

# DEVELOPMENT AND OCCURRENCE OF LARVAE AND JUVENILES OF THE ROCKFISHES *SEBASTES CRAMERI*, *SEBASTES PINNIGER*, AND *SEBASTES HELVOMACULATUS* (FAMILY SCORPAENIDAE) OFF OREGON<sup>1</sup>

SALLY L. RICHARDSON<sup>2</sup> AND WAYNE A. LAROCHE<sup>3</sup>

## ABSTRACT

Developmental series of larvae and juveniles of three species of northeast Pacific rockfishes (Scorpaenidae: *Sebastes*) are illustrated and described: *S. crameri* (8.0 to 130.5 mm standard length), *S. pinniger* (7.8 to 181 mm standard length), and *S. helvomaculatus* (7.7 to 183 mm standard length). The descriptions include a literature review, characters used for identification including meristics and supraocular spine patterns, distinguishing features, general development, morphology, fin development, spination, scale formation, and pigmentation. Occurrence in waters off Oregon is discussed.

The approach that was used to identify larval and juvenile specimens of *Sebastes* from plankton, midwater trawl, and bottom trawl collections from Oregon waters is presented, since 36 species reportedly occur there. Developmental terminology is newly defined for *Sebastes*. Larval and juvenile spination is presented schematically and defined.

Larvae and juveniles of the three species described here are compared with other known *Sebastes* larvae and juveniles from the northeast Pacific.

Data gathered during this study extend the southern range limit of *Sebastes emphaeus* to Punta Gordo, Calif.

Rockfish of the genus *Sebastes* are an important group of fishes in the northeast Pacific both in terms of number of species and in commercial and sport fisheries. Sixty-nine species of *Sebastes* occur between the Gulf of California and the Gulf of Alaska (Chen 1971, 1975). In 1975, Pacific trawl landings of *Sebastes* spp. in the United States and Canada, categorized as "Pacific ocean perch" and "other rockfish," were 17,400 metric tons (t) or 23.9% of the total trawl landings (Verhoeven 1976). In California, rockfish compose half the number of sportfish caught (Young 1969).

"Pacific ocean perch" (primarily *Sebastes alutus*) trawl landings in the United States and Canada declined from a peak of 14,000 t in 1965 to 8,500 t in 1975 and "other rockfish" landings subsequently increased from 8,600 t in 1965 to 16,300 t in 1973 and 13,300 t in 1975 (Pacific Marine Fisheries Commission 1964-76; Verhoeven 1976).

Because of this shift in composition of trawl landings, knowledge of the biology of the individual species involved, including their early life history, is becoming increasingly important. Such information is relatively scarce, partly because of the difficulty involved in identifying the young stages.

Rockfish larvae, which are extruded live from ovoviviparous females, are pelagic as are young juveniles. The pelagic larvae are very abundant, ranking third or fourth in annual larval fish abundance off California (Ahlstrom 1961, 1965) and second only to osmerid larvae off Oregon (Richardson 1977; Richardson and Pearcy 1977). Juveniles are important as forage items for larger fishes, such as albacore (Powell et al. 1952) and salmon (Whitney 1893; Silliman 1941; Pritchard and Tester 1944; Merkel 1957), and marine birds (Follett and Ainley 1976).

Pelagic larvae and juveniles of relatively few of the 69 northeast Pacific rockfish species have been described. Illustrations or partial descriptions of pigment patterns have been presented for preextrusion or newborn larvae of 47 of these species but only 26 of these were reared to the point of yolk absorption (Table 1). The first larval developmental series of *Sebastes* spp. were presented as two unnamed species (Ahlstrom 1965) the second of

<sup>1</sup>From a final report for NOAA NMFS Contract No. 03-6-208-35343 submitted to Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Boulevard East, Seattle, WA 98112, on 15 June 1977.

<sup>2</sup>School of Oceanography, Oregon State University, Corvallis, Oreg.; present address: Gulf Coast Research Laboratory, P.O. Drawer AG, Ocean Springs, MS 39564.

<sup>3</sup>School of Oceanography, Oregon State University, Corvallis, OR 97331.

which is now known to be *S. paucispinis* (Moser 1967; Moser et al. 1977). Complete development series from newly hatched larvae to benthic juveniles have only been described for *S. cortezi*, *S. jordani*, *S. levis*, *S. macdonaldi*, *S. melanostomus*, *S. paucispinis*, and *Sebastes* sp. — Gulf of California Type A (Moser 1967, 1972; Moser et al. 1977; Moser and Ahlstrom 1978).

This paper is a contribution to the knowledge of the early life history of northeast Pacific rockfishes. Developmental series of three species, *S. cramerii*, *S. pinniger*, and *S. helvomaculatus*, are described for the first time. The first two species are important contributors to Oregon trawl landings (Niska 1976). Information on occurrence of larvae and juveniles of these three species off Oregon is also given. Because of the large species complex of *Sebastes* in the northeast Pacific and the difficulty in identifying young rockfish, e.g., adult keys cannot be used, the approach that was used to identify the specimens in this study is presented as part of the methodology.

## MATERIALS AND METHODS

### Collections

Specimens described in this paper came from collections in the School of Oceanography, Oregon State University. The collections were obtained with 70 cm bongo nets, neuston nets, meter nets, Isaacs-Kidd midwater trawls, beam trawls, and otter trawls off the Oregon coast since 1961 during all months of the year. Samples were taken along the entire coast, but were concentrated along an east-west transect off Newport, Oreg. (lat. 44°39.1' N). All material had been preserved in either 5 or 10% Formalin<sup>4</sup> and most had been transferred to 30 or 40% isopropyl alcohol. Over 12,000 *Sebastes* larvae and juveniles were sorted from the available collections.

### Approach to Identification

Geographic ranges of all known northeast Pacific species [excluding the new species being described by Lea and Fitch (Chen 1975), presumably from California] were recorded from the literature (Appendix Table 1). Additional range information gathered during this study extends the

southern range of *S. emphaeus* through Oregon to Punta Gordo, Calif. (lat. 40°12.9' N, long. 124°23.7' W, depth 97 m). Adults of only 36 of these species are reported to occur off Oregon. The occurrence of two of these, *S. eos* and *S. rosaceus*, is questionable north of northern California (Chen 1971). Although ocean currents could potentially carry larvae and juveniles of additional species into Oregon waters, it is unlikely that large numbers of young of other species would be taken in an area where the adults do not occur. Following this assumption, tables of morphological characters were prepared for these 36 potential species. The most useful characters for identifying young rockfish were shape of the upper profile of the head (interorbital space) and presence or absence of specific head spines, particularly the supraocular (Appendix Table 2); number, including range and usual (most commonly occurring) number of dorsal fin rays, anal fin rays, and pectoral fin rays (Appendix Table 3); total number of gill rakers on the first gill arch (Appendix Table 4); number of lateral line pores (Appendix Table 5); number of diagonal scale rows below the lateral line (Appendix Table 6). Proportions of body parts related to standard length such as length of upper jaw, head length, length of longest dorsal spine, and body depth at pelvic fin insertion were compiled but were not particularly useful. Additional information which was sometimes helpful included records from trawl surveys off Oregon (Demory et al. 1976) and commercial catch trends in Oregon (Niska 1976) which gave indications of species common in trawlable habitats in the area. Pigment banding patterns of adults were also useful.

Initially, counts were made on each juvenile to be identified along with notes on additional, potentially useful characters. Data for each specimen were then screened through each of the appendix tables, and the species which did not agree were eliminated as potential candidates. This approach, together with some additional data from the literature as noted in the text, lead to positive identification for the species included in this paper.

