NOAA Technical Report NMFS 137 May 1998

Guide to the Identification of Larval and Early Juvenile Poachers (Scorpaeniformes: Agonidae) from the Northeastern Pacific Ocean and Bering Sea

Morgan S. Busby

U.S. Department of Commerce

NOAA Technical Reports NMFS

Technical Reports of the *Fishery Bulletin*

The *NOAA Technical Report NMFS* (ISSN 0892-8908) series is published by the Scientific Publications Office, National Marine Fisheries Service, NOAA, 7600 Sand Point Way N.E., Seattle, WA 98115-0070.

The Secretary of Commerce has determined that the publication of this series is necessary in the transaction of the public business required by law of this Department. Use of funds for printing of this series has been approved by the Director of the Office of Management and Budget.

The *NOAA Technical Report NMFS* series of the *Fishery Bulletin* carries peer-reviewed, lengthy original research reports, taxonomic keys, species synopses, flora and fauna studies, and data intensive reports on investigations in fishery science, engineering, and economics. The series was established in 1983 to replace two subcategories of the Technical Report series: "Special Scientific Report—Fisheries" and "Circular." Copies of the *NOAA Technical Report NMFS* are available free in limited numbers to government agencies, both federal and state. They are also available in exchange for other scientific and technical publications in the marine sciences.

NOAA Technical Report NMFS 137

A Technical Report of the *Fishery Bulletin*

Guide to the Identification of Larval and Early Juvenile Poachers (Scorpaeniformes: Agonidae) from the Northeastern Pacific Ocean and Bering Sea

Morgan S. Busby

May 1998

U.S. Department of Commerce
Seattle, Washington

Suggested reference

Busby, Morgan S. 1998. Guide to the identification of larval and early juvenile poachers (Scorpaeniformes: Agonidae) from the northeastern Pacific Ocean and Bering Sea. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 137, 88 p.

Purchasing additional copies

Additional copies of this report are available for purchase in paper copy or microfiche from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; 1-800-553-NTIS; http://www.ntis.gov.

Copyright law

Proprietary products

Guide to the Identification of Larval and Early Juvenile Poachers (Scorpaeniformes: Agonidae) from the Northeastern Pacific Ocean and Bering Sea

MORGAN S. BUSBY

Resource Assessment and Conservation Engineering Division
Alaska Fisheries Science Center
National Marine Fisheries Service, NOAA
7600 Sand Point Way N.E.
Seattle, Washington 98115

ABSTRACT

Developmental stages of 22 species representing 16 genera of agonid fishes occurring in the northeastern Pacific Ocean from San Francisco Bay to the Arctic Ocean are presented. Three of these species also occur in the North Atlantic Ocean. Larval stages of nine species are described for the first time. Additional information or illustrations intended to augment original descriptions are provided for eight species. Information on five other species is provided from the literature for comparative purposes.

The primary objective of this guide is to present taxonomic characters to help identify the early life history stages of agonid fishes in field collections. Meristic, morphometric, osteological, and pigmentation characters are used to identify agonid larvae. Meristic features include numbers of median-fin elements, pectoral-fin rays, dermal plates, and vertebrae. Eye diameter, body depth at the pectoral-fin origin, snout to first dorsal-fin length, and pectoral-fin length are the most useful morphological characters. Presence, absence, numbers, and/or patterns of dermal plates in lateral rows or on the ventral surface of the gut are also useful. Other important characters are the presence, absence, numbers, and ornamentation of larval head spines. Lastly, distinct pigmentation patterns are often diagnostic. The potential utility of larval characters in phylogenetic analysis of the family Agonidae is discussed.

Introduction

The family Agonidae is a morphologically diverse group of relatively small, benthic marine fishes. Commonly called poachers and alligatorfishes, the family is composed of 20 genera and 45 nominal species. Agonids are characterized most notably by the presence of fused or overlapping bony plates encasing the body. Members of other families such as the Gasterosteidae, Pegasidae, Syngnathidae, and Triglidae also possess dermal plates but are not considered close relatives of the Agonidae (Freeman, 1951; Pietsch, 1978). Agonids are hypothesized to be the sister group of the family Hemitripteridae, in the superfamily Cottoidea (Yabe, 1985). A thorough systematic study and phylogenetic analysis of the family was recently conducted by Kanayama (1991).

Most agonids occur in the North Pacific Ocean. Four species are known in the North Atlantic and one from the coast of Chile and the Patagonia-Falklands area. Sixteen genera represented by 25 species occur in the northeastern Pacific Ocean and Bering Sea. The remainder are found mostly in the northwestern Pacific around Japan (Matarese et al., 1989; Kanayama, 1991).

Few studies on the ontogeny of agonid fishes have been conducted. Agonids spawn demersal eggs and have planktonic larval stages (Matarese et al., 1989). Washington et al. (1984), Maeda and Amaoka (1988), and Busby and Ambrose (1993) reported that formation of most external body parts, including dermal bony plates and spines, begins early in larval development. These and other studies have included brief descriptions and illustrations of various early life history stages for 14 genera and 15 of the 25 species from the northeastern Pacific Ocean. With the exception of Busby and Ambrose (1993), none provided detailed descriptions of morphological and/or osteological development at all stages of larval development.

This guide includes the agonid species known to occur in the northeastern Pacific Ocean from San Francisco Bay to the Arctic Ocean as listed by Matarese et al. (1989). Three of these species are circumarctic in distribution and also occur in the North Atlantic Ocean. The primary objective of this guide is to present taxonomic characters to help researchers identify the early life history stages of agonid fishes from field collections. Developmental stages of 22 species representing 16 genera of agonid fishes are presented. Descriptions of early life history stages for nine of these 22 species are presented for the first time. Additional information or illustrations intended to augment the original descriptions are presented for eight species. Information on the five remaining species is provided from existing publications for comparative purposes.

Methods

Most of the agonid larvae examined in this study were collected in coastal waters of the northeastern Pacific Ocean from the Channel Islands, California, to the Chukchi Sea. Some specimens from the North Atlantic Ocean were also examined. Nearly all of the specimens examined were obtained from, and are currently housed in, the larval fish collection of the Alaska Fisheries Science Center's (AFSC) Ichthyoplankton Laboratory in Seattle, Washington. Collection data for AFSC specimens can be found in Dunn and Rugen (1989)[1], Dewitt and Clark (1992, 1993), and Schleiger et al. (1995). Additional material was obtained from the AFSC's Auke Bay Laboratory (ABML); Atlantic Reference Center (ARC); California Cooperative Oceanic Fisheries Investigations (CalCOFI); Department of Fisheries and Oceans, Canada (DFO); Natural History Museum of Los Angeles County (LACM); Oregon State University (OSU); University of Alaska Fairbanks Museum (UAM); University of Alaska at Juneau (UAJ); University of Washington (UW); and the Vancouver, B.C., Canada, Public Aquarium (VPA). Institutional acronyms follow Leviton et al. (1985) and Leviton and Gibbs (1988). However, AFSC, CalCOFI, and VPA do not have acronyms designated in Leviton et al. (1985) or Leviton and Gibbs (1988) so their self designated acronyms are used instead. A collection location (e.g., AFSC, 5MF91, Methot, St. G036A) or museum catalog number (e.g., ARC, 9010796) is given for each specimen illustrated. Specimens were originally preserved in 3.5% or 5.0% formalin and stored in 3.5% buffered formalin or 70% ethanol.

Taxonomic characters of agonid larvae were determined using the serial approach. This method uses adult characters to identify juveniles and progressively links them to smaller specimens through a continuous sequence of shared or similar features. Pigmentation patterns, morphological characteristics, dermal plate formation, head spination, and meristic features were all used as diagnostic characters. Identification of adult and juvenile specimens was accomplished using taxonomic information published by Miller and Lea (1972), Hart (1973), Eschmeyer et al. (1983), and Kanayama (1991). Taxonomic classification follows Kanayama (1991), as does the order of presentation. Common names of fishes (Robins et al., 1991) are used throughout. Developmental series were illustrated using a camera lucida attached to a dissecting stereomicroscope.

Nomenclature of larval developmental stages follows Kendall et al. (1984). The juvenile stage of agonid fishes is defined here as beginning upon ossification of the adult complement of fin elements and dermal plates in all rows, with the exception of the lateral line row, and the disappearance of the larval finfold (Ahlstrom et al., 1976; Kendall et al., 1984; Maeda and Amaoka, 1988). The juvenile stage ends at the onset of sexual maturity.

Only melanistic pigmentation (black) is described because formalin fails to preserve other pigments. In the description of pigmentation, the terms "band" and "bar" refer to aggregations of melanophores that approximate vertically oriented rectangles. A band is always complete and a bar incomplete. A "stripe" approximates a line or elongate rectangle and is horizontally oriented. A "patch" is any other distinguishable aggregation of melanophores.

Morphometric measurements were made with the aid of a calibrated digital image analysis system. This system consists of a video camera attached to a dissecting stereomicroscope or camera lens, a microcomputer with a digital imaging (or "frame-grabber") board, and a video monitor. Only larvae that were not badly damaged during collection and/or preservation were measured. Standard length (SL) is used throughout unless otherwise noted. The following measurements were made on larvae and early juveniles (modified from Busby and Ambrose, 1993):

Standard length (SL)—Snout tip to notochord tip prior to development of caudal fin, then to posterior margin of hypural element.

[1] Dunn, J. R., and W. C. Rugen. 1989. A catalog of Northwest and Alaska Fisheries Center ichthyoplankton cruises 1965–1988. Dep. Commer., NOAA, Northwest and Alaska Fisheries Center Processed Report 89-04, 87 p.

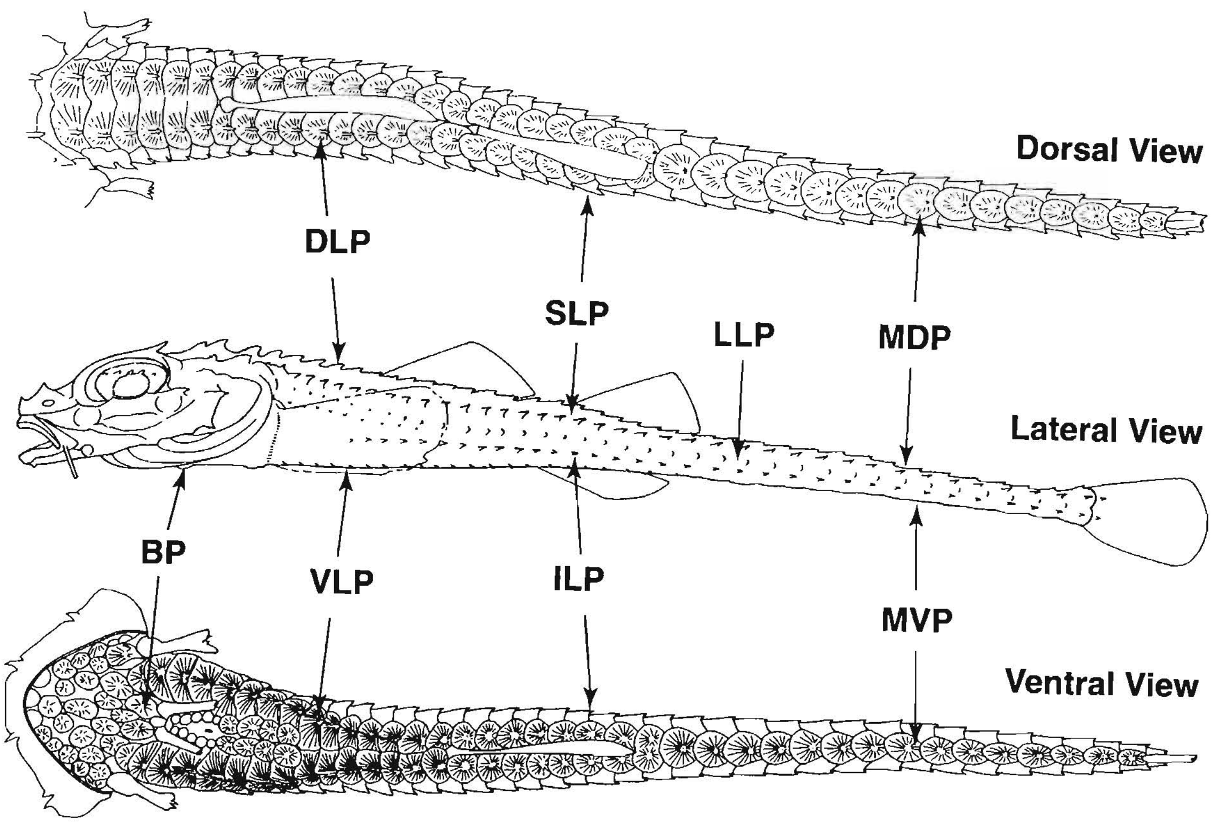


Figure 1
Terminology of bony plates in agonid larvae: DLP=dorsolateral, MDP=mid-dorsal, SLP=supralateral, LLP=lateral line, ILP=infralateral, VLP=ventrolateral, MVP=mid-ventral, BP=breast (after Gruchy, 1969).

Body depth—Vertical distance from dorsal to ventral body margin at pectoral-fin base.

Predorsal length—Distance along body midline from snout tip to a vertical line through insertion of first dorsal-fin spine or ray.

Snout to anus length—Distance along body midline from snout tip to a vertical line through center of anal opening.

Head length (HL)—Snout tip to posterior edge of opercle (to pectoral-fin base in small larvae before opercular margin is visible).

Head width—Distance across head between dorsal margins of orbits.

Snout length—Snout tip to anterior margin of orbit of left eye.

Eye diameter—Greatest diameter of left orbit.

Pectoral fin length—Distance from pectoral-fin base to tip of the longest ray.

Selected specimens were cleared and differentially stained to identify cartilage and bone with alcian blue and alizarin red-S (Potthoff, 1984). Skeletal elements and dermal plates were recognized as ossified upon initial uptake of alizarin red-S. Most counts of meristic features were made on stained specimens but some unstained specimens were also counted. Because the number of specimens available for some taxa was limited, not all stages of development could be stained. Nomenclature of skeletal elements follows that used by Leipertz (1985).

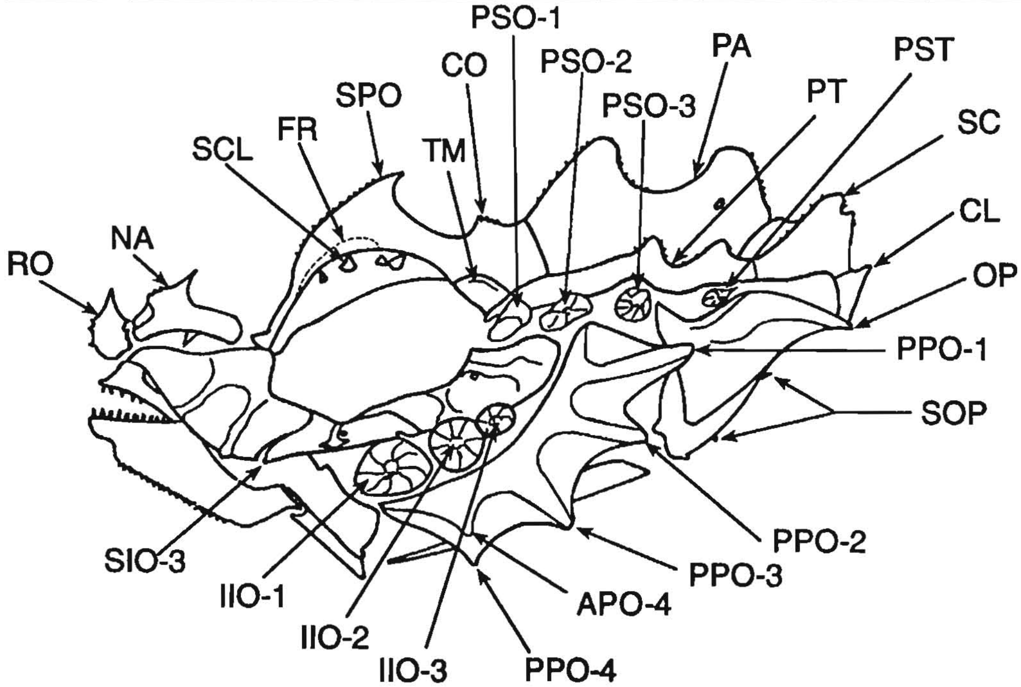
Dermal plate nomenclature follows that of Gruchy (1969) (Fig. 1). Plate rows are named dorsolateral (DLP), mid-dorsal (MDP), supralateral (SLP), lateral line (LLP), infralateral (ILP), ventrolateral (VLP), and mid-ventral (MVP). Some taxa do not possess a supralateral plate row. Dermal plates are also present on the ventral surface of the gut or breast region (BP).

Nomenclature of agonid larval head spination follows Busby and Ambrose (1993) (Figs. 2, 3; Table 1) with the following additions:

AN—Angular spine; a single, ventrally projecting spine originating from the ventral edge of the angular bone.

AR—Articular spine; a single posteriorly projecting spine originating from the articular bone.

DN—Dentary spines; two to four short, broad-based, vertically elongate spines originating from the dentary bone.



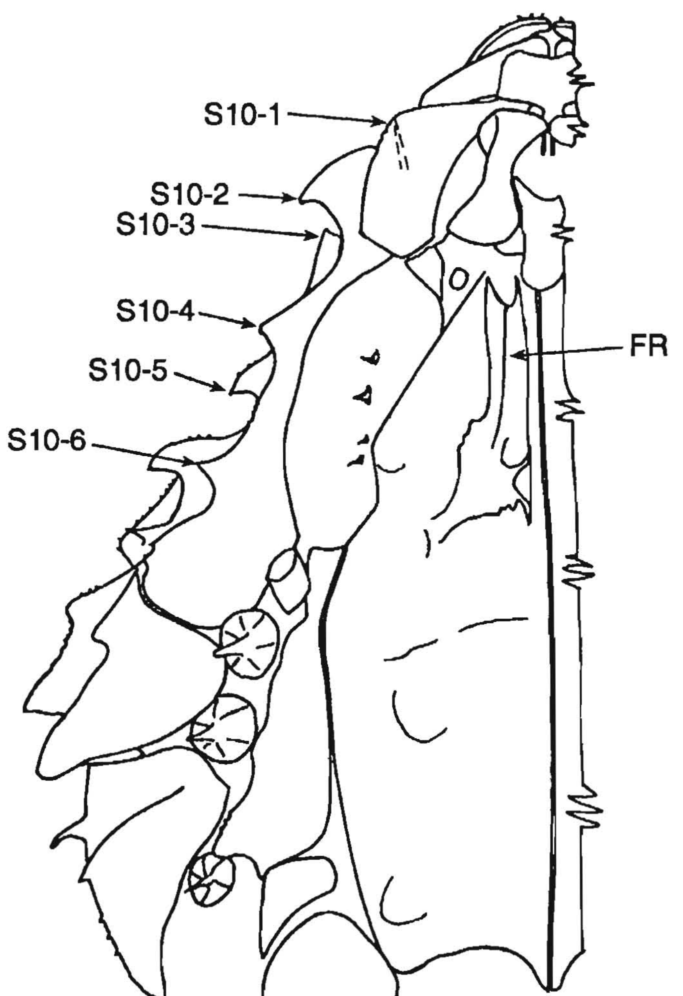


Figure 2 (Top)
Positions and abbreviations of larval head spines and plates in agonids. Based on a 17.2 mm cleared and stained larva of *Odontopyxis trispinosa* (Busby and Ambrose, 1993).

Figure 3 (Left)
Top view above eye showing superior infraorbital and frontal spines of a 17.2 mm cleared and stained larva of *Odontopyxis trispinosa* (Busby and Ambrose, 1993).

Table 1

Head spine terminology in agonid larvae listed by sequence of development in *Odontopyxis trispinosa.* (P) designates dermal plate (Busby and Ambrose, 1993).

Abbreviation	Spine/plate name	Bone of origin	Adult spine/plate
PA	Parietal	Parietal	Parietal
SPO	Supraocular	Frontal	Supraocular
SC	Supracleithral	Supracleithrum	Supracleithral
CO	Coronal	Frontal	(Overgrown)
PT	Pterotic	Pterotic	Pterotic
NA	Nasal	Nasal	Nasal
APO-4	4th anterior preopercular	Preopercle	(Overgrown)
PPO-1,2	1st, 2nd posterior preopercular	Preopercle	Preopercular
PPO-3,4	3rd, 4th posterior preopercular	Preopercle	Preopercular
SIO-5,6	5th, 6th superior infraorbital	Infraorbital 3	Posterior infraorbitals
CL	Cleithral	Cleithrum	(Overgrown)
TM	Tympanic	Frontal	(Overgrown)
OP	Opercular	Opercle	Opercular
FR	Frontal	Frontal	(Overgrown)
SOP	Subopercular	Subopercle	Gill cover spine
SIO-1,2	1st, 2nd superior infraorbital	Infraorbital 1 (Lachrymal)	Anterior infraorbital
PSO-1	1st postocular	Frontal	Postocular
PSO-2,3	2nd, 3rd postocular (P)	(Dermal)	Postocular plates
RO	Rostral	Rostral Plate	Rostral
PST	Posttemporal (P)	(Dermal)	(Overgrown)
IIO-1,2	1st, 2nd inferior infraorbital (P)	(Dermal)	Anterior, medial cheek plates
SIO-3,4	3rd, 4th superior infraorbital	Infraorbital 2 (Jugal)	Medial infraorbital
IIO-3	3rd inferior infraorbital (P)	(Dermal)	Posterior cheek plate
SCL	Sclerotics (P)	Sclerotic	Eyeball plates

General Characteristics of Agonid Larvae and Early Juveniles

Meristic Features (Table 2)

Matarese et al. (1989) presented a summary of information on the distributions and meristic features of agonid fishes occurring in the northeastern Pacific Ocean. Updated data from Kanayama (1991) and this study were added to the Matarese et al. (1989) summary (Table 2). This table is intended to be a quick reference for taxonomists identifying larval and juvenile agonids in the study area.

Counts of fin elements and vertebrae can be useful in the identification of agonid larvae. The combination of dorsal-fin spines with dorsal, anal, and pectoral-fin rays are useful in determining subfamilies, genera, and in some cases, species. Vertebral counts, when used in conjunction with fin-element meristics, can aid in species determination.

Numbers of dermal plates in the various rows typically reflect vertebral counts. Taxa with low vertebral counts have lower plate counts than those with higher vertebral counts. Dermal plate counts are presented in the accounts of meristic feature development for each taxon. Meristic features alone, however, should not be used for species determination.

Morphology

Morphological characteristics are very useful in the identification of agonid larvae at all stages of development. Body depth at the pectoral-fin base as a function of standard length is particularly important (Fig. 4). In this guide, agonid larvae are referred to as deep (>18.0% SL; e.g., *Hypsagonus quadricornis*), medium (10.0–18.0% SL; e.g., *Xeneretmus latifrons* and *Odontopyxis trispinosa*), and slender bodied (<10.0% SL; e.g., *Aspidophoroides monopterygius*). Other helpful morphological characters include eye diameter and snout length as a proportion of head length, and pectoral-fin length and snout to first dorsal-fin distance as a proportion of standard length.

Table 2

Summary of meristic characters of family Agonidae. All have pelvic fin counts of I,2 and six branchiostegal rays, except *Pallasina barbata* which sometimes has five. Compiled from Matarese et al. (1989), Kanayama (1991), and this study.

Taxon	Distribution	Vertebrae			Fins			
		Precaudal	(Total)	Caudal	Dorsal	Anal	Pectoral	Caudal
Hypsagonus mozinoi	Cent. Calif.–Brit. Col.[1]	10	(34)	24	VII–IX,6–8	10–12	11–12	
Hypsagonus quadricornus	Wash.–Bering Sea	11	(35–37)	24–26	VIII–XI,5–7	9–11	12–14	3,(6+6),2
Percis japonica	Bering Sea	14	(40–42)	26–28	V–VII,6–8	7–9	12–13	
Leptagonus decagonus	Bering Sea–Arctic/N. Atlantic	13	(44–49)	31–36	V–VIII,5–8	6–8	13–17	3,(6+6),1
Leptagonus frenatus	Brit. Col.–Bering Sea	12–13	(45–48)	33–35	VI–VIII,6–8	6–7	15–17	3–4,(6+6),1
Leptagonus leptorhynchus	Gulf of Alaska–Bering Sea	12	(42–45)	30–33	VI–IX,5–8	6–8	13–15	
Podothecus acipenserinus	N. Calif.–Chukchi Sea	12–13	(39–42)	27–29	VII–X,6–9	6–9	16–19	3,(6+6),0–1
Agonopsis vulsa	S. Calif.–Gulf of Alaska	12	(38–42)	26–30	VIII–X,7–9	10–12	13–15	3,(6+6),1
Bothragonus swani	Cent. Calif.–Gulf of Alaska	10–11	(29–32)	18–21	II–V,4–6	4–5	10–12	2,(6+6),1
Bathyagonus nigripinnis	N. Calif.–Bering Sea	11–12	(43–46)	32–34	VI–VIII,6–7	6–9	14–17	
Bathyagonus pentacanthus	S. Calif.–Bering Sea	12	(40–46)	28–34	V–VIII,5–8	6–9	14–16	2,(6+6),1
Bathyagonus alascanus	N. Calif.–Bering Sea	11–12	(39–42)	27–30	V–VIII,5–8	6–8	14–16	2,(6+5),1
Bathyagonus infraspinatus	N. Calif.–Bering Sea	11–12	(38–39)	26–28	V–VIII,5–8	5–8	15–16	2,(6+5),1
Xeneretmus latifrons	Baja Calif.–Brit. Col.	11–13	(39–43)	28–30	VI–VIII,6–8	6–9	13–15	2,(6+6),1
Xeneretmus leiops	S. Calif.–SE Alaska		(39–42)		VI–VII,6–8	5–8	13–15	
Xeneretmus triacanthus	Baja Calif.–Brit. Col.	12	(41–42)	29–30	V–VII,6–7	5–7	12–14	
Odontopyxis trispinosa	Baja Calif.–SE Alaska	10–12	(37–42)	27–30	III–VI,5–7	5–7	13–15	3,(6+6),0
Ulcina olriki	Bering Sea–Arctic/N. Atlantic	10	(37–40)	27–30	5–7	5–7	13–16	1,(5+5),0
Aspidophoroides monopterygius[2]	Gulf of Alaska–Arctic/N. Atlantic	11–12	(48–54)	37–42	4–6	4–6	9–11	2,(5+5),1
Anoplagonus inermis	N. Calif.–Aleutian Is.	11–12	(41–45)	30–33	4–6	4–5	8–11	2,(6+5–6),0–1
Stellerina xyosterna	Baja Calif.–Gulf of Alaska	13	(34–37)	21–24	VI–VIII,5–7	8–9	17–19	3,(6+6),1
Chesnonia verrucosa	Cent. Calif.–Bering Sea	13–14	(34–38)	21–25	VII–IX,6–9	7–13	14–15	3,(6+6),1
Occella dodecaedron	Aleutian Is.–Chukchi Sea	13	(37–40)	24–27	VIII–XI,6–9	13–16	14–16	
Occella impi[3]	Brit. Col.		(37)		IX,6	9	18	
Pallasina barbata	Cent. Calif.–Arctic	14–16	(42–52)	28–36	V–IX,6–9	8–14	10–13	2,(6+5),1

[1] Larvae collected in the Bering Sea.
[2] *Aspidophoroides monopterygius* is a senior synonym of *A. bartoni* (Kanayama, 1991).
[3] Probably a junior synonym of *Stellerina xyosterna* (Matarese et al., 1989; Kanayama, 1991).

Pigmentation

Pigmentation of agonid larvae can be highly variable between developmental stages and among conspecifics. In general, agonid larvae are lightly, moderately, or heavily pigmented. The presence, absence, and distribution patterns of pigmentation on the head, gut, body, finfolds, and fins are all very useful taxonomic characters. Detailed descriptions of pigmentation are provided for each taxon.

Dermal Plate Development

Dermal plates of agonid fishes are distinguishable in early (typically preflexion) larvae as small spines (Fig. 5A). With growth, the spines increase in length and become broader at the base (Fig. 5B). Bone develops in a radial pattern from the base of the spine as the plate base increases in diameter (Figs. 5B,C). In the case of DLP, SLP, ILP, and VLP, the plates grow until they overlap (Fig. 5D). This typically occurs during the late

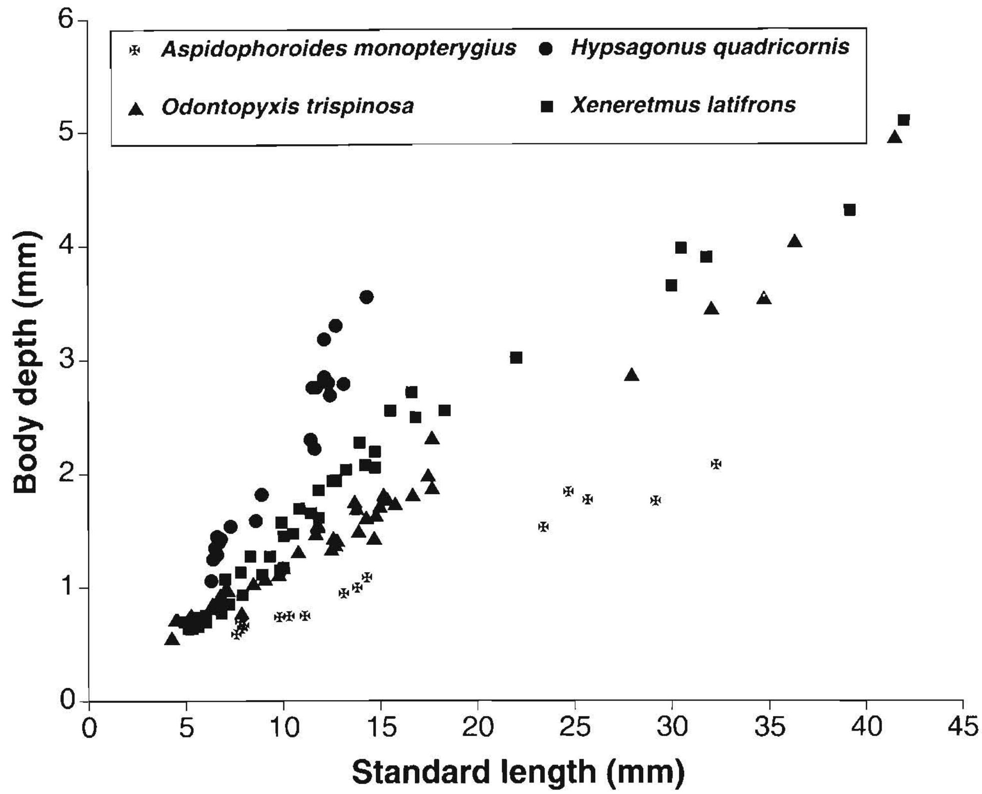


Figure 4

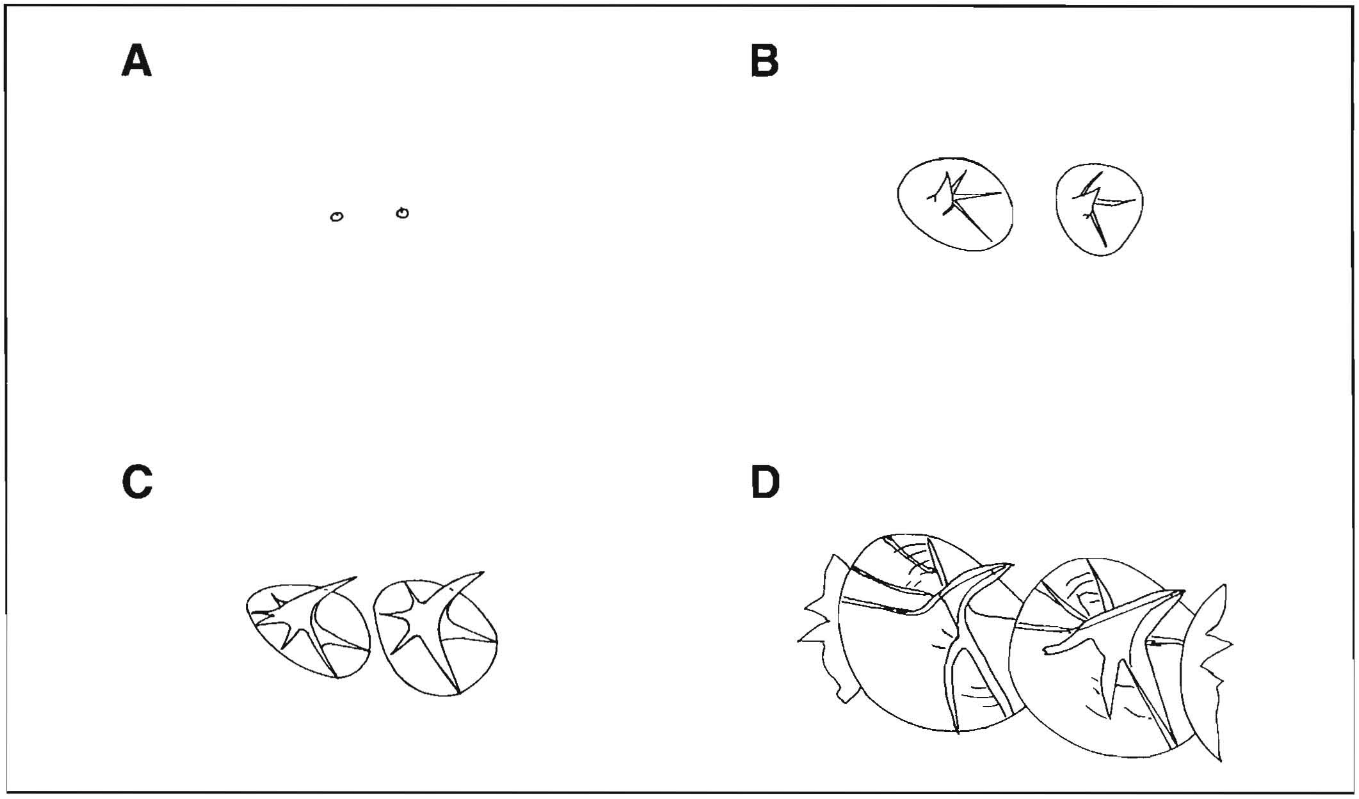
Plot of body depth (mm) vs. standard length (mm) for larval and early juvenile *Aspidophoroides monopterygius, Hypsagonus quadricornis, Odontopyxis trispinosa,* and *Xeneretmus latifrons* (modified from Busby and Ambrose, 1993).

postflexion or early juvenile stages. In the case of MDP and MVP, the paired plates fuse along the dorsal or ventral midline (Figs. 6A,B). The fused plates grow and eventually overlap with adjacent fused plates (Fig. 6B). The distance between spines of fused plates is reduced as growth and fusion progress (Fig. 6C) until the spines themselves eventually fuse (Fig. 6D).

Lateral line plates begin development as two dorsoventrally paired spines (Fig. 7A). In some taxa, the dorsal spine exceeds the ventral spine in length by two to three times. As growth and ossification progress, the bases of the spines broaden considerably (Fig. 7B). Eventually, the spines begin to curve toward the center of the plate (Fig. 7C). After further growth, adjacent plates meet and a membrane or sheath, which forms the lateral line canal, develops over the curved spines (Fig. 7D). Development of the lateral line canal is usually completed by the end of the juvenile stage.

Head Spination

The shape and ornamentation of the parietal spine (PA) and supraocular spine (SPO) (Fig. 2) are of particular importance as are the number and length of superior infraorbital spines (SIO) (Fig. 3). The presence or absence of rostral (RO), dentary (DN), inferior infraorbital (IIO), and postocular (PSO) spines can also be useful taxonomic characters. Many of the head spines visible during larval stages become overgrown with bone and/or skin and are not present in adults (Laroche, 1986). All spines discussed are paired with the exception of the rostral (RO).


A
B
C
D

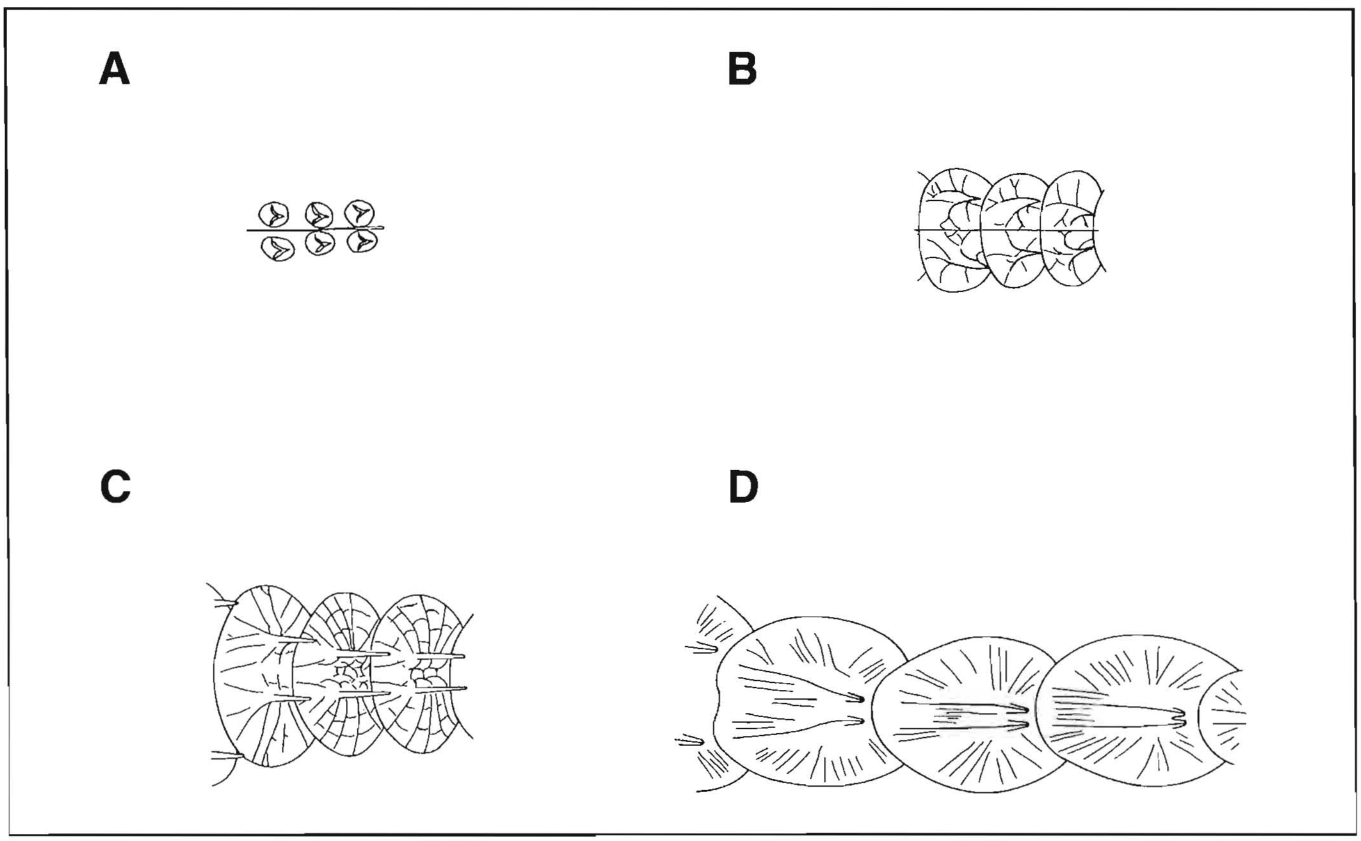

A
B
C
D

Figure 5 (left, top)

Development of agonid dermal plates from supralateral row. (A) *Odontopyxis trispinosa* 8.3 mm; VPA, Lambert Channel, 5-8-89, #90. (B) *Bathyagonus alascanus* 12.3 mm; AFSC, 5MF91, Methot, St. G036A. (C) *B. alascanus* 15.5 mm; AFSC, 5MF91, Methot, St. G036A. (D) *B. alascanus* 22.0 mm; AFSC, 5MF90, shrimp trawl, Haul 55.

Figure 6 (left, bottom)

Development of agonid dermal plates in *Bathyagonus alascanus* from mid-dorsal row. (A) 12.3 mm; AFSC, 5MF91, Methot, St. G036A. (B) 15.5 mm; AFSC, 5MF91, Methot, St. G036A. (C) *B. alascanus* 22.0 mm; AFSC, 5MF90, shrimp trawl, Haul 55. (D) 67.0 mm; AFSC, 1MF89, 505, sled, net 1, St. G023Z.

