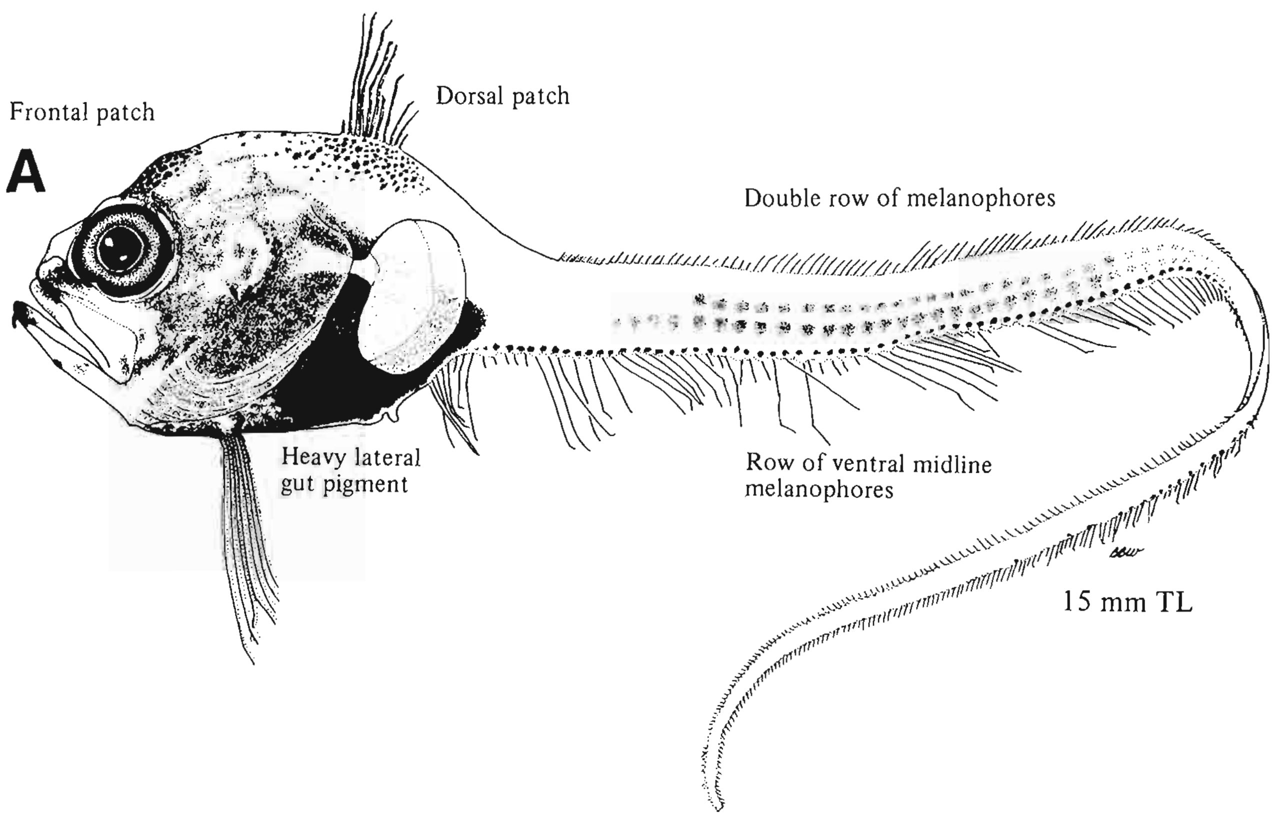
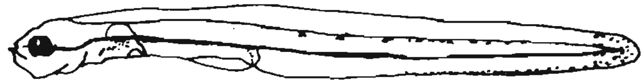


Figure A, Fahay and Markle 1984. North Atlantic specimen tentatively identified as *Nezumia*.



Ophidiiformes

The ophidiiforms occupy mostly benthic habitats ranging from the shallow tropics to abyssal depths and subarctic locations. Adults have long tapering bodies, with or without a caudal fin, and long dorsal and anal fins. The order comprises 4 families, 86 genera, and 294 species (J. Nelson 1984). The two suborders are defined according to mode of reproduction: Ophidioidei (Ophidiidae) are oviparous and Bythitoidei (Aphyonidae and Bythitidae) are viviparous (Cohen and Nielsen 1978). Ophidiiform eggs of oviparous forms are pelagic, may have one oil globule, and are spherical or ellipsoidal (Gordon et al. 1984). Larvae are not well known; of the eight species found in the study area only two larval series have been identified and are presented here. A third series of an unidentified ophidiid has been tentatively identified as *Spectrunculus grandis*.

Families in study area: **Ophidiidae**
Aphyonidae
Bythitidae

OPHIDIIDAE

Fishes of this group are found primarily in tropical and temperate waters, although a few occur in subarctic locations. In the northeastern Pacific there are six species within five genera in the family. Larvae are known only for *Chilara taylori*, but a second series has been tentatively identified as *Spectrunculus grandis*. These larvae occur in samples collected off northern California, Oregon, and Washington. Since meristic characters, especially vertebral counts, are unavailable for several species in the area, only a tentative identification can be made. Available meristics, however, match those of *Spectrunculus grandis*. These larvae resemble those of the pleuronectid, *Embassichthys bathybius*, and have been routinely mixed with them in samples. They can be distinguished from *E. bathybius* (p. 580) larvae by number of myomeres (>75 vs. 65), less finfold pigment, and a less pronounced loop in the gut.

Table 25
Meristic characters of family Ophidiidae.

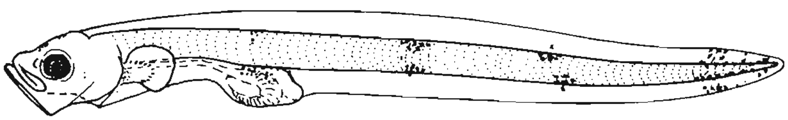
		Vertebrae		Fins				Gill rakers		
Taxon	Distribution	Precaudal	Caudal	Dorsal	Anal	Pectoral	Pelvic	Upper	Lower	Branchiostegals
Bassozetus sp.	Oregon									
Chilara taylori	SSC - Oregon	18-19	68-72	198-216	156-170		I,1	1-4	5-9	7
Dicrolene filamentosa	SSC - Oregon			100-104	84-90	23-29	I,2	5	17	8
Holcomycteronus profundissimus	Oregon	18-21		107-118	80-95	15-17	I,2			8
*Spectrunculus grandis**	Cent. Calif. - Gulf of Alaska	23	56	103-140	73-106	26-30	I,2	3-4	8-9	8
Spectrunculus radcliffei	Gulf of Alaska									

*Aboussouan and Rasonarivo (1986) described a larva as *S. grandis* from the Indian Ocean. The counts are the following:

precaudal vertebrae	18-19
caudal vertebrae	53
dorsal fin	118
anal fin	96
pectoral fin	23/24
pelvic fin	I,2
caudal fin	4+4/5

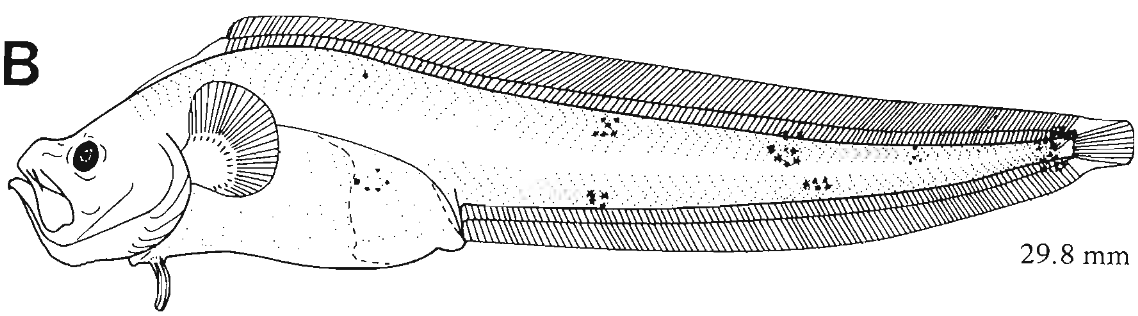
Ophidiidae (tentatively *Spectrunculus grandis*)

A



15.6 mm SL

B



29.8 mm SL

Figures A–B, NWAFC originals (B. Vinter).

MERISTICS

Vertebrae	Total: 86-88-91
	Precaudal: 18-18-19
	Caudal: 68-70-72
Branchiostegal rays	7-7-7
Caudal fin	X, 4+5, X
Pelvic fin	Jugular
	S: 1-1-1 R: 1-1-1
Dorsal fin	R: 198-X-216
Pectoral fin	R: 22-X-25
Anal fin	R: 156-X-170
Gill rakers	U: 1-X-4 L: 5-X-9

LIFE HISTORY

Range[a]	South of southern California to Oregon, 42-46°N
Ecology	Epi- and mesobenthal, 1-244 m
ELH pattern	Oviparous, eggs unknown, pelagic larvae
Spawning	Season: Larvae collected in fall (Baja California)[b]
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

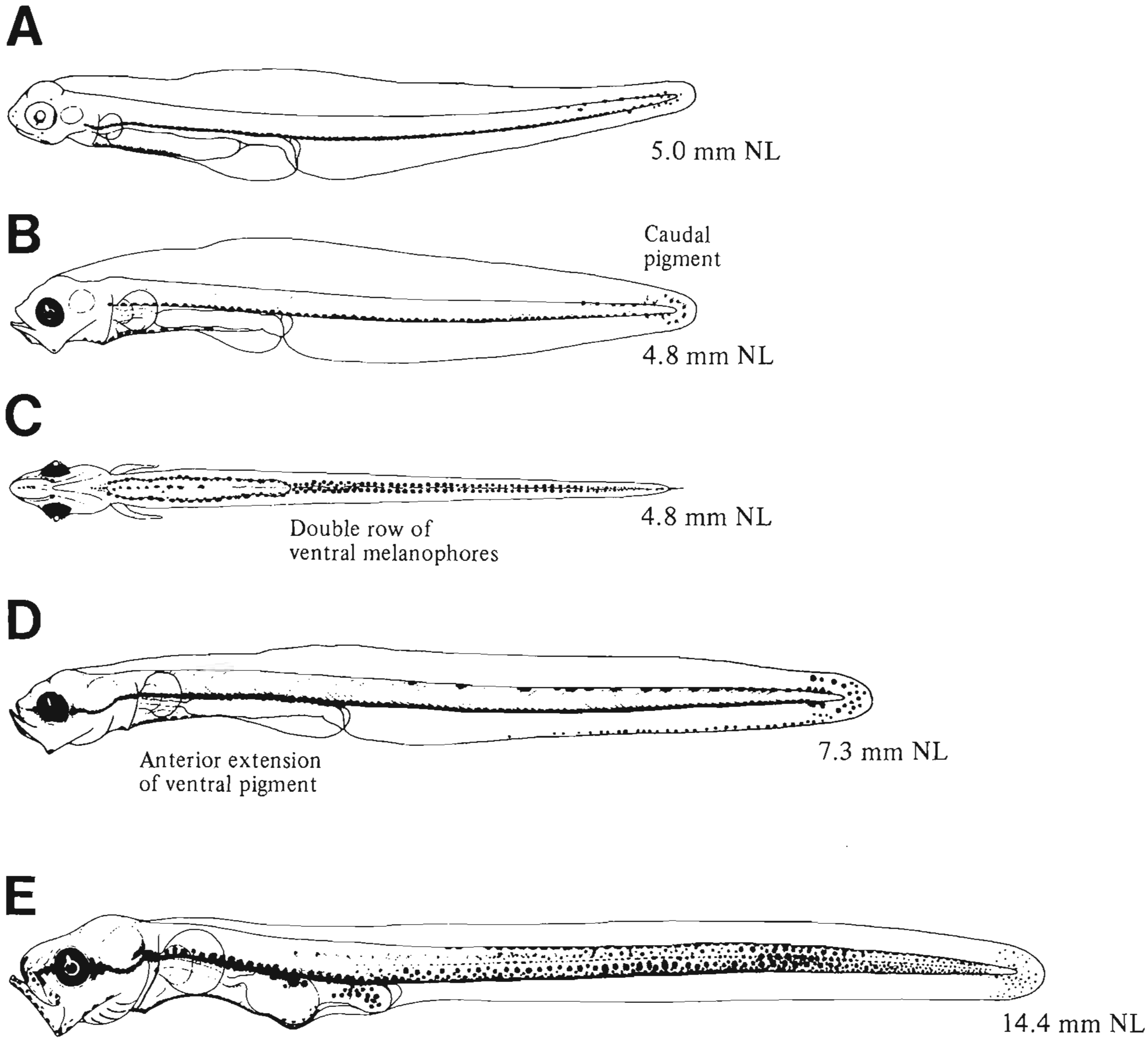
Preanal length	<50% SL
Length at flexion	
Length at transformation	22-30 mm SL
Sequence of fin development	

Pigment
- Caudal fin pigment
- Ventral (double series) with development, extends along base of brain and onto snout
- Ventral gut

Diagnostic characters
- Gut loops form at 14 mm SL
- Distinctive pigment pattern
- High number of myomeres (86-91)

[a] Center of distribution is Pt. Eugenia, Baja California.
[b] Ambrose et al. 1983

Ref: Ambrose et al. 1983.



Figures A–E (C, ventral view), Ambrose et al. 1983.

Fishes of this group are found in tropical and temperate waters, freshwater, and at abyssal depths. The families Aphyonidae and Bythitidae, which form the suborder, are represented in the Northeast Pacific by four species within four genera. Only larvae of *Brosmophycis marginata* are known. All bythitoid males possess an intromittent organ, some with pseudoclaspers.

Table 26
Meristic characters of suborder Bythitoidei.

		Vertebrae		Fins				Gill rakers		
Taxon	Distribution	Precaudal (Total)	Caudal	Dorsal	Anal	Pectoral	Pelvic	Upper (Total)	Lower	Branchiostegals
Aphyonidae										
Barathronus pacificus	N. Calif. - Oregon	37-38	46-51	71-75	62-69	25-26	I,1	5-7	26-28	
Sciadonus pedicellaris	SSC - Oregon	43-47	36-39	91-93	42-47	11-14	I,1	(14-15)		9-10
Bythitidae										
Brosmophycis marginata	SSC - SE Alaska	16-17	47-49	99-110	72-81	20-26	I,2			7
Cataetyx rubrirostris	S. Calif. - Oregon	(60-62)		102-109	76-82		I,1	3		8

MERISTICS

Vertebrae	Total: 63-64-65 Precaudal: 16-16-17 Caudal: 47-48-49
Branchiostegal rays	7-7-7
Caudal fin	
Pelvic fin	Jugular S: 1-1-1 R: 2-2-2
Dorsal fin	R: 99-101-110
Pectoral fin	R: 20-X-26
Anal fin	R: 72-75-81
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to SE Alaska, 55-59°N
Ecology	Epi- and mesobenthal, 3-256 m
ELH pattern	Probably ovoviviparous, pelagic larvae
Spawning	Season: Spring[a] Area: Mode: Migration:
Fecundity	Range/function: 12,000-30,000[a]
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	
Hatch size	9.0 mm NL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE[b]

Preanal length	<50% SL
Length at flexion	>13.5-18.0 mm SL
Length at transformation	
Sequence of fin development	

Pigment
- Newly hatched larvae have pigment on lower jaw
- Alternating dorsal/ventral spots
- Above/below anterior portion of tail tip (more pronounced in specimens <12.5 mm SL)
- Swimbladder and on gut

Diagnostic characters
- Pigment pattern: Dorsal/ventral spots

[a] Hart 1973
[b] A figure of a postflexion bythitid from the Atlantic Ocean is included for comparison.

Ref: NWAFC, unpubl.

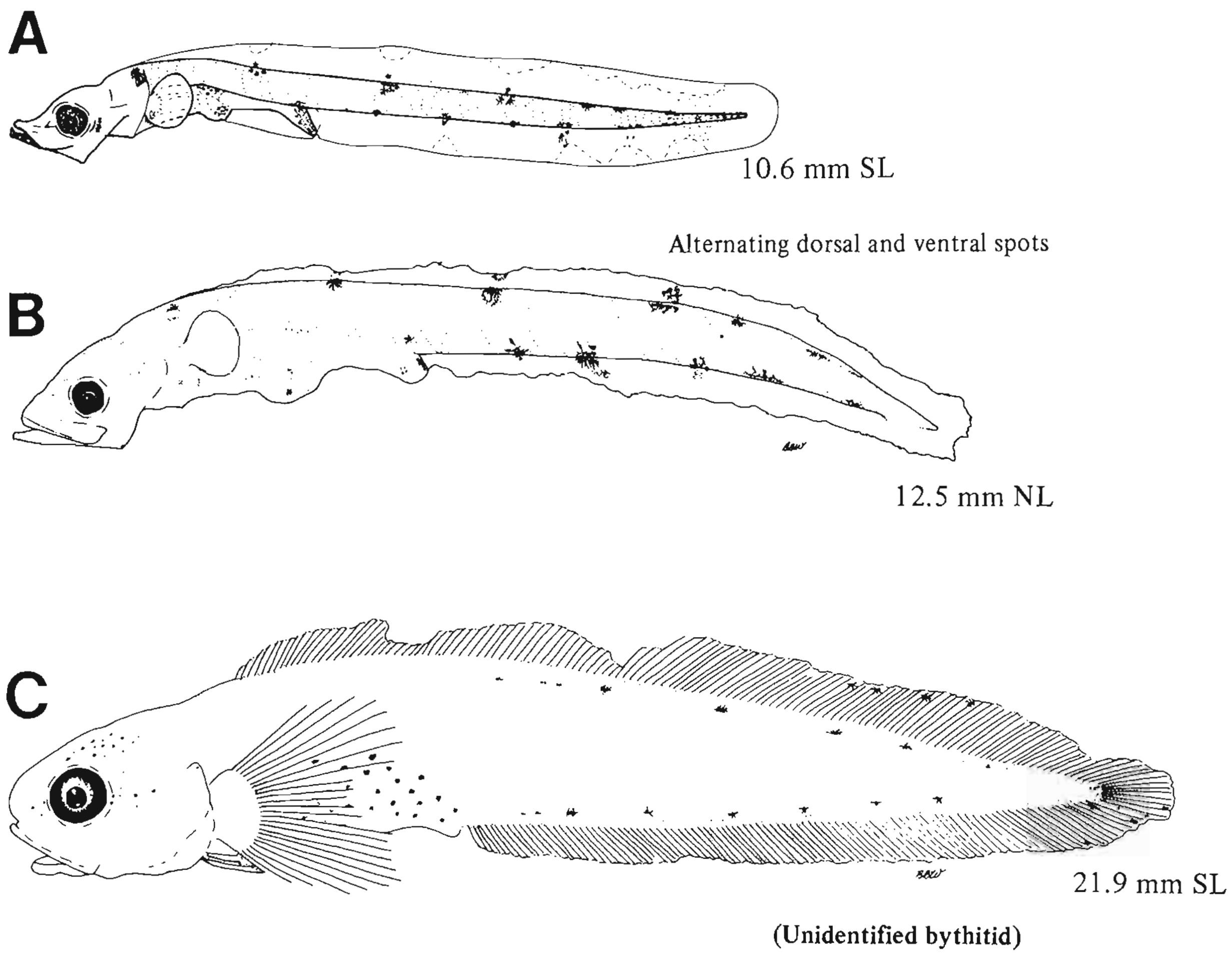
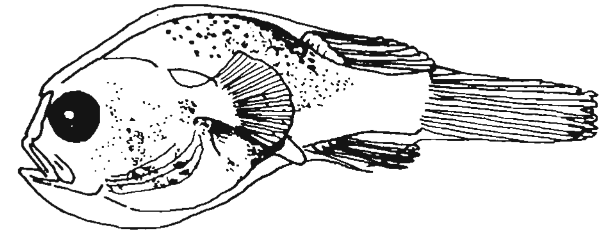


Figure A, NWAFC original (B. Vinter); B–C, Gordon et al. 1984 (C, North Atlantic specimen).



Lophiiformes

The order Lophiiformes includes some of the most unusual fishes known. Adults exhibit several forms: Dorsoventrally flattened and ventrally compressed forms found in shallow-water benthic habitat, and globose, flabby-bodied forms found at meso- and bathypelagic depths. Worldwide there are 18 families, 63 genera, and 262 species (Pietsch 1984). All families are characterized by having a luring apparatus (illicium) bearing a terminal bait (esca) originating from three modified anterior dorsal spines and a narrow tube-like gill opening located near the pectoral fin. Extreme sexual dimorphism is common among the fishes within the suborder Ceratioidei. Males are one-third the size of females or smaller and sometimes are permanently attached (parasitic) to them. Eggs of most lophiiforms are spawned in gelatinous "veils" which may be up to 1.5 m wide and 12 m long (Pietsch 1984). Several species have eggs attached to the adult (Pietsch and Grobecker 1987). Larvae are pelagic and many have large heads and an envelope of highly inflated skin. Neither eggs nor larvae have been collected in the study area.

Families in study area: **Ceratiidae**
Oneirodidae

CERATIOIDEI

The suborder Ceratioidei is represented within the study area by members of the families Oneirodidae and Ceratiidae. Ceratioids differ from other members of the Lophiiformes in being meso- and bathypelagic, lacking pelvic fins (except larval Caulophrynidae), and in having extreme sexual dimorphism.

Oneirodidae

Found worldwide, oneirodids (dreamers) are represented by five species within three genera (*Oneirodes*, *Chaenophryne*, and *Bertella*) in the Northeast Pacific. Reproduction is accomplished by facultative or non-parasitic attachment of the male onto the body of the female (Pietsch 1976). Eggs and larvae are pelagic. Eggs are probably released in gelatinous veils which might break up in plankton nets. Eggs are presumably small, generally 0.5-0.8 mm, and hatching occurs between 2.5 and 3.5 mm SL (Bertelsen 1984). Larvae have a transparent envelope of gelatin, under colorless skin, which may serve as an aid to flotation (Idyll 1964, Pietsch 1984).

According to Bertelsen (1984), larval characters for oneirodids include the following:

- Presence in larval males of a rudiment of illical bone
- Moderately elongate body shape (body depth up to 80-90% in most ceratioids but less pronounced in oneirodids)
- Larvae surrounded by inflated transparent skin (similar to other ceratioids)
- Head length usually about 45% SL
- Pigment: Ceratioids possess four main pigment areas (peritoneal, dorsal, caudal, and opercular). In oneirodids, the opercular pigment is dense and occurs in different patterns

At metamorphosis (usually between 8 and 10 mm SL), larvae descend into deeper waters.

Ceratiidae

Recently, two ceratiids (seadevils) have been identified from the Bering Sea, *Ceratias holboelli* and *Ceratias* sp. (Pietsch 1986). Larval ceratiids are distinguished from other ceratioid families in having the following combination of characters (Pietsch 1986):

- Body "hump-backed," mouth subvertical
- Female with caruncles on dorsal surface of trunk
- 4-5 dorsal fin rays, 4 anal fin rays
- Pectoral fins not reaching beyond dorsal and anal fins
- Pelvic fins absent

Table 27
Meristic characters of Ceratioidei.

Taxon	Distribution	Vertebrae Precaudal	(Total)	Vertebrae Caudal	Fins Dorsal	Fins Anal	Fins Pectoral	Branchiostegals
Ceratiidae								
Ceratias holboelli	Bering Sea				4-5	4		
Ceratias sp.	Bering Sea				4-5	4		
Oneirodidae								
Bertella idiomorpha	SSC - Gulf of Alaska	5		15	5-6	4-5	17-21	6
Chaenophryne longiceps	SSC - Oregon		(21)		6-7	5-6	17-22	6
Chaenophryne melanorhabdus	SSC - Brit. Col.	9		10	6-8	5-6	16-17	6
Oneirodes bulbosus	Oregon - Bering Sea	4		16	6-7	4	15-18	6
Oneirodes thompsoni	N. Calif. - Bering Sea	4		16	5-6	4	14-17	6

MERISTICS

Vertebrae	Total: 21-21-21 Precaudal: X-X-X Caudal: X-X-X
Branchiostegal rays	6-6-6
Caudal fin	
Pelvic fin	Absent
Dorsal fin	R: 6-7-7
Pectoral fin	R: 17-19-22
Anal fin	R: 5-5-6
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to Oregon, 42-46°N
Ecology	Mesopelagic, 200-1000 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Area: Mode: Males attach to body of female[a] Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE[b]

Preanal length
Length at flexion
Length at transformation
Sequence of fin development
Pigment

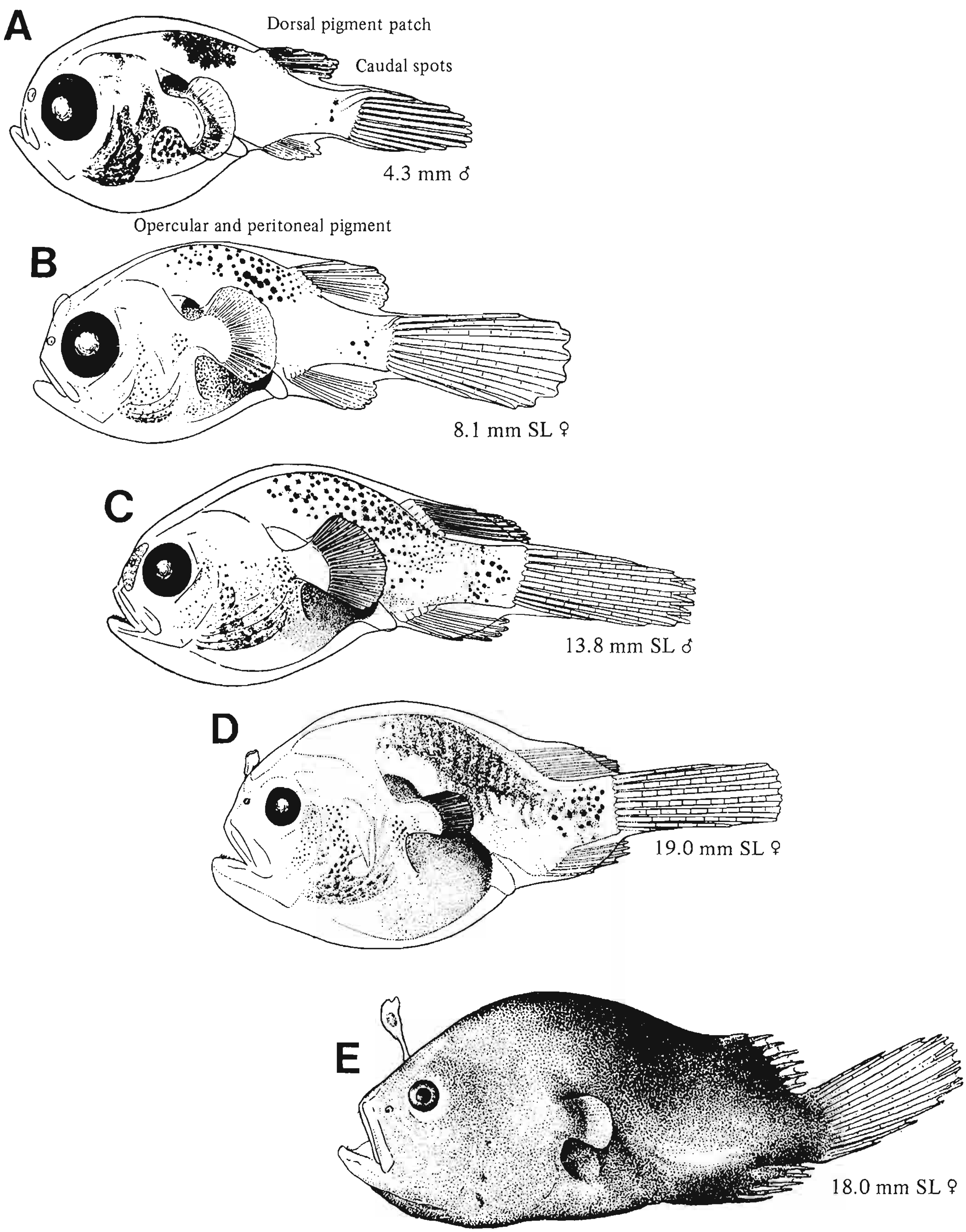
- Pigment appears in all four pigment areas
  —Peritoneal
  —Anterior body, begins as a small dorsal patch
  —Opercular
  —Caudal, initially a few spots

Diagnostic characters

- Generally more lightly pigmented than *Oneirodes* spp.

[a] Pietsch 1976
[b] Because of the possibility of involvement of other species in the description, and geographic variation, specimens in our area could differ.

Ref: Bertelsen 1984.



Figures A–E, Bertelsen 1951 (North Atlantic specimens).

MERISTICS

Vertebrae	Total: 20-20-20 Precaudal: 4-4-4 Caudal: 16-16-16
Branchiostegal rays	6-6-6
Caudal fin	
Pelvic fin	Absent
Dorsal fin	R: 6-X-7
Pectoral fin	R: 15-16-18
Anal fin	R: 4-4-4
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	Oregon, 42-46°N, to Bering Sea, 54-66°N
Ecology	Mesopelagic, 200-1000 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Area: Mode: Males attach to body of female[a] Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE[b]

Preanal length
Length at flexion
Length at transformation
Sequence of fin development
Pigment - Species group

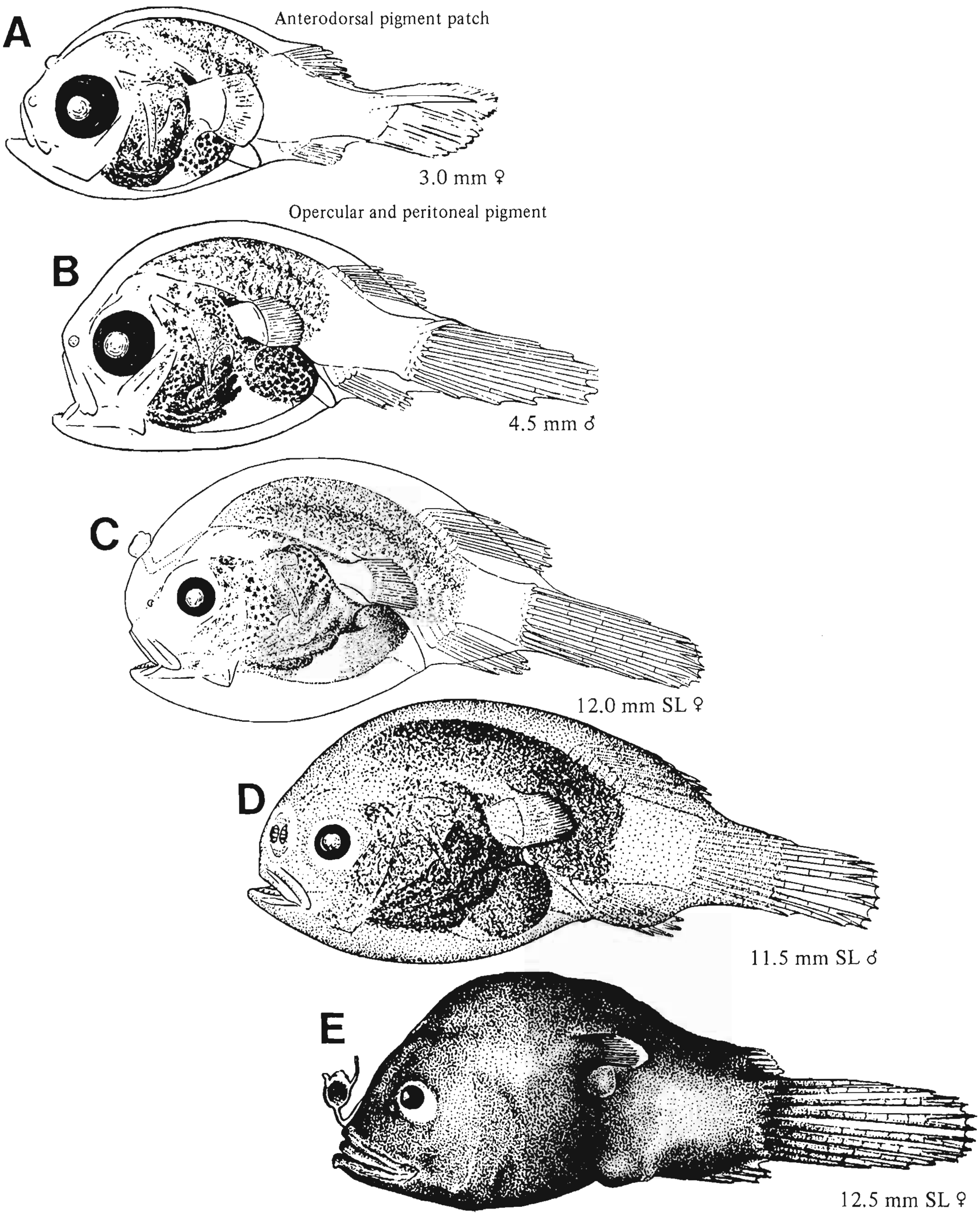
- Pigment in three out of the four main pigment areas
  —Peritoneal
  —Anterior body
  —Opercular
- Caudal pigment is light and appears late in development

Diagnostic characters

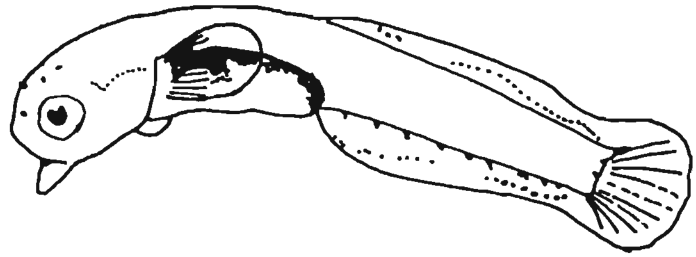
[a] Pietsch 1976

[b] Figures of *Oneirodes eschrichti* group (Bertelsen 1951) are presented for comparison only. Because of the possibility of involvement of other species in the description, and geographic variation, specimens of *Oneirodes* in our area could differ.

Ref: Bertelsen 1984.



Figures A–E, Bertelsen 1951 (North Atlantic specimens from the *O. eschrichti* group).



Gobiesociformes

The gobiesociforms (clingfishes) are mostly small, inshore bottom-dwelling species occurring in tropical and temperate seas. Noted primarily for having the pelvic fins modified into a sucking disc, the order has 2 families, 36 genera, and 114 species (J. Nelson 1984). All but one genus and four species are members of Gobiesocidae. Eggs are demersal, attached to substrate or kelp, ovate to ellipsoidal, and 0.7-1.9 mm. Oil globules (1-100) coalesce to one during development (Allen 1984). Larvae are well developed at hatching and may have a fully formed pelvic disc at this time (Marliave 1975a). Most are heavily pigmented and have long guts (50-70% SL) (Allen 1984).

Family in study area: **Gobiesocidae**

MERISTICS

Vertebrae	Total: 32-33-34 Precaudal: 12-14-14 Caudal: 19-19-20
Branchiostegal rays	6-6-6
Caudal fin	Total rays=11-13
Pelvic fin	Disc S: 1-1-1 R: 4-4-4
Dorsal fin	R: 13-16-16
Pectoral fin	R: 21-22-23
Anal fin	R: 13-14-15
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to SE Alaska, 55-59°N
Ecology	Intertidal, nearshore, 0-8 m
ELH pattern	Oviparous; demersal, attached, guarded eggs; pelagic larvae
Spawning	Season: Winter-spring (British Columbia)[a] Area: Demersal, on underside of rocks, usually intertidal[a] Mode: Polygamous males guard eggs (laid in monolayer)[a] Migration:
Fecundity	Range/function: 194-382 per female[b]
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.68-1.92 mm (1.78)
No. of oil globules	
Oil globule diameter	
Yolk	Bilobed in embryo and yolksac larva
Envelope	
Hatch size	5.7 mm SL, yolksac present until 6.2 mm SL
Incubation time/temp.	30 d/9-11°C
Pigment	

Diagnostic characters
- Adhesive, hemispherical, flat at point of attachment

LARVAE

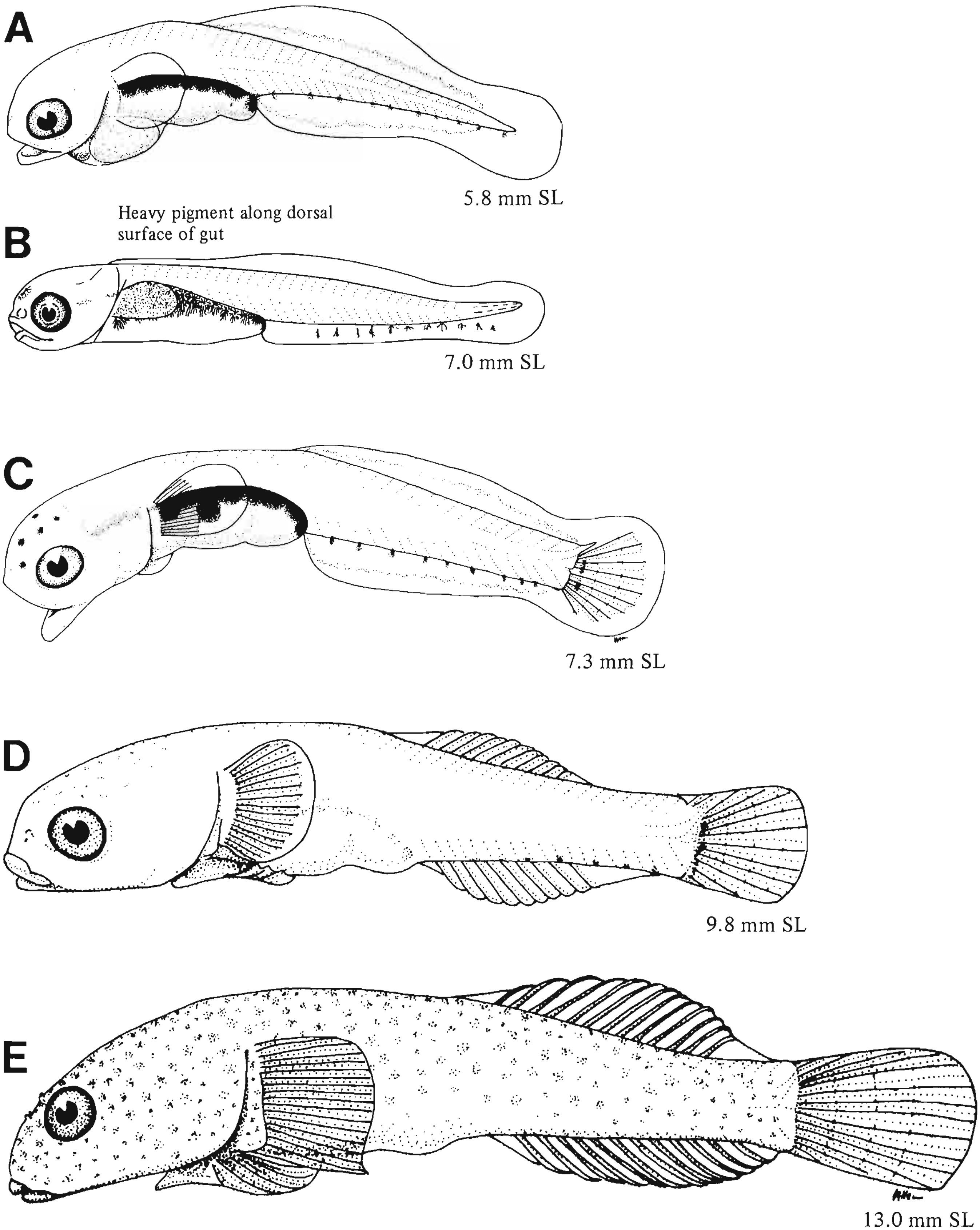
Head length	21-35% SL; gut length (preanal minus head length) 25% SL
Length at flexion	7 mm SL
Length at transformation	10-13 mm SL
Sequence of fin development	Pectoral fin buds form at 7.0 mm SL; pelvic disc is formed by 7.3 mm SL and fully functioning by 9.1 mm SL

Pigment
- Dorsally on gut
- With development, on snout and dorsal region of head

Diagnostic characters
- Large melanophores on dorsal surface of gut, lack of pigment on lateral surface
- Forms pelvic disc
- Number of myomeres (32-34)

[a] Marliave 1975a
[b] Johnson 1970

Ref: Allen 1984, Allen and Ilg 1983.



Figures A, C–E, Allen and Ilg 1983; B, NWAFC original (B. Vinter).

MERISTICS

Vertebrae	Total: 35-X-36
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	5-X-7
Caudal fin	Total rays=8
Pelvic fin	Disc
	S: 1-1-1 R: 4-4-4
Dorsal fin	R: 6-7-8
Pectoral fin	R: 14-15-17
Anal fin	R: 6-7-8
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Intertidal, nearshore
ELH pattern	Oviparous; demersal, attached eggs; pelagic larvae
Spawning	Season:
	Area: Kelp beds, on blades[a]
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.3 mm
No. of oil globules	One
Oil globule diameter	
Yolk	
Envelope	
Hatch size	<4 mm SL; yolksac present at 4 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	~50% SL
Length at flexion	
Length at transformation	
Sequence of fin development	

Pigment (based on figure only)
- Lateral melanophores (40-50)
- No postanal ventral melanophores
- No hypural pigment

Diagnostic characters
- Pelvic disc at hatching
- Number of myomeres (35-36)

Note: Marliave (1975a) reared *Rimicola muscarum* in the laboratory. Eggs (1.3 mm in diameter) had a single oil globule, and late-stage embryos developed a pelvic disc. Hatching occurred when embryos reached 4.0 mm SL. He described them as identical to *Gobiesox maeandricus* larvae except that they were markedly smaller, without nasal pigment, and with the pelvic disc at hatching. According to Marliave (Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8, pers. commun., 16 Oct. 1986), *R. muscarum* probably lacks a pelagic stage and the specimen illustrated here from Allen (1979) is misidentified.

[a] Allen 1984

Ref: Allen 1979, Marliave 1975a.

A

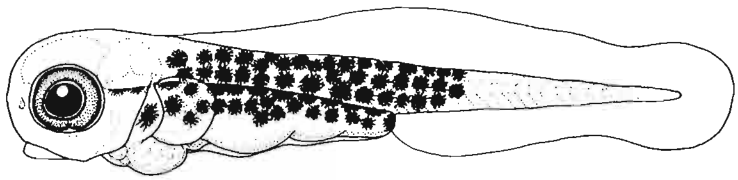
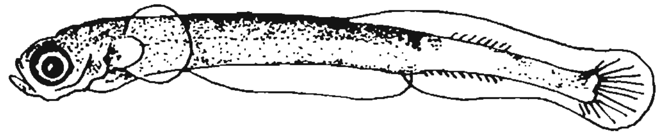
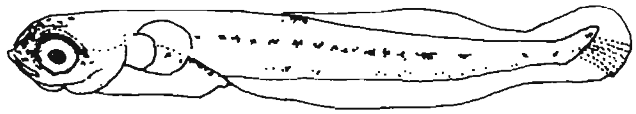


Figure A, Allen 1979.





Atherinomorpha: Beloniformes
Atheriniformes

The Beloniformes and Atheriniformes together comprise a group of fishes found in freshwater and marine habitats within tropical and temperate areas. The Beloniformes (not always accorded ordinal status [J. Nelson 1984]), consists of 5 families, 37 genera, and 180 species (Collette et al. 1984a). Marine forms of this order are mostly epipelagic, the best known being exocoetids, or flying fish. There are 6 families (White et al. 1984), 49 genera, and 235 species of atheriniforms (J. Nelson 1984). The two orders belong to the superorder Atherinomorpha and share the development of large demersal eggs with filaments and oil globules that coalesce at the vegetal pole (Collette 1984). Filaments may be short or long, grouped or evenly scattered, and adhesive or non-adhesive. Beloniform larvae are well formed at hatching and many have a preanal finfold and beak-like jaws (Collette et al. 1984a). Atheriniform larvae have direct development (i.e., no specialized larval or juvenile stages), a preanal finfold, and a single row of melanophores on the dorsal midline (White et al. 1984).

Families in study area: **Scomberesocidae**
Atherinidae

MERISTICS

Vertebrae	Total: 62-65-69
	Precaudal: 37-38-40
	Caudal: 24-27-29[a]
Branchiostegal rays	14-X-15
Caudal fin	X, 7+8, X
Pelvic fin	Abdominal
	R: 6-6-6
Dorsal fin	R: 14-X-18[a]
Pectoral fin	R: 12-13-15
Anal fin	R: 18-X-21[a]
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Epipelagic, 0-200 m
ELH pattern	Oviparous, eggs attach to flotsam (kelp) with adhesive filaments, pelagic larvae
Spawning	Season: Winter-fall;[b] peaks Feb-July[c]
	Area:
	Mode: Schools[b]
	Migration:
Fecundity	Range/function: ~1800 during each of 6-7 spawnings[b]
Age at first maturity	2 yr[b]
Longevity	5 yr[b]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.58 (1.68 mm)×2.13 mm
No. of oil globules	None
Oil globule diameter	
Yolk	Homogeneous
Envelope	Adhesive filaments, 12-15 in polar cluster and 1 lateral
Hatch size	6.0-8.5 mm SL (family)
Incubation time/temp	
Pigment	

Diagnostic characters
- Adhesive filaments in polar cluster
- Single lateral filament
- Slightly ovoid

LARVAE

Preanal length	65% SL
Length at flexion	
Length at transformation	
Sequence of fin development	Caudal, dorsal and anal, pectorals, pelvics (caudal forms at hatching)

Pigment
- Dense body pigment

Diagnostic characters (see Table 3)
- Persistent preanal finfold
- Unpigmented area on ventrolateral region of caudal peduncle
- At 20-40 mm SL, upper and lower jaw are slightly elongate but do not form prominent beak; with growth a slight beak develops

[a] Collette et al. 1984a
[b] Fitch and Lavenberg 1971
[c] Wang 1981

Ref: Collette et al. 1984a, Fitch and Lavenberg 1971, Uchida et al. 1958.

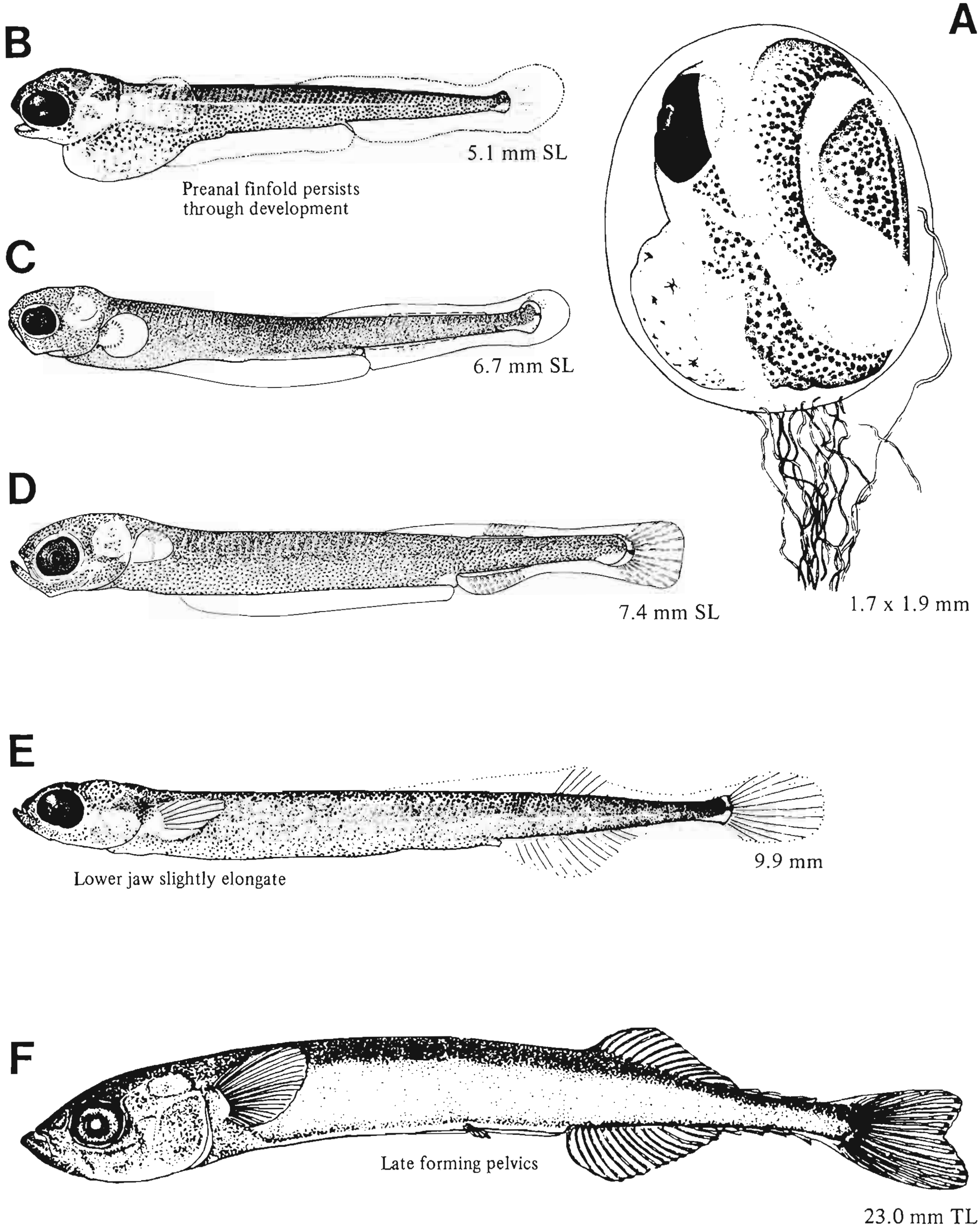


Figure A, Matarese and Sandknop 1984; B, Collette et al. 1984a; C–D, NWAFC originals (B. Vinter); E, Moser 1981; F, Uchida et al. 1958.

MERISTICS[a]

Vertebrae	Total: 44-48-52	
	Precaudal: 32-34-37	
	Caudal: 11-13-15	
Branchiostegal rays	5-X-6	
Caudal fin		
Pelvic fin	Abdominal	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 6-X-10	R: 8-X-14
Pectoral fin	R: 13-13-13	
Anal fin	S: 1-1-1	R: 19-X-25
Gill rakers	U: 4-X-8	L: 21-X-34

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Nearshore shelf pelagic
ELH pattern	Oviparous, eggs with adhesive filaments, pelagic larvae
Spawning	Season: May-July[b]
	Area: Mudflats, eelgrass[b]
	Mode: Schools[b]
	Migration: To mudflats in sloughs[a]
Fecundity	Range/function:
Age at first maturity	2-3 yr[c]
Longevity	6-7 yr[b]

EARLY LIFE HISTORY DESCRIPTION[d]

EGGS

Diameter	1.5-1.7 mm[e]
No. of oil globules	Initially may have one to many, but they usually coalesce to one
Oil globule diameter	
Yolk	Amber, granular
Envelope	6-7 filaments[f]
Hatch size	4.3-4.9 mm SL; yolk absorbed by 7 mm SL
Incubation time/temp.	9 d/15-18°C

Pigment
- Dorsal and lateral spots on head, few anterior spots on yolksac

Diagnostic characters
- Narrow perivitelline space

LARVAE

Preanal length	30-40% SL
Length at flexion	7.7-10.5 mm SL
Length at transformation	15 mm SL
Sequence of fin development	Caudal, pectorals, anal rays and 2nd dorsal, pelvics, 1st dorsal and anal spines

Pigment
- Dorsal midline from snout to caudal peduncle
- Mediolateral beginning above gut
- Dorsal and ventral surface of gut
- Ventrally on tail

Diagnostic characters

Distinguished from *Atherinopsis californiensis* by
- Presence of melanophores along ventral body midline and ventral gut

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[a] Meristic information from White et al. (1984) is very different from the information in our database. Due to confusion in the literature over the definition of spines and rays, only total elements are reported by White et al. (1984) and they are as follows:

Vertebrae	43-49	Pectoral fin	12-15
First dorsal fin	3-7	Anal fin	9-14
Second dorsal fin	10-14	Gill rakers	14-27

[b] Hart 1973

[c] Fitch and Lavenberg 1975

[d] Additional unpubl. data provided by W. Watson, H.J. Walker, and R. Davis (W. Watson, Marine Ecological Consultants, 531 Encinitas Blvd., Suite 110, Encinitas, CA 92024, pers. commun., 3 Nov. 1986).

[e] Wang 1981

[f] According to White et al. (1984), two egg types are reported for the species, one with 40-78 filaments attached at both ends and the other with about 6 filaments attached only at one end.

Ref: Wang 1981, White et al. 1984.

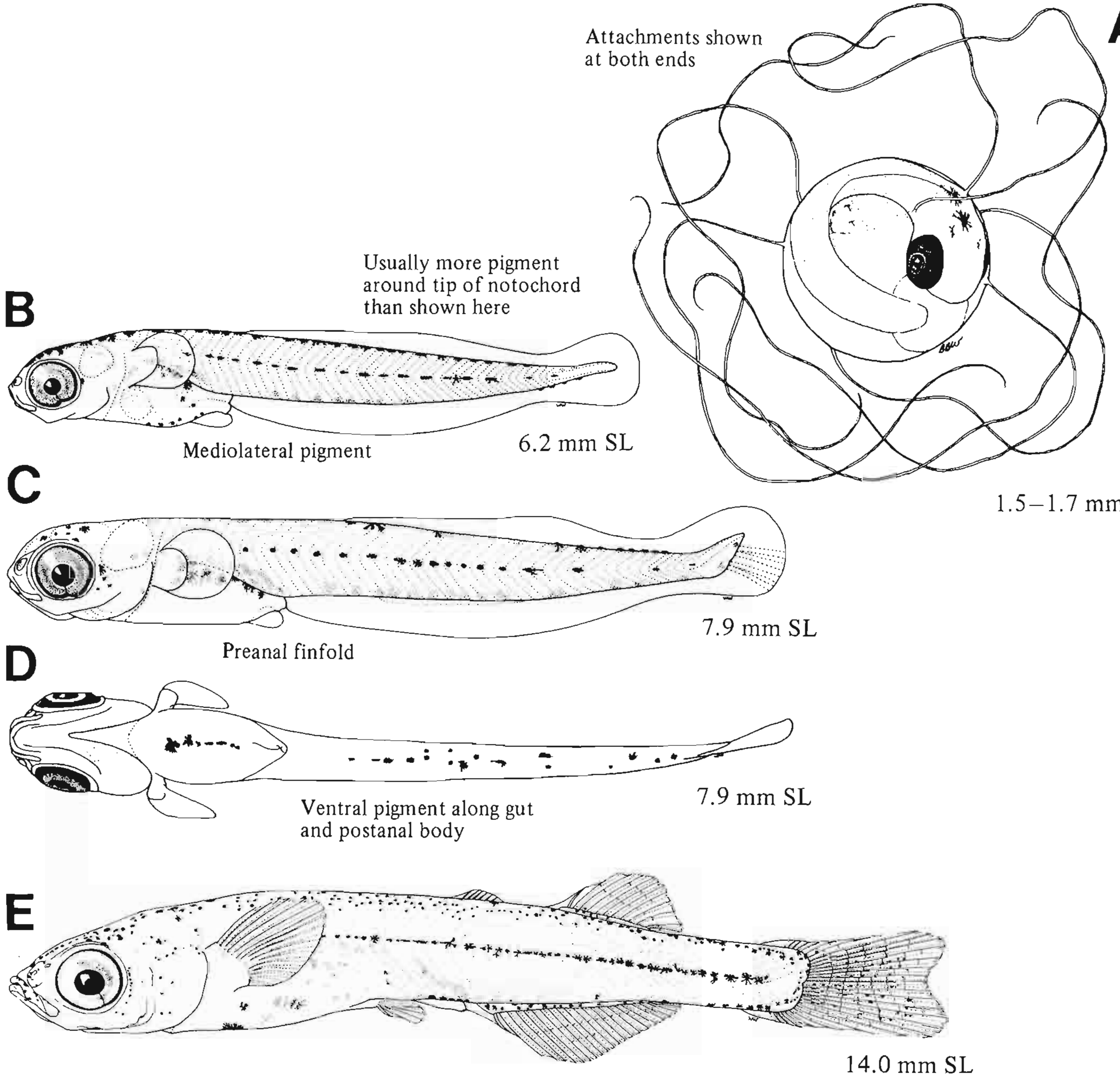


Figure A, White et al. 1984; B–E (D, ventral view), Watson and McGowen, unpubl.

MERISTICS[a]

Vertebrae	Total: 50-51-52	
	Precaudal: 9-12-14	
	Caudal: 37-39-41	
Branchiostegal rays	5-X-6	
Caudal fin		
Pelvic fin	Abdominal	
	S: 1-1-1	R: 6-6-6
Dorsal fin	S: 6-X-10	R: 11-X-14
Pectoral fin	R: 15-15-15	
Anal fin	S: 1-1-1	R: 21-X-26
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	South of southern California to Oregon, 42-46°N
Ecology	Nearshore shelf pelagic
ELH pattern	Oviparous, eggs with filaments in a mass or attached to substrate, pelagic larvae
Spawning	Season: Fall-spring[b]
	Area: On algae, eelgrass[b]
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION[c]

EGGS

Diameter	1.9-2.5 mm[b]
No. of oil globules	Many (23-44) which coalesce to one or few
Oil globule diameter	0.4-0.6 mm (consolidated)
Yolk	Yellow-orange, granular
Envelope	13-19 filaments scattered on surface
Hatch size	7.5-8.6 mm SL; yolk absorbed by 10 mm SL
Incubation time/temp.	17-19 d/12-16°C

Pigment

- Dorsal spots along nape

Diagnostic characters

- Narrow perivitelline space
- 1-2 cm filaments

LARVAE

Preanal length	<50% SL
Length at flexion	8.8 to ≤11.5 mm SL
Length at transformation	18.1-19.5 mm SL
Sequence of fin development	Caudal, pectorals, anal rays and 2nd dorsal, pelvics, 1st dorsal and anal spines

Pigment

- Dorsal midline from snout to caudal peduncle, sometimes with a break in nape area
- Mediolateral usually begins posterior to gut during preflexion stage

Diagnostic characters

Distinguished from *Atherinops affinis* by

- First 5-6 postanal myomeres always lack ventral pigment through the larval and early juvenile stages
- Lack of ventral midline melanophores until midflexion
- Mediolateral pigment originates further posterior

[a] Meristics from White et al. (1984) are as follows:

Vertebrae	46-53
First dorsal fin	4-9
Second dorsal fin	10-15
Pectoral fin	14-17
Anal fin	20-29
Gill rakers	18-44

[b] Wang 1981

[c] Additional unpubl. data provided by W. Watson, H.J. Walker, and R. Davis (W. Watson, Marine Ecological Consultants, 531 Encinitas Blvd., Suite 110, Encinitas, CA 92024, pers. commun., 3 Nov. 1986).

Ref: Wang 1981, White et al. 1984.

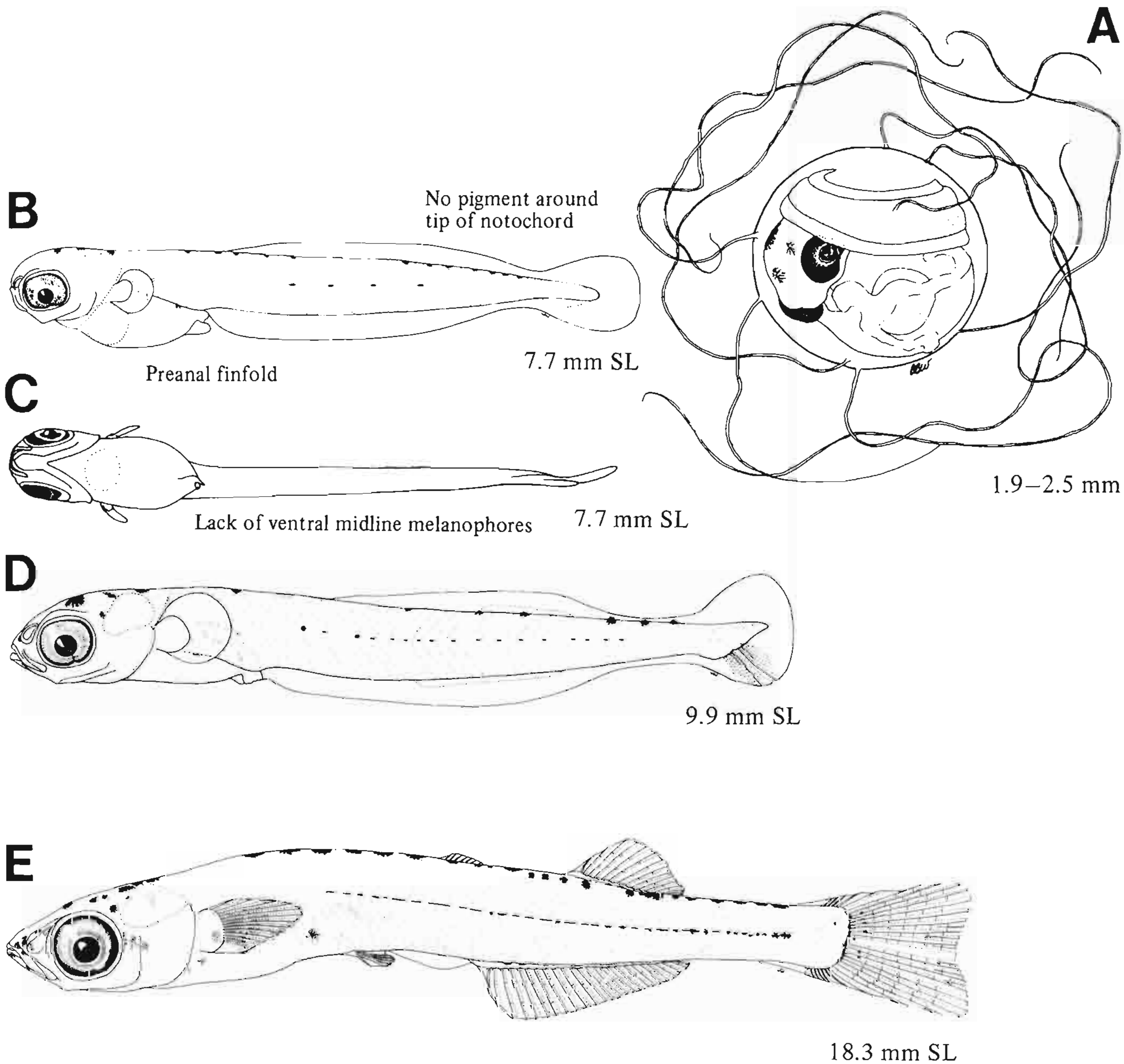
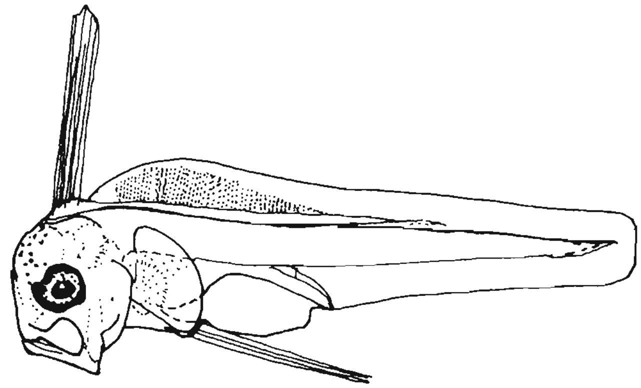


Figure A, White et al. 1984; B–E (C, ventral view), Watson and McGowen, unpubl.



Lampriformes

Fishes of the order Lampriformes are extremely diverse. Occupying meso- and epipelagic habitats, some are deep-bodied while others are long and ribbon-like. Extreme specialization and unique body shapes have caused conflicting proposals for evolutionary relationships within the order (Olney 1984). According to Olney (1984), there are 7 families, 12 genera, and 21 families worldwide (not found in polar seas). Lampriforms share the unique arrangement of protrusible premaxilla and maxilla, or specializations thereof. Early-life-history information is available for only four genera. Eggs are large (1.7-4.0 mm) with thick resilient chorions, pelagic, and may be shaded with amber, pink, or red hues. Advanced stages of eggs of some forms are easily recognized due to precocious development of anterior dorsal and pelvic rays and distinctive pigment patterns. Newly hatched lampriforms are identified by their well-developed protrusible jaws and elongate anterior dorsal and pelvic fin elements which are often ornamented with highly pigmented serial or terminal swellings (Olney 1984).

Families in study area: **Lampridae**
Trachipteridae

MERISTICS[a]

Vertebrae	Total: 43-X-46 Precaudal: 19-X-21 Caudal: 23-24-25
Branchiostegal rays	6-X-7
Caudal fin	Total rays=30-32
Pelvic fin	Abdominal R: 13-X-17
Dorsal fin	R: 48-X-52
Pectoral fin	R: 21-X-24
Anal fin	R: 33-X-42
Gill rakers	U: 2-X-3 L: 13-X-14

LIFE HISTORY

Range	South of southern California to Gulf of Alaska, 54-60°N
Ecology	Epi- and mesopelagic
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Spring[b] Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS - Family

Diameter	Large, 1.7-4.0 mm
No. of oil globules	
Oil globule diameter	
Yolk	Homogeneous in known forms
Envelope	Thick, resilient
Hatch size	
Incubation time/temp.	~3 weeks
Pigment	

Diagnostic characters
- Precocious development of fins
- Ovarian eggs have thick chorion with amber tint

LARVAE

Preanal length	<50% SL, increasing with development to ≥50% SL
Length at flexion	
Length at transformation	
Sequence of fin development	Anterior dorsal and pelvics precocious; dorsal, anal, and caudal; pectorals

Pigment
- Initially on crown and dorsal surface of gut; with development, increases along entire body except for tail region and above anal fin

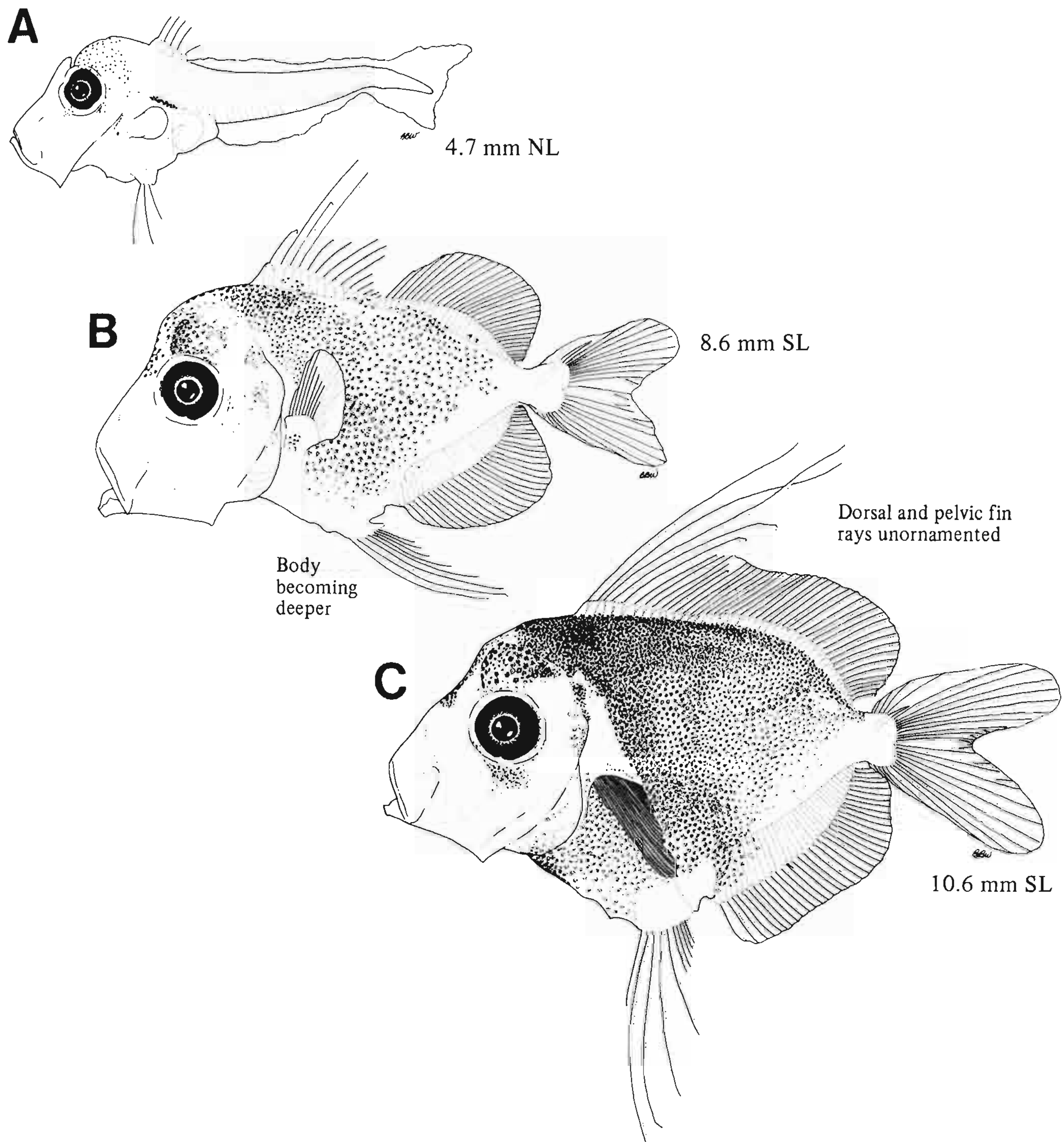
Diagnostic characters

Distinguished from *Trachipterus altivelis* (p. 246) by
- Lack of ornamentation on dorsal and pelvic fins (when fins are intact)
- Rapid change in body form from slender at hatching to deep-bodied by 10.6 mm SL

Lampriform characters
- Well-developed protrusible jaws
- Differentiated guts with open lumen and little yolk
- Elongate anterior dorsal elements (may be ornamented) and well-developed pelvic elements (may be ornamented with lengths to 40-60% NL)

[a] Data from Olney (1984) in part, only total elements reported.
[b] Fitch and Lavenberg 1971

Ref: Olney 1984.



Figures A–C, Olney 1984.

MERISTICS

Vertebrae	Total: 90-92-94 Precaudal: 35-35-39 Caudal: 53-59-59
Branchiostegal rays	6-X-7
Caudal fin	
Pelvic fin	Thoracic R: 6-X-7
Dorsal fin	R: 160-X-191
Pectoral fin	R: 10-X-11
Anal fin	Absent
Gill rakers	U: 3-X-5 L: 9-X-11

LIFE HISTORY

Range	South of southern California to Gulf of Alaska, 54-60°N
Ecology	Epi- and mesopelagic, 0-900 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	2.6-3.7 mm
No. of oil globules	None
Oil globule diameter	
Yolk	Homogeneous
Envelope	Clear, smooth, thick
Hatch size	
Incubation time/temp.	

Pigment
- Head and gut
- Finfold
- Ornamentation on elongate rays

Diagnostic characters
- Precocious development of elongate rays in anterior dorsal fin and pelvic fins

LARVAE

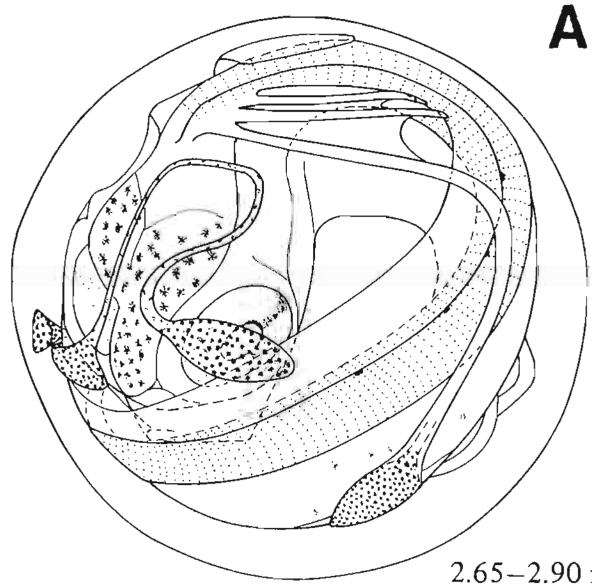
Preanal length	<50% SL, with development increasing to >50% SL
Length at flexion	
Length at transformation	
Sequence of fin development	Anterior dorsal and pelvics precocious, posterior dorsal, caudal, pectorals

Pigment
- Initially only on head and anterior/dorsal gut; with development pigment appears on lateral surface of gut, along body over gut, and in a series above notochord along 3/4 BL
- Several spots develop above and below notochord in caudal region

Diagnostic characters
- See *Lampris guttatus* (p. 244)

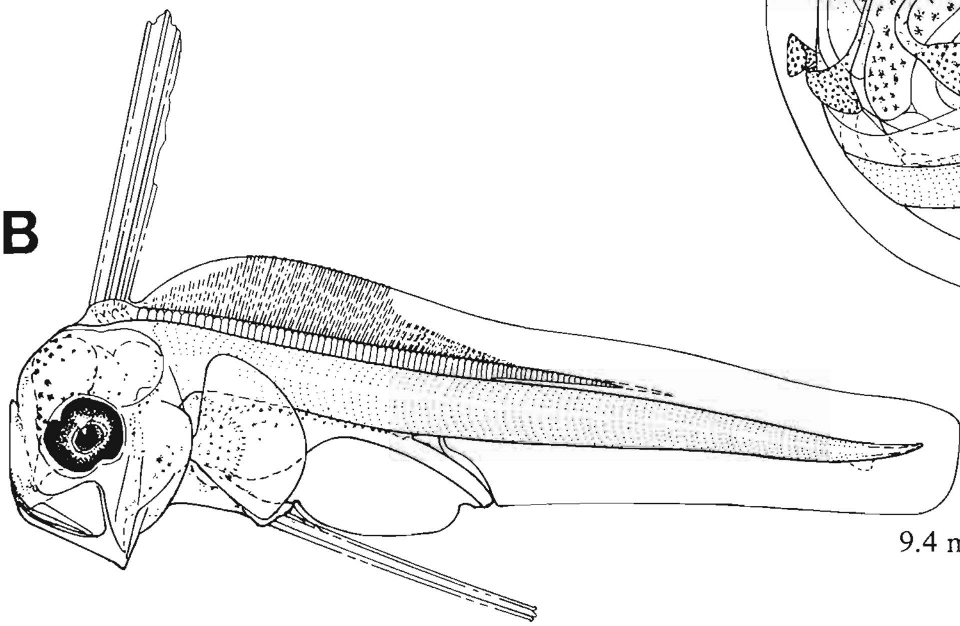
Ref: NWAFC, unpubl.

A



2.65–2.90 mm

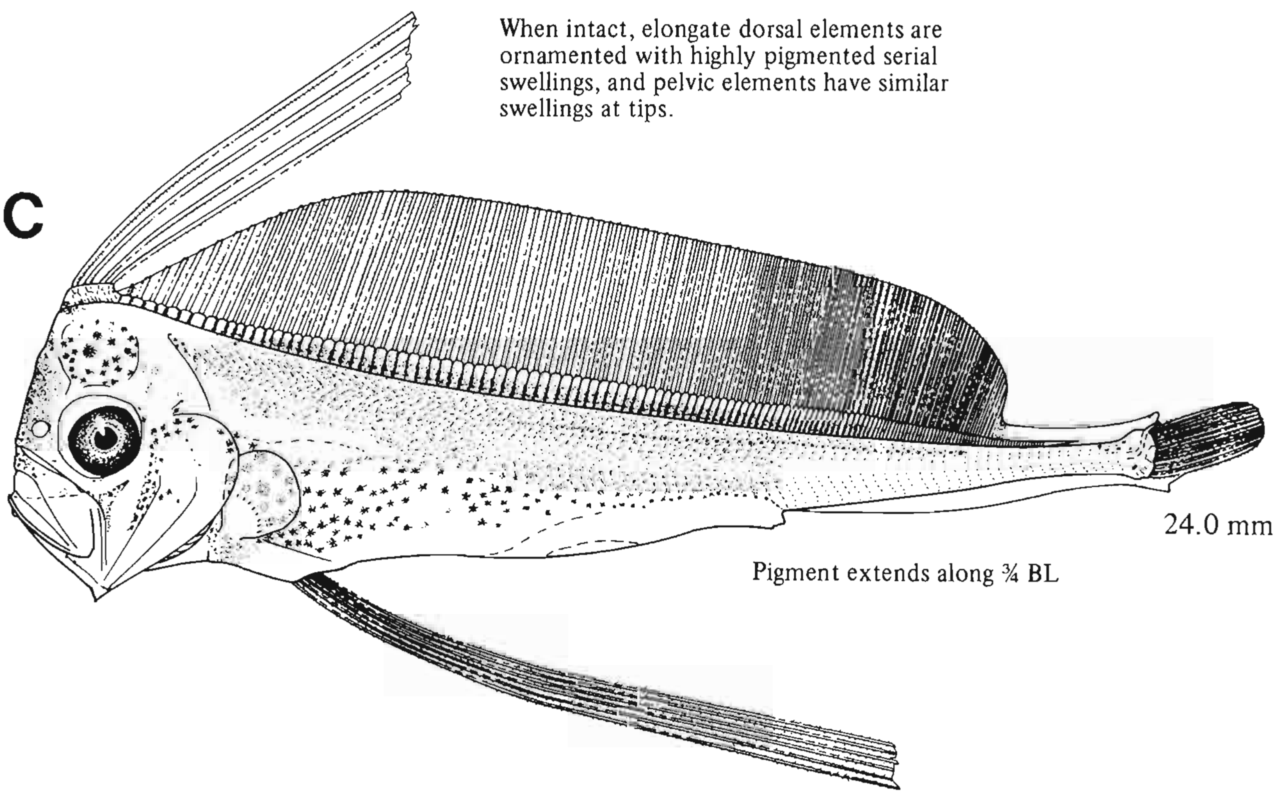
B



9.4 mm SL

When intact, elongate dorsal elements are ornamented with highly pigmented serial swellings, and pelvic elements have similar swellings at tips.

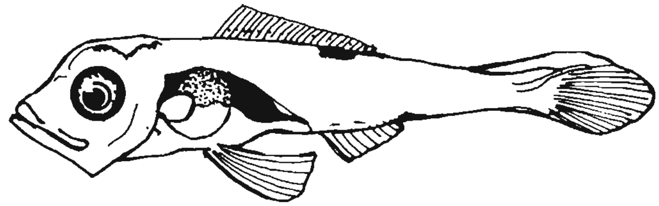
C



24.0 mm SL

Pigment extends along ¾ BL

Figure A, Matarese and Sandknop 1984; B–C, NWAFC originals (B. Vinter).



Beryciformes

Fishes of the order Beryciformes are cosmopolitan in distribution. The composition of the order is subject to much variation, but according to Keene and Tighe (1984), it consists of 16 families, 42 genera, and 155 species. Although several characters define the beryciforms (e.g., a high number of pelvic and caudal fin rays and the presence of dorsal, anal, and pelvic fin spines), none are unique to the order. No information is available on eggs, and other early-life-history stages are known for only six families. In the Northeast Pacific, larvae are known for only two families, Anoplogastridae and Melamphaidae. Anoplogastrids have large heads with short deep bodies, and well-developed preopercular, rostral, and cranial spines. Larvae of the best known family, Melamphaidae, are longer-bodied and more slender with spination generally restricted to the preopercle.

A summary of meristic characters is provided for members of the suborder Cetomimoidei (Barbourisiidae, Cetomimidae, Rondeletiidae), as larvae are unknown.

Families in study area: **Anoplogastridae**
Melamphaidae
Barbourisiidae
Cetomimidae
Rondeletiidae

MERISTICS

Vertebrae	Total: 25-X-28
	Precaudal: 12-12-12
	Caudal: 16-16-16
Branchiostegal rays	8-X-9
Caudal fin	X, 17, X
Pelvic fin	Thoracic
	S: 1-1-1 R: 6-6-6
Dorsal fin	R: 17-18-19
Pectoral fin	R: 14-15-16
Anal fin	R: 8-X-9
Gill rakers	U: 7-X-11 L: 7-X-11

LIFE HISTORY

Range	South of southern California to Oregon, 42-46°N
Ecology	Epi- and mesopelagic, below 610 m
ELH pattern	Parity and eggs unknown, pelagic larvae
Spawning	Season: Summer (California)[a]
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length	
Length at flexion	4.5-6.0 mm SL
Length at transformation	
Sequence of fin development	Pelvic fins last to develop

Pigment
- At 6 mm SL, lateral surface of body to caudal peduncle, gut, and pectoral fin base pigmented
- Pigment increases with development

Diagnostic characters
- Spination
  —Serrate frontal ridge terminates in a short stout supraocular spine
  —Long serrate parietal spine
  —Long serrate preopercular spine directed posteroventrad

Juveniles
- Increase in dark pigment
- Reduction of spines

[a]Fitch and Lavenberg 1968

Ref: Keene and Tighe 1984.

A

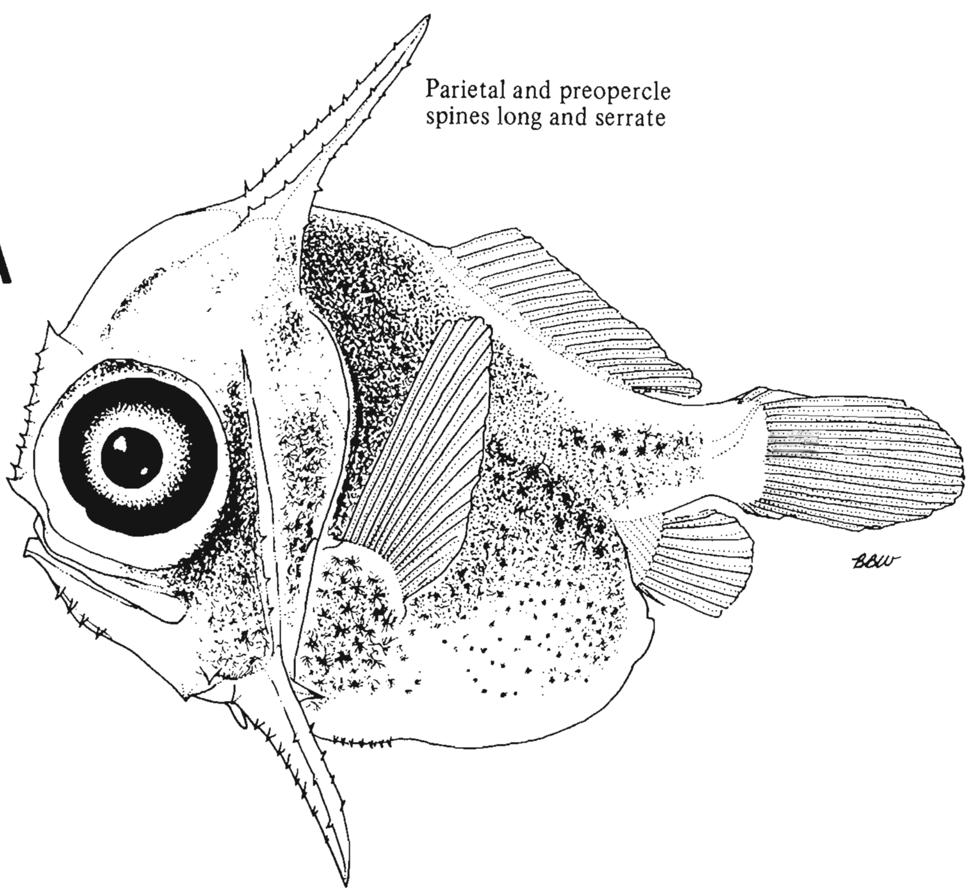


Figure A, Keene and Tighe 1984.

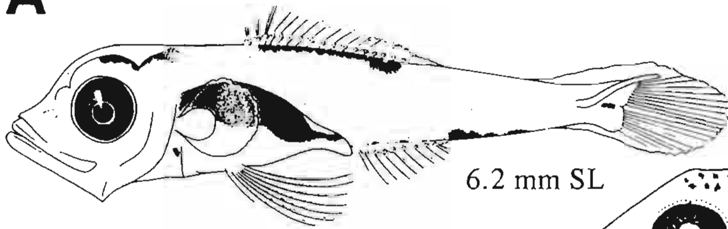
MELAMPHAIDAE

Melamphaids, or bigscales, are small (15 cm), darkly colored, bathypelagic fish found in most oceans. They are distinguished by exceptionally thin skull bones, sometimes with ridges or crests. They are represented in the study area by five species within four genera: *Melamphaes*, *Poromitra*, *Scopeloberyx*, and *Scopelogadus*. A complete descriptive series is known only for *Melamphaes lugubris*. Generally, small melamphaid larvae (2-10 mm) are relatively elongate and slender as compared with later stages, and possess early and rapidly developing pelvic fins which are long and darkly pigmented. *Melamphaes*, *Scopeloberyx*, and *Scopelogadus* larvae usually have two spots near the posterior end of the dorsal and anal fin margin; with development these spots spread both anteriorly and posteriorly along the dorsal and ventral midlines (Keene and Tighe 1984). Other pigment occurs on the cranium, peritoneum, and along the caudal peduncle. Although usually damaged, the second or third dorsal fin ray is elongate in larvae of these three genera. Larger larvae (5-10 to 20 mm) can generally be distinguished by body shape, presence of preopercular spines (e.g., *Poromitra*), and meristic characters. The following generic meristic characters are based on Ebeling (1962) and E.H. Ahlstrom notes, in part.

		Fins			
Genus	Vertebrae	Dorsal	Anal	Pectoral	Pelvic
Melamphaes	27-31	III, 13-16	I,7-9	14-17	I,7
Poromitra	24-29	III, 9-14	I,8-11	13-15	I,7-8
Scopeloberyx	23-27	II-III, 10-13	I,7-9	12-14	I,7-8
Scopelogadus	24-26	II, 10-12	I,7-9	13-15	I,7-8

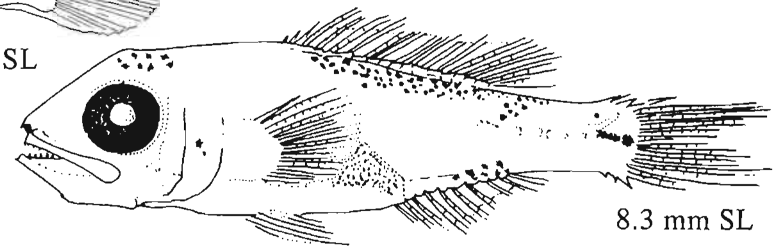
MELAMPHAES

A *Melamphaes lugubris*



6.2 mm SL

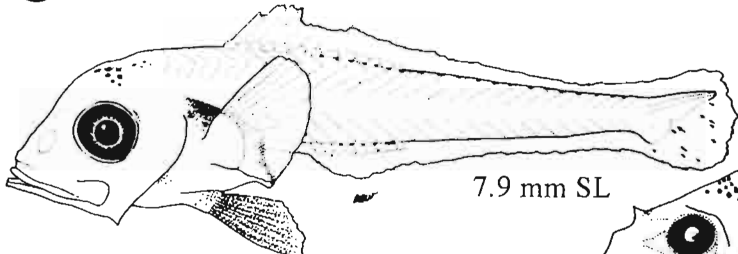
B *Melamphaes lugubris*



8.3 mm SL

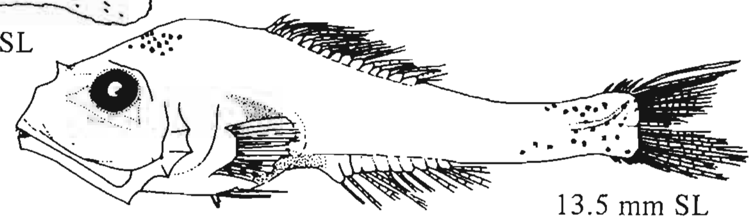
POROMITRA

C *Poromitra crassiceps*



7.9 mm SL

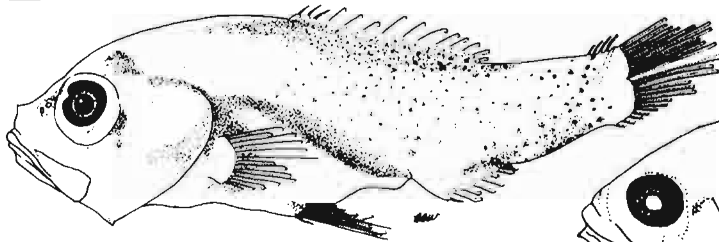
D *Poromitra* sp.



13.5 mm SL

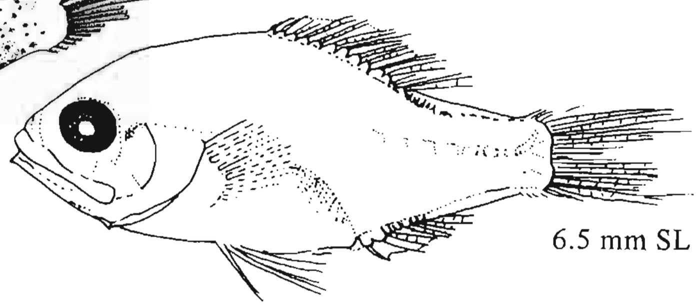
SCOPELOBERYX

E *Scopeloberyx robustus*



13.0 mm SL

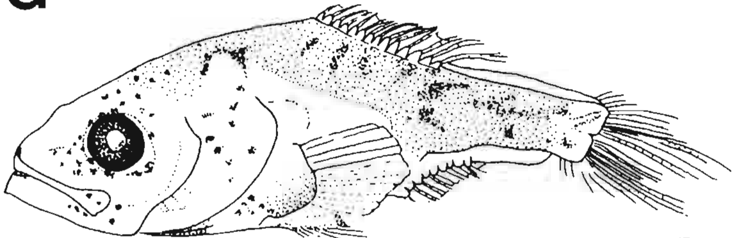
F *Scopeloberyx* sp.



6.5 mm SL

SCOPELOGADUS

G *Scopelogadus bispinosus*



8.0 mm SL

Figures A–G, Keene and Tighe 1984 (B–G, North Atlantic specimens).

MERISTICS

Vertebrae	Total: 28-X-31	
	Precaudal: 11-12-12	
	Caudal: 16-X-19	
Branchiostegal rays	8-8-8	
Caudal fin	X, 10+9, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 7-7-7
Dorsal fin	S: 3-3-3	R: 14-15-16
Pectoral fin	R: 15-16-17	
Anal fin	S: 1-1-1	R: 7-8-9
Gill rakers	U: 5-X-6	L: 15-X-18

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Mesopelagic, 200-1000 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS - Family

Diameter	0.81-0.96 mm SL
No. of oil globules	One to many
Oil globule diameter	
Yolk	Segmented
Envelope	Clear, spherical
Hatch size	Probably <2 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	45-55% SL
Length at flexion	~6 mm SL
Length at transformation	
Sequence of fin development	Pelvics, dorsal and caudal, anal, pectorals

Pigment
- Dorsally on top of head
- Peritoneum
- Postanal: Two spots near posterior of dorsal and anal anlagen which spread anteriorly and posteriorly along dorsal and ventral midline
- Spot on caudal peduncle

Diagnostic characters
- Pigment (see above): Patches, bands
- 2nd or 3rd dorsal ray elongate (until 5-10 mm SL)
- Pelvics: (2-10 mm SL) develop rapidly and are long, fragile, and pigmented

Distinguished from *Sebastolobus* spp. (p. 336) at sizes <5 mm SL by
- Postanal pigment band more anterior, beginning at myomere 15
- Precocious development of pelvic fin

M. parvus larvae are unknown. The following meristic information may aid in identification.

Total vertebrae	27-29
Precaudal vertebrae	11-12
Caudal vertebrae	16-17
Dorsal fin rays	III, 13-15
Anal fin rays	I, 7-9
Pectoral fin rays	14-15
Pelvic fin rays	I, 7

Ref: Keene and Tighe 1984.

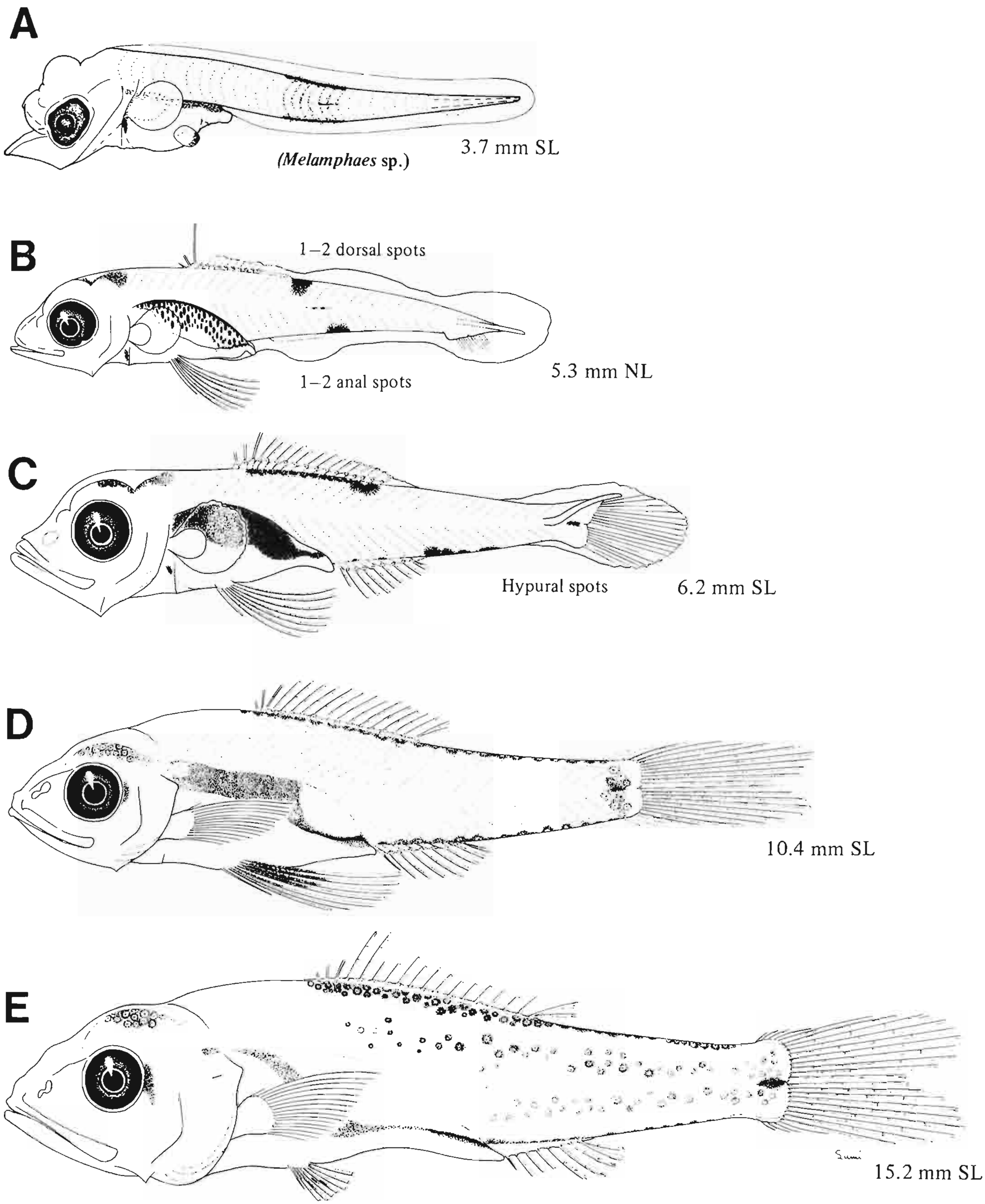


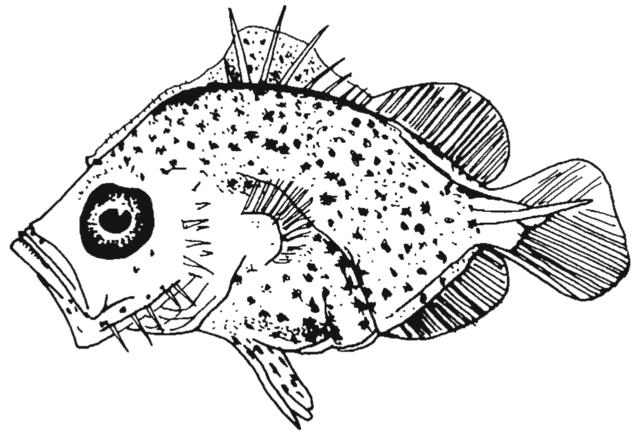
Figure A, NWAFC original (B. Vinter); B–E, Keene and Tighe 1984.

Fishes of the suborder Cetomimoidei are bathypelagic with whale-shaped bodies, large mouths, highly distensible stomachs, and luminous tissue on the body. Eyes may be reduced or rudimentary. Whalefishes are divided into three families: Cetomimidae, Rondeletiidae, and Barbourisiidae. Worldwide in distribution, the suborder consists of 8 genera and 18 species. Of these, five species in five genera have been collected in the northeastern Pacific. Adults are taken by deep tows generally in excess of 400 m, and then only rarely. No information on life history, eggs, or larvae is available (Keene and Tighe 1984).

Table 28
Meristic characters of suborder Cetomimoidei.

		Vertebrae		Fins				Gill rakers		
Taxon	Distribution	Precaudal (Total)	Caudal	Dorsal	Anal	Pectoral	Pelvic	Upper	Lower	Branchiostegals
Barbourisiidae		(42-44)								
Barbourisia rufa	Cent. Calif. - Arctic	17-18	25	20-22	16-18	13-14	6	4-6	14-16	6-7
		(42-44)								
Cetomimidae		(51-52)								
Cetomimus sp.	Bering Sea									
Cetostoma regani	Cent. Calif. - Oregon			30	27	14	Absent			8
Gyrinomimus sp.*	N. Calif. - Brit. Col.									
Rondeletiidae		(24-27)								
Rondeletia loricata	S. Calif. - Oregon	10	16	13-16	13-14	9-11	5	4-6	14-16	8
		(24-26)								

*Peden et al. 1985.



Zeiformes

The zeiforms occur in tropic and temperate areas of all oceans, in benthic and pelagic habitats from shallow to deep-water areas; little else is known of the life history of most fish in this group. Adults are generally deep-bodied with large eyes, greatly distensible jaws, and dorsal, anal and/or pelvic fin spines. The order is loosely organized according to a number of characters, none of which are unique. Presently, there are 6 families, 21 genera, and about 36 species throughout their distribution (J. Nelson 1984). The order is represented in the study area by one taxon, *Allocyttus* sp., a member of the Oreosomatidae. Eggs of only three species are known. Sizes range from 1.0 to 2.25 mm in diameter; all have a smooth chorion, homogeneous yolk, and a single oil globule (Tighe and Keene 1984). Larvae are generally deep-bodied and may be heavily pigmented. Forms exhibit a variety of armaments including serrated cranial ridges and spines, preopercular spines, and hardened cones or scaley knobs.

Family in study area: **Oreosomatidae**

MERISTICS

Vertebrae	Total: 39-39-40	
	Precaudal: 13-X-14	
	Caudal: 26-26-26	
Branchiostegal rays	7-7-7	
Caudal fin	Total rays=12-18	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 6-6-6
Dorsal fin	S: 6-X-7	R: 30-X-36
Pectoral fin	R: 19-X-21	
Anal fin	S: 2-X-3	R: 28-X-33
Gill rakers	U: 6-6-6	L: 18-X-21

LIFE HISTORY

Range	Cent. California, 34-38°N, to Bering Sea, 54-66°N
Ecology	Meso- and bathybenthal, 366-732 m
ELH pattern	Eggs and larvae unknown
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE[b]

Preanal length
Length at flexion
Length at transformation
Sequence of fin development
Pigment

Diagnostic characters - Family

- Limited data on prejuveniles only; pelagic prejuveniles are oval in outline and possess a leathery skin with distinct hardened cones or scaly knobs laterally and ventrally

[a] *Allocyttus folletti* and *A. verrucosus* may occur in the study area, but identification to species is not possible. Kobayashi et al. (1968) suggested *A. folletti* should be a synonym of *A. verrucosus*.

[b] Early-life-history stages of *Allocyttus* spp. are unknown. An illustration of a prejuvenile of *Oreosoma atlanticum* is presented for comparison only. A photograph of an *Allocyttus verrucosus* juvenile (95 mm TL) is presented in Kobayashi et al. (1968).

Ref: Kobayashi et al. 1968, Tighe and Keene 1984.

A *Oreosoma atlanticum*

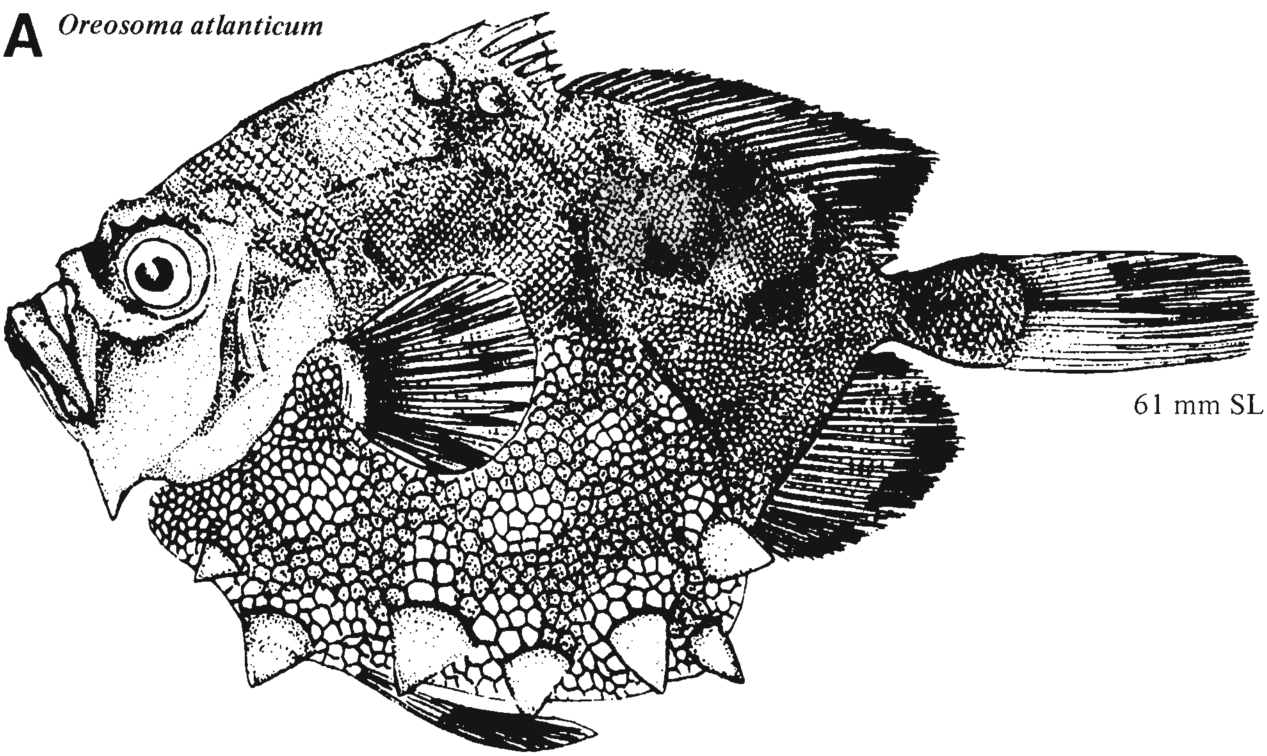


Figure A, Abe and Kaji 1972 (Tasman Sea specimen).

Gasterosteiformes

The order Gasterosteiformes is made up of small, cryptically colored fish found in freshwater or marine habitats in tropical and temperate areas. Most species have small mouths at the end of tubular snouts and dermal plates covering the body. Historically divided into two or three orders, the group, as supported by Pietsch (1978) and Fritzsche (1984), contains 10 families with well over 200 species. Eggs are broadcast or deposited in nests or on algae, or for syngnathids, in male brood pouches. Eggs of families other than Syngnathidae are 1.5-2.1 mm in diameter, may have one or more oil globules, and have thick chorions. Most gasterosteiform larvae hatching from externally incubated eggs (except gasterosteids) have the same distinctive characters (i.e., elongate snout and small mouth, dermal plates) as the adults. Although adult gasterosteids are sometimes collected in plankton samples, early-life-history stages are unlikely to occur and are not treated here.

Families in study area: **Aulorhynchidae**
Gasterosteidae
Syngnathidae

MERISTICS

Vertebrae	Total: 54-54-56	
	Precaudal: 24-25-26	
	Caudal: 29-29-31	
Branchiostegal rays	4-4-4	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 4-4-4
Dorsal fin	S: 23-X-27	R: 9-X-11
Pectoral fin	R: X-X-X	
Anal fin	S: 1-1-1	R: 9-X-10
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	South of southern California to SE Alaska, 55-59°N
Ecology	Nearshore shelf pelagic
ELH pattern	Oviparous; demersal, adhesive, guarded eggs; larvae briefly pelagic
Spawning	Season: Late spring-summer (Brit. Col.);[a] Feb-July (Calif.);[b] year-round (Calif.)[c]
	Area: Demersal, on algae or marine plants[a]
	Mode: Nest building; males territorial, polygamous[c]
	Migration:
Fecundity	Range/function: 150-600/mass[a]
Age at first maturity	1 yr[c]
Longevity	9 yr[b]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	2.0-2.1 mm
No. of oil globules	One
Oil globule diameter	
Yolk	Yellow to yellow-green
Envelope	Thick
Hatch size	8 mm TL
Incubation time/temp.	2-6 wk/10°C
Pigment	

Diagnostic characters
- Protracted hatch always occurs, embryos develop asynchronously

LARVAE

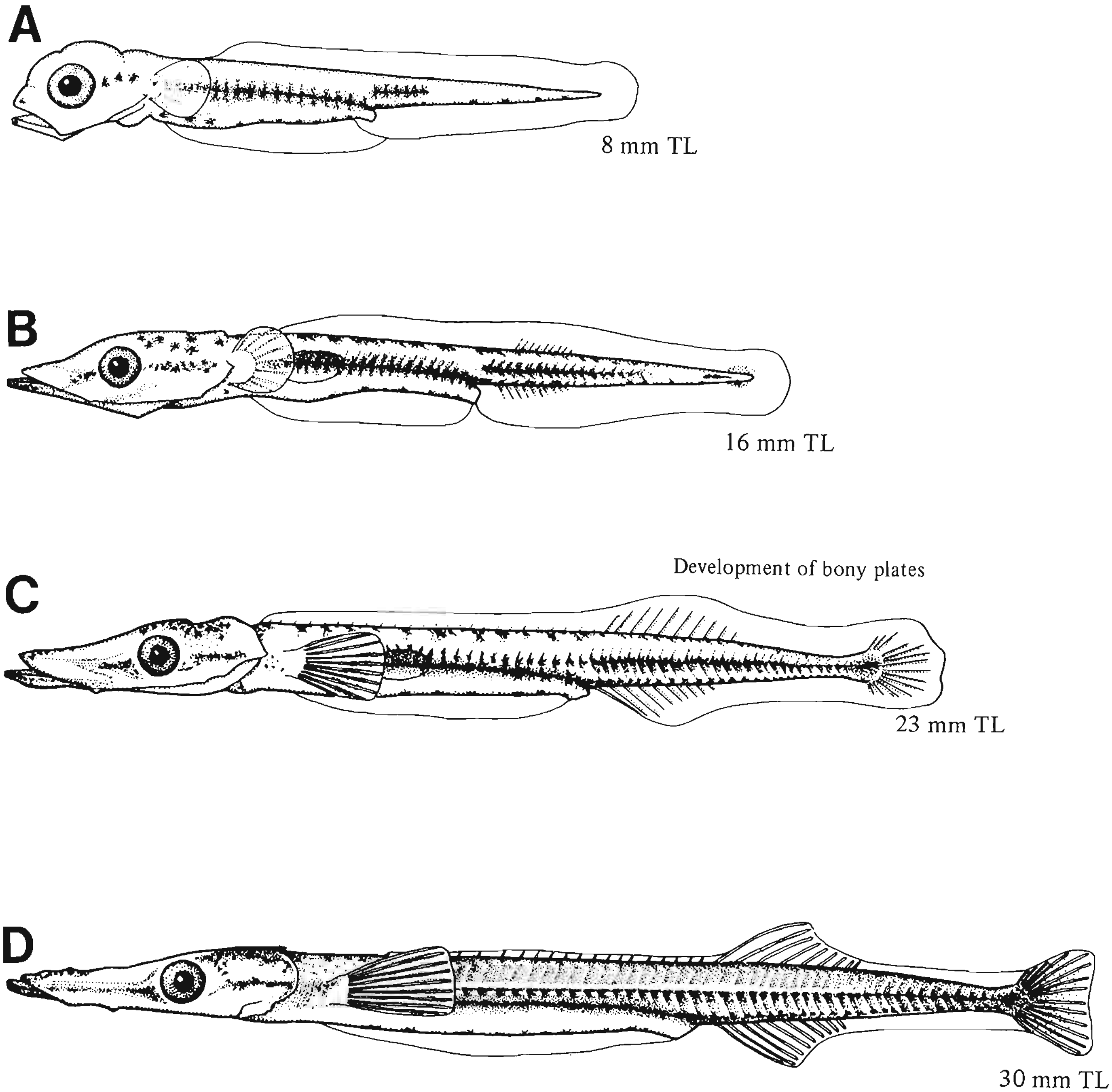
Preanal length	60-65% SL
Length at flexion	>16 mm TL
Length at transformation	
Sequence of fin development	Pectorals; dorsal rays, anal, and caudal; dorsal spines; pelvics

Pigment
- Gut: Along dorsal surface and ventral midline
- Postanal body: Dorsal and ventral midline to tail; along notochord initially over anal fin but increasing anteriorly
- Head: Dorsal and posterior to eye

Diagnostic characters
- Pigment generally heavier than on syngnathids
- Bony plates develop by notochord flexion
- Elongated snout

[a] Marliave 1975a
[b] Fitch and Lavenberg 1975
[c] Limbaugh 1962

Ref: Fritzsche 1984, Ida 1976, Limbaugh 1962, Marliave 1976.



Figures A–D, Marliave 1976.

MERISTICS

Vertebrae	Total: 56-61-64 Precaudal: 19-20-21 Caudal: 37-41-43
Branchiostegal rays	2-X-3
Caudal fin	
Pelvic fin	Absent
Dorsal fin	R: 28-38-43
Pectoral fin	R: 11-X-13
Anal fin	R: 2-X-3
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to SE Alaska, 55-59°N
Ecology	Intertidal, nearshore
ELH pattern	Oviparous, eggs and larvae develop in brood pouch
Spawning	Season: Spring-summer[a] Area: Inshore protected areas[b] Mode: Males retain eggs and developing larvae until the young have reached a juvenile stage of development[b] Migration:
Fecundity	Range/function: 225[a]
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.0-1.5 mm
No. of oil globules	One or more
Oil globule diameter	0.4-0.5 mm
Yolk	Bright yellow
Envelope	
Hatch size	4.5-5.0 mm TL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE[c]

Preanal length	35-40% TL
Length at flexion	
Length at transformation	
Sequence of fin development	

Pigment

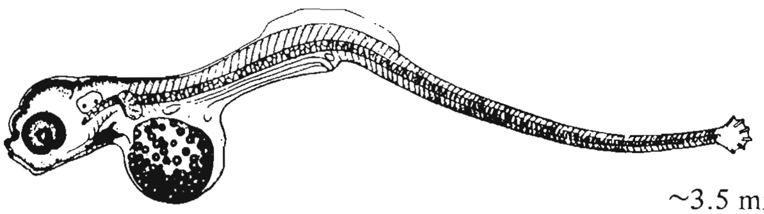
- Sparse at hatching, developing to form vertical blotches covering the head and body

Diagnostic characters

[a] Wang 1981
[b] Hart 1973
[c] Larval illustrations of *Syngnathus leptorhynchus* are unavailable. Illustrations of early-life-history stages of other members of the genus are presented for comparison and may differ from early-life-history stages of *S. leptorhynchus*.

Ref: Wang 1981.

A *Syngnathus fuscus*



~3.5 mm TL

B *Syngnathus schlegeli*

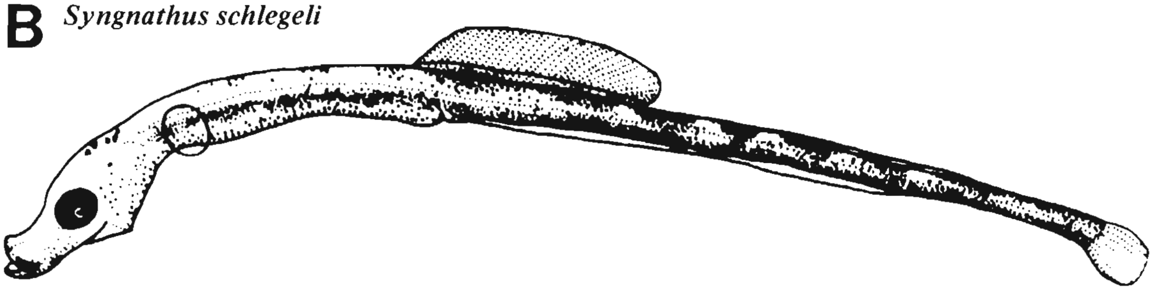
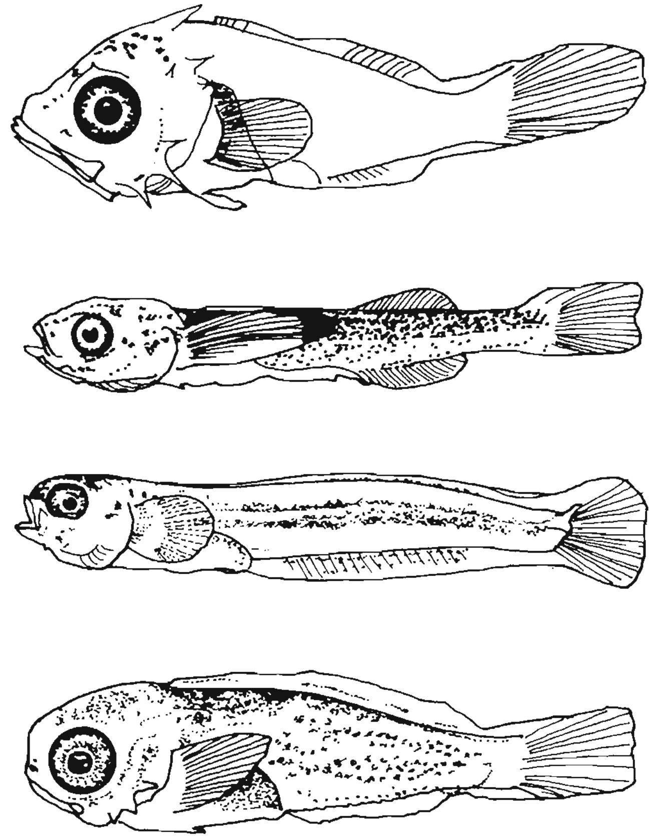


Figure A, Ryder 1887 (reversed, Atlantic specimen from brooding pouch); B, Chung 1977 (western Pacific specimen).



Scorpaeniformes

Most scorpaeniforms are bottom-oriented and have large heads, large rounded pectoral fins, rounded caudal fins, and many have head spines or bony plates (or combinations thereof). One character unites the group: a bony suborbital stay extending from the third suborbital bone to the opercle. Within the Scorpaeniformes, there are 20 families, 269 genera, and about 1160 species (J. Nelson 1984). The order is usually divided into four suborders: Scorpaenoidei, Anoplopomatoidei, Hexagrammoidei, and Cottoidei. Although members of the order are distributed worldwide, more than 250 species occur in the North Pacific Ocean and Bering Sea of which 190 are endemic.

Reproduction is oviparous except in *Sebastes* where eggs are internally fertilized and live feeding young are extruded. Larvae are extremely diverse. Head spines are common in larval scorpaenoids and cottoids.

Families in study area: **Scorpaenidae**
Anoplopomatidae
Hexagrammidae
Cottidae
Agonidae
Cyclopteridae

Scorpaenidae

In the study area this speciose family consists of *Sebastes*, with about 40 species, and *Sebastolobus* with 3 species. The larvae can be identified to genus, but identification is presently possible for only a few of the species of *Sebastes*. Information is included here which will aid in identifying species for which early-life-history series are known, and also characters are presented which may prove useful in identifying species whose larvae are not yet known. Full text pages are provided for those species for which an illustration is available of a postflexion larva and at least one other stage. Species with illustrations of only an extrusion larva or pelagic juvenile are treated in the comparative sections. For *Sebastes* species accounts, a section on head spines has been substituted for the egg section, and counts of lateral line pores and total gill rakers have been added to the meristic section.

Sebastinae

Among the 70 or so species of *Sebastes* in the Northeast Pacific, 40 species are known to occur in the study area (Table 29). Meristic information on the following pages has been updated from recent sources (Chen 1986; Laroche, in prep.). *Sebastes* are ovoviviparous (or viviparous[1]) and give birth to live young which are similar in stage of development to first-feeding larvae of oviparous scorpaenids. Eggs, generally between 0.75 and 1.9 mm diameter, are retained in the lumen of the ovary after ovulation and internal fertilization. Eggs possess a homogeneous yolk, narrow perivitelline space, fragile smooth chorion, and one to many oil globules. Hatching precedes extrusion with newborn larvae, 3.8-7.5 mm SL, having already utilized most of their yolk.

Newly extruded larvae have functional eyes, jaws, and pectoral fins. Notochord flexion occurs at about 6-12 mm SL and transformation (acquisition of adult complement of fin rays) occurs at about 15-25 mm SL. Many species have a distinct pelagic juvenile stage that may last until about 60 mm SL. Preflexion larvae have relatively slender bodies and compact guts (13-23% SL). Snout-to-anus length may increase from 40-50% SL to >60% SL in some species during the larval period. Preflexion larvae usually have pigment over the gut and a series of postanal ventral melanophores. Some species may have pigment along the dorsal midline which develops gradually. Other pigment may occur on the brain, jaws, opercle, fins (especially pectorals), and caudal peduncle.

A prominent feature in *Sebastes* larvae is head spination. Pterotic, parietal, and preopercular spines form before larvae undergo flexion, and other spines appear gradually thereafter. The full complement of head spines generally develops during the larval period, and some spines that develop in the larval period (e.g., pterotic, anterior preopercles, and lower post-temporal, and others in some) are overgrown during the juvenile stage (Washington et al. 1984b).

Larval series of 16 species of *Sebastes* occurring in our study area are known. Extrusion or yolk-exhaustion larvae have been illustrated for 32 species, and pelagic juveniles have been illustrated for 33 species. Although *Sebastes* larvae are often abundant in plankton samples from the Northeast Pacific in winter and spring, the specific identity of most cannot presently be determined.

Sebastolobinae

Sebastolobus is represented by three species in the study area. Eggs are extruded in bilobed gelatinous masses which float at the surface. The eggs are slightly elliptical and have homogeneous yolk, a narrow perivitelline space, and a smooth chorion. A single oil globule (0.18-0.20 mm diameter) is present (Pearcy 1962, Moser 1974).

Besides differences in meristic characters, *Sebastolobus* larvae can be distinguished from those of *Sebastes* in that preflexion larvae have a postanal band of pigment instead of the ventral and possibly dorsal midline melanophores in *Sebastes*. A parietal ridge develops in *Sebastolobus* and terminates in a double spine, the parietal and nuchal. In *Sebastes* the parietal spine develops singly, usually with a smaller nuchal spine immediately posterior to it.

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[1]Boehlert and Yoklavich (1984) demonstrated that in *Sebastes melanops* the embryos receive some nutrition from the ovarian fluid during gestation.

Table 29

Distribution, parturition season, and meristic characters of genus *Sebastes*. Range of counts followed by mode in parentheses. All have modal counts of 13 dorsal spines (except *S. polyspinis* with 14[a]) and 3 anal spines (Chen 1986).

Taxon	Distribution	Parturition	Fin rays: Dorsal	Fin rays: Anal	Fin rays: Pectoral	Total gill rakers on first arch	No. of lateral line pores
S. aleutianus	S. Calif.-Bering Sea	Apr[b]	13-15 (14)	7-8 (7)	17-19 (18)	28-33 (31)	30-33
S. alutus	S. Calif.-Bering Sea	Jan-May[c]	13-16 (15)	7-9 (8)	17-19 (18)	34-39 (35/38)	46-55
S. auriculatus	SSC-SE Alaska	Mar-June[d]	12-14 (13)	6-7 (7)	16-19 (18)	25-29 (27)	42-50
S. aurora	S. Calif.-Brit. Col.	Mar-May[e]	12-13 (13)	5-7 (6)	17-19 (17)	24-28 (27)	28-31
S. babcocki	S. Calif.-Bering Sea	Apr-May[b]	13-15 (14)	6-8 (7)	17-20 (19)	29-33 (31)	42-51
S. borealis	Cent. Calif.-Bering Sea	Apr[c]	12-15 (13)	6-8 (7)	17-20 (19)	27-31 (30)	28-32
S. brevispinis	SSC-Bering Sea	June[b], June-July[c]	13-15 (14)	7-7 (7)	17-18 (18)	33-36 (33)	46-51
S. caurinus	SSC-Gulf of Alaska	Apr[b]	11-14 (13)	5-7 (6)	16-18 (17)	26-31 (28)	39-47
S. chlorostictus	SSC-Wash.	July[f]	11-13 (12)	5-7 (6)	16-18 (17)	31-36 (33)	35-43
S. ciliatus	Brit. Col.-Bering Sea		14-16 (15)	6-9 (8)	17-19 (18)	32-35 (35)	42-53
S. crameri	S. Calif.-Bering Sea	Feb[c]	13-15 (13)	7-7 (7)	18-20 (19)	30-34 (32)	40-51
S. diploproa	SSC-Gulf of Alaska	May-June[b], July[c]	11-14 (12)	5-7 (7)	17-18 (18)	32-37 (34)	32-42
S. elongatus	SSC-Gulf of Alaska	May-June[b]	12-14 (13)	6-7 (6)	16-18 (17)	29-33 (31)	37-47
S. emphaeus	N. Calif.-Gulf of Alaska	Aug-Sept[g]	13-15 (14)	6-7 (7)	16-18 (17)	37-41 (40)	40-46
S. entomelas	SSC-Gulf of Alaska	Apr[c], Nov-Mar[h]	14-16 (15)	7-9 (8)	18-19 (18)	34-38 (36)	54-60
S. flavidus	S. Calif.-Gulf of Alaska	Mar[c], Nov-Feb[h]	14-15 (14)	7-8 (8)	17-18 (18)	34-37 (36)	49-55
S. glaucus	Bering Sea		14-17 (15)	7-9 (8)	18-20 (19)	35-41 (38)	
S. goodei	SSC-Brit. Col.	Dec-Mar[h]	13-14 (14)	8-9 (8)	16-18 (17)	34-39 (36)	50-57
S. helvomaculatus	SSC-Gulf of Alaska	June[c]	12-14 (13)	6-7 (6)	15-17 (16)	28-33 (30)	34-45
S. jordani	SSC-Gulf of Alaska	Mar[c], Nov-Mar[h]	13-16 (14)	9-10 (9)	19-22 (20)	40-47 (44)	53-64
S. maliger	Cent. Calif.-Gulf of Alaska	Apr[c]	11-13 (13)	6-7 (7)	16-18 (17)	29-33 (31)	34-45
S. melanops	Cent. Calif.-Aleutian Is.	Apr[b]	14-15 (15)	7-9 (8)	18-19 (19)	34-38 (37)	47-55
S. melanostictus	Bering Sea		13-14 (14)	7-7 (7)	18-18 (18)	32-35 (33)	
S. melanostomus	SSC-Wash.		12-14 (13)	6-8 (7)	18-20 (19)	30-34 (31)	28-33
S. miniatus	SSC-Brit. Col.	Nov-Mar[h]	13-15 (14)	6-7 (7)	17-18 (18)	36-42 (41)	41-48
S. mystinus	SSC-Aleutian Is.	Nov-Jan[i]	15-17 (16)	8-10 (9)	17-19 (18)	32-38 (35)	47-53
S. nebulosus	S. Calif.-SE Alaska		12-14 (13)	6-7 (7)	17-18 (18)	27-31 (28)	38-43
S. nigrocinctus	Cent. Calif.-SE Alaska	May[c]	12-15 (14)	6-7 (7)	18-19 (19)	28-32 (28)	36-46[k]
S. paucispinis	SSC-Gulf of Alaska	Jan-Feb[c], Nov-Apr[j]	13-15 (14)	8-10 (9)	14-16 (15)	27-32 (28)	51-62
S. pinniger	SSC-Gulf of Alaska	Jan-Mar[c], Nov-Mar[f]	13-15 (14)	7-7 (7)	16-18 (17)	41-44 (43)	40-47
S. polyspinis	Brit. Col.-Bering Sea		13-16 (15)	7-9 (8)	17-19 (18)	35-39 (36)	43-53
S. proriger	S. Calif.-Bering Sea	July[c]	14-15 (15)	7-7 (7)	16-17 (17)	36-41 (38)	48-55
S. rastrelliger	SSC-Oregon		12-13 (13)	6-6 (6)	18-20 (19)	17-25 (23)	40-49
S. reedi	N. Calif.-SE Alaska	Apr[c]	13-15 (14)	7-8 (7)	18-20 (19)	30-36 (34)	47-55
S. ruberrimus	SSC-Gulf of Alaska	June[b], July[c]	14-16 (15)	7-7 (7)	18-19 (19)	26-30 (29/30)	39-45
S. rufus	SSC-Oregon	Dec-May[e]	13-16 (15)	8-9	17-19 (18)	32-37 (35)	49-56
S. saxicola	SSC-Gulf of Alaska	Feb[c], Nov-Mar[h]	11-13 (12)	6-7 (7)	16-18 (16)	30-35 (32)	35-43
S. variegatus	Brit. Col.-Gulf of Alaska	June[c]	14-15 (14)	6-7 (7)	17-19 (18)	37-41 (38)	43-52
S. wilsoni	S. Calif.-Gulf of Alaska	June[c]	13-15 (14)	5-6 (6)	16-18 (17)	37-42 (39)	37-46
S. zacentrus	S. Calif.-Gulf of Alaska	July[c]	13-15 (14)	7-8 (7)	16-18 (17)	33-37 (35)	39-47

[a] Incorrectly reported as 13 instead of 14 in Chen (1986:Table 2). L.-C. Chen, Dep. Zool., San Diego St. Univ., San Diego, CA 92192, pers. commun., 21 July 1988.
[b] Off Canada (Hart 1973).
[c] Off Canada (Westrheim 1975).
[d] Puget Sound (Washington et al. 1978).
[e] North-central California (Wyllie Echeverria 1987).
[f] Off California (Moser 1967).
[g] Puget Sound (Moulton 1975).
[h] Off north-central California (Phillips 1964).
[i] Off California (Wales 1952).
[j] Off California (Frey 1971).
[k] One rare count of 50.

Head spines

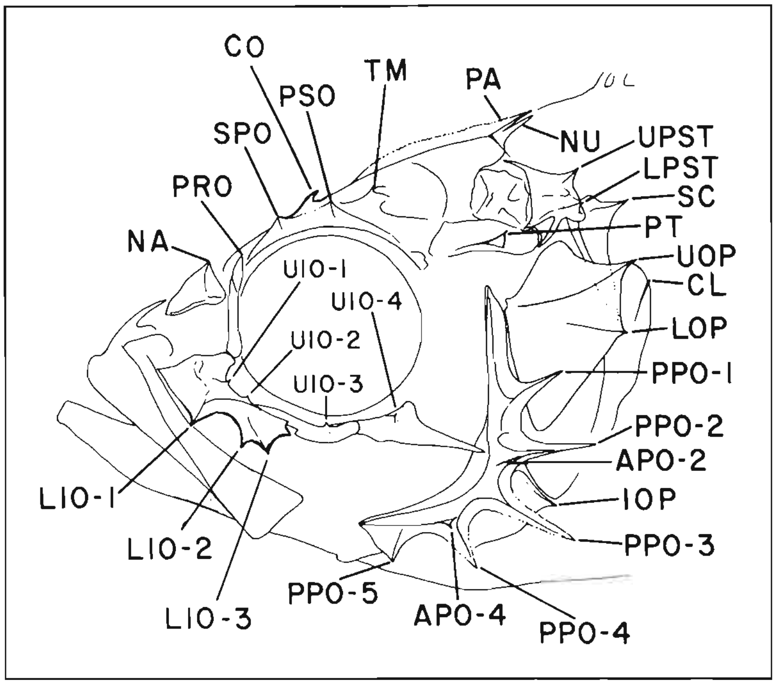
There are differences in terminology for *Sebastes* head spines between the two major sources of early-life-history descriptions (i.e., Richardson and Laroche 1979, Moser and Ahlstrom 1978). Most of the differences are semantic; however, the numbering of anterior preopercular spines is a substantive difference (Table 30). Among the species studied to date, posterior preopercular spine 1 has not had an anterior spine associated with it. Therefore, Richardson and Laroche (1979) gave the number 1 to the anterior preopercular spine associated with the second posterior preopercular spine. Moser and Ahlstrom (1978) gave the same numbers to the anterior and posterior preopercular spines. Thus the same anterior preopercular spine is numbered one less by Richardson and Laroche (1979) than it is by Moser and Ahlstrom (1978). Succeeding descriptions by these and other authors perpetuate these differences (e.g., Washington et al. 1984b). Here we use the system of Moser and Ahlstrom (1978).

There are also differences between the *Sebastes* head spine terminology used for adults and that used for larvae (Table 30). This situation resulted from the difficulty of determining spine/bone associations by external examination of adults and is complicated by the overgrowth of some spines during development (Richardson and Laroche 1979). The major points of confusion are that the supracleithral of larvae is called the upper posttemporal spine of adults, and the cleithral spine of larvae is called the supracleithral spine of adults. Head spine patterns which may help identify adult *Sebastes* are listed in Table 31.

Table 30

Head spine terminology in *Sebastes*, listed by sequence in which the spines develop in *S. melanostomus* (Moser and Ahlstrom 1978). Names used by Richardson and Laroche (1979) are listed only when they differ from those used by Moser and Ahlstrom (1978).

Abbreviation	Moser and Ahlstrom (1978)	Richardson and Laroche (1979)	Bone of origin	Adult spine
PA	Parietal		Parietal	Parietal
NU	Nuchal		Parietal	Nuchal
PSO	Postocular		Frontal	Postocular
PT	Pterotic		Pterotic	(Overgrown)
LPST	Lower posttemporal	Inferior posttemporal	Posttemporal	(Overgrown)
UOP	Upper opercular	Superior opercular	Opercle	Opercular
UIO-1	1st upper infraorbital	Superior infraorbital series, 1st	Infraorbital 1	(Overgrown)
LIO-1	1st lower infraorbital	Inferior infraorbital series, 1st	Infraorbital 1	Lachrymal projection (suborbital spine)
APO-2	2nd anterior preopercular	Anterior preopercular series, 1st	Preopercle	(Overgrown)
PPO-2	2nd posterior preopercular	Posterior preopercular series, 2nd	Preopercle	Preopercular
APO-3	3rd anterior preopercular	Anterior preopercular series, 2nd	Preopercle	(Overgrown)
PPO-3	3rd posterior preopercular	Posterior preopercular series, 3rd	Preopercle	Preopercular
APO-4	4th anterior preopercular	Anterior preopercular series, 3rd	Preopercle	(Overgrown)
PPO-4	4th posterior preopercular	Posterior preopercular series, 4th	Preopercle	Preopercular
PPO-1	1st posterior preopercular	Posterior preopercular series, 1st	Preopercle	Preopercular
PPO-5	5th posterior preopercular	Posterior preopercular series, 5th	Preopercle	Preopercular
UIO-4	4th upper infraorbital	Superior infraorbital series, 4th	Infraorbital 3	(Overgrown)
SC	Supracleithral		Supracleithrum	Cleithral
LIO-2	2nd lower infraorbital	Inferior infraorbital series, 2nd	Infraorbital 1	Lachrymal projection (suborbital spine)
LIO-3		Inferior infraorbital series, 3rd	Infraorbital 1	(Overgrown)
LOP	Lower opercular	Inferior opercular	Opercle	Opercular
UIO-2	2nd upper infraorbital	Superior infraorbital series, 2nd	Infraorbital 1	(Overgrown)
UPST	Upper posttemporal	Superior posttemporal	Posttemporal	Supracleithral
SPO	Supraocular		Frontal	Supraocular
UIO-3	3rd upper infraorbital	Superior infraorbital series, 3rd	Infraorbital 2	(Overgrown)
NA	Nasal		Nasal	Nasal
PRO	Preocular		Lateral ethmoid (prefrontal)	Preocular
CL	Cleithral		Cleithrum	(Overgrown)
IOP	Interopercular		Interopercular (interopercle)	Gill cover spine
TM	Tympanic		Frontal	Tympanic
SOP	Subopercular		Subopercular (subopercle)	Gill cover spine
CO	Coronal		Frontal	Coronal



Positions and abbreviations of larval head spines in larval *Sebastes*. Based on a 16.0-mm stained larva of *Sebastes melanostomus* augmented to show the position of the coronal (CO) and 3rd lower infraorbital (LI0-3) spines. From Moser and Ahlstrom (1978) and Laroche (in prep.).

Table 31

Presence and absence of head spines which are diagnostic for adults of members of the genus *Sebastes* (+ indicates presence, 0 indicates absence, blank indicates unknown character state).

	Pre-ocular	Supra-ocular	Post-ocular	Tympanic	Coronal		Pre-ocular	Supra-ocular	Post-ocular	Tympanic	Coronal
S. aleutianus	+	+	+	+	+	*S. maliger*	+	0	+	+	0
S. alutus	+	+	+	+	0	*S. melanops*	0	0	+	+	0
S. auriculatus	+	0	+	+	+	*S. melanostictus*			+	+	
S. aurora	+	+	+	+	0	*S. melanostomus*	+	+	+	+	0
S. babcocki	+	0	+	+	0	*S. miniatus*	+	+	+	+	0
S. borealis	+	+	+	+	+	*S. mystinus*	+	+	+	+	0
S. brevispinis	0	0	+	+	0	*S. nebulosus*	+	0	+	+	0
S. caurinus	+	0	+	+	0	*S. nigrocinctus*	+	0	+	+	+
S. chlorostictus	+	+	+	+	0	*S. paucispinis*	+	0	0	+	0
S. ciliatus	0	+	+	+	0	*S. pinniger*	+	+	+	+	0
S. crameri	+	+	+	+	0	*S. polyspinis*	0	0	+	+	0
S. diploproa	+	0	+	+	0	*S. proriger*	+	0	+	+	0
S. elongatus	+	0	+	+	0	*S. rastrelliger*	+	0	+	+	0
S. emphaeus	+	0	+	+	0	*S. reedi*	+	+	+	+	0
S. entomelas	+	+	+	+	0	*S. ruberrimus*	+	+	+	+	0
S. flavidus	0	0	+	+	0	*S. rufus*			+	+	0
S. glaucus			+	+	0	*S. saxicola*	+	0	+	+	0
S. goodei	0	0	+	0	0	*S. variegatus*	+	0	+	+	0
S. helvomaculatus	+	+	+	+	0	*S. wilsoni*	+	0	+	+	0
S. jordani	+	0	+	+	0	*S. zacentrus*	+	0	+	+	0

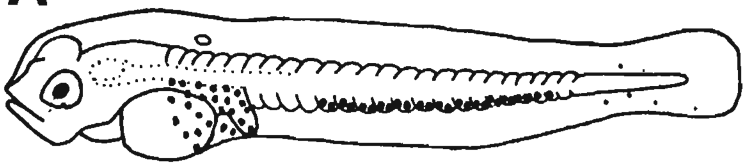
Extrusion or Yolk-Exhaustion Larvae

Various authors have illustrated and described larvae which have been extruded from pregnant female *Sebastes*. In some cases, the larvae have been maintained in seawater for several days after extrusion, and in a few cases (e.g., Stahl-Johnson 1985, Moser and Butler 1987) the larvae were fed and reared. With handling, pregnant *Sebastes* will release larvae that are not full-term, and such larvae may be represented in some illustrations. Furthermore, some illustrations were drawn by adding observed pigmentation for a particular species to a general outline of an extrusion *Sebastes* larva (c.f. Westrheim et al. 1968a). The generalized outline used by Westrheim et al. (e.g., 1968a) and DeLacy et al. (1964) lacked pectoral fins, apparently the result of an oversight. Several illustrations of extrusion larvae have been published for some species, and there are notable differences among some of these illustrations. One of the illustrations of an extrusion larva purported to be *Sebastes zacentrus* by Harling et al. (1971) was obviously misidentified, as discussed by Laroche and Richardson (1981). With these problems in mind, pages 273-280 present all of the published, and some previously unpublished, illustrations of extrusion larvae of *Sebastes* spp. which occur in the study area, not so much for use in species identifications but as reference for further research.