Developmental series were established backwards from juveniles primarily on the basis of pigmentation, particularly that of the pectoral and pelvic fins and that on the dorsal and ventral body margins, general body shape (e.g., short and stubby, slender and elongate), and constancy in number of dorsal, anal, and pectoral fin rays which could be counted back to postflexion, sometimes

<sup>4</sup>References to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

flexion, larvae. Developmental series could not be carried back to newly extruded larvae in the plankton samples with certainty. Pigmentation is the primary character used to distinguish small larvae prior to development of fin rays and head spines. Pigment patterns of newborn larvae are often similar among a number of species and these patterns may change considerably by the time the yolk is absorbed (Westrheim 1975; Moser et al. 1977). Preextrusion and newborn larvae have been described for 29 of the 36 species of *Sebastes* off Oregon, but larvae reared to yolk absorption have only been described for 15 (Table 1). The number of species which have patterns similar to those that have been described is unknown. Rearing larvae of the remaining species to yolk absorption will be necessary to provide an adequate foundation for identification of small larvae in plankton samples. We had no opportunity to rear larvae from known parents.

### Meristics<sup>5</sup>

Counts were made on unstained material as not enough specimens were available to make complete stained series for developmental ossification studies. [One to several pelagic juveniles of *S. crameri*, *S. pinniger*, and *S. helvomaculatus* were stained with alizarin red S (Taylor 1967) for examination of general bone structure, spination, and secondary caudal rays.] Fin spines and rays were only counted when they appeared to be fully formed structures under magnification, which may approximate initial ossification. Bases of fin rays, visible prior to actual ray formation, were not counted. In *Sebastes*, the 13th dorsal spine and the 3d anal spine form first as soft rays which then transform to spines beginning at the basal portion and continuing distally. These were considered to be "prespines" until spine formation was complete.

Counts were made of dorsal fin spines and rays, anal fin spines and rays, pectoral fin rays, pelvic fin rays, principal caudal fin rays, gill rakers on the upper and lower limb of the first gill arch, lateral line pores, and diagonal scale rows below the lateral line. In some cases India ink was applied to the right side of a fish to increase visibility of the latter two features.

### Morphometrics

Measurements of various body parts of selected specimens were made to the nearest 10th or 100th of a millimeter using an ocular micrometer in a stereomicroscope as follows:

Standard length (SL) = snout tip to notochord tip preceding development of caudal fin, then to posterior margin of hypural plate.

Snout to anus length = distance along body midline from snout tip to vertical through posterior margin of hindgut at anus.

Head length (HL) = snout tip to cleithrum until no longer visible, then to posteriormost margin of opercle (SL of 30.3 mm on *S. crameri*, 16.8 mm on *S. pinniger*, 41.6 mm on *S. helvomaculatus*).

Snout length = snout tip to anterior margin of orbit of left eye.

Upper jaw length = snout tip to posterior margin of maxillary.

Eye diameter = greatest diameter of left orbit.

Interorbital distance = distance between dorsal margins of orbits.

Body depth at pectoral fin base = vertical distance from dorsal to ventral body margin at base of pectoral fin.

Body depth at anus = vertical distance from dorsal to ventral body margin immediately posterior to anus.

Pectoral fin length = distance from base to tip of longest ray.

Pectoral fin base depth = width of base of pectoral fin.

Pelvic spine length = distance from base to tip of pelvic spine.

Pelvic fin length = distance from base to tip of longest ray.

Snout to origin of pelvic fin = distance along body midline to vertical through insertion of pelvic fin.

Parietal spine length = distance along posterior margin of parietal spine from insertion to tip.

Nuchal spine length = distance along posterior margin of nuchal spine from insertion to tip.

Preopercular spine length (third spine, posterior series) = distance from tip to basal insertion if visible, or to a line connecting the points of deepest indentation between preopercular spines 2 and 3 and spines 3 and 4 (posterior series).

Length of angle gill raker = distance from tip of gill raker to point of articulation with gill arch.

<sup>5</sup>The term "meristic" is used here to refer to all countable characters.

TABLE 1.—Summary of data on preextrusion larvae (P) or newborn, reared larvae (L) of northeast Pacific species of *Sebastes*. Asterisk indicates figure is included.

Species	Source													
	Eigenmann (1892)	Wales (1952)	Morris (1956)	Delacy et al. (1964)	Ahlsrom (1965)	Moser (1967)	Waldron (1968)	Westheim et al. (text footnote 7)	Westheim et al. (text footnote 9)	Efremenko and Lisovenko (1970)	Harling et al. (text footnote 10) Moser (1972)	Westheim (1975)	Moser et al. (1977)	Moser and Ahlsrom (1978)
<i>S. aleutianus</i>								P*		P*		P		
<i>S. alutus</i>				P*				P*		P*		P		
<i>S. atrovirens</i>														
<i>S. auriculatus</i>	(P*)			P*								P	L*	
<i>S. aurora</i>														
<i>S. babcocki</i>				1P*				1P*		1P*		P		
<i>S. borealis</i>														
<i>S. brevispinis</i>				P*						P*		P	P	
<i>S. carnatus</i>						L*						P	L*	
<i>S. caurinus</i>				P*								P	L*	
<i>S. chlorostictus</i>						L*							L*	
<i>S. chrysomelas</i>														
<i>S. ciliatus</i>											P*	P		
<i>S. constellatus</i>													L*	
<i>S. cortezi</i>														
<i>S. crameri</i>								P*				P		
<i>S. dalli</i>						L*							L*	
<i>S. diploproa</i>				P*								P	P	
<i>S. elongatus</i>						L*				P*		P	L*	
<i>S. emphaeus</i>														
<i>S. ensifer</i>													L*	
<i>S. entomelas</i>											P*	P		
<i>S. eos</i>						L*							L*	
<i>S. exsul</i>														
<i>S. flavidus</i>				P*								P	P	
<i>S. gilli</i>													L*	
<i>S. goodei</i>				L*								P	L*	
<i>S. helvomaculatus</i>										P*		P		
<i>S. hopkinsi</i>													L*	
<i>S. jordani</i>				L*			L*					P	L*	
<i>S. lentiginosus</i>														
<i>S. levis</i>						L*							L*	
<i>S. macdonaldi</i>						L*							L*	
<i>S. maliger</i>				P*								P	P	
<i>S. melanops</i>														
<i>S. melanostomus</i>													L*	L*
<i>S. miniatus</i>													L*	
<i>S. mystinus</i>		P*												
<i>S. nebulosus</i>										P*				
<i>S. nigrocinctus</i>														
<i>S. notius</i>														
<i>S. ovalis</i>														
<i>S. paucispinis</i>				L*	L*	L*						P	L*	
<i>S. peduncularis</i>														
<i>S. phillipsi</i>														
<i>S. pinniger</i>							L*					P	L*	
<i>S. polyspinis</i>														
<i>S. proriger</i>												P		
<i>S. rastrelliger</i>														
<i>S. reedi</i>									P*			P		
<i>S. rosaceus</i>														
<i>S. rosenblatti</i>													L*	
<i>S. ruberrimus</i>				P*								P	L*	
<i>S. rubrivinctus</i>	P			(3)				(3)		(3)				
<i>S. rufinanus</i>														
<i>S. rufus</i>														
<i>S. saxicola</i>				L*					P*			P	P	
<i>S. semicinctus</i>						L*							L*	
<i>S. serranoides</i>													P	
<i>S. serriceps</i>													L*	
<i>S. simulator</i>														
<i>S. sinensis</i>														
<i>S. spinorbis</i>														
<i>S. umbrosus</i>							L*						L*	
<i>S. variegatus</i>												P		
<i>S. varispinis</i>														
<i>S. wilsoni</i>														
<i>S. zacentrus</i>												P	P	
<i>S. new sp.</i> (Lea and Fitch)														

<sup>1</sup>Described as *S. rubrivinctus*, but northern occurrence indicates it must be *S. babcocki*.

<sup>2</sup>Described as *S. rhodochloris*.

<sup>3</sup>These descriptions of *S. rubrivinctus* must be *S. babcocki* due to the northern occurrence of specimens.

Longest dorsal fin spine = distance from base to tip.

Longest dorsal fin ray = distance from base to tip.

Longest anal fin spine = distance from base to tip.

All body lengths given refer to standard length unless noted otherwise.

### Developmental Terminology

Terminology for development of *Sebastes* spp. used in this paper is as follows:

Preflexion larva = prior to notochord flexion.

Flexion larva = undergoing notochord flexion from time urostyle begins to slant upward until urostyle is in final upturned position and caudal fin is formed.