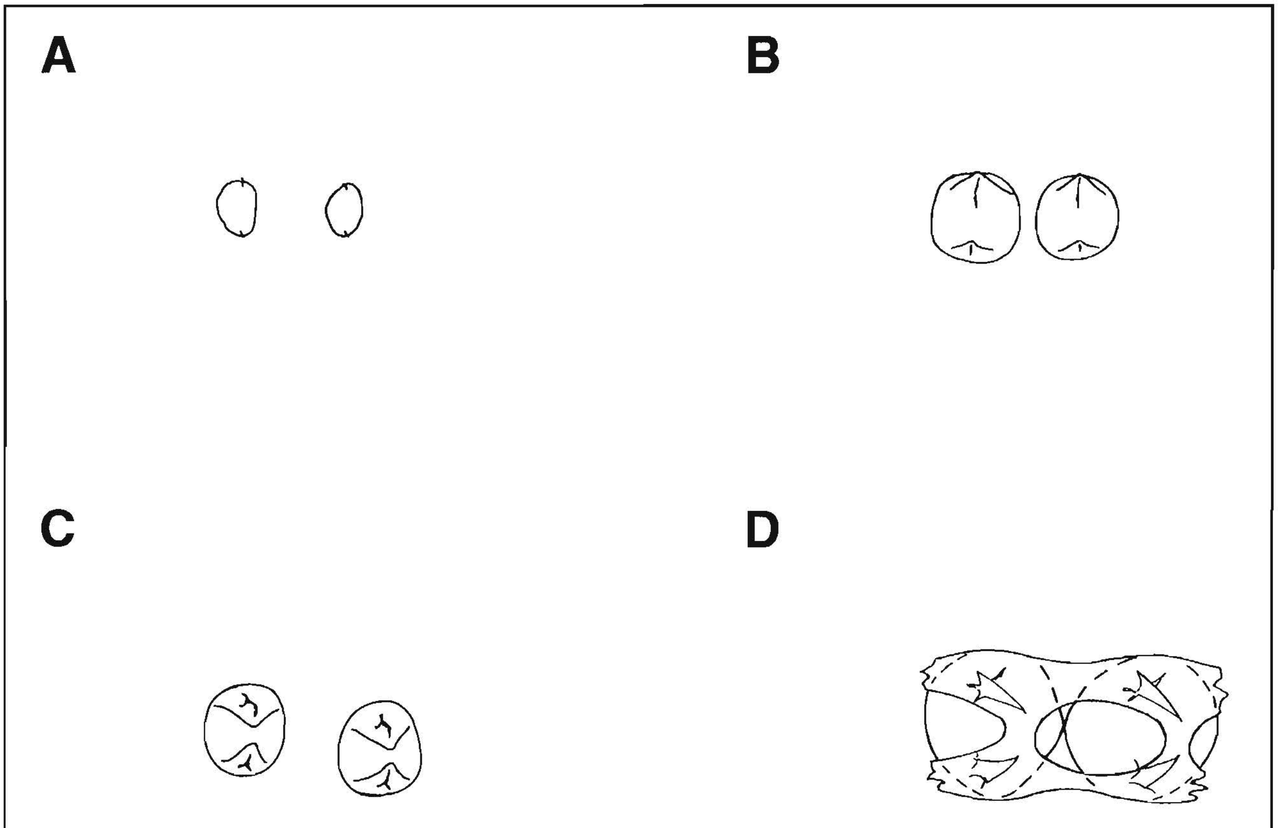


Figure 7

Development of agonid dermal plates in *Bathyagonus alascanus* from lateral line row and lateral line canal. (A) 12.3 mm; AFSC, 5MF91, Methot, St. G036A. (B) 15.5 mm; AFSC, 5MF91, Methot, St. G036A. (C) 18.0 mm; AFSC, 5MF91, Methot, St. G036A. (D) 22.0 mm; 5MF90, shrimp trawl, Haul 55.

Identification of Larval and Early Juvenile Agonids

Subfamily Percidinae

Hypsagonus mozinoi—kelp poacher

Literature—Originally described as *Agonomalus mozinoi* (Wilimovsky and Wilson, 1978), the kelp poacher was recently placed in the genus *Hypsagonus* (Kanayama, 1991). Marliave (1978) described eggs and yolk-sac larvae (5.5, 6.0 mm total length, TL) spawned and hatched in the laboratory. Matarese et al. (1989) presented illustrations of the 5.5 mm TL specimen from Marliave (1978) and an 8.2 mm specimen in early flexion stage. Additional information on the development of larval *H. mozinoi* is presented here based on examination of seven larvae, 3.9–8.3 mm.

Distribution—Adult *H. mozinoi* are reported to range from central California to British Columbia, Canada, in rocky intertidal and near-shore habitats to depths of 11 m (Eschmeyer et al., 1983; Matarese et al., 1989). Larvae are extremely rare in plankton samples. Only five larvae were collected in AFSC cruises from 1965 to 1991. Two of these larvae were collected in the eastern Bering Sea and three from the Gulf of Alaska near Kodiak Island. This suggests that the adult range is farther north and west than previously reported.

Morphology (Table 3)—Larvae of *H. mozinoi* hatch between 3.9 and 5.5 mm. Notochord flexion begins at 8.1 mm. Larvae are medium-bodied with mean body depth 16.8% SL in preflexion larvae, decreasing to 16.0% SL during flexion. Predorsal length is short at 28.7% SL in flexion larvae. Eye diameter is large at 47.7% head length (HL) preflexion decreasing to 42.8% HL in flexion larvae. Postflexion and juvenile stages are unknown.

Pigmentation (Fig. 8)—Larvae of *H. mozinoi* are heavily pigmented. In preflexion larvae, melanophores are present on the head, gut, pectoral-fin base, and anterior half of the body with the exception of a small area along the dorsal midline above the pectoral fin (Fig. 8A). Irregularly-shaped patches of melanophores are also present on the dorsal finfold at midbody and the anterior region of the anal finfold. In flexion larvae,

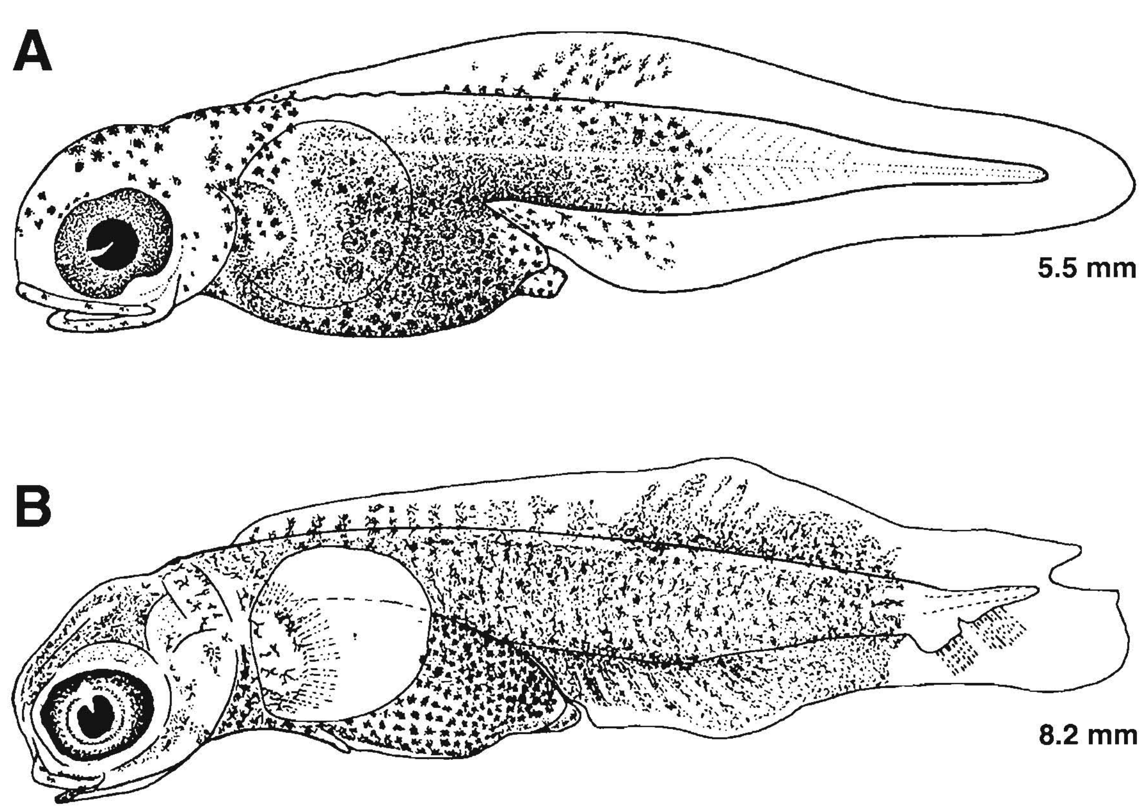


Figure 8
Larval stages of *Hypsagonus mozinoi.* (A) Preflexion larva 5.5 mm TL (Marliave, 1978). (B) Early flexion larva 8.2 mm (Matarese et al., 1989).

Table 3

Body proportions of *Hypsagonus mozinoi* larvae. Values given for each body proportion are expressed as percentage of standard length (SL) or head length (HL): mean, standard deviation, and range given in parentheses.

Body proportion	Preflexion		Flexion		Body proportion	Preflexion		Flexion	
Sample size	6		2		Head length/SL	21.2±1.0	(20.1–23.0)	24.0±3.2	(21.8–26.3)
Standard length (mm)	6.2±1.8	(3.9–8.0)	8.3±0.1	(8.2–8.3)	Head width/HL	31.4±4.5	(26.9–37.9)	27.4±1.3	(26.5–28.3)
Body depth/SL	16.8±1.8	(14.5–18.2)	16.0±0.5	(15.7–16.4)	Snout length/HL	12.1±1.9	(9.9–14.7)	14.2±1.1	(13.4–15.0)
Predorsal length/SL	27.4[1]	(27.4)	28.7	(28.7)	Eye diameter/HL	47.7±5.6	(38.7–54.3)	42.8±12.0	(34.2–51.3)
Snout to anus length/SL	53.4±3.5	(50.3–59.5)	58.2±1.7	(57.0–59.4)	Pectoral-fin length/SL	13.5±1.3	(11.5–14.6)	12.5±1.3	(11.6–13.4)

[1] Sample size = 1.

Table 4

Meristics of adult *Hypsagonus mozinoi*. Counts compiled from Wilimovsky and Wilson (1978), Matarese et al. (1989), and Kanayama (1991).

Standard length (mm)	Dorsal fin		Anal fin rays	Pectoral fin rays	Pelvic fin spines, rays	Branchiostegal rays	Neural spines			Haemal spines	Centra			Body plates[1]				
	spines	rays					abdominal	caudal	total		abdominal	caudal	total	DLP+MDP	SLP	LLP	ILP	VLP+MVP
Adults	VII–IX	6–8	10–12	11–12	I,2	6	10	23	33	24	10	24	34	30–36	23–33	18–20	27–32	18–24

[1] DLP—dorsolateral; MDP—mid-dorsal; SLP—supralateral; LLP—lateral line; ILP—infralateral; VLP—ventrolateral; MVP—mid-ventral.

pigmentation becomes more dense and completely covers the head, gut, and body to the caudal peduncle (Fig. 8B). The dorsal and anal finfolds are almost entirely covered with melanophores while the pectoral and caudal finfolds lack pigmentation.

Meristic Features (Table 4)—Specimens of larvae were not available for clearing and staining. In contrast to other agonids, *H. mozinoi* have low pectoral-fin ray (11–12), vertebral (34), and dermal plate counts and comparatively high dorsal and anal-fin element counts (VII–IX,6–8;10–12).

Head Spines—Specimens of *H. mozinoi* were not available to clear and stain.

Species Comparisons—Larvae of *H. mozinoi* are very similar in appearance to larvae of *H. quadricornis*. However, *H. mozinoi* have more pigmentation on the head and finfolds than *H. quadricornis* during flexion. Also, pigmentation on the body and fins of *H. mozinoi* does not separate into bands. Flexion larvae of *H. quadricornis* are slightly deeper-bodied than *H. mozinoi* (18.0% SL compared to 16.0% SL). Larval *H. mozinoi* have a considerably larger eye than *H. quadricornis*. *Hypsagonus mozinoi* and *H. quadricornis* show some overlap in nearly all meristic features but can sometimes be distinguished by counts of dorsal fin elements (*H. mozinoi*: VII–IX,6–8; *H. quadricornis*: VIII–XI,5–7).

Hypsagonus quadricornis—fourhorn poacher

Literature—Washington et al. (1984) provided an illustration of an 11.5 mm postflexion larva. The unidentified agonid larva illustrated as Figure B, page 457, in Matarese et al. (1989) is also *H. quadricornis*. Additional information on development is presented here based on examination of 28 specimens, 6.4–14.4 mm.

Distribution—Adult *H. quadricornis* range from Washington (Puget Sound) to the Bering Sea in nearshore, rocky bottom habitats at depths of 15–258 m (Eschmeyer et al., 1983; Matarese et al., 1989; Kanayama, 1991). Larvae are uncommon in plankton samples. All specimens examined in this study were collected from the Gulf of Alaska near Kodiak Island and the eastern Bering Sea.

Morphology (Table 5)—Preflexion *H. quadricornis* are unknown, possibly because they hatch from eggs while in the flexion stage. Flexion is evident in the smallest specimen examined (6.4 mm) and was complete at 9.0 mm. The juvenile stage begins at 14.0 mm. Larvae are deep-bodied with mean body depth of 18.0% SL in preflexion specimens, increasing to 23.9% SL in juveniles. Predorsal length is short at 32.3% SL in flexion larvae.

Pigmentation (Fig. 9)—Larvae of *H. quadricornis* are heavily pigmented. In early flexion larvae, melanophores cover the entire gut and all but the posteriormost region of the body and hypural region (Fig. 9A). Pigmentation extends onto the dorsal and anal finfolds. A few melanophores are present on the head and pectoral-fin base. In late flexion larvae, a patch of melanophores is present at the anterior margin of the first (spinous) dorsal fin (Fig. 9B). Pigmentation on the body, second dorsal fin, and anal fin is separated into two distinct bands. These bands remain visible in postflexion larvae, juveniles, and adults (Fig. 9C).

Meristic Features (Table 6)—In contrast to other agonids, *H. quadricornis* have low pectoral-fin ray, vertebral, and dermal plate counts and high dorsal and anal-fin element counts. Dorsal, anal, and pectoral fins are complete at 8.8 mm. The pelvic fins are complete at 11.5 mm and the caudal at 14.0 mm. The caudal fin has 3,(6+6),2 rays. Adult complements of dermal plates are present in all rows at 14.0 mm.

Head Spines—Flexion larvae of 8.8 mm possess parietal, supraocular, anterior and posterior preoperculars, and cleithral spines. Postflexion larvae of 11.5 mm possess a well-defined bilobed parietal spine (Fig. 9C). The supraocular spine is robust and projects slightly anteriorly. Nasal (NA), frontal, tympanic, three superior infraorbital (1,2,4), postocular, pterotic, and supracleithral spines are also present. In addition, 14.0 mm juveniles possess the third superior infraorbital, posttemporal, opercular, subopercular, and interopercular spines.

Species Comparisons—Larvae of *H. quadricornis* and *H. mozinoi* are very similar in appearance. However, *H. quadricornis* have less pigmentation on the head and finfolds than *H. mozinoi* during flexion. Also, pigmentation on the body and fins of *H. mozinoi* does not separate into bands. Flexion larvae of *H. quadricornis* are slightly deeper-bodied than *H. mozinoi* (18.0% SL compared to 16.0% SL). Larval *H. quadricornis* have a considerably smaller eye than *H. mozinoi*. *Hypsagonus quadricornis* and *H. mozinoi* can sometimes be distinguished by counts of dorsal fin elements (*H. mozinoi*: VII–IX,6–8; *H. quadricornis*: VIII–XI,5–7).

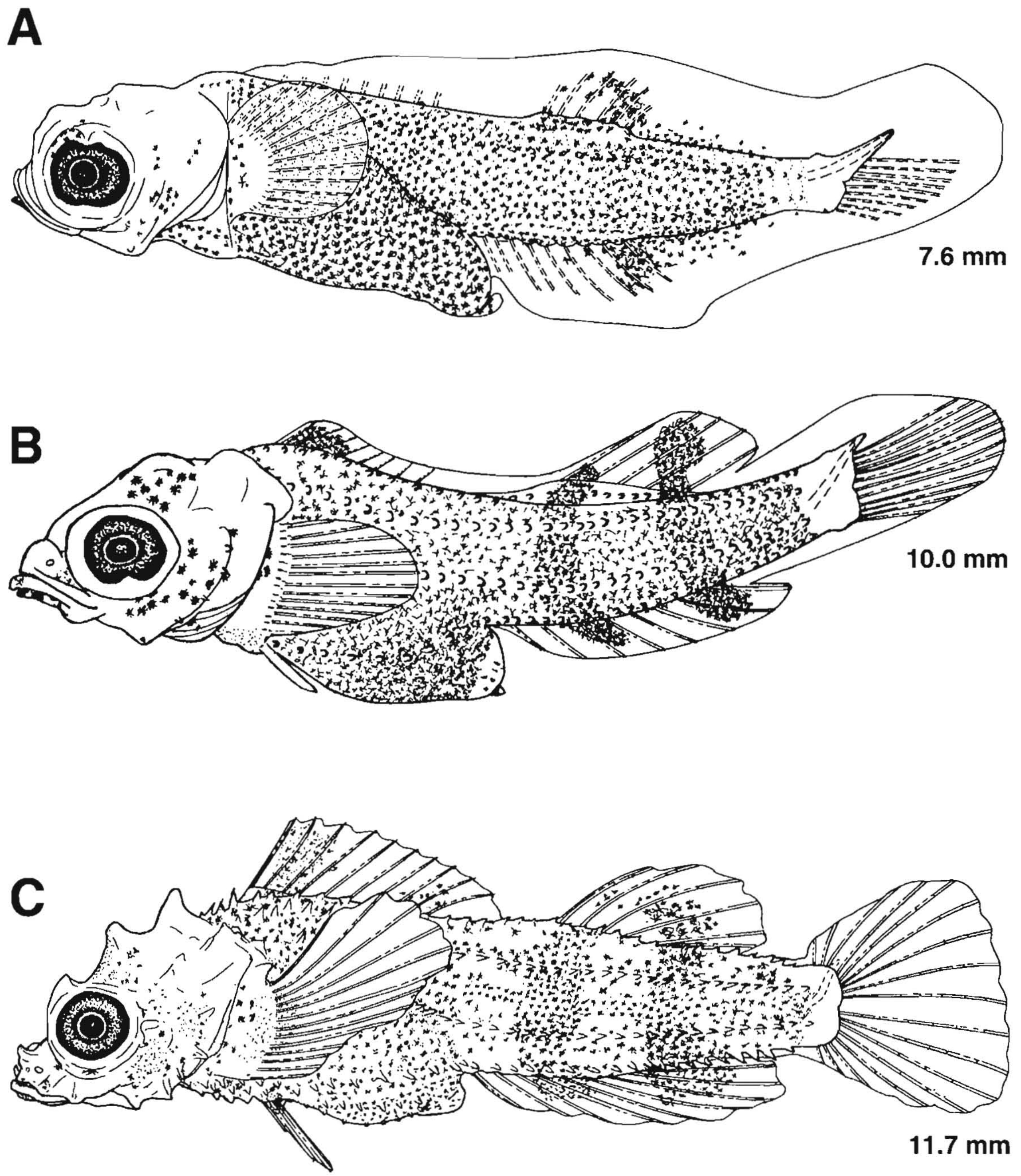


Figure 9
Larval stages of *Hypsagonus quadricornis.* (A) Early flexion larva 7.6 mm; UW (B. Miller), 7803 ZD, D1Z2. (B) Late flexion larva 10.0 mm (Matarese et al., 1989). (C) Postflexion larva 11.7 mm; AFSC, 1CH83, St. G01A, 6B5, net 1.

Table 5

Body proportions of *Hypsagonus quadricornis* larvae and early juveniles. Values given for each body proportion are expressed as percentage of standard length (SL) or head length (HL); mean, standard deviation, and range given in parentheses.

Body proportion	Flexion		Postflexion		Juvenile	
Sample size	10		10		1	
Standard length (mm)	7.2±0.9	(6.4–9.0)	12.2±0.5	(11.5–13.2)	14.4	(14.4)
Body depth/SL	18.0±1.5	(14.6–19.9)	21.6±2.3	(17.9–25.1)	23.9	(23.9)
Predorsal length/SL	32.3±2.4	(29.5–35.9)	32.9±2.5	(27.1–36.2)	31.1	(32.1)
Snout to anus length/SL	56.1±3.2	(48.9–60.1)	55.2±2.0	(52.1–57.4)	49.2	(49.2)
Head length/SL	23.4±2.7	(20.0–28.3)	31.5±2.7	(25.3–34.1)	30.9	(30.9)
Head width/HL	25.7±6.6	(17.2–37.1)	23.7±3.6	(16.7–29.7)	15.8	(15.8)
Snout length/HL	20.6±2.5	(15.5–23.7)	22.7±3.7	(19.8–29.8)	32	(32.0)
Eye diameter/HL	39.9±4.4	(31.8–46.7)	26.4±3.2	(22.9–34.9)	27.2	(27.2)
Pectoral fin length/SL	15.0±2.5	(11.3–20.2)	24.7±2.0	(20.3–27.1)	31.9	(31.9)

Table 6

Meristics of cleared and stained *Hypsagonus quadricornis* larvae and early juveniles. Specimens between dashed lines (– – –) are undergoing notochord flexion.

Standard length (mm)	Dorsal fin spines	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Pelvic fin spines, rays	Branchiostegal rays	Neural spines abdominal	Neural spines caudal	Neural spines total	Haemal spines	Centra abdominal	Centra caudal	Centra total	Body plates[1] DLP+MDP	SLP	LLP	ILP	VLP+MVP
6.6							11	19	30	19								
8.8	X	7	10	12	I	6	11	21	32	21	11	19	30		18		21	
11.5	XI	6	9	13	I,2	6	11	23	34	23	11	24	35	30	24	2	26	21
13.1	XI	6	9	13	I,2	6	11	23	34	23	11	24	35	35	34	6	28	31
14.0	X	6	11	13	I,2	6	11	23	34	23	11	24	35	40	36	8	29	32

[1] DLP—dorsolateral; MDP—mid-dorsal; SLP—supralateral; LLP—lateral line; ILP—infralateral; VLP—ventrolateral; MVP—mid-ventral.

Percis japonica—dragon poacher

Literature—Maeda and Amaoka (1988) described a single 13.8 mm flexion larva from the Bering Sea. To date, this is the only larva of this species ever reported. Information from Maeda and Amaoka (1988) is summarized here for comparative purposes.

Distribution—Adult *P. japonica* range from northern Japan and the Okhotsk Sea to the eastern Bering Sea and Gulf of Alaska and are abundant on muddy or sandy substrates at depths of 150–250 m (Kanayama, 1991).

Morphology (Table 7)—Preflexion *P. japonica* are unknown. Sizes at hatching or at the beginning of notochord flexion are also unknown. The flexion larva is deep-bodied with mean body depth at the pectoral-fin origin of 26.8% SL during flexion. Predorsal length is short but a value was not provided by Maeda and Amaoka (1988). However, the value will be similar to values reported for *Hypsagonus* (27–32% SL). Postflexion and juvenile stages are unknown.

Pigmentation (Fig. 10)—The larvae of *P. japonica* is heavily pigmented. In flexion larvae, melanophores cover the entire gut and body with the exception of the caudal peduncle and hypural region. Melanophores also cover the head and pectoral-fin base. A small patch of melanophores is present on the first dorsal fin. Dark blotches of pigmentation are present on the second dorsal and anal fins. The blotch on the anal fin is the most conspicuous of the two.

Meristic Features (Table 8)—Specimens of larvae were not available for clearing and staining. In contrast to most other agonids, *P. japonica* have low dorsal spine (V–VII), pectoral-fin ray (12–13), and dermal plate counts.

Head Spines—Head spination of *P. japonica* has not been described in detail. Postflexion larvae have a relatively flat parietal spine or ridge. Head spination of the larva illustrated in Maeda and Amaoka (1988) appears generally reduced compared to other agonids.

Diagnostic Characters—*Percis japonica* have more vertebrae than *H. mozinoi* and *H. quadricornis*, fewer dorsal-fin spines, and a relatively flat parietal ridge when compared to *H. quadricornis*, and fewer anal-fin rays than *H. mozinoi*. The conspicuous blotches of pigmentation on the second dorsal and anal fins easily distinguish larvae of *P. japonica* from other deep-bodied agonid larvae.

Table 7

Body proportions of *Percis japonica* larvae. Values given for each body proportion are expressed as percentage of standard length (SL) or head length (HL) (Maeda and Amaoka, 1988).

Body proportion	Flexion
Sample size	1
Standard length	13.8
Body depth/SL	26.8
Predorsal length/SL	
Snout to anus length/SL	62.3
Head length/SL	29.7
Head width/HL	
Snout length/HL	26.8
Eye diameter/HL	29.3
Pectoral-fin length/SL	

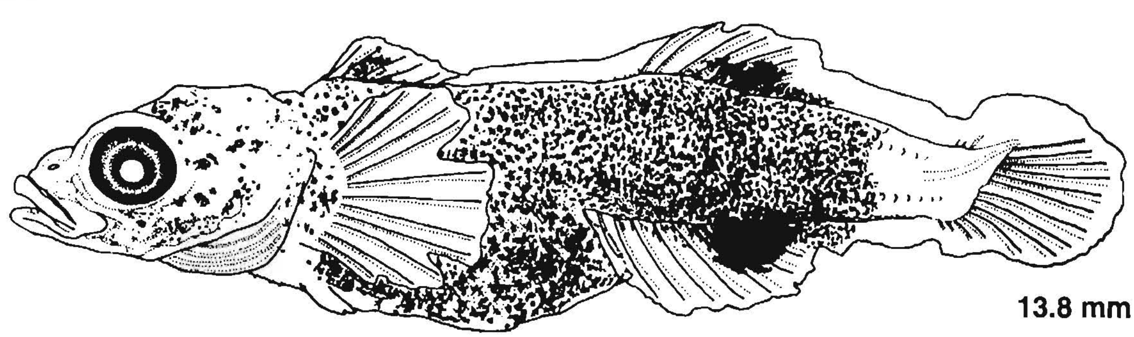


Figure 10

Larval stage of *Percis japonica*—flexion larva 13.8 mm (Maeda and Amaoka, 1988).

Table 8

Meristics of adult *Percis japonica*. Counts compiled from Matarese et al. (1989) and Kanayama (1991).

Standard length (mm)	Dorsal fin		Anal fin rays	Pectoral fin rays	Pelvic fin spines, rays	Branchi-ostegal rays	Neural spines			Haemal spines	Centra			Body plates[1]				
	spines	rays					abdominal	caudal	total		abdominal	caudal	total	DLP+MDP	SLP	LLP	ILP	VLP+MVP
Adults	V–VII	6–8	7–9	12–13	I,2	6	14	25	39	25	14	26	40–42	33–41	36–40	30–40	33–37	30–38

[1] DLP—dorsolateral; MDP—mid–dorsal; SLP—supralateral; LLP—lateral line; ILP—infralateral; VLP—ventrolateral; MVP—mid–ventral.

Subfamily Agoninae

Leptagonus decagonus—Atlantic poacher

Literature—Formerly included in the genus *Agonus*, the Atlantic poacher was recently placed in the genus *Leptagonus* by Kanayama (1991). Ehrenbaum (1905) presented an illustration and a brief description of a 21 mm larva. A brief description of the external morphology and pigmentation of larval *L. decagonus* based on 87 specimens collected in the western North Atlantic was reported by Dunbar (1947). New information presented here is based on examination of 16 specimens, 8.9–29.5 mm.

Distribution—Adult *L. decagonus* are circumarctic in distribution and also occur in the northern Bering Sea and North Atlantic Ocean. Adults are common on sandy or muddy substrates at depths of 120 to 930 m (Kanayama, 1991). Larvae are uncommon in plankton samples. Specimens examined in this study were collected in the western North Atlantic.

Morphology (Table 9)—Notochord flexion in *L. decagonus* begins at 11.5 mm and is completed at 18.0 mm. The juvenile stage begins before 29.5 mm. Larvae are slender-bodied during preflexion with mean body depth of 9.2% SL. They are medium-bodied throughout the remainder of development, increasing to 13.0% SL in juveniles. Snout length increases from 16.6% HL in preflexion larvae to 32.3% HL in juveniles. Pectoral-fin length increases from 12.5% SL in preflexion to 29.4% SL in juveniles.

Pigmentation (Fig. 11)—Larvae of *L. decagonus* are moderately pigmented. Preflexion and early flexion larvae have several large melanophores on top of the head with smaller ones covering the opercular and hyoid regions (Fig. 11A). Melanophores cover the dorsolateral surface of the gut. Ventrally, a row of small, closely-spaced melanophores extends from the isthmus to the end of the mid-gut. Two or three melanophores are present on the ventral surface of the hind-gut. Two wide bars of melanophores are present on the lateral surface of the body posterior to the gut. The bars are connected by a row of melanophores present along the dorsal and ventral midline. Melanophores also cover the notochord tip. Pigmentation extends from the anteriormost bar partially into the dorsal finfold and to the margin of the anal finfold. A triangular-shaped patch of melanophores is present on the anal finfold below the second bar. Melanophores cover nearly the entire caudal finfold.

In late flexion larvae, melanophores cover the entire body and head with the exception of the snout tip (Fig. 11B). The wide bars of melanophores present in earlier stages are either faint or indistinguishable. A few melanophores are visible on the pectoral-fin blade and outer margin. Melanophores cover only approximately one-half of the caudal finfold at this stage of development. Pigmentation in juveniles differs little from late flexion larvae. In general, the distribution of pigmentation in juveniles is more homogenous and individual melanophores appear smaller (Fig. 11C).

Meristic Features (Table 10)—Dorsal, anal, and pectoral fins are complete by 13.7 mm. The adult number of caudal-fin rays, 3,(6+6),1, is present at 29.5 mm. Pelvic fins and the vertebral column are also complete at 29.5 mm. In contrast with most agonids, *L. decagonus* have a high vertebral count (44–49). Dermal plates have adult complements at 29.5 mm but are probably complete much earlier.

Head Spines—Early flexion larvae possess a row of small parietal spinules which are overgrown with bone to form ridges or crests with serrated edges in late flexion larvae (Figs. 11A and 11B). All preopercular spines are present by 13.7 mm. Supraocular and nasal spines develop by 16.3 mm. Superior and inferior infraorbital, frontal, postocular, posttemporal, and pterotic spines are present in juveniles.

Species Comparisons—Larvae of *L. decagonus* are very similar in appearance to larvae of *L. frenatus*. *Leptagonus frenatus*, however, have no pigmentation dorsally on the head throughout development. They also have no pigmentation on the opercular and hyoid regions until postflexion. The pectoral fin of *L. frenatus* has few or no melanophores on the base and a distinct band at the outer edge. The second patch of pigmentation on the anal fin covers less area in *L. decagonus* than *L. frenatus* and does not extend to the ventral edge of the finfold.

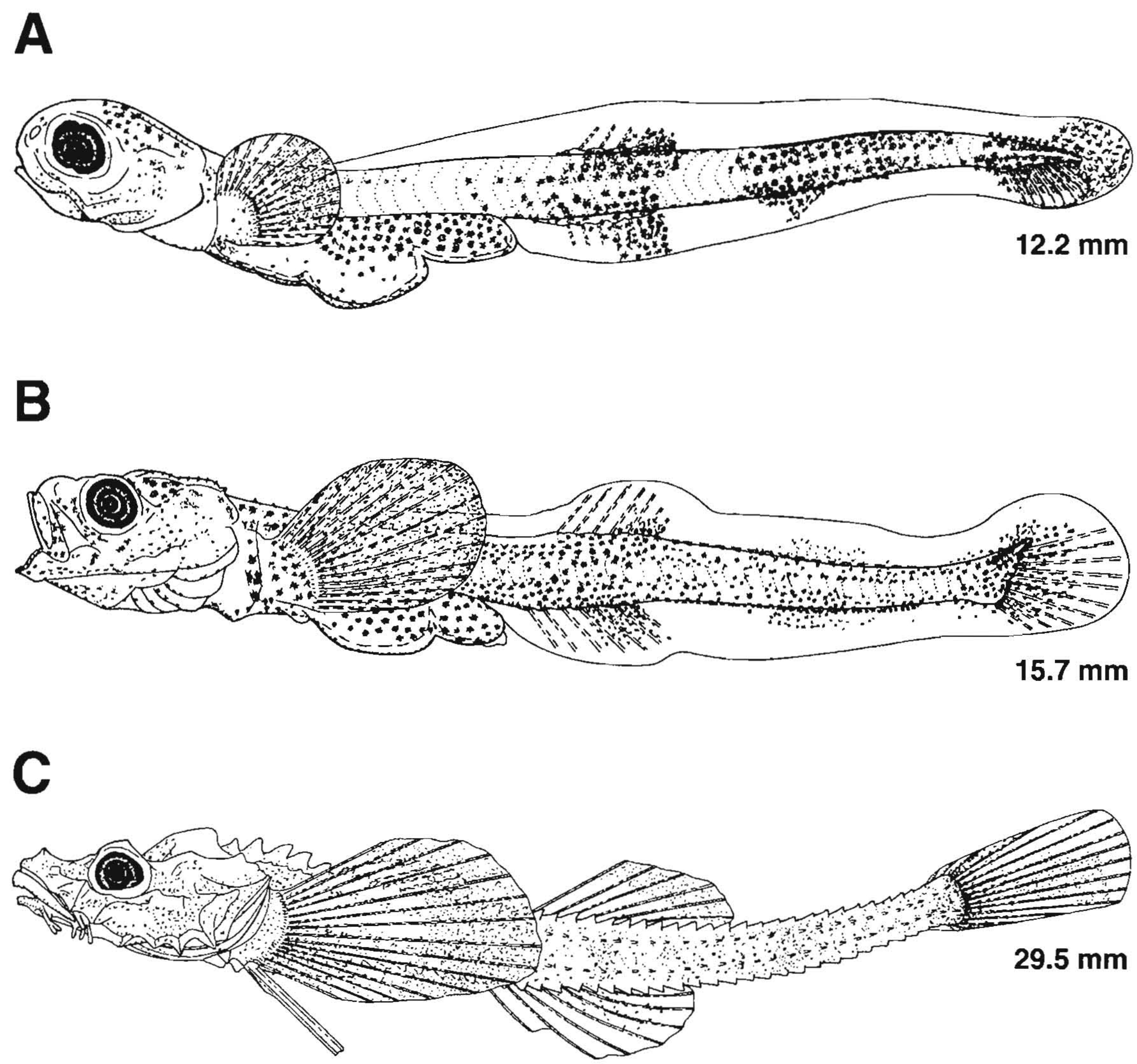


Figure 11

Developmental stages of *Leptagonus decagonus* (Atlantic specimens). (A) Early flexion larva 12.5 mm, ARC 9010796. (B) Late flexion larva 15.7 mm, ARC 9010768. (C) Juvenile 29.5 mm, ARC 9010751.

Table 9

Body proportions of *Leptagonus decagonus* larvae and juveniles. Values given for each body proportion are expressed as percentage of standard length (SL) or head length (HL); mean, standard deviation, and range given in parentheses.

Body proportion	Preflexion		Flexion		Juvenile	
Sample size	4		11		1	
Standard length (mm)	9.7±3.1	(8.9–10.7)	14.5±2.2	(12.0–17.9)	29.5	(29.5)
Body depth/SL	9.2±2.0	(6.4–10.6)	10.2±1.7	(7.4–12.4)	13.0	(13.0)
Predorsal length/SL			34.6±0.5[1]	(34.0–35.2)	36.1	(36.1)
Snout to anus length/SL	49.1±7.9	(39.3–57.9)	47.0±4.1	(40.0–54.1)	42.9	(42.9)
Head length/SL	21.1±1.9	(19.8–23.8)	21.2±3.1	(17.5–26.8)	26.6	(26.6)
Head width/HL	20.7±7.7	(10.4–27.2)	20.1±3.5	(15.6–25.6)	22.4	(22.4)
Snout length/HL	16.6±5.0	(10.2–20.7)	24.8±5.6	(17.0–34.4)	32.3	(32.3)
Eye diameter/HL	31.3±6.3	(26.4–40.4)	27.3±5.0	(19.2–34.8)	20.0	(20.0)
Pectoral-fin length/SL	12.5±3.7	(9.0–17.1)	19.6±5.0	(13.3–25.5)	29.4	(29.4)

[1] Sample size = 4.

Table 10

Meristics of cleared and stained *Leptagonus decagonus* larvae and juveniles. Specimens between dashed lines (– – –) are undergoing notochord flexion.

Standard[1] length (mm)	Dorsal fin spines	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Pelvic fin spines, rays	Branchi-ostegal rays	Neural spines abdominal	Neural spines caudal	Neural spines total	Haemal spines	Centra abdominal	Centra caudal	Centra total	Body plates[2] DLP+MDP	Body plates[2] SLP	Body plates[2] LLP	Body plates[2] ILP	Body plates[2] VLP+MVP
8.8																		
11.9																		
13.7	V	5	6	15		6	13	24	37	24	13	24	37	23	36		36	16
16.3	VII	7	8	15		6	13	28	41	28	13	28	41	20	32		39	12
29.5	VI	6	7	16	I,2	6	13	32[3]	45	31	13	32	45	42	41	25	42	40

[1] All are Atlantic specimens.
[2] DLP—dorsolateral; MDP—mid-dorsal; SLP—supralateral; LLP—lateral line; ILP —infralateral; VLP—ventrolateral; MVP—mid-ventral.
[3] Two neural spines on preural centra.

Leptagonus frenatus—sawback poacher

Literature—Formerly placed in the genus *Sarritor*, Kanayama (1991) included the sawback poacher in the genus *Leptagonus*. Development of larval and early juvenile *L. frenatus* is described for the first time here based on examination of 45 specimens, 7.1–29.0 mm.

Distribution—Adult *L. frenatus* range from British Columbia, Canada, to the Bering Sea (Matarese et al., 1989). Adults are common in the Bering Sea in muddy sand or rocky habitats at depths of 50 to 250 m (Kanayama, 1991). Larvae are common in plankton samples from the eastern Bering Sea. Larvae and juveniles examined in this study were collected in the northern Gulf of Alaska and eastern Bering Sea.

Morphology (Table 11)—Notochord flexion in *L. frenatus* begins at 9.0 mm and is completed at 16.0 mm. The juvenile stage begins at approximately 24.0 mm. Larvae are medium-bodied with mean body depth of 10.1% SL in preflexion specimens, increasing slightly to 12.3% SL in juveniles. Snout length increases from 13.9% HL in preflexion larvae to 29.7% HL in juveniles. Pectoral-fin length increases from 13.4% SL in preflexion larvae to 28.6% SL in juveniles.

Pigmentation (Fig. 12)—Larvae of *L. frenatus* are moderately pigmented. The heads of preflexion and early flexion larvae lack pigmentation with the exception of three or four melanophores on the posterior region of the upper jaw (Figs. 12A,B).

Melanophores are present on the posterior half of the lateral surface of the gut and along the entire ventral surface. A small patch of melanophores is present on the dorsal midline just beyond midbody. This patch extends slightly onto the dorsal finfold. A larger patch is present ventrally which extends to the ventral margin of the anal finfold. Seen together, these dorsal and ventral patches appear as a bar. Melanophores cover the posterior one-third of the body to the notochord tip. A faint row of melanophores along the ventral midline connects the pigmented anterior and posterior regions of the body. In line with the anterior edge of the posterior body pigmentation, an irregularly-shaped second band of melanophores extends onto the anal finfold. A circular-shaped patch of melanophores covers approximately two-thirds of the caudal finfold.

In late flexion and postflexion larvae, melanophores appear on the operculum and snout (Figs. 12C,D). Pigmentation on the lateral surface of the gut increases until it is completely covered with melanophores in the postflexion stage. Bands of pigmentation develop on the inner and outer margins of the pectoral fins with the outer band being more pronounced. Additional melanophores develop along the ventral midline of the body between the two major regions of pigmentation. In late flexion larvae, a second patch of melanophores appears posteriorly on the dorsal finfold. This patch is greatly reduced or absent in postflexion larvae. The amount of area covered by melanophores on the caudal fin is reduced as development progresses. Overall, pigmentation of postflexion larvae differs little from late flexion larvae. In general, the distribution of pigmentation in postflexion larvae is more homogenous and individual melanophores appear smaller (Fig. 12D).

Meristic Features (Table 12)—Dorsal and pectoral fins attain adult ray complements by 13.7 mm. An adult count of anal-fin rays is present at 15.2 mm. Dorsal-fin spines and the pelvic fin are complete at 17.5 mm. The vertebral column is complete at 20.0 mm and the caudal fin (3,(6+6),1 or 4,(6+6),1) at 24.0 mm. Like *L. decagonus*, *L. frenatus* have higher vertebral counts (45–48) than many other agonids. With the exception of the lateral line row (LLP), dermal plates are complete by 24.0 mm. The lateral line row is complete at 29.0 mm.

Head Spines—Head spination of *L. frenatus* is generally reduced and less elaborate than other agonids. Early flexion larvae possess a row of small parietal spinules that are overgrown with bone to form ridges or crests in late flexion larvae (Figs. 12B,C). Cleithral, coronal, nasal, preopercular, and supraocular spines are present by 13.7 mm. Superior and inferior infraorbital, frontal, tympanic, and sclerotic spines are complete at 17.5 mm. In addition, postocular, posttemporal, and pterotic spines are present in juveniles.

Species Comparisons—Larvae and juveniles of *L. frenatus* are most similar in appearance to larvae of *L. decagonus*. *Leptagonus frenatus*, however, have no pigmentation dorsally on the head throughout development and lack pigmentation on the opercular and hyoid regions until postflexion. The pectoral fin of *L. frenatus* has few or no melanophores on the base and a distinct band at the outer edge. The second patch of pigmentation on the anal fin covers more area in *L. frenatus* than *L. decagonus* and extends to the ventral edge of the finfold.