EXTRUSION OR YOLK-EXHAUSTION LARVAE

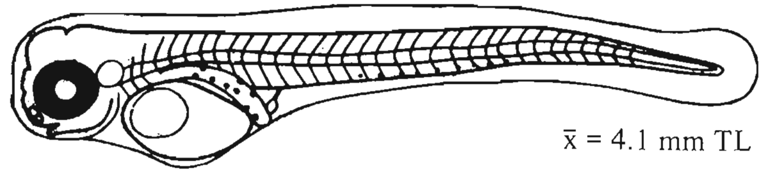
S. aleutianus

A



$\bar{x} = 5.3$ mm TL

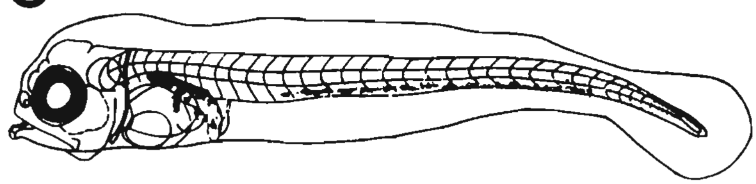
B



$\bar{x} = 4.1$ mm TL

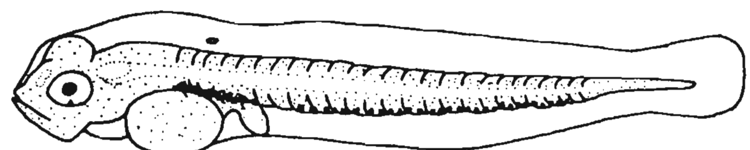
S. alutus

C



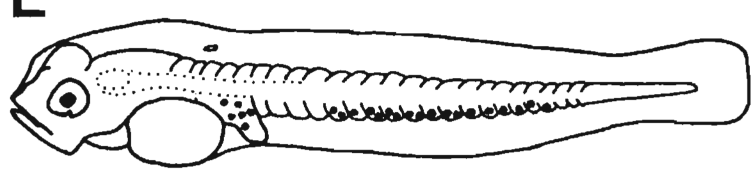
$\bar{x} = 6.1$ mm TL

D



~ 5.3 mm TL

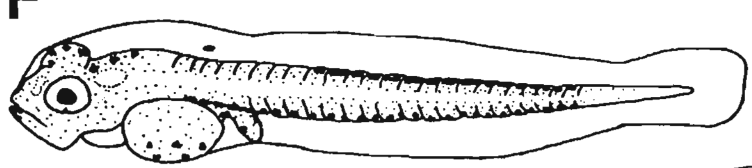
E



$\bar{x} = 6.1$ mm TL

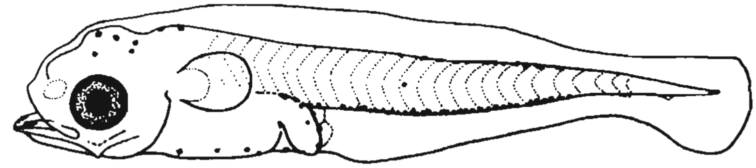
S. auriculatus

F



~ 5.8 mm TL

G



5.5 mm

Figures A, E, Westrheim et al. 1968a; B–C, Efremenko and Lisovenko 1970; D, F, DeLacy et al. 1964; G, Moser et al. 1977.

EXTRUSION OR YOLK-EXHAUSTION LARVAE

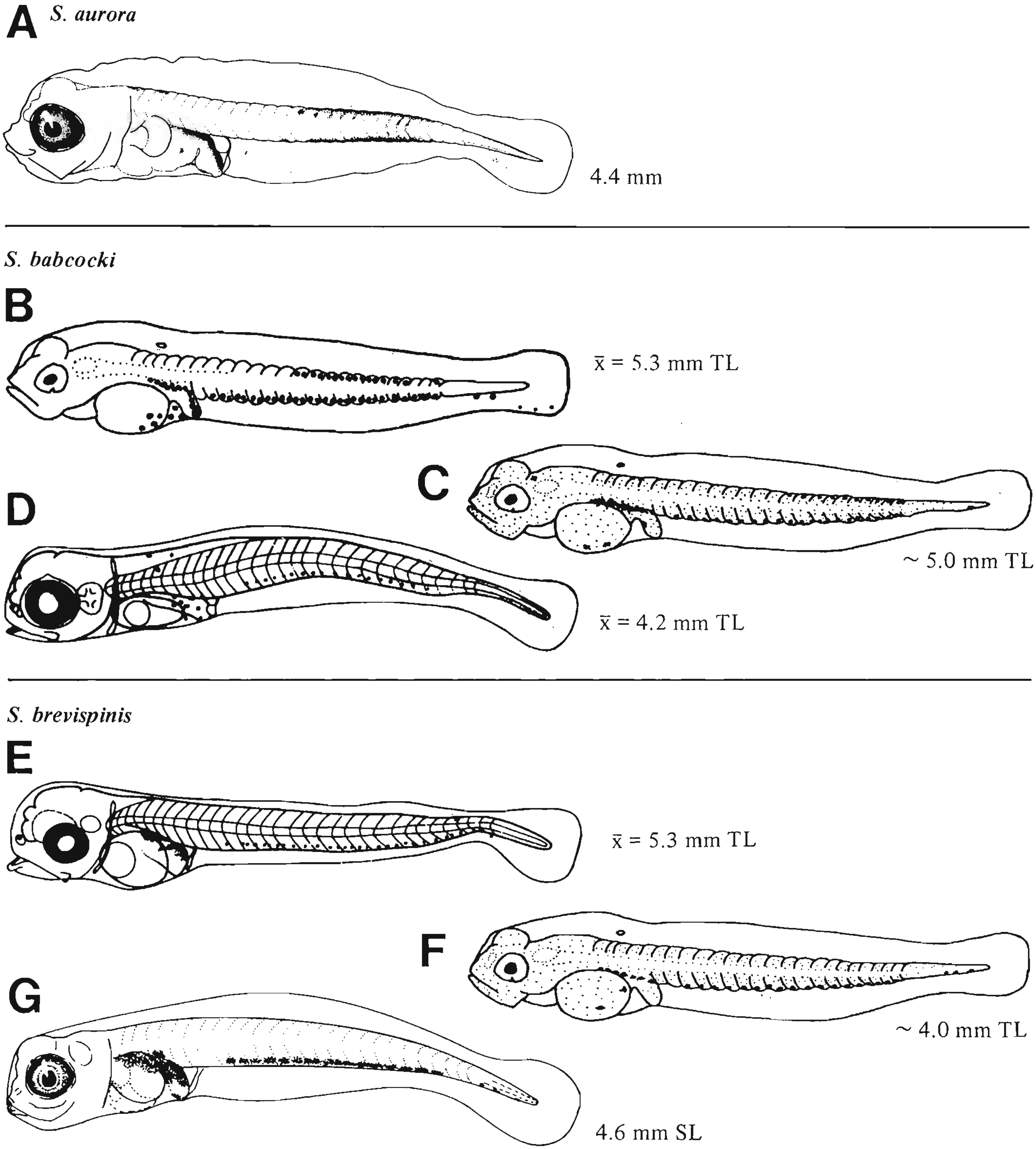
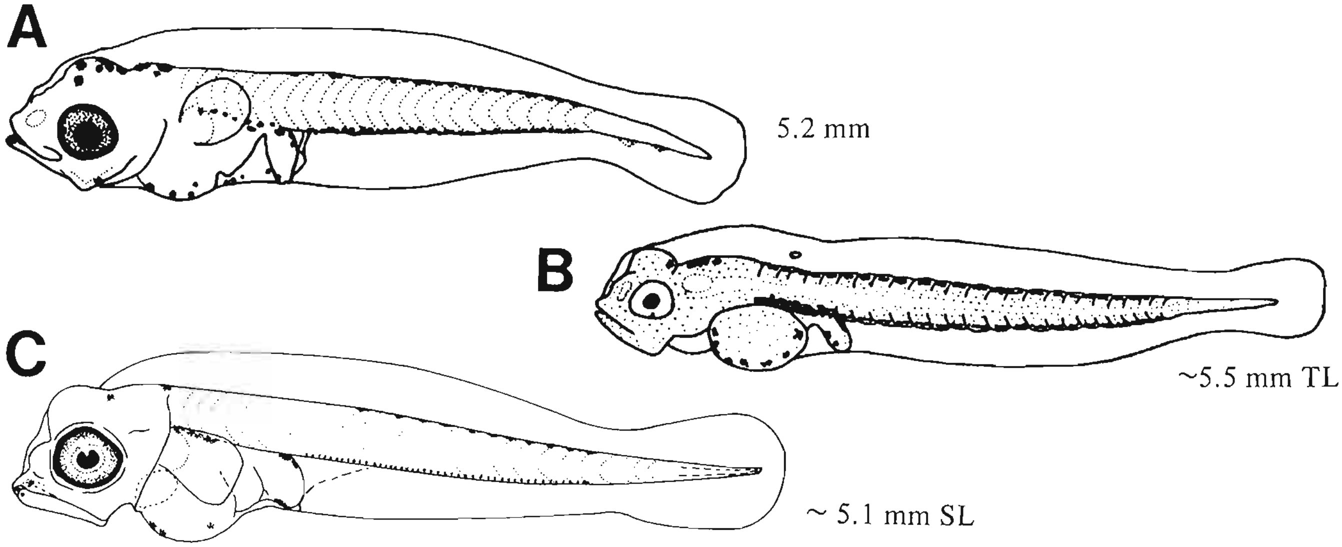


Figure A, Moser et al. 1985; B, Westrheim et al. 1968a; C, F, DeLacy et al. 1964; D, E, Efremenko and Lisovenko 1970; G, NWAFC original (B. Vinter).

EXTRUSION OR YOLK-EXHAUSTION LARVAE

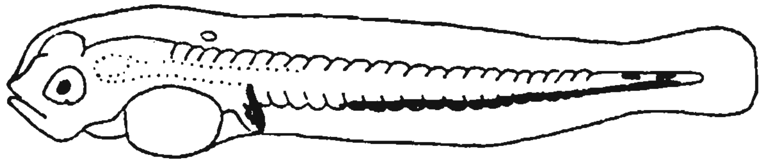
S. caurinus



D *S. chlorostictus*

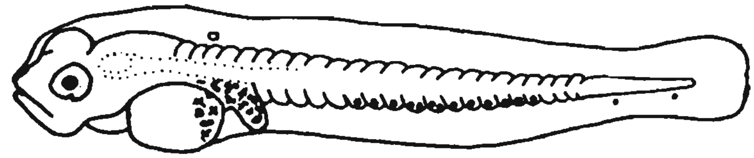
4.2 mm

E *S. ciliatus*



$\bar{x}$ = 5.8 mm TL

F *S. crameri*

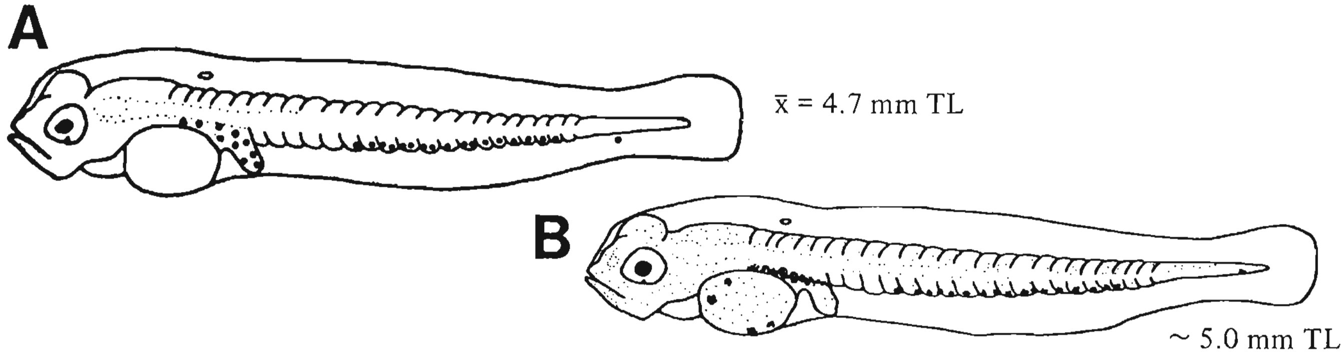


$\bar{x}$ = 5.9 mm TL

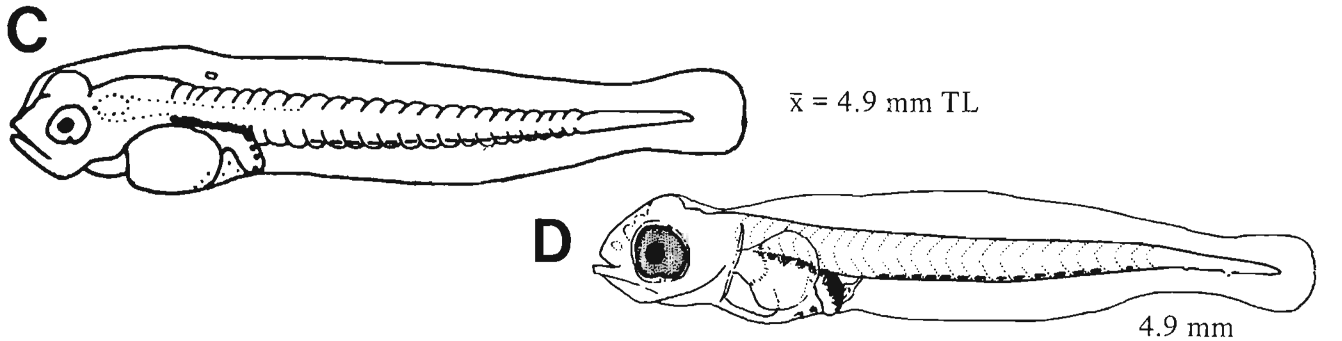
Figures A, D, Moser et al. 1977; B, DeLacy et al. 1964; C, NWAFC original (B. Vinter); E, Harling et al. 1971; F, Westrheim et al. 1968a.

EXTRUSION OR YOLK-EXHAUSTION LARVAE

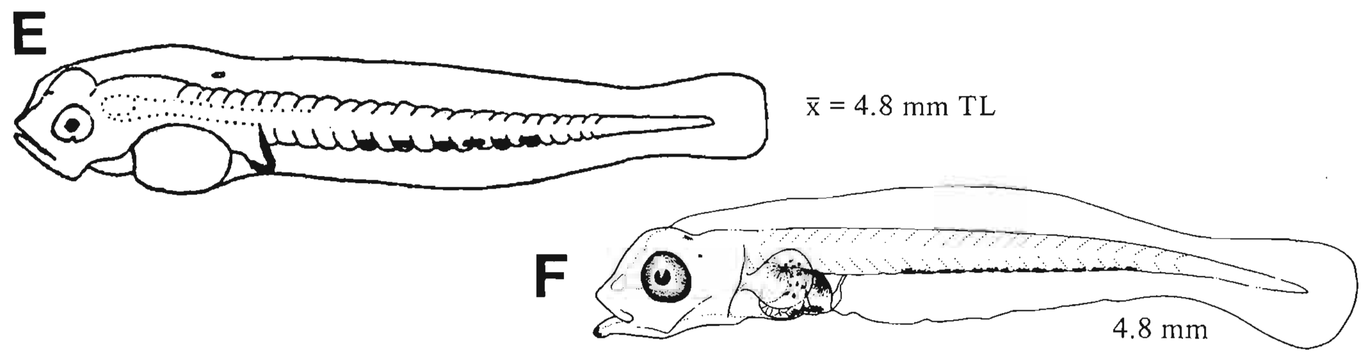
S. diploproa



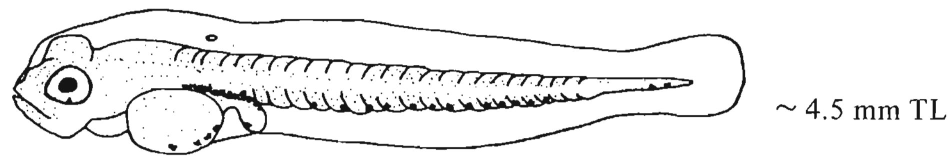
S. elongatus



S. entomelas



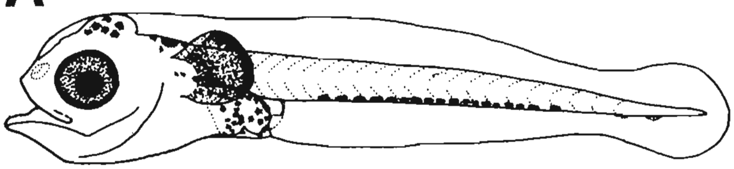
G *S. flavidus*



Figures A, C, Westrheim et al. 1968b; B, G, DeLacy et al. 1964; D, Moser et al. 1977; E, Harling et al. 1971; F, Moser and Butler 1987.

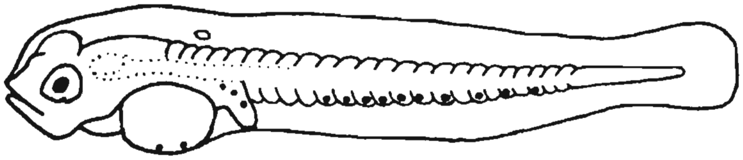
EXTRUSION OR YOLK-EXHAUSTION LARVAE

A *S. goodei*



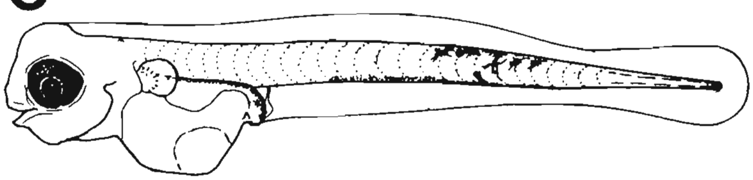
5.8 mm

B *S. helvomaculatus*



x̄ = 4.1 mm TL

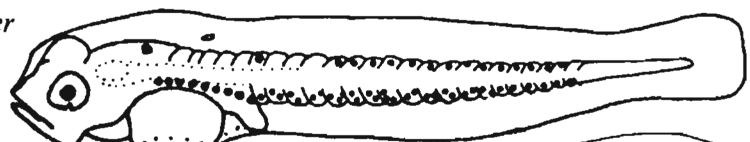
C *S. jordani*



4.6 mm SL

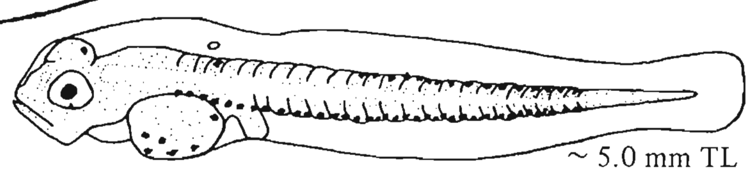
S. maliger

D



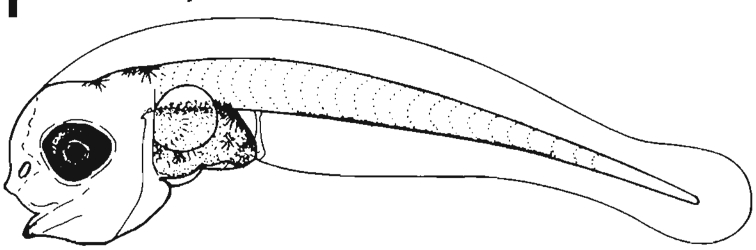
x̄ = 5.6 mm TL

E



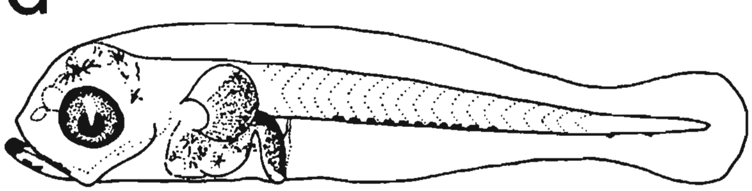
~ 5.0 mm TL

F *S. melanops*



4.0 mm SL

G *S. melanostomus*

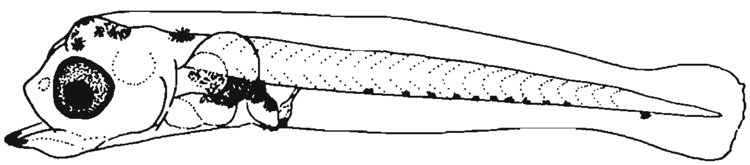


4.4 mm

Figures A, G, Moser et al. 1977; B, D, Westrheim et al. 1968b; C, F, NWAFC originals (B. Vinter); E, DeLacy et al. 1964.

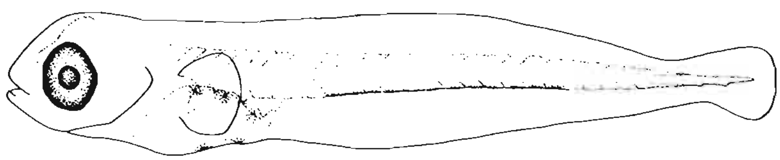
EXTRUSION OR YOLK-EXHAUSTION LARVAE

A *S. miniatus*



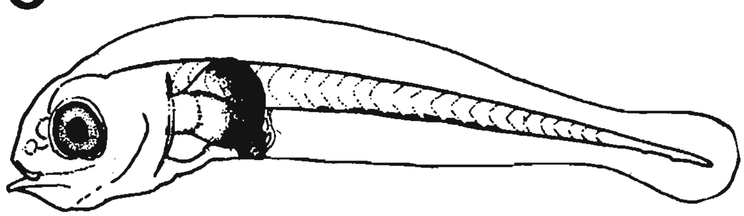
4.3 mm

B *S. mystinus*



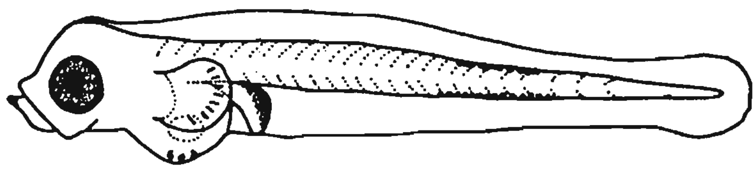
3.8 mm NL

C *S. paucispinis*



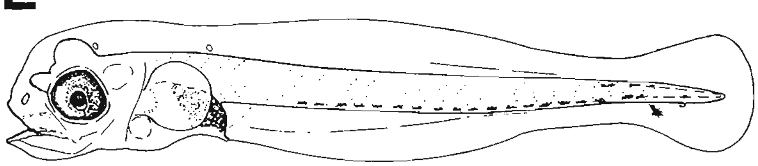
6.1 mm

D *S. pinniger*



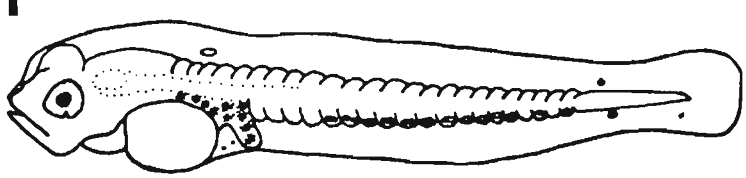
4.0 mm

E *S. polyspinis*



6.1 mm SL

F *S. proriger*

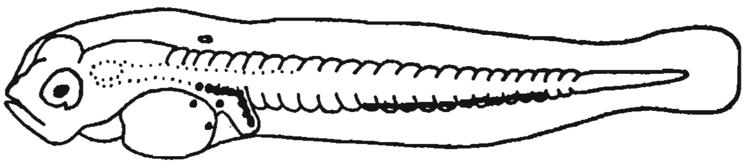


$\bar{x}$ = 5.4 mm TL

Figures A, C–D, Moser et al. 1977; B, Wold, unpubl.; E, NWAFC original (B. Vinter); F, Westrheim et al. 1968b.

EXTRUSION OR YOLK-EXHAUSTION LARVAE

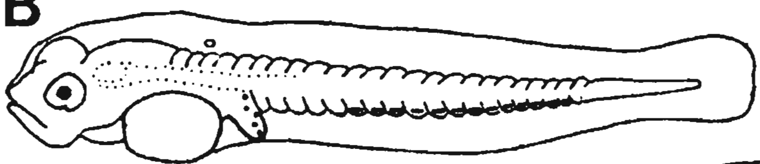
A *S. reedi*



$\bar{x}$ = 6.0 mm TL

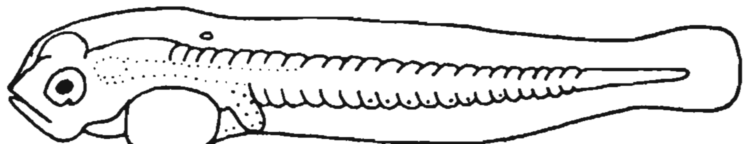
S. ruberrimus

B



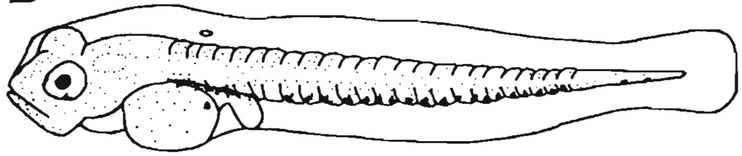
$\bar{x}$ = 4.4 mm TL

C



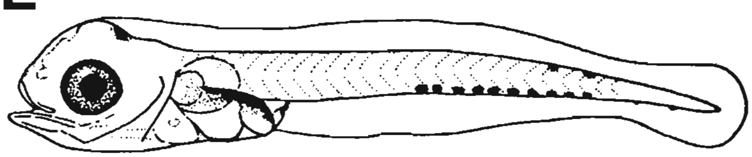
$\bar{x}$ = 4.2 mm TL

D



~ 5.0 mm TL

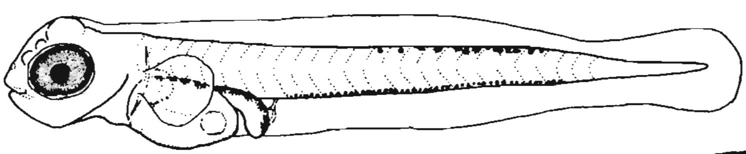
E *S. rufus*



5.3 mm

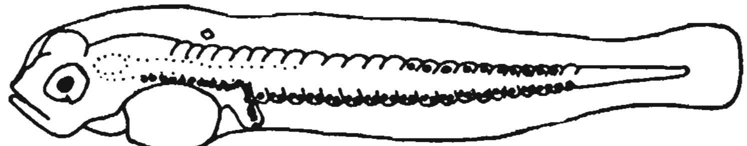
S. saxicola

F



4.7 mm

G

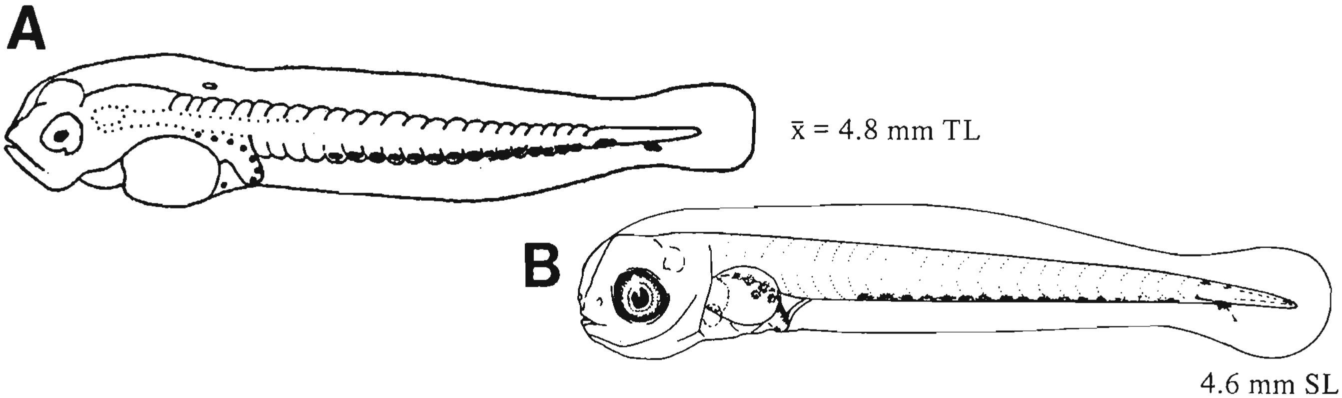


$\bar{x}$ = 5.2 mm TL

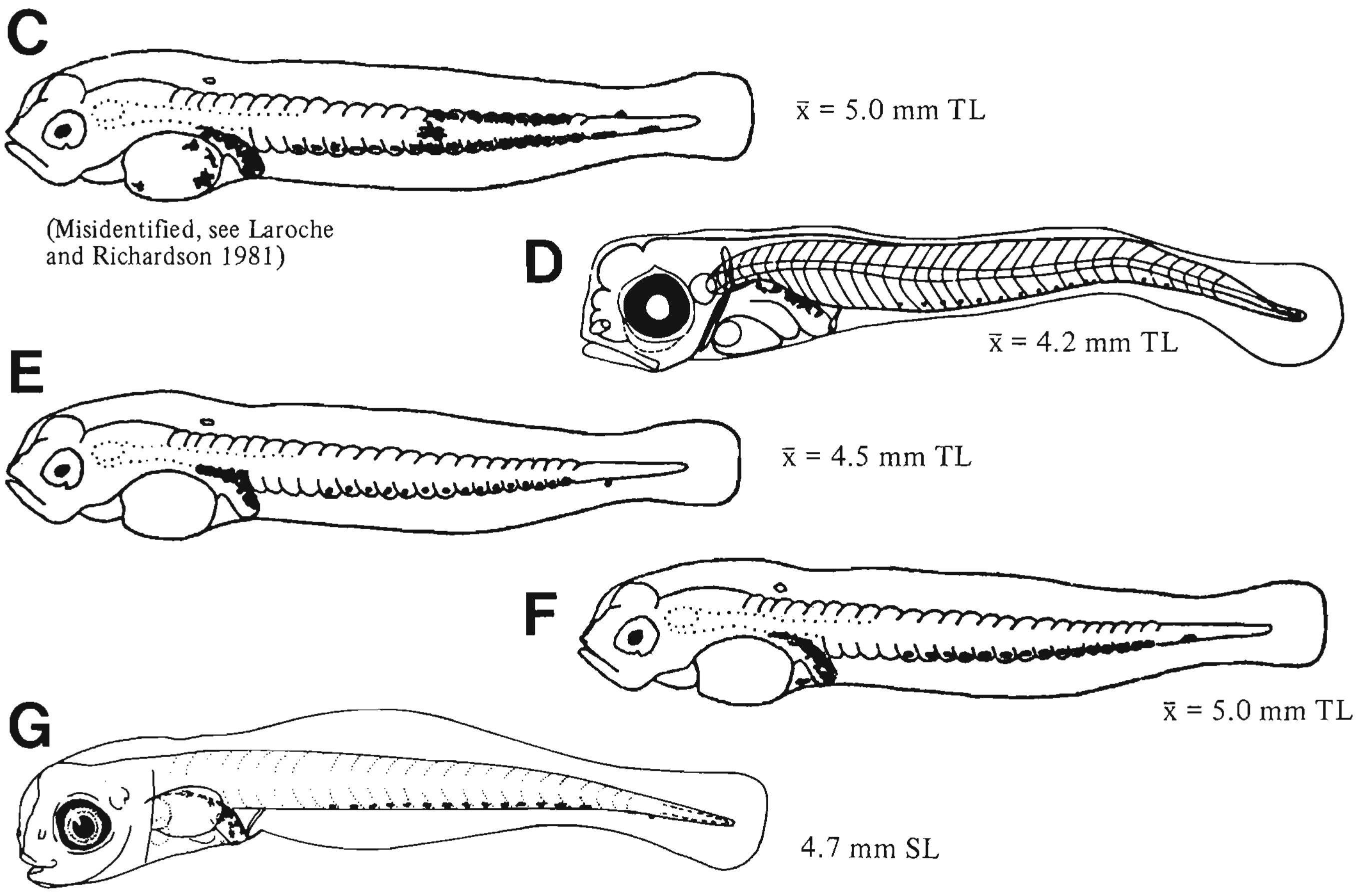
Figures A, G, Westrheim et al. 1968a; B, Harling et al. 1971; C, Westrheim et al. 1968b; D, DeLacy et al. 1964; E–F, Moser et al. 1977.

EXTRUSION OR YOLK-EXHAUSTION LARVAE

S. variegatus



S. zacentrus



Figures A, C, F, Harling et al. 1971; B, G, NWAFC originals (B. Vinter); D, Efremenko and Lisovenko 1970; E, Westrheim et al. 1968b.

Sebastes **Pelagic Juveniles**

The following six pages present illustrations of pelagic juveniles of 33 of the 40 species of *Sebastes* occurring in the study area. Pelagic juveniles of the remaining species are unknown or have not yet been illustrated. Illustrations are grouped to form a pictorial key based primarily on pigment characters of the juveniles as derived from Laroche (in prep.). Species are grouped on the pages according to predominant pigment characters; within these groups, species are separated according to other pigment characters. Several species possess identical states for these characters. Identification of these will require use of additional characters such as meristics, body shape, head spination, time and location of collection, and other pigment characters. These characters should also be checked on fish separated based on the pictorial key to verify their identity. Variation in pigment can be expected due to size and other differences in specimens of a species. Also, pigment characters of species for which pelagic juveniles are unknown may closely resemble those species illustrated here, which would lead to misidentification unless other characters were examined.

PELAGIC JUVENILES
Black pigment blotch at posterior of spinous dorsal fin

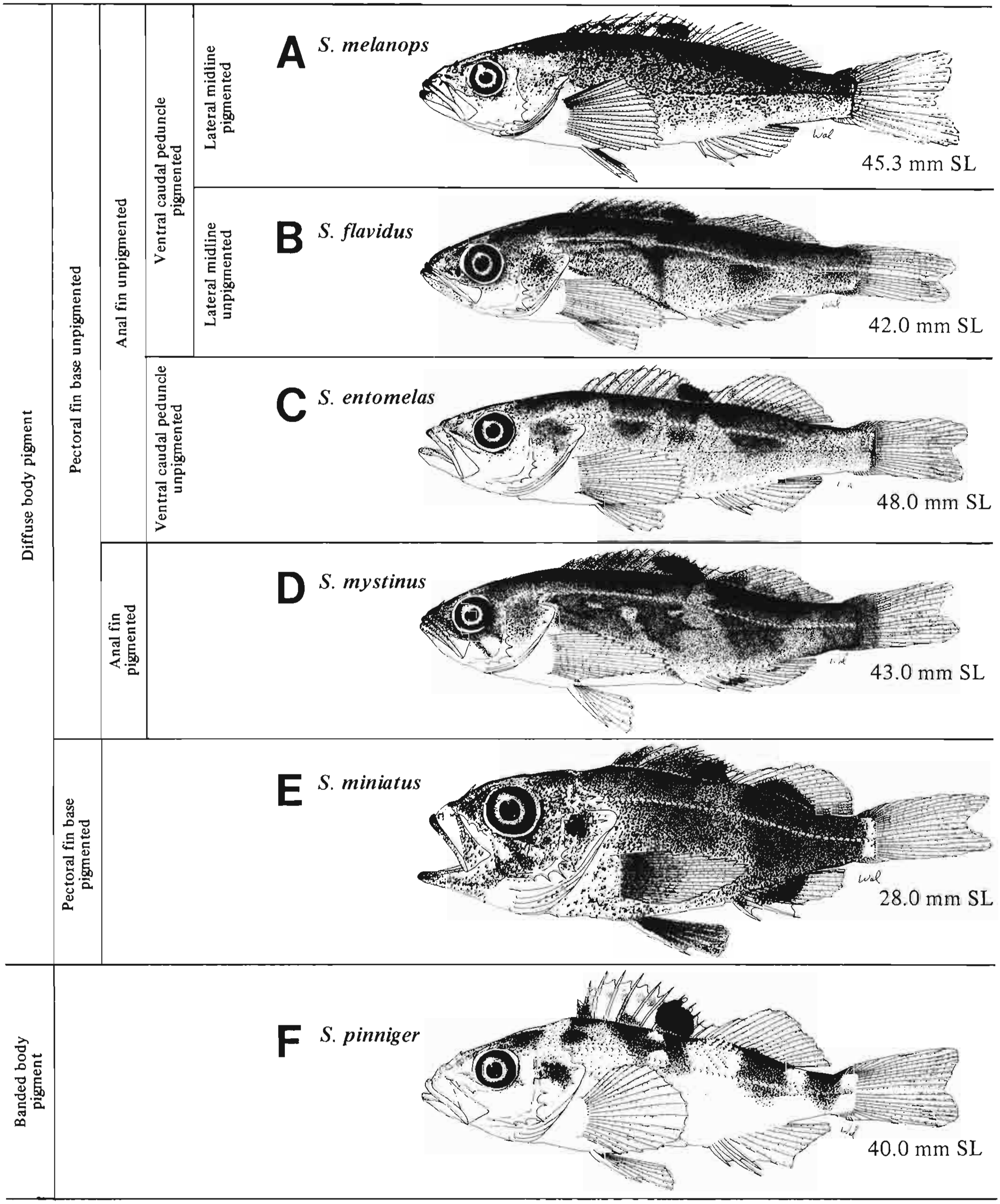


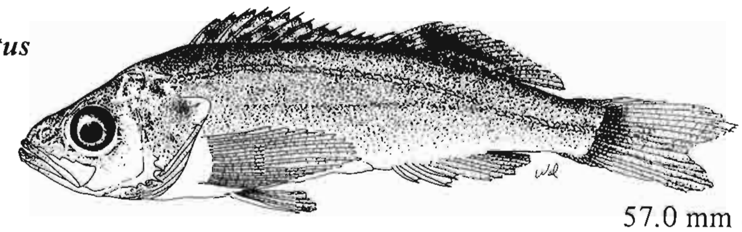
Figure A, Laroche and Richardson 1980; B–F, Laroche, in prep.

PELAGIC JUVENILES
Fringe of pigment on spinous dorsal fin
Body pigment diffuse

Anal fin without distinct stripe of pigment

No fringe of pigment on pectoral and pelvic fins

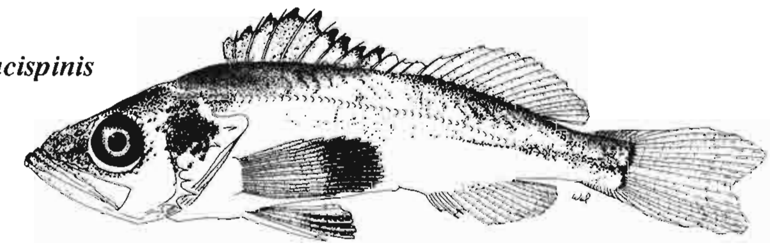
A *S. alutus*



57.0 mm SL

Fringe of pigment on pectoral and pelvic fins

B *S. paucispinis*

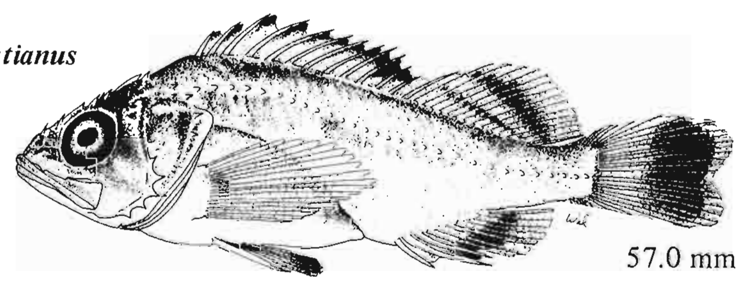


46.0 mm SL

Both soft dorsal and anal fins have distinct stripe of pigment

Caudal fin with distinct band of pigment

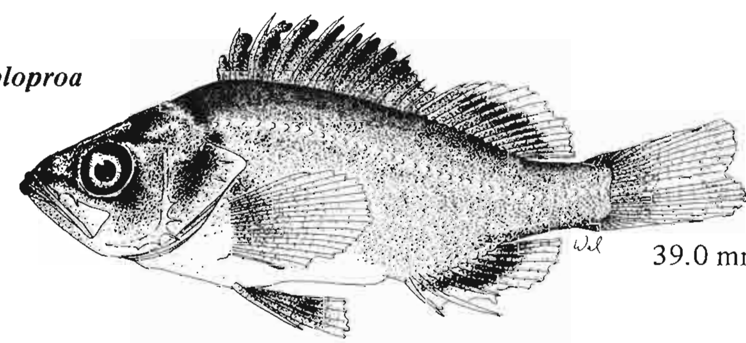
C *S. aleutianus*



57.0 mm SL

Caudal fin without distinct band of pigment

D *S. diploproa*

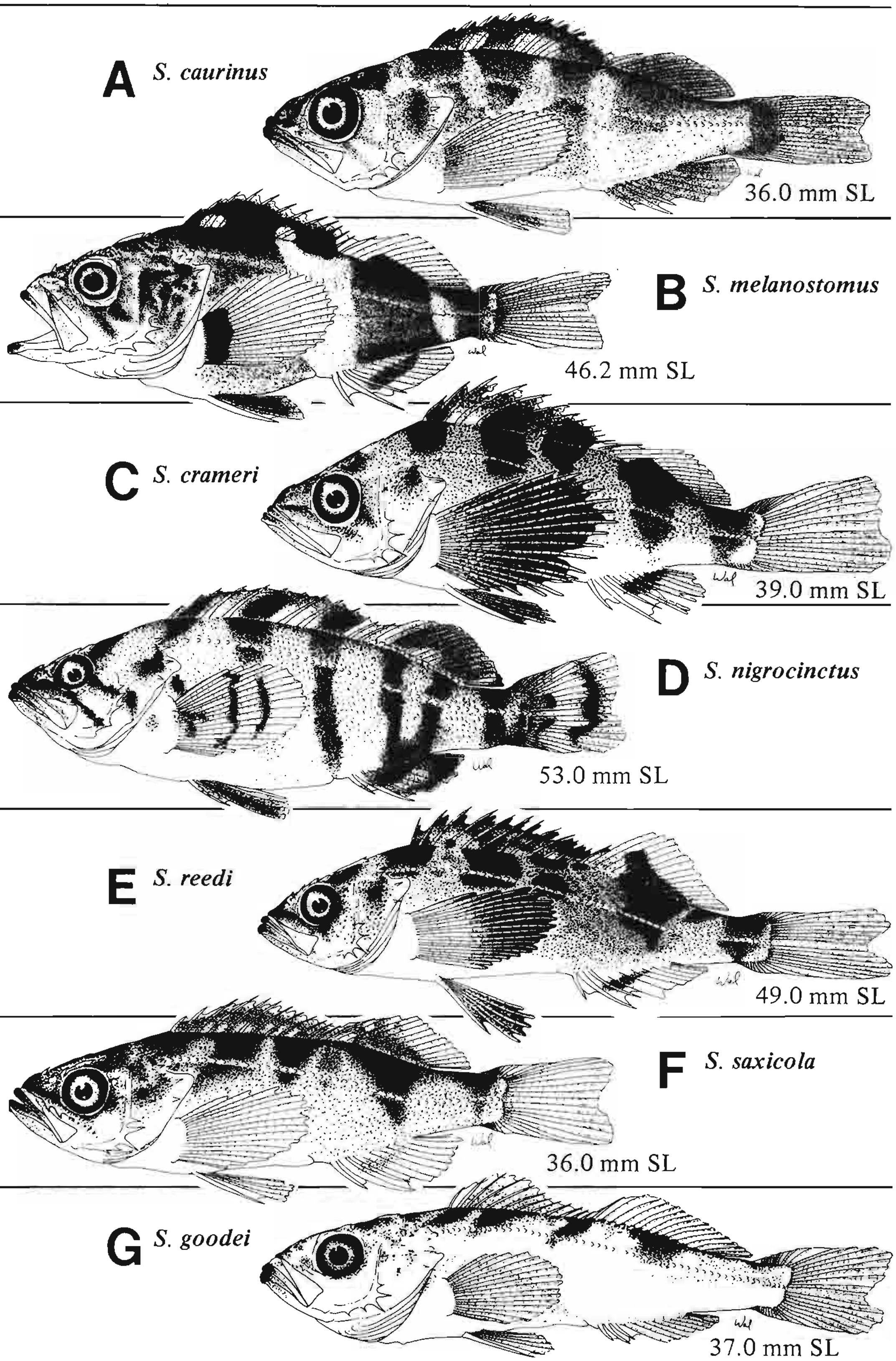


39.0 mm SL

Figures A–D, Laroche, in prep.

PELAGIC JUVENILES
Body with three or more distinct bands of pigment

				Figure
Saddles or bands extend onto spinous and/or soft dorsal fins	Bands extend onto both spinous and soft dorsal fins	Pectoral fin pigmented proximally	Anal fin pigment uniform	A *S. caurinus*
			Distinct stripe on anal fin	B *S. melanostomus*
		Pectoral fin totally pigmented	Pectoral uniformly pigmented	C *S. crameri*
			Two or more bands of pectoral pigment	D *S. nigrocinctus*
	Bands extend onto soft dorsal fin only	Fringe of pigment on pectoral		E *S. reedi*
Saddles or bands do not extend onto dorsal or anal fins				F *S. saxicola*
	Bands slant anteroventrally			G *S. goodei*



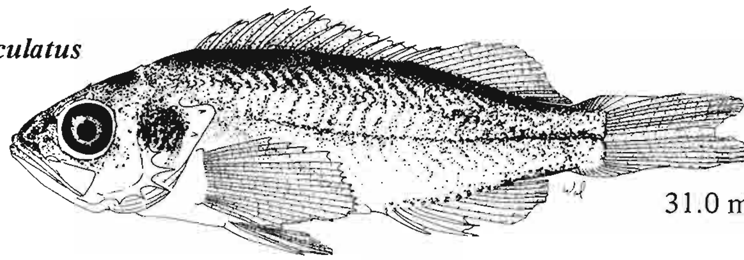
Figures A–G, Laroche, in prep.

PELAGIC JUVENILES
Diffuse body and dorsal fin pigment
Ventral caudal peduncle pigmented

No distinct pigment along proximal margin of caudal fin

Body pigment aligned along myosepta

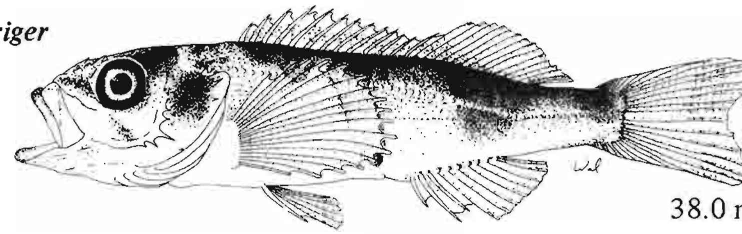
A *S. auriculatus*



31.0 mm SL

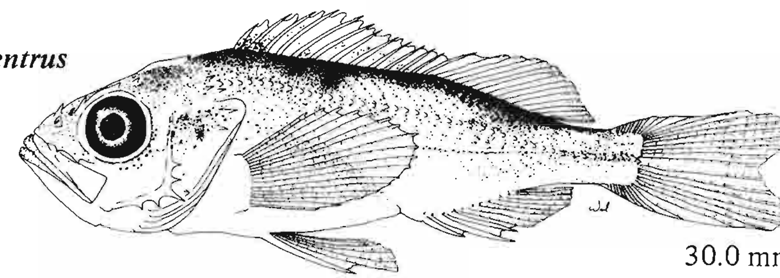
Body pigment not aligned along myosepta

B *S. proriger*



38.0 mm SL

C *S. zacentrus*

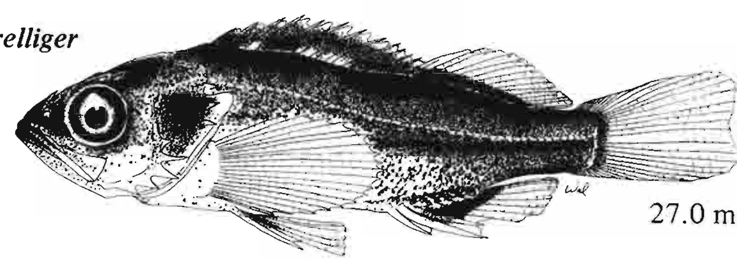


30.0 mm SL

Distinct pigment along proximal margin of caudal fin

Distinct stripe of pigment along proximal margin of soft dorsal and anal fins

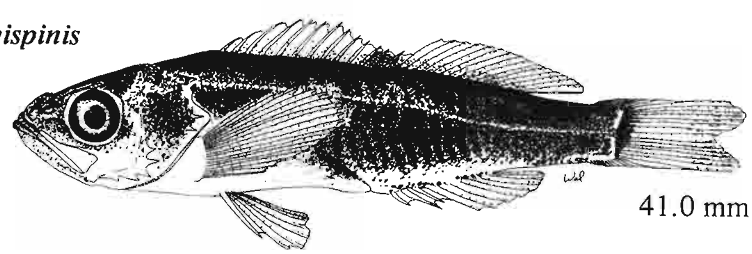
D *S. rastrelliger*



27.0 mm SL

No distinct stripe of pigment along proximal margin of soft dorsal and anal fins

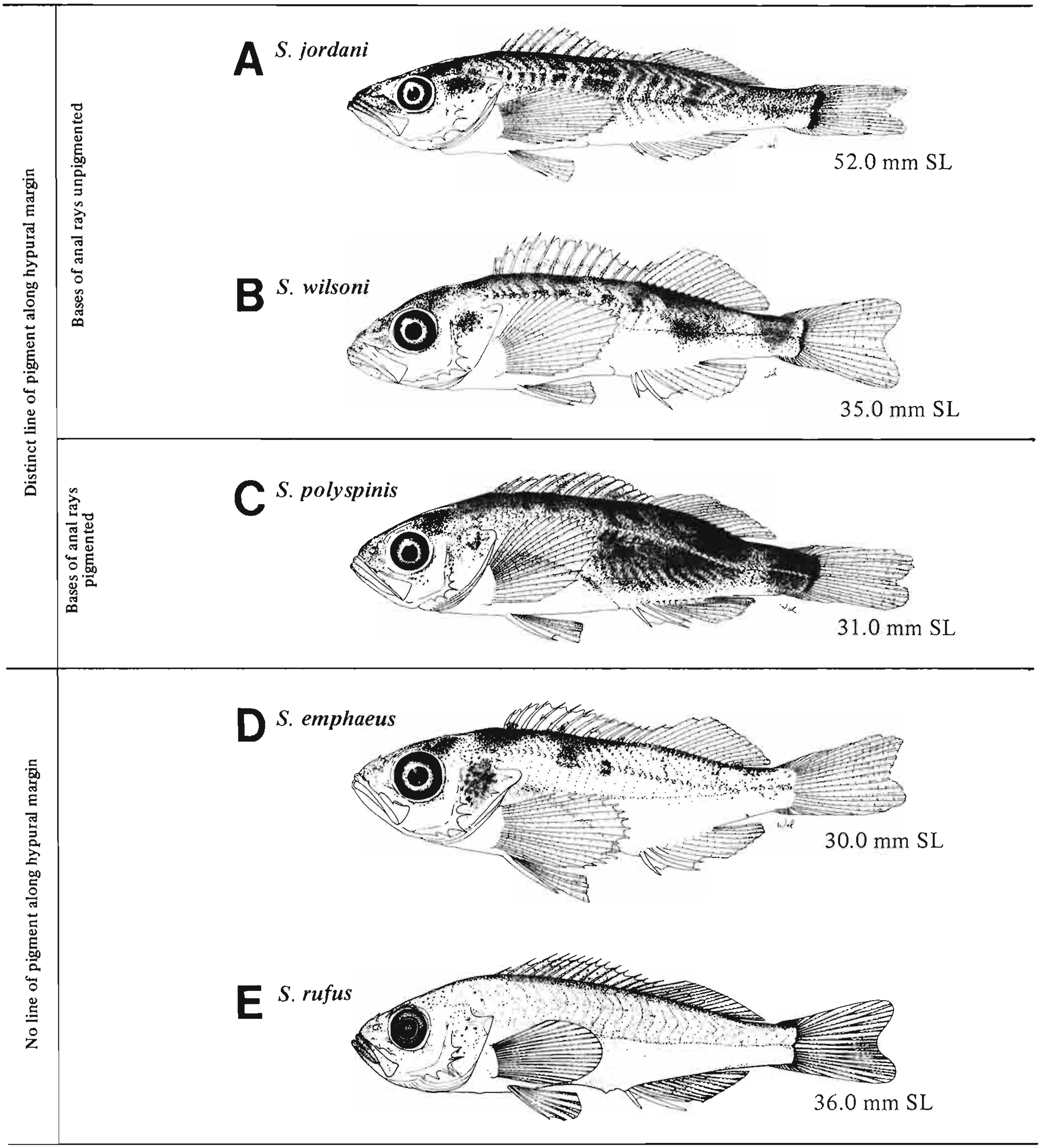
E *S. brevispinis*



41.0 mm SL

Figures A–E, Laroche, in prep.

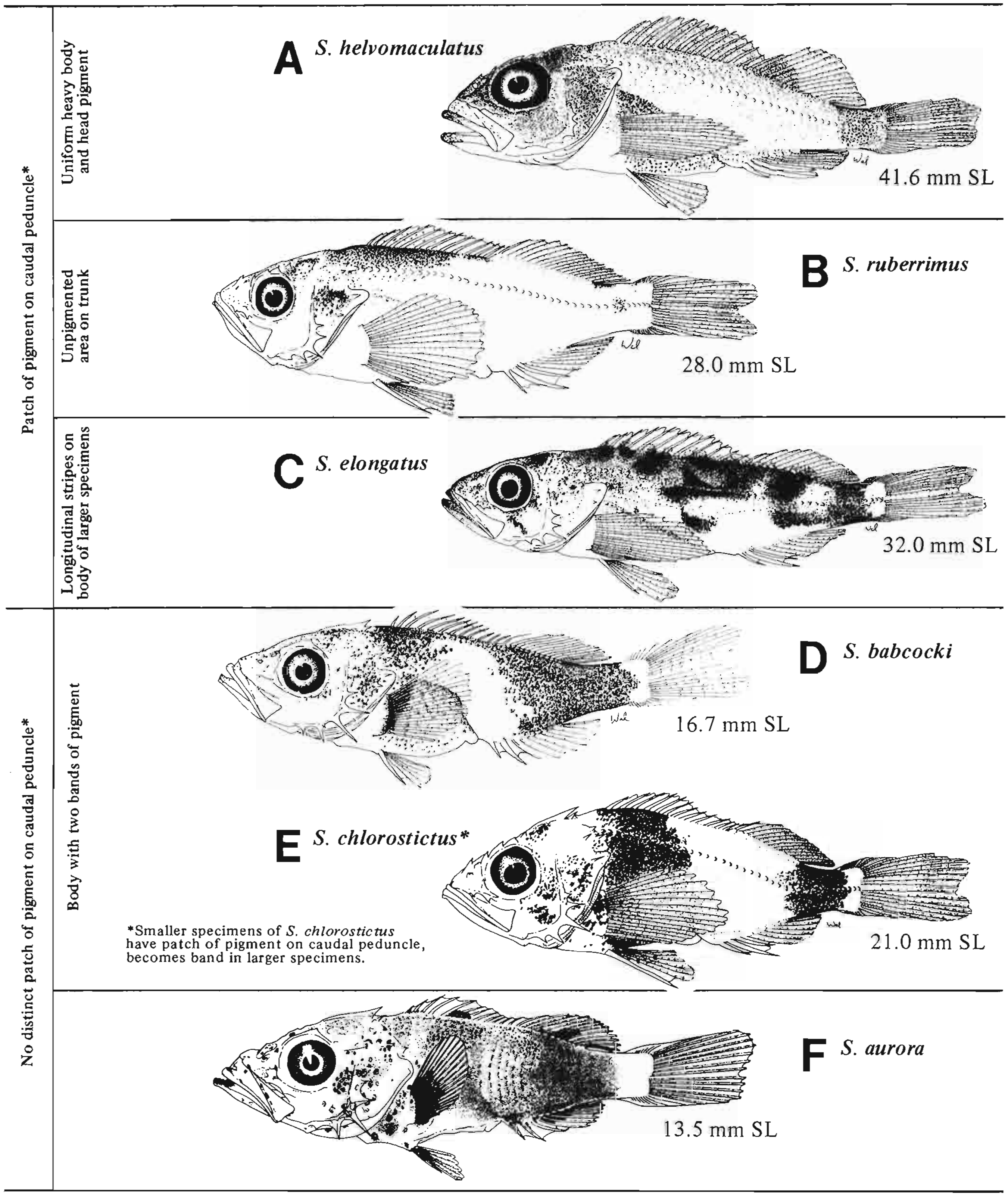
PELAGIC JUVENILES
Diffuse body and dorsal fin pigment
Ventral caudal peduncle unpigmented



Figures A–D, Laroche, in prep.; E, NWAFC original (B. Vinter).

PELAGIC JUVENILES

Body with fewer than three pigment bands, with stripes of pigment, or with a patch of pigment on the caudal peduncle



Figures A–E, Laroche, in prep.; F, Moser et al. 1985.

MERISTICS

Vertebrae	Total: 27-27-27	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	7-7-7	
Caudal fin	X, 8+7, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 13-13-14	R: 13-14-15
Pectoral fin	R: 17-18-19	
Anal fin	S: 3-3-3	R: 7-7-8
Gill rakers	U: 8-9-11	L: 20-22-24
	(T: 28-31-33)	
Lateral line pores	30-33	

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Meso- and bathybenthal, 183-732 m
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: Apr[a]
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

HEAD SPINES

Preocular	+
Postocular	+
Coronal	+
Supraocular	+
Tympanic	+
Inferior infraorbital	2

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size 4.1-5.3 mm TL
Preanal length
Length at flexion
Length at transformation
Sequence of fin development
Pigment
- Extrusion larvae: Series along ventral body
- Postflexion larvae >19.3 mm SL: Pigment covering entire body except on lower cheek, pectoral fin base, and tail tip

Diagnostic characters

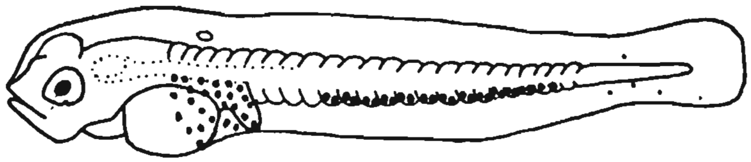
PELAGIC JUVENILES

- Body pigment light, diffuse
- Banded pigment on median fins

[a]Hart 1973

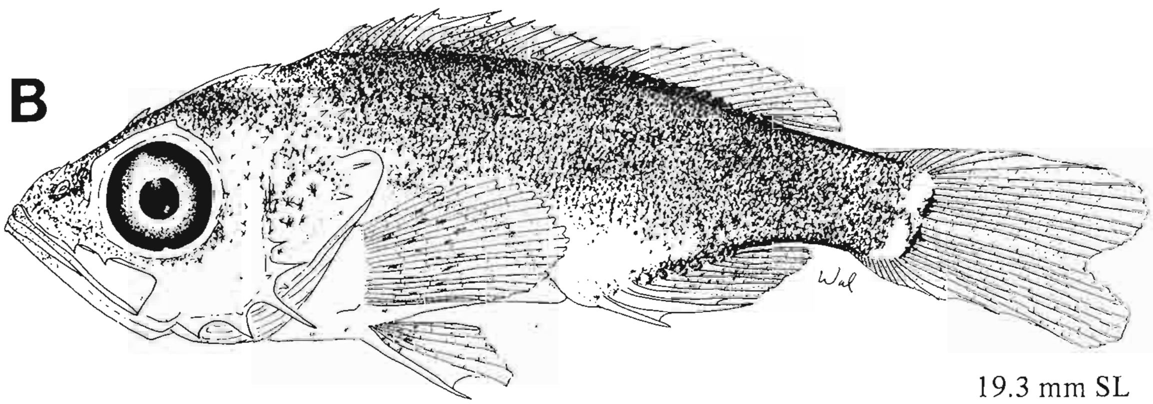
Ref: Laroche, in prep.

A



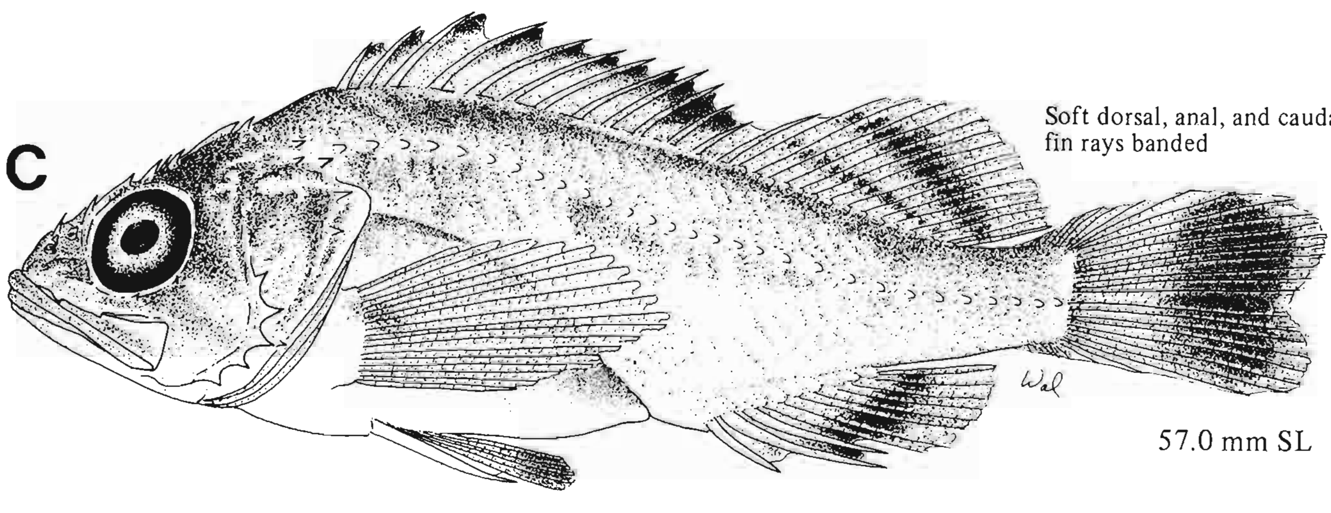
$\bar{x}$ = 5.3 mm TL

B



19.3 mm SL

C



Soft dorsal, anal, and caudal fin rays banded

57.0 mm SL

Figure A, Westrheim et al. 1968a; B–C, Laroche, in prep.

MERISTICS

Vertebrae	Total: 26-26-27	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	7-7-7	
Caudal fin	9-11, 8+7, 9-11	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 13-13-13	R: 12-13-14
Pectoral fin	R: 16-18-19	
Anal fin	S: 3-3-3	R: 6-7-7
Gill rakers	U: 8-8-10	L: 18-20-21
	(T: 25-27-29)	
Lateral line pores	42-50	

LIFE HISTORY

Range	South of southern California to SE Alaska, 55-59°N
Ecology	Nearshore shelf demersal
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: Mar-June[a]
	Area:
	Mode:
	Migration:
Fecundity	Range/function: 52,000-339,000[b]
Age at first maturity	5 yr (females)[c]
Longevity	

HEAD SPINES

Preocular	+
Postocular	+
Coronal	+
Supraocular	0
Tympanic	+
Inferior infraorbital	2

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size	4.7-6.7 mm SL
Preanal length	<50% SL
Length at flexion	Between 7.4 and 9.0 mm SL
Length at transformation	
Sequence of fin development	Caudal and pectorals, pelvics, dorsal and anal

Pigment[d]

- Mostly on dorsal head, with development covering entire head
- Nape
- Gut: Dorsal and ventrolateral surface, increasing laterally with development
- Dorsal and ventral midline melanophores begin posterior to anus; with development, dorsal melanophores extend to nape
- Increase in lateral pigment on posterior half of body and to hypural region
- Pectoral fins

Diagnostic characters

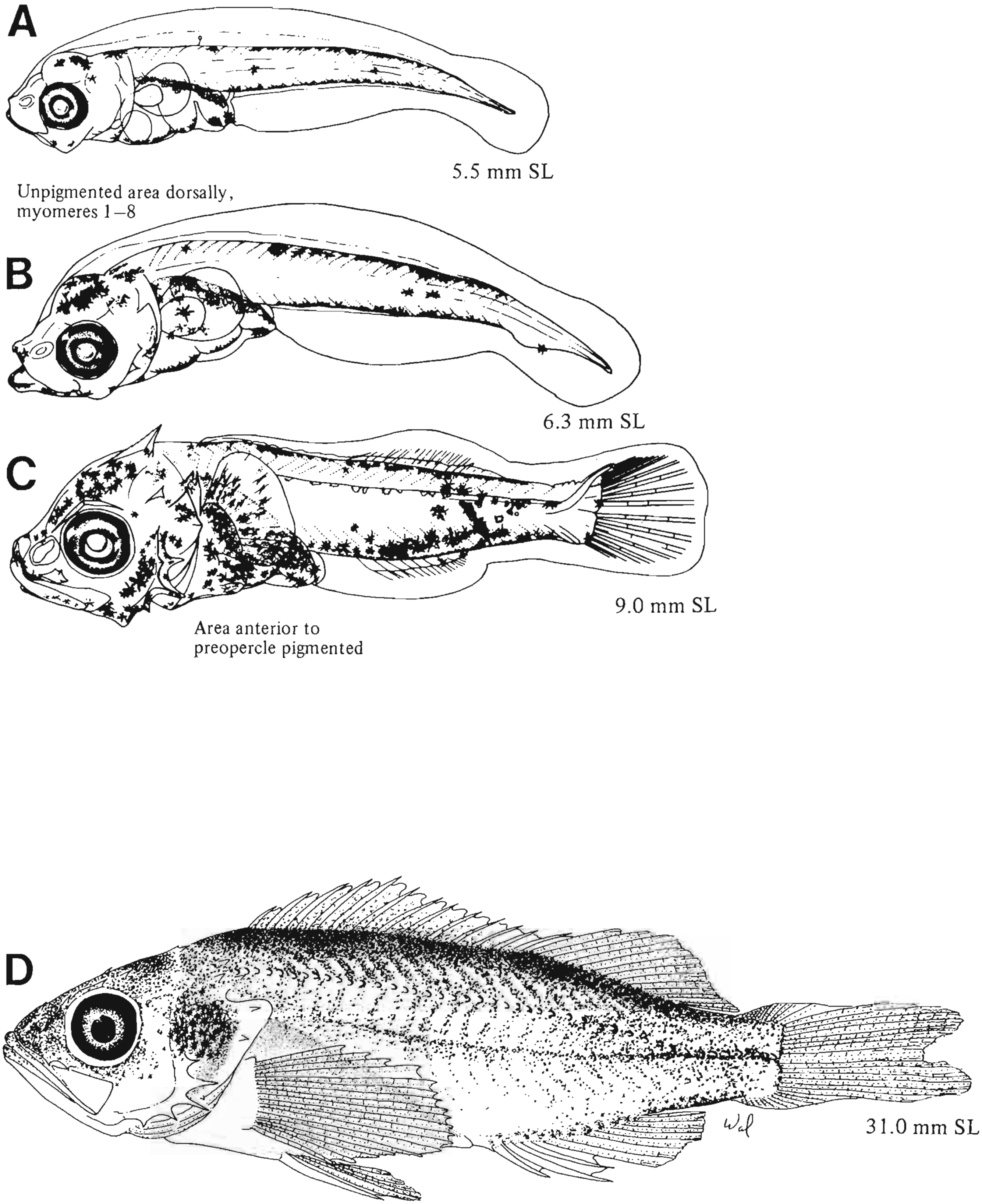
Distinguished from *S. caurinus* (p. 296) by
- Dorsal midline melanophores postanally at birth, gradually spread forward to nape
- More pigment on opercular than in *S. caurinus*

PELAGIC JUVENILES

- Diffuse body pigment
- Opercular pigment blotch present
- Lateral midline pigmented

[a] Washington et al. 1978
[b] Hart 1973
[c] Wyllie Echeverria 1987
[d] Description of pigment and illustrations based on laboratory-reared specimens which may be more melanistic than wild-caught specimens.

Ref: Laroche, in prep.; Stahl-Johnson (1985), who noted a mistake in Moser et al. (1977); yolk-depleted *S. auriculatus* figure reversed with *S. caurinus*.



Figures A–C, Stahl-Johnson 1985 (reared); D, Laroche, in prep.

MERISTICS

Vertebrae	Total: 26-26-26	
	Precaudal: 10-10-10	
	Caudal: 16-16-16	
Branchiostegal rays	7-7-7	
Caudal fin	10, 8+7, 9-10	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 13-13-13	R: 12-13-13
Pectoral fin	R: 17-17-19	
Anal fin	S: 3-3-3	R: 5-6-7
Gill rakers	U: 7-8-8	L: 18-19-20
	(T: 24-27-28)	
Lateral line pores	28-31	

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Epi-, meso-, and bathybenthal, 125-768 m
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: Mar-May (north-central California)[a]
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

HEAD SPINES

Preocular[b]	+
Postocular	+
Coronal	0
Supraocular	+
Tympanic	+
Inferior infraorbital	2

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size	4.4 mm SL
Preanal length	∼44% increasing with development to 64% SL
Length at flexion	6.5-8.6 mm SL
Length at transformation	13 mm SL
Sequence of fin development	Caudal; pectorals; pelvics, dorsal, and anal

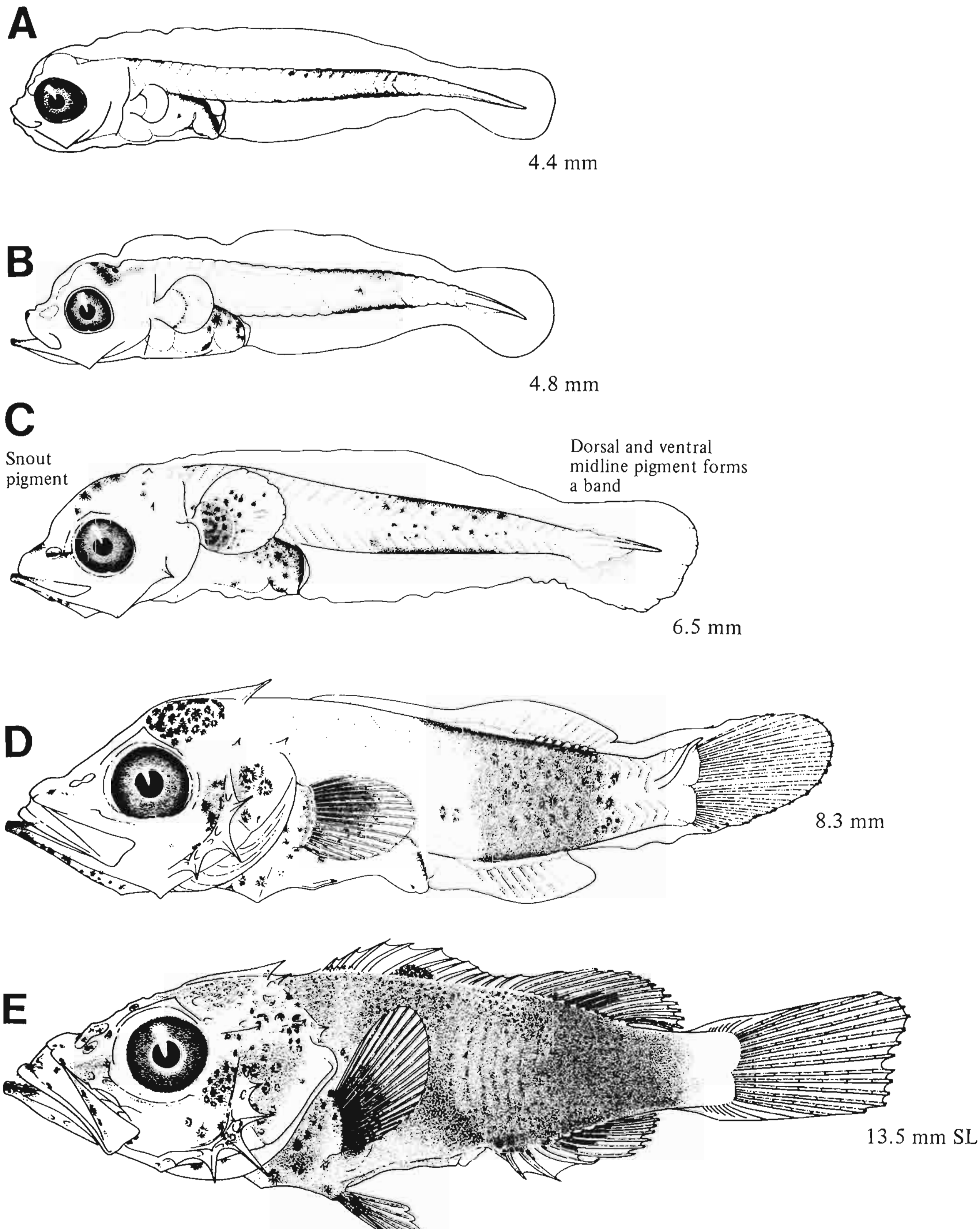
Pigment
- Head: Dorsal spots spreading with development to opercle then to entire head
- Snout and jaws pigmented
- Gut: Posterior pigment increasing dorsolaterally with development
- Postanal body: Dorsal and ventral midline over body (between postanal myomeres 4 and 15); lateral pigment increases with development to form a band
- Pectoral fin first, other fins with development

Diagnostic characters
- Morphology: Snout-to-anus length greater than in other species studied
- Pigment: Snout, postanal band

PELAGIC JUVENILES[c]
- Low total gill raker count (24-28) and lateral line pore count (28-31) are diagnostic for the species
- Body pigment faintly banded with unpigmented caudal peduncle
- Pectoral rays heavily pigmented medially

[a] Wyllie Echeverria 1987
[b] According to Moser et al. (1985), the preocular spine develops by 10.5 mm SL but is not visible on their 13.5-mm SL specimen shown here.
[c] Largest pelagic juvenile collected is 34.4 mm SL.

Ref: Moser et al. 1985.



Figures A–E, Moser et al. 1985.

MERISTICS

Vertebrae	Total: 26-26-26
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	7-7-7
Caudal fin	X, 8+7, X
Pelvic fin	Thoracic
	S: 1-1-1 R: 5-5-5
Dorsal fin	S: 13-13-13 R: 13-14-15
Pectoral fin	R: 17-19-20
Anal fin	S: 3-3-3 R: 6-7-8
Gill rakers	U: X-X-X L: X-X-X
	(T: 29-31-33)
Lateral line pores	42-51

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Epi- and mesobenthal, 91-475 mm
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: Apr-May[a]
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	4 yr (females)[b]
Longevity	

HEAD SPINES

Preocular	+
Postocular	+
Coronal	0
Supraocular	0
Tympanic	+
Inferior infraorbital	2

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size 4.2-5.3 mm
Preanal length
Length at flexion
Length at transformation
Sequence of fin development
Pigment
- Extrusion larvae
  —Series along ventral body
  —Shorter series along posterior dorsal midline
- Postflexion larvae >14.6 mm SL
  —Wide postanal band
  —Light pigment dorsally on head and laterally on gut

Diagnostic characters

PELAGIC JUVENILES

- Body pigment in two bands
- Little pigment on median fins

[a] Hart 1973
[b] Wyllie Echeverria 1987

Ref: Laroche, in prep.

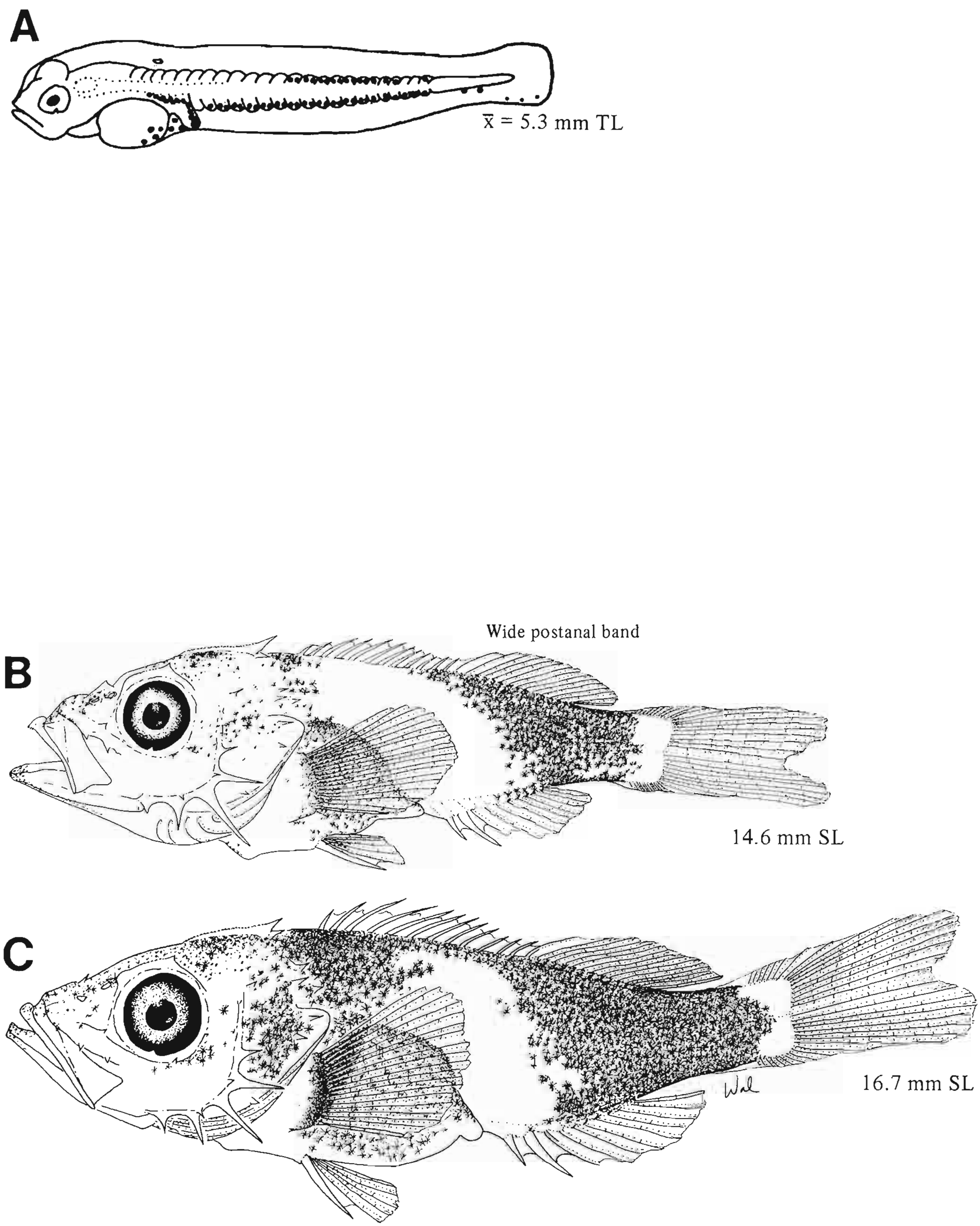


Figure A, Westrheim et al. 1968a; B–C, Laroche, in prep.

MERISTICS

Vertebrae	Total: 25-26-26
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	7-7-7
Caudal fin	9-11, 8+7, 9-11
Pelvic fin	Thoracic
	S: 1-1-1 R: 5-5-5
Dorsal fin	S: 13-13-13 R: 11-13-14
Pectoral fin	R: 16-17-18
Anal fin	S: 3-3-3 R: 5-6-7
Gill rakers	U: 8-X-10 L: 19-X-21 (T: 26-28-31)
Lateral line pores	39-47

LIFE HISTORY

Range	South of southern California to Gulf of Alaska, 54-60°N
Ecology	Nearshore shelf demersal, 0-183 m
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: Apr[a]
	Area:
	Mode:
	Migration:
Fecundity	Range/function: 20,000-640,000[a]/ $F=0.000000027404 \times L^{4.9567}$, L=TL mm;[b] $F=0.0000000034554 \times L^{5.30011}$, L=TL mm[c]
Age at first maturity	3-4 yr[d]
	6 yr (females)[e]
Longevity	

HEAD SPINES

Preocular	+
Postocular	+
Coronal	0
Supraocular	0
Tympanic	+
Inferior infraorbital	2

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size	5.3 mm SL
Preanal length	41% SL increasing with development to 49% SL
Length at flexion	Between 7.5 and 9.5 mm SL
Length at transformation	
Sequence of fin development	Caudal and pectorals, pelvics, dorsal and anal

Pigment

- Head: Dorsal and nape spreading, with development, to entire head
- Gut: Dorsal and ventrolateral surface, increasing laterally with development
- Dorsal midline melanophores extend from head to just anterior to tail with no break over gut
- Ventral midline melanophores, with development increasing ventrolaterally and in hypural region

Diagnostic characters

- See notes on *S. auriculatus* (p. 290) about reared specimens

Distinguished from *S. auriculatus* by
- Until midflexion, more dorsal midline pigment anterior to anus
- Less pigment in the opercular region (flexion and postflexion)

PELAGIC JUVENILES

- Four pigment bands on body
- Fins pigmented

[a] Hart 1973
[b] Washington et al. 1978
[c] DeLacy et al. 1964
[d] Patten 1973
[e] Wyllie Echeverria 1987

Ref: Laroche, in prep.; Stahl-Johnson 1985.

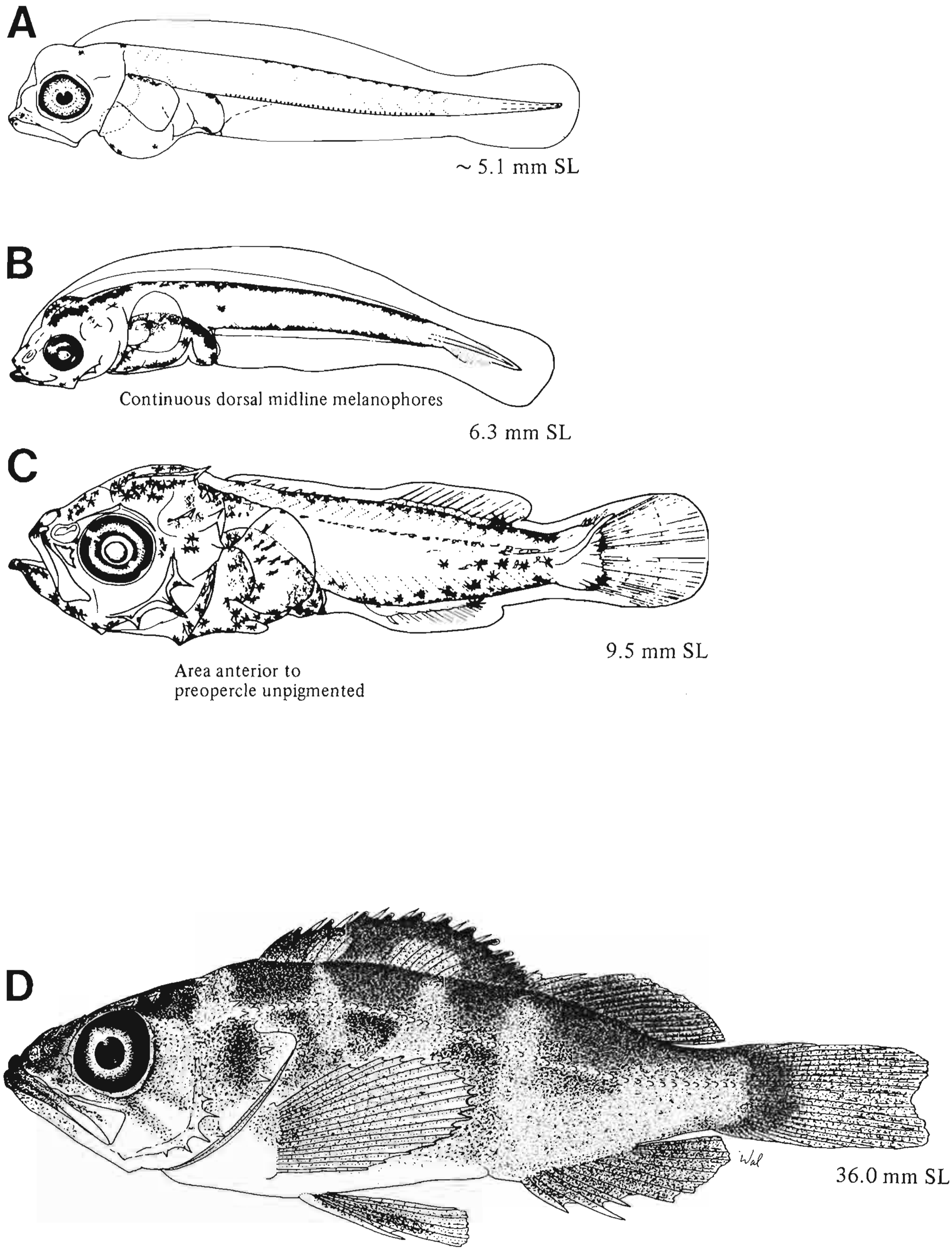


Figure A, NWAFC original (B. Vinter); B–C, Stahl-Johnson 1985 (reared); D, Laroche, in prep.

MERISTICS

Vertebrae	Total: 26-26-26	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	7-7-7	
Caudal fin	X, 8+7, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 13-13-13	R: 13-13-15
Pectoral fin	R: 17-18-19	
Anal fin	S: 3-3-3	R: 7-7-7
Gill rakers	U: 8-9-10	L: 21-23-25
	(T: 30-32-34)	
Lateral line pores	40-51	

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Epi- and mesobenthal, 29-549 m
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: Feb (Brit. Col.[a]-Oregon[b]); Nov-Mar in southern part of range[c]
	Area:
	Mode:
	Migration:
Fecundity	Range/function: 50,000-609,800[c]
Age at first maturity	5-6 yr[c]
	4 yr (females)[d]
Longevity	30 yr[c]

HEAD SPINES

Preocular	+
Postocular	+
Coronal	0
Supraocular	+
Tympanic	+
Inferior infraorbital	2

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size	5.7 mm SL
Preanal length	54-65% SL
Length at flexion	8.0-9.3 mm SL
Length at transformation	16-21 mm SL[e]
Sequence of fin development	Caudal and pectorals, pelvics, dorsal and anal

Pigment
- Extrusion larvae: Series along ventral body
- Pigmented pectorals and pelvics
- Heavy nape and top of head
- No dorsal midline
- ∿11 ventral midline melanophores reducing to ∿4 on caudal peduncle
- Spinous dorsal fin
- Tip of lower jaw

Diagnostic characters
- Heavy nape and paired fin pigment
- Pigment on spinous dorsal fin

PELAGIC JUVENILES
- Five pigment bands on body, four extending onto dorsal fin
- Paired fins heavily pigmented

[a] Hart 1973
[b] Hitz 1962
[c] Phillips 1964
[d] Wyllie Echeverria 1987
[e] Juveniles become benthic at 40-60 mm SL.

Ref: Laroche, in prep.; Richardson and Laroche 1979; Washington et al. 1984b; Westrheim 1975.

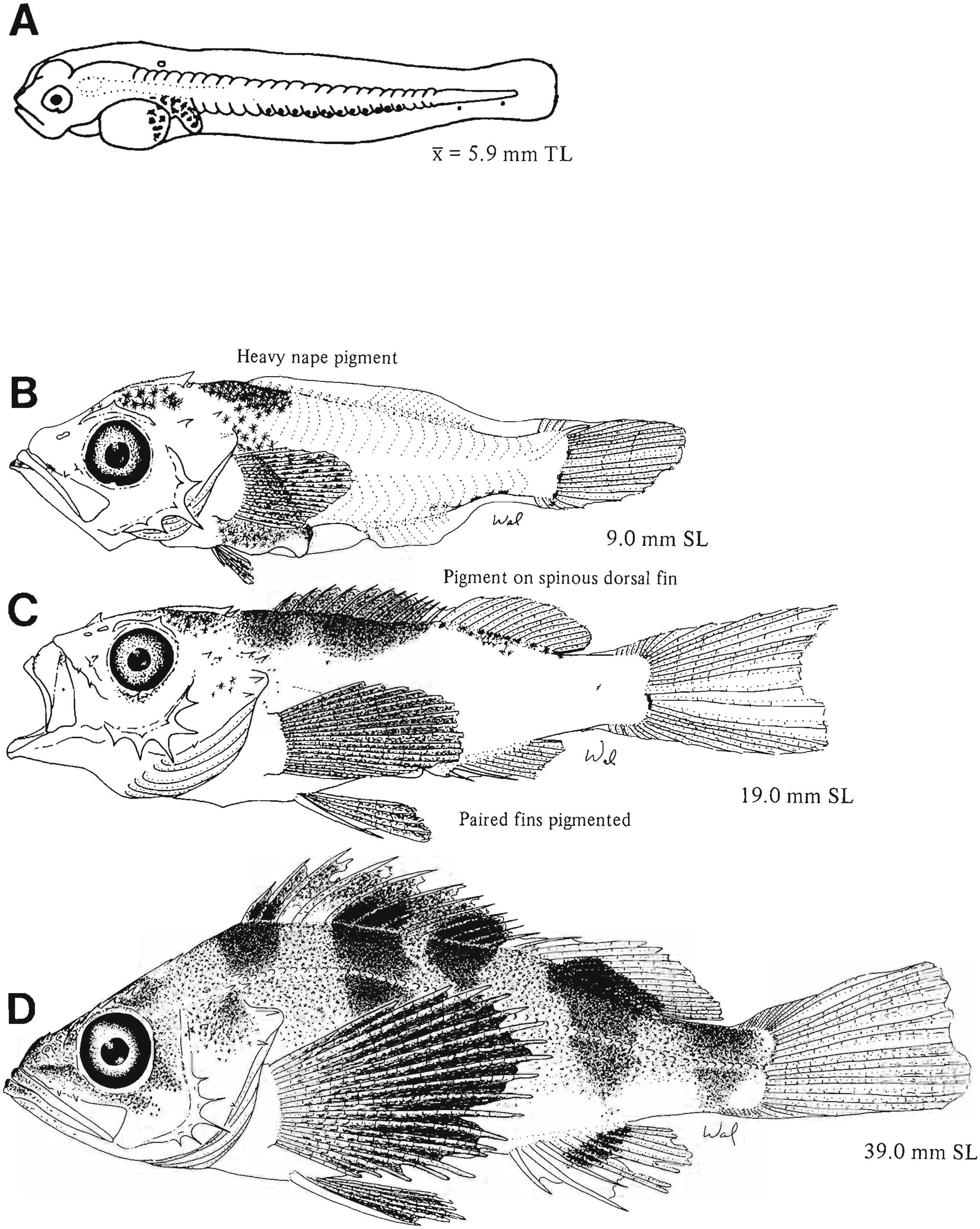


Figure A, Westrheim et al. 1968a; B–C, Richardson and Laroche 1979; D, Laroche, in prep.

MERISTICS

Vertebrae	Total: 26-26-26	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	7-7-7	
Caudal fin	X, 8+7, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 13-13-13	R: 11-12-14
Pectoral fin	R: 17-18-18	
Anal fin	S: 3-3-3	R: 5-7-7
Gill rakers	U: 9-10-12	L: 23-24-27
	(T: 32-34-37)	
Lateral line pores	32-42	

LIFE HISTORY

Range	South of southern California to Gulf of Alaska, 54-60°N
Ecology	Epi- and mesobenthal, 91-579 m
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: May-June;[a] July;[b] May-Aug (Oregon)[c]
	Area:
	Mode:
	Migration:
Fecundity	Range/function: 14,000-304,000[d]
Age at first maturity	4-5 yr[d]
	7 yr (females)[e]
Longevity	

HEAD SPINES

Preocular	+
Postocular	+
Coronal	0
Supraocular	0
Tympanic	+
Inferior infraorbital	2

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size 5.2 mm
Preanal length
Length at flexion
Length at transformation
Sequence of fin development
Pigment
- Extrusion larvae: Series along ventral body
- Postflexion larvae >8.7 mm SL
  - —Pigment at base of parietal spine, increasing with development to head and nape
  - —Internal spots along anal fin pterygiophores
  - —Along hypural margin

Diagnostic characters

PELAGIC JUVENILES

- Body and fins (except distal portions) pigmented
- Spinous dorsal fin with fringe of pigment
- Distinct band of pigment on soft dorsal and anal fins

---
[a] Hart 1973
[b] Westrheim 1975
[c] Hitz 1962
[d] Phillips 1964
[e] Wyllie Echeverria 1987

Ref: Laroche, in prep.

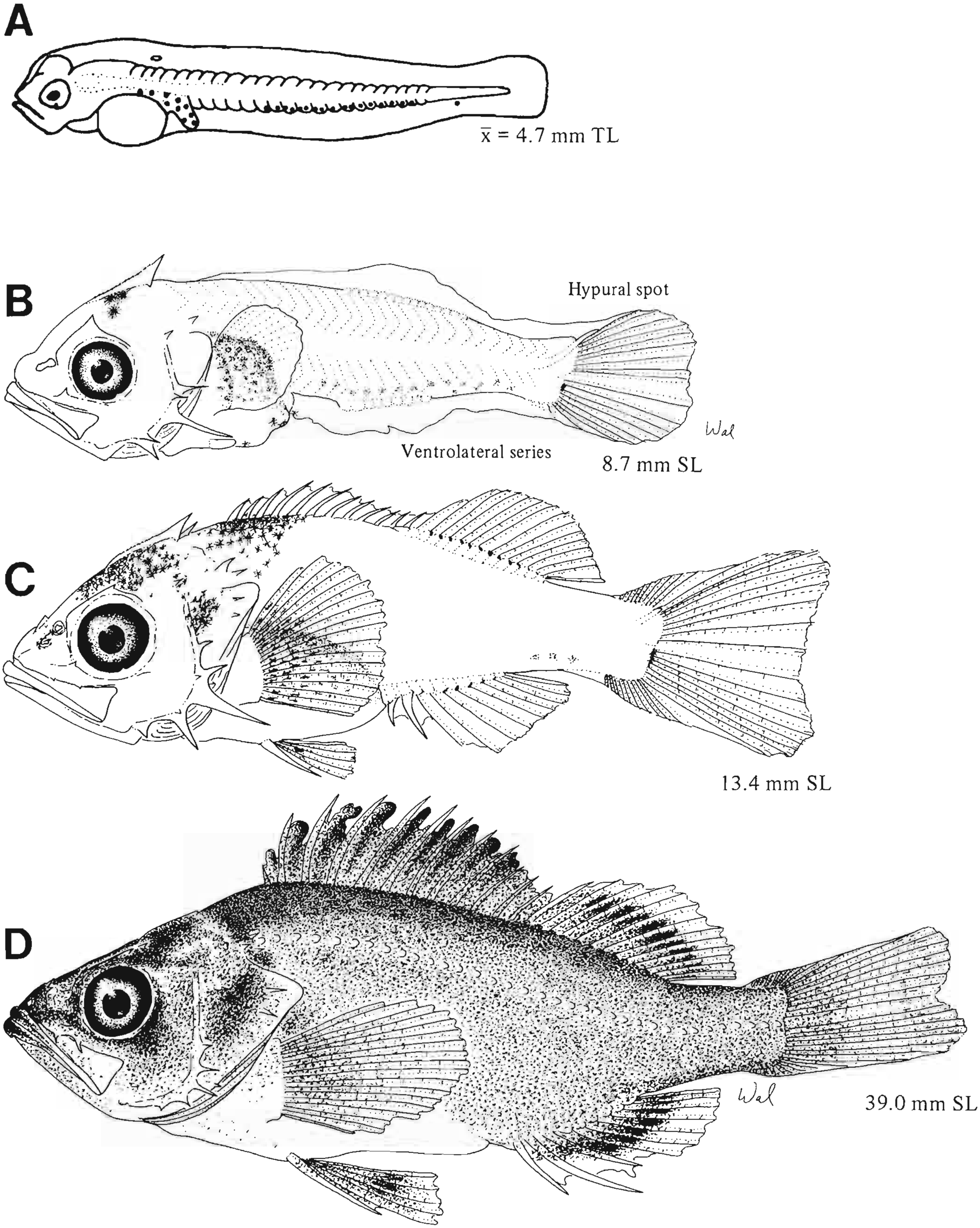


Figure A, Westrheim et al. 1968b; B–D, Laroche, in prep.

MERISTICS

Vertebrae	Total: 26-26-26	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	7-7-7	
Caudal fin	X, 8+7, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 13-13-13	R: 12-13-14
Pectoral fin	R: 16-17-18	
Anal fin	S: 3-3-3	R: 6-6-7
Gill rakers	U: 8-9-10	L: 20-22-23
	(T: 29-31-33)	
Lateral line pores	37-47	

LIFE HISTORY

Range	South of southern California to Gulf of Alaska, 54-60°N
Ecology	Epi- and mesobenthal, 61-402 m
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: May-June[a]
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	7 yr (females)[b]
Longevity	

HEAD SPINES

Preocular	+
Postocular	+
Coronal	0
Supraocular	0
Tympanic	+
Inferior infraorbital	2

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size ~5 mm
Preanal length
Length at flexion
Length at transformation
Sequence of fin development
Pigment
- Extrusion larvae: Series along ventral body
- Postflexion larvae >17.4 mm SL
  —Along dorsal body margin
  —Internal row of spots along lateral midline
  —Above and below notochord along caudal peduncle
  —A few spots along ventral body margin

Diagnostic characters

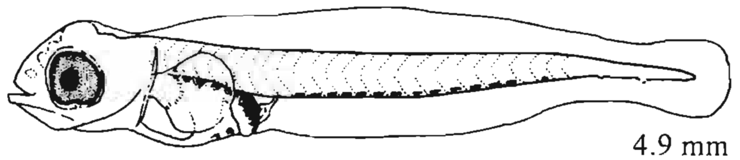
PELAGIC JUVENILES

- Body pigment blotchy, longitudinal stripe on larger specimens
- Fins lightly pigmented, or unpigmented

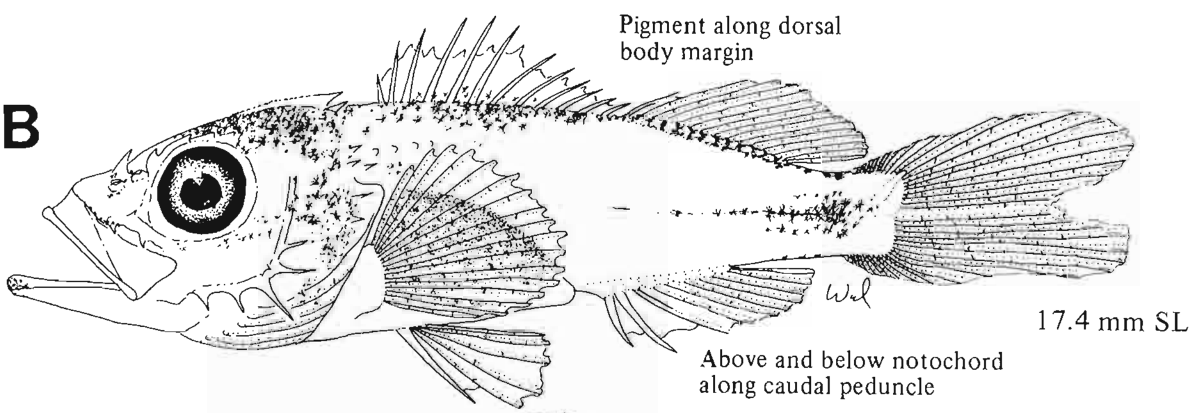
[a] Hart 1973
[b] Wyllie Echeverria 1987

Ref: Laroche, in prep.

A



B



C

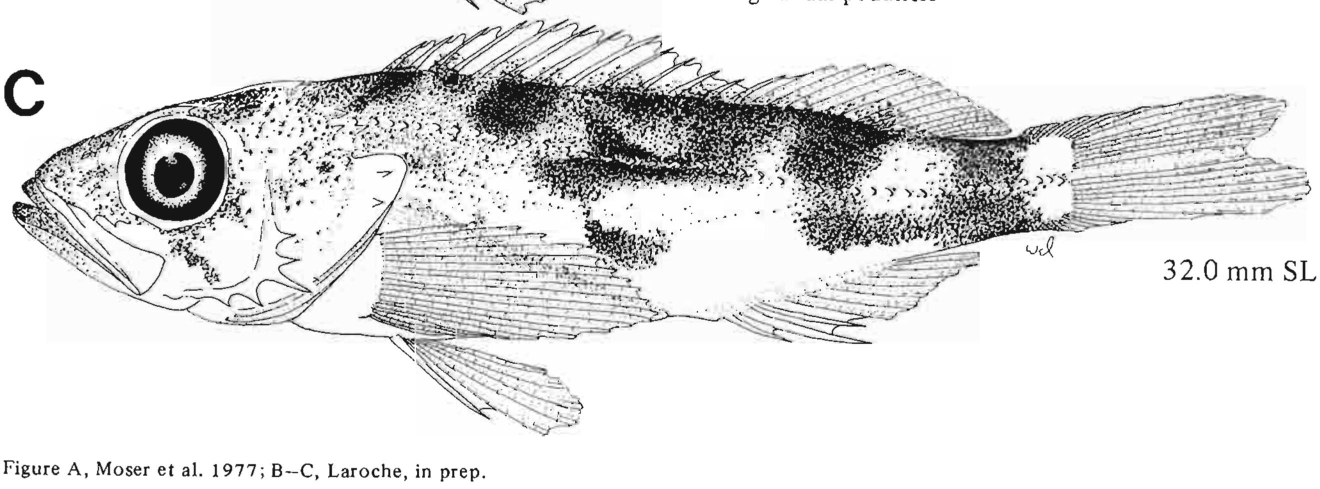


Figure A, Moser et al. 1977; B–C, Laroche, in prep.

MERISTICS

Vertebrae	Total: 27-27-28
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	7-7-7
Caudal fin	X, 8+7, X
Pelvic fin	Thoracic
	S: 1-1-1 R: 5-5-5
Dorsal fin	S: 13-13-13 R: 13-14-15
Pectoral fin	R: 16-17-18
Anal fin	S: 3-3-3 R: 6-7-7
Gill rakers	U: 11-11-13 L: 28-30-31 (T: 37-40-41)
Lateral line pores	40-46

LIFE HISTORY

Range	N. California, 38-42°N, to Gulf of Alaska, 54-60°N
Ecology	Epi- and mesobenthal, 10-366 m
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: Aug-Sept[a]
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	2-3 yr[a]
Longevity	

HEAD SPINES

Preocular	+
Postocular	+
Coronal	0
Supraocular	0
Tympanic	0
Inferior infraorbital	2

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size
Preanal length
Length at flexion
Length at transformation
Sequence of fin development
Pigment

- Postflexion larvae >16.4 mm SL
  - —Along base of soft dorsal fin rays
  - —Along base of parietal spine
  - —Along lateral line in caudal peduncle area

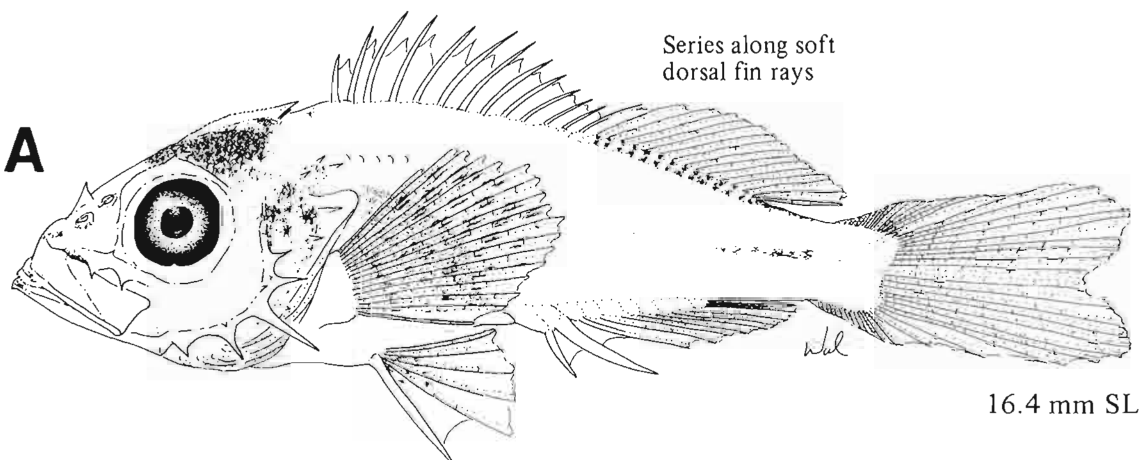
Diagnostic characters

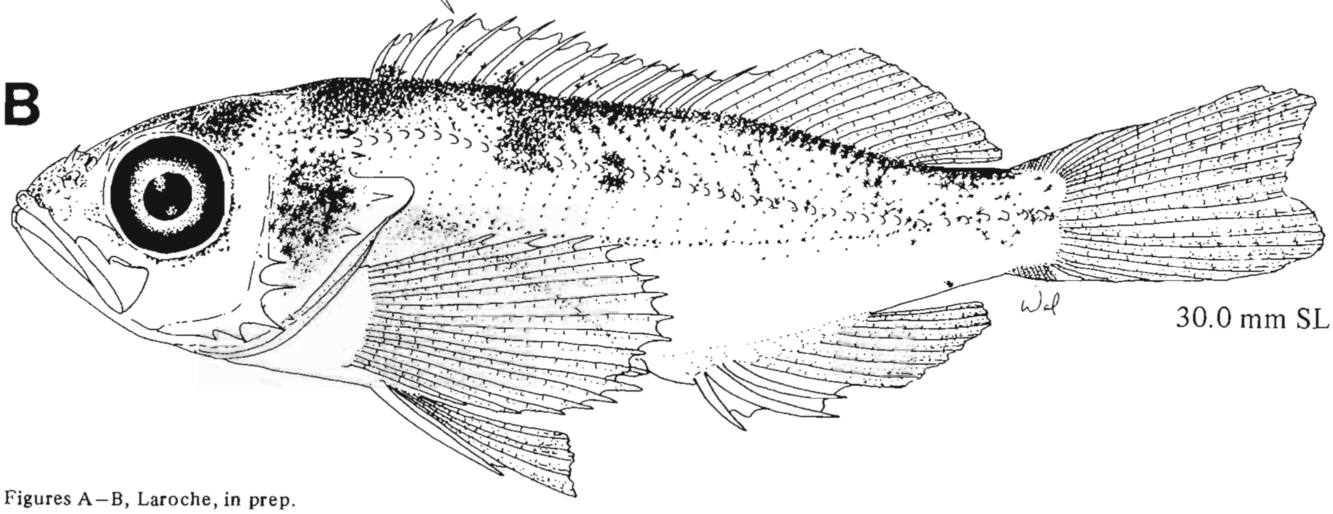
PELAGIC JUVENILES

- Body pigment mainly dorsal to midline
- Opercular blotch present
- Lateral midline pigmented
- Little fin pigment

[a]Moulton 1975

Ref: Laroche, in prep.





Figures A–B, Laroche, in prep.

MERISTICS

Vertebrae	Total: 26-26-27
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	7-7-7
Caudal fin	X, 8+7, X
Pelvic fin	Thoracic
	S: 1-1-1 R: 5-5-5
Dorsal fin	S: 13-13-13 R: 14-15-16
Pectoral fin	R: 18-18-19
Anal fin	S: 3-3-3 R: 7-8-9
Gill rakers	U: 9-10-11 L: 24-26-28
	(T: 34-36-38)
Lateral line pores	54-60

LIFE HISTORY

Range	South of southern California to Gulf of Alaska, 54-60°N
Ecology	Epi- and mesobenthal, 0-375 m
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: Nov-Mar;[a]
	Apr (British Columbia)[b]
	Area:
	Mode:
	Migration:
Fecundity	Range/function: 55,600-915,200[a]
Age at first maturity	3-4 yr (California)[a]
	5 yr (females)[c]
Longevity	28 yr[d]
	56 yr (females)[e]
	57 yr (males)[e]

HEAD SPINES

Preocular	+
Postocular	+
Coronal	0
Supraocular	+
Tympanic	+
Inferior infraorbital	3

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size	4.5-5.0 mm SL (pre-extrusion)
Preanal length	56-61% SL
Length at flexion	9.9-12.9 mm SL, complete at 14 mm SL
Length at transformation	21.7-30.6 mm SL[f]
Sequence of fin development	Caudal and pectorals, pelvics, dorsal and anal

Pigment
- Extrusion larvae: Short series midway along ventral body
- Larvae >10 mm SL
  - —Beneath dorsal fin
  - —Above and below notochord at tail
  - —Dorsal and ventral margin of caudal peduncle
  - —Moderate on paired fins

Diagnostic characters
- Pigment along dorsal fin base
- Relatively slender body
- No pigment at anal ray bases
- Pigment at tip of notochord

PELAGIC JUVENILES
- Pigment blotch on last few dorsal fin spines
- Body heavily pigmented
- Pectoral fin base, anal fin, and ventral caudal peduncle unpigmented

[a] Phillips 1964
[b] Westrheim 1975
[c] Wyllie Echeverria 1987
[d] Toole 1982
[e] R. Mandapat, Wash. Dep. Fish., 7600 Sand Point Way N.E., Seattle, WA 98115-0070, pers. commun., 1 June 1987.
[f] Juveniles are pelagic at 55-75 mm SL.

Ref: Laroche, in prep.; Laroche and Richardson 1981; Moser and Butler 1987; Washington et al. 1984b.

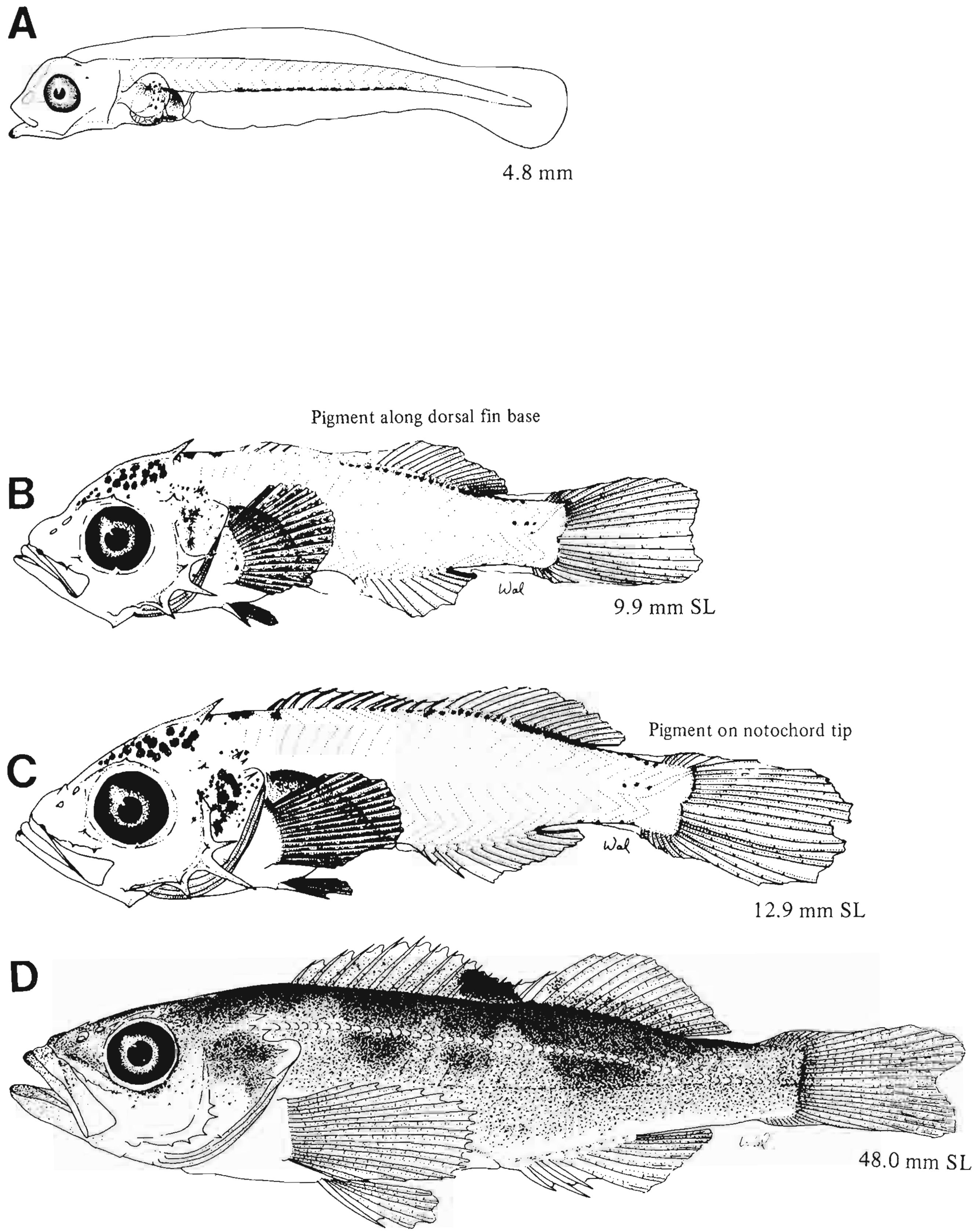


Figure A, Moser and Butler 1987; B–C, Laroche and Richardson 1981; D, Laroche, in prep.

MERISTICS

Vertebrae	Total: 26-26-26 Precaudal: X-X-X Caudal: X-X-X
Branchiostegal rays	7-7-7
Caudal fin	12, 8+7, 12-13
Pelvic fin	Thoracic S: 1-1-1 R: 5-5-5
Dorsal fin	S: 12-13-13 R: 14-14-15
Pectoral fin	R: 17-18-18
Anal fin	S: 3-3-3 R: 7-8-8
Gill rakers	U: 8-11-12 L: 24-26-27 (T: 34-36-37)
Lateral line pores	49-55

LIFE HISTORY

Range	S. California, 32-34°N, to Gulf of Alaska, 54-60°N
Ecology	Epi- and mesobenthal, 0-549 m
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: Nov-Feb;[a] Mar[b] Area: Mode: Migration:
Fecundity	Range/function: 48,000-632,800/ $F=82721.8\times L-323516$[c]
Age at first maturity	3-5 yr[a] 7 yr (females)[d]
Longevity	

HEAD SPINES

Preocular	0
Postocular	+
Coronal	0
Supraocular	0
Tympanic	+
Inferior infraorbital	3

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size	4.5 mm SL (pre-extrusion)
Preanal length	50-75% SL
Length at flexion	Complete at 10.1 mm SL
Length at transformation	23-27 mm SL[e]
Sequence of fin development	Caudal and pectorals, pelvics, dorsal and anal

Pigment
- Extrusion larvae: Series along ventral body
- See also *S. melanops* (p. 314)
- Moderate on paired fins
- Over tip of notochord
- Along base of second dorsal fin, developing all along dorsal midline
- Dorsal and ventral margin of caudal peduncle
- At bases of some dorsal and anal fin rays

Diagnostic characters
- See also *S. melanops*
- Number of pectoral fin rays (18)
- Lateral line pores 49-55, usually >50
- Slender caudal peduncle
- Heavy pigment develops along entire dorsal midline
- Pigment at bases of some dorsal and anal fin rays

PELAGIC JUVENILES
- Pigment blotch on last few dorsal fin spines
- Body heavily pigmented, diffuse
- Ventral caudal peduncle pigmented

[a] Phillips 1964
[b] Westrheim 1975
[c] Gunderson et al. 1980
[d] Wyllie Echeverria 1987
[e] Juveniles are pelagic at 40-50 mm SL.

Ref: DeLacy et al. 1964; Laroche, in prep.; Laroche and Richardson 1980.

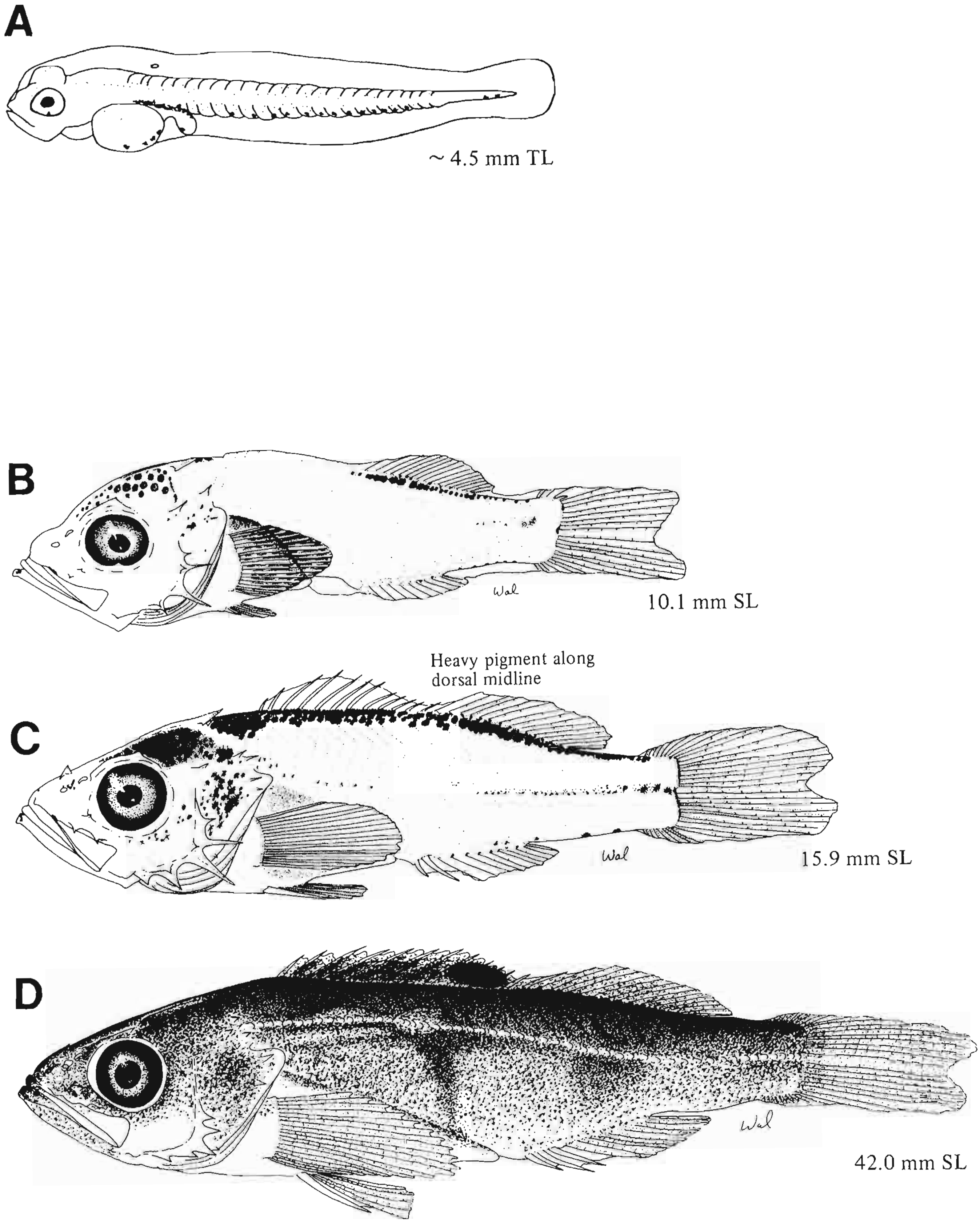


Figure A, DeLacy et al. 1964; B–C, Laroche and Richardson 1980; D, Laroche, in prep.

MERISTICS

Vertebrae	Total: 26-26-26	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	7-7-7	
Caudal fin	X, 8+7, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-5-5
Dorsal fin	S: 12-13-14	R: 12-13-14
Pectoral fin	R: 15-16-17	
Anal fin	S: 3-3-3	R: 6-6-7
Gill rakers	U: 8-9-9	L: 19-21-22
	(T: 28-30-33)	
Lateral line pores	34-45	

LIFE HISTORY

Range	South of southern California to Gulf of Alaska, 54-60°N
Ecology	Epi- and mesobenthal, 25-549 m
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: June[a]
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	8 yr (females)[b]
Longevity	

HEAD SPINES

Preocular	+
Postocular	+
Coronal	0
Supraocular	+
Tympanic	+
Inferior infraorbital	2

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size	4.1 mm SL
Preanal length	56-63% SL
Length at flexion	7.7-8.8 mm SL
Length at transformation	12.0-18.6 mm SL[c]
Sequence of fin development	Caudal and pectorals, pelvics, dorsal and anal

Pigment
- Extrusion larvae: Series along ventral body
- Lack of body pigment, with development caudal peduncle patch
- Pigmented area at base of long parietal spine
- Pigmented fringes of pectoral and pelvic fins

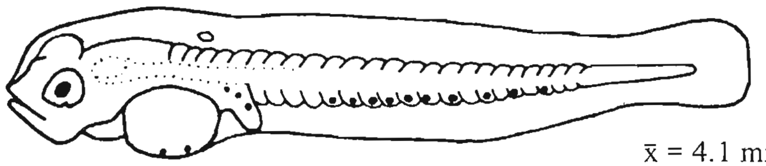
Diagnostic characters
- Pigmented fringes of pectoral and pelvic fins
- Lack of body pigment
- Long serrate parietal and middle posterior preopercular spines

PELAGIC JUVENILES
- Body pigment diffuse, heavier over gut and on caudal peduncle

[a] Westrheim 1975
[b] Wyllie Echeverria 1987
[c] Juveniles are pelagic to 60 mm SL.

Ref: Laroche, in prep.; Richardson and Laroche 1979; Washington et al. 1984b; Westrheim 1975.

A



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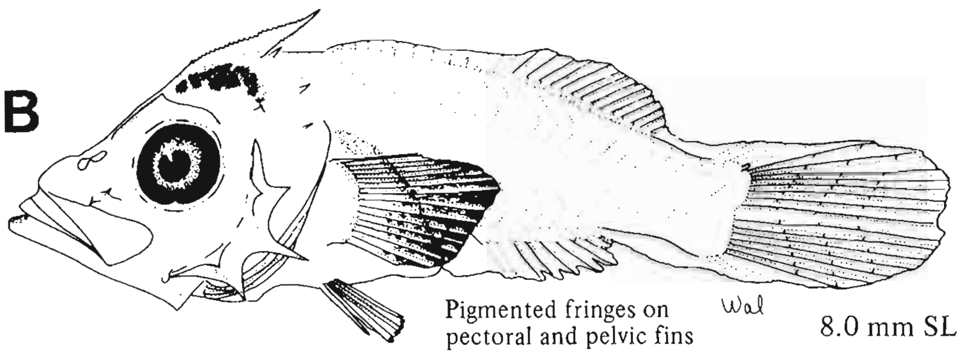

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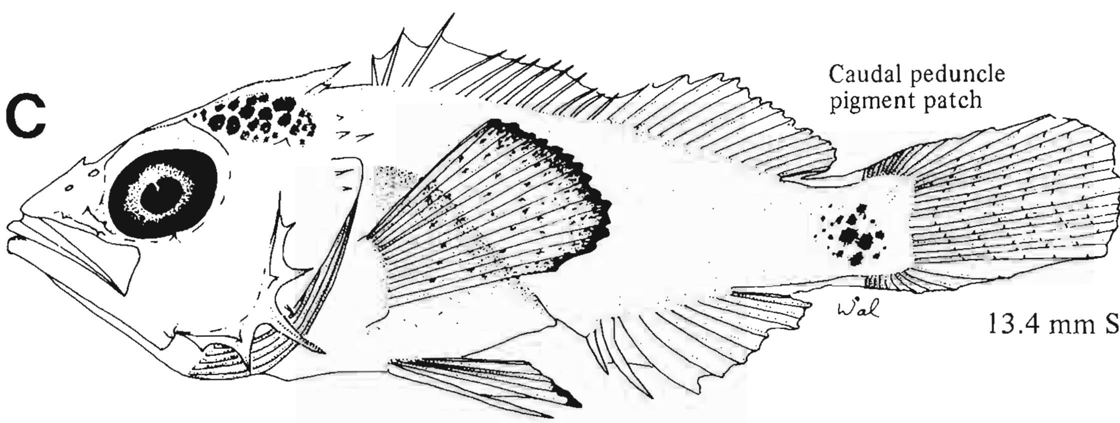

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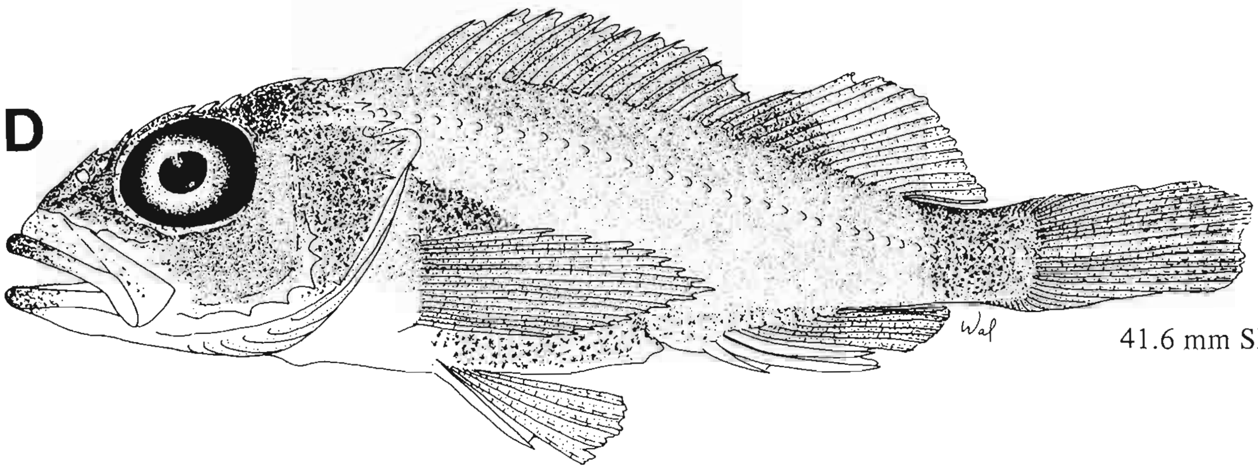


Figure A, Westrheim et al. 1968a; B–C, Richardson and Laroche 1979; D, Laroche, in prep.

MERISTICS

Vertebrae	Total: 26-26-26	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	7-7-7	
Caudal fin	X, 8+7, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 13-13-13	R: 13-14-16
Pectoral fin	R: 19-20-22	
Anal fin	S: 3-3-3	R: 9-9-10
Gill rakers	U: 12-12-12	L: 31-31-31
	(T: 40-44-47)	
Lateral line pores	53-64	

LIFE HISTORY

Range	South of southern California to Gulf of Alaska, 54-60°N
Ecology	Epi- and mesobenthal, 0-350 m
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: Nov-Mar;[a] Mar[b]
	Area:
	Mode:
	Migration:
Fecundity	Range/function: 7000-50,000[c]
Age at first maturity	3 yr (females)[d]
Longevity	

HEAD SPINES

Preocular	+
Postocular	+
Coronal	0
Supraocular	0
Tympanic	+
Inferior infraorbital	2

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size	5.4 mm SL
Preanal length	36%, with development 54% SL
Length at flexion	8-10 mm SL
Length at transformation	~27-30 mm SL[e]
Sequence of fin development	Caudal and pectorals, pelvics, dorsal and anal

Pigment
- Brain (dorsal head on crown)
- Pigment over dorsolateral surface of gut
- Dorsal and ventral postanal midline (see illustrations)

Diagnostic characters
- Most slender *Sebastes* sp. larvae described to date (body depth <25% SL)
- Large larvae (5.4 mm SL at hatching, 8-10 mm SL at flexion)
- Opposing dorsal and ventral postanal midline pigment
- Anterior placement of anus in juveniles/adults
- Large gap between anus and origin of anal fin

PELAGIC JUVENILES
- Elongate shape, large gap between anus and origin of anal fin
- Body pigment diffuse, but myosepta pattern evident

[a] Phillips 1964
[b] Westrheim 1975
[c] Hart 1973
[d] Wyllie Echeverria 1987
[e] Juveniles are pelagic at 30-63 mm SL.

Ref: Laroche, in prep.; Moser et al. 1977; Washington et al. 1984b.

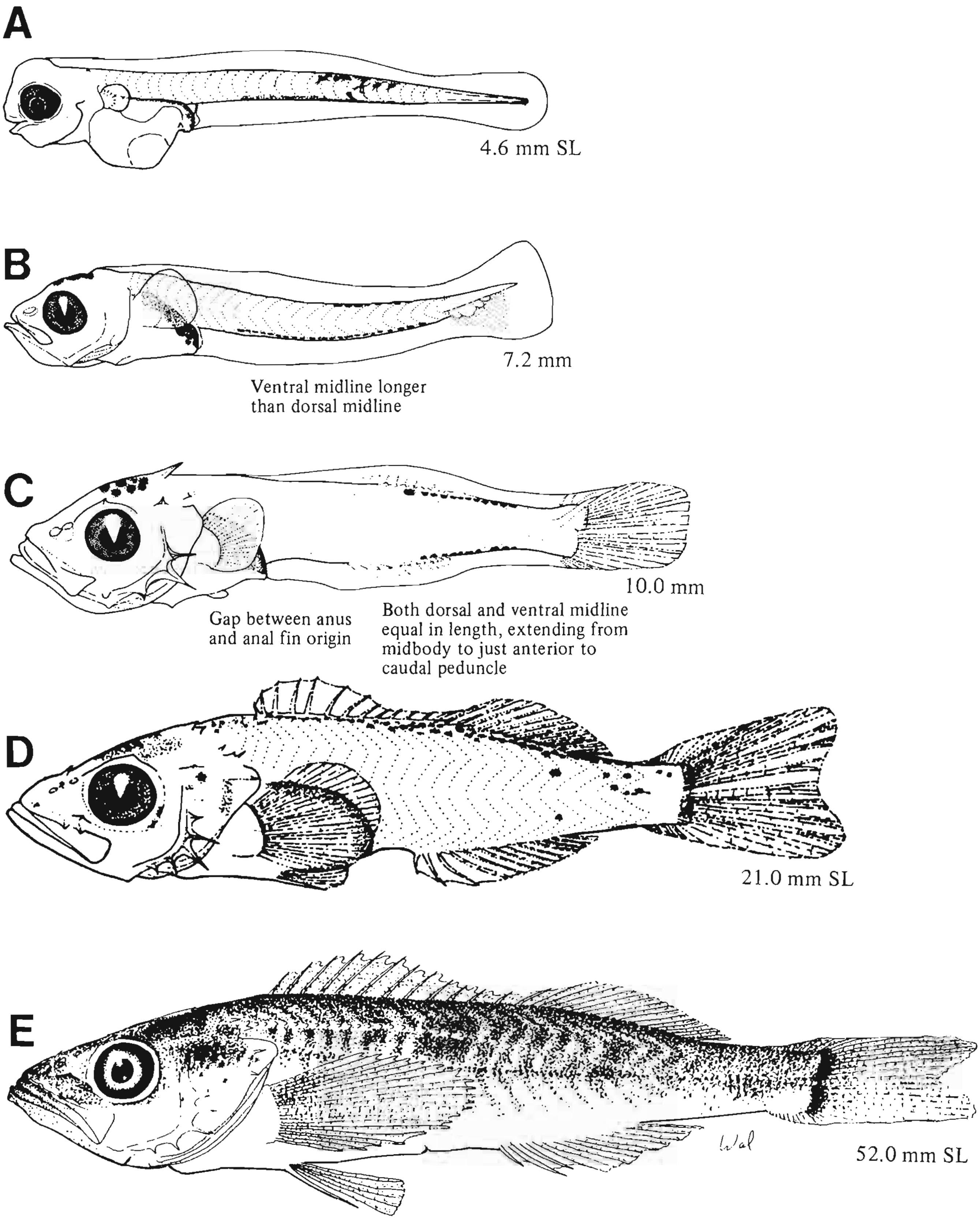


Figure A, NWAFC original (B. Vinter); B–D, Moser et al. 1977; E, Laroche, in prep.

MERISTICS

Vertebrae	Total: 26-26-26
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	7-7-7
Caudal fin	12, 8+7, 12-13
Pelvic fin	Thoracic
	S: 1-1-1 R: 5-5-5
Dorsal fin	S: 13-13-14 R: 14-15-15
Pectoral fin	R: 18-19-19
Anal fin	S: 3-3-3 R: 7-8-9
Gill rakers	U: 9-11-13 L: 23-26-28
	(T: 34-37-38)
Lateral line pores	47-55

LIFE HISTORY

Range	Cent. California, 34-38°N, to Aleutian Is., 51-55°N
Ecology	Epi- and mesobenthal, 0-366 m
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: Jan;[a] Feb-Apr[b]
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	7 yr (females)[c]
Longevity	

HEAD SPINES

Preocular	0
Postocular	+
Coronal	0
Supraocular	0
Tympanic	+
Inferior infraorbital	3

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size	
Preanal length	50-75% SL
Length at flexion	Complete at 10.6 mm SL
Length at transformation	24-33 mm SL[d]
Sequence of fin development	Caudal and pectorals, pelvics, dorsal and anal

Pigment
- Extrusion larvae: Series along ventral body
- Larvae >10.6 mm SL
  —Head, on crown and opercle
  —Pigment over dorsolateral surface of gut
  —Dorsal midline heavier than ventral midline
  —Hypural margin
  —Along posterior lateral line, extends anteriorly along notochord with development
  —Paired fin blades moderately pigmented
  —Discrete melanophores at the articulation of several dorsal and anal fin rays

Diagnostic characters
Distinguished from *S. flavidus* (p. 308) by
- High pectoral fin ray count (usually 19)
- Fewer lateral line pores (usually <50)
- Deeper, shorter caudal peduncle

PELAGIC JUVENILES
- Body pigment heavy, diffuse
- Pigment blotch on last few dorsal fin spines
- Lateral midline pigmented

[a]Westrheim 1975
[b]Hart 1973
[c]Wyllie Echeverria 1987
[d]Juveniles are pelagic at 40-50 mm SL.

Ref: Laroche and Richardson 1980.

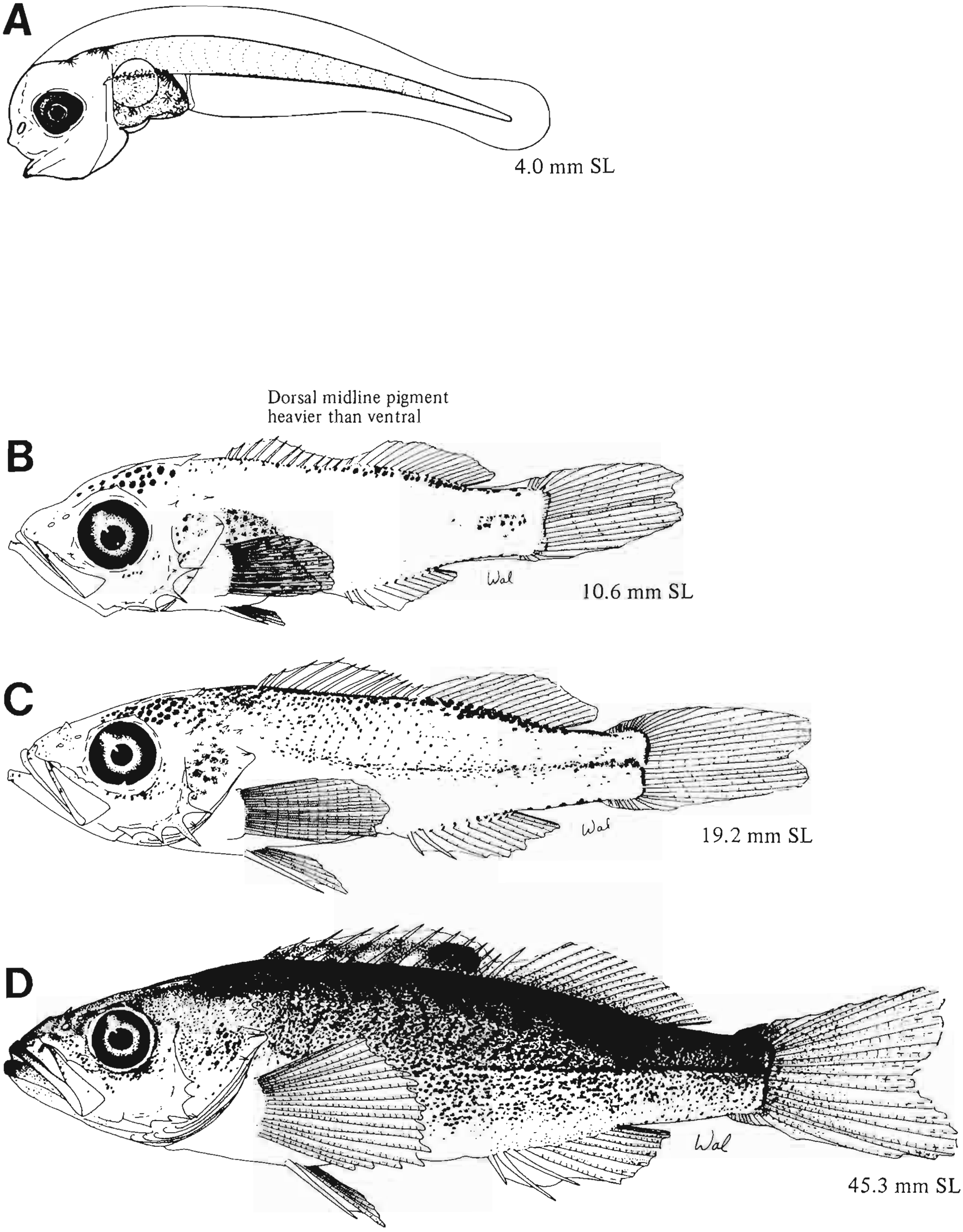


Figure A, NWAFC original (B. Vinter); B–D, Laroche and Richardson 1980.