Postflexion larva = from completion of notochord flexion (urostyle may still extend beyond the base of the caudal fin) to onset of transformation of 13th dorsal spine and 3d anal spine from soft ray to spine, and to the associated onset of development of juvenile pigment pattern (usually addition of pigment to the dorsum).

Transforming larva = from onset to completion of transformation of 13th dorsal spine and 3d anal spine from soft ray to fully developed spine. Also from the onset of development of juvenile pigment pattern to development of distinctive juvenile pigmentation, often in the form of melanistic saddles over the dorsum.

Pelagic juvenile = from completion of formation of 13th dorsal and 3d anal spine (and thus attain-

ment of adult complement of actual fin spines and rays) and development of juvenile pigmentation until no longer captured pelagically.

Benthic juvenile = from time of first capture on bottom and usual associated decrease in intensity of melanistic pigmentation to attainment of sexual maturity.

### Spinination (Figure 1, Table 2)

Difficulties arise in naming all the spines found in the head region of larvae and juveniles of *Sebastes* because not all are found in adults. Further complications arise because the names traditionally used for a number of the head spines do not reflect the bone from which the spine originates. For these reasons we include a composite diagram of spines which may occur during the larval and juvenile periods. The terminology is a combination and modification of that used by Phillips (1957), Chen (1971), Moser (1972), and Moser and Ahlstrom (1978). Most names used in this paper are the same as those used for adult rockfishes to avoid confusion, even though the bones from which the spines originate are not indicated by the name. Exceptions are as follows. The two spines found on the opercular margin are here called the subopercular and the interopercular according to the bones from which they originate. The superior posttemporal (supracleithral of adults), inferior posttemporal (not found in adults), and supracleithral (cleithral of adults) are so-called because of their origin. This is done to avoid confusion with a spine present on the posterior margin of the cleithrum, which is here called the cleithral spine. Use of the term infraorbital

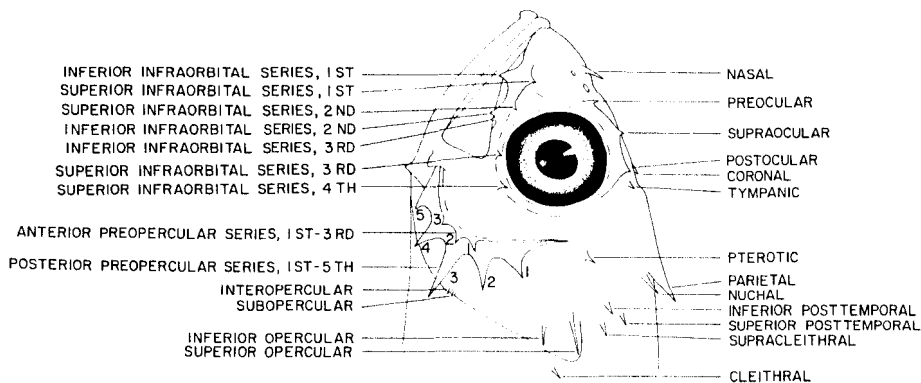


FIGURE 1.—Composite diagram of spines present in the head region of larval and juvenile *Sebastes* species including names used in this paper. Refer to Table 2 for corresponding names used for adults and bones from which spines originate.

TABLE 2.—Names of head region spines of larval and juvenile *Sebastes* spp. used in this paper with corresponding names used for adults and bones from which the spines originate. Spines listed in the first column are shown in Figure 1 clockwise beginning with the nasal.

Name used in this paper	Name used in adults <sup>1</sup>	Bone from which spine(s) originates <sup>2</sup>
Nasal	Nasal	Nasal
Preocular	Preocular	Prefrontal
Supraocular	Supraocular	Frontal
Postocular	Postocular	Frontal
Coronal	Coronal	Frontal
Tympanic	Tympanic	Frontal
Pterotic	Pterotic	Pterotic
Parietal	Parietal	Parietal
Nuchal	Nuchal	Parietal
Inferior posttemporal	—	Posttemporal
Superior posttemporal	Supracleithral	Posttemporal
Supracleithral	Cleithral	Supracleithrum
Cleithral	—	Cleithrum
Superior opercular	Opercular	Opercle
Inferior opercular	Opercular	Opercle
Subopercular	Gill cover spine	Subopercle
Interopercular	Gill cover spine	Interopercle
Posterior preopercular series, 1st-5th	Preopercular	Preopercle
Anterior preopercular series, 1st-3d	—	Preopercle
Superior infraorbital series, 4th	—	Infraorbital 3 (2d suborbital)
Superior infraorbital series	—	Infraorbital 2 (1st suborbital)
Inferior infraorbital series, 3d	—	Infraorbital 1 (preorbital)
Inferior infraorbital series, 2d	Lachrymal projection (suborbital spine)	Infraorbital 1 (preorbital)
Superior infraorbital series, 2d	—	Infraorbital 1 (preorbital)
Superior infraorbital series, 1st	—	Infraorbital 1 (preorbital)
Inferior infraorbital series, 1st	Lachrymal projection (suborbital spine)	Infraorbital 1 (preorbital)

<sup>1</sup>After Phillips (1957) and Chen (1971).

<sup>2</sup>After Matsubara (1943) and Weitzman (1962).

follows Weitzman (1962) as recommended by Poss.<sup>6</sup>

### SEBASTES CRAMERI (JORDAN) (Figures 2, 3, 4)

*Literature.*—Pigment patterns of preextrusion larvae of *S. crameri* were described by Westrheim et al.,<sup>7</sup> including one figure, and Westrheim (1975). Preextrusion larvae (mean total length = 5.7 mm) have a row of 10 to 23 melanophores (45% of 60 larvae had <16 melanophores) along the ventral body midline which stops short of the anus by four myomeres. Melanophore(s) are also usually present on the ventral finfold in the hypural region. The gut is pigmented. No pigment occurs on the head, nape, or dorsal body midline, however, Westrheim (1975) reported that *S. crameri* larvae, along with several other species, reared for several days develop pigment spots on the head, nape, and/or lower jaw.

*Identification* (Table 3, Appendix Tables 2-6).—Eighty-one specimens of *S. crameri*, ranging from 8.0 to 130.5 mm, were identified. Juveniles were identified using the following combination of characters recorded from specimens in our collections:

Gill rakers = 30-34  
Lateral line pores = 43-50  
Pectoral fin rays = 18-20, usually 19  
Anal fin soft rays = 7  
Dorsal fin soft rays = 13-15  
Supraocular spine = present  
Interorbital space = flat to convex.

No other species on our list of potential species agrees with all these characters. In addition, the characteristic pigment banding of adults was obvious on larger juveniles. Larvae and juveniles were relatively abundant in our collections and adults are known to be abundant in terms of biomass in trawl catches off the Oregon coast (Demory et al. 1976; Niska 1976). The developmental series was linked together primarily on the basis of pigmentation and also body shape and time of occurrence. Identification of most of the smaller specimens was further substantiated by meristics, particularly the constancy in number of anal and pectoral fin rays (Table 3).

<sup>6</sup>S. G. Poss, Ph.D. Candidate, Department of Zoology, University of Michigan, Ann Arbor, MI 48109, pers. commun. July 1977.

<sup>7</sup>Westrheim, S. J., W. R. Harling, and D. Davenport. 1968. Preliminary report on the maturity, spawning season and larval identification of rockfishes (*Sebastes*) collected off British Columbia in 1967. Fish. Res. Board Can., Manusc. Rep. 951, 23 p.