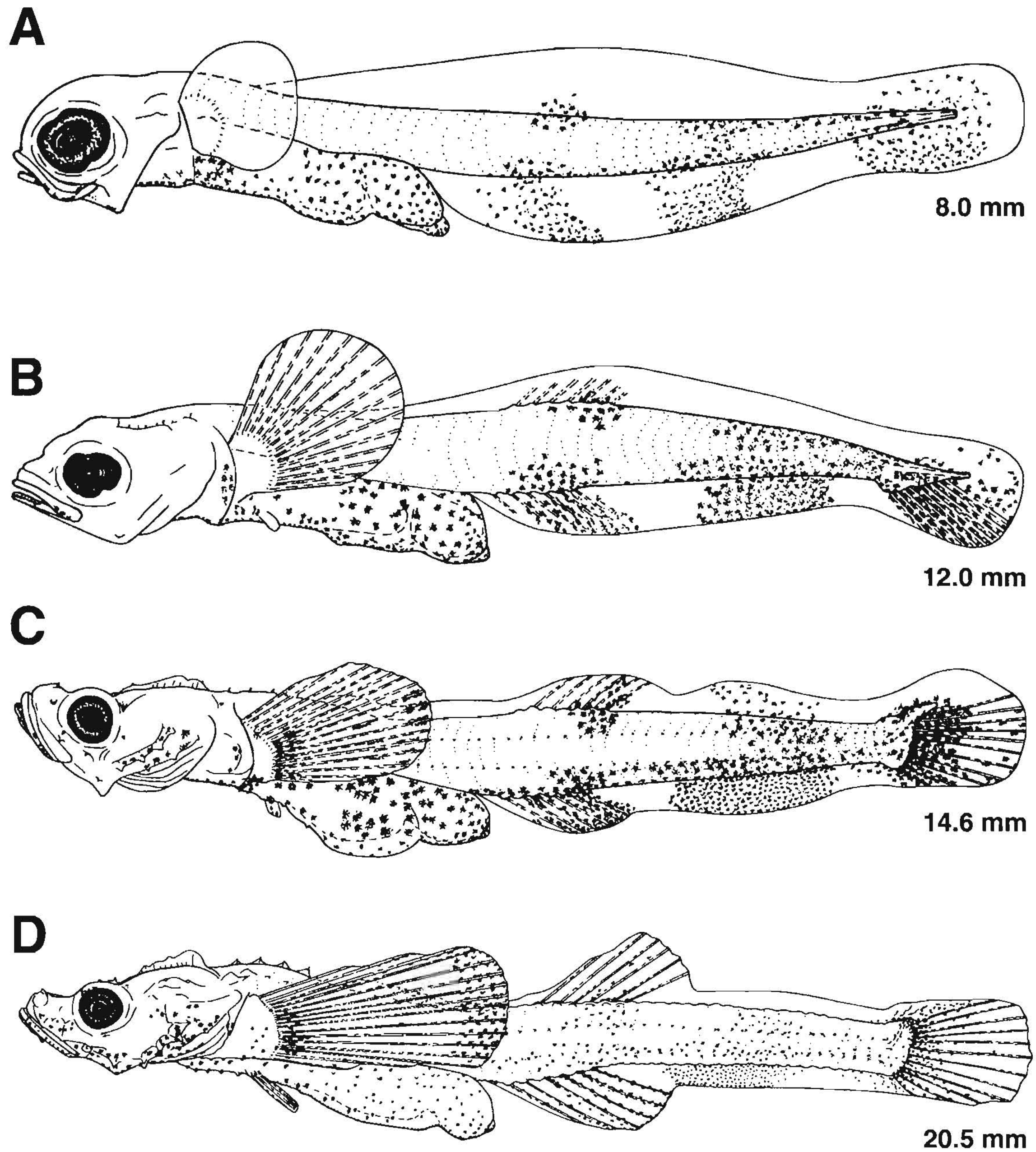


Figure 12

Developmental stages of *Leptagonus frenatus*. (A) Preflexion larva 8.6 mm; AFSC, 2KE-72, B-54. (B) Early flexion larva 12.0 mm; UAM, AC242, PRBS 22, 14V77. (C) Flexion larva 14.6 mm; AFSC, 1CH83, St. G016A, N505. (D) Postflexion larva 20.5 mm; AFSC, 4MF81, St. G069A, 6B5.

Table 11

Body proportions of *Leptagonus frenatus* larvae and juveniles. Values given for each body proportion are expressed as percentage of standard length (SL) or head length (HL); mean, standard deviation, and range given in parentheses.

Body proportion	Preflexion		Flexion		Postflexion		Juvenile	
Sample size	5		18		11		3	
Standard length (mm)	7.8±0.5	(7.1–8.4)	12.3±2.5	(9.0–15.6)	19.5±1.4	(17.0–21.4)	26.1±2.5	(23.7–28.7)
Body depth/SL	10.1±1.5	(8.5–12.5)	12.1±1.3	(10.1–14.6)	12.6±1.6	(9.8–15.2)	12.3±0.9	(11.7–13.3)
Predorsal length/SL			35.6±2.1	(33.0–38.4)	37.4±1.4	(34.9–39.5)	37.9±1.4	(36.5–39.3)
Snout to anus length/SL	47.4±2.6	(43.3–50.3)	51.5±4.7	(43.5–61.8)	54.0±2.1	(49.7–56.2)	50.5±1.1	(49.2–51.4)
Head length/SL	17.1±1.8	(15.2–19.5)	20.7±3.2	(15.8–27.3)	26.3±1.2	(23.8–28.4)	27.9±3.5	(24.7–31.6)
Head width/HL	31.2±10.0	(21.2–42.5)	23.2±5.7	(15.1–31.3)	24.1±4.4	(17.7–31.2)	33.3±3.7	(29.2–36.4)
Snout length/HL	13.9±4.4	(11.3–20.4)	22.8±9.3	(7.8–39.7)	32.6±3.7	(27.0–40.7)	29.7±5.1	(23.9–33.5)
Eye diameter/HL	42.2±5.0	(35.6–46.5)	28.2±6.9	(19.9–39.7)	18.2±1.9	(14.4–20.8)	16.2±2.6	(15.6–19.1)
Pectoral-fin length/SL	13.4±1.8	(12.2–16.4)	17.5±5.0	(10.5–24.4)	28.5±3.0	(22.6–32.8)	28.6±1.8	(27.7–30.6)

Table 12

Meristics of cleared and stained *Leptagonus frenatus* larvae and juveniles. Specimens between dashed lines (– – –) are undergoing notochord flexion.

Standard length (mm)	Dorsal fin spines	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Pelvic fin spines, rays	Branchi-ostegal rays	Neural spines abdominal	Neural spines caudal	Neural spines total	Haemal spines	Centra abdominal	Centra caudal	Centra total	Body plates[1] DLP+MDP	SLP	LLP	ILP	VLP+MVP
8.4						5												
9.9				14		5								4	38		33	10
11.9				12		5								4	34		30	10
13.7		6	5	15		6	5		5					16	37		37	10
15.2	IV	8	7	15		6	12	9	21	7	12	27	39	24	39		35	12
17.5	VII	7	6	16	I,2	6	12	26	38	26	12	32	44	38	42		36	19
20.0	VII	6	5	16	I,2	6	13	33	46	33	13	33	46	38	40		41	24
24.0	VII	7	8	17	I,2	6	13	32	45	32	13	33	46	41	41		42	38
29.0	VII	7	6	16	I,2	6	13	34[2]	47	34[2]	13	34	47	45	45	39	43	44

[1] DLP—dorsolateral; MDP—mid-dorsal; SLP—supralateral; LLP—lateral line; ILP—infralateral; VLP—ventrolateral; MVP—mid-ventral.

[2] Two neural and haemal spines on preural centra.

Leptagonus leptorhynchus—longnose poacher

Literature—Formerly included in the genus *Sarritor*, the longnose poacher was placed in the genus *Leptagonus* by Kanayama (1991). A developmental series of larval *Leptagonus leptorhynchus* 8.0–19.6 mm was described by Maeda and Amaoka (1988). Pertinent information from their report is summarized here for comparative purposes.

Distribution—Adult *L. leptorhynchus* range from the Gulf of Alaska to the Bering Sea (Matarese et al., 1989). Adults are common off northern Japan on sandy substrates from 50 to 200 m (Kanayama, 1991). However, *L. leptorhynchus* is apparently uncommon in the northeastern Pacific and Bering Sea as it is not among taxa reported by Allen and Smith (1988). Larvae are extremely uncommon in plankton samples. Only two were collected during AFSC cruises from 1965 to 1993.

Morphology (Table 13)—Notochord flexion in *L. leptorhynchus* begins at 10.6 mm and is complete at 14.5 mm. Length at which the juvenile stage begins is unknown. Larvae are slender-bodied with mean body depth of 6.3% SL in preflexion specimens, increasing slightly to 9.4% SL postflexion. (These measurements are questionable as illustrations of *L. leptorhynchus* (Fig. 13) appear similar in body depth to *L. decagonus* and *L. frenatus*, which are closer to 10.0% SL during preflexion and 12.0–13.0% SL as postflexion larvae and juveniles (Figs. 11 and 12)). Snout length increases from 13.3–24.4% HL in preflexion larvae to 27.0–31.9% HL in postflexion larvae. Pectoral-fin length increases from 8.3% SL in preflexion larvae to 26.8% SL in postflexion larvae.

Pigmentation (Fig. 13)—Larvae of *L. leptorhynchus* are heavily pigmented. The head of preflexion and early flexion larvae is devoid of pigmentation with the exception of a single melanophore on the dorsal margin of the operculum (Fig. 13A). The isthmus, pectoral-fin base, and gut are covered with melanophores. Pigmentation completely covers the body from the area above the hindgut to the caudal peduncle with the exception of the lateral line. An irregular row of melanophores is present on the dorsal finfold along the body midline extending from midbody to the caudal peduncle. Two irregularly-shaped patches of melanophores are present on the anal finfold extending from the ventral midline of the body to the ventral margin of the finfold. The anteriormost of these patches is located at about midbody and is the smaller and narrower of the two. The second patch of melanophores begins at the posterior edge of the anterior patch and has a very broad base that is centered at about three-quarters body length. The posterior portion of the caudal peduncle, notochord tip, and caudal finfold lack pigment. In flexion larvae, additional melanophores develop on the snout, interocular, and opercular regions (Figs. 13B–D). Melanophores also develop near the insertion of the pectoral fin and gradually increase in numbers toward the outer margin with development. By the end of flexion, melanophores cover the entire body with the exception of the caudal peduncle and hypural region. In postflexion larvae, the head and dorsalmost two-thirds of the pectoral fin are completely covered with melanophores (Fig. 13E). The body is completely covered with pigmentation. A crescent-shaped patch of melanophores on the caudal fin surrounds the hypural region. This patch covers less than one-quarter of the caudal fin.

Meristic Features (Table 14)—The anal fin attains an adult complement of rays at 10.0 mm. Dorsal and pectoral-fin elements are complete by 10.4 mm. These counts, however, are probably of unossified elements as differential staining techniques were not used. Ossification of fin elements probably does not occur until about 13.0 mm as seen in other *Leptagonus*. The pelvic fin is not complete until 19.3 mm. Counts of caudal fin and vertebral elements during larval development are not reported. With the exception of the lateral line row (LLP), dermal plate counts attain adult complements by 14.1 mm. The lateral line row is complete at 19.6 mm.

Head Spines—Head spination of *L. leptorhynchus* appears similar to other *Leptagonus* species. Early flexion larvae possess small parietal spines which grow to distinct, weakly bilobed crests by mid-flexion (Figs. 13B,C). Opercular and preopercular spines form between 10.0 and 12.4 mm. Nasal and supraocular spines are first seen at 13.6 mm. A pair of posttemporal spines appear at 10.9 mm and fuse at 14.1–15.2 mm. Two pairs of postocular spines (anterior and posterior) first appear at 13.6 mm and fuse at 16.9 mm.

Species Comparisons—The pigmentation pattern on larval *L. leptorhynchus* is similar to that seen on *L.*

Table 13

Body proportions of *Leptagonus leptorhynchus* larvae and juveniles. Values given for each body proportion are expressed as percentage of standard length (SL) or head length (HL); mean (single value), range (two values) (Maeda and Amaoka, 1988).

Body proportion	Preflexion	Flexion	Postflexion
Sample size	5	5	11
Standard length (mm)	8.0–10.4	10.6–14.1	13.6–19.6
Body depth/SL	6.3		9.4
Predorsal length/SL			
Snout to anus length/SL	46.4		58.9
Head length/SL			
Head width/HL			
Snout length/HL	13.3–24.4		27.0–31.9
Eye diameter/HL	40.0		16.7
Pectoral-fin length/SL	8.3		26.8

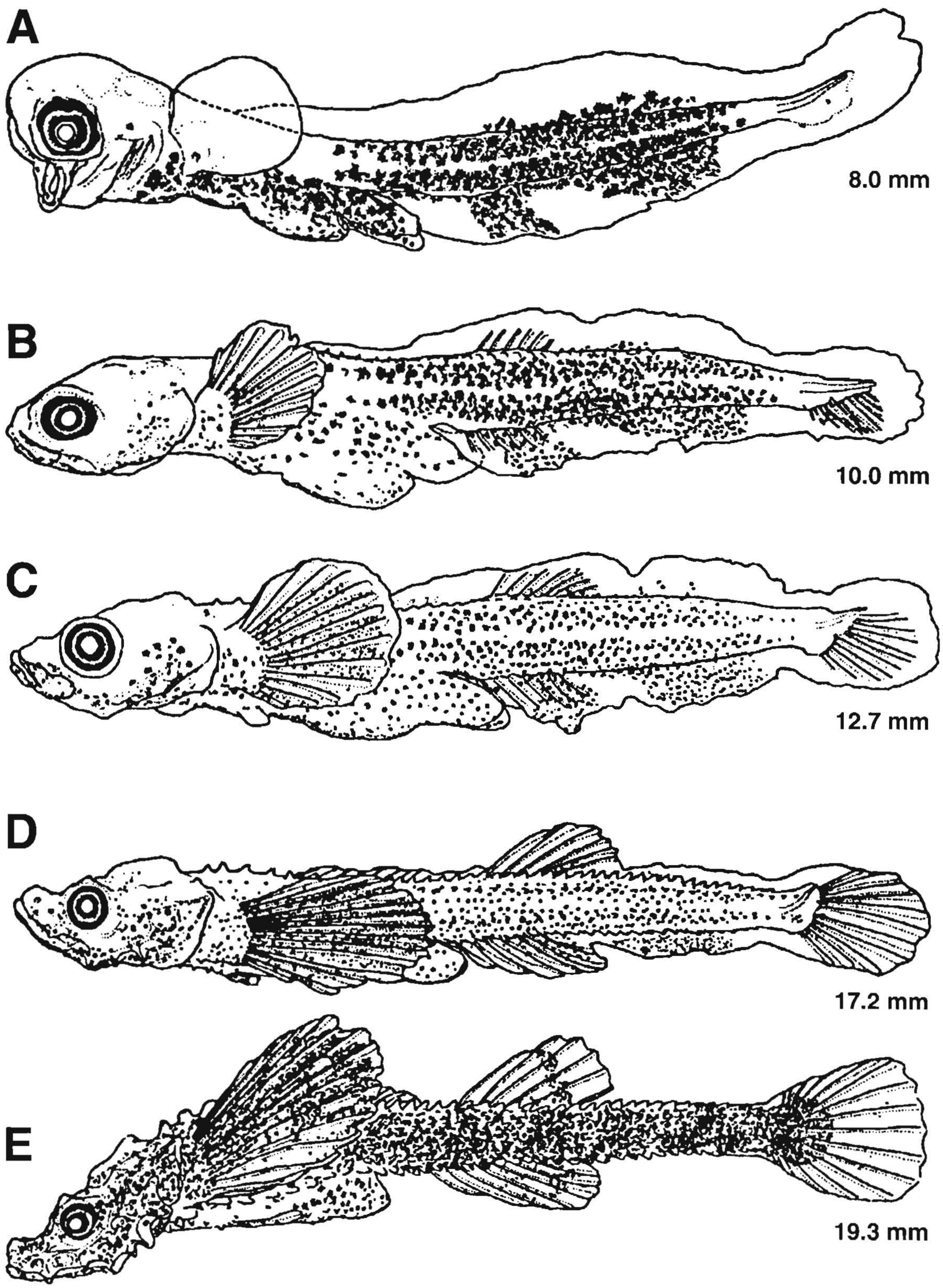


Figure 13

Development of larval *Leptagonus leptorhynchus* (Maeda and Amaoka, 1988). (A) Preflexion larva 8.0 mm. (B) Early flexion larva 10.0 mm. (C) Mid-flexion larva 12.7 mm. (D) Late flexion larva 17.2 mm. (E) Postflexion larva 19.3 mm.

Table 14

Meristics of *Leptagonus leptorhynchus* larvae and adults. Specimens between dashed lines (– – –) are undergoing notochord flexion. Larval counts from Maeda and Amaoka (1988). Adult counts compiled from Matarese et al. (1989) and Kanayama (1991).

Standard[1] length (mm)	Dorsal fin spines	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Pelvic fin spines, rays	Branchiostegal rays	Neural spines abdominal	Neural spines caudal	Neural spines total	Haemal spines	Centra abdominal	Centra caudal	Centra total	Body plates[2] DLP+MDP	Body plates[2] SLP	Body plates[2] LLP	Body plates[2] ILP	Body plates[2] VLP+MVP
8.0															19		9	
8.4														3	31		21	
9.8	I	5	6	15										4	29		28	7
10.0	II	6	7	14										28	34		30	8
10.4	VII	6	6	14										8	31		30	7
10.6	I	7	8	15										4	33		35	9
10.7	I	7	7	15										4	34		30	7
10.9	IV	6	7	14										23	34		31	9
12.7	IX	7	7	14										37	36		40	21
14.1	IX	7	7	14										37	38		39	35
13.6	VII	6	6	14										37	36		41	27
14.5	VIII	6	7	14										39	37		39	28
14.9	IX	7	7	14										40	40		40	36
15.2	VIII	7	6	14	2									41	43		41	38
16.4	IX	6	7	14	2									39	41		40	37
16.9	VIII	6	6	14	3									41	44		42	40
17.2	IX	6	7	14	3									39	43		42	37
17.3	VIII	6	6	14	3									40	36	9	40	41
17.9	IX	7	7	14	3									42	37	8	39	40
19.3	IX	6	7	14	I,2									39	36	17	40	39
19.6	IX	6	7	15	I,2									43	38	26	43	42
Adults	VI–IX	5–8	6–8	13–15	I,2	6	12	30	42	30	12	31	42–45	37–45	35–42	20–33	39–43	34–44

[1] Larval counts (8.0–19.6 mm) are from unstained specimens.

[2] DLP—dorsolateral; MDP—mid-dorsal; SLP—supralateral; LLP—lateral line; ILP—infralateral; VLP—ventrolateral; MVP—mid-ventral.

decagonus and *L. frenatus* larvae but is more dense and appears darker. *Leptagonus leptorhynchus* appear even more similar to other heavily pigmented agonid larvae such as *Agonopsis vulsa, Bathyagonus* spp., and *Xeneretmus latifrons*. All of these taxa, however, have more pigmentation on the dorsal finfold, a unique meristic feature, or head spination which differentiate them from *L. leptorhynchus*.

***Podothecus acipenserinus*—sturgeon poacher**

Literature—Development of larval and early juvenile *Podothecus acipenserinus* is described for the first time here based on examination of 75 specimens, 6.0–34.2 mm.

Distribution—Adult *P. acipenserinus* range from northern California to the Chukchi Sea and primarily inhabit areas with muddy substrates (Eschmeyer et al., 1983; Matarese et al., 1989). Adults are commonly caught off British Columbia, Canada, at depths from 18 to 55 m (Hart, 1973). In the Bering Sea, adults are frequently collected by otter trawl at 50–300 m depths (Kanayama, 1991). Larvae are common in plankton samples. Specimens examined in this study were collected throughout the adult range.

Morphology (Table 15)—Notochord flexion in *P. acipenserinus* begins at 8.0 mm and is completed at 12.5 mm. The juvenile stage begins at approximately 21.0 mm. Size at transformation varies geographically (smaller in southern part of range, particularly in Puget Sound, Washington; see diagnostic characters).

Larvae are medium-bodied with mean body depth of 11.6% SL in preflexion specimens, increasing slightly to 13.5% SL in juveniles. Snout length increases remarkably from 19.5% HL in preflexion larvae to 41.1% HL in juveniles. The mouth position of juveniles and adults is strongly subterminal (inferior). Pectoral-fin length increases from 15.3% SL in preflexion larvae to 24.8% SL in postflexion larvae.

Pigmentation (Fig. 14)—Larvae of *P. acipenserinus* are moderately pigmented. The heads of preflexion larvae possess a light covering of melanophores on the lower jaw and operculum (Fig. 14A). Widely-spaced melanophores are also present on the pectoral-fin base, lateral surface of the gut, and body from immediately posterior to the anus to the caudal peduncle. A distinct row of melanophores is present along the entire length of the ventral midline of the gut. A few additional melanophores are present near the notochord tip. The dorsal finfold has a few melanophores near midbody. Irregularly-spaced melanophores cover nearly the entire anal finfold with the exception of the anterior margin and the area anterior to the caudal finfold. A distinct row of evenly-spaced melanophores is present along the ventral edge of the anal finfold. Additional melanophores are present on the ventral portion of the caudal finfold below the notochord tip.

In flexion larvae, additional melanophores develop on the opercular, postocular, infraorbital, and upper jaw areas of the head (Figs. 14A,B). Several unevenly-spaced melanophores are present on the pectoral fin. In postflexion larvae, melanophores cover the entire head with the exception of the area on the dorsal surface surrounding the parietal spines (Fig. 14D). Melanophores nearly cover the entire pectoral fin. Pigmentation completely covers the head in juveniles and is

Table 15

Body proportions of *Podothecus acipenserinus* larvae and juveniles. Values given for each body proportion are expressed as percentage of standard length (SL) or head length (HL); mean, standard deviation, and range given in parentheses.

Body proportion	Preflexion		Flexion		Postflexion		Juvenile	
Sample size	3		5		7		13	
Standard length (mm)	6.9±0.9	(6.0–7.8)	10.3±1.5	(8.3–12.2)	16.6±2.4	(13.8–19.9)	28.0±4.7	(21.0–34.2)
Body depth/SL	11.6±0.4	(11.2–11.9)	11.7±1.4	(9.3–13.1)	13.0±1.4	(11.5–15.4)	13.5±1.3	(11.8–15.3)
Predorsal length/SL	49.6±1.1	(48.9–50.9)	51.3±1.9	(48.1–52.6)	49.9±0.7	(49.0–50.9)	48.1±3.4	(42.9–52.0)
Snout to anus length/SL					35.6±1.8	(32.6–36.9)	40.4±2.4	(36.6–41.9)
Head length/SL	20.7±2.3	(18.2–22.8)	23.5±2.1	(19.9–25.5)	26.7±1.2	(24.8–28.2)	31.6±2.4	(26.7–35.0)
Head width/HL	26.5±2.4	(24.8–29.2)	25.3±3.7	(21.7–30.0)	29.1±1.3	(28.8–31.6)	21.2±3.5	(15.6–27.0)
Snout length/HL	19.5±2.6	(16.5–21.2)	24.8±7.9	(15.4–34.6)	36.2±4.6	(29.3–41.2)	41.1±4.7	(28.9–46.5)
Eye diameter/HL	32.6±5.7	(27.7–38.8)	25.8±5.3	(20.9–34.2)	18.7±3.3	(15.0–24.0)	17.5±3.8	(12.6–25.1)
Pectoral-fin length/SL	15.3±2.4	(14.6–18.0)	23.0±4.7	(16.0–26.8)	27.7±2.9	(23.6–30.8)	24.8±3.5	(19.9–29.7)

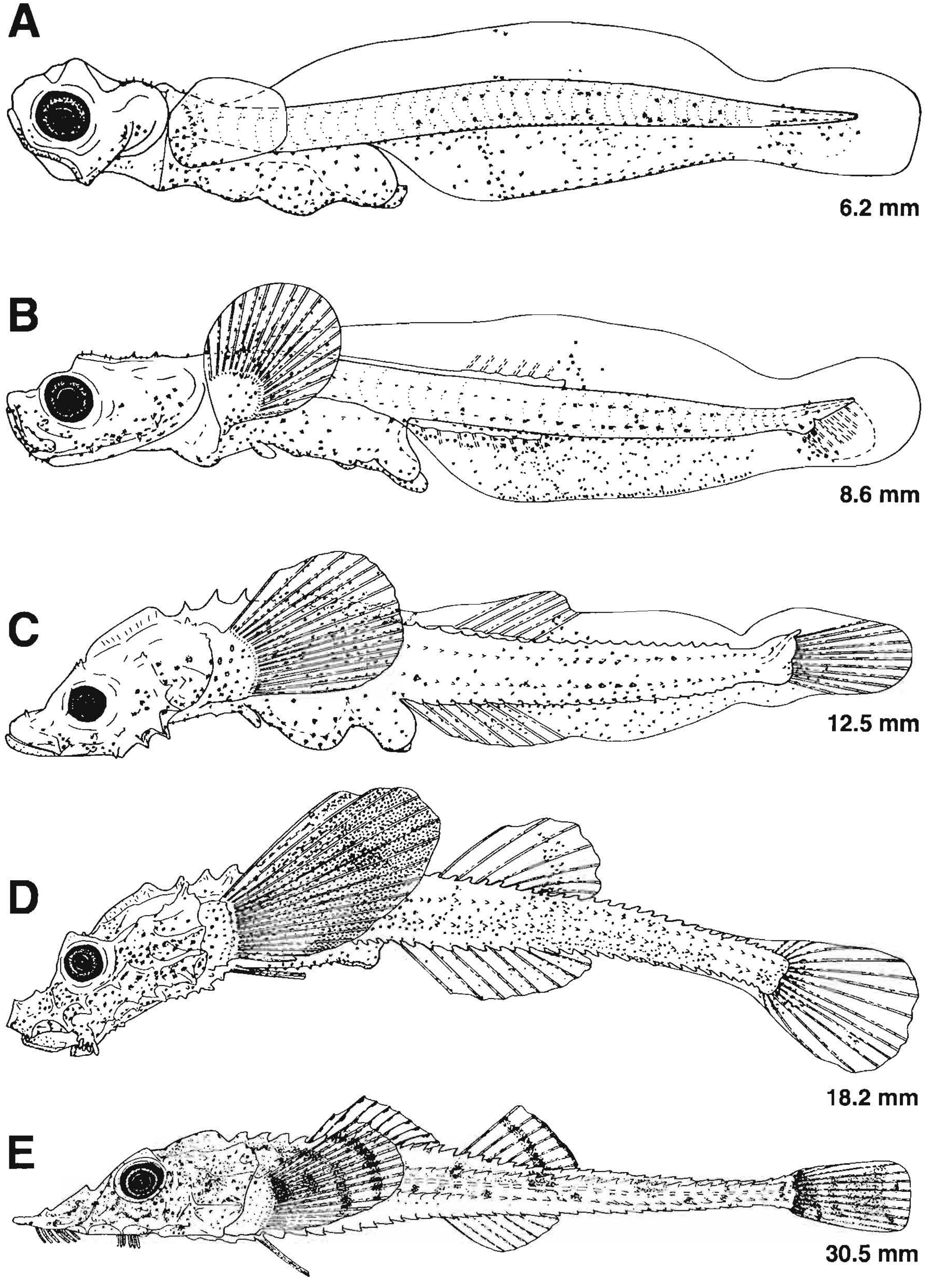


Figure 14

Developmental stages of *Podothecus acipenserinus*. (A) Preflexion larva 6.2 mm; AFSC, 2PO85, St. G080A, 6B3. (B) Early flexion larva 8.6 mm; AFSC, 3MF89, St. G038A, 6B3. (C) Late flexion larva 12.5 mm; AFSC, 1SH81, St. 208, 6B5. (D) Postflexion larva 18.2 mm; UAJ, ABM 117-8. (E) Juvenile 30.5 mm, UW 22067.

Table 16

Meristics of cleared and stained *Podothecus acipenserinus* larvae and juveniles. Specimens between dashed lines (- - -) are undergoing notochord flexion.

Standard length (mm)	Dorsal fin spines	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Pelvic fin spines, rays	Branchiostegal rays	Neural spines abdominal	Neural spines caudal	Neural spines total	Haemal spines	Centra abdominal	Centra caudal	Centra total	Body plates[1] DLP+MDP	SLP	LLP	ILP	VLP+MVP
6.7																		
8.4														3	28		28	9
10.0						5	5			12				20	34		34	11
11.4	V			6		4	12	24	36	24	12	24	36	31	37	2	36	26
12.9	IX	7	8	18	I,2	6	12	28	40	28	12	29	41	34	39	2	36	29
12.9	IX	8	8	18	I,2	6	12	26	38	26	12	27	39	33	38	3	36	32
13.8	IX	8	8	18	I,2	6	12	27	39	27	12	28	40	35	37	4	36	33
15.5	IX	7	8	17	I,2	6	12	28	40	28	12	29	41	38	39	3	37	35
17.7	IX	7	8	18	I,2	6	12	28	40	28	12	29	41	38	39	2	37	36
17.8	IX	7	8	18	I,2	6	12	28[2]	40	27	12	28	40	37	38	3	36	34
19.5	IX	7	8	18	I,2	6	12	28[2]	40	28	12	28	40	37	39	12	36	35
22.0	VIII	6	7	16	I,2	6	13	27[2]	40	26	13	27	40	37	39	34	37	36
23.0	VIII	7	9	18	I,2	6	12	27[2]	39	26	12	27	39	37	38	32	37	36
27.9	VIII	7	8	16	I,2	6	12	27[2]	39	26	12	27	39	36	37	38	37	34
34.2	VIII	7	7	16	I,2	6	12	27[2]	39	26	12	27	39	35	38	36	37	35

[1] DLP—dorsolateral; MDP—mid-dorsal; SLP—supralateral; LLP—lateral line; ILP—infralateral; VLP—ventrolateral; MVP—mid-ventral.

[2] Two neural spines on preural centra.

separated into distinct patches on the body and bands on the fins (Fig. 14E).

Meristic Features (Table 16)—All fins have adult complements of spines and rays at 12.9 mm. The caudal fin usually has 3,(6+6),1 rays but one specimen (22.0 mm) lacks the inferior procurrent ray (3,(6+6),0). All vertebrae were ossified at 12.9 mm. All specimens of 17.8 mm or greater possess two neural spines on the preural centra. The DLP+MDP, SLP, and ILP dermal plate rows are complete at 12.9 mm. At 15.5 mm, the VLP+MVP, row has an adult complement of plates. The LLP's are complete on one 27.9 mm individual but not on another of 34.2 mm.

Head Spines—Head spination of *P. acipenserinus* larvae is more elaborate than most agonids. Early flexion larvae possess small parietal spinules that are overgrown during ontogeny to form a relatively flat parietal crest (Figs. 14A–C). Opercular, anterior and posterior preopercular, inferior and superior infraorbital, supracleithral, and supraocular spines form by 10.0 mm. The supracleithral and superior infraorbital spines become quite prominent during postflexion. Forward-projecting nasal spines are first seen at 11.4 mm and undergo remarkable lengthening during postflexion and juvenile stages (Figs. 14D,E). Frontal, postocular, and posttemporal spines are also present on postflexion larvae.

Species Comparisons—Larval *P. acipenserinus* appear most similar to *L. decagonus* and *L. frenatus* larvae. However, *P. acipenserinus* have fewer vertebrae (39–42). Pigmentation on the body and finfolds of prejuvenile *P. acipenserinus* is not separated into bands or patches and they have notably less pigmentation on the caudal finfold and fin. The pectoral fin of postflexion *P. acipenserinus* is shaped differently, having longer dorsal than ventral rays, a more rounded outer edge, and more pigmentation than *L. decagonus* or *L. frenatus*.

Podothecus acipenserinus larvae and juveniles display variation in pigmentation and size at transformation over their geographic range. The description provided here applies to specimens collected in the Gulf of Alaska and Bering Sea. In Puget Sound, Washington, flexion is complete at about 10.0 mm and the juvenile stage begins at 13.0–13.5 mm. The size at which flexion begins in *P. acipenserinus* from Puget Sound is unknown as no such specimens were available for study. Pigmentation of larvae and juveniles from Puget Sound is more dense than those from Alaskan waters but distributed in the same manner.

***Agonopsis vulsa*—northern spearnose poacher**

Literature—Development of larval and early juvenile *Agonopsis vulsa* is described for the first time here based on examination of 19 specimens, 5.1–43.8 mm.

Distribution—Adult *A. vulsa* range from southern California (Point Loma) to the Gulf of Alaska in nearshore habitats at depths of 18 to 163 m (Eschmeyer et al., 1983; Matarese et al., 1989). Larvae are uncommon in plankton samples. Larvae and juveniles examined in this study were collected in coastal waters of Oregon, Washington, and British Columbia, Canada.

Morphology (Table 17)—Notochord flexion in *A. vulsa* begins at 7.5 mm and is complete at 11.5 mm. The juvenile stage begins at approximately 25.0 mm. Larvae are medium-bodied with mean body depth of 15.1% SL in preflexion specimens, increasing slightly to 16.4% SL in juveniles. Snout length increases remarkably from 18.3% HL in preflexion larvae to 30.7% HL in juveniles as the projecting nasal bone and rostrum develop (Fig. 15). Compared to most other agonids, *A. vulsa* has a notably long anal-fin base.

Pigmentation (Fig. 15)—Larvae of *A. vulsa* are heavily pigmented. In preflexion larvae, melanophores are present dorsally on the head, snout, operculum, and isthmus (Fig. 15A). Melanophores completely cover the gut, pectoral-fin base, and body with the exception of the notochord tip. Dense bands are present anteriorly on the dorsal and anal finfolds between areas of lighter pigmentation. The posterior regions of the dorsal and anal finfolds are completely covered with dense aggregations of melanophores.

The dorsal and anal finfolds of flexion larvae possess one small band of densely aggregated melanophores anteriorly followed by two irregularly-shaped patches posteriorly (Figs. 15B,C). On the dorsal finfold, the posteriormost patch is the smaller of the two and does not meet the dorsal midline of the body. The posteriormost patch on the anal finfold extends ventrally from the body midline to the finfold edge. The remainder of the dorsal and anal finfolds are completely covered with lighter pigmentation.

In late flexion larvae, the head is completely covered with melanophores with a conspicuous patch posterior to the eye (Fig. 15C). Four dense bands of pigmentation begin to form on the body. A few melanophores are present near the ventral margin of the hypural.

In postflexion larvae, a fifth band of dense pigmentation develops on the caudal peduncle (Fig. 15D). Melanophores cover most of the dorsal and anal fins with the exception of some irregularly-shaped patches void of pigmentation. Patterns of pigmentation on the fins at this stage vary considerably among individuals. Melanophores also cover the pelvic fin.

Juveniles possess crescent-shaped bands at the insertions of the pectoral and caudal fins (Fig. 15E). Mel-

Table 17

Body proportions of *Agonopsis vulsa* larvae and juveniles. Values given for each body proportion are expressed as percentage of standard length (SL) or head length (HL); mean, standard deviation, and range given in parentheses.

Body proportion	Preflexion		Flexion		Postflexion		Juvenile	
Sample size	5		7		6		1	
Standard length (mm)	6.4±1.1	(5.1–7.3)	8.5±1.0	(7.5–10.3)	14.3±2.4	(11.9–18.7)	43.8	(43.8)
Body depth/SL	15.1±1.2	(13.7–16.6)	16.1±1.6	(12.9–17.7)	16.2±1.7	(14.0–18.7)	16.4	(16.4)
Predorsal length/SL					41.9±3.0	(37.9–45.8)	37.4	(37.4)
Snout to anus length/SL	51.9±1.7	(50.0–53.6)	52.9±4.3	(46.6–60.3)	49.2±2.2	(46.3–51.9)	35.2	(35.2)
Head length/SL	15.3±1.6	(13.1–16.6)	21.0±5.2	(15.4–26.8)	25.6±2.4	(21.7–28.0)	26.5	(26.5)
Head width/HL	35.9±9.3	(26.5–49.2)	25.1±2.6	(21.0–28.9)	28.9±2.7	(25.6–33.0)	16.7	(16.7)
Snout length/HL	18.3±4.0	(13.3–24.6)	20.7±4.7	(12.7–26.9)	19.9±4.1	(14.9–25.2)	30.7	(30.7)
Eye diameter/HL	48.0±3.6	(44.0–53.7)	37.9±5.6	(31.8–46.4)	33.4±4.9	(27.0–38.6)	24.7	(24.7)
Pectoral-fin length/SL	12.6±2.8	(8.4–15.0)	16.6±2.9	(13.8–21.2)	25.4±2.4	(22.0–28.1)	22.9	(22.9)

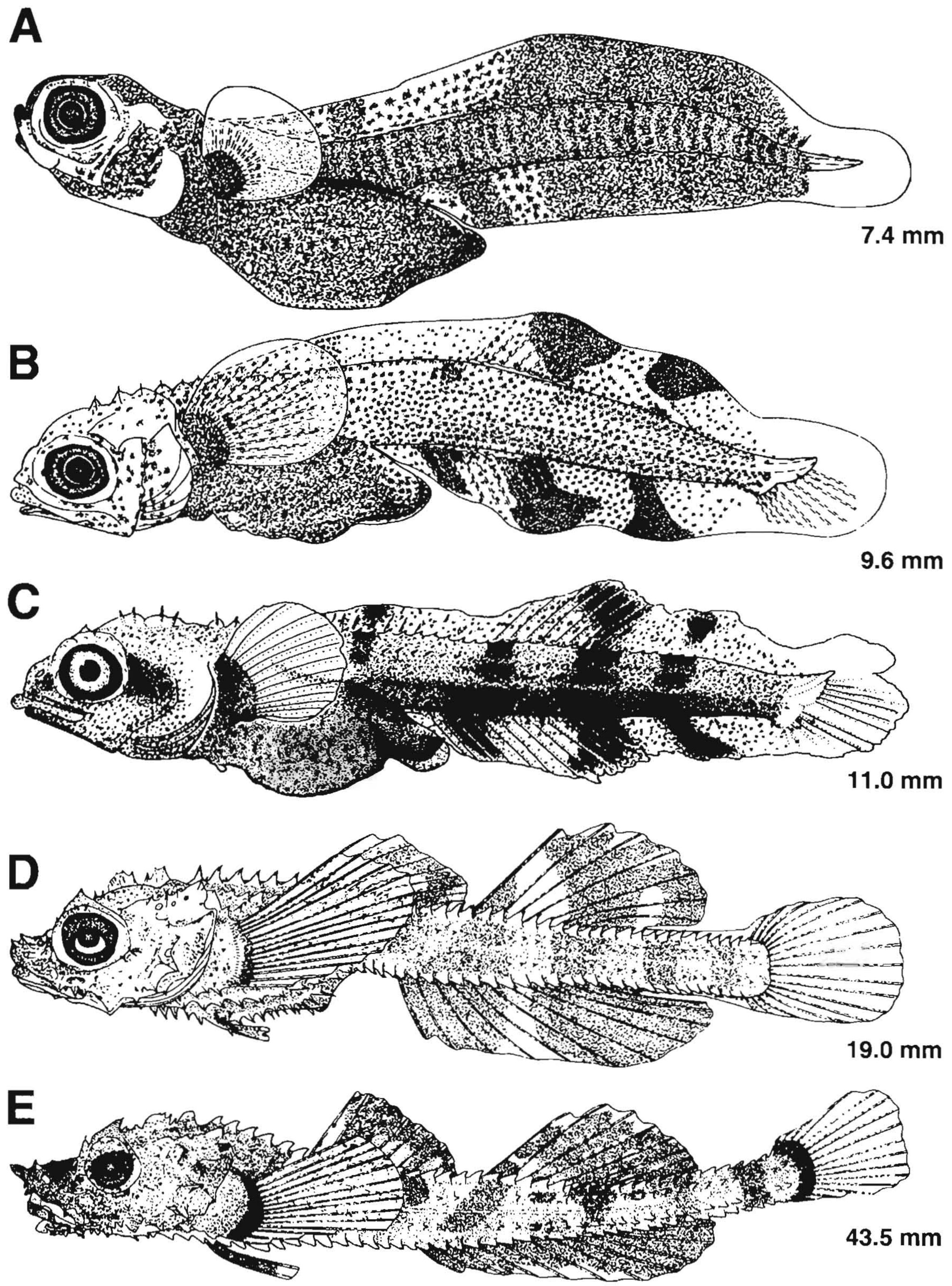


Figure 15
Developmental stages of *Agonopsis vulsa.* (A) Preflexion larva 7.4 mm; PBS (D. Hay), April 1990, Strait of Georgia, 60 cm bongo, 350μ. (B) Early flexion larva 9.6 mm; PBS (D. Hay), April 1990, Strait of Georgia, 60 cm bongo, 350μ. (C) Flexion larva 11.0 mm; OSU, 833E, NH10, 11 April 1972. (D) Postflexion larva 19.0 mm; OSU, 1065E, IX-30, 28 III 73. (E) Juvenile 43.5 mm; AFSC, 1PO82, St. G012A, 6B5.

Table 18

Meristics of cleared and stained *Agonopsis vulsa* larvae. Specimens between dashed lines (- - -) are undergoing notochord flexion.

Standard length (mm)	Dorsal fin spines	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Pelvic fin spines, rays	Branchiostegal rays	Neural spines abdominal	Neural spines caudal	Neural spines total	Haemal spines	Centra abdominal	Centra caudal	Centra total	Body plates[1] DLP+MDP	SLP	LLP	ILP	VLP+MVP
5.6						4								6	25		22	4
7.5				7		5								3	29		25	10
9.0		4	5	10		6	3	16	19					3	32		30	10
11.2	IX	8	11	14	I,2	6	12	26	38	25	12	4	16	35	38	3	36	33
13.2	VIII	7	11	14	I,2	6	12	28	40	28	12	29	41	34	36	2	36	36
15.0	XI	8	12	14	I,2	6	12	29	41	29	12	30	42	37	37	20	38	34

[1] DLP—dorsolateral; MDP—mid-dorsal; SLP—supralateral; LLP—lateral line; ILP—infralateral; VLP—ventrolateral; MVP—mid-ventral.

anophores cover a greater area of the dorsal and anal fins in juveniles than in postflexion larvae. With the exception of the posteriormost band, the pigmentation pattern present on the body in postflexion larvae transforms into irregularly-shaped patches of melanophores in juveniles.

Meristic Features (Table 18)—Dorsal, anal, pectoral, and pelvic fins attain adult complements of elements at 11.2 mm. In contrast to other agonids, *A. vulsa* has a high anal-fin ray count (10–12). The caudal fin is complete at 15.0 mm and has 3,(6+6),1 rays. All vertebral elements are ossified at 13.2 mm. The DLR+MDP, SLP, and ILP dermal plate rows are not complete at 15.0 mm. The count of 38 ILP is higher than the range of 35–36 reported by Kanayama (1991). Although no specimens were available for study, the remaining dermal plate rows probably attain adult complements by 25.0 mm.

Head Spines—The larval head spination of *A. vulsa* is elaborate and complex. Preflexion larvae possess small parietal spinules and three posterior preopercular spines at 5.6 mm. Flexion larvae are unique in having spines protruding through the parietal ridge or crest (Figs. 15B,C). Bone partially fills the spaces between the spines, giving the edge of the parietal crest in postflexion larvae and juveniles a jagged appearance (Figs. 15D,E). A pair of forward-projecting nasal spines, present in adults, is first seen in postflexion larvae (Fig. 15D). Coronal and supraocular spines are present at 9.0 mm. At 11.2 mm, nasal, three strong dentary, angular, articular, frontal, tympanic, pterotic, interopercular, supracleithral, cleithral, the fourth posterior preopercular, and all anterior preopercular spines are present. In addition, late-postflexion larvae and juveniles also possess well-defined superior infraorbital and postocular spines.