MERISTICS

Vertebrae	Total: 26-26-26
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	7-7-7
Caudal fin	9-10, 8+7, 9-11
Pelvic fin	Thoracic
	S: 1-1-1 R: 5-5-5
Dorsal fin	S: 13-13-13 R: 12-13-14
Pectoral fin	R: 18-19-20
Anal fin	S: 3-3-3 R: 6-7-8
Gill rakers	U: 8-X-9 L: 22-22-22
	(T: 30-31-34)
Lateral line pores	28-33

LIFE HISTORY

Range	South of southern California to Washington, 46-48°30′N
Ecology	Epi-, meso-, and bathybenthal, 125-768 m
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: Abundance of newborn larvae peaks in February off S. California[a]
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	8 yr (females)[b]
Longevity	

HEAD SPINES

Preocular	+
Postocular	+
Coronal	0
Supraocular	+
Tympanic	+
Inferior infraorbital	2

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size	4.5 mm SL
Preanal length	37% SL increasing with development to 62% SL
Length at flexion	6.2-7.2 mm SL
Length at transformation	~16 mm SL[c]
Sequence of fin development	Caudal and pectorals, pelvics, dorsal and anal

Pigment
- Preflexion larvae
  - —Single row postanal ventral midline (~8 spots)
  - —Brain
  - —Lower jaw, streak along upper jaw
  - —Dorsolaterally on gut
  - —Pectoral fin
- Flexion larvae: Opercle blotch and upper jaw streak
- Postflexion and pelagic juveniles: Anterior bar; with development, two additional bars form, under second dorsal and on caudal peduncle

Diagnostic characters
- Pigment
  - —Jaw, opercle blotch, postanal bars
  - —Blades of paired fins heavily pigmented
  - —Band of pigment on body centered at about dorsal spine 5-7
- Head spination (see p. 271)
  - —Large serrate parietal spine
  - —Large weakly serrate preopercle angle spine
- Deep bodied (>35% SL)

PELAGIC JUVENILES
- Banded body pigment extends onto dorsal and anal fins
- Pectoral fin, but not base, pigmented

[a] Moser and Ahlstrom 1978
[b] Wyllie Echeverria 1987
[c] Largest pelagic juvenile collected is 46.2 mm SL; smallest demersal juvenile collected is 36.0 mm SL.

Ref: Laroche, in prep.; Moser and Ahlstrom 1978.

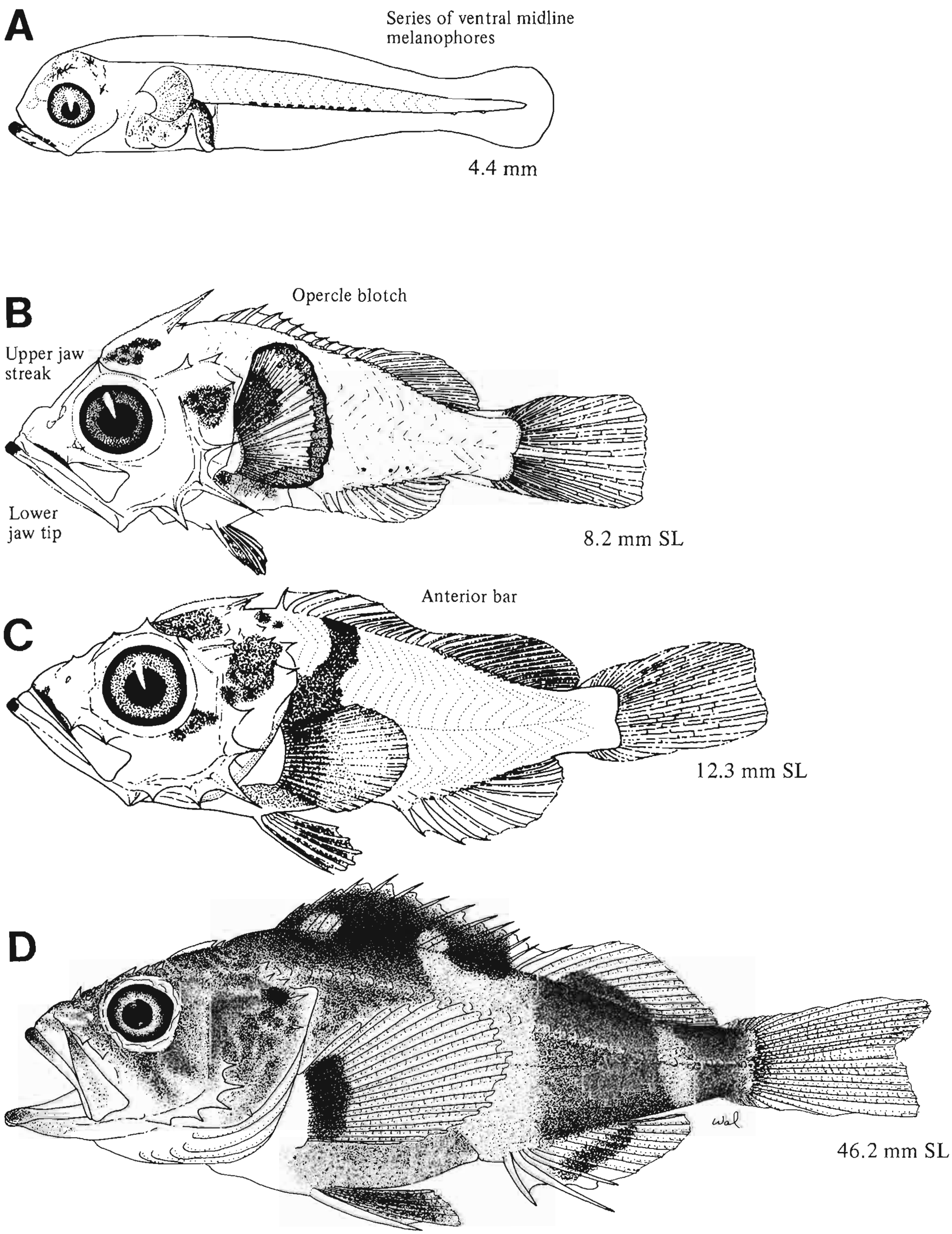


Figure A, Moser et al. 1977; B–C, Moser and Ahlstrom 1978; D, Laroche, in prep.

MERISTICS

Vertebrae	Total: 26-26-26 Precaudal: X-X-X Caudal: X-X-X
Branchiostegal rays	7-7-7
Caudal fin	X, 8+7, X
Pelvic fin	Thoracic S: 1-1-1 R: 5-5-5
Dorsal fin	S: 13-13-13 R: 13-14-15
Pectoral fin	R: 17-18-18
Anal fin	S: 3-3-3 R: 6-7-7
Gill rakers	U: X-X-X L: X-X-X (T: 36-41-42)
Lateral line pores	41-48

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Epi- and mesobenthal, 0-274 m
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: Nov-Mar[a] Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	5 yr (females)[b]
Longevity	

HEAD SPINES

Preocular	+
Postocular	+
Coronal	0
Supraocular	+
Tympanic	+
Inferior infraorbital	2

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size 4.3 mm
Preanal length
Length at flexion
Length at transformation
Sequence of fin development
Pigment

- Extrusion larvae: Short series midway along ventral body
- Postflexion larvae >12.3 mm SL
  —Dorsolateral patch under spinous dorsal
  —Along dorsal and anal fin ray bases
  —Series along ventral midline toward caudal, becoming internal
  —Along hypural margin

Diagnostic characters

PELAGIC JUVENILES

- Body and head pigment diffuse, heavy
- Pigment blotch on last few dorsal fin spines
- Paired fins pigmented

[a] Phillips 1964
[b] Wyllie Echeverria 1987

Ref: Laroche, in prep.

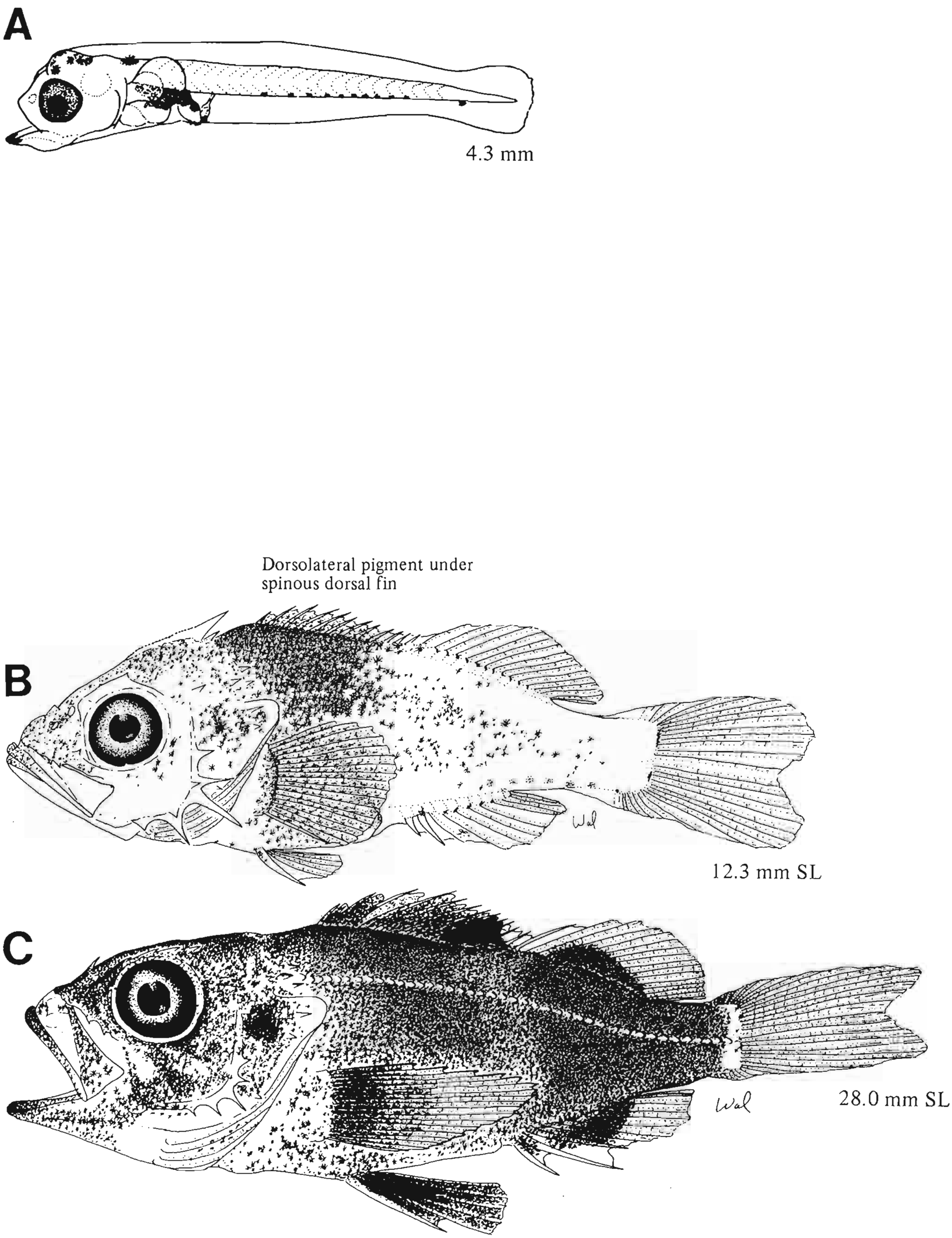


Figure A, Moser et al. 1977; B–C, Laroche, in prep.

MERISTICS

Vertebrae	Total: 26-26-27	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	7-7-7	
Caudal fin	X, 8+7, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 13-13-13	R: 15-16-17
Pectoral fin	R: 17-18-19	
Anal fin	S: 3-3-3	R: 8-9-10
Gill rakers	U: 9-10-12	L: 23-25-29
	(T: 32-35-38)	
Lateral line pores	47-53	

LIFE HISTORY

Range	South of southern California to Aleutian Is., 51-55°N
Ecology	Epi- and mesopelagic, 0-549 m
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: Nov-Jan[a]
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	6 yr (females)[b]
Longevity	

HEAD SPINES

Preocular	+
Postocular	+
Coronal	0
Supraocular	+
Tympanic	+
Inferior infraorbital	3

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size 5.2 mm; 3.8 mm SL[c]
Preanal length
Length at flexion
Length at transformation
Sequence of fin development
Pigment

- Extrusion larvae: Short series along ventral body[c]
- Preflexion larvae
  - —Spots develop at tip of lower jaw and on pectoral fin blade[c]
  - —Spots form at junction of cleithra
- Postflexion larvae >12.8 mm SL
  - —Along body margins beneath soft dorsal fin and posterior to anal fin
  - —Hypural margin
  - —Internal and external spots along lateral line

Diagnostic characters

PELAGIC JUVENILES

- Body and head pigment diffuse, heavy
- Pigment blotch on last few dorsal fin spines

[a]Wales 1952
[b]Wyllie Echeverria 1987
[c]L. Wold and G. Moreno, Moss Landing Mar. Lab., Moss Landing, CA 95039-0450, pers. commun., 26 July 1988. Drawing (Fig. A) by L. McMasters. Based on results from California Sea Grant Project R/F 115.

Ref: Efremenko and Lisovenko 1970; Laroche, in prep.

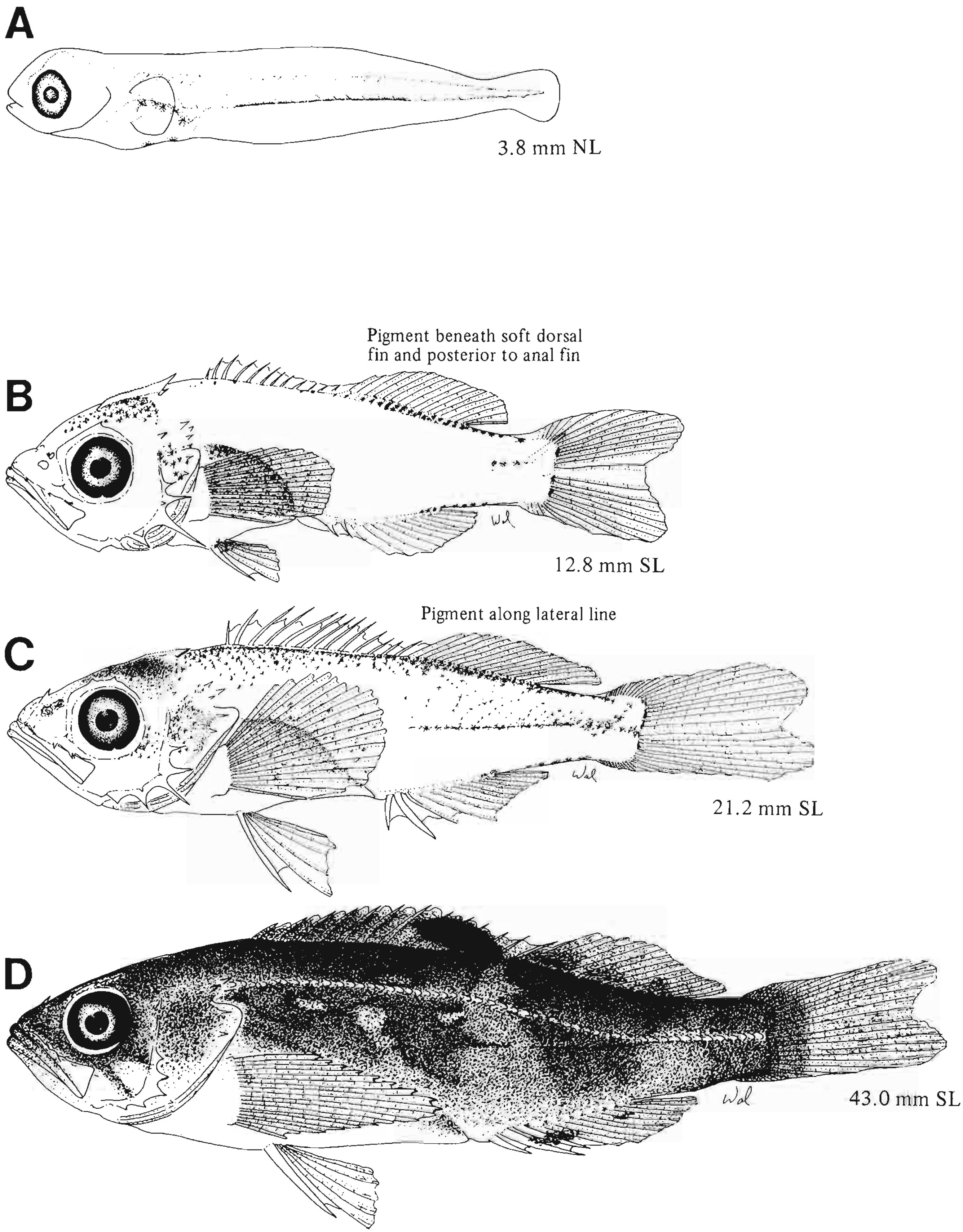


Figure A, Wold, unpubl.; B–D, Laroche, in prep.

MERISTICS

Vertebrae	Total: 26-26-26	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	7-7-7	
Caudal fin	X, 8+7, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 13-13-15	R: 13-14-15
Pectoral fin	R: 14-15-16	
Anal fin	S: 3-3-3	R: 8-9-10
Gill rakers	U: 8-8-9	L: 20-21-21
	(T: 27-28-32)	
Lateral line pores	51-62	

LIFE HISTORY

Range	South of southern California to Gulf of Alaska, 54-60°N
Ecology	Epi- and mesobenthal, 0-475 m
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: Jan-Feb;[a] Nov-Apr[b]
	Area: Semi-demersal (25-305 m)[c]
	Mode:
	Migration:
Fecundity	Range/function: 20,000[d]-2,440,000[e] (may mature more than one brood per year)[c]
Age at first maturity	3-4 yr[d]
	4 yr (females)[f]
Longevity	30 yr[g]
	60 yr[h]

HEAD SPINES

Preocular	+
Postocular	0
Coronal	0
Supraocular	0
Tympanic	+
Inferior infraorbital	3-4

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size	4-5 mm SL
Preanal length	<50%, with development 50-75% SL
Length at flexion	7.2-9.7 mm SL
Length at transformation	~15 mm SL
Sequence of fin development	Caudal and pectorals, pelvics, dorsal and anal

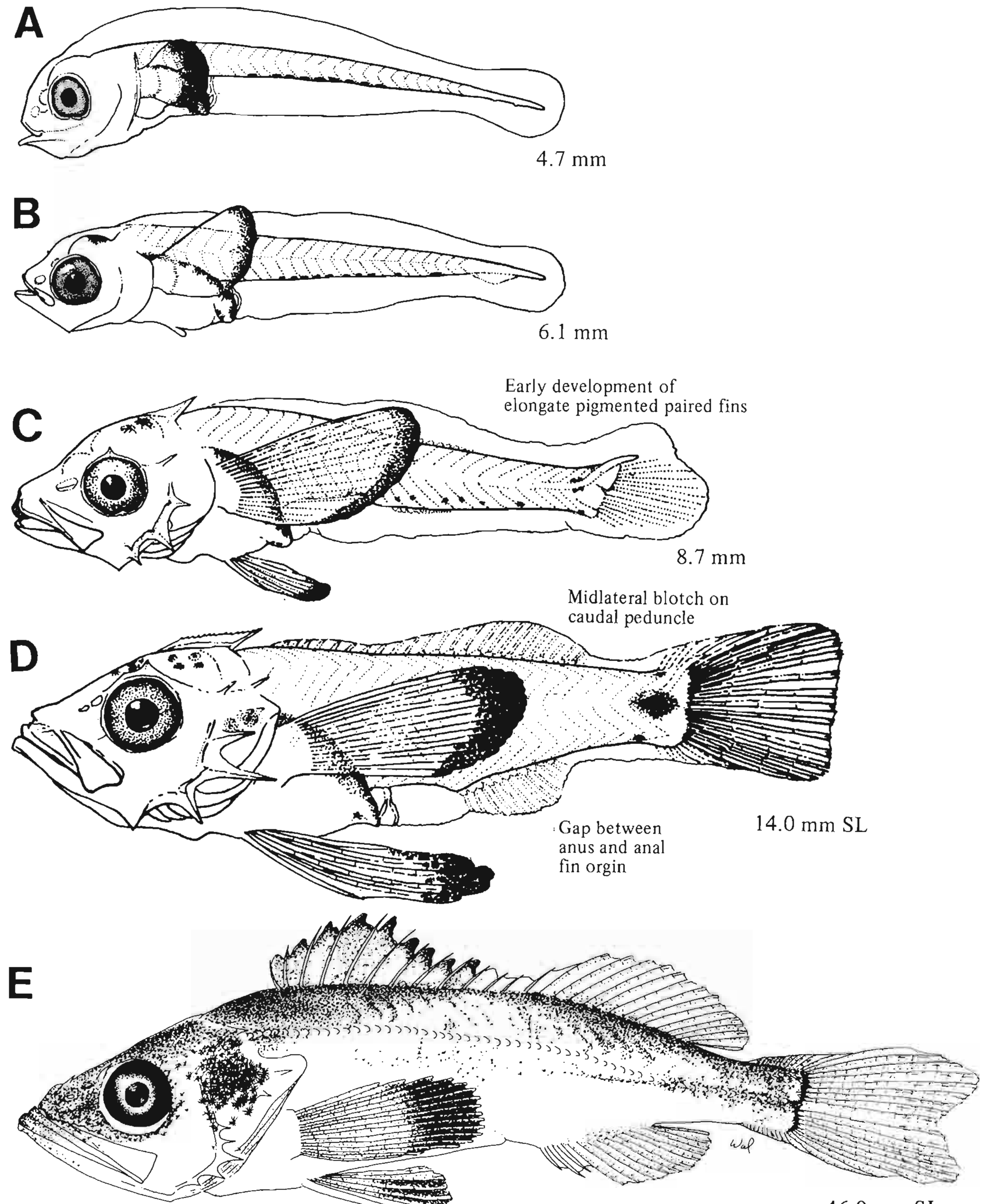
Pigment
- Fringed margins of pectoral and pelvic fins
- Few (6-14) ventral midline melanophores migrate with development to form large patch on caudal peduncle

Diagnostic characters
- Early development of elongate pigmented paired fins
- Midlateral pigment blotch on caudal peduncle
- Gap between anus and anal fin origin

PELAGIC JUVENILES
- Body pigment diffuse, light
- Paired and first dorsal fins heavily pigmented distally

[a] Westrheim 1975
[b] Frey 1971
[c] Moser 1967
[d] Phillips 1964
[e] Gunderson et al. 1980
[f] Wyllie Echeverria 1987
[g] Hart 1973
[h] Beamish 1979

Ref: Laroche, in prep.; Moser 1967; Moser et al. 1977.



Figures A–D, Moser et al. 1977; E, Laroche, in prep.

MERISTICS

Vertebrae	Total: 26-26-26 Precaudal: X-X-X Caudal: X-X-X
Branchiostegal rays	7-7-7
Caudal fin	X, 8+7, X
Pelvic fin	Thoracic S: 1-1-1 R: 5-5-5
Dorsal fin	S: 13-13-13 R: 13-14-15
Pectoral fin	R: 16-17-18
Anal fin	S: 3-3-3 R: 7-7-7
Gill rakers	U: 12-14-15 L: 26-28-31 (T: 41-43-44)
Lateral line pores	40-47

LIFE HISTORY

Range	South of southern California to Gulf of Alaska, 54-60°N
Ecology	Epi- and mesobenthal, 0-425 m
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: Jan-Mar (Brit. Col.);[a] Nov-Mar (California)[b] Area: Mode: Migration:
Fecundity	Range/function: 260,000-1,897,600[c]/ $F = 64221.3 \times L - 2330029$[d]
Age at first maturity	3-5 yr[c] 9 yr (females)[e]
Longevity	

HEAD SPINES

Preocular	+
Postocular	+
Coronal	0
Supraocular	+
Tympanic	+
Inferior infraorbital	2

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size	3.6-4.0 mm SL
Preanal length	59-64% SL
Length at flexion	<7.8-8.8 mm SL
Length at transformation	12.8-18.4 mm SL[f]
Sequence of fin development	Caudal and pectorals, pelvics, dorsal and anal

Pigment

- Initially: Lower jaw, ventral surface of gut and posterior gut, short dorsal and ventral midline series at ~3/4 BL between myomeres 18 and 24
- Short dorsal and ventral midline series on caudal peduncle
- Lightly pigmented paired fins
- Head: Dorsal surface; with development, patch also on upper part of opercle
- Paired fins have large melanophores on blades

Diagnostic characters

- Pigment: Opercular spot, spots on nape
- Morphology: Deep bodied (~40% SL)
- Spines: Large serrate parietal and third posterior preopercular spine

PELAGIC JUVENILES

- Body pigment banded, mainly above lateral midline
- Pigment blotch on last few dorsal fin spines, little pigment on rest of fins

[a] Westrheim 1975
[b] Moser 1967
[c] Phillips 1964
[d] Gunderson et al. 1980
[e] Wyllie Echeverria 1987
[f] Larvae are pelagic to 50 mm SL.

Ref: Laroche, in prep.; Moser et al. 1977; Richardson and Laroche 1979; Waldron 1968; Washington et al. 1984b.

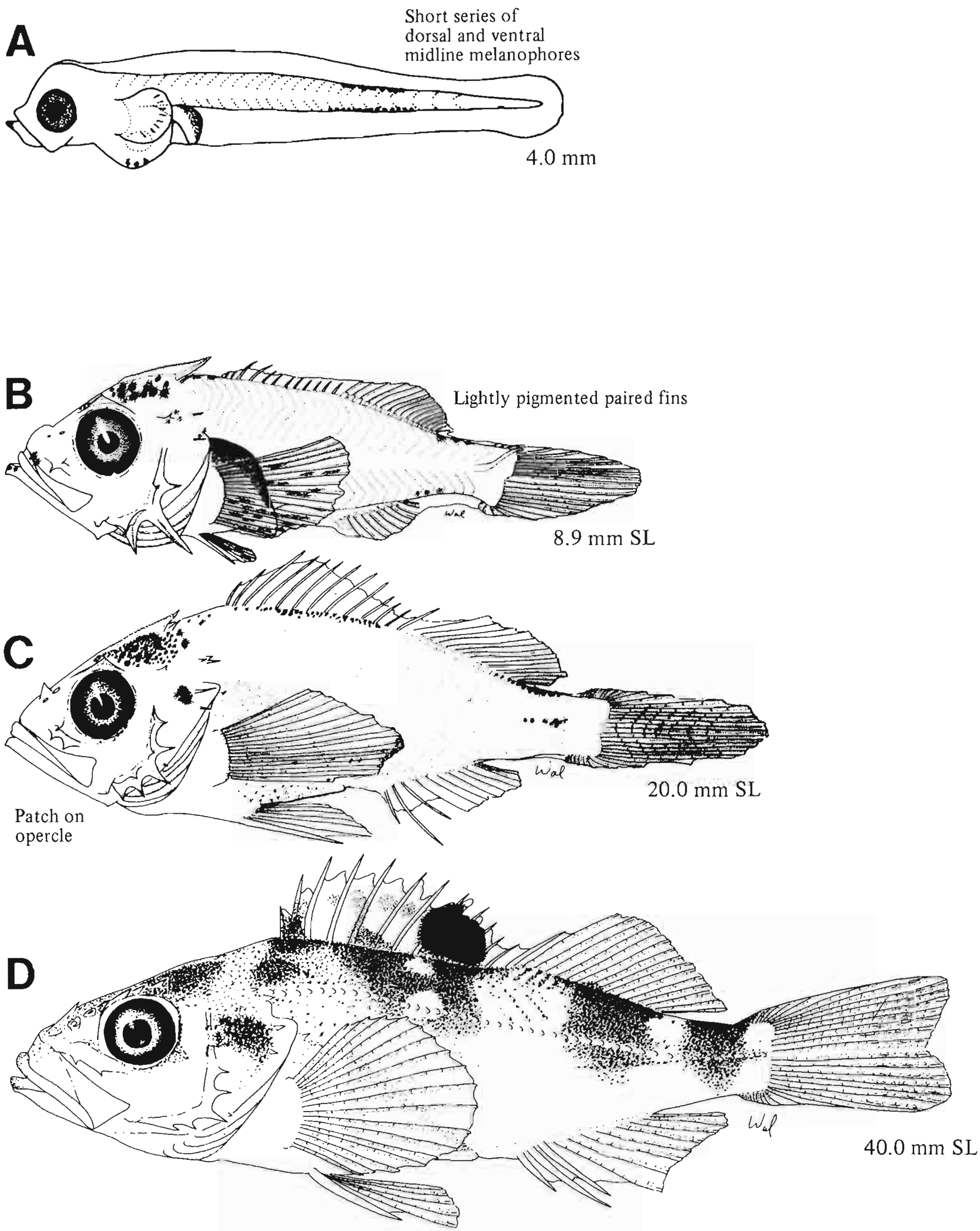


Figure A, Moser et al. 1977; B–C, Richardson and Laroche 1979; D, Laroche, in prep.

MERISTICS

Vertebrae	Total: 27-27-27	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	7-7-7	
Caudal fin	X, 8+7, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 13-13-13	R: 14-15-15
Pectoral fin	R: 16-17-17	
Anal fin	S: 3-3-3	R: 7-7-7
Gill rakers	U: 10-11-13	L: 26-27-30
	(T: 36-38-41)	
Lateral line pores	48-55	

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Epi- and mesobenthal, 12-274 m
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: July[a]
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

HEAD SPINES

Preocular	+
Postocular	+
Coronal	0
Supraocular	0
Tympanic	+
Inferior infraorbital	2

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size
Preanal length
Length at flexion
Length at transformation
Sequence of fin development
Pigment

- Extrusion larvae: Series along ventral body
- Postflexion larvae >16.8 mm SL
  - —On head dorsally
  - —Along dorsal body margin and anal fin ray base
  - —Internal and external spots along lateral midline
  - —Hypural margin

Diagnostic characters

PELAGIC JUVENILES

- Body elongate, pigment diffuse
- Little fin pigment

[a] Westrheim 1975

Ref: Laroche, in prep.

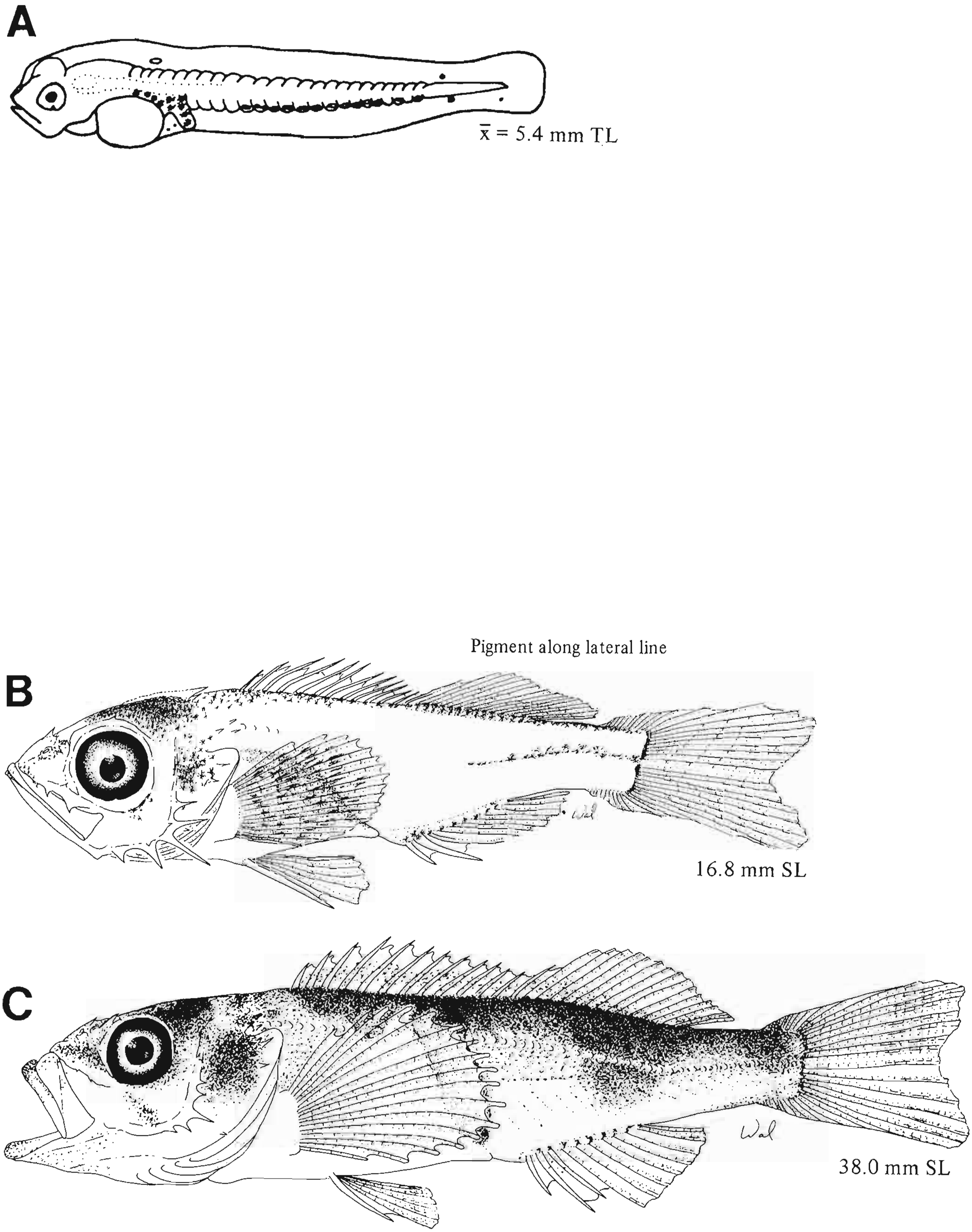


Figure A, Westrheim et al. 1968b; B–C, Laroche, in prep.

MERISTICS

Vertebrae	Total: 26-26-26	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	7-7-7	
Caudal fin	X, 8+7, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: X-X-X	R: 13-14-15
Pectoral fin	R: 18-19-20	
Anal fin	S: 3-3-3	R: 7-7-8
Gill rakers	U: 9-10-11	L: 23-24-27
	(T: 30-34-36)	
Lateral line pores	47-55	

LIFE HISTORY

Range	N. California, 38-42°N, to SE Alaska, 55-59°N
Ecology	Epi- and mesobenthal, 141-366 m
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: Apr[a]
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

HEAD SPINES

Preocular	+
Postocular	+
Coronal	0
Supraocular	+
Tympanic	+
Inferior infraorbital	2

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size

Preanal length

Length at flexion

Length at transformation

Sequence of fin development

Pigment

- Extrusion larvae: Short series along ventral body
- Postflexion larvae >18.5 mm SL
  - —Dorsally on head
  - —Along dorsal body margin
  - —Hypural margin

Diagnostic characters

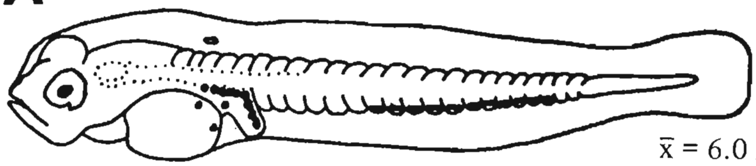
PELAGIC JUVENILES

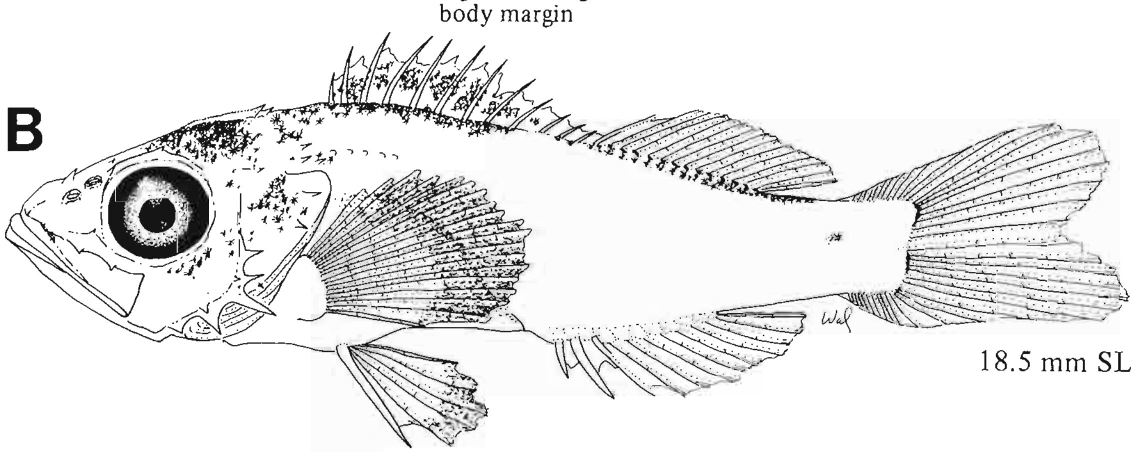
- Body pigment banded, heavy
- Fins heavily pigmented

[a] Westrheim 1975

Ref: Laroche, in prep.

A





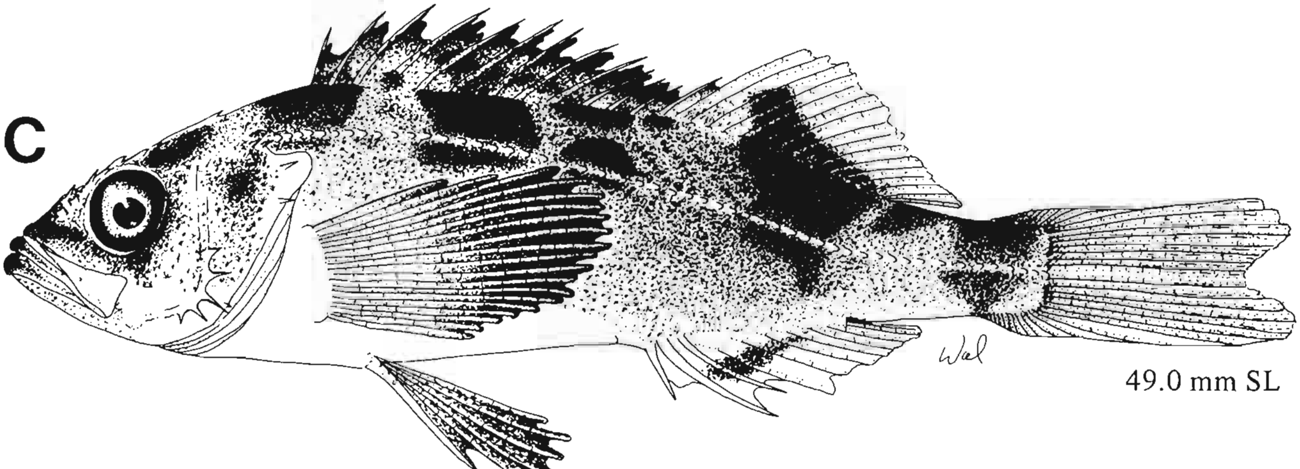


Figure A, Westrheim et al. 1968a; B–C, Laroche, in prep.

MERISTICS

Vertebrae	Total: 27-27-28	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	7-7-7	
Caudal fin	13-14, 8+7, 12-14	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 13-13-13	R: 13-15-16
Pectoral fin	R: 17-18-19	
Anal fin	S: 3-3-3	R: 8-X-9
Gill rakers	U: X-X-X	L: X-X-X
	(T: 32-35-37)	
Lateral line pores	49-56	

LIFE HISTORY

Range	South of southern California to Oregon, 42-46°N[a]
Ecology	Epi- and mesobenthal
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: Dec-May (north-central California)[b]
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	3 yr (females, California)[b]
Longevity	

HEAD SPINES

Preocular	+
Postocular	+
Coronal	0
Supraocular	+
Tympanic	+
Inferior infraorbital	2

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size	4.3-4.8 mm BL
Preanal length	38-43% BL
Length at flexion	7.2-7.6 mm BL
Length at transformation	
Sequence of fin development	

Pigment
- Increases from extrusion through flexion
- Tip of lower jaw
- Line develops on maxillaries
- Above brain and on nape
- Develops on opercular region
- Short ventral midline series
- Dorsal midline series develops
- Some internal pigment posteriorly above notochord
- Base and blade of pectoral fin

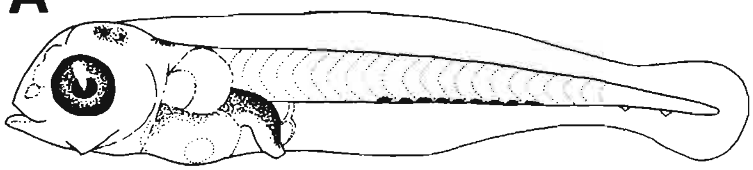
Diagnostic characters

PELAGIC JUVENILES
- Relatively light, uniform pigment
- Midlateral line pigmented
- Myosepta outlined with pigment

[a] NWAFC meristic database
[b] Wyllie Echeverria 1987

Ref: Moser and Butler 1987.

A



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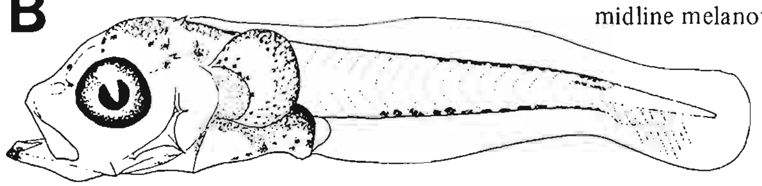

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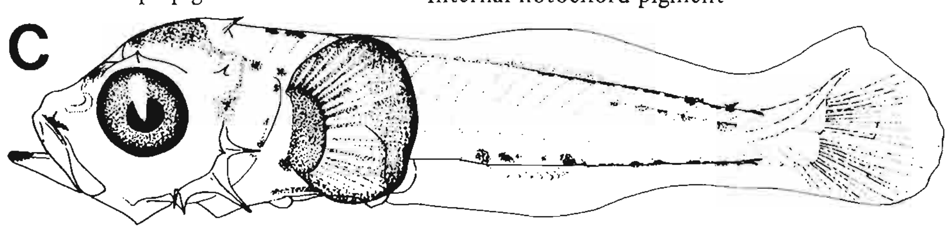
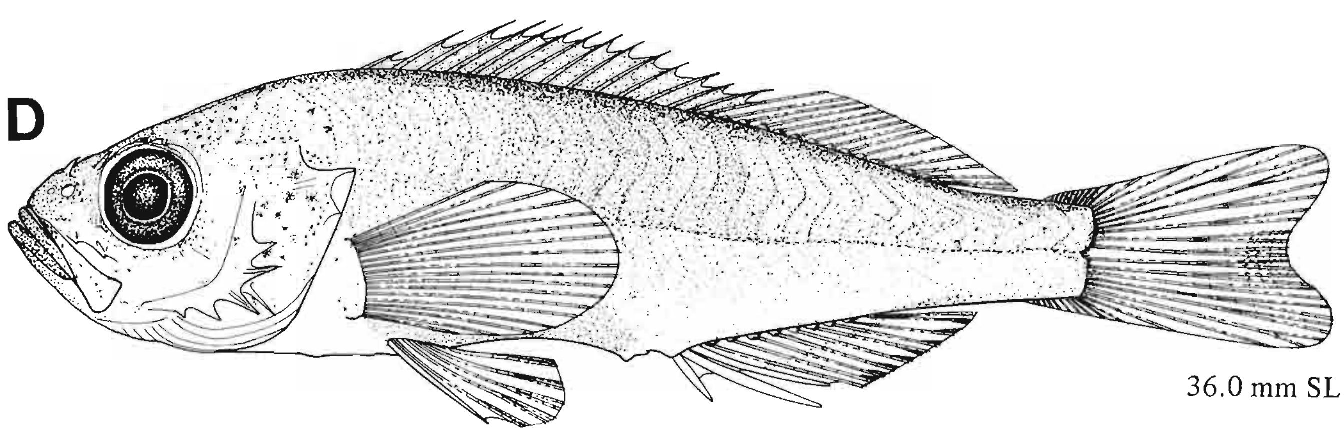


D



Figures A–C, Moser and Butler 1987; D, NWAFC original (B. Vinter).

MERISTICS

Vertebrae	Total: 26-26-26
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	7-7-7
Caudal fin	X, 8+7, X
Pelvic fin	Thoracic
	S: 1-1-1 R: 5-5-5
Dorsal fin	S: 13-13-13 R: 11-12-13
Pectoral fin	R: 16-16-18
Anal fin	S: 3-3-3 R: 6-7-7
Gill rakers	U: 8-10-10 L: 22-23-26 (T: 30-32-35)
Lateral line pores	35-43

LIFE HISTORY

Range	South of southern California to Gulf of Alaska, 54-60°N
Ecology	Epi- and mesobenthal, 46-421 m
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: Dec-Mar;[a] Feb[b]
	Area:
	Mode:
	Migration:
Fecundity	Range/function: 13,500-230,000[a]
Age at first maturity	2-4 yr[a]
	2 yr (females)[c]
Longevity	

HEAD SPINES

Preocular	+
Postocular	+
Coronal	0
Supraocular	0
Tympanic	+
Inferior infraorbital	2

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size

Preanal length

Length at flexion

Length at transformation

Sequence of fin development

Pigment

- Extrusion larvae: Series along ventral body, shorter series along posterior dorsal midline
- Postflexion larvae >17 mm SL
  —Pigment aligned along epaxial musculature
  —Internal and external spots along lateral midline

Diagnostic characters

PELAGIC JUVENILES

- Body pigment banded
- Median fins pigmented

[a] Phillips 1964
[b] Westrheim 1975
[c] Wyllie Echeverria 1987

Ref: Laroche, in prep.

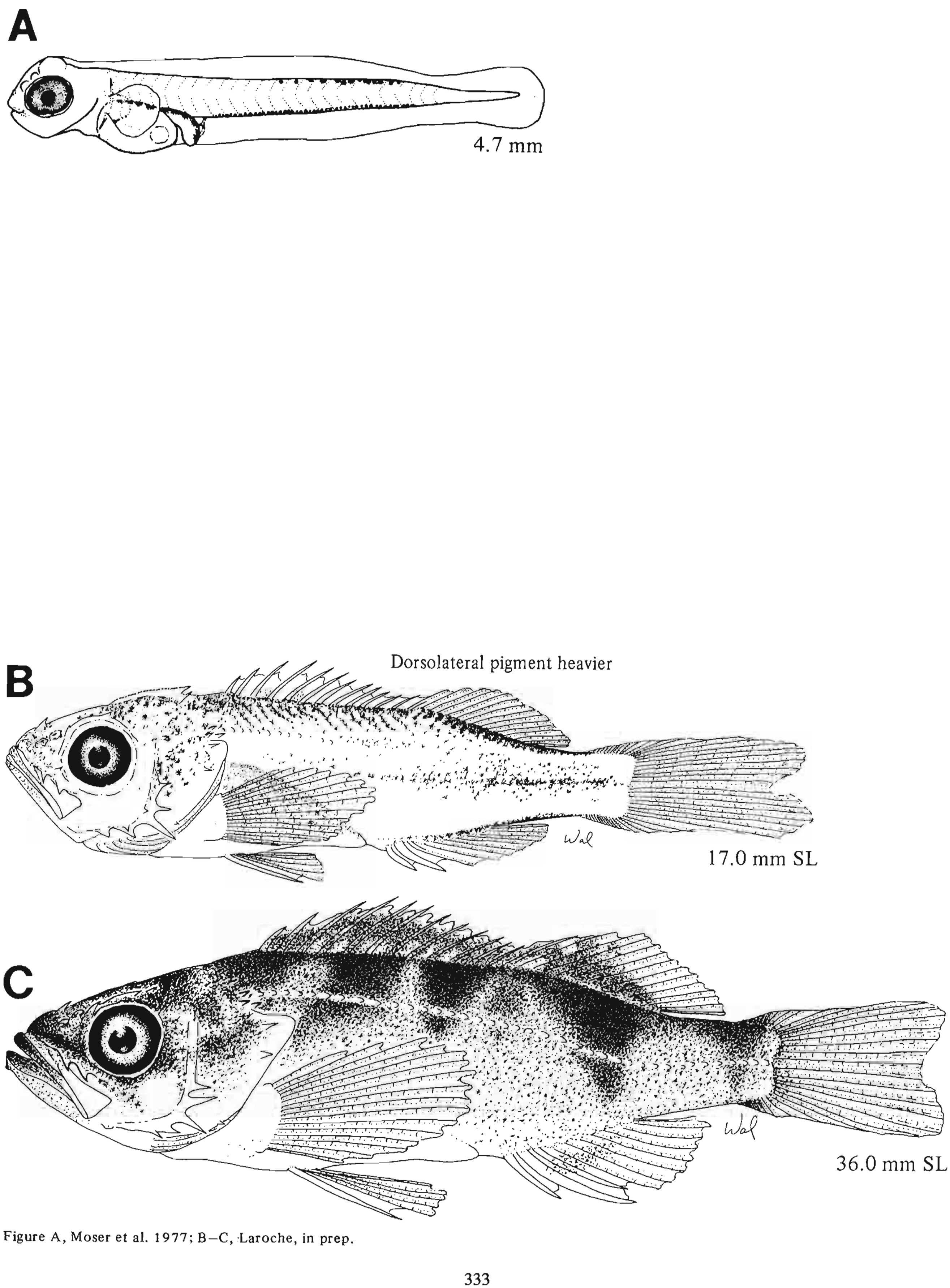


Figure A, Moser et al. 1977; B–C, Laroche, in prep.

MERISTICS

Vertebrae	Total: 27-27-27	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	7-7-7	
Caudal fin	X, 8+7, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 13-13-13	R: 13-14-15
Pectoral fin	R: 16-17-18	
Anal fin	S: 3-3-3	R: 7-7-8
Gill rakers	U: 9-10-11	L: 23-25-27
	(T: 33-35-37)	
Lateral line pores	39-47	

LIFE HISTORY

Range	South of southern California to Gulf of Alaska, 54-60°N
Ecology	Epi- and mesobenthal, 25-475 m
ELH pattern	Ovoviviparous, pelagic larvae
Spawning	Season: July (British Columbia)[a]
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

HEAD SPINES

Preocular	+
Postocular	+
Coronal	0
Supraocular	0
Tympanic	+
Inferior infraorbital	2

EARLY LIFE HISTORY DESCRIPTION

LARVAE

Hatch size	4.3 mm SL
Preanal length	50-75% SL
Length at flexion	7.4-9.0 mm SL
Length at transformation	~13.5-20.0 mm SL; 13.7-19.6 mm[b,c]
Sequence of fin development	Caudal and pectorals, pelvics, dorsal and anal

Pigment
- Extrusion larvae: Posterior gut, along ventral midline, and on head
- Larvae >7.4 mm SL: A few melanophores along ventral midline, head, and dorsal gut
- Postflexion larvae >12.7 mm SL: Along dorsal midline and fin base, on caudal peduncle

Diagnostic characters
- Moderately pigmented pectorals and pelvics
- Lack of body pigment
- Long, deeply serrate parietal spine and posterior preopercular spine
- Little ventral postanal midline pigment
- Development of dorsal midline pigment (>10 mm SL)
- Large head (>40% SL), deep body (>30% SL)

PELAGIC JUVENILES
- Body pigment diffuse, lateral midline pigmented
- Little fin pigment

[a] Westrheim 1975
[b] Washington et al. 1984b
[c] Juveniles are pelagic to 65 mm SL, although they may become demersal at 35 mm SL.

Ref: Laroche, in prep.; Laroche and Richardson 1981; Westrheim 1975.

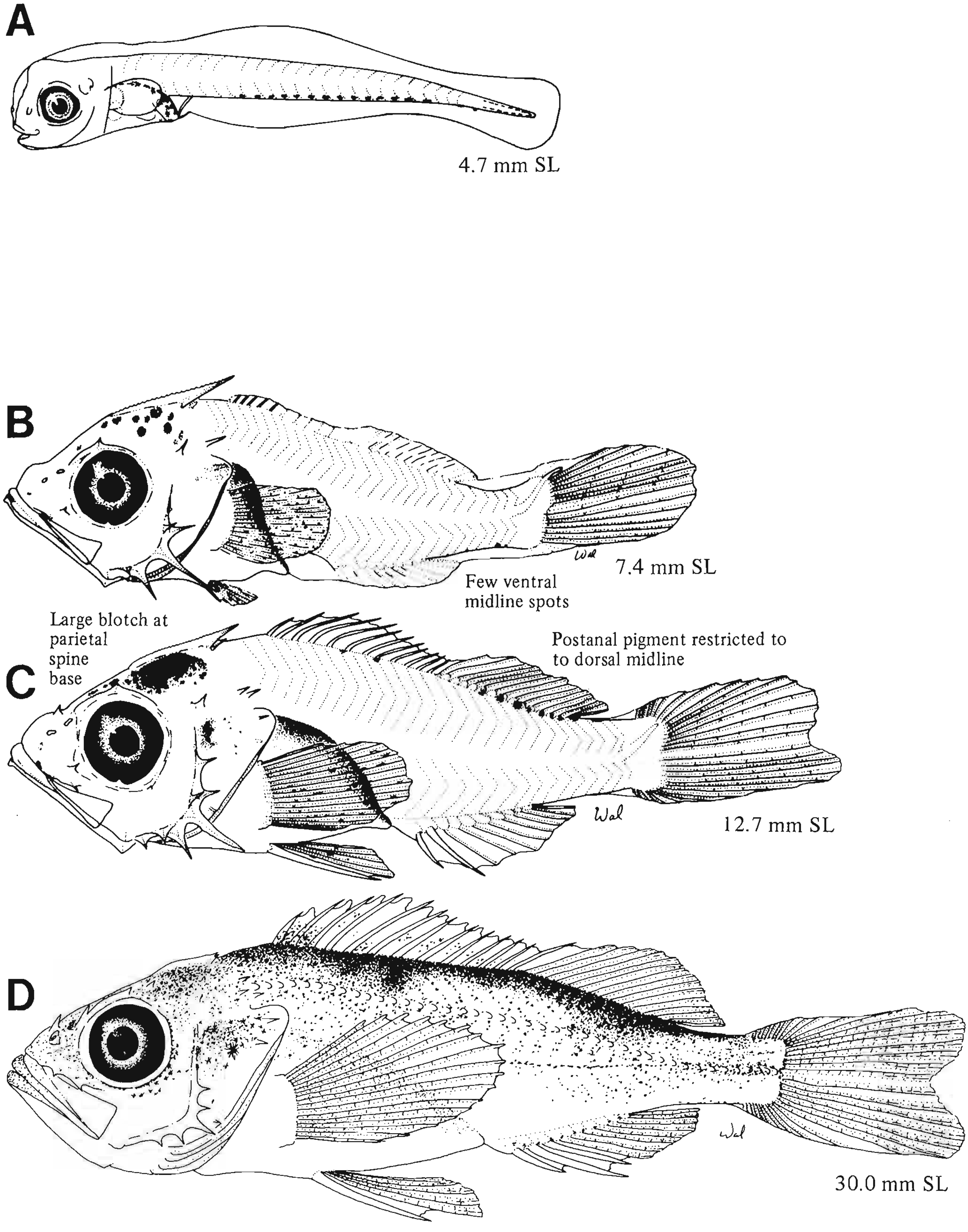


Figure A, NWAFC original (B. Vinter); B–C, Laroche and Richardson 1981; D, Laroche, in prep.

MERISTICS *S. alascanus* Bean 1890

Vertebrae	Total: 29-30-31	
	Precaudal: 10-10-11	
	Caudal: 18-20-21	
Branchiostegal rays	7-7-7	
Caudal fin	X, 8+8, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 14-16-17	R: 8-9-10
Pectoral fin	R: 20-21-23	
Anal fin	S: 3-3-3	R: 3-5-5
Gill rakers	U: 5-6-8	L: 12-14-17

MERISTICS *S. altivelis* Gilbert 1896

Vertebrae	Total: 28-X-29	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	7-7-7	
Caudal fin	X, 8+8, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 15-X-16	R: 8-X-10
Pectoral fin	R: 22-X-24	
Anal fin	S: 3-3-3	R: 4-X-6
Gill rakers	U: 7-X-9	L: 14-X-17

MERISTICS *S. macrochir* Günther 1880

Vertebrae	Total: 29-29-29	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	7-7-7	
Caudal fin	X, 8+7, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 15-15-16	R: 8-X-10
Pectoral fin	R: 22-X-23	
Anal fin	S: 3-3-3	R: 5-5-5
Gill rakers	U: 7-X-8	L: 13-X-14

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N[a]
Ecology	Benthal[b]
ELH pattern	Oviparous; gelatinous, pelagic egg masses;[c] pelagic larvae
Spawning	Season: Jan-June (California);[d] spring (Oregon)[c]

EARLY LIFE HISTORY DESCRIPTION

LARVAE - Genus[e]

Preanal length	<50%, with development increasing to 50-75% SL
Length at flexion	6.0-7.5 mm SL
Length at transformation	14-20 mm SL[f]
Sequence of fin development	Pectorals; caudal; dorsal, anal, and pelvics

Pigment - Genus
- Postanal band that disappears with development
- Pectoral fins pigmented at fringes
- Body lacks pigment from ~6-12 mm SL

Diagnostic characters
- <10.0 mm SL: Not separable to species
- >10.0 mm SL: *S. alascanus* less robust, shorter, and with fewer pectoral rays than *S. altivelis*

Distinguished from *Melamphaes lugubris* (p. 254) at sizes <5 mm SL by
- Postanal pigment band more posterior, beginning about myomere 20
- Pelvic fin not precocious in *Sebastolobus* spp.

[a] *S. macrochir* found only in the Bering Sea.
[b] *S. alascanus* epi-, meso-, and bathybenthal (26-1524 m); *S. altivelis* meso- and bathybenthal (305-1524 m); *S. macrochir* mesobenthal.
[c] Pearcy 1962
[d] Moser 1974
[e] Larvae of *S. macrochir* are unknown.
[f] Juveniles are pelagic to 42-56 mm SL.

Ref: Moser 1974, Moser et al. 1977, Washington et al. 1984b.

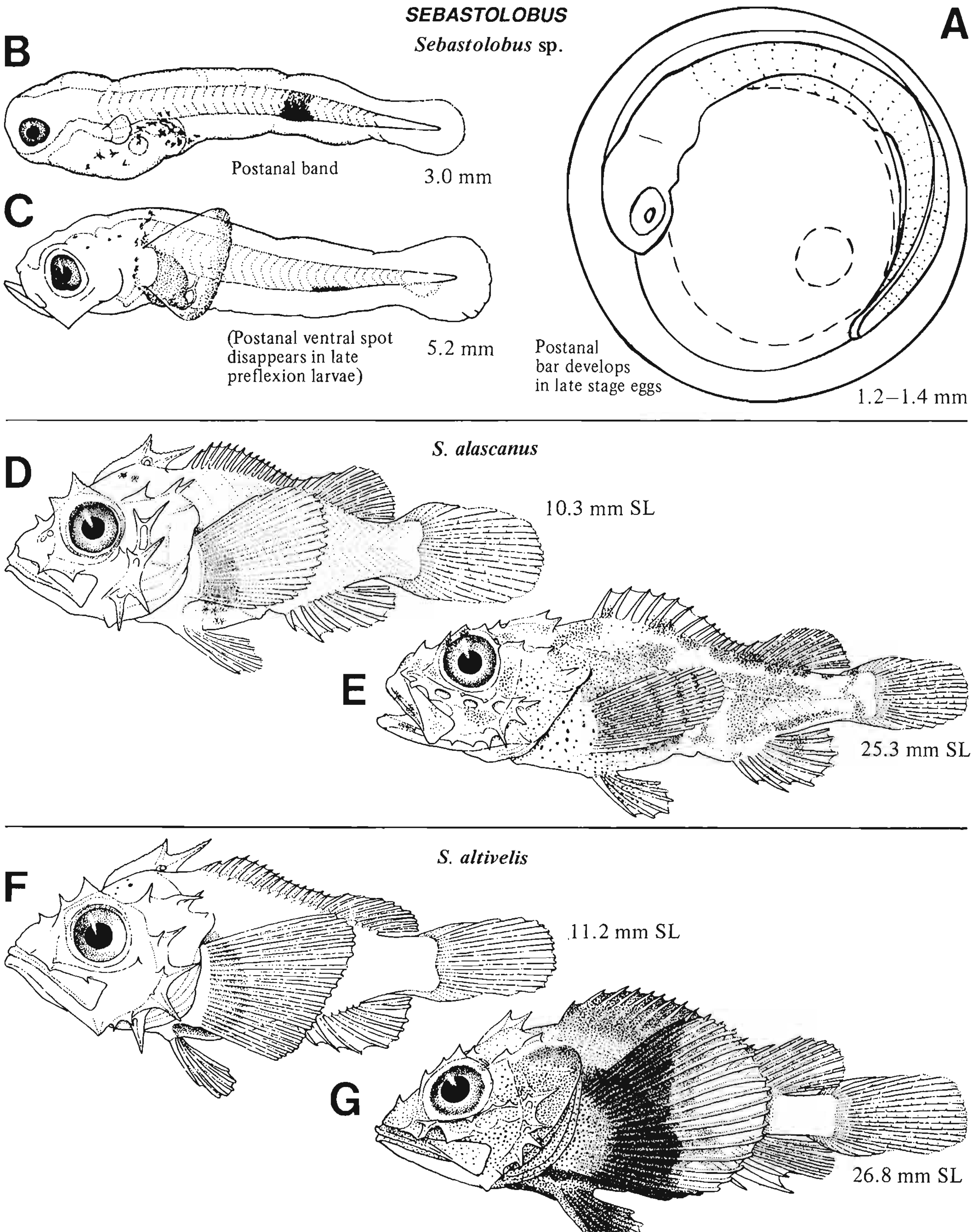


Figure A, NWAFC original (B. Vinter); B–G, Moser et al. 1977.

MERISTICS

Vertebrae	Total: 61-63-66	
	Precaudal: 29-31-33	
	Caudal: 31-33-34	
Branchiostegal rays	6-6-6	
Caudal fin	X, 7+7, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 17-22-30	R: 16-18-21
Pectoral fin	R: 14-14-14	
Anal fin	S: 2-X-3	R: 15-19-23
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Epi-, meso-, and bathybenthal, 0 (juveniles) - 2740 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Dec-Apr (California);[a] Sept-Apr (Oregon-Brit.Col.);[b] fall-summer (Bering Sea)[b]
	Area: Pelagic (175-1450 m)[b]
	Mode:
	Migration: To deeper water[c]
Fecundity	Range/function: 100,000[a]-1,300,000[d]
Age at first maturity	5-7 yr[d]
Longevity	55 yr[e]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	2.05-2.10 mm
No. of oil globules	None
Yolk	Homogeneous
Envelope	Smooth, unsculptured
Hatch size	6 mm SL
Incubation time/temp.	

Pigment
- Unpigmented embryo

Diagnostic characters
- Narrow perivitelline space
- Unpigmented embryo with high myomere count and long gut
- No oil globule
- Large size (2.05-2.10 mm)

LARVAE

Preanal length	50-60% SL
Length at flexion	∼12.0 mm SL
Length at transformation	
Sequence of fin development	Caudal, pectorals, 2nd dorsal (rays) and anal, 1st dorsal (spines), pelvics

Pigment
- Initially unpigmented
- Preflexion larvae develop dorsal and ventral midline pigment
- Flexion and later larvae are heavily and uniformly pigmented

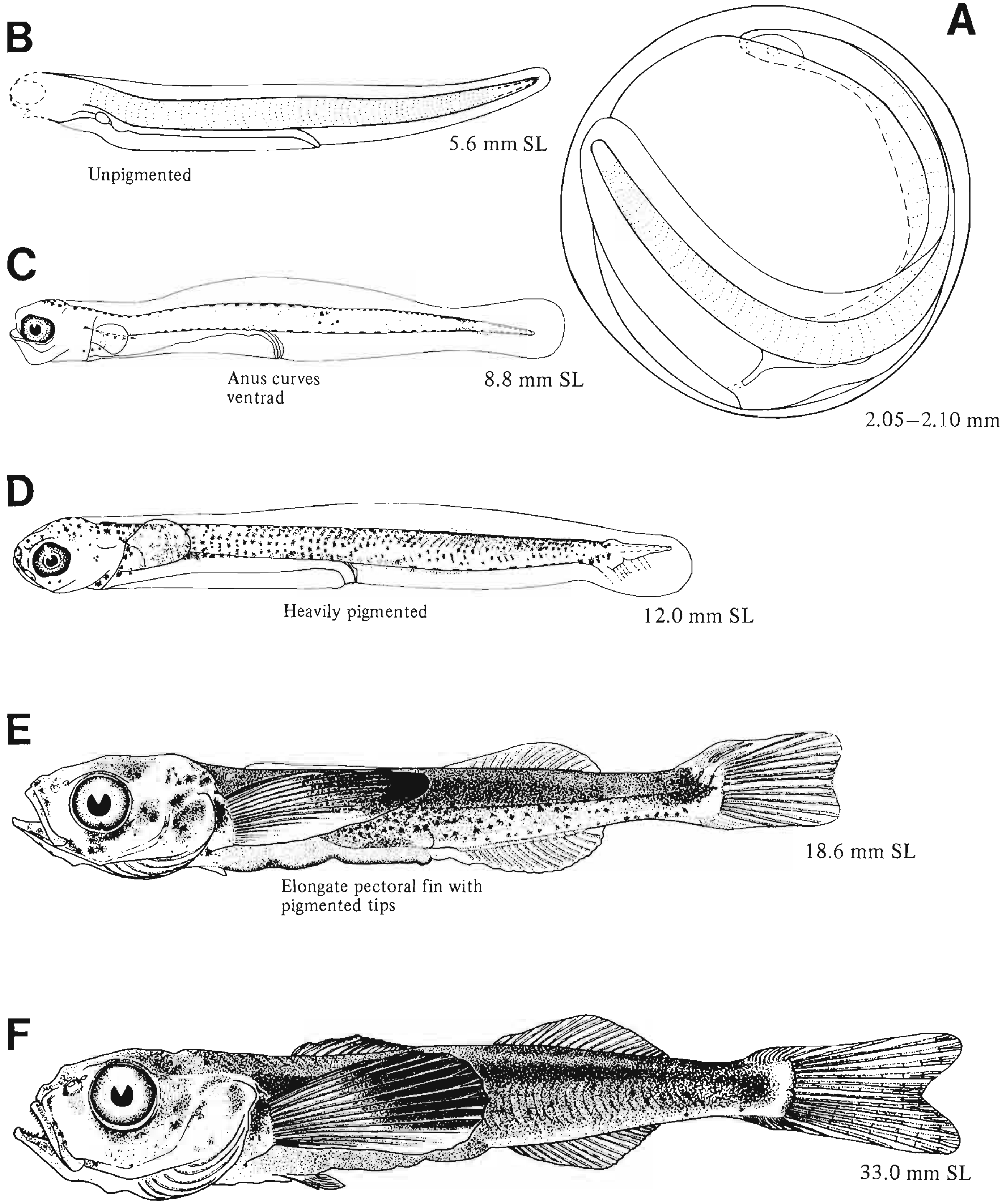
Diagnostic characters (see Table 3)
- Slender, heavily pigmented larvae (flexion)
- Long preanal length (50-60% SL)
- >15 mm SL: long pigmented pectoral fins
- Separate dorsal fins (larger larvae)

Larvae of *Erilepis zonifer* (skilfish), an anoplopomatid from the study area, are unknown. The following meristics distinguish them from *A. fimbria.*

Total vertebrae	45-46
Dorsal fin rays	XII-XVI, 15-19
Pectoral fin rays	16-19
Anal fin rays	III, 11-14

[a] Phillips and Imamura 1954
[b] Mason et al. 1983
[c] Kendall and Matarese 1987
[d] Alton and Webber 1976
[e] McFarlane and Beamish 1983

Ref: Ahlstrom and Stevens 1976, Kendall and Matarese 1987.



Figures A–D, Kendall and Matarese 1987; E–F, Ahlstrom and Stevens 1976.

Hexagrammidae

The greenlings, endemic to the North Pacific Ocean, are composed in our area of nine species in five genera. Most adult greenlings are demersal and occur nearshore; however, larvae commonly occur off the continental shelf. Eggs are demersal and are usually guarded in nests. Development from hatching to juvenile is direct without any marked transformation. An epipelagic juvenile stage occurs in most species. Larvae are heavily pigmented with scattered melanophores over most of the body, especially dorsally. Characters that will distinguish hexagrammids from other heavily pigmented larvae are presented in Table 3. Identification is accomplished using a combination of pigment and meristic characters along with geographic occurrence. *Oxylebius pictus* and *Zaniolepis* spp. larvae have lower vertebral counts, larger pectoral fins with heavier pigment, and differ from other genera in a number of morphological features (e.g., larger heads, longer preanal length, and deeper bodies). *Ophiodon elongatus* larvae can be separated by the presence of a pointed snout and a large terminal mouth. *Pleurogrammus monopterygius* larvae lack pigment on the snout which serves to distinguish them from larvae of *Hexagrammos* spp. Differences among the larvae of the various species of *Hexagrammos* spp. are discussed in Tables 34-35 and illustrated on page 351.

Table 32

Meristic characters of Northeast Pacific hexagrammids. For all species the normal count for branchiostegal rays is 6 and for pelvic fin rays is I,5 (Kendall and Vinter 1984).

	Vertebrae			Fin rays: Dorsal				Caudal: Dorsal		Caudal: Ventral		Gill rakers
Species	Precaudal	Caudal	Total	First (spines)	Second (soft rays)	Total anal*	Pectoral	Secondary	Principal	Principal	Secondary	First arch
Oxylebius pictus	13-15	23-25	36-40	15-17	13-16	14-17	14-17	9	7	6	9	11-14
Zaniolepis frenata	14-15	26-28	40-43	21	12	18-19						
Zaniolepis latipinnis	14	28	42	21-22	11-12	18-20	14	6-8	7	6	7-9	11-12
Ophiodon elongatus	23-24	33-35	56-59	25-28	19-21	21-25	16-18	13-15	7	7	12-14	19-28
Pleurogrammus monopterygius	26-28	32-35	58-63	21-24	24-30	23-28	23-28	16-19	8	11	16-20	22-27
Hexagrammos decagrammus	20-22	33-35	52-57	21-23	22-26	23-26	18-20	12-16	7	9	12-14	15-20
Hexagrammos lagocephalus	20-23	32-34	52-57	20-23	20-25	21-24	18-21	17-22	7	10	15-19	14-18
Hexagrammos octogrammus	18-19	32-35	50-54	18-20	22-25	23-26	18-19	15-17	7	8	14-15	14-17
Hexagrammos stelleri	20-22	31-34	51-56	22-25	18-22	22-25	18-20	16-17	7	8	14-15	16-20

*Anal spines are very weak in *Pleurogrammus* and *Hexagrammos*, therefore only total anal fin elements are given for these taxa. Counts for anal spines in specific taxa are given on the individual text pages.

Table 33

Larval characters that allow distinction between *Oxylebius pictus* and *Zaniolepis* spp. (Kendall and Vinter 1984).

	Oxylebius pictus	*Zaniolepis* spp.
3-7 mm SL		
Presence of pigment		
On isthmus	No	Yes
Laterally above gut	Less	More
On ventral midline of trunk	More	Less
On tip of snout and onto tip of palate	No	Yes
On internal surface of pectoral fin base	Yes	No
On lower lip	No	Sometimes
Morphology		
Eye size	Smaller (<20% head length)	Larger (>30% head length)
Preanal finfold (5 to 8 mm)	No	Yes
Pectoral fin length	Reaches anus by 8.0 mm	Reaches anus by 5.5 mm
Notochord flexion	7-9 mm	5-7 mm
Dorsal indentation on eye	No	Yes
>7 mm SL		
Spiny scales cover body	No	Yes
Body depth	Stout (<30% SL)	Slender (<25% SL)

MERISTICS

Vertebrae	Total: 36-X-40	
	Precaudal: 13-13-15	
	Caudal: 23-24-25	
Branchiostegal rays	6-6-6	
Caudal fin	9, 7+6, 9	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 15-X-17	R: 13-X-17
Pectoral fin	R: 14-X-17	
Anal fin	S: 3-X-4	R: 12-X-14
Gill rakers	U: 2-X-5	L: 7-X-8

LIFE HISTORY

Range	South of southern California to Gulf of Alaska, 54-60°N
Ecology	Nearshore shelf demersal, intertidal to 49 m
ELH pattern	Oviparous; demersal, adhesive eggs; pelagic larvae
Spawning	Season: May-Aug (Puget Sound);[a] Oct-July (Calif.)[b]
	Area: Demersal, on or near rocks[b]
	Mode: Eggs guarded by male; may have three breeding cycles/season[b]
	Migration:
Fecundity	Range/function: 12,000-28,000/ $F=0.0338 \times L^{2.114}$, L=TL mm (Shilshole breakwater, Washington); $F=0.003 \times L^{2.628}$, L=TL mm (Monterey, Calif.)[b]
Age at first maturity	3 yr (females)[b]
	2 yr (males)[b]
Longevity	>8 yr[c]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	
Hatch size	4-5 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

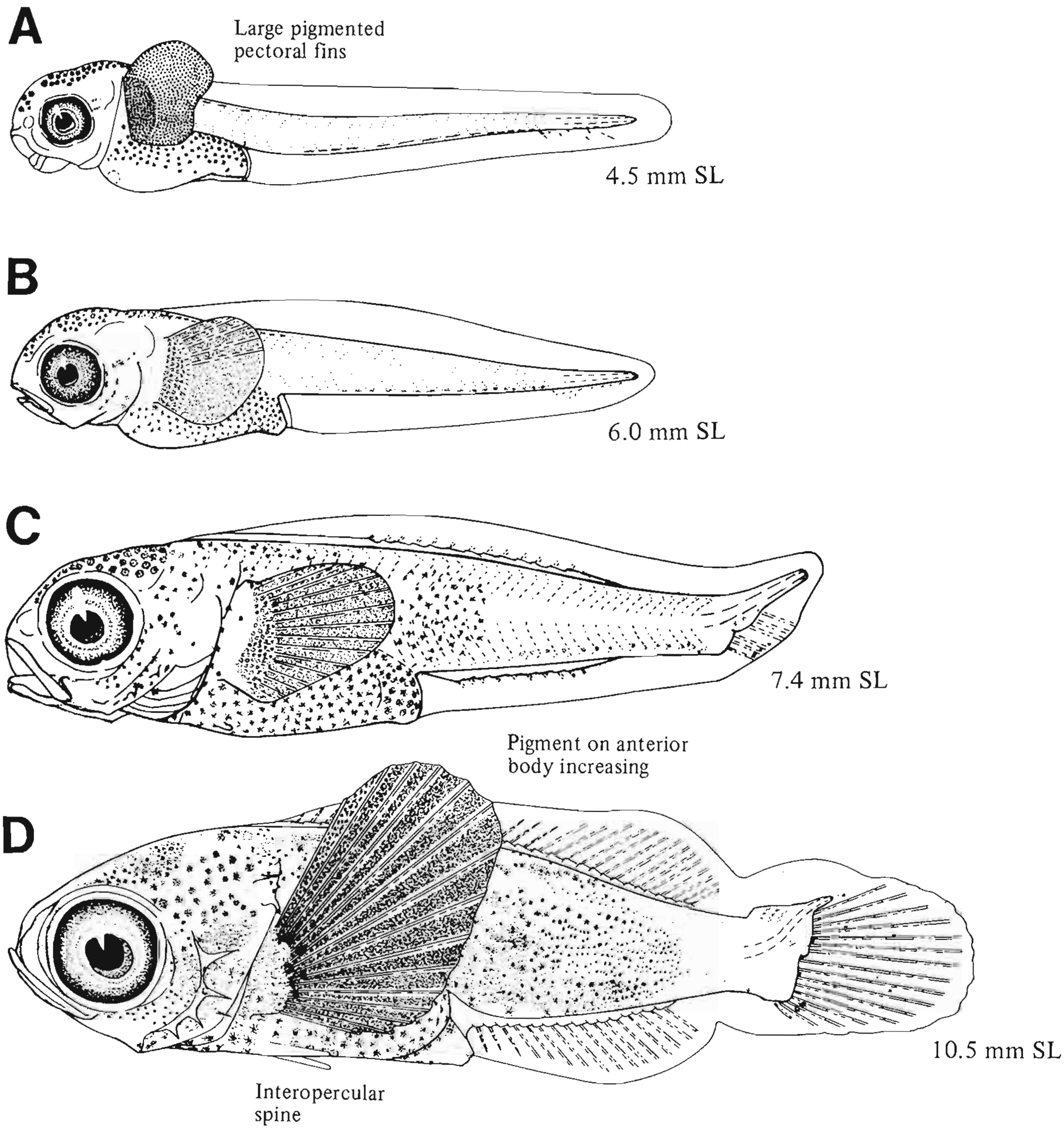
Preanal length	54-64% SL
Length at flexion	7-9 mm SL
Length at transformation	16-20 mm SL
Sequence of fin development	Pectorals, caudal, 2nd dorsal (rays) and anal, 1st dorsal (spines) and pelvics

Pigment
- Pectoral fin
- Ventral midline
- Dorsolateral on gut
- Flexion larvae with increased pigment on anterior body

Diagnostic characters
- See Table 33 for characters that allow separation from *Zaniolepis* spp.
- Large pigmented pectoral fins

[a] Patten 1980
[b] DeMartini 1976
[c] Fitch and Lavenberg 1975

Ref: Kendall and Vinter 1984.



Figures A–D, Kendall and Vinter 1984.

MERISTICS — *Z. frenata* Eigenmann and Eigenmann 1889

Vertebrae	Total: 40-X-43	
	Precaudal: 14-14-15	
	Caudal: 26-28-28	
Branchiostegal rays	6-X-7	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 21-21-21	R: 12-12-12
Pectoral fin	R: X-X-X	
Anal fin	S: 3-3-3	R: 15-X-16
Gill rakers	U: X-X-X	L: 10-X-11

MERISTICS — *Z. latipinnis* Girard 1857

Vertebrae	Total: 42-42-42	
	Precaudal: 14-14-14	
	Caudal: 28-28-28	
Branchiostegal rays	6-X-7	
Caudal fin	6-8, 7+6, 7-9	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 21-X-22	R: 11-X-12
Pectoral fin	R: 14-14-14	
Anal fin	S: 3-3-3	R: 15-X-17
Gill rakers	U: 3-3-3	L: 8-X-9

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N[a]
Ecology	Benthal[b]
ELH pattern	Oviparous, demersal eggs, pelagic larvae
Spawning	Season: Fall-winter (California)[c]
	Area:
	Mode:
	Migration:
Fecundity	Range/function: 350-6530 (may produce three clutches/season)[c]
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.40-1.56 mm[d]
No. of oil globules	30-50 (red, orange)[d]
Oil globule diameter	0.04-0.12 mm[d]
Yolk	
Envelope	Finely striated[d]
Hatch size	2.5 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

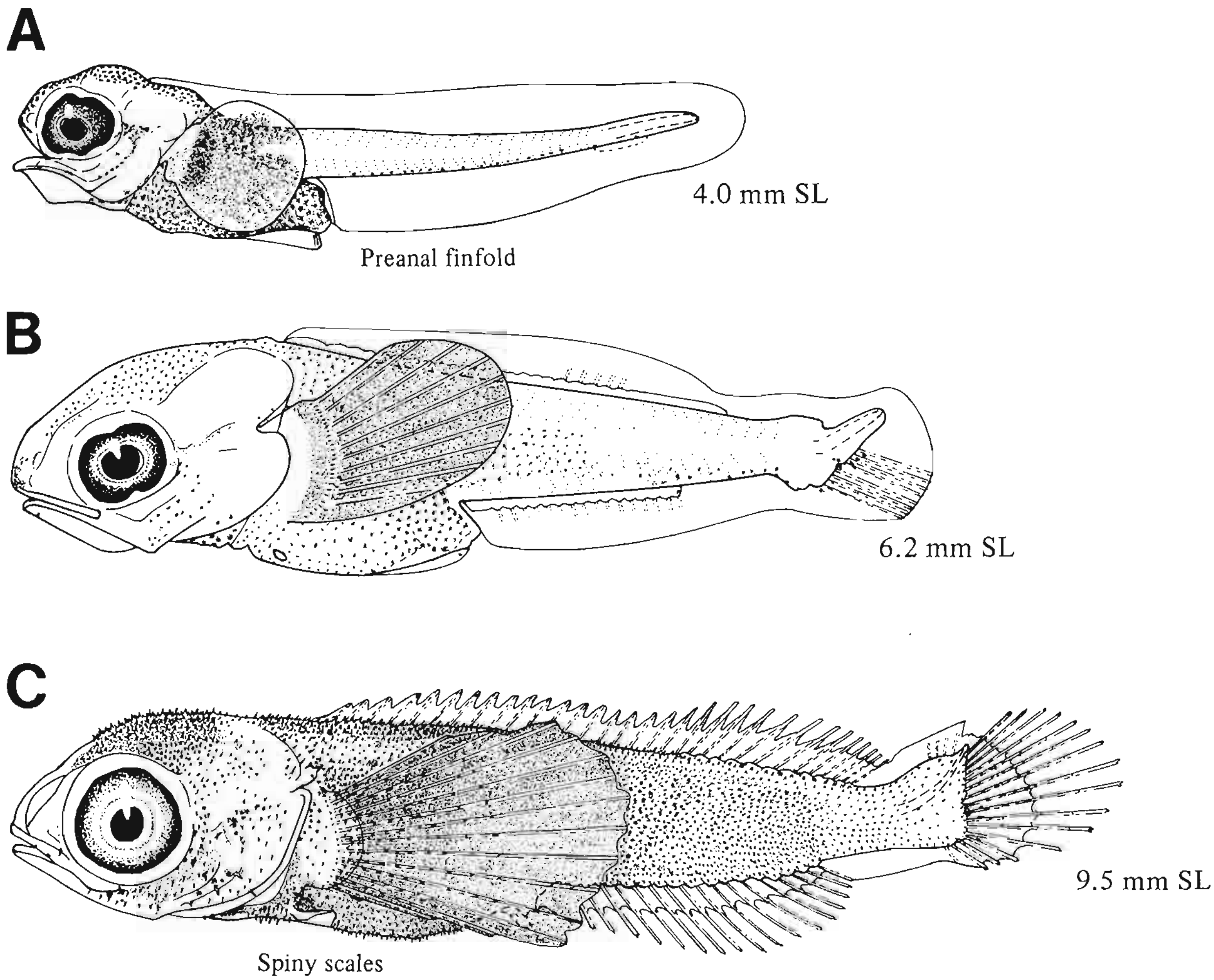
Preanal length	~50% SL
Length at flexion	5-7 mm SL
Length at transformation	
Sequence of fin development	Pectorals, caudal, 2nd dorsal (rays) and anal, 1st dorsal (spines) and pelvics

Pigment
- Laterally on gut
- Ventral midline
- Flexion larvae with increased pigment on body

Diagnostic characters
- See Table 33 for characters that allow separation from *Oxylebius pictus*
- Spiny scales

[a] *Z. frenata* only to Oregon, 42-46°N.
[b] *Z. frenata* epi- and mesobenthal (55-244 m); *Z. latipinnis* nearshore shelf (37-201 m).
[c] *Z. latipinnis* only (Goldberg 1980a).
[d] Data are from unfertilized, hydrated eggs of *Z. frenata* (W. Watson, Marine Ecological Consultants, 531 Encinitas Blvd., Suite 110, Encinitas, CA 92024, pers. commun., 6 Feb. 1988).

Ref: Kendall and Vinter 1984.



Figures A–C, Kendall and Vinter 1984.

MERISTICS

Vertebrae	Total: 56-X-59	
	Precaudal: 23-23-24	
	Caudal: 33-34-35	
Branchiostegal rays	6-X-7	
Caudal fin	13-15, 7+7, 12-14	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 25-X-28	R: 19-X-21
Pectoral fin	R: 16-X-18	
Anal fin	S: 3-3-3	R: 21-X-25
Gill rakers	U: 5-X-8	L: 16-X-19

LIFE HISTORY

Range	South of southern California to Gulf of Alaska, 54-60°N
Ecology	Epi- and mesobenthal, intertidal to 475 m
ELH pattern	Oviparous; demersal, adhesive, attached eggs; pelagic larvae
Spawning	Season: Dec-Apr[a]
	Area: Intertidal to 19 m below low tide;[a] nest in rocky areas with high current velocities[b]
	Mode: One or more nests guarded by male[c]
	Migration: To shallow water[d]
Fecundity	Range/function: 60,000-500,000[e]/ $N=0.0002824 \times L^{3.001}$ [f]
Age at first maturity	2-3 yr[g]
Longevity	20 yr[h]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	2.24-3.23 mm
No. of oil globules	One
Oil globule diameter	
Yolk	
Envelope	Opaque, thick
Hatch size	7-10 mm SL (9.3 mm SL)
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

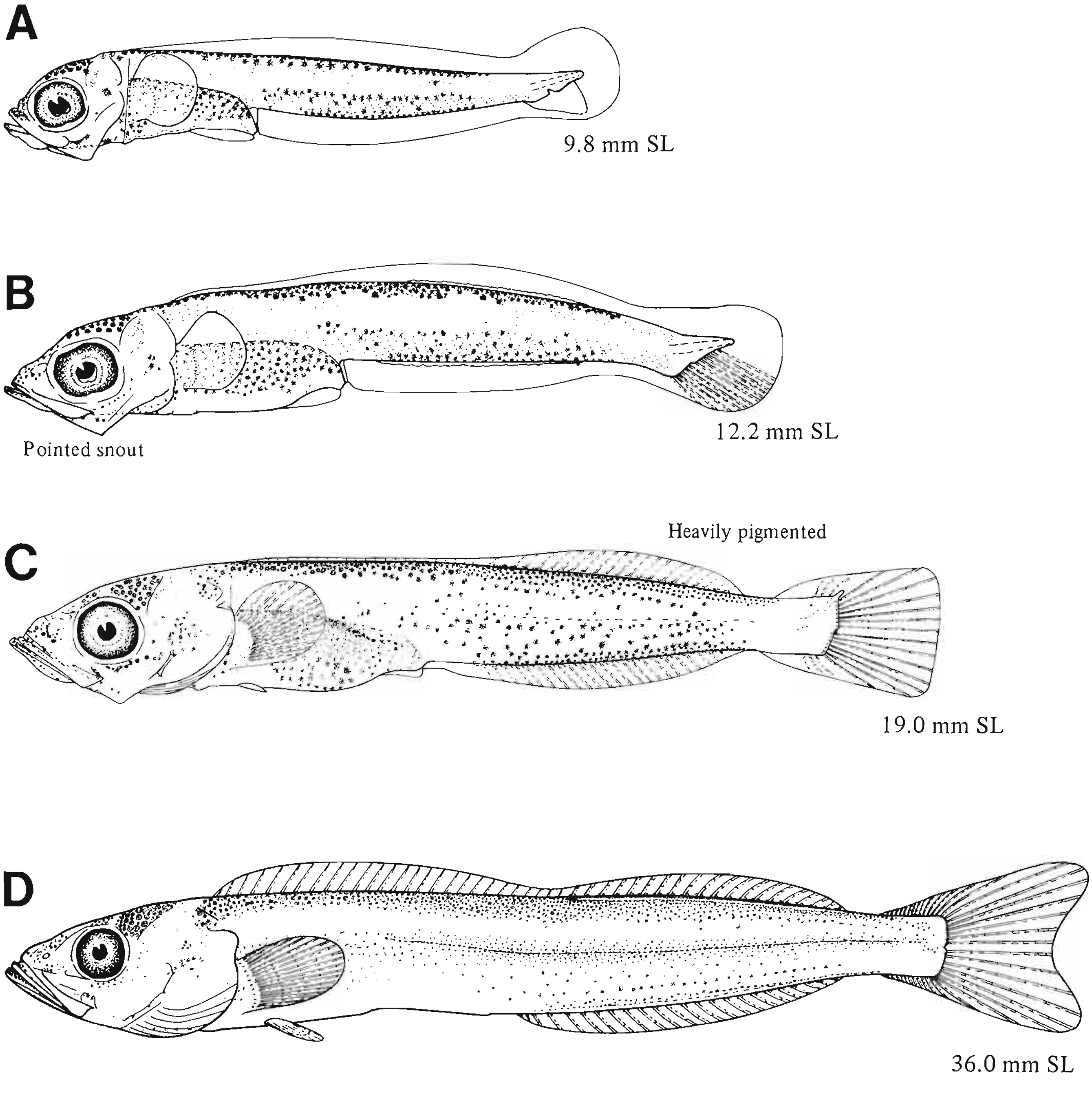
Preanal length	~43-55% SL
Length at flexion	11-15 mm SL
Length at transformation	30 mm SL; larvae remain pelagic to 52 mm SL
Sequence of fin development	Caudal and pectorals, 2nd dorsal (rays) and anal, 1st dorsal (spines), pelvics

Pigment
- Head and snout
- Laterally on surface of gut
- Along dorsal midline and ventrolateral body
- Rather uniformly pigmented (flexion)

Diagnostic characters (see Table 3)
Distinguished from other hexagrammids by
- Pointed snout, protruding lower jaw
- Large terminal mouth with gape directed upward
- Longer gut
- Distribution of pigment on tail

[a]LaRiviere et al. 1981
[b]Giorgi 1981
[c]Jewell 1968
[d]Miller and Geibel 1973
[e]Phillips 1959
[f]Hart 1967; N=egg number.
[g]Frey 1971
[h]Fitch and Lavenberg 1971

Ref: Kendall and Vinter 1984.



Figures A–D, Kendall and Vinter 1984.

MERISTICS

Vertebrae	Total: 58-X-63 Precaudal: 26-X-28 Caudal: 32-X-35	
Branchiostegal rays	5-X-7	
Caudal fin	16-19, 8+11, 16-20	
Pelvic fin	Thoracic S: 1-1-1	R: 5-5-5
Dorsal fin	S: 21-X-24	R: 24-X-30
Pectoral fin	R: 23-X-28	
Anal fin	R: 23-X-28	
Gill rakers	U: 6-X-8	L: 16-X-19

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Epi- and mesobenthal, intertidal to 575 m
ELH pattern	Oviparous; demersal, attached eggs; pelagic larvae
Spawning	Season: June-Sept (Bering Sea)[a] Area: Mode: Nests guarded by males[b] Migration:
Fecundity	Range/function: 3653-18,694;[c] 43,000[a]
Age at first maturity	3-4 yr[a]
Longevity	11 yr[a]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	2.5-2.8 mm
No. of oil globules	Many in group
Oil globule diameter	1.38-1.40 mm
Yolk	
Envelope	Smooth
Hatch size	~8 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	33-50% SL
Length at flexion	14-19 mm SL
Length at transformation	
Sequence of fin development	Caudal, pectorals, dorsal and anal, pelvics

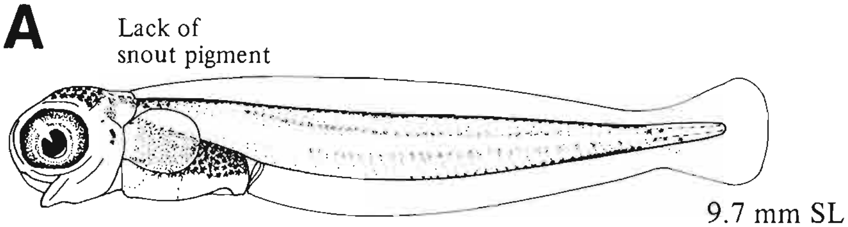
Pigment
- Midbrain and internally on hindbrain
- Dorsolateral surface of gut
- Postanal: Dorsal midline along body length to last myomere; ventral midline extends only from mid-body to last myomere
- Internal above and below notochord

Diagnostic characters (see Table 3)
Distinguished from other hexagrammids by
- Pigment pattern (unpigmented snout)
- Morphology: Larger eye, shorter snout

[a]Gorbunova 1962
[b]Kendall and Vinter 1984
[c]Lee 1985

Ref: Kendall and Vinter 1984.

A



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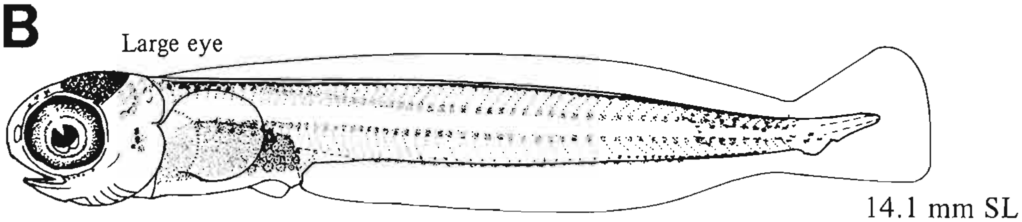

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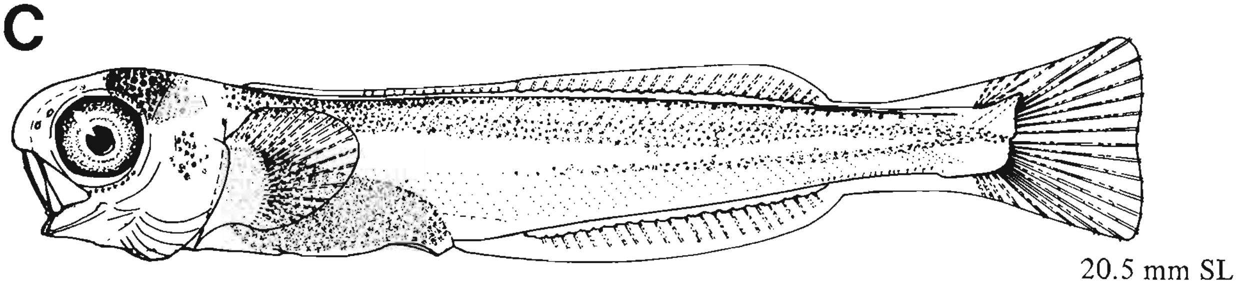

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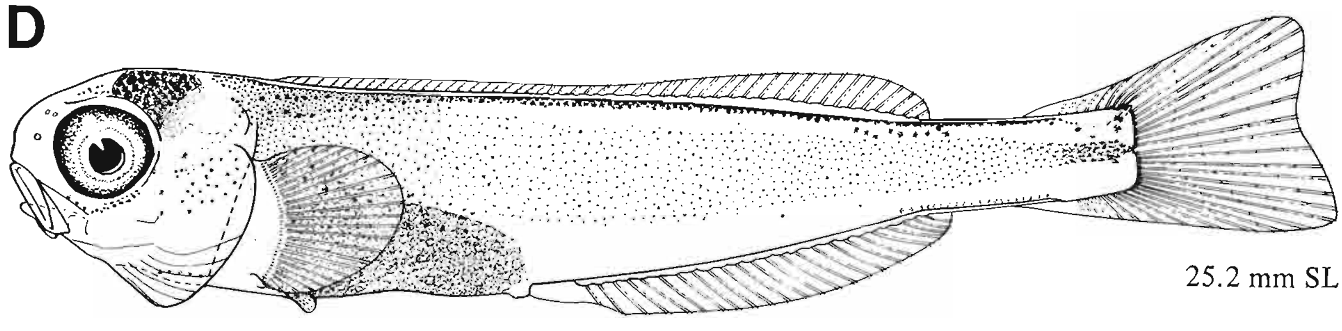


Figures A–D, Kendall and Vinter 1984.

Table 34
Guide for identifying Northeast Pacific species of *Hexagrammos* based on meristic characters (Kendall and Vinter 1984).

Based on principal ventral caudal fin rays*		
Principal ventral caudal rays	8	
precaudal vertebrae	20-22	= *H. stelleri*
precaudal vertebrae	18-19	= *H. octogrammus*
Principal ventral caudal rays	9	= *H. decagrammus*
Principal ventral caudal rays	10	= *H. lagocephalus*
Based on extremes of meristic characters		
Dorsal fin spinous rays	18-19	= *H. octogrammus*
	20-23	= indeterminate
	24-25	= *H. stelleri*
Dorsal fin soft rays	18-19	= *H. stelleri*
	20-25	= indeterminate
	26	= *H. decagrammus*
Total anal fin elements	21	= *H. lagocephalus*
	22-26	= indeterminate
Precaudal vertebrae	18-19	= *H. octogrammus*
	20-23	= indeterminate
Caudal vertebrae	31	= *H. stelleri*
	32-35	= indeterminate
Total vertebrae	50	= *H. octogrammus*
	51-57	= indeterminate

*Prior to completion of caudal fin development, the principal ventral caudal fin ray count can be one less in larvae.

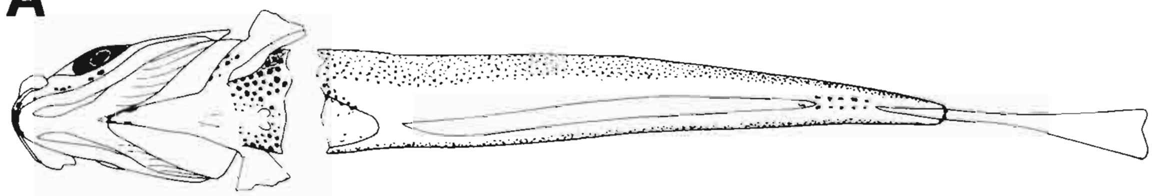
Table 35
Pigmentation characteristics that distinguish larvae <30 mm of the four species of *Hexagrammos* in the Northeast Pacific (Kendall and Vinter 1984, in part).[a]

	Pigment area			
Species	Postanal ventral midline	Isthmus	Notochord tip	Internal pectoral fin base[b] (>17 mm)
H. stelleri	Absent until ~15 mm, then starts to form posteriorly (on caudal peduncle), later (>23 mm) forms along entire base of anal fin.	Absent at hatching. Anterior half gradually becomes pigmented starting at 10 mm.	Absent	Present
H. decagrammus	Absent until ~13 mm, then starts to form along anal fin base near its origin. By 18 mm along anal fin base to caudal peduncle. Spots more numerous and smaller than on *H. lagocephalus*.	About four equal-sized and -spaced spots form on each side making a "V." Present from ~9 mm on.	Absent at hatching but forms by ~10 mm.	Inconsistently present
H. lagocephalus	Present throughout development. Particularly dense on caudal peduncle. Spots along anal fin base tend not to touch each other. Spots uneven in spacing and size to create irregular line. Few spots anterior to origin of anal fin.	An anterior medial spot and about five equal-sized and -spaced spots present from ~9 mm on.	Present	Absent
H. octogrammus	Present throughout development. Extends from anus to base of caudal fin. Dense on caudal peduncle. Spots tend to touch each other to create a continuous straight line.	Present; anteriormost and posteriormost spots larger than others. Anterior medial spot seen at 10 mm, up to five on each side of isthmus seen at 12 mm. Spacing uneven.	Present	Present

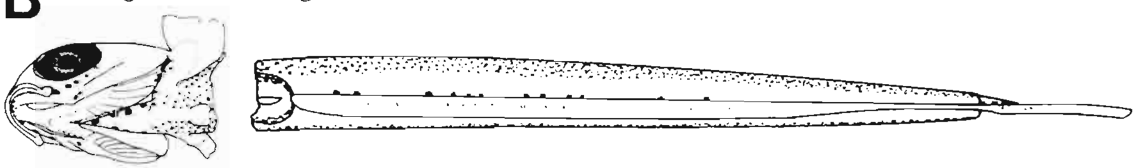
[a] Pigmentation characteristics discussed in this table were based on larvae collected in the Gulf of Alaska. Variation in some of these features is known to occur in larvae from other areas.
[b] One to a few spots occur near the dorsal edge of the internal surface of the pectoral fin base.

VENTRAL VIEW OF *HEXAGRAMMOS* SPP. LARVAE (16-18 mm SL)
DEPICTING PIGMENT ON THE LOWER JAW, ISTHMUS, AND POSTANAL VENTRAL MIDLINE

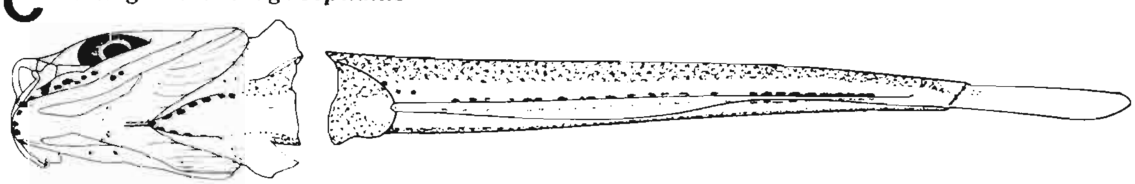
A *Hexagrammos stelleri*



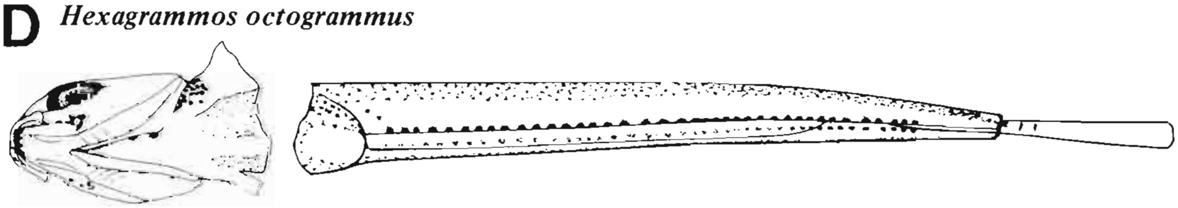
B *Hexagrammos decagrammus*



C *Hexagrammos lagocephalus*



D *Hexagrammos octogrammus*



Figures A–D, Kendall and Vinter 1984.

MERISTICS

Vertebrae	Total: 52-X-57	
	Precaudal: 20-21-22	
	Caudal: 33-X-35	
Branchiostegal rays	6-6-6	
Caudal fin	12-16, 7+9, 12-14	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 21-X-23	R: 22-X-26
Pectoral fin	R: 18-X-20	
Anal fin	R: 23-X-26	
Gill rakers	U: 3-X-5	L: 9-X-14

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Intertidal, nearshore, 0-46 m
ELH pattern	Oviparous; demersal, attached eggs; pelagic larvae
Spawning	Season: Oct-Nov[a]
	Area:
	Mode: Egg masses on rocks[a]
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	
Hatch size	7-9 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

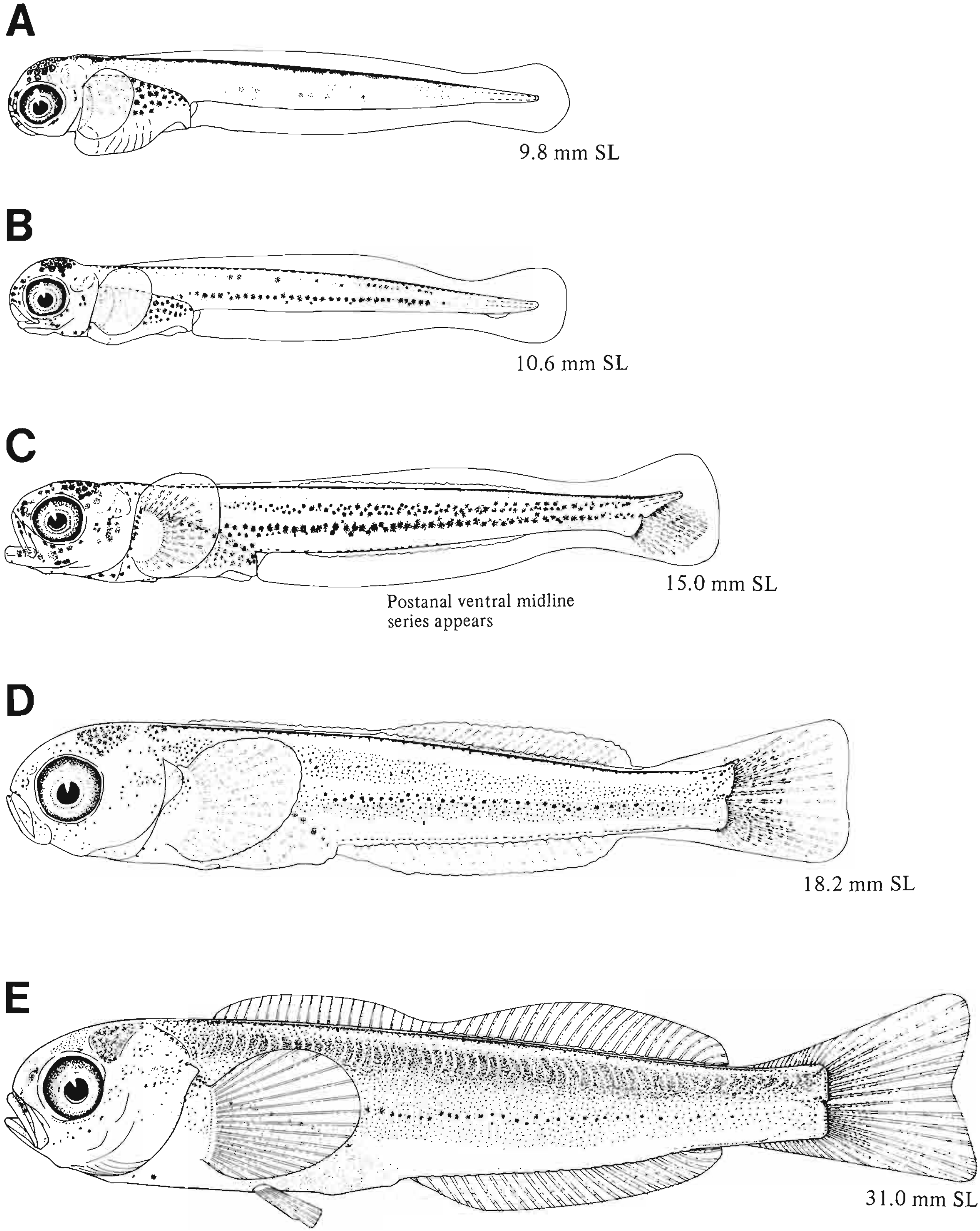
Preanal length	Much <50% before flexion
Length at flexion	12-18 mm SL
Length at transformation	Epipelagic to 50 mm SL
Sequence of fin development	Caudal, pectorals, 2nd dorsal (rays) and anal, 1st dorsal (spines), pelvics

Pigment
- Heavily pigmented
- Postanal ventral midline absent until ~13 mm SL, then starts near anal fin origin; reaches caudal peduncle by 18 mm SL

Diagnostic characters (see Table 3 and tables this section)
- Principal caudal fin ray count in juveniles (7+9)

[a] Marliave 1975a

Ref: Kendall and Vinter 1984.



Figures A–E, Kendall and Vinter 1984.

MERISTICS

Vertebrae	Total: 52-X-57 Precaudal: 20-20-23 Caudal: 32-33-34	
Branchiostegal rays	6-6-6	
Caudal fin	17-22, 7+10, 15-19	
Pelvic fin	Thoracic S: 1-1-1	 R: 5-5-5
Dorsal fin	S: 20-X-23	R: 20-X-25
Pectoral fin	R: 18-X-21	
Anal fin	R: 21-X-24	
Gill rakers	U: 4-X-5	L: 9-X-11

LIFE HISTORY

Range	Cent. California, 34-38°N, to Bering Sea, 54-66°N
Ecology	Intertidal, nearshore
ELH pattern	Oviparous; demersal, adhesive, attached eggs; pelagic larvae
Spawning	Season: June-Aug (Aleutian Is.);[a] June-Sept (west. Pacific)[b] Area: On rocks or algal holdfasts in areas of strong currents[a] Mode: Intermittent, males guard nests[c] Migration:
Fecundity	Range/function: 14,400-103,000[b]
Age at first maturity	3-4 yr[b]
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	
Hatch size	7-9 mm SL
Incubation time/temp.	30 d/6-10°C
Pigment	

Diagnostic characters

LARVAE

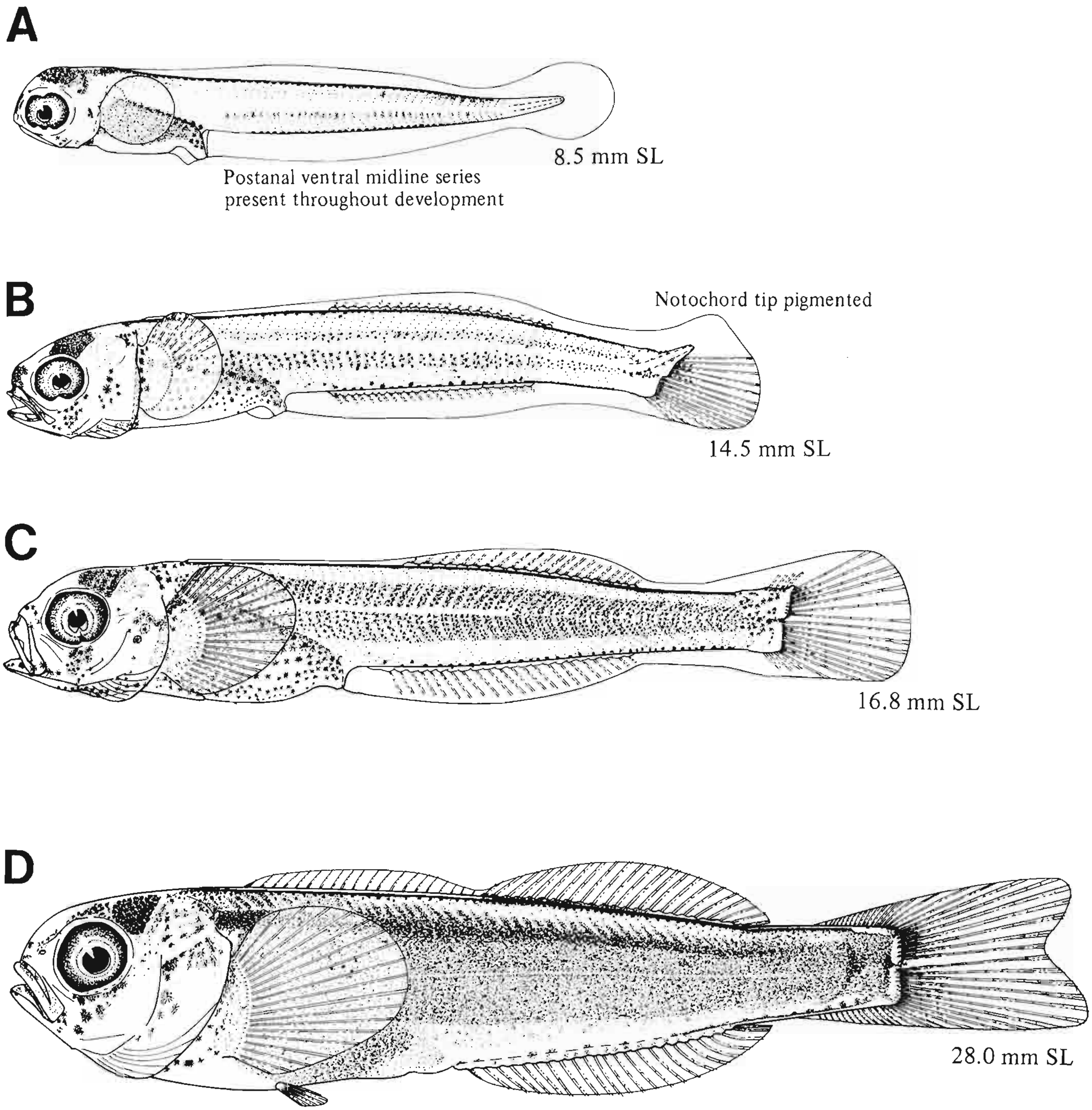
Preanal length	Much <50% before flexion
Length at flexion	~16 mm SL
Length at transformation	
Sequence of fin development	Caudal, pectorals, 2nd dorsal (rays) and anal, 1st dorsal (spines), pelvics

Pigment
- Heavily pigmented
- Postanal ventral midline present throughout development, particularly heavy on caudal peduncle; spots create irregular line

Diagnostic characters (see Table 3 and tables this section)
- Principal caudal fin ray count in juveniles (7+10)

[a] Simenstad 1971
[b] Gorbunova 1962
[c] Kendall and Vinter 1984

Ref: Kendall and Vinter 1984.



Figures A–D, Kendall and Vinter 1984.

MERISTICS

Vertebrae	Total: 50-X-54	
	Precaudal: 18-X-19	
	Caudal: 32-X-35	
Branchiostegal rays	6-6-6	
Caudal fin	15-17, 7+8, 14-15	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 18-X-20	R: 22-X-25
Pectoral fin	R: 18-X-19	
Anal fin	R: 23-X-26	
Gill rakers	U: 4-X-5	L: 11-X-12

LIFE HISTORY

Range	Brit. Col., 48°30′-55°N, to Bering Sea, 54-66°N
Ecology	Nearshore shelf demersal
ELH pattern	Oviparous; demersal, attached eggs; pelagic larvae
Spawning	Season:
	Area:
	Mode: Nests guarded by males[a]
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS[b]

Diameter	1.75-2.10 mm
No. of oil globules	Many
Oil globule diameter	0.8 mm
Yolk	
Envelope	
Hatch size	7-9 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

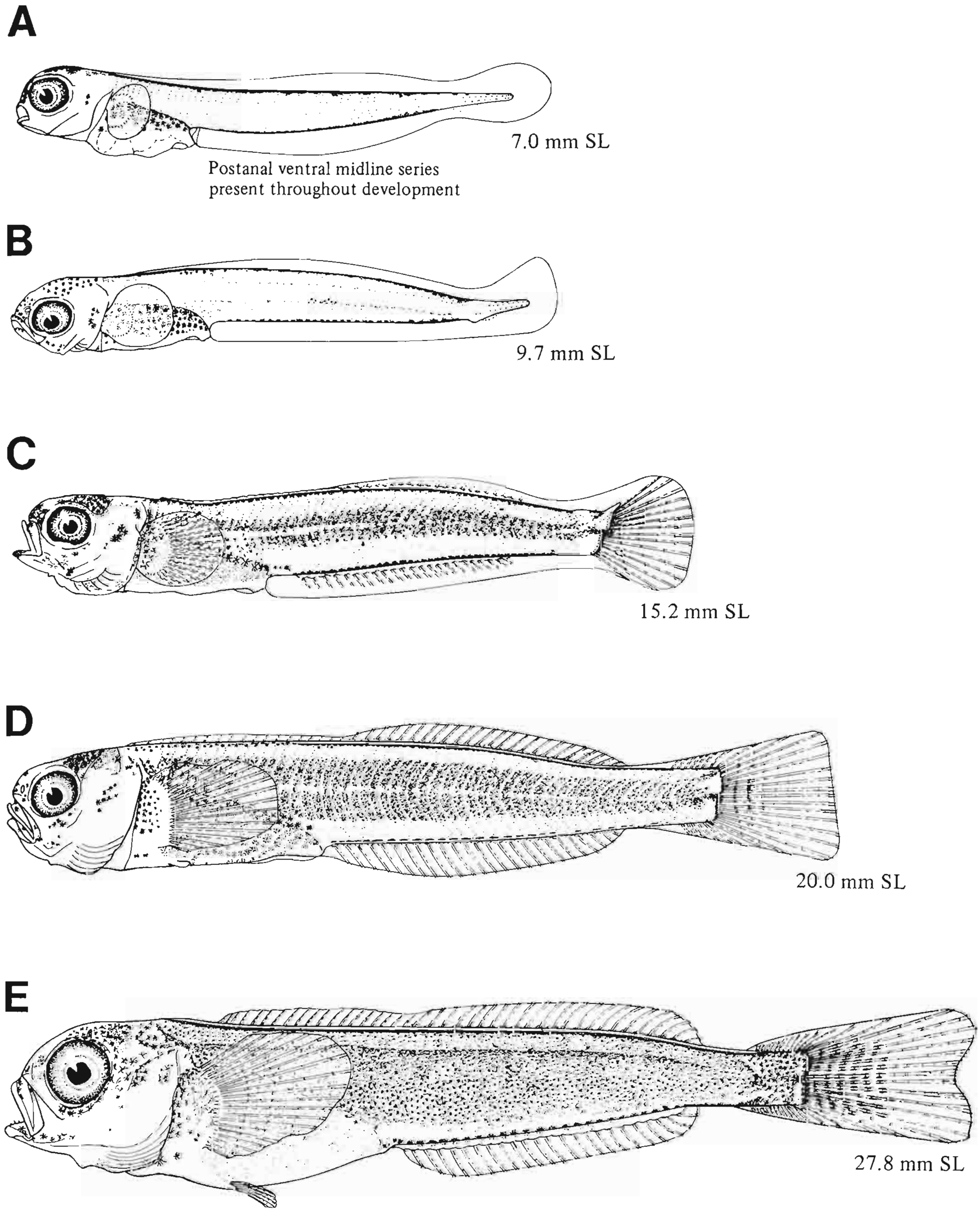
Preanal length	Much <50% before flexion
Length at flexion	~16 mm SL
Length at transformation	
Sequence of fin development	Caudal, pectorals, 2nd dorsal (rays) and anal, 1st dorsal (spines), pelvics

Pigment
- Most heavily pigmented *Hexagrammos* sp.
- Postanal ventral midline present throughout development, forms continuous line from anus to base of caudal fin

Diagnostic characters (see Table 3 and tables this section)
- Principal caudal fin ray count in juveniles (7+8)

[a] Kendall and Vinter 1984
[b] Data are from Gorbunova (1962) as cited in Washington et al. (1984b).

Ref: Kendall and Vinter 1984.



Figures A–E, Kendall and Vinter 1984.

MERISTICS

Vertebrae	Total: 51-X-56 Precaudal: 20-X-22 Caudal: 31-X-34
Branchiostegal rays	6-6-6
Caudal fin	16-17, 7+8, 14-15
Pelvic fin	Thoracic S: 1-1-1 R: 5-5-5
Dorsal fin	S: 22-X-25 R: 18-X-22
Pectoral fin	R: 18-X-20
Anal fin	R: 22-X-25
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	Oregon, 42-46°N, to Chukchi Sea, north of 66°N
Ecology	Nearshore shelf demersal, intertidal to 175 m
ELH pattern	Oviparous; demersal, attached eggs; pelagic larvae
Spawning	Season: Feb[a] or Apr[b] (British Columbia); reported summer to fall at extremes of range in Pacific Ocean[c] Area: Mode: May be deposited on rocks[a] Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	
Hatch size	7-9 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	Much <50% before flexion
Length at flexion	~15 mm SL
Length at transformation	
Sequence of fin development	Caudal, pectorals, 2nd dorsal (rays) and anal, 1st dorsal (spines), pelvics

Pigment
- Most lightly pigmented *Hexagrammos* sp.
- Postanal ventral midline absent until ~15 mm SL, then starts on caudal peduncle; by ~23 mm SL all along anal fin base

Diagnostic characters (see Table 3 and tables this section)
- Principal caudal fin ray count in juveniles (7+8)

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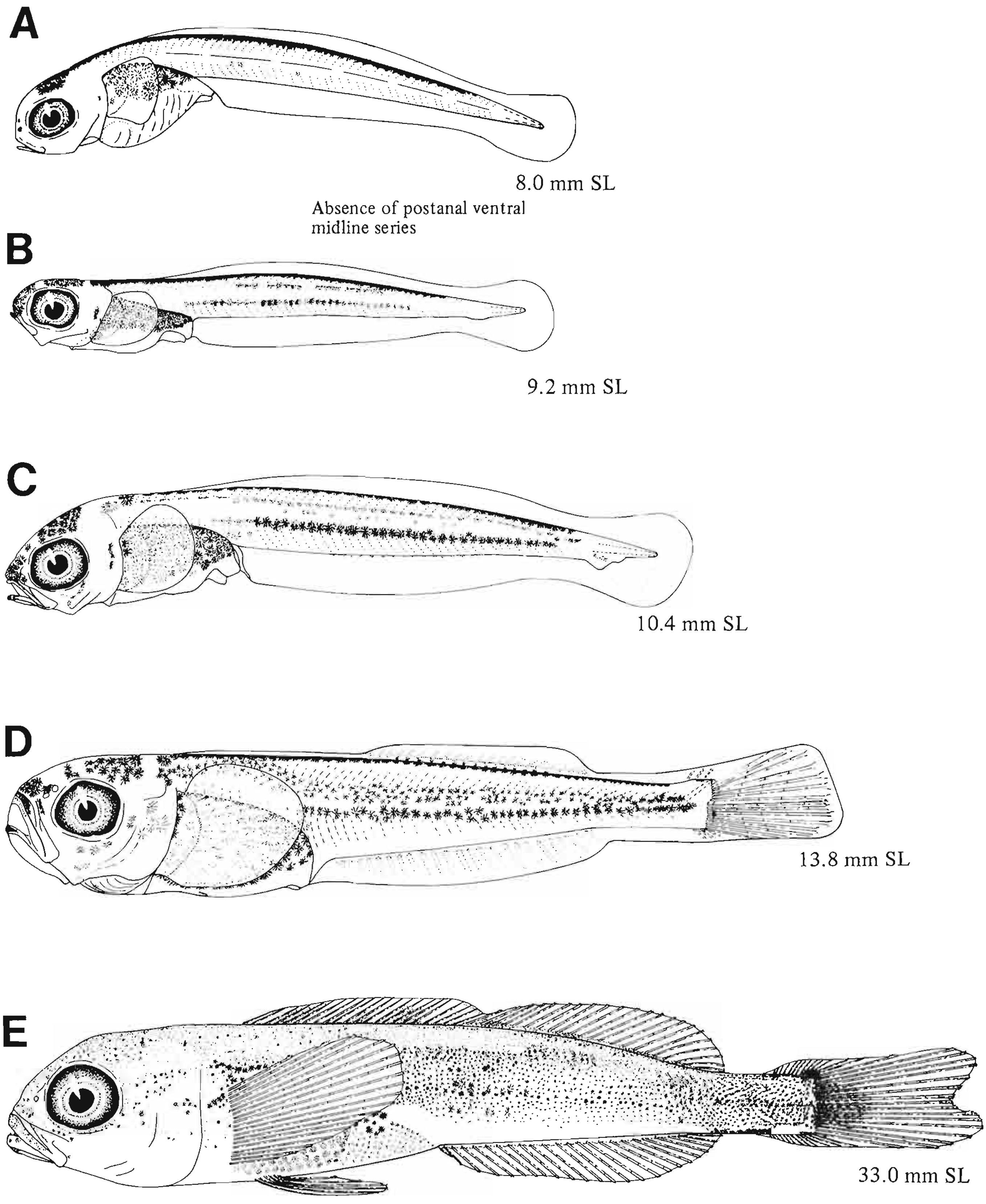
[a] Clemens and Wilby 1961
[b] Hart 1973
[c] Gorbunova 1962

Ref: Kendall and Vinter 1984.



Figures A–E, Kendall and Vinter 1984.

COTTIDAE

The sculpins are represented by over 100 species within 45 genera in the study area. Most species are benthic as juveniles and adults and planktonic as larvae. Adults commonly occur in nearshore and intertidal regions throughout the study area. Cottids generally produce demersal eggs that are guarded in shallow water. Although larval cottids are commonly collected during ichthyoplankton surveys, the early life histories of most species are poorly known and larval descriptions are available for fewer than half the species. The cottid section is arranged according to the phenetic groups first described by Richardson (1981a) and recently updated by Washington et al. (1984a).[1] Preceding the taxonomic sections, the groups are briefly described, representative taxa from each group are illustrated, and a table of meristic characters is provided (Table 36). Betsy Washington provided vertebral counts for several genera based on her osteological studies of the cottids.[2] In most cases (except for *Clinocottus acuticeps* where $n=3$), counts were taken from one specimen.

[1] Psychrolutidae (sensu J. Nelson 1984) is included within Cottidae.

[2] B.B. Washington, NMFS Natl. Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, pers. commun., 8 Dec. 1986.

Table 36
Larval information, numbers of species, and meristic characters of genera of cottids from the Northeast Pacific Ocean. Counts are from Washington et al. (1984a) unless otherwise noted.

		Number of species			Fins				
					Dorsal				
Genera	Larval[a] group	Total[b]	With larval descriptions	Vertebrae	Spines	Soft rays	Anal	Pectoral	Pelvic
Archaulus		1			IX-X	28-29	22-23	16	I, 3
Artediellichthys		1			VII-IX	12-13	9-11	21-23	I, 3
Artedielliscus		1							
Artediellus		5		28-30	VI-IX	11-14	10-14	20-24	I, 3
Artedius	Art[c]	6	4	30-35	VII-X	14-18	10-14	13-17	I, 2-3
Ascelichthys	Myo	1		33-36	VII-X	17-19	13-16	16-18	0
Asemichthys		1		33-35	IX-XI	14-16	15-16	16-18	I, 3
Blepsias	Hem	2	1	37-39	VI-IX	20-24	18-21	11-17	I, 3
Chitonotus	Myo	1		35-36	VIII-XI	14-17	14-17	16-18	I, 2-3
Clinocottus	Art	4	4	31-34	VII-X	13-17	9-13	12-15	I, 3
Cottus	Lep	2	1	34-39	VII-XI	16-21	12-18	13-17	I, 4
Dasycottus	Mal	1		34-35	VIII-XI	13-16	12-16	22-26	I, 3
Enophrys	Myo	3	1	29-35	VII-IX	9-15	8-13	15-19	I, 2-3
Eurymen		1		38	VIII	21-23	15-17	25-26	I, 3
Gilbertidia[d]	Psy	1		33-35	VII-VIII	18-19	12-15	14-17	I, 3
Gymnocanthus	Myo	4	1-2	35-40	IX-XII	13-18	14-20	15-21	I, 3
Hemilepidotus	Hem-Sco	6	5	35-39	X-XII	17-22	13-19	15-19	I, 3-4
Hemitripterus	Hem	2	1	38-41	XI-XIX	11-14	12-15	18-22	I, 3
Icelinus	Myo	5	1	34-39	IX-XII	14-18	11-17	14-19	I, 2
Icelus	Myo	6		37-42	VII-X	17-25	13-20	15-20	I, 3
Jordania		1		46-48	XVII-XVIII	15-18	22-24	13-15	I, 4-5
Leptocottus	Lep	1		35-39	VI-VIII	15-20	15-20	17-20	I, 4
Malacocottus	Mal	2-3	1	30-33	VIII-X	12-15	9-13	19-23	I, 3
Megalocottus		2			VIII-X	12-15	11-13	16-18	I, 3
Micr台ocottus		1		32-34	VII-IX	12-14	10-12	14-17	I, 3
Myoxocephalus	Myo	9-10	1-2	34-46	VIII-XII	10-20	8-17	14-19	I, 3
Nautichthys	Hem	3	1	35-41	VII-X	19-30	14-21	13-17	I, 3
Oligocottus	Art	3	2	33-37	VII-X	15-20	12-15	12-15	I, 3
Paricelinus	Myo	1		42-43	XII-XIII	19-20	23-24	14-15	I, 5
Phallocottus		1			X-XII	22-24	22-25	14-16	I, 3
Porocottus		2		34-38	VIII-X	13-18	11-18	13-19	I, 3
Psychrolutes	Psy	2	1	33-37	VIII-XII	12-20	10-14	19-26	I, 3
Radulinus	Myo	2	2	38-40	VIII-XI	20-23	21-25	17-20	I, 3
Rhamphocottus	Rha	1		26-28	VII-IX	12-14	6-9	14-18	I, 3-4
Scorpaenichthys	Hem-Sco	1		35-37	VIII-XII	15-19	11-14	14-16	I, 4-5
Sigmistes		2		34-36	VIII-X	19-26	14-20	13-15	I, 3
Stelgistrum		2		36	VIII-IX	17-19	12-14	14-16	I, 3
Sternias		1		44-46	X-XI	22-24	22-24	16-18	I, 3
Stlegicottus		1			IX	19	17	18	I, 3
Synchirus	Myo	1		38-39	VIII-X	19-21	18-21	21-24	I, 3
Taurocottus		1			XI	15-16	12-13	19	I, 3
Thecopterus		1			X	14	11	20	I, 2
Thyriscus		1		38-39	X	21	17	15	I, 3
Triglops		6	1?	45-54	IX-XIII	21-32	20-32	15-22	I, 3
Zesticelus	Myo	1		25-26	V-VII	10-13	8-11	19-21	I, 2-3

[a] Art - *Artedius*
Hem - *Hemitripterus*
Hem-Sco - *Hemilepidotus-Scorpaenichthys*
Lep - *Leptocottus*
Mal - *Malacocottus*
Myo - *Myoxocephalus*
Psy - *Psychrolutes*
Rha - *Rhamphocottus*
[b] Limited to study area.
[c] *Artedius meanyi* is placed in *Myoxocephalus* group.
[d] B.B. Washington, NMFS Natl. Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, pers. commun., 8 Dec. 1986.

PHENETIC GROUPS

***Rhamphocottus* (*Rhamphocottus*)** Larvae are extremely deep-bodied with a long snout-anus length. Melanophores develop uniformly over the body except on the caudal peduncle and ventral gut surface. Small prickles develop all over the body by 9-10 mm, and only one preopercular spine develops.

***Hemilepidotus-Scorpaenichthys* (*Hemilepidotus*, *Scorpaenichthys*)** Larvae are relatively long and slender at hatching with moderately long guts (40-60% SL) and rounded snouts. They become increasingly deep-bodied. Larvae are relatively heavily pigmented. Four prominent preopercular spines develop.

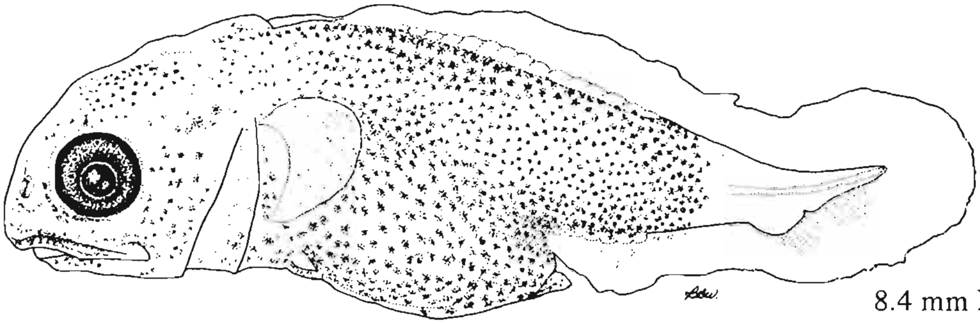
***Myoxocephalus* (*Artedius meanyi*, *Ascelichthys*, *Chitonotus*, *Enophrys*, *Gymnocanthus*, *Icelinus*, *Icelus*, *Myoxocephalus*, *Paricelinus*, *Radulinus*, *Synchirus*, *Triglops*)** Larvae are generally slender-bodied with pointed snouts. Pigment is variable, but most members have heavy pigment on dorsal surface of the gut, nape, and along the postanal ventral midline. Larvae develop four preopercular spines and a distinct bony preopercular shelf. Parietal, nuchal, supracleithral, posttemporal, and occasionally postocular spines develop.

***Artedius* (*Artedius* other than *A. meanyi*; *Clinocottus*, *Oligocottus*)** Larvae are stubby-bodied with a slightly humped appearance at the nape. Snouts are rounded and guts trail distinctively below the ventral body midline. Some species have gut diverticula. Pigment is relatively light, occurring on the nape, over the gut, and along the postanal ventral midline. Larvae develop a unique preopercular spine pattern with 6-24 spines (enlarged on illustrations).

PHENETIC GROUPS

RHAMPHOCOTTUS

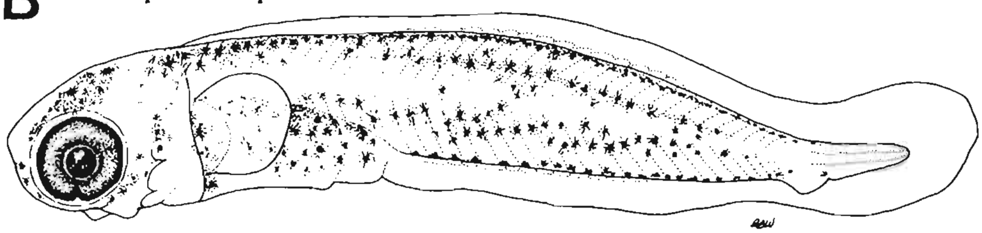
A *Rhamphocottus richardsoni*



8.4 mm NL

HEMILEPIDOTUS – SCORPAENICHTHYS

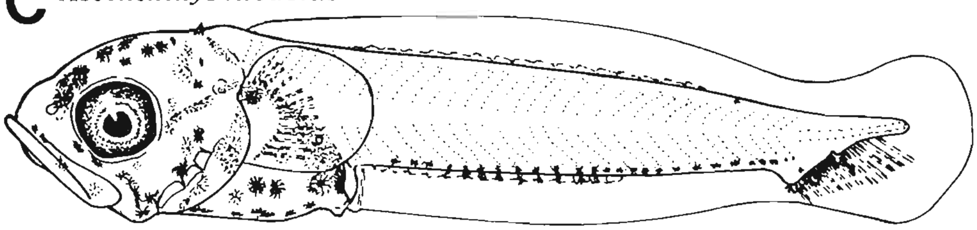
B *Hemilepidotus spinosus*



8.9 mm NL

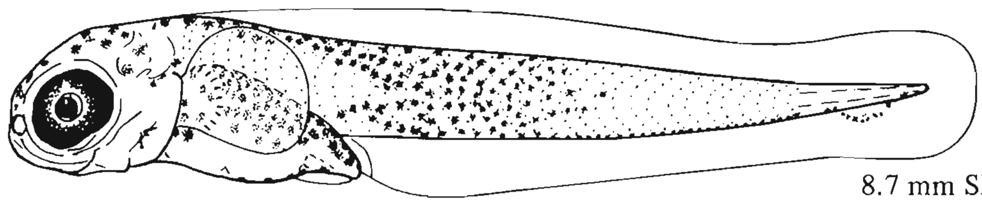
MYOXOCEPHALUS

C *Ascelichthys rhodorus*



9.0 mm SL

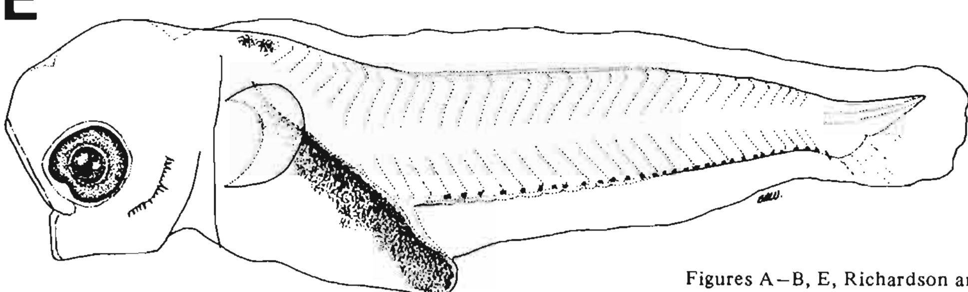
D *Myoxocephalus* G



8.7 mm SL

ARTEDIUS

E *Artedius harringtoni*



6.9 mm NL

Figures A–B, E, Richardson and Washington 1980; C, Matarese and Marliave 1982; D, NWAFC original (B. Vinter).