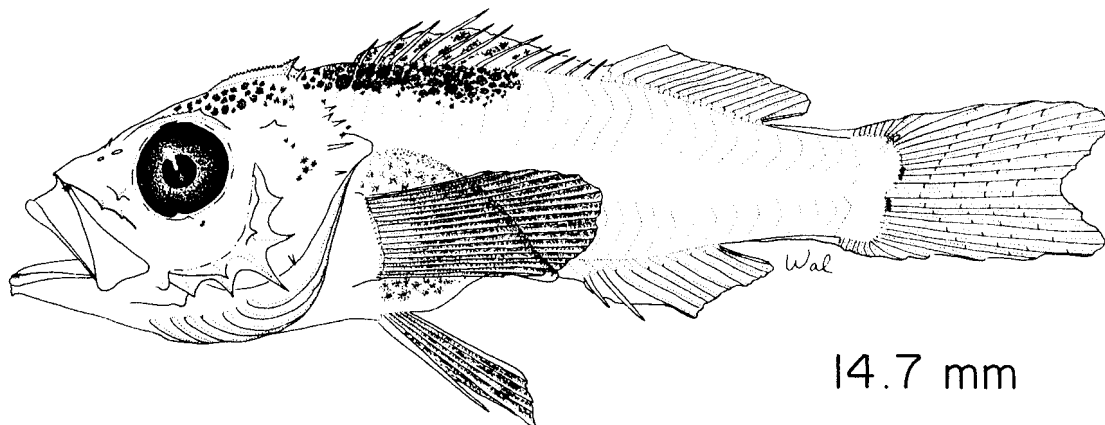
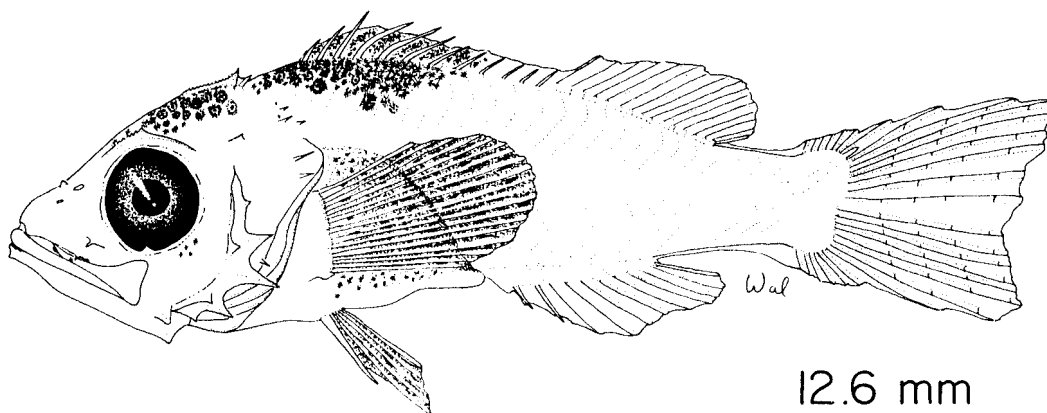
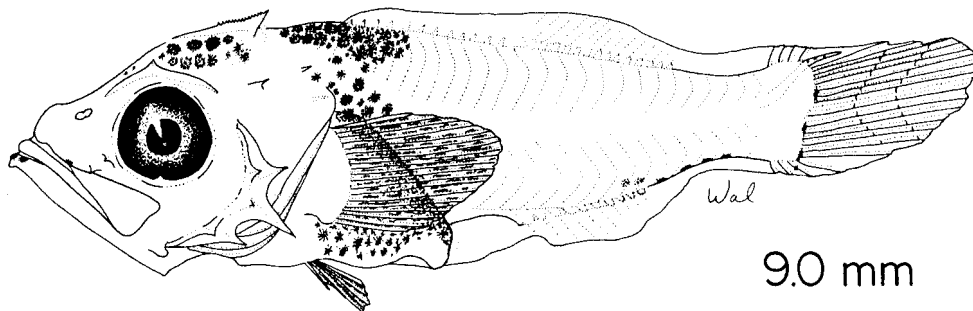
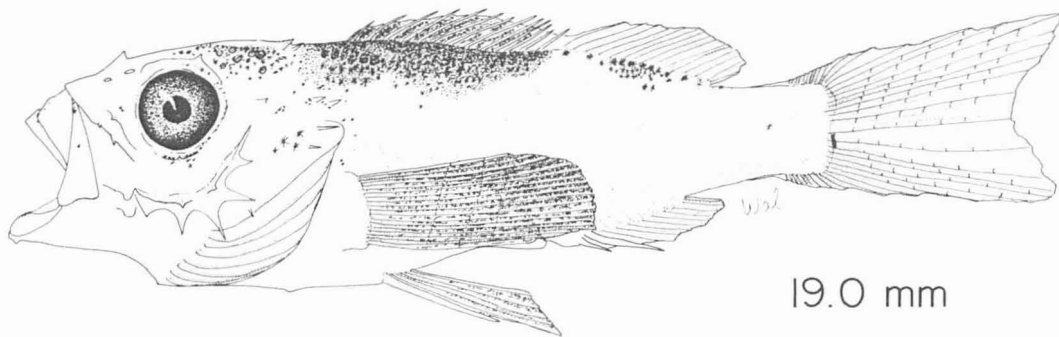
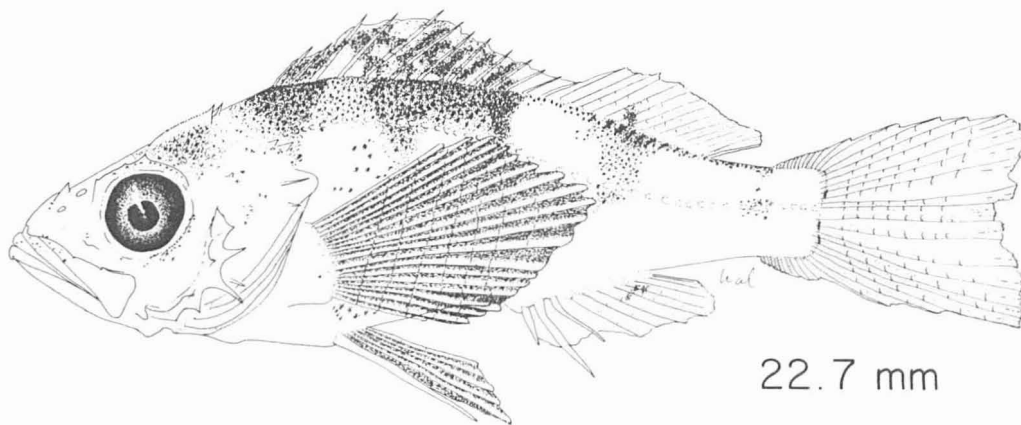


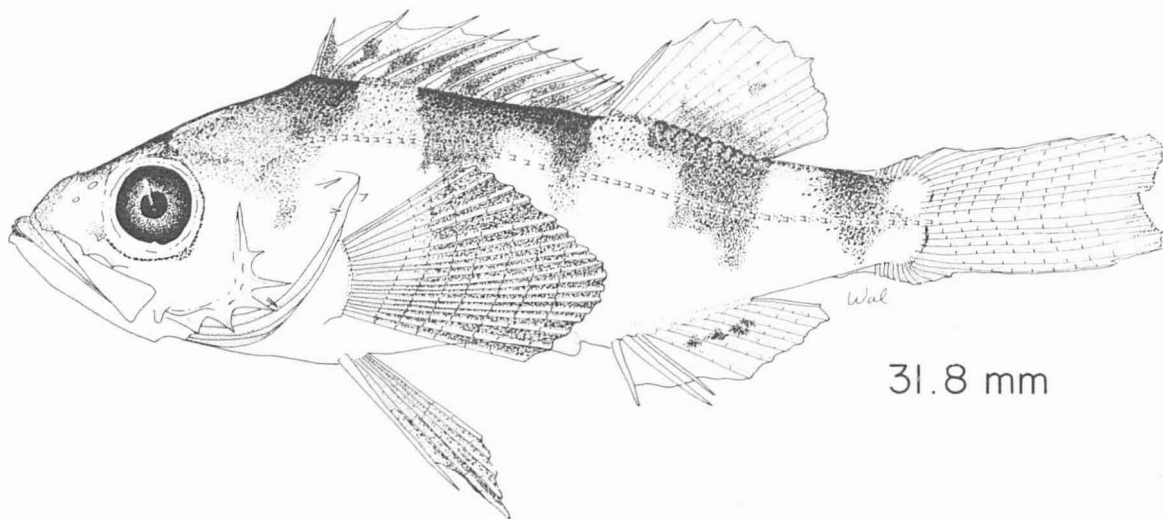
FIGURE 2.—Planktonic larvae (9.0, 12.6, 14.7 mm) of *Sebastes crameri*.