Species Comparisons—Larval and juvenile *A. vulsa* are very similar in appearance to larvae and juveniles of the genus *Bathyagonus*, subfamily Anoplagoninae. However, they are easily identified using pigmentation and meristic characters. Dense aggregations and patches of melanophores in the dorsal and anal finfolds distinguish preflexion and early flexion *A. vulsa* from *Bathyagonus* spp. One or more unpigmented regions are present on the dorsal, anal, or both finfolds in all *Bathyagonus* spp. Later stages are distinguished by pigmentation patterns, the unique spiny parietal ridge, and higher anal-fin ray counts (10–12) of *A. vulsa*. Typically, *A. vulsa* have more dorsal spines (8–10) than *Bathyagonus* spp. (5–8, usually 6 or 7). *Bathyagonus nigripinnis* have more vertebrae (43–46) and a more slender body morphology than *A. vulsa*.

Subfamily Anoplagoninae

***Bothragonus swani*—rockhead**

Literature—Eggs and a developmental series of laboratory-reared *Bothragonus swani* 7.5–16.5 mm TL were described by Marliave (1975). A 6.3 mm SL individual illustrated by Washington et al. (1984) appeared to be in a much later stage of development than larvae of similar length described by Marliave (1975). This same illustration was labeled as being misidentified by Matarese et al. (1989). However, Ambrose (1996) reports that the specimen is probably an undescribed species of *Bothragonus*. Additional information intended to augment the original description of *B. swani* larvae and juveniles is presented here based on examination of 16 specimens, 5.7–20.3 mm.

Distribution—Adult *B. swani* range from central California to the Gulf of Alaska and are collected in tidepools and nearshore waters in depths to 18 m (Eschmeyer et al., 1983; Matarese et al., 1989; Kanayama, 1991). Larvae are extremely uncommon in plankton samples. Specimens examined in this study were collected off California and in inside passage waters of British Columbia, Canada.

Morphology (Table 19)—Notochord flexion in *B. swani* begins at 7.0 mm and is completed at 10.0 mm (not shown in figures). The juvenile stage begins at approximately 14.0 mm. Larvae are deep-bodied with mean body depth of 17.8% SL in preflexion specimens, increasing to 20.3% SL in juveniles. Predorsal length is large at approximately 50% SL during flexion and postflexion stages. The outer edges of the pectoral-fin rays are free, giving the fin a lobed or fingerlike appearance (Fig. 16). The pectoral fin is relatively large, increasing in length from 26.4% SL in preflexion larvae to 39.7% SL postflexion. Larvae have very well-developed teeth during preflexion. A very distinct occipital pit is present in late postflexion larvae and juveniles.

Pigmentation (Fig. 16)—Larvae of *B. swani* are moderately pigmented. Preflexion larvae possess melanophores on the dorsal surface of the head, snout, upper and lower jaws, and operculum (Fig. 16A). Melanophores are also present on the pectoral-fin base and anterior ventral surface of the gut. An irregularly-shaped patch of melanophores that increases in depth posteriorly extends from the nape to about midbody. Another patch, present ventrally immediately above or posterior to the anus, nearly meets the dorsal pigmentation to form a band. The amount of pigmentation on the head and gut increases in later preflexion and flexion stages (Figs. 16B,C). In juveniles, a distinct band of melanophores extends across the body between the posteriormost rays of the dorsal and anal fins (Fig. 16D).

Meristic Features (Table 20)—All fins, with the exception of the caudal, have adult complements of ele-

Table 19

Body proportions of *Bothragonus swani* larvae and juveniles. Values given for each body proportion are expressed as percentage of standard length (SL) or head length (HL); mean, standard deviation, and range given in parentheses.

Body proportion	Preflexion		Flexion		Postflexion		Juvenile	
Sample size	3		2		2		4	
Standard length (mm)	6.4±0.4	(6.1–6.8)	7.8±1.2	(7.0–8.7)	12.2±1.7	(11.0–13.4)	15.4±3.0	(14.1–20.3)
Body depth/SL	17.8±1.9	(15.7–19.3)	18.4±2.8	(16.4–20.4)	20.7±1.9	(19.4–22.0)	20.3±3.5	(18.0–25.5)
Predorsal length/SL	49.1±0.6	(48.5–49.6)	57.8±13.4	(48.3–67.3)	59.5±2.5	(57.8–61.3)	56.0±5.3	(48.2–57.1)
Snout to anus length/SL			50.1[1]	(50.1)	50.2±0.7	(49.7–50.7)	48.6±1.4	(47.1–50.3)
Head length/SL	21.5±0.9	(21.0–22.6)	25.9±7.4	(20.6–31.1)	28.7±5.0	(25.1–32.2)	27.8±1.9	(25.6–29.0)
Head width/HL	46.8±5.0	(41.8–51.7)	36.7±4.7	(33.4–40.0)	44.5±6.4	(40.1–48.9)	41.7±3.1	(38.5–43.9)
Snout length/HL	22.3±4.4	(17.8–26.6)	25.1±3.1	(22.9–27.3)	26.6±1.8	(25.4–27.9)	29.3±2.1	(27.2–31.4)
Eye diameter/HL	44.3±1.4	(42.6–45.2)	36.6±6.7	(31.8–41.3)	25.5±0.9	(24.8–26.1)	27.0±2.2	(24.9–30.0)
Pectoral-fin length/SL	26.4±1.0	(25.5–27.4)	32.1±8.2	(26.3–37.9)	39.7±4.6	(36.5–43.0)	33.6±0.7	(33.0–36.6)

[1] Sample size = 1.

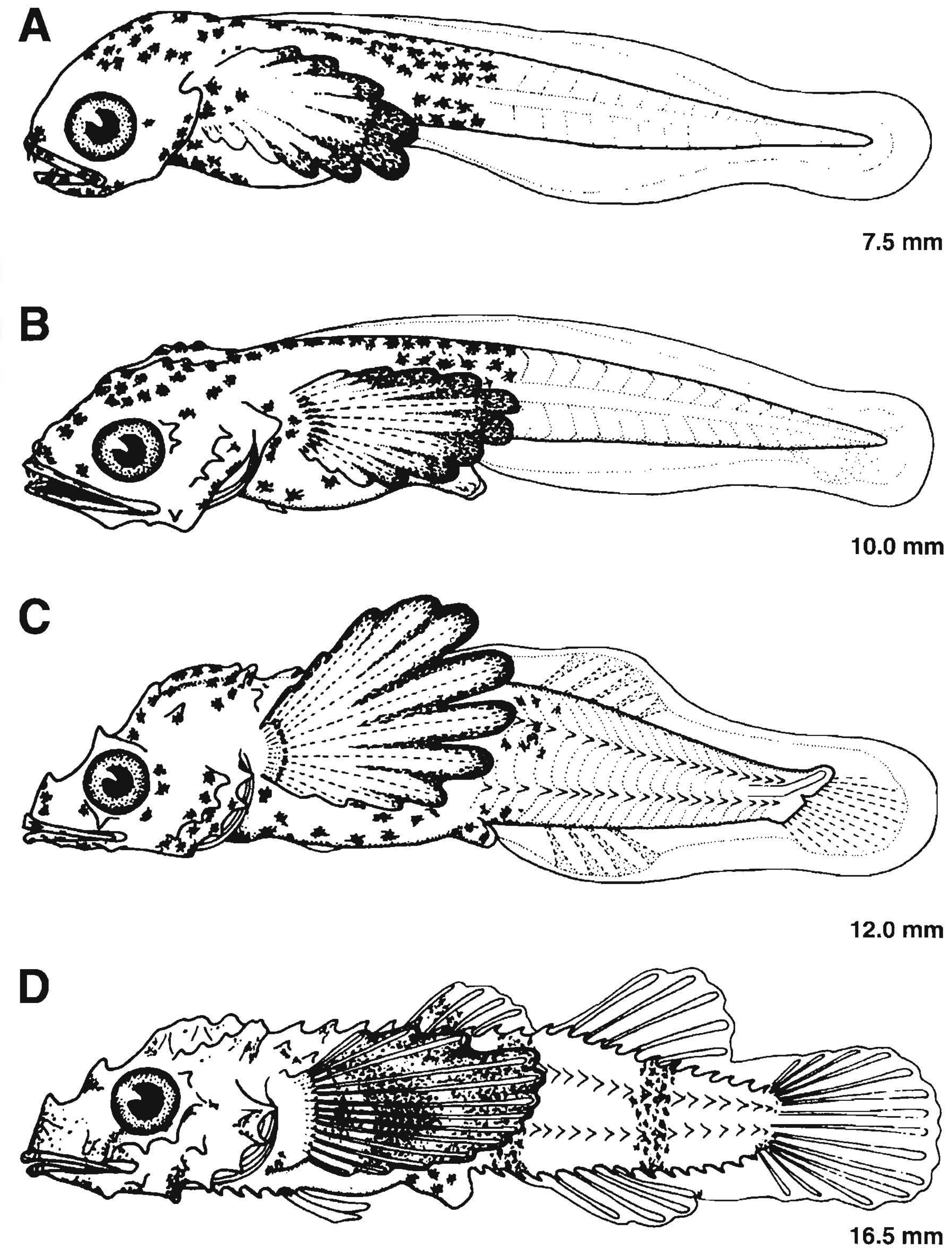


Figure 16

Developmental stages of *Bothragonus swani* (Marliave, 1975). (A) Preflexion larva 7.5 mm TL. (B) Preflexion larva 10.0 mm TL. (C) Flexion larva 12.0 mm TL. (D) Juvenile 16.5 mm TL.

Table 20

Meristics of cleared and stained *Bothragonus swani* larvae and juveniles. Specimens between dashed lines (- - -) are undergoing notochord flexion.

Standard length (mm)	Dorsal fin spines	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Pelvic fin spines, rays	Branchiostegal rays	Neural spines abdominal[2]	Neural spines caudal	Neural spines total	Haemal spines	Centra abdominal	Centra caudal	Centra total	Body plates[1] DLP+MDP	SLP	LLP	ILP	VLP+MVP
5.7				10		5												
6.1				10		5			28	8								
7.7	IV	4	4	12	I,2	6	9	18	27	17	10	21	31	15	23	2	25	17
10.3	IV	5	5	12	I,2	6	10	20	30	21	11	21	32	23	24	17	27	17
13.8	IV	5	5	12	I,2	6	10	20	30	21	11	21	32	28	25	31	27	27
20.0[3]	IV	5	5	11	I,2	6								26	27	32	28	26

[1] DLP—dorsolateral; MDP—mid-dorsal; SLP—supralateral; LLP—lateral line; ILP—infralateral; VLP—ventrolateral; MVP—mid-ventral.
[2] Neural spine absent from first centrum.
[3] Not cleared and stained.

ments at 7.7 mm. The caudal fin is complete at 10.3 mm and has a count of 2,(6+6),1 rays. All vertebrae are ossified at 7.7 mm. Neural spines are absent on the first vertebral centrum. All dermal plate rows, with the exception of the SLP, are complete at 13.8 mm. The SLP row is complete (count=26) in an unstained 14.1 mm specimen not shown in Table 20.

Head Spines—Head spination of *B. swani* larvae is considerably more elaborate than most other members of the subfamily Anoplagoninae. Early flexion larvae possess three bumps on the top of the head that are precursors of the parietal crest or ridge (Fig. 16B). Nasal, supraocular, postocular, pterotic, anterior and posterior preopercular, and cleithral spines are present in early flexion larvae. The supracleithral, superior infraorbital spines, and inferior infraorbital plates are complete in postflexion larvae.

Species Comparisons—Larval *B. swani* are unique among all agonids in the study area, having pectoral fins with a lobed or scalloped edge and the lowest vertebral count (29–32). *Bothragonus swani* larvae appear most similar to the deep-bodied larvae of the subfamily Percidinae (*Hypsagonus mozinoi, H. quadricornis,* and *Percis japonica*). However, *B. swani* has less pigmentation on the body and a much longer predorsal length (the insertion of the first dorsal pterygiophore is near midbody). In the Percidinae, the insertion of the first dorsal pterygiophore is just posterior to the nape.

***Bathyagonus nigripinnis*—blackfin poacher**

Literature—Development of larval *Bathyagonus nigripinnis* is described for the first time here based on examination of 14 specimens, 6.0–13.1 mm.

Distribution—Adult *B. nigripinnis* range from northern California to the Bering Sea and inhabit soft substrates at depths of 91 to 1,247 m (Eschmeyer et al., 1983; Matarese et al., 1989). Adults are commonly collected by trawl in depths from 100 to 500 m (Kanayama, 1991). Larvae are very rare in plankton samples. All specimens of larvae examined in this study were collected in the Bering Sea with the exception of one collected off Southeast Alaska.

Morphology (Table 21)—Notochord flexion in *B. nigripinnis* begins at 8.0 mm. Size at which flexion is complete is unknown. Postflexion and juvenile stages are also unknown. Larvae are medium-bodied with mean body depth of 10.6% SL in preflexion specimens, increasing slightly to 11.7% SL in flexion larvae. Snout length increases from 18.1% HL in preflexion larvae to 23.7% HL in flexion larvae. Flexion larvae already have an upturned or superior mouth position, characteristic of adults (Figs. 17A–C). Pectoral-fin length increases from 11.7% SL in preflexion larvae to 15.7% SL during flexion.

Pigmentation (Fig. 17)—Larvae of *B. nigripinnis* are heavily pigmented. The heads of preflexion larvae possess a light covering of melanophores on the upper and lower jaws, operculum, and hyoid region (Fig. 17A). Dense pigmentation completely covers the body and gut. The dorsal finfold is completely covered with melanophores from a point around midbody to the notochord tip. The anal finfold is completely covered with melanophores and the caudal finfold lacks pigmentation. In early flexion larvae, three or more melanophores are present on the pectoral-fin base (Fig. 17B).

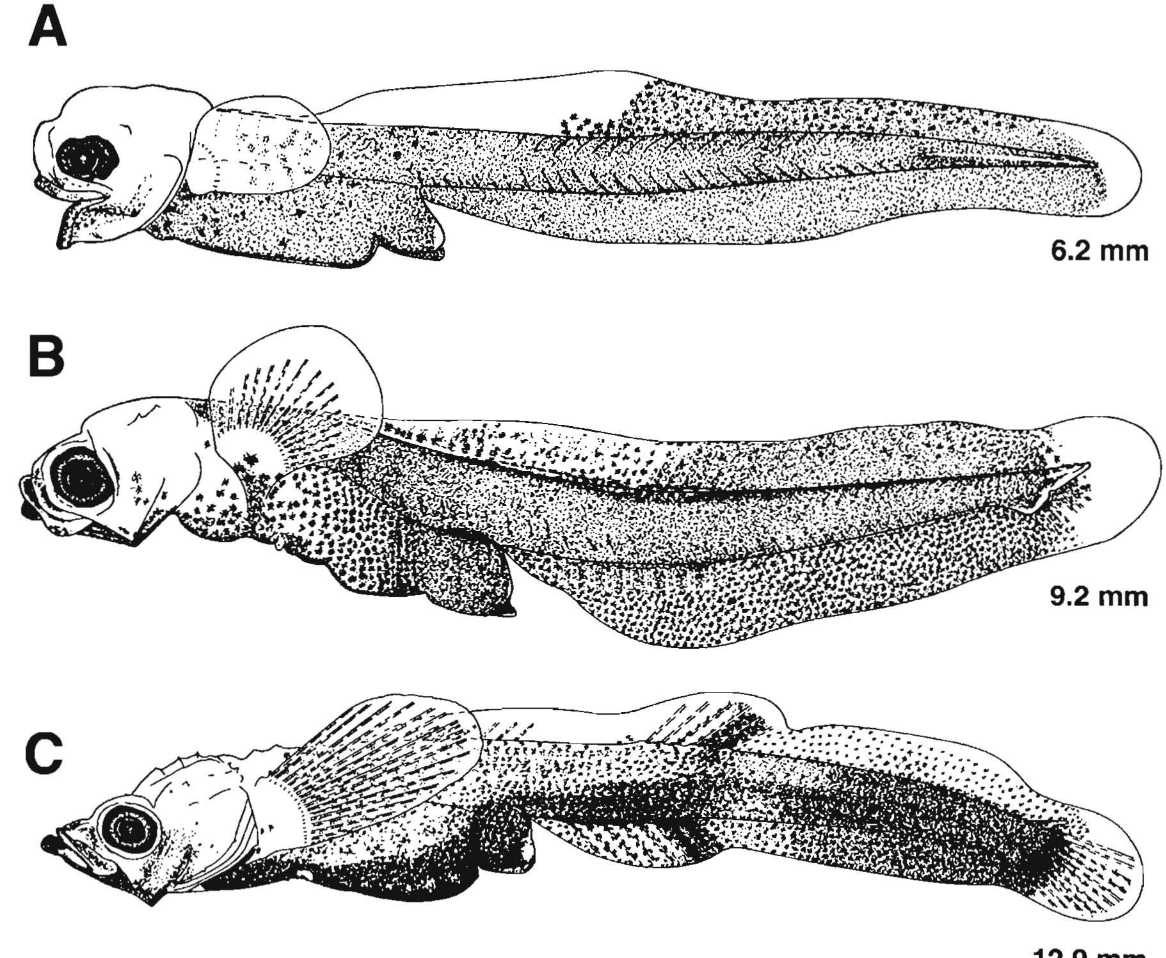


Figure 17

Developmental stages of *Bathyagonus nigripinnis*. (A) Preflexion larva 6.2 mm; AFSC, 1PO85, St. G099A, 6B3. (B) Early flexion larva 9.2 mm; AFSC, 1SH84, St. G118A, 6B5. (C) Late flexion larva 12.9 mm; ABML, TC9003, 0708R.

Table 21

Body proportions of *Bathyagonus nigripinnis* larvae. Values given for each body proportion are expressed as percentage of standard length (SL) or head length (HL); mean, standard deviation, and range given in parentheses.

Body proportion	Preflexion		Flexion		Body proportion	Preflexion		Flexion	
Sample size	6		8		Head length/SL	15.2±1.6	(13.2–17.1)	18.0±3.5	(14.5–24.5)
Standard length (mm)	6.9±0.6	(6.0–7.5)	10.0±2.1	(8.0–13.1)	Head width/HL	18.3±3.9	(13.6–21.4)	17.7±4.0	(11.6–21.7)
Body depth/SL	10.6±1.0	(9.8–12.2)	11.7±2.2	(9.7–16.8)	Snout length/HL	18.1±6.0[2]	(11.9–27.0)	23.7±6.7	(14.1–28.9)
Predorsal length/SL	40.8±3.2	(36.0–43.7)	46.4±4.0	(41.0–51.8)	Eye diameter/HL	35.4±6.0	(29.7–42.7)	29.6±6.9	(23.4–40.3)
Snout to anus length/SL			38.8±1.9[1]	(37.5–40.1)	Pectoral-fin length/SL	11.7±1.3	(9.4–12.9)	15.7±4.5	(10.8–18.1)

[1] Sample size = 2.
[2] Sample size = 5.

Table 22

Meristics of cleared and stained *Bathyagonus nigripinnis* larvae and adults. Specimens between dashed lines (– – –) are undergoing notochord flexion.

Standard length (mm)	Dorsal fin spines	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Pelvic fin spines, rays	Branchiostegal rays	Neural spines abdominal	Neural spines caudal	Neural spines total	Haemal spines	Centra abdominal	Centra caudal	Centra total	Body plates[1] DLP+MDP	Body plates[1] SLP	Body plates[1] LLP	Body plates[1] ILP	Body plates[1] VLP+MVP
6.6																		
8.9				13		6								3	37		32	12
10.9	V	7	6	15		6	11	23	34	19				8	38		35	14
13.2	IV	6	6	15		6	11	32	43	33				5	40		38	9
Adults	VI–VIII	6–7	6–9	14–17	I,2	6	12	32	44	32	12	33	43–46	40–45	39–43	42–46	38–42	37–46

[1] DLP—dorsolateral; MDP—mid-dorsal; SLP—supralateral; LLP—lateral line; ILP—infralateral; VLP—ventrolateral; MVP—mid-ventral.

The anterior half of the dorsal finfold becomes covered with melanophores in some individuals. In late flexion larvae, melanophores on the body and finfolds appear to disperse dorsally and aggregate ventrally (Fig. 17C). The ventral regions of the body and gut have a more dense covering of melanophores than the dorsal, with the exception of the caudal peduncle and hypural regions. Pigmentation in the finfolds becomes less dense on the dorsal and anterior half of the anal finfolds. Diagonally oriented dark bands of melanophores cover the posterior rays of the anal and second dorsal fins. The posterior half of the anal finfold and hypural region are also covered with a very dense aggregation of melanophores.

Meristic Features (Table 22)—The second dorsal, anal, and pectoral fins have adult complements of elements at 10.9 mm. The first dorsal and caudal fins are not complete in the largest specimen examined (13.2 mm). The SLP dermal plate row is the only one complete at 13.2 mm. No vertebral centra are ossified in the largest specimen examined. Adults have 43–46 vertebrae (Matarese et al., 1989; Kanayama, 1991). Adult complements of neural and haemal spines are ossified at 13.2 mm but no centra are stained in that specimen.

Head Spines—Because no postflexion *B. nigripinnis* were available for study, only a partial description of head spine development is possible. Early flexion larvae possess small parietal spinules at 8.9 mm. The spinules are overgrown with bone during ontogeny but can still be seen protruding through the relatively flat parietal crest in flexion larvae (Fig. 17C). Angular, nasal, posterior preopercular, superior infraorbitals, supracleithral, supraocular, and tympanic spines are present at 10.9 mm. A rostral plate with a cluster of spines is present in adults but the size or stage that it develops is unknown.

Species Comparisons—Larval *B. nigripinnis* appear most similar to larvae of the other *Bathyagonus* spp. However, *B. nigripinnis* always have more vertebrae (43–46) than *B. alascanus* (39–42) and *B. infraspinatus* (38–39), and sometimes more than *B. pentacanthus* (40–46). Although all *Bathyagonus* are considered to have medium body depths, *B. nigripinnis* appears more slender than *B. alascanus* and *B. pentacanthus*, especially during preflexion. The pigmentation pattern of *B. nigripinnis* is very similar to *B. pentacanthus* but is heavier (more dense) in all regions with the exception of the pectoral-fin base. Pigmentation patterns on the dorsal and anal finfolds also distinguish *B. nigripinnis* from *B. alascanus* and *B. infraspinatus*. Flexion is complete at a larger size in *B. nigripinnis* (>13.2 mm) than all other *Bathyagonus* (≤12.0 mm).

Bathyagonus pentacanthus—bigeye poacher

Literature—Development of larval and juvenile *B. pentacanthus* is described for the first time here based on examination of 25 specimens, 4.1–26.0 mm.

Distribution—Adult *B. pentacanthus* range from southern California to the Bering Sea and primarily inhabit soft substrates at depths of 110 to 910 m (Eschmeyer et al., 1983; Matarese et al., 1989; Kanayama, 1991). Larvae are uncommon in plankton samples. Specimens examined in this study were collected in coastal waters of California and Oregon, and inside-passage waters of British Columbia, Canada.

Morphology (Table 23)—Notochord flexion in *B. pentacanthus* begins at 7.5 mm and is completed at approximately 12.0 mm. The juvenile stage begins at approximately 25.0 mm. Larvae are medium-bodied with mean body depth 12.7% SL preflexion, which increases to 16.2% SL in juveniles. Snout length increases from 18.0% HL preflexion to 30.4% HL postflexion. Pectoral-fin length increases from 10.2% SL in preflexion larvae to 27.2% SL postflexion. The posterior half of the dorsal and anal finfolds remain until nearly 25.0 mm (Fig. 18).

Pigmentation (Fig. 18)—Larvae of *B. pentacanthus* are heavily pigmented. The heads of preflexion larvae possess a light covering of melanophores on the upper and lower jaws and the operculum (Fig. 18A). The pectoral-fin base, body, and gut are completely covered with melanophores. A small cluster of melanophores is present near the anterior margin of the dorsal finfold. The dorsal finfold is covered almost entirely with melanophores from a point directly above the anus to the notochord tip. Melanophores completely cover the anal finfold and are absent from the caudal finfold.

In flexion larvae, pigmentation on the head and pectoral-fin base becomes more dense (Fig. 18B). A crescent-shaped band of dense pigmentation is present at the insertion of the pectoral fin. Pigmentation on the dorsal finfold forms a separate irregularly shaped patch at the location of the second dorsal fin. Additional melanophores develop on the posterior portion of the anal finfold and ventral portion of the caudal finfold.

In late flexion and early postflexion larvae, pigmentation on the body separates into six or seven distinct bands (Fig. 18C). A crescent-shaped band of melanophores is present at the hypural margin. Pigmentation becomes more dense on the head and fins in late postflexion larvae and juveniles (Fig. 18D). Bands of pigmentation on the body become darker and more distinct.

Meristic Features (Table 24)—All fins, with the exception of the caudal and pelvic, are complete at 10.0 mm. The pelvic fins are complete at 13.8 mm. The caudal fin is completely developed at 17.0 mm and has 2,(6+6),1 rays. All vertebral elements are ossified and all dermal plate rows are complete at 17.0 mm.

Head Spines—Two rows of small parietal spinules are present in preflexion larvae of approximately 6.0 mm. These spinules are overgrown during ontogeny to form a bilobed parietal crest (Figs. 18B–D). The first anterior and posterior preopercular spines are present in preflexion larvae of about 7.7 mm length and the remainder (2–4) during mid-flexion at about 10.0 mm. The coronal, pterotic, supracleithral, supraocular, and last superior infraorbital spines are also present at 10.0 mm.

Cleithral, third dentary, frontal, nasal, postocular, and posttemporal spines are present in 13.8 mm early postflexion larvae. Angular, articular, first and second dentary (1,2), and tympanic spines and inferior infraorbital plates are present at 17.0 mm. In late postflexion larvae and juveniles, a small accessory spine is present between the two lobes of the parietal crest (Fig. 18D). A rostral plate with a cluster of spines develops during the juvenile stage.

Species Comparisons—Larval *B. pentacanthus* appear most similar to larvae of the other *Bathyagonus* spp. However, *B. pentacanthus* always have more vertebrae (43–46) than *B. infraspinatus* (38–39) and *B. alascanus* (39–42). Although all *Bathyagonus* have medium body depths, *B. pentacanthus* appears slightly deeper bodied than *B. nigripinnis*, especially during preflexion. The pectoral-fin base of *B. pentacanthus* is covered with melanophores, distinguishing its pigmentation pattern from *B. nigripinnis* and *B. alascanus*. Unlike *B. alascanus* and *B. infraspinatus*, the entire body and anal finfold is completely covered with pigmentation. The crescent-shaped bands of pigmentation seen on the pectoral-fin insertion and the hypural margin in postflexion *B. pentacanthus* are absent from other *Bathyagonus* larvae. Two pairs of dermal plates are present on the breast region immediately anterior to the pelvic fins in postflexion larvae greater than 13.5 mm. In contrast, *B. alascanus*, *B. infraspinatus*, and *B. nigripinnis* have only a single pair (Fig. 19).

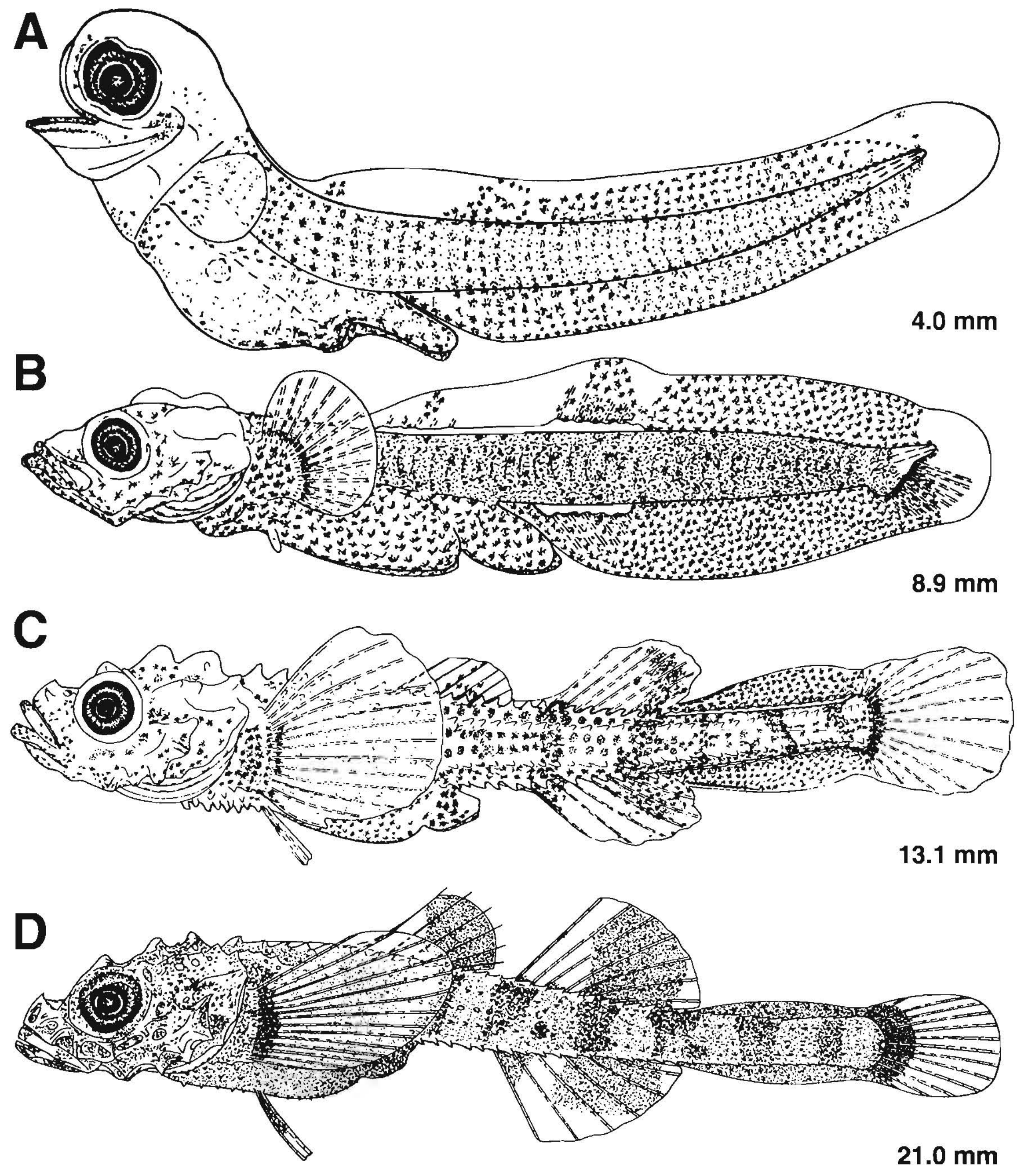


Figure 18

Developmental stages of *Bathyagonus pentacanthus.* (A) Preflexion larva 4.0 mm; LACM, 040-88-75-0B-025, 21 Feb 83, 1YS. (B) Flexion larva 8.9 mm; CalCOFI, 7202 AX, St. 83.51. (C) Early postflexion larva 13.1 mm; VPA, 5/21/91, #6 Lambert Channel. (D) Late postflexion larva 21.0 mm; LACM, 9842-5.

Table 23

Body proportions of *Bathyagonus pentacanthus* larvae. Values given for each body proportion are expressed as percentage of standard length (SL) or head length (HL); mean, standard deviation, and range given in parentheses.

Body proportion	Preflexion		Flexion		Postflexion	
Sample size	3		7		13	
Standard length (mm)	5.9±1.6	(4.1–7.1)	10.3±1.4	(8.4–12.0)	19.8±3.8	(13.2–24.9)
Body depth/SL	12.7±1.3	(11.7–14.1)	14.3±3.9	(11.3–23.0)	16.2±1.7	(13.1–19.0)
Predorsal length/SL	51.4±4.6	(46.2–54.9)	55.8±3.6	(50.1–60.3)	45.7±2.8	(42.5–50.4)
Snout to anus length/SL			43.6±1.4[1]	(42.0–45.4)	40.2±1.8	(37.3–43.9)
Head length/SL	19.3±0.9	(18.4–20.2)	25.9±2.9	(23.7–30.4)	28.3±2.0	(25.2–30.1)
Head width/HL	18.8±3.9	(16.0–23.3)	19.5±1.0	(15.0–21.9)	17.8±3.5	(13.6–23.1)
Snout length/HL	18.0±5.9	(11.4–22.6)	24.6±5.3	(15.6–33.6)	30.4±2.5	(25.2–34.7)
Eye diameter/HL	38.5±6.8	(32.7–46.0)	25.9±6.6	(16.5–36.3)	22.6±2.9	(19.4–28.0)
Pectoral-fin length/SL	10.2±1.6	(9.1–12.0)	20.1±3.8	(15.6–20.9)	27.2±2.4	(23.9–32.2)

[1] Sample size = 5.

Table 24

Meristics of cleared and stained *Bathyagonus pentacanthus* larvae and early juveniles. Specimens between dashed lines (– – –) are undergoing notochord flexion.

Standard length (mm)	Dorsal fin spines	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Pelvic fin spines, rays	Branchiostegal rays	Neural spines abdominal	Neural spines caudal	Neural spines total	Haemal spines	Centra abdominal	Centra caudal	Centra total	Body plates[1] DLP+MDP	SLP	LLP	ILP	VLP+MVP
6.0														2	25		28	8
7.7	VI			12		4								2	29		26	8
10.0	VI	7	7	13		6	12	29	41	29	12			15	37		33	8
13.8	VI	7	6	13	I,2	6	12	32	44	32	12	25	37	39	37	39	40	39
17.0	VI	7	7	15	I,2	6	12	32	44	32	12	33	45	43	42	40	39	41
26.0	VII	7	8	15	I,2	6	12	33	45	32	12	33	45	44	45	43	42	43

[1] DLP—dorsolateral; MDP—mid-dorsal; SLP—supralateral; LLP—lateral line; ILP—infralateral; VLP—ventrolateral; MVP—mid-ventral.

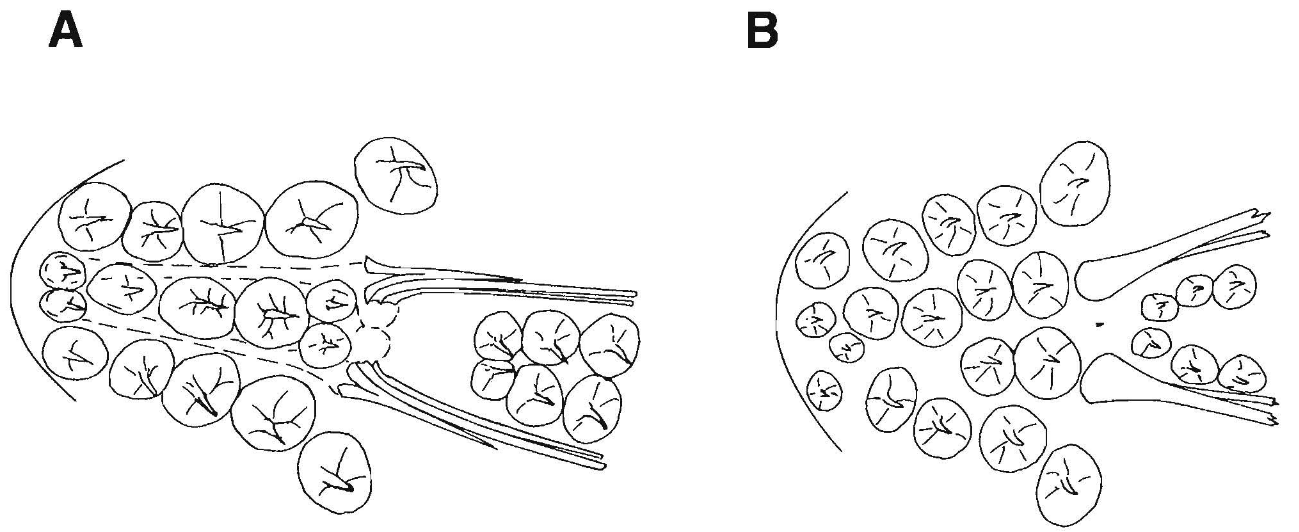


Figure 19

Ventral view of gut showing breast plate patterns in *Bathyagonus* larvae. (A) *Bathyagonus alascanus* 14.1 mm (single pair of plates anterior to pelvic fin); AFSC, 5MF91, St. G038A, Methot. (B) *Bathyagonus pentacanthus* 13.8 mm (two pairs of plates anterior to pelvic fin); OSU, 1074E, VII-15, 29 March 1973.

***Bathyagonus alascanus*—gray starsnout**

Literature—Development of larval and early juvenile *Bathyagonus alascanus* is described for the first time here based on examination of over 200 specimens, 5.0–72.0 mm.

Distribution—Adult *B. alascanus* range from northern California to the Bering Sea and primarily inhabit rocky substrates at depths of 18 to 252 m (Eschmeyer et al., 1983; Matarese et al., 1989; Kanayama, 1991). Larvae are common in plankton samples. *Bathyagonus alascanus* are by far the most commonly occurring larval agonid in samples collected on AFSC ichthyoplankton surveys in the Gulf of Alaska near Kodiak Island.

Morphology (Table 25)—Notochord flexion in *B. alascanus* begins at 7.5 mm and is completed between 11.0 and 12.0 mm. The juvenile stage begins at approximately 18.0 mm. Larvae are medium-bodied with mean body depth of 11.4% SL preflexion, increasing to 16.1% SL in juveniles. Snout length increases from 14.6% HL preflexion to 26.5% HL postflexion. Pectoral-fin length increases from 13.0% SL in preflexion larvae to 28.4% SL postflexion.

Pigmentation (Fig. 20)—Larvae of *B. alascanus* are heavily pigmented. The heads of preflexion larvae possess melanophores on the upper and lower jaws and the sub- and postocular regions (Fig. 20A). The body and gut are completely covered with melanophores. In some individuals, a band-shaped region devoid of pigmentation is present on the body immediately posterior to the anus (Fig. 20B). A small cluster of melanophores is present on the anterior portion of the dorsal finfold above the hindgut. The dorsal finfold is covered with melanophores from a point about two-thirds body length to the caudal peduncle. Pigmentation on the anal finfold begins just beyond midbody and also continues to the caudal peduncle. On both the dorsal and anal finfolds, pigmentation alternates between dark and light bands with the posterior band of the anal fin being the widest. A few melanophores are present on the dorsal portion of the caudal finfold just anterior to the notochord tip. A patch of melanophores is present on the caudal finfold ventrally.

In flexion larvae, pigmentation on the dorsal and anal finfolds becomes more uniform and bands become less distinct (Fig. 20B). In late flexion larvae, pigmentation on the body begins to separate into bands and finfold pigmentation becomes more diffuse (Fig. 20C). The two dark bands on the anal finfold, however, can still be distinguished. In postflexion larvae and early juveniles, pigmentation on the body is separated into about 5 to 7 distinct bands (Fig. 20D). Bands on the median finfolds or fins are no longer distinguishable. The patch of melanophores present on the ventral portion of the caudal finfold just anterior to the notochord tip in preflexion and flexion

Table 25

Body proportions of *Bathyagonus alascanus* larvae and early juveniles. Values given for each body proportion are expressed as percentage of standard length (SL) or head length (HL); mean, standard deviation, and range given in parentheses.

Body proportion	Preflexion		Flexion		Postflexion		Juvenile	
Sample size	4		9		10		8	
Standard length (mm)	6.0±0.5	(5.6–6.6)	8.9±1.0	(7.5–10.2)	13.6±1.9	(11.1–16.9)	23.5±7.1	(18.2–39.2)
Body depth/SL	11.4±0.9	(10.4–12.6)	13.0±1.9	(11.6–14.4)	15.9±1.6	(13.4–18.2)	16.1±3.6	(9.3–19.4)
Predorsal length/SL	52.2±5.3	(48.4–60.0)	53.0±2.8	(48.8–56.6)	53.8±3.1	(49.3–58.9)	43.0±5.3	(34.0–47.2)
Snout to anus length/SL			40.5±2.6[1]	(37.3–43.5)	41.6±1.5	(39.1–42.8)	42.0±3.0	(35.8–44.9)
Head length/SL	16.9±1.9	(14.7–19.2)	20.5±3.4	(16.3–25.9)	25.4±2.4	(22.0–29.6)	26.3±2.0	(23.7–29.2)
Head width/HL	23.4±7.1	(17.2–32.4)	21.0±2.8	(17.9–27.1)	21.0±3.0	(16.0–24.4)	19.4±3.8	(13.4–24.5)
Snout length/HL	14.6±3.1	(11.6–17.7)	23.8±3.5	(20.0–29.4)	26.5±3.3	(20.0–33.0)	25.7±4.8	(19.7–36.2)
Eye diameter/HL	39.0±6.1	(33.8–45.8)	31.9±6.5	(22.1–42.4)	26.6±2.6	(21.9–30.4)	26.3±5.4	(22.0–38.8)
Pectoral-fin length/SL	13.0±2.3	(10.9–16.2)	17.7±4.8	(11.9–24.5)	28.4±3.7	(23.3–34.1)	27.7±5.0	(18.4–32.6)

[1] Sample size = 4.