***Psychrolutes* (*Gilbertidia*, *Psychrolutes*)** Larvae are tadpole-shaped with large rounded heads tapering toward the tail. They possess an outer layer of flabby skin. The head, nape, gut, and pectoral fins are pigmented. No postanal ventral midline melanophores are present, but pigment is added laterally with development. Head and preopercular spines are absent.

***Malacocottus* (*Dasycottus*, *Malacocottus*)** Similar to *Psychrolutes* group but larvae develop 4-5 preopercular spines.

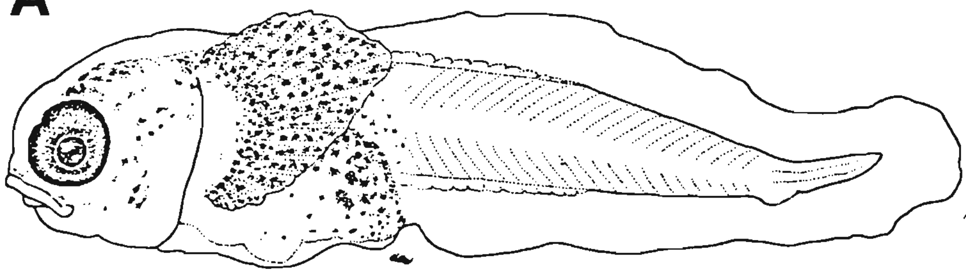
***Leptocottus* (*Cottus*, *Leptocottus*)** Larvae are relatively slender with rounded snouts and moderately short guts. Pigment is light on the postanal body. Other pigment occurs on nape, over gut, and widely spaced along the postanal ventral midline. Four weak preopercular spines develop but other head spines are lacking.

***Hemitripterus* (*Blepsias*, *Hemitripterus*, *Nautichthys*)** Newly hatched larvae are elongate and slender, becoming deeper with development. *Nautichthys* larvae have long pigmented pectoral fins. Pigmentation is heavy, covering the body except for the caudal peduncle. Pigment extends into the dorsal and ventral finfolds. Larvae develop four prominent preopercular spines.

PHENETIC GROUPS

PSYCHROLUTES

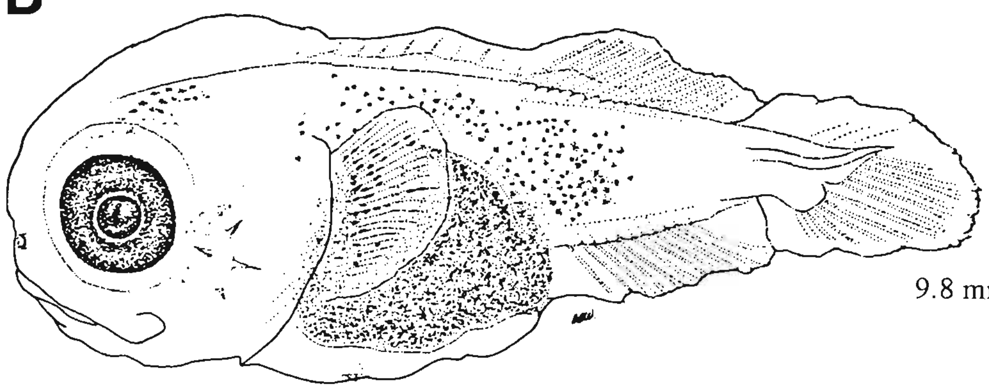
A *Psychrolutes paradoxus*



7.7 mm NL

MALACOCOTTUS

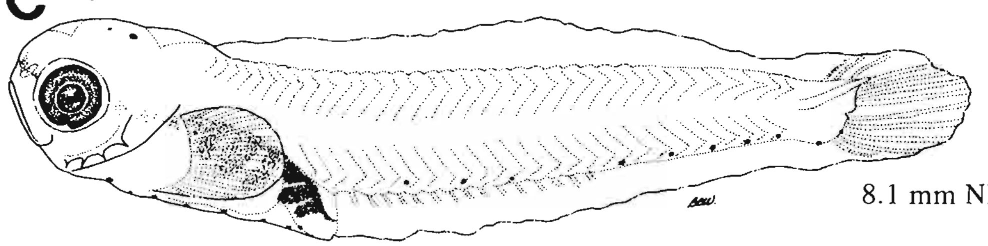
B *Malacocottus zonurus*



9.8 mm NL

LEPTOCOTTUS

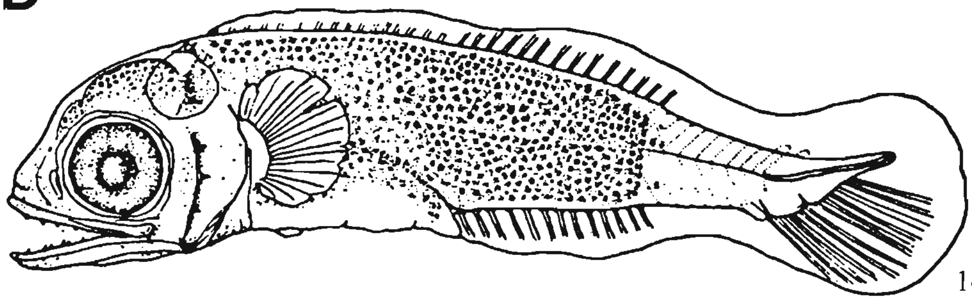
C *Leptocottus armatus*



8.1 mm NL

HEMITRIPTERUS

D *Hemitripterus villosus*



14.4 mm SL

Figures A–B, Richardson and Bond 1980; C, Richardson and Washington 1980; D, Okiyama and Sando 1976.

MERISTICS

Vertebrae	Total: 26-26-28	
	Precaudal: 12-12-12[a]	
	Caudal: 15-15-15[a]	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-4
Dorsal fin	S: 7-8-9	R: 12-12-14
Pectoral fin	R: 14-15-18	
Anal fin	R: 6-7-9	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Epi- and mesobenthal, intertidal to 274 m
ELH pattern	Oviparous, demersal eggs, pelagic larvae
Spawning	Season: Aug-Oct (California);[b] winter (British Columbia)[c]
	Area: Nearshore (20 m)[d]
	Mode: Egg masses guarded by females[d]
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	2.5-2.8 mm
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	Orange;[c] white[d]
Hatch size	6-7 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

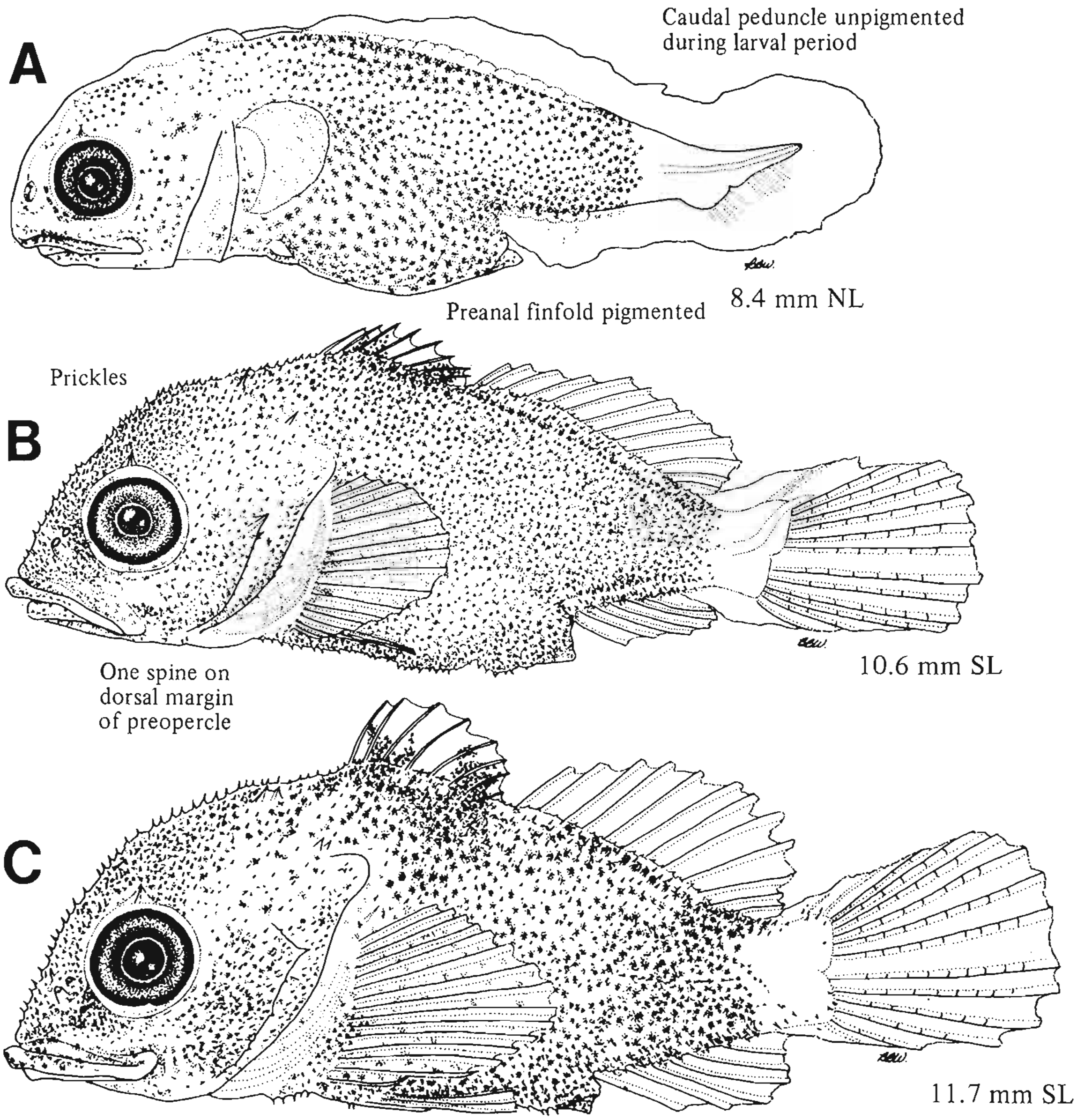
Preanal length	>50% SL
Length at flexion	6.9-10.0 mm NL
Length at transformation	14-15 mm SL
Sequence of fin development	Dorsal, anal, and pectorals followed by caudal and pelvics

Pigment
- Larvae are uniformly covered with melanophores except for caudal peduncle and the ventral surface of gut

Diagnostic characters (see Table 3)
- Morphology: Deep-bodied, very long snout-to-anus length
- Uniformily heavily pigmented
- Presence of pigmented preanal finfold
- Prickles develop over most of body by 9-10 mm SL
- Spines: Only one preopercular (small spiny projections appear along the preopercular margin); others include parietal, nuchal, supracleithral, posttemporal, and postocular

[a] B.B. Washington, NMFS Natl. Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, unpubl.
[b] Fitch and Lavenberg 1975
[c] Hart 1973
[d] Garrison and Miller 1982

Ref: Blackburn 1973, Marliave 1975a, Richardson and Washington 1980, Saruwatari et al. 1987, Washington et al. 1984b.



Figures A–C, Richardson and Washington 1980.

Table 37

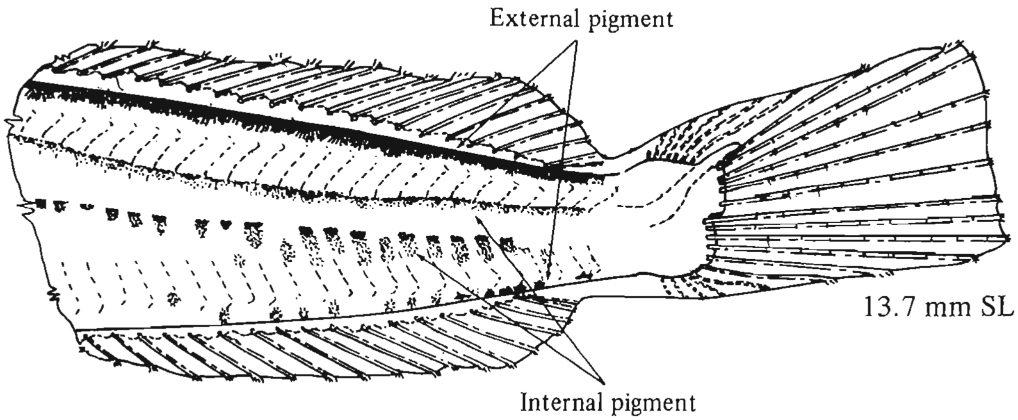
Selected postanal pigmentation characters useful in distinguishing preflexion and flexion *Hemilepidotus* larvae (Matarese and Vinter 1985). Larvae of *H. papilio* are unknown. All lengths are mm SL.

	Pigmentation characters							
Taxon	Dorsal midline	Dorso-lateral	Above notochord (internal)	Below notochord (internal)	Ventro-lateral	Ventral midline	Caudal region	Diagnostic
Hemilepidotus spinosus	By 5 mm, a continuous line from head to posteriormost myomere, becoming heavier	By 6 mm, becoming heavier	By 8-9 mm, along length of body	Not obvious	By 6 mm, becoming heavier	From anus to posteriormost myomere, >15 melanophores	Sparse, ventral midline continuous	Lateral, ventral midline
H. hemilepidotus	Until 7 mm, unpigmented area between myomeres 4-11 becoming moderately heavy	By 11 mm, moderate	By 6-7 mm, along length of body	By 8-9 mm, begins posterior to anus	By 11 mm, moderate	Begins 9 myomeres after anus, <15 melanophores	None	Lateral, lack of caudal pigment
H. jordani[a]	Similar to *H. hemilepidotus* but not as heavy	None	Similar to *H. hemilepidotus*	Similar to *H. hemilepidotus*	Some internal only	By flexion, a few internal melanophores	None	Lack of lateral and caudal pigment
H. zapus	Similar to *H. hemilepidotus* but not as heavy	None	By 6 mm, along length of body	By 8 mm, incomplete; begins posterior to anus	Some internal only	Begins 11 myomeres after anus, <15 melanophores	Ventral midline continuous, above and below urostyle	Urostyle
H. gilberti[b]	Pigment begins 8-9 myomeres after anus	None	None	None	None	Begins 10 myomeres after anus, <15 melanophores	None	Unpigmented area along dorsal midline, lack of lateral pigment

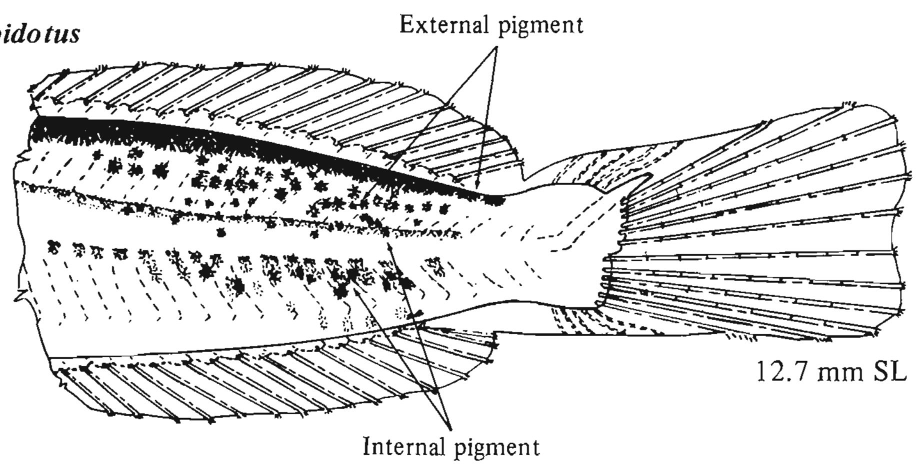
[a] Preflexion larvae of *H. hemilepidotus* and *H. jordani* cannot presently be separated in samples from areas where they co-occur.
[b] Specimens were not available; description based on figures in Hattori (1964).

POSTANAL PIGMENT PATTERNS OF *HEMILEPIDOTUS* SPP. LARVAE

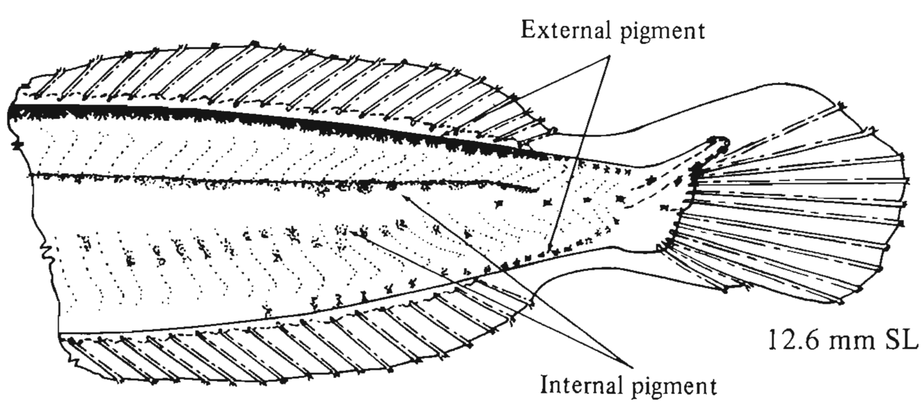
A *H. jordani*



B *H. hemilepidotus*



C *H. zapus*



Figures A–C, Matarese and Vinter 1985.

Table 38

Characters useful in distinguishing pelagic juveniles of *Hemilepidotus* spp. (Peden 1978, in part). Specimens of *H. papilio* and *H. gilberti* have not been collected from the study area and are not included here.

Character	*H. hemilepidotus*	*H. jordani*	*H. spinosus*	*H. zapus*
Pectoral fin rays	16(15-17)	18(17-19)	15-16(14-16)	16(15-17)
Total soft fin rays; dorsal, anal, and both pectoral fins	63-68	71 78	63-66	67-76
Lateral line pores	65(59-68)	64(59-68)	63(57-67)	52(47-58)
Vertebrae	35-37	37-39	36	37-38
Horizontal rows in ventral scale band	6 or 7	∼8	∼4	8 or 9
Gill membranes fused to isthmus so as to form a free fold posteriorly	Yes	Yes	No free fold posteriorly	Yes
Horizontal rows in dorsal scale band	⩽5	⩽5	⩾6	⩽5

PELAGIC JUVENILES

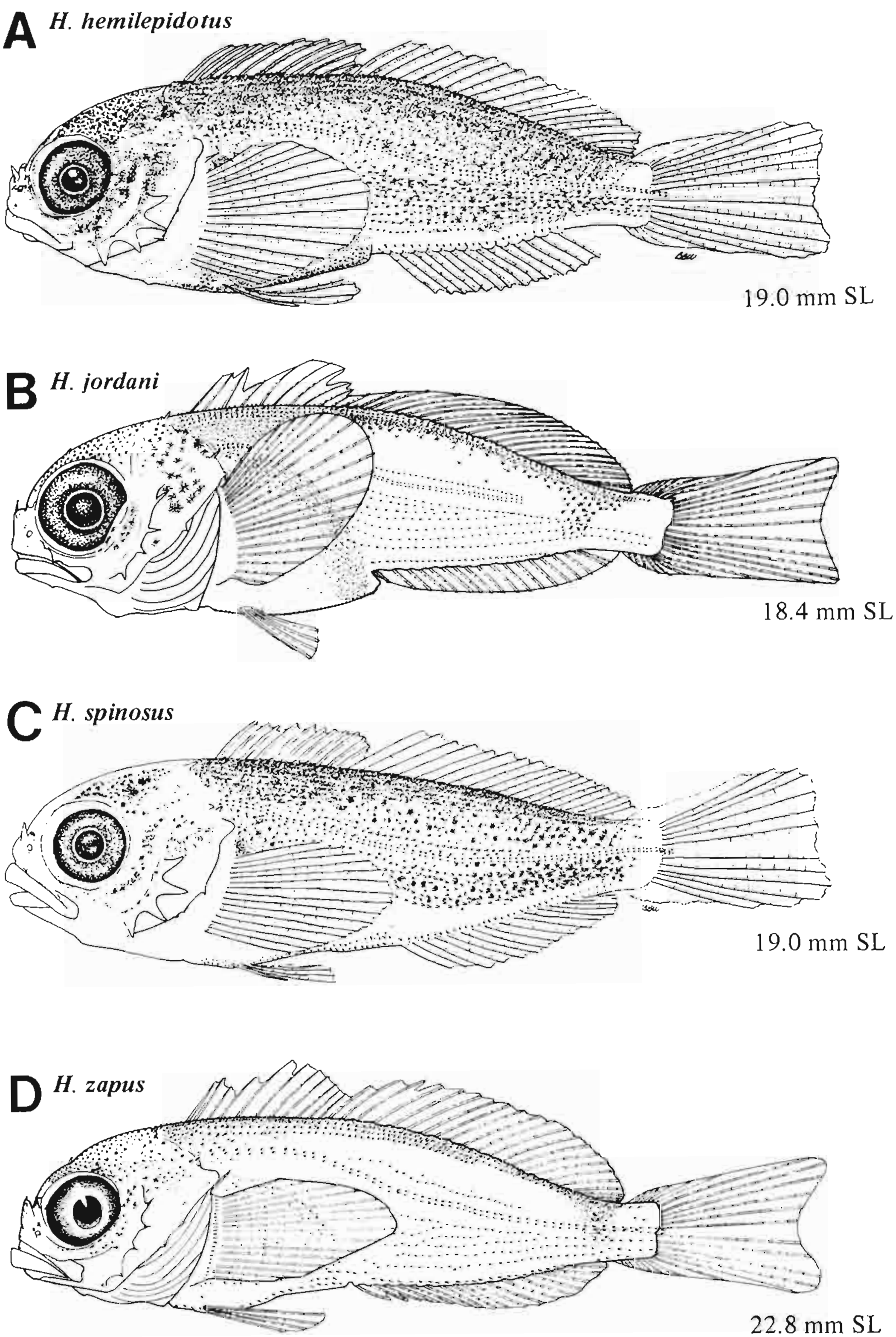


Figure A, C, Richardson and Washington 1980; B, NWAFC original (B. Vinter); D, Matarese and Vinter 1985.

MERISTICS

Vertebrae	Total: 36-X-38	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 4-4-4
Dorsal fin	S: 11-X-12	R: 17-X-22
Pectoral fin	R: 15-X-17	
Anal fin	R: 14-X-19	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	Bering Sea, 54-66°N
Ecology	Nearshore shelf demersal
ELH pattern	Oviparous, eggs probably demersal, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

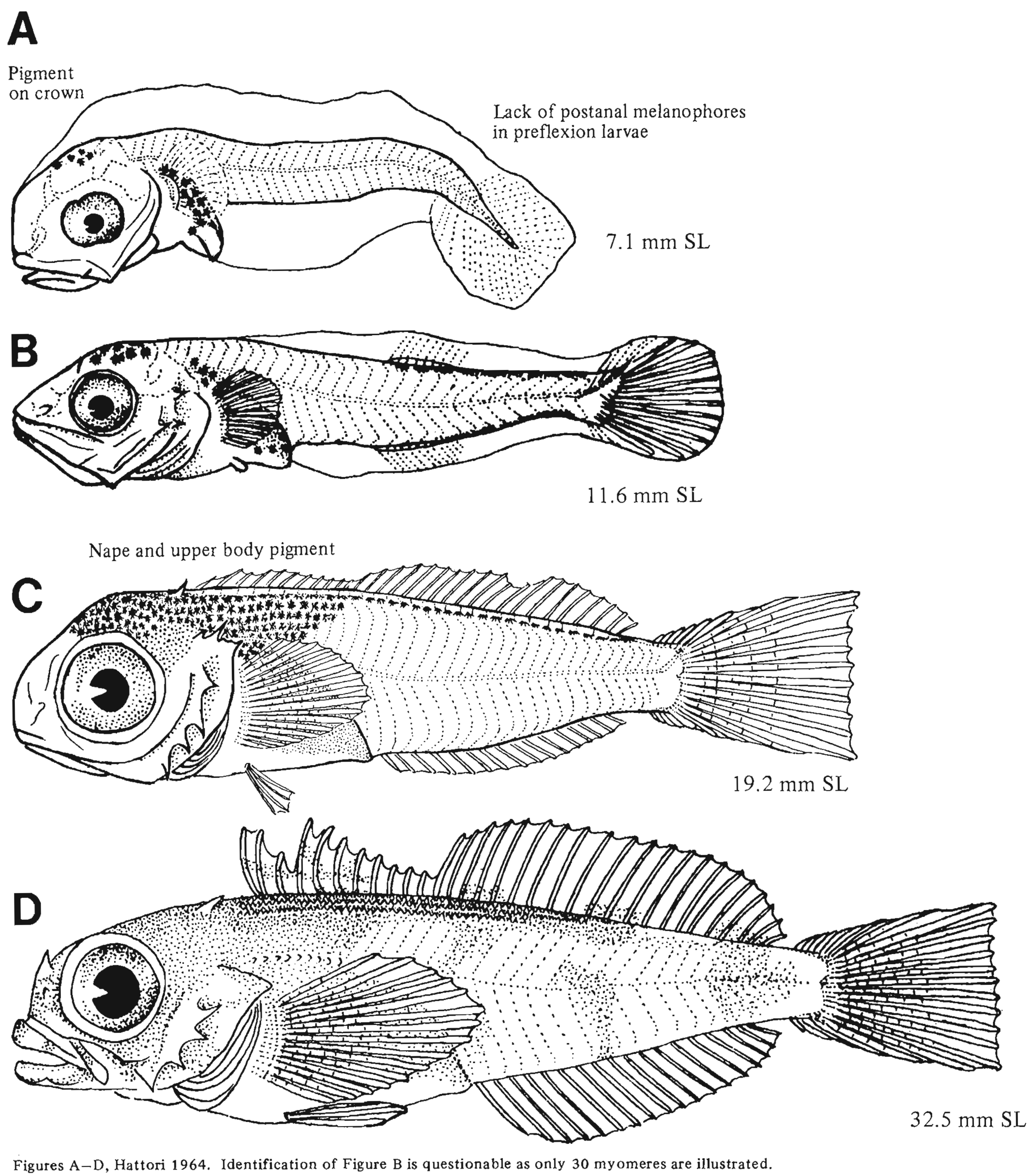
LARVAE

Preanal length	<50% SL increasing with development to 50% SL
Length at flexion	~7-12 mm SL
Length at transformation	
Sequence of fin development	

Pigment
- Head and dorsal gut
- With development, nape, upper body, and along dorsal midline

Diagnostic characters (see Tables 3 and 37)
- Unpigmented area along dorsal midline in preflexion larvae
- Lack of lateral pigment throughout larval period

Ref: Hattori 1964, Matarese and Vinter 1985.



Figures A–D, Hattori 1964. Identification of Figure B is questionable as only 30 myomeres are illustrated.

MERISTICS

Vertebrae	Total: 35-36-37	
	Precaudal: 12-12-12[a]	
	Caudal: 24-24-24[a]	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-4-4
Dorsal fin	S: 10-11-13	R: 18-19-20
Pectoral fin	R: 15-16-17	
Anal fin	R: 13-15-16	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	Cent. California, 34-38°N, to Bering Sea, 54-66°N
Ecology	Epi- and mesobenthal, intertidal to 275 m
ELH pattern	Oviparous; demersal, adhesive, guarded eggs; pelagic larvae
Spawning	Season: Oct-Jan[b]
	Area: Shallow water on rocks or pilings in areas with high current velocities[b]
	Mode: Guarded by female, male, or both[b]
	Migration:
Fecundity	Range/function: 59,000-126,000[b]
Age at first maturity	4 yr[b]
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.5-1.6 mm
No. of oil globules	One
Oil globule diameter	0.31-0.56 mm
Yolk	
Envelope	
Hatch size	5-6 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

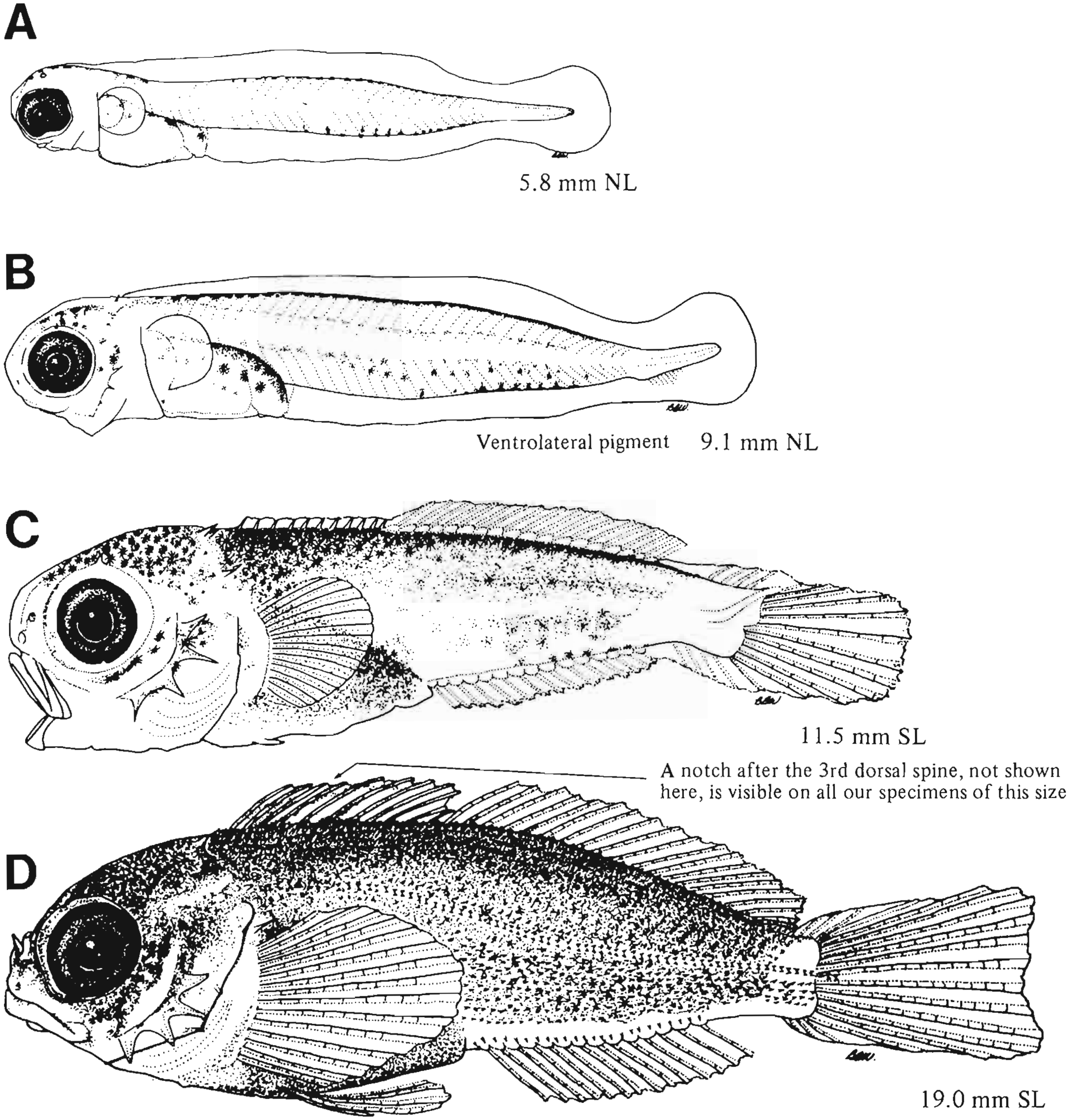
Preanal length	34% SL increasing with development to >50% SL
Length at flexion	<9 mm SL
Length at transformation	>19-23 mm SL
Sequence of fin development	

Pigment
- Dorsal pigment on head and gut
- Break in dorsal midline pigment above gut (preflexion)
- Short posteriorly placed ventral midline series
- Lateral pigment on postanal body

Diagnostic characters (see Tables 3 and 37-38)
- Pigment
  —Lack of pigment around urostyle
  —Presence of dorso- and ventrolateral pigment

[a] B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, unpubl.
[b] Garrison and Miller 1982

Ref: Richardson and Washington 1980, Washington et al. 1984b.



Figures A–D, Richardson and Washington 1980.

MERISTICS

Vertebrae	Total: 37-38-39	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-4-4
Dorsal fin	S: 10-11-12	R: 17-21-22
Pectoral fin	R: 17-18-19	
Anal fin	R: 16-17-18	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	SE Alaska, 55-59°N, to Bering Sea, 54-66°N
Ecology	Epi- and mesobenthal, 25-525 m
ELH pattern	Oviparous, eggs probably demersal, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE[a]

Preanal length
Length at flexion
Length at transformation
Sequence of fin development
Pigment
- Similar to *H. hemilepidotus* except generally less pigmented (see p. 374)
- Ventrolateral pigment internal only

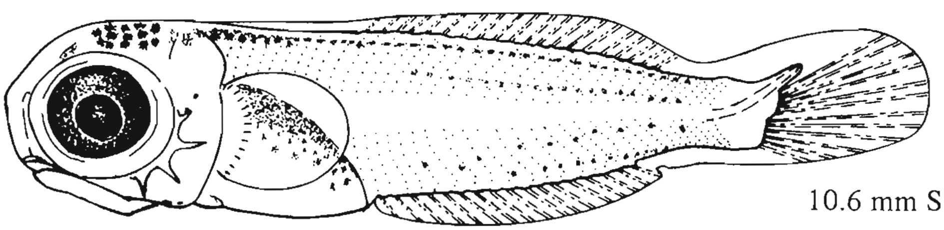
Diagnostic characters (see Tables 3 and 37-38)
- Lack of lateral and caudal pigment

Distinguished from *H. hemilepidotus* postflexion larvae by
- Less dorso- and ventrolateral pigment (see figure, p. 371)
- Delayed development of postocular and parietal spines

[a] Preflexion larvae of *H. hemilepidotus* and *H. jordani* cannot presently be separated in samples from areas where they co-occur.

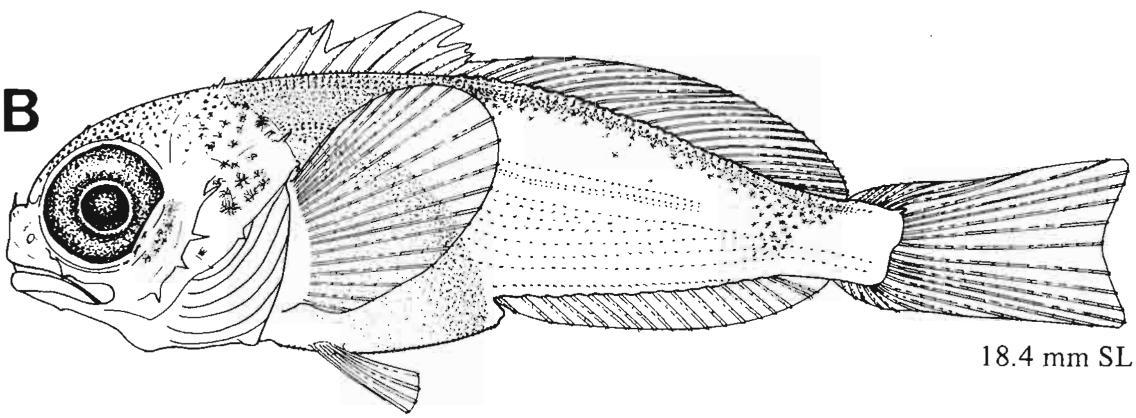
Ref: Matarese and Vinter 1985.

A Postocular and parietal spines
not developed by this size



10.6 mm SL

B



18.4 mm SL

Figures A–B, NWAFC originals (B. Vinter).

MERISTICS

Vertebrae	Total: 35-36-37	
	Precaudal: 12-12-12	
	Caudal: 23-24-25	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 4-4-4
Dorsal fin	S: 10-11-11	R: 18-20-20
Pectoral fin	R: 14-15-16	
Anal fin	R: 14-15-16	
Gill rakers	U: 2-2-2	L: 5-X-8

LIFE HISTORY

Range	S. California, 32-34°N, to SE Alaska, 55-59°N
Ecology	Nearshore shelf demersal, intertidal to 97 m
ELH pattern	Oviparous, eggs probably demersal, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	
Hatch size	~5 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

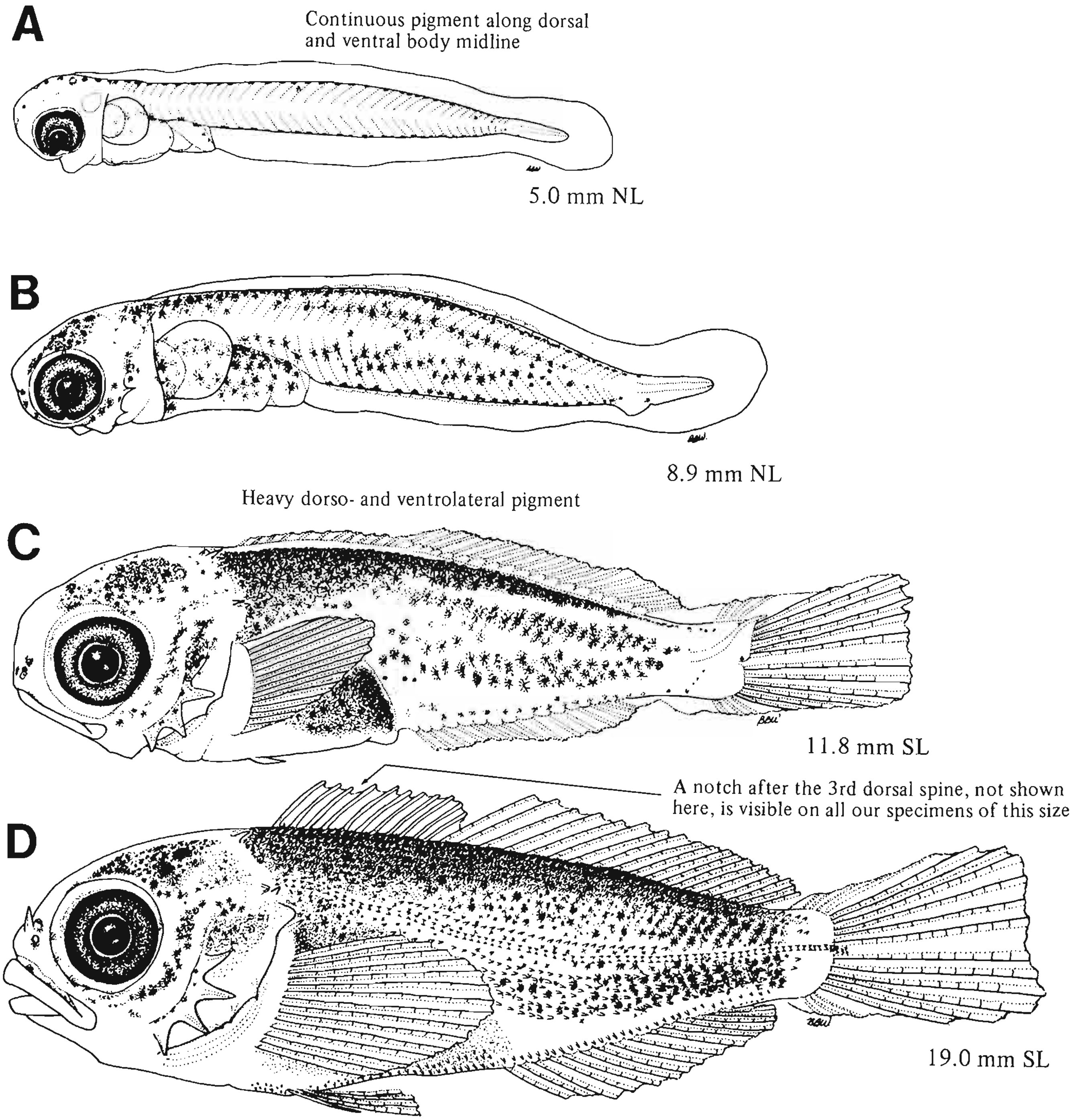
LARVAE

Preanal length	38% SL increasing with development to >50% SL
Length at flexion	7.6-10.0 mm SL
Length at transformation	19 mm SL
Sequence of fin development	

Pigment
- Dorso- and ventrolateral at 6 mm SL becoming heavier with development
- Preflexion larvae (>5 mm SL) have continuous line of dorsal midline pigment extending from head to posteriormost myomere

Diagnostic characters (see Tables 3 and 37-38)
- Pigment: Lateral, ventral midline
- Preflexion: Continuous pigment along dorsal and ventral body midline
- Flexion and larger: Heavy concentration of lateral pigment

Ref: Richardson and Washington 1980, Washington et al. 1984b.



Figures A–D, Richardson and Washington 1980.

MERISTICS

Vertebrae	Total: 37-38-38	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	6-6-6	
Caudal fin	X, 6+6, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 4-4-4
Dorsal fin	S: 11-11-12	R: 18-20-22
Pectoral fin	R: 15-15-17	
Anal fin	R: 16-17-17	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	Aleutian Is., 51-55°N, to Chukchi Sea, north of 66°N
Ecology	Nearshore shelf demersal
ELH pattern	Oviparous, eggs probably demersal, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	
Hatch size	~4.3 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

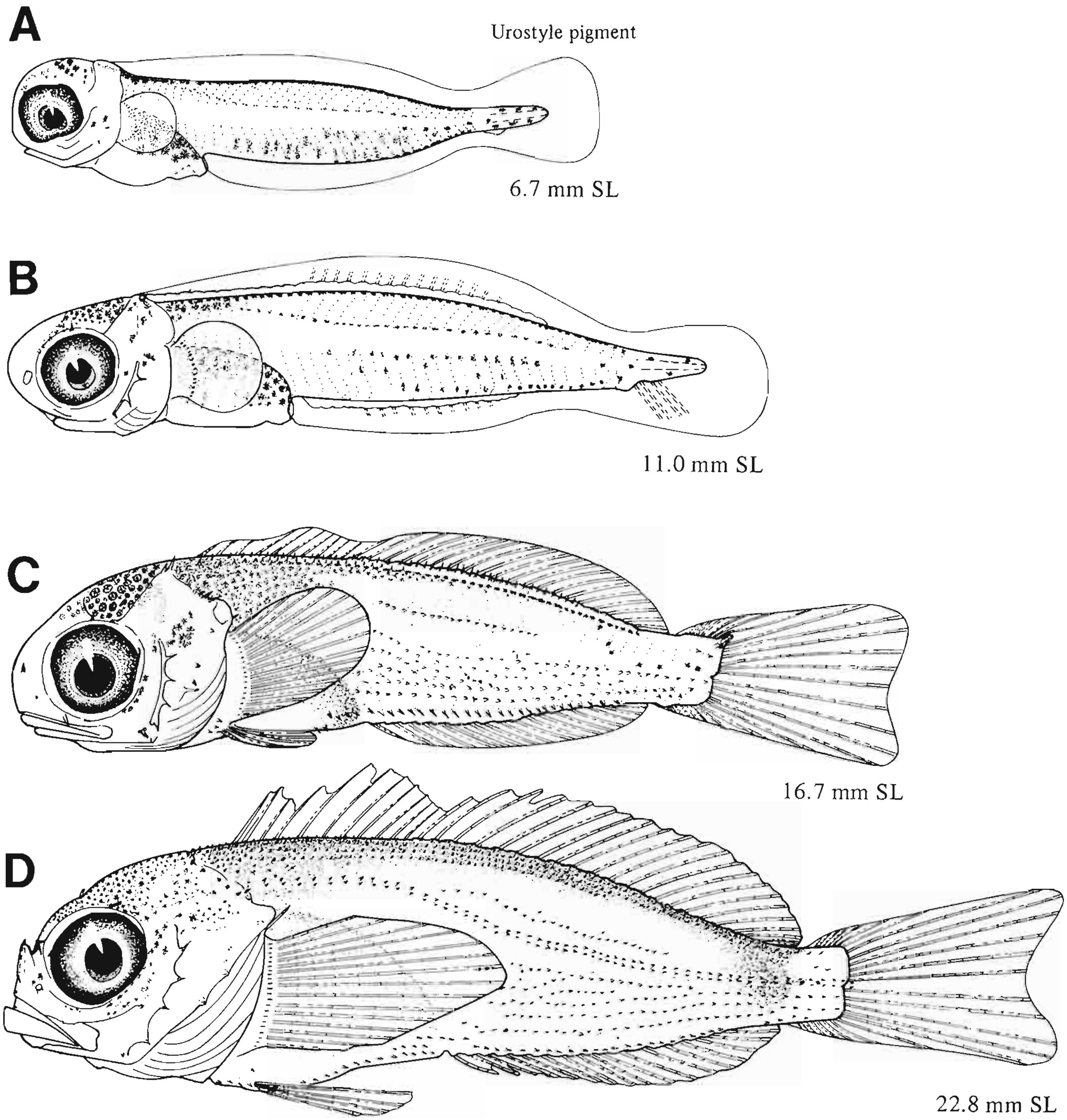
Preanal length	<50% SL
Length at flexion	Complete at 13 mm SL
Length at transformation	>22.8 mm SL
Sequence of fin development	

Pigment
- Similar to *H. hemilepidotus* except generally less pigmented (see p. 374)
- Preflexion larvae have pigment above and below urostyle

Diagnostic characters (see Tables 3 and 37-38)
- Pigment above and below urostyle

See also pelagic juvenile figure of *H. hemilepidotus* and *H. jordani* (p. 371)

Ref: Gorbunova 1964, Matarese and Vinter 1985.



Figures A–D, Matarese and Vinter 1985.

MERISTICS

Vertebrae	Total: 35-36-37 Precaudal: 13-15-16 Caudal: 20-21-23	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic S: 1-1-1	 R: 4-5-5
Dorsal fin	S: 8-11-12	R: 15-18-19
Pectoral fin	R: 14-15-16	
Anal fin	R: 11-13-14	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	South of southern California to SE Alaska, 55-59°N
Ecology	Nearshore shelf demersal, intertidal to 76 m
ELH pattern	Oviparous; demersal, adhesive, attached eggs; pelagic larvae
Spawning	Season: Nov-Mar (California);[a] Jan-May (British Columbia)[b] Area: In rocky crevices[c] or on algae[d] Mode: Migration:
Fecundity	Range/function: 49,000-98,000 (may spawn twice in one season)[a]
Age at first maturity	3-4 yr (females)[a] 2-3 yr (males)[a]
Longevity	13 yr[a]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.4-1.9 mm
No. of oil globules	One large with 1-4 smaller ones
Oil globule diameter	0.2-0.3 mm[e]
Yolk	Homogeneous
Envelope	Thick, translucent
Hatch size	4-6 mm SL;[f] 3.1-4.8 mm SL[e] (yolk absorbed by 6.5 mm SL)
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

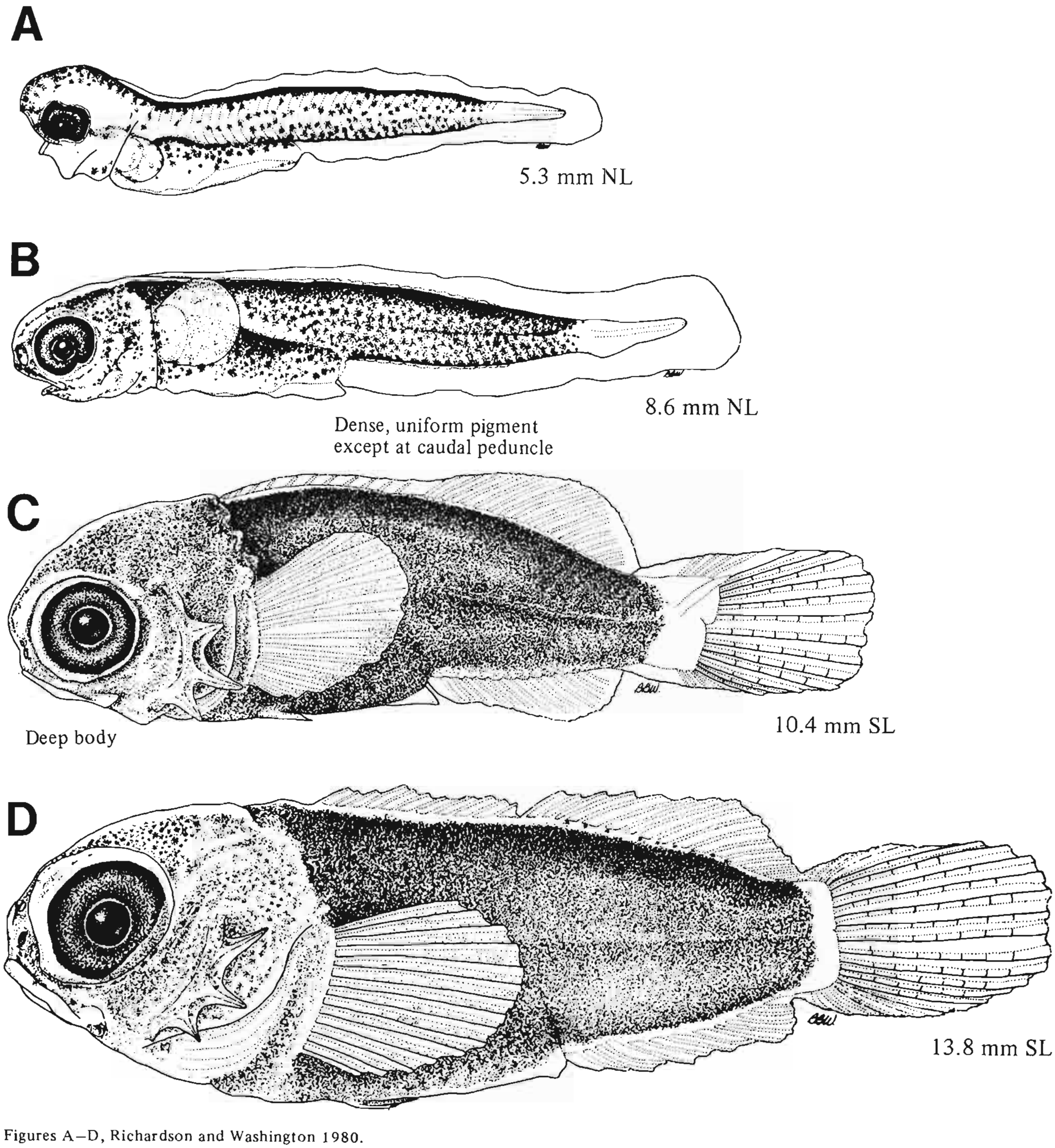
Preanal length	45-50% SL
Length at flexion	~7.5-8.7 mm SL
Length at transformation	14 mm SL, but remains pelagic until 35 mm SL
Sequence of fin development	

Pigment
- Dense pigment covering body except for caudal peduncle

Diagnostic characters (see Table 3)
- Develops bony bumps on areas where head spines occur in *Hemilepidotus* spp.
- Becomes increasingly deep-bodied with development
- Uniformity of pigment

[a] O'Connell 1953
[b] Pillsbury 1957
[c] Feder et al. 1974
[d] Burge and Schultz 1973
[e] Wang 1981
[f] Richardson and Washington 1980

Ref: O'Connell 1953, Richardson and Washington 1980, Wang 1981, Washington et al. 1984b.



Figures A–D, Richardson and Washington 1980.

MERISTICS

Vertebrae	Total: 33-33-35[a]	
	Precaudal: 11-11-11[b]	
	Caudal: 24-24-24[b]	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 2-3-3[c]
Dorsal fin	S: 9-10-10	R: 14-16-17
Pectoral fin	R: 14-15-16	
Anal fin	R: 10-12-12	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	N. California, 38-42°N, to SE Alaska, 55-59°N
Ecology	Nearshore shelf demersal, intertidal to 82 m
ELH pattern	Parity and eggs unknown, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

[a]Total myomere count from Figures A and B = 36.
[b]B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, unpubl.
[c]I,2 is the most common count. The first ray is greatly thickened and broadly branched distally, probably leading to the erroneous counts of I,3 in the literature (B.B. Washington, pers. commun., 8 Dec. 1986).

Ref: Richardson and Washington 1980 (as *Icelinus* spp.), Washington 1986, Washington et al. 1984b.

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	
Hatch size	~3 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	<50% SL
Length at flexion	6.2-9.4 mm SL
Length at transformation	13-19 mm SL
Sequence of fin development	Caudal, 2nd dorsal (rays) and anal, 1st dorsal (spines) and pectorals, pelvics (pectorals and pelvics formed by 11.5 mm SL)

Pigment
- Low number (<15) ventral midline melanophores
- Dorsal and anal finfolds
- Base of cleithrum

Diagnostic characters
- Short gut (33% SL)
- Pointed snout
- Pigment (see above)
- Four preopercular spines, other spines (as for *Myoxocephalus* group)
- Pelvic fin ray count I,2; visible in late-stage larvae and juveniles

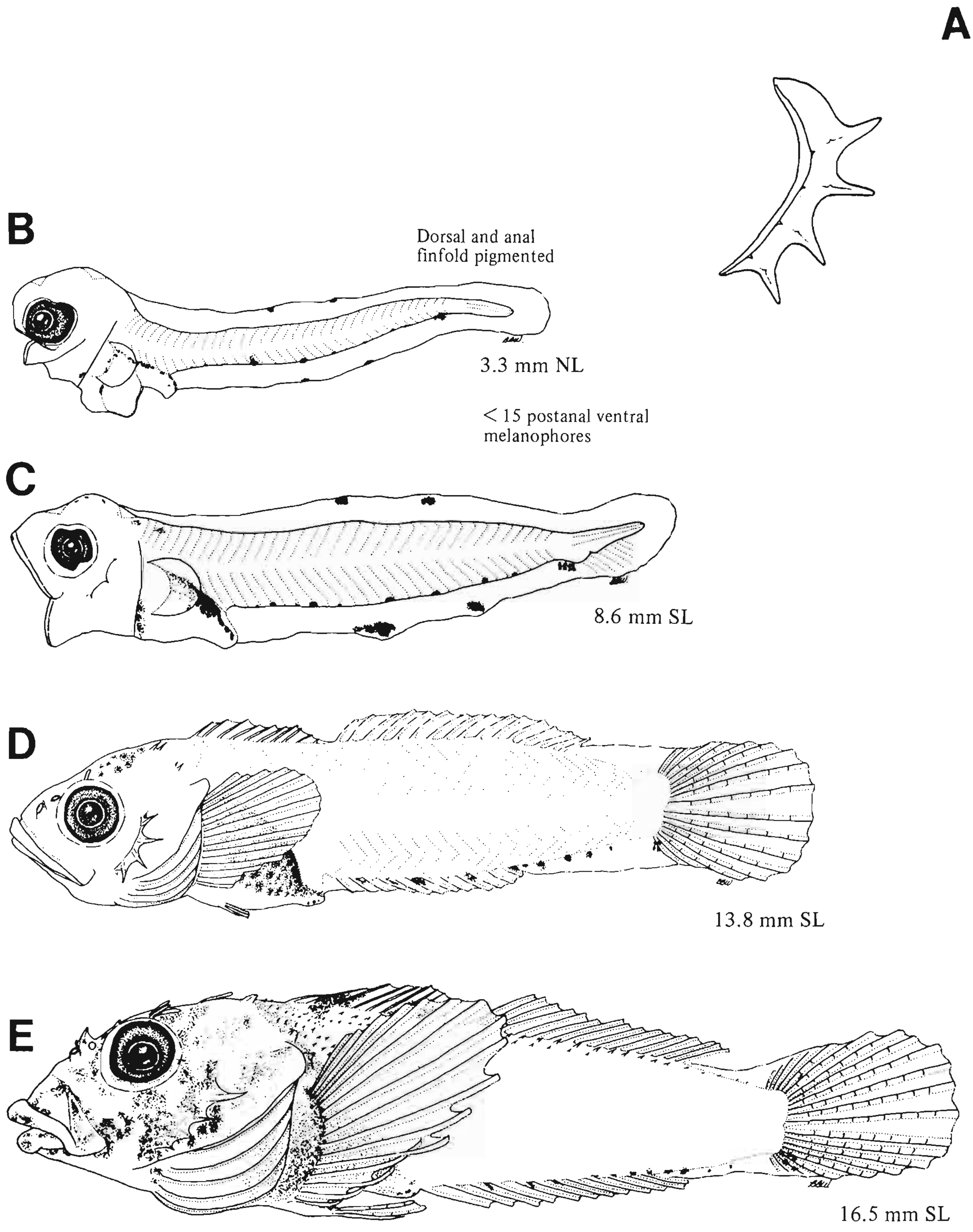


Figure A, Washington 1986; B–E, Richardson and Washington 1980. Total myomere counts for Figures B and C are 36.

MERISTICS

Vertebrae	Total: 33-36-36 Precaudal: 10-11-12 Caudal: 24-25-25
Branchiostegal rays	6-6-7
Caudal fin	10-13, 6+7, 8-11
Pelvic fin	Absent
Dorsal fin	S: 7-9-10 R: 17-18-19
Pectoral fin	R: 16-17-18
Anal fin	R: 13-15-16
Gill rakers	U: 0-X-3 L: 3-X-5

LIFE HISTORY

Range	Cent. California, 34-38°N, to SE Alaska, 55-59°N
Ecology	Intertidal, nearshore shelf demersal
ELH pattern	Oviparous; demersal, adhesive eggs; pelagic larvae
Spawning	Season: Mar (British Columbia)[a] Area: Cobble beach, under boulders[a] Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.7-2.0 mm
No. of oil globules	None
Oil globule diameter	
Yolk	Homogeneous, transparent blue developing to purple
Envelope	Smooth
Hatch size	6 mm SL
Incubation time/temp.	24 d/10°C
Pigment	

Diagnostic characters

LARVAE

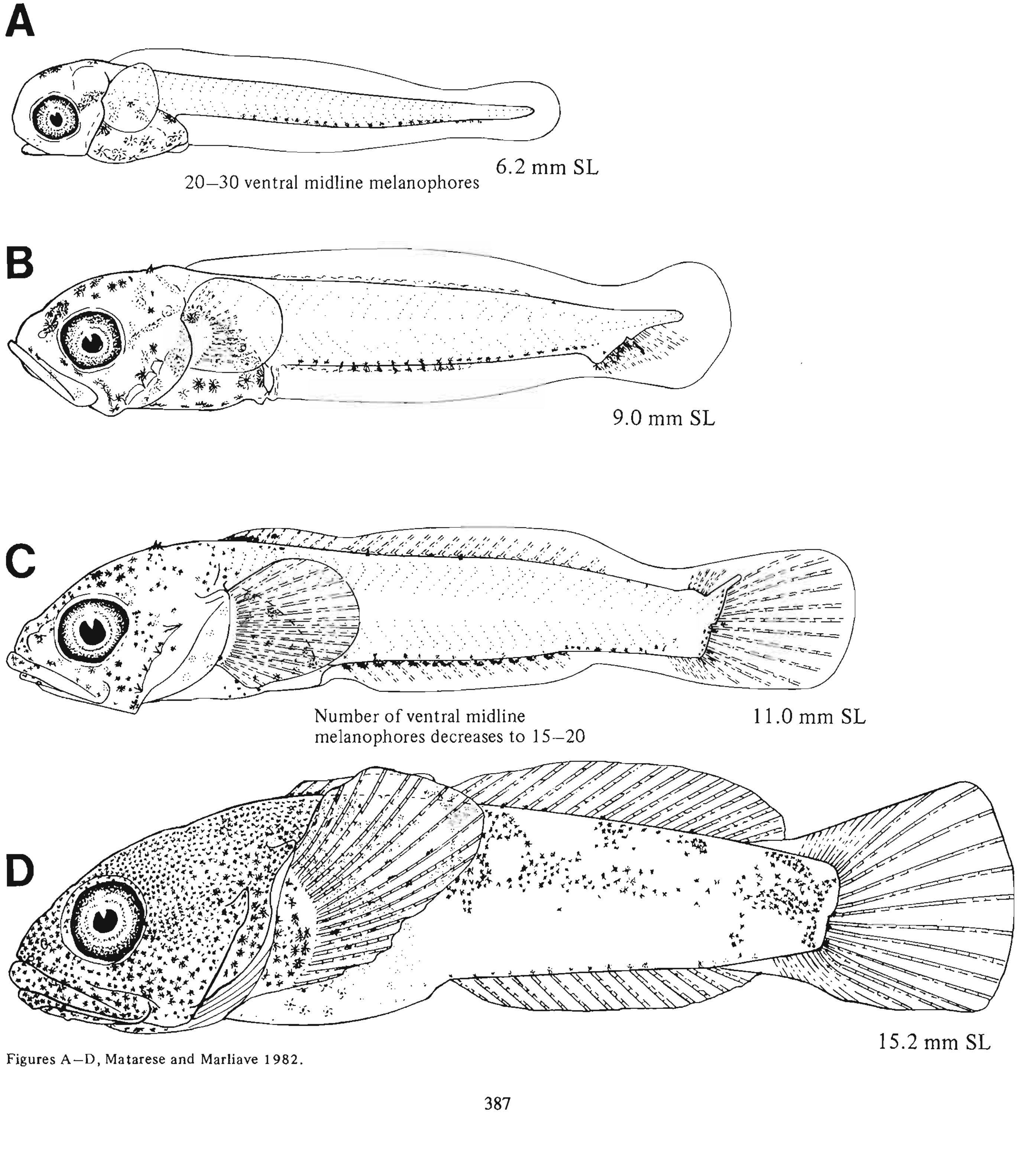
Preanal length	<50% SL
Length at flexion	8.8-11.0 mm SL
Length at transformation	12-13 mm SL
Sequence of fin development	

Pigment
- Heavy pigment on head and gut
- 20-30 ventral midline melanophores prior to flexion, 15-20 in postflexion larvae

Diagnostic characters
- Moderately slender form
- Pointed snout
- Four preopercular spines
- Ventral midline melanophores (the number at various developmental stages)

[a] Matarese and Marliave 1982

Ref: Matarese and Marliave 1982.



Figures A–D, Matarese and Marliave 1982.

MERISTICS

Vertebrae	Total: 35-35-36	
	Precaudal: 10-11-11	
	Caudal: 24-25-25	
Branchiostegal rays	6-6-6	
Caudal fin	X, 6+6, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 2-3-3
Dorsal fin	S: 8-10-11	R: 14-16-17
Pectoral fin	R: 16-17-18	
Anal fin	R: 14-16-17	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Nearshore shelf demersal, intertidal to 142 m
ELH pattern	Oviparous; adhesive, demersal eggs; pelagic larvae
Spawning	Season: Winter-spring (Calif.)[a]
	Area:
	Mode: Internal fertilization[b]
	Migration:
Fecundity	Range/function: 450-1900 ($\bar{x}$ 1043) may produce three clutches/season[a]
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.02-1.05 mm
No. of oil globules	One large, 5-8 small
Oil globule diameter	0.3 mm (large)
Yolk	
Envelope	Salmon-colored
Hatch size	2.9-3.0 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

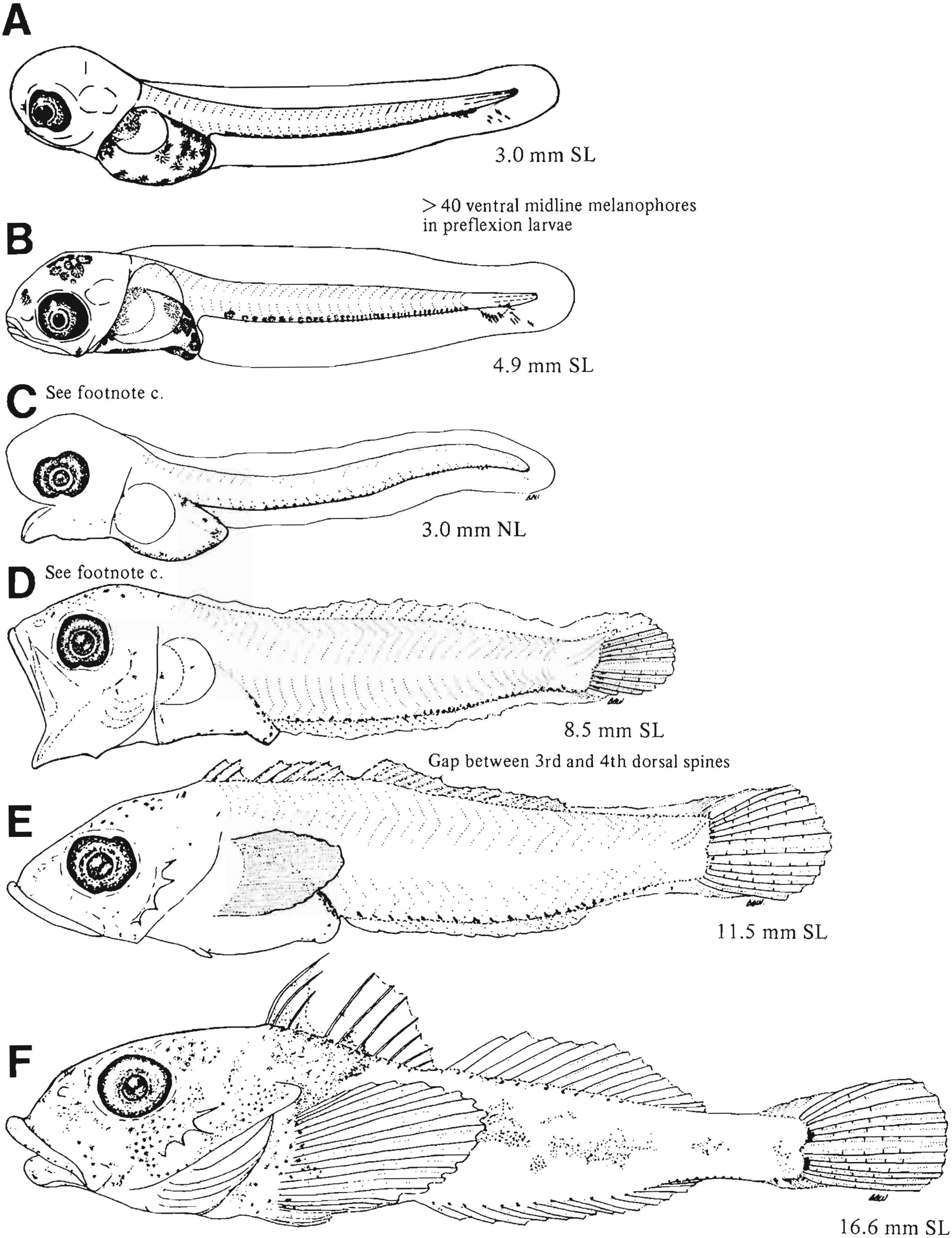
Preanal length	<50% SL
Length at flexion	
Length at transformation	Begins ~16.6 mm SL
Sequence of fin development	Caudal first, pelvics last

Pigment
- Dorsolateral gut pigment generally light according to Richardson and Washington (1980),[c] but specimens we collect have heavier pigment (compare Figures A and B with C and D)
- Our specimens have heavy crown pigment

Diagnostic characters
- Number of ventral midline melanophores >40 in preflexion larvae (<6 mm SL) and >20 in others
- Upper two preopercular spines larger than lower two

[a] Goldberg 1980b
[b] Misitano 1980
[c] Richardson suspects Figures C and D are incorrect; series requires reevaluation (S.L. Richardson, deceased, pers. commun., Oct. 1984). Washington suspects they are *Icelinus*, probably *I. quadriseriatus*, which occurs outside our study area (B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, pers. commun., 8 Dec. 1986).

Ref: Misitano 1980, Richardson and Washington 1980, Washington et al. 1984b.



Figures A–B, NWAFC originals (B. Vinter); C–F, Richardson and Washington 1980.

MERISTICS

Vertebrae	Total: 29-31-31	
	Precaudal: 11-11-12	
	Caudal: 18-20-20	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 7-8-9	R: 9-12-13
Pectoral fin	R: 15-16-17	
Anal fin	R: 8-9-10	
Gill rakers	U: 0-X-1	L: 4-X-6

LIFE HISTORY

Range	Cent. California, 34-38°N, to Gulf of Alaska, 54-60°N
Ecology	Nearshore shelf demersal, 0-20 m
ELH pattern	Oviparous; adhesive, demersal, guarded eggs; pelagic larvae
Spawning	Season: Feb-May (Puget Sound)[a] Area: On rocks or pilings nearshore[a] Mode: Internal fertilization likely,[b] polygamous male guards nests[c] Migration:
Fecundity	Range/function: 18,800-31,900 (spawn twice each season)[a]
Age at first maturity	
Longevity	

[a] DeMartini 1978
[b] Andriashev 1954
[c] Misitano 1978

Ref: Misitano 1978, Richardson and Washington 1980, Washington et al. 1984b.

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.7-2.0 mm
No. of oil globules	One
Oil globule diameter	0.36 mm
Yolk	Homogeneous, orange
Envelope	Clear, orange-brown
Hatch size	4.9-5.2 mm SL (5 mm SL)
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

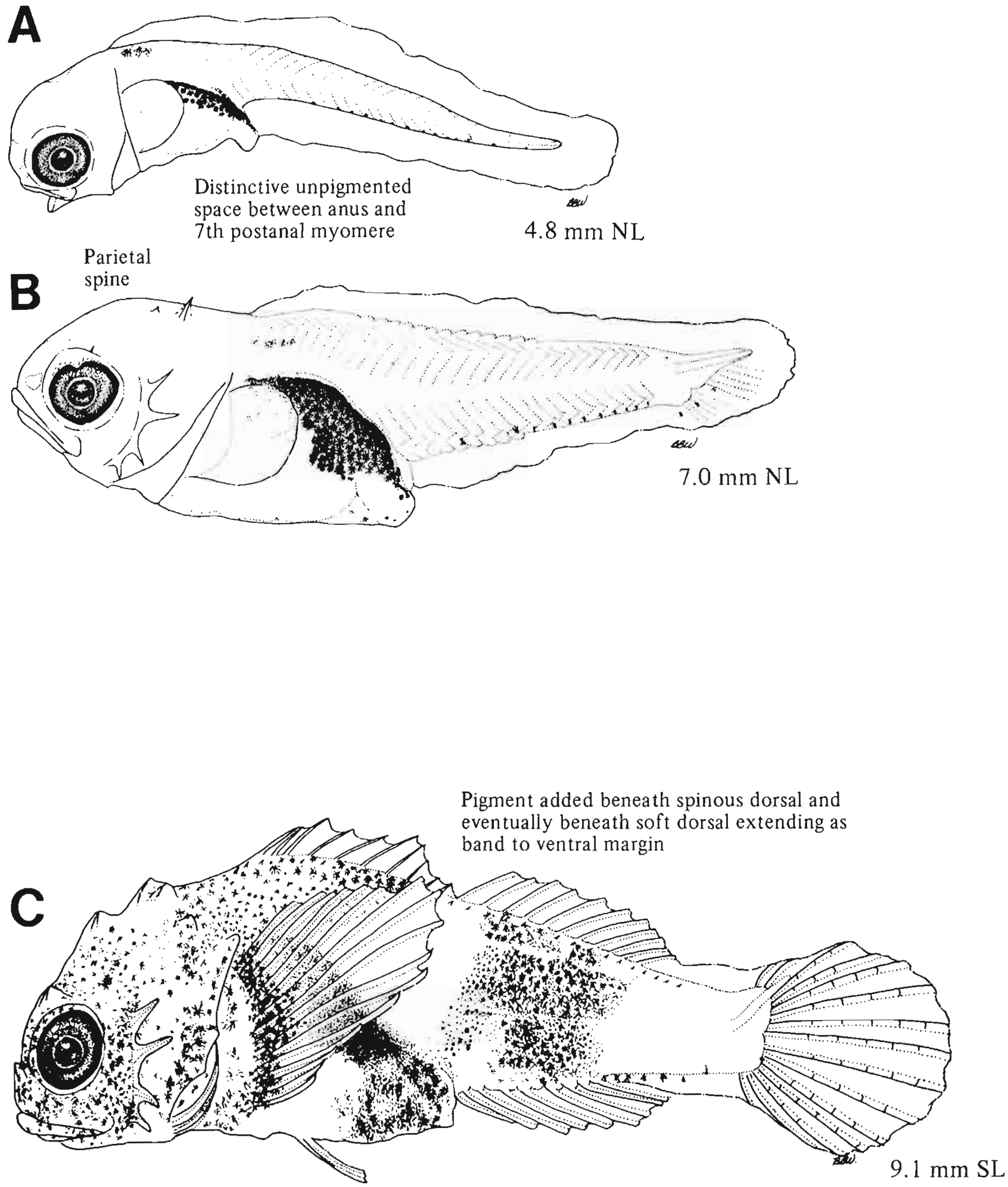
Preanal length	48-55% SL
Length at flexion	5.2-7.0 mm SL
Length at transformation	7.6-7.8 mm SL
Sequence of fin development	Caudal first; pectorals and pelvics formed by 9 mm SL

Pigment
- Dorsal surface of gut
- Ventral midline melanophores (≤15)
- Nape

Diagnostic characters
- Only stout-bodied member of *Myoxocephalus* group
- Ventral midline: ≤15 melanophores beginning several myomeres after anus
- Four preopercular spines
- Head spines prominent (e.g., parietal)
- Low vertebral count (29-31)

Eggs and larvae of *E. diceraus* and *E. lucasi* are unknown. The following information may aid in their identification.

	E. diceraus	*E. lucasi*
Total vertebrae	31-35	32-34
Dorsal fin spines	7-8	7-8
Dorsal fin rays	13-15	12-14
Anal fin rays	11-13	9-11
Pectoral fin rays	15-19	15-18
Pelvic fin rays	2-3	2-3
Range	SE Alaska-Arctic	Brit. Col.-Bering Sea



Figures A–C, Richardson and Washington 1980.

Presently we cannot identify to species *Gymnocanthus* larvae from samples collected in our study area. We identify one type, *Gymnocanthus* A, and include illustrations of *G. hertzensteini* for comparison. Generic characters include:

- Patch of pigment on crown
- Heavy dorsal pigment on gut, increasing dorsolaterally with development
- Numerous, closely spaced, ventral midline melanophores in preflexion larvae

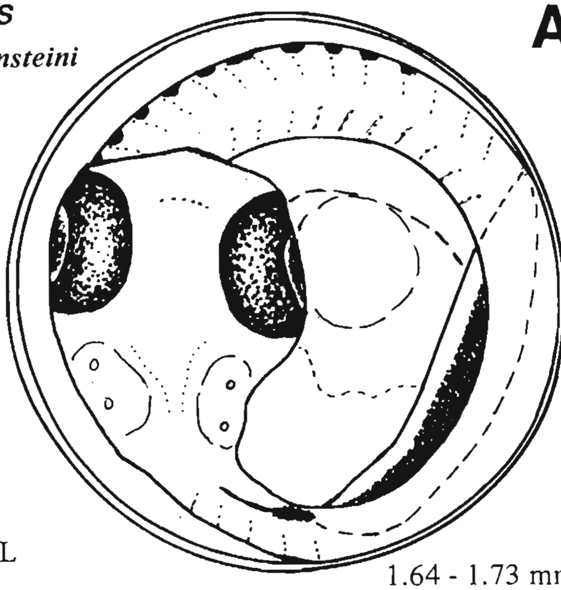
The following meristic information may aid in their identification.

			Fins				
			Dorsal				
Species	Distribution	Vertebrae	Spines	Rays	Anal rays	Pectoral rays	Pelvic rays
Gymnocanthus detriscus	Bering Sea	37-39	IX-XI	15-18	15-19	19-20	I,3
Gymnocanthus galeatus	Brit. Col. - Bering Sea	37-40	X-XII	14-17	17-20	19-21	I,3
Gymnocanthus pistilliger	SE Alaska - Bering Sea	35-38	IX-XI	13-16	14-18	15-20	I,3
Gymnocanthus tricuspis	Bering Sea - Arctic	36-40	X-XII	15-17	15-18	17-20	I,3

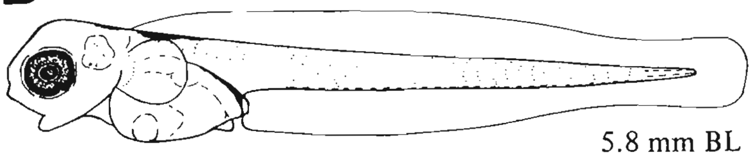
GYMNOCANTHUS

Gymnocanthus hertzensteini

A



B

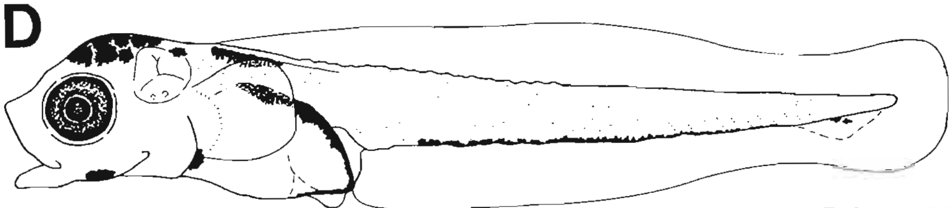


C

Heavy blotch on crown

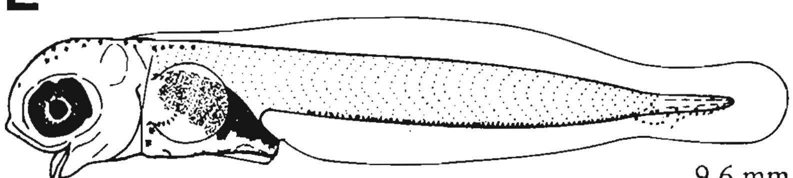
Heavy pigment on dorsolateral gut surface

D



Gymnocanthus A

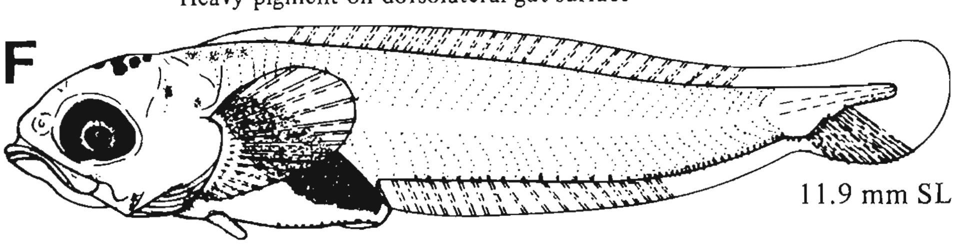
E



Numerous, closely spaced ventral midline melanophores

Heavy pigment on dorsolateral gut surface

F



Ventral midline melanophores widely spaced anteriorly and closely spaced posteriorly

Figures A–D, Kyushin 1970 (reared from specimens collected near Hokkaido, Japan; B–D, redrawn); E–F, NWAFC originals (B. Vinter).

MERISTICS

Vertebrae	Total: 36-38-40	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 10-11-12	R: 15-15-17
Pectoral fin	R: 17-18-20	
Anal fin	R: 15-17-18	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	Bering Sea, 54-66°N, to Arctic (throughout)
Ecology	Epi- and mesobenthal, 0-240 m
ELH pattern	Oviparous, demersal eggs, pelagic larvae
Spawning	Season: Winter-spring[a]
	Area:
	Mode: Internal fertilization likely[a]
	Migration:
Fecundity	Range/function: 2000-3500 (117-158 mm specimens)[a]
Age at first maturity	4 yr[a]
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter 2 mm
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

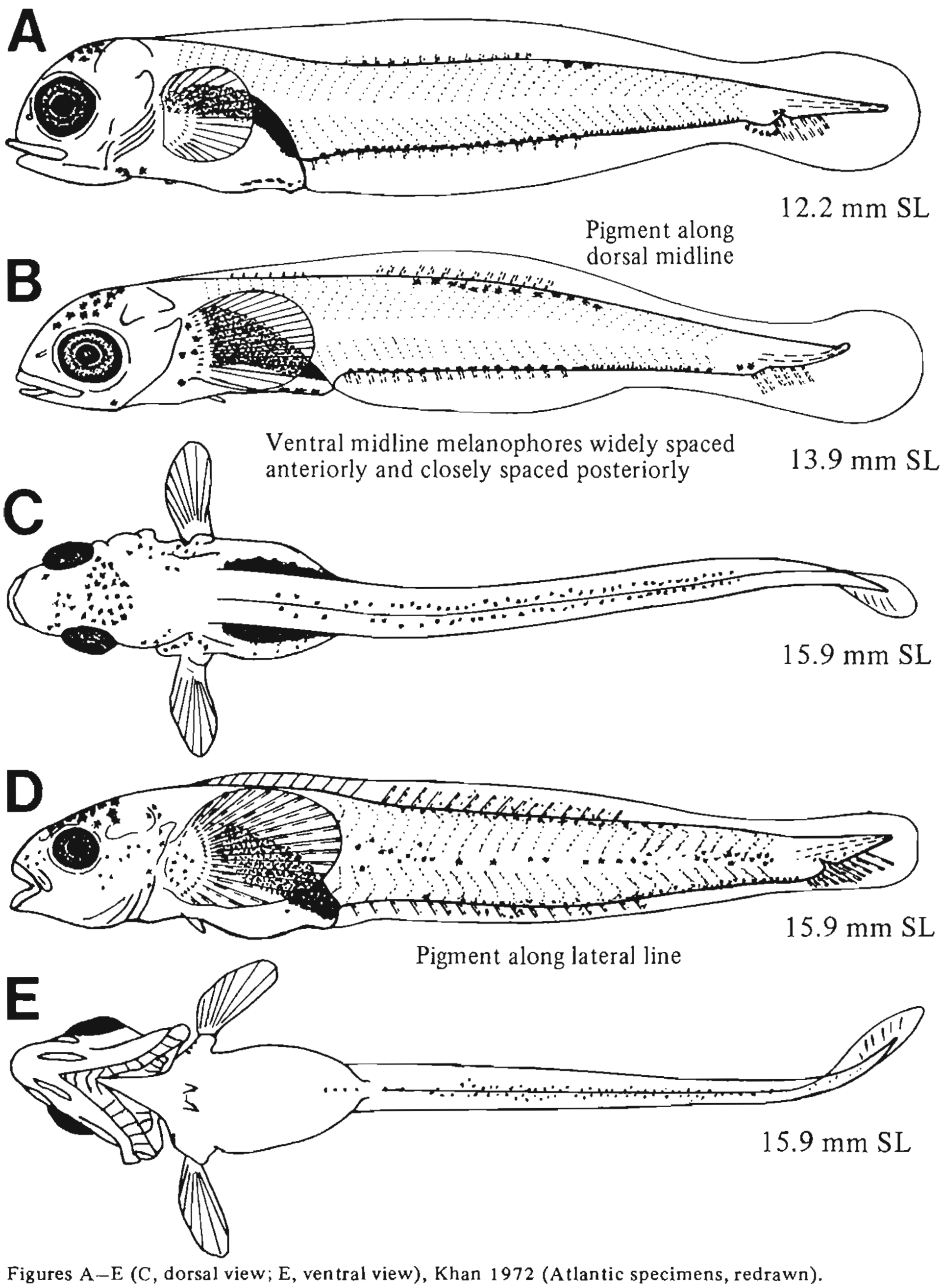
LARVAE

Preanal length
Length at flexion
Length at transformation
Sequence of fin development
Pigment[b]
- Heavy pigment on crown and dorsolateral surface of gut
- Larvae >12.2 mm SL have pigment along dorsal midline, and larvae >13.9 mm SL develop pigment along lateral line
- Ventral midline melanophores are widely spaced anteriorly and closely spaced posteriorly

Diagnostic characters
- Specimens of other species of *Gymnocanthus* at comparable developmental stages have not been described

[a] Andriashev 1954
[b] Specimens have not been collected from our study area. Illustrations of out-of-area specimens are presented for comparison and may differ.

Ref: Andriashev 1954, Khan 1972, Washington et al. 1984b.



Figures A–E (C, dorsal view; E, ventral view), Khan 1972 (Atlantic specimens, redrawn).

Eggs and larvae of *Icelinus* spp. from the study area are unknown. Illustrations of *Icelinus* A and B, both tentatively identified as *I. borealis* by Washington and Richardson (unpubl.),[1] are presented here.

The following meristic characters may aid in their identification.

			Fins				
			Dorsal				
Species	Distribution	Vertebrae	Spines	Rays	Anal rays	Pectoral rays	Pelvic rays
Icelinus borealis	Wash. - Bering Sea	35-36	IX-XI	14-17	11-14	14-17	I,2
Icelinus burchami	S. Calif. - SE Alaska	35-37	X-XI	16-18	12-14	16-19	I,2
Icelinus filamentosus	S. Calif. - Gulf of Alaska	34-37	X-XII	15-17	13-16	16-18	I,2
Icelinus fimbriatus	S. Calif. - Brit. Col.	37	XI	15-17	13-14	17	I,2
*Icelinus tenuis**	SSC - Brit. Col.	37-39	IX-XI	16-18	14-17	15-17	I,2

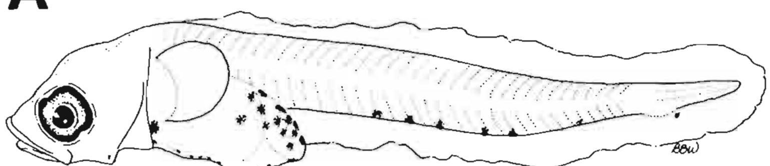
*A partial series of *I. tenuis* larvae has been identified at Los Angeles County Museum (R. Feeney, Los Ang. Cty. Mus. Nat. Hist., 900 Exposition Blvd., Los Angeles, CA 90007, pers. commun., Oct. 1986).

[1]B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560.

ICELINUS

Icelinus A

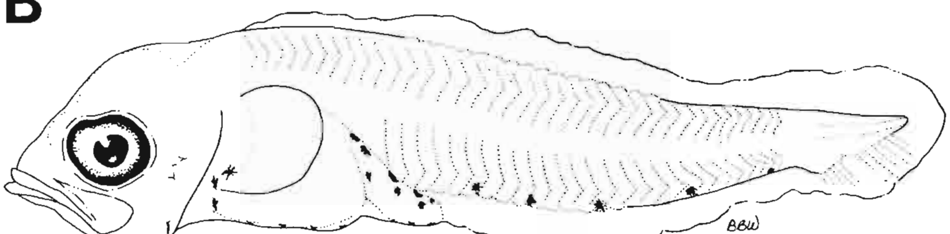
A



7.1 mm SL

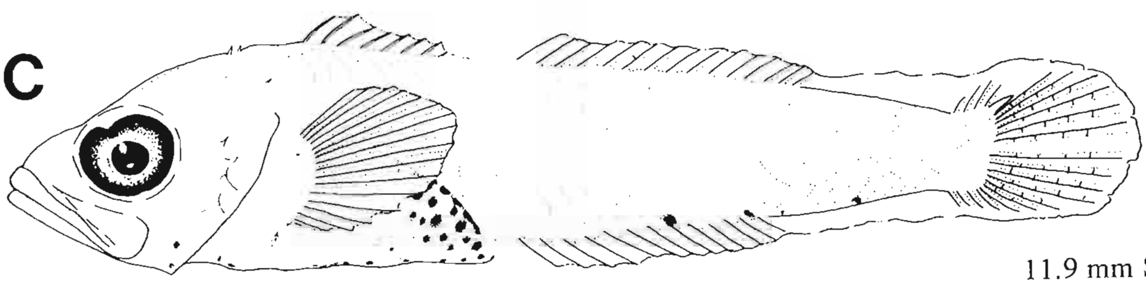
Icelinus B

B



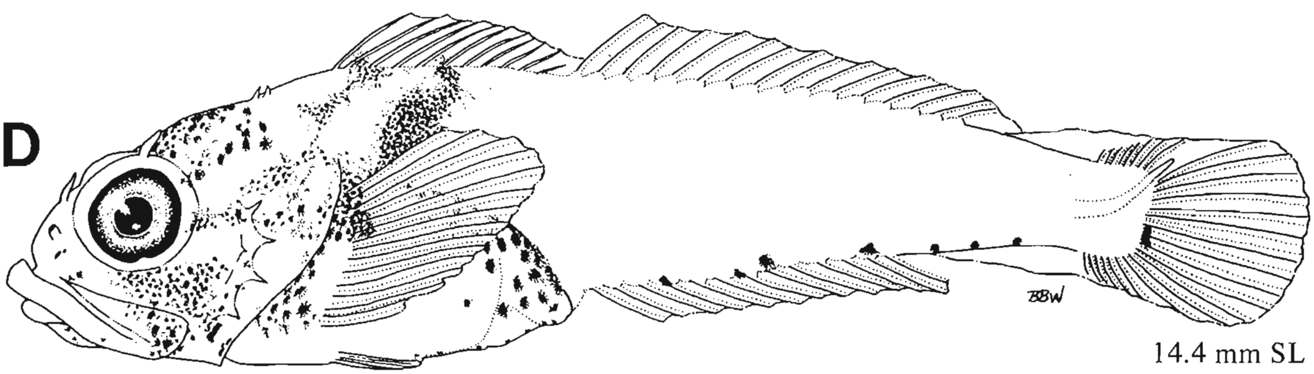
7.9 mm SL

C



11.9 mm SL

D



14.4 mm SL

Figures A–D, Washington and Richardson, unpubl.

Eggs and larvae of *Icelus* spp. from our study area are unknown. The following meristic characters may aid in their identification.

			Fins				
			Dorsal				
Species	Distribution	Vertebrae	Spines	Rays	Anal rays	Pectoral rays	Pelvic rays
Icelus canaliculatus	Gulf of Alaska - Bering Sea	41	VII-VIII	22-25	18-20	15-19	I,3
Icelus euryops	Gulf of Alaska - Bering Sea		VIII-X	20-23	15-19	16-18	I,3
*Icelus scutiger**	Gulf of Alaska - Bering Sea	39-41	IX-X	18-21	17-19	17-19	I,3
Icelus spatula	Gulf of Alaska - Arctic	39-41	VII-X	17-22	13-18	16-20	I,3
Icelus spiniger	Brit. Col. - Bering Sea	40-42	VIII-X	19-24	15-20	17-20	I,3
Icelus uncinalis	Bering Sea	37-40	IX-X	18-20	14-16	17-18	I,3

*Placed in the genus *Rastrinus* by D.W. Nelson (1984).

Presently we cannot identify to species *Myoxocephalus* larvae from samples we collect in our study area. We collect at least two types based on the following pigmentation characters:

***Myoxocephalus* B** Ventral midline melanophore series (>40 spots), dorsal pigment on gut, and crown pigment; with development, dorsolateral pigment appears covering about 2/3 body length, small ventrolateral patch appears at midbody. Ventrolateral body from over gut to about six myomeres after anus is unpigmented.

***Myoxocephalus* G (probably *M. polyacanthocephalus*)** Preflexion pigment pattern similar to flexion pattern of the other *Myoxocephalus* type; crown, gut, and ventral midline series with dorsolateral and lateral pigment covering 2/3 body length. Body pigment becomes more intense and crown pigment covers entire head with development. No unpigmented area on lateral body over gut and anus.

The following meristic characters may aid in their identification.

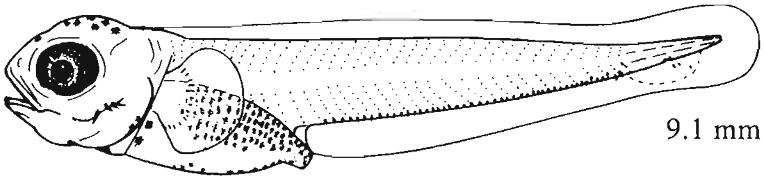
			Fins				
			Dorsal				
Species	Distribution	Vertebrae	Spines	Rays	Anal rays	Pectoral rays	Pelvic rays
*Myoxocephalus axillaris**	Bering Sea - Arctic		VIII-X	15-17	11-13	14-16	I,3
Myoxocephalus brandti	Bering Sea		IX	15	12-13	16-17	I,3
Myoxocephalus jaok	Gulf of Alaska - Chukchi Sea	35-38	VIII-XI	13-17	12-16	17-19	I,3
Myoxocephalus niger	Bering Sea	36-39	VIII-X	14-18	10-12	16-18	I,3
Myoxocephalus polyacanthocephalus	Wash. - Bering Sea	34-37	IX-X	10-15	8-13	16-19	I,3
Myoxocephalus quadricornis	Bering Sea - Arctic	38-42	VII-X	12-16	13-17	14-18	I,3
*Myoxocephalus scorpioides**	Bering Sea - Arctic	35-38	VIII-X	13-18	10-14	14-17	I,3
*Myoxocephalus scorpius**	SE Alaska - Arctic	38-46	VIII-XII	12-20	10-16	16-19	I,3
Myoxocephalus stelleri	Bering Sea - Chukchi Sea		VIII-X	15-16	11-14	16-18	I,3
*Myoxocephalus verrucosus**	Brit. Col. - Arctic		IX-XII	15-18	13-15	16-19	I,3

*According to Neelov (1979), *M. scorpioides* = *M. axillaris*, and *M. scorpius* in the study area is *M. verrucosus*.

MYOXOCEPHALUS

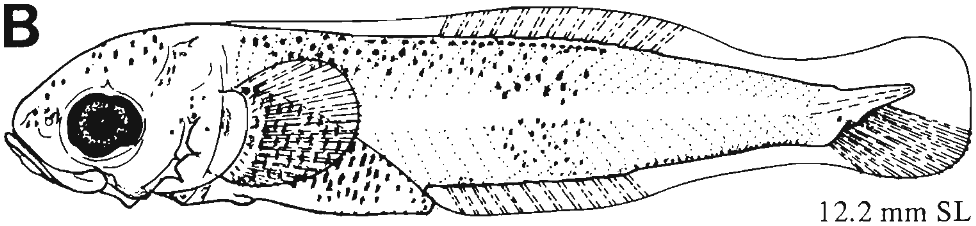
Myoxocephalus B

A



9.1 mm SL

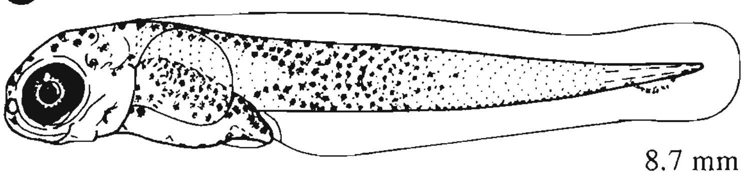
B



12.2 mm SL

Myoxocephalus G

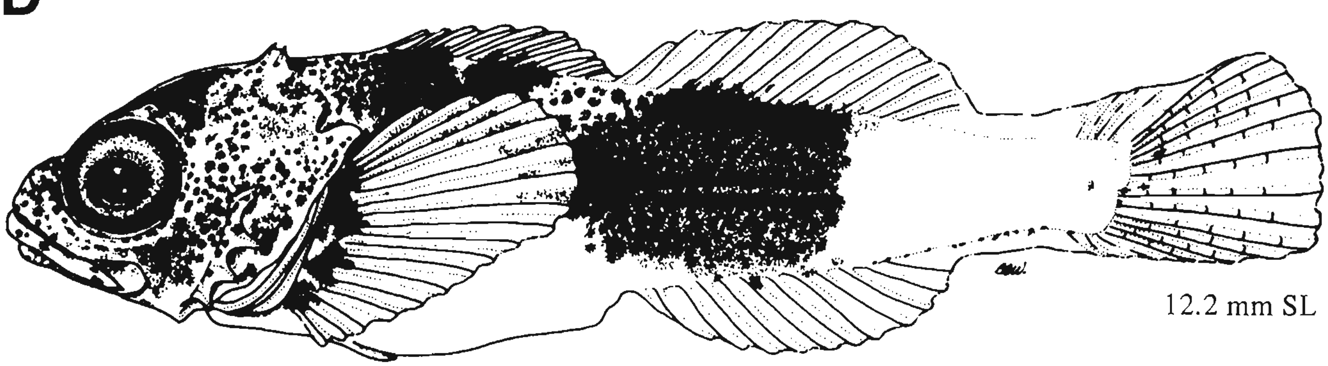
C



8.7 mm SL

M. polyacanthocephalus

D



12.2 mm SL

Figures A–C, NWAFC originals (B. Vinter); D, Richardson 1981a.

MERISTICS

Vertebrae	Total: 38-X-46	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 8-X-12	R: 12-X-20
Pectoral fin	R: 16-X-19	
Anal fin	R: 10-X-16	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	Brit. Col., 48°30′-55°N, to Arctic, not specific
Ecology	Epi-, meso-, and bathybenthal, 0-550 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Winter[b]
	Area:
	Mode: Eggs guarded by males[b]
	Migration:
Fecundity	Range/function: 2700[b]
Age at first maturity	3-4 yr[b]
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	2.0-2.5 mm;[b] 1.8-2.5 mm[c]
No. of oil globules	Several
Oil globule diameter	0.4-0.5 mm
Yolk	
Envelope	
Hatch size	7.4-8.6 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

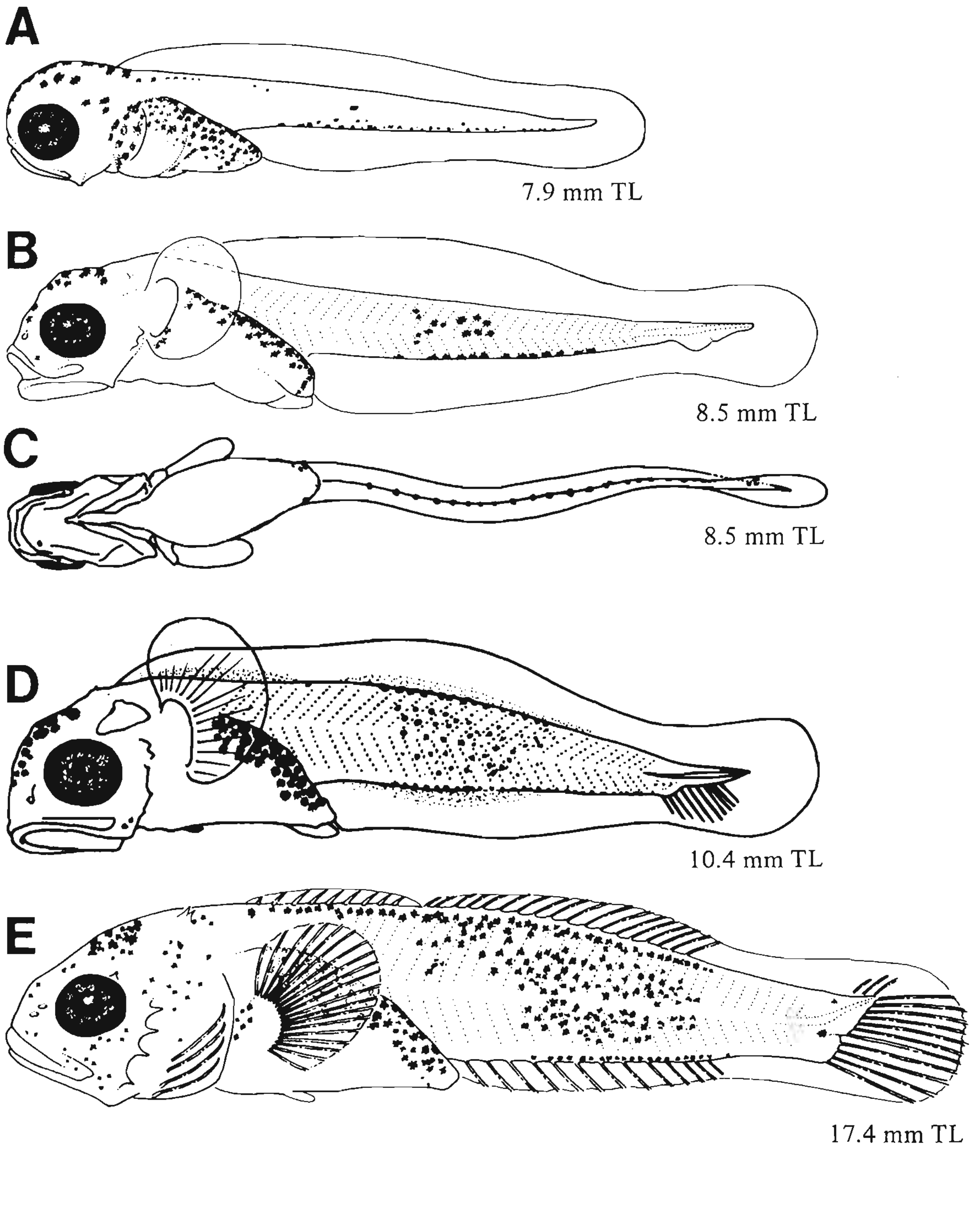
Preanal length	
Length at flexion	9-15 mm SL
Length at transformation	17-20 mm SL
Sequence of fin development	

Pigment
- Crown, dorsolateral gut surface, ventral midline starting at myomere 16
- Develops midbody patch at flexion with dorsal pigment extending anteriorly

Diagnostic characters

[a] According to Neelov (1979), specimens from our area are *M. verrucosus*. Illustrations of Atlantic specimens of *M. scorpius* are presented for comparison. Specimens from our area may differ.
[b] Andriashev 1954
[c] Washington et al. 1984b

Ref: Andriashev 1954, Washington et al. 1984b.



Figures A–B, E, Fahay 1983 (A, after Rass 1949; B, E, after Khan 1972); C–D (C, ventral view), Khan 1972 (B–E, Gulf of St. Lawrence specimens).

MERISTICS

Vertebrae	Total: 42-42-43	
	Precaudal: 12-12-12[a]	
	Caudal: 31-31-31[a]	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 12-13-13	R: 19-19-20
Pectoral fin	R: 14-15-15	
Anal fin	R: 23-24-24	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	S. California, 32-34°N, to Brit. Col., 48°30′-55°N
Ecology	Nearshore shelf demersal, 0-183 m
ELH pattern	Parity and eggs unknown, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	
Hatch size	<5.6 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

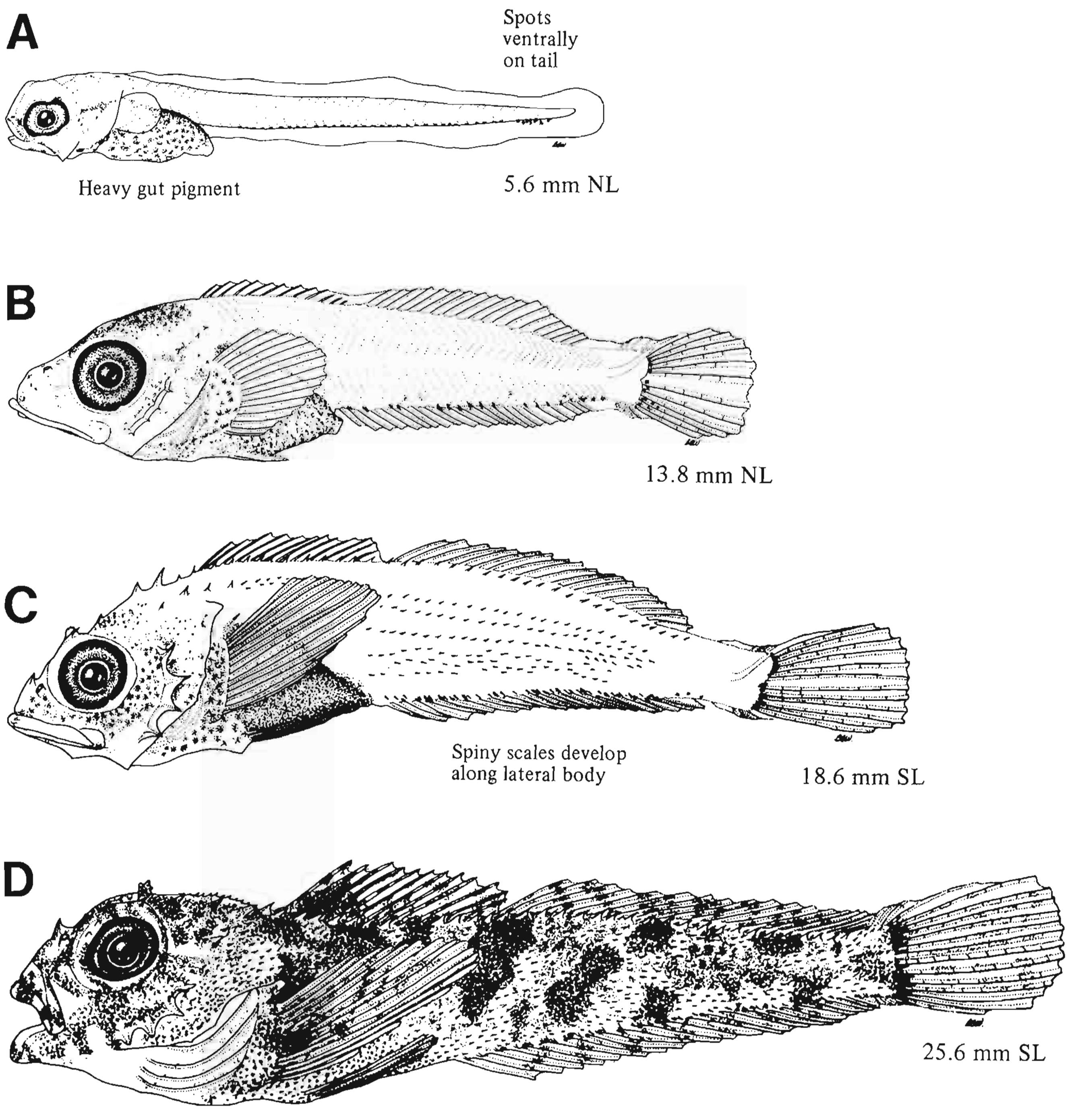
Preanal length	35-36% SL, increasing with development
Length at flexion	
Length at transformation	~25 mm SL
Sequence of fin development	

Pigment
- Gut pigmented all over
- Ventral midline melanophores >30, decreasing to 15-20 by postflexion stage
- Melanophores near tail tip

Diagnostic characters
- Pigment pattern (tail pigment)
- Pointed snout and slender body
- Four preopercular spines
- Myomeres (42-43)
- Spiny scales develop in postflexion larvae

[a] B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, unpubl.

Ref: Richardson and Washington 1980.



Figures A–D, Richardson and Washington 1980.

MERISTICS

Vertebrae	Total: 38-39-40	
	Precaudal: 12-X-13	
	Caudal: 27-27-27	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 8-9-10	R: 20-22-23
Pectoral fin	R: 17-18-20	
Anal fin	R: 21-23-25	
Gill rakers	U: X-X-1	L: 7-X-8

LIFE HISTORY

Range	South of southern California to Gulf of Alaska, 54-60°N
Ecology	Epi- and mesobenthal, 18-283 m
ELH pattern	Oviparous, demersal eggs, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	
No. of oil globules	
Oil globule diameter	
Yolk	Homogeneous
Envelope	
Hatch size	≤4.7 mm NL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	44-54% SL
Length at flexion	7.2-10.9 mm NL
Length at transformation	≥14-15 mm SL
Sequence of fin development	

Pigment

- Heavy over body except dorsolaterally above body midline over gut and dorsally and laterally on tail tip

Diagnostic characters (see Table 3)

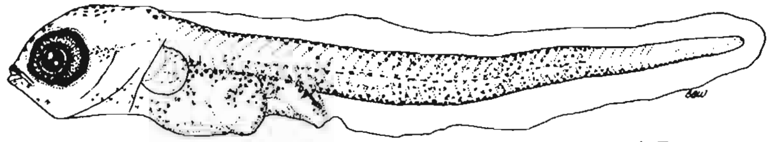
- Heavy pigmentation
- Preopercular spines not prominent
- Gut distinctively coiled

Distinguished from *Scorpaenichthys marmoratus* (p. 382) by

- Series of melanophores along lateral line

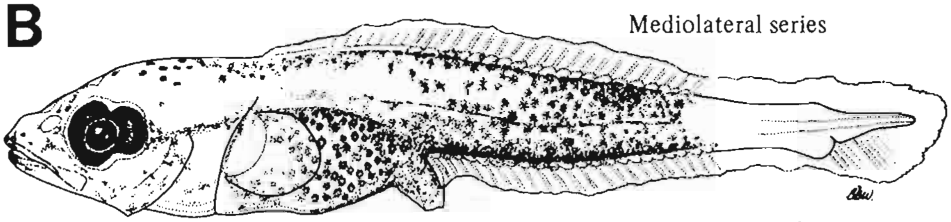
Ref: Richardson and Washington 1980, Washington et al. 1984b.

A



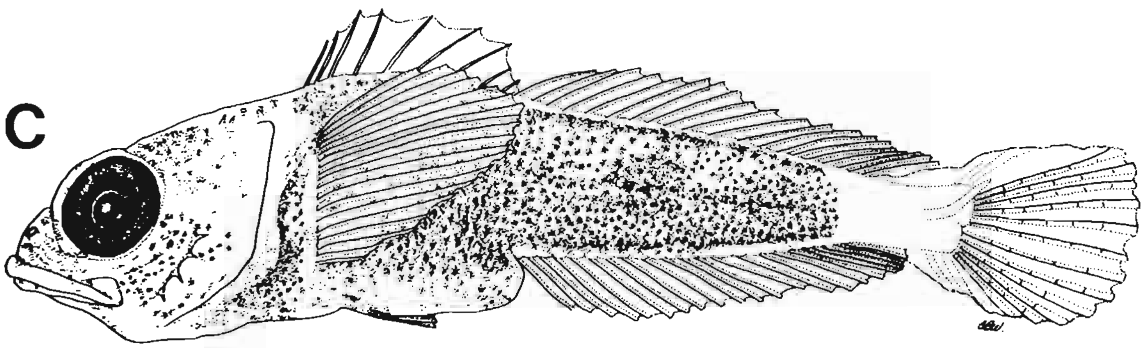
4.7 mm NL

B



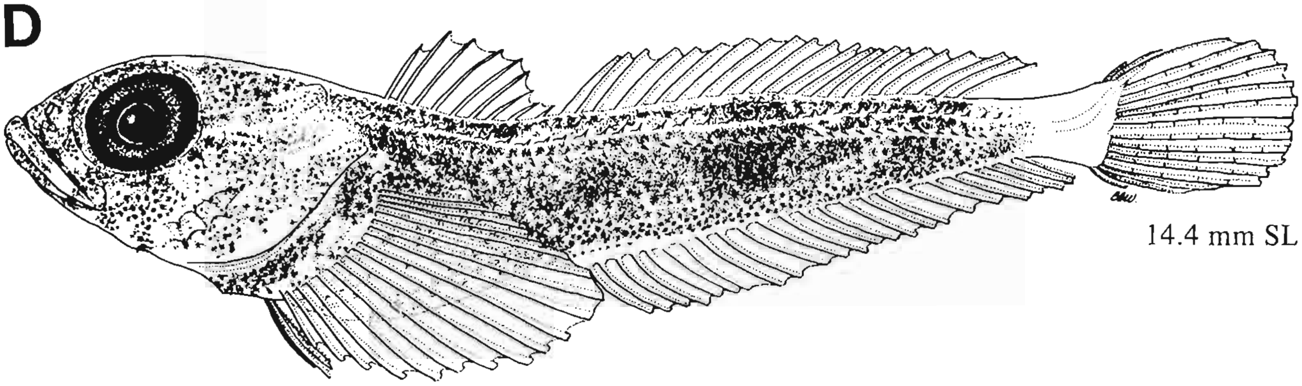
9.6 mm NL

C



12.6 mm SL

D



14.4 mm SL

Figures A–D, Richardson and Washington 1980.

MERISTICS

Vertebrae	Total: 39-40-40	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	6-6-6	
Caudal fin	X, 6+6, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 8-9-11	R: 20-20-22
Pectoral fin	R: 18-19-20	
Anal fin	R: 21-22-23	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	S. California, 32-34°N, to Brit. Col., 48°30′-55°N
Ecology	Nearshore shelf demersal, 15-146 m
ELH pattern	Oviparous, eggs probably demersal, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk Homogeneous
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

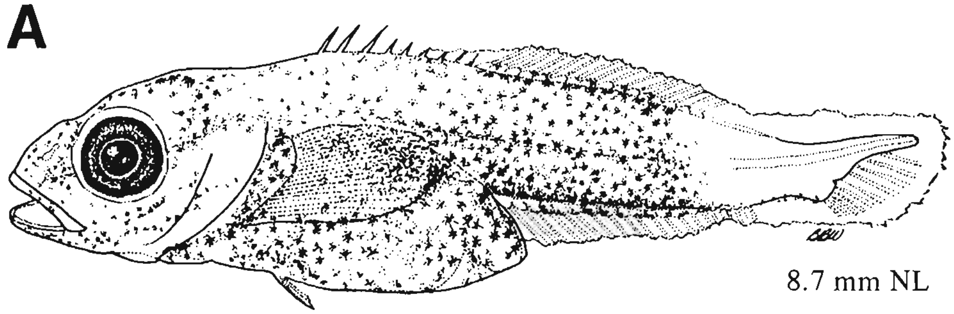
LARVAE

Preanal length ~58% SL
Length at flexion ~8.7 mm SL
Length at transformation
Sequence of fin development
Pigment
- Generally heavily pigmented over anterior 3/4 body

Diagnostic characters (see Table 3)
Distinguished from *R. asprellus* by
- Greater portion of tail unpigmented
- Morphological differences
  —Preanal length longer
  —Greater body depth

Ref: Richardson and Washington 1980.

A



8.7 mm NL

Figure A, Richardson and Washington 1980.

MERISTICS

Vertebrae	Total: 38-39-39	
	Precaudal: 12-12-12	
	Caudal: 26-26-26	
Branchiostegal rays	6-6-6[a]	
Caudal fin	8-9, 6+5, 7-8	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 8-10-10	R: 19-20-21
Pectoral fin	R: 21-22-24	
Anal fin	R: 18-20-21	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range S. California, 32-34°N, to SE Alaska, 55-59°N

Ecology Intertidal, nearshore shelf demersal

ELH pattern Oviparous; demersal, attached, adhesive eggs; pelagic larvae

Spawning Season: Jan-Feb through Apr (British Columbia), larvae collected in spring;[b] May[c]
Area: Shallow, rocky subtidal areas (extreme nearshore), larvae collected 0 and 4 m from shore[b]
Mode: Internal fertilization, eggs laid in masses on *Laminaria* holdfasts (15-20 eggs/mass)[b]
Migration:

Fecundity Range/function:

Age at first maturity

Longevity

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk Homogeneous, pink (wild)
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

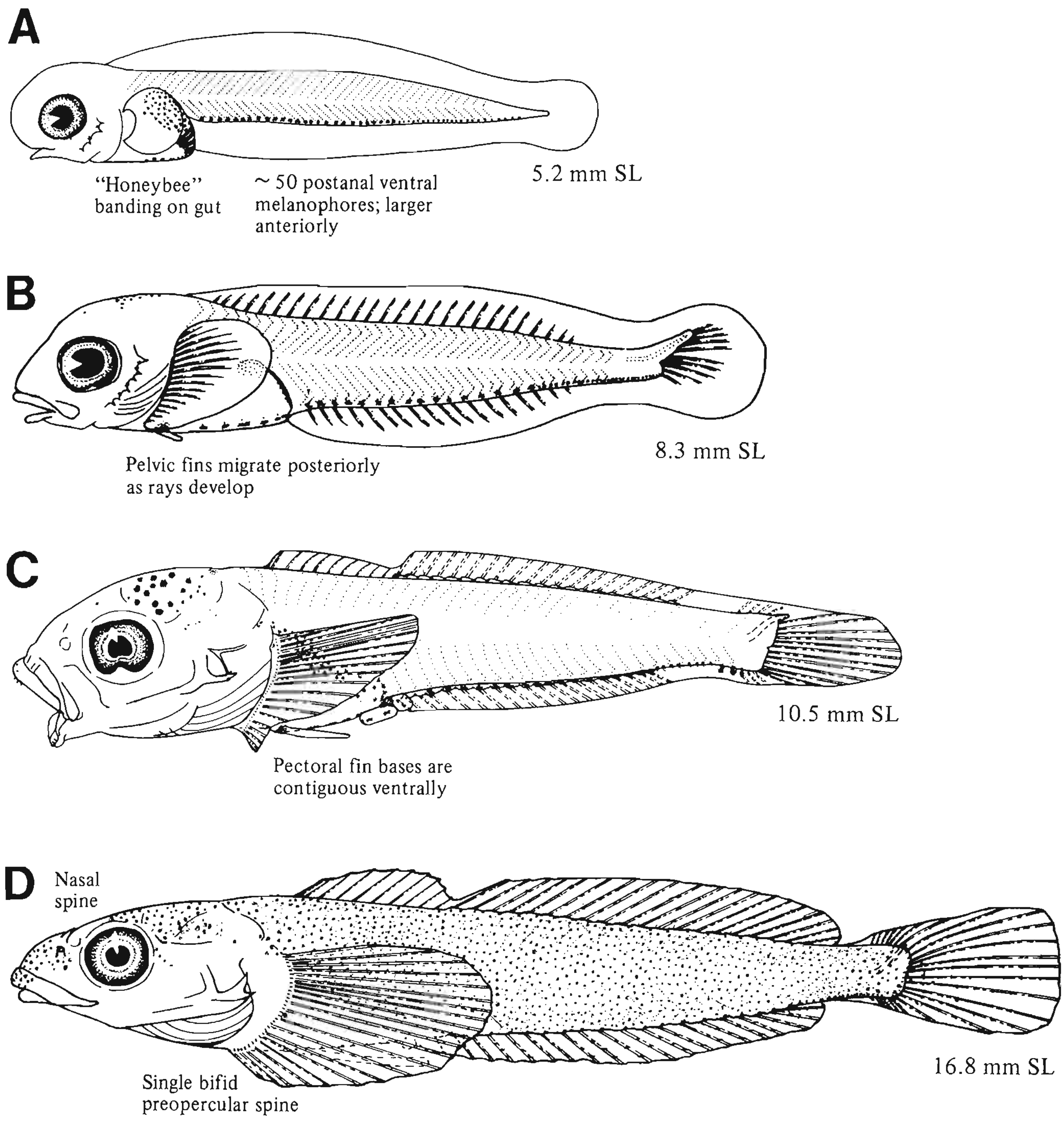
LARVAE[d]

Preanal length 37-42% SL
Length at flexion 6.5-8.5 mm SL
Length at transformation
Sequence of fin development Pectorals and caudal, dorsal and anal, pelvics
Pigment
- Gut pattern
- High number of postanal ventral melanophores ($\bar{x}$ 51 in preflexion, 47 in flexion)

Diagnostic characters
- Pigment on gut
- Accessory or inner-shelf spines associated with preopercular spines in preflexion larvae (not present in other members of *Myoxocephalus* group)
- Pectoral fin rays develop toward each other ventrally
- Spines: Nasal spines develop at 12-14 mm SL

[a] According to Marliave et al. (1985), branchiostegal rays = 7.
[b] Marliave et al. 1985
[c] Hart 1973
[d] Tentative placement in *Myoxocephalus* group.

Ref: Marliave et al. 1985.



Figures A–B, Marliave et al. 1985; C–D, NWAFC originals (B. Vinter).

Presently we cannot identify to species *Triglops* spp. larvae from samples we collect in our study area. Illustrations of *Triglops* sp. (designated as B here) (Richardson and Washington 1980) and *Triglops* A (Washington and Richardson, unpubl.[1]) are presented here. Generic characters include:

- High myomere count (>45)
- Pointed snout
- Heavy dorsolateral pigmentation on gut
- Postanal ventral midline melanophores, probably becoming embedded in postflexion larvae (except *Triglops* B as figured by Richardson and Washington [1980]).

The following meristic information may aid in their identification.

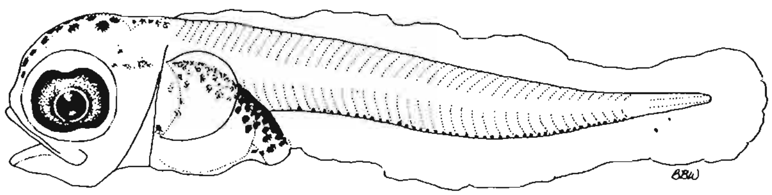
			Fins				
			Dorsal				
Species	Distribution	Vertebrae	Spines	Rays	Anal rays	Pectoral rays	Pelvic rays
Triglops forficata	Gulf of Alaska - Bering Sea	52-54	IX-XI	27-32	27-32	20-22	I,3
Triglops jordani	Bering Sea		IX-XI	24-28	23-29	19-21	I,3
Triglops macellus	Wash. - Bering Sea	51	X-XI	27-31	27-31	15-17	I,3
Triglops metopias	SE Alaska - Bering Sea	48-49	X-XI	23-27	22-27	18-22	I,3
Triglops pingeli	Wash. - Arctic	46-48	IX-XIII	22-28	20-28	16-19	I,3
Triglops scepticus	SE Alaska - Bering Sea	45-46	X-XII	21-23	22-24	17-19	I,3

[1]B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560.

TRIGLOPS

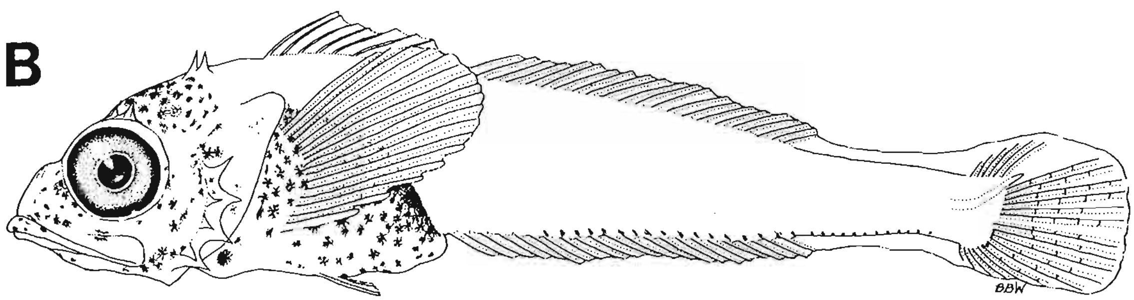
Triglops A (possibly *T. scepticus* based on counts)

A



Ventral midline melanophores 6.5 mm SL

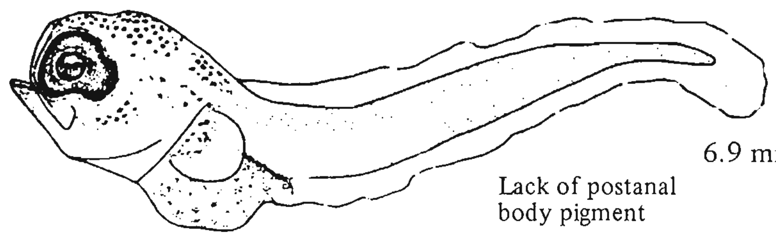
B



16.9 mm SL

Triglops B

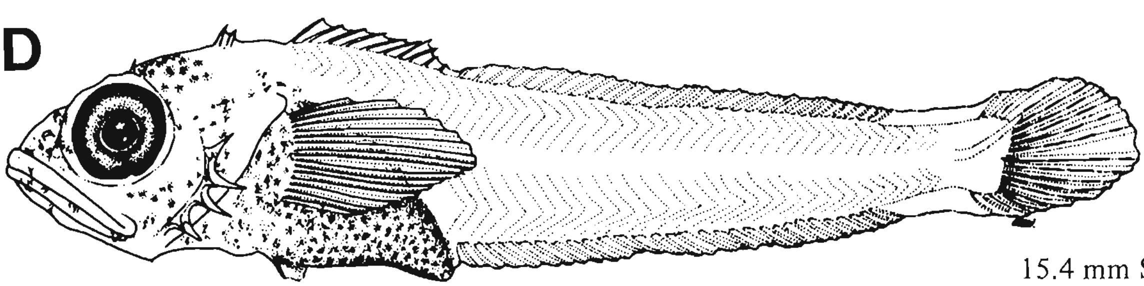
C



6.9 mm NL

Lack of postanal body pigment

D



15.4 mm SL

Figures A–B, Washington, unpubl.; C–D, Richardson and Washington 1980.

MERISTICS

Vertebrae	Total: 32-33-35	
	Precaudal: 11-X-12[a]	
	Caudal: 22[a]-X-23	
Branchiostegal rays	6-6-6	
Caudal fin	X, 6+6, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 8-9-10	R: 16-17-18
Pectoral fin	R: 14-15-16	
Anal fin	R: 12-13-14	
Gill rakers	U: 1-1-1	L: 4-X-5

LIFE HISTORY

Range	Cent. California, 34-38°N, to Aleutian Is., 51-55°N
Ecology	Nearshore shelf demersal, intertidal to 55 m
ELH pattern	Oviparous; demersal, adhesive, attached eggs; pelagic larvae
Spawning	Season: Feb-May[b]
	Area: Intertidal, under rocks[b]
	Mode: Polygamous males, eggs laid in nests[b]
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

[a]B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, unpubl.
[b]Marliave 1975a
[c]Pigment patterns within the genus *Artedius* appear to be highly variable. Reared specimens vary between hatches and stages (J. Marliave, Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8, pers. commun., 16 Oct. 1986). Wild specimens collected from Yaquina Bay, Oregon, show variations from the pigment patterns described in Washington (1986) (B. Mundy, NMFS Southwest Fish. Cent., Honolulu Lab., 2570 Dole St., Honolulu, HI 96822, pers. commun., 1 Oct. 1986).

Ref: Marliave 1975a; Richardson and Washington 1980 (see *Artedius* 2); Washington 1981, 1986.

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	
No. of oil globules	
Oil globule diameter	
Yolk	Homogeneous; blue, purple, or gray
Envelope	
Hatch size	3.5-3.8 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	<50% SL
Length at flexion	5.9-6.8 mm NL
Length at transformation	12-14 mm SL
Sequence of fin development	Caudal, dorsal and anal rays, dorsal spines, pectorals, pelvics

Pigment[c]
- Lack of head pigment
- Usually relatively light nape pigment present
- 13-19 postanal ventral midline melanophores

Diagnostic characters
Distinguished from other cottids by
- Body shape stubby, humped
- Presence of gut diverticula
- Preopercular spines (postflexion, 18-22)
- Parietal spines (postflexion)

Distinguished from other *Artedius* spp. with gut diverticula by

	Preflexion		Flexion	
	No. of postanal ventral melanophores	Presence of nape pigment	Presence of brain pigment	No. of preopercular spines
A. fenestralis	13-19	Irreg.	No	18-22
A. lateralis	22-32	No	Yes	14-16
Artedius 3	9-13	Yes	No	22-24

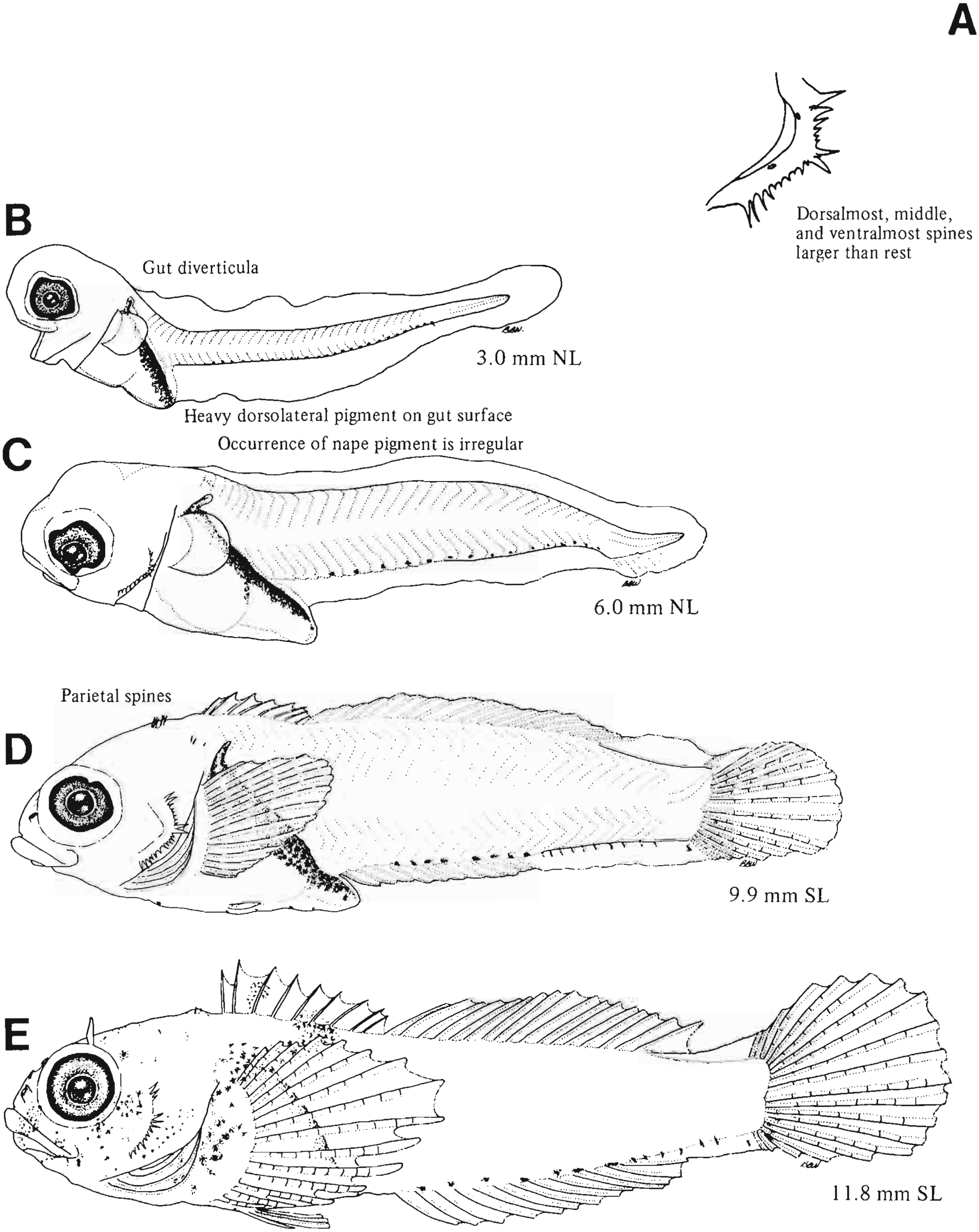


Figure A, Washington 1986; B–E, Richardson and Washington 1980.

MERISTICS

Vertebrae	Total: 32-33-34	
	Precaudal: 11-X-12	
	Caudal: 22-X-23	
Branchiostegal rays	7-7-7	
Caudal fin	X, 6+6, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 9-9-9	R: 15-17-18
Pectoral fin	R: 13-14-15	
Anal fin	R: 10-13-14	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	S. California, 32-34°N, to Aleutian Is., 51-55°N
Ecology	Nearshore shelf demersal, intertidal to 21 m
ELH pattern	Oviparous, eggs unknown, pelagic larvae
Spawning	Season: Possibly spring (California)[a]
	Area:
	Mode: Internal fertilization likely[b]
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	
No. of oil globules	
Oil globule diameter	
Yolk	Homogeneous
Envelope	
Hatch size	<3 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	<50% SL
Length at flexion	5.2-6.4 mm NL
Length at transformation	~13.6 mm SL (12-14 mm SL)
Sequence of fin development	Caudal, dorsal and anal rays, dorsal spines, pectorals, pelvics

Pigment (see *A. fenestralis*, p. 414, footnote c)
- Lack of head pigment
- Presence of nape pigment
- 21-33 postanal ventral midline melanophores

Diagnostic characters
Distinguished from other *Artedius* spp. (*A. fenestralis*, *A. lateralis*, and *Artedius* 3) by
- Pigment (see above)
- Absence of gut diverticula
- Humped appearance in nape region
- Preopercular spines: 18-22 (late flexion, postflexion)
- Seven branchiostegal rays

[a]Burge and Schultz 1973
[b]NWAFC unpubl.

Ref: Richardson and Washington 1980; Washington 1981, 1986.

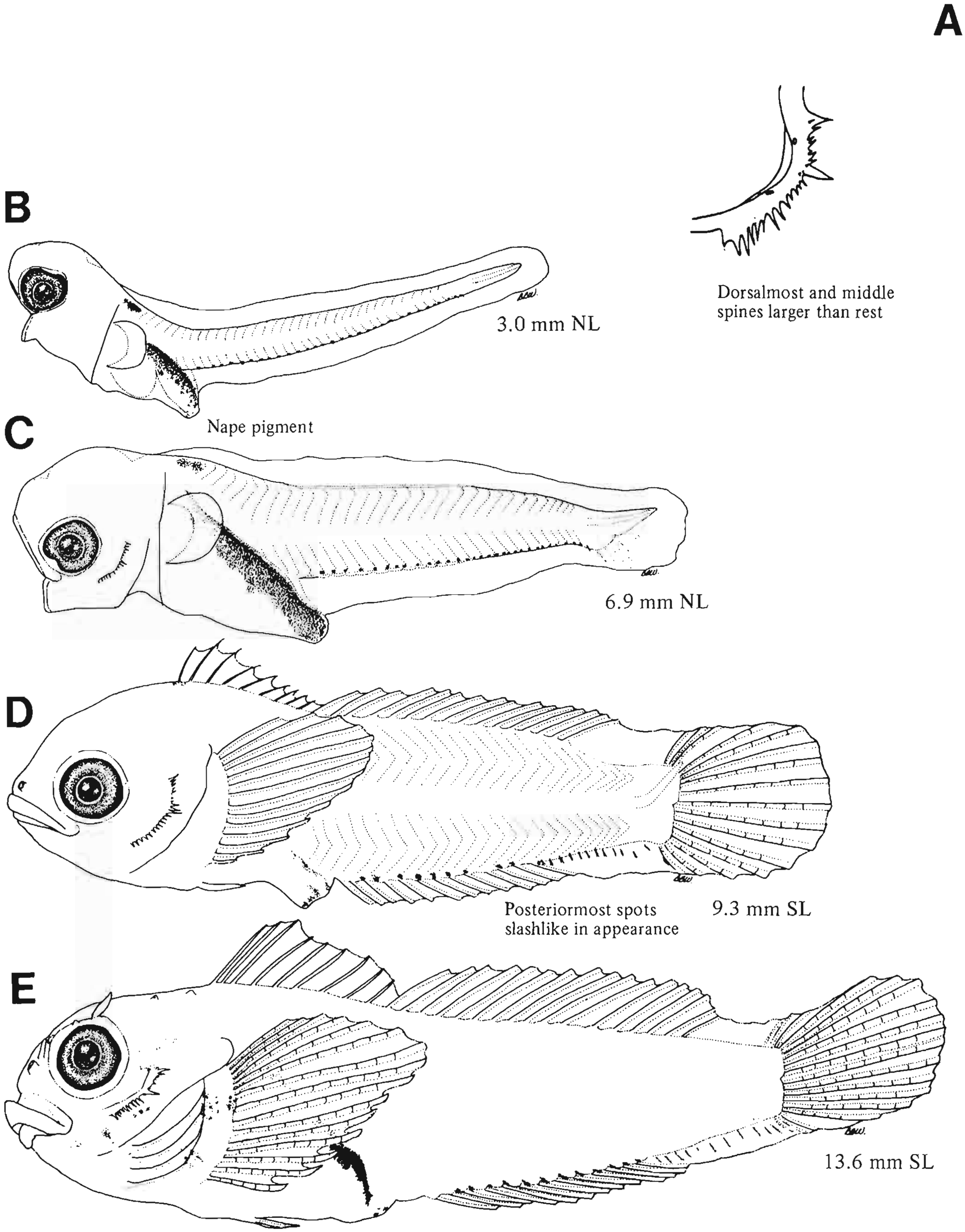


Figure A, Washington 1986; B–E, Richardson and Washington 1980.

MERISTICS

Vertebrae	Total: 32-33-34	
	Precaudal: 11-11-11	
	Caudal: 21-22-23	
Branchiostegal rays	6-6-6	
Caudal fin	X, 6+6, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 7-9-10	R: 15-16-17
Pectoral fin	R: 14-15-16	
Anal fin	R: 12-13-14	
Gill rakers	U: 1-X-2	L: 6-X-9

LIFE HISTORY

Range	South of southern California to Aleutian Is., 51-55°N
Ecology	Nearshore shelf demersal, intertidal to 13 m
ELH pattern	Oviparous; demersal, adhesive, attached eggs; pelagic larvae
Spawning	Season: Winter-spring (Brit. Col.);[a] June (Puget Sound)[b]
	Area: Demersal, on underside of rocks[a]
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	0.98-1.16 mm (1.07 mm)
No. of oil globules	One
Oil globule diameter	0.22 mm
Yolk	Homogeneous; red, yellow, or orange
Envelope	Colorless, 0.031 mm thick
Hatch size	3.9-4.5 mm SL (4.1 mm SL)
Incubation time/temp.	16 d/15°C
Pigment	

Diagnostic characters

LARVAE

Preanal length	<50% SL
Length at flexion	5.0-6.3 mm SL
Length at transformation	8-10 mm SL
Sequence of fin development	Caudal, dorsal and anal rays, dorsal spines, pectorals, pelvics

Pigment (see *A. fenestralis*, p. 414, footnote c)
- Lack of head and nape pigment is preflexion larvae
- Number (22-32) and size variation of postanal ventral midline melanophores
- Postflexion larvae have a marked increase in head pigment

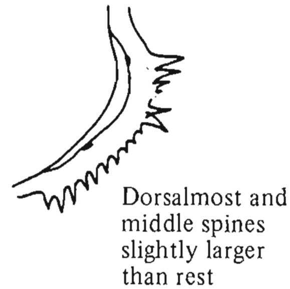
Diagnostic characters
- Presence of gut diverticula
- Pigment (see above)

Distinguished from other *Artedius* spp. with gut diverticula (*A. fenestralis* and *Artedius* 3) by
- See *A. fenestralis*

[a] Marliave 1977
[b] NWAFC, unpubl.