19.0 mm



22.7 mm



31.8 mm

FIGURE 3.—Transforming specimen (19.0 mm) and pelagic juveniles (22.7, 31.8 mm) of *Sebastes crameri*.



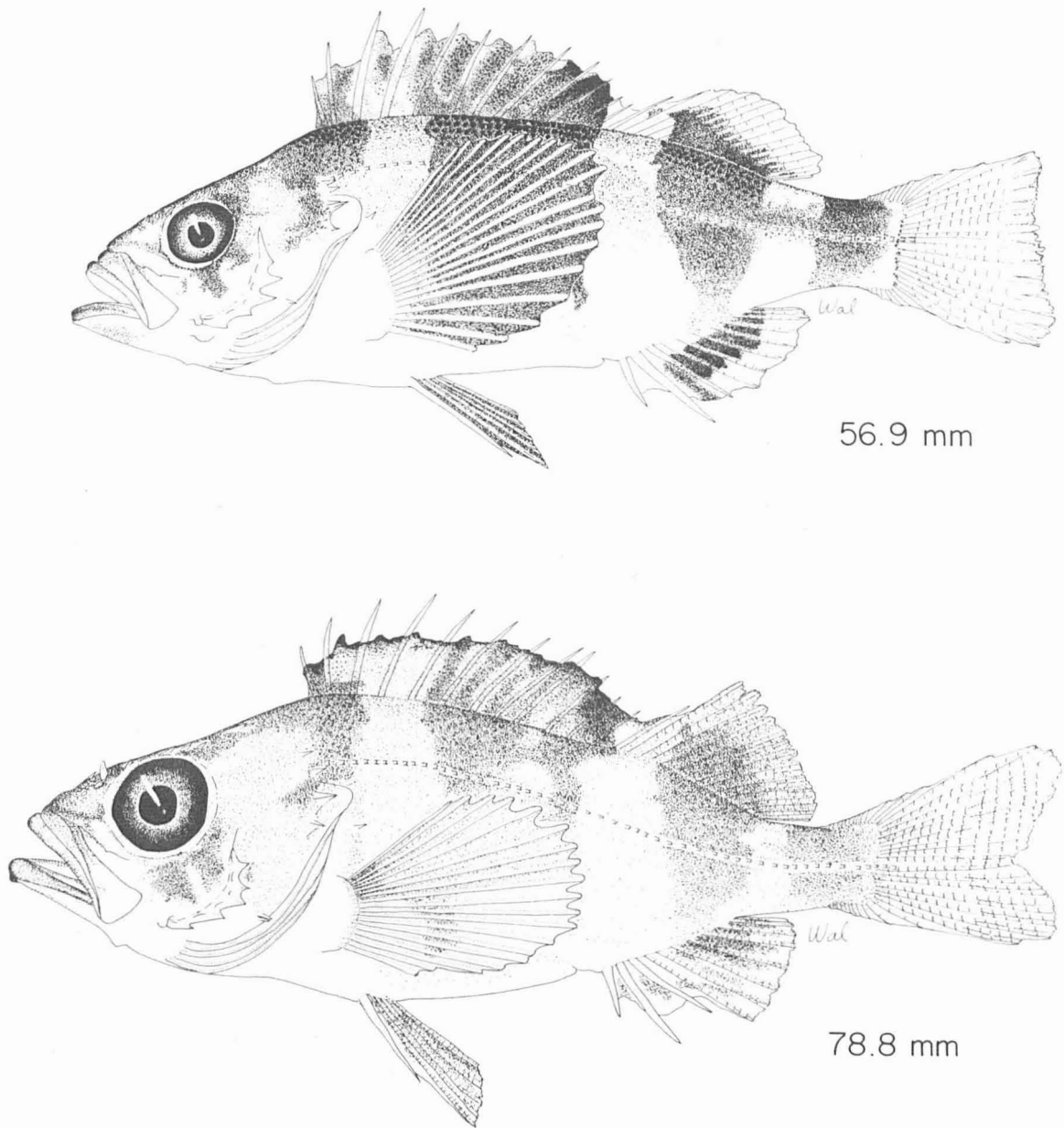


FIGURE 4.—Pelagic juvenile (56.9 mm) and benthic juvenile (78.8 mm) of *Sebastes crameri*.

*Distinguishing Features.*—Characters useful to distinguish the smallest identified larvae (8.0 mm) are the heavily pigmented pectoral and pelvic fins, the presence of a heavy nape pigment patch from which some melanophores extend down and over the gut externally on the body wall, the absence of dorsal midline pigment other than at the nape, the presence of ventral midline pig-

ment as  $\approx 11$  distinct melanophores of which the anterior ones are embedded and only the posteriormost ones remain on the ventral body surface, and pigment at the tip of the lower jaw. The presence of pigment on the first dorsal fin in larvae as small as 11 mm is also a useful character. Meristics, presence of a supraocular spine, flat to convex shape of the interorbital space, heavily pigmented

TABLE 3.—Meristics from larvae and juveniles of *Sebastes crameri* off Oregon, based on unstained specimens. Specimens above dashed line are undergoing notochord flexion. All specimens had 8 superior and 7 inferior principal caudal fin rays and 7 branchiostegal rays on each side.