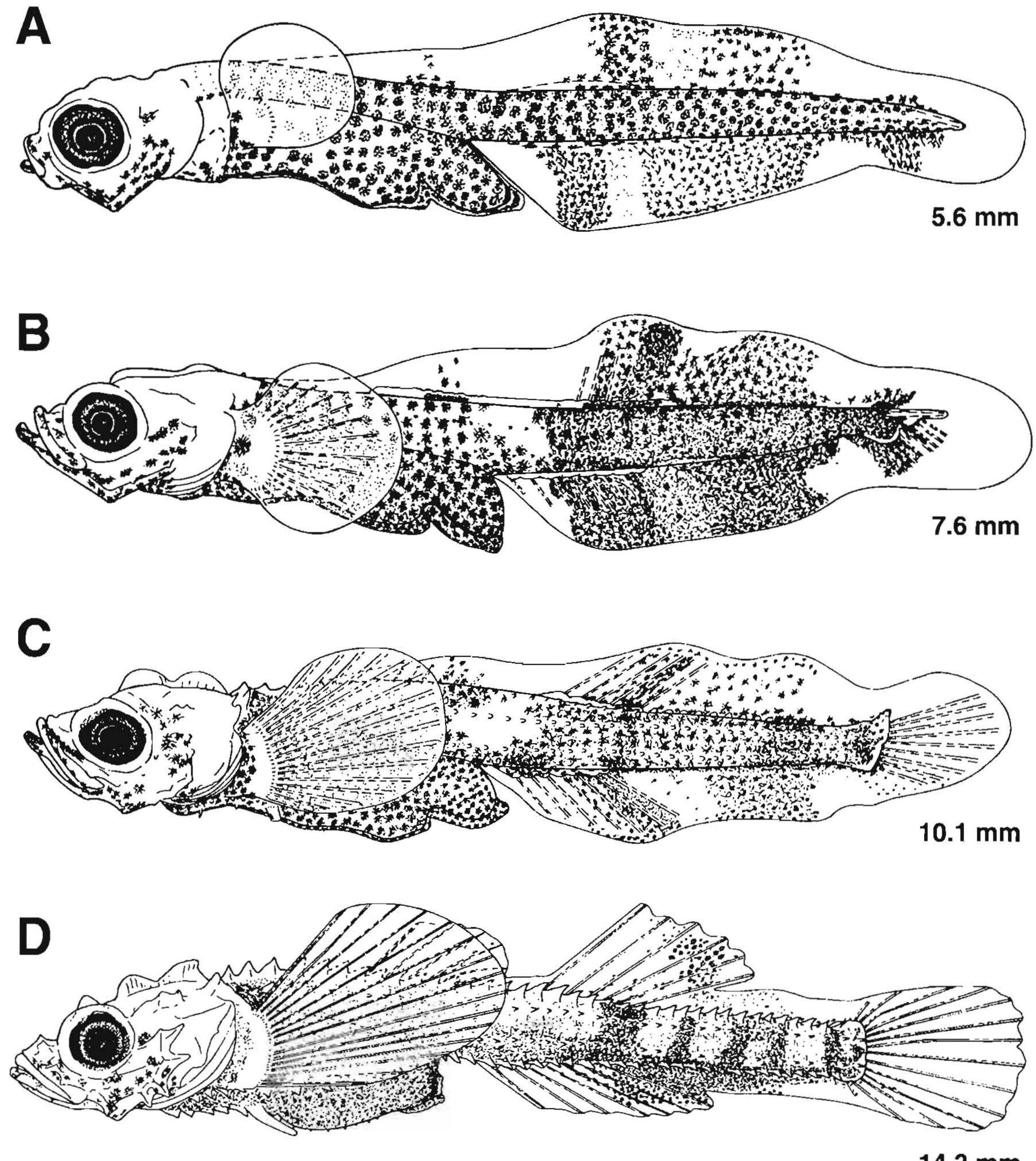


Figure 20
Developmental stages of *Bathyagonus alascanus*. (A) Preflexion larva 5.6 mm; AFSC, 1SH84, St. G067A, 6B5. (B) Early flexion larva 7.6 mm; AFSC, 4MF88, St. D001A-4, IT5 Net 1. (C) Late flexion larva 10.1 mm; AFSC, 1CH83, St. G021A, 6B5. (D) Postflexion larva 14.3 mm; AFSC, 2MF78, St. G51A, TT-2.

larvae remains in postflexion larvae and juveniles but is less distinct.

Meristic Features (Table 26)—All fins, with the exception of the caudal and pelvic, are complete at 9.9 mm. The pelvic fins are complete at 12.2 mm. The caudal fin is completely developed at 12.3 mm and has 2,(6+6),1 rays. All vertebral centra are ossified at 12.3 mm. All dermal plate rows, with the exception of the lateral line (LLP), have adult complements of plates at 12.3 mm. The LLP row is complete at 18.0 mm.

Head Spines—Two rows of small parietal spinules are present in preflexion larvae of approximately 7.3 mm. These spinules are overgrown during ontogeny to form a bilobed parietal crest (Figs. 20B–D). The angu-

Table 26

Meristics of cleared and stained *Bathyagonus alascanus* larvae and juveniles. Specimens between dashed lines (– – –) are undergoing notochord flexion.

Standard length (mm)	Dorsal fin spines	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Pelvic fin spines, rays	Branchi-ostegal rays	Neural spines abdominal	Neural spines caudal	Neural spines total	Haemal spines	Centra abdominal	Centra caudal	Centra total	Body plates[1] DLP+MDP	Body plates[1] SLP	Body plates[1] LLP	Body plates[1] ILP	Body plates[1] VLP+MVP
5.2																		
5.4															21		22	
6.5															18		16	
7.3				9											28		28	
– – –																		
7.7				6			3		3						21		15	
8.5		2	2	12										4	30		25	
8.8	II	3	3	15		6	11	17	28	17	9		9	22	34		33	9
9.9	V	5	6	15		6	11	19	30	22	11	1	12	22	30		31	32
10.0	VI	5	7	15		6	12	20	32	20	7		7	22	35		31	10
10.8	VI	6	7	15	I	6	12	26	38	26	12	26	38	34	37	2	34	32
– – –																		
12.2	VI	6	7	16	I,2	6	11	28	39	28	11	21	32	31	35	1	36	26
12.3	V	6	7	15	I,2	6	12	27	39	27	12	28	40	35	38	1	36	33
12.9	VI	6	7	15	I,2	6	11	29[2]	40	28	11	29	40	38	36	7	37	35
14.1	VI	5	6	15	I,2	6	11	28	39	28	11	29	40	37	38	12	35	36
14.7	VI	6	6	15	I,2	6	12	29	41	29	12	30	42	38	39	17	38	36
15.5	VY	6	6	15	I,2	6	12	27[3]	39	27	12	28	40	38	37	29	36	37
18.0	VI	6	7	16	I,2	6	11	29	40	29	11	30	41	39	39	40	40	38
18.0	VII	6	6	15	I,2	6	11	29	40	29	11	30	41	39	38	40	39	37
22.0	VI	6	8	15	I,2	6	12	28	40	28	12	29	41	38	38	39	37	37

[1] DLP—dorsolateral; MDP—mid-dorsal; SLP—supralateral; LLP—lateral line; ILP—infralateral; VLP—ventrolateral; MVP—mid-ventral.
[2] Two neural spines on preural centra.
[3] Last neural spine has a bifurcated tip.

lar, articular, posterior preopercular, pterotic, supracleithral, and supraocular spines are present in flexion larvae of approximately 8.8 mm length. By 9.9 mm, the first anterior preopercular, dentary, and subopercular spines are present. The remaining anterior preopercular (2–4), coronal, cleithral, frontal, nasal, and the first and fifth superior infraorbital (1,5) spines develop by 10.8 mm. In postflexion larvae of 12.3 mm length, the opercular, second and third infraorbital (2,3), and tympanic spines are present. The interopercular, two postocular, third superior infraorbital (3) spines, and the second and third infraorbital plates (2,3) develop by 14.7 mm. The posttemporal spine is first seen in postflexion larvae at 15.5 mm and is complete in early juveniles of approximately 18.0 mm length. The final inferior infraorbital (1) is also present in early juveniles. Sclerotic plates are present on a 22.0 mm juvenile. A rostral plate with a cluster of spines develops during the juvenile stage.

Species Comparisons—Larval *B. alascanus* appear very similar to larvae of the other *Bathyagonus* spp. However, *B. alascanus* always have fewer vertebrae (39–42) than *B. nigripinnis* (43–46) and usually fewer than *B. pentacanthus* (40–46). The pectoral-fin base of *B. alascanus* is not completely covered with melanophores; this distinguishes its pigmentation pattern from *B. infraspinatus* and *B. pentacanthus*. Postflexion and juvenile *B. alascanus* have distinct bands of pigmentation on the lateral body while *B. infraspinatus* have irregularly-spaced patches. Unlike other *Bathyagonus* larvae, pigmentation on the dorsal and anal finfolds of *B. alascanus* alternates between dark and light bands. *Bathyagonus alascanus* have a unique patch of melanophores on the ventral portion of the caudal finfold just anterior to the notochord tip. This pigmentation is present throughout development and is not present in other larval and juvenile *Bathyagonus*.

A single pair of dermal plates is present on the breast region immediately anterior to the pelvic fins in postflexion larvae. In contrast, *B. pentacanthus* have two pairs of plates anterior to the pelvic fin (Fig. 19). Larval finfolds are retained longer and fin elements are completed later in *B. alascanus* than *B. infraspinatus*.

Bathyagonus infraspinatus**—**spinycheek starsnout

Literature—Development of larval and early juvenile *B. infraspinatus* is described for the first time here based on examination of 75 specimens, 4.5–23.5 mm.

Distribution—Adults range from northern California to the Bering Sea and primarily inhabit sandy mud substrates at depths of 18 to 183 m (Eschmeyer et al., 1983; Matarese et al., 1989; Kanayama, 1991). Larvae are uncommon in plankton samples. Specimens examined in this study were collected throughout their adult range.

Morphology (Table 27)—Notochord flexion in *B. infraspinatus* begins at 7.5 mm and is complete by about 12.0 mm. The juvenile stage begins at approximately 17.0 mm. Larvae are medium-bodied with mean body depth of 12.8% SL preflexion, increasing to 16.1% SL postflexion. Snout length increases from 19.4% HL preflexion to 28.9% HL in juveniles. Pectoral-fin length increases from 13.4% SL in preflexion larvae to 31.4% SL in postflexion larvae.

Pigmentation (Fig. 21)—Larvae of *B. infraspinatus* are heavily pigmented. Melanophores are present on the upper and lower jaws and postocular region of the head (Fig. 21A). Also, melanophores cover the pectoral-fin base, gut, and most of the body. A band-shaped region devoid of pigmentation is present on the body immediately posterior to the anus. A small cluster of melanophores is present on the dorsal finfold above the anus. The dorsal and anal finfolds are covered with melanophores from about mid-body to immediately anterior to the notochord tip. Pigmentation is absent from the caudal finfold.

In flexion larvae, pigmentation on the dorsal finfold extends posteriorly, nearly to the notochord tip (Fig. 21B). Pigmentation on the anal finfold extends to the ventral edge of the developing hypural.

In postflexion larvae, pigmentation on the head extends posteriorly to partially cover the operculum (Fig. 21C). Pigmentation on the body separates into five or more irregularly-shaped patches. In late postflexion larvae and early juveniles, melanophores completely cover the head (Fig. 21D). Pigmentation on the body separates into five or more irregular or near circular-shaped aggregations dorsally and up to ten smaller aggregations ventrally (Fig. 21D).

Meristic Features (Table 28)—All fins are complete at 10.2 mm. The caudal fin has 2,(6+5),1 rays. All vertebral elements are ossified at 12.6 mm. The DLP+MDP, SLP, and ILP dermal plate rows have adult complements of plates at 12.6 mm. The VLP+MVP row is complete at 13.4 mm and the LLP at 23.5 mm.

Head Spines—Two rows of small parietal spinules are present in preflexion larvae of approximately 4.5 mm length. These spinules are overgrown rapidly during ontogeny to form a bilobed parietal ridge or crest

Table 27

Body proportions of *Bathyagonus infraspinatus* larvae and early juveniles. Values given for each body proportion are expressed as percentage of standard length (SL) or head length (HL); mean, standard deviation, and range given in parentheses.

Body proportion	Preflexion		Flexion		Postflexion		Juvenile	
Sample size	7		12		13		3	
Standard length (mm)	5.7±0.9	(4.5–7.0)	9.7±1.5	(7.5–11.5)	14.3±1.5	(12.1–16.6)	20.0±2.4	(17.2–21.7)
Body depth/SL	12.8±2.2	(10.9–17.3)	14.0±2.9	(9.8–18.6)	16.1±1.9	(13.3–19.2)	14.3±1.6	(12.9–16.0)
Predorsal length/SL			41.4±3.8	(35.7–49.1)	42.6±2.3	(38.2–46.8)	42.5±1.8	(40.7–44.2)
Snout to anus length/SL	45.4±1.8	(42.1–47.1)	53.6±4.1	(47.6–60.9)	49.1±4.2	(42.3–57.6)	45.4±3.6	(42.4–49.4)
Head length/SL	17.9±1.9	(16.0–21.1)	25.0±3.6	(18.5–31.2)	28.8±2.0	(24.3–31.8)	28.4±1.9	(26.6–30.4)
Head width/HL	24.7±4.6	(19.3–32.5)	19.8±4.2	(14.0–27.4)	21.4±3.3	(16.8–26.8)	18.8±1.9	(16.8–20.5)
Snout length/HL	19.4±5.4	(9.5–25.9)	23.3±2.7	(18.5–26.4)	27.0±3.0	(21.7–31.9)	28.9±2.2	(26.6–31.0)
Eye diameter/HL	38.0±5.1	(31.0–45.2)	26.1±3.2	(22.5–30.5)	24.4±2.0	(20.7–28.0)	25.2±1.7	(23.4–26.9)
Pectoral fin-length/SL	13.4±1.7	(11.6–16.4)	24.8±7.2	(15.3–35.5)	31.4±2.2	(26.8–35.4)	26.2±4.7	(23.3–31.6)

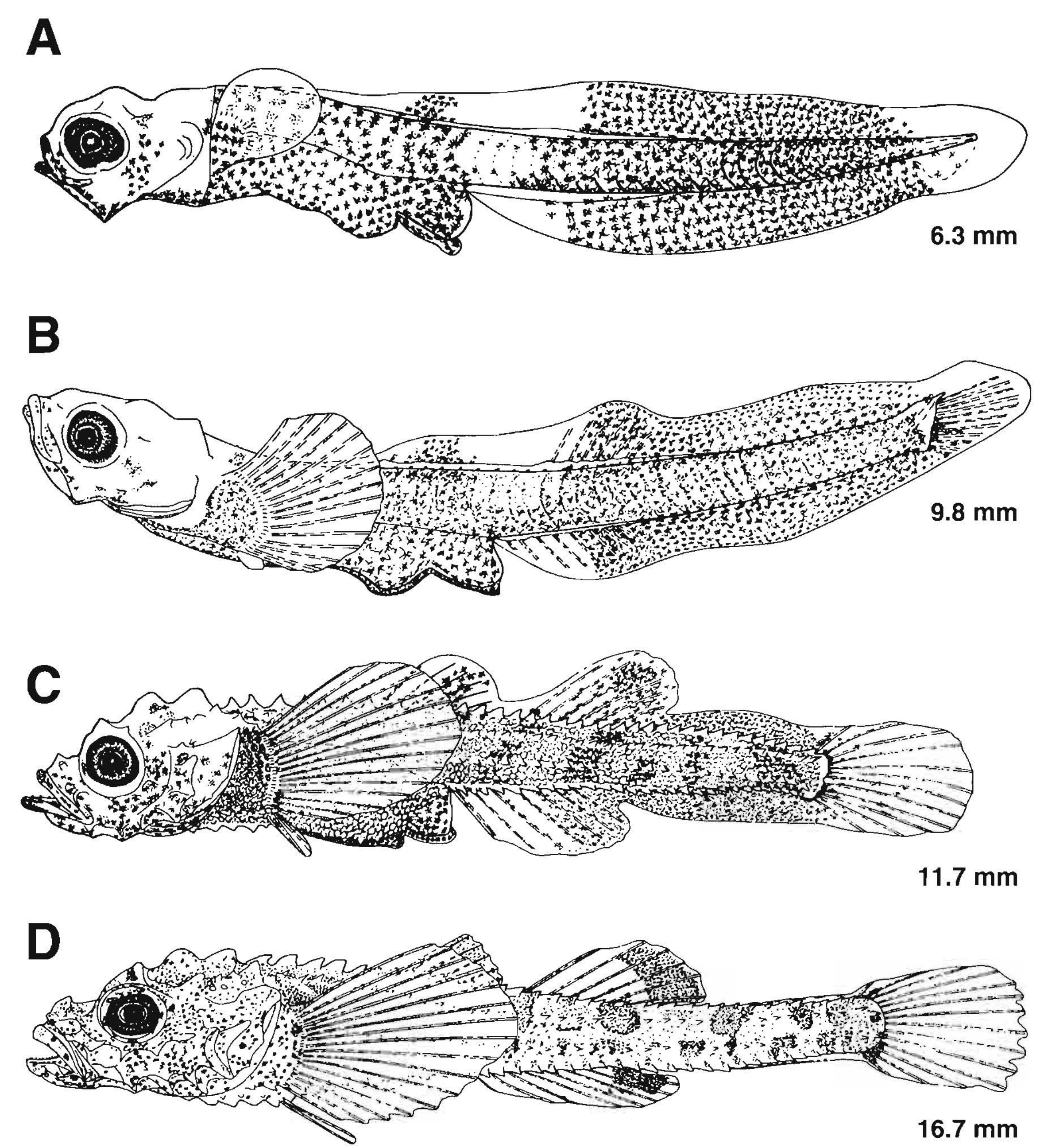


Figure 21

Developmental stages of *Bathyagonus infraspinatus.* (A) Preflexion larva 6.3 mm; AFSC, 3MF87, St. 074, sample 53, moc 7. (B) Flexion larva 9.8 mm; AFSC, 4MF81, St. G031A, 6B5. (C) Postflexion larva 11.7 mm; VPA, N. of Gravelly Bay, 5/4/89, sled trawl. (D) Juvenile 16.7 mm; AFSC, 5MF91, St. G009A, Methot.

(Figs. 21A-D). Anterior and posterior preopercular, nasal, supraocular, second and fifth superior infraorbital, cleithral, supracleithral, pterotic, opercular, angular, and articular spines are present in flexion larvae of about 10.2 mm length. Dentary, frontal, tympanic, superior infraorbitals (1,3,4), subopercular, and interopercular spines and inferior infraorbital plates (1–3) are present in postflexion larvae of 12.6 mm length. Postflexion larvae of 13.4 mm also have coronal, postocular, and posttemporal spines. Sclerotic spines are present by 15.1 mm. A rostral plate with a cluster of spines develops during the juvenile stage.

Species Comparisons—Larval *B. infraspinatus* appear very similar to larvae of other *Bathyagonus* spp. How-

Table 28

Meristics of cleared and stained *Bathyagonus infraspinatus* larvae and juveniles. Specimens between dashed lines (– – –) are undergoing notochord flexion.

Standard length (mm)	Dorsal fin		Anal fin rays	Pectoral fin rays	Pelvic fin spines, rays	Branchi-ostegal rays	Neural spines			Haemal spines	Centra			Body plates[1]				
	spines	rays					abdominal	caudal	total		abdominal	caudal	total	DLP+MDP	SLP	LLP	ILP	VLP+MVP
4.5														1	16		16	
6.7				10										3	28		22	
7.4				9										2	25		20	
8.4				12										3	28		27	
8.5				11		5	12	26	38	26				3	27		26	
10.2	VI	6	6	15	I,2	5	12	27	39	27		2	2	31	36		35	27
10.4	V	6	7	15		6	11	26	37	26				12	34		32	9
12.6	V	5	8	14	I,2	6	12	25	37	25	12	26	38	36	36	36	35	33
13.4	V	6	7	15	I,2	6	12	26[2]	38	25	12	26	38	36	37	28	35	34
15.1	VI	7	7	15	I,2	6	11	27	38	27	11	28	39	37	37	37	36	35
16.8	V	6	7	15	I,2	6	11	26	37	26	11	27	38	36	36	37	35	34
18.3	VI	5	8	16	I,2	6	11	26	37	26	11	27	38	36	36	37	35	35
23.5	V	7	8	15	I,2	6	11	27	38	27	11	28	39	38	37	38	37	36

[1] DLP—dorsolateral; MDP—mid-dorsal; SLP—supralateral; LLP—lateral line; ILP—infralateral; VLP—ventrolateral; MVP—mid-ventral.

[2] Two neural spines on preural centra.

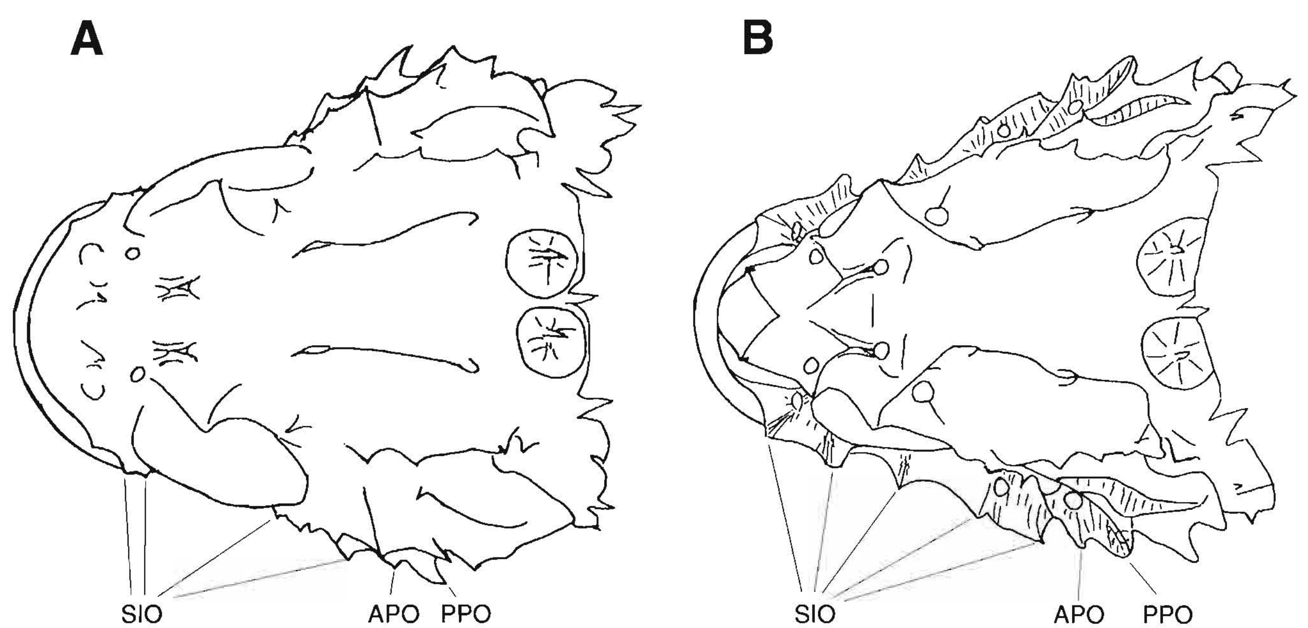


Figure 22
Dorsal view of head showing laterally projecting superior infraorbital spines (SIO) and anterior and posterior preopercular spines (APO, PPO). (A) *Bathyagonus alascanus* 15.5 mm; AFSC, 5MF91, St. G036A, Methot. (B) *Bathyagonus infraspinatus* 15.1 mm; AFSC, 5MF91, St. C012A, Methot.

ever, *B. infraspinatus* always have fewer vertebrae (38–39) than *B. nigripinnis* (43–46) and *B. pentacanthus* (40–46). *Bathyagonus infraspinatus* also has fewer dermal plates in all rows than *B. nigripinnis* and *B. pentacanthus.* The pectoral-fin base of *B. infraspinatus* is completely covered with melanophores; this differentiates its pigmentation pattern from *B. alascanus* and *B. nigripinnis.* The operculum of postflexion *B. infraspinatus* is covered with melanophores unlike that of *B. alascanus,* which is unpigmented. Unlike *B. nigripinnis* and *B. pentacanthus,* the anterior edge of the anal finfold of *B. infraspinatus* is unpigmented. Preflexion and flexion *B. infraspinatus* also possess a band-shaped area devoid of pigmentation on the body posterior to the anus. Postflexion and juvenile *B. infraspinatus* have irregularly-spaced patches of pigmentation on the lateral body while *B. alascanus* have distinct bands.

Unlike *B. pentacanthus,* postflexion *B. infraspinatus* possess a single pair of breast plates on the breast region immediately anterior to the pelvic fins similar to *B. alascanus* and *B. nigripinnis* (Fig. 19). Larval finfolds are retained longer and fin elements are completed later in *B. alascanus* than *B. infraspinatus.* Postflexion and juvenile *B. infraspinatus* are unique in that the first anal-fin ray is aligned below the posterior region of the first dorsal fin. (Note: Eschmeyer et al. (1983) reported that adult *B. pentacanthus* sometimes have the first anal-fin ray aligned under the posterior margin of the first dorsal fin, but this was not observed in any postflexion larvae or juvenile specimens examined in this study.) In other *Bathyagonus* species, the first anal-fin ray is aligned under the space between the first and second dorsal fins. The superior infraorbital spines of postflexion *B. infraspinatus* are longer and more distinct than those of *B. alascanus* (Fig. 22).

***Xeneretmus latifrons*—blacktip poacher**

Literature—Development of larval and early juvenile *X. latifrons* was described in detail by Busby and Ambrose (1993). A summary of their description with some updated information on the juvenile stage is presented here for comparative purposes.

Distribution—Adult *X. latifrons* occur from northern Baja California to Vancouver Island on soft substrates at depths of 18 to 400 m (Miller and Lea, 1972; Hart, 1973; Eschmeyer et al., 1983) and are common in waters off southern British Columbia, Canada (Kanayama, 1991). Larvae are common in plankton samples throughout their adult range (Busby and Ambrose, 1993).

Morphology (Table 29)—Notochord flexion in *X. latifrons* begins at approximately 8.5 mm and is complete at about 11.0 mm. The juvenile stage begins at approximately 20.0 mm. Busby and Ambrose (1993) did not recognize any of their specimens as juveniles based on osteological criteria. However, using the definition of the juvenile stage established for this study (adult complements of ossified fin elements, complete dermal plate rows with the exception of LLP, and absence of larval finfold), all specimens greater than 20.0 mm are juveniles. Larvae are medium-bodied with mean body depth of 13.3% SL in preflexion specimens, increasing slightly to 15.3% SL postflexion. Snout length increases from 18.8% HL in preflexion larvae to 24.2% HL in juveniles. Pectoral-fin length increases from 8.4% SL in preflexion larvae to 23.3% SL postflexion, then decreases to 17.9% SL in juveniles.

Pigmentation (Fig. 23)—Larvae of *X. latifrons* are heavily pigmented. Preflexion larvae possess melanophores on the upper and lower jaws and operculum (Fig. 23A). Melanophores are also present on the pectoral-fin base, lateral surface of the gut, and most of the body. The dorsal half of the body above the gut is devoid of pigmentation as is the posteriormost region of the body and notochord tip. A row of single melanophores is present along the dorsal and ventral margins of the body immediately anterior to the notochord tip. A small cluster of melanophores develops near the anterior margin of the dorsal finfold at about 6.0 mm (Fig. 23B). The dorsal and anal finfolds are partially covered with large, irregularly-shaped patches of pigmentation extending from about midbody to the notochord tip.

In early flexion larvae, pigmentation covers more of the pectoral-fin base, body, and finfolds than in preflexion larvae (Fig. 23B). Melanophores develop on the posterior region of the body and notochord tip. Pigmentation on the dorsal and anal finfolds extends farther toward the outer margins. In late flexion larvae, pigmentation on the body separates into 6–8 bands (Fig. 23C). A distinct band of pigmentation is present on the caudal fin at the posterior margin of the devel-

Table 29

Body proportions of *Xeneretmus latifrons* larvae and early juveniles. Values given for each body proportion are expressed as percentage of standard length (SL) or head length (HL); mean, standard deviation, and range given in parentheses.

Body proportion	Preflexion		Flexion		Postflexion		Juvenile	
Sample size	15		8		16		6	
Standard length (mm)	6.3±1.1	(4.9–8.3)	9.9±0.6	(8.9–10.8)	13.9±2.1	(10.8–18.3)	32.6±7.1	(22.0–42.0)
Body depth/SL	13.3±1.4	(11.9–15.7)	14.2±1.6	(12.1–15.9)	15.3±0.9	(13.9–16.6)	12.5±0.9	(11.0–13.8)
Snout to anus length/SL	51.7±4.5	(44.7–61.9)	56.7±2.7	(53.6–60.8)	51.3±3.8	(44.0–57.9)	36.9±3.6	(32.4–42.7)
Head length/SL	20.3±3.0	(17.1–26.8)	25.3±2.3	(21.7–28.7)	26.3±1.5	(24.2–27.4)	27.5±2.3	(23.5–30.1)
Head width/HL	53.9±6.0	(48.2–73.4)	54.8±2.0	(50.8–56.7)	58.4±5.6	(47.3–67.9)	48.1±6.0	(41.5–58.8)
Snout length/HL	18.8±4.2	(7.1–26.9)	22.6±2.0	(18.7–25.0)	24.5±2.2	(19.6–28.2)	24.2±4.3	(20.9–32.3)
Eye diameter/HL	37.5±5.1	(27.7–45.2)	29.8±1.2	(27.9–32.0)	27.4±2.1	(25.1–31.4)	31.0±2.8	(26.0–33.7)
Pectoral-fin length/SL	8.4±2.8	(6.1–15.1)	17.1±4.1	(9.9–23.6)	23.3±2.2	(18.6–26.5)	17.9±1.1	(16.9–20.0)

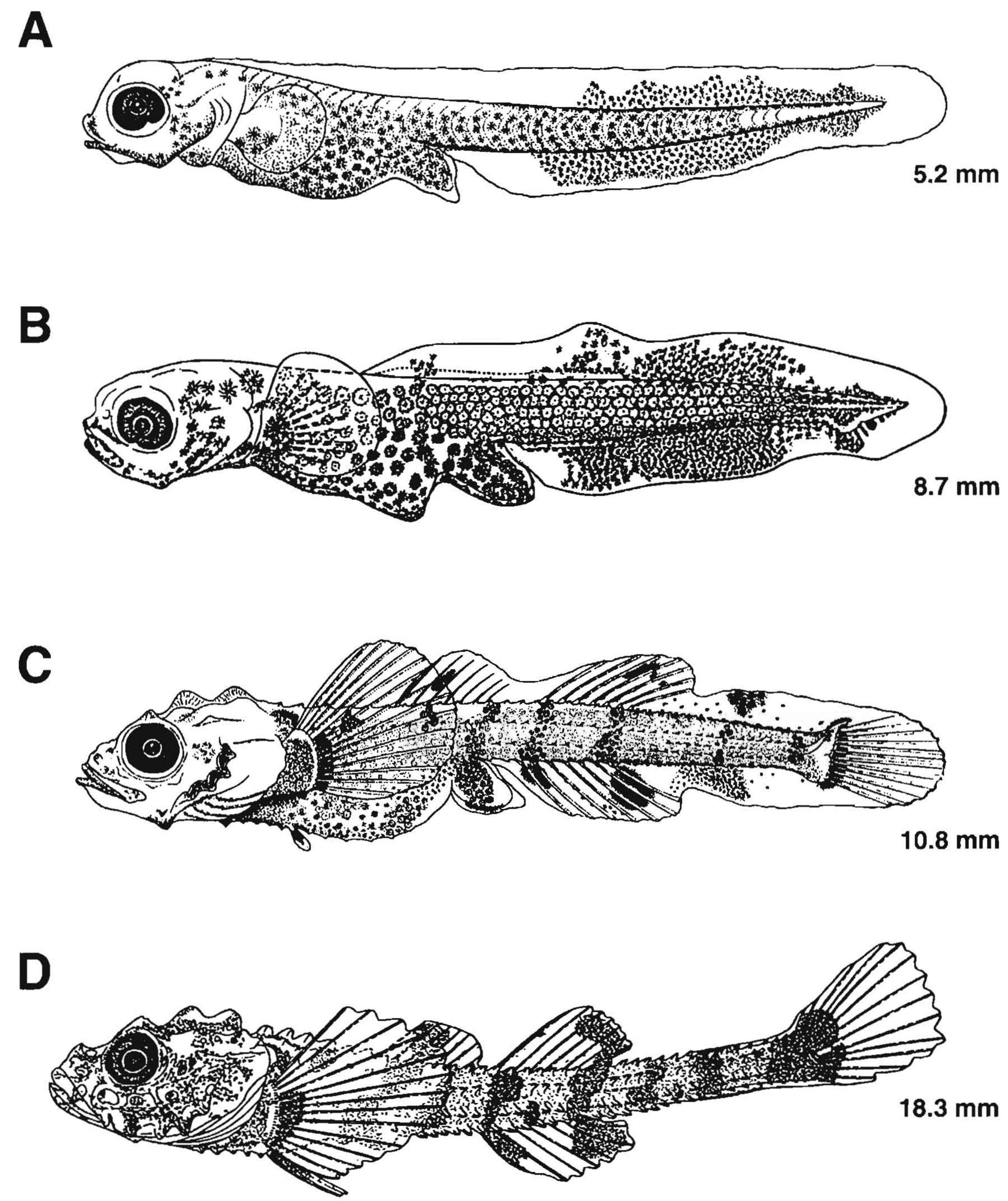


Figure 23
Developmental stages of *Xeneretmus latifrons* (Busby and Ambrose, 1993). (A) Preflexion larva 5.2 mm. (B) Early flexion larva 8.7 mm. (C) Flexion larva 10.8 mm. (D) Postflexion larva 18.3 mm.

oping hypural. This band of pigmentation expands posteriorly in postflexion larvae and juveniles (Fig. 23D). Melanophores cover nearly the entire head in postflexion larvae and juveniles.

Meristic Features (Table 30)—All fins are complete at 13.8 mm. The caudal fin has 2,(6+6),1 rays. All vertebral centra are ossified at 13.8 mm and all remaining elements at 14.5 mm. All dermal plate rows have adult counts at 13.8 mm.

Head Spines—Head spination in *X. latifrons* larvae is generally reduced compared to other members of the subfamily Anoplagoninae.

Table 30

Meristics of cleared and stained *Xeneretmus latifrons* larvae and juveniles. Specimens between dashed lines (- - -) are undergoing notochord flexion (Busby and Ambrose, 1993). Abdominal and caudal neural spines, haemal spines, and abdominal and caudal centra counts corrected.

Standard length (mm)	Dorsal fin spines	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Pelvic fin spines, rays	Branchiostegal rays	Neural spines abdominal	Neural spines caudal	Neural spines total	Haemal spines	Centra abdominal	Centra caudal	Centra total	Body plates[1] DLP+MDP	Body plates[1] SLP	Body plates[1] LLP	Body plates[1] ILP	Body plates[1] VLP+MVP
7.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
8.7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
11.9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
12.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
13.8	VII	7	8	15	I,2	6	12	27	39	29	12	30	42	38	38	38	38	38
14.5	VI	7	7	14	I,2	6	12	29	41	29	12	30	42	38	38	38	38	38
21.0	VII	6	7	14	I,2	6	12	29	41	29	12	30	42	41	41	41	40	41
30.5	VII	7	7	15	I,2	6	12	28	40	28	12	29	41	38	38	40	38	38
31.8	VII	7	7	14	I,2	6	12	28	40	28	12	29	41	38	38	42	38	38
39.2	VI	6	7	14	I,2	6	12	28	40	28	12	29	41	38	38	40	38	38

[1] DLP—dorsolateral; MDP—mid-dorsal; SLP—supralateral; LLP—lateral line; ILP—infralateral; VLP—ventrolateral; MVP—mid-ventral.

Early flexion larvae of *X. latifrons* possess two rows of small parietal spinules that are overgrown during ontogeny to form distinctly bilobed parietal crests in late flexion larvae (Figs. 23B,C). Angular, articular, anterior and posterior preopercular, frontal, posttemporal, pterotic, supraocular, supracleithral, and tympanic spines are present at 10.8 mm. The superior infraorbital series begins to form during flexion and is complete by postflexion. Dentary and rostral spines are present in postflexion larvae and juveniles. Sclerotic plates are present in juveniles and adults.

Species Comparisons—Larval *X. latifrons* appear most similar to larvae of *Bathyagonus* spp. (in particular *B. pentacanthus*) and *Odontopyxis trispinosa*. Pigmentation on the finfolds of *X. latifrons* covers a smaller area, has irregularly shaped patches (uneven outer edges), and does not extend continuously to the outer margin of the finfolds as in *Bathyagonus*. Postflexion and juvenile *X. latifrons* have a distinct, single rostral spine, unlike *Bathyagonus* which develop a rostral plate with a cluster of spines during the juvenile stage.

Although *O. trispinosa* and *X. latifrons* are both considered to be of medium body depth, *O. trispinosa* is notably more slender throughout development (10.7–11.7% SL vs. 13.3–15.3% SL). Flexion larvae of *X. latifrons* have a longer pectoral fin than *O. trispinosa* (average 17.1% vs. 10.8% SL). Patches of pigmentation on the dorsal and anal finfolds of *O. trispinosa* are nearly triangular in shape. In *X. latifrons* larvae, pigmentation on the dorsal and anal finfolds is more continuous and irregularly shaped. Absent in *X. latifrons*, a semicircular patch of melanophores covers nearly the entire caudal finfold of *O. trispinosa*. Larval and juvenile *X. latifrons* have fewer head spines than *O. trispinosa*. Postflexion larvae of *O. trispinosa* possess three inferior infraorbital plates and a distinct occipital pit that are absent in *X. latifrons*.

***Odontopyxis trispinosa*—pygmy poacher**

Literature—Development of larval and early juvenile *O. trispinosa* was described in detail by Busby and Ambrose (1993). A summary of their description is presented here for comparative purposes with updated information.

Distribution—Adult *O. trispinosa* occur from central Baja California to southeast Alaska in sandy or rocky habitats at depths of 10 to 400 m (Miller and Lea, 1972; Hart, 1973; Eschmeyer et al., 1983; Kanayama, 1991). Larvae are common in plankton samples throughout the adult range (Busby and Ambrose, 1993).

Morphology (Table 31)—Notochord flexion in *O. trispinosa* begins at approximately 7.0 mm and is completed by 11.8 mm. The juvenile stage begins at approximately 18.0 mm. Larvae are medium-bodied with mean body depth of 11.7% SL in preflexion specimens, decreasing slightly to 10.5% SL in juveniles. Snout length increases from 20.4% HL in preflexion larvae to 27.0% HL postflexion. Pectoral fin length increases from 7.0% SL in preflexion larvae to 19.5% SL postflexion. A distinct occipital pit is present in postflexion larvae and later stages.

Pigmentation (Fig. 24)—Larvae of *O. trispinosa* are heavily pigmented. The heads of preflexion larvae possess melanophores on the upper and lower jaws, operculum, and posttemporal region (Fig. 24A). Melanophores are also present on the pectoral-fin base, lateral surface of the gut, and most of the body. The dorsal half of the body above the gut is devoid of pigmentation as is the posteriormost region of the body and notochord tip. A small cluster of melanophores is present on the anterior portion of the dorsal finfold above the gut. Four nearly triangular-shaped patches of melanophores are present on the dorsal finfold. The first is isolated from the other three and is located at about midbody. The other three patches are located posteriorly and are connected immediately above the dorsal margin of the body. Three nearly triangular-shaped patches are present on the anal finfold. The first is relatively small and located just posterior to the anus. The second is located at about midbody and the third more posteriorly. A distinct semicircular-shaped patch nearly covers the caudal finfold and is continuous with the posterior patches of melanophores on the dorsal and anal finfolds.

Pigmentation present on the body of preflexion larvae expands to cover the posterior region of the body and notochord tip in early flexion larvae (Fig. 24B). Patches of melanophores on the finfolds of late flexion larvae become irregularly shaped (Fig. 24C). In postflexion larvae, pigmentation on the body separates into seven distinct bands (Fig. 24D). The two anteriormost bands are connected by a bar of pigmentation ventrally. This pigmentation pattern is retained throughout most of the juvenile stage.

Table 31

Body proportions of *Odontopyxis trispinosa* larvae and early juveniles. Values given for each body proportion are expressed as percentage of standard length (SL) or head length (HL); mean, standard deviation, and range given in parentheses.

Body proportion	Preflexion		Flexion		Postflexion		Juvenile	
Sample size	12		8		20		5	
Standard length (mm)	5.7±1.0	(4.3–7.2)	9.4±1.5	(7.1–11.7)	14.5±1.9	(11.8–17.7)	34.6±5.1	(28.0–41.6)
Body depth/SL	11.7±1.0	(10.2–13.4)	10.7±1.2	(8.4–12.4)	10.7±0.9	(9.0–12.4)	10.5±0.7	(9.8–11.6)
Snout to anus length/SL	47.9±1.4	(45.7–50.3)	46.2±2.5	(43.2–50.8)	42.5±2.8	(38.9–46.6)	33.3±1.2	(32.1–34.9)
Head length/SL	18.4±1.2	(16.1–20.5)	19.4±2.2	(16.5–21.8)	22.4±1.9	(19.2–25.4)	23.8±1.5	(22.7–26.4)
Head width/HL	48.7±8.7	(40.4–72.2)	50.1±9.7	(44.0–73.5)	47.2±3.3	(43.1–54.9)	37.1±2.0	(34.4–38.9)
Snout length/HL	20.4±2.3	(16.7–23.8)	24.8±2.7	(21.7–29.1)	27.0±2.3	(24.0–32.7)	24.3±2.1	(21.1–26.3)
Eye diameter/HL	33.3±4.0	(25.7–41.7)	26.1±1.9	(23.0–29.0)	23.0±1.5	(19.4–25.3)	23.3±0.9	(22.2–24.8)
Pectoral-fin length/SL	7.0±0.7	(5.3–8.4)	10.8±2.9	(7.1–14.2)	19.5±1.7	(16.3–21.3)	17.1±0.4	(16.6–17.4)

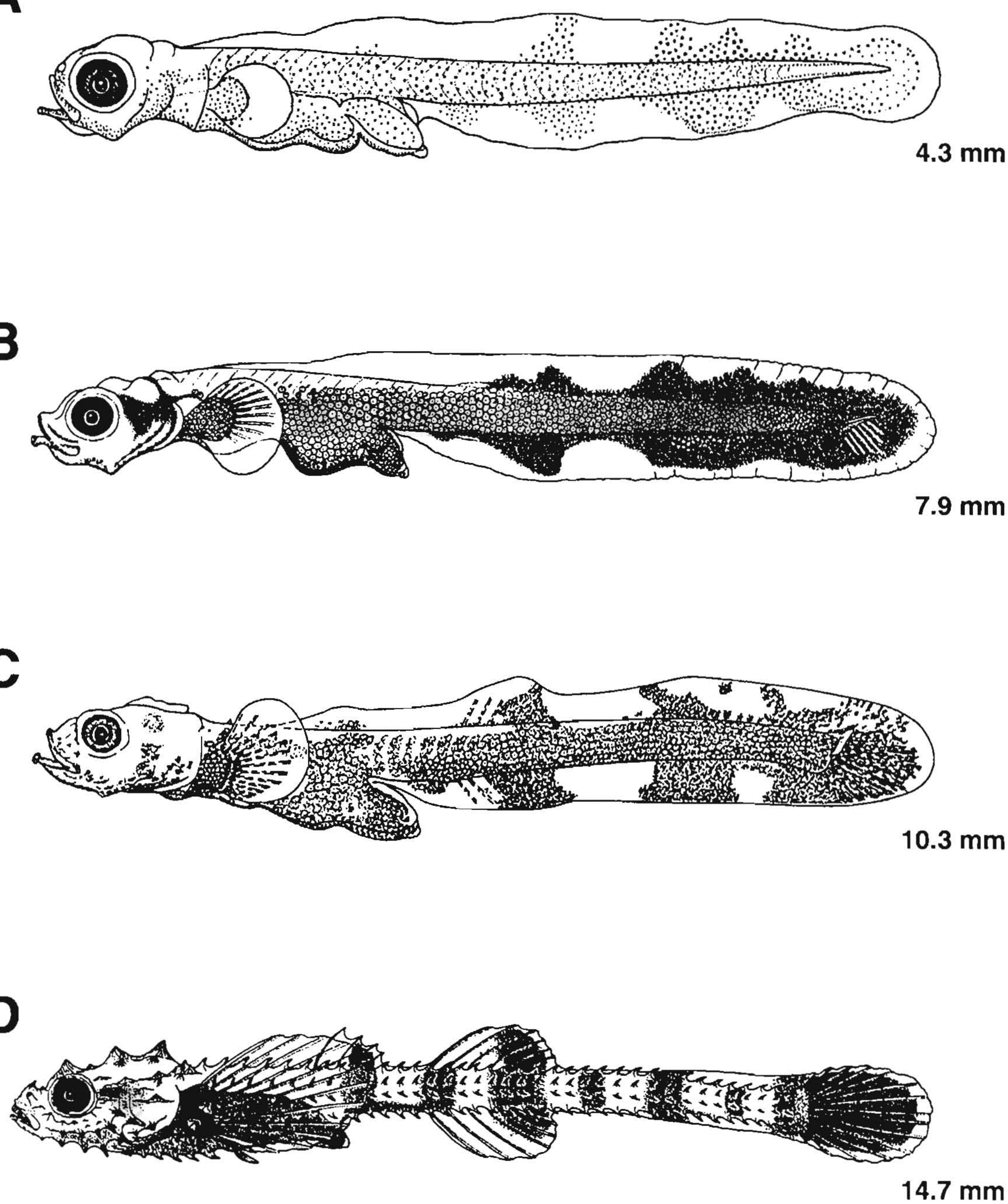


Figure 24
Developmental stages of *Odontopyxis trispinosa* (Busby and Ambrose, 1993). (A) Preflexion larva 4.3 mm. (B) Early flexion larva 7.9 mm. (C) Flexion larva 10.3 mm. (D) Postflexion larva 14.7 mm.