Ref: Marliave 1975a; Richardson and Washington 1980; Washington 1981, 1986; Washington et al. 1984b.

A



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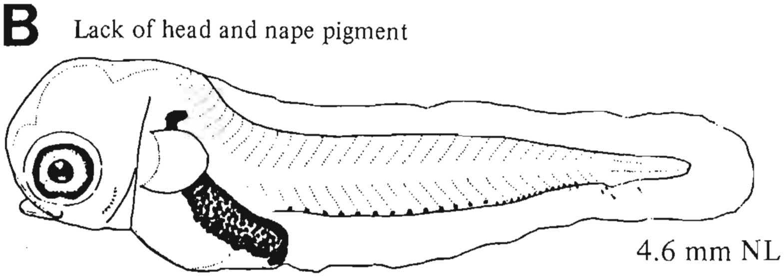

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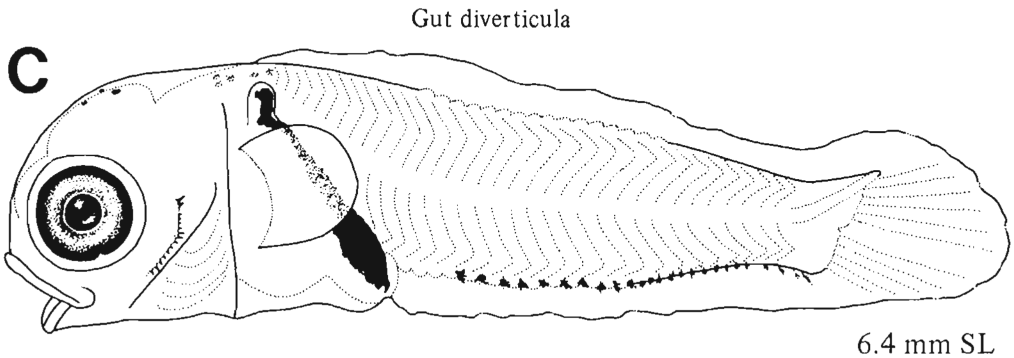

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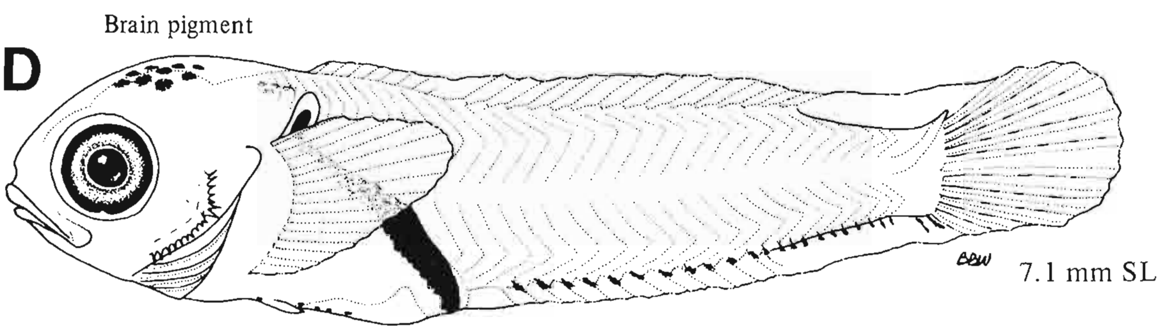

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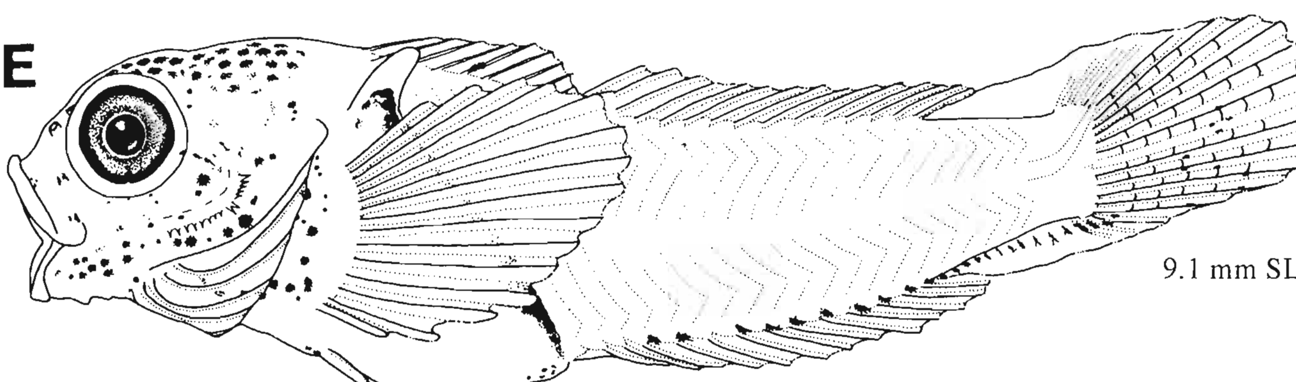


Figures A–E, Washington 1986.

MERISTICS — *A. corallinus* (Hubbs 1926)

Vertebrae	Total: 31-32-33 Precaudal: X-X-X Caudal: 41-X-43
Branchiostegal rays	6-6-6
Caudal fin	X, 6+6, X
Pelvic fin	Thoracic S: 1-1-1 R: 3-3-3
Dorsal fin	S: 8-9-9 R: 15-16-16
Pectoral fin	R: 14-15-16
Anal fin	R: 12-13-13
Gill rakers	U: X-X-X L: X-X-X

MERISTICS — *A. notospilotus* Girard 1856

Vertebrae	Total: 32-33-34 Precaudal: 12-12-12 Caudal: 21-21-21
Branchiostegal rays	6-6-6
Caudal fin	X, 6+6, X
Pelvic fin	Thoracic S: 1-1-1 R: 3-3-3
Dorsal fin	S: 9-9-10 R: 14-15-16
Pectoral fin	R: 14-16-17
Anal fin	R: 11-12-13
Gill rakers	U: 2-2-2 L: 8-X-10

LIFE HISTORY

Range	South of southern California to Washington, 46-48°30′N
Ecology	Intertidal, nearshore shelf demersal
ELH pattern	Parity and eggs unknown, pelagic larvae
Spawning	Season: Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	
Hatch size	≤2.9 mm NL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE (*Artedius* 3)[a]

Preanal length	45% SL
Length at flexion	5.6-6.9 mm NL
Length at transformation	
Sequence of fin development	Caudal, dorsal and anal rays, dorsal spines and pectorals, pelvics

Pigment (see *A. fenestralis*, p. 414, footnote c)

- Nape pigment
- 9-13 evenly spaced postanal ventral midline melanophores; begin about 3-4 myomeres posterior to anus

Diagnostic characters

Distinguished from other *Artedius* spp. with gut diverticula (*A. fenestralis* and *A. lateralis*) by

- Low number of postanal ventral midline melanophores in small larvae (9-13)
- Pigment: Lack of head pigment and presence of nape pigment
- Preopercular spines form earlier than other *Artedius* spp. (<4.1 mm NL)
- Number of preopercular spines higher than in other *Artedius* spp.

[a] *Artedius* 3 larvae are either *A. corallinus* or *A. notospilotus*. For a complete description see Washington (1986).

Ref: Washington 1986.

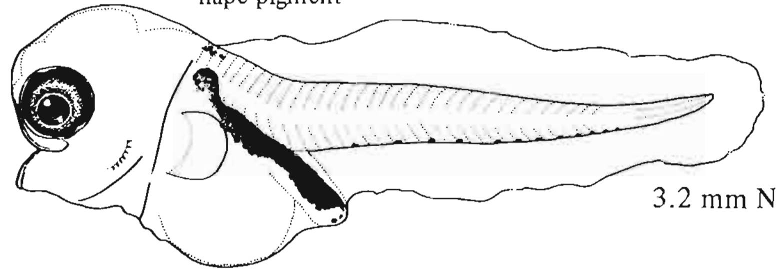
Artedius 3

A

Artedius type spine pattern: dorsalmost, middle, and ventralmost spines larger than rest

B

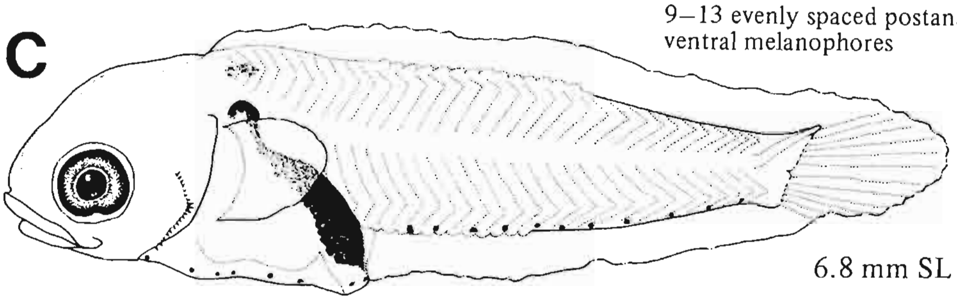
Gut diverticula and nape pigment



3.2 mm NL

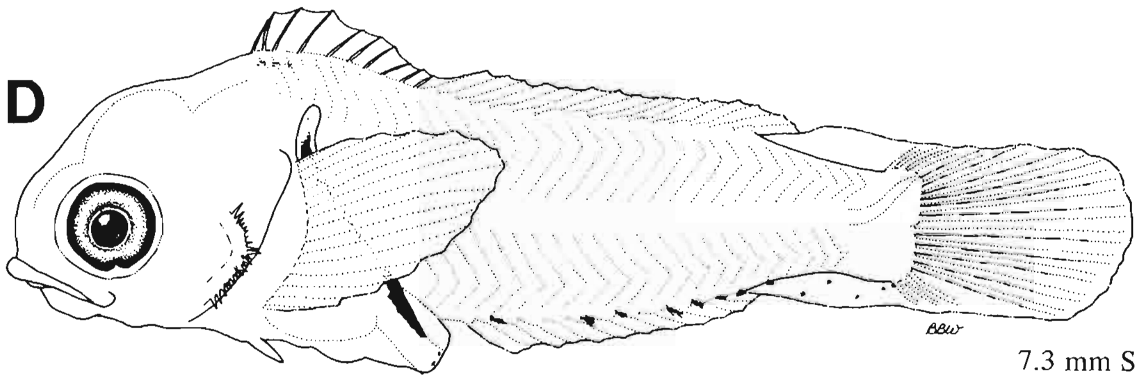
C

9–13 evenly spaced postanal ventral melanophores



6.8 mm SL

D



7.3 mm SL

Figures A–D, Washington 1986.

MERISTICS

Vertebrae	Total: 31-32-33	
	Precaudal: 10-X-11[a]	
	Caudal: 21-22-23	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 7-8-9	R: 13-15-17
Pectoral fin	R: 13-14-15	
Anal fin	R: 9-12-13	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	Cent. California, 34-38°N, to Bering Sea, 54-66°N
Ecology	Intertidal, nearshore shelf demersal
ELH pattern	Oviparous, demersal eggs, pelagic larvae
Spawning	Season: Spring[b]
	Area: Vertical rock surfaces under *Fucus* in upper intertidal zone (laid in monolayer)[b]
	Mode: Internal fertilization likely[c]
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.0-1.2 mm
No. of oil globules	
Oil globule diameter	
Yolk	Homogeneous; brown or purple
Envelope	
Hatch size	3-4 mm NL (3.1-3.3 mm NL)
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	~63% SL
Length at flexion	5.5-7.3 mm NL
Length at transformation	13-14 mm SL
Sequence of fin development	Caudal, dorsal and anal rays, dorsal spines, pectorals, pelvics

Pigment
- Dorsal gut surface
- Relatively few (4-10) ventral midline melanophores

Diagnostic characters
Distinguished from all other cottids by
- Long gut with hindgut diverticula
- Flabby appearance
- Outer bubble of skin

[a] B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, unpubl.
[b] Marliave 1981a
[c] Andriashev 1954

Ref: Blackburn 1973; Richardson and Washington 1980; Washington 1981, 1986; Washington et al. 1984b.

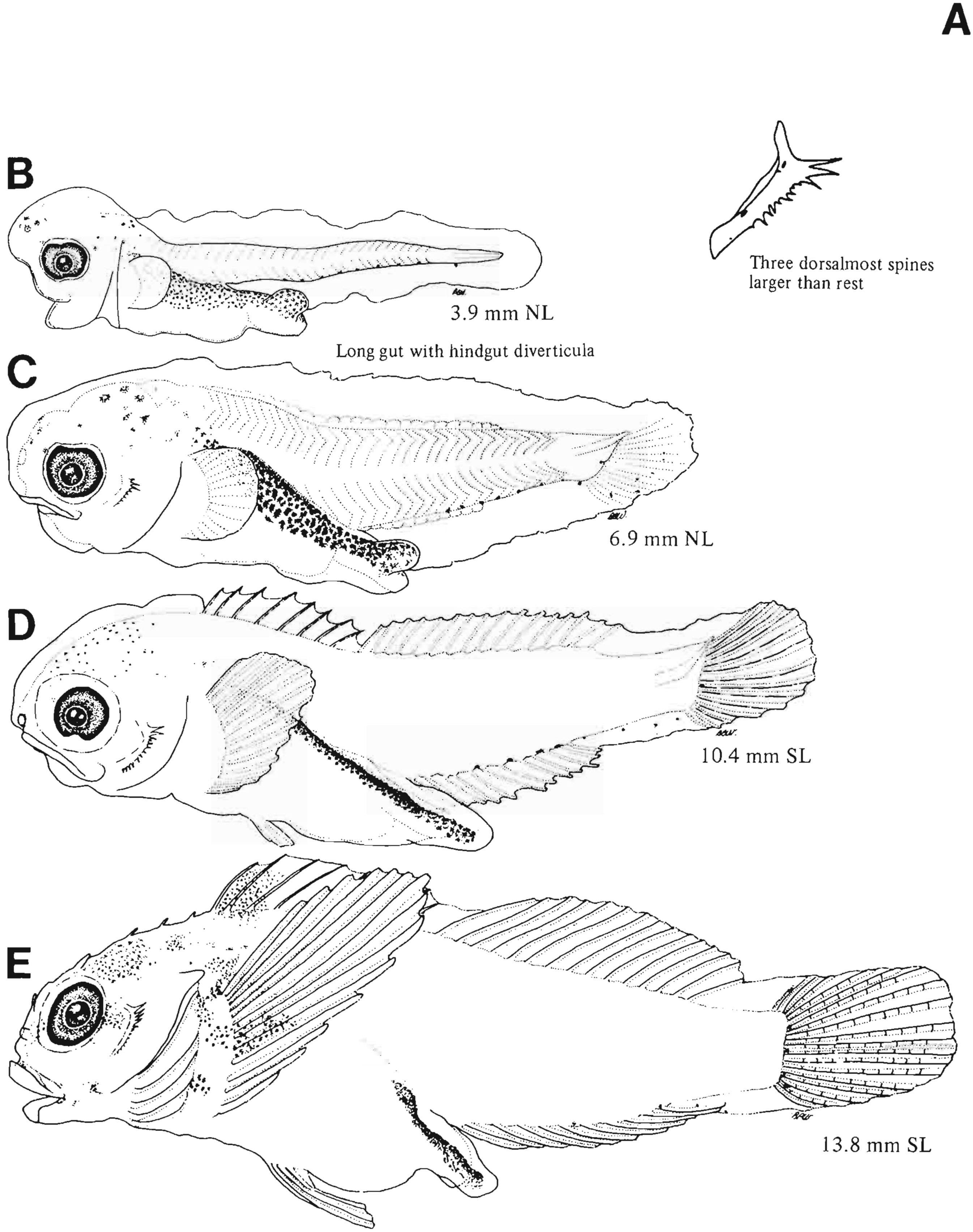


Figure A, Washington 1986; B–E, Richardson and Washington 1980.

MERISTICS

Vertebrae	Total: 33-33-34	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	6-6-6	
Caudal fin	X, 6+6, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 8-9-10	R: 14-15-17
Pectoral fin	R: 12-14-15	
Anal fin	R: 9-10-12	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Intertidal
ELH pattern	Oviparous, demersal eggs, pelagic larvae
Spawning	Season:
	Area:
	Mode: Internal fertilization likely[a]
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	
No. of oil globules	
Oil globule diameter	
Yolk	Homogeneous
Envelope	
Hatch size	~4 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

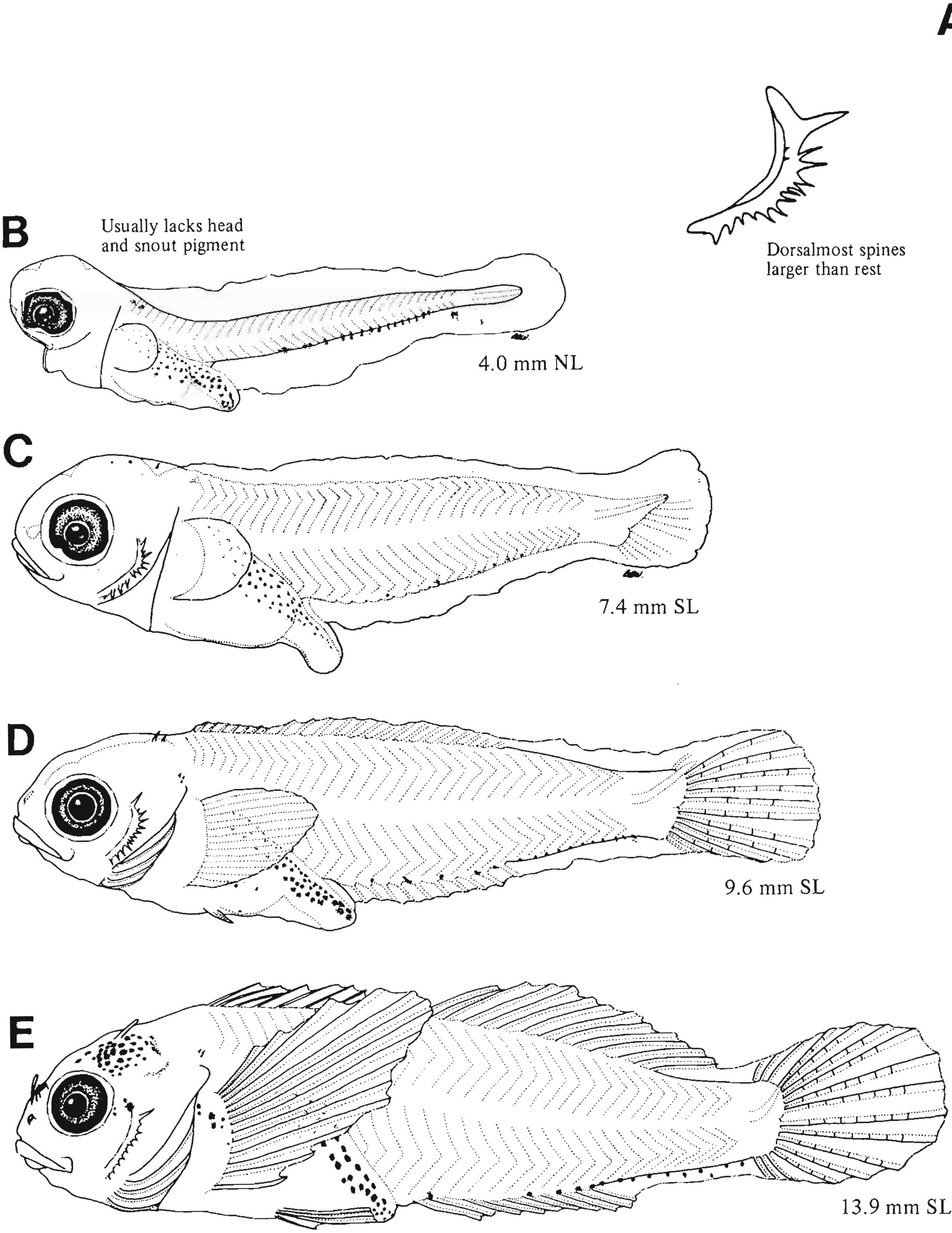
Preanal length	<50% SL
Length at flexion	6.4-9.6 mm SL
Length at transformation	13-14 mm SL
Sequence of fin development	Caudal, 2nd dorsal (rays) and anal, pectorals, 1st dorsal (spines), pelvics

Pigment
- Presence of head pigment is variable during development
- Light pigment on gut
- High number ventral midline melanophores (15-21)

Diagnostic characters
- Usually lacks head pigment; although variable, other *Clinocottus* spp. have head and snout pigment
- Long trailing gut
- Absence of hindgut diverticula
- 11-14 preopercular spines, tiny parietal spine

[a] Andriashev 1954

Ref: Richardson and Washington 1980 (see Cottidae 2); Washington 1981, 1986.



Figures A, D–E, Washington 1986; B–C, Richardson and Washington 1980.

MERISTICS

Vertebrae	Total: 32-33-34 Precaudal: 11-12-12 Caudal: 20-21-23
Branchiostegal rays	6-6-6 (occasionally 7)
Caudal fin	X, 6+6, X
Pelvic fin	Thoracic S: 1-1-1 R: 3-3-3
Dorsal fin	S: 8-9-10 R: 13-16-17
Pectoral fin	R: 13-14-15
Anal fin	R: 11-11-12
Gill rakers	U: 1-1-1 L: 5-5-5

LIFE HISTORY

Range	S. California, 32-34°N, to Gulf of Alaska, 54-60°N
Ecology	Intertidal
ELH pattern	Oviparous, demersal eggs, pelagic larvae
Spawning	Season: Area: Mode: Internal fertilization likely[a] Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.5-2.0 mm
No. of oil globules	
Oil globule diameter	
Yolk	Homogeneous
Envelope	
Hatch size	5.1-5.4 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	<50% SL
Length at flexion	6.2-~8.1 mm SL
Length at transformation	12.9-13.5 mm SL
Sequence of fin development	Caudal; dorsal, anal, and pectorals; pelvics

Pigment

- Heavy on head, nape, dorsolateral surface of gut
- Ventral midline melanophores along posteriormost 10 myomeres

Diagnostic characters

- Late flexion: 15-20 preopercular spines and a cluster of spines in parietal region

Distinguished from other preflexion *Clinocottus* spp. by

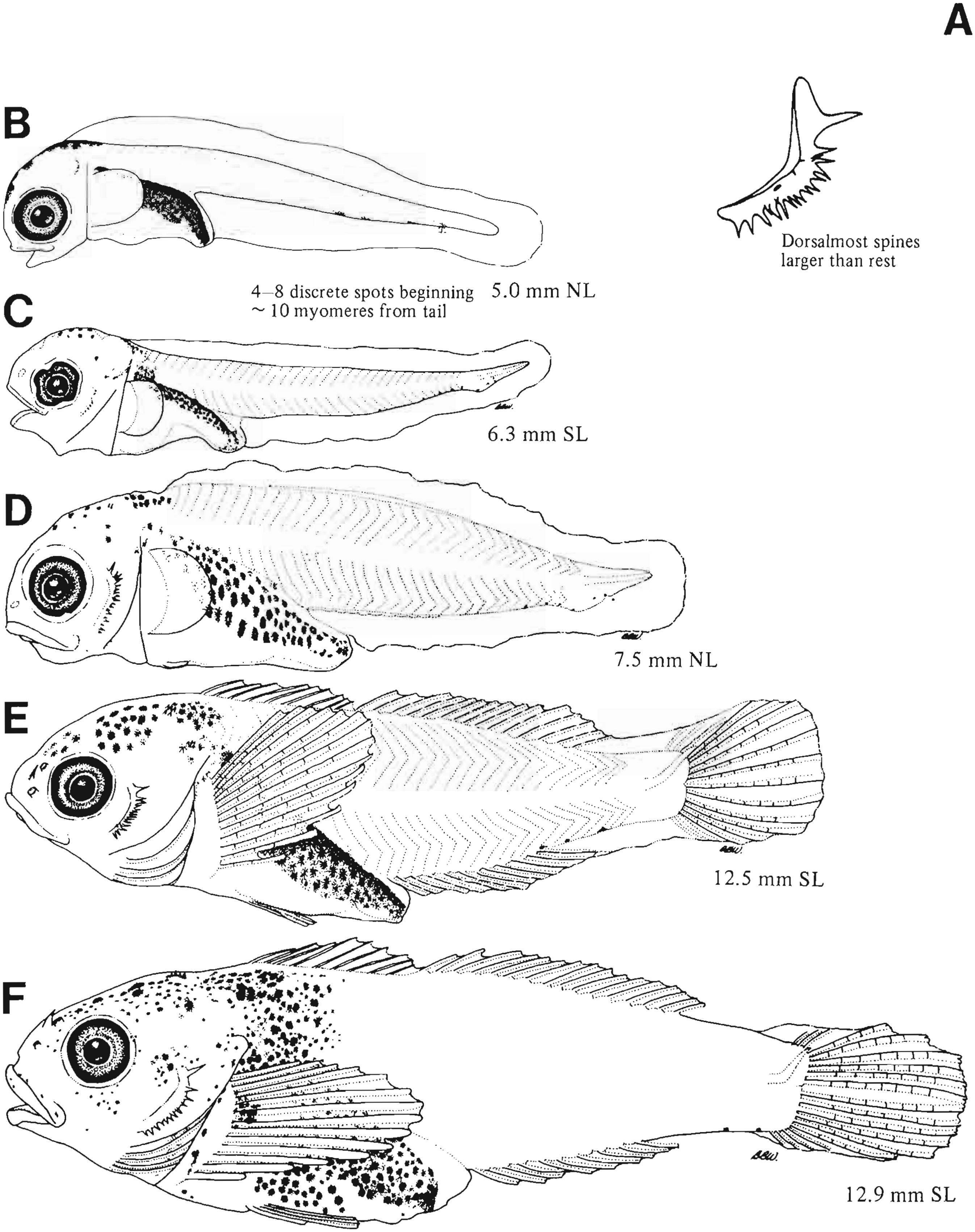
- Heavy pigment on head, nape, and gut

Distinguished from *C. recalvus* by

- 4-8 ventral midline melanophores

[a] Andriashev 1954

Ref: Richardson and Washington 1980 (see Cottidae 3); Washington 1981, 1986; Washington et al. 1984b.



Figures A–B, F, Washington 1986; C–E, Richardson and Washington 1980.

MERISTICS

Vertebrae	Total: 32-33-33	
	Precaudal: 10-11-12	
	Caudal: 20-22-23	
Branchiostegal rays	6-6-6	
Caudal fin	X, 6+6, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 8-9-9	R: 14-16-16
Pectoral fin	R: 13-14-15	
Anal fin	R: 9-12-13	
Gill rakers	U: 1-1-1	L: 4-X-7

LIFE HISTORY

Range	South of southern California to Oregon, 42-46°N
Ecology	Intertidal, nearshore shelf demersal
ELH pattern	Oviparous, demersal eggs, pelagic larvae
Spawning	Season:
	Area:
	Mode: Internal fertilization likely,[a] males guard nests[b]
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.25-1.35 mm (1.3 mm)
No. of oil globules	Several
Oil globule diameter	
Yolk	Homogeneous
Envelope	
Hatch size	~4.6 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	
Length at flexion	
Length at transformation	9-11 mm SL
Sequence of fin development	

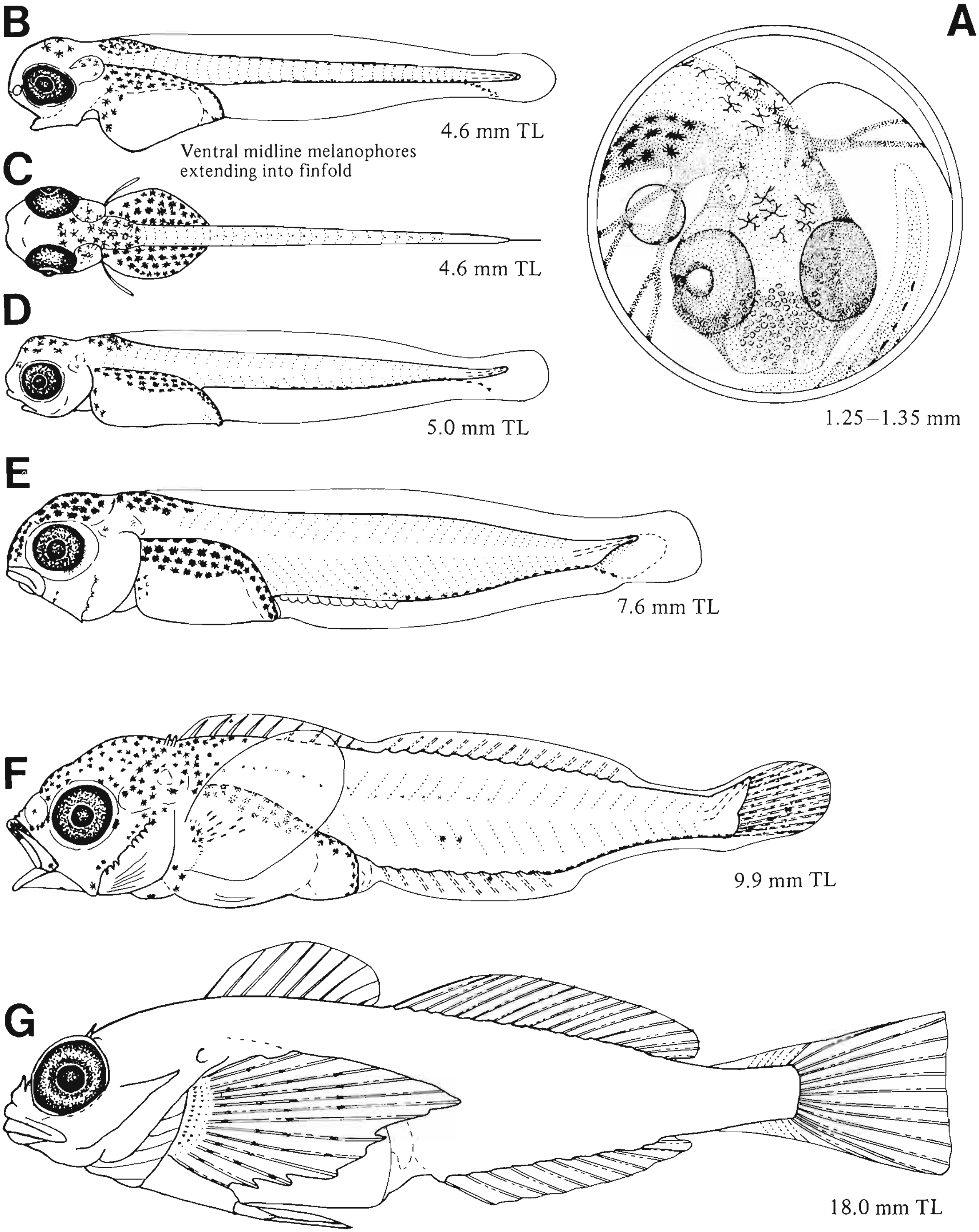
Pigment
- Heavy on dorsolateral surface of gut
- Series of ventral midline melanophores extending into finfold
- Heavy pigment on snout, crown, and nape

Diagnostic characters
- Multiple preopercular spines

Distinguished from other *Clinocottus* spp. by
- Minimal trailing of hindgut

[a]Andriashev 1954
[b]Morris 1951

Ref: Morris 1951.



Figures A–G (C, dorsal view), Morris 1951 (B–G, redrawn). Redrawn figures are based only on distribution of melanophores. Other pigment cells shown on the original figures are deleted.

MERISTICS

Vertebrae	Total: 33-34-34	
	Precaudal: 11-12-12	
	Caudal: 21-22-23	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 8-8-9	R: 15-17-18
Pectoral fin	R: 12-14-15	
Anal fin	R: 12-13-14	
Gill rakers	U: 1-1-1	L: 4-X-5

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Intertidal
ELH pattern	Oviparous; demersal, adhesive eggs; pelagic larvae
Spawning	Season: Apr-July (Puget Sound)[a]
	Area: Intertidal, between rocks, barnacles, or bay mussels (not attached to substrate)[b]
	Mode: Internal fertilization, multiple spawning (three)[a]
	Migration:
Fecundity	Range/function:
Age at first maturity	1 yr[a]
Longevity	

[a] Atkinson 1939

[b] J. Marliave, Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8, pers. commun., 25 Oct. 1988.

[c] Specimens reared in the laboratory have shown a high degree of variability in pigmentation. Postanal ventral melanophores range from 10 to >50. Other characters appear to vary between geographical area, e.g., presence of ventral or lateral gut pigment and the nape bubble (J. Marliave, pers. commun., 25 Oct. 1988).

Ref: Stein 1973; Washington 1981, 1986; Washington et al. 1984b.

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.3-1.5 mm
No. of oil globules	One large, many small
Oil globule diameter	
Yolk	Green, brown, or red[b]
Envelope	
Hatch size	4.2-4.5 mm NL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	37% SL, increasing with development to 48% SL
Length at flexion	7.2-7.6 mm SL
Length at transformation	7.5-10.0 mm SL
Sequence of fin development	Caudal, dorsal and anal rays, dorsal spines, pectorals, pelvics

Pigment[c]
- Head and nape
- Dorsolateral surface of gut
- Postanal ventral midline series, with development becoming more closely spaced posteriorly

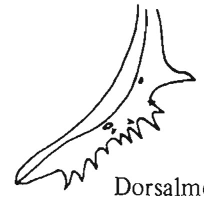
Diagnostic characters
- Bubble of skin anterior to origin of dorsal finfold

Distinguished from *O. snyderi* by
- Ventral midline melanophores (>15)
- Bubble of skin pigmented

Eggs and larvae of *O. rimensis* are unknown. The following information will aid in identification.

Total vertebrae	34-37
Precaudal	11-13
Caudal	22-25
Dorsal fin spines	8-10
Dorsal fin rays	16-19
Anal fin rays	13-15
Pectoral fin rays	13-15
Pelvic fin rays	3
Range	SSC-SE Alaska

A



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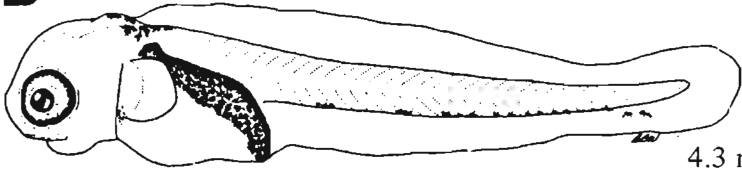
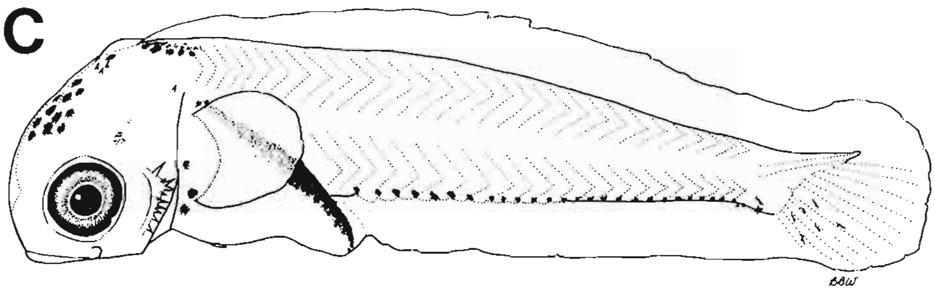
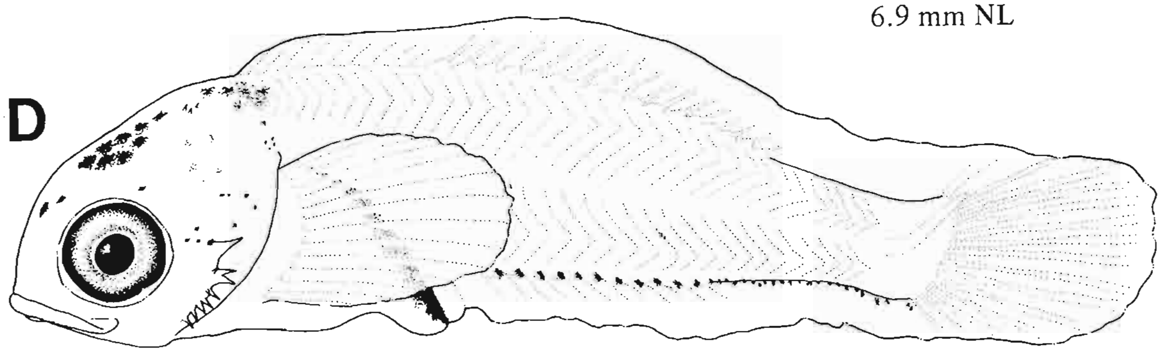


C



D



Figures A–D, Washington 1986 (B–D, reared).

MERISTICS

Vertebrae	Total: 34-35-37	
	Precaudal: 10-11-12	
	Caudal: 23-24-25	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 7-8-9	R: 17-19-20
Pectoral fin	R: 12-14-15	
Anal fin	R: 12-14-15	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	South of southern California to SE Alaska, 55-59°N
Ecology	Intertidal, nearshore shelf demersal
ELH pattern	Oviparous, demersal eggs, pelagic larvae
Spawning	Season: Winter-spring; fall in more northerly populations[a]
	Area:
	Mode: Internal fertilization (spawn twice/season)[a]
	Migration:
Fecundity	Range/function:
Age at first maturity	<1 yr[a]
Longevity	>2 yr[a]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.2-1.3 mm
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	
Hatch size	4.47 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	<45% SL
Length at flexion	6.2-8.4 mm SL
Length at transformation	11-13 mm SL
Sequence of fin development	Caudal, dorsal and anal rays, dorsal spines, pectorals, pelvics

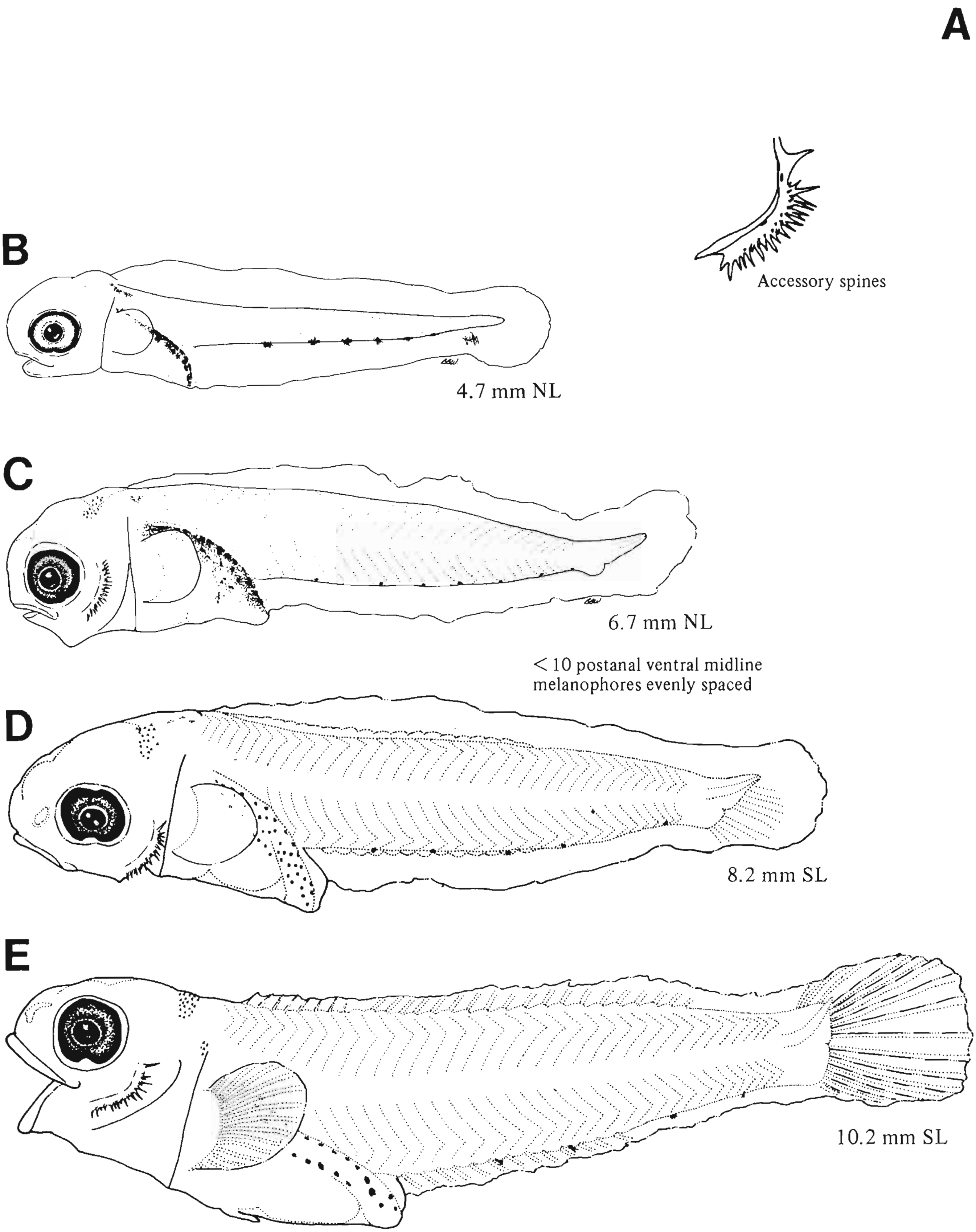
Pigment
- Head and nape very lightly pigmented
- Dorsolateral surface of gut
- Ventral midline series with <10 evenly spaced melanophores

Diagnostic characters
- Spines
  - —Patch of parietal spines
  - —10-12 spines develop along preopercular margin
  - —8-10 accessory spines form anteriorly at the bases of the preopercular spines

Distinguished from *O. maculosus* by
- Bubble of skin anterior to origin of dorsal finfold unpigmented and less obvious than *O. maculosus*
- Ventral midline melanophores (<10)

[a]Grossman and DeVlaming 1984

Ref: Richardson and Washington 1980 (see Cottidae 1); Stein 1973; Washington 1981, 1986; Washington et al. 1984b.



Figures A–B, D–E, Washington 1986; C, Richardson and Washington 1980 (B–C, reared).

MERISTICS

Vertebrae	Total: 33-34-35	
	Precaudal: 13-13-13[a]	
	Caudal: 20-20-20[a]	
Branchiostegal rays	7-7-7	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 7-X-8	R: 18-X-19
Pectoral fin	R: 14-16-17	
Anal fin	R: 12-14-15	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	Washington, 46-48°30′N, to Bering Sea, 54-66°N
Ecology	Epi- and mesobenthal, 0-225 m
ELH pattern	Oviparous, demersal eggs, pelagic larvae
Spawning	Season: Aug (British Columbia)[b]
	Area: Rocky subtidal areas on solid substrate[b]
	Mode: Polygamous males guard nest[c]
	Migration:
Fecundity	Range/function: $\bar{x}$ 130[b]
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	~2.3 mm
No. of oil globules	
Oil globule diameter	
Yolk	Homogeneous; pink
Envelope	White
Hatch size	~6-7 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length
Length at flexion
Length at transformation 18-20 mm SL (settle)[d]
Sequence of fin development
Pigment (*Psychrolutes* Group)
- Head, nape, gut, and pectoral fins
- Lacks postanal ventral melanophores

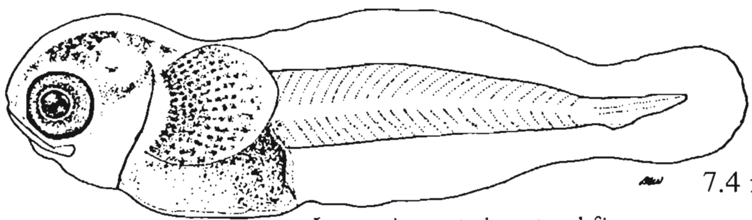
Diagnostic characters
- Morphology
  - —Tadpole shape
  - —Large head
  - —Outer layer of loose flabby skin
- Large pigmented pectoral fins
- No head or preopercular spines

Distinguished from *Psychrolutes paradoxus* (p. 436) by
- Pectoral fin ray count (14-17)
- Less body pigment

[a] B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, unpubl.
[b] Marliave 1975a
[c] J. Marliave, Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8, pers. commun., 16 Oct. 1986.
[d] Juveniles have a tendency to reenter the water column for feeding, producing a protracted period of ambivalence about settlement (Marliave 1981b).

Ref: Marliave 1975a, Washington et al. 1984b.

A



B

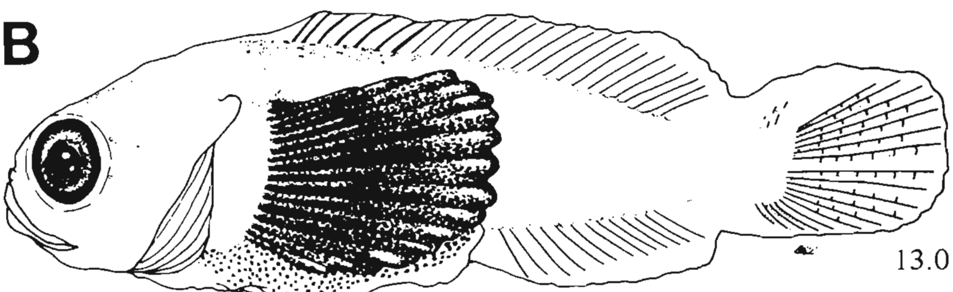


Figure A, Richardson and Bond 1978; B, Richardson 1981a.

MERISTICS

Vertebrae	Total: 36-36-37	
	Precaudal: 11-11-11[a]	
	Caudal: 21-21-21[a]	
Branchiostegal rays	7-7-7	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 9-11-12	R: 12-14-17
Pectoral fin	R: 19-21-23	
Anal fin	R: 10-12-14	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	Washington, 46-48°30′N, to Bering Sea, 54-66°N
Ecology	Epi- and mesobenthal, 9-219 m
ELH pattern	Oviparous, demersal eggs, pelagic larvae
Spawning	Season: Winter-spring (British Columbia)[b]
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

[a]B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, unpubl.
[b]Marliave 1975a

Ref: Blackburn 1973, Marliave 1975a.

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	~1.4 mm
No. of oil globules	
Oil globule diameter	
Yolk	Homogeneous
Envelope	
Hatch size	~6-7 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	
Length at flexion	
Length at transformation	~13-14 mm SL
Sequence of fin development	

Pigment
- Initially restricted to head, gut, and upper body (including pectoral fins); with development, increasing to 3/4 body

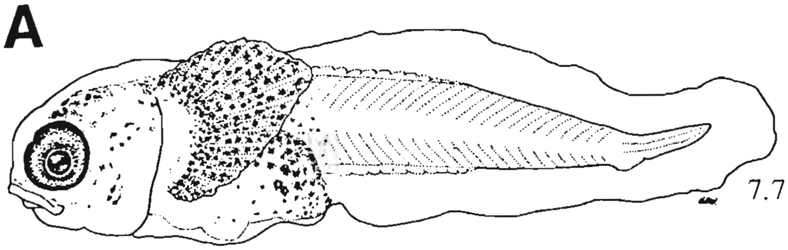
Diagnostic characters
- Morphology
  —Tadpole shape
  —Large head
  —Outer layer of loose flabby skin
- Large pigmented pectoral fins
- No head or preopercular spines

Distinguished from *Gilbertidia sigalutes* (p. 434) by
- More lateral pigment on head and body with development
- Pectoral fin ray count (19-23)

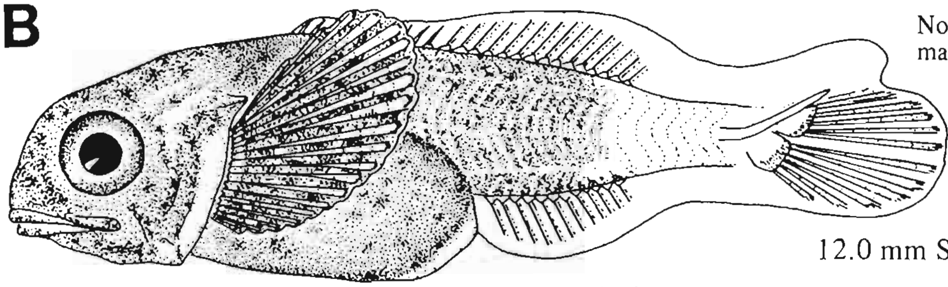
Eggs and larvae of *P. phrictus* are unknown (see Cottoid A, p. 438). The following information will aid in identification.

Total vertebrae	33-35
Dorsal fin spines	8-9
Dorsal fin rays	19-20
Anal fin rays	12-14
Pectoral fin rays	22-26
Pelvic fin rays	3
Range	Cent. Calif.-Bering Sea

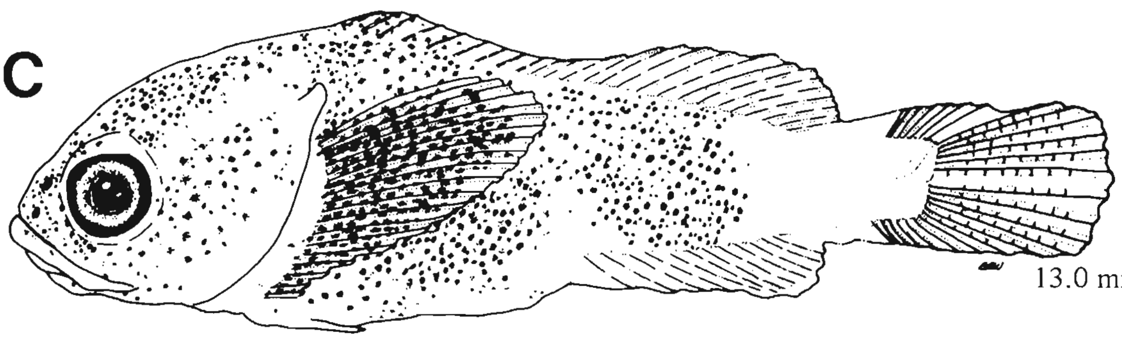
A



B



C



D

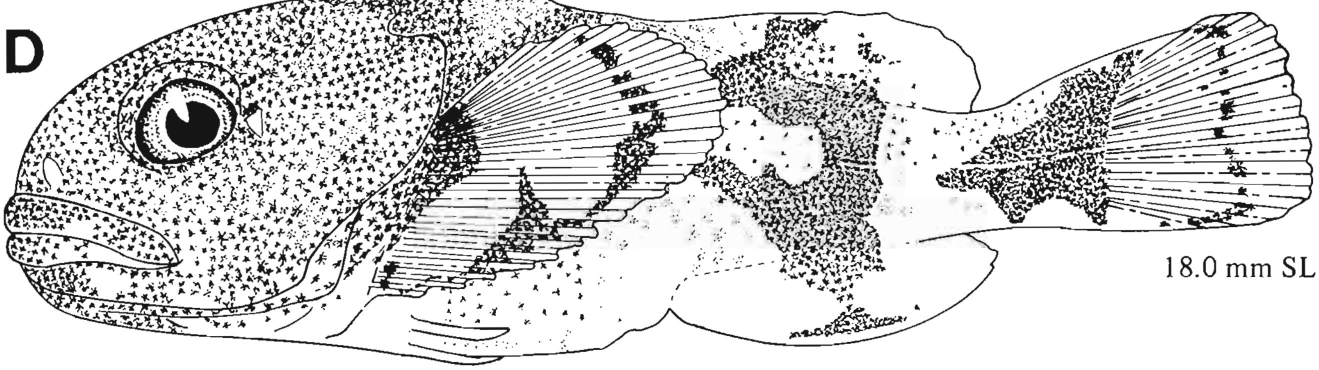


Figure A, Richardson and Bond 1978; B, Marliave 1975a (redrawing provided by Marliave); C, Richardson 1981a; D, NWAFC original (B. Vinter).

MERISTICS

Vertebrae	Total: 35-35-35	
	Precaudal: 12-12-12	
	Caudal: 23-23-23	
Branchiostegal rays	7-7-7	
Caudal fin	X, 6+7, X	
Pelvic fin	Abdominal	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 8-8-8	R: 20-20-20
Pectoral fin	R: 26-26-26	
Anal fin	R: 14-14-14	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	Oregon, 42-46°N
Ecology	Unknown
ELH pattern	Parity and eggs unknown, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE[b]

Preanal length	58% SL, increasing with development to 79% SL
Length at flexion	~9.8 mm SL
Length at transformation	>13.4 mm SL
Sequence of fin development	

Pigment

- Larvae are pigmented over entire body except at the tail tip; dorsal and anal finfolds and the distal portion of the pectoral fin are unpigmented

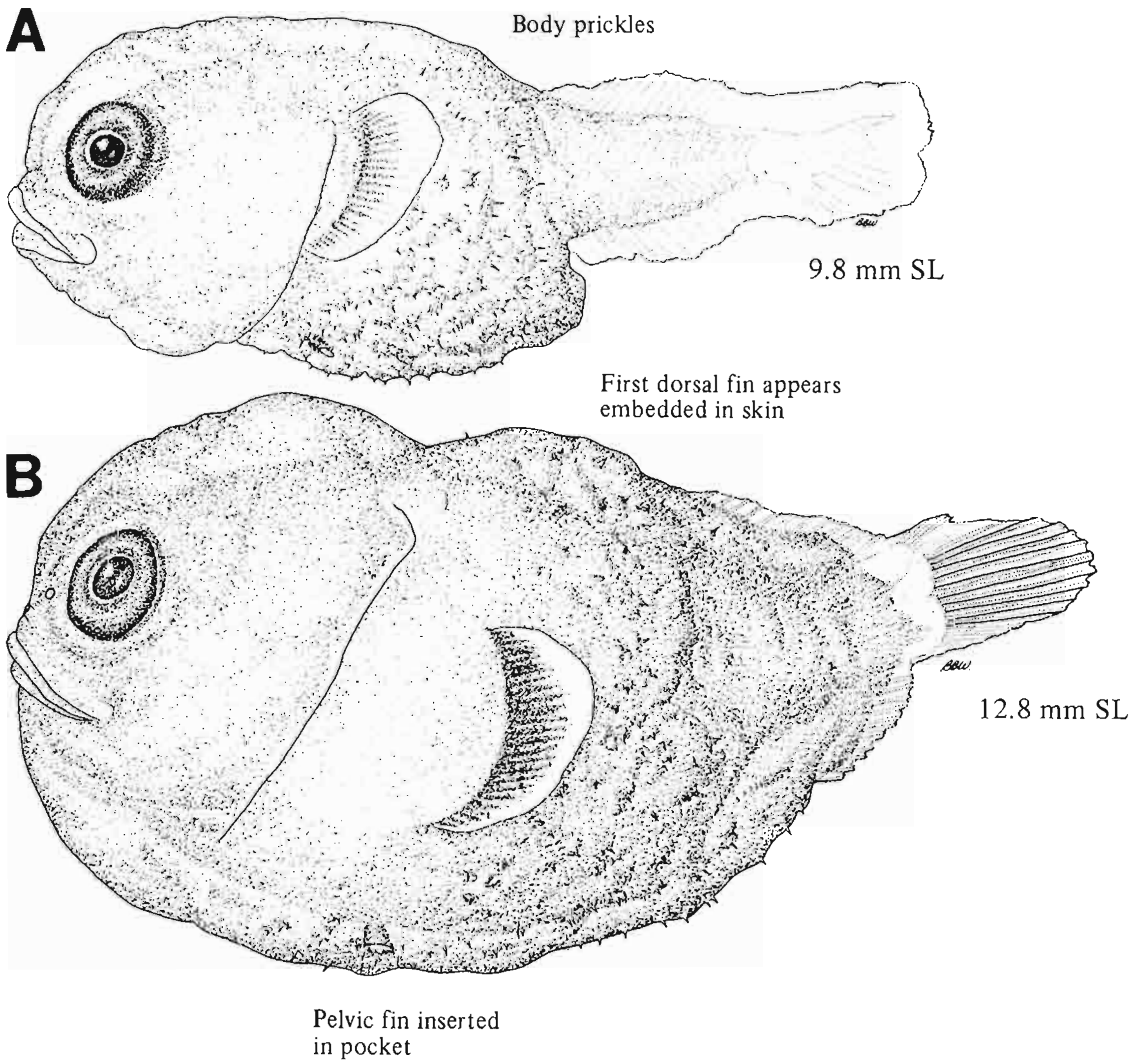
Diagnostic characters

- Lack of head spines
- Prickles over body
- Globose morphology unlike any other cottid
- Loose outer skin
- Pelvic fin appears to be inserted in pockets of skin with only the tips exposed

Meristic characters of Cottoid A specimens agree with those of *Psychrolutes phrictus* (pectoral rays = 26, branchiostegals = 7), but identification is tentative until additional material is available (see discussion in Richardson and Washington [1980]).

[a]Based on three specimens (9.8, 12.8, 13.4 mm SL) collected off Oregon.
[b]Tentative placement in *Psychrolutes* group.

Ref: Richardson and Washington 1980.



Figures A–B, Richardson and Washington 1980.

MERISTICS

Vertebrae	Total: 34-35-35
	Precaudal: 10-X-13[a]
	Caudal: 23[b]-X-26
Branchiostegal rays	7-7-7
Caudal fin	X, 6+6, X
Pelvic fin	Thoracic
	S: 1-1-1 R: 3-3-3
Dorsal fin	S: 8-10-11 R: 13-15-16
Pectoral fin	R: 22-25-26
Anal fin	R: 12-14-16
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	Washington, 46-48°30′N, to Bering Sea, 54-66°N
Ecology	Epi-, meso-, and bathybenthal, 18-825 m
ELH pattern	Parity unknown, eggs probably demersal, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	
No. of oil globules	
Oil globule diameter	
Yolk	Homogeneous
Envelope	
Hatch size	~7.4 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	<50% SL
Length at flexion	
Length at transformation	
Sequence of fin development	Fins complete at 12 mm SL

Pigment
- Heavy spots on head and gut
- Double row of small pigment spots occurs along the midline of the ventral surface of gut; more pronounced in specimens >8 mm SL
- Pectoral fin pigmented at base

Diagnostic characters
- Similar to *Psychrolutes* group but with four preopercular spines

[a] One specimen with precaudal vertebrae = 13 (B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, unpubl.).
[b] B.B. Washington, unpubl.

Ref: Blackburn 1973.

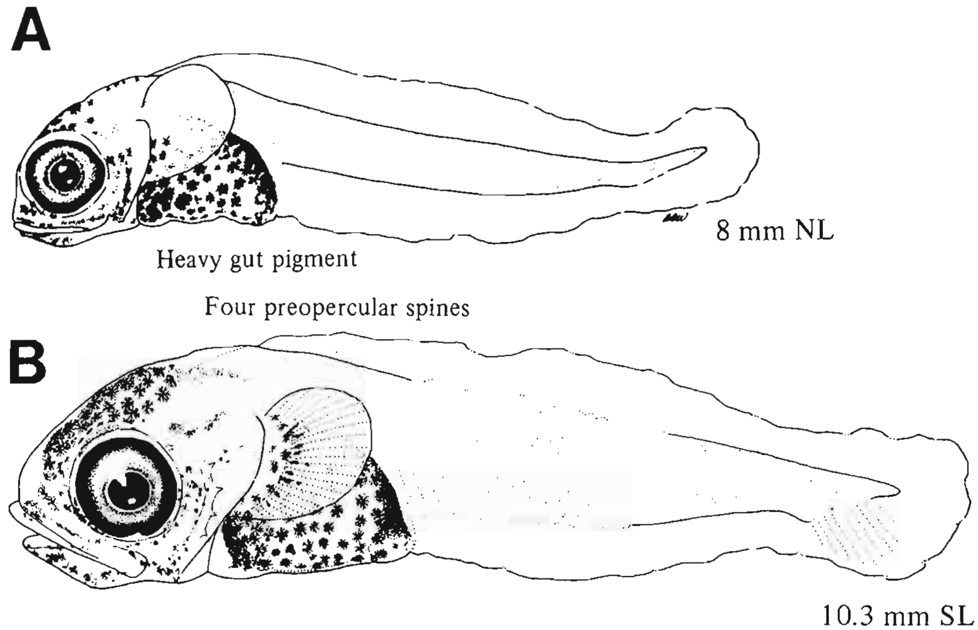


Figure A, Richardson 1981a; B, Washington et al. 1984a.

MERISTICS

Vertebrae	Total: 30-32-33	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	7-7-7	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 8-9-9	R: 12-14-15
Pectoral fin	R: 19-20-23	
Anal fin	R: 9-11-12	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	Washington, 46-48°30′N, to Bering Sea, 54-66°N
Ecology	Epi-, meso-, and bathybenthal, 75-1980 m
ELH pattern	Parity and eggs unknown, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

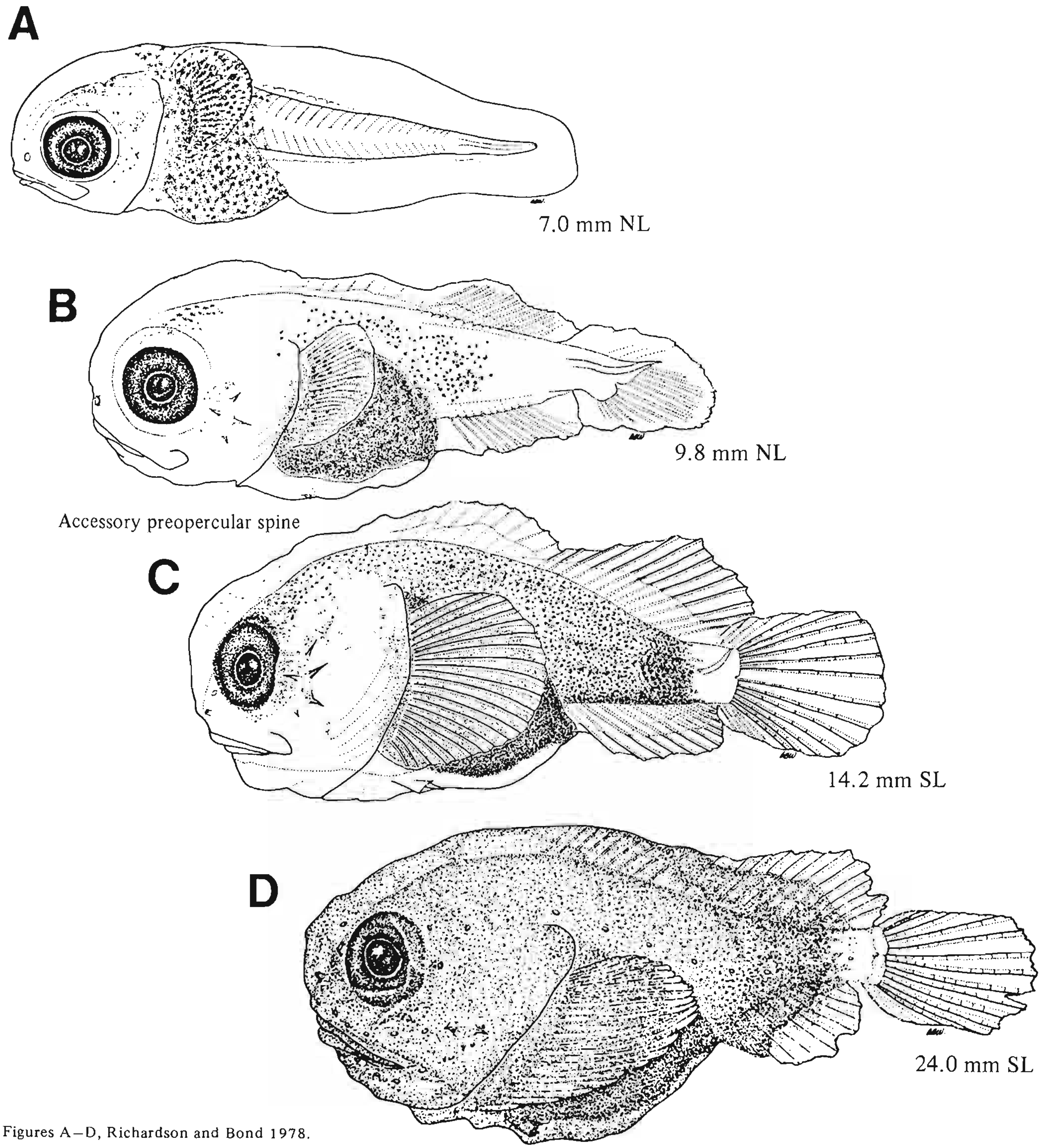
Preanal length
Length at flexion
Length at transformation
Sequence of fin development
Pigment
- Head, nape, entire gut
- Laterally over 1/4 body, with development increasing to 3/4 body

Diagnostic characters
- Fifth accessory preopercular spine (sometimes difficult to see)
- Outer layer of loose skin more pronounced than in other genera (genus)

Eggs and larvae of *M. kincaidi* are unknown. The following information may aid in identification.

Total vertebrae	31-33
Dorsal fin spines	8-10
Dorsal fin rays	13-15
Anal fin rays	10-13
Pectoral fin rays	19-21

Ref: Richardson and Bond 1978.



Figures A–D, Richardson and Bond 1978.

MERISTICS

Vertebrae	Total: 34-37-39	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	6-6-6	
Caudal fin	X, 6+6, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 4-4-4
Dorsal fin	S: 7-9-11	R: 18-20-21
Pectoral fin	R: 14-15-17	
Anal fin	R: 14-17-18	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	S. California, 32-34°N, to Gulf of Alaska, 54-60°N
Ecology	FW or anadromous type
ELH pattern	Oviparous; demersal, adhesive eggs; pelagic larvae
Spawning	Season: Jan-Apr;[a] Feb-July[b]
	Area: Under rocks[b]
	Mode: Polygamous males, eggs guarded[b]
	Migration: Downstream in spring to spawn[b]
Fecundity	Range/function: 280-10,980[a]
Age at first maturity	
Longevity	>7 yr[b]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.4-1.6 mm
No. of oil globules	One large, some small
Oil globule diameter	0.2-0.3 mm
Yolk	Homogeneous; granular[a]
Envelope	Thick, transparent, orange
Hatch size	4.5-5.0 mm SL;[a] 5.5-6.3 mm SL[c]
Incubation time/temp.	15-16 d/12°C
Pigment	

Diagnostic characters

LARVAE

Preanal length	40% SL
Length at flexion	~7 mm SL
Length at transformation	10 mm SL
Sequence of fin development	Pectorals and pelvics by 10 mm SL

Pigment

- Dorsal and ventral gut surface
- Postanal ventral midline series decreasing in number and becoming more evenly spaced with development

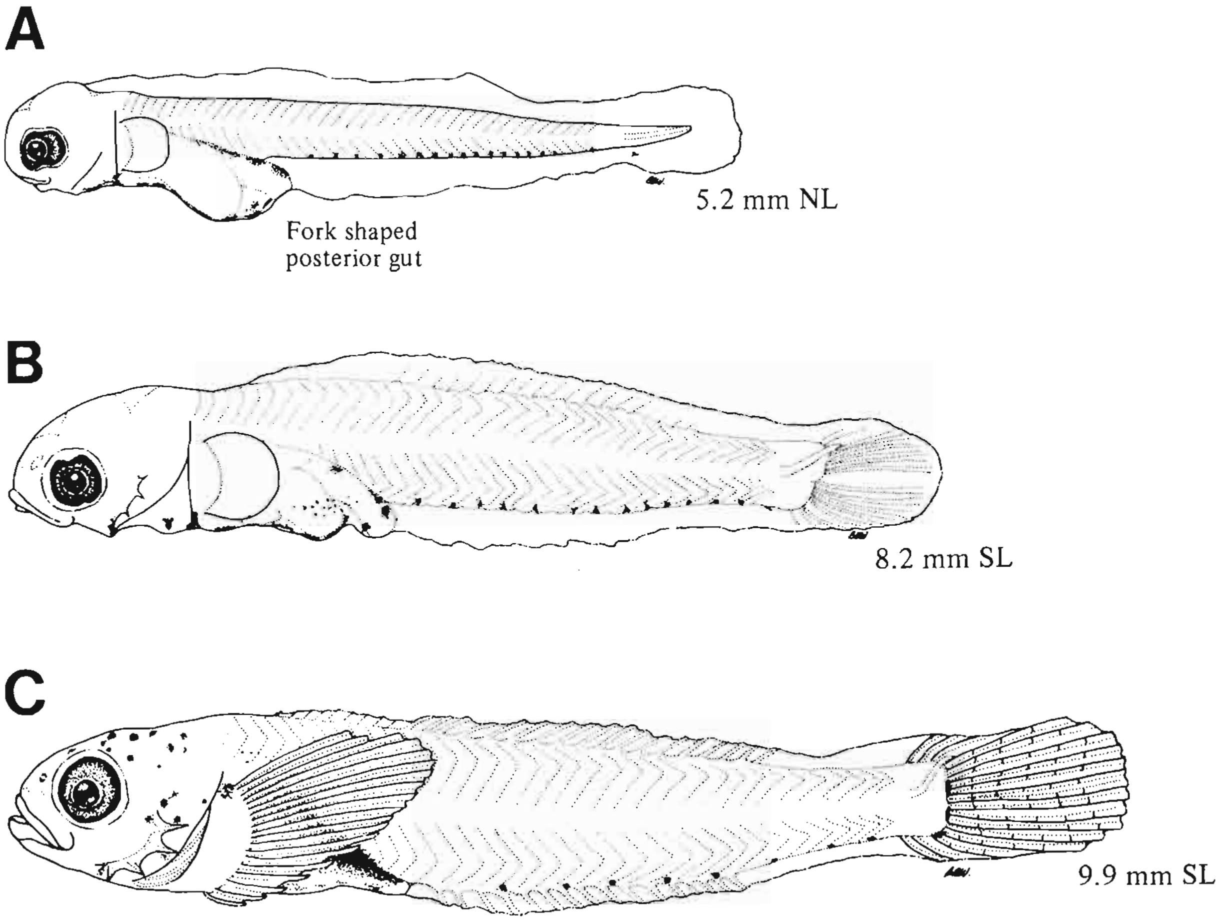
Diagnostic characters

- Morphology: Slender, round snout
- Spines: Four preopercular, without other head spines
- Gut shape unique, posteriorly forked

Larvae of *C. aleuticus* are unknown. Spawning takes place primarily in freshwater and larvae may not occur in coastal marine plankton.

[a]Wang 1981
[b]Morrow 1980
[c]Richardson and Washington 1980

Ref: Morrow 1980, Stein 1972, Richardson and Washington 1980, Wang 1981, Washington et al. 1984b.



Figures A–C, Richardson and Washington 1980.

MERISTICS

Vertebrae	Total: 35-36-39	
	Precaudal: 10-11-12	
	Caudal: 24-25-27	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 4-4-4
Dorsal fin	S: 6-7-8	R: 15-18-20
Pectoral fin	R: 17-19-20	
Anal fin	R: 15-16-20	
Gill rakers	U: 1-X-3	L: 8-X-10

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Nearshore shelf demersal, intertidal to 91 m
ELH pattern	Oviparous; demersal, adhesive eggs; pelagic larvae
Spawning	Season: Oct-Mar (California)[a]
	Area:
	Mode:
	Migration:
Fecundity	Range/function: 2000-11,000/[b] $N=0.355 \times L^{1.84}$, N=no. maturing eggs, L=TL mm[a]
Age at first maturity	1 yr[a]
Longevity	5 yr[c]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.4-1.5 mm (1.43)
No. of oil globules	One, smaller ones
Oil globule diameter	0.3 mm
Yolk	
Envelope	Thick, transparent, bumpy
Hatch size	3.8-5.0 mm SL; 3.9-4.8 TL[a]
Incubation time/temp.	9-14 d/15°C
Pigment	

Diagnostic characters

LARVAE

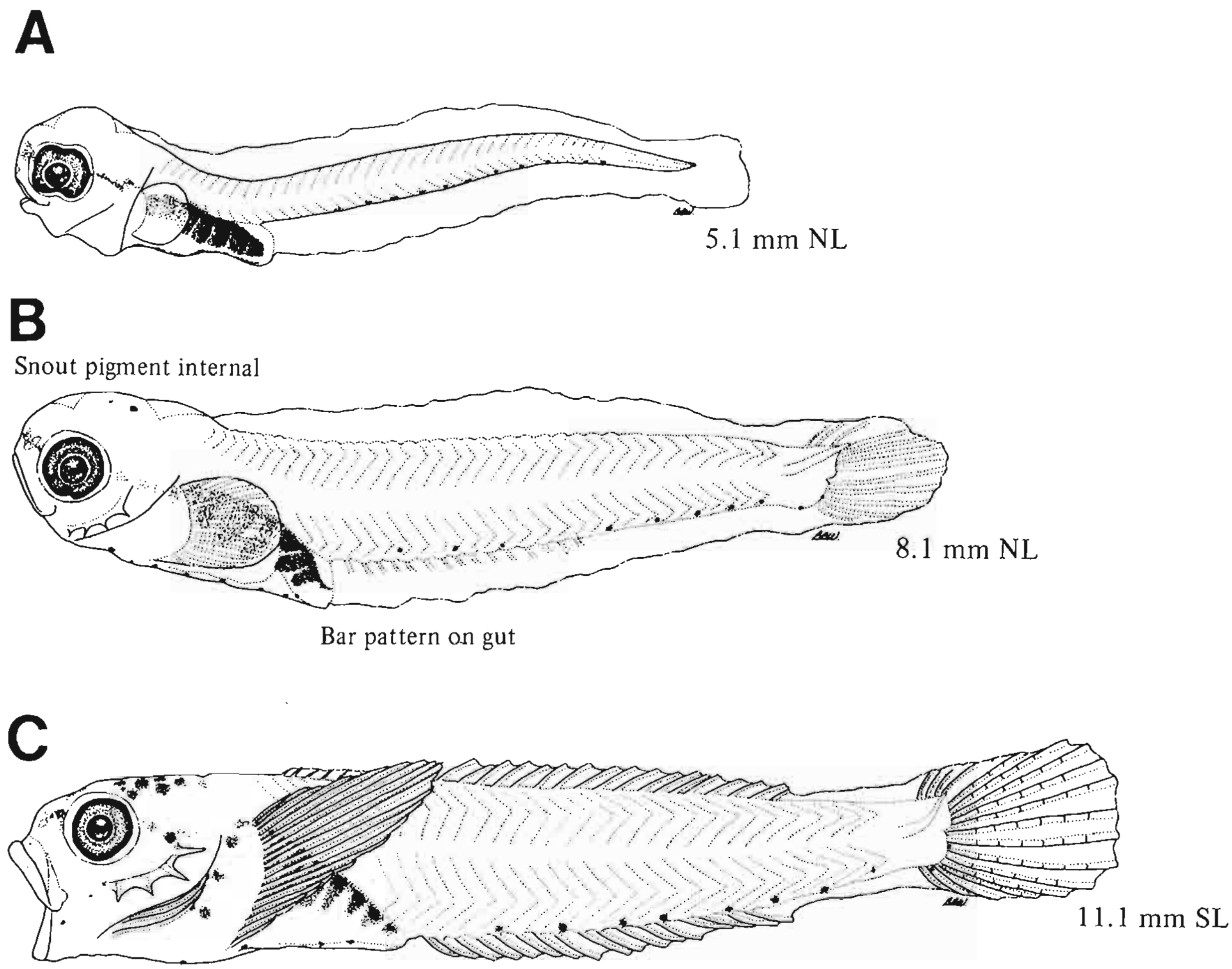
Preanal length	37-40% SL
Length at flexion	~8 mm SL
Length at transformation	15-20 mm SL
Sequence of fin development	

Pigment
- Internal snout pigment
- 6-8 bars of pigment on dorsolateral surface of gut
- Postanal ventral midline series

Diagnostic characters
- Gut pigment appearing as 6-8 bars
- Internal snout pigment

[a]Jones 1962
[b]Wang 1981
[c]Fitch and Lavenberg 1975

Ref: Jones 1962, Wang 1981, Washington et al. 1984b.



Figures A–C, Richardson and Washington 1980.

MERISTICS

Vertebrae	Total: 37-38-38	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 7-8-9	R: 20-21-22
Pectoral fin	R: 15-16-17	
Anal fin	R: 18-19-20	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	Brit. Col., 48°30′-55°N, to Bering Sea, 54-66°N
Ecology	Nearshore shelf demersal
ELH pattern	Probably oviparous, eggs probably demersal, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

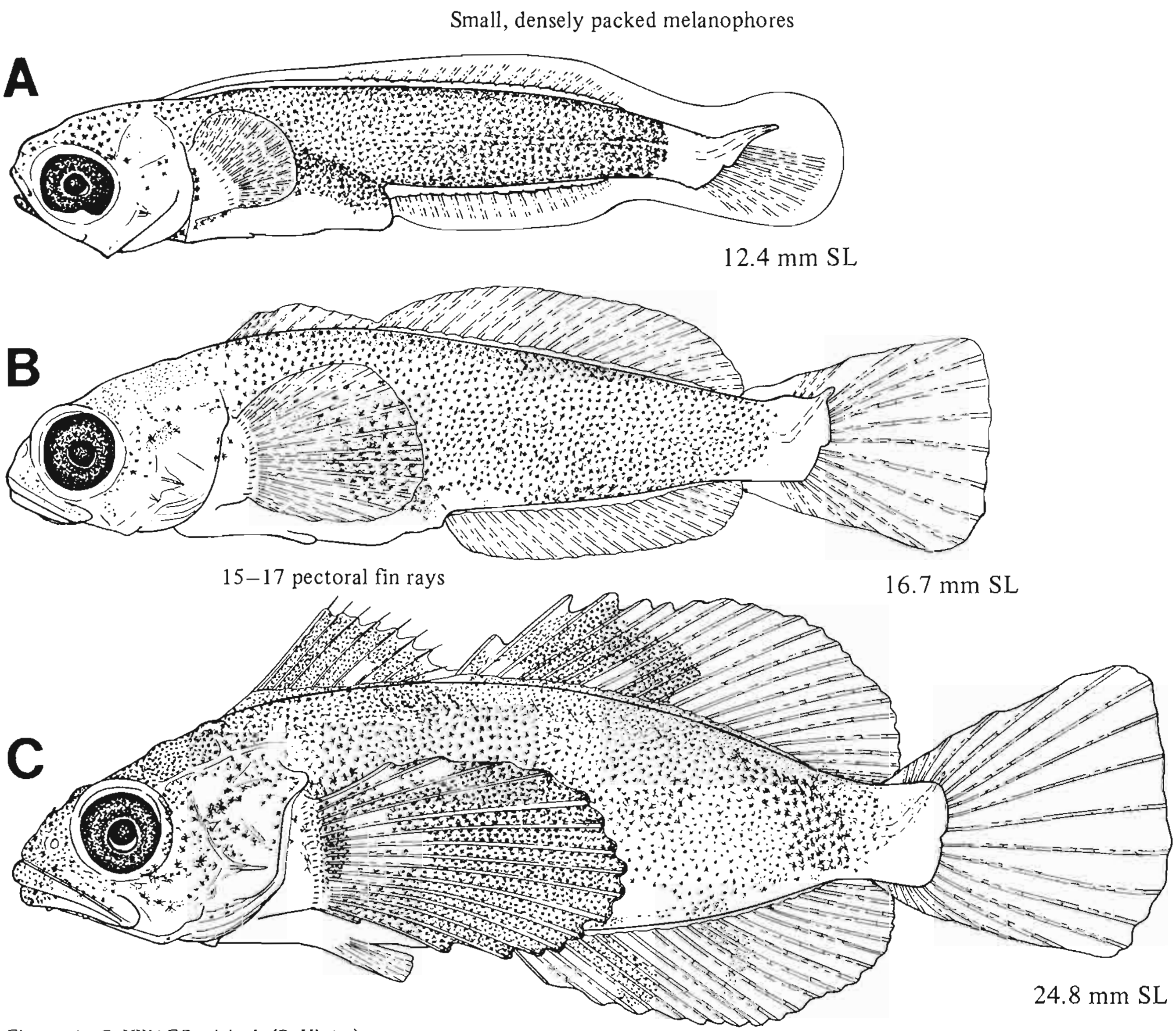
Diagnostic characters

LARVAE

Preanal length
Length at flexion ⩽12 mm SL
Length at transformation
Sequence of fin development
Pigment
- Entire body heavily pigmented with small, densely packed melanophores except for caudal peduncle, opercle area, and ventrolateral gut surface

Diagnostic characters (see Table 3)
- Genus
  —Elongate body becoming deeper with development
  —Pigment relatively heavy
  —Strong frontoparietal ridge

Distinguished from *B. cirrhosus* by
- More pectoral fin rays (15-17)
- Pigment
  —Larger area of caudal peduncle unpigmented
  —Smaller, denser melanophores
  —Lack of pigment on underside of mouth



Figures A–C, NWAFC originals (B. Vinter).

MERISTICS

Vertebrae	Total: 37-37-39[a]	
	Precaudal: 13-13-13[a]	
	Caudal: 26-26-26[a]	
Branchiostegal rays	6-6-6	
Caudal fin	X, 6+6, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 6-8-8	R: 20-23-24
Pectoral fin	R: 11-12-13	
Anal fin	R: 18-19-21	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	Cent. California, 34-38°N, to Bering Sea, 54-66°N
Ecology	Nearshore shelf demersal, intertidal to 37 m
ELH pattern	Oviparous, demersal eggs, pelagic larvae
Spawning	Season: Late winter (British Columbia)[b]
	Area: Demersal, on rocks[c]
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	
No. of oil globules	
Oil globule diameter	
Yolk	Homogeneous
Envelope	Clear, light brown
Hatch size	
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

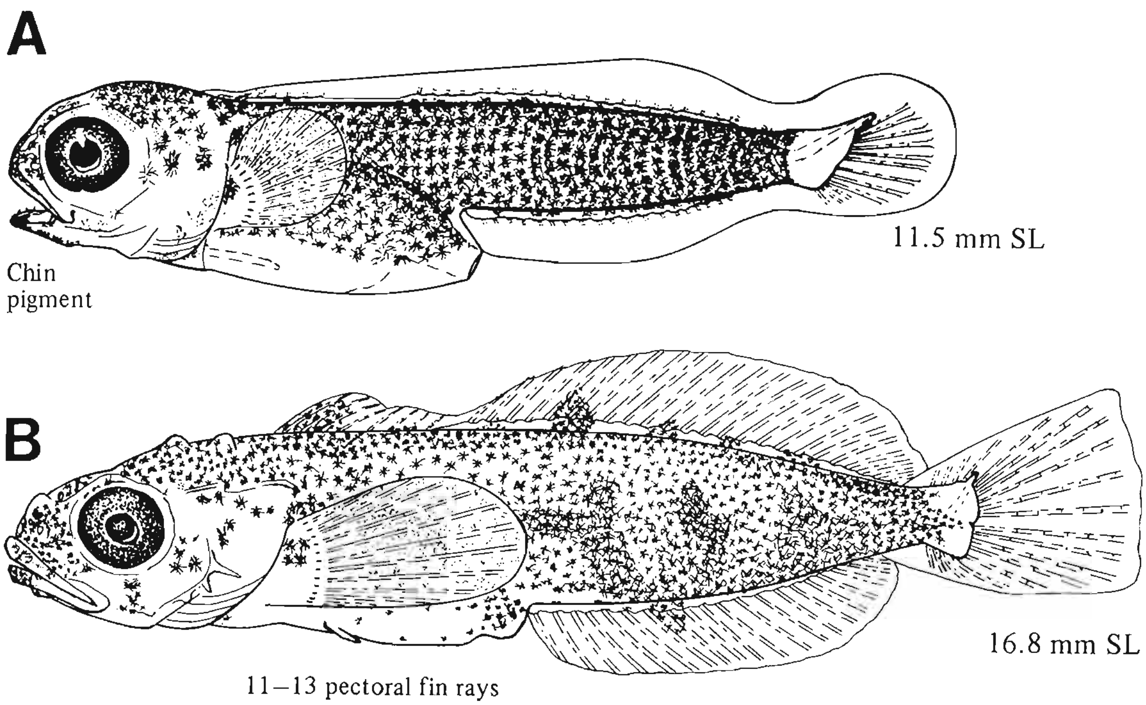
Preanal length	<50% SL
Length at flexion	≤11 mm SL
Length at transformation	
Sequence of fin development	

Pigment
- Entire body heavily pigmented except for caudal peduncle, opercle area, and ventrolateral gut surface
- Pigment along underside of mouth between dentary bones (chin)

Diagnostic characters (see Table 3)
Distinguished from *B. bilobus* by
- Low number of pectoral fin rays (11-13)
- Shorter area of caudal peduncle unpigmented
- Pigment on underside of mouth
- See *B. bilobus* for generic characters (p. 448)

[a] B.B. Washington, NMFS Systematics Lab., Natl. Mus. Nat. Hist., Wash., D.C. 20560, unpubl.
[b] Marliave 1975a
[c] Clemens and Wilby 1961

Ref: Marliave 1975a, Washington et al. 1984b.



Figures A–B, NWAFC originals (B. Vinter).

MERISTICS

Vertebrae	Total: 39-39-41	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 16-17-19	R: 11-12-13
Pectoral fin	R: 18-19-20	
Anal fin	R: 12-14-15	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	Gulf of Alaska, 54-60°N, to Bering Sea, 54-66°N
Ecology	Nearshore shelf demersal
ELH pattern	Oviparous; demersal, adhesive eggs; pelagic larvae
Spawning	Season: Fall (Funka Bay, Japan)[a]
	Area: Rocky sea bottom, 10-30 m[a]
	Mode:
	Migration:
Fecundity	Range/function: 2250-11,170/ $E=0.00002147 \times L^{3.374}$, E=ovarian eggs, L=BL mm[a]
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	4.41-4.61 mm
No. of oil globules	Multiple (120-160)
Oil globule diameter	0.05-0.26 mm
Yolk	Yellow/orange
Envelope	Thick, white
Hatch size	14.1-15.2 mm SL;[a] 10.9-11.6 mm SL[b]
Incubation time/temp.	100 d/12°C

Pigment
- Light on yolksac

Diagnostic characters
- Oil globules coalesce to one by late embryonic development

LARVAE

Preanal length	~50% SL
Length at flexion	≤14.4 mm SL (close to hatching)
Length at transformation	~20 mm SL
Sequence of fin development	

Pigment
- Heavily pigmented at hatching (head, 3/4 BL, and dorsolateral surface of gut)
- Distinctive finfold pigment

Diagnostic characters (see Table 3)
- *Hemitripterus* group characters
- Finfold pigment
- Prickles, scales
- Newly hatched larvae large and well developed

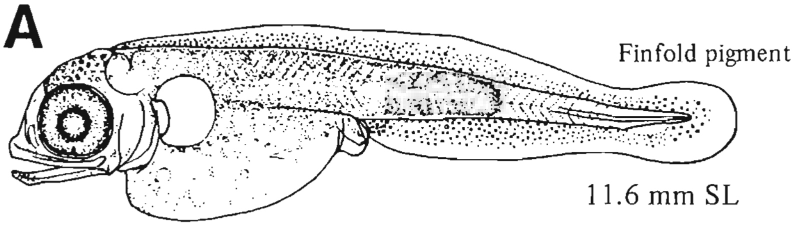
Eggs and larvae of *H. bolini* are unknown. The following information will aid in identification.

Total vertebrae	38-40
Dorsal fin spines	11-15
Dorsal fin rays	11-14
Anal fin rays	12-14
Pectoral fin rays	20-22
Pelvic fin rays	3
Range	N. Calif.[c] - Bering Sea

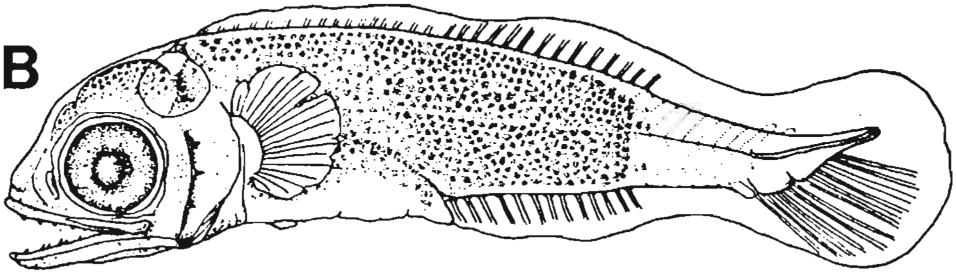
[a] Kyushin 1968
[b] Okiyama and Sando 1976
[c] Lea and Quirollo 1986

Ref: Kyushin 1968, Okiyama and Sando 1976.

A

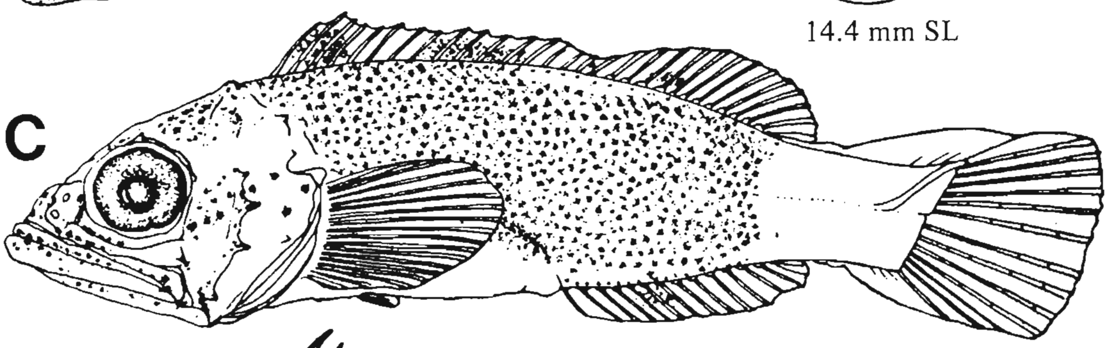


B



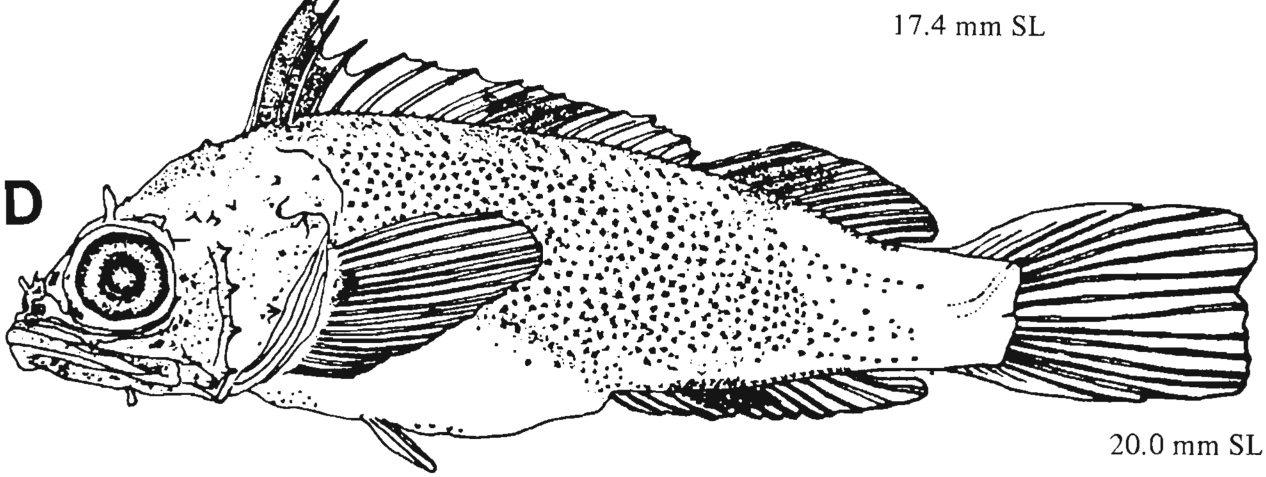
14.4 mm SL

C



17.4 mm SL

D



Figures A–D, Okiyama and Sando 1976 (reared from specimens collected near Hokkaido, Japan).

MERISTICS

Vertebrae	Total: 40-41-41	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 8-8-9	R: 27-29-30
Pectoral fin	R: 13-14-14	
Anal fin	R: 16-19-21	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	Cent. California, 34-38°N, to Bering Sea, 54-66°N
Ecology	Nearshore shelf demersal, 0-110 m
ELH pattern	Oviparous; demersal, adhesive, attached eggs; pelagic larvae
Spawning	Season: Fall-spring[a]
	Area: Intertidal, in mussel zone[a]
	Mode:
	Migration: Females move from subtidal area to mussel zone to deposit eggs[a]
Fecundity	Range/function:
Age at first maturity	1 yr[b]
Longevity	

[a] J. Marliave, Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8, pers. commun., 16 Oct. 1986.
[b] Fitch and Lavenberg 1975
[c] Andriashev 1954; eggs 2.5-2.7 mm.

Ref: Blackburn 1973, Marliave 1975a, Richardson and Washington 1980, Washington et al. 1984b.

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	2.0-2.5 mm
No. of oil globules	One
Oil globule diameter	
Yolk	Orange
Envelope	
Hatch size	~9 mm TL (possibly as small as 7 mm TL)
Incubation time/temp.	
Pigment	

Diagnostic characters
- Wild: Only egg with bright orange yolk laid in *Mytilus* beds[a]

LARVAE

Preanal length	~50% SL
Length at flexion	~9-11 mm SL
Length at transformation	~26 mm SL (largest pelagic specimen caught = 16-17 mm SL)
Sequence of fin development	

Pigment
- Finfold pigment
- Distinctive pigment over lateral surface of trunk
- Pectorals pigmented in band posteriorly

Diagnostic characters (see Table 3)
- Long pigmented pectorals (of sample size = 2, length of pectorals ranged from 42 to 59% SL)
- Bumps and parietal ridge

The following information will aid in identification of *N. pribilovius* (larvae unknown)[c] and *N. robustus* (eggs and larvae unknown).

	N. pribilovius	*N. robustus*
Total vertebrae	36-37	35
Dorsal fin spines	7-10	7- 8
Dorsal fin rays	22-26	19-21
Anal fin rays	15-20	14-15
Pectoral fin rays	15-17	14-16
Pelvic fin rays	3	3
Range	SE Alaska - Chukchi Sea	Wash. - Bering Sea

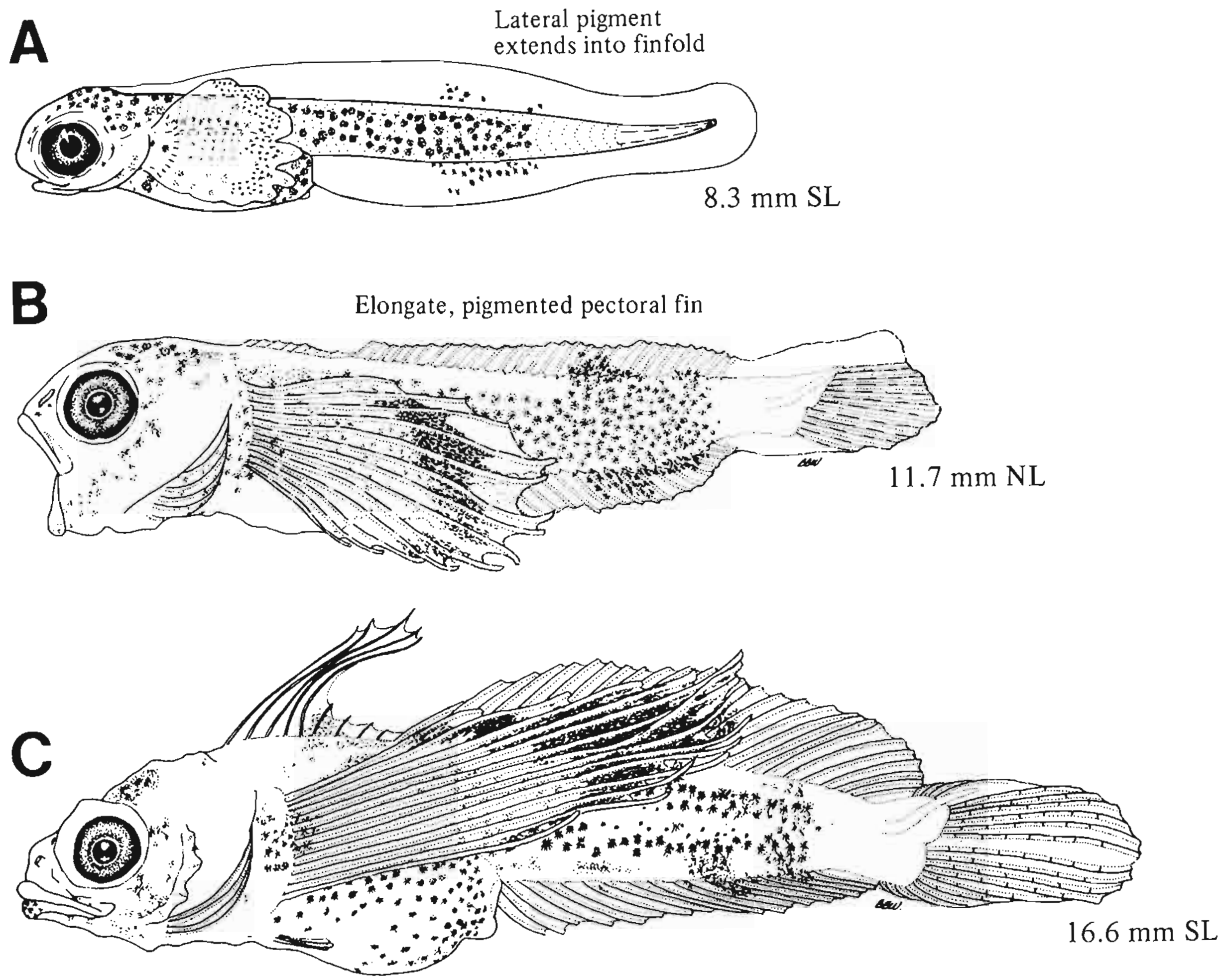


Figure A, NWAFC original (B. Vinter); B–C, Richardson and Washington 1980.

AGONIDAE

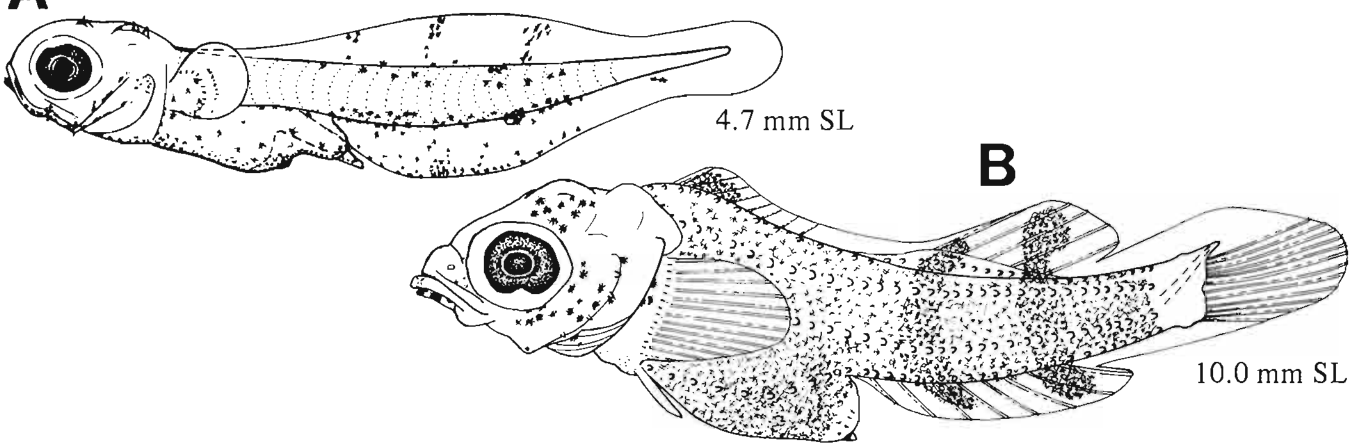
Poachers and alligatorfishes range from Baja California to the Bering Sea, with the center of abundance in the North Pacific. They are mostly elongate with large fused bony plates covering the body. Pectoral fins are fanlike. Adults are demersal and occur from moderate depths to 1250 m. Some have also been found in tidepools (Hart 1973, Garrison and Miller 1982). The family is represented by 25 species and 15 genera within the study area. Among the few species studied, demersal adhesive eggs are attached to holdfasts of laminarians (Breder and Rosen 1966, Garrison and Miller 1982). Larvae are pelagic and are occasionally taken in plankton nets near the surface. Bony plates, characteristic of agonids, first appear in the larvae as spines. Settlement in some species may occur at approximately 2 months after hatching (Marliave 1975a). Descriptions of larvae of three species are available for inclusion here (*Agonomalus mozinoi*, *Bothragonus swani*, and *Xeneretmus latifrons*). Illustrations of single specimens are provided for *Stellerina*, *Hypsagonus*, *Ocella*, *Aspidophoroides* (species outside study area), and an unidentified agonid. Two illustrations are provided for Agonidae A, another unidentified agonid from the study area.

Table 39
Meristic characters of family Agonidae. All have pelvic counts of I,2 and 6 branchiostegal rays.

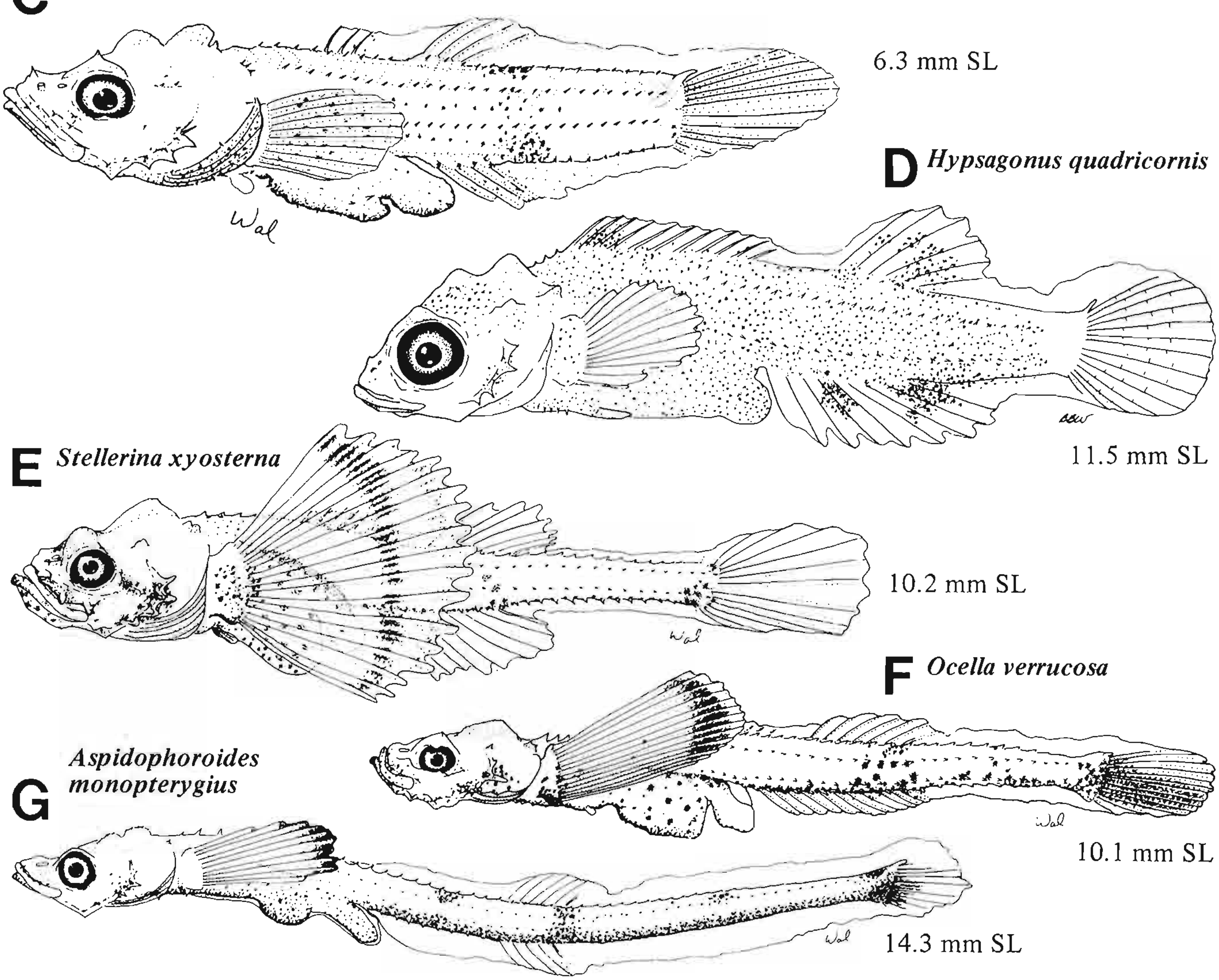
Taxon	Distribution	Vertebrae: Precaudal	Vertebrae: Caudal	Vertebrae: (Total)	Fins: Dorsal	Fins: Anal	Fins: Pectoral	Gill rakers: Upper	Gill rakers: Lower	Gill rakers: (Total)
Agonomalus mozinoi	Cent. Calif.-Brit. Col.				VIII-IX,6-8	11-12	11-12			
Agonopsis vulsa	SSC-Gulf of Alaska			(39-42)	VIII-X,7-9	10-12	13-15			
Agonus acipenserinus[a]	N. Calif.-Chukchi Sea			(39-41)	VII-X,6-9	6-9	16-19			
Agonus decagonus[a]	Bering Sea-Arctic			(47-48)[b]	V-VII,5-8	6-8	13-16			
Anoplagonus inermis	N. Calif.-Aleutian Is.			(41-45)	4-6	4-5	8-10			
Aspidophoroides bartoni	Gulf of Alaska-Arctic			(51-53)	4-6	4-6	9-10			
Aspidophoroides olriki	Bering Sea-Arctic			(38-40)	5-7	5-7	13-16			
Bathyagonus alascanus	N. Calif.-Bering Sea			(39-41)	V-VIII,5-8	6-8	15			
Bathyagonus infraspinatus	N. Calif.-Bering Sea			(38-39)	V-VIII,5-8	5-8	15-16			
Bathyagonus nigripinnis	N. Calif.-Bering Sea			(44-45)	VI-VIII,6-7	7-9	15-16			
Bathyagonus pentacanthus	S. Calif.-Bering Sea			(40-46)	V-VIII,5-8	6-9	14-16			
Bothragonus swani	Cent. Calif.-Gulf of Alaska			(29-31)	II-V,4-6	4-5	10-12			
Hypsagonus quadricornus	Wash.-Bering Sea			(36)	IX-XI,5-7	9-11	12-14			
Ocella dodecaedron	Aleutian Is.-Chukchi Sea			(38-39)	IX-XI,7-8	14-16	14-15			
Ocella impi[c]	Brit. Col.			(37)[b]	IX,6	9	18			
Ocella verrucosa	Cent. Calif.-Bering Sea	13-14	21-24		VII-IX,6-9	7-12	14-15	1-2	8-12	
Odontopyxis trispinosa	SSC-SE Alaska	10-12	27-30		III-VI,5-7	5-7	13-15		7	
Pallasina barbata	Cent. Calif.-Bering Sea			(45-47)	V-IX,6-7	9-14	10-13			
Percis japonicus	Bering Sea			(42)	V-VII,6	7-9	12			
Sarritor frenatus	Brit. Col.-Bering Sea			(46-48)	VI-VIII,6-8	6-7	15-17			
Sarritor leptorhynchus	Gulf of Alaska-Bering Sea			(42-44)	VI-IX,5-8	6-8	13-15			
Stellerina xyosterna	SSC-Brit. Col.			(34-37)	VI-VIII,5-7	8-9	17-19	1-2	8-12	(10-14)
Xeneretmus latifrons	SSC-Brit. Col.	11-13	28-30		VI-VIII,6-8	6-9	13-15		10-11	
Xeneretmus leiops	S. Calif.-SE Alaska			(39-42)	VI-VII,6-8	5-8	13-15			
Xeneretmus triacanthus	SSC-Brit. Col.	12	29-30		V-VII,6-7	5-7	12-14	1	8-13	

[a] Placement in the genus *Agonus* is questionable (Lea and Dempster 1982).
[b] W.A. Laroche, 24 Maple Park, Box 216, Enosburg Falls, VT 05450, pers. commun., 10 Dec. 1986.
[c] *Ocella impi* may not be a valid species, rather it may be the juvenile of *Stellerina xyosterna* (A.E. Peden, Brit. Col. Prov. Mus., Victoria, B.C., Canada V8V 1X4, pers. commun., 22 Jan. 1987).

AGONIDAE A



OTHER AGONIDS



Figures A–B, NWAFC originals (B. Vinter); C–G, Washington et al. 1984b (Figure C was misidentified in Washington et al. (1984b) as *Bothragonus swani*; G, Atlantic specimen).

MERISTICS

Vertebrae	Total: X-X-X	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 2-2-2
Dorsal fin	S: 8-X-9	R: 6-X-8
Pectoral fin	R: 11-X-12	
Anal fin	R: 11-X-12	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	Cent. California, 34-38°N, to Brit. Col., 48°30′-55°N
Ecology	Nearshore shelf demersal, intertidal to 11 m
ELH pattern	Oviparous, demersal eggs, pelagic larvae
Spawning	Season: Winter-spring[a]
	Area:
	Mode: Repeated deposition of eggs in separate masses[b]
	Migration:
Fecundity	Range/function: 6-25 eggs/mass[b]
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	∼1 mm
No. of oil globules	
Oil globule diameter	
Yolk	Red
Envelope	
Hatch size	5.5 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE[c]

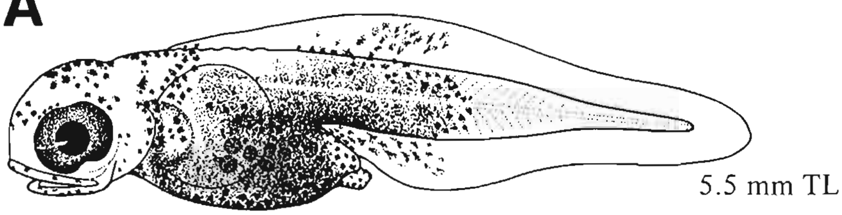
Preanal length
Length at flexion
Length at transformation
Sequence of fin development
Pigment
- Dorsal and ventral finfolds
- Heavily pigmented body, pigment increasing with development

Diagnostic characters
- Based on one specimen (8.2 mm SL), they are superficially similar to cottid *Hemitripterus* group (p. 448)

[a] W.A. Laroche, 24 Maple Park, Box 216, Enosburg Falls, VT 05450, pers. commun., 10 Dec. 1986.
[b] J. Marliave, Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8, pers. commun., 16 Oct. 1986.
[c] Incomplete series.

Ref: Washington et al. 1984a,b.

A



B

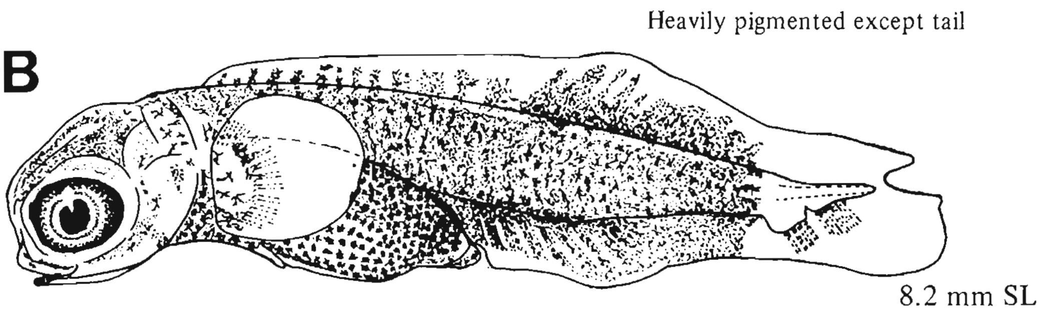


Figure A, Marliave 1978; B, NWAFC original (B. Vinter).

MERISTICS

Vertebrae	Total: 29-30-31	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 2-2-2
Dorsal fin	S: 2-3-5	R: 4-5-6
Pectoral fin	R: 10-12-12	
Anal fin	R: 4-4-5	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	Cent. California, 34-38°N, to Gulf of Alaska, 54-60°N
Ecology	Nearshore shelf demersal, intertidal to 18 m
ELH pattern	Oviparous; demersal, attached eggs; pelagic larvae
Spawning	Season: Winter-spring[a]
	Area: On kelp holdfasts[b]
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	2 mm
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	
Hatch size	7.5 mm TL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	
Length at flexion	~10-12 mm TL
Length at transformation	>16 mm TL
Sequence of fin development	

Pigment
- Upper and lower jaw
- Dorsal head
- Anterior gut and body
- Outer edge of pectoral fin
- Flexion and postflexion larvae develop several vertical bars on body

Diagnostic characters
- Large pigmented pectoral fins
- Body spines develop in flexion larvae
- Body short and stocky compared with *Xeneretmus latifrons*

[a] W.A. Laroche, 24 Maple Park, Box 216, Enosburg Falls, VT 05450, pers. commun., 10 Dec. 1986.
[b] Marliave 1975a

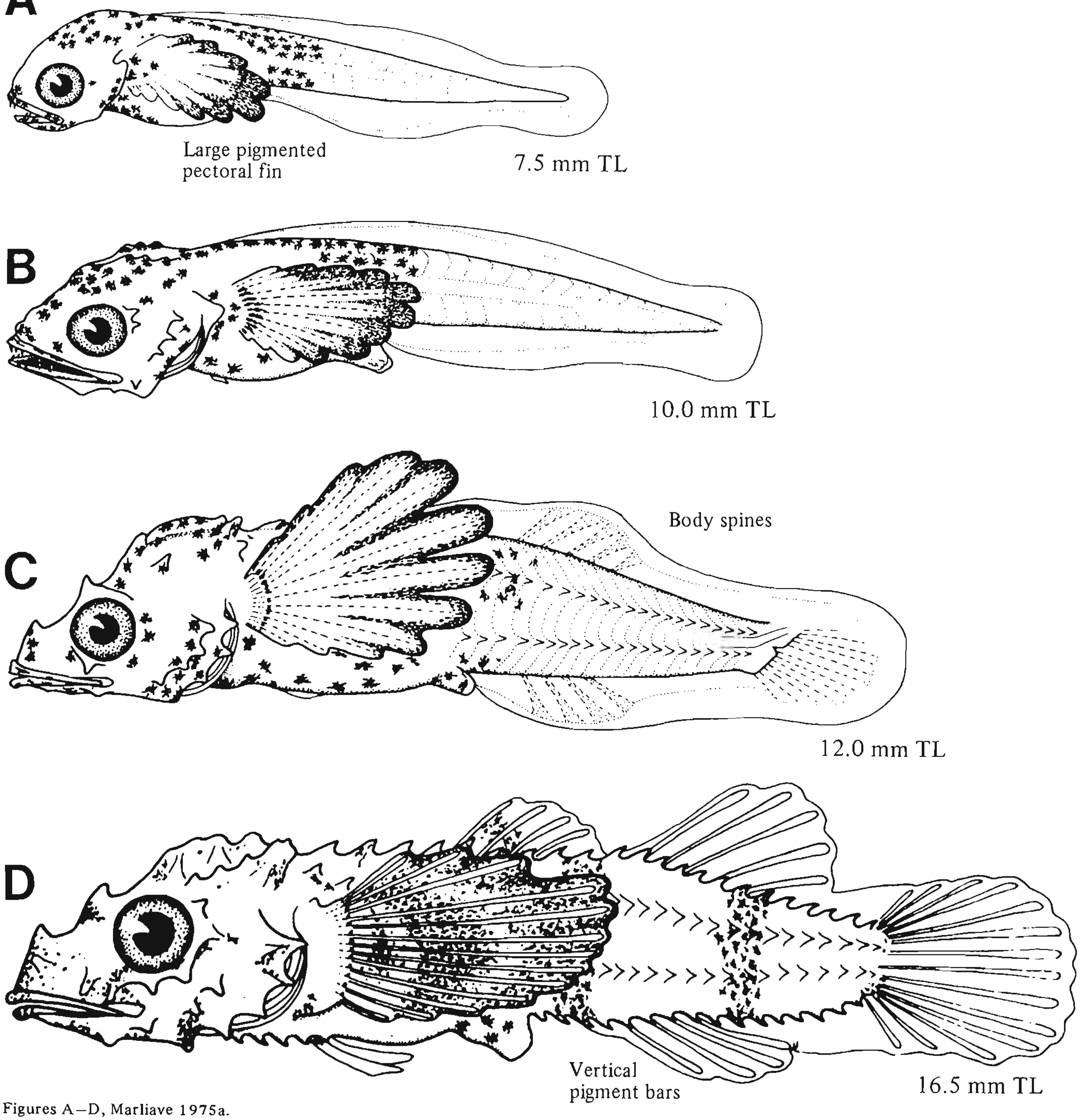
Ref: Marliave 1975a, Washington et al. 1984b.

A

B

C

D



Figures A–D, Marliave 1975a.

MERISTICS

Vertebrae	Total: 39-41-42	
	Precaudal: 11-12-13	
	Caudal: 28-29-30	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 2-2-2
Dorsal fin	S: 6-7-8	R: 6-7-9
Pectoral fin	R: 13-14-15	
Anal fin	R: 6-7-9	
Gill rakers	U: X-X-X	L: 10-X-11

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Epi- and mesobenthal, 18-400 m
ELH pattern	Oviparous, eggs probably demersal, pelagic larvae
Spawning	Season: Spring[a,b]
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size ~7 mm TL
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length
Length at flexion ~10 mm TL
Length at transformation
Sequence of fin development
Pigment[c]

- Body pigment extending into finfold in four vertical bars: Over posterior gut, midbody, at 3/4 body length, and tail region
- Preflexion larvae have pigment on jaws

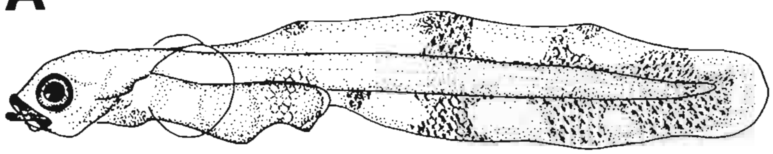
Diagnostic characters

- Four vertical pigment bars extending into finfolds
- Body spines develop in postflexion larvae
- Long slender body compared with *Bothragonus swani*

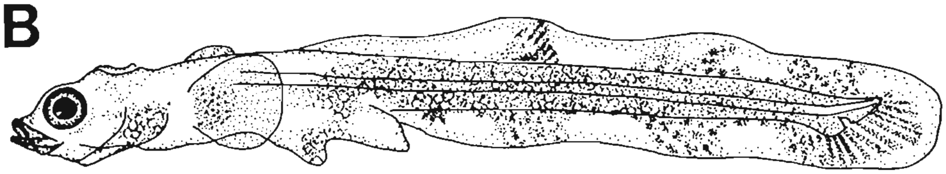
[a] Marliave 1975a
[b] Fitch and Lavenberg 1968
[c] J. Marliave, Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8, pers. commun., 16 Oct. 1986.

Ref: Marliave 1975a, Washington et al. 1984b.

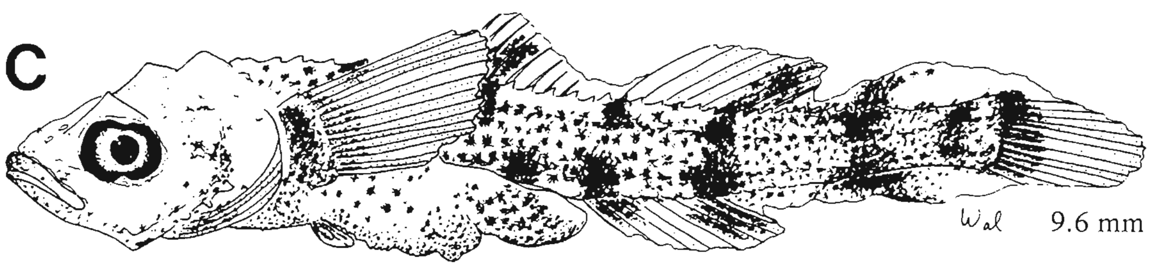
A



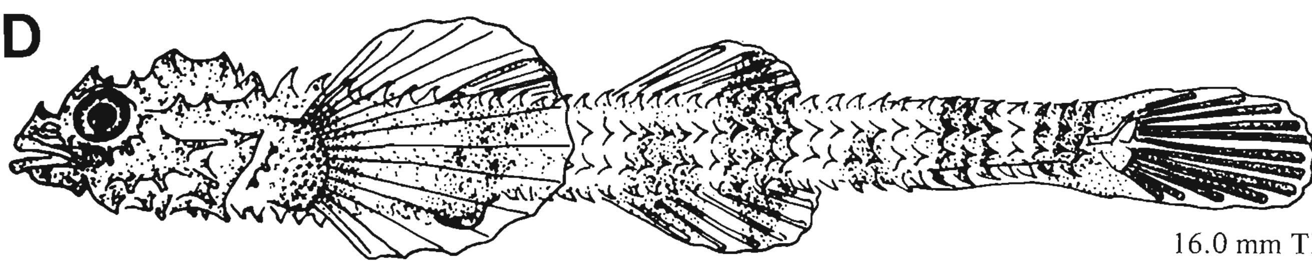
B



C



D



Figures A–B, D, Marliave 1975a (D, length in Marliave 1975a is given as 21.0 mm TL [footnote c]) ; C, Washington et al. 1984b.

The family Cyclopteridae is composed of two subfamilies: the Cyclopterinae (lumpsuckers) and the Liparidinae (snailfishes). Although both subfamilies possess a ventral sucking disc, many differences distinguish the two groups (e.g., lumpsuckers have 2 dorsal fins and about 23-29 vertebrae, and snailfishes have a single dorsal fin and about 38-86 vertebrae).

Cyclopterinae

Cyclopterines are found exclusively in the cooler waters of the Northern Hemisphere. The subfamily is represented by eleven species in five genera in the Northeast Pacific and Bering Sea. Mostly benthic, adults may be found clinging to rocks in tidal zones or in rocky habitat as deep as 225 m (Hart 1973). Eggs, which are adhesive, 1.9-5.0 mm in diameter, and may contain one or more oil globules, are laid in nest sites within rocky crevices or shells and are guarded during incubation (Able et al. 1984). Newly hatched larvae may be identified as cyclopterines by their stout body shape, heavy pigmentation, large sucking disc on the ventral surface, and advanced state of development. They are found attached to substrate and prefer areas with current (A.C. Matarese and S.F. Borton, unpubl.). Larvae of only two species can be identified in our area, *Aptocyclus ventricosus* and *Eumicrotremus orbis*.

Table 40

Meristic characters of subfamily Cyclopterinae. All have pelvic discs and six branchiostegal rays.

		Vertebrae		Fins			Gill rakers	
Taxon	Distribution	Precaudal	Caudal	Dorsal	Anal	Pectoral	Upper	Lower
Aptocyclus ventricosus	Brit. Col.-Bering Sea	14	13-15	V,8-11	6-9	19-22		5-7
Cyclopteropsis phrynoides	Gulf of Alaska-Bering Sea			VII,11		25		
Eumicrotremus andriashevi	Bering Sea-Chukchi Sea			VI-VII,10-12	10-11	23-27		
Eumicrotremus barbatus	Aleutian Is.	11	16	VII,11	10	23		
Eumicrotremus birulai	Gulf of Alaska-Bering Sea	11	17	VI-VII,9-12	9-11	25-29		6-9
Eumicrotremus gyrinops	Aleutian Is.-Bering Sea			VIII,9	9	24		
Eumicrotremus orbis	Wash.-Bering Sea	10-11	17-18	V-VII,9-11	9-11	19-27		5-6
Eumicrotremus soldatovi	Bering Sea	11	18	VI,11-12	10	24		
Eumicrotremus taranetzi	Bering Sea	11	16	V-VI,9-10	9-10	24-26		6-7
Lethotremus muticus	Aleutian Is.-Bering Sea			VII,11	10	23		
Pelagocyclus vitiazi	Bering Sea			IV-V,9-10	8-9	19-21		

MERISTICS

Vertebrae	Total: 27-X-29	
	Precaudal: 14-14-14	
	Caudal: 13-X-15	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Disc	
	S: X-X-X	R: X-X-X
Dorsal fin	S: 5-5-5	R: 8-10-11
Pectoral fin	R: 19-20-22	
Anal fin	R: 6-8-9	
Gill rakers	U: X-X-X	L: 5-X-7

LIFE HISTORY

Range	Brit. Col., 48°30′-55°N, to Bering Sea, 54-66°N
Ecology	Epi-, meso-, and bathypelagic, 0-1500 m
ELH pattern	Oviparous; demersal, adhesive eggs; demersal larvae
Spawning	Season:
	Area:
	Mode: Males guard eggs[a]
	Migration:
Fecundity	Range/function: 3800[a]
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	2.3-2.4 mm
No. of oil globules	(Present)
Oil globule diameter	
Yolk	
Envelope	
Hatch size	6.5-7.0 mm TL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	33% SL
Length at flexion	6.5-7.0 mm TL
Length at transformation	
Sequence of fin development	Pectorals and pelvic disc form before hatching

Pigment
- Initially, body is lightly pigmented but with development pigment increases to cover entire body

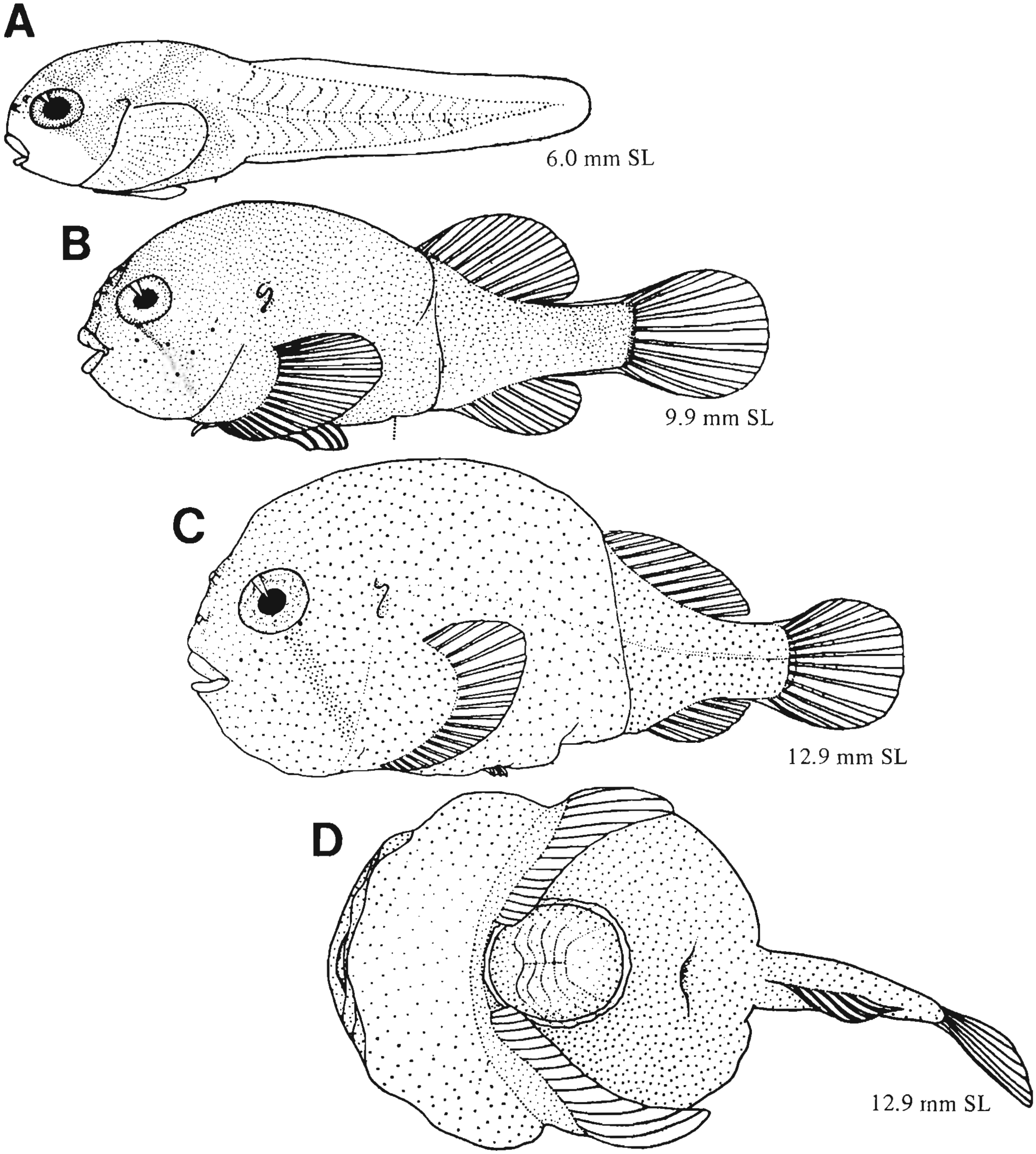
Diagnostic characters
- Smooth body (lack of spines)

Distinguished from other cyclopterines by
- Distribution
- Meristic characters:

Total vertebrae	27-29
Dorsal fin spines	5
Dorsal fin rays	8-11
Anal fin rays	6-9

[a] Able et al. 1984

Ref: Able et al. 1984, Kobayashi 1962.



Figures A–D (D, ventral view), Kobayashi 1962 (A, reared from specimens collected near Hokkaido, Japan).

MERISTICS

Vertebrae	Total: 26-X-29	
	Precaudal: 10-X-11	
	Caudal: 17-X-18	
Branchiostegal rays	6-6-6	
Caudal fin	X, 5+4, X	
	Total rays=9-12	
Pelvic fin	Disc	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 5-6-7	R: 9-10-11
Pectoral fin	R: 19-23-27	
Anal fin	R: 9-10-11	
Gill rakers	U: X-X-X	L: 5-X-6

LIFE HISTORY

Range	Washington, 46-48°30′N, to Chukchi Sea, north of 66°N
Ecology	Epi-, meso-, and bathybenthal, 0-575 m
ELH pattern	Oviparous; demersal, attached, adhesive eggs; demersal larvae
Spawning	Season: Fall-winter (Brit. Col.)[a]
	Area:
	Mode: Males guard eggs laid in nests[b]
	Migration:
Fecundity	Range/function: 305-1590 (737 at 52.5 mm)/ $F=47.67 \times L-1766.86$, L=TL mm[b]
Age at first maturity	1 yr (males)[b]
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.9-2.2 mm
No. of oil globules	One to multiple
Oil globule diameter	
Yolk	Clear, homogeneous
Envelope	Translucent
Hatch size	4.5-4.7 SL
Incubation time/temp.	26 d/9.7-12.0°C
Pigment	

Diagnostic characters
- Degree of body pigment
- Precocious fin development

LARVAE

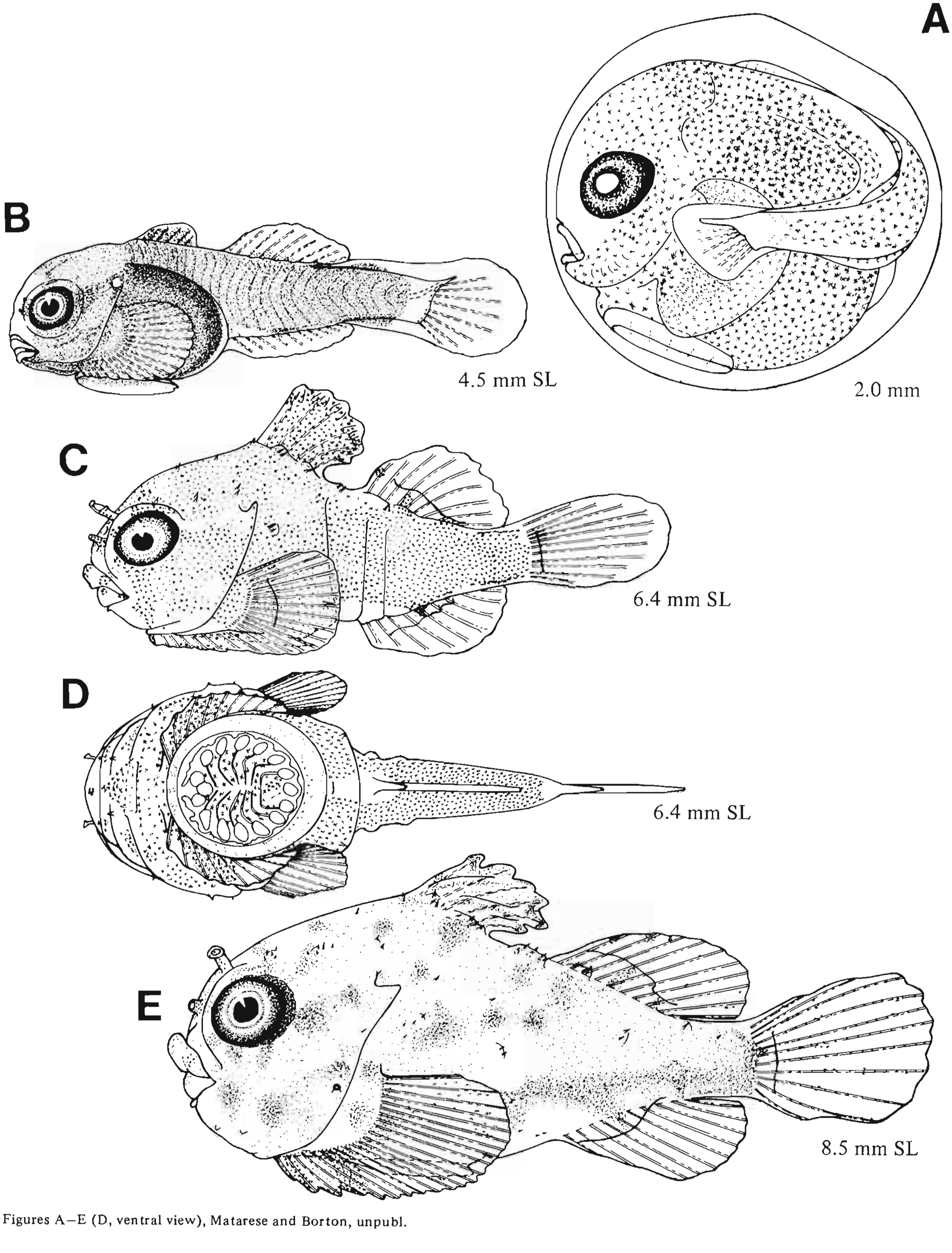
Preanal length	50-75% SL
Length at flexion	Prior to hatch
Length at transformation	6.9-8.7 mm SL
Sequence of fin development	Pelvics and caudal (prior to hatch), dorsal spines, dorsal rays, pectorals, anal (although caudal development is initiated prior to hatch, it is the last to complete development)

Pigment
- Initially, heavily pigmented except caudal peduncle, area around anus, first three anal rays, and snout

Diagnostic characters
- Pigment: Small melanophores covering most of body and dorsal fin
- Morphology: Globular shape, spines
- Precocious fin development

[a] Arita 1969
[b] A.C. Matarese and S.F. Borton, unpubl.

Ref: Matarese and Borton, unpubl.



Figures A–E (D, ventral view), Matarese and Borton, unpubl.