Standard length (mm)	Dorsal fin spines and rays	Anal fin spines and rays	Pectoral fin rays		Pelvic fin spines and rays		Gill rakers (first arch)		Lateral line pores		Diagonal scale rows
			Left	Right	Left	Right	Left	Right	Left	Right	
8.0	( <sup>1</sup> )	( <sup>1</sup> )	—	19	( <sup>2</sup> )	( <sup>2</sup> )	—	—	—	—	—
8.0	( <sup>1</sup> )	( <sup>1</sup> )	19	19	( <sup>2</sup> )	( <sup>2</sup> )	—	—	—	—	—
9.0	III+ <sup>3</sup> ,13-14	II,7	19	19	I, <sup>1</sup>	I, <sup>1</sup>	—	—	—	—	—
9.0	<sup>3</sup> ,14	II,7	19	19	I, <sup>1</sup>	I, <sup>1</sup>	—	—	—	—	—
9.3	<sup>3</sup> ,14	II,7	19	19	I, <sup>1</sup>	I, <sup>1</sup>	—	—	—	—	—
-----											
10.6	VI+ <sup>3</sup> ,13	II,7	19	19	1,5	1,5	—	—	—	—	—
10.6	VIII+ <sup>3</sup> ,14	II,7	19	19	1,5	1,5	—	—	—	—	—
10.7	IX+ <sup>3</sup> ,13	II,7	—	19	1,5	1,5	—	—	—	—	—
12.2	X+ <sup>3</sup> ,14	III,7	19	19	1,5	1,5	—	19+ 8=27	—	—	—
12.6	XI+ <sup>3</sup> ,13	III,7	19	19	1,5	1,5	—	≈19+ 8=27	—	—	—
12.8	XI+ <sup>3</sup> ,14	III,7	19	19	1,5	1,5	—	—	—	—	—
13.6	XIII <sup>3</sup> ,13	III,7	19	19	1,5	1,5	—	≈18+ 8=26	—	—	—
13.8	XIII <sup>3</sup> ,14	III,7	19	20	1,5	1,5	—	≈20+ 8=28	—	—	—
14.4	XIII <sup>3</sup> ,14	III,7	19	19	1,5	1,5	—	≈20+ 8=28	—	—	—
14.7	XIII <sup>3</sup> ,14	III,7	20	19	1,5	1,5	—	21+ 9=30	—	—	—
15.4	XIII <sup>3</sup> ,14	III,7	18	18	1,5	1,5	—	—	—	—	—
<sup>4</sup> 16.0	XIII <sup>3</sup> ,14	III,7	19	19	1,5	1,5	—	21+ 8=29	—	—	—
<sup>4</sup> 16.3	XIII <sup>3</sup> ,14	III,7	19	19	1,5	1,5	—	22+ 8=30	—	—	—
<sup>4</sup> 17.3	XIII <sup>3</sup> ,13	III,7	19	19	1,5	1,5	—	21+ 9=30	—	—	—
<sup>4</sup> 17.4	XIII <sup>3</sup> ,13	III,7	19	19	1,5	1,5	—	22+ 9=31	—	—	—
<sup>4</sup> 18.2	XIII <sup>3</sup> ,14	III,7	19	19	1,5	1,5	—	20+ 9=29	—	—	—
<sup>4</sup> 18.4	XIII <sup>3</sup> ,13	III,7	20	19	1,5	1,5	—	22+ 9=31	—	—	—
<sup>4</sup> 18.6	XIII <sup>3</sup> ,14	III,7	20	20	1,5	1,5	—	22+ 8=30	—	—	—
<sup>4</sup> 19.0	XIII <sup>3</sup> ,14	III,7	19	20	1,5	1,5	—	22+10=32	—	—	—
<sup>4</sup> 20.0	XIII <sup>3</sup> ,14	III,7	19	19	1,5	1,5	21+ 9=30	22+ 9=31	—	—	—
<sup>4</sup> 20.3	XIII <sup>3</sup> ,14	III,7	19	19	1,5	1,5	22+ 9=31	22+ 9=31	—	—	—
<sup>4</sup> 21.0	XIII <sup>3</sup> ,14	III,7	19	19	1,5	1,5	22+ 9=31	21+ 9=30	—	—	—
<sup>5</sup> 22.7	XIII,13	III,7	20	20	1,5	1,5	22+ 9=31	22+ 9=31	—	—	—
<sup>5</sup> 23.5	XIII,13	III,7	19	19	1,5	1,5	23+ 9=32	22+10=32	—	—	—
<sup>5</sup> 24.2	XIII,14	III,7	19	19	1,5	1,5	23+ 9=32	22+ 9=31	—	—	—
<sup>5</sup> 25.6	XIII,15	III,7	19	20	1,5	1,5	22+ 9=31	23+ 9=32	—	—	—
<sup>5</sup> 28.6	XIII,14	III,7	19	19	1,5	1,5	22+ 9=31	23+10=33	—	—	—
<sup>5</sup> 30.0	XIII,13	III,7	19	19	1,5	1,5	22+ 9=31	23+ 9=32	≈48	≈47	—
<sup>5</sup> 31.8	XIII,13	III,7	19	19	1,5	1,5	23+10=33	22+10=32	46	—	—
<sup>5</sup> 35.7	XIII,14	III,7	19	19	1,5	1,5	23+ 9=32	23+ 9=32	45	≈43	—
<sup>5</sup> 38.2	XIII,14	III,7	19	19	1,5	1,5	23+10=33	23+ 9=32	—	—	—
<sup>5</sup> 56.9	XIII,14	III,7	19	19	1,5	1,5	22+ 9=31	22+ 9=31	45	46	—
<sup>6</sup> 46.8	XIII,13	III,7	19	19	1,5	1,5	24+ 9=33	23+ 9=32	≈48	—	—
<sup>6</sup> 49.2	XIII,14	III,7	19	19	1,5	1,5	23+10=33	24+10=34	≈43	≈46	—
<sup>6</sup> 58.9	XIII,14	III,7	19	19	1,5	1,5	22+ 9=31	22+ 9=31	45	45	—
<sup>6</sup> 63.0	XIII,14	III,7	19	19	1,5	1,5	23+ 9=32	23+ 9=32	45	46	—
<sup>6</sup> 63.2	XIII,13	III,7	19	19	1,5	1,5	22+ 9=31	23+ 9=32	50	46	—
<sup>6</sup> 65.0	XIII,14	III,7	19	20	1,5	1,5	24+ 9=33	24+ 9=33	49	50	—
<sup>6</sup> 67.6	XIII,14	III,7	19	19	1,5	1,5	22+10=32	23+10=33	47	48	—
<sup>6</sup> 78.8	XIII,14	III,7	19	19	1,5	1,5	22+ 9=31	22+ 9=31	48	44	—
<sup>6</sup> 86.1	XIII,13	III,7	19	18	1,5	1,5	23+ 9=32	23+ 9=32	46	46	—
<sup>6</sup> 91.8	XIII,14	III,7	19	19	1,5	1,5	22+10=32	23+10=33	47	49	≈53
<sup>6</sup> 94.4	XIII,14	III,7	19	19	1,5	1,5	22+ 8=30	22+ 9=31	49	47	≈59
<sup>6</sup> 94.7	XIII,14	III,7	19	20	1,5	1,5	23+10=33	23+ 9=32	45	45	—
<sup>6</sup> 96.2	XIII,13	III,7	19	18	1,5	1,5	22+ 9=31	22+ 9=31	47	45	≈55
<sup>6</sup> 105.6	XIII,13	III,7	19	19	1,5	1,5	22+ 9=31	22+ 9=31	47	47	≈51
<sup>6</sup> 125.7	XIII,14	III,7	19	19	1,5	1,5	23+ 9=32	23+10=33	45	44	≈59
<sup>6</sup> 130.5	XIII,13	III,7	20	20	1,5	1,5	23+10=33	23+ 9=32	46	47	≈60

<sup>1</sup>Forming.<sup>2</sup>Not formed.<sup>3</sup>Posteriormost dorsal or anal spine appears as a soft ray.<sup>4</sup>Transforming.<sup>5</sup>Pelagic juvenile.<sup>6</sup>Benthic juvenile.

pectoral and pelvic fins, and pigment banding pattern on the body serve to distinguish juveniles.

*General Development.*—The smallest specimens (8.0-9.0 mm) of *S. crameri* in the series are undergoing the final stages of notochord flexion, which is completed by the time larvae are 10 mm. Transformation from postflexion larvae to pelagic juveniles is rather gradual beginning when larvae

are about 16 mm. It is characterized by addition of pigment beneath the second dorsal fin along with initiation of structural change of the "prespines" in the dorsal and anal fins. Transformation is complete in 22 mm specimens and the juvenile pigment pattern is obvious. Transition from pelagic to benthic habitat probably occurs when fish are 40 to 60 mm. The largest pelagic juvenile, captured in a neuston net, was 56.9 mm and the

smallest juvenile taken in a bottom trawl was 46.8 mm.

*Morphology* (Tables 4, 5).—Measurements of various body parts were made on 53 selected specimens of *S. crameri*, ranging from 8.0 to 130.5 mm long, to examine developmental morphology. Relative body depth at the pectoral fin base and at the anus increases somewhat, 32 to 34% SL and 24 to 28% SL, respectively, during development from flexion larvae to benthic juveniles. A more marked change occurs in snout to anus distance which increases from 54 to 65% SL. The distance from the snout to the pelvic fin base increases slightly.

Head length decreases somewhat during development from 39 to 36% SL, while major decreases occur in eye diameter (40-33% HL), upper jaw length (56-41% HL), and interorbital distance (36-23% HL). Snout length first increases slightly and then decreases with respect to head length. The length of the angle gill raker increases from 9 to 16% HL.

*Fin Development* (Tables 3, 4, 5).—Pectoral fins are formed in 8 mm larvae of *S. crameri* and the adult complement of 18 to 20 (usually 19) fin rays (or ray elements) are countable in 9 mm specimens. The fins become more elongate with development, increasing from 17% SL in flexion larvae to a maximum of 32% SL in pelagic juveniles. Depth of the pectoral fin base decreases from 13 to 10% SL.

Pelvic fin buds are present on 8 mm larvae and the forming spines and rays (I, 5) can be counted in 9 mm larvae although they are not fully developed until the larvae reach about 10 mm. Length of the pelvic fins increased from 7 to 21% SL during the larval and juvenile periods. Length of the pelvic spine, which is less than the longest ray, increases from 5% SL in flexion larvae to 19% during transformation, and then decreases to an average of 13% in benthic juveniles.

In 8.0 mm larvae the adult complement of 8 + 7 principal caudal rays can be counted although notochord flexion does not appear to be complete until larvae are >9.3 mm. Counts of superior and inferior secondary caudal rays made on one stained juvenile, 38.2 mm, were 12 and 13, respectively.