Meristic Features (Table 32)—Dorsal and anal fins are complete at 12.6 mm. Pectoral and pelvic fins are complete at 13.2 mm. The caudal fin is complete at 17.2 mm and has 3,(6+6),0 rays. All vertebral centra are ossified at 13.8 mm and all remaining elements at 15.4 mm. All dermal plate rows, with the exception of the lateral line series, have adult counts at 13.8 mm. The lateral line plate row is complete at 17.2 mm.

Head Spines—Head spination in *O. trispinosa* larvae is generally more elaborate than other members of the subfamily Anoplagoninae. Early flexion larvae possess two rows of small parietal spinules that are overgrown

Table 32

Meristics of cleared and stained *Odontopyxis trispinosa* larvae and juveniles. Specimens between dashed lines (- - -) are undergoing notochord flexion (Busby and Ambrose, 1993). Abdominal and caudal neural spines, haemal spines, and abdominal and caudal centra counts corrected.

Standard length (mm)	Dorsal fin spines	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Pelvic fin spines, rays	Branchi-ostegal rays	Neural spines abdominal	Neural spines caudal	Neural spines total	Haemal spines	Centra abdominal	Centra caudal	Centra total	Body plates[1] DLP+MDP	Body plates[1] SLP	Body plates[1] LLP	Body plates[1] ILP	Body plates[1] VLP+MVP
5.3																		
5.8																		
6.1																		
7.0																		
- - -																		
7.7																		
8.3																		
8.5																		
9.3																		
10.0																		
11.4																		
11.7																		
- - -																		
12.5																		
12.6	V	6	6	13	I	6	3		3	3	11	27	38	30	35		35	32
13.1		3				6	2		2									
13.2	V	6	6	14	I,2	6	10	23	33	6	10	30	40	32	38	2	36	34
13.8		3				6	2		2									
13.8	IV	6	7	13	I,2	6	10	25	35	8	10	30	40	34	38		36	37
14.2	V	7	6	14	I,2	6	11	21	32	8	11	28	39	34	36	1	35	34
14.8	V	7	6	14	I,2	6	11	27	38	27	11	28	39	36	38	38	37	36
15.2	V	6	6	13	I,2	6	10	28	38	28	10	29	39	37	39	33	37	37
15.2	IV	4	6	14	I,2	6	10	28	38	28	10	29	39	37	37	1	35	36
15.4	IV	6	7	14	I,2	6	10	27	37	27	10	28	38	36	37	23	36	37
16.7	V	6	6	14	I,2	6	11	27	38	27	11	28	39	37	37	20	35	37
17.2	VI	6	7	14	I,2	6	10	28	38	28	10	29	39	37	38	38	36	37
27.0	IV	6	5	14	I,2	6	11	27	38	27	11	28	39	36	37	39	36	36
29.0	V	6	6	14	I,2	6	10	27	37	27	10	28	38	37	39	38	36	37
41.0	IV	6	6	13	I,2	6	10	27	37	27	10	28	38	36	38	39	36	36

[1] DLP—dorsolateral; MDP—mid-dorsal; SLP—supralateral; LLP—lateral line; ILP—infralateral; VLP—ventrolateral; MVP—mid-ventral.

during ontogeny to form a nearly flat parietal crest in late flexion larvae (Fig. 24C). The crest becomes distinctly bilobed in postflexion larvae (Fig. 24D). Flexion larvae of approximately 12.6 mm length possess nasal, supraocular, coronal, pterotic, cleithral, supracleithral, anterior and posterior preopercular, tympanic, opercular, and the two posteriormost superior infraorbital (5,6) spines. The frontal spine is present at 13.8 mm. Interopercular and the two anteriormost superior infraorbital spines (1,2) begin forming during the postflexion stage at about 14.2 mm. The prominent rostral spine, dentary spines, and the posttemporal and postocular plates ossify at 14.8 mm. The median superior infraorbital spines (3,4) and first two inferior infraorbital plates (1,2) are also ossified at 14.8 mm. The third infraorbital and sclerotic plates are ossified by 17.2 mm.

Species Comparisons—Larval *O. trispinosa* are most similar in appearance to *X. latifrons* larvae. Although larvae of both *O. trispinosa* and *X. latifrons* are considered to be of medium body depth, *O. trispinosa* is notably more slender throughout development (10.7–11.7% SL vs. 13.3–15.3% SL). Flexion larvae of *X. latifrons* have a longer pectoral fin than *O. trispinosa* (average 17.1% SL vs. 10.8% SL). Patches of pigmentation on the dorsal and anal finfolds of *O. trispinosa* are nearly triangular in shape. In *X. latifrons* larvae, pigmentation on the dorsal and anal finfolds is more continuous and irregularly shaped. A semicircular patch of melanophores covers nearly the entire caudal finfold of *O. trispinosa* and is absent in *X. latifrons*. Larval and juvenile *X. latifrons* have fewer head spines than *O. trispinosa*. Postflexion larvae of *O. trispinosa* possess three inferior infraorbital plates and a distinct occipital pit that are absent in *X. latifrons*.

Ulcina olriki—Arctic alligatorfish

Literature—Previously included in the genus *Aspidophoroides*, the Arctic alligatorfish was recently placed in the genus *Ulcina* by Kanayama (1991). Dunbar (1947) provided an illustration and brief description of postflexion *Ulcina olriki* (20–21 mm). Additional information on the development of *U. olriki* is presented here based on examination of seven specimens, 6.2–26.5 mm.

Distribution—Adult *U. olriki* are circumarctic in distribution and also occur in the northern Bering Sea and North Atlantic Ocean (Kanayama, 1991). Larvae are very uncommon in plankton samples. Specimens examined in this study were collected in the northern Bering Sea and the North Atlantic Ocean.

Morphology (Table 33)—Notochord flexion in *U. olriki* begins between 8.0 and 9.0 mm. Flexion is complete by 20.0 mm but the exact size of completion is unknown as specimens between 10.5 and 20.0 mm were unavailable for study. The juvenile stage begins at approximately 25.0 mm. Larvae are slender-bodied during preflexion with mean body depth of 9.9% SL and are medium-bodied throughout the remainder of development (10.6–14.6% SL).

Ulcina olriki have no first (spinous) dorsal fin and thus a very long predorsal length (50.7–56.8% SL). Snout length increases from 11.5% HL in preflexion larvae to 27.6% HL in juveniles. Pectoral-fin length increases remarkably from 9.6% SL in preflexion larvae to 31.8% SL in juveniles.

Pigmentation (Fig. 25)—Larvae of *U. olriki* are moderately pigmented. Preflexion and flexion larvae possess a light covering of melanophores on the head dorsally (Fig. 25A). A few melanophores are also present on the operculum and lower jaw.

A row of fine melanophores is present along the ventral midline of the gut. Several large melanophores are present on the lateral surface of the mid- and hindgut.

Four distinct regions of pigmentation are present on the lateral surface of the body. The first is a band located immediately anterior to the dorsal and anal-fin origins. A second patch of melanophores is located at about midbody and is aligned with the posterior margins of the dorsal and anal fins in postflexion larvae. The third is located about midway between the dorsal and caudal fins. Finally, a large patch of pigmentation covers the caudal peduncle, notochord tip, and about three-quarters of the caudal finfold. Dense pigmentation also covers the outer edges of the pectoral, dorsal, and anal fins.

The head is covered with melanophores in postflexion larvae and juveniles (Fig. 25B). Melanophores are present on the pectoral-fin base and juveniles possess a large patch of pigmentation near the center of the pectoral-fin blade. The large patch of melanophores on the notochord tip and caudal finfold remains throughout development but is less prominent and covers a lesser proportion of the finfold in postflexion larvae and of the caudal fin in juveniles.

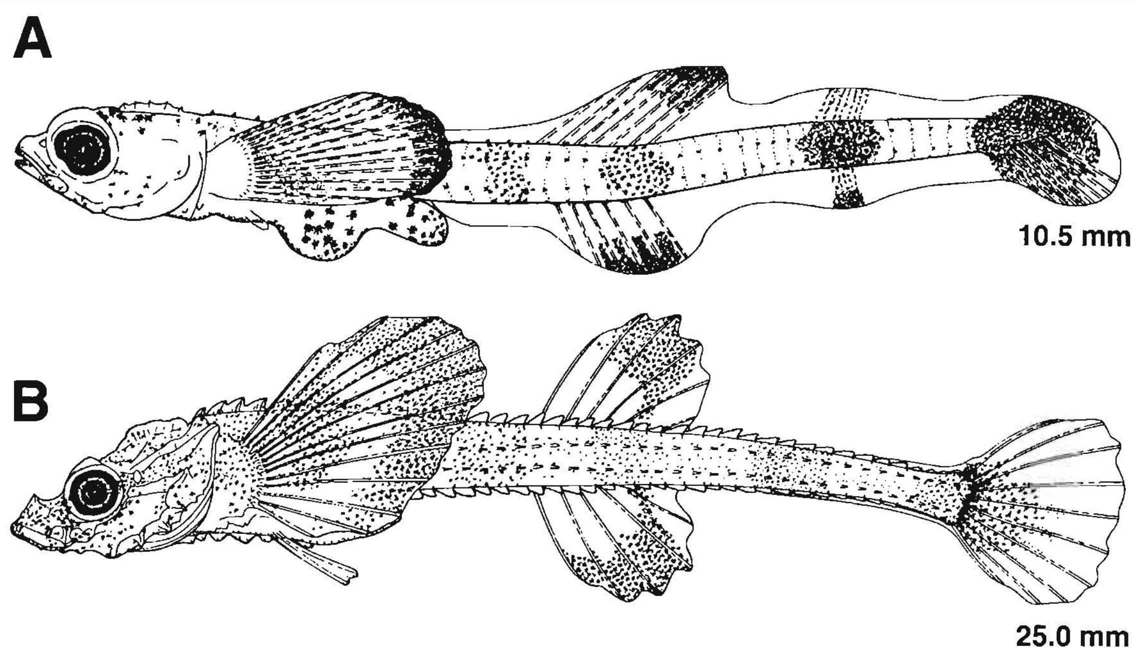


Figure 25
Developmental stages of *Ulcina olriki* (Atlantic specimens). (A) Flexion larva 10.5 mm, ARC 9010753. (B) Early juvenile 25.0 mm, ARC 9010755.

Table 33

Body proportions of *Ulcina olriki* larvae and early juveniles. Values given for each body proportion are expressed as percentage of standard length (SL) or head length (HL); mean, standard deviation, and range given in parentheses.

Body proportion	Preflexion		Flexion		Postflexion		Juvenile	
Sample size	1		1		2		2	
Standard length (mm)	6.2	(6.2)	10.0	(10.0)	22.4±2.5	(20.6–24.2)	25.9±0.8	(25.3–26.4)
Body depth/SL	9.9	(9.9)	10.6	(10.6)	14.4±0.5	(14.0–14.7)	14.6±1.0	(13.9–15.3)
Predorsal length/SL			50.7	(50.7)	55.4±0.0	(55.4–55.4)	56.8±0.8	(56.2–57.4)
Snout to anus length/SL	41.9	(41.9)	43.0	(43.0)	42.8±2.2	(41.2–44.3)	40.0±2.4	(38.8–41.7)
Head length/SL	14.8	(14.8)	19.0	(19.0)	23.5±1.8	(22.3–24.8)	23.2±0.4	(22.9–23.5)
Head width/HL	20.5	(20.5)	21.3	(21.3)	19.5±3.1	(17.3–21.7)	20.4±1.8	(19.1–21.7)
Snout length/HL	11.5	(11.5)	18.0	(18.0)	27.1±1.0	(26.4–27.8)	27.6±0.4	(27.4–27.9)
Eye diameter/HL	39.3	(39.3)	29.3	(29.3)	22.6±3.2	(20.4–24.9)	15.9±0.4	(15.6–16.1)
Pectoral-fin length/SL	9.6	(9.6)	18.7	(18.7)	27.7±2.2	(26.2–29.3)	31.8±0.9	(31.2–32.4)

Table 34

Meristics of *Ulcina olriki* early juveniles and adults. Adult counts compiled from Matarese et al. (1989) and Kanayama (1991).

Standard length (mm)	Dorsal fin spines	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Pelvic fin spines, rays	Branchiostegal rays	Neural spines abdominal	Neural spines caudal	Neural spines total	Haemal spines	Centra abdominal	Centra caudal	Centra total	Body plates[1] DLP+MDP	Body plates SLP	Body plates LLP	Body plates ILP	Body plates VLP+MVP
26.5[2]		5	6	14	I,2	6	10	28[3]	38	27	10	28	38	36		37	36	33
Adults		5–7	5–7	13–16	I,2	6	10	27	37	27	10	28	37–40	33–39		26–32	34–37	27–39

[1] DLP—dorsolateral; MDP—mid-dorsal; SLP—supralateral; LLP—lateral line; ILP—infralateral; VLP—ventrolateral; MVP—mid-ventral.
[2] Atlantic specimen.
[3] Two neural spines on preural centra.

Meristic Features (Table 34)—A complete developmental series was unavailable to clear and stain. Ossification is complete or progressing in all bony elements of the 26.5 mm individual examined. The caudal fin is also complete and has 1,(5+5),0 rays. The lateral line plate count of 37 reported here is higher than 26–32 reported for adult *U. olriki* by Kanayama (1991).

Head Spines—Head spination in *U. olriki* larvae is generally reduced and less elaborate than most other members of the subfamily Anoplagoninae. Early flexion larvae possess two rows of small parietal spinules (Fig. 25A) that are overgrown during ontogeny to form a nearly flat parietal ridge or crest in postflexion larvae and juveniles (Fig. 25B). Juveniles possess numerous other head spines including nasal, a weakly projecting supraocular, anterior and posterior preoperculars, and superior infraorbitals. The stages and sizes at which they develop, however, remain unknown.

Species Comparisons—Larval *U. olriki* are most similar in appearance to *Aspidophoroides monopterygius* and *Anoplagonus inermis* larvae that also lack a first (spinous) dorsal fin and a supralateral dermal plate row. Of these taxa, *U. olriki* has the fewest vertebrae (37–40), the most pectoral-fin rays (13–16), and the fewest caudal rays (1,(5+5),0). *Ulcina olriki* has significantly lower plate counts than *A. monopterygius* in all rows and a deeper body morphology in flexion, postflexion, and juvenile stages. The large patch of pigmentation covering the notochord tip and most of the caudal finfold is more conspicuous in preflexion and flexion *U. olriki* than in *A. monopterygius*.

Aspidophoroides monopterygius—alligatorfish

Literature—*Aspidophoroides bartoni* was recently made a junior synonym of *A. monopterygius* by Kanayama (1991). Bigelow and Schroeder (1953) described the appearance and distribution of adults and provided an illustration of an 11.0 mm flexion larva. Washington et al. (1984) included an illustration of a 14.3 mm flexion larva. Maeda and Amaoka (1988) described and illustrated 7.3 and 17.7 mm larvae of *A. bartoni* (= *A. monopterygius*) from Japanese waters. Additional information on larval development of *A. monopterygius*, based on examination of 18 specimens, 5.1–32.5 mm, is presented here.

Distribution—Adult *A. monopterygius* are circumarctic in distribution and also occur southward to the Gulf of Alaska in the Pacific and to Cape Cod and New Jersey in the Atlantic (Bigelow and Schroeder, 1953; Kanayama, 1991). Larvae are uncommon in plankton samples. Specimens examined in this study were collected in the Gulf of Alaska and Bering Sea.

Morphology (Table 35)—Notochord flexion begins at 8.0 mm and is complete by 15.0 mm. It is unknown when the juvenile stage begins as the largest individuals examined (30.0 mm) possess larval finfold. Larvae are slender-bodied with a mean body depth of 8.1% SL preflexion, decreasing to 6.2% SL postflexion. *Aspidophoroides monopterygius* has no first (spinous) dorsal fin and thus a long predorsal length (55.2 to 57.4% SL). Development of the dorsal fin is first noted in the flexion stage. Snout length increases from 23.0% HL in preflexion larvae to 29.6% HL postflexion. Pectoral fin length increases substantially from 11.3% SL in preflexion larvae to 27.2% SL postflexion.

Pigmentation (Fig. 26)—Larvae of *A. monopterygius* are moderately pigmented. Preflexion larvae possess a light aggregation of melanophores on the opercular region and a small patch at the corner of the mouth (Fig. 26A). The isthmus and most of the ventral surface of the gut are covered with melanophores. Additional pigmentation is present on the lateral surface of the gut above the constriction and posteriorly on the anus. Three distinct patches and a small bar of melanophores are present on the lateral surface of the body near the dorsal midline posterior to the anus. A long bar or line of pigmentation extends along the ventral midline of the body from immediately behind the anus to near the end of the notochord. Another distinct patch of melanophores is present at the outer margin of the anal finfold at about midbody. An additional irregularly-shaped patch of pigmentation is present near the ventral margin of the notochord on the finfold.

In early flexion larvae, a dense band of melanophores begins to develop on the outer margin of the pectoral fin (Fig. 26B). The entire edge of the fin is covered with pigmentation before flexion ends (Fig. 26C). During

Table 35

Body proportions of *Aspidophoroides monopterygius* larvae. Values given for each body proportion are expressed as percentage of standard length (SL) or head length (HL); mean, standard deviation, and range given in parentheses.

Body proportion	Preflexion		Flexion		Preflexion	
Sample size	5		7		5	
Standard length (mm)	6.9±1.3	(5.1–7.9)	11.5±2.3	(8.0–14.3)	27.1±3.6	(23.4–32.3)
Body depth/SL	8.1±2.0	(6.2–10.9)	6.4±0.4	(5.7–6.9)	6.2±0.5	(5.6–7.0)
Snout to anus length/SL	42.1±3.0	(39.5–46.8)	40.6±3.3	(36.7–46.0)	35.0±2.1	(32.7–38.0)
Predorsal length/SL			55.2±3.1[1]	(51.8–58.3)	57.4±3.1	(54.6–62.5)
Head length/SL	12.9±1.6	(11.2–14.6)	14.4±2.3	(11.7–17.4)	18.2±2.6	(14.5–20.0)
Head width/HL	28.0±4.2	(23.1–34.7)	20.7±5.3	(13.2–28.0)	11.6±3.4	(7.8–16.2)
Snout length/HL	23.0±3.9	(17.6–28.3)	27.5±4.2	(21.7–33.3)	29.6±2.4	(25.7–31.8)
Eye diameter/HL	44.0±7.2	(34.4–54.0)	31.9±8.0	(22.7–44.4)	17.6±2.5	(14.9–21.5)
Pectoral-fin length/SL	11.3±2.0	(9.8–14.7)	19.1±5.1	(11.0–25.3)	27.2±2.4	(23.2–29.4)

[1] Sample size = 4.

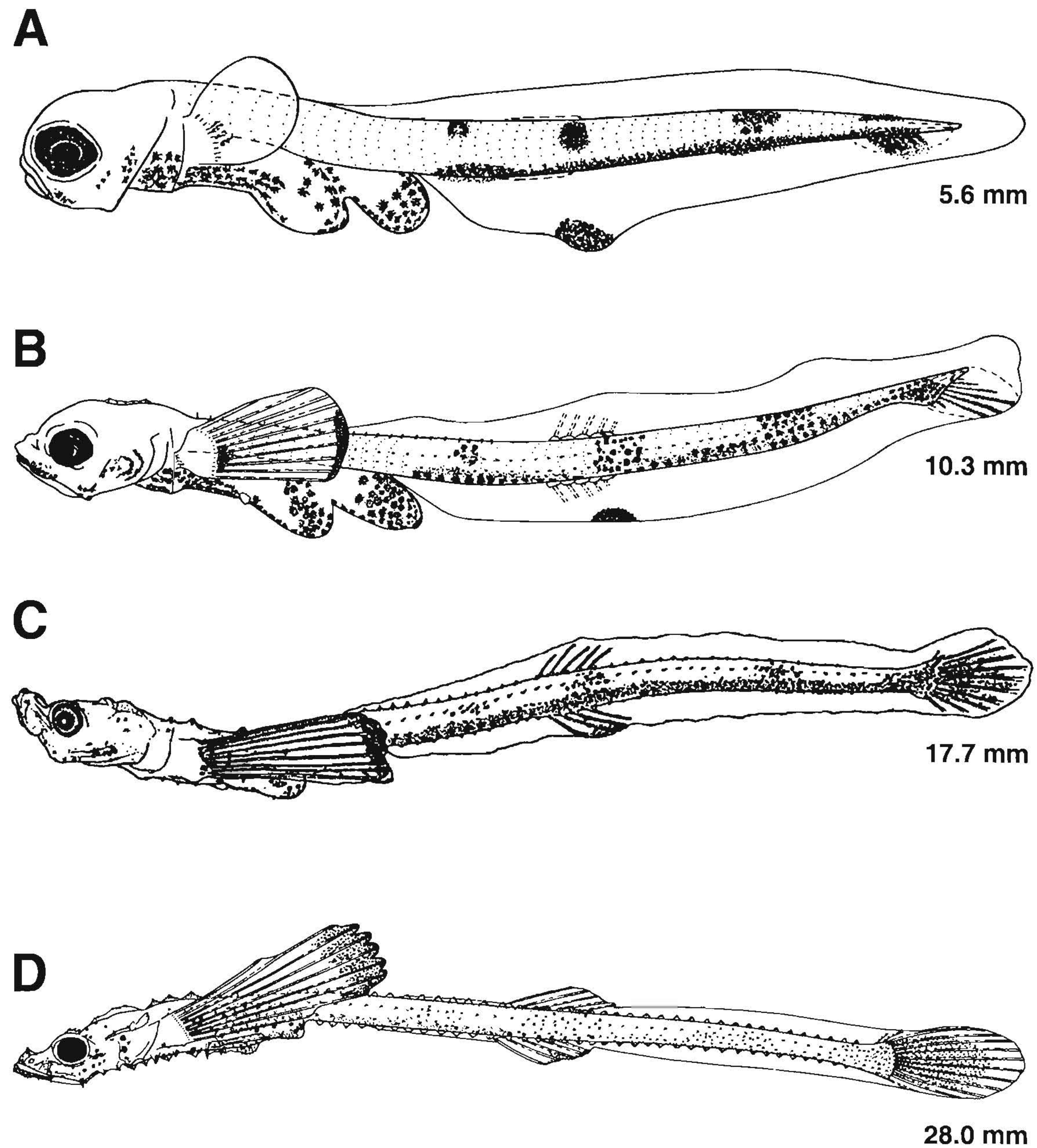


Figure 26

Developmental stages of *Aspidophoroides monopterygius*. (A) Preflexion larva 5.6 mm, UW 032240. (B) Early flexion larva 10.8 mm; AFSC, 1MD82, St. G130A, 6B5. (C) Late flexion larva 17.7 mm (Maeda and Amaoka, 1988). (D) Postflexion larva 28.0 mm; AFSC, 3MF79, St. S101A, TT-2.

flexion, the three patches and small bar of melanophores near the dorsal midline of the body expand and join the pigmentation on the postanal ventral midline (Figs. 26B,C). Melanophores are also present on the caudal finfold and developing rays. In postflexion larvae, pigmentation becomes more diffuse on the head and body. The band of pigmentation on the edge of the pectoral fin is wider and melanophores cover nearly three-quarters of the caudal fin.

Meristic Features (Table 36)—The anal and pectoral fins have adult counts of ossified rays at 12.1 mm. The dorsal and pelvic fins are complete at 24.5 mm. Ossification is complete or progressing in all bony elements of the 24.5 mm individual examined including the ver-

Table 36

Meristics of cleared and stained *Aspidophoroides monopterygius* larvae. Specimens between dashed lines (- - -) are undergoing notochord flexion.

Standard length (mm)	Dorsal fin spines	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Pelvic fin spines, rays	Branchiostegal rays	Neural spines abdominal	Neural spines caudal	Neural spines total	Haemal spines	Centra abdominal	Centra caudal	Centra total	Body plates[1] DLP+MDP	Body plates[1] SLP	Body plates[1] LLP	Body plates[1] ILP	Body plates[1] VLP+MVP
6.1																		
10.0						4								6		38	44	4
12.1		4	4	9		6	6		6		11	33	44	34		40	46	24
15.4		4	5	9		6	7		7		11	34	45	36		40	48	26
24.5		5	5	9	1,2	6	11	40	51	40	11	41	52	47		49	51	43
32.5		5	6	9	1,2	6	12	41	53	41	12	42	54	51		50	51	46

[1] DLP—dorsolateral; MDP—mid-dorsal; SLP—supralateral; LLP—lateral line; ILP—infralateral; VLP—ventrolateral; MVP—mid-ventral.

tebral column. The caudal fin is also complete and has 2,(5+5),1 rays. All rows of dermal bony plates, with the exception of the VLP+MVP, are complete at 24.5 mm. The VLP+MVP row is complete at 32.5 mm.

Head Spines—Head spination in *A. monopterygius* larvae is generally less elaborate than other members of the subfamily Anoplagoninae. Early flexion larvae possess two rows of small parietal spinules (Fig. 26B) that are overgrown during ontogeny to form a bilobed or irregularly arched parietal crest in late flexion and postflexion larvae (Figs. 25C,D). Mid-flexion larvae possess numerous other head spines including coronal, tympanic, first superior infraorbital, second and third anterior and posterior preopercular, and an interopercular. In addition, late flexion larvae have supracleithral, first anterior and posterior preopercular, superior infraorbital, and subopercular spines. Postflexion larvae possess nasal, dentary, serrated supraocular, the fourth anterior and posterior preopercular, postocular, and pterotic spines.

Species Comparisons—Larval *Aspidophoroides monopterygius* are similar in appearance to *Ulcina olriki* and *Anoplagonus inermis* larvae, which also lack a first (spinous) dorsal fin and a supralateral dermal plate row. Of these taxa, *A. monopterygius* has the most slender body morphology throughout development. In addition, *A. monopterygius* have the most vertebrae (48–54), and the highest dermal plate counts in all rows. *Aspidophoroides monopterygius* have fewer pectoral-fin rays (9–11) than *U. olriki* (13–16). With a caudal-fin ray formula of 2,(5+5),1, *A. monopterygius* is an intermediate between *U. olriki* (1,(5+5),0) and *A. inermis* (2,(6+6),0–1). The three distinct patches and small bar of melanophores on the lateral body near the dorsal midline are unique among agonids. *Aspidophoroides monopterygius* larvae have no pigmentation on the dorsal finfold whereas *A. inermis* and *U. olriki* do.

***Anoplagonus inermis*—smooth alligatorfish**

Literature—Development of larval and early juvenile *A. inermis* are described for the first time here based on examination of 15 specimens, 5.0–21.7 mm.

Distribution—Adult *A. inermis* occur from northern California to the Aleutian Islands in rocky habitats at depths from 7.5 to 102 m (Eschmeyer et al., 1983; Matarese et al., 1989; Kanayama, 1991). Larvae are uncommon in plankton samples. Specimens examined in this study were collected throughout their adult range.

Morphology (Table 37)—Notochord flexion begins at 7.5 mm and is complete by 11.0 mm. The juvenile stage begins at approximately 17.0 mm. Larvae are medium-bodied, with a mean body depth of 11.5% SL preflexion, increasing to 13.6% SL in juveniles. *Anoplagonus inermis* has no first (spinous) dorsal fin and thus a very long predorsal length (60.7–66.7% SL). Head length increases from 18.2% SL in preflexion larvae to 29.1% SL in juveniles. Snout length increases from 19.6% HL in preflexion larvae to 30.7% HL postflexion. Pectoral-fin length increases remarkably from 11.8% SL in preflexion larvae to 28.7% SL in juveniles.

Pigmentation (Fig. 27)—Larvae of *A. inermis* are heavily pigmented. Preflexion larvae possess numerous melanophores dorsally on the head and nape (Fig. 27A). A few melanophores are also present on the opercular region, isthmus, and the posterolateral surface of the gut. The lateral surface of the body is covered nearly entirely with melanophores from the constriction of the gut to the anterior portion of the caudal peduncle. A few melanophores are present on the body immediately anterior to the notochord tip. An irregularly-shaped patch of melanophores is present on the dorsal finfold just beyond midbody. The patch is oriented diagonally towards the posterior and extends from the dorsal midline of the body to the outer margin of the finfold. A nearly identical (isomeric) patch of pigmentation is present on the anal finfold. In addition, two small patches of melanophores are present near the anterior and posterior regions of the anal finfold.

Pigmentation covers nearly the entire lateral surface of the gut in flexion larvae (Fig. 27B). A few melanophores are present on the pectoral-fin base. Melanophores previously located on the posterior region of the anal fin migrate onto the ventral margin of the developing hypural. In postflexion larvae, a uniquely-shaped patch of pigmentation is present immediately posterior to the center of the pectoral fin (Fig. 27C).

A distinct stripe of pigmentation extends through the eye of juveniles (Fig. 27D). Pigmentation on the pectoral fin expands to cover nearly the entire fin. Melanophores also cover a greater proportion of the dorsal and anal fins. A crescent-shaped patch of melanophores is present on the caudal fin at the hypural margin.

Meristic Features (Table 38)—All fins are complete at 11.5 mm. The caudal fin has 2,(6+5),1 or 2,(6+6),0 rays. The vertebral column and all rows of dermal bony plates are also complete at 11.5 mm. Counts of 41 or 42 DLP+MDP or ILP are higher than those reported by Kanayama (1991).

Head Spines—Early flexion larvae possess two rows of small parietal spinules (Fig. 27B) that are overgrown during ontogeny to form a relatively flat parietal crest in postflexion larvae and juveniles (Figs. 27C,D). Early flexion larvae possess several other head spines including coronal, interopercular, and the second and third anterior and posterior preoperculars.

In addition, postflexion larvae and early juveniles possess dentary, angular, nasal, supraocular, frontal, tympanic, all superior infraorbital (1–5), first and fourth anterior and posterior preopercular, pterotic, posttemporal, subopercular, cleithral, and supracleithral spines.

Species Comparisons—Larval *Anoplagonus inermis* are similar to *U. olriki* and *Aspidophoroides monopterygius* larvae, which also lack a first (spinous) dorsal fin and a supralateral dermal plate row. Of these taxa, *A. inermis* has the deepest body morphology throughout development. In addition, *A. inermis* has more vertebrae (41–45) than *U. olriki* (37–40) and fewer than *A. monopterygius* (48–54). This meristic trend is also true of dermal plate counts in all rows for these three taxa. *Anoplagonus inermis* has fewer pectoral-fin rays (8–11) than *U. olriki* (13–16). With a caudal-fin ray formula of 2,(6+5),1 or 2,(6+6),0, *A. inermis* has more rays than *A. monopterygius* (2,(5+5),1) or *U. olriki* (1,(5+5),0). *Anoplagonus inermis* is the most heavily pigmented of these three taxa throughout development, with melanophores covering most of the lateral body.

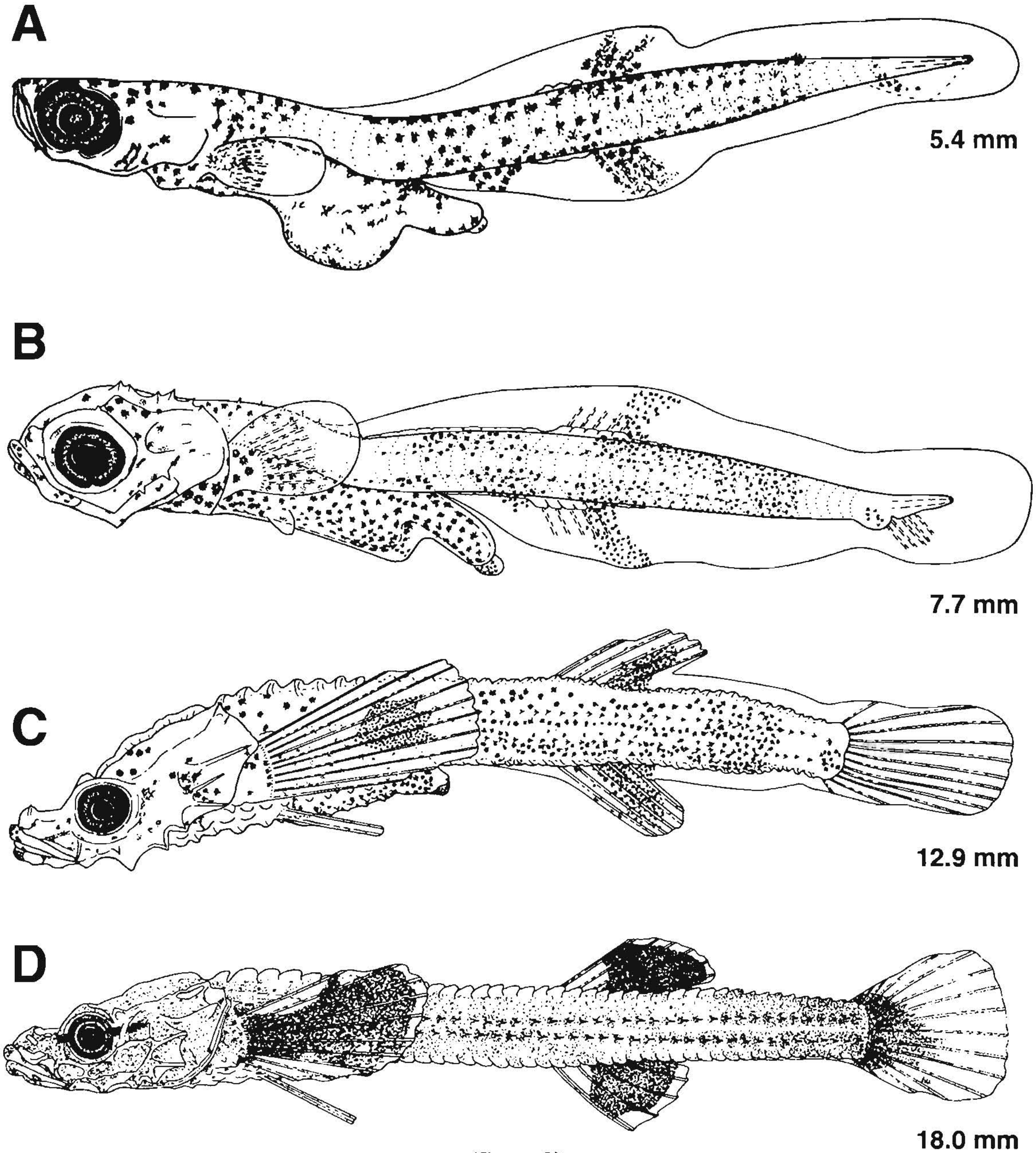


Figure 27

Developmental stages of *Anoplagonus inermis.* (A) Preflexion larva 5.4 mm; AFSC, 1PO85, St. G113A, N505. (B) Early flexion larva 7.7 mm, UW 032232. (C) Postflexion larva 12.9 mm, UW 032239. (D) Early juvenile 18.0 mm; VPA, Lambert Channel, 4/29/89, 3.

Table 37

Body proportions of *Anoplagonus inermis* larvae and early juveniles. Values given for each body proportion are expressed as percentage of standard length (SL) or head length (HL); mean, standard deviation, and range given in parentheses.

Body proportion	Preflexion		Flexion		Postflexion		Juvenile	
Sample size	5		1		6		3	
Standard length (mm)	6.2±0.9	(5.5–7.1)	7.6	(7.6)	13.5±1.5	(12.0–15.9)	19.4±2.0	(17.9–21.7)
Body depth/SL	11.5±1.4	(9.6–13.4)	11.2	(11.2)	12.7±1.5	(10.7–15.0)	13.6±0.3	(13.3–13.8)
Snout to anus length/SL	49.7±5.2	(41.3–55.3)	56.6	(56.6)	51.1±3.2	(47.2–56.1)	43.2±2.6	(40.3–45.0)
Predorsal length/SL					66.7±0.9	(63.6–66.3)	63.3±3.1	(60.7–66.7)
Head length/SL	18.2±2.7	(16.3–22.9)	19.1	(19.1)	27.0±1.4	(24.8–28.9)	29.1±2.1	(27.5–31.5)
Head width/HL	25.8±6.6	(17.6–33.0)	25.0	(25.0)	26.3±6.2	(20.3–36.6)	18.5±1.7	(16.6–18.9)
Snout length/HL	19.6±5.2	(14.6–26.9)	22.2	(22.2)	30.7±5.3	(27.4–41.2)	28.4±4.2	(25.3–33.2)
Eye diameter/HL	45.1±10.8	(32.1–60.6)	39.5	(39.5)	22.0±3.6	(16.3–26.8)	18.4±2.1	(16.1–20.0)
Pectoral-fin length/SL	11.8±3.2	(6.7–14.5)	11.7	(11.7)	24.3±1.3	(22.5–26.1)	28.7±4.8	(24.9–34.1)

Table 38

Meristics of cleared and stained *Anoplagonus inermis* larvae and early juveniles. Specimens between dashed lines (- - -) are undergoing notochord flexion.

Standard length (mm)	Dorsal fin spines	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Pelvic fin spines, rays	Branchiostegal rays	Neural spines abdominal	Neural spines caudal	Neural spines total	Haemal spines	Centra abdominal	Centra caudal	Centra total	Body plates[1] DLP+MDP	Body plates[1] SLP	Body plates[1] LLP	Body plates[1] ILP	Body plates[1] VLP+MVP
6.3																		
8.2														10		26	25	11
11.5		5	5	11	I,2	6	12	30	42	30	12	31	43	41		41	41	38
15.7		5	5	10	I,2	6	12	27	39	27	12	32	44	39		42	42	40
17.8		5	5	10	I,2	6	11	30	41	30	11	31	42	41		41	39	41

[1] DLP—dorsolateral; MDP—mid-dorsal; SLP—supralateral; LLP—lateral line; ILP—infralateral; VLP—ventrolateral; MVP—mid-ventral.

Subfamily Brachyopsinae

Stellerina xyosterna—pricklebreast poacher

Literature—An illustration of a 10.2 mm postflexion larva of *Stellerina xyosterna* was presented by Washington et al. (1984).

Wang (1986) included illustrations of 6.1 and 9.4 mm larvae and a brief description of eggs. The 9.4 mm specimen is incorrectly labeled as a juvenile. Additional information on the development of larvae and early juveniles, based on examination of 15 specimens, 4.7–14.3 mm, is presented here.

Distribution—Adult *S. xyosterna* occur from San Carlos Bay, Baja California, to the Gulf of Alaska on sand or mud substrates at depths from 4.6 to 75 m (Eschmeyer et al., 1983; Peden and Jamieson, 1988; Kanayama, 1991). Larvae are common in plankton samples from inshore and estuarine areas. Specimens examined in this study were collected in nearshore and estuarine areas of Oregon and Washington.

Morphology (Table 39)—The size at which notochord flexion begins in *S. xyosterna* is unclear. Flexion and caudal-fin ray development are evident in the smallest specimen examined (5.8 mm). Larvae probably hatch from eggs in the flexion stage. Flexion is complete at 9.5 mm. The juvenile stage begins at 14.0 mm. Larvae are medium-bodied with a mean body depth of 13.1% SL during flexion, increasing to 16.8% SL in juveniles. The head and lower jaw are very robust in appearance. Snout length increases from 21.8% HL in flexion larvae to 27.9% HL in juveniles. The very large, fan-shaped pectoral fin increases in length from 37.0% SL in flexion larvae to 38.4% SL postflexion and decreases to 36.7% SL in juveniles.

Pigmentation (Fig. 28)—Larvae of *S. xyosterna* are lightly pigmented. Preflexion larvae possess a few melanophores on the opercular region, lower jaw, and pectoral-fin base (Fig. 28A). Additional melanophores are evenly distributed over the lateral surface of the gut. A row of evenly-spaced melanophores is present along the ventral midline of the gut. A very distinct row of large melanophores is present on the pectoral-fin rays approximately three-fourths of the distance from the fin base to the outer edge. Two or more melanophores form irregular and varying patterns near midbody. A row of irregularly-spaced, postanal ventral melanophores ending at the caudal peduncle is present. In some individuals these melanophores are on the ventral surface of the body, while in others they appear to be on the anal finfold. An additional small patch of pigmentation is present near the ventral edge of the hypural region. Some of this patch extends on to the posterior region of the anal finfold.