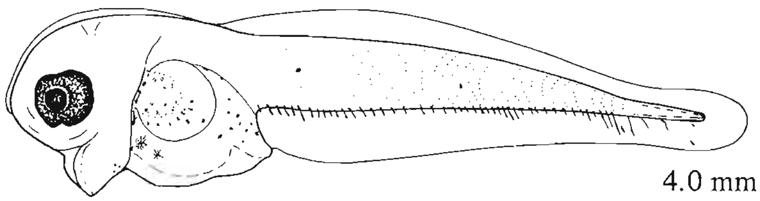
Liparidinae

This large subfamily is circumpolar about both poles in distribution. Within the study area there are 74 described species within 14 genera. Adults are demersal or pelagic and have been found from tidepools to depths of 7000 m (Hart 1973, Able et al. 1984). Spawning habits are diverse. Adhesive clumps of eggs (1-8 mm) have been seen attached to algae, mollusc shells, and tubeworms; eggs and larvae of *Careproctus* spp. have been found in gill cavities of lithodid crabs (Anderson and Cailliet 1974). Parental care of eggs (i.e., hiding, paternal guarding, or both) is exhibited in most taxa studied. Most species studied, especially deep-water forms, hatch at an advanced stage of development (Able et al. 1984). Larvae are planktonic or benthic. Only one complete larval series is available from our area, *Rhinoliparis barbulifer*. Illustrations of two unidentified larvae are provided since each of them is relatively common in our collection. The small larva (4.0 mm SL) is common in our Gulf of Alaska collections whereas the larger larva (5.8 mm SL) is routinely collected in our surveys along the Pacific Coast and represents one of the ten most abundant groups of ichthyoplankton collected off Oregon (Mundy, pers. commun.)[1]. Representatives of specimens from other areas (Atlantic, Arctic) are presented for three genera: *Careproctus*, *Paraliparis*, and *Liparis*. Early juvenile specimens of *Paraliparis* sp. (probably *P. deani*) are occasionally collected in plankton nets. Illustrations of a tentatively identified partial series of *Nectoliparis pelagicus* are also provided.

[1]B. Mundy, NMFS Southwest Fish. Cent., Honolulu Lab., 2570 Dole St., Honolulu, HI 96822-2396, pers. commun., 1 Oct. 1986.

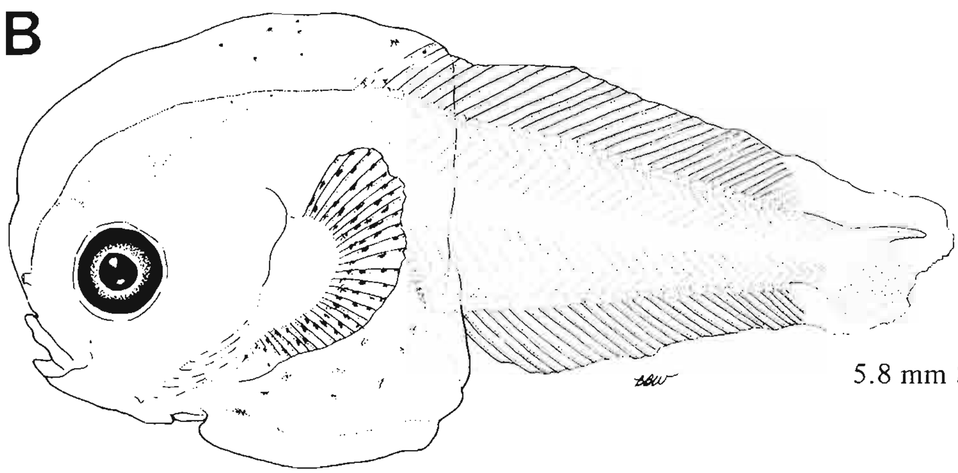
Unidentified Liparidinae

A



4.0 mm SL

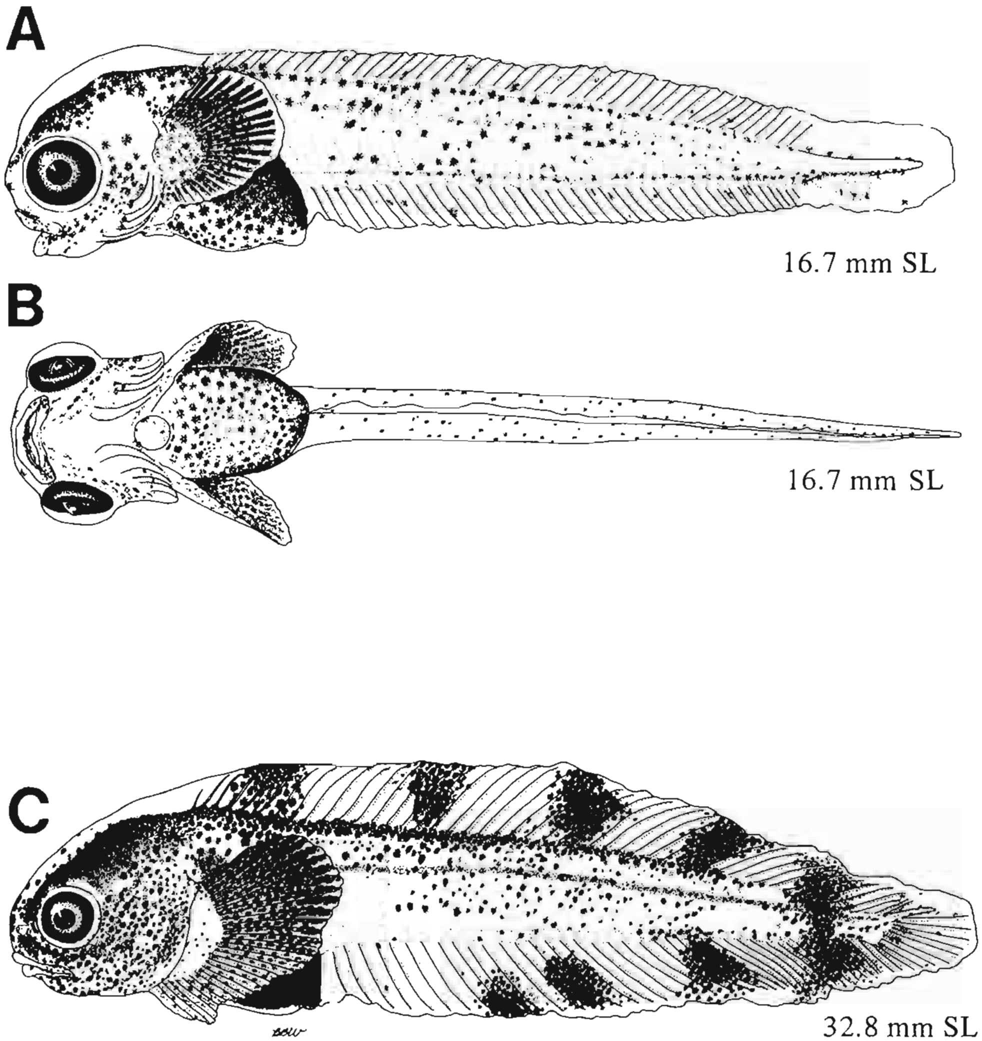
B



5.8 mm SL

Figure A, NWAFC original (B. Vinter); B, Able et al. 1984.

LIPARIS
L. fabricii

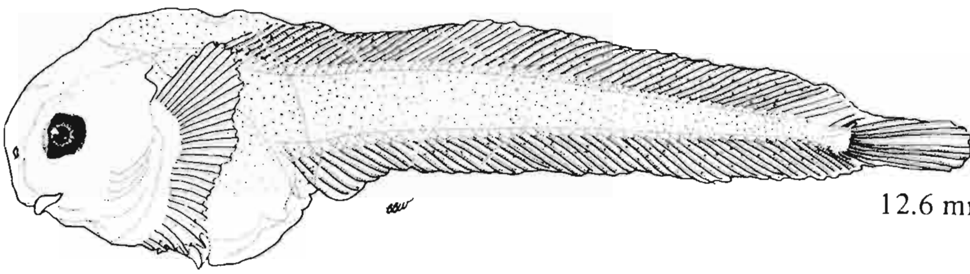


Figures A–C (B, ventral view), Able et al. 1984 (Arctic specimens).

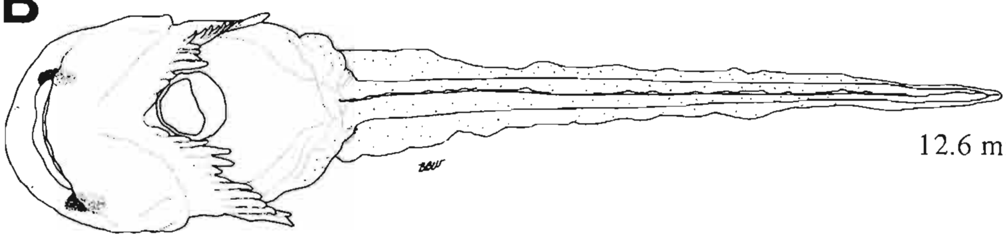
CAREPROCTUS

A

C. reinhardti



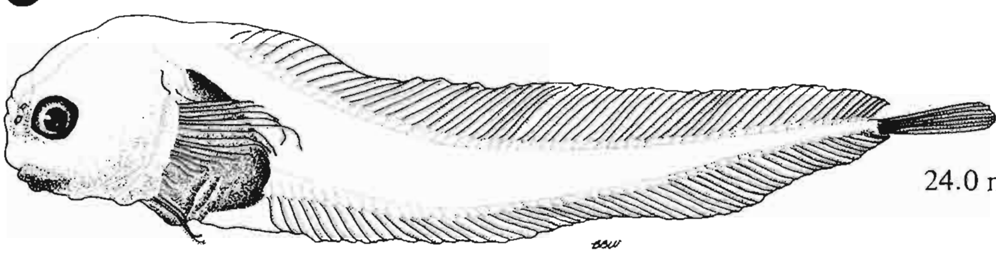
B



PARALIPARIS

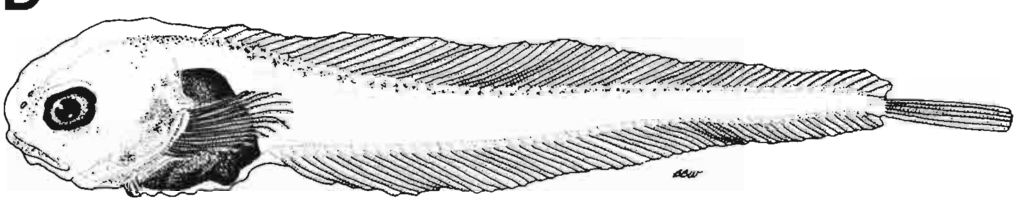
C

P. copei

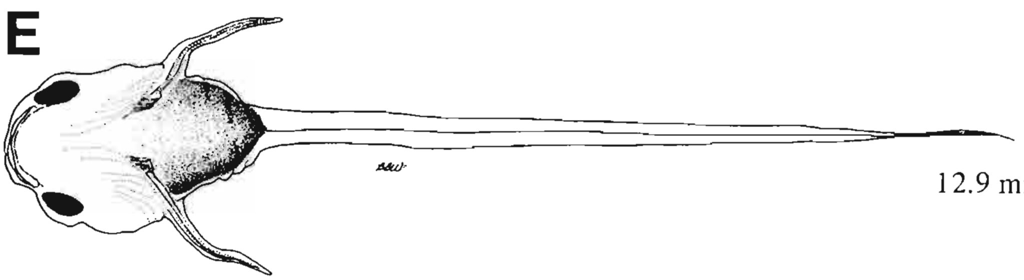


D

P. calidus



E



Figures A–E (B, E, ventral views), Able et al. 1984 (Atlantic specimens).

Table 41
Meristic characters of subfamily Liparidinae.[a]

Taxon	Distribution	Vertebrae: Precaudal	Vertebrae: Caudal	Vertebrae: (Total)	Fins: Dorsal	Fins: Anal	Fins: Pectoral	Fins: Pelvic	Gill rakers: Upper	Gill rakers: Lower	Gill rakers: (Total)	Branchiostegals
Acantholiparis[b]	Bering Sea							Absent				6
Acantholiparis caecus	Oregon	8-10	43-46		48-52	43-45	21	Absent			(10-11)	6-7
Acantholiparis opercularis	Calif.-Bering Sea	9	41		45-52	38-47	20-24	Absent			(8-10)	6
Careproctus abbreviatus	SE Alaska-Bering Sea				39	32	21	Disc				6
Careproctus attenuatus	Bering Sea				48	40	34	Disc				6
Careproctus bowersianus	Bering Sea	9-10	47-50		51-54	46-48	34-38	Disc				6
Careproctus cameliae	Bering Sea				50	45	28	Disc				6
Careproctus canus	Aleutian Is.	11-12	44-47	(55-58)	51-53	43-46	33-36	Disc				6
Careproctus colletti	Aleutian Is.-Bering Sea			(59-63)	52-58	47-52	25-31	Disc				6
Careproctus cypselurus	Oregon-Bering Sea	8	57-59	(64-70)	58-64	52-58	32-37	Disc				6
Careproctus ectenes	Aleutian Is.-Bering Sea				48	44	30-32	Disc				6
Careproctus filamentosus	Oregon	9-10	54-58	(63-68)	58-63	51-55	21-24	Disc				6
Careproctus furcellus	Bering Sea	10-11	56-61	(66-71)	60-65	54-59	32-37	Disc				6
Careproctus gilberti	Cent. Calif.-Bering Sea	8-9	47-49	(55-58)	45-55	41-48	30-33	Disc				6
Careproctus longifilis	SSC-Oregon	7-10	46-50	(55-58)	50-54	44-48	17-23	Disc				6
Careproctus melanurus	SSC-Bering Sea	8-11	49-53	(57-63)	53-58	47-51	27-33	Disc				6
Careproctus microstomus	Oregon	9-10	58-59	(67-69)	61-67	54-60	22-27	Disc				6
Careproctus mollis	Bering Sea				51	47	35	Disc				6
Careproctus opisthotremus	Aleutian Is.-Bering Sea				46	36	32	Disc				6
Careproctus oregonensis	Oregon	8-10	57-60	(65-69)	61-67	55-57	19-23	Disc				6
Careproctus ostentum	Aleutian Is.-Bering Sea				54	47	32	Disc				6
Careproctus ovigerum	Oregon-Brit. Col.	10-12	35-39	(47-49)	43-45	34-37	31-34	Disc				6
Careproctus pellucidus	SE Alaska				52-55	45-48	33-35	Disc				6
Careproctus phasma	Bering Sea				53	45	34	Disc				6
Careproctus pycnosoma	Bering Sea	10	36-39	(46-49)	42-45	36-39	38-39	Disc				
Careproctus rastrinus	SE Alaska-Bering Sea	8-9	50-52	(59-64)	55-59	49-52	33-37	Disc				6
Careproctus scottae	SE Alaska-Bering Sea				52-56	47-51	32-34	Disc	2	10		6
Careproctus simus	Aleutian Is.-Bering Sea	10-11	48-52		54-58	47-51	31-37	Disc				6
Careproctus spectrum	SE Alaska-Bering Sea				52	47	32	Disc				6
Careproctus zachirus	Aleutian Is.	12-13	44-46	(56-58)	51-58	43-45	28-31	Disc				
Crystallichthys cyclospilus	Gulf of Alaska-Bering Sea	11	42	(52-53)	48-50	42-43	33-36	?				6
Crystallichthys mirabilis	Bering Sea				53	44	30-33	?				6
Elassodiscus caudatus	Cent. Calif.-SE Alaska	9-11	46-51		49-55	41-50	27-29	Disc				6
Elassodiscus tremebundus	Bering Sea	9-12	52-63	(62-74)	55-67	49-60	25-33	Disc				6
Gyrinichthys minytremus	Aleutian Is.-Bering Sea				25	14	25	Disc				6
Liparis bristolensis	Bering Sea-Chukchi Sea			(49)	38-40	30-35	33-37	Disc				6
Liparis callyodon	Wash.-Bering Sea			(41-42)	33-35	25-27	28-31	Disc				6

Table 41 (continued)

		Vertebrae			Fins				Gill rakers			
Taxon	Distribution	Precaudal	Caudal	(Total)	Dorsal	Anal	Pectoral	Pelvic	Upper	Lower	(Total)	Branchiostegals
Liparis catharus	SE Alaska	12	38		46	36	37	Disc				6
Liparis cyclopus	Oregon-Bering Sea			(42-44)	35-37	29-31	29-32	Disc				6
Liparis dennyi	Wash.-Aleutian Is.			(44-45)	37-40	30-34	36-39	Disc				6
Liparis florae	S. Calif.-Bering Sea			(39-40)	31-33	25-27	29-33	Disc	0-1	3-4		
Liparis fucensis	Cent. Calif.-SE Alaska	10-11	29-30		33-35	27-29	37-43	Disc			(8-9)	6
Liparis gibbus	SE Alaska-Arctic	10-12	34-38		38-46	32-37	37-45	Disc			(6-10)	6
Liparis grebnitzki	Bering Sea				32	27	29	Disc				6
Liparis mednius	Bering Sea				29[c]	27	27	Disc				6
Liparis megacephalus	Bering Sea				43-44	36	36-38	Disc				6
Liparis micraspidophorus	Aleutian Is.-Bering Sea				31-32	25-27	30-32	Disc				6
Liparis mucosus	SSC-SE Alaska			(36-38)	28-32	22-25	27-32	Disc				6
Liparis ochotensis	Gulf of Alaska-Bering Sea				45	36-38	39-42	Disc				6
Liparis pulchellus	Cent. Calif.-Bering Sea	11-12	40-42		47-53	39-42	36-37	Disc		6-9		6
Liparis rutteri	N. Calif.-Bering Sea			(37-39)	30-32	23-27	30-33	Disc				6
Liparis tunicatus	Bering Sea-Arctic	10-12	35-38		39-44	33-37	32-38	Disc		5-11		6
Lipariscus nanus	Cent. Calif.-SE Alaska				40-52	37-49	13-15	Disc				5
Nectoliparis pelagicus	Cent. Calif.-Bering Sea	9-12	50-52	(61-64)	44-56	40-51	19-25	Absent				5
Odontoliparis ferox	Oregon	11	48		51	46	17	Absent				6
Osteodiscus cascadiae	Oregon-Brit. Col.	8-9	43-47	(51-56)	47-52	40-44	20-25	Absent				6
Paraliparis cephalus	S. Calif.-Bering Sea	9-10	47-54		50-57	44-51		Absent				6
Paraliparis dactylosus	Cent. Calif.-Bering Sea			(59-61)	54-56	49-51	28-30	Absent				6
Paraliparis deani	N. Calif.-SE Alaska				56-58	44-48	18-22	Absent				6
Paraliparis holomelas	Bering Sea				58-61	54	23	Absent				6
Paraliparis latifrons	SSC-Oregon	9-10	51-52	(61)	54-57	48-50	21-24	Absent				6
Paraliparis megalopis	Oregon	9	67	(76)	66-71	63-65	16-19	Absent				6
Paraliparis melanobranchus	Oregon				60	53	17	Absent				6
Paraliparis mento	Cent. Calif.-Wash.	9-10	51-52		55-59	49-51	16-18	Absent				6
Paraliparis paucidens	Oregon-Brit. Col.	10-12	55-56	(66-67)	58-60	53-54	19-24	Absent				6
Paraliparis pectoralis	Oregon-Bering Sea	10-11	51-54	(61-64)	55-58	49-52	28-32	Absent				6
Paraliparis rosaceus	SSC-Brit. Col.	11-13	56-61	(67-74)	57-69	53-60	18-22	Absent				6
Paraliparis ulochir	SSC-Bering Sea	9-10	62-65	(72-74)	65-69	60-64	21-24	Absent				6
Polypera beringiana	Wash.-Bering Sea				38-39	31-32	36-37	Disc				6
Polypera greeni	Brit. Col.-Bering Sea			(47)	37-40	31-32	33-37	Disc				6
Rhinoliparis attenuatus	Cent. Calif.-Bering Sea			(80-83)	74-78	70-73	21-25	Absent				6
Rhinoliparis barbulifer	S. Calif.-Bering Sea			(68)	63-68	57-59	18-21	Absent				6
Temnocora candida	Gulf of Alaska-Bering Sea			(68)	45-48	39	33-37	Disc				6

[a] The NWAFC meristic database was updated for the Liparidinae by the papers of Kido (1983, 1984, 1985), Kido and Kitagawa (1986), and unpublished data from D. Stein (Oregon St. Univ., Corvallis, OR 97331, pers. commun., 29 Oct. 1986).

[b] At least two undescribed species in addition to *A. opercularis* probably occur in the Bering Sea.

[c] According to Soldatov and Lindberg (1930), *Liparis mednius* has six dorsal spines.

MERISTICS

Vertebrae	Total: 61-X-64	
	Precaudal: 9-X-12	
	Caudal: 50-X-52	
Branchiostegal rays	5-5-5	
Caudal fin		
Pelvic fin	Absent	
Dorsal fin	R: 44-X-56	
Pectoral fin	R: 19-20-25	
Anal fin	R: 40-X-51	
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	Cent. California, 34-38°N, to Bering Sea, 54-66°N
Ecology	Nearshore shelf demersal
ELH pattern	Oviparous, eggs probably demersal, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE[a]

Preanal length Changes with development
Length at flexion
Length at transformation
Sequence of fin development
Pigment

- Darkly pigmented peritoneum
- Ventral half of head pigmented, appearing bearded

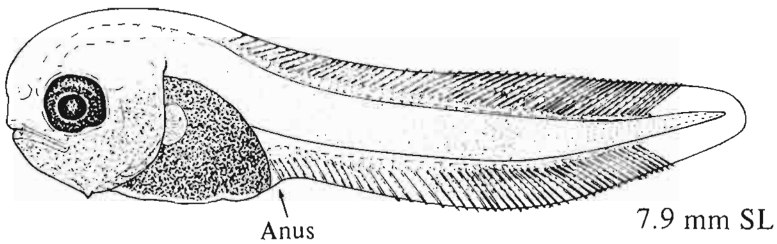
Diagnostic characters

- Presence of two separate pectoral fin lobes
- General tadpole shape
- Position of anus: Apparently moves forward with development; in adults anus is directly under eye
- Absence of disc
- Number of branchiostegal rays (five)

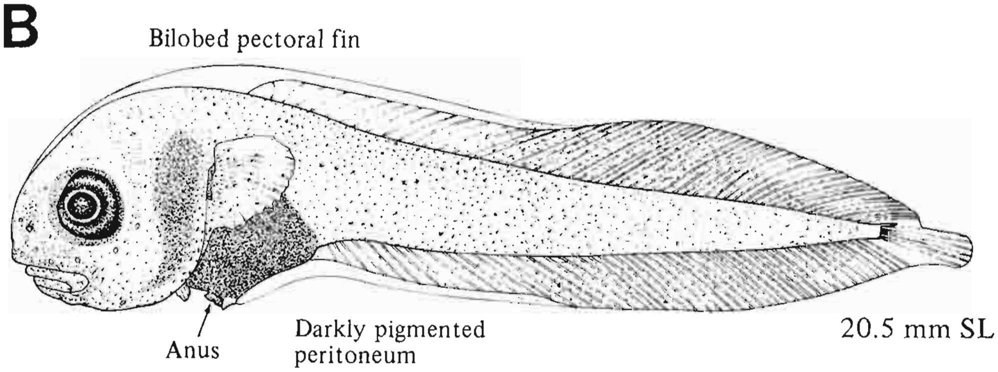
[a] Identification of small larvae prior to pectoral fin development and movement of anus forward is tentative. A cleared and stained 7.9-mm SL specimen has five branchiostegal rays.

Ref: Hart 1973.

A



B



Figures A–B, NWAFC originals (B. Vinter).

MERISTICS

Vertebrae	Total: X-X-X
	Precaudal: X-X-X
	Caudal: X-X-X
Branchiostegal rays	6-6-6
Caudal fin	
Pelvic fin	Absent
Dorsal fin	R: 56-X-58
Pectoral fin	R: 18-X-22
Anal fin	R: 44-X-48
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	N. California, 38-42°N, to SE Alaska, 55-59°N
Ecology	Epi-, meso-, and bathybenthal, 55-1008 m
ELH pattern	Oviparous; demersal, adhesive eggs; pelagic larvae
Spawning	Season: Continuous and periodic spawning occurs with other *Paraliparis* spp.[a]
	Area: Probably under rocks or in/on invertebrates with hard exoskeletons[a]
	Mode: Parental care (egg guarding) likely for periodic spawners[a]
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	~2 mm
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	
Hatch size	
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE[b]

Preanal length
Length at flexion
Length at transformation
Sequence of fin development
Pigment

Diagnostic characters
- Characteristic notch in pectoral fin
- General body shape
- Absence of disc

[a]Stein 1980b
[b]Juvenile specimens only, probably *P. deani*.

Ref: Able et al. 1984, Hart 1973.

A

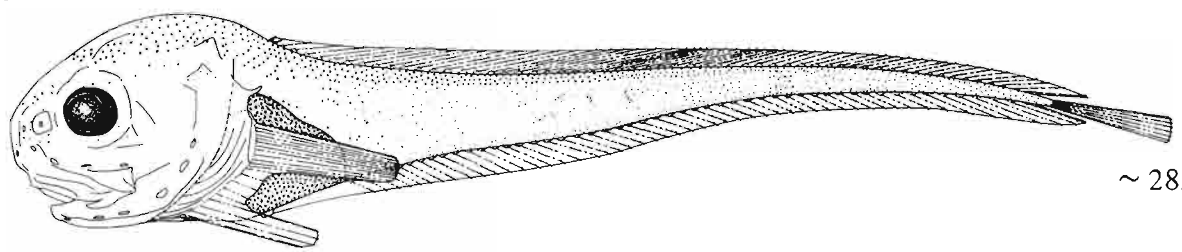


Figure A, NWAFC original (B. Vinter).

MERISTICS

Vertebrae	Total: 68-68-68 Precaudal: X-X-X Caudal: X-X-X	
Branchiostegal rays	6-6-6	
Caudal fin	X, 3, X	
Pelvic fin	Absent	
Dorsal fin	S: 63-X-65	R: X-X-X
Pectoral fin	R: 18-X-20	
Anal fin	S: 57-X-59	R: X-X-X
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Meso- and bathybenthal
ELH pattern	Parity unknown, eggs probably demersal, benthopelagic larvae[a]
Spawning	Season: Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	2.5 mm
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	
Hatch size	≤9.1 mm SL
Incubation time/temp.	

Pigment
- Unpigmented

Diagnostic characters
- Yolk absorbed by 11.7 mm SL
- Flexion and fin ray development occurs prior to hatching

LARVAE (postflexion and juvenile)

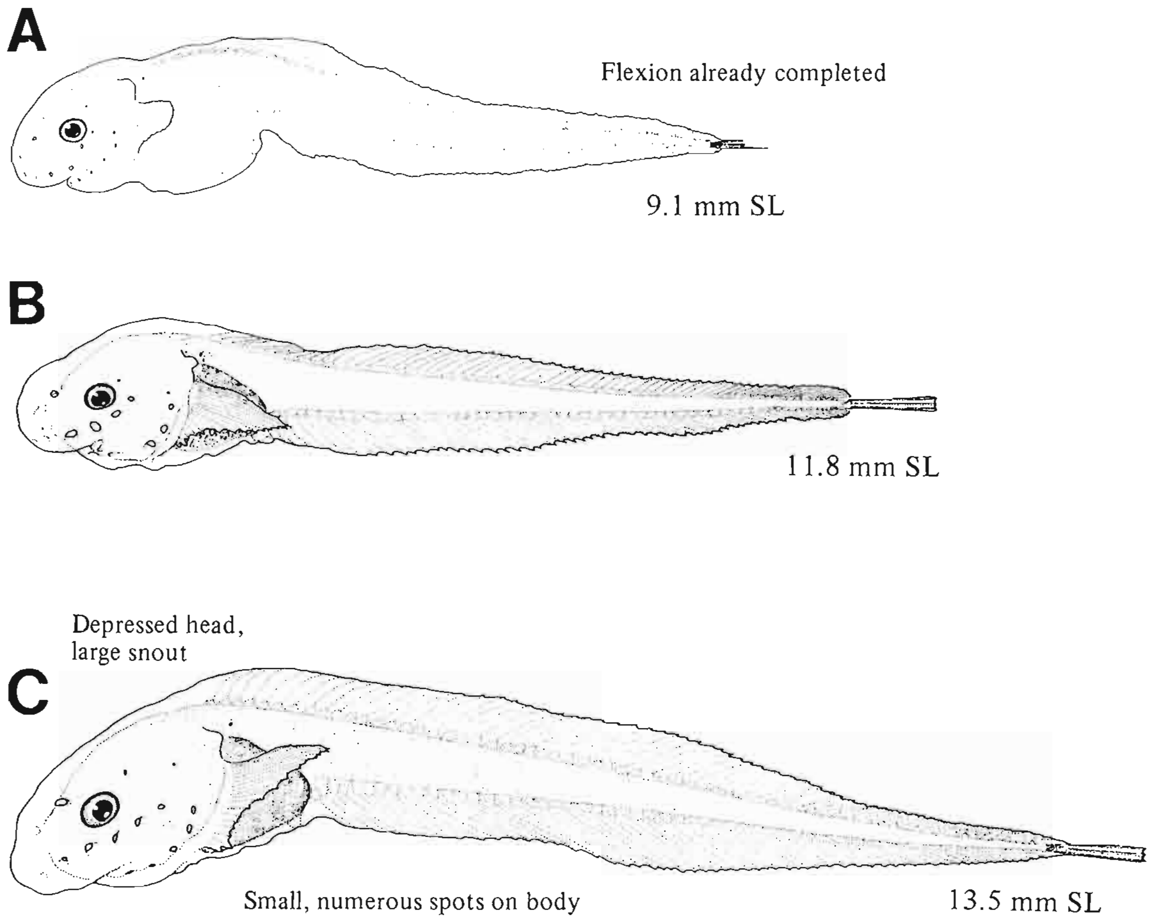
Preanal length	<50% SL
Length at flexion	<9.1 mm SL
Length at transformation	
Sequence of fin development	Dorsal, anal, and caudal; pectoral

Pigment
- Larvae <11.0 mm SL have no pigment
- Nape, peritoneum, and lateral body pigmented by 12.5 mm SL
- Pigment on the head and body increases in larger specimens

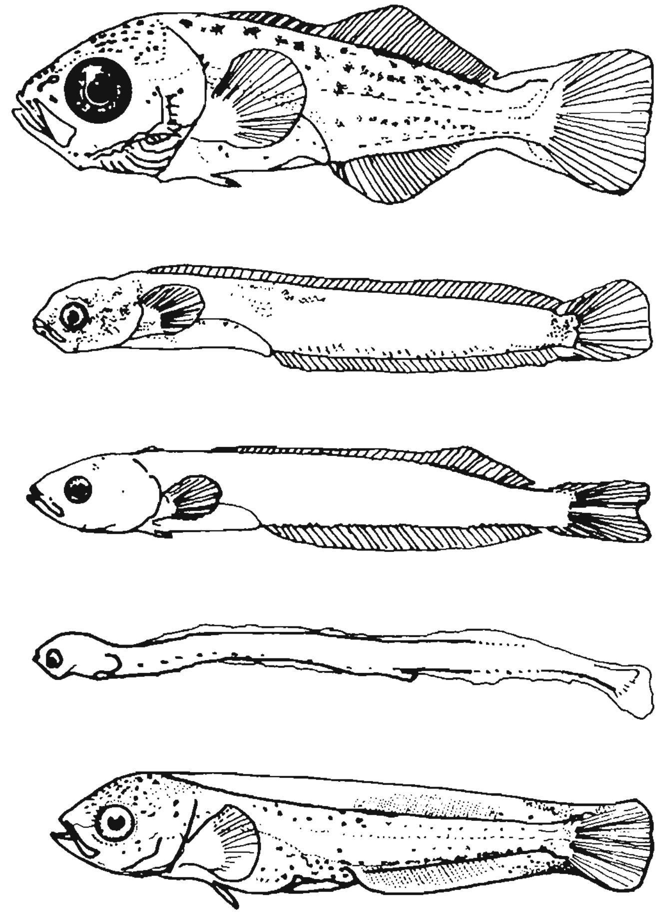
Diagnostic characters
- Loose skin over body
- Morphology
  —Depressed head
  —Large snout
  —Slender tapering body
- Absence of disc

[a] Kido and Kitagawa 1986

Ref: Able et al. 1984, Kido and Kitagawa 1986.



Figures A–C (A, yolksac larva; B–C, juveniles), Kido and Kitagawa 1986 (specimens from Iwate Prefecture, Honshu, Japan).



Perciformes

The most diversified of all fish orders is the Perciformes. Although the order encompasses the entire range of fish forms and behavior, most species are adapted for life as predators in shallow or surface waters. More than a dozen characters (many secondarily lost) define this group of spiny-rayed fishes. Most obvious of these are fin spines, two dorsal fins, scales generally ctenoid, pelvic fin inserted forward of the abdomen, and vertical insertion of the pectoral fin. There are 22 suborders, 150 families, 1,367 genera, and about 7,800 species within the order (J. Nelson 1984). The most speciose groups are the percoids and zoarcoids. Within the study area, nine suborders are represented; four of them are composed of a single species. Most species are members of the families Stichaeidae and Zoarcidae.

Some early-life-history stages are known for most families within our area except for Zoarcidae and Scytalinidae. When describing the sequence of fin ray development for percoids, we used the patterns A-F summarized in G.D. Johnson (1984) (see also Introduction, p. 29). A summary of meristic characters of zoarcids is provided to assist in identification.

Families in study area:

Carangidae	**Zaproridae**
Bramidae	**Scytalinidae**
Caristiidae	**Trichodontidae**
Sciaenidae	**Clinidae**
Pentacerotidae	**Icosteidae**
Bathymasteridae	**Ammodytidae**
Zoarcidae	**Gobiidae**
Stichaeidae	**Trichiuridae**
Cryptacanthodidae	**Scombridae**
Pholididae	**Luvaridae**
Anarhichantidae	**Stromateidae**
Ptilichthyidae	**Centrolophidae**
	Tetragonuridae

MERISTICS

Vertebrae	Total: 25-25-25	
	Precaudal: 10-10-10	
	Caudal: 15-15-15	
Branchiostegal rays	7-X-8	
Caudal fin	9-10, 9+8, 8-9	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 4-X-7	R: 24-X-29
Pectoral fin	R: X-X-X	
Anal fin	S: 2-X-3[a]	R: 15-X-18
Gill rakers	U: 5-X-8	L: 12-X-19

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Epipelagic
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	~1.3 mm
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	Smooth
Hatch size	
Incubation time/temp.	24-48 hr/18-30°C
Pigment	

Diagnostic characters

LARVAE

Preanal length	~50-75% SL
Length at flexion	>4.1 mm SL
Length at transformation	
Sequence of fin development	"A" pattern:[b] 2nd dorsal (rays), anal, and caudal simultaneously followed by 1st dorsal (spines), pelvics, and pectorals (some carangids have precocious pelvics)

Pigment
- Uniform heavy pigmentation
- Body: Dorsolateral, lateral midline, and scattered on ventrolateral
- Vomer and branchiostegal membrane
- Antimedial rows on dorsal body margin present or absent[c]

Diagnostic characters
- Relatively deep bodied
- Uniform heavy pigment except in caudal region
- Pigment on branchiostegal membrane
- 25 myomeres
- Flexion and postflexion
  - —Large posttemporal and supracleithral, supraocular and preopercular spines (not serrate)
  - —No supraoccipital crest

[a] The first two spines are physically separated from the third, shorter spine which is associated with the anal fin soft rays.
[b] G.D. Johnson 1984
[c] Laroche et al. 1984

Ref: Laroche et al. 1984, Sanzo 1931b.

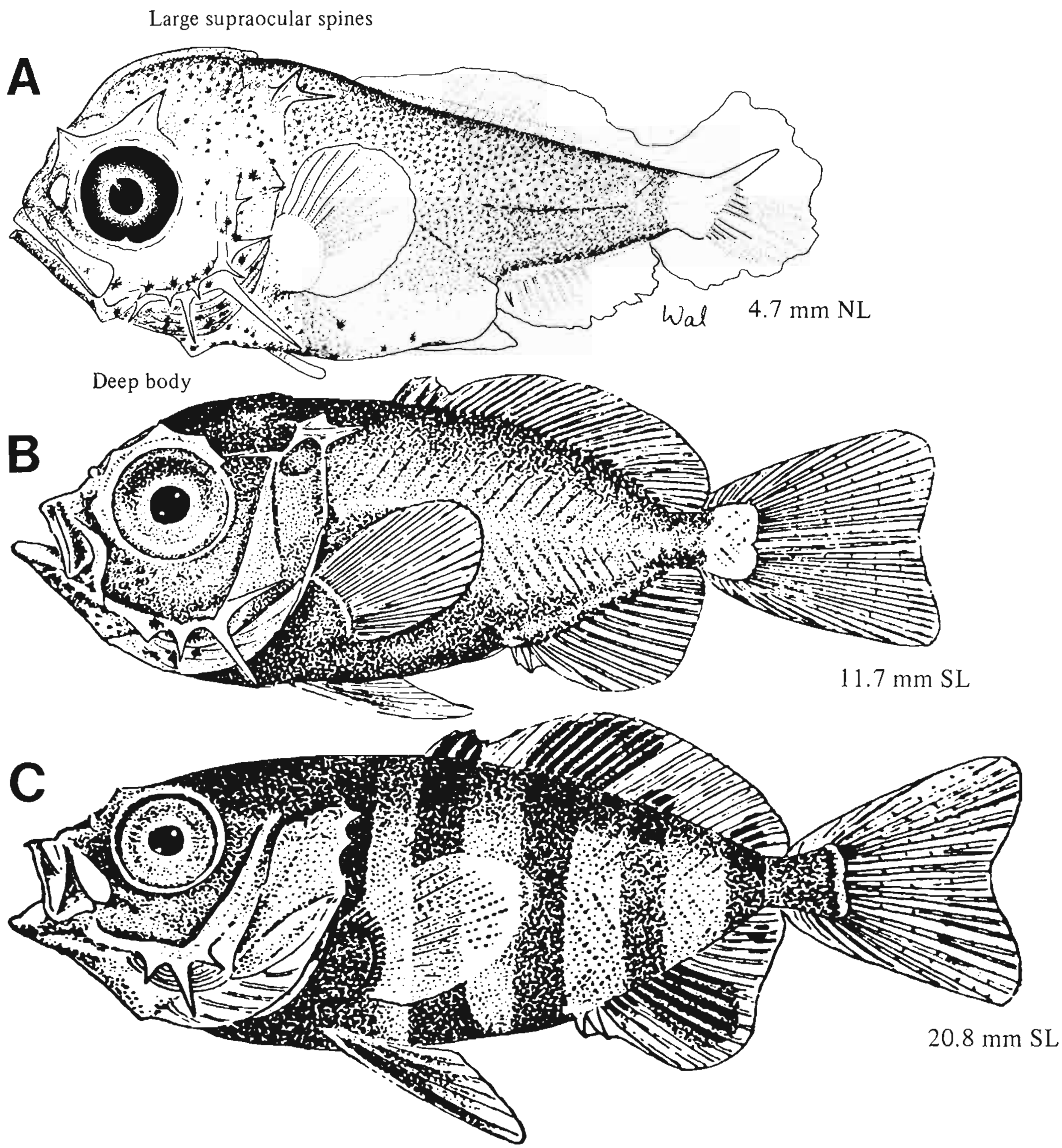


Figure A, Laroche et al. 1984 (Gulf of Mexico specimen); B–C, Sanzo 1931b (eastern Atlantic specimens).

MERISTICS

Vertebrae	Total: 23-24-25	
	Precaudal: 10-10-10	
	Caudal: 14-14-14	
Branchiostegal rays	7-X-8	
Caudal fin	9-10, 9+8, 9-10	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 8-X-9	R: 28-X-38
Pectoral fin	R: X-X-X	
Anal fin	S: 2-X-3[a]	R: 22-X-33
Gill rakers	U: 7-X-15	L: 25-X-42

LIFE HISTORY

Range	South of southern California to Gulf of Alaska, 54-60°N
Ecology	Epi- and mesopelagic, 0-403 m[b]
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Jan-Nov;[c] Mar-Aug (California)[d]
	Area: Epipelagic, offshore[e]
	Mode:
	Migration:
Fecundity	Range/function: 53,000[b]
Age at first maturity	2-3 yr[e]
Longevity	>30 yr[e]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	0.90-1.08 mm
No. of oil globules	One
Oil globule diameter	0.25 mm
Yolk	Segmented
Envelope	Smooth, clear
Hatch size	1.91-2.38 mm SL
Incubation time/temp.	24-48 hr/18-30°C

Pigment
- Oil globule
- Dorsal and ventral melanophores

Diagnostic characters
- Anterior position of oil globule in yolksac larvae
- Pigment
- Lack of yolk pigment distinguishes eggs from *Merluccius productus* (p. 186) and *Scomber japonicus* (p. 554)

LARVAE

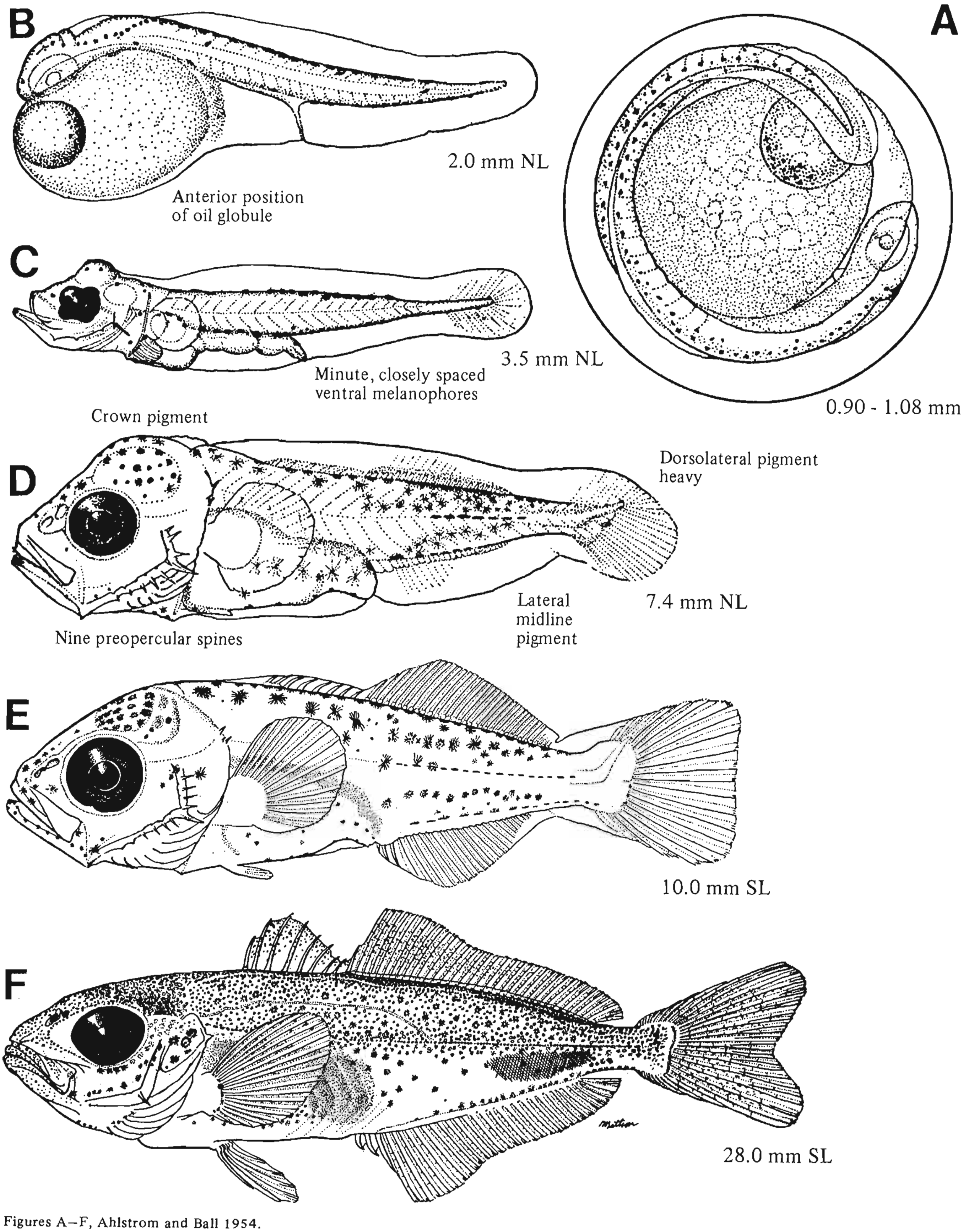
Preanal length	52-61% SL[f]
Length at flexion	8-11 mm SL
Length at transformation	16 mm SL
Sequence of fin development	"A" pattern:[g] 2nd dorsal (rays), anal, and caudal simultaneously followed by 1st dorsal (spines), pelvics, and pectorals (some carangids have precocious pelvics)

Pigment
- Crown, dorsal and ventral midline
- Mediolateral streak
- Some superficial lateral pigment develops

Diagnostic characters
- Low myomere count (usually 24)
- Dorsal body margin pigment; antimedial rows absent with median rows only
- Flexion and postflexion
  —~9 preopercular spines (not serrate)
  —Supraoccipital crest present

[a] The first two spines are physically separated from the third, shorter spine which is associated with the anal fin soft rays.
[b] Hart 1973
[c] Frey 1971
[d] MacCall and Stauffer 1983
[e] Fitch and Lavenberg 1971
[f] Remains within this range from 2.2 to 50.0 mm SL.
[g] G.D. Johnson 1984

Ref: Ahlstrom and Ball 1954, Laroche et al. 1984.



Figures A–F, Ahlstrom and Ball 1954.

MERISTICS

Vertebrae	Total: 39-40-41 Precaudal: 15-16-17 Caudal: 23-24-26
Branchiostegal rays	7-X-8
Caudal fin	8, 9+8, 7
Pelvic fin	Thoracic S: 1-1-1 R: 5-5-5
Dorsal fin[a]	S: 3-3-5 R: 30-X-35 D1+D2=33-36
Pectoral fin	R: 21-22-23
Anal fin[a]	S: 2-X-3 R: 25-X-29 A1+A2=27-30
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Epipelagic, 0-200 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Spring (California)[b] Area: Pelagic[b] Mode: Migration: To the south to spawn[b]
Fecundity	Range/function:
Age at first maturity	
Longevity	>6 yr[b]

[a] Since spines are weak or lacking in fins, there has been much confusion in the literature. According to data collected by G.D. Johnson (Natl. Mus. Nat. Hist., Wash., D.C., 20560, pers. commun., 7 Nov. 1986), all dorsal and anal elements are soft rays. Total counts from Mead (1972) are therefore more useful and are presented here.
[b] Fitch and Lavenberg 1971
[c] G.D. Johnson 1984
[d] G.D. Johnson, pers. commun., 7 Nov. 1986.

Ref: Mead 1972.

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.56-1.60 mm
No. of oil globules	One
Oil globule diameter	0.40×0.32 mm
Yolk	
Envelope	
Hatch size	
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

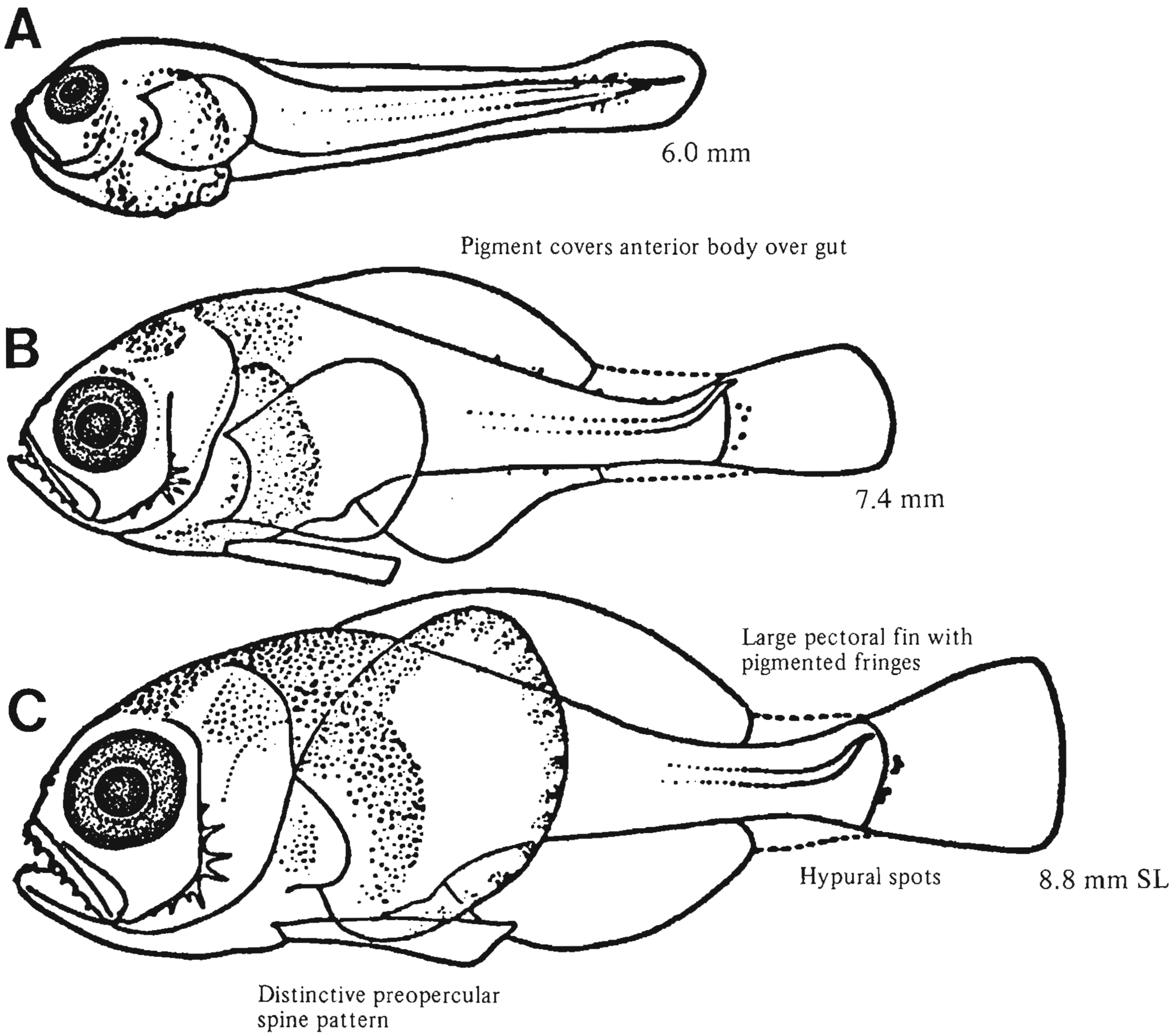
Preanal length	<50% SL
Length at flexion	By 7.4 mm SL
Length at transformation	
Sequence of fin development	Both "C" and "D" patterns[c] described for the family are not present in this species[d]

Pigment
- Gut and anterior body
- Crown
- With development along hypural margin
- Pectoral fin fringes

Diagnostic characters
- Pigment covers anterior body
- Body depth: Deep upper body
- Large pectoral fin
- Patterns of preopercular spines are useful diagnostic characters for bramid larvae

Taractes asper larvae are unknown. The following information may aid in their identification.

Total vertebrae	41-42
Caudal	17-18
Precaudal	23-24
Dorsal fin (D1+D2)	31-34
Anal fin (A1+A2)	23-26
Pectoral fin rays	18-20
Pelvic fin	I,5
Range	Cent. Calif.-Gulf of Alaska



Figures A–C, Mead 1972 (eyes redrawn).

MERISTICS

Vertebrae	Total: 37-38-40
	Precaudal: 16-16-16
	Caudal: 19-19-19
Branchiostegal rays	7-7-7
Caudal fin	6-7, 9+8, 6
Pelvic fin	Thoracic
	S: 1-1-1 R: 5-5-5
Dorsal fin[a]	D1+D2=32-34
Pectoral fin	R: 14-X-19
Anal fin[a]	A1+A2=20-22
Gill rakers	U: 6-6-6 L: 16-16-16

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Mesopelagic, 305-610 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length	
Length at flexion	Between 5.8 and 10.1 mm SL
Length at transformation	
Sequence of fin development	"A" pattern:[b] 2nd dorsal (rays), anal, and caudal simultaneously followed by 1st dorsal (spines), pelvics, and pectorals

Pigment
- Postanal bar pattern
- Head and mediolateral gut

Diagnostic characters
- Myomeres (>35)
- Distinct pigment pattern with bars
- Head and body shape

[a] There is confusion in the literature whether spines are present in the dorsal (1-3) and anal (1) fins. According to data collected by G.D. Johnson, all dorsal and anal elements are soft rays (Natl. Mus. Nat. Hist., Wash., D.C. 20560, pers. commun., 7 Nov. 1986). Total counts are therefore more useful and are presented here.
[b] G.D. Johnson 1984

Ref: G.D. Johnson 1984.

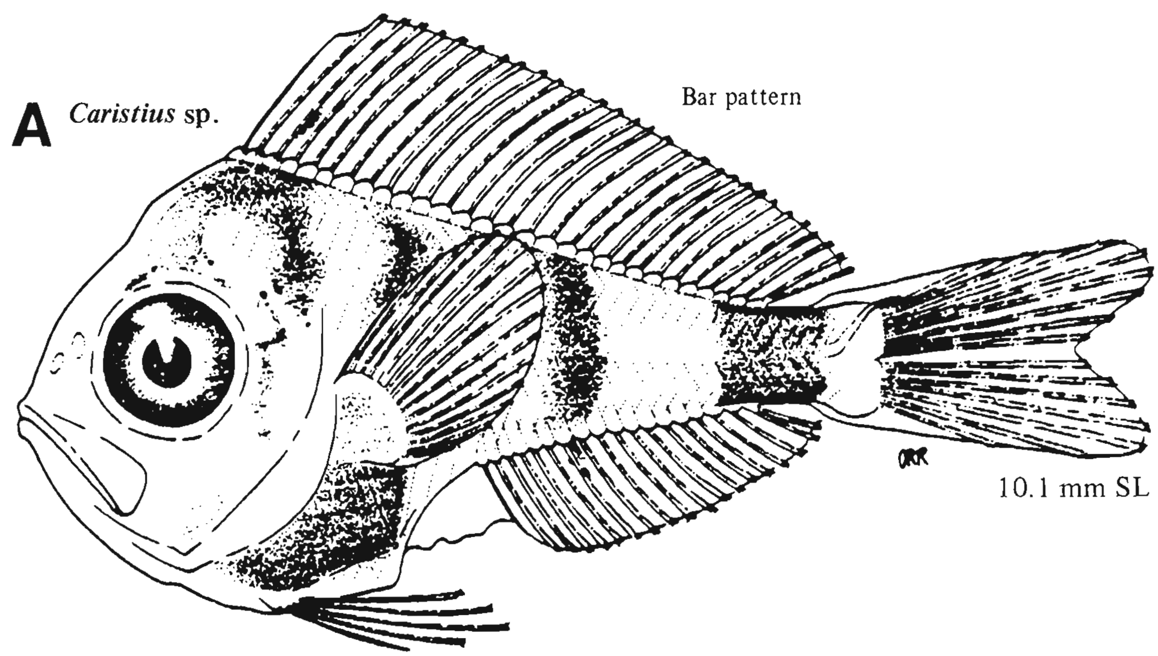


Figure A, G.D. Johnson 1984.

MERISTICS

Vertebrae	Total: 26-26-26	
	Precaudal: 10-11-12	
	Caudal: 14-15-16	
Branchiostegal rays	7-X-8	
Caudal fin	X, 9+8, X (15-17 secondary)	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 13-X-16	R: 18-22-25
Pectoral fin	R: 16-17-19	
Anal fin	S: 2-2-2	R: 10-11-12
Gill rakers	U: 9-X-12	L: 17-X-21

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Nearshore shelf pelagic
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Winter-spring[a]
	Area: Pelagic[b]
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	0.85 mm
No. of oil globules	1-3, coalesce early to 1
Oil globule diameter	0.23 mm
Yolk	Homogeneous, becoming pigmented
Envelope	Transparent, smooth
Hatch size	1.5-2.0 mm SL
Incubation time/temp.	52 hr/20°C

Pigment
- Yolk and oil globule
- Embryonic pigment increases on head and trunk (dorsally and dorsolaterally)

Diagnostic characters

LARVAE

Prenanal length	38-53% SL
Length at flexion	5.4-6.4 mm SL
Length at transformation	>12.7 mm SL
Sequence of fin development	2nd dorsal (rays), anal, 1st dorsal (spines), pelvics

Pigment
- Presence of nape melanophore
- Melanophore above hindgut absent or small
- 2-21 ventral melanophores; number increasing with development

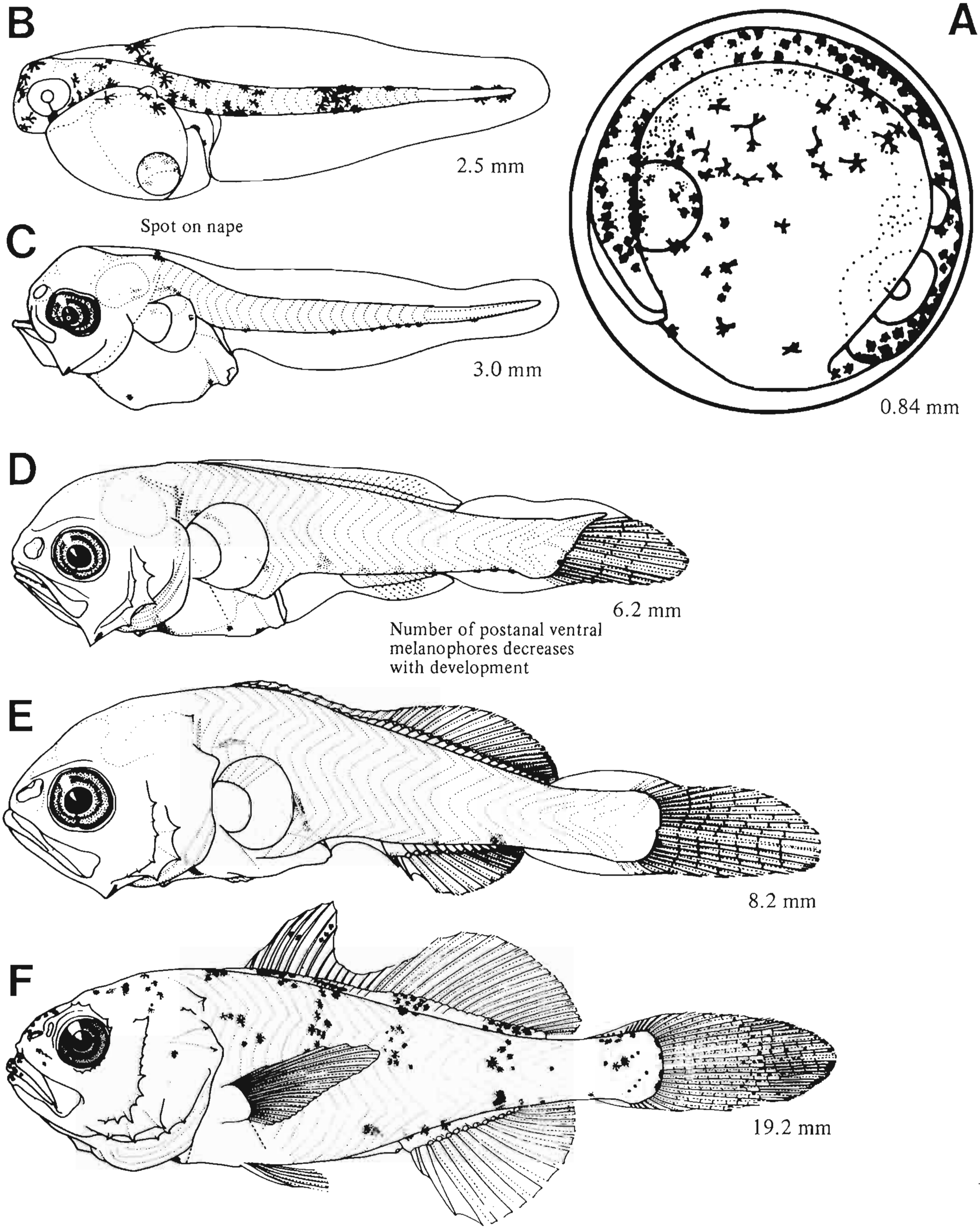
Diagnostic characters

Among the fish larvae occurring in the study area, *G. lineatus* most closely resembles *Scomber japonicus* (p. 554). The myomere counts will usually separate them.

G. lineatus	26
S. japonicus	30-31

[a] Hart 1973
[b] Watson 1982

Ref: Watson 1982.



Figures A–F, Watson 1982.

MERISTICS[b]

Vertebrae	Total: 24-X-25	
	Precaudal: 12-X-13	
	Caudal: 13-13-13	
Branchiostegal rays	7-7-7	
Caudal fin	7, 9+8, 5-6	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 13-X-15	R: 8-X-10
Pectoral fin	R: 16-X-19	
Anal fin	S: 3-4-5	R: 6-X-9
Gill rakers	U: 5-X-8	L: 14-X-20

LIFE HISTORY

Range	N. California, 38-42°N, to Gulf of Alaska, 54-60°N
Ecology	Epi- and mesopelagic, 0-402 m
ELH pattern	Oviparous, pelagic eggs, larvae probably pelagic[c]
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

[a] *Pentaceros* = *Pseudopentaceros* (Hardy 1983). J. Nelson (1984) does not recognize the genus *Pseudopentaceros* and cites Smith (1964) who included *Pseudopentaceros* in the synonomy of *Pentaceros*. Hardy (1983) removed *Pseudopentaceros* from synonomy but his work is not cited in J. Nelson (1984). The genus *Pseudopentaceros* may include up to three species:

Pseudopentaceros richardsoni—Restricted to Southern Hemisphere

P. wheeleri—North Pacific Ocean from Japan to Hawaii

P. pectoralis—North Pacific, Hawaii to Aleutian Is. (overlaps with *P. wheeleri* in central Pacific)

Hardy (1983) describes *P. wheeleri* as the most slender form. He suggests they are the "slender forms" referred to by Zama et al. (1977a) in their description of *Pentaceros richardsoni*. Hardy does not synonomize their "high-bodied" forms with *P. wheeleri*. The juvenile form described by Zama et al. (1977a) may include *P. wheeleri* in part. Hardy (1983) names this species as the one targeted on the Hawaiian ridge for intense commercial fishing. *Pseudopentaceros wheeleri* and *P. pectoralis* are probably the same species at different ontogenetic stages. Most likely two species occur worldwide (Humphreys et al. 1989).

[b] Hardy 1983; includes meristic data for *Pseudopentaceros richardsoni*, *P. pectoralis*, and *P. wheeleri*.

[c] Juveniles collected at surface to at least 260 mm FL; the shift from pelagic to bottom life may be ambivalent, occurring between 260 and 300 mm FL.

Ref: Hardy 1983, Humphreys et al. 1989, G.D. Johnson 1984, Zama et al. 1977b.

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length
Length at flexion <9 mm SL
Length at transformation
Sequence of fin development
Pigment (early juvenile *P. richardsoni*)
- Entire body heavily pigmented with intense patches along dorsal body midline and on spinous dorsal, anal, and pelvic fins

Diagnostic characters (early juvenile *P. richardsoni*)
- Pigment pattern
- Bony cranial projections, spines by 10-16 mm SL; most prominent are the following: median supraoccipital; posttemporal; lateral expansions which develop over orbit, becoming highly serrated along the edge with development; preopercular
- Anteriorly serrated pelvic spine
- With development there is a reduction in spination

A *P. richardsoni*

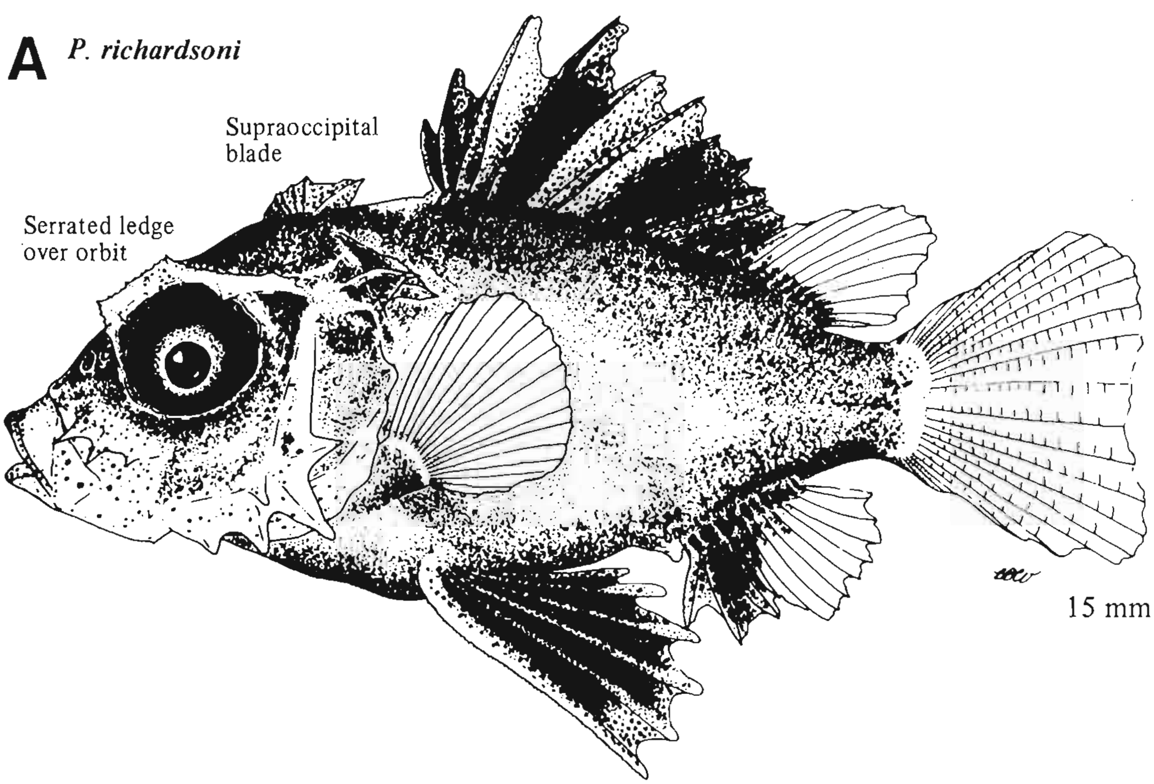


Figure A, G.D. Johnson 1984 (southern hemisphere specimen).

This endemic North Pacific family occurs throughout the study area where four species from two genera are found. Ronquils are elongate with long dorsal and anal fins composed almost entirely of soft rays. Little is known of the adult habits in the family except for some members of the genus *Rathbunella*, occurring from south of Point Conception to northern California, which inhabit rocky areas 10-92 m deep (and are occasionally taken with trawl nets). Courtship of *Rathbunella* is paired and may result in spawning occurring over a protracted period of time. Demersal eggs, which measure 0.9-1.1 mm and contain one oil globule, are deposited in a nonadhesive mass that is guarded by the male (Fitch and Lavenberg 1975, NWAFC unpubl.).

Pelagic larvae of *Ronquilus jordani* are collected in ichthyoplankton surveys conducted off Alaska and along the Pacific coast to northern California. *Bathymaster* spp. (6-40 mm SL) are routinely collected in the Gulf of Alaska and in the Bering Sea. *Ronquilus* larvae can be separated from *Bathymaster* larvae by their lack of pigment around the urostyle. *Bathymaster* spp. larvae are presently not identifiable to species. Meristic characters offer some potential for larger larvae (e.g., *B. signatus* usually has higher counts, especially vertebrae and total caudal fin rays). Before their fin rays develop, bathymasterid larvae may often be confused with stichaeid larvae. Most stichaeids (except members of the Stichaeini tribe) have a myomere count >55, whereas bathymasterids have a count <55. *Ronquilus jordani* larvae (myomeres 49-50) most closely resemble *Stichaeus punctatus* larvae (myomeres 51-55) due to the presence of distinctive lateral pigment along the hypaxial myomeres. *Bathymaster* spp. larvae (myomeres 49-55) most closely resemble those of *Bryozoichthys-Chirolophis* (myomeres about 60-75) due to the presence of pigment around the urostyle.

Table 42

Meristic characters of family Bathymasteridae.[a] All have pelvic fin counts of I,5, 7+7 principal caudal fin rays, and 6 branchiostegal rays.

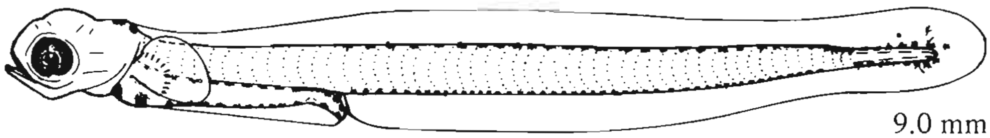
Taxon	Distribution	Vertebrae Precaudal	Vertebrae Caudal	Fins Dorsal[b]	Fins Anal[b]	Fins Pectoral	Fins Caudal Upper	Fins Caudal Lower	Gill rakers Upper	Gill rakers Lower
Bathymaster caeruleofasciatus	Brit. Col.-Bering Sea	14-15-16	35-38-39 (Total 50-53-53)	44-47-48	33-35-36	16-18-19			5	12-14
Bathymaster leurolepis	Gulf of Alaska-Bering Sea	14-15-15	35-36-37 (Total 49-51-52)	45-46-47	32-34-34	17-18-19	10	10	4-5	12-14
Bathymaster signatus	Wash.-Arctic	15-16-16	34-37-39 (Total 54-54-55)	46-48-49	33-34-36	19-20-21	10-12	9-11		15-18
Ronquilus jordani	N. Calif.-Bering Sea	13-14-15	34-36-37 (Total 49-50-50)	44-45-46	33-35-35	17-17-19	5-7	5-7		

[a] For some characters modal values are listed between range of values.
[b] Total counts include weak anterior spines; *Bathymaster* spp. usually possess two dorsal spines and one anal spine, and *Ronquilus* usually has one dorsal and one anal spine.

Bathymaster A

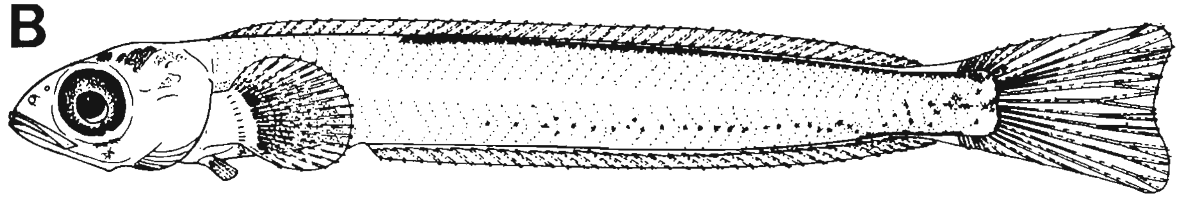
A

Pigmented urostyle



9.0 mm SL

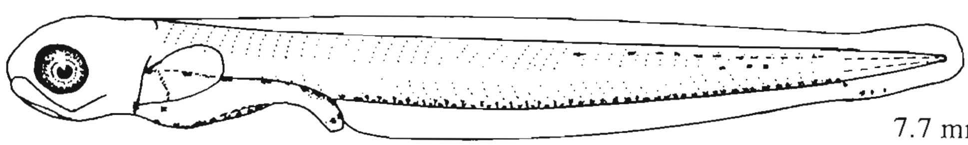
B



29.6 mm SL

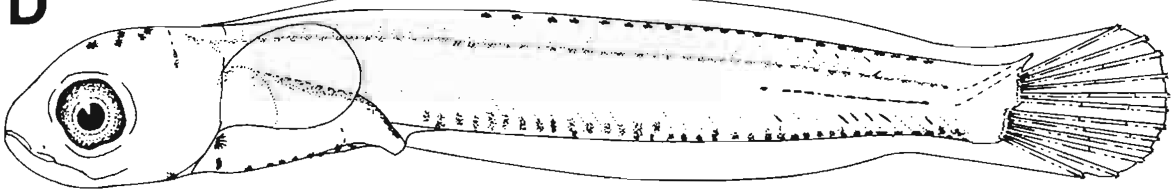
Ronquilus jordani

C



7.7 mm SL

D



Pigment along hypaxial myomeres

10.4 mm SL

Figures A–D, NWAFC originals (B. Vinter).

ZOARCIDAE

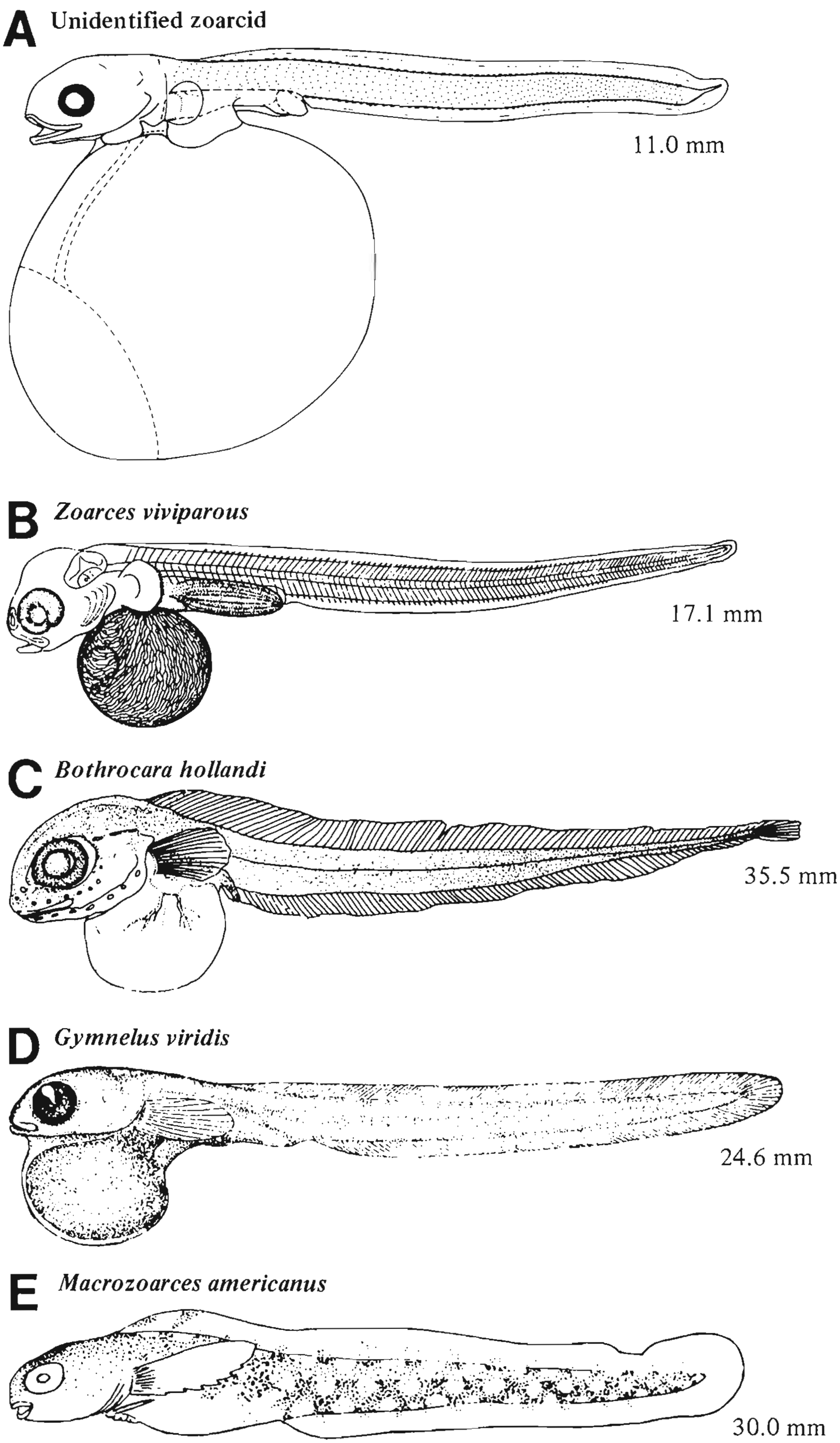
Eelpouts are found chiefly in colder marine waters of the Northern Hemisphere. They have elongate, tapered bodies with long dorsal and anal fins confluent with the caudal fin. The pelvic fins are small and jugular when present. The head is large and the mouth is often big with thick lips. Within the study area there are 48 species within 14 genera. Adults are found from the intertidal zone to depths of more than 1900 m (Hart 1973). Although members of the genus *Zoarces* are viviparous, all species in our area, where reproductive mode is known, are oviparous. Oviparous species have been observed guarding their eggs by wrapping themselves around the egg mass. Demersal eggs are adhesive, spherical, and possess one oil globule. Diameters range from 1.7 to 9.0 mm. Newly hatched larvae are quite advanced and strongly resemble adult zoarcids (Anderson 1984b). Larvae of only five taxa have been illustrated; four are from outside the study area. Larvae probably become demersal or semidemersal soon after hatching because they are virtually never collected in plankton nets.

Table 43

Meristic characters of family Zoarcidae (taxonomy after Anderson 1984a,b).

		Vertebrae		Fins				Gill rakers		
Taxon	Distribution	Precaudal (Total)	Caudal	Dorsal	Anal	Pectoral	Pelvic[a]	Upper (Total)	Lower	Branchiostegals
Bothrocara brunneum	SSC-Bering Sea	22	94	107-112	92-96	14-17	ab	3-5	14-15	
Bothrocara hollandi	Bering Sea			114-117	94-99	15-17	ab	4	11	6
Bothrocara molle	SSC-Bering Sea	(120)		100-112	89-101	13-14	ab	(22)		
Bothrocara pusillum	SE Alaska-Brit. Col.	18-20	95-101	113-121	100-107	14-17	ab			
Bothrocara remigerum	Cent. Calif.-Wash.	23	96	107-117	93-94	13-16				
		(116)								
Derepodichthys alepidotus	SSC-Brit. Col.	22-26	92-98	110-116	94-101	10-11	3	0-1	11-12	6
Gymnelis hemifasciatus	Gulf of Alaska-Arctic	18-21	65-77	80-92[b]						
		(85-95)								
Gymnelis popovi	Gulf of Alaska-Bering Sea			101	89		ab	3	12	
Gymnelis viridis	Aleutian Is.-Arctic	(87-99)		92-93	74	10-12	ab			
Krusensterniella pavlovskii	Bering Sea	20-21	88-89	70-75		12	ab			
Lycenchelys altus	Aleutian Is.	21	67	83	68	18		1	7	
		(88)						(8)		
Lycenchelys camchaticus	SSC-Bering Sea	21-24	97-103	112-117	98-105	13-17		2	13-16	6
								(14-18)		
Lycenchelys crotalinus	S. Calif.-Bering Sea	22-24	98-107	113-123	99-109	14-17		1	14-18	6
Lycenchelys hippopotamus	Bering Sea	23-24	109-113			13-17		3	12-14	6
Lycenchelys jordani	Calif.-SE Alaska	22-24	100-109	116	93	15-17		1	15-18	6
Lycenchelys longirostris	Bering Sea	21-22	92-93	108-109	93-95	15-16		(9-11)		
		(113-115)								
Lycenchelys microporus	Bering Sea	29	94			18		2	10	6
Lycenchelys pliciferus	Bering Sea	28-29	96-97			15				6
Lycenchelys rassi	Bering Sea	23-25	98-103	119	104	15-16		1-2	8-11	6
Lycenchelys ratmanovi	Bering Sea	22-23	88-89			16-19		1-2	7-9	6
Lycenchelys roseus	Aleutian Is.	28	118-119	130-133	114-115	14-15		1-2	9-10	
Lycenchelys volki	Bering Sea	30	96			17		2	14	6
Lycodapus derjugini	Bering Sea	14-15	56-59	70-79	57-68	6-7	ab			6
Lycodapus dermatinus	SSC-SE Alaska	13-15	62-68	70-75	62-66	6-7	ab			6
Lycodapus endemoscotus	SSC-Brit. Col.	14-17	72-79	84-91	74-81	6-8	ab			6
Lycodapus fierasfer	SSC-Bering Sea	13-15	69-77	78-85	68-74	6-8	ab			6
Lycodapus leptus	Bering Sea	16-19	78-82	91-94		6-8	ab			6
Lycodapus mandibularis	S. Calif.-Bering Sea	14-17	67-80	76-90	65-79	6-9	ab			6
Lycodapus pachysoma	Oregon-Brit. Col.	14-16	60-63	70-74	58-64	7-8	ab			6
Lycodapus parviceps	Wash.-Bering Sea	18-20	81-85	94-98		8-9	ab			6
Lycodapus poecilus	Bering Sea	15-17	65-72	75-83		5-7	ab			6
Lycodapus psarosomatus	Bering Sea	17-19	77-82	89-93		8	ab			6
Lycodes brevipes	Oregon-Bering Sea	20-22	80-82	85-102	74-89	19-21	3	2-3	11	
Lycodes concolor	Bering Sea	22	92-93	47-118	98-99	21		0-2	12	
Lycodes cortezianus	S. Calif.-SE Alaska	22-24	83-90	112-114	95-97	18-21	3	2	11	6
Lycodes diapterus	S. Calif.-Bering Sea	21-23	100	90-124	94-107	18-25	3	1	13	
Lycodes mucosus	Bering Sea-Arctic	(90-92)		88-93	69-73	17-18				
Lycodes pacifica	SSC-Gulf of Alaska	21-23	79-85	90-107	70-90	16-19	3	0-2	8-12	
Lycodes palearis	Oregon-Chukchi Sea	(96-105)		94-106	83-90	17	3	2-3	10	
Lycodes raridens	Bering Sea-Arctic	(97)		83-93	72-76	18-19		3	10-12	
Lycodes turneri	Bering Sea-Arctic	(90-100)		89-97	69-78	15-18	3			
Lyconema barbatum[c]	SSC-Bering Sea	20-21	86-93	101-105	90-94	15		2	8-9	
Melanostigma pammelas	SSC-Brit. Col.	19-20	69-72	73-88	64-75	6-8	ab	(11-13)		6-7
Nalbantichthys elongatus[c]	Bering Sea	25	119-125	143-152	121-127	6	ab			7
Opaeophacus acrogeneius[c,d]	Bering Sea	25-26		141-148	121-124	4-5	ab	3	11	6
		(144-149)								
Pachycara bulbiceps	SSC-Brit. Col.			109	89	16	ab			6
Puzanovia rubra[c]	Bering Sea	22-24	110-125	137-147	115-128	10-12	ab	3-5	9-13	6
Taranetzella lycoderma[c]	Oregon-Bering Sea	19-20	69-78	84-91	71-79	15	3	3	13	
		(90-97)								

[a]ab = absent.
[b]Dorsal fin count does not include one spine.
[c]Total principal caudal fin ray counts available for only the following species: *Lyconema barbatum*, 12; *Nalbantichthys elongatus*, 7-10; *Opaeophacus acrogeneius*, 8-9; *Puzanovia rubra*, 9-12; *Taranetzella lycoderma*, 8.
[d]Bond and Stein 1984



Figures A–E, Kendall et al. 1983 (B, collected from Gulf of Riga, Baltic Sea; C, Japan Sea specimen; D, Barents Sea specimen; E, collected near New Brunswick).

STICHAEIDAE

Pricklebacks are found mostly in the North Pacific in inshore areas. Adults are long and somewhat eel-like with a long dorsal fin composed of all spines in most species. Seventeen genera and 26 species are found in the study area. This family is separated into eight tribes grouped within four subfamilies. Six tribes within three subfamilies occur in our area.[1] Larvae are abundant in the area but very few larval series have been described. Before fin rays develop, small larvae are elongate and resemble other elongate forms, especially bathymasterids and pholidids (see Table 4). In general, bathymasterids have fewer myomeres and pholidids have a longer gut and more myomeres. Since so few complete larval series are available, general characters based on only a few species are presented for each tribe.

Stichaeinae

Adult characters include: Pelvic fins I,3-4
(*Gymnoclinus* I,2)
Large pectoral fins
Vertebrae 49-76

Stichaeini

Genera found within the study area: *Eumesogrammus* (one species) and *Stichaeus* (one species). Myomere counts are low (<55). *Stichaeus* larvae are identified by the distinctive lateral pigment along the hypaxial myomeres.

Chirolophini

Genera found within the study area: *Bryozoichthys* (two species), *Chirolophis* (four species), and *Gymnoclinus* (one species). Myomere counts are >55. Larvae are generally more pigmented than Stichaeini. Melanophores occur along the dorsal and ventral body midline, over the notochord internally, and, in some taxa, around the urostyle.

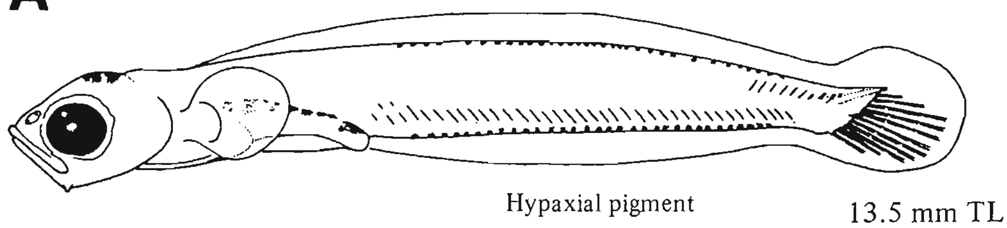
[1]Makushok (1958) places the genera *Eulophias* and *Azygopterus* in separate tribes under Xiphisterinae. Anderson (1984b) places them together in the Eulophiini. Other nomenclatural changes not affecting taxa in the study area are presented by Yatsu (1986).

Ref: Anderson 1984a,b; Makushok 1958.

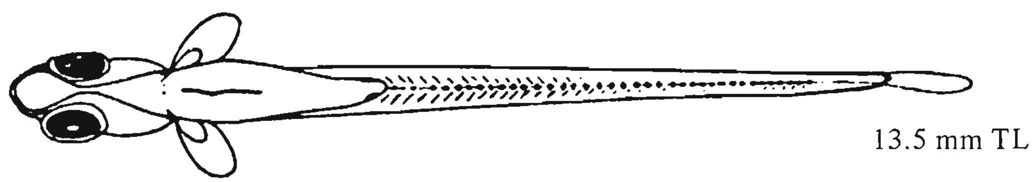
STICHAEINI

Stichaeus punctatus

A



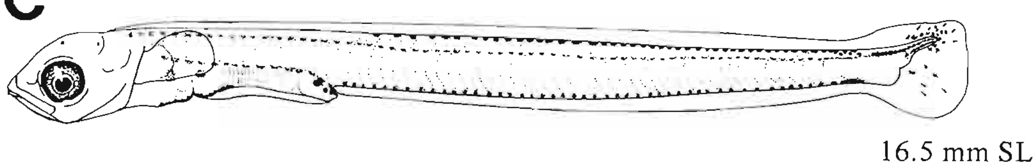
B



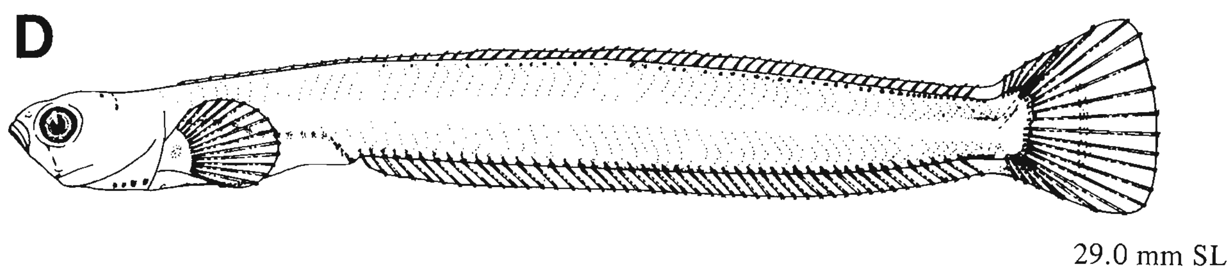
CHIROLOPHINI

Bryozoichthys–Chirolophis

C



D



Figures A–B (B, ventral view), Fahay 1983 (after Faber 1976, North Atlantic specimen); C–D, NWAFC originals (B. Vinter).

Lumpeninae

Adult characters include: Pelvic fins I,3 or absent
Large pectoral fins
Vertebrae 60-81

Lumpenini

Genera found within the study area: *Acantholumpenus* (one species), *Anisarchus* (one species), *Lumpenella* (one species), *Lumpenus* (four species), and *Poroclinus* (one species). Lumpenini larvae generally lack pigment along the dorsal midline. Diagnostic pigment usually occurs over the dorsal surface of the gut and anus, along the ventral midline, and in the hypural area.

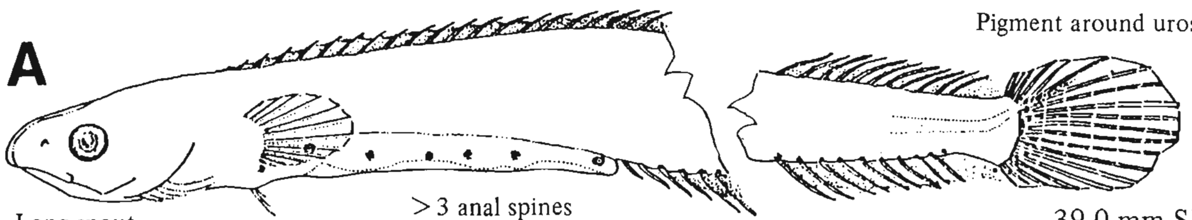
Lumpenella larvae generally have >70 myomeres and pigment around the urostyle, and, with development, can be identified by their distinctive snout and the presence of up to five anal spines. *Lumpenus* spp. larvae can be identified by meristics, number of postanal ventral melanophores, and number of melanophores on the anus. Hypural pigment is usually restricted to several spots along the posterior edge of the hypural area. *Poroclinus* larvae have distinctive pigment occurring above and below the notochord in the caudal peduncle area. They can also be distinguished from other Lumpenini by the presence of three anal spines.

Ref: Anderson 1984a,b; Makushok 1958.

LUMPENINI

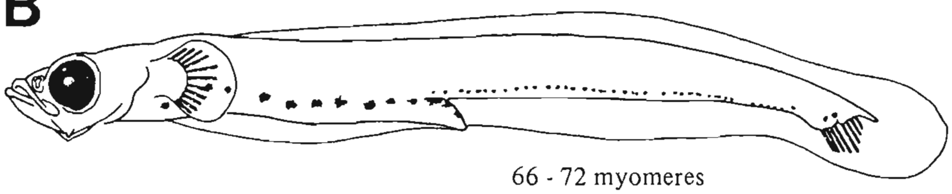
Lumpenella longirostris

A

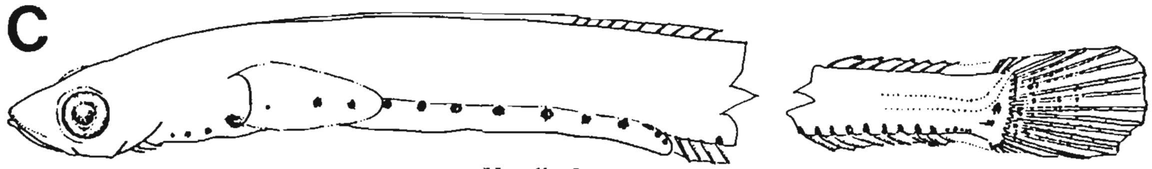


Lumpenus maculatus

B

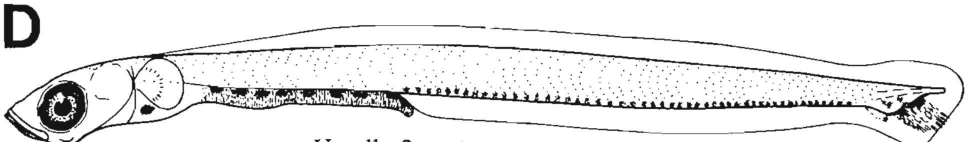


C

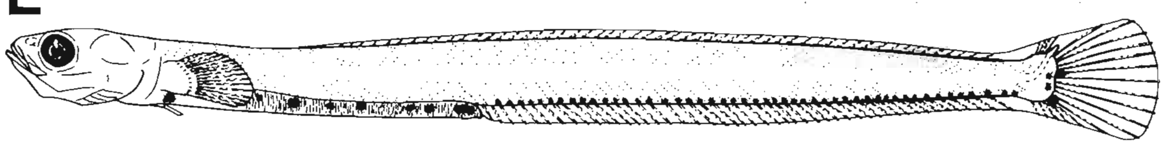


Lumpenus sagitta

D

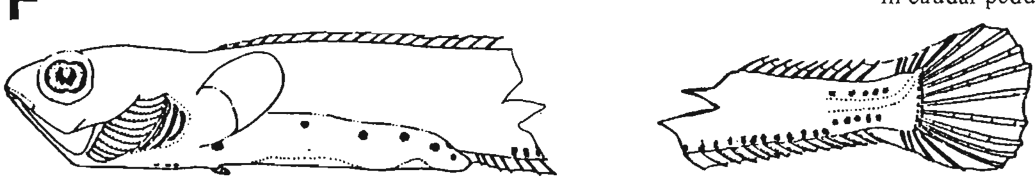


E



Poroclinus rothrocki

F



Figures A, C, F, Garrison, unpubl.; B, Fahay 1983 (after Faber 1976, Atlantic specimen); D–E, NWAFC originals (B. Vinter).

Opisthocentrini

Genera found within the study area: *Allolumpenus* (one species), *Opisthocentrus* (one species), and *Plectobranchus* (one species). Larvae are known only for *Opisthocentrus* and *Plectobranchus*. *Plectobranchus* larvae have a distinctive pigment pattern quite dissimilar to *Opisthocentrus* (see species pages). *Opisthocentrus* larvae appear to resemble Alectrini larvae (e.g., similar pigment pattern and lack of pelvic fins).

Xiphisterinae

Adult characters include: Pelvic fins absent
Pectoral fins small
Vertebrae 57-84

Alectrini

Genera found within the study area: *Alectridium* (one species) and *Anoplarchus* (two species). Only larvae of *Anoplarchus purpurescens* are known from our area. They have a row of postanal ventral midline melanophores and a few spots along the hypural margin. No single unique character distinguishes them from Xiphisterini larvae but usually a combination of characters allows identification. These characters include fewer myomeres (58-68 vs. generally >70), smaller relative eye diameter, fewer melanophores dorsally on gut, and presence of hypural spots throughout the larval period (see species pages).

Xiphisterini

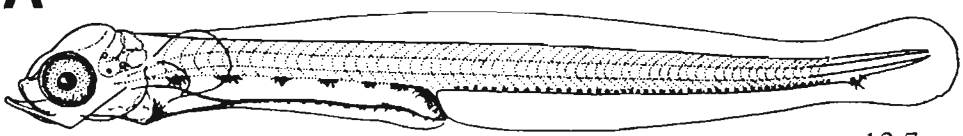
Genera found within the study area: *Cebidichthys* (one species), *Phytichthys* (one species), and *Xiphister* (two species). Although series of *Phytichthys* and *Xiphister* have been described, larvae are difficult to distinguish from one another and from *Anoplarchus*. Xiphisterini larvae usually have a row of postanal ventral melanophores and a row of internal pigment above the notochord.

Ref: Anderson 1984a,b; Makushok 1958.

OPISTHOCENTRINI

Opisthocentrus ocellatus

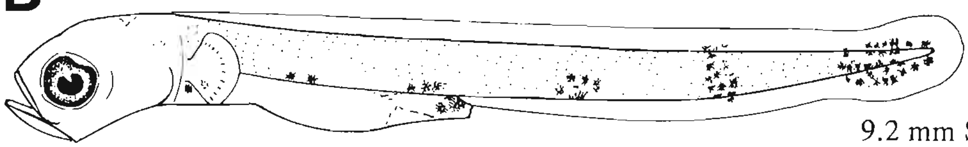
A



12.7 mm TL

Plectobranchus evides

B

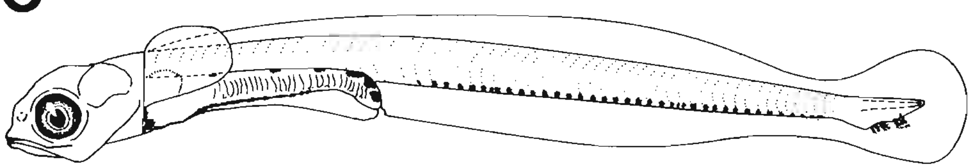


9.2 mm SL

ALECTRINI

Anoplarchus purpurescens

C

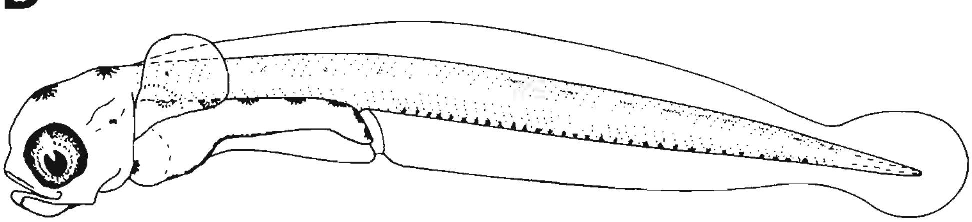


9.0 mm SL

XIPHISTERINI

Xiphister atropurpureus

D



8.0 mm SL

Figure A, Shiogaki 1982 (reared from Japanese specimens); B–D, NWAFC originals (B. Vinter).

Table 44
Meristic characters of family Stichaeidae.

Taxon	Distribution	Vertebrae Precaudal	Vertebrae Caudal	Vertebrae (Total)	Fins Dorsal	Fins Anal	Fins Pectoral	Fins Pelvic[a]	Gill rakers Upper	Gill rakers Lower	Branchiostegals
STICHAEINAE											
Stichaeini											
Eumesogrammus praecisus	Bering Sea-Arctic	15-16	34-36	(50-52)	XLVII-XLIX	II,31-33	18	I,3			6
Stichaeus punctatus	Brit. Col.-Arctic	14-16	36-40	(51-55)	XLVI-XLIX	I-II,32-35	15-16	I,4			6
Chirolophini											
Bryozoichthys lysimus	Aleutian Is.-Bering Sea	16-17	53-54		LXIII-LXVI	I,49-50	14-15	I,3	4-5	9-11	6
Bryozoichthys marjorius	Brit. Col.-Aleutian Is.	15-17	56-59	(72-75)	LXII-LXXI	I,51-59	14-16	I,3	5-6	9-10	6
Chirolophis decoratus	N. Calif.-Bering Sea				LXI-LXIII	I,44-51	14-15	I,4			6
Chirolophis nugator	S. Calif.-Aleutian Is.				LIII-LV	I,37-42	13-14	I,4			6
Chirolophis snyderi	Bering Sea	16-17	46-49	(63-65)	LVIII-LXI	I,43-45	15	I,4			6
Chirolophis tarsodes	Brit. Col.-Bering Sea				LVIII-LX	I,43-45	14-15	I,3-4			6
Gymnoclinus cristulatus	Bering Sea				LXI	40-43	14	I,1-2			6
LUMPENINAE											
Lumpenini											
Acantholumpenus mackayi	Bering Sea	27-29	49-52	(76-80)	LXVIII-LXXV	II,41-47	14-15	I,3			6
Anisarchus medius	SE Alaska-Arctic										
Lumpenella longirostris[b]	Brit. Col.-Gulf of Alaska	24-25	47-49		LXI-LXXI	II-V,36-42	13-14	I,2-3			6
Lumpenus fabricii[b]	SE Alaska-Arctic	26-28	44-48	(70-75)	LXI-LXV	I,40-43	13-16	I,3			6
Lumpenus maculatus[b]	Wash.-Arctic	26-30	39-43	(66-72)	LVII-LXIV	I-II,34-40	14-16	I,3-4			6
Lumpenus medius	SE Alaska-Arctic	23-25	43-50	(65-70)	LVIII-LXIII	I,37-42		I,3			6
Lumpenus sagitta[b]	N. Calif.-Bering Sea	26-28	46-54		LXIV-LXXII	I,45-50	15-17	I,3-4			6
Poroclinus rothrocki	S. Calif.-Bering Sea			(65)	LVII-LXVII	III,40-44	13-15	I,3[c]			6
Opisthocentrini											
Allolumpenus hypochromus	S. Calif.-Brit. Col.				XLIV-XLIX	I,31	12	I,3			6
Opisthocentrus ocellatus	Bering Sea	22-23	40-44	(63-67)	LVIII-LXII	II,37-39	20-21	ab			5
Plectobranchus evides[b]	S. Calif.-Brit. Col.			(60)	LIV-LVII	II-III,34-36	15	I,3			5-6
XIPHISTERINAE											
Alectrini											
Alectridium aurantiacum	Bering Sea	19-21	46-48	(65-68)	LIX-LXIII	I,41-44	11	ab			5
Anoplarchus insignis	N. Calif.-Aleutian Is.	17-19	44-49		LVII-LXIV	40-46	9-10	ab			5
Anoplarchus purpurescens	S. Calif.-Bering Sea	17-19	40-46	(58-64)	LIV-LX	I,36-41	9-10	ab	3-5	5-10	5
Xiphisterini											
Cebidichthys violaceus	SSC-Oregon	23-25	40-47	(65-71)	XXII-XXV, 40-43	I-II,39-42	10-11	ab	3-4	6-10	6
Phytichthys chirus[b]	S. Calif.-Bering Sea	24-25	50-52	(75-76)	LXIX-LXXVIII	II-III,40-50	15	ab			6
Xiphister atropurpureus[b]	SSC-Bering Sea	22-24	51-56	(75-80)	LXV-LXXII	I,49-55	11-12	ab	2-3	6-10	6
Xiphister mucosus[b]	Cent. Calif.-SE Alaska	29-31	44-53	(73-83)	LXXI-LXXVIII	I,46-50	12	ab			6

[a] ab = absent.
[b] Principal caudal fin ray counts available for only the following species: *Lumpenella longirostris*, 6+6-7; *Lumpenus fabricii*, 6+7; *Lumpenus maculatus*, 7+6; *Lumpenus sagitta*, 6+7; *Plectobranchus evides*, 6+5; *Phytichthys chirus*, 6+7; *Xiphister atropurpureus*, 6+7; *Xiphister mucosus*, 6+7.
[c] Rudimentary.

MERISTICS

Vertebrae	Total: 63-X-67	
	Precaudal: 22-X-23	
	Caudal: 40-X-44	
Branchiostegal rays	5-5-5	
Caudal fin		
Pelvic fin	Absent	
Dorsal fin	S: 58-X-62	
Pectoral fin	R: 20-X-21	
Anal fin	S: 2-2-2	R: 37-X-39
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	Bering Sea, 54-66°N
Ecology	Nearshore shelf demersal
ELH pattern	Oviparous; demersal, adhesive eggs; pelagic larvae
Spawning	Season: Dec-Jan (Mutsu Bay, Japan)[a]
	Area: Narrow cavities under stones on muddy sand bottoms[a]
	Mode: Eggs spawned in masses and guarded by female[a]
	Migration:
Fecundity	Range/function: 700-3300[a]
Age at first maturity	1 yr[a]
Longevity	2-3 yr[a]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.89-2.01 mm
No. of oil globules	One large, many small (yellow)
Oil globule diameter	
Yolk	Colorless
Envelope	
Hatch size	9-10 mm SL
Incubation time/temp.	48 d/5-10°C
Pigment	

Diagnostic characters

LARVAE

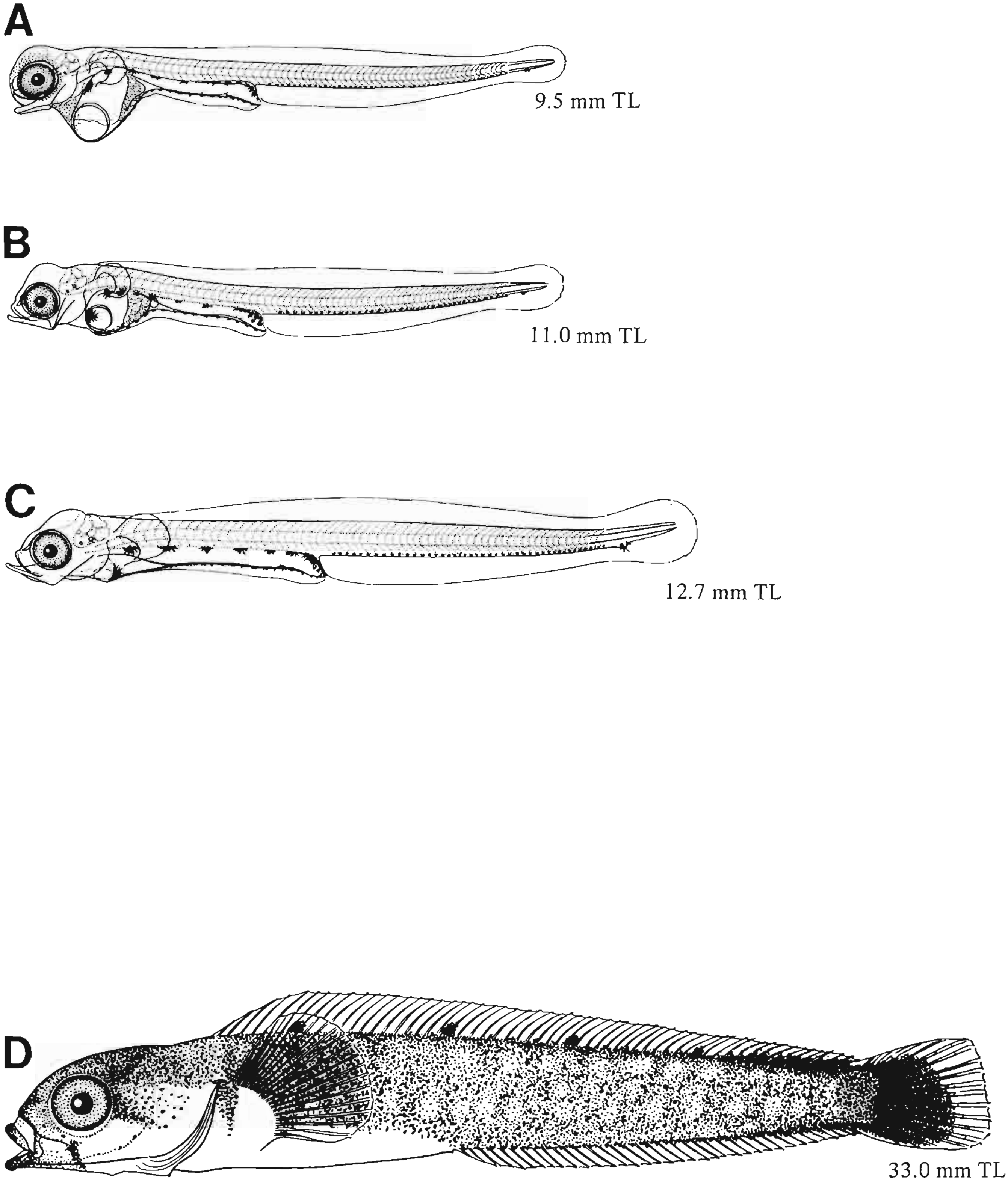
Preanal length	<50% SL
Length at flexion	
Length at transformation	33-40 mm SL[b]
Sequence of fin development	

Pigment
- Dorsally and ventrally on gut
- Postanal ventral melanophores
- Hypural spot

Diagnostic characters

[a] Shiogaki 1982
[b] Collected with a small trawl net.

Ref: Shiogaki 1982.



Figures A–D, Shiogaki 1982 (A–C, reared from specimens collected from Mutsu Bay, Japan; D, collected from Mutsu Bay, Japan-probably newly settled).

MERISTICS

Vertebrae	Total: 60-60-60	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	5-X-6	
Caudal fin	X, 6+5, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 54-X-57	
Pectoral fin	R: 15-15-15	
Anal fin	S: 2-X-3	R: 34-X-36
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	S. California, 32-34°N, to Brit. Col., 48°30′-55°N
Ecology	Epi- and mesobenthal, 84-274 m
ELH pattern	Probably oviparous, eggs probably demersal, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

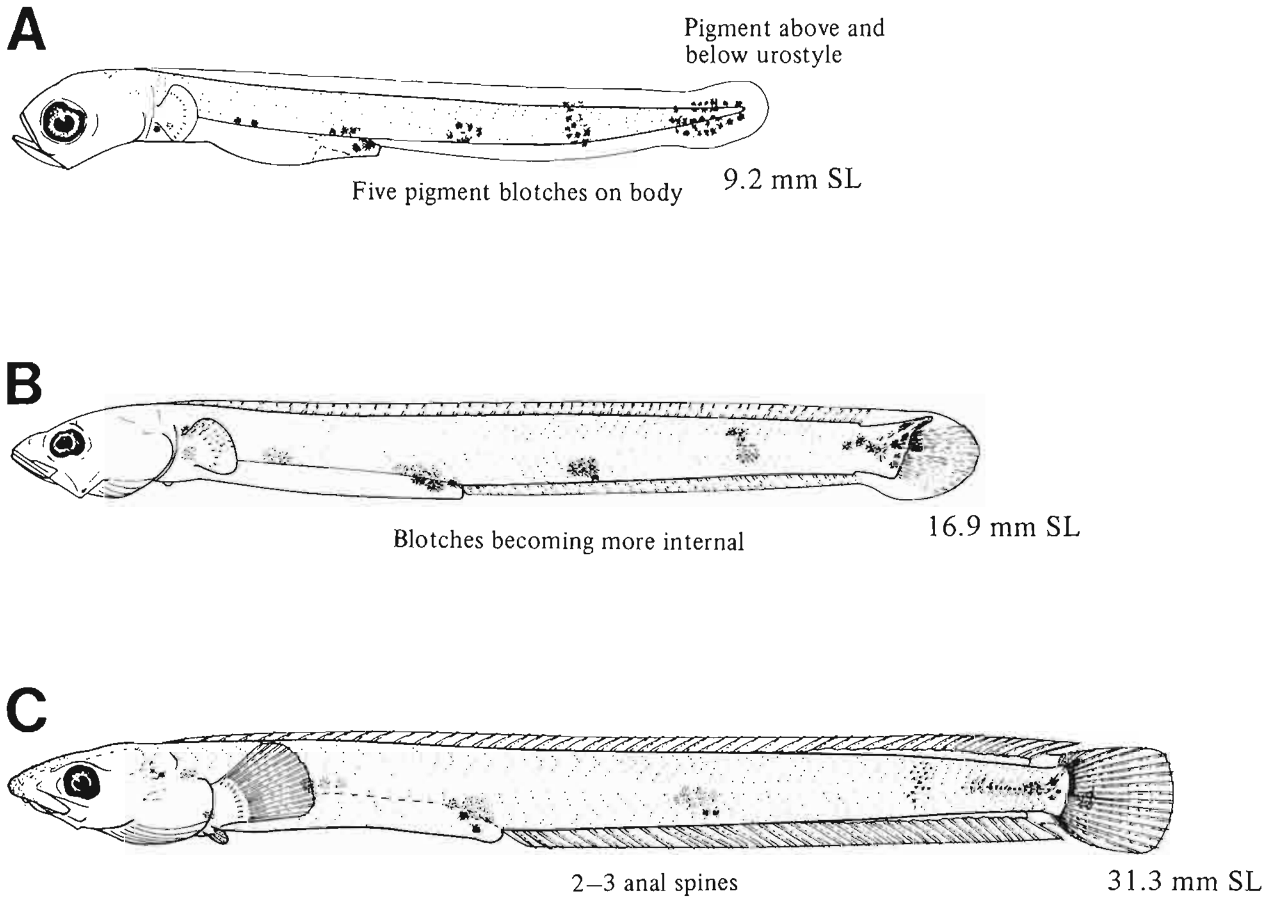
Diagnostic characters

LARVAE[a]

Preanal length ~50% SL
Length at flexion Between 10 and 16 mm SL
Length at transformation
Sequence of fin development
Pigment
- Blotch medially over gut near cleithrum
- Blotches on ventral body at midgut, hindgut over anus, and at myomeres 30 and 45
- Pigment becomes more internal in larger specimens
- Above and below notochord, increasing with development anteriorly in area where hypurals form

Diagnostic characters
- Pigment pattern: Five blotches along body
- Meristics: anal spines 2-3
  pelvic fin I,3

[a] Larvae obtained from Bruce Mundy, formerly of Oregon State University (present address, NMFS Southwest Fish. Cent., Honolulu Lab., 2570 Dole St., Honolulu, HI 96822-2396); originally identified by S.L. Richardson (deceased).



Figures A–C, NWAFC originals (B. Vinter).

Anoplarchus purpurescens Gill 1861

MERISTICS

Vertebrae	Total: 58-60-64	
	Precaudal: 17-18-19	
	Caudal: 40-43-46	
Branchiostegal rays	5-5-5	
Caudal fin		
Pelvic fin	Absent	
Dorsal fin	S: 54-X-60	
Pectoral fin	R: 9-X-10	
Anal fin	S: 1-1-1	R: 36-39-41
Gill rakers	U: 3-X-5	L: 5-X-10

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Nearshore shelf demersal, intertidal to 30 m
ELH pattern	Oviparous; demersal, adhesive, attached eggs; pelagic larvae
Spawning	Season: Jan[a]-Mar[b]
	Area: Demersal, under rocks or on shells[a]
	Mode: Pairs; eggs laid in masses;[c] females guard nests[d]
	Migration:
Fecundity	Range/function: 2000-3000[d]
Age at first maturity	2-3 yr[d]
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.27-1.45 mm
No. of oil globules	1-3, with development 1 large and 1 small
Oil globule diameter	
Yolk	
Envelope	White
Hatch size	~7.5 mm TL
Incubation time/temp.	
Pigment	

Diagnostic characters
- Eggs laid in pedestal-shaped mass (flattened with lateral constriction)[c]

LARVAE

Preanal length	40-45% SL
Length at flexion	~10 mm SL
Length at transformation	~12 mm SL
Sequence of fin development	

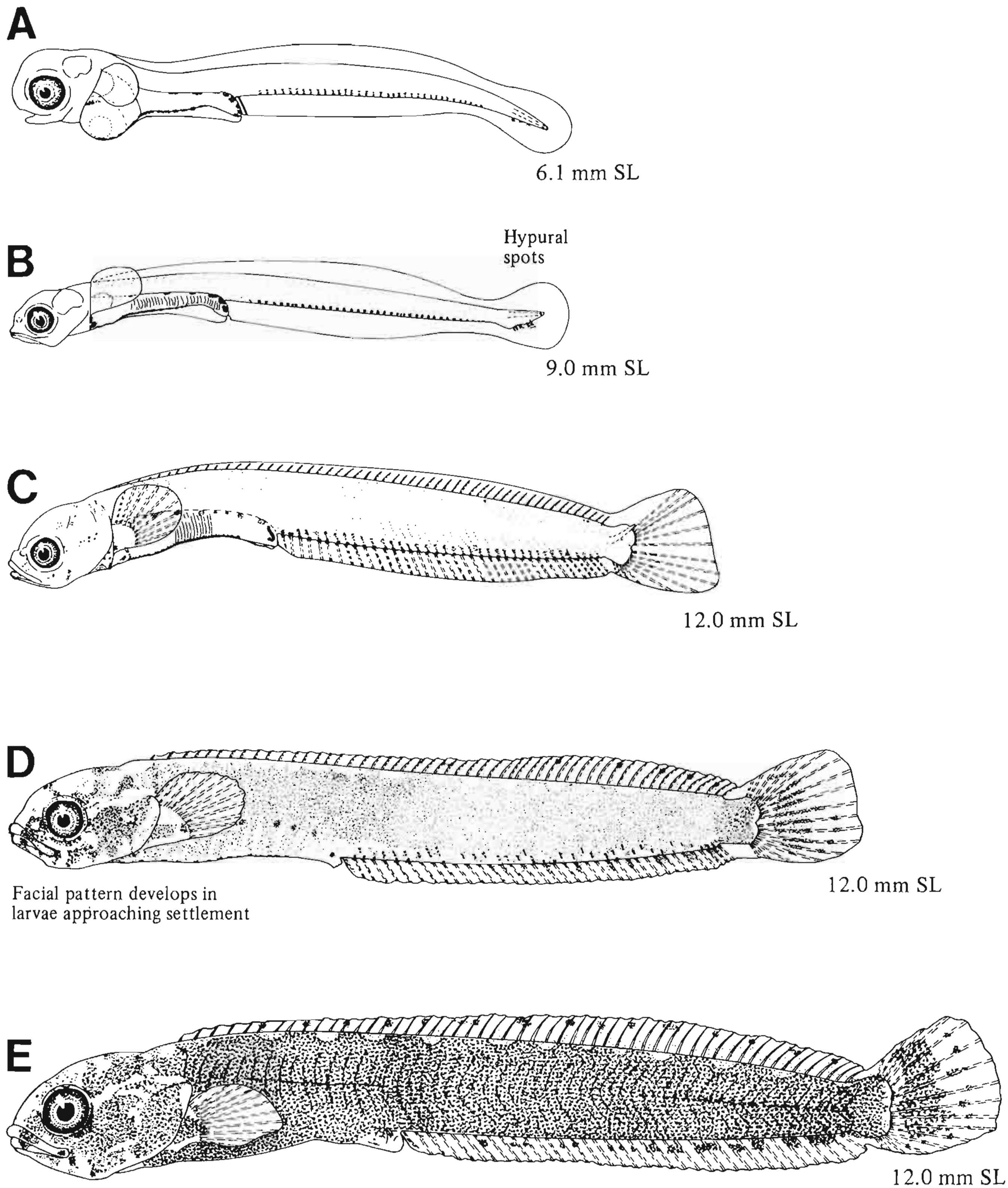
Pigment
- Postanal ventral midline: A melanophore on nearly every myoseptum, at base of each anal fin ray
- A few melanophores at caudal fin base along hypural margin
- Dorsal and ventral gut pigment: Dorsally about five spots on posterior half, ventrally a continuous line on anterior 2/3 of gut
- Heavy uniform superficial body pigment on larvae >12 mm SL (early juveniles)

Diagnostic characters

Distinguished from *Xiphister* spp. (p. 516, 518) and *Phytichthys chirus* (p. 514) by
- Smaller relative eye diameter
- Fewer dorsal gut melanophores (<8)
- Hypural spots throughout larval period

[a] Marliave 1975a
[b] Schultz and DeLacy 1932
[c] J. Marliave, Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8, pers. commun., 16 Oct. 1986.
[d] Peppar 1965

Ref: Marliave 1975a, Peppar 1965, Schultz and DeLacy 1932.



Figures A–E, NWAFC originals (B. Vinter, reared).

MERISTICS

Vertebrae	Total: 75-X-76	
	Precaudal: 24-X-25	
	Caudal: 50-X-52	
Branchiostegal rays	6-6-6	
Caudal fin	X, 6+7, X	
Pelvic fin	Absent	
Dorsal fin	S: 69-X-78	
Pectoral fin	R: 15-15-15	
Anal fin	S: 2-X-3	R: 40-X-50
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Intertidal, nearshore shelf demersal
ELH pattern	Oviparous; demersal, adhesive eggs; pelagic larvae
Spawning	Season: Mid-winter (Brit. Col.)[a]
	Area: Exposed intertidal, under rocks[a]
	Mode: Pairs; single parent guards[a]
	Migration:
Fecundity	Range/function: 1100 (one mass)[a]
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION[a]

EGGS

Diameter	2.25 mm
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	White
Hatch size	11.2 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters
- Eggs laid in conical-shaped mass

LARVAE

Preanal length	45% SL
Length at flexion	13 mm SL
Length at transformation	18-21 mm SL
Sequence of fin development	Caudal, dorsal and anal, pectorals

Pigment
- Postanal ventral midline with about 30 spots
- Dorsally about eight spots on gut; ventral pigment present (not shown on figure)
- Row of internal pigment over notochord

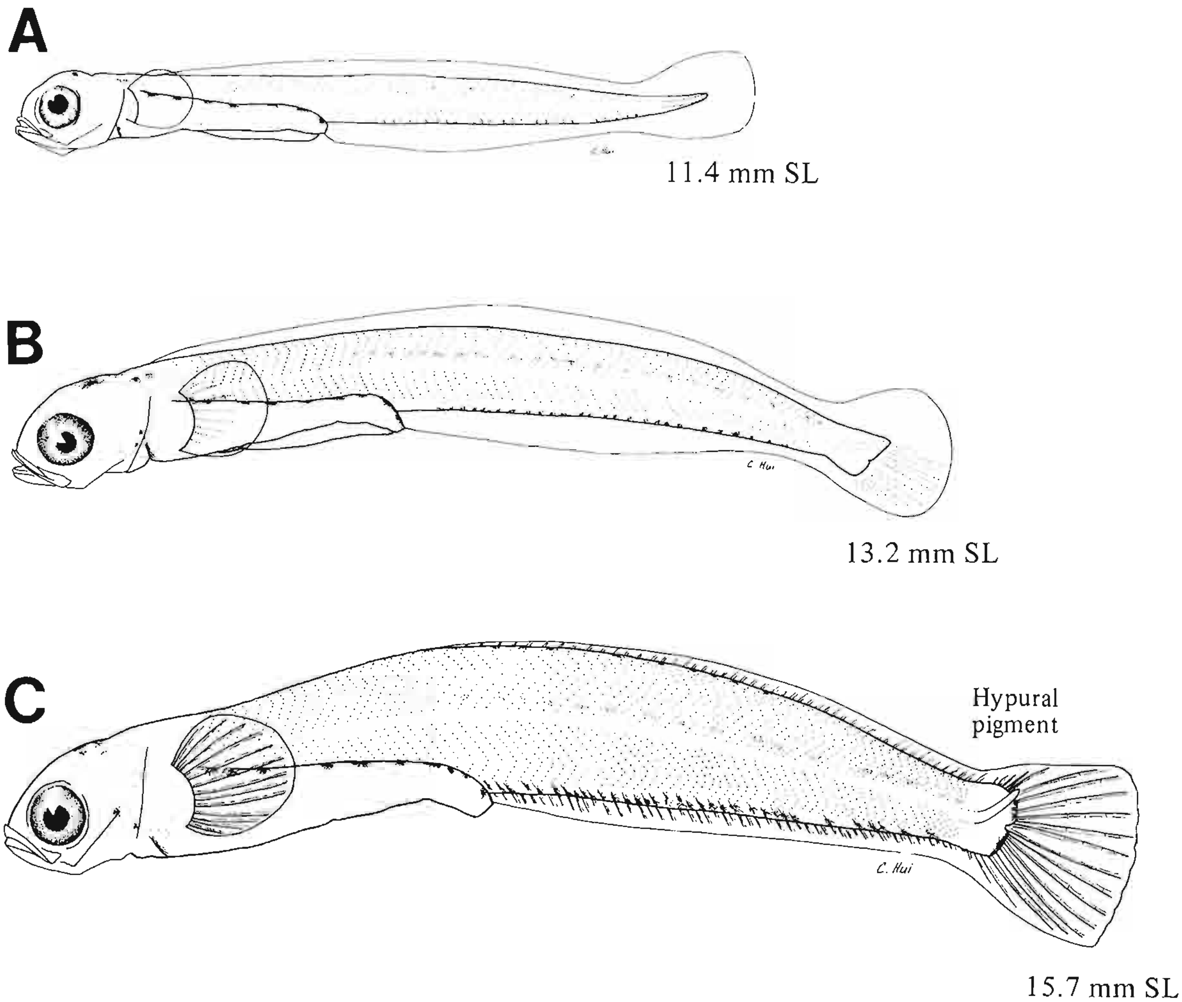
Diagnostic characters

Distinguished from *Xiphister* spp. (p. 516, 518) by
- Relatively larger at comparable stages of development (e.g., hatching occurs >10.0 mm SL)
- Larger relative eye diameter
- Dorsal body midline unpigmented in preflexion and flexion larvae

Distinguished from *Anoplarchus purpurescens* (p. 512) by
- Lack of hypural spots in preflexion and flexion larvae

[a] J. Marliave, Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8, pers. commun., 16 Oct. 1986. Drawings by C. Hui.

Ref: Marliave, unpubl.



Figures A–C, Marliave, unpubl.

MERISTICS

Vertebrae	Total: 75-75-80 Precaudal: 22-23-24 Caudal: 51-52-56	
Branchiostegal rays	6-6-6	
Caudal fin	X, 6+7, X	
Pelvic fin	Absent	
Dorsal fin	S: 65-X-72	
Pectoral fin	R: 11-X-12	
Anal fin	S: 1-1-1	R: 49-X-55
Gill rakers	U: 2-X-3	L: 6-X-10

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Nearshore shelf demersal, intertidal to 8 m
ELH pattern	Oviparous; demersal, adhesive eggs; pelagic larvae
Spawning	Season: Late winter-early spring (British Columbia)[a] Area: Intertidal, under rocks[a] Progression: Early in protected waters, later on exposed shores[a] Mode: Pairs; males guard nests[b] Migration:
Fecundity	Range/function: 900-1700[b]
Age at first maturity	2-3 yr[c]
Longevity	

EARLY LIFE HISTORY DESCRIPTION[d]

EGGS

Diameter	2.25 mm
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	White
Hatch size	8.5 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	43-45% SL
Length at flexion	11 mm SL
Length at transformation	18 mm SL
Sequence of fin development	Caudal, anal and dorsal, pectorals

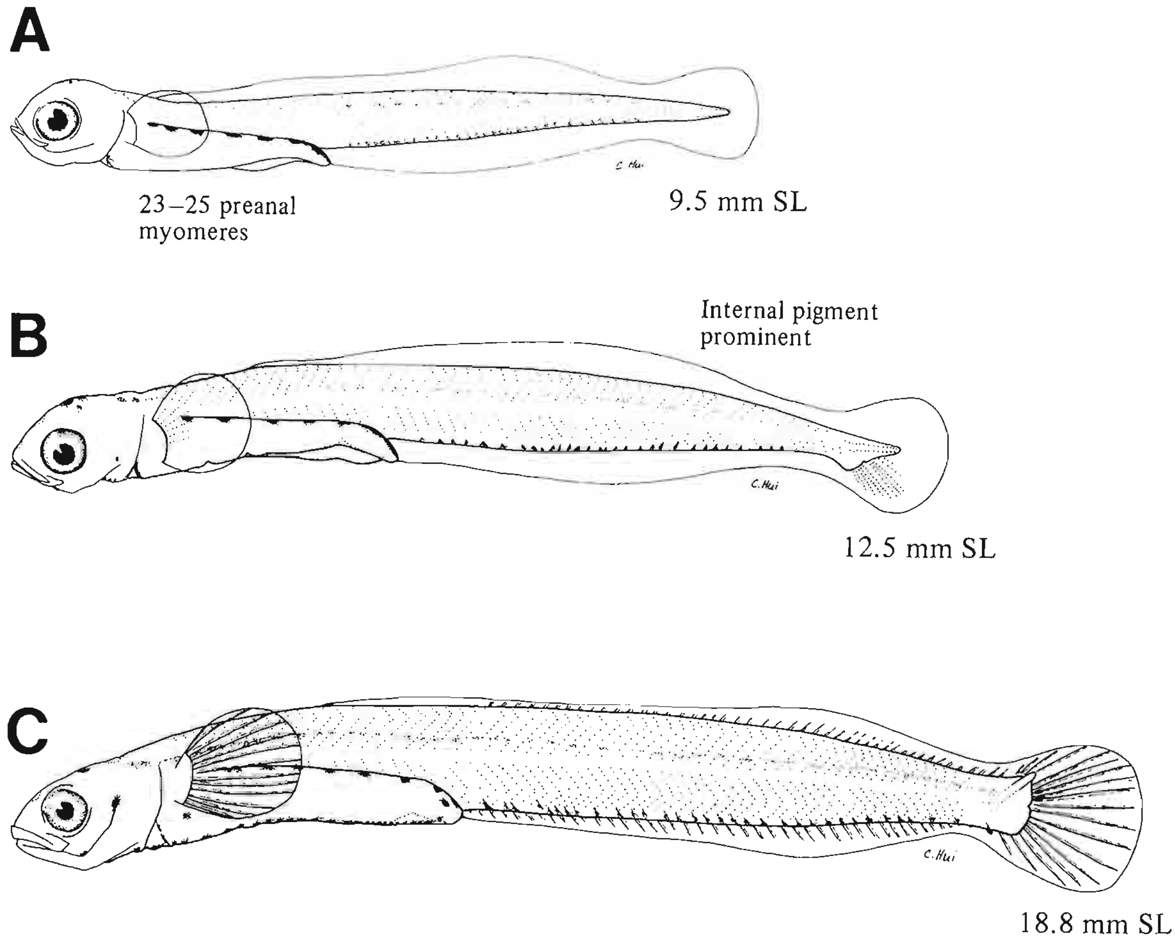
Pigment
- Postanal ventral midline with about 36 spots (range 28-46)
- Dorsally about eight spots on gut; ventral pigment present (not shown on figure)
- Row of internal pigment over notochord

Diagnostic characters
- See *Anoplarchus purpurescens* (p. 512) and *Phytichthys chirus* (p. 514)

Distinguished from *X. mucosus* by
- Relatively smaller at comparable stages of development
- Internal pigment over notochord generally more prominent
- Relatively short snout-anus length (preanal myomeres 23-25 vs. 28-30 in *X. mucosus*)

[a] Marliave 1975b
[b] Marliave and DeMartini 1977
[c] Wingert 1974
[d] J. Marliave, Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8, pers. commun., 16 Oct. 1986. Drawings by C. Hui.

Ref: Marliave, unpubl.



Figures A–C, Marliave, unpubl.

MERISTICS

Vertebrae	Total: 73-81-83	
	Precaudal: 29-30-31	
	Caudal: 44-50-53	
Branchiostegal rays	6-6-6	
Caudal fin	X, 6+7, X	
Pelvic fin	Absent	
Dorsal fin	S: 71-X-78	
Pectoral fin	R: 12-12-12	
Anal fin	S: 1-1-1	R: 46-X-50
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	Cent. California, 34-38°N, to SE Alaska, 55-59°N
Ecology	Nearshore shelf demersal, intertidal to 18 m
ELH pattern	Oviparous; demersal, adhesive eggs; pelagic larvae
Spawning	Season: Late winter-spring (British Columbia)[a]
	Area: Exposed intertidal, under rocks[a]
	Mode: Pairs; males guard nests[b]
	Migration:
Fecundity	Range/function: 5500-9500[a]
Age at first maturity	5 yr[c]
Longevity	

EARLY LIFE HISTORY DESCRIPTION[d]

EGGS

Diameter	2.5 mm
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	White
Hatch size	9.5 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	47-49% SL
Length at flexion	12 mm SL
Length at transformation	18 mm SL
Sequence of fin development	Caudal, dorsal and anal, pectorals

Pigment
- Postanal ventral midline about 26 spots (range 18-35)
- Dorsally about eight spots on gut; ventral pigment present (not shown on figure)
- Row of internal pigment over notochord

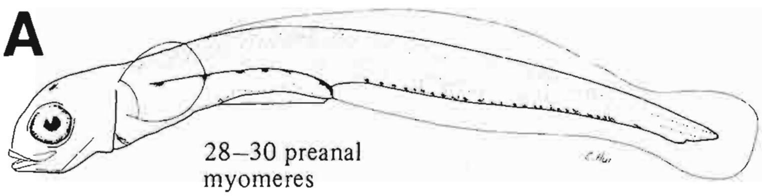
Diagnostic characters
- See *Anoplarchus purpurescens* (p. 512) and *Phytichthys chirus* (p. 514)

Distinguished from *X. atropurpureus* by
- Generally larger at comparable stages of development
- Internal pigment over notochord generally lighter

[a] Marliave 1975a
[b] Marliave and DeMartini 1977
[c] Wingert 1974
[d] J. Marliave, Vancouver Public Aquarium, P.O. Box 3232, Vancouver, B.C., Canada V6B 3X8, pers. commun., 16 Oct. 1986. Drawings by C. Hui.

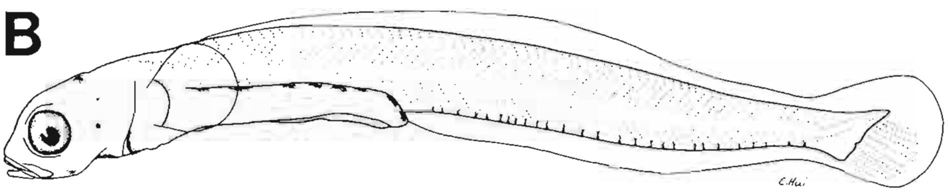
Ref: Marliave 1975a; Marliave, unpubl.

A



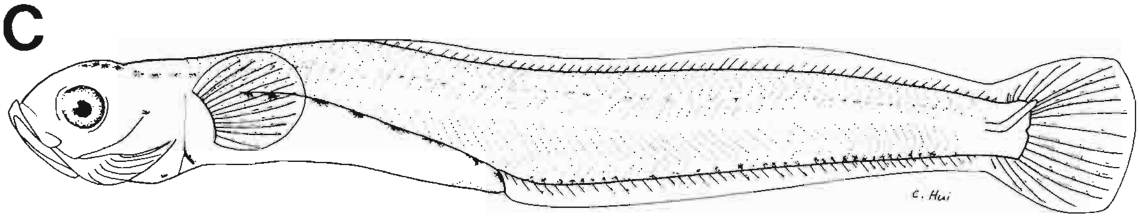
9.5 mm SL

B



12.7 mm SL

C



17.3 mm SL

Figures A–C, Marliave, unpubl.

MERISTICS *Delolepis gigantea* (Kittlitz 1858)

Vertebrae	Total: 81-X-85 Precaudal: X-X-X Caudal: 49-X-51	
Branchiostegal rays	6-6-6	
Caudal fin	X, 7+8, X	
Pelvic fin	Absent	
Dorsal fin	S: 73-X-77	
Pectoral fin	R: 13-13-13	
Anal fin	S: 2-2-2	R: 43-X-49
Gill rakers	U: X-X-X	L: X-X-X

MERISTICS *Lyconectes aleutensis* Gilbert 1896

Vertebrae	Total: 71-X-77 Precaudal: X-X-X Caudal: 47-X-51	
Branchiostegal rays	6-6-6	
Caudal fin	X, 7+8, X	
Pelvic fin	Absent	
Dorsal fin	S: 60-X-69	
Pectoral fin	R: 12-X-13	
Anal fin	S: 2-X-3	R: 45-X-49
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	N. California, 38-42°N, to Bering Sea, 54-66°N
Ecology	Nearshore shelf demersal (*D. gigantea*, 6-128 m); epi- and mesobenthal (*L. aleutensis*, 46-350 m)
ELH pattern	Oviparous, demersal eggs, pelagic larvae
Spawning	Season: Spring-summer (*L. aleutensis*)[b] Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	4.41-4.85 mm (*D. gigantea*); 1.8 mm (*L. aleutensis*)
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	Smooth (*D. gigantea*)
Hatch size	Larvae with yolk at 16-17 mm SL (*D. gigantea*)
Incubation time/temp.	
Pigment	
Diagnostic characters	

LARVAE

Preanal length	~50% SL (*D. gigantea*); <50% SL (*L. aleutensis*)
Length at flexion	
Length at transformation	
Sequence of fin development	Caudal, pectorals, dorsal and anal; fin development may begin prior to hatching in *D. gigantea*
Pigment	

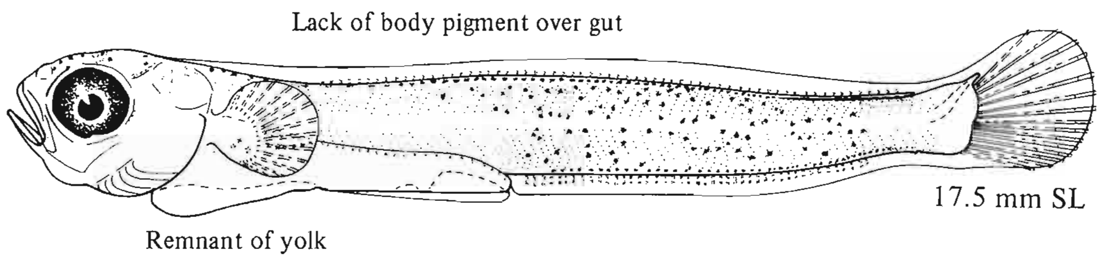
Diagnostic characters (see Table 3)

- Number of myomeres: 81-85 in *D. gigantea*, 71-77 in *L. aleutensis*
- Pigment on isthmus and over gut (absent in *D. gigantea*)
- Preanal length: ~50% SL in *D. gigantea*, <50% SL in *L. aleutensis*
- Size at stage of development: *D. gigantea* larvae hatch at a larger size and more advanced stage of development

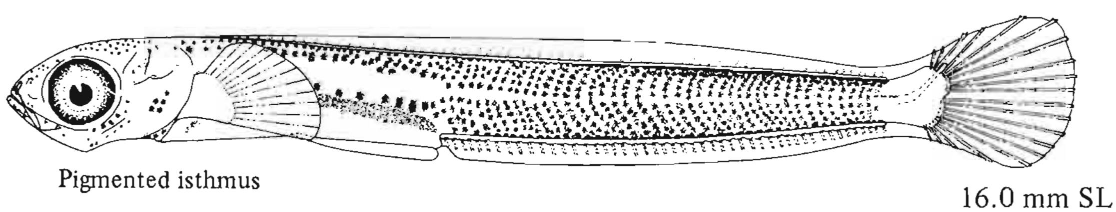
[a] Nawojchik (1986) includes *Lyconectes* and *Delolepis* in the genus *Cryptacanthodes*.
[b] Hart 1973

Ref: Hart 1973.