Bases of some dorsal and anal fin rays and spines are visible on 8 mm larvae. Development of the second dorsal and anal soft rays occurs simultaneously with the central rays forming first and

the posteriormost rays last. Developing soft ray elements are visible and adult complements can be counted on 9 mm larvae although rays do not appear fully formed until larvae are >10 mm. Dorsal spines begin to form slightly after initiation of soft ray formation at  $\approx$ 9 mm. The third, fourth, and fifth dorsal spines develop first. The 12th spine is not formed until larvae are >13 mm long. The second anal spine is formed at 10.6 mm and the first is formed by 12 mm. The transition of dorsal and anal fin "prespines" to spines is complete at around 22 mm. The longest dorsal spine increases from 22 to 45% HL during the pelvic phase, and decreases to 37% in benthic juveniles. The longest dorsal ray increases from 26 to 41-43% HL during development. The longest anal spine increases from 16 to 37 or 38% HL.

*Spination* (Tables 4, 6).—Spines visible on the left side of the head of an 8.0 mm larva of *S. crameri* consist of the parietal; the second, third, and fourth preopercular spines of the posterior series; the first, second, and third preopercular spines of the anterior series; the postocular; and the pterotic. Another more developed 8.0 mm specimen has a developing nuchal spine bump; the inferior post-temporal; the first spine of the inferior infraorbital series, and the first spine on the superior infraorbital series.

The parietal spine is relatively short, averaging 6.5 to 6.6% HL in larvae and decreasing to 3.0% HL in pelagic juveniles. The nuchal spine increases in length from 1% HL in flexion larvae to 4% in postflexion and transforming specimens then decreases to 3% in pelagic juveniles. Parietal and nuchal spines begin to fuse near their bases at 10.7 mm, gradually fusing towards the tips until in specimens >38 mm the parietal tip is no longer visible. In benthic juveniles the nuchal and parietal spines are fused and their relative lengths are  $\approx$ 2% HL; however, increased pigment and musculature allowed measurement only from tip to body junction. The parietal spine and ridge are not serrated in larvae <9 mm. Serrations first appear at the center of the parietal ridge at 9 mm and persist until  $\approx$ 39 mm.

The posterior series of preopercular spines are among the most prominent in the larvae. The first through fifth spines of the series are present in larvae >10 mm. The third spine of the series is the largest, averaging 17 or 18% HL in larvae and then decreasing to 7% HL in benthic juveniles. Spines in the posterior preopercular series never

TABLE 4.—Body proportions of larvae and juveniles of *Sebastes crameri*, *S. pinniger*, and *S. helvomaculatus*. Values given are percent standard length (SL) or head length (HL) including mean, standard deviation, and range in parentheses. (Number of specimens measured may be derived from Tables 5, 8, and 11.)

Item	<i>Sebastes crameri</i>	<i>Sebastes pinniger</i>	<i>Sebastes helvomaculatus</i>
<i>Body depth at pectoral fin base/SL:</i>			
Flexion	31.8±2.05(29.0-33.8)	40.3±0.92(39.7-41.0)	33.3±1.44(32.5-35.0)
Postflexion	31.7±1.26(30.3-34.9)	38.1±2.51(33.7-42.0)	33.4±0.46(33.0-33.9)
Transforming	32.4±1.74(29.5-35.6)	35.9±1.36(33.3-38.3)	32.6±1.79(30.6-35.8)
Pelagic Juvenile	32.7±1.89(30.3-37.4)	33.0±1.88(29.8-37.0)	31.2±1.58(28.4-32.9)
Benthic Juvenile	34.4±1.96(30.1-36.5)	34.9±2.15(32.7-37.0)	33.4±1.63(32.3-34.6)
<i>Body depth at anus/SL:</i>			
Flexion	23.6±0.67(22.6-24.4)	27.6±0.92(26.9-28.2)	20.7±0.61(20.0-21.2)
Postflexion	24.9±1.19(22.6-26.5)	28.5±1.92(24.7-30.6)	24.5±2.56(21.6-26.3)
Transforming	26.7±1.34(24.7-29.4)	27.6±1.63(24.8-30.9)	24.7±1.22(23.1-26.9)
Pelagic Juvenile	26.8±1.15(25.2-29.2)	26.0±1.11(23.9-28.0)	23.2±1.24(21.2-25.0)
Benthic Juvenile	27.7±1.56(25.1-30.7)	29.8±3.68(27.3-34.0)	25.4±2.33(23.7-27.0)
<i>Snout to anus length/SL:</i>			
Flexion	54.0±1.28(52.5-55.9)	58.8±1.63(57.7-60.0)	56.1±1.28(55.0-57.5)
Postflexion	60.5±3.25(55.1-65.1)	59.6±3.42(51.7-62.6)	59.1±0.50(58.6-59.6)
Transforming	61.0±3.26(54.3-65.0)	60.6±1.84(58.1-63.1)	61.7±1.86(59.2-64.5)
Pelagic Juvenile	61.6±2.63(57.9-64.3)	61.4±3.50(56.0-67.4)	62.8±2.46(59.8-66.0)
Benthic Juvenile	65.0±1.81(61.5-68.7)	64.2±3.27(60.6-67.0)	63.8±1.06(63.0-64.5)
<i>Snout to pelvic fin origin/SL:</i>			
Flexion	37.6±1.56(35.0-38.9)	41.1±3.61(38.5-43.6)	40.5±1.27(39.0-41.2)
Postflexion	40.8±2.02(38.1-44.3)	40.7±3.03(34.7-44.9)	40.9±0.45(40.4-41.3)
Transforming	39.8±3.49(34.1-46.5)	41.9±2.74(38.7-46.2)	42.8±3.13(38.0-47.3)
Pelagic Juvenile	38.9±3.23(34.0-44.5)	39.9±3.83(32.9-45.5)	42.8±3.16(39.3-48.2)
Benthic Juvenile	40.5±1.86(37.3-43.1)	42.7±2.86(41.0-46.0)	40.0±0.92(39.4-40.7)
<i>Head length/SL:</i>			
Flexion	39.0±1.55(37.5-41.1)	43.0±0.92(42.3-43.6)	41.4±1.27(40.0-42.5)
Postflexion	38.9±1.90(36.8-43.4)	42.4±2.58(38.2-47.7)	42.0±2.03(40.4-44.3)
Transforming	36.6±2.43(32.8-38.7)	40.5±1.39(38.0-42.6)	40.8±1.92(36.4-43.0)
Pelagic Juvenile	35.8±1.82(32.3-38.3)	37.5±2.52(33.3-42.1)	40.1±1.48(37.5-41.9)
Benthic Juvenile	36.4±2.75(31.8-39.9)	36.6±0.51(36.0-37.0)	37.6±0.57(37.2-38.0)
<i>Eye diameter/HL:</i>			
Flexion	40.2±1.82(37.8-42.9)	37.3±1.27(36.4-38.2)	38.8±1.63(29.4-31.2)
Postflexion	38.2±1.87(33.9-40.0)	39.3±1.89(37.5-41.3)	36.3±0.36(35.9-36.6)
Transforming	36.9±2.47(33.3-42.1)	37.5±1.35(34.2-38.7)	35.5±2.38(32.0-38.8)
Pelagic Juvenile	30.4±2.60(26.6-35.0)	34.2±2.77(30.8-42.3)	33.6±1.76(30.8-36.9)
Benthic Juvenile	31.6±2.05(28.9-35.6)	26.8±3.22(24.0-30.3)	31.6±5.30(27.8-35.3)
<i>Upper jaw length/HL:</i>			
Flexion	46.5±4.35(40.5-50.0)	47.8±0.99(47.1-48.5)	45.0±3.29(41.2-46.9)
Postflexion	43.6±2.45(40.0-46.3)	46.1±3.73(41.2-52.4)	44.0±3.00(41.0-47.0)
Transforming	43.8±5.55(34.2-50.9)	42.1±3.64(35.6-47.0)	45.7±4.23(39.7-53.1)
Pelagic Juvenile	41.3±4.06(33.9-47.5)	41.3±3.14(34.6-47.4)	45.1±2.63(40.2-47.6)
Benthic Juvenile	41.2±2.44(37.8-45.6)	44.9±2.15(42.7-47.0)	52.1±0.78(51.5-52.6)
<i>Snout length/HL:</i>			
Flexion	29.1±1.38(27.0-30.7)	26.9±0.28(26.7-27.1)	32.3±2.20(30.0-34.4)
Postflexion	30.0±1.65(26.1-31.7)	28.7±3.45(23.8-34.8)	33.0±1.18(31.7-34.1)
Transforming	31.2±2.69(27.0-35.6)	30.2±3.31(25.8-36.5)	32.4±3.72(25.0-37.9)
Pelagic Juvenile	28.2±2.97(24.6-32.1)	27.3±3.68(21.7-32.5)	31.7±2.49(26.7-34.1)
Benthic Juvenile	26.3±2.43(22.4-31.2)	28.8±0.72(28.0-29.4)	26.7±0.42(26.4-27.0)
<i>Interorbital distance/HL:</i>			
Flexion	35.6±1.95(32.4-37.1)	37.3±1.27(36.4-38.2)	30.6±1.04(29.4-31.2)
Postflexion	33.0±1.94(29.3-36.0)	34.2±2.26(30.4-38.2)	31.4±0.55(30.8-31.8)
Transforming	31.2±3.39(25.9-36.8)	30.0±1.82(26.3-32.3)	27.0±2.89(23.3-30.6)
Pelagic Juvenile	25.9±2.48(23.0-30.0)	24.4±3.31(19.5-30.8)	21.5±3.83(13.3-25.6)
Benthic Juvenile	21.6±2.18(18.0-26.8)	19.8±1.37(18.3-21.0)	14.6±2.47(12.9-16.4)
<i>Angle gill raker length/HL:</i>			
Flexion	8.6±0.00(8.6)	—	—
Postflexion	11.4±1.77(8.6-14.4)	10.6±1.42(8.3-12.3)	13.4±0.95(12.3-14.1)
Transforming	13.1±1.13(11.1-15.1)	13.0±0.72(11.5-14.5)	15.1±1.46(12.9-18.0)
Pelagic Juvenile	13.9±0.82(13.3-15.1)	14.1±1.21(11.7-16.5)	14.2±1.90(12.7-15.7)
Benthic Juvenile	15.8±1.06(13.7-17.4)	14.9±1.10(13.8-16.0)	10.6±0.50(10.3-11.0)
<i>Longest dorsal spine length<sup>1</sup>/HL:</i>			
Flexion	—	—	—
Postflexion	21.6±2.26(19.4-24.1)	20.1±6.05(13.0-28.8)	19.0±0.64(18.6-19.5)
Transforming	34.3±7.13(26.2-45.1)	32.4±5.49(23.6-40.6)	29.2±6.08(22.4-37.5)
Pelagic Juvenile	44.7±1.55(42.0-46.2)	38.0±3.79(33.1-46.2)	30.9±2.93(28.0-35.7)
Benthic Juvenile	36.9±4.32(31.7-44.3)	35.6±4.74(32.0-41.0)	37.0±4.88(33.6-40.5)
<i>Longest dorsal ray length<sup>2</sup>/HL:</i>			
Flexion	—	—	22.8±7.39(15.9-30.6)
Postflexion	26.2±6.96(14.6-33.3)	31.5±4.26(23.8-38.0)	26.4±5.14(20.5-29.5)
Transforming	41.4±2.32(39.3-43.9)	38.5±3.60(30.8-42.9)	36.1±3.08(32.5-41.7)
Pelagic Juvenile	42.0±2.97(38.1-46.7)	41.6±3.46(35.4-48.7)	35.1±2.53(32.0-38.1)
Benthic Juvenile	43.1±4.74(37.6-48.1)	42.6±3.83(40.0-47.0)	42.8±3.89(40.0-45.5)
<i>Longest anal spine length<sup>3</sup>/HL:</i>			
Flexion	—	—	—
Postflexion	15.6±3.16(9.6-18.5)	18.7±2.52(14.6-21.3)	16.0±1.91(14.6-17.3)
Transforming	28.1±3.46(23.0-32.0)	28.5±5.65(20.0-38.6)	27.3±4.46(22.4-36.1)