In flexion and postflexion larvae, additional melanophores develop on the edges of the pectoral-fin base and outer margin of the pectoral fin (Figs. 28B,C).

Table 39

Body proportions of *Stellerina xyosterna* larvae and early juveniles. Values given for each body proportion are expressed as percentage of standard length (SL) or head length (HL); mean, standard deviation, and range given in parentheses.

Body proportion	Flexion		Postflexion		Juvenile
Sample size	5		6		1
Standard length (mm)	6.8±1.4	(5.5–8.8)	11.5±1.4	(9.9–13.2)	14.3 (14.3)
Body depth/SL	13.1±1.9	(11.0–15.6)	14.9±1.9	(12.2–17.5)	16.8 (16.8)
Predorsal length/SL	51.0±3.1	(46.6–55.0)	49.4±2.7	(46.8–54.6)	46.0 (46.0)
Snout to anus length/SL	31.8[1]	(31.8)	36.7±1.9	(34.8–40.2)	41.0 (41.0)

Body proportion	Flexion		Postflexion		Juvenile
Head length/SL	22.1±2.8	(18.9–25.1)	26.6±1.5	(24.1–28.1)	28.4 (28.4)
Head width/HL	29.3±6.4	(20.4–37.2)	18.2±1.8	(15.4–20.8)	15.0 (15.0)
Snout length/HL	21.8±7.5	(13.8–33.3)	27.1±3.3	(22.8–31.8)	27.9 (27.9)
Eye diameter/HL	26.9±7.8	(17.7–33.6)	19.2±1.3	(17.8–21.1)	16.6 (16.6)
Pectoral-fin length/SL	37.0±4.0	(31.1–42.0)	38.4±2.3	(35.8–42.3)	36.7 (36.7)

[1] Sample size = 1.

Additional melanophores cover the head and pectoral fin in late postflexion larvae and juveniles (Fig. 28D). The pigmentation pattern on the pectoral fin of juveniles shows great individual variation with complete or nearly complete melanophore coverage by the adult stage. Patches of pigmentation are also present on the dorsal and anal fins. Additional melanophores develop that cover the hypural region.

Meristic Features (Table 40)—The pectoral fin is first to attain an adult complement of elements at 9.1

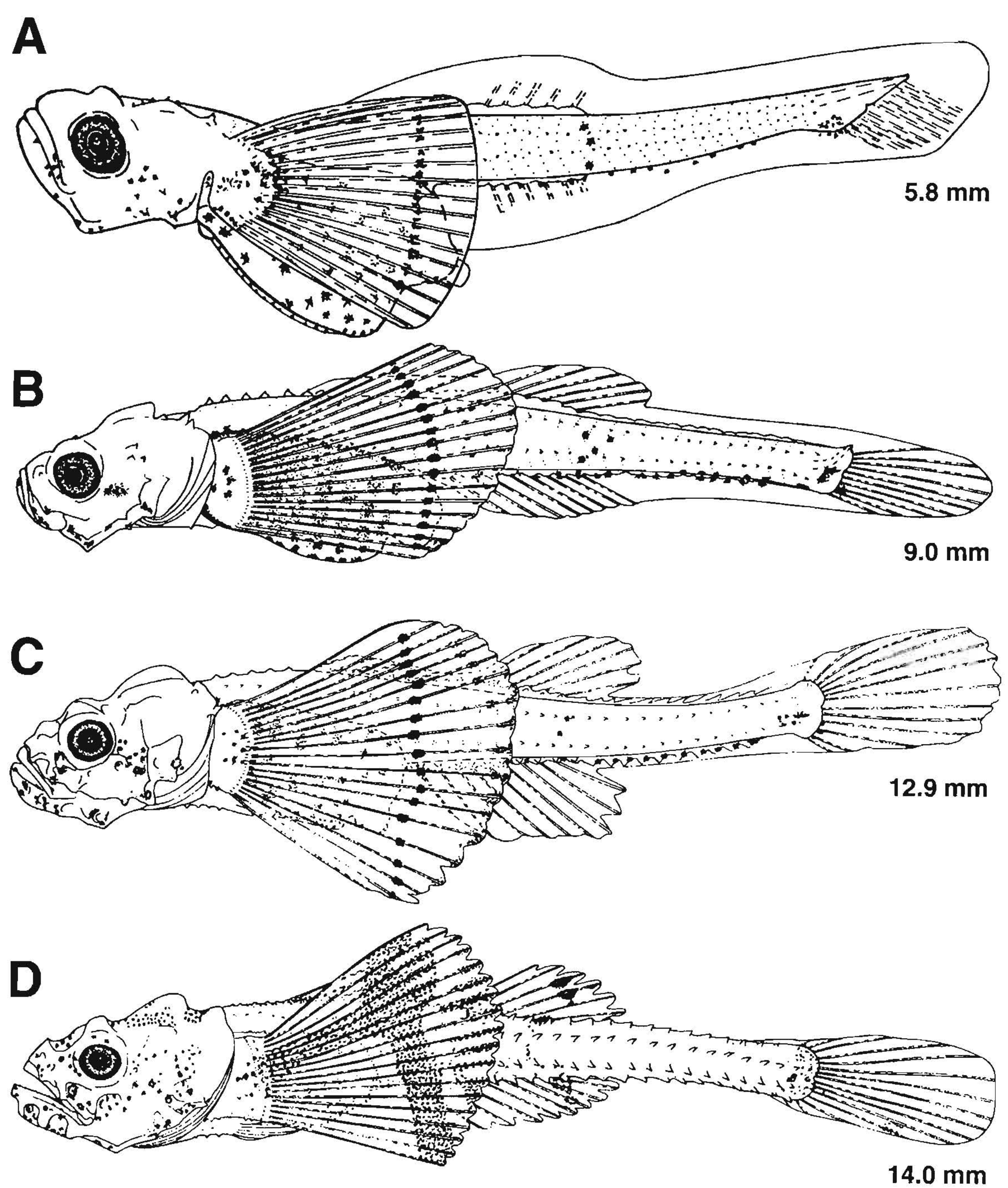


Figure 28

Developmental stages of *Stellerina xyosterna.* (A) Flexion larva 5.8 mm; AFSC, 7105-6P-1, 1. (B) Late flexion larva 9.0 mm; AFSC, K72-2, 3-3/8, 501. (C) Postflexion larva 12.9 mm; AFSC, K72-2, 3-3/1, 489. (D) Early juvenile 14.0 mm; AFSC, SEI 77-9, St. 090, 6B5.

Table 40

Meristics of cleared and stained *Stellerina xyosterna* larvae and early juveniles. Specimens between dashed lines (- - -) are undergoing notochord flexion.

Standard	Dorsal fin		Anal fin	Pectoral	Pelvic fin	Branchi-ostegal	Neural spines			Haemal	Centra			Body plates[1]				
length (mm)	spines	rays	rays	fin rays	spines, rays	rays	abdominal	caudal	total	spines	abdominal	caudal	total	DLP+MDP	SLP	LLP	ILP	VLP+MVP
4.7																		
6.5														5	28		29	11
8.3				8		5	4		4					26	30		33	24
9.1				18		6	7		7					32	30		33	31
10.2				19		6	7		7		3		3	33	30		33	28
11.1	VII	5	8	19	I,2	6	13	22	35	21	13	23	36	34	32	3	33	29
12.9	VII	6	9	19	I,2	6	13	23	36	22	13	23	36	34	28	6	32	31
14.0	VII	6	8	18	I,2	6	13	23	36	22	13	24	37	36	30	25	33	32

[1] DLP—dorsolateral; MDP—mid-dorsal; SLP—supralateral; LLP—lateral line; ILP—infralateral; VLP—ventrolateral; MVP—mid-ventral.

mm. All remaining fins and vertebral elements are complete at 11.1 mm. The caudal fin has 3,(6+6),1 rays. All rows of dermal bony plates are complete, with the exception of the VLP+MVP and LLP at 10.2 mm. The VLP+MVP row is complete at 11.1 mm. The LLP are not complete in the largest specimens examined (14.0, 14.3 mm).

Head Spines—The head spines of *S. xyosterna* larvae are generally thick and broad-based giving the head, and particularly the lower jaw, a very robust appearance. Early flexion larvae possess two rows of small parietal spinules (Fig. 28A) that are overgrown during ontogeny to form a highly arched parietal crest in postflexion larvae and juveniles (Figs. 28C,D). Flexion larvae of 8.3 mm length possess supraocular, first, third, and fifth superior infraorbitals, all anterior and posterior preoperculars, pterotic, and cleithral spines. At 9.1 mm, nasal and frontal spines are present. The frontal spine is fused with the supraocular spine medially. At 10.2 mm, three broad-based dentary spines are present, as are articular and angular spines and the first, second, third, and fifth inferior infraorbital plates. The second and fourth superior infraorbital spines and fourth inferior infraorbital plate are present in postflexion larvae of 11.1 mm. Posttemporal and supracleithral spines are present at 12.9 mm.

Species Comparisons—Larvae and juveniles of *S. xyosterna* are most similar to those of *Chesnonia verrucosa*, another member of the subfamily Brachyopsinae. Flexion in *S. xyosterna* begins at 5.5 mm and ends at 9.5 mm, while *C. verrucosa* begins flexion at 6.0 mm and ends at 12.0 mm. Pigmentation of the pectoral fin is restricted to a row of large single melanophores in flexion and postflexion *S. xyosterna; C. verrucosa* has a distinctly wider band of pigmentation. *Stellerina xyosterna* larvae also have considerably less pigmentation on the lateral body and caudal fin throughout development. Juvenile *C. verrucosa* retain the band seen on the pectoral fin of larvae; *S. xyosterna* juveniles develop irregularly-shaped bands and patches. *Chesnonia verrucosa* have fewer pectoral-fin rays (13–15) and usually more anal-fin rays (7–13) than *S. xyosterna* (17–19, 8–9). *Chesnonia verrucosa* also have more dermal plates in the SLP and ILP rows (*C. verrucosa* SLP 34-35, ILP 35-37: *S. xyosterna* SLP 28-31, ILP 28-31).

Chesnonia verrucosa—warty poacher

Literature—The warty poacher, formerly included in the genus *Occella*, was placed in the genus *Chesnonia* by Kanayama (1991). Washington et al. (1984) provided an illustration of a 10.1 mm flexion larva. New information on the development of larval and early juveniles based on examination of 18 specimens, 5.8–16.0 mm, is presented here.

Distribution—Adult *C. verrucosa* occur from central California to the Bering Sea on soft substrates at depths of 18 to 274 m (Eschmeyer et al., 1983; Matarese et al., 1989). Larvae are uncommon in plankton samples. Specimens of larvae and juveniles examined in this study were collected mostly from nearshore waters off Oregon.

Morphology (Table 41)—Notochord flexion in *C. verrucosa* begins at 6.0 mm and is complete at 12.0 mm. The juvenile stage begins at about 15.5 mm. Larvae are slender-bodied during preflexion and flexion stages with mean body depths of 7.1–8.7% SL. As postflexion larvae and juveniles, they are medium-bodied (10.0–13.3% SL). Head length increases from 15.1% SL in preflexion larvae to 25.1% SL in juveniles. The snout is relatively long, increasing in length from 23.9% HL in preflexion larvae to 35.5% HL postflexion. The extremely large, fan-shaped pectoral fin increases in length from 25.2% SL in flexion larvae to 34.7% SL postflexion and decreases to 30.6% SL in juveniles.

Pigmentation (Fig. 29)—Larvae of *C. verrucosa* are lightly pigmented. Preflexion larvae possess a few melanophores on the opercular region, lower jaw, and pectoral-fin base (Fig. 29A). A vertical row of regularly-spaced melanophores is present near the outer edge of the pectoral finfold. Additional melanophores are evenly distributed over the ventral and posterolateral surfaces of the gut. At midbody, 5–10 widely-spaced melanophores, arranged in an irregular pattern, are present. A row of 5–8 melanophores is present on the anal finfold near the ventral midline of the body. Two or more additional melanophores may also be located on the anal finfold, separate from the midline row. An additional small cluster of 3–5 melanophores is present near the ventral edge of the hypural region immediately anterior to the notochord tip.

In flexion and postflexion larvae, a thick band of pigmentation develops at approximately four-fifths of the distance toward the outer margin of the pectoral fin (Figs. 29B,C). A row of five or more evenly-spaced melanophores is present on the anterior half of the ventral midline of the gut. Additional melanophores cover the lateral surface of the body, ventral midline, and hypural region. Melanophores are present on the developing caudal-fin rays and cover nearly the entire fin in postflexion larvae.

In late postflexion larvae and early juveniles, pigmentation on the lateral body is present as three distinct

Table 41

Body proportions of *Chesnonia verrucosa* larvae and early juveniles. Values given for each body proportion are expressed as percentage of standard length (SL) or head length (HL); mean, standard deviation, and range given in parentheses.

Body proportion	Preflexion	Flexion		Postflexion		Juvenile
Sample size	1	13		2		1
Standard length (mm)	5.8 (5.8)	8.5±1.8	(6.0–11.8)	12.1±0.1	(12.1–12.2)	15.5 (15.5)
Body depth/SL	7.1 (7.1)	8.7±1.2	(7.4–11.7)	10.0±1.0	(9.3–10.7)	13.3 (13.3)
Predorsal length/SL	46.6 (46.6)	49.7±2.8	(42.3–53.0)	47.3±0.2	(47.2–47.5)	46.4 (46.4)
Snout to anus length/SL		35.6±2.0[1]	(32.8–36.7)	37.0±4.0	(34.2–39.8)	36.8 (36.8)
Head length/SL	15.1 (15.1)	19.5±2.2	(14.6–22.5)	22.3±3.0	(20.2–24.3)	25.1 (25.1)
Head width/HL	20.5 (20.5)	21.3±4.8	(14.7–28.4)	18.6±4.0	(15.8–21.5)	22.9 (22.9)
Snout length/HL	23.9 (23.9)	25.4±5.4	(17.6–34.0)	35.5±6.3	(31.0–40.0)	27.1 (27.1)
Eye diameter/HL	39.3 (39.3)	22.7±5.3	(17.0–37.0)	19.2±2.5	(17.4–21.0)	16.2 (16.2)
Pectoral-fin length/SL	12.6 (12.6)	25.2±3.9	(18.7–34.1)	34.7±0.3	(34.5–34.9)	30.6 (30.6)

[1] Sample size = 3.

bands connected ventrally by a thin bar (Figs. 29C,D). The first band is present between the posterior margins of the dorsal and anal fins. The second is located on, or immediately anterior to, the caudal peduncle, and the third covers the hypural region. In juveniles, additional melanophores are present on the head and pectoral-fin base. The caudal fin remains almost completely covered with melanophores with the exception of the superior procurrent rays and the posterior edge.

Meristic Features (Table 42)—The pectoral fin is first to attain an adult complement of rays at 6.5 mm. All remaining fins, with the exception of the pelvic and caudal, are complete at 10.6 mm. The pelvic and caudal fins are complete at 16.0 mm. The caudal fin has

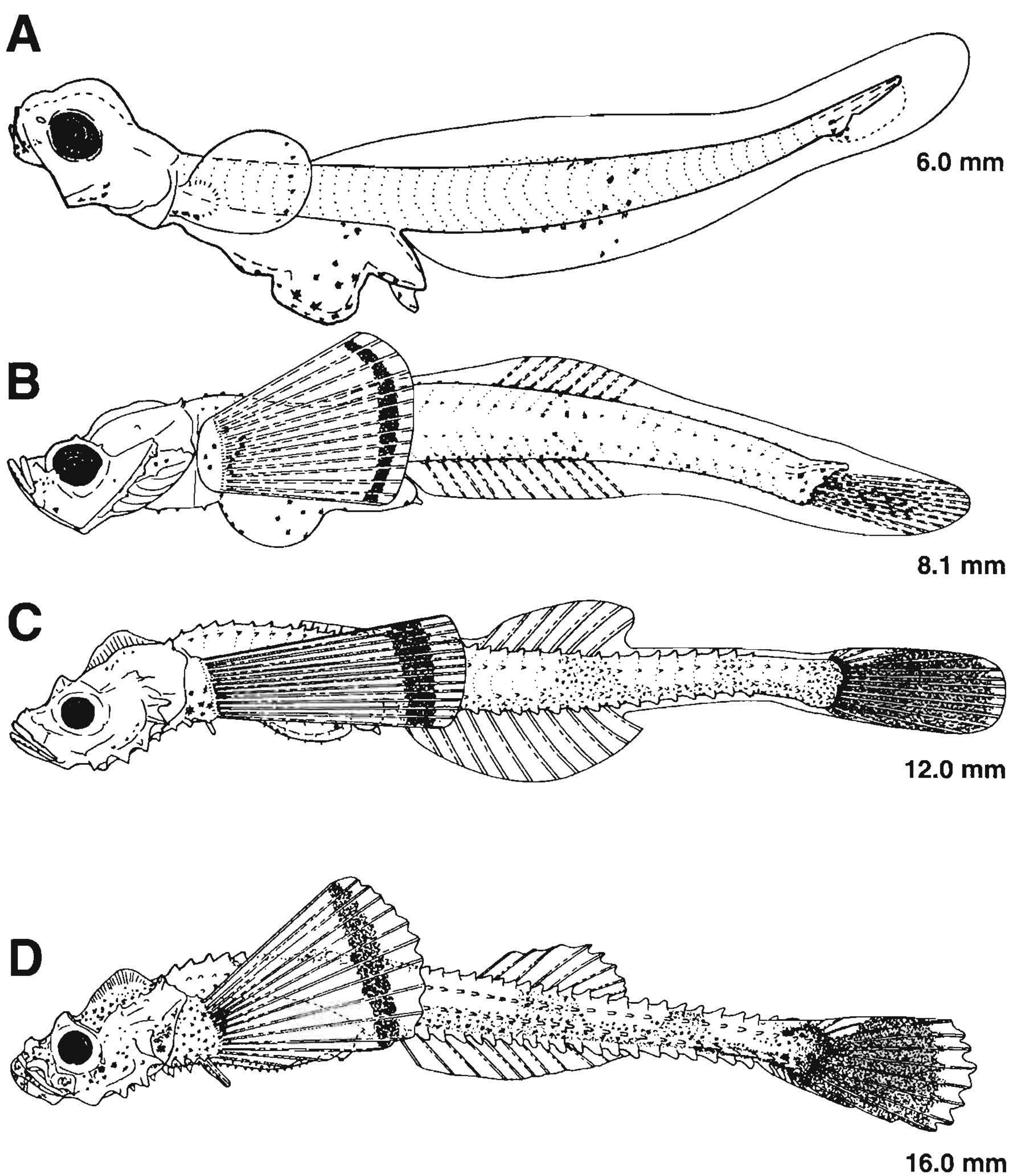


Figure 29
Developmental stages of *Chesnonia verrucosa.* (A) Preflexion larva 6.0 mm; OSU, 748E, 3-4IV72, NH1. (B) Flexion larva 8.1 mm; OSU, 1002E, III-1, 17 Mar 73. (C) Postflexion larva 12.0 mm; OSU, 824E, VII-1, 30 Mar 72. (D) Early juvenile 16.0 mm; OSU, 1093E, XI-1, 8 Apr 73.

Table 42

Meristics of cleared and stained *Chesnonia verrucosa* larvae and early juveniles. Specimens between dashed lines (- - -) are undergoing notochord flexion.

Standard length (mm)	Dorsal fin spines	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Pelvic fin spines, rays	Branchiostegal rays	Neural spines abdominal	Neural spines caudal	Neural spines total	Haemal spines	Centra abdominal	Centra caudal	Centra total	Body plates[1] DLP+MDP	SLP	LLP	ILP	VLP+MVP
6.5				14		5								6	33		33	9
8.4				14		6	9		9	5	13	17	30	26	35		36	24
10.6	VII	6	10	14		6	13	13	26	12	13	17	30	31	33		34	23
12.2	IX	8	12	14		6	13	25[2]	38	24	13	25	38	35	34		35	30
16.0	VIII	7	11	14	I,2	6	13	24[2]	37	23	13	24	37	36	34	22	35	33

[1] DLP—dorsolateral; MDP—mid-dorsal; SLP—supralateral; LLP—lateral line; ILP—infralateral; VLP—ventrolateral; MVP—mid-ventral.
[2] Two neural spines on preural centra.

3,(6+6),1 rays. All vertebral elements are ossified at 12.2 mm. All rows of dermal bony plates are complete at 12.2 mm with the exception of the ILP and LLP. The ILP row is complete at 16.0 mm with a count of 35. The ILP count of 35 is below the range of 36–37 reported by Kanayama (1991). The LLP were not complete in the largest specimen examined (16.0 mm).

Head Spines—The head spines of *C. verrucosa* larvae are generally thick and broad-based, giving the head a somewhat robust appearance. Early preflexion larvae possess two rows of small parietal spinules (Fig. 28A) that are overgrown during ontogeny to form a highly arched parietal crest in late preflexion and all later stages (Figs. 29A–D). Preflexion larvae also possess the first and second anterior and posterior preopercular spines, and a subopercular spine. Early flexion larvae of approximately 8.4 mm length have three dentary, articular, supraocular, coronal, third and fourth anterior and posterior preopercular, first and fifth superior infraorbital, pterotic, cleithral, and supracleithral spines. The nasal spine develops during late flexion at approximately 10.6 mm. The frontal, second and third superior infraorbital, and second subopercular are present at 12.2 mm. The fourth superior infraorbital is present at 16.0 mm.

Species Comparisons—Larvae and juveniles of *C. verrucosa* are most similar to those of *Stellerina xyosterna*, another member of the subfamily Brachyopsinae. Flexion in *S. xyosterna* begins at 5.5 mm and ends at 9.5 mm, while *C. verrucosa* begins flexion at 6.0 mm and ends at 12.0 mm. Pigmentation of the pectoral fin is restricted to a row of large, single melanophores in flexion and postflexion *S. xyosterna*, while *C. verrucosa* has a distinctly wider band of pigmentation. *Chesnonia verrucosa* larvae also have considerably more pigmentation on the lateral body and caudal fin throughout development. Juvenile *C. verrucosa* retain the band seen on the pectoral fin of larvae; *S. xyosterna* juveniles develop irregularly-shaped bands and patches. *Chesnonia verrucosa* have fewer pectoral-fin rays (13–15) and usually more anal-fin rays (7–13) than *S. xyosterna* (17–19, 8–9). *Chesnonia verrucosa* also have more dermal plates in the SLP and ILP rows (*C. verrucosa* SLP 34-35, ILP 35-37; *S. xyosterna* SLP 28-31, ILP 28-31).

***Occella dodecaedron*—Bering poacher**

Literature—A partial series of postflexion and early juvenile *Occella dodecaedron* (10.7–21.4 mm) was described by Maeda and Amaoka (1988). No specimens were available for this study. The description by Maeda and Amaoka (1988) is summarized here for comparison with other taxa for identification purposes.

Distribution—Adults occur from the Aleutian Islands to the Chukchi Sea at depths from 7 to 325 m (Allen and Smith, 1988; Matarese et al., 1989). Kanayama (1991) reports *O. dodecaedron* occurring off California but this report is very questionable.

Miller and Lea (1972) and Hubbs et al. (1979) do not report this species from California waters. No specimens were found in collections examined for this study and occurences of larvae have not been reported in the Northeast Pacific Ocean.

Morphology (Table 43)—The size at which notochord flexion in *O. dodecaedron* begins is unknown but it is apparently complete by 10.7 mm. The juvenile stage begins at approximately 14.0 mm. Larvae are slender-bodied (9.2–9.3% SL) as postflexion larvae and medium-bodied as juveniles (10.7–15.3% SL). Head length increases from 25.7% SL postflexion to 29.0% SL in juveniles. Snout length increases from 13.2% HL in postflexion larvae to 22.2% HL in juveniles. The length of the pectoral fin decreases from 28.0–29.2% SL postflexion to 20.4–25.5% SL in juveniles.

Pigmentation (Fig. 30)—Larvae of *O. dodecaedron* are light to moderately pigmented as postflexion larvae and heavily pigmented as juveniles. Early postflexion larvae possess melanophores on the opercular and posttemporal regions of the head, lateral surface of the gut, pectoral-fin base, and postanal body to the caudal peduncle (Fig. 30A). Distinct dark, irregularly-shaped

Table 43

Body proportions of *Occella dodecaedron* larvae and early juveniles. Values given for each body proportion are expressed as percentage of standard length (SL) or head length (HL); mean (single value), or range (two values) (Maeda and Amaoka, 1988).

Body proportion	Postflexion	Juvenile
Sample size	2	6
Standard length (mm)	10.2,12.0	14.1–21.4
Body depth/SL	9.2–9.3	10.7–15.3
Predorsal length/SL		
Snout to anus length/SL	52.5–54.2	43.5–50.4
Head length/SL	25.7	29.0
Head width/HL		
Snout length/HL	13.2	22.2
Eye diameter/HL	23.3–23.5	20.4–22.2
Pectora-fin length/SL	28.0–29.2	20.4–25.5

Table 44

Meristics of *Occella dodecaedron* larvae and early juveniles. Larval counts from Maeda and Amaoka (1988). Adult counts compiled from Matarese et al. (1989) and Kanayama (1991).

Standard[1] length (mm)	Dorsal fin spines	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Pelvic fin spines, rays	Branchiostegal rays	Neural spines abdominal	Neural spines caudal	Neural spines total	Haemal spines	Centra abdominal	Centra caudal	Centra total	Body plates[2] DLP+MDP	SLP	LLP	ILP	VLP+MVP
10.7	XII	8	15	15	I,2									39	37	20	37	36
12.0	X	7	13	15	I,2									39	36	29	37	36
14.1	IX	8	15	15	I,2									38	35	25	37	37
17.8	X	8	15	15	I,2									38	36	37	39	36
18.6	XI	9	14	15	I,2									39	39	30	39	36
19.6	X	7	15	14	I,2									38	37	40	38	35
20.9	IX	9	15	14	I,2									39	38	40	38	38
21.4	X	7	15	15	I,2									39	36	40	39	37
Adults	VIII–XI	6–9	13–16	14–16	I,2	6	13	25	38	25	13	26	37–40	34–44	33–37	39–42	36–39	31–43

[1] Larval and juvenile counts are from unstained specimens.

[2] DLP—dorsolateral; MDP—mid-dorsal; SLP—supralateral; LLP—lateral line; ILP—infralateral; VLP—ventrolateral; MVP—mid-ventral.

patches of pigmentation are present on the posteriormost portions of the second dorsal and anal fins. During late postflexion, additional melanophores develop on the head and lateral body (Fig. 30B).

Melanophores completely cover the head and lateral surface of the body in juveniles (Fig. 30C). A single vertical row of large melanophores develops on the pectoral fin about four-fifths of the distance from the base to the outer edge of the fin. Additional melanophores develop on the posteriormost portions of the second dorsal and anal fins to form very dark blotches. Approximately three-quarters of the caudal fin is covered with melanophores.

Meristic Features (Table 44)—Maeda and Amaoka (1988) report that counts of elements for all fins are complete in the smallest specimen examined (10.7 mm). However, no count is reported for the caudal fin. All rows of dermal bony plates are also complete at 10.7 mm with the exception of the LLP. The LLP row is complete at 19.6 mm.

Head Spines—The head spines of *O. dodecaedron* larvae have not been examined in great detail. Maeda and Amaoka (1988) reported the presence of a low (not highly arched) parietal crest and nasal, four preoperculars (probably PPO 1-4 perhaps fused with APO 1-4), supraocular, postocular, and posttemporal spines in their 10.7 mm specimen (Fig. 30A). It also appears that the specimen possibly has two superior infraorbital (2,4), an angular, and a supracleithral spine. The 12.0 mm specimen (Fig. 30B) appears to have at least four supe-

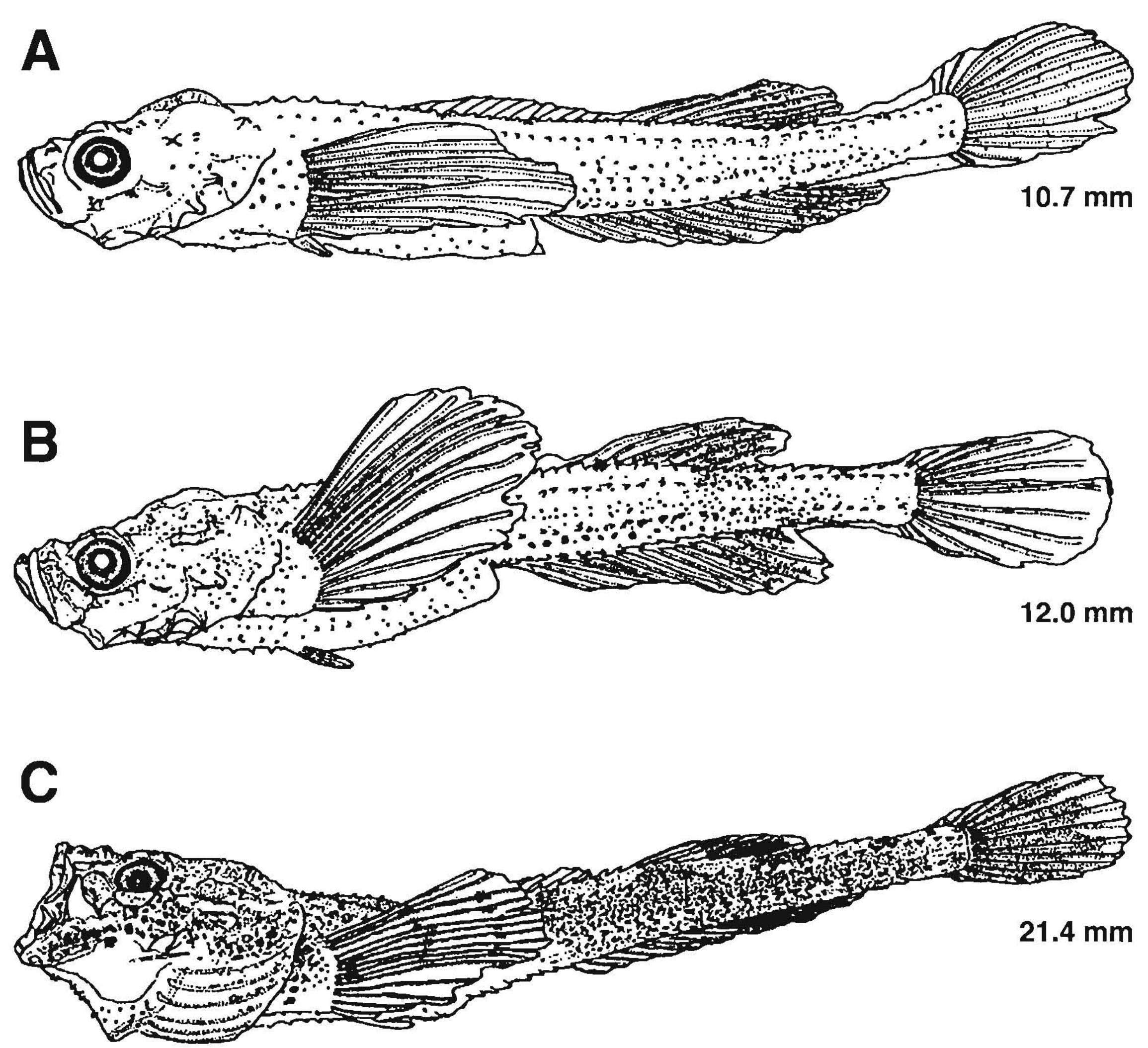


Figure 30
Development of larval *Occella dodecaedron* (Maeda and Amaoka, 1988). (A) Early postflexion larva 10.7 mm. (B) Late postflexion larva 12.0 mm. (C) Juvenile 21.4 mm.

rior infraorbital spines (1–3,5). It is difficult, if not impossible, to identify any head spines in the juvenile specimen (Fig. 30C).

Species Comparison—Larvae and juveniles of *O. dodecaedron* are similar to those of *Chesnonia verrucosa* and *Stellerina xyosterna*, the other members of the subfamily Brachyopsinae. The pectoral fin of *O. dodecaedron* is unpigmented until the juvenile stage and is somewhat oval in shape with rounded edges. *Chesnonia verrucosa* and *S. xyosterna* have fan-shaped pectoral fins with more abrupt edges and distinct rows or bands of melanophores near the outer edges. *Occella dodecaedron* has more pigmentation than *Stellerina xyosterna* on the lateral body. *Chesnonia verrucosa* has more pigmentation than *O. dodecaedron* on the caudal fin during the flexion stage. *Occella dodecaedron* has more anal-fin rays (13–16) than *S. xyosterna* (8–9) and usually more than *C. verrucosa* (7–13). *Occella dodecaedron* has fewer pectoral-fin rays (14–16) than *S. xyosterna* (17–19), higher dermal plate counts in all rows (Tables 39 and 43), and usually more vertebrae (34–37,37–40).

***Pallasina barbata*—tubenose poacher**

Literature—Maeda and Amaoka (1988) described a partial series of *Pallasina* sp. (flexion, postflexion). Two other species of *Pallasina*, *P. aix* and *P. eryngia*, were recognized based on lower jaw barbel length, pectoral-fin ray counts, and number of pre-pelvic plates. Kanayama (1991) considered *P. aix* and *P. eryngia* junior synonyms of *P. barbata*. With this synonymization, the larvae described by Maeda and Amaoka (1988) as *Pallasina* sp. must have been *Pallasina barbata*. Information on flexion and postflexion stages provided by Maeda and Amaoka (1988) is combined with new information on preflexion and juvenile stages, based on examination of nine specimens, 6.4–47.2 mm.

Distribution—Adult *P. barbata* occur from central California to the Bering Sea, Japan, and the Arctic in shallow nearshore waters from the intertidal zone to 55 m and possibly to 128 m (Eschmeyer et al., 1983; Matarese et al., 1989). Adults are usually found in eel grass or seaweed beds with sandy bottoms (Eschmeyer et al., 1983; Kanayama, 1991). Larvae are uncommon in plankton samples. Larvae and juveniles examined in this study were collected throughout their adult range with the exception of the Arctic Ocean.

Morphology (Table 45)—Notochord flexion in *P. barbata* begins at 7.0 mm and is complete between 11.5 and 12.0 mm. The juvenile stage begins at approximately 23.0 mm with some variability among individuals. Larvae are slender-bodied throughout development with body depth decreasing from 9.6% SL in preflexion larvae to 7.3% SL in juveniles. Head length increases from 15.7% SL in preflexion larvae to 24.5% SL in juveniles. Snout morphology is unique among agonids, being very long and tube-shaped with a small, upturned (superiorly oriented) mouth. Snout length increases remarkably from 20.4% HL in preflexion larvae to 40.0% HL in juveniles. The lower jaw protrudes beyond the upper in postflexion larvae and juveniles. A forward-projecting barbel is present at the tip of the lower jaw in juveniles and adults. The length of the barbel varies geographically (Kanayama, 1991). Pectoral-fin length increases from 6.3% SL in preflexion larvae to 19.0% SL in juveniles.

Pigmentation (Fig. 31)—Larvae of *P. barbata* are heavily pigmented. Large melanophores are present dorsally on the head and nape of preflexion larvae (Fig. 31A). Additional pigmentation is present on the lower jaw, postocular, and posttemporal regions. Melanophores are also present on the pectoral-fin base, isthmus, and the dorsolateral surface of the gut. The lateral surface of the body is completely covered with pigmentation from immediately above the hindgut to the hypural region. Ventral pigmentation on the postanal body is particularly dense. The finfolds and notochord tip are unpigmented.

Pigmentation on the dorsal surface of the head and pectoral-fin base is gradually reduced during the flexion stage (Fig. 31B). Additional pigmentation develops on the tip of the upper jaw. Melanophores become very densely aggregated ventrally on the body. In late postflexion larvae, melanophores develop on the anterior portion of the caudal fin and cover nearly the entire fin in early juveniles (Fig. 31C). A distinct stripe of pigmentation extends from about mid-snout through the eye to the posterior margin of the head in juveniles.

Meristic Features (Table 46)—The second dorsal, anal, and pectoral fins have adult complements of rays at 7.6 mm. However, these counts are from an unstained specimen so it is not known if the elements were ossified. The first (spinous) dorsal fin is complete at 9.7 mm. The DLP+MDP, ILP, and VLP+MVP dermal plate rows have counts within the range of adults at 10.2 mm, but may not be complete until 12.7 mm. The SLP row is complete at 11.6 mm and the LLP at 34.5 mm. The SLP counts of 30 in the largest juvenile specimens are lower than the adult range of 33–52 given by Kanayama (1991). The pelvic fin elements, branchiostegal rays, and vertebrae are complete in the smallest cleared and stained juvenile specimen examined (24.6 mm). *Pallasina barbata* is the only agonid that sometimes has five branchiostegal rays.

Head Spines—Because larvae of *P. barbata* were unavailable for clearing and staining, the descriptive account of head spination provided by Maeda and Amaoka (1988) of unstained specimens is summarized here.

The parietal ridge (or crest) and supraocular spine are present at 9.7 mm (the parietal ridge appears highly arched and bilobed (Fig. 31B)). A pair of posttemporal spines appears at 10.2 mm that fuse at 14.9 mm. A pair of nasal spines is also present at 14.9 mm. The anterior and posterior preopercular spines are complete during late postflexion. Two pairs of postocular spines develop between 12.7 and 17.2 mm and fuse at 18.3 mm. The second through fourth branchiostegal rays have a small spiny process near the proximal tip.

In addition, a cleared and stained juvenile (24.6 mm) has angular, articular, coronal, supracleithral, opercular, subopercular, and pterotic spines. Frontal and tympanic spines were present at 34.5 mm. Postocular and six inferior infraorbital dermal plates were present at 43.1 mm.

Species Comparisons—The slender body morphology, heavy pigmentation on the lateral body, tube-shaped snout with barbel, and high vertebral count (42–52) distinguish *P. barbata* from all other agonids. *Aspidophoroides monopterygius* is also slender-bodied with a high vertebral count (48–54) but it is not heavily pigmented, has a shorter snout, and has no first dorsal fin. Preflexion and flexion larvae of *P. barbata* may possibly be confused with heavily pigmented *Bathyagonus*. However, unlike any *Bathyagonus* larvae, *P. barbata* has no finfold pigmentation.

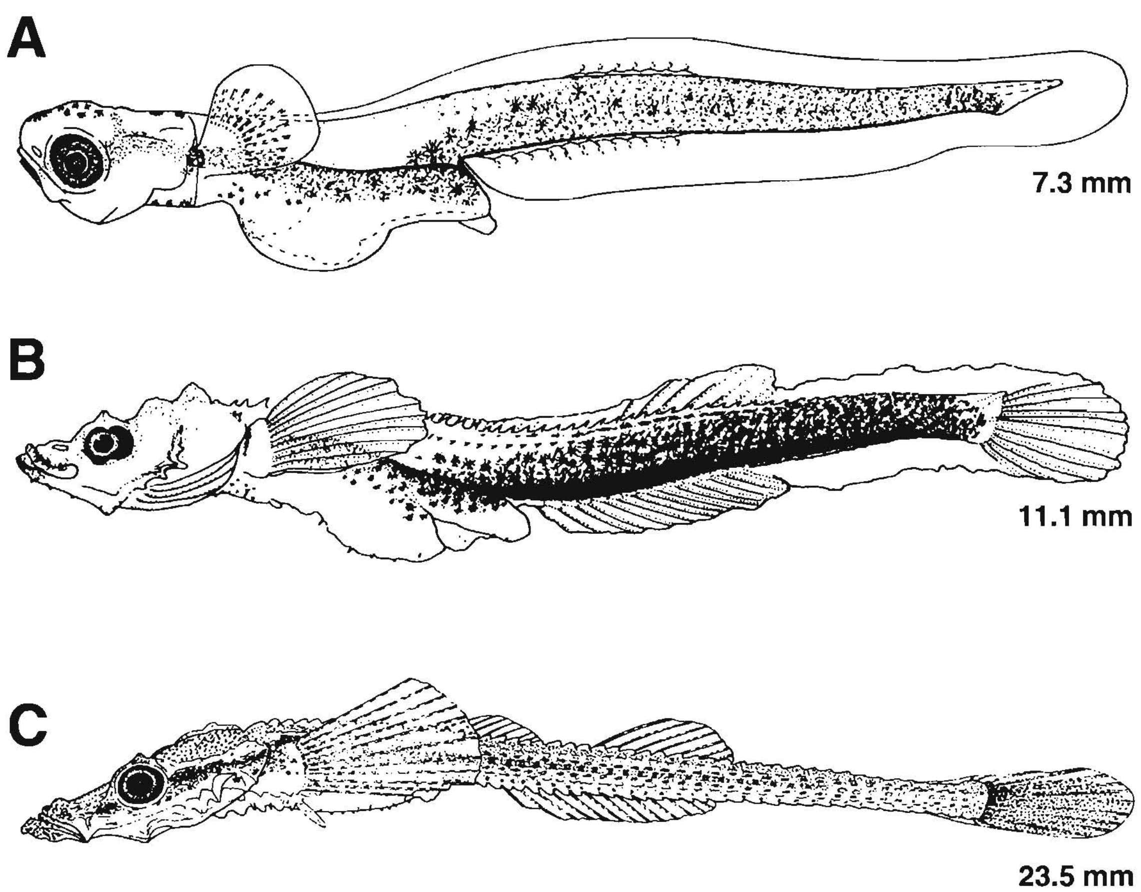


Figure 31
Developmental stages of *Pallasina barbata*. (A) Preflexion larva 7.3 mm; OSU, 748E, 3-4IV72, NH1. (B) Late flexion larva 11.1 mm; OSU, 559D, 14 May 71, NH1. (C) Early juvenile 23.5 mm; VPA, 5/21/74.

Table 45

Body proportions of *Pallasina barbata* larvae and juveniles. Values given for each body proportion are expressed as percentage of standard length (SL) or head length (HL); mean, standard deviation, and range given in parentheses. Postflexion values from Maeda and Amaoka (1988).