A *Delolepis gigantea*



B *Lyconectes aleutensis*



Figures A–B, NWAFC originals (B. Vinter).

PHOLIDIDAE

Although some species of gunnels are found in the North Atlantic, most members of this family are located in the eastern Pacific. Pholidids are eel-like with long compressed bodies, a dorsal fin extending from head to caudal fin and made up entirely of spines, and small pelvic fins (I,1) when present. There are nine species in three genera within the study area.[1] Adults are demersal, occurring from as deep as 75 m to tidepools (Hart 1973). Pholidids are noted for paired spawning and subsequent guarding of eggs which may be 1.4-3.0 mm and have one oil globule (A.C. Matarese, unpubl.). One or both partners may guard the eggs during incubation by coiling around them (Breder and Rosen 1966). Larvae are pelagic and may settle after 50 days (Garrison and Miller 1982).

Presently, larvae of *Pholis* spp. cannot be identified to species in our study area. The following characters may be helpful in separating *Pholis* spp. larvae from those of *Apodichthys flavidus*.

Morphology Head and eye generally smaller in *Pholis* at comparable stages of development

Meristics Presence of pelvic fins and two anal spines in *Pholis*

Pigment Internal pigment above notochord is less pronounced and disappears sometime before larvae undergo flexion; presence of a continuous series of melanophores along ventral surface of gut; pigment spots along dorsal surface of gut are smaller and more numerous (postflexion)

Meristic characters may be useful in separating larger *Pholis* postflexion larvae and juveniles. Off Washington, Oregon, and California, myomere counts enable separation of *P. clemensi* (94-98) and *P. schultzi* (89-93) from other species (usually <90).

Larvae of *Xererpes fucorum* are inadequately known. *X. fucorum* can be separated from *Pholis* spp. by their lack of pelvic fins and from *Apodichthys flavidus* by the presence of one or two anal spines and a lower dorsal spine count (83-87 vs. 90-94).

[1]Yatsu (1985) proposes alternative generic placements for several species; according to his arrangement, nine species within four genera occur in the area.

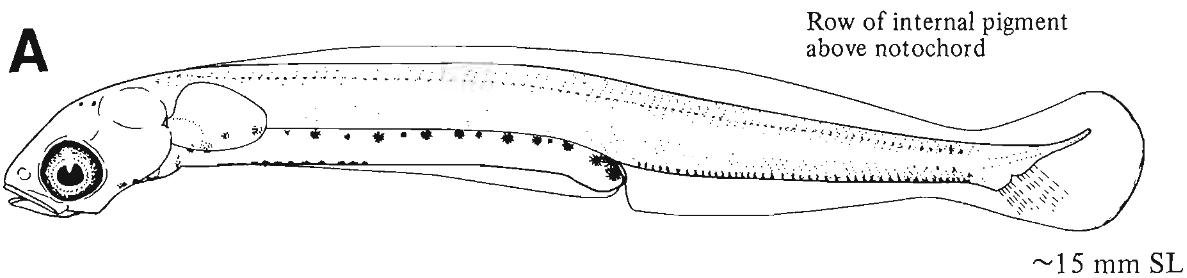
Table 45
Meristic characters of family Pholididae.*

		Vertebrae		Fins				Gill rakers		
Taxon	Distribution	Precaudal (Total)	Caudal	Dorsal	Anal	Pectoral	Pelvic	Upper	Lower	Branchiostegals
Apodichthys flavidus	S. Calif.-Gulf of Alaska	50-51	48	XC-XCIV	I,36-42	14		3	10-13	5
Pholis clemensi	N. Calif.-SE Alaska	37-39	57-59	LXXXVII-XCI	II,48-53	11-14	I,1		11	5
Pholis dolichogaster	Aleutian Is.-Bering Sea	41-45	56-57	XCIII-XCVI	II,48-51	13-15	I,1			5
Pholis fasciata	Bering Sea	40-44	50	LXXXIII-LXXXVIII	II,41-44	11-13	I,1			5
Pholis gilli	Bering Sea			LXXXIV	II,43		I,1			5
Pholis laeta	N. Calif.-Bering Sea	40-42 (81-89)	43-44	LXXIV-LXXXI	II,32-38	11-12	I,1			5
Pholis ornata	Cent. Calif.-Brit. Col.	(80-87)		LXXIV-LXXX	II,34-38	11-12	I,1			5
Pholis schultzi	Cent. Calif.-Brit. Col.	(89-93)		LXXX-LXXXIX	II,40-44	10-12	I,1-2	1-2	7-10	
Xererpes fucorum	SSC-Brit. Col.	52	40	LXXXII-LXXXVII	I,29-38	12		1-2	6-9	5

*Yatsu (1985) places *Pholis clemensi*, *P. laeta*, and *P. schultzi* in the genus *Allopholis*. *P. dolichogaster* is placed in the genus *Rhodymenichthys*. *Xererpes fucorum* is placed in the genus *Apodichthys*.

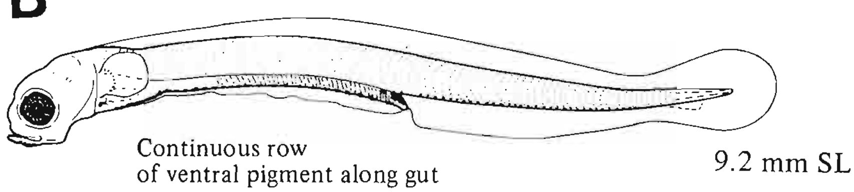
Apodichthys flavidus

A



Pholis sp.

B



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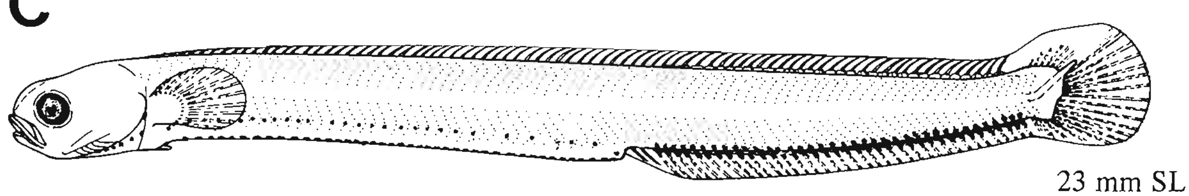

Figures A–C, NWAFC originals (B. Vinter).

MERISTICS

Vertebrae	Total: 88-X-89	
	Precaudal: 29-X-31	
	Caudal: 57-X-59	
Branchiostegal rays	6-X-7	
Caudal fin		
Pelvic fin	Absent	
Dorsal fin	S: 81-X-88	
Pectoral fin	R: 20-X-22	
Anal fin	S: X-X-X	R: 50-X-55
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	Bering Sea, 54-66°N
Ecology	Nearshore shelf demersal
ELH pattern	Oviparous; demersal, adhesive eggs; pelagic larvae
Spawning	Season:
	Area:
	Mode: Pairs; eggs guarded by one or both parents[a]
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	4-8 mm
No. of oil globules	One
Oil globule diameter	
Yolk	
Envelope	
Hatch size	~17-18 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	50% SL
Length at flexion	<20 mm SL
Length at transformation	~40 mm SL
Sequence of fin development	

Pigment (see Table 3)
- Heavily pigmented over body except ventral surface of gut, pectoral fin base, and posteriormost opercular area

Diagnostic characters
Distinguished from *Anarrhichthys ocellatus* by
- Morphology: Body not elongate
- Lower vertebral count (88-89 myomeres)
- Eye diameter (large)

[a] Breder and Rosen 1966

Ref: Andriashev 1954, Barsukov 1959.

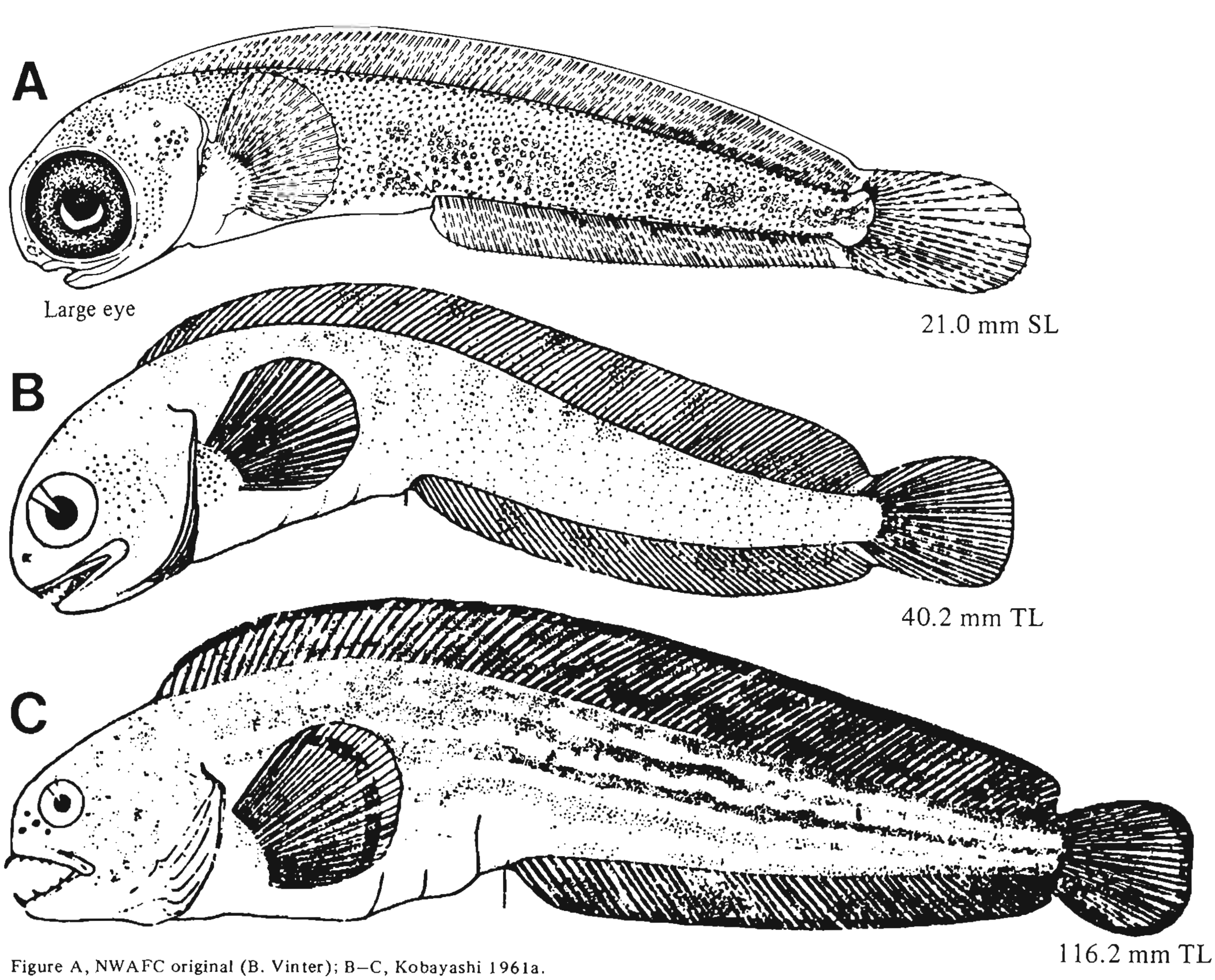

Figure A, NWAFC original (B. Vinter); B–C, Kobayashi 1961a.

MERISTICS

Vertebrae	Total: 221-247-251	
	Precaudal: 36-37-39	
	Caudal: 183-204-214	
Branchiostegal rays	6-X-7	
Caudal fin		
Pelvic fin	Absent	
Dorsal fin	S: 218-X-250	
Pectoral fin	R: 19-X-20	
Anal fin	S: 0-0-1	R: 180-X-233
Gill rakers	U: 3-X-5	L: 11-X-15

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Epi- and mesobenthal, 0-226 m
ELH pattern	Oviparous; demersal, adhesive eggs; pelagic larvae
Spawning	Season: Oct-Feb[a]
	Area: In caves or rocky crevices[a]
	Mode: Pairs; eggs guarded by both parents[a]
	Migration: Mated pairs sedentary, den site permanent[a]
Fecundity	Range/function: ~10,000[a]
Age at first maturity	
Longevity	4 yr[a]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	5.2-5.4 mm
No. of oil globules	
Oil globule diameter	
Yolk	Reddish
Envelope	Smooth; white, becoming brownish
Hatch size	33.5 mm SL
Incubation time/temp.	3-4.5 mo
Pigment	

Diagnostic characters
- Embyro coils around 3-3.5 times within envelope

LARVAE

Preanal length	25% SL at hatching, decreasing with development
Length at flexion	Tail fully formed at hatching
Length at transformation	Hatch as juveniles
Sequence of fin development	Fins fully formed at hatching with yolk present

Pigment
- Dorsal head
- Upper body over gut
- Small concentrated melanophores along dorsal and ventral body midlines that extend onto the body laterally and into the finfolds with development

Diagnostic characters
- Elongate body shape
- High number of myomeres (221-251)

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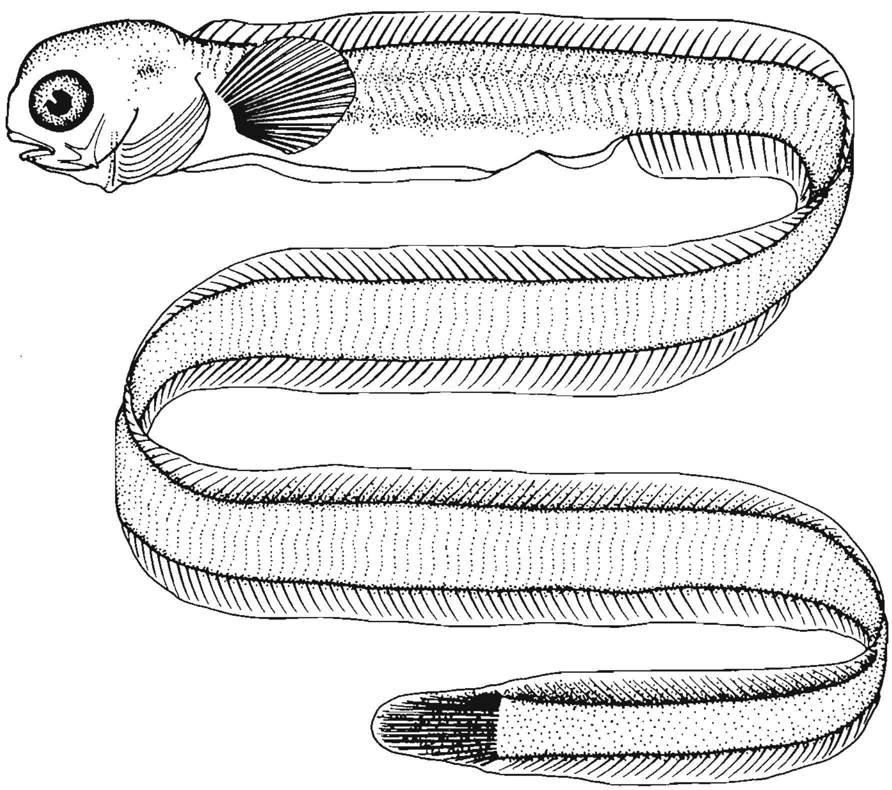
[a]Marliave 1987

Ref: Marliave 1975a, 1987.

A



65 mm TL

Figure A, Marliave 1975a.

MERISTICS[a]

Vertebrae	Total: 227-X-240 Precaudal: 53-X-59 Caudal: 174-X-181
Branchiostegal rays	5-5-5
Caudal fin	
Pelvic fin	Absent
Dorsal fin	S: 83-X-90 R: 137-X-145
Pectoral fin	R: 13-13-13
Anal fin	R: 180-X-196
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	Oregon, 42-46°N, to Bering Sea, 54-66°N
Ecology	Nearshore shelf demersal, 0-80 m
ELH pattern	Parity and eggs unknown, pelagic larvae
Spawning	Season: Spring[b] Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length	Gut length 35-40% SL (decreases with development)
Length at flexion	
Length at transformation	∼114 mm SL
Sequence of fin development	Dorsal and anal first at 40 mm SL

Pigment (larvae 20.3-36.0 mm SL)

- Head
  - —Lower jaw
  - —Isthmus
  - —Internally at base of hindbrain
- Gut: Dorsal and ventral surface
- Body: Concentrated dorsally and ventrally
- Caudal: ''Fleshy caudal extension'' is distinctly pigmented; pigment is scattered evenly dorsally and ventrally on body and into finfolds

Diagnostic characters

- Morphology: Elongate form, gut length (40% SL)
- Number of myomeres (>225)
- Pigment pattern: Concentrated ventrolateral spots and pigment on fleshy caudal extension

---

[a] Kobayashi (1961b) reports slightly different meristics in specimens from Japanese waters:

Dorsal fin spines	79-83
Dorsal fin rays	141-157
Anal fin rays	166-193
Pectoral fin rays	11-13
Branchiostegal rays	6

Richardson and Dehart (1975) note that in four larval specimens collected off Oregon the total vertebral counts of 227 were considerably lower than counts in Bering Sea specimens (236-240).

[b] Larvae 20.3-36.0 mm SL collected March-May 18 km from coast of Oregon.

Ref: Richardson and Dehart 1975.

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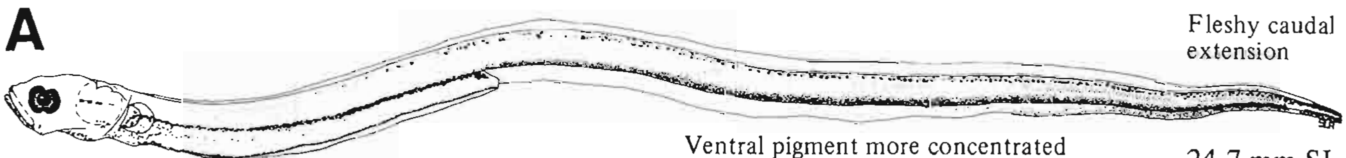


Figure A, Richardson and Dehart 1975.

MERISTICS

Vertebrae	Total: 61-X-62	
	Precaudal: 24-X-26	
	Caudal: X-X-X	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Absent	
Dorsal fin	S: 54-X-57	
Pectoral fin	R: 20-X-25	
Anal fin	S: 4-4-4	R: 24-X-30
Gill rakers	U: 8-8-8	L: 18-X-20

LIFE HISTORY

Range	Cent. California, 34-38°N, to Bering Sea, 54-66°N
Ecology	Epi-, meso-, and bathybenthal, 10-675 m
ELH pattern	Parity and eggs unknown, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	4 yr (male)[a]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

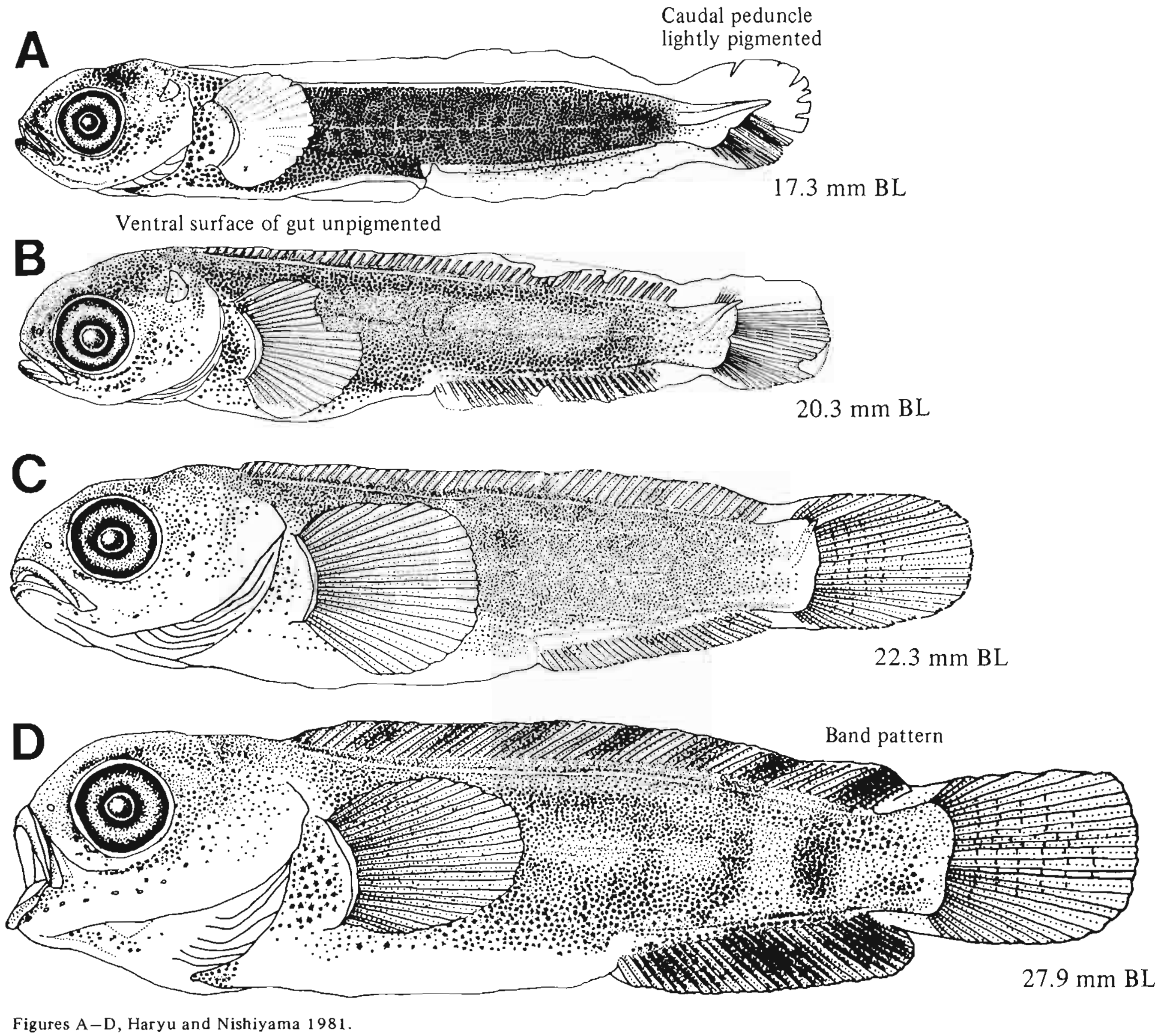
Preanal length	55% SL, with development increasing to 65% SL
Length at flexion	17-24 mm BL
Length at transformation	~30 mm SL
Sequence of fin development	Caudal, pectorals, dorsal, anal

Pigment
- Body, except ventral surface of gut and tip of tail, entirely pigmented with small densely concentrated melanophores throughout development
- Becomes banded in juveniles

Diagnostic characters (see Table 3)
- Small melanophores covering body
- Rounded snout

[a] Fitch and Lavenberg 1971

Ref: Chapman and Townsend 1938, Haryu and Nishiyama 1981.



Figures A–D, Haryu and Nishiyama 1981.

MERISTICS

Vertebrae	Total: 44-X-47	
	Precaudal: 12-12-14[a]	
	Caudal: 32-34-40[a]	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 14-X-16	R: 18-X-20
Pectoral fin	R: 21-X-22	
Anal fin	S: 1-1-1	R: 28-X-29
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	N. California, 38-42°N, to Bering Sea, 54-66°N
Ecology	Epi- and mesobenthal, 20-375 m
ELH pattern	Oviparous; demersal, adhesive, attached eggs; pelagic larvae
Spawning	Season: Winter-spring (British Columbia)[a]
	Area: Rocky intertidal[a]
	Mode:
	Migration: Along shore to rocky areas[a]
Fecundity	Range/function: ~1000[a]
Age at first maturity	
Longevity	

[a] Marliave 1981c

[b] M. Okiyama, Univ. Tokyo, Ocean Res. Inst., 1-15-1 Minamidai, Nakano-Ku, Tokyo 164, Japan, pers. commun., 8 Nov. 1985.

Ref: Marliave 1981c.

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	3.5 mm
No. of oil globules	One
Oil globule diameter	
Yolk	
Envelope	
Hatch size	13 mm SL (preserved)
Incubation time/temp.	~1 yr
Pigment	

Diagnostic characters
- Precocious caudal development

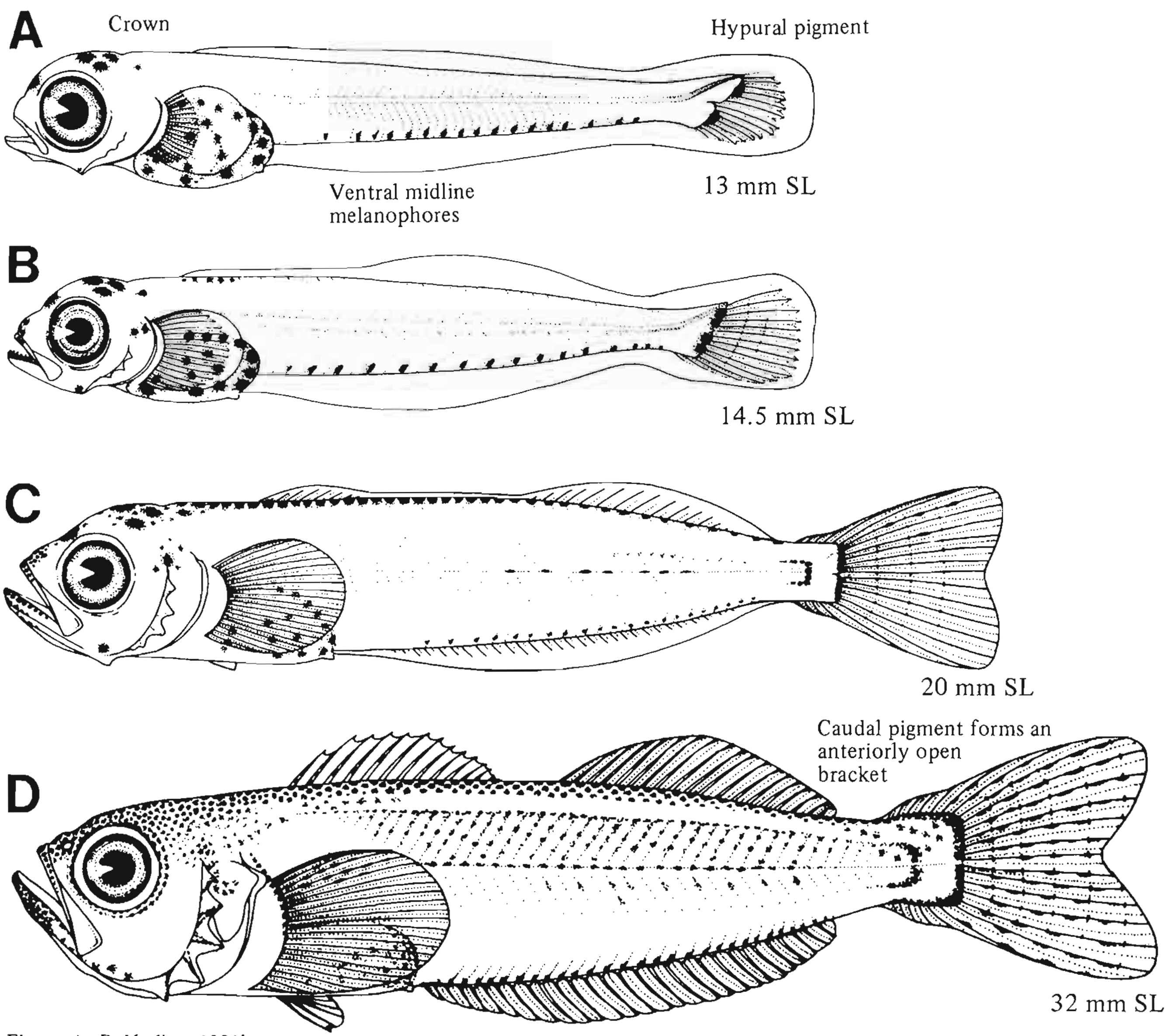
LARVAE

Preanal length	35-40% SL, increases with development
Length at flexion	Occurs prior to hatch
Length at transformation	
Sequence of fin development	Caudal, dorsal and anal, pectorals and pelvics

Pigment
- On about every other myomere along ventral midline
- Distinct spots on hypural margin, increase in number with development to become a line
- Large melanophores cover entire surface of gut
- Several large melanophores on crown
- Anterior dorsal midline starts on nape, increases posteriorly

Diagnostic characters
- Early caudal development
- Hypural margin pigment: First forms line, then an anteriorly open bracket; similar smaller bracket develops on the caudal peduncle
- Slightly separate dorsal fins
- Anal fin longer than second dorsal fin

To distinguish from *Arctoscopus japonicus* (present in the Bering Sea)[b]
- *A. japonicus* larvae are less advanced at similar stages of development than those of *T. trichodon*, e.g., newly hatched *A. japonicus* larvae possess no developing fin rays and an unflexed notochord
- Dorsal margin pigment not present until juvenile stage in *A. japonicus*
- *A. japonicus*: Dorsal X-XI,13; anal 30-31



Figures A–D, Marliave 1981b.

Clinids are found in both Atlantic and Pacific tropical and temperate waters. They are small (many <7.5 cm) and elongate, and somewhat deep-bodied. The dorsal fin extends from behind the head almost to the caudal fin. In the northeastern Pacific the family is represented by only three species in two genera. Adults inhabit nearshore rocky areas from intertidal zones to depths of 50 m. Spawning behavior consists of nest building by a male in a rocky crevice, on seaweed, or in the lumen of a living sponge (Breder and Rosen 1966). Eggs, which are laid by one or more females, form clumps. The adhesive eggs (0.85-1.7 mm) have one or more oil globules which may be uncolored, pale yellow, or orange; sticky filaments are present on eggs of some species. Males of some tribes possess a modified anal fin or intromittent organ (Ophiclini, Clinini), and reproduction within those tribes is either viviparous or ovoviviparous. Larvae are pelagic for a brief period before settling to the bottom (Breder and Rosen 1966). The early-life-history stages of *Heterostichus rostratus* are presented here. Other clinids in the study area include two species of the genus *Gibbonsia*. In comparison to *H. rostratus*, members of *Gibbonsia* have fewer myomeres (48-54), anal fin rays (23-29), pectoral fin rays (11-13), and upper gill rakers (3-4). They undergo flexion and transformation earlier than *H. rostratus* (5.0-8.1 mm SL and ~19 mm SL, respectively).[1] Pigment is generally limited to the ventral midline and dorsally over the swimbladder.

[1]W. Watson, Marine Ecological Consultants, 531 Encinitas Blvd., Suite 110, Encinitas, CA 92024, pers. commun., 1983.

Table 46
Meristic characters of family Clinidae.

		Vertebrae		Fins				Gill rakers		
Taxon	Distribution	Precaudal	Caudal	Dorsal	Anal	Pectoral	Pelvic	Upper	Lower	Branchiostegals
Gibbonsia metzi	SSC-Brit. Col.	18-20	32-34	XXXIV-XXXVII, 7-10	II,24-29	11-13	I,3	3-4	7-8	5-6
Gibbonsia montereyensis	SSC-Brit. Col.	16-17	32-35	XXXIV-XXXVI, 5-8	II,23-28	11-13	I,3	3-4	7-12	6
Heterostichus rostratus	SSC-Brit. Col.	21-22	34-36	XXXV-XXXVIII, 11-13	II,31-35	12-14	I,3	5-7	12-13	6

MERISTICS

Vertebrae	Total: 55-57-58	
	Precaudal: 21-22-22	
	Caudal: 34-35-36	
Branchiostegal rays	6-6-6	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 3-3-3
Dorsal fin	S: 35-37-38	R: 11-X-13
Pectoral fin	R: 12-13-14	
Anal fin	S: 2-2-2	R: 31-X-35
Gill rakers	U: 5-X-7	L: 12-X-13

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30'-55°N
Ecology	Nearshore shelf demersal, intertidal to 40 m
ELH pattern	Oviparous; adhesive, attached eggs; pelagic[a] larvae
Spawning	Season: Mar;[b] Feb-Apr;[c] spring[a]
	Area: Egg mass found on floating kelp filaments[a]
	Mode: Pairs; males guard nests[a]
	Migration:
Fecundity	Range/function: 400-1200 (may spawn several times/yr)[a]
Age at first maturity	1-1.5 yr[a] (females 14 cm TL)
Longevity	5 yr (females)[a]
	3 yr (males)[a]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.35 mm;[d] 1.4 mm[a]
No. of oil globules	One
Oil globule diameter	
Yolk	Red or brown
Envelope	16 filaments in a cluster
Hatch size	5.5-6.2 mm TL
Incubation time/temp.	12-17 d/18°C

Pigment
- Yolk
- Ventral midline melanophores on embryo

Diagnostic characters
- Filaments

LARVAE

Preanal length	50% SL
Length at flexion	~7-9 mm SL
Length at transformation	By 25 mm SL, 30-50 mm TL
Sequence of fin development	Caudal, dorsal and anal, pectorals and pelvics

Pigment
- Postanal ventral midline series: Denser posteriorly, with development becoming about one melanophore at base of each anal fin ray
- Anteriorly and dorsally on gut

Diagnostic characters
- Pigmented swimbladder (not shown on figures)
- Ventral midline melanophores
- More myomeres (56-60) than *Gibbonsia* spp. (47-53)
- Dorsal and anal fin development begins posteriorly

[a] Stepien 1986
[b] Wang 1981
[c] W. Watson, Marine Ecological Consultants, 531 Encinitas Blvd., Suite 110, Encinitas, CA 92024, pers. commun., 3 Nov. 1986.
[d] Barnhart 1932

Ref: Barnhart 1932, Matarese et al. 1984a, Stepien 1986.

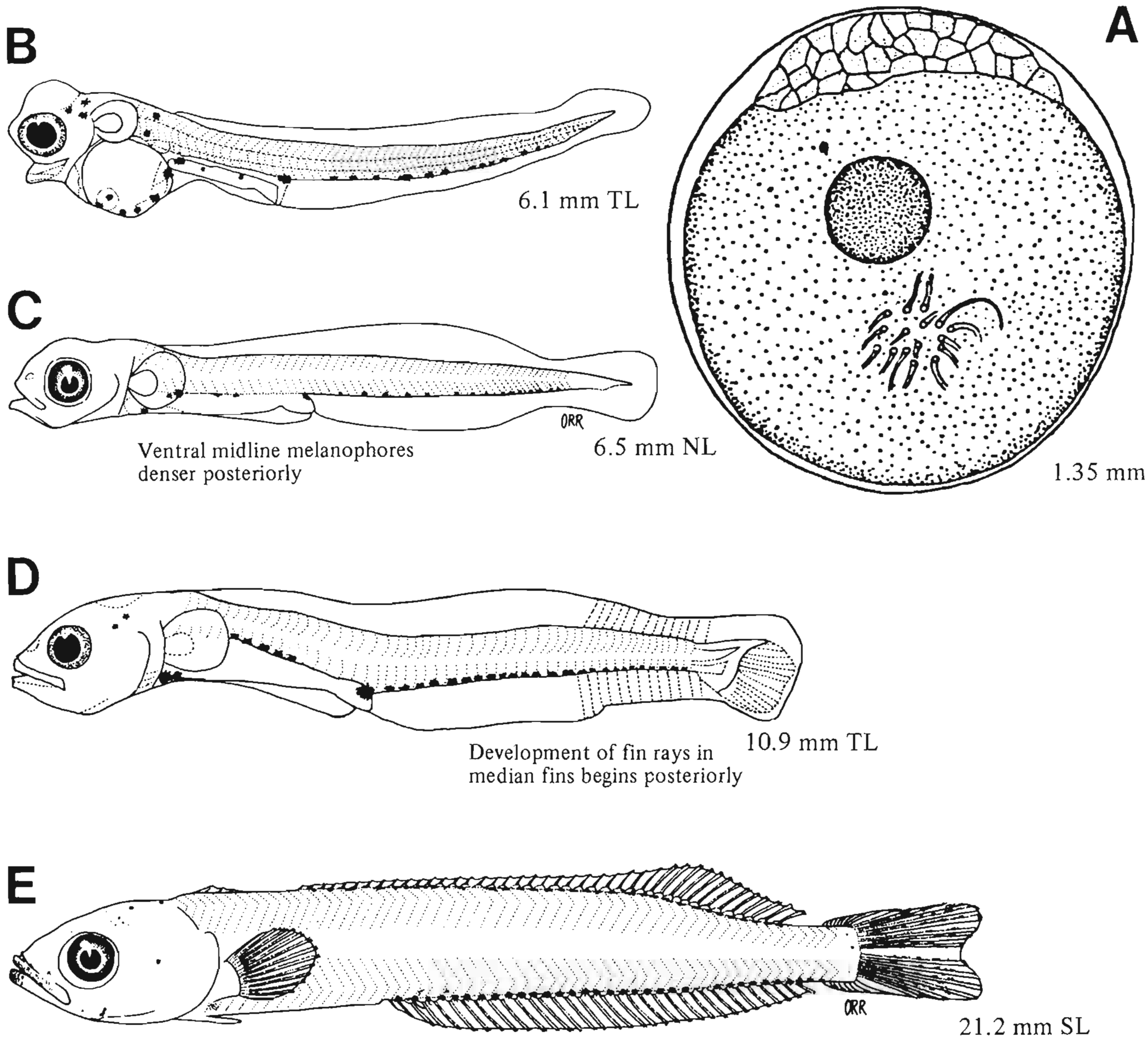


Figure A, Barnhart 1932; B, D, Stepien 1986 (reared); C, E, Matarese et al. 1984a.

MERISTICS

Vertebrae	Total: 66-X-68 Precaudal: 23-23-23 Caudal: 45-45-45
Branchiostegal rays	6-X-7
Caudal fin	6-9, 9+8, 6-9
Pelvic fin	Abdominal in larvae, absent in adults S: 1-1-1 R: 4-4-4
Dorsal fin	R: 52-X-56
Pectoral fin	R: 20-X-21
Anal fin	R: 34-X-44
Gill rakers	U: 1-1-1 L: 6-6-6

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Epi- and mesopelagic
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Spring-early summer, early fall;[a] winter[b] Area: Pelagic[a] Mode: Migration: To coastal areas[b]
Fecundity	Range/function: 230,000-430,000[b]
Age at first maturity	3-4 yr[b]
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	2.8-3.1 mm
No. of oil globules	One
Oil globule diameter	Initially 0.42-0.60 mm
Yolk	Homogeneous, opaque becoming clear
Envelope	Smooth
Hatch size	6.5 mm SL
Incubation time/temp.	

Pigment
- Yolk
- Oil globule
- Embryo: Finfolds, above and below tail, body

Diagnostic characters
- Large size
- Large oil globule, decreasing in size with embryonic development

LARVAE

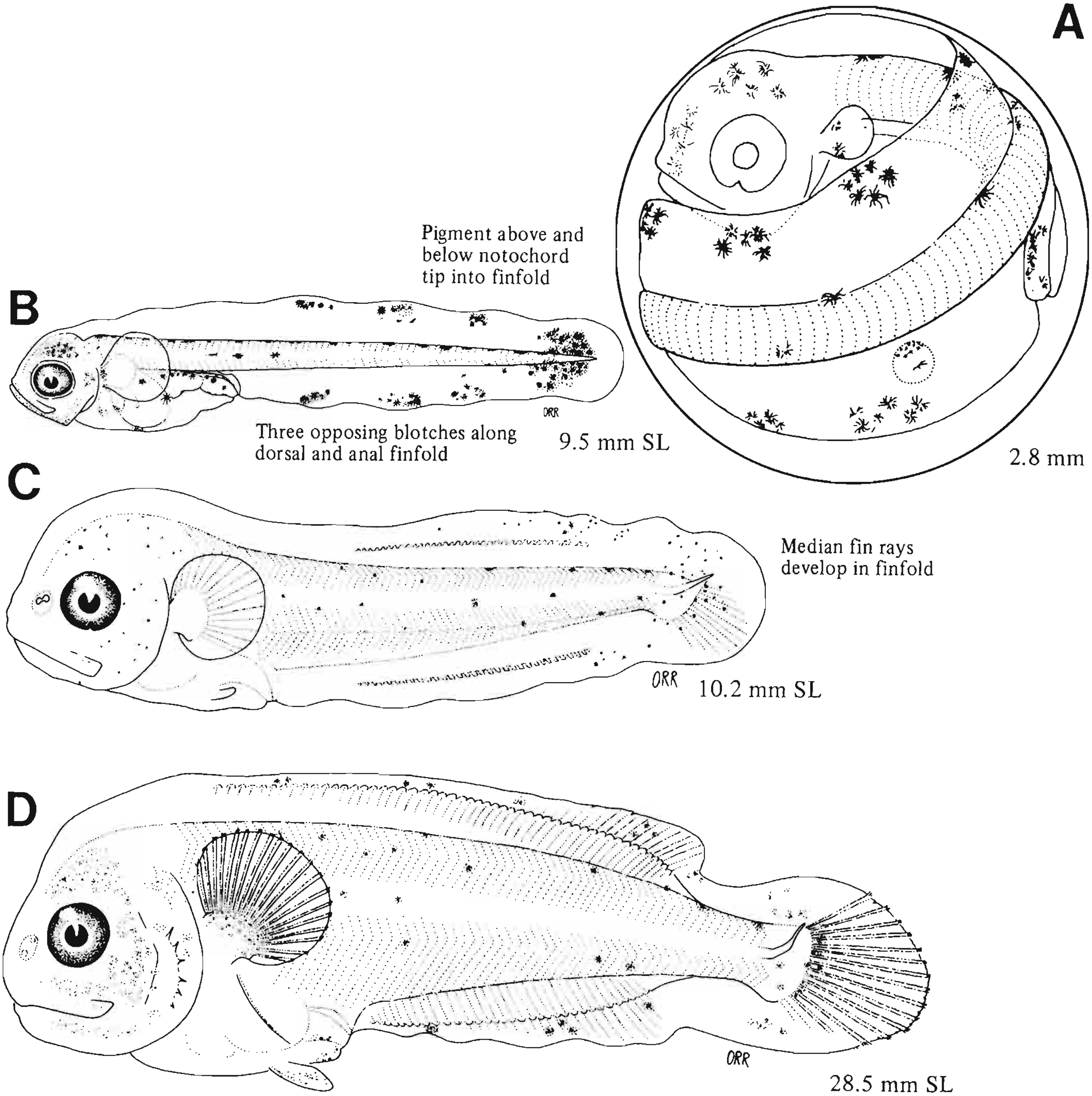
Preanal length	~40% SL
Length at flexion	11-17 mm SL
Length at transformation	
Sequence of fin development	Pectorals, pelvics, dorsal, anal; caudal not complete in 28.5 SL specimen

Pigment
- Head and gut covered with discrete spots
- Dorsal body margin
- Caudal finfold pigment becoming less prominent with development
- Pectoral and pelvic fin bases (postflexion)
- Three opposing blotches on dorsal and ventral finfolds in preflexion larvae

Diagnostic characters
- Preflexion pigment: Three opposing blotches in median finfold, one in caudal finfold
- Pelvic fin present in larvae, lost in adults
- Dorsal and anal fin begin to develop in finfold, have deep bases
- Morphological changes with development, from elongate to deep-bodied
- Blunt head
- Small preopercular spines

[a] NWAFC, unpubl.
[b] Fitch and Lavenberg 1971

Ref: Matarese et al. 1984b; Matarese, unpubl.



Figures A–D, Matarese et al. 1984b.

MERISTICS

Vertebrae	Total: 65-67-74 Precaudal: 40-44-47 Caudal: 23-24-25
Branchiostegal rays	6-X-8
Caudal fin	X, 8+7, X
Pelvic fin	Absent
Dorsal fin	R: 54-X-63
Pectoral fin	R: 13-14-15
Anal fin	R: 24-X-32
Gill rakers	U: 3-X-6 L: 16-X-22

LIFE HISTORY

Range	S. California, 32-34°N, to Arctic, not specific
Ecology	Epi- and mesobenthal, intertidal to 275 m
ELH pattern	Oviparous; demersal, adhesive eggs; pelagic larvae
Spawning	Season: Nov-Feb[a] Areas: In areas of strong current[b] Mode: Migration:
Fecundity	Range/function: 1000[c] (*A. personatus*, western Pacific)-22,100[d] (southwestern Barents Sea)
Age at first maturity	1 yr[e] (western Pacific)
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	0.67-0.91 mm (0.80 mm)
No. of oil globules	One
Oil globule diameter	~0.26 mm
Yolk	
Envelope	
Hatch size	6-7 mm SL (as small as 4 mm)
Incubation time/temp.	2-12 wk

Pigment
- Embryo: Eyes, dorsal and ventral body

Diagnostic characters

LARVAE

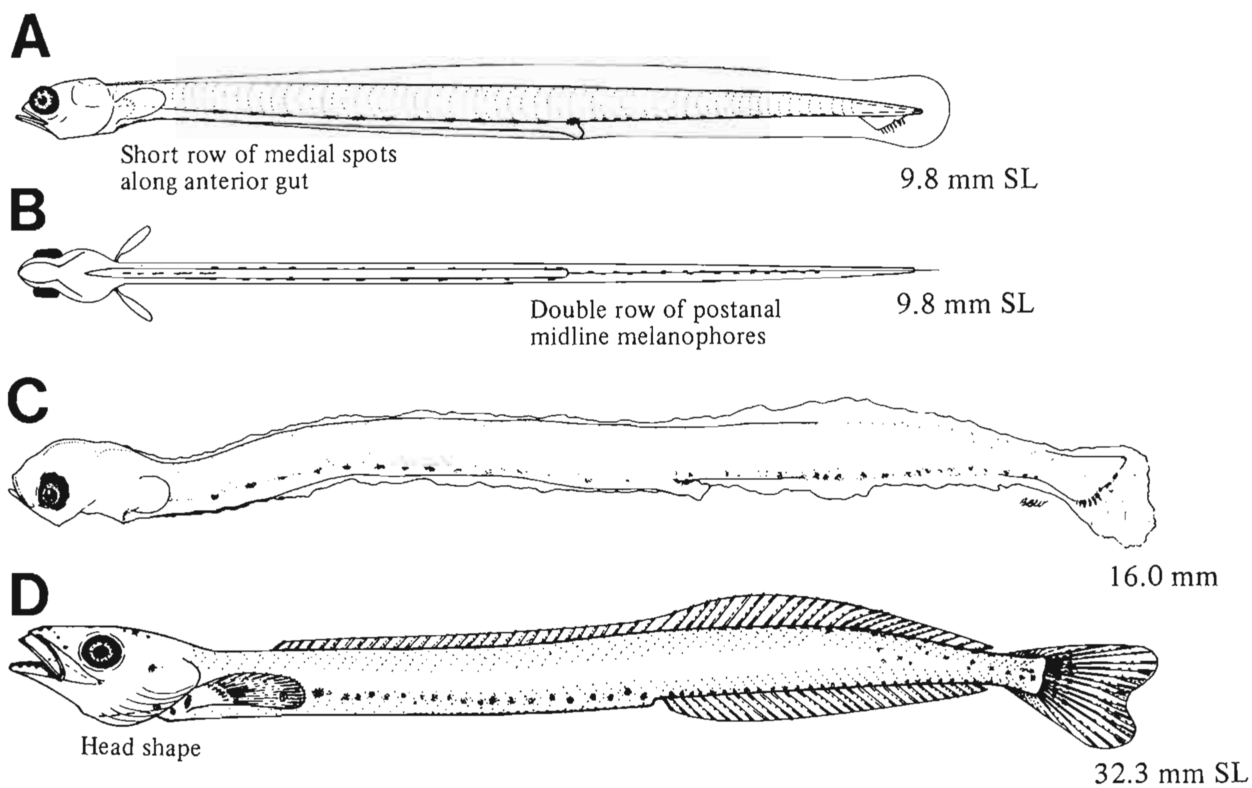
Preanal length	~60% SL
Length at flexion	11-13 mm SL
Length at transformation	16-31 mm SL
Sequence of fin development	Caudal, pectorals, dorsal and anal

Pigment
- Gut
- Double row postanal ventral pigment

Diagnostic characters (see Table 4)
- Elongate body
- Gut length (~60% SL)
- Lightly pigmented
- Postanal ventral pigment (double row)
- Dorsal and anal fins begin development opposed to each other
- Elongate head shape in larger specimens

[a] Trumble 1973
[b] Andriashev 1954
[c] Inoue et al. 1967
[d] Macy et al. 1978
[e] Hamada 1966

Ref: Kobayashi 1961c, Stevens et al. 1984.



Figures A–B, D, (B, ventral view), NWAFC originals (B. Vinter); C, Stevens et al. 1984.

Gobiidae is the most speciose family of marine fishes, although some species occur in brackish or freshwater environments. Gobies are generally small bottom-dwelling fishes with pelvic fins united to form a sucking disc. Found mainly in subtropical and tropical areas, adults inhabit shallow to moderate depths in salt and brackish water (some in freshwater). The study area includes three species: *Clevelandia ios*, *Coryphopterus nicholsi*, and *Lepidogobius lepidus*. Larvae are easily recognized by their conspicuously pigmented swimbladder and pigment patterns. Larvae are commonly collected inshore and in bays and estuaries. They are rare in coastal ichthyoplankton collections in the study area.

Small larvae of *Clevelandia* and *Lepidogobius* have been confused for some time in the literature. Since we have incomplete developmental series of the two species, we are presenting a consensus of opinion from researchers who have had more experience studying or collecting gobies. Gobiid larvae with three dorsal melanophores previously assigned to *Clevelandia* are now considered *Lepidogobius* (Wang 1986; W. Watson and G. McGowen, pers. commun.[1]).

[1]W. Watson, Marine Ecological Consultants, 531 Encinitas Blvd., Suite 110, Encinitas, CA 92024, pers. commun., 3 Nov. 1986; G. McGowen, Los Ang. Cty. Mus. Nat. Hist., 900 Exposition Blvd., Los Angeles, CA 90036, pers. commun., 31 Oct. 1986.

Table 47

Early-life-history characters of gobiid larvae from the Northeast Pacific (Wang 1981, in part).

	Clevelandia ios	*Coryphopterus nicholsi*	*Lepidogobius lepidus*
Spawning Site	Burrow	Rocky reef	Burrow
Egg Shape	Elliptical with narrow, blunt distal end	Spindle-shaped, narrow, elongate	Elliptical
Larvae			
Total myomeres	34-36	25-26	36-38
Preanal myomeres	16-18	9-10	14-17
Postanal myomeres	16-19	14-17	19-23
Distinguishing pigmentation	Single large melanophore along dorsal midline of body which forms a band at about myomere 26	A series of 10-15 melanophores along ventral body midline and a shorter series along dorsal midline near caudal	Three dorsal midline melanophores, posteriormost forming a band at about myomeres 19-26
Juveniles			
Dorsal fin	IV-VI; 0-I, 14-17	V-VI; I-II, 9-15	VI-IX; 0-I, 14-18
Anal fin	0-I, 14-17	0-I, 11-14	0-I, 13-16
Pectoral fin	18-21	21-24	20-22
Vertebrae	35-37	26	37-38
Distribution	Seawater-polyhaline-oligohaline	Seawater-polyhaline	Seawater-polyhaline-oligohaline
Distinguishing characteristics	∼12 dark bands on dorsum; ∼12 close melanophores on lateral line	Large black eye; black margin on spinous dorsal fin; side of body without dark vertical bands	Black margin on spinous dorsal fin; broad dark band at base of caudal region; body pigmentation light

MERISTICS

Vertebrae	Total: 35-36-37	
	Precaudal: 15-15-15	
	Caudal: 21-21-22	
Branchiostegal rays	3-X-5	
Caudal fin		
Pelvic fin	Thoracic	
	R: 5-5-5	
Dorsal fin	1st S: 4-X-6	
	2nd S: 0-X-1	R: 14-X-17
Pectoral fin	R: 20-20-20	
Anal fin	S: 0-X-1	R: 14-X-17
Gill rakers	U: 1-X-3	L: 5-X-7

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Intertidal
ELH pattern	Oviparous; demersal, attached eggs; pelagic larvae
Spawning	Season: Nov-June or later[a]
	Area:
	Mode:
	Migration:
Fecundity	Range/function: 750-1000 (may be multiple spawners)[b]/ $F=0.0306 \times L^{2.04}$[c]
Age at first maturity	1 yr[c]
Longevity	2-3 yr[c]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	0.70-0.85 mm
No. of oil globules	Many coalescing to one
Oil globule diameter	
Yolk	
Envelope	Transparent; adhesive threads at one pole
Hatch size	2.7-3.8 mm SL
Incubation time/temp.	10-12 d/15-15.5°C
Pigment	

Diagnostic characters
- Ellipsoidal

LARVAE

Preanal length	45-52% SL
Length at flexion	
Length at transformation	
Sequence of fin development	Caudal, 2nd dorsal and anal, 1st dorsal and pectorals, pelvics

Pigment
- Single large melanophore along dorsal midline of body which forms a band at about myomere 26
- Dorsal surface of swimbladder

Diagnostic characters (see Table 47)
- Conspicuously pigmented swimbladder (family)

Distinguished from *Coryphopterus nicholsi* by
- Total myomeres (fewer in *C. nicholsi*, 25-26 vs. 35-37)

Distinguished from *Lepidogobius lepidus* by
- Pigment pattern: No anterior melanophores along dorsal midline; present in *L. lepidus*

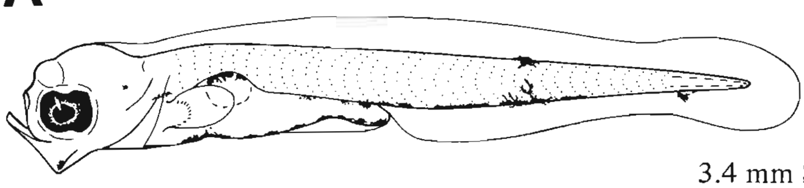
Postflexion
- Dorsal spine count (4-6), anal count (14-17), mouth size

[a]Wang 1981
[b]Prasad 1958
[c]Brothers 1975

Ref: Prasad 1958, Ruple 1984, Wang 1981.

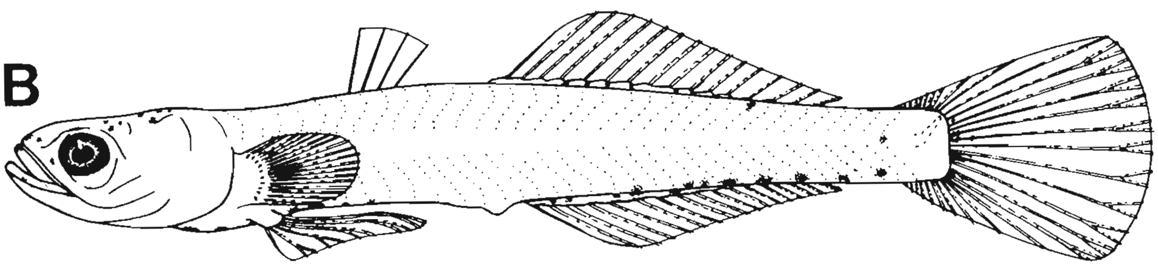
A

One blotch along dorsal surface posteriorly



3.4 mm SL

B



15.0 mm SL

Figures A–B, NWAFC originals (B. Vinter; specimens loaned by Bruce Mundy, formerly of Oregon State University. The 15.0 mm SL specimen was slightly damaged, so the swimbladder could not be accurately illustrated).

MERISTICS

Vertebrae	Total: 26-26-26	
	Precaudal: 11-11-11	
	Caudal: 15-15-15	
Branchiostegal rays	3-X-5	
Caudal fin		
Pelvic fin	Thoracic	
	R: 6-6-6	
Dorsal fin	1st S: 4-X-8	
	2nd S: 1-X-2	R: 9-X-15
Pectoral fin	R: 16-X-23	
Anal fin	S: 0-X-1	R: 11-X-13
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Nearshore shelf demersal, intertidal to 106 m
ELH pattern	Oviparous; demersal, attached eggs; pelagic larvae
Spawning	Season: Feb[a]-Oct[b] (California) Area: Under rocks[a] Mode: Pairs; eggs guarded by males[a] Migration:
Fecundity	Range/function: 3274-4788 (may be multiple spawners)[a]
Age at first maturity	2-5 yr (females)[a] 3-5 yr (males)[a]
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	2.1×0.48 mm
No. of oil globules	Multiple
Oil globule diameter	
Yolk	
Envelope	Transparent, smooth
Hatch size	2.94 mm TL
Incubation time/temp.	
Pigment	

Diagnostic characters
- Ellipsoidal (pointed at each end)
- Pigmented dorsally over yolk and along ventral body midline

LARVAE

Preanal length	50% SL
Length at flexion	
Length at transformation	
Sequence of fin development	Caudal, 2nd dorsal and anal, 1st dorsal and pectorals, pelvics

Pigment
- Dorsal surface of swimbladder
- Dorsal surface of posterior gut
- Series of dorsal midline melanophores along posterior half of body
- 10-15 postanal ventral melanophores
- With development, pigment in hypural area

Diagnostic characters (see Table 47 and *Clevelandia ios*, p. 544)
- Myomeres (26)

[a] Wiley 1973
[b] Ebert and Turner 1962

Ref: Ruple 1984, Wang 1981.

A

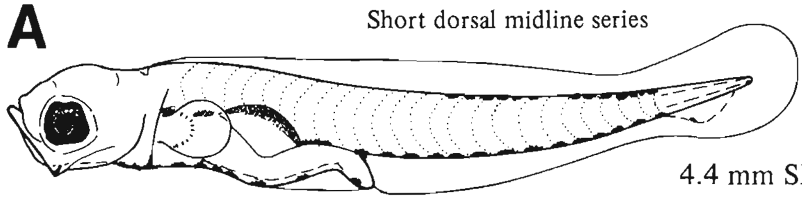


Figure A, NWAFC original (B. Vinter; specimen loaned by Bruce Frost, University of Washington, for illustration).

MERISTICS

Vertebrae	Total: 37-37-38 Precaudal: 15-15-15 Caudal: 22-22-23
Branchiostegal rays	3-X-4
Caudal fin	
Pelvic fin	Thoracic R: 5-5-5
Dorsal fin	1st S: 6-X-9 2nd S: 0-X-1 R: 14-X-18
Pectoral fin	R: 20-20-20
Anal fin	S: 0-X-1 R: 13-X-16
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to Brit. Col., 48°30′-55°N
Ecology	Nearshore shelf demersal, intertidal to 201 m
ELH pattern	Oviparous, demersal eggs, pelagic larvae
Spawning	Season: Nov-June (California)[a] Area: Intertidal mudflats[a] Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.3-1.8 × 0.8-1.0 mm (unfertilized)
No. of oil globules	Many (unfertilized)
Oil globule diameter	
Yolk	Granular, yellowish
Envelope	Transparent, smooth
Hatch size	
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	42-45% TL
Length at flexion	
Length at transformation	
Sequence of fin development	Caudal, 2nd dorsal and anal, 1st dorsal and pectorals, pelvics

Pigment
- Dorsal surface of swimbladder
- Three dorsal midline melanophores, posteriormost forming a band at about myomeres 19-26

Diagnostic characters (see Table 47 and *Clevelandia ios*, (p. 544)

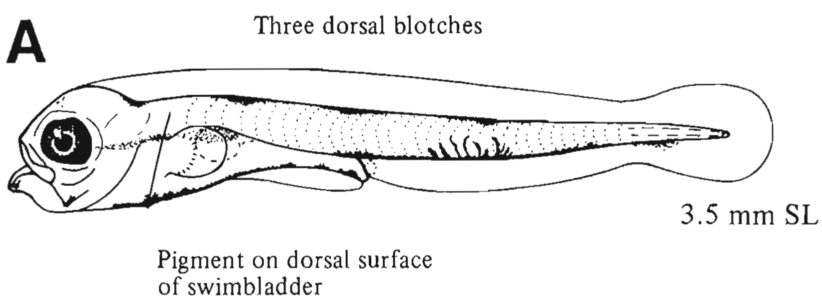
Distinguished from *C. ios* by
- Anterior melanophores along dorsal midline; not present in *C. ios*

Distinguished from *Coryphopterus nicholsi* by
- Total myomeres (fewer in *C. nicholsi*, 25-26 vs. 37-38)

[a] Wang 1981

Ref: Ruple 1984, Wang 1981.

A



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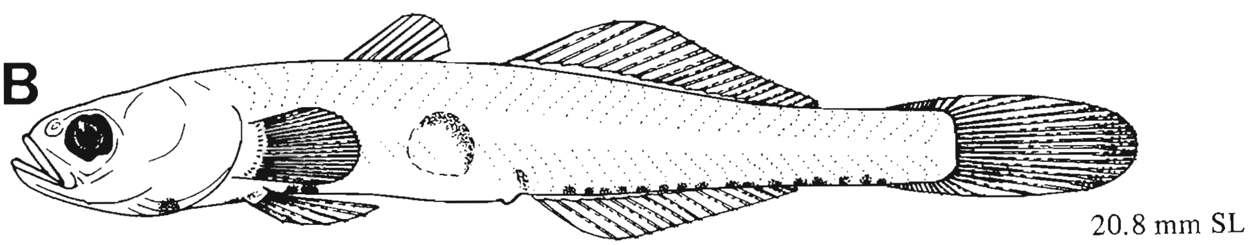


Figures A–B, NWAFC originals (B. Vinter; specimens loaned by Bruce Mundy, formerly of Oregon State University, for illustration).

There are four species of cutlassfishes in three genera of this family in the northeastern Pacific. General body shape is elongate and ribbonlike, tapering to a small caudal fin. Voracious predators, most have a large, well-toothed mouth and pointed snout. Adult cutlassfishes are benthopelagic but have been found at the surface at night (Fritzsche 1978). Spawning occurs offshore, resulting in pelagic eggs which can be 1.6-2.5 mm and have a single reddish-yellow oil globule (Breder and Rosen 1966, Fritzsche 1978). Pelagic larvae have a high myomere count (generally >100) and develop three dorsal spines, the first of which may be elongate (Schmidt and Strubberg 1918). Larvae have a small head with a long, tapering body (Ozawa 1986e). No early-life-history stages have been collected in our area.

Table 48
Meristic characters of family Trichiuridae.

		Vertebrae		Fins				Gill rakers		
Taxon	Distribution	Precaudal (Total)	Caudal	Dorsal	Anal	Pectoral	Pelvic	Upper	Lower	Branchiostegals
Aphanopus carbo	N. Calif.-Brit. Col.	42-46	55-59	XXXVIII-XLIII, 53-56	I-II, 44-49	12	I,1			7-8
Benthodesmus elongatus	Cent. Calif.-Brit. Col.	(148-153)		XLIV-XLVII, 98-102	II, 91-98	12	I,1	5	9	7
Benthodesmus tenuis	Brit. Col.	(121-131)		XXXIX-XLII, 79-88	II, 69-75					
Lepidopus fitchi	SSC-Oregon	35 (84-92)	50	IX, 78-86	II, 41-49	12	I,1*	7	10	7

*The soft ray is rudimentary (Rosenblatt and Wilson 1987).

MERISTICS *B. elongatus* (Steindachner 1891)

Vertebrae	Total: 148-X-153	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	7-7-7	
Caudal fin		
Pelvic fin	Thoracic	
	S: 1-1-1	R: 1-1-1
Dorsal fin	S: 44-44-47	R: 98-X-102
Pectoral fin	R: 12-12-12	
Anal fin	S: 2-2-2	R: 91-93-98
Gill rakers	U: 5-5-5	L: 9-9-9

MERISTICS *B. tenuis* (Günther)

Vertebrae	Total: 121-X-131	
	Precaudal: X-X-X	
	Caudal: X-X-X	
Branchiostegal rays	7-7-7	
Caudal fin		
Pelvic fin	Thoracic	
	S: X-X-X	R: X-X-X
Dorsal fin	S: 39-X-42	R: 79-X-88
Pectoral fin	R: X-X-X	
Anal fin	S: 2-2-2	R: 69-X-75
Gill rakers	U: X-X-X	L: X-X-X

LIFE HISTORY

Range	Cent. California, 34-38°N,[a] to Brit. Col., 48°30′-55°N
Ecology	Epi- and mesopelagic
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

[a] *B. tenuis* range restricted to British Columbia.
[b] Description based on *B. elongatus simonyi*, a subspecies from the North Atlantic, and *B. elongatus pacificus* from Japan. Ozawa (1986e) describes and figures one late postflexion larva of *B. tenuis* (27.1 mm SL). Larvae of *B. elongatus* and *B. tenuis* from our area may differ.
[c] Ozawa 1986e

Ref: Collette et al. 1984b, Evseenko 1982, Gorbunova 1982b, Ozawa 1986e, Peden and Hughes 1986.

EARLY LIFE HISTORY DESCRIPTION

EGGS - Family

Diameter	1.7-2.0 mm
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	
Hatch size	4.5-6.5 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE[b]

Preanal length	
Length at flexion	
Length at transformation	
Sequence of fin development	Dorsal first fin to develop

Pigment
- Blotch on upper preopercle
- Crown
- Dorsal midline beginning just anterior to dorsal fin origin and running along developing fin, increasing with development
- Dorsolateral gut
- Ventrolateral blotch about mid-postanal body; with development becoming a series along ventral midline about 3/4 length of anal fin
- *B. elongatus pacificus* has a blotch at the origin of the anal fin (not shown on figure)[c]

Diagnostic characters
- Family
  —Serrate spines in dorsal, anal, and pelvic fins
  —In some genera (e.g., *Benthodesmus*), the anteriormost rays of the dorsal fin are extremely elongate in the smallest larvae
- Genus
  —Caudal fin development distinct
  —Pelvic fin located approximately below pectoral fin
  —Number of dorsal fin spines (>30)

BENTHODESMUS

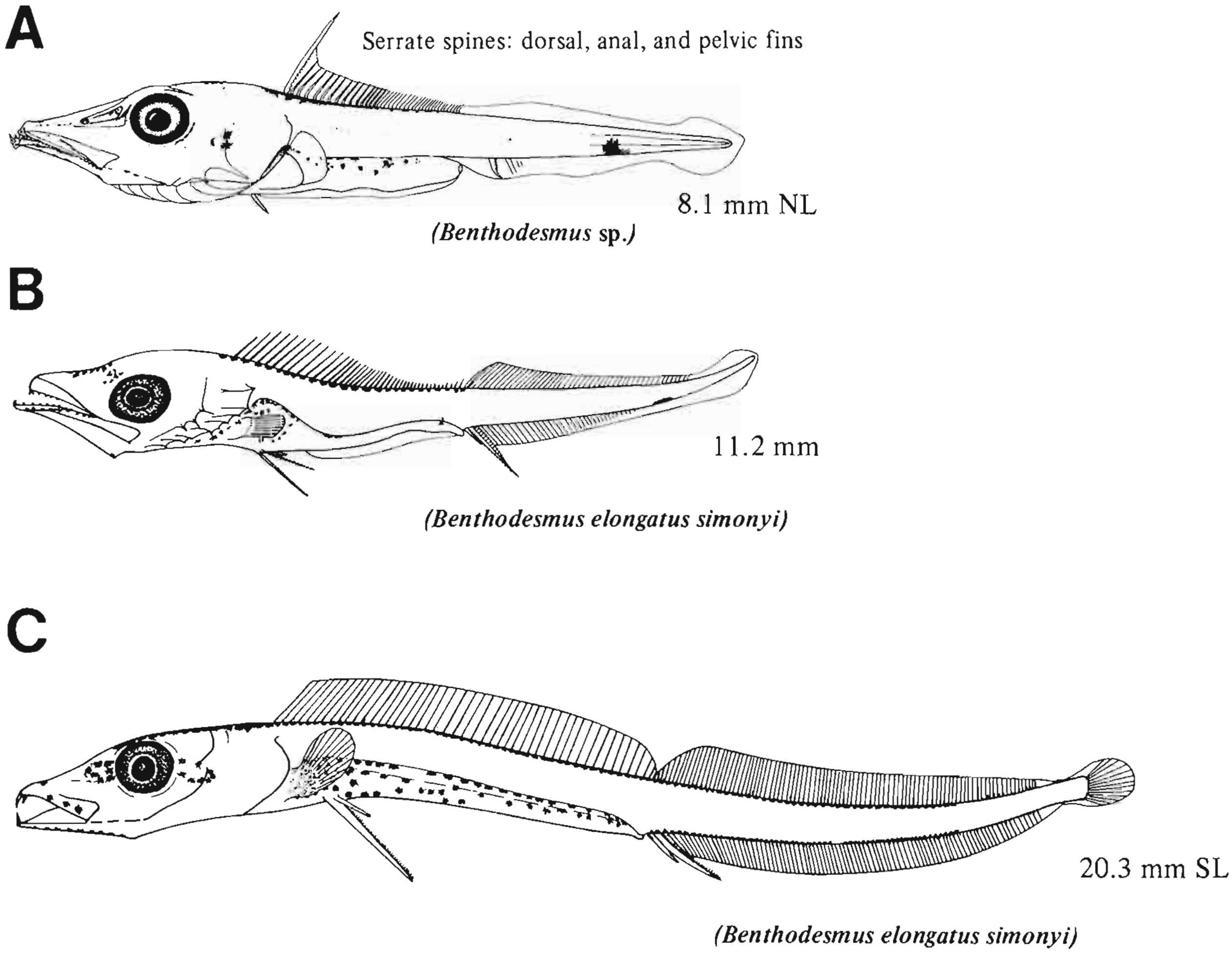


Figure A, Collette et al. 1984b (Gulf of Mexico specimen); B, Gorbunova 1982b; C, Evseenko 1982 (B–C, redrawn; subspecies from North Atlantic).

MERISTICS

Vertebrae	Total: 30-31-31	
	Precaudal: 14-14-15	
	Caudal: 16-17-17	
Branchiostegal rays	7-7-7	
Caudal fin	X, 9+8, X	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 9-10-12	R: 11-12-12
Pectoral fin	R: 20-20-20	
Anal fin	S: 1-1-1	R: 11-X-12
Gill rakers	U: 11-13-14	L: 27-28-30

LIFE HISTORY

Range	South of southern California to SE Alaska, 55-59°N
Ecology	Epi- and mesopelagic, 0-300 m[a]
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Apr-July (California)[b]
	Area: 0-72 m, 3-32 km from shore[c]
	Mode:
	Migration:
Fecundity	Range/function: >1 million (may spawn more than once each year)[b]
Age at first maturity	2 yr[b]-6 yr[d]
Longevity	10 yr[b]; 12 yr[e]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	0.9-1.3 mm
No. of oil globules	One, ventral
Oil globule diameter	0.26 mm
Yolk	Homogeneous
Envelope	Smooth, clear
Hatch size	3.3 mm SL
Incubation time/temp.	

Pigment
- Oil globule
- Yolk

Diagnostic characters
- Posterior position of oil globule

LARVAE

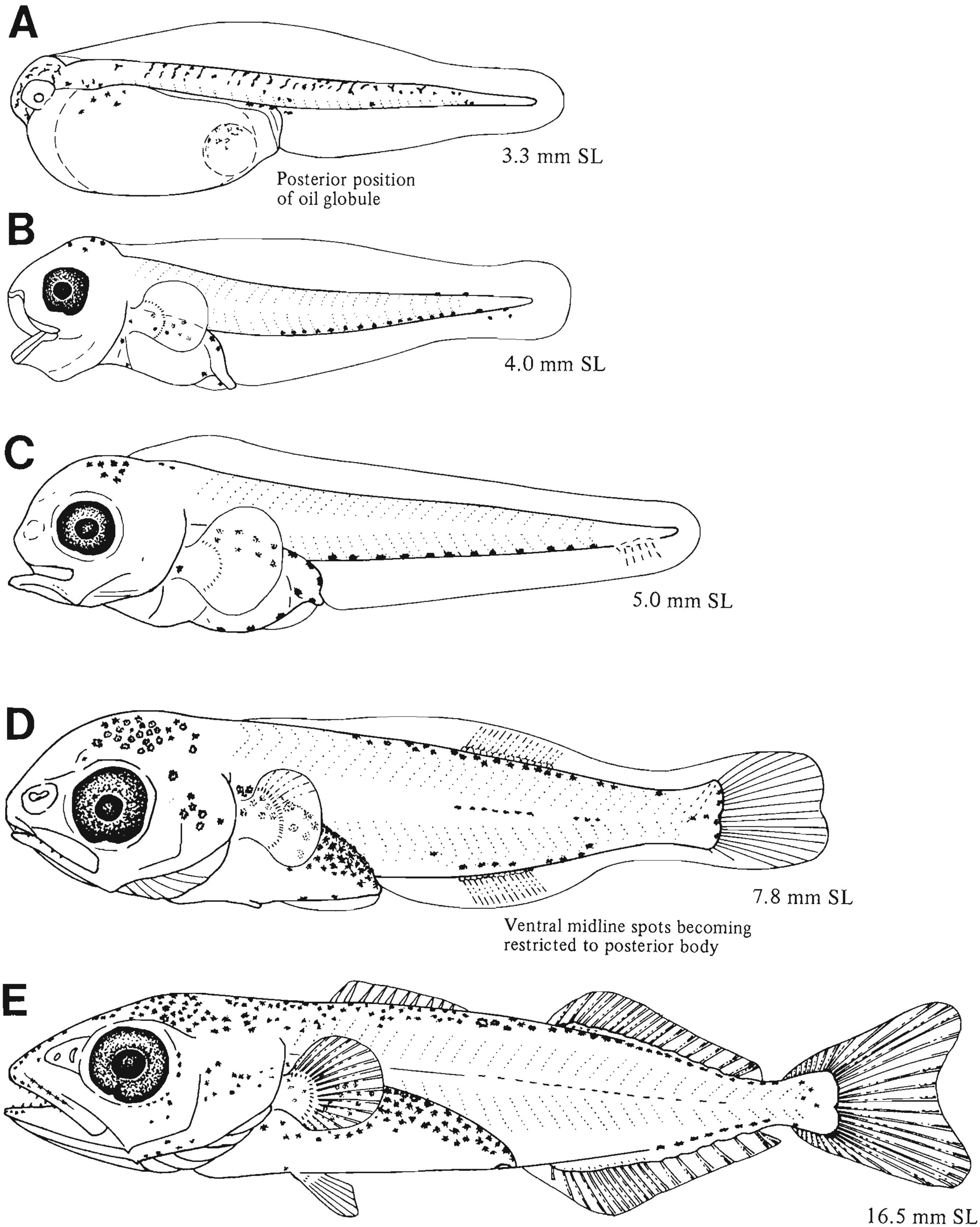
Preanal length	52%, increasing with development to 64% SL
Length at flexion	6 mm SL
Length at transformation	15 mm SL
Sequence of fin development	2nd dorsal (rays) and anal, 1st dorsal (spines), pectorals and pelvics

Pigment
- Pigment on crown extends anteriorly with development
- Dorsolaterally on gut
- Ventral midline
- Postflexion
  - —Short dorsal midline series develops under dorsal fin, spreading anteriorly
  - —Ventral midline becomes restricted to posterior half of body
  - —Mediolateral pigment

Diagnostic characters
- Large head with teeth
- Myomeres (30-31)
- Pigment pattern

[a] Collette and Nauen 1983
[b] Hart 1973
[c] Fritzsche 1978
[d] Schaefer 1980
[e] Fitch and Lavenberg 1971

Ref: Berrien 1978, Collette et al. 1984b, G.D. Johnson 1984, Kramer 1960.



Figures A–E, Kramer 1960 (redrawn).

MERISTICS

Vertebrae	Total: 22-22-23	
	Precaudal: 10-10-10	
	Caudal: 12-12-13	
Branchiostegal rays	5-X-6	
Caudal fin	X, 16, X	
Pelvic fin[a]	Thoracic	
	S: 1-1-1	R: 4-4-4
Dorsal fin[a]	S: 2-2-2	R: 24-24-24
Pectoral fin	R: 17-X-20	
Anal fin[a]	S: 14-X-17	
Gill rakers	U: 4-X-6	L: 11-X-14

LIFE HISTORY

Range	South of southern California to Washington, 46-48°30′N
Ecology	Epi- and mesopelagic
ELH pattern	Parity and eggs unknown, pelagic larvae
Spawning	Season: Spring-early summer[b]
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

[a] Meristics for larvae and adults are different:

	Larvae	Adults
Dorsal fin rays	24	11-14
Anal fin rays	18	13-15
Pelvic fin rays	4	absent

[b] Fitch and Lavenberg 1971

[c] Based on illustrations only, specimens were not available.

[d] G.D. Johnson, Natl. Mus. Nat. Hist., Wash., D.C. 20560, pers. commun., 7 Nov. 1986.

Ref: Leis and Richards 1984, Nishikawa 1987.

EARLY LIFE HISTORY DESCRIPTION

EGGS

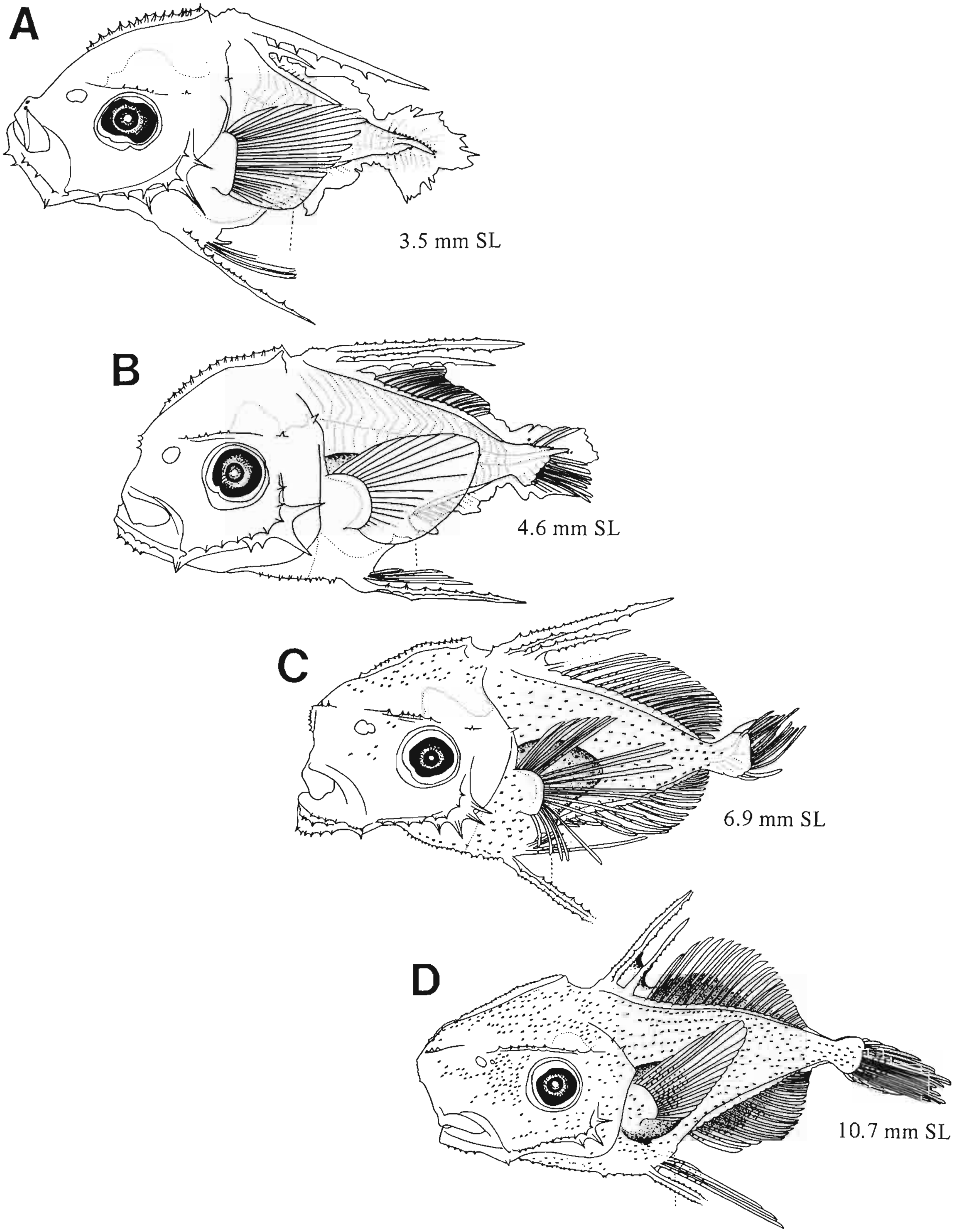
Diameter
No. of oil globules
Oil globule diameter
Yolk
Envelope
Hatch size <3.5 mm SL
Incubation time/temp.
Pigment

Diagnostic characters

LARVAE

Preanal length ~60% SL, decreasing with development
Length at flexion
Length at transformation
Sequence of fin development Pelvics and anterior dorsal fin spines form early
Pigment[c]
- Few spots on upper jaw
- With development above urostyle
- Lightly on caudal fin, hypural region with several spots
- Gut
- With development on pectoral fin rays

Diagnostic characters
- Morphology
  - —Deep-bodied but not as kite-shaped as acanthurids
  - —Large square-shaped head with small terminal mouth
  - —Extensive head spination
  - —With development, minute spines on soft rays and along body surface
  - —Dorsal and pelvic spines elongate, finely serrated
  - —Loss of meristic elements with growth
- Not shown on figure[d]
  - —Spines on ascending process of premaxillary bone (important feature uniquely shared with *Zanclus canescens*, a closely related acanthuroid, and acanthurids)
  - —Small dorsal spine anterior to first dorsal spine appears later in development



Figures A–D, Nishikawa 1987 (western Pacific specimen).

MERISTICS

Vertebrae	Total: 56-59-62	
	Precaudal: 22-24-25 (adults)[a]	
	Caudal: 33-35-38	
Branchiostegal rays	7-7-7	
Caudal fin	11-14, 9+8, 10-13	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 3-3-3	R: 34-39-43
Pectoral fin	R: 18-X-21	
Anal fin	S: 3-3-3	R: 20-X-29
Gill rakers	U: 4-X-6	L: 12-X-14

LIFE HISTORY

Range	South of southern California to Gulf of Alaska, 54-60°N
Ecology	Epipelagic, 0-91 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.52-1.80 mm
No. of oil globules	One
Oil globule diameter	0.30-0.44 mm (large)
Yolk	Homogeneous
Envelope	Clear, smooth
Hatch size	
Incubation time/temp.	

Pigment

- Dorsal pigment along body
- Ventral pigment from head to tip of tail
- Underside of oil globule becomes pigmented with development

Diagnostic characters

LARVAE

Preanal length	50-58% SL
Length at flexion	~9.3-11.0 mm SL
Length at transformation	~20 mm SL
Sequence of fin development	Caudal, 2nd dorsal (rays), anal, pectorals, 1st dorsal (spines), pelvics

Pigment

- Dorsal and ventral body midline pigment
- Lateral line dashes develop during flexion
- Head and tail pigment increases with development
- Become heavily, uniformly pigmented including fin membranes

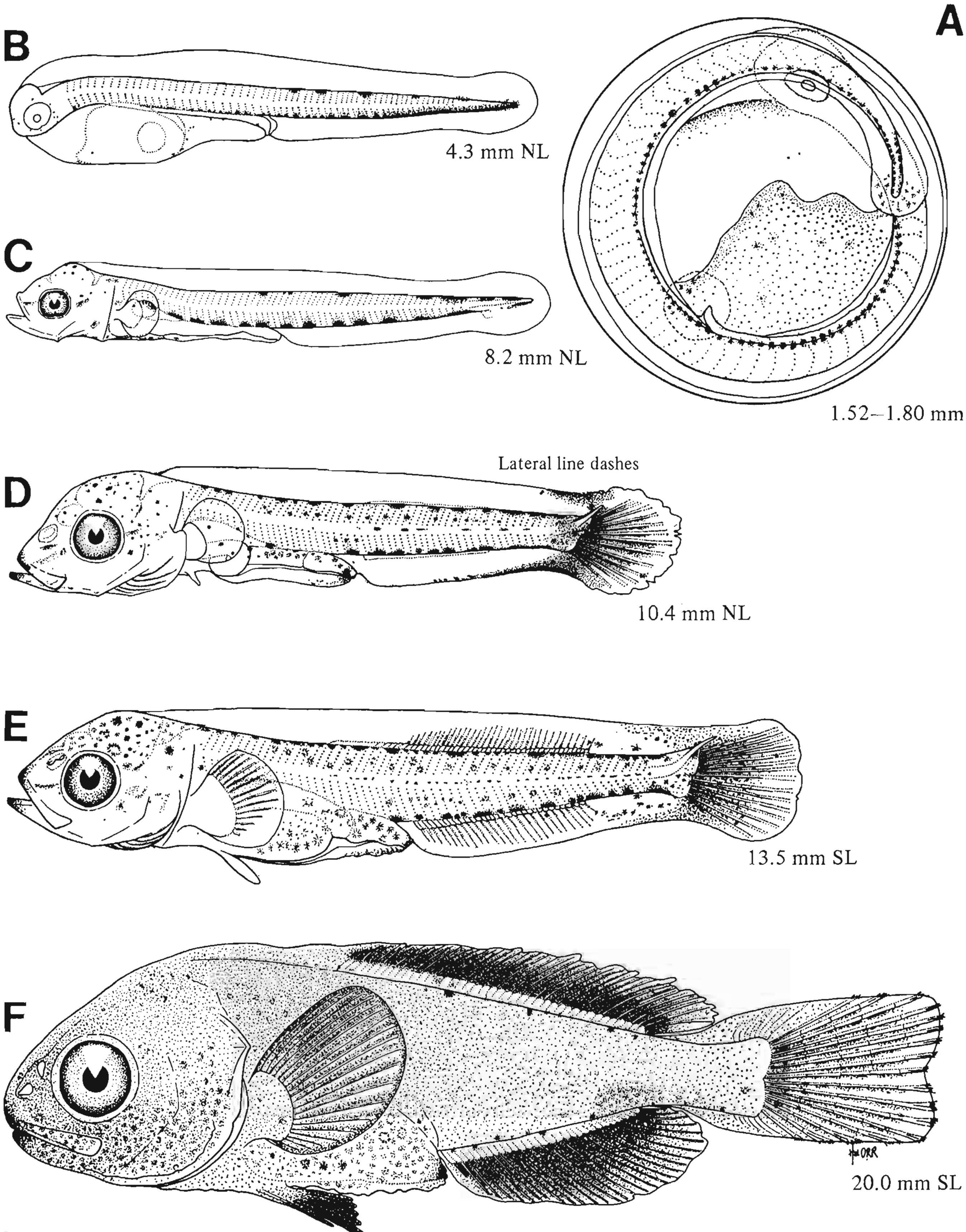
Diagnostic characters

Distinguished from *Tetragonurus cuvieri* (p. 560) by

- High myomere counts (56-62)
- Preflexion: Dorsal body pigment over posterior half of body; only on tail in *T. cuvieri*
- Flexion: No preopercular spines
- Postflexion
  - —Dorsal and anal spines weak, few (three) dorsal spines
  - —More dorsal and anal fin rays than in *T. cuvieri*

[a]Number of preanal myomeres appears to decrease with development (B. Sumida, NMFS Southwest Fish. Cent., P.O. Box 271, La Jolla, CA 92038, pers. commun., 16 Dec. 1986).

Ref: Ahlstrom et al. 1976, Horn 1984.



Figures A–F, Ahlstrom et al. 1976.

MERISTICS

Vertebrae	Total: 52-53-57	
	Precaudal: 25-28-29 (adults)[a]	
	Caudal: 24-26-28	
Branchiostegal rays	5-6-6	
Caudal fin	9-13, 9+8, 9-12	
Pelvic fin	Thoracic	
	S: 1-1-1	R: 5-5-5
Dorsal fin	S: 15-17-21	R: 10-12-17
Pectoral fin	R: 14-X-17	
Anal fin	S: 2-2-2	R: 9-X-15
Gill rakers	U: 6-6-6	L: 7-X-14

LIFE HISTORY

Range	South of southern California to Aleutian Is., 51-55°N
Ecology	Epipelagic
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.10-1.28 mm
No. of oil globules	One
Oil globule diameter	0.25-0.30 mm (amorphous)
Yolk	Homogeneous
Envelope	Smooth, golden
Hatch size	4.0-4.1 mm SL
Incubation time/temp.	

Pigment
- Oil globule
- Distinctive pigment on embryo; double dorsal line separating prior to head, outlining brain, and extending forward to snout
- Ventral pigment above digestive tract, continuing along tail

Diagnostic characters
- Pigment

LARVAE

Preanal length	60-70% SL
Length at flexion	7.6-10.1 mm SL
Length at transformation	~21.4 mm SL
Sequence of fin development	Caudal; 2nd dorsal (rays), anal, and pectorals; 1st dorsal (spines); pelvics

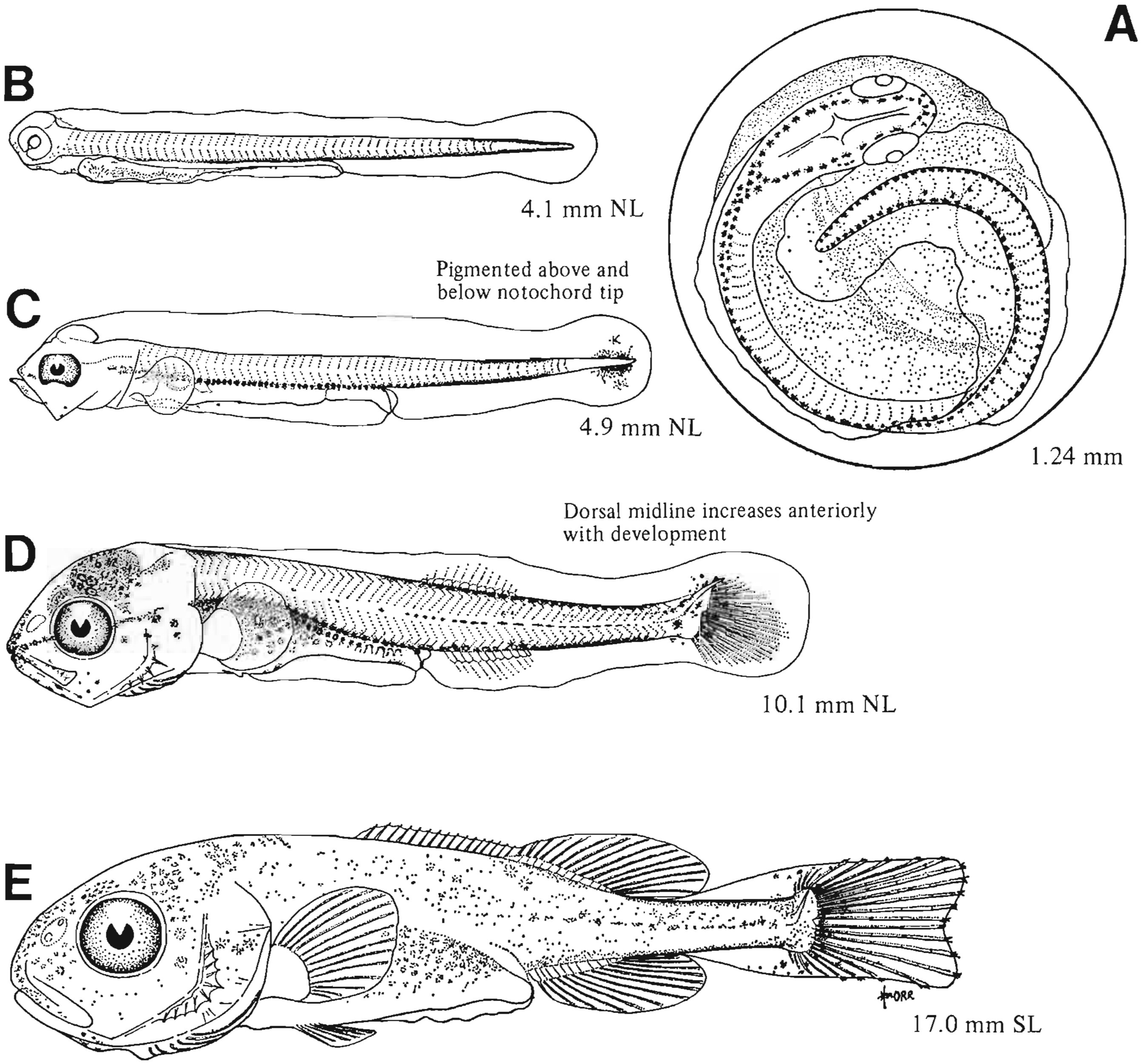
Pigment
- Tail
- Lateral line notable during flexion
- Eye bar
- Dorsal midline on caudal peduncle extending anteriorly with development

Diagnostic characters

Distinguished from *Icichthys lockingtoni* (p. 558) by
- Myomere count (52-57)
- Pigment
  —Notochord tip and base of caudal
  —Ventral row over gut to tail
- Early formation of opposing 2nd dorsal and anal fins
- Slender body with long caudal peduncle

[a] Number of preanal myomeres appears to decrease with development (B. Sumida, NMFS Southwest Fish. Cent., P.O. Box 271, La Jolla, CA 92038, pers. commun., 16 Dec. 1986).

Ref: Ahlstrom et al. 1976.



Figures A–E, Ahlstrom et al. 1976.

MERISTICS

Vertebrae	Total: 28-30-31	
	Precaudal: 11-13-14 (adults)[a]	
	Caudal: 17-17-19	
Branchiostegal rays	6-6-6	
Caudal fin	7-9, 9+8, 6-8	
Pelvic fin	Absent	
Dorsal fin	S: 2-3-4	R: 41-45-48
Pectoral fin	R: 19-21-23	
Anal fin	S: 2-3-3	R: 35-39-44
Gill rakers	U: 3-3-3	L: 11-11-11

LIFE HISTORY

Range South of southern California to Brit. Col., 48°30'-55°N
Ecology Epipelagic, 9-91 m
ELH pattern Oviparous, pelagic eggs, pelagic larvae
Spawning Season: Spring-summer (California)[b]
Area:
Mode:
Migration:
Fecundity Range/function:
Age at first maturity
Longevity

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter
No. of oil globules One
Oil globule diameter 0.2 mm (in yolksac larva)
Yolk
Envelope
Hatch size 1.8-2.0 mm SL
Incubation time/temp.
Pigment

Diagnostic characters

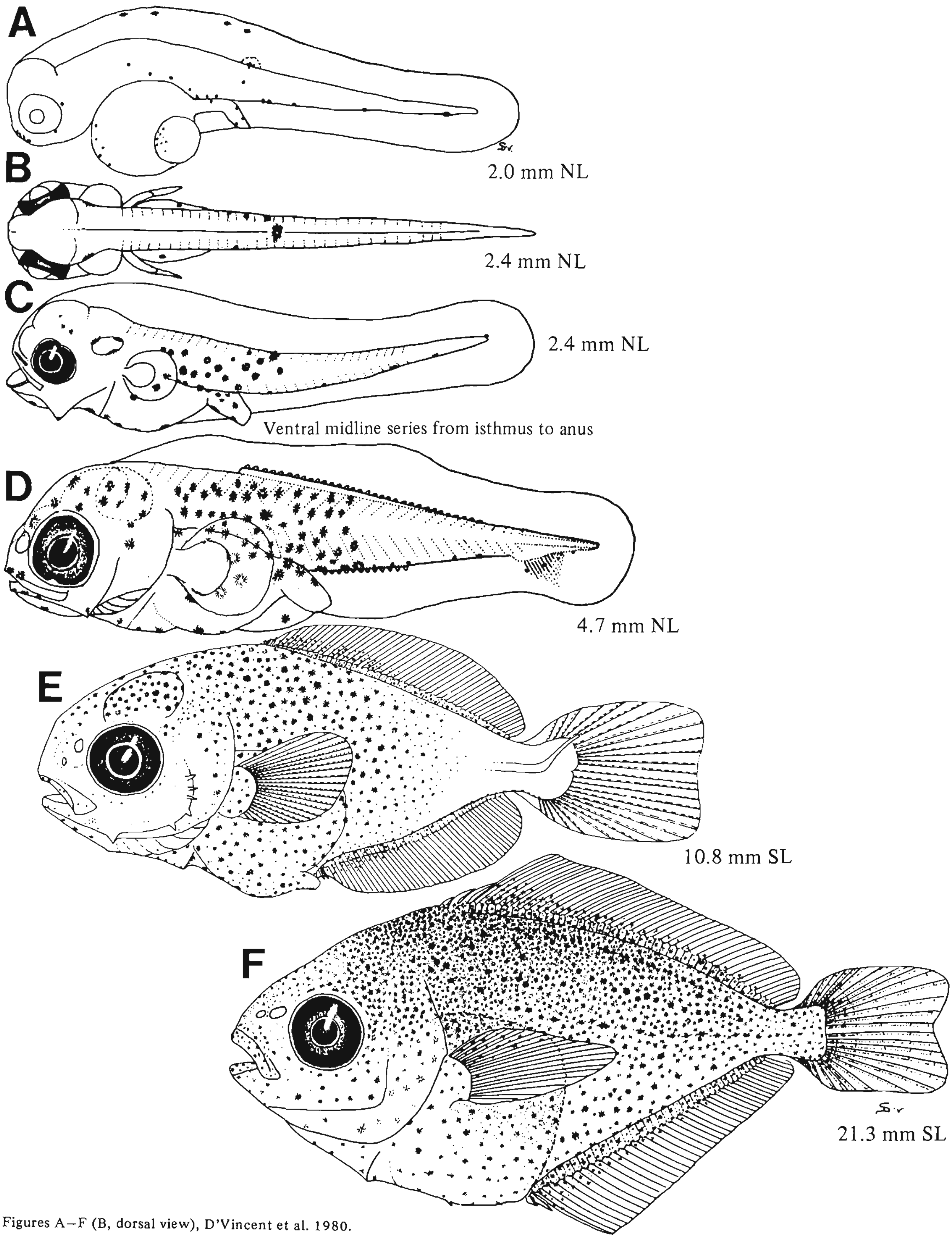
LARVAE

Preanal length 55%, with development decreasing to 44% SL
Length at flexion 5-7 mm SL
Length at transformation ~20 mm SL
Sequence of fin development
Pigment
- Anterior body
- Median ventral series of melanophores from isthmus to anus
- Large melanophores on head and anterior half of body, becoming uniformly pigmented on anterior 3/4 of body, later over whole body

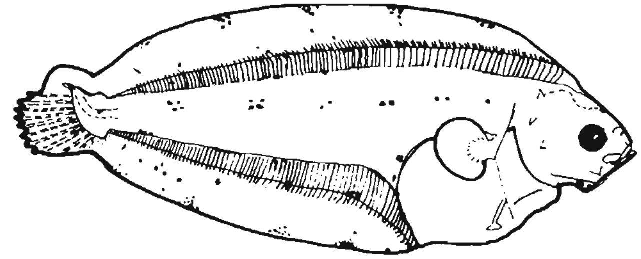
Diagnostic characters
- Pigment
- Increase in relative body depth during ontogeny
- Absence of pelvic fins

[a] Number of preanal myomeres appears to decrease with development (B. Sumida, NMFS Southwest Fish. Cent., P.O. Box 271, La Jolla, CA 92038, pers. commun., 16 Dec. 1986).
[b] Fitch and Lavenberg 1971

Ref: D'Vincent et al. 1980.



Figures A–F (B, dorsal view), D'Vincent et al. 1980.



Pleuronectiformes

Pleuronectiforms are benthic fishes that are asymmetrical with both eyes on one side of the head. Asymmetry is also reflected in dentition, cranial osteology, pelvic fin placement and morphology, pigment, and squamation. Worldwide in distribution, there are 7 families, with well over 120 genera and 500 species (Ahlstrom et al. 1984a). Most families are defined as dextral (eyes on right side) or sinistral (eyes on left side), although some species are indiscriminate. A total of 3 families with 31 species occur in the study area. Much is known about the early life history of many species. Eggs of most are pelagic, spherical, and have homogeneous yolks. Chorions may be smooth, striated, or ornamented with raised polygonal patterns (Ahlstrom et al. 1984a). Early larvae are bilaterally symmetrical and swim upright. Of help in larval identification are body shape (short gut, elongate body), pigment patterns (postanal bands, pigment on the urostyle and finfolds), and meristic characters. Size at transformation and the development of spines and elongate dorsal or pelvic fin rays can be diagnostic. During transformation, the eyes migrate to their adult position and the larvae assume the distinctive flat profile unique to the order. At this point, juveniles settle and become benthic inhabitants.

Families in study area: **Paralichthyidae**
Pleuronectidae
Cynoglossidae

Table 49

Characters useful in identifying pleuronectiform larvae. Size data are after Ahlstrom et al. (1984a), in part. All measurements are in millimeters NL or SL. Taxa listed alphabetically within families.

Species[a]	Size at hatching	Size at notochord flexion	Size at transformation	Total myomeres
Paralichthyidae				
Citharichthys sordidus	2.0	10.0-11.4	20.0-39.0	39-40
C. stigmaeus	2.0	9.2-10.2	24.0-36.0	36-39
Pleuronectidae				
Acanthopsetta nadeshnyi	<3.0	8.4-9.9	20.0-24.0	39-40[b]
Atheresthes evermanni	<8.4	11.5-15.0	—	—
A. stomias	<10.0	10.0-12.0	33.0- ?	47-50
Clidoderma asperrimum	—	—	—	42-44[b]
Embassichthys bathybius	9.0	15.4-16.2	16.2- ?	57-65
Eopsetta jordani	2.8	—	—	41-45
Glyptocephalus stelleri	4.1-5.2	15.0-17.0	19.0-48.0	52-60
G. zachirus	5.0-6.0	15.3-24.0	49.0-72.0	63-66
Hippoglossoides elassodon	5.3-6.9	9.0-10.2	18.0- ?	43-47
H. robustus	4.0	11.0- ?	>28.6	44
Hippoglossus stenolepis	7.8-8.5	13.6-17.8	14.7-24.1	49-51
Inopsetta ischyra	—	—	—	41
Isopsetta isolepis	2.7-2.9	9.1-14.0	15.0->21.9	41-42
Lepidopsetta bilineata	3.4-4.0	8.4-9.9	>17.7	39-42
Limanda aspera	2.2-2.8	7.5-9.5	10.0- ?	40-41
L. proboscidea	<4.8	—	—	—
Liopsetta glacialis	3.7	—	—	37-41
Lyopsetta exilis	5.6	9.0-10.9	15.7-24.7	43-47
Microstomus pacificus	6.0	10.0-15.0	20.0->45.0	50-55
Parophrys vetulus	2.3-2.8	8.8-10.5	17.5- ?	42-47
Platichthys stellatus	1.9-2.1	5.5-6.0	8.0- ?	35-38
Pleuronectes quadrituberculatus	5.6	8.0-10.0	10.0- ?	41-42
Pleuronichthys coenosus	3.9	6.2-8.5	8.2->11.4	37-39
P. decurrens	4.9-5.5	7.8-11.0	10.5->21.0	38-41
Psettichthys melanostictus	<3.0	8.0-10.0	>22.6	38-41
Reinhardtius hippoglossoides	10.0-16.0	25.0-27.0	45.0-65.0	61-64
Cynoglossidae				
Symphurus atricauda	1.9	9.4-10.8	19.0-24.2	50-52

[a] The following nomenclatural changes have been recommended by Sakamoto (1984):

Glyptocephalus (= *Errex*) *zachirus*	*Liopsetta* (= *Pleuronectes*)
Isopsetta (= *Pleuronectes*)	*Parophrys* (= *Pleuronectes*)
Lepidopsetta (= *Pleuronectes*)	*Lyopsetta* (= *Eopsetta*)
Limanda (= *Pleuronectes*)	

[b] M. Okiyama, Ocean Res. Inst., Univ. Tokyo, 1-15-1 Minamidai, Nakano-Ku, Tokyo 164, Japan, pers. commun., 17 Oct. 1986.

MERISTICS

Vertebrae	Total: 39-X-40 Precaudal: 11-11-12 Caudal: 27-28-29
Branchiostegal rays	6-X-7
Caudal fin	X, 7+6, X Total rays=17[a]
Pelvic fin	Thoracic R: 6-6-6
Dorsal fin	R: 86-91-102
Pectoral fin	R: 12-12-12
Anal fin	R: 67-72-81
Gill rakers	U: 6-X-9 L: 12-13-16

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Epi-, meso-, and bathybenthal, 0-549 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Mar-May (Puget Sound)[b]; July-Sept (Calif.; may spawn twice each season)[c] Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	2-3 yr[b]
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	0.55-0.77 mm;[c] 0.51-0.79 mm[d]
No. of oil globules	One
Oil globule diameter	0.09-0.12 mm
Yolk	Homogeneous
Envelope	Smooth
Hatch size	~2.0 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

We cannot identify *Citharichthys* spp. eggs to species. We collect two types of paralichthyid eggs: the first type has an average diameter of ~0.64-0.68 mm, and the other type averages ~0.78-0.88 mm.

LARVAE[e]

Preanal length	<50% SL
Length at flexion	<10.0-11.4 mm SL
Length at transformation	20->39 mm SL
Sequence of fin development	Dorsal, anal, caudal, pelvics, pectorals or caudal, dorsal and anal, pelvics, pectorals

Pigment

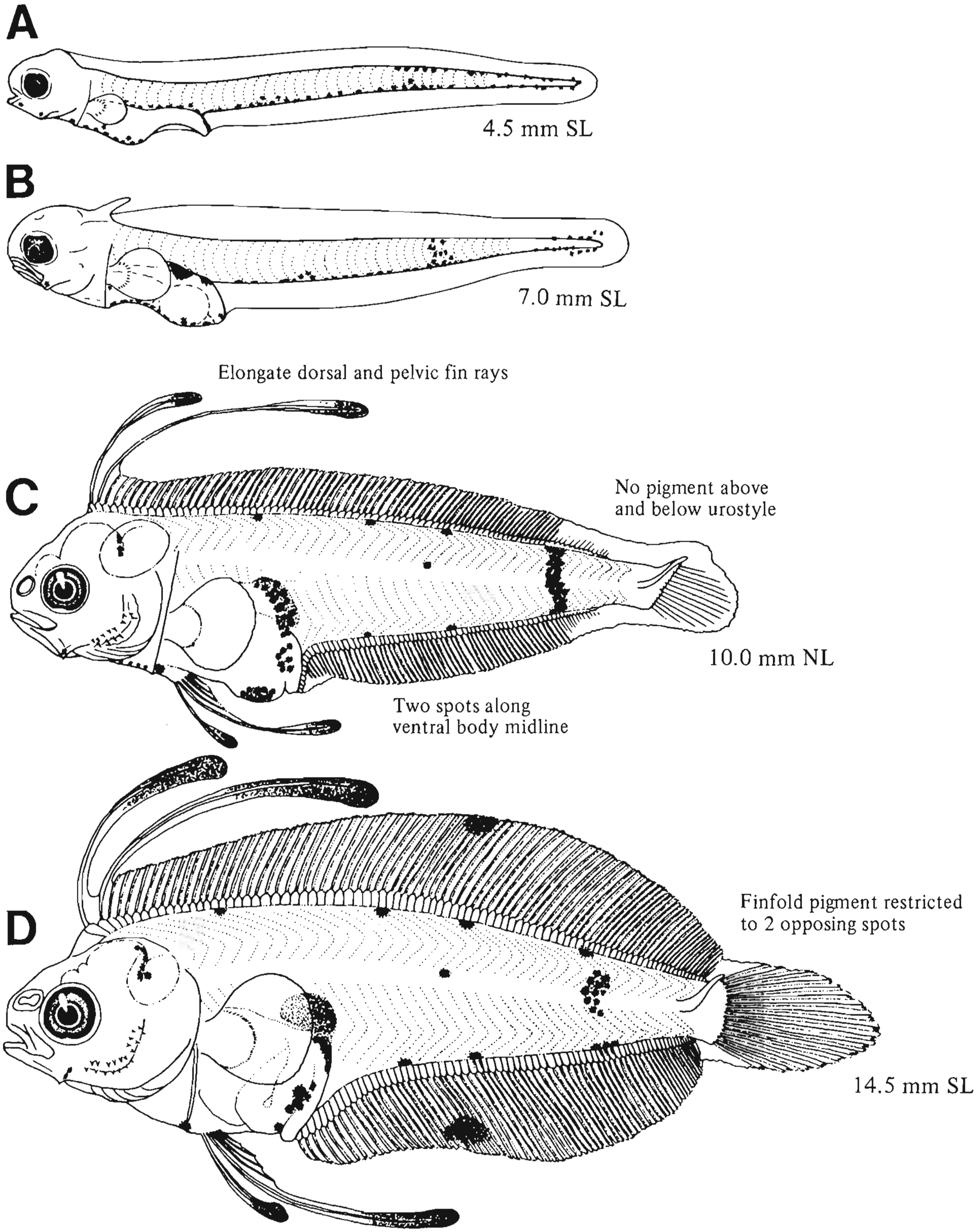
- Ventral body midline pigment posterior to anus, coalesces later into two melanophores
- Band at 3/4 BL
- Posteriorly on gut
- Tips of elongate dorsal and pelvic fin rays

Diagnostic characters

- Elongate dorsal and pelvic fin rays

[a] 11 branched rays.
[b] Smith 1936
[c] Arora 1951
[d] Ahlstrom et al. 1984a
[e] Early preflexion larvae (<6-7 mm SL) of *C. sordidus* and *C. stigmaeus* are not identifiable to species until the elongate dorsal fin rays form on *C. sordidus* (~7 mm SL). Preflexion larvae collected in our study area do not resemble the published illustrations of either species (Ahlstrom and Moser 1975); they have ventral gut pigment extending more anteriorly, a series of postanal ventral midline melanophores, no finfold pigment, and less intense caudal pigment (Fig. A). Specimens >6.9 mm SL that have elongated dorsal fin rays are *C. sordidus* (Fig. B), but do not exhibit the intense caudal pigment shown by Ahlstrom and Moser (1975). Our specimens indicate a decrease in intensity of caudal pigment with development for *C. sordidus* and an increase for *C. stigmaeus*. The preflexion larva of *C. sordidus* illustrated by Ahlstrom and Moser (1975) may belong to another species probably south of our study area, most likely *C. xanthostigma* (B. Sumida, NMFS Southwest Fish. Cent., Box 271, La Jolla, CA 92038, pers. commun., 16 Dec. 1986).

Ref: Ahlstrom 1965, Ahlstrom and Moser 1975, Ahlstrom et al. 1984a.



Figures A–B, NWAFC originals (B. Vinter); C–D, Ahlstrom and Moser 1975.

MERISTICS

Vertebrae	Total: 36-37-39 Precaudal: 9-10-10 Caudal: 27-28-29
Branchiostegal rays	6-X-7
Caudal fin	2, 7+6, 2 Total rays=17[a]
Pelvic fin	Thoracic R: 6-6-6
Dorsal fin	R: 75-84-97
Pectoral fin	R: 12-12-12
Anal fin	R: 58-64-77
Gill rakers	U: 3-X-5 L: 7-8-10

LIFE HISTORY

Range	South of southern California to SE Alaska, 55-59°N
Ecology	Epi- and mesobenthal, 0-366 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Spring-summer (Calif.)[b] Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	0.75-0.83 mm
No. of oil globules	One
Oil globule diameter	0.09-0.10 mm
Yolk	Homogeneous
Envelope	Smooth
Hatch size	2 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters
See notes on *C. sordidus* (p. 568)

LARVAE

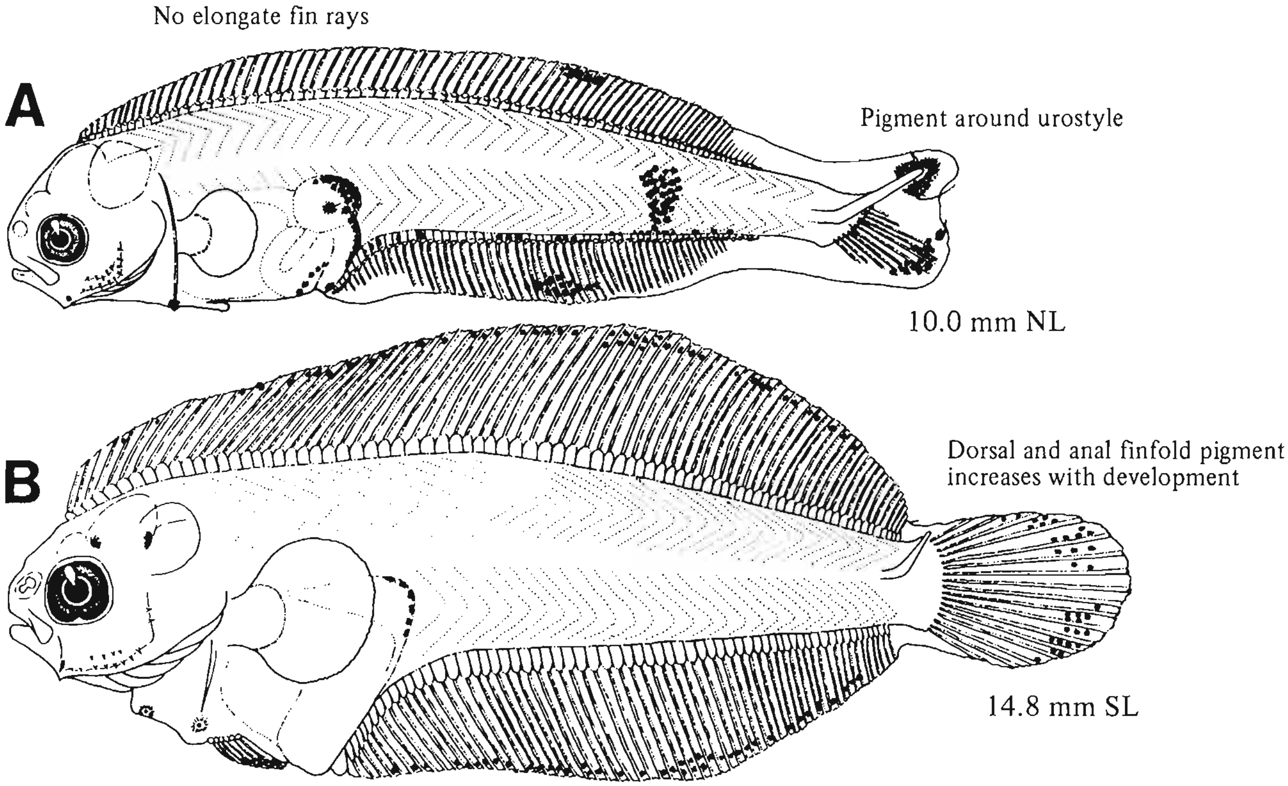
Preanal length	
Length at flexion	9.2-10.2 mm SL
Length at transformation	24.0-35.5 mm SL
Sequence of fin development	Dorsal, anal, caudal, pelvics, pectorals <u>or</u> caudal, dorsal and anal, pelvics, pectorals

Pigment (see *C. sordidus*)
- Urostyle pigment increases in intensity to flexion stage, then fades
- Small melanophores along ventral body midline posterior to anus; these migrate onto anal fin pterygiophores in postflexion larvae
- Band at 3/4 BL, lost after flexion
- Caudal fin

Diagnostic characters
- Lack of elongate fin rays

[a] 11 branched rays.
[b] Ahlstrom and Moser 1975

Ref: Ahlstrom et al. 1984a.



Figures A–B, Ahlstrom and Moser 1975.

The majority of species in the order (27 out of a total of 31) belong to the family Pleuronectidae. Ahlstrom et al. (1984a) summarize the following ontogenetic characters for the family.

Egg size ranges from 0.66 to 4.50 mm, yolk is homogeneous, oil globules are absent in most species, and the chorion is smooth (exceptions include *Pleuronichthys ritteri* and *P. cornutus*). Some light sculpturing of the chorion is seen in several species.

Larvae hatch from 1.7 to 16.0 mm SL. They possess no elongate dorsal or pelvic fin rays, gut is normal, and spines are limited to the preopercular, otic, and frontal regions, although absent in most.

The caudal fin ray count is not stabilized within pleuronectids, in contrast to most other taxa. Most pleuronectids have 17-19 total caudal fin rays (18 is most common). Within species there is variability in the total fin ray count and in the number of rays that are branched. Since variability exists, total counts, number of branched rays, and principal and secondary rays are given when available.

Table 50

Pigment characters and myomere counts that may be useful in the identification of pleuronectid larvae during the preflexion and early flexion stages.*

	Pigment characters					
				Finfold		
Genus	Number of bands	Slashlike hypaxial pigment	Urostyle	Dorsal	Anal	Total myomeres
Postanal pigment bands present						
Embassichthys	3	No	Yes	Yes	Yes	57-65
Eopsetta	2	No	Yes	No	No	41-45
Glyptocephalus	3-4	No	Yes	Yes/no	Yes/no	52-66
Hippoglossoides	3-4	Yes	Yes	Yes	Yes	44-51
Isopsetta	3	No	Yes	No	Yes	41-42
Lepidopsetta	1	No	No, few spots	Yes	Yes	39-42
Microstomus	4	No	Yes	Yes	Yes	50-55
Postanal pigment bands absent						
Acanthopsetta	—	Yes	Yes	No	No	39-40
Atheresthes	—	No	Yes/no	No	No	47-50
Hippoglossus	—	No	Yes	Yes	Yes	49-51
Limanda	—	Yes	No	No	Yes	40-41
Liopsetta	—	No	Yes	No	No	37-41
Lyopsetta	—	Yes	Yes	Yes	Yes	43-47
Parophrys	—	Yes	Yes	No	Yes	42-47
Platichthys	—	No	Yes	Yes	Yes	35-38
Pleuronectes	—	No	No	No	Yes	41-42
Pleuronichthys	—	No	Yes	Yes	Yes	38-41
Psettichthys	—	No	Yes	Yes	Yes	38-41
Reinhardtius	—	No	Yes	Yes	Yes	61-64

*Characters are discussed only for taxa where at least some early-life-history stages are known. Only general trends are presented since pigment may vary from specimen to specimen. In cases where actual specimens were not available, subjective decisions were made based on previously published illustrations.

MERISTICS

Vertebrae	Total: 39-X-42
	Precaudal: 9-X-10
	Caudal: 30-X-31
Branchiostegal rays	7-X-8
Caudal fin	Total rays=18
Pelvic fin	Thoracic
	R: 6-6-6
Dorsal fin	R: 67-X-78
Pectoral fin	R: 9-X-11
Anal fin	R: 54-X-62
Gill rakers	U: X-X-X L: 10-X-12

LIFE HISTORY

Range	Bering Sea, 54-66°N
Ecology	Epi- and mesobenthal
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Summer[a]
	Area: Deep water[a]
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	0.86-1.03 mm (0.92 mm)
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	Smooth
Hatch size	<3 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

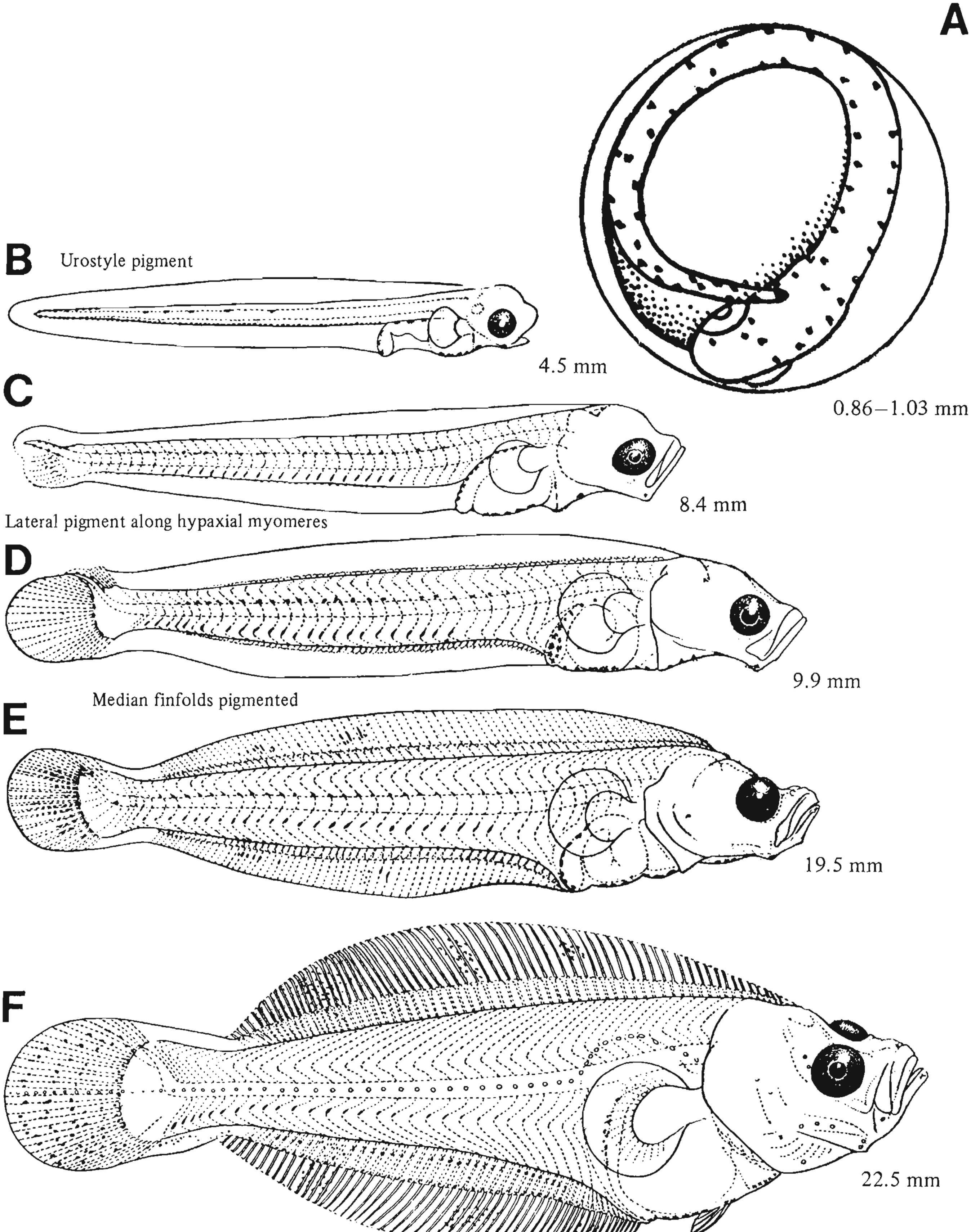
Preanal length	<50% SL
Length at flexion	8.4-9.9 mm SL
Length at transformation	~20-24 mm SL
Sequence of fin development	Caudal, dorsal and anal, pelvics, pectorals

Pigment
- Series of ventral midline melanophores extending around urostyle
- Several spots above notochord, number increases with development
- During flexion, pigment develops along hypaxial myomeres
- Initially, gut pigment restricted to dorsal and anteroventral surface; with development it extends posterodorsally and along ventral surface

Diagnostic characters
- Pigment
  —Pigment pattern without bands
  —Presence of hypaxial pigment
  —Presence of pigment around urostyle

[a] Pertseva-Ostroumova 1961

Ref: Ahlstrom et al. 1984a, Pertseva-Ostroumova 1961.



Figures A–F, Pertseva-Ostroumova 1961.

MERISTICS

Vertebrae	Total: 49-X-52 Precaudal: 10-X-11 Caudal: 39-X-41
Branchiostegal rays	7-X-8
Caudal fin	
Pelvic fin	Thoracic R: 6-6-6
Dorsal fin	R: 95-107-112
Pectoral fin	R: 13-X-14
Anal fin	R: 75-X-92
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	Gulf of Alaska, 54-60°N, to Bering Sea, 54-66°N
Ecology	Epi- and mesobenthal
ELH pattern	Oviparous, bathypelagic eggs, pelagic larvae
Spawning	Season: Fall-winter[a] Area: Demersal, deep water[a] Mode: Migration:
Fecundity	Range/function: 130,000-500,000[a]
Age at first maturity	9-10 yr (females)[a] 6-7 yr (males)[a]
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	2.05-2.20 mm; 2.5-3.5 mm[a]
No. of oil globules	None
Oil globule diameter	
Yolk	Greenish yellow
Envelope	Thin, smooth, clear
Hatch size	<8.4 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	
Length at flexion	~11.5-15.0 mm SL
Length at transformation	
Sequence of fin development	Caudal, dorsal and anal, pelvics, pectorals

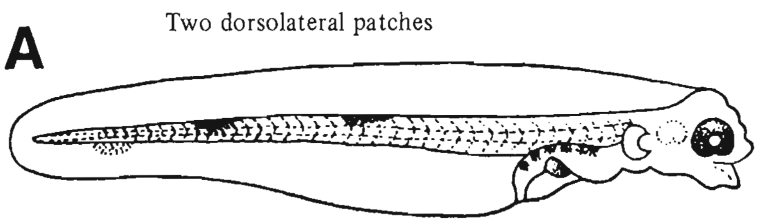
Pigment
- Two dorsolateral patches which, with development, meet and extend over the caudal peduncle

Diagnostic characters
According to figures in Pertseva-Ostroumova (1961), pigment pattern and morphology are similar to *A. stomias.* No larvae of *A. evermanni* have been identified from the study area.

[a] Pertseva-Ostroumova 1961

Ref: Ahlstrom et al. 1984a, Pertseva-Ostroumova 1961.

A



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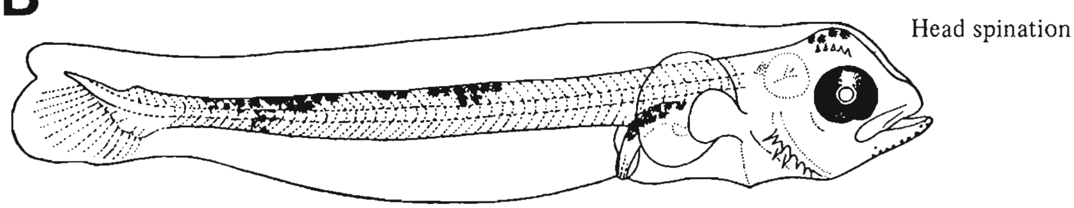


Figures A–B, Pertseva-Ostroumova 1961 (sizes not given).

MERISTICS

Vertebrae	Total: 47-49-50
	Precaudal: 12-12-12
	Caudal: 35-37-38
Branchiostegal rays	7-X-8
Caudal fin	Total rays = 17[a]
Pelvic fin	Thoracic
	R: 6-6-6
Dorsal fin	R: 92-108-115
Pectoral fin	R: 14-X-15
Anal fin	R: 72-87-99
Gill rakers	U: 4-4-4 L: 11-X-13

LIFE HISTORY

Range	Cent. California, 34-38°N, to Bering Sea, 54-66°N
Ecology	Epi-, meso-, and bathybenthal, 18-900 m
ELH pattern	Oviparous, mesopelagic eggs, mesopelagic larvae
Spawning	Season: Dec-Mar (Bering Sea);[b] Aug (Gulf of Alaska)[c]
	Area: 108-360 m[c]
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	20 yr[d]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	~3 mm
No. of oil globules	None
Oil globule diameter	
Yolk	
Envelope	Smooth
Hatch size	
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	<50% SL
Length at flexion	~10-12 mm SL
Length at transformation	25.6-33.0 mm SL
Sequence of fin development	Caudal, dorsal and anal, pelvics, pectorals

Pigment

- Pigment on midbrain, spreading with development to dorsal surface of head, lower jaw, opercle
- Dorsally on gut, spreading laterally with development
- Two dorsolateral patches which, with development, meet and increase in size to cover caudal peduncle posteriorly

Diagnostic characters

Distinguished from other pleuronectids by

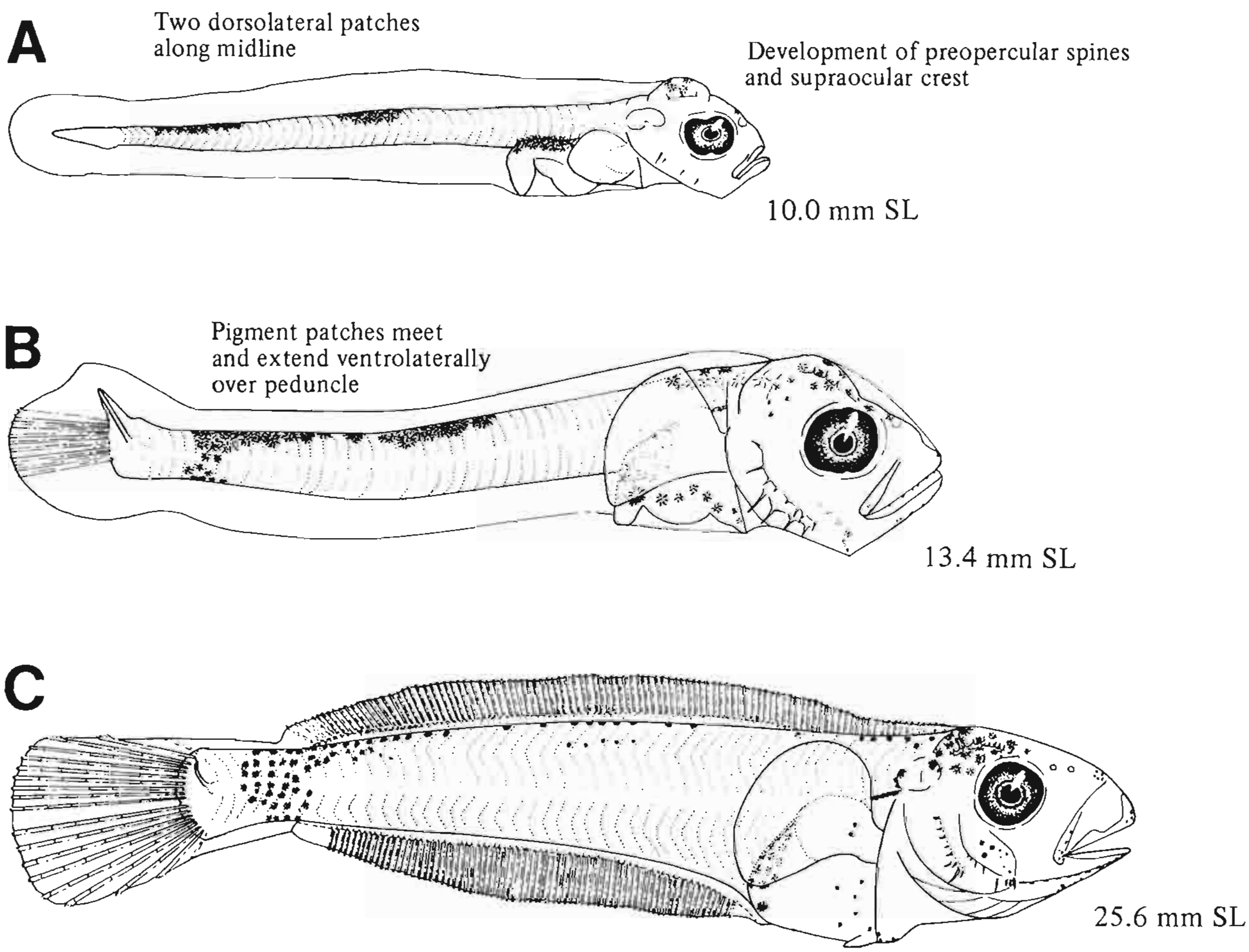
- Head spination: Early development of preopercular spines
- Pigmented supraocular crest
- Pigment pattern without bands; two dorsal patches with a lack of ventral pigment
- Head and snout blunt

Distinguished from *A. evermanni* by

- See *A. evermanni* (p. 576)

[a] 13 branched rays.
[b] Pertseva-Ostroumova 1961
[c] Hirschberger and Smith 1983
[d] Kabata and Forrester 1974

Ref: Ahlstrom et al. 1984a, Pertseva-Ostroumova 1961.



Figures A–C, NWAFC originals (B. Vinter).

MERISTICS

Vertebrae	Total: 57-62-65 Precaudal: 13-14-14 Caudal: 44-48-51
Branchiostegal rays	7-X-8
Caudal fin	X, 10+9, X Total rays = 19-21[a]
Pelvic fin	Thoracic R: 5-X-6
Dorsal fin	R: 109-X-117
Pectoral fin	R: 11-11-11
Anal fin	R: 94-X-98
Gill rakers	U: 6-X-9 L: 14-X-16

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Meso- and bathybenthal, 320-1433 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Spring (possibly winter-spring)[b] Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

[a] 17 branched rays.
[b] Richardson 1981b
[c] According to Figures C and E from Richardson (1981b), flexion occurs rapidly between 15.4 and 16.2 mm SL. However, the 18.5-mm NL specimen (Fig. D) illustrated by Ahlstrom et al. (1984a) does not appear fully flexed. Differences in size may be a result of preservation.

Ref: Ahlstrom et al. 1984a, Richardson 1981b.

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	2.8-3.1 mm
No. of oil globules	None
Oil globule diameter	
Yolk	Homogeneous
Envelope	Smooth
Hatch size	~9 mm SL
Incubation time/temp.	

Pigment
- Eye
- Hindgut extending out into yolk
- Three postanal bands

Diagnostic characters
- Size
- Pigment pattern

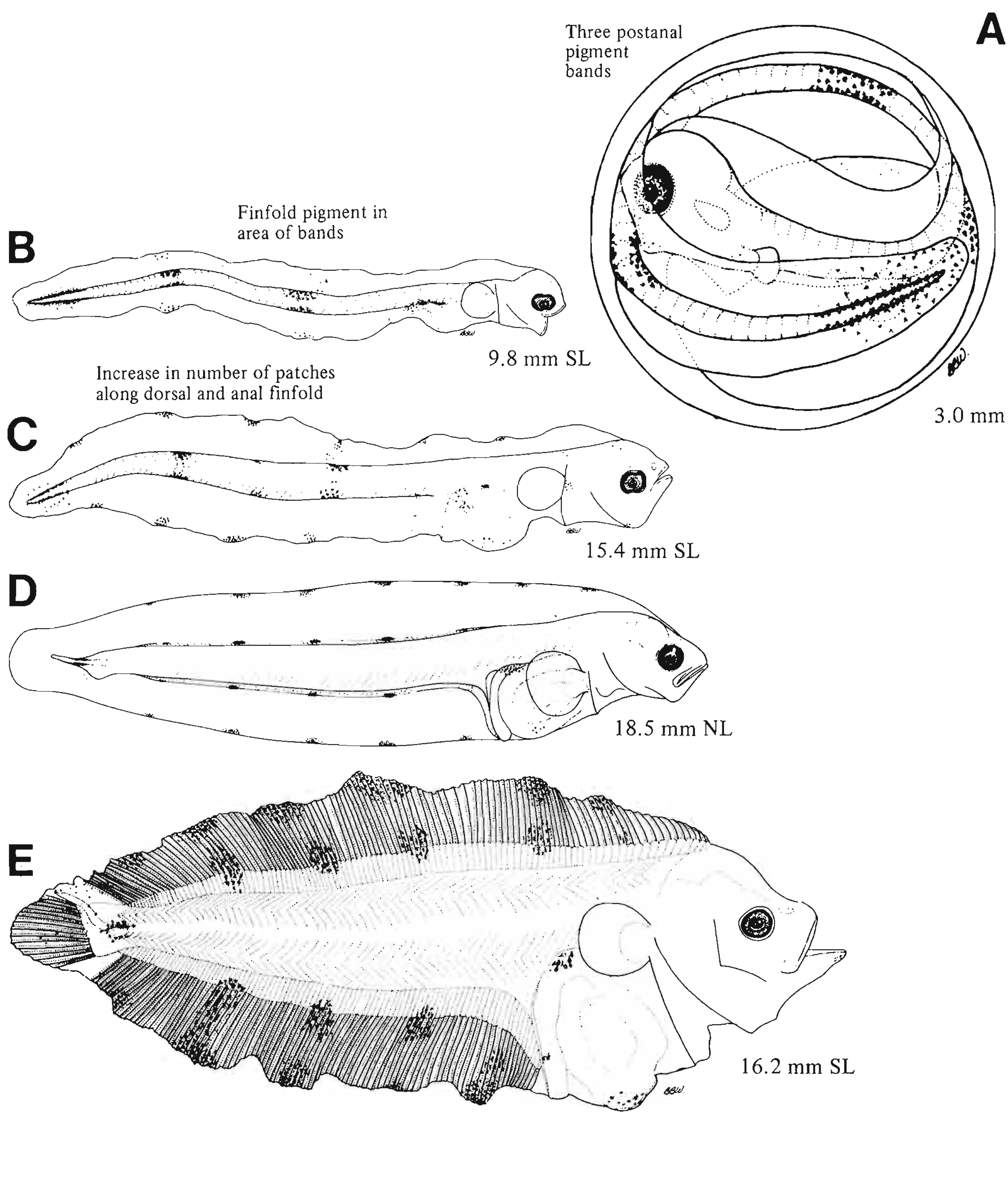
LARVAE

Preanal length	40% SL
Length at flexion	15.4-16.2 mm SL[c]
Length at transformation	>16.2 mm SL when eye migration commences
Sequence of fin development	Caudal, dorsal, and anal; pelvics; pectorals

Pigment
- Initially, three postanal bands with pigment on the finfold in region of bands; number of dorsal and ventral spots change with size and stage of development
- Pigmentation increases with development along finfold margin (~7 spots along dorsal and 5 spots along anal in flexion larvae)

Diagnostic characters
- Postanal band pattern in preflexion larvae (three bands)
- High myomere count (57-65)

Distinguished from similar larvae with high myomere count by
- Presence of three postanal pigment bands and median finfold pigment
  —*Reinhardtius hippoglossoides* (p. 622): Lightly pigmented and without bands
  —*Glyptocephalus* spp. (p. 584, 586): Three bands (more laterally intense) in *G. stelleri*; in *G. zachirus*, caudal band, no finfold pigment
  —Unidentified ophidiid larvae (p. 213): More myomeres (>75), less finfold pigment, and less pronounced loop in gut



Figures A–C, E, Richardson 1981b; D, Ahlstrom et al. 1984a.

MERISTICS

Vertebrae	Total: 41-X-45
	Precaudal: 11-11-11
	Caudal: 30-32-34
Branchiostegal rays	7-X-8
Caudal fin	X, 9+8, X
	Total rays=19[a]
Pelvic fin	Thoracic
	R: 6-6-6
Dorsal fin	R: 82-97-103
Pectoral fin	R: 13-13-13
Anal fin	R: 67-73-79
Gill rakers	U: X-X-X L: 15-X-17

LIFE HISTORY

Range	South of southern California to Gulf of Alaska, 54-60°N
Ecology	Epi-, meso-, and bathybenthal, 0-550 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Dec-Apr[b]
	Area: Off continental slope, 274-366 m[c]
	Mode:
	Migration: To deep water for spawning[c]
Fecundity	Range/function: 400,000-1,200,000[d]
Age at first maturity	3-8 yr (females)[c]
	4-9 yr (males)[c]
Longevity	25 yr (females)[c]
	21 yr (males)[c]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.21-1.25 mm
No. of oil globules	None
Oil globule diameter	
Yolk	
Envelope	
Hatch size	2.8 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE[e]

Preanal length	<50% SL
Length at flexion	
Length at transformation	
Sequence of fin development	

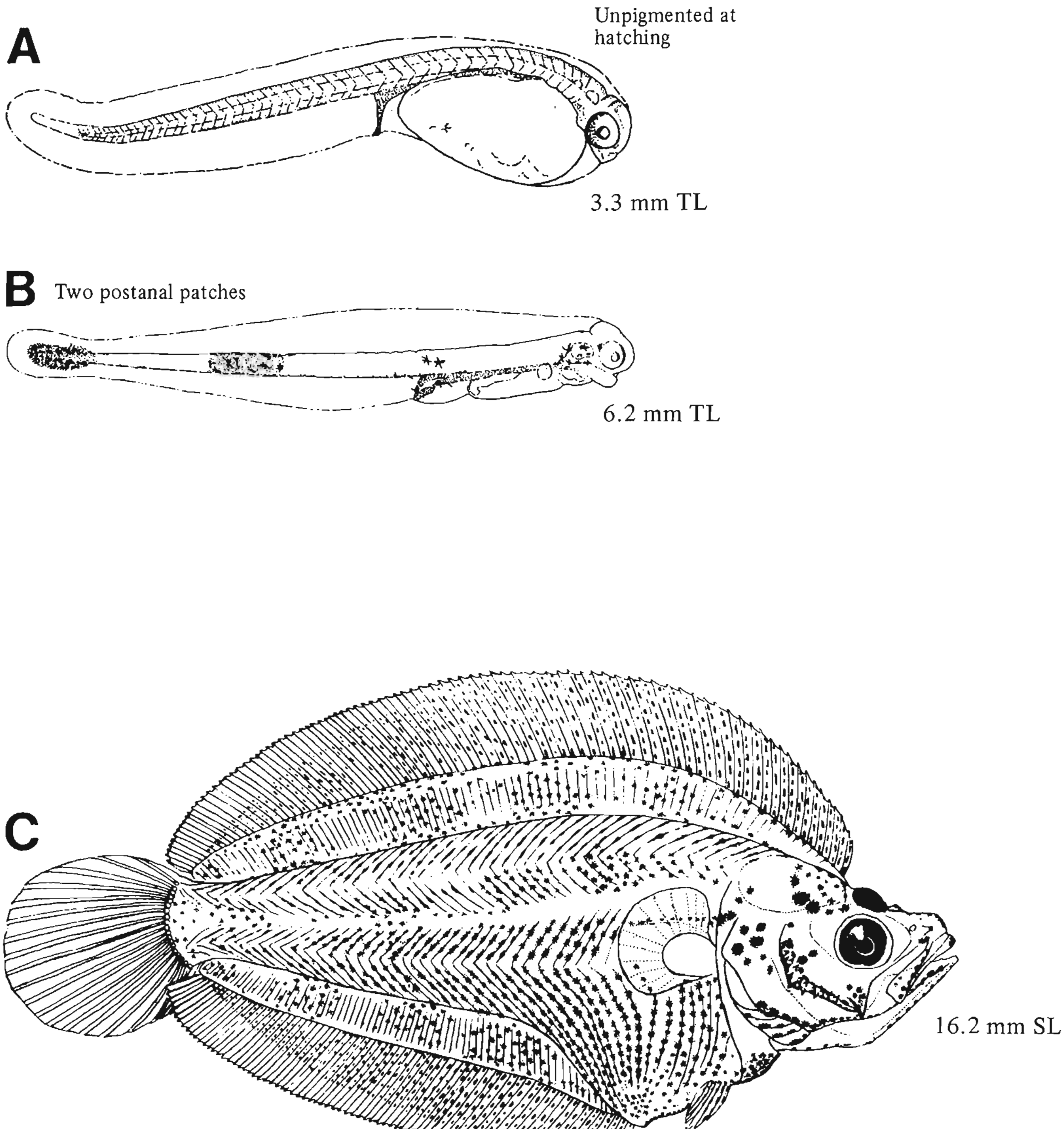
Pigment
- Unpigmented at hatching
- Preflexion
  - —Midbody patch and urostyle pigment
  - —Melanophores on body over anus
  - —Posteriorly on gut and on head
- Flexion and early postflexion larvae are undescribed

Diagnostic characters

Distinguished from other pleuronectids by
- Presence of two postanal pigment bands including pigment on urostyle
- Presence of preopercular spines

[a] 15 branched rays.
[b] Alderdice and Forrester 1971
[c] Frey 1971
[d] Forrester 1969
[e] Larvae are rare. Since most routine ichthyoplankton surveys sample only to 200 m, the absence of small larvae in field collections indicates larvae may occur below 200 m.

Ref: Ahlstrom et al. 1984a, Alderdice and Forrester 1971.



Figures A–B, Alderdice and Forrester 1971; C, Ahlstrom et al. 1984a.

MERISTICS

Vertebrae	Total: 52-X-60	
	Precaudal: 9-9-9	
	Caudal: 43-43-43	
Branchiostegal rays	7-7-7	
Caudal fin		
Pelvic fin	Thoracic	
	R: 6-6-6	
Dorsal fin	R: 83-X-97	
Pectoral fin	R: 10-X-12	
Anal fin	R: 72-X-80	
Gill rakers	U: X-X-X	L: 7-X-10

LIFE HISTORY

Range	Bering Sea, 54-66°N
Ecology	Epi- and mesobenthal
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season:
	Area:
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.20-1.61 mm
No. of oil globules	None
Oil globule diameter	
Yolk	Homogeneous
Envelope	Thick, sometimes striated
Hatch size	4.1-5.2 mm SL
Incubation time/temp.	

Pigment
- Yolksac
- Late-stage embryo

Diagnostic characters

LARVAE

Preanal length	<50% SL
Length at flexion	15-17 mm SL
Length at transformation	50-60 mm SL;[a] eye migration begins at 35 mm SL
Sequence of fin development	Caudal, dorsal and anal, pelvics, pectorals

Pigment
- Finfold (dorsal and anal)
- Three postanal bands

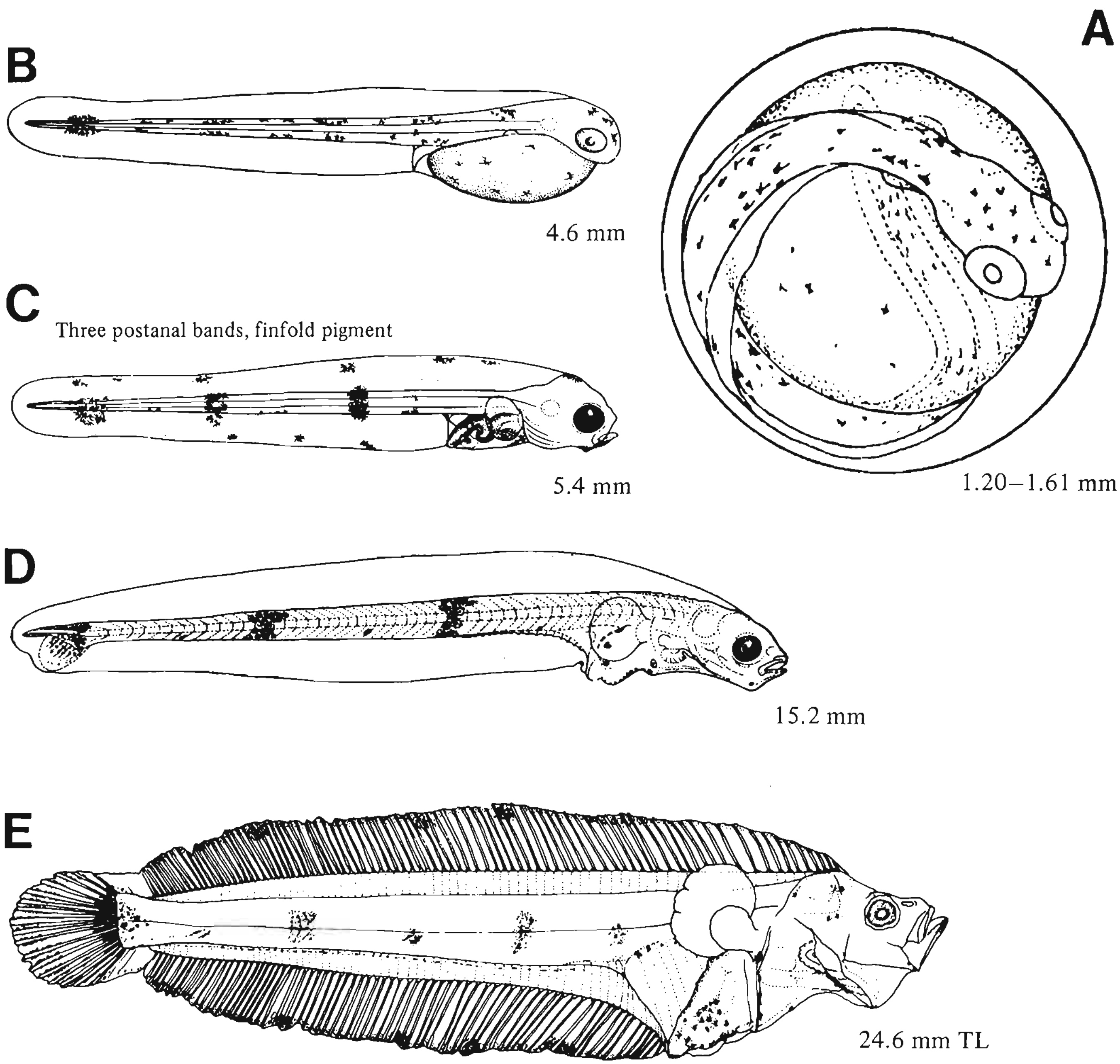
Diagnostic characters

Distinguished from other pleuronectids by
- Presence of three postanal pigment bands
- High myomere count (52-60)
- Presence of preopercular spines

Distinguished from *G. zachirus* by
- Fewer myomeres (52-60)
- Pigment pattern
  - —Presence of finfold pigment
  - —Difference in band pattern (fewer bands)

[a] Ahlstrom et al. 1984a: 19-48 mm SL.

Ref: Ahlstrom et al. 1984a, Okiyama 1963, Okiyama and Takahashi 1976, Pertseva-Ostroumova 1961.



Figures A–D, Pertseva-Ostroumova 1961 (B–C, reversed); E, Okiyama and Takahashi 1976.

MERISTICS

Vertebrae	Total: 63-64-66 Precaudal: 12-13-14 Caudal: 50-51-52
Branchiostegal rays	7-7-7
Caudal fin	4, 8+7, 4 Total rays=22-23[a]
Pelvic fin	Thoracic R: 6-6-6
Dorsal fin	R: 87-102-110
Pectoral fin	R: 11-X-13
Anal fin	R: 78-85-93
Gill rakers	U: 4-4-4 L: 5-X-8

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Epi-, meso-, and bathybenthal, 0-850 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Jan-June[b] Area: Mode: Migration:
Fecundity	Range/function: 3900-238,000/ $F=0.00000053797 \times L^{4.22667}$, L=TL mm[b]
Age at first maturity	5-9 yr (females)[b] 3-5 yr (males)[b]
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.80-2.2 mm
No. of oil globules	None
Oil globule diameter	
Yolk	Homogeneous
Envelope	Surface may be irregular or appear bumpy
Hatch size	~5 mm SL
Incubation time/temp.	

Pigment
- Pigment on yolksac
- Late stage (three bands + caudal)

Diagnostic characters

Distinguished from *Lyopsetta exilis* (p. 606) and *Microstomus pacificus* (p. 608) by
- Size
- Pigment on yolksac, late-stage embryo
- Wide perivitelline space
- Size of embryo (coiling in *G. zachirus*)

LARVAE

Preanal length	<50% SL
Length at flexion	15.3-24.0 mm SL
Length at transformation	49-59 mm SL[c]
Sequence of fin development	Caudal, dorsal and anal, pelvics, pectorals

Pigment
- Postanal body
  - —Three bands
  - —Caudal band (above, below, and in finfold)
  - —Melanophores between bands
- Head, lower jaw, gut
- With development, caudal pigment becomes restricted to hypural area

Diagnostic characters
- See *G. stelleri* (p. 584)

Distinguished from other pleuronectids by
- Presence of four postanal pigment bands
- High myomere count (63-66)
- Presence of preopercular spines

See *Embassichthys bathybius* (p. 580) and *Microstomus pacificus* (p. 608) for similar larvae

[a] 13 branched rays.
[b] Hosie and Horton 1977
[c] According to Ahlstrom et al. (1984a), transformation may occur as late as 72 mm SL.

Ref: Ahlstrom and Moser 1975, Ahlstrom et al. 1984a.

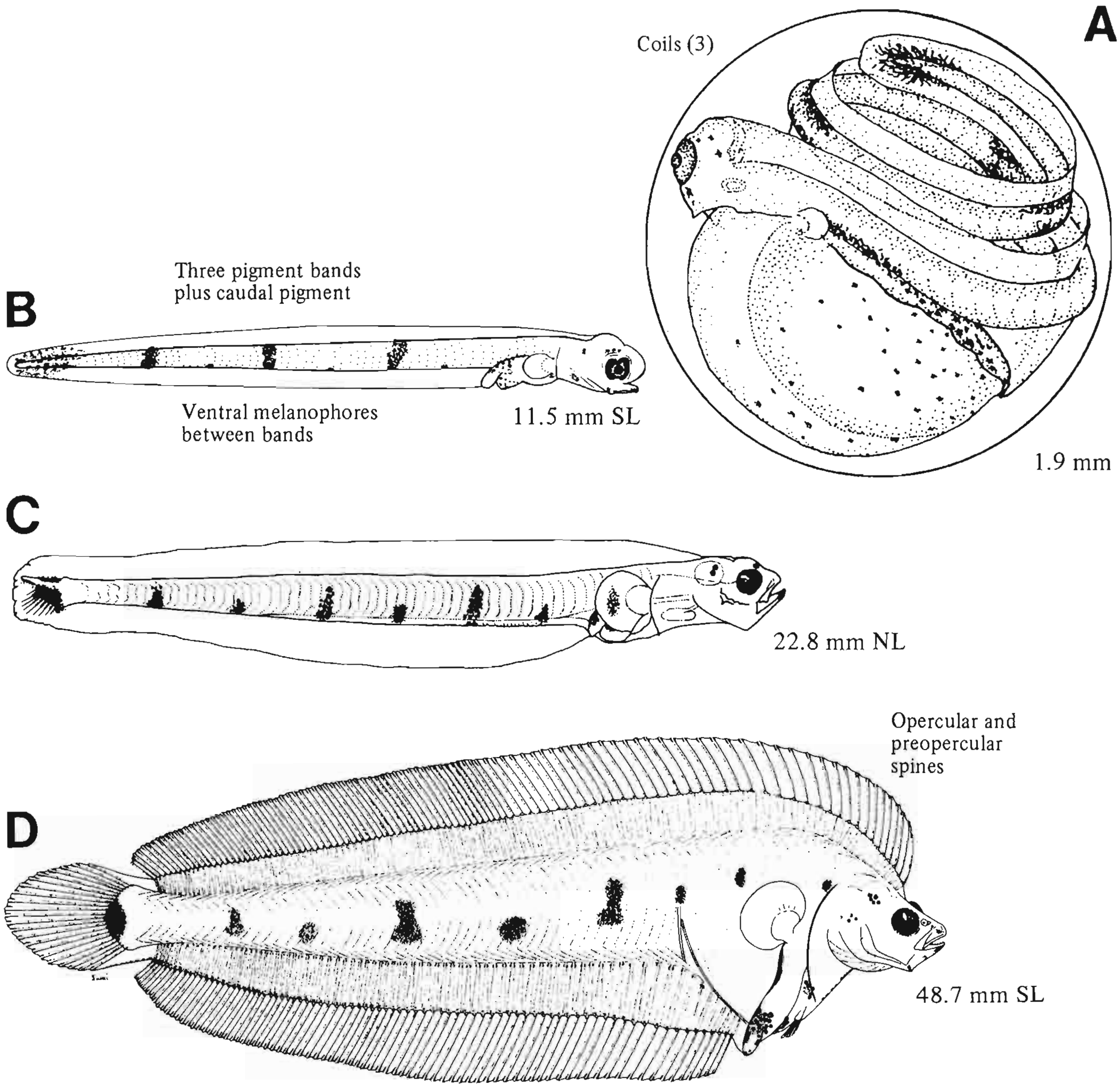


Figure A, Ahlstrom and Moser 1980; B, NWAFC original (B. Vinter); C–D, Ahlstrom et al. 1984a (after Ahlstrom and Moser 1975).

MERISTICS

Vertebrae	Total: 43-44-47
	Precaudal: 12-13-13
	Caudal: 32-X-35
Branchiostegal rays	7-7-7
Caudal fin	X, 7+7, X
	Total rays=18[a]
Pelvic fin	Thoracic
	R: 6-6-6
Dorsal fin	R: 72-79-90
Pectoral fin	R: 10-X-12
Anal fin	R: 55-62-71
Gill rakers	U: X-X-X L: 14-20-26

LIFE HISTORY

Range	Cent. California, 34-38°N, to Bering Sea, 54-66°N
Ecology	Epi-, meso-, and bathybenthal, 0-875 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Feb-July[b]
	Area: 50-305 m[b]
	Mode:
	Migration:
Fecundity	Range/function: 70,000-600,000[c]
Age at first maturity	1-2 yr[c]
Longevity	21 yr[b]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	2.75-3.75 mm (2.9-3.5 mm)
No. of oil globules	None
Oil globule diameter	
Yolk	Homogeneous, colorless
Envelope	Smooth
Hatch size	5.3-6.9 mm SL[d]
Incubation time/temp.	

Pigment
- Yolksac
- Late-stage embryo: On body and in dorsal and ventral finfold

Diagnostic characters
- Wide perivitelline space
- Body and finfold pigment

LARVAE

Preanal length	<50% SL
Length at flexion	9-10 mm SL
Length at transformation	Probably gradual, beginning between 18 and 21 mm SL
Sequence of fin development	Caudal, dorsal, and anal; pelvics; pectorals

Pigment
- Three postanal bands and along ventral midline
- Around urostyle
- Finfold
- With development becoming less pigmented

Diagnostic characters

Distinguished from other pleuronectids with three postanal pigment bands by
- Presence of hypaxial, fin, and urostyle pigment
- Low myomere count (43-47)

[a] 12 branched rays.
[b] Salveson 1976
[c] Miller 1969
[d] Pertseva-Ostroumova 1961

Ref: Ahlstrom et al. 1984a, Pertseva-Ostroumova 1961.

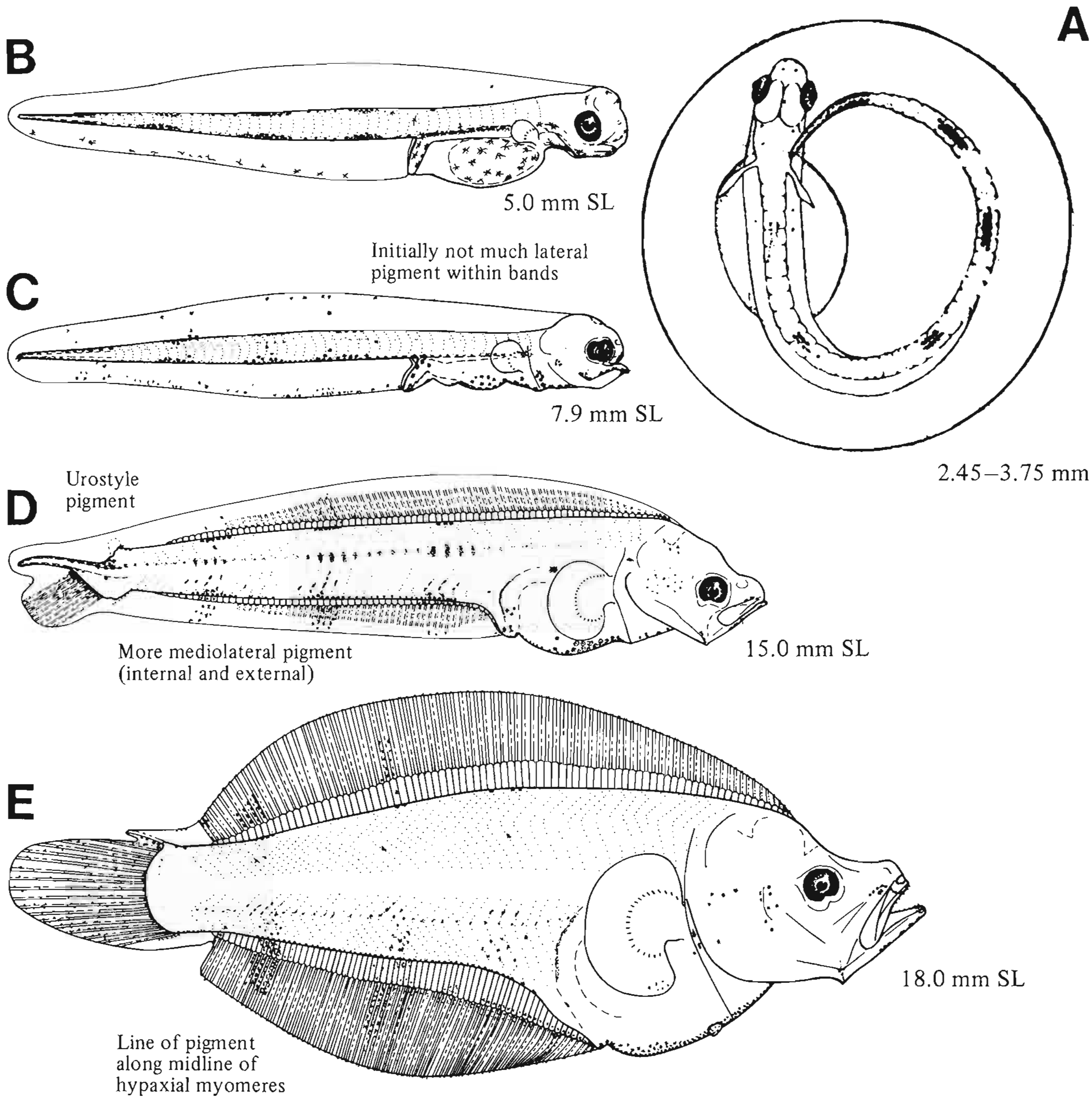


Figure A, Pertseva-Ostroumova 1961; B–E, NWAFC originals (B. Vinter).

MERISTICS

Vertebrae	Total: 44-44-44
	Precaudal: 12-12-12
	Caudal: 32-32-32
Branchiostegal rays	7-7-7
Caudal fin	
Pelvic fin	Thoracic
	R: 6-6-6
Dorsal fin	R: 66-74-80
Pectoral fin	R: 10-10-10
Anal fin	R: 53-59-64
Gill rakers	U: 1-1-1 L: 10-12-17

LIFE HISTORY

Range	Aleutian Is., 51-55°N, to Chukchi Sea, north of 66°N
Ecology	Epi- and mesobenthal, 18-425 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Apr-June[a]
	Area: Shallow gulfs and bays (50-150 m)[a]
	Mode:
	Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	2.04-2.69 mm; occasionally up to 2.90 mm
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	Smooth, thin
Hatch size	4 mm SL
Incubation time/temp.	

Pigment
- Yolksac
- Late-stage embryo: On body

Diagnostic characters
- Wide perivitelline space
- Smaller in diameter than *H. elassodon*

LARVAE

Preanal length	<50% SL
Length at flexion	~11 mm SL
Length at transformation	>28.6 mm SL[b]
Sequence of fin development	

Pigment
- Three postanal bands extending into finfold

Diagnostic characters
- See *H. elassodon* (p. 588)

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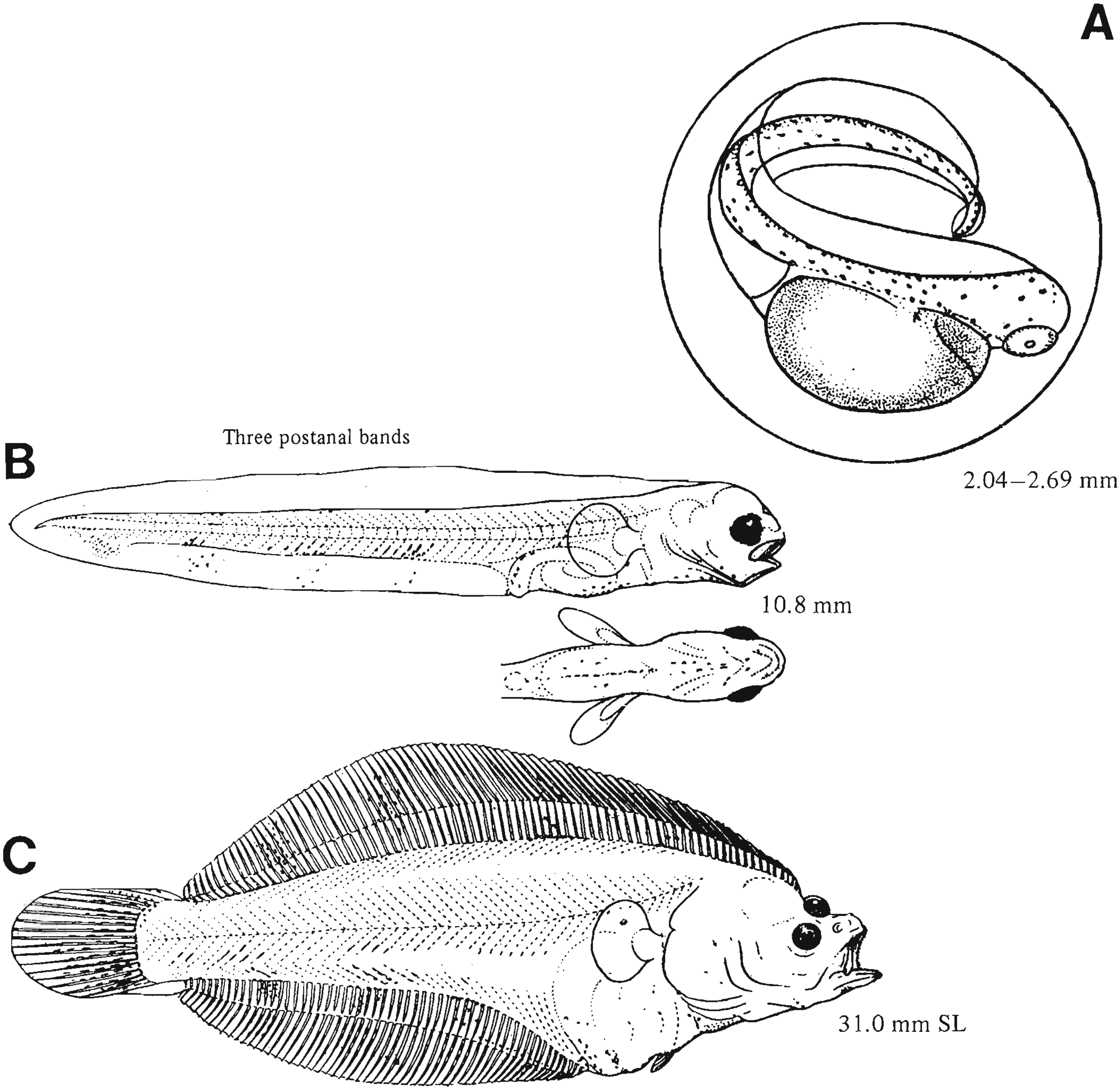
[a] Pertseva-Ostroumova 1961
[b] Ahlstrom et al. 1984a

Ref: Ahlstrom et al. 1984a, Pertseva-Ostroumova 1961.



Figures A–C (B insert, ventral view of head), Pertseva-Ostroumova 1961.

MERISTICS

Vertebrae	Total: 49-50-51 Precaudal: 16-16-16 Caudal: 35-35-35
Branchiostegal rays	7-7-7
Caudal fin	Total rays=19
Pelvic fin	Thoracic R: 6-6-6
Dorsal fin	R: 89-99-109
Pectoral fin	R: 19-19-19
Anal fin	R: 64-75-81
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to Chukchi Sea, north of 66°N
Ecology	Epi-, meso-, and bathybenthal, 6-1110 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Nov-Mar[a] Area: 180-550 m[a] Mode: Migration: To deepwater spawning banks in Gulf of Alaska[b]
Fecundity	Range/function: 200,000-4 million[c]
Age at first maturity	7-20 yr (females)[a] 5-20 yr (males)[a]
Longevity	42 yr (females)[d] 27 yr (males)[d]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	2.9-3.8 mm
No. of oil globules	
Oil globule diameter	
Yolk	Homogeneous, dense, yellow (after preservation)
Envelope	Shallow honeycomb pattern (not always visible on preserved specimens but slight surface irregularities are easily discernible)
Hatch size	7.8-8.5 mm SL
Incubation time/temp.	

Pigment
- Embryo unpigmented at hatching

Diagnostic characters
- Large size (>3.0 mm)
- Lack of pigment

LARVAE

Preanal length	<50% SL
Length at flexion	13.6-17.8 mm SL
Length at transformation	14.7-24.1 mm SL[e]
Sequence of fin development	Caudal, dorsal and anal, pelvics, pectorals

Pigment
- Lack of pigment in yolksac larvae
- Series of melanophores along dorsal surface of notochord and along ventral midline
- Median finfolds pigmented along edge

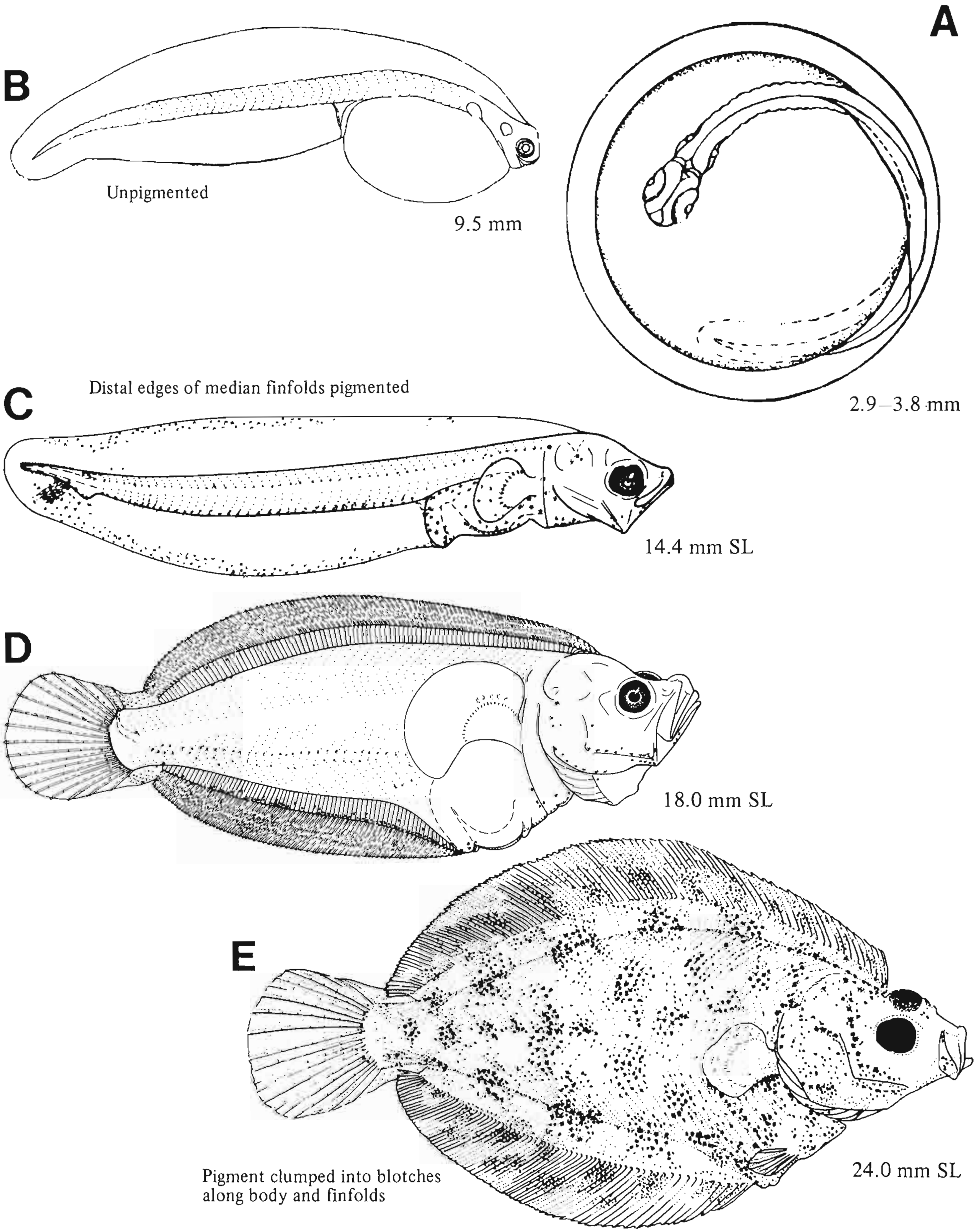
Diagnostic characters

Distinguished from other pleuronectids by
- Myomeres (49-51)
- Pigment: Lack of bands, and presence of pigment on ventral midline and along edges of median finfolds

Distinguished from *Reinhardtius hippoglossoides* (both have large yolksac larvae) by
- See *R. hippoglossoides* (p. 622)

[a] St. Pierre 1984
[b] Thompson and Van Cleve 1936
[c] Schmitt and Skud 1978
[d] Webber and Alton 1976
[e] Become juveniles at 28 mm SL.

Ref: Ahlstrom et al. 1984a, Pertseva-Ostroumova 1961, Thompson and Van Cleve 1936.



Figures A–B, Pertseva-Ostroumova 1961 (after Thompson and Van Cleve 1939); C–D, NWAFC originals (B. Vinter); E, Ahlstrom et al. 1984a.

MERISTICS

Vertebrae	Total: 41-42-42
	Precaudal: 10-10-11
	Caudal: X-X-X
Branchiostegal rays	7-X-8
Caudal fin	X, 7+6, X
	Total rays=18[a]
Pelvic fin	Thoracic
	R: 6-6-6
Dorsal fin	R: 78-86-90
Pectoral fin	R: 11-X-13
Anal fin	R: 58-66-69
Gill rakers	U: X-X-X L: 7-X-8

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Epi- and mesobenthal, 20-425 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Feb-Apr[b]
	Area: Coastal waters[b]
	Mode: Schools[b]
	Migration:
Fecundity	Range/function: 350,000-650,000[c]
Age at first maturity	3 yr (females)[b]
	2 yr (males)[b]
Longevity	11 yr (females)[d]
	10 yr (males)[d]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	0.84-1.00 mm; occasionally up to 1.10 mm
No. of oil globules	None
Oil globule diameter	
Yolk	Homogeneous
Envelope	Striated
Hatch size	2.7-2.9 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

Very difficult to distinguish from the three other 1.0-mm pleuronectid eggs in the area:
Parophrys vetulus (p. 610)
Platichthys stellatus (p. 612)
Psettichthys melanostictus (p. 620)

LARVAE

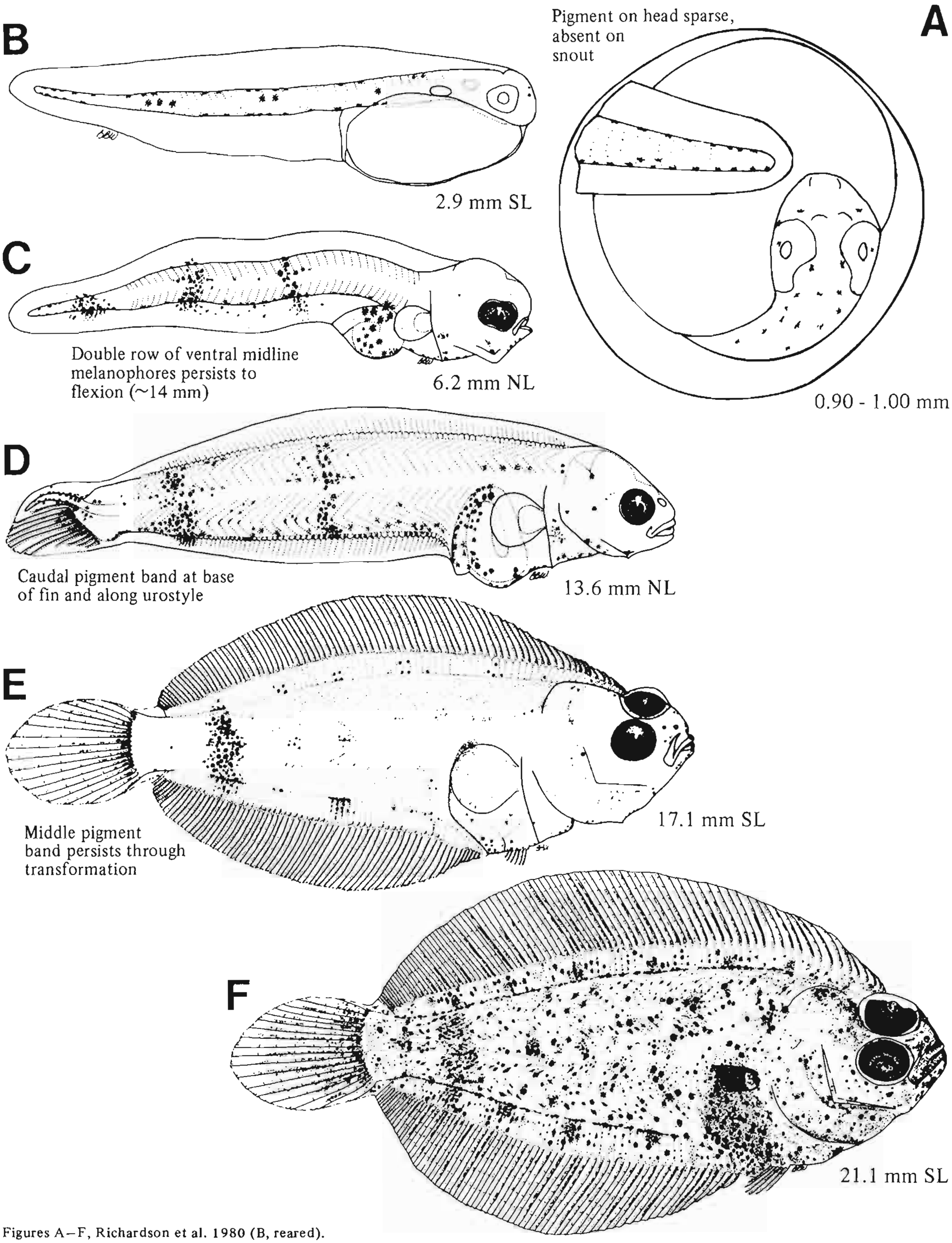
Preanal length	<50% SL
Length at flexion	9-10 to 14 mm SL
Length at transformation	15->21 mm SL
Sequence of fin development	Caudal, dorsal, and anal; pelvics; pectorals

Pigment
- Three postanal bands at 50, 67, 90% SL
- Melanophores extend ventrally on gut and along posterior portion of abdominal cavity

Diagnostic characters
- Three pigment bands
- Low myomere count (41-42)

[a] 11 branched rays.
[b] Smith 1936
[c] Forrester 1969
[d] Hart 1973

Ref: Richardson et al. 1980.



Figures A–F, Richardson et al. 1980 (B, reared).

MERISTICS

Vertebrae	Total: 39-40-42
	Precaudal: 10-11-12
	Caudal: 28-30-31
Branchiostegal rays	7-7-7
Caudal fin	Total rays = 18-19[a]
Pelvic fin	Thoracic
	R: 6-6-6
Dorsal fin	R: 65-76-84
Pectoral fin	R: 8-11-13
Anal fin	R: 50-58-65
Gill rakers	U: 3-3-3 L: 5-X-8

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Epi-, meso-, and bathybenthal, 0-579 m
ELH pattern	Oviparous; demersal, adhesive eggs; pelagic larvae
Spawning	Season: Feb-Apr[b]
	Area:
	Mode:
	Migration:
Fecundity	Range/function: 400,000-1,300,000 (Brit. Col.);[c] 150,000-400,000 (Bering Sea);[d] 80,000-920,000 (western Pacific)/ $F=0.0004891 \times L^{3.720}$, L=BL cm[e]
Age at first maturity	3-4 yr (females)[b]
	2 yr (males)[b]
Longevity	15 yr (females)[f]
	22 yr (males)[f]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	0.87-1.00 mm; 1.02-1.09 mm[g]
No. of oil globules	None
Oil globule diameter	
Yolk	Homogeneous
Envelope	Thick, elastic, bright yellow or orange
Hatch size	5 mm SL; 3.6-4.0 mm SL;[g] 3.4-3.8 mm SL[h]
Incubation time/temp.	9-12 d/6.5-8.0°C
Pigment	

Diagnostic characters
- Demersal egg

LARVAE

Preanal length	<50% SL
Length at flexion	8.4-9.9 mm SL
Length at transformation	~20 mm SL; >17.7 mm SL[h]
Sequence of fin development	Caudal, dorsal, and anal; pelvics; pectorals

Pigment
- Dorsally on peritoneum, ventrolateral gut pigment becoming posterolateral with development
- Postanal ventral melanophores ~3/4 length of body
- Two dorsolateral patches, the posterior one becoming a band meeting the ventral surface
- Anal finfold lightly pigmented on posterior half

Diagnostic characters

Distinguished from other pleuronectids by
- Presence of one band posteriorly on body, not as conspicuous as most
- Size at transformation (20 mm SL)
- Advanced stage of development at hatching

See *Lepidopsetta* 2 (p. 599) and *Psettichthys melanostictus* (p. 620)

[a] 12 branched rays.
[b] Smith 1936
[c] Forrester 1969
[d] Fadeev 1965
[e] Shvetsov 1979
[f] Hart 1973
[g] Pertseva-Ostroumova 1961
[h] Ahlstrom et al. 1984a

Ref: Ahlstrom et al. 1984a, Forrester 1964, Pertseva-Ostroumova 1961.

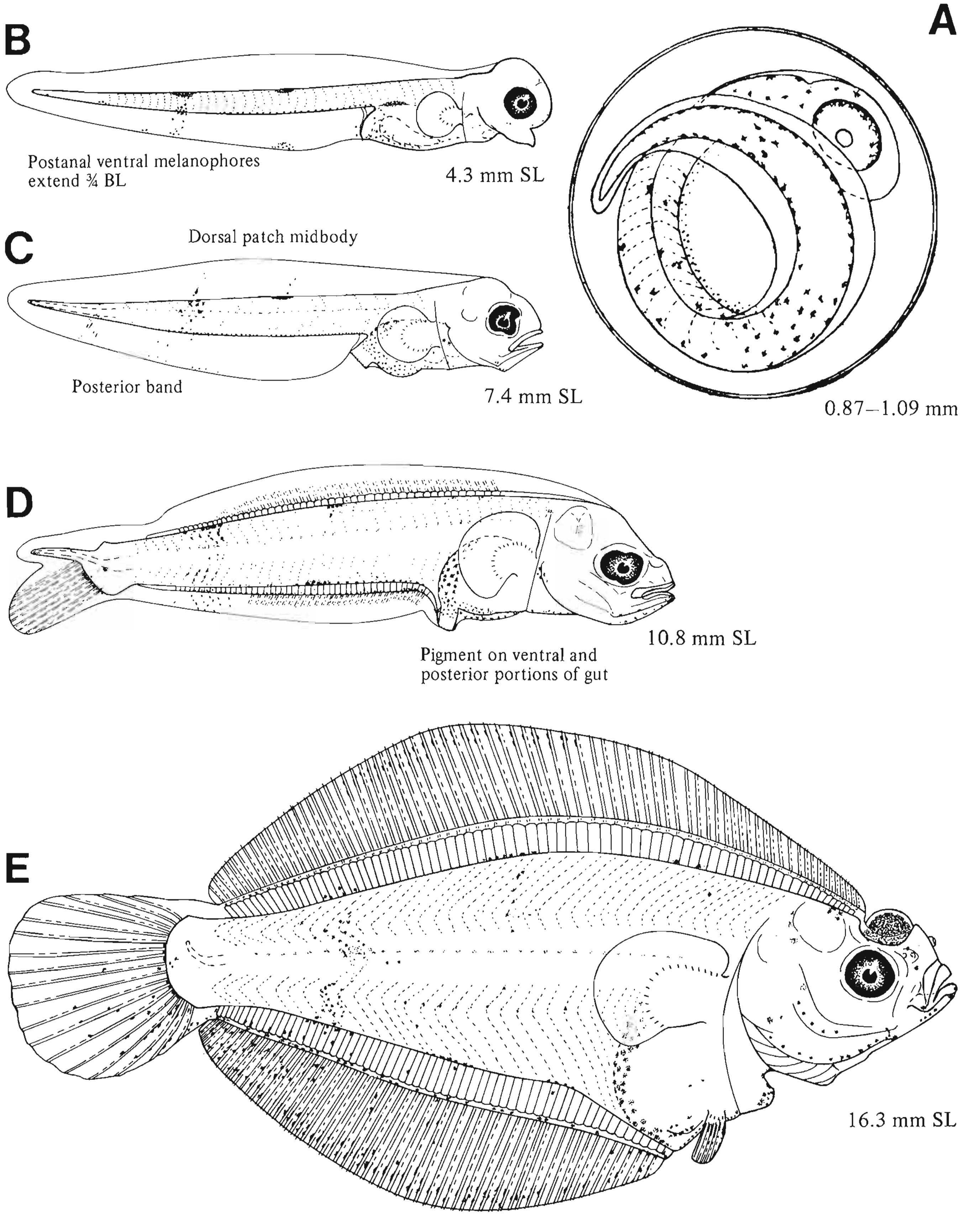


Figure A, Pertseva-Ostroumova 1961; B–E, NWAFC originals (B. Vinter).

Lepidopsetta bilineata/Lepidopsetta 2/Psettichthys melanostictus

Two readily distinguishable types of *Lepidopsetta* larvae are collected in our study area which we designate *Lepidopsetta bilineata* and *Lepidopsetta* 2. Wilimovsky et al. (1967) had previously indicated that there are two subspecies of *Lepidopsetta* in the Northeast Pacific based on adult specimens (*L. b. bilineata* and *L. b. peracuata*). *Lepidopsetta* 2 larvae are very similar to larvae of *Psettichthys melanostictus* at certain stages of development. We present *Lepidopsetta* 2 as a separate series, since these larvae are distinct from those of *L. bilineata* and *P. melanostictus*. The following pigment patterns and morphological characters separate the three kinds of larvae.

Psettichthys melanostictus (see also p. 620)

Range from California to Alaska, but the center of distribution appears to be off California, Oregon, and Washington.

Pigment
- Postanal ventral midline melanophores: Usually restricted to 3-4 large spots
- Tail pigment less prominent than on *Lepidopsetta* 2
- Pigment on upper and lower jaw
- Isthmus pigment heavier than on others
- First spot along dorsal midline more anterior (over anus)

Morphology
- Gut coiled, shape of posterior gut
- Deeper body (wider finfold)

***Lepidopsetta* 2** (see p. 600, 601)

Range from Puget Sound to Alaska, and center of distribution appears to be off Southeast Alaska and in the Gulf of Alaska.

Pigment
- Postanal ventral midline melanophores: A series of small melanophores extending from the gut to the last myomere; sometimes a larger spot occurs about midbody (with larvae 6.3-9.7 mm SL, there may be more spots than at other sizes)
- First spot along dorsal midline behind anus
- Other: Tail pigment more intense, but mouth and isthmus pigment less intense than on *Psettichthys*

Morphology
- Eye relatively larger than on *Psettichthys* at similar ontogenetic stages
- Gut shape simple

Lepidopsetta bilineata (see also p. 596)

Range from southern California to the Bering Sea.

Pigment
- Postanal ventral midline melanophores: A series of small melanophores extending from the gut to about 2/3 body
- Only two spots along dorsal midline; anterior spot at midbody, posterior spot forming a band at about myomere 30
- No heavy pigment along edges of median finfold
- Tail pigment less prominent than on others
- Pigment along hypural edge

Morphology
- Gut shape simple

Finfold pigment may or may not be an additional criterion for separating *Lepidopsetta* 2 and *Psettichthys*. Many *Psettichthys* specimens in our collection appear to have more prominent finfold pigment that is retained longer during development; however, many of these are laboratory-reared specimens. More wild-caught *Psettichthys* specimens are needed to verify whether they all have intense finfold pigment.

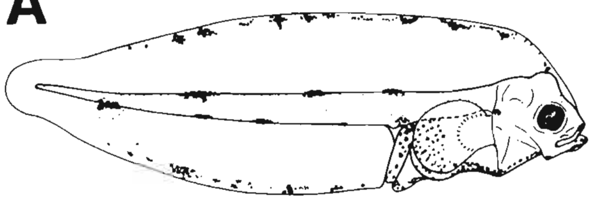
Yolksac larvae are more difficult to separate. *Psettichthys* larvae appear to possess upper and lower jaw pigment, smaller, more concentrated melanophores in the finfold and on the urostyle, and the last postanal band has a ventral stripe only. *Lepidopsetta* 2 yolksac larvae appear to have only lower jaw pigment, larger, fewer, and evenly spaced melanophores in the finfold and urostyle, and the last postanal band has a dorsal and ventral stripe.

Literature: Specimens illustrated by Ahlstrom et al. (1984a) are both *Psettichthys* based primarily on the presence of the coiled gut and the 2-3 large ventral melanophores (Fig. 351C, p. 662, and Fig. 352E, p. 663). Hickman (1959) illustrated six *Psettichthys* larvae from specimens he reared from eggs (his Figs. 1 and 2) and from specimens he collected in Puget Sound (his Figs. 3-6). Hickman's Figures 3 and 4 appear to resemble *Lepidopsetta* 2 larvae, while his other figures appear to resemble *Psettichthys*.

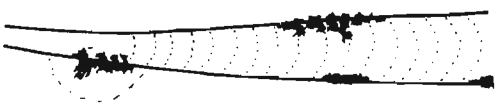
PSETTICHTHYS / LEPIDOPSETTA

Psettichthys melanostictus

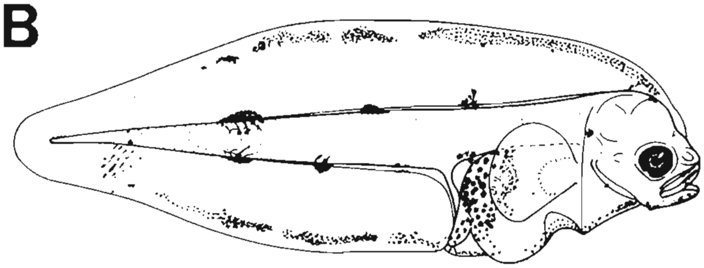
A



6.9 mm SL



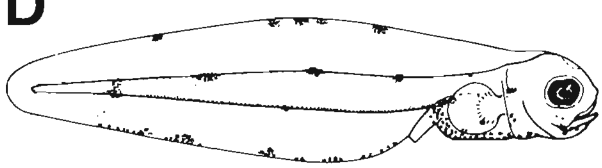
B



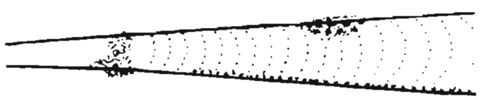
8.1 mm SL

Lepidopsetta 2

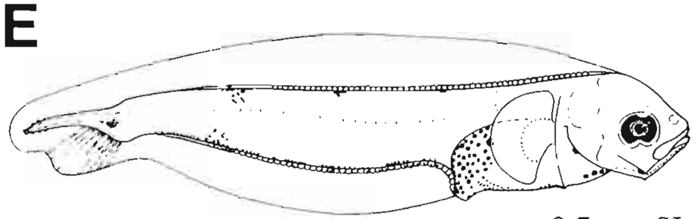
D



6.3 mm SL



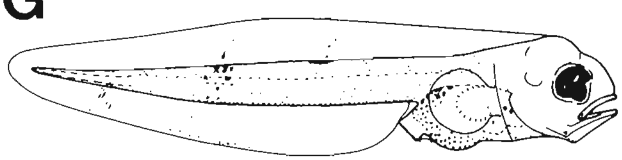
E



9.7 mm SL

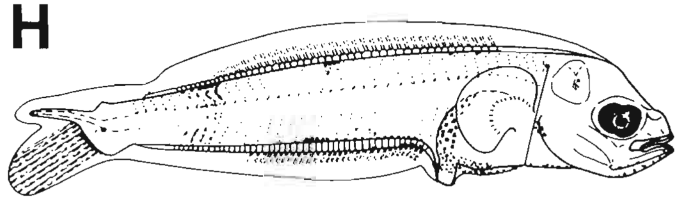
Lepidopsetta bilineata

G



7.4 mm SL

H

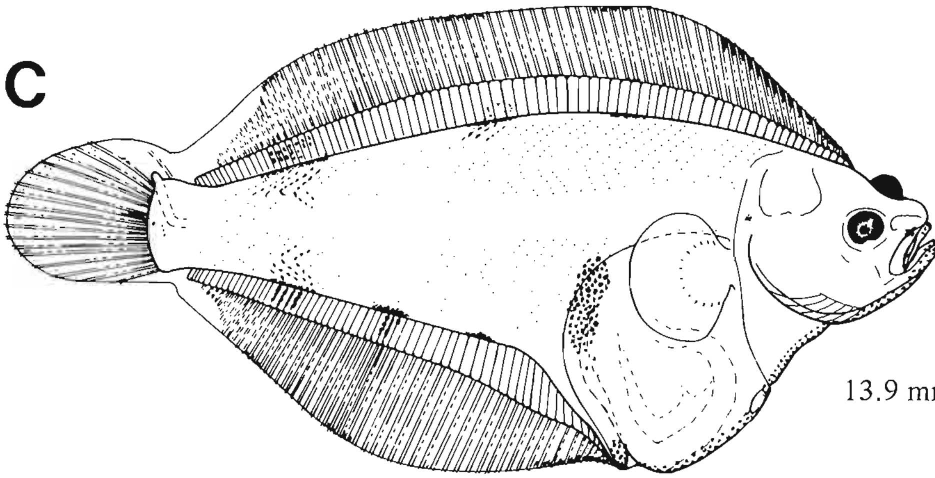


10.8 mm SL

Figures A–I, NWAFC originals (B. Vinter; A, D, G, include a detailed enlargement of tail).

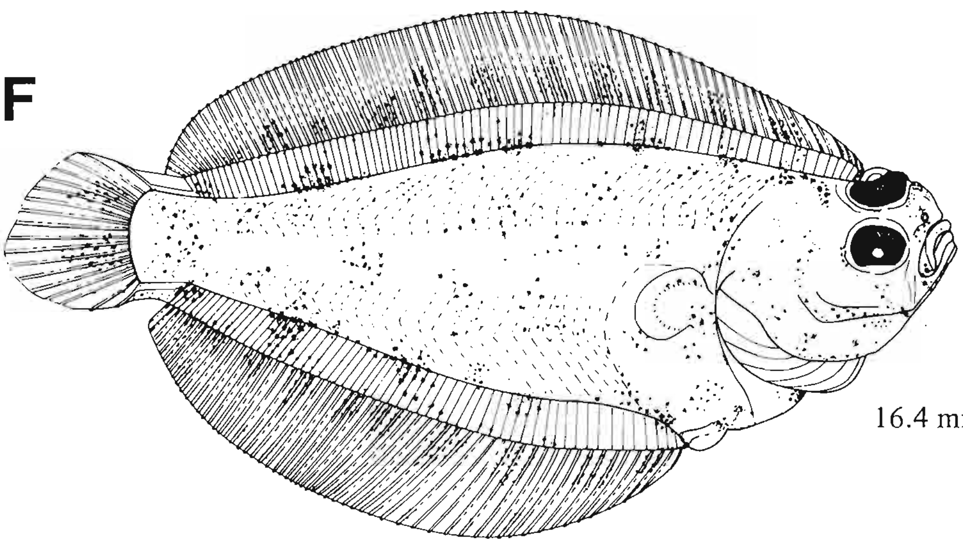
PSETTICHTHYS / LEPIDOPSETTA

C



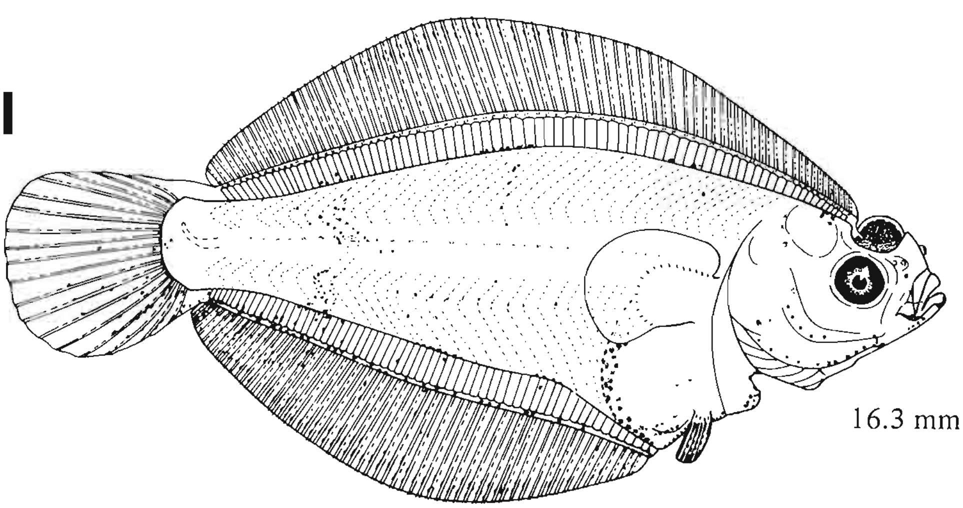
13.9 mm SL

F



16.4 mm SL

I



16.3 mm SL

MERISTICS

Vertebrae	Total: 40-40-41 Precaudal: 10-X-12 Caudal: 28-X-30
Branchiostegal rays	7-7-7
Caudal fin	Total rays=18[a]
Pelvic fin	Thoracic R: 6-6-6
Dorsal fin	R: 61-69-77
Pectoral fin	R: 10-X-12
Anal fin	R: 49-52-58
Gill rakers	U: X-X-X L: 8-X-10

LIFE HISTORY

Range	Brit. Col., 48°30′-55°N, to Chukchi Sea, north of 66°N
Ecology	Epi-, meso-, and bathybenthal, 10-600 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Summer[b] Area: Inner shelf region[b] Mode: Mass[b] Migration: To shallower water of shelf[b]
Fecundity	Range/function: 1,300,000-3,300,000/ $F=0.0747565 \times L^{2.86517}$ (F in 1000 eggs), L=TL cm[b]
Age at first maturity	6-7 yr (females)[b] 4-5 yr (males)[b]
Longevity	19 yr (females)[b] 17 yr (males)[b]

[a] 12 branched rays.
[b] Salveson and Alton 1976b
[c] Ahlstrom et al. 1984a
[d] According to Allen and Smith (1988), this species occurs in the Bering Sea.
[e] Pertseva-Ostroumova 1961

Ref: Ahlstrom et al. 1984a, Pertseva-Ostroumova 1961, Schmidt 1950.

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	0.76-0.85 mm
No. of oil globules	None
Oil globule diameter	
Yolk	Homogeneous, yellowish
Envelope	Clear, smooth
Hatch size	2.25-2.80 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters
- Size

LARVAE

Preanal length	<50% SL
Length at flexion	~7 mm SL; 7.5-9.5 mm SL[c]
Length at transformation	15-17 mm SL; may begin at 10 mm SL[c]
Sequence of fin development	Caudal, dorsal and anal, pelvics, pectorals

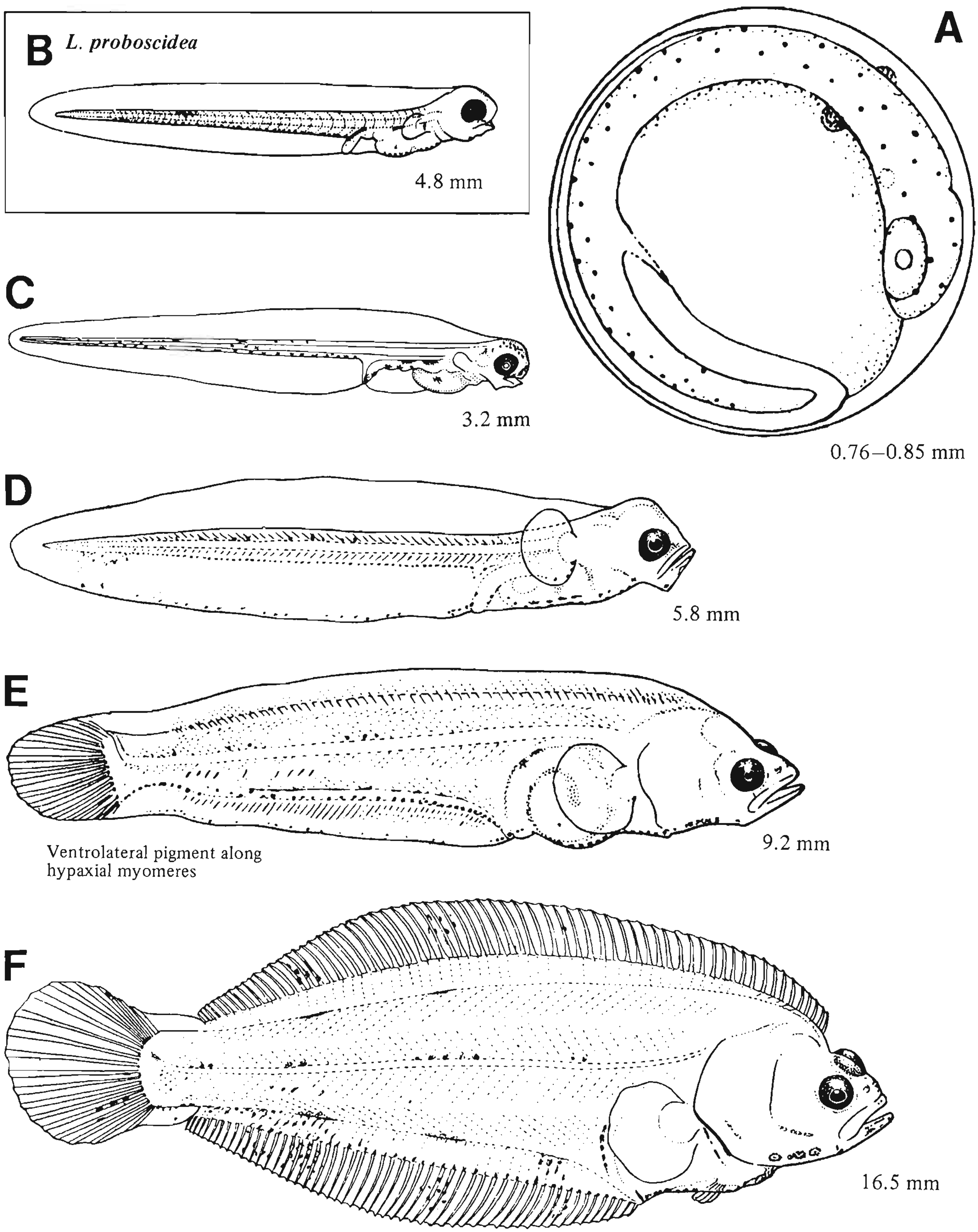
Pigment
- Mediolateral, along notochord
- Ventrolateral, along hypaxial myomeres
- Anal finfold

Diagnostic characters

Distinguished from other pleuronectids without postanal pigment bands by
- Ventrolateral pigment along hypaxial myomeres
- Size at transformation (15-17 mm SL)
- Finfold pigment restricted to anal fin
- Urostyle unpigmented

L. proboscidea and *L. sakhalinensis*[d] eggs and larvae are incompletely known. The following information may aid in identification.

	L. proboscidea	*L. sakhalinensis*
Egg diameter	0.72-0.87 mm	
Total vertebrae	38-40	
Precaudal	11	
Caudal	27-29	
Dorsal fin rays	62-69	68-76
Pectoral fin rays	12	
Anal fin rays	46-50	53-59
Range	Bering Sea-Chukchi Sea	
Spawning season	Spring-summer[e]	



Figures A–F (C, reversed), Pertseva-Ostroumova 1961.

MERISTICS

Vertebrae	Total: 37-X-41
	Precaudal: 11-X-13
	Caudal: 26-26-26
Branchiostegal rays	7-X-8
Caudal fin	Total rays=18
Pelvic fin	Thoracic
	R: 6-6-6
Dorsal fin	R: 48-X-64
Pectoral fin	R: 8-X-12
Anal fin	R: 33-X-46
Gill rakers	U: 2-X-4 L: 7-X-8

LIFE HISTORY

Range	Bering Sea, 54-66°N, to Arctic, not specific
Ecology	Nearshore shelf demersal
ELH pattern	Oviparous, demersal eggs, pelagic larvae
Spawning	Season: Jan-Mar[a]
	Area: Shallow water, 5-10 m[a]
	Mode:
	Migration:
Fecundity	Range/function: 31,000-230,000[a]
Age at first maturity	2+ yr (usually 4-5)[b]
Longevity	>9 yr[b]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.2-1.7 mm (1.54-1.70 mm)
No. of oil globules	None
Oil globule diameter	
Yolk	Clear, homogeneous
Envelope	Thin, smooth
Hatch size	3.7 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE[c]

Preanal length	<50% SL
Length at flexion	
Length at transformation	
Sequence of fin development	

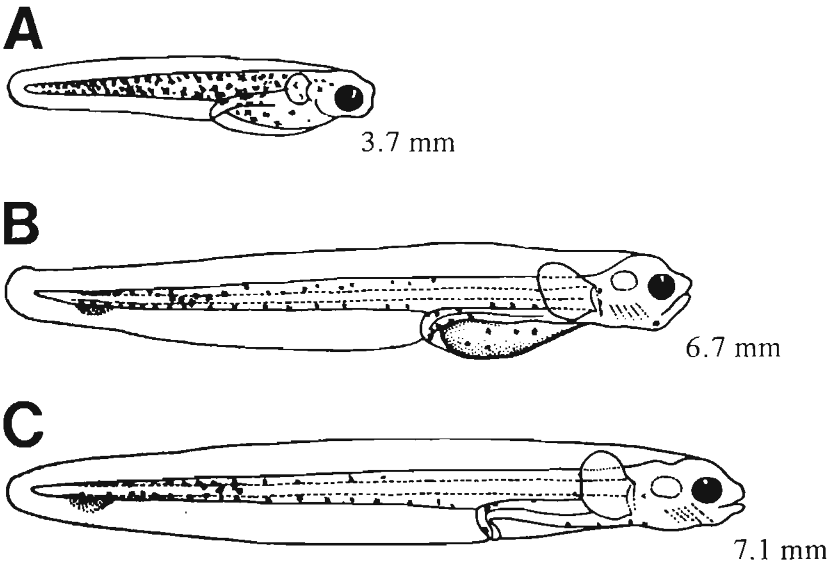
Pigment
- Newly hatched larvae heavily pigmented, but with development pigment appears to be restricted to postanal body above and below notochord

Diagnostic characters

Distinguished from other pleuronectids without pigment bands by
- No pigment in finfolds or along hypaxial myomeres
- Myomere count (37-41)

[a] Pertseva-Ostroumova 1961
[b] Andriashev 1954
[c] Preflexion larvae only.

Ref: Pertseva-Ostroumova 1961.



Figures A–C, Pertseva-Ostroumova 1961 (figures reversed).

MERISTICS

Vertebrae	Total: 43-45-47 Precaudal: 11-12-13 Caudal: 32-33-35
Branchiostegal rays	7-7-7
Caudal fin	X, 8+7, X Total rays=19[a]
Pelvic fin	Thoracic R: 6-6-6
Dorsal fin	R: 72-77-88
Pectoral fin	R: 10-10-10
Anal fin	R: 57-60-66
Gill rakers	U: 2-X-3 L: 9-X-11

LIFE HISTORY

Range	South of southern California to Gulf of Alaska, 54-60°N
Ecology	Epi-, meso-, and bathybenthal, 25-800 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Feb;[b] Apr[c] Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	3-5 yr (females)[c] 2-3 yr (males)[c]
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.47-1.71 mm
No. of oil globules	None
Oil globule diameter	
Yolk	Homogeneous
Envelope	Surface may be irregular and appear bumpy
Hatch size	~5.6 mm SL
Incubation time/temp.	

Pigment
- Yolksac
- Late-stage embryo: Distinct caudal pigment visible

Diagnostic characters
- Caudal pigment
- Smallest size range of three similar-looking pleuronectid eggs in the 1.5-2.5 mm size range; see *Glyptocephalus zachirus* (p. 586) and *Microstomus pacificus* (p. 608)

LARVAE

Preanal length	<50% SL
Length at flexion	9.0-10.9 mm SL
Length at transformation	15.7-24.7 mm SL
Sequence of fin development	Caudal, dorsal and anal, pelvics, pectorals

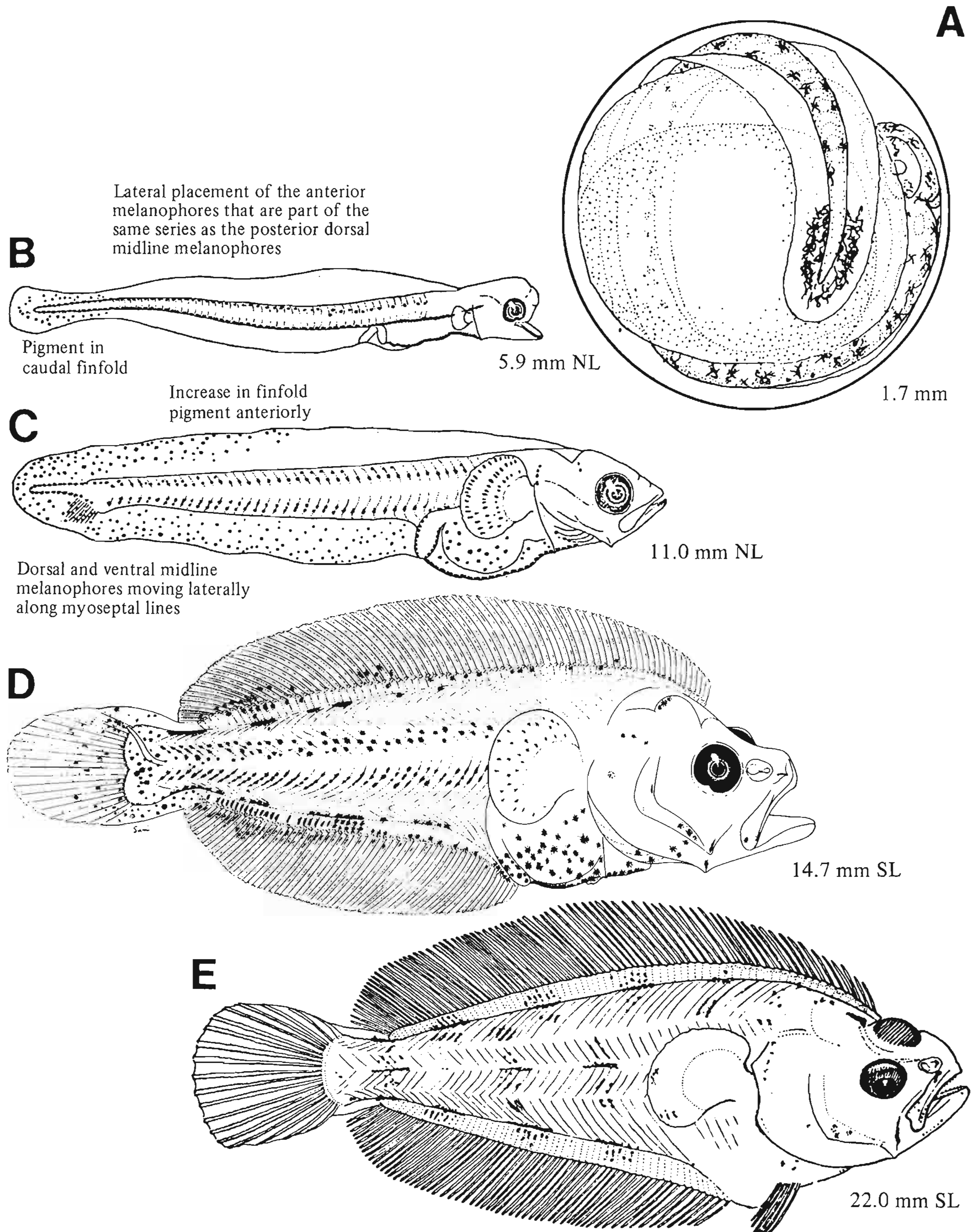
Pigment
- Early and midflexion larvae
  —Dorsal and ventral midline melanophores around tail and in finfold; with development, these melanophores move laterally on body along myoseptal lines
  —Finfold pigment increases to cover anal finfold and posterior half of dorsal finfold
- Gut pigment increases ventrally with development

Diagnostic characters

Distinguished from other pleuronectids without pigment bands by
- Pigment pattern: Continuous dorsal and ventral midline
- In preflexion larvae, the anterior melanophores of the dorsal midline series extend laterally
- Finfold pigment

[a] 12-13 branched rays.
[b] Hart 1973
[c] Smith 1936

Ref: Ahlstrom and Moser 1975, Ahlstrom et al. 1984a.



Figures A–E, Ahlstrom and Moser 1975.

MERISTICS

Vertebrae	Total: 50-52-55 Precaudal: 11-12-13 Caudal: 38-40-41
Branchiostegal rays	7-7-7
Caudal fin	X, 9+8, X Total rays=21[a]
Pelvic fin	Thoracic R: 6-6-6
Dorsal fin	R: 94-105-116
Pectoral fin	R: 8-X-12
Anal fin	R: 80-87-96
Gill rakers	U: 5-X-8 L: 8-X-11

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Epi-, meso-, and bathybenthal, 9-1189 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Nov-Aug[b] Area: 80-550 m[b] Mode: Migration: Offshore for spawning[c]
Fecundity	Range/function: 37,188[d]-260,000[e]
Age at first maturity	5 yr[f]
Longevity	45 yr[g]

[a] 13-16 branched rays.
[b] Hirschberger and Smith 1983
[c] Westrheim and Morgan 1962
[d] Hagerman 1952
[e] Harry 1959
[f] Frey 1971
[g] Chilton and Beamish 1982

Ref: Ahlstrom and Moser 1975, Ahlstrom et al. 1984a, Richardson 1981b.

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	2.05-2.68 mm
No. of oil globules	None
Oil globule diameter	
Yolk	Homogeneous
Envelope	Smooth, slightly thick
Hatch size	~6 mm SL
Incubation time/temp.	27 d/10°C

Pigment
- Yolksac
- Late-stage embryo: Caudal pigment not as pronounced as *Lyopsetta exilis* (p. 606)

Diagnostic characters
- Largest egg of three similar-looking pleuronectid eggs; see *L. exilis* and *Glyptocephalus zachirus* (p. 586)

LARVAE

Preanal length	<50% SL
Length at flexion	10-15 mm SL
Length at transformation	Eye migration begins at 20 mm SL; larvae remain pelagic >45 mm SL
Sequence of fin development	Caudal, dorsal and anal, pelvics, pectorals

Pigment
- Lower jaw; dorsally and ventrally on gut, with development becoming restricted to ventral surface (isthmus to anus)
- Preflexion
  —Three pigment patches in addition to tail and finfold
  —Anterior patch restricted to ventral area; two posterior patches have dorsal and ventral components extending into finfold
  —Around urostyle and in finfold
- Flexion: Pigment patches occur above notochord and along distal ends of finfold
- Postflexion: Pigment patches along dorsal and anal pterygiophores

Diagnostic characters

Distinguished from other pleuronectids with 3-4 pigment bands by
- Pigment bands extending into finfold
- Morphology: Early larvae long and slender, becoming deep-bodied during development
- Otic spines
- Myomeres (50-55)

See also *G. zachirus* (p. 586) and *Hippoglossoides elassodon* (p. 588)

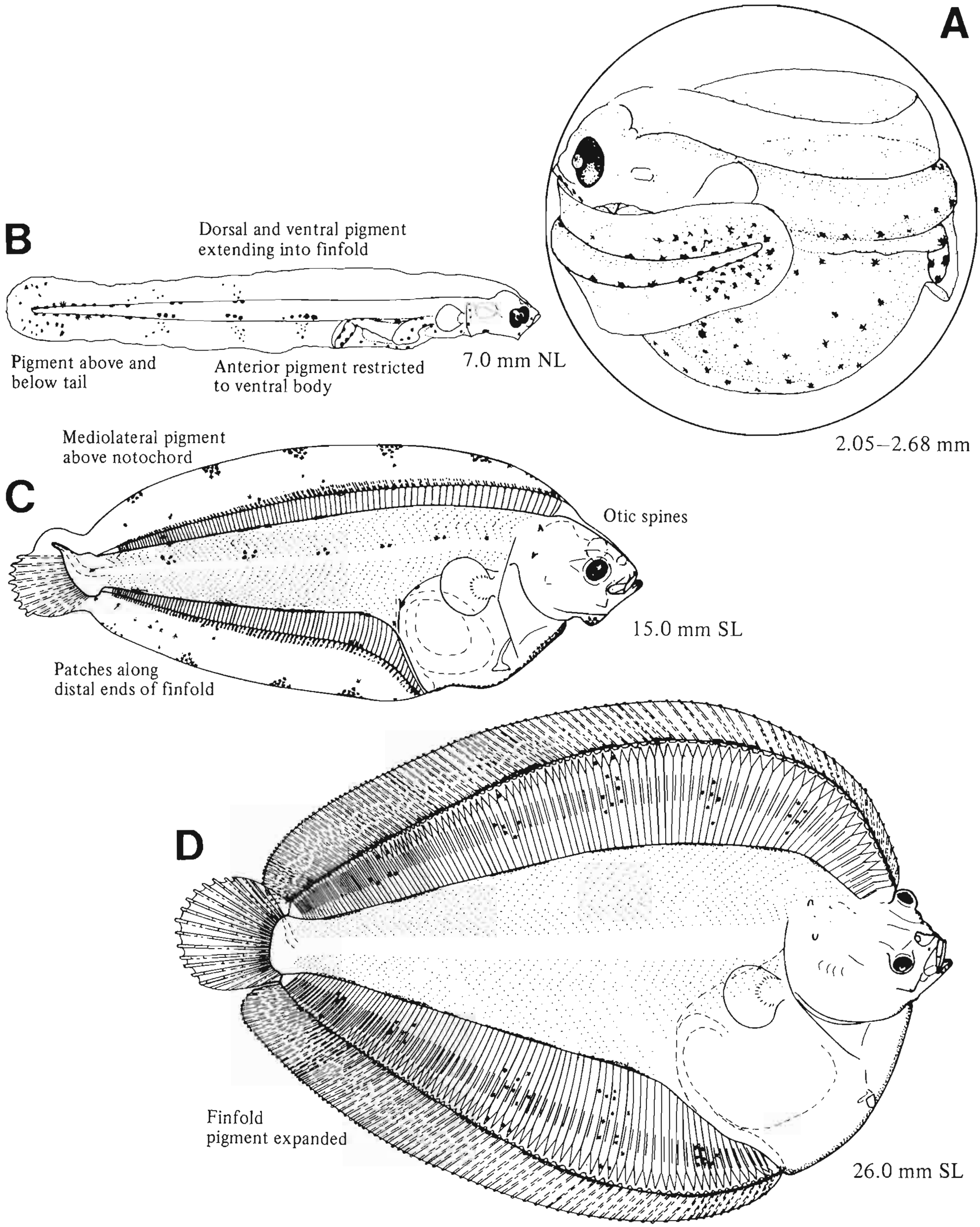


Figure A, Ahlstrom and Moser 1975; B, Ahlstrom et al. 1984a (after Ahlstrom and Moser 1975); C–D, NWAFC originals (B. Vinter).

MERISTICS

Vertebrae	Total: 42-44-47 Precaudal: 10-11-12 Caudal: 31-33-34
Branchiostegal rays	7-X-8
Caudal fin	X, 7+7, X Total rays=18[a]
Pelvic fin	Thoracic R: 6-6-6
Dorsal fin	R: 72-80-82
Pectoral fin	R: 10-X-12
Anal fin	R: 54-60-70
Gill rakers	U: 4-X-6 L: 10-X-13

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Epi-, meso-, and bathybenthal, intertidal to 550 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Oct-May (California);[b] Jan-Apr (Puget Sound)[c] Area: Demersal[d] Mode: Migration: Southern migration from feeding grounds to sheltered water in channels or bights[d]
Fecundity	Range/function: 150,000-1,950,000[e]
Age at first maturity	3-4 yr (females)[c] 2 yr (males)[c]
Longevity	17 yr[f]

[a] 12 branched rays.
[b] Jow 1969
[c] Smith 1936
[d] Ketchen 1956
[e] Ketchen 1947
[f] Frey 1971
[g] Ahlstrom et al. 1984a

Ref: Budd 1940, Ahlstrom and Moser 1975, Ahlstrom et al. 1984a.

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	0.80-1.05 mm
No. of oil globules	None
Oil globule diameter	
Yolk	Homogeneous
Envelope	Thin, smooth, transparent
Hatch size	2.3-2.8 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters
- See *Isopsetta isolepis* (p. 594)

LARVAE

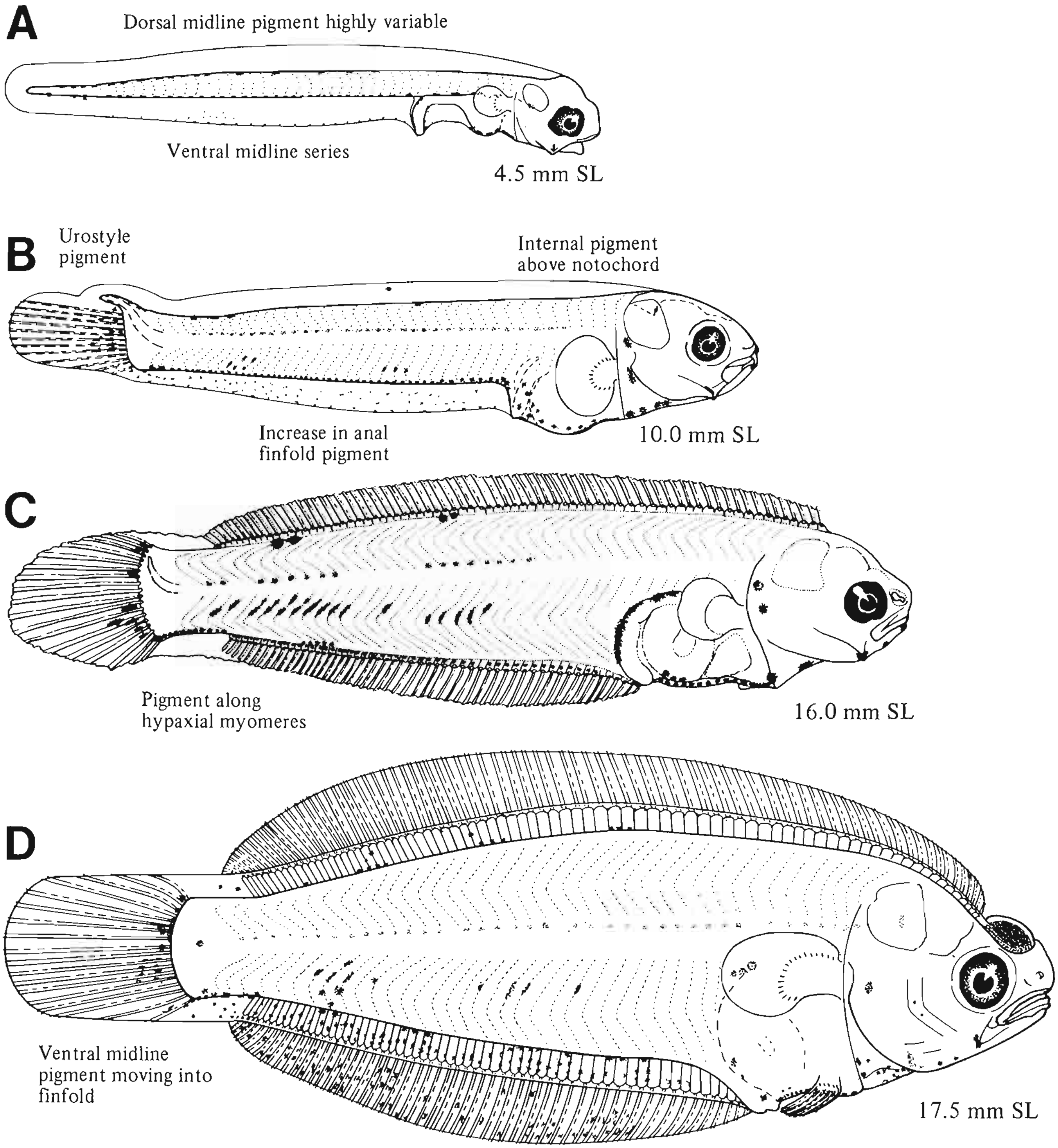
Preanal length	43-45% SL
Length at flexion	~10 mm SL; 8.8-10.5 mm SL[g]
Length at transformation	Eye migration prior to 17.5 mm SL
Sequence of fin development	Caudal, dorsal and anal, pelvics, pectorals

Pigment
- Initially, anteroventrally on gut; with development, extending posteriorly; in postflexion, a line of pigment forms along the posterior hindgut and anus
- Dorsal and ventral midline: Ventral beginning prior to anus (~ myomere 5) and dorsal at ~ myomere 15 (pigment is variable); dorsal midline becoming less prominent with development as internal pigment develops above notochord through flexion stage
- Myoseptal pigment develops along hypaxial myomeres in postflexion larvae
- Finfold pigment restricted to anal finfold

Diagnostic characters

Distinguished from other pleuronectids without pigment bands by
- Dorsal and ventral midline pigment, hypaxial pigment
- Finfold pigment restricted to anal finfold

Note: The number of dorsal midline melanophores in preflexion larvae is highly variable.



Figures A–B, D, NWAFC originals (B. Vinter); C, Ahlstrom et al. 1984a (after Ahlstrom and Moser 1975).

MERISTICS

Vertebrae	Total: 35-36-38 Precaudal: 10-11-12 Caudal: 24-25-26
Branchiostegal rays	7-7-7
Caudal fin	Total rays=18
Pelvic fin	Thoracic R: 6-6-6
Dorsal fin	R: 52-59-66
Pectoral fin	R: 9-10-10
Anal fin	R: 38-42-47
Gill rakers	U: 3-3-3 L: 6-X-8

LIFE HISTORY

Range	S. California, 32-34°N, to Arctic, not specific
Ecology	Epi- and mesobenthal, freshwater (upstream) to 375 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Nov-Feb (California);[a] Feb-Apr (Puget Sound);[b] May-June (Bering Sea)[c] Area: Shallow water[a] Migration:
Fecundity	Range/function: 900,000[c]-11 million[a]
Age at first maturity	3-4 yr (females)[a]
Longevity	21 yr[d]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	0.88-1.28 mm
No. of oil globules	None
Oil globule diameter	
Yolk	Homogeneous
Envelope	Striated, yellow
Hatch size	1.9-2.1 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters
- See *Isopsetta isolepis* (p. 594)

LARVAE

Preanal length	<50% SL
Length at flexion	~7 mm SL; 5.5-6.0 mm SL[e]
Length at transformation	10.5 mm SL (may be slightly smaller, 8-9 mm SL)
Sequence of fin development	Caudal, dorsal and anal, pelvics, pectorals

Pigment
- Lightly scattered over head and posteroventrally along gut
- Initially, in preflexion larvae, postanal pigment scattered along anal finfold and along posterior 1/3 of body
- Around urostyle
- Internally above notochord, becoming less concentrated with development
- Pigment in dorsal fin disappears with development
- Postflexion larvae lightly pigmented with lateral patches

Diagnostic characters

Distinguished from other pleuronectids without pigment bands by
- Lack of dorsal midline pigment
- Small size at transformation (<10 mm SL)

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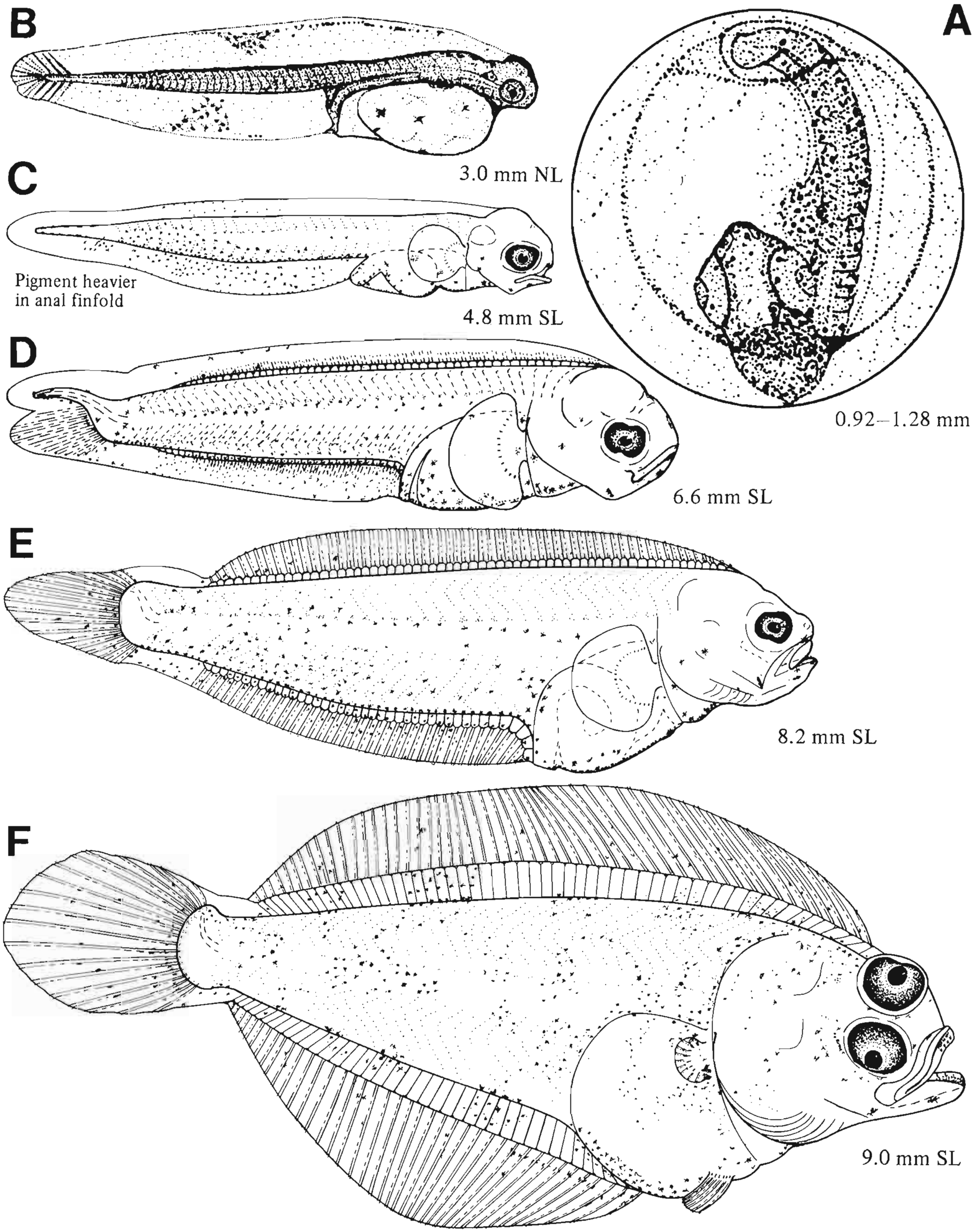
[a] Orcutt 1950
[b] Hart 1973
[c] Fadeev 1965
[d] Wolotira et al. 1977
[e] Ahlstrom et al. 1984a

Ref: Ahlstrom et al. 1984a, Orcutt 1950, Pertseva-Ostroumova 1961, Yusa 1957.



Figures A–B, Orcutt 1950 (B, reversed); C–F, NWAFC originals (B. Vinter).

MERISTICS

Vertebrae	Total: 41-X-42 Precaudal: 18-18-19 Caudal: X-X-X
Branchiostegal rays	7-X-8
Caudal fin	
Pelvic fin	Thoracic R: 6-6-6
Dorsal fin	R: 62-69-71
Pectoral fin	R: 11-11-11
Anal fin	R: 51-51-56
Gill rakers	U: X-X-X L: 7-7-7

LIFE HISTORY

Range	Gulf of Alaska, 54-60°N, to Chukchi Sea, north of 66°N
Ecology	Epi- and mesobenthal, 6-475 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Spring[a] Area: Mode: Migration: Inshore[a]
Fecundity	Range/function:
Age at first maturity	4 yr[a]
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.67-2.21 mm (1.7-1.9 mm)
No. of oil globules	None
Oil globule diameter	
Yolk	
Envelope	Thick wavy surface (color: bronze hue)
Hatch size	~5.85 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	<50% SL
Length at flexion	~8-10 mm SL
Length at transformation	Beginning by 10.7 mm SL
Sequence of fin development	Caudal, dorsal and anal, pelvics, pectorals

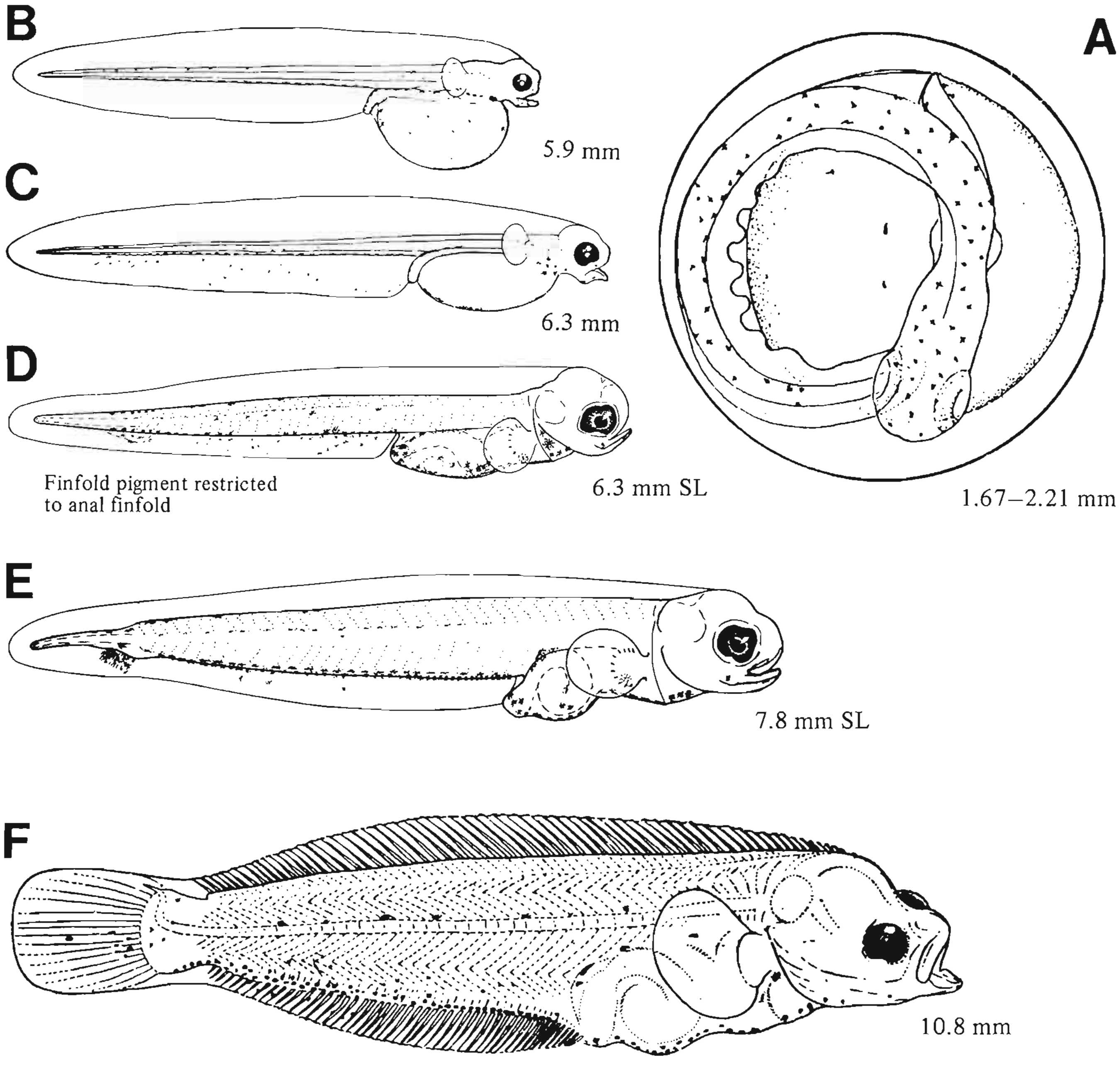
Pigment
- Isthmus, posteroventrally on gut
- Initially, in preflexion larvae, dorsal spots over posterior half of body that become less prominent with development
- Ventral midline melanophores extend onto finfold and on caudal region
- Internal row above notochord throughout development

Diagnostic characters

Distinguished from other pleuronectids without pigment bands by
- Pigment pattern
  - —Urostyle unpigmented
  - —No slash-like pigment along hypaxial myomeres
  - —Finfold pigment mainly restricted to anal finfold
- Size at transformation ~10 mm SL

[a] Pertseva-Ostroumova 1961

Ref: Ahlstrom et al. 1984a.



Figures A–C, F, Pertseva-Ostroumova 1961 (B–C, reversed); D–E, NWAFC originals (B. Vinter).

MERISTICS

Vertebrae	Total: 37-38-39 Precaudal: 12-13-13 Caudal: 24-25-26
Branchiostegal rays	7-X-8
Caudal fin	Total rays=19
Pelvic fin	Thoracic R: 6-6-6
Dorsal fin	R: 65-72-78
Pectoral fin	R: 9-11-12
Anal fin	R: 46-50-56
Gill rakers	U: 3-X-4 L: 8-X-11

LIFE HISTORY

Range	South of southern California to SE Alaska, 55-59°N
Ecology	Epi- and mesobenthal, 0-350 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Mar-Aug (California)[a] Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.20-1.56 mm
No. of oil globules	None
Oil globule diameter	
Yolk	Homogeneous
Envelope	Sculptured with polygonal pattern
Hatch size	3.9 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters
- Egg diameter (1.20-1.56 mm)
- Polygonal sculpturing on envelope surface

LARVAE

Preanal length	<50% SL
Length at flexion	6.2-8.5 mm NL
Length at transformation	8.2->11.4 mm SL
Sequence of fin development	Caudal slightly before dorsal and anal, pelvics, pectorals

Pigment
- Preflexion larvae: Opposing pigment clusters on dorsal and ventral finfolds, increasing with development
- Small melanophores covering all but posterior 1/4 of body

Diagnostic characters (see Table 3)

Distinguished from other pleuronectids without pigment bands by
- Heavy pigment pattern

Distinguished from *P. decurrens* by
- Pigment pattern: *P. coenosus* has less finfold pigment than *P. decurrens*
- Precaudal vertebrae 12-13, whereas *P. decurrens* usually has 14-15
- Lack of pterotic spines

Note: Preflexion larvae occasionally have more snout and lower jaw pigment than shown on figure.

[a] Budd 1940

Ref: Ahlstrom et al. 1984a, Sumida et al. 1979.

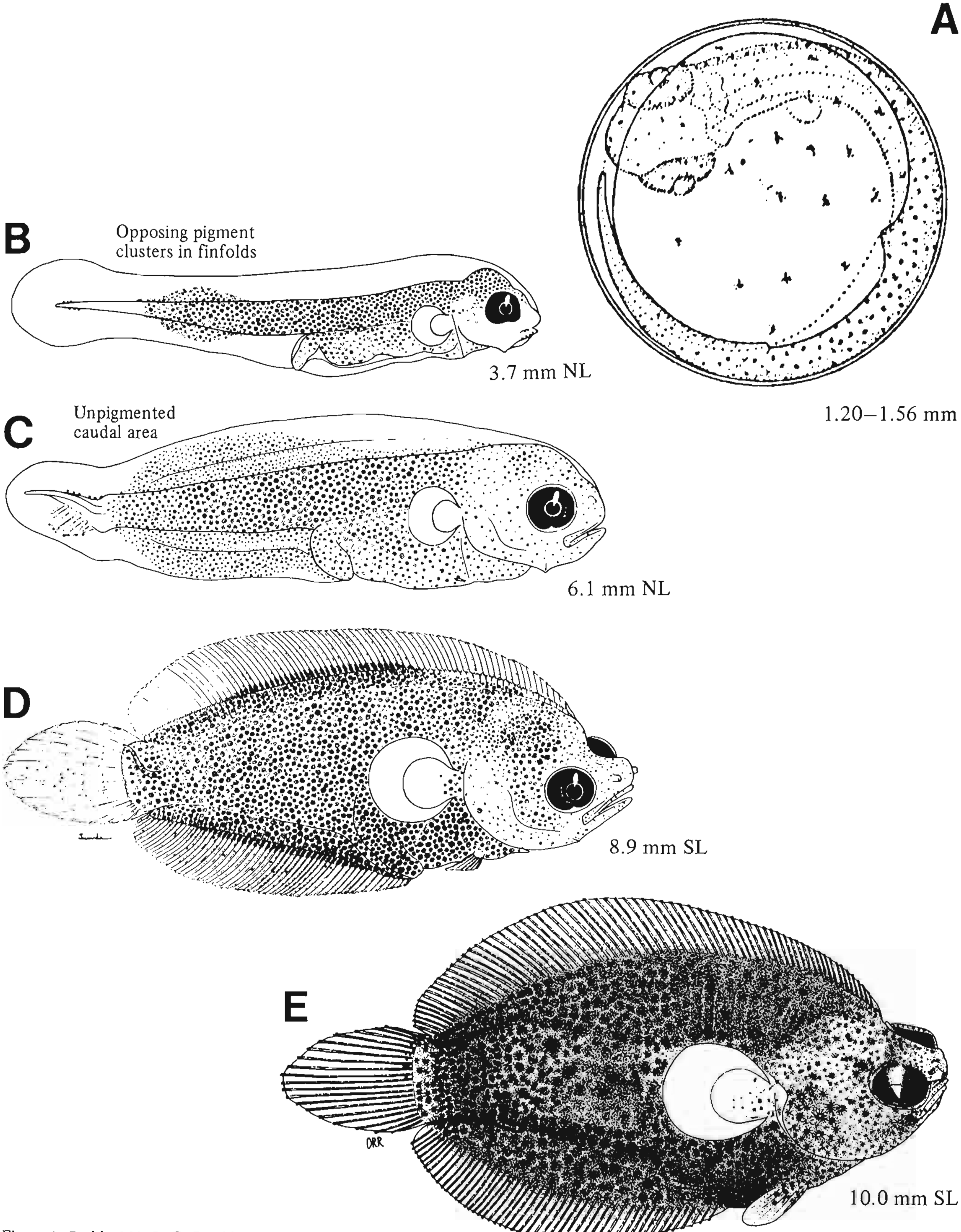


Figure A, Budd 1940; B–E, Sumida et al. 1979.

MERISTICS

Vertebrae	Total: 38-39-41 Precaudal: 13-14-15 Caudal: 24-25-26
Branchiostegal rays	7-X-8
Caudal fin	2, 7+7, 2 Total rays=19[a]
Pelvic fin	Thoracic R: 4-6-7
Dorsal fin	R: 67-75-81
Pectoral fin	R: 9-12-14
Anal fin	R: 45-50-55
Gill rakers	U: 3-X-4 L: 6-X-9

LIFE HISTORY

Range	South of southern California to Bering Sea, 54-66°N
Ecology	Epi-, meso-, and bathybenthal, 8-532 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	1.84-2.08 mm
No. of oil globules	None
Oil globule diameter	
Yolk	Homogeneous
Envelope	Sculptured with polygonal pattern
Hatch size	4.9-5.5 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters
- Egg diameter (1.84-2.08 mm)
- Polygonal sculpturing on envelope surface

LARVAE

Preanal length	~50% SL
Length at flexion	7.8-11.0 mm NL
Length at transformation	10.5->21.0 mm SL[b]
Sequence of fin development	Caudal slightly before dorsal and anal, pelvics, pectorals

Pigment
- Nearly entire body and finfolds pigmented except posteriorly in preflexion larvae; banding pattern develops in postflexion larvae

Diagnostic characters (see Table 3)

Distinguished from other pleuronectids without pigment bands by
- Heavy pigment pattern
- Pterotic spines

Distinguished from *P. coenosus* by
- See *P. coenosus* (p. 616)
- In addition to having pterotic spines, more pigment, and more precaudal myomeres, *P. decurrens* is larger at various stages of development (see figures).

[a] 12 branched rays.
[b] Eye migration by 10 mm SL, but not complete in some until >21 mm SL.

Ref: Ahlstrom et al. 1984a, Sumida et al. 1979.

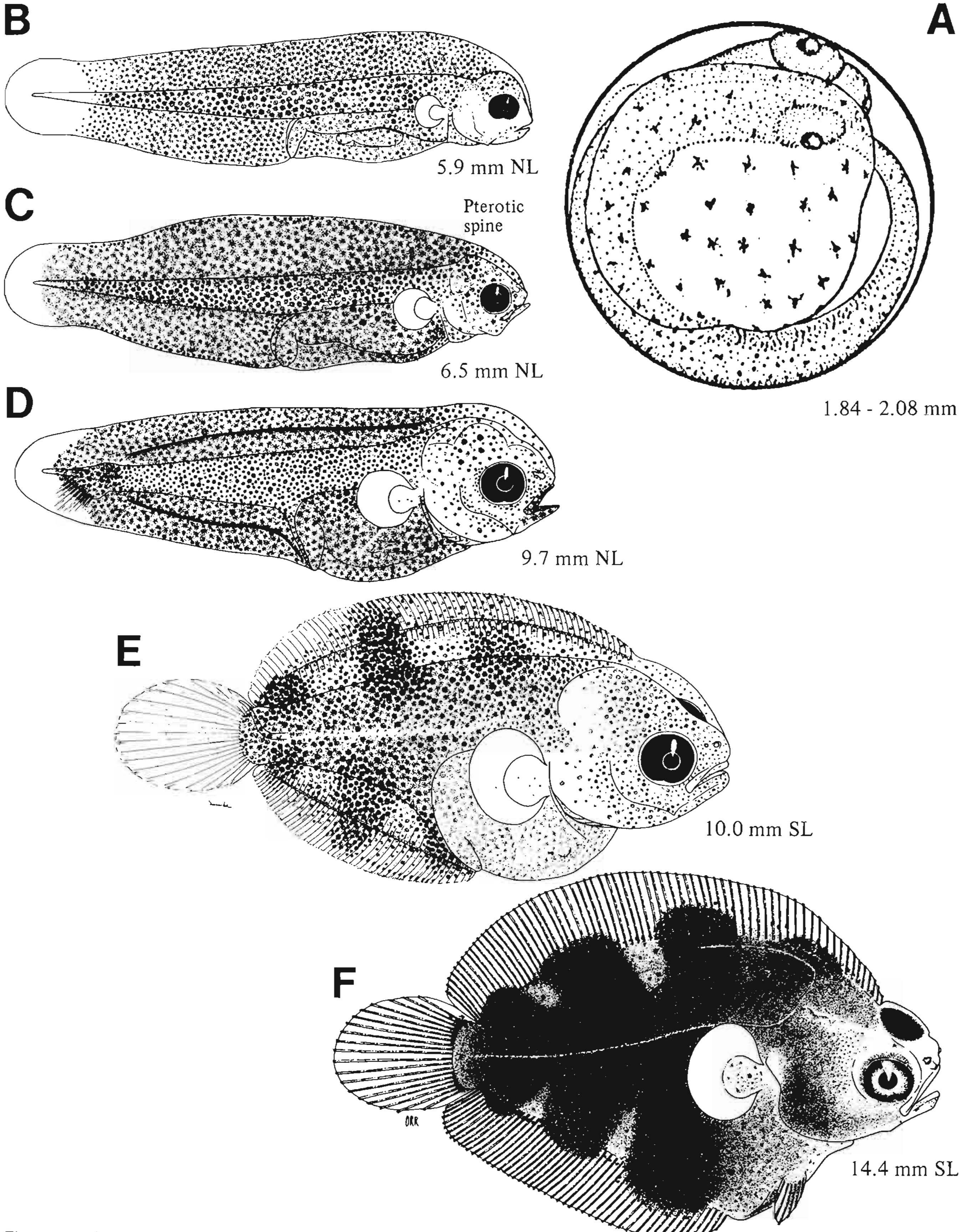


Figure A, Budd 1940; B–F, Sumida et al. 1979.

MERISTICS

Vertebrae	Total: 38-39-41 Precaudal: 11-11-12 Caudal: 28-28-30
Branchiostegal rays	7-7-7
Caudal fin	2, 7+7, 2 Total rays=18[a]
Pelvic fin	Thoracic R: 6-6-6
Dorsal fin	R: 73-85-88
Pectoral fin	R: 10-X-12
Anal fin	R: 53-58-62
Gill rakers	U: 5-X-7 L: 14-X-18

LIFE HISTORY

Range	S. California, 32-34°N, to Bering Sea, 54-66°N
Ecology	Epi- and mesobenthal, 1-325 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Jan-Mar (Puget Sound);[b] July (British Columbia)[c] Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	2-3 yr (females)[d] 2 yr (males)[e]
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	0.83-1.04 mm
No. of oil globules	None
Oil globule diameter	
Yolk	Clear
Envelope	
Hatch size	<3 mm SL
Incubation time/temp.	

Pigment
- Yolksac: May appear as early as late middle stage

Diagnostic characters
See *Isopsetta isolepis* (p. 594); usually pigment on yolksac and in later stages on finfold

LARVAE (see discussion, p. 599)

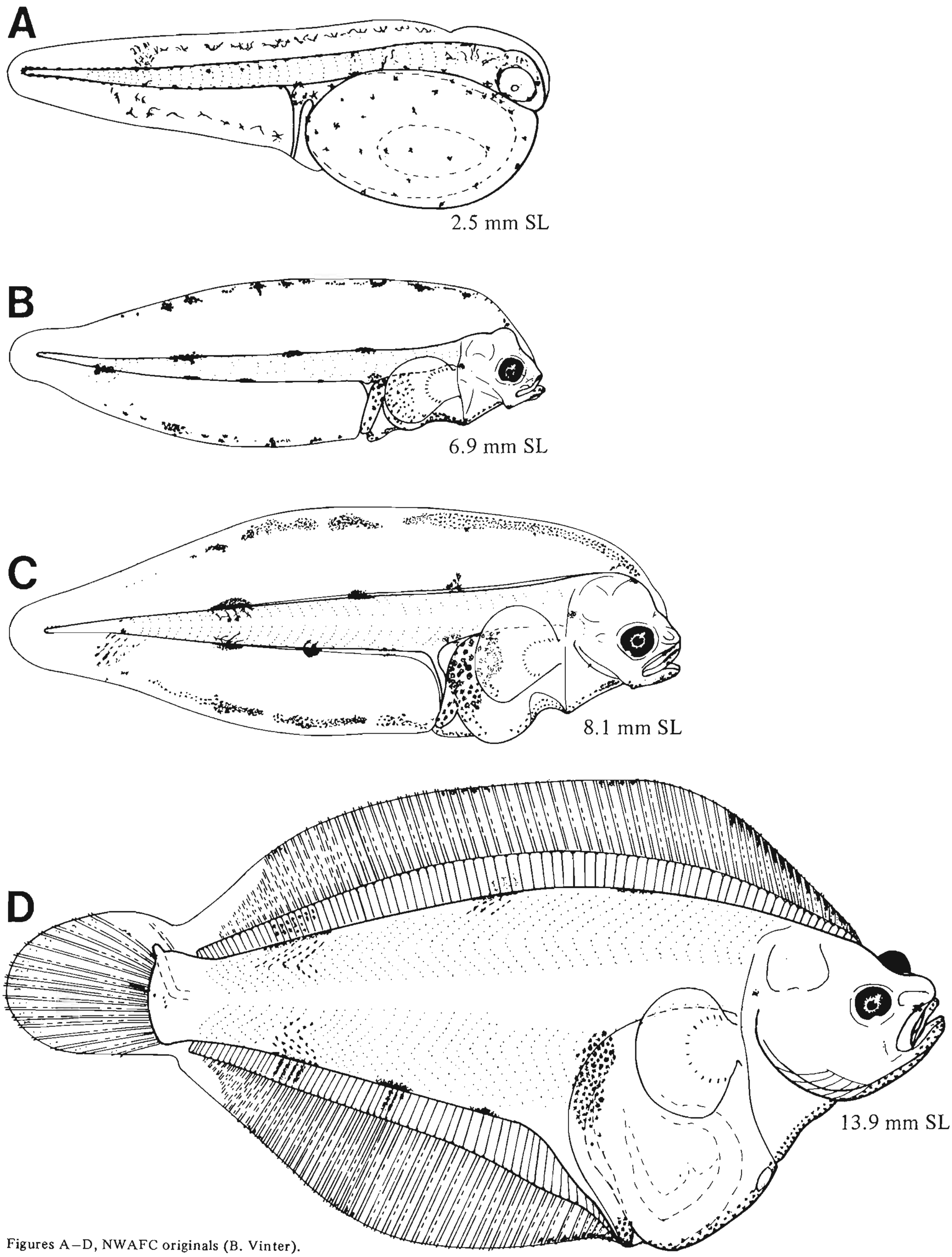
Preanal length	<50% SL
Length at flexion	~8-10 mm SL
Length at transformation	>22.6 mm SL
Sequence of fin development	Caudal, dorsal and anal, pelvics, pectorals

Pigment
- Postanal body
  - —3-4 large spots along ventral midline
  - —Three spots along dorsal midline; the first spot more anteriorly placed than the first ventral spot
- Prominent pigment along edges of dorsal and ventral finfolds
- Mouth, isthmus
- Gut pigmented along ventral midline and posterior edge

Diagnostic characters
See *Lepidopsetta bilineata* (p. 596) and *Lepidopsetta* 2 (p. 599)
Distinguished from other pleuronectids with pigment bands by
- Distinctive pigment along edges of dorsal and ventral finfolds and dorsal and ventral body midlines

[a] 12 branched rays.
[b] English 1961
[c] Manzer 1947
[d] Smith 1936

Ref: Ahlstrom et al. 1984a.



Figures A–D, NWAFC originals (B. Vinter).

MERISTICS

Vertebrae	Total: 61-63-64
	Precaudal: 17-18-19
	Caudal: 43-45-46
Branchiostegal rays	7-7-7
Caudal fin	
Pelvic fin	Thoracic
	R: 5-6-7
Dorsal fin	R: 83-97-105
Pectoral fin	R: 11-14-15
Anal fin	R: 63-72-79
Gill rakers	U: 3-X-6 L: 11-X-16

LIFE HISTORY

Range	South of southern California to Chukchi Sea, north of 66°N
Ecology	Epi-, meso-, and bathybenthal, 14-2000 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Fall[a]
	Area: Continental slope (>100 m)[a]
	Mode:
	Migration:
Fecundity	Range/function: 15,000-215,000 (Atlantic)/ $F=0.000063\times L^{4.66}$, L=FL cm[a]
Age at first maturity	13 (females, Okhotsk Sea)[a]
Longevity	>23 yr[a]

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	4.0-4.5 mm
No. of oil globules	None
Oil globule diameter	
Yolk	Homogeneous
Envelope	Smooth, transparent
Hatch size	10-16 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters

LARVAE

Preanal length	<50% SL
Length at flexion	25-27 mm SL
Length at transformation	45-65 mm SL
Sequence of fin development	Caudal, dorsal and anal, pelvics, pectorals

Pigment
- Ventrally and posterolaterally on gut
- Light ventrolateral pigment along body from above gut, some dorsal, along peduncle; also in finfold above and below tail (~posterior 1/3)
- Increase in pigmentation in postflexion specimens

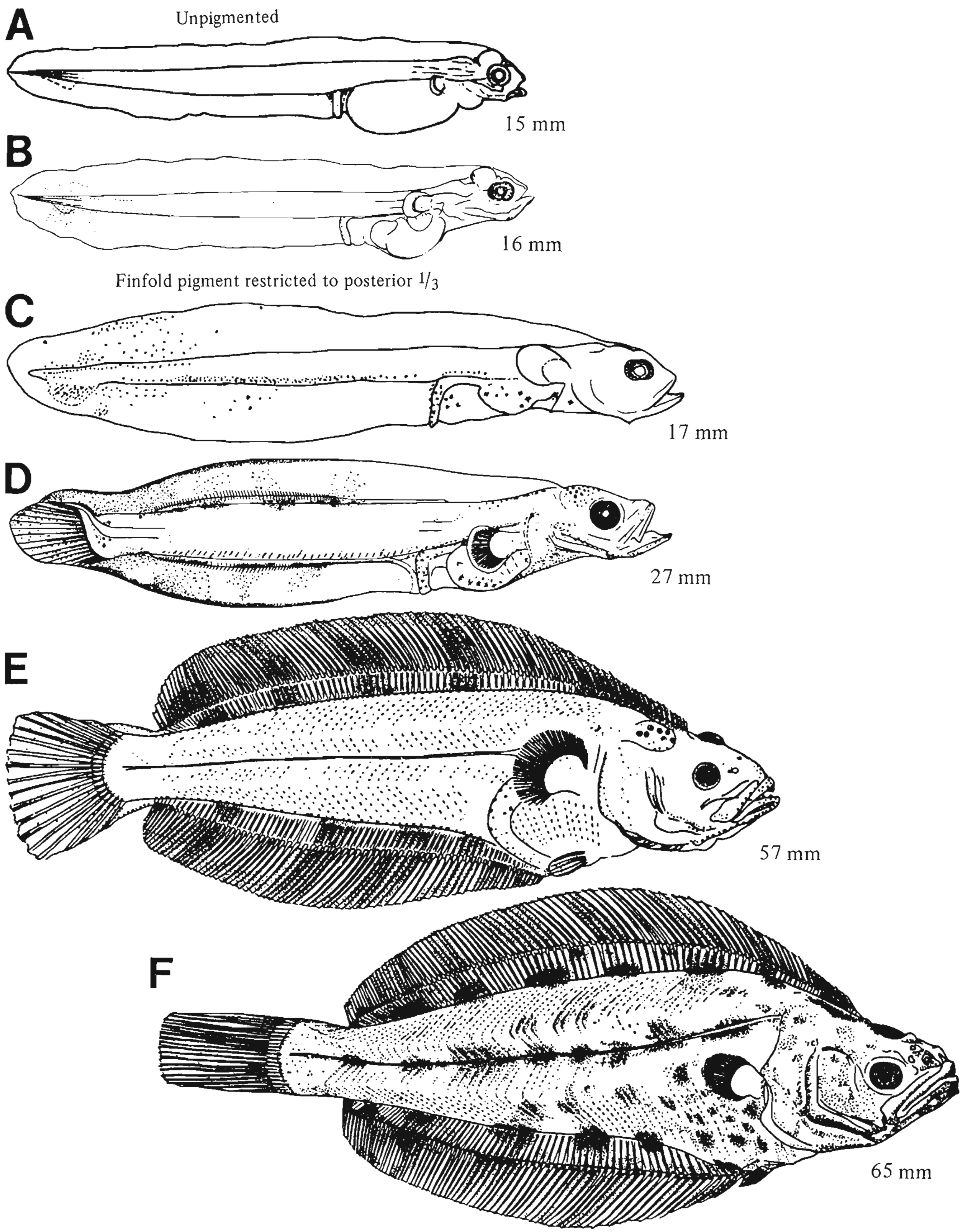
Diagnostic characters
- Newly hatched larvae large and unpigmented (except for eye)

Distinguished from other pleuronectids with >60 myomeres by
- No band pattern and overall lightly pigmented
  - —*Glyptocephalus zachirus* (p. 586): Four postanal bands with more lateral intensity
  - —*Embassichthys bathybius* (p. 580): Three postanal bands

Distinguished from *Hippoglossus stenolepis* (p. 592) (both have large unpigmented yolksac larvae) by
- Depth of collection (>200 m)
- High myomere count (61-64)
- Hatch size (10-16 mm SL)

[a] Dunn and Sample 1976

Ref: Ahlstrom et al. 1984a, Jensen 1935.



Figures A–F, Jensen 1935 (A–D, reversed; specimens collected from West Greenland waters).

MERISTICS

Vertebrae	Total: 50-51-52 Precaudal: 9-9-9 Caudal: 41-X-43
Branchiostegal rays	6-6-6
Caudal fin	Total rays=12[a]
Pelvic fin	Thoracic; 4 rays on eyed side, absent on blind side
Dorsal fin	R: 95-X-106
Pectoral fin	Present during larval period but lacking in juvenile and adult stages
Anal fin	R: 77-X-90
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to Oregon, 42-46°N
Ecology	Nearshore shelf demersal, 1-201 m
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: June-Sept[b] Area: Mode: Migration:
Fecundity	Range/function:
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	0.71-0.78 mm
No. of oil globules	Multiple, 10-23
Oil globule diameter	
Yolk	Homogeneous
Envelope	Smooth, colored
Hatch size	1.9 mm SL
Incubation time/temp.	
Pigment	

Diagnostic characters
- Multiple oil globules

LARVAE

Preanal length	50% NL decreasing with development to 28% SL
Length at flexion	9.4-10.8 mm SL
Length at transformation	19.0-24.2 mm SL
Sequence of fin development	Anterior dorsal; caudal, dorsal, and anal; pelvics[c] (pectorals disappear at metamorphosis)

Pigment
- Small melanophores along dorsal midline, larger along ventral midline
- Single band posteriad on tail
- Large blotches at finfold margin, with development restricted to along the distal edges
- Head, gut, and swimbladder

Diagnostic characters
- Morphology: Large head and tapering body
- Gut mass trails posteriad
- Five exserted dorsal fin rays develop by 6.0 mm SL but they are no longer than other fin rays (in other species of *Symphurus*, elongate anterior dorsal fin rays persist)
- Pelvic fin on blind side begins disappearing at 18.0-22.0 mm SL[c]

[a] All rays on hypurals, all unbranched.
[b] Fitch and Lavenberg 1975
[c] E.H. Ahlstrom notes

Ref: Ahlstrom et al. 1984a.

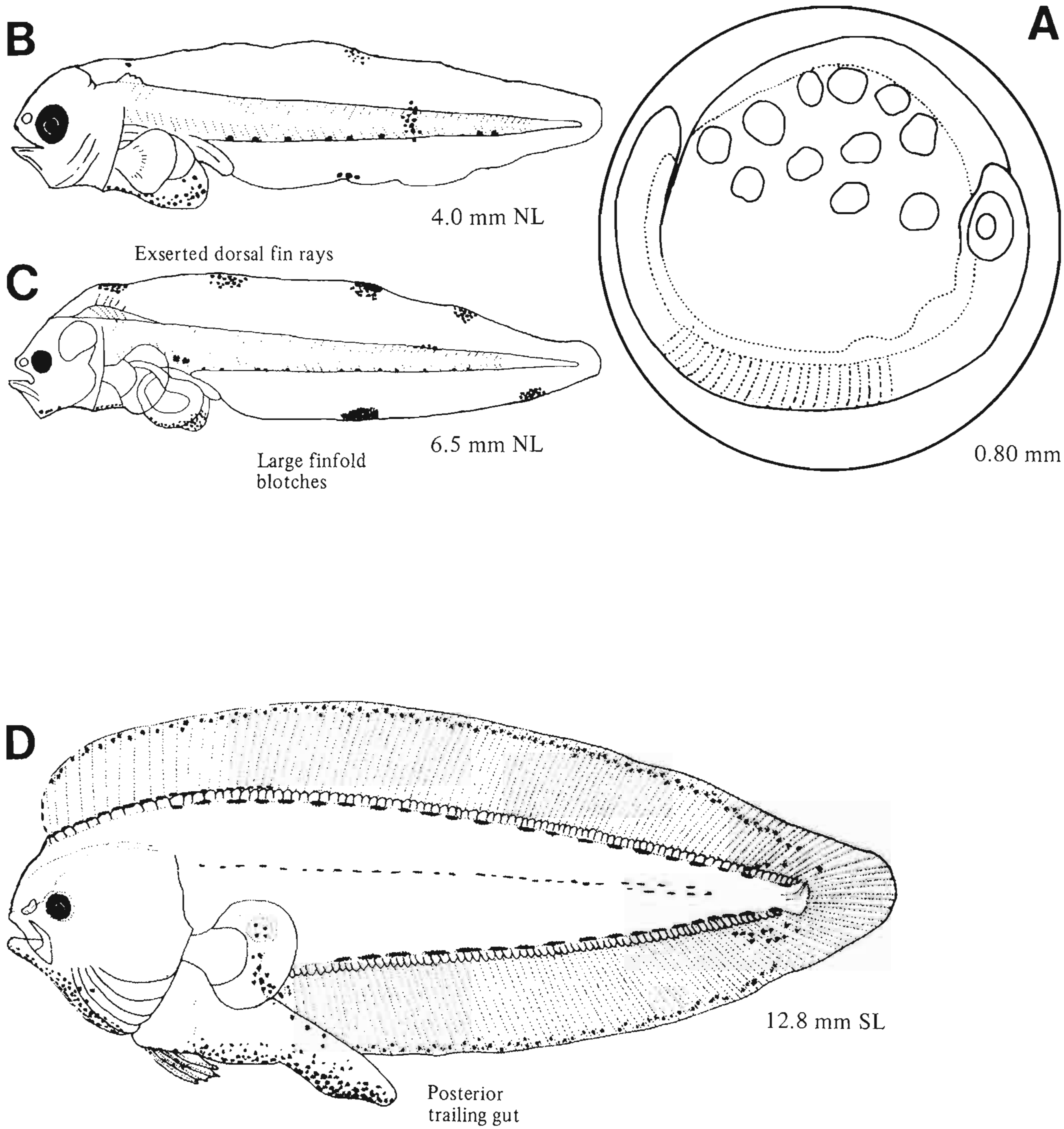
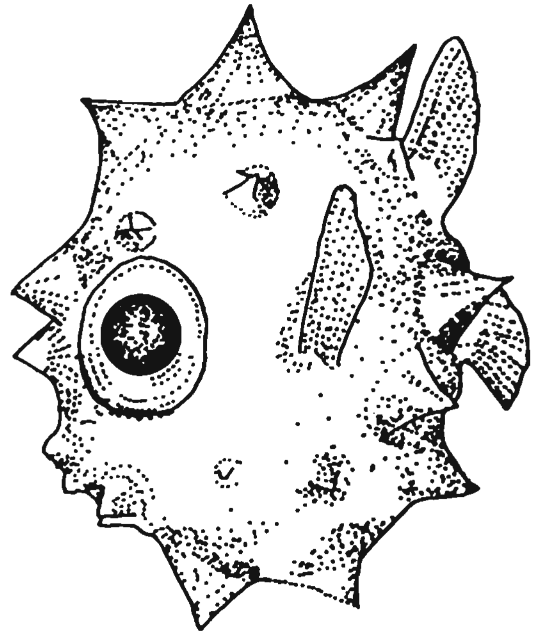


Figure A, Matarese and Sandknop 1984; B–D, Ahlstrom et al. 1984a.



Tetraodontiformes

Although most fishes of the Tetraodontiformes are tropical and associated with the bottom, some are found in temperate zones and remain pelagic throughout their lifespans. The general body shape is rounded or boxlike and the body may be encased in a bony carapace or covered with sharp spines. Many species are able to inflate themselves with water or air. Eight families, 92 genera, and 329 species make up the order (J. Nelson 1984). Only one family, Molidae, is found in the Northeast Pacific. The most unusual of the tetraodontiforms, molids have no caudal fin and propel themselves with large dorsal and anal fins. Eggs are pelagic, 1.42-1.80 mm in diameter, and have multiple oil globules (Leis 1984). Larvae hatch with a functioning jaw, pigmented eyes, and a dermal sac enclosing the head and trunk. With development, body spines form and the tail atrophies. Molids may have a long prejuvenile stage marked by retention of spines and a shape unlike that of adults (Leis 1984).

Family in study area: **Molidae**

MERISTICS

Vertebrae	Total: 17-X-18 Precaudal: 8-X-9 Caudal: 8-9-9
Branchiostegal rays	6-6-6
Caudal fin	Absent
Pelvic fin	Absent
Dorsal fin	R: 15-X-18
Pectoral fin	R: 11-X-13
Anal fin	R: 14-X-18
Gill rakers	U: X-X-X L: X-X-X

LIFE HISTORY

Range	South of southern California to SE Alaska, 55-59°N
Ecology	Epipelagic
ELH pattern	Oviparous, pelagic eggs, pelagic larvae
Spawning	Season: Spring-summer[a] Area: Mode: Migration:
Fecundity	Range/function: 300 million[b]
Age at first maturity	
Longevity	

EARLY LIFE HISTORY DESCRIPTION

EGGS

Diameter	
No. of oil globules	
Oil globule diameter	
Yolk	
Envelope	
Hatch size	<1.84 mm TL
Incubation time/temp.	Other members of family hatch in 7-8 days
Pigment	

Diagnostic characters - Family
- Pelagic, large (1.4-1.8 mm), and have multiple oil globules

Larvae

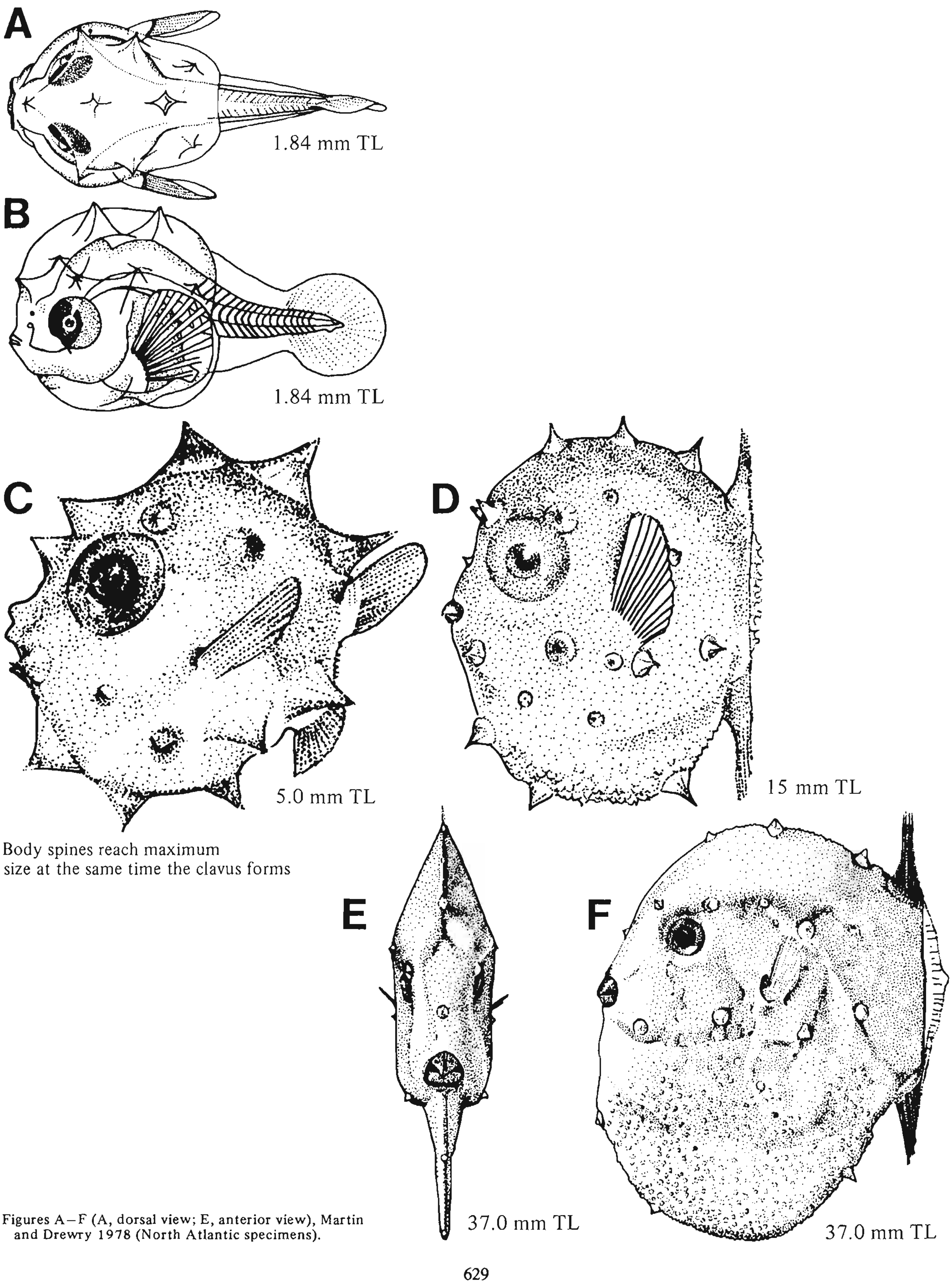
Preanal length	<50% SL increasing with development to >50% SL
Length at flexion	Does not occur
Length at transformation	Long ontogenetic stage between larvae and juveniles
Sequence of fin development	Pectorals and caudal, dorsal and anal

Pigment - Family
- Usually heavily pigmented over gut and dorsal surfaces

Diagnostic characters
- Morphology: Wide, deep body
- Body spines with a ventral keel (form soon after hatching)
- Tail in young is normal but soon atrophies and a true caudal never forms; notochord flexion does not take place, so the clavus (gradual thickening near the distal end) is not homologous with the caudal fin[c]

[a] Martin and Drewry 1978
[b] Hart 1973
[c] Leis 1984

Ref: Leis 1984.



Figures A–F (A, dorsal view; E, anterior view), Martin and Drewry 1978 (North Atlantic specimens).

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