Body proportion	Preflexion	Flexion		Postflexion		Juvenile	
Sample size	1	3		8		5	
Standard length (mm)	6.4 (6.4)	8.5±2.3	(7.1–11.1)		(11.6–21.0)	34.7±10.6	(23.8–47.2)
Body depth/SL	9.6 (9.6)	9.0±0.3	(8.7–9.4)	5.2		7.3±0.5	(6.7–8.0)
Predorsal length/SL	48.4 (48.4)	46.7±4.4	(41.7–50.2)		(44.3–44.8)	38.6±4.0	(34.4–43.8)
Snout to anus length/SL						41.8±2.5	(37.6–43.9)
Head length/SL	15.7 (15.7)	18.6±3.4	(15.5–22.3)		(22.2–22.4)	24.5±2.0	(22.1–25.1)
Head width/HL	56.4 (56.4)	20.8±3.4[1]	(18.3–23.2)			11.4±1.1	(10.4–13.1)
Snout length/HL	20.4 (20.4)	18.2±4.7	(18.2–26.1)	32.7		40.0±4.6	(35.0–46.2)
Eye diameter/HL	34.7 (34.7)	30.6±1.2	(24.3–31.4)	16.3		14.2±2.3	(12.1–17.0)
Pectoral-fin length/SL	6.3 (6.3)	11.0±7.1	(6.3–19.3)		(17.1–19.1)	19.0±1.7	(17.8–21.4)

[1] Sample size = 2.

Table 46

Meristics of larvae and cleared and stained juvenile *Pallasina barbata*. Specimens between dashed lines (– – –) are undergoing notochord flexion. Counts for 7.6–21.0 mm specimens from Maeda and Amaoka (1988). Adult counts compiled from Matarese et al. (1989) and Kanayama (1991).

Standard[1] length (mm)	Dorsal fin spines	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Pelvic fin spines, rays	Branchiostegal rays	Neural spines abdominal	Neural spines caudal	Neural spines total	Haemal spines	Centra abdominal	Centra caudal	Centra total	Body plates[2] DLP+MDP	Body plates[2] SLP	Body plates[2] LLP	Body plates[2] ILP	Body plates[2] VLP+MVP
– – –																		
7.6		8	11	12										12	30		37	2
9.7	V	7	10	13										34	32		39	27
10.2	VI	8	12	13										36	32		41	38
– – –																		
11.6	V	8	11	12										38	33		40	37
12.7	VI	8	11	11										42	36		45	41
13.8	VII	7	11	12										41	33		43	38
14.9	VI	7	10	11										42	34		41	41
15.7	VI	8	12	12										43	36		43	39
17.2	VI	8	10	11										43	36		45	41
18.3	V	6	10	11										43	35	8	44	43
21.0	V	8	11	11										42	36	23	45	41
24.6	VI	7	12	12	I,2	5	15	27	42	27	15	31	46	44	34	12	42	43
34.5	VII	7	11	11	I,2	5	14	20	43	20	14	30	44	43	30	44	39	37
43.1	VII	7	10	12	I,2	6	15	29	44	29	15	30	45	42	30	45	40	39
Adults	V–IX	6–9	9–14	10–13	I,2	5–6	17	31	48	31	17	32	42–52	33–58	33–52	44–54	39–48	31–52

[1] 7.6–21.0 mm counts are from unstained specimens.

[2] DLP—dorsolateral; MDP—mid-dorsal; SLP—supralateral; LLP—lateral line; ILP—infralateral; VLP—ventrolateral; MVP—mid-ventral.

Discussion

The most important characters for identifying agonid larvae and early juveniles are body depth, pectoral-fin length, pigmentation on the body and fins, and the number of vertebrae and pectoral-fin rays (Table 47). These characters, used in conjunction with other meristic features such as dorsal, anal, caudal-fin elements (Table 2), and dermal plate counts and head spination (individual species accounts), can be used to accurately identify larvae of 22 of the 25 agonid species occurring in the northeastern Pacific Ocean and Bering Sea and 3 taxa from the northwestern Atlantic and Arctic Oceans. In several cases, the state of morphological or pigmentation characters change during ontogeny. There are still several gaps in the knowledge of early life history stages of agonid fishes (Table 48).

Although not considered in this study, eggs of agonids are poorly known. Agonids are reported to spawn clumps of adhesive eggs on the holdfasts of laminarians, inside living barnacles, under tube worm cases, and on sand or smooth rock (Breder and Rosen, 1966; Marliave, 1975; Marliave, 1978). Eggs of two intertidal poachers, *Bothragonus swani* and *Hypsagonus mozinoi*, and one nearshore/estuarine poacher, *Stellerina xyosterna*, are known from the study area. Eggs of *B. swani* are 2 mm in diameter and brown in coloration. Eggs of *H. mozinoi* are 1 mm, laid in clumps of 6–25, and change in coloration from red to brown with development (Marliave, 1978). Unfertilized eggs of *S. xyosterna* are 1.3–1.4 mm and have a yellowish clear yolk, numerous oil globules, and a very thick transparent chorion (Wang, 1986). Incubation times for agonid eggs are reported to be from several months to one year (Breder and Rosen, 1966).

Early life history stages of *Xeneretmus leiops* and *X. triacanthus* remain completely unknown. These fish are more abundant in the southern portions of their ranges and may not spawn in the study area. It is uncertain if *Hypsagonus quadricornis* and *S. xyosterna* have preflexion stages. The smallest specimens examined of each species were small (6.4, 5.8 mm), appeared newly hatched, and had flexed notochord tips and developing caudal-fin rays. Preflexion larvae are also unknown for *Percis japonica* and *Occella dodecaedron*. Flexion larvae of *O. dodecaedron* are also unknown. *Occella impi* was described by Gruchy (1970) from a single juvenile or prejuvenile specimen and is probably a junior synonym of *S. xyosterna* (Matarese et al., 1989; Kanayama, 1991). The status of *O. impi* could be easily determined in a future study with a thorough comparison of the holotype to the specimens of larval and juvenile *S. xyosterna* presented here.

Postflexion larvae of *H. mozinoi, P. japonicus,* and *Bathyagonus nigripinnis* remain undescribed. Juveniles of *H. mozinoi, P. japonicus, B. nigripinnis,* and *Aspidophoroides monopterygius* are also not known. Juvenile *A. monopterygius* probably appear very similar to postflexion larvae with the larval finfold absent. Head spination and ossification sequences of *H. mozinoi* and *P. japonica* remain undescribed and are incompletely described for *Leptagonus leptorhynchus, B. nigripinnis, Ulcina olriki,* and *O. dodecaedron.*

Early life history characters presented here add additional evidence corroborating previous studies on the systematics of agonid fishes. In most respects, groupings of agonid taxa based on larval characters follow Kanayama's (1991) proposed taxonomic arrangement. The Percidinae all have relatively deep-bodied, heavily pigmented larvae. Although larval head-spine characters are completely known only for *H. quadricornis,* it is very likely that postflexion *H. mozinoi* also have a large, strongly bilobed parietal spine. *Percis japonica* differs from *H. quadricornis* by having a relatively flat parietal ridge.

The subfamily Agoninae is a less clearly defined group. *Leptagonus* have two epurals, *Agonopsis vulsa* have one, and *Podothecus acipenserinus* have two as postflexion larvae and one as juveniles and adults. All have inferior mouth orientation as postflexion larvae and juveniles. *Leptagonus leptorhynchus* and *A. vulsa* are heavily pigmented, while the other taxa of the subfamily are only moderately pigmented.

The subfamily Anoplagoninae is equally diverse in body morphology and pigmentation. *Bothragonus swani* is unique among the Anoplagoninae with its two epurals and it is the only deep-bodied form. In contrast, *A. monopterygius* is extremely slender-bodied. Larvae of the Anoplagoninae are heavily pigmented with the exception of *B. swani, U. olriki,* and *A. monopterygius. Ulcina olriki, A. monopterygius,* and *Anoplagonus inermis* appear to form a natural group having no spinous dorsal fin or supralateral dermal plate row. Jordan and Starks (1904) placed these taxa in a separate subfamily (Aspidophoroidinae). *Bathyagonus nigripinnis* is unusual among members of its genus (and subfamily) with its upturned (superior) mouth and notably more slender body morphology. With *B. swani* and the former members of the Aspidophoroidinae removed (*U. olriki, A. monopterygius, Anoplagonus inermis*), the remaining taxa of the Anoplagoninae are a relatively homogenous grouping of medium-bodied, heavily pigmented larval forms.

Members of the subfamily Brachyopsinae all have upturned (superior) mouths notable in the postflexion and/or juvenile stage, which is particularly pronounced in *Pallasina barbata. Stellerina xyosterna* and *Chesnonia verrucosa* larvae are very similar, each having highly arched parietal crests, well-defined dentary spines, large fan-shaped pectoral fins with a row or band of pigmentation near the edge, and sparse pigmentation on the

Table 47

Summary of some characters useful in identifying larval and juvenile agonids from the northeastern Pacific Ocean (Busby and Ambrose, 1993, in part). Taxa with multistate characters undergo changes during ontogeny.

	Characters						
Taxon	Body depth	Body pigmentation	Vertebrae	Pectoral fin length[1]	Pectoral fin rays	Pectoral fin pigmentation	Number of dorsal fins
Percidinae							
Hypsagonus mozinoi	Medium[2]	Heavy	34	Normal	11–12	None	2
H. quadricornis	Deep	Heavy	35–37	Normal	12–14	None	2
Percis japonica	Deep	Heavy	40–42	Normal	12	None	2
Agoninae							
Leptagonus decagonus	Slender/medium	Moderate	44–49	Normal	13–17	Scattered	2
L. frenatus	Medium	Moderate	45–48	Normal	15–17	None/edges	2
L. leptorhynchus	Slender[3]	Heavy	42–45	Normal	13–15	None/patches	2
Podothecus acipenserinus	Medium	Moderate	39–42	Normal	16–19	Scattered/bands	2
Agonopsis vulsa	Medium	Heavy	38–42	Normal	13–15	None	2
Anoplagoninae							
Bothragonus swani	Deep	Light	29–32	Long	10–12	Edge	2
Bathyagonus nigripinnis	Medium	Heavy	43–46	Normal	14–17	None	2
B. pentacanthus	Medium	Heavy	40–46	Normal	14–16	None	2
B. alascanus	Medium	Heavy	39–42	Normal	14–16	None	2
B. infraspinatus	Medium	Heavy	38–39	Long	15–16	None	2
Xeneretmus latifrons	Medium	Heavy	39–43	Normal	13–15	None	2
X. leiops							2
X. triacanthus							2
Odontopyxis trispinosa	Medium	Heavy	37–42	Normal	13–15	None	2
Ulcina olriki	Slender/medium	Moderate	37–40	Long	13–16	Edge	1
Aspidophoroides monopterygius	Slender	Moderate	48–54	Normal	9–11	Edge	1
Anoplagonus inermis	Medium	Heavy	41–45	Normal	8–11	Patch	1
Brachyopsinae							
Stellerina xyosterna	Medium	Light	34–37	Long	17–19	Row	2
Chesnonia verrucosa	Slender/medium	Light	34–38	Long	14–15	Band	2
Occella dodecaedron	Slender/medium	Light/moderate/heavy	37–40	Normal	14–16	None/row	2
O. impi[4]	Medium	Light	37	Long	18		2
Pallasina barbata	Slender	Heavy	42–52	Normal	10–13	None	2

[1] Long = mean length greater than 30.0% SL at any developmental stage.
[2] Greatest body depth of those classified as medium bodied (10–18% SL).
[3] Measurements of Maeda and Amaoka (1988) are questionable, see text.
[4] Probably a junior synonym of *S. xyosterna* (Matarese et al., 1989; Kanayama, 1991).

Table 48

Status of knowledge of early life history stages, head spination, and osteological development of family Agonidae in the Northeast Pacific Ocean and Bering Sea. "?" indicates stage may not exist. "Inc." indicates incomplete knowledge of development.

	Life history stage/feature						
Taxon	Eggs	Preflexion	Flexion	Postflexion	Juvenile	Head spines	Seq. of ossification
Percidinae							
Hypsagonus mozinoi	X	X	X				
H. quadricornis		?	X	X	X	X	X
Percis japonica			X				
Agoninae							
Leptagonus decagonus		X	X	X	X	X	X
L. frenatus		X	X	X	X	X	X
L. leptorhynchus		X	X	X	X	Inc.	Inc.
Podothecus acipenserinus		X	X	X	X	X	X
Agonopsis vulsa		X	X	X	X	X	X
Anoplagoninae							
Bothragonus swani	X	X	X	X	X	X	X
Bathyagonus nigripinnis		X	X			Inc.	Inc.
B. pentacanthus		X	X	X	X	X	X
B. alascanus		X	X	X	X	X	X
B. infraspinatus		X	X	X	X	X	X
Xeneretmus latifrons		X	X	X	X	X	X
X. leiops							
X. triacanthus							
Odontopyxis trispinosa		X	X	X	X	X	X
Ulcina olriki		X	X	X	X	Inc.	Inc.
Aspidophoroides monopterygius		X	X	X	X	X	
Anoplagonus inermis		X	X	X	X	X	X
Brachyopsinae							
Stellerina xyosterna	X[1]	?	X	X	X	X	X
Chesnonia verrucosa		X	X	X	X	X	X
Occella dodecaedron				X	X	Inc.	Inc.
O. impi[2]					X	Inc.	
Pallasina barbata		X	X	X	X	X	X

[1] Unfertilized eggs.

[2] Probably a junior synonym of *S. xyosterna* (Matarese et al., 1989; Kanayama, 1991).

lateral body. *Occella dodecaedron* shares these larval characters but they are less pronounced. *Pallasina barbata* is unique within the Brachyopsinae with its tube-shaped mouth, slender body morphology throughout development, an asymmetrically bilobed parietal ridge, and heavy pigmentation on the lateral body. Postflexion larvae of *S. xyosterna, C. verrucosa,* and *P. barbata* have two epurals that fuse to form one in juveniles and adults. Although caudal fin development in *O. dodecaedron* was not examined, it is probably similar to the other taxa of the Brachyopsinae.

The inter- and intrafamilial relationships of the family Agonidae have been relatively well established. Yabe (1985) hypothesized that the Hemitripteridae and Agonidae are sister groups within the superfamily Cottoidea. The general external appearance and morphology of *Nautichthys oculofasciatus* larvae (family Hemitripteridae) (Fig. 32) bears striking resemblance to larvae of the agonids *H. quadricornis* (Fig. 9) and *B. swani* (Fig. 16). Like preflexion *B. swani, N. oculofasciatus* has a relatively large eye, melanophores on top of the head, and a large pectoral fin with a lobed or scalloped, pigmented edge. Like flexion and postflexion *H. quadricornis, N. oculofasciatus* are deep-bodied (>18.0% SL), have anterior placement of the first dorsal pterygiophores and spines, and heavy pigmentation on

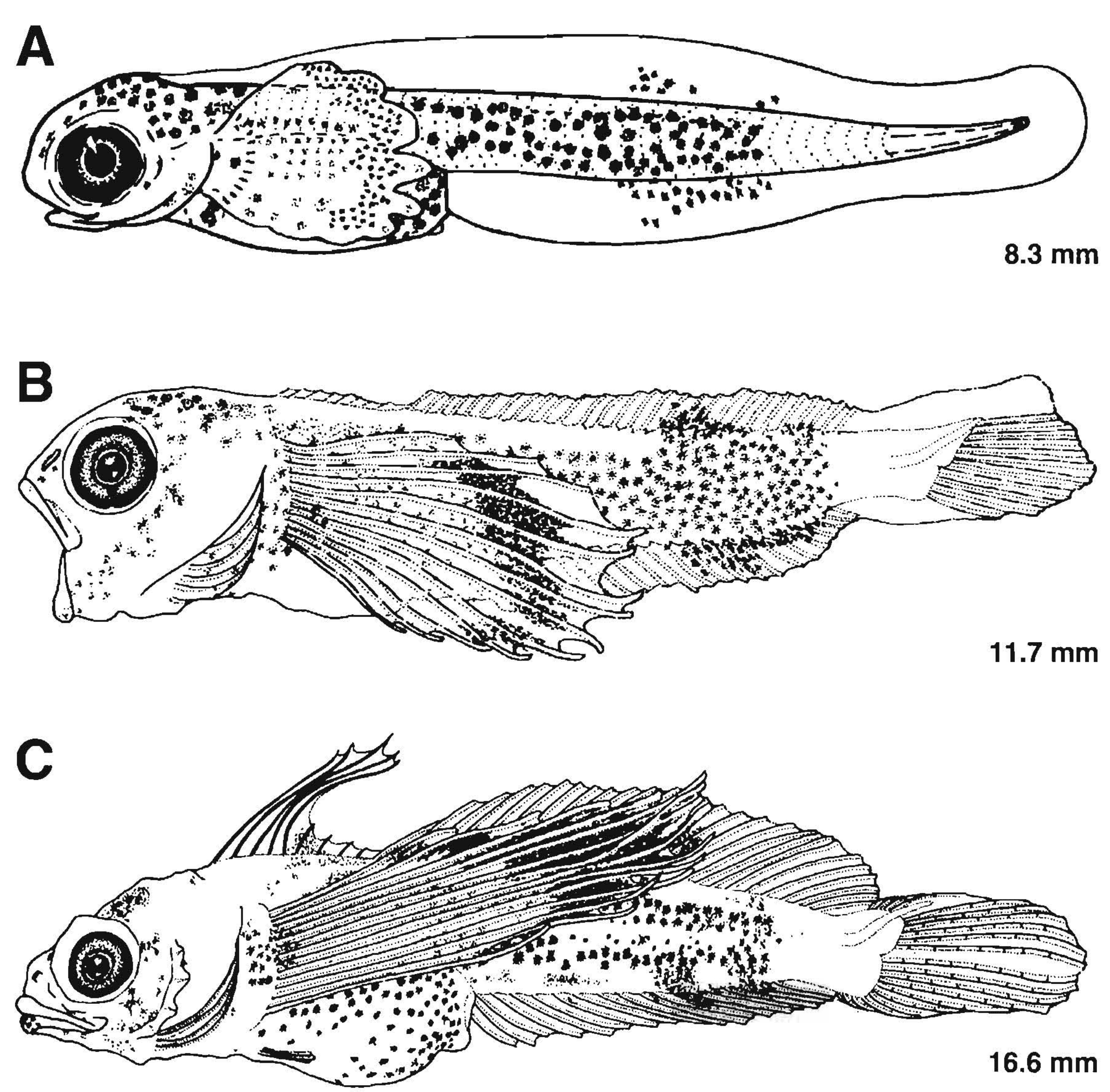


Figure 32
Development of larval *Nautichthys oculofasciatus* (Matarese et al., 1989). (A) Preflexion larva 8.3 mm. (B) Flexion larva 11.7 mm. (C) Late flexion larva 16.6 mm.

the lateral body with intrusions of melanophores into the dorsal and anal finfolds. Postflexion *N. oculofasciatus* (not illustrated) have a large, bilobed parietal ridge, and a pronounced supraocular spine very similar to those of *H. quadricornis* (Fig. 9C). Although these taxa appear very similar, *N. oculofasciatus* are easily distinguished from *B. swani* and *H. quadricornis* by having higher vertebral (40–41), dorsal-fin ray (27–30), and anal-fin ray (16–21) counts, and numerous spinules on the lateral body. The spinules are not arranged in rows and do not develop into dermal plates as in the Agonidae.

Several larval characters show potential for use in future phylogenetic analyses. Head spination, in particular the morphology of the parietal ridge or crest, has at least four character states. *Hypsagonus quadricornis* (Percidinae) has a strongly bilobed parietal (Fig. 9). *Agonopsis vulsa* (Agoninae) is unique among agonids having a moderately bilobed parietal crest ornamented with protruding spinules (Fig. 15). *Ulcina olriki, Aspidophoroides monopterygius,* and *Anoplagonus inermis* (Anoplagoninae Figs. 25–27) have relatively flat parietal ridges, while *Stellerina xyosterna* and *Chesnonia verrucosa* (Brachyopsinae Figs. 28, 29) have highly arched parietal crests. The hemitripterid *N. oculofasciatus* has a large, strongly bilobed parietal ridge (postflexion) very similar to that of *H. quadricornis,* thus polarity of the character may be inferred by using *N. oculofasciatus* as an outgroup (large bilobed parietal ridge = pleisiomorphic state). The presence or absence, number, and morphology of other head spines and dermal plates such as the rostral, nasal, supraocular, superior and inferior infraorbitals, dentary, coronal, tympanic, and postoculars may also be useful.

Development of the caudal fin in agonids may also be of interest. Adult agonids have one epural, with the exception of the Percidinae and *Bothragonus swani,* which have two. The potential outgroup *Nautichthys oculofasciatus* has the pleisiomorphic condition of two epurals (Kanayama, 1991). During development, most agonids clearly have one or two epurals (Figs. 33, 34). However, postflexion larvae of *Podothecus acipenserinus* (Agoninae), *Ulcina olriki, Aspidophoroides monopterygius, Anoplagonus inermis* (Anoplagoninae), *Stellerina xyosterna, Chesnonia verrucosa,* and *Pallasina barbata* (Brachyopsinae) have two epurals that fuse to form one during the late postflexion or early juvenile stage (Fig. 35). Fusion of two epurals during larval development may be considered an intermediate state between the pleisiomorphic state (2 epurals) and the apomorphic state (1 epural).

The phylogenetic analysis of the family Agonidae conducted by Kanayama (1991) is quite thorough and his classification is supported by larval characters in most but not all cases. He did not, however, use the widely accepted outgroup analysis methodology of Maddison et al. (1984) to determine character polarity. Also, he did not include any early life history characters in his analysis. The larval stages of fishes possess a unique array of characters and adaptations that often differ greatly from those of adults. These characters are extremely useful in studies of taxonomy and systematics (Moser and Ahlstrom, 1974). Future collections and taxonomic research may reveal the few remaining undocumented early life history stages of agonid fishes and their diagnostic characters. Overall, it appears that larval characters of agonids show great promise for use in phylogenetic analyses. The early life history characters presented here, and others not yet investigated, should be considered in future systematic studies of this extremely interesting family of fishes.

Acknowledgments

This work would not have been possible without the taxonomic assistance and illustrating expertise of Beverly Vinter. Ann Matarese examined numerous specimens and commented on preliminary drafts of the manuscript. Charles Leap (National Marine Fisheries Service) compiled and labeled illustrations and created all other graphics. Wayne Laroche (Stonefish Environmental and Taxonomic Services) illustrated figures 15C and 31B. Deborah Blood, Ann Matarese, Arthur Kendall Jr., H. Geoffrey Moser (National Marine Fisheries Service); Jean R. Dunn (University of Washington); Douglas Markle (Oregon State University); Boris Sheiko (Russian Academy of Sciences, Kamchatka Institute of Ecology), and two anonymous reviewers read the draft manuscript and provided numerous helpful comments and suggestions. Specimens were provided by the following individuals and organizations: Nora Foster (UAM), Lou Haldorson (UAJ), Doug Hay (DFO), Doug Markle (OSU), Jeff Marliave (VPA), Ann Matarese (AFSC), Bruce Miller (UW), H. Geoffrey Moser (CalCOFI), Gerald McGowan (LACM), Lou Van Guelpen (ARC), Theodore Pietsch (UW), and Bruce Wing (ABML).

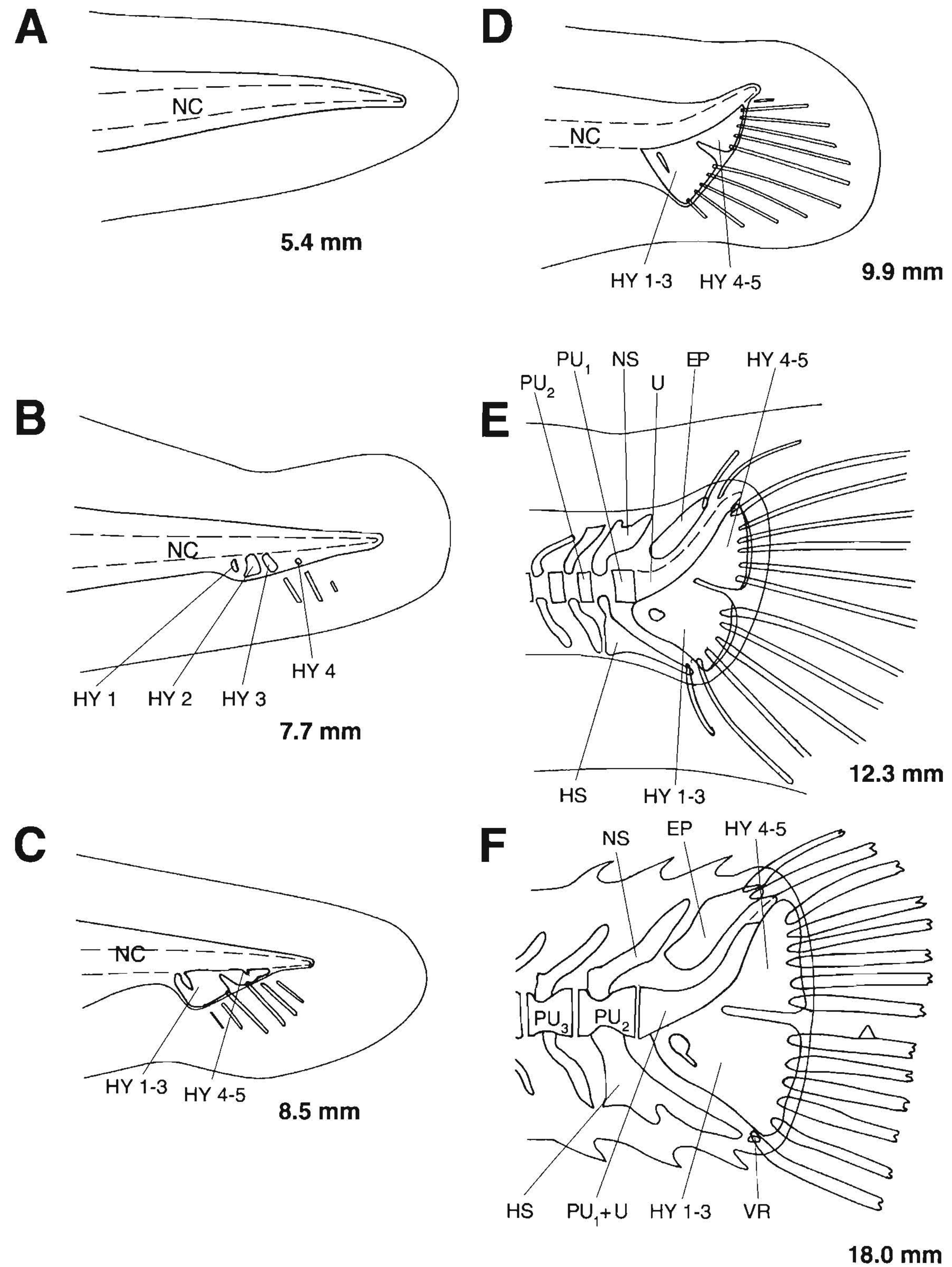


Figure 33

Development of caudal skeleton of *Bathyagonus alascanus* showing the one epural condition. (A) Preflexion larva 5.4 mm; AFSC, 2MF86, St. G049A. (B) Early flexion larva 7.7 mm; AFSC, Fox 86 III, St. 166, Moc 15, sample 109, net 2. (C) Midflexion larva 8.5 mm; AFSC, 4MF92, St. G002A, 6B5. (D) Late flexion larva 9.9 mm; AFSC, 1CH83, St. G021A, 6B5. (E) Postflexion larva 12.3 mm; AFSC, 5MF91, St. G036A, Methot. (F) Early juvenile 18.0 mm; AFSC, 5MF91, St. G036A, Methot. EP=epural, HS=haemal spine, HY=hypural, NC=notochord, NS=neural spine, PU=preural centra, U=ural centra, VR=ventral caudal radial.

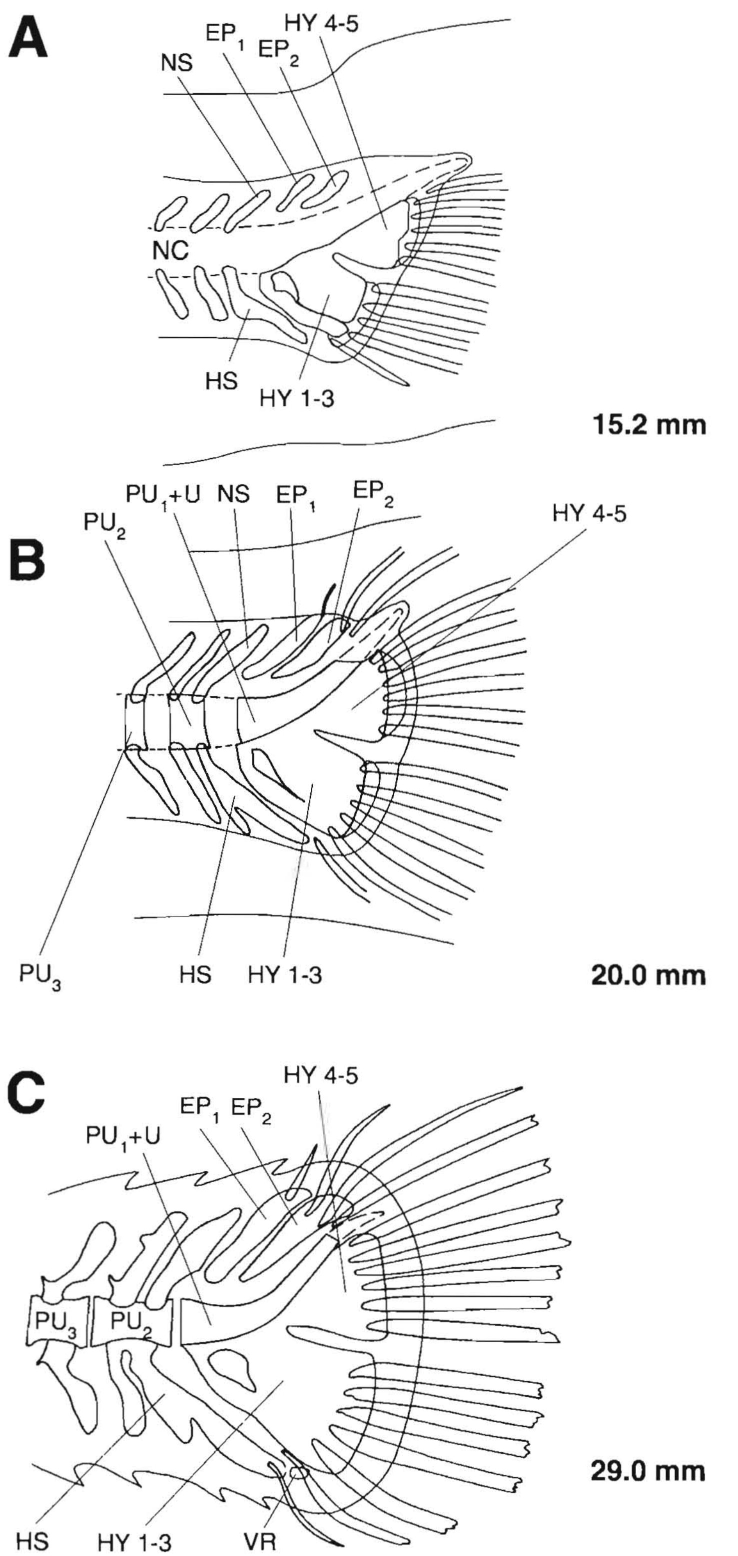


Figure 34

Development of caudal skeleton of *Leptagonus frenatus* showing the two epural condition. Preflexion, early flexion, and mid-flexion development identical to *B. alascanus* (Figs. 33A-C). (A) Late flexion larva 15.2 mm; AFSC, 1CH83, St. G035A, 6B5. (B) Post flexion larva 20.0 mm; AFSC, 4MF81, St. G024A, 6B5. (C) Early juvenile 29.0 mm; AFSC, 5MF91, St. G057A, Methot. EP=epural, HS=haemal spine, HY=hypural, NC=notochord, NS=neural spine, PU=preural centra, U=ural centra, VR=ventral caudal radial.

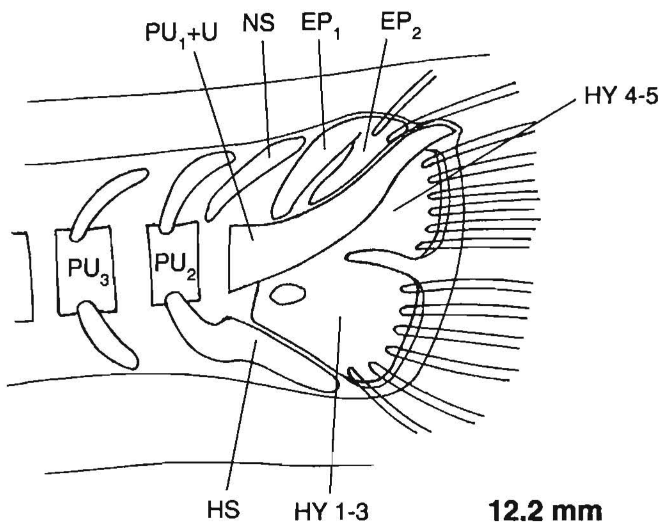


Figure 35
Caudal skeleton of postflexion *Chesnonia verrucosa* larva 12.2 mm showing fusion of epurals. OSU, 337D, NH1, 22V70. EP= epural, HS=haemal spine, HY=hypural, NC=notochord, NS=neural spine, PU=preural centra, U=ural centra.

Literature Cited

Ahlstrom, E. H., J. L. Butler, and B. Y. Sumida.
1976. Pelagic stromateoid fishes (Pisces, Perciformes) of the eastern Pacific: kinds, distributions, and early life histories and and observations on five of these from the Northwest Atlantic. Bull. Mar. Sci. 26:285–402.

Allen, M. J., and G. B. Smith.
1988. Atlas and zoogeography of the common fishes in the Bering Sea and northeastern Pacific. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 66, 151 p.

Ambrose, D. A.
1996. Agonidae: poachers. *In* H. G. Moser (ed.), Guide to the early stages of fishes in the California Current region, p. 844–859. CalCOFI Atlas 33.

Bigelow, H. B., and W. C. Schroeder.
1953. Fishes of the Gulf of Maine. U.S. Fish Wildl. Serv., Bull. 53:1–577.

Breder, C. M., and D. E. Rosen.
1966. Modes of reproduction in fishes. Natural History Press, N.Y., 941 p.

Busby, M. S., and D. A. Ambrose.
1993. Development of larval and early juvenile pygmy poacher, *Odontopyxis trispinosa*, and blacktip poacher, *Xeneretmus latifrons* (Scorpaeniformes: Agonidae). Fish. Bull. 91:397–413.

Dewitt, C., and J. Clark.
1992. Fisheries-Oceanography Coordinated Investigations: 1990 field operations report. U.S. Dep. Commer., NOAA Data Rep. ERL PMEL-39, 98 p.
1993. Fisheries-Oceanography Coordinated Investigations: 1991 field operations report. U.S. Dep. Commer., NOAA Data Rep. ERL PMEL-41, 112 p.

Dunbar, M. J.
1947. Marine young fish from the Canadian eastern Atlantic. Bull. Fish. Res. Bd. Can. 73:1–11.

Ehrenbaum, E.
1905. Eir und larven von fischen. Nord. Plankton 1(4):1–216.

Eschmeyer, W. N., E. S. Herald, and H. Hammann.
1983. A field guide to Pacific coast fishes of North America from the Gulf of Alaska to Baja California. Houghton Mifflin Co., Boston, 336 p.

Freeman, H. W.
1951. Contribution on the evolution and classification of the fishes of the family Agonidae. Ph.D. diss., Stanford Univ., Palo Alto, Calif., 288 p.

Gruchy, C. C.
1969. Canadian records of the warty poacher *Ocella verrucosa*, with notes on the standardization of plate terminology in Agonidae. J. Fish. Res. Bd. Can. 26:1467–1472.
1970. *Occella impi*, a new species of sea poacher from British Columbia with notes on related species (Agonidae, Pisces). J. Fish. Res. Bd. Can. 27:1109–1114.

Hart, J. L.
1973. Pacific fishes of Canada. Bull. 180, Fish. Res. Bd. Can., 740 p.

Hubbs, C. L., W. I. Follett, and L. J. Dempster.
1979. List of the fishes of California. Occas. Pap. Cal. Acad. Sci. 133, 51 p.

Jordan, D. S., and E. C. Starks.
1904. A review of the Japanese fishes of the family Agonidae. Proc. U.S. Natl. Mus. 27(1365):575–599.

Kanayama, T.
1991. Taxonomy and phylogeny of the family Agonidae (Pisces: Scorpaeniformes). Mem. Fac. Fish. Hokkaido Univ. 38(1,2):1–199.

Kendall, A. W., Jr., E. H. Ahlstrom, and H. G. Moser.
1984. Early life history stages of fishes and their characters. *In* H. G. Moser, W. G. Richards, D. M. Cohen, M. P. Fahay, A. W. Kendall Jr., and S. L. Richardson (eds.), Ontogeny and systematics of fishes, p. 11–12. Am. Soc. Ichthyol. Herpetol., Spec. Publ. 1.

Laroche, W. A.
1986. A preliminary morphological investigation of the Agonidae: Towards reconstruction of agonid phylogeny and biogeographic history of neritic/littoral cold marine fishes. M.S. thesis, Humboldt State Univ., Arcata, Calif., 130 p.

Leipertz, S. L.
1985. A review of the fishes of the agonid genus *Xeneretmus* Gilbert. Proc. Cal. Acad. Sci. 44:17–40.

Leviton, A. E., and R. H. Gibbs Jr.
1988. Standards in herpetology and ichthyology: Part 1. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. Suppl. 1: Additions and corrections. Copeia 1988:(1)280-282.

Leviton, A. E., R. H. Gibbs Jr., E. Heal, and C. E. Dawson.
1985. Standards in herpetology and ichthyology: Part 1. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. Copeia 1985 (3):802-832.

Maddison, W. P., M. J. Donoghue, and D. R. Maddison.
1984. Outgroup analysis and parsimony. Syst. Zool. 33:83–103.

Maeda, K., and K. Amaoka.
1988. Taxonomic study on larvae and juveniles of agonid fishes in Japan. Mem. Fac. Fish., Hokkaido Univ. 35:47–124.

Marliave, J. B.
1975. The behavioral transformation from the planktonic larval stage of some marine fishes reared in the labora-

tory. Ph.D. dissertation, Univ. British Columbia, Vancouver, Canada, 231 p.
1978. Spawning and yolk-sac larvae of the agonid fish species, *Agonomalus mozinoi* Wilimovsky and Wilson. Syesis 11: 285–286.

Matarese, A. C., A. W. Kendall Jr., D. M. Blood, and B. M. Vinter.
1989. Laboratory guide to early life history stages of Northeast Pacific fishes. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 80, 652 p.

Miller, D. J., and R. K. Lea.
1972. Guide to the coastal marine fishes of California. Calif. Dep. Fish Game, Fish Bull. 157, 235 p.

Moser, H. G., and E. H. Ahlstrom.
1974. Role of larval stages in systematic investigations of marine teleosts: the Myctophidae, a case study. Fish. Bull. 72:391–413.

Peden, A. E., and G. S. Jamieson.
1988. New distributional records of marine fishes off Washington, British Columbia, and Alaska. Can. Field-Naturalist 102(3):491–494.

Pietsch, T. W.
1978. Evolutionary relationships of the sea moths (Teleostei: Pegasidae) with a classification of gasterosteiform families. Copeia 1978:517–529.

Potthoff, T.
1984. Clearing and staining techniques. *In* H.G. Moser, W. G. Richards, D. M. Cohen, M. P. Fahay, A. W. Kendall Jr., and S. L. Richardson (eds.), Ontogeny and systematics of fishes, p. 35–37. Am. Soc. Ichthyol. Herpetol., Spec. Publ. 1.

Robins, C. R., R. M. Bailey, C. E. Bond, J. R. Brooker, E. A. Lachner, R. N. Lea, and W. B. Scott.
1991. Common and scientific names of fishes. Am. Fish. Soc., Spec. Publ. 20, 183 p.

Schleiger, D. R., C. DeWitt, and S. A. Macklin.
1995. Fisheries-Oceanography Coordinated Investigations: 1992 field operations report. U.S. Dep. Commerce, NOAA Data Rep. ERL PMEL-54, 77 p.

Wang, J. C. S.
1986. Fishes of the Sacramento-San Joaquin estuary and adjacent waters, California: A guide to the early life histories. Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary, Tech. Rep. 9, 602 p. [Available from Ecological Analysts, Inc., 2150 John Glen Drive, Concord, CA 94520.]

Washington, B. B., H. G. Moser, W. A. Laroche, and W.J. Richards.
1984. *In* H. G. Moser, W. G. Richards, D. M. Cohen, M. P. Fahay, A. W. Kendall Jr., and S. L. Richardson (eds.), Ontogeny and systematics of fishes, p 405–428. Am. Soc. Ichthyol. Herpetol., Spec. Publ. 1.

Wilimovsky, N. J., and D. E. Wilson.
1978. A new species of Agonidae, *Agonomalus mozinoi*, from the west coast of North America. Syesis 11:73–79.

Yabe, M.
1985. Comparative osteology and myology of the superfamily Cottoidea (Pisces: Scorpaeniformes), and its phylogenetic classification. Mem. Fac. Fish., Hokkaido Univ. 32:1–130.

Note added in proof: At the time this manuscript went to press, 19 occurrences from the Bering and Chukchi Seas of the veteran poacher (*Podothecus veternus*), identified by Dr. Boris Sheiko, Russian Academy of Sciences, Kamchatka Institute of Ecology, were verified in the University of Washington Fish Collection. These are the first verified records of this species in the Bering Sea. This brings the total number of species of agonid fishes known from the northeastern Pacific Ocean and Bering Sea to 26. The new range of *P. veternus* appears to be extended eastward from Peter the Great Bay and the Okhotsk Sea (Kanayama, 1991) to St. Matthew Island and Norton Sound, Alaska, and north to the Chukchi Sea. Since none of the larvae and early juvenile *P. acipenserinus* used in this study were collected from areas that far north, it is unlikely that any specimens identified as *P. acipenserinus* could be *P. veternus*. In fact, none of the illustrations of *P. acipenserinus* larvae and early juveniles are of Bering Sea specimens.