TABLE 4.—Continued.

Item	<i>Sebastes crameri</i>	<i>Sebastes pinniger</i>	<i>Sebastes helvomaculatus</i>
Pelagic Juvenile	37.8 ± 4.36(31.2-43.5)	37.4 ± 4.07(30.8-44.0)	32.4 ± 5.70(26.8-38.1)
Benthic Juvenile	36.5 ± 4.34(30.6-44.3)	34.5 ± 2.50(32.0-37.0)	48.8 ± 4.67(45.5-52.1)
<i>Pectoral fin length/SL:</i>			
Flexion	17.1 ± 1.52(15.0-18.9)	25.0 ± 2.69(23.1-26.9)	23.6 ± 2.11(21.2-25.0)
Postflexion	21.1 ± 2.26(17.0-23.5)	24.7 ± 2.64(20.2-28.5)	24.4 ± 0.57(23.9-25.0)
Transforming	27.1 ± 1.54(24.7-29.5)	27.0 ± 2.42(22.7-31.5)	26.0 ± 1.45(24.3-28.3)
Pelagic Juvenile	32.1 ± 1.73(30.2-35.3)	26.2 ± 1.36(24.0-28.5)	26.6 ± 0.28(26.1-26.9)
Benthic Juvenile	29.5 ± 3.61(25.0-38.9)	24.3 ± 1.21(22.9-25.0)	27.0 ± 0.85(26.4-27.6)
<i>Pectoral fin base depth/SL:</i>			
Flexion	12.6 ± 1.27(10.8-13.8)	14.8 ± 0.92(14.1-15.4)	12.5 ± 0.00(12.5)
Postflexion	11.1 ± 0.39(10.4-11.8)	12.6 ± 0.83(11.4-13.6)	11.5 ± 0.84(11.0-12.5)
Transforming	10.4 ± 0.61(9.5-11.7)	10.7 ± 0.59(9.7-11.5)	9.9 ± 0.64(9.0-10.8)
Pelagic Juvenile	9.6 ± 0.51(8.5-10.2)	9.1 ± 0.64(8.2-10.1)	9.0 ± 0.33(8.2-9.1)
Benthic Juvenile	10.2 ± 0.53(8.8-10.9)	8.9 ± 0.23(8.6-9.0)	9.3 ± 0.71(8.8-9.8)
<i>Pelvic fin length/SL:</i>			
Flexion	7.3 ± 1.81(5.2-9.8)	13.8 ± 2.19(12.3-15.4)	13.5 ± 1.32(12.5-15.0)
Postflexion	15.3 ± 1.46(12.3-16.9)	17.2 ± 4.12(10.0-22.8)	15.5 ± 0.70(14.8-16.2)
Transforming	20.6 ± 1.01(18.3-22.1)	22.7 ± 1.59(20.8-25.3)	19.3 ± 1.62(16.7-21.6)
Pelagic Juvenile	20.9 ± 0.60(20.1-21.9)	21.7 ± 1.29(19.4-23.7)	19.2 ± 1.36(17.3-21.4)
Benthic Juvenile	20.7 ± 0.97(18.5-22.2)	21.3 ± 2.08(19.0-23.0)	22.7 ± 0.99(22.0-23.4)
<i>Pelvic spine length/SL:</i>			
Flexion	4.7 ± 1.42(3.4-6.2)	5.1 ± 0.00(5.1)	8.3 ± 0.15(8.2-8.5)
Postflexion	11.4 ± 2.20(6.8-14.6)	12.1 ± 2.99(8.2-15.0)	12.3 ± 2.26(10.2-14.7)
Transforming	18.8 ± 1.65(14.5-20.1)	19.5 ± 1.38(17.6-21.7)	17.6 ± 1.02(15.8-19.1)
Pelagic Juvenile	19.0 ± 1.35(16.2-20.7)	17.9 ± 2.10(14.5-22.1)	16.4 ± 1.99(13.5-18.9)
Benthic Juvenile	13.9 ± 1.34(12.3-17.1)	12.5 ± 0.50(12.0-13.0)	14.9 ± 0.71(14.4-15.4)
<i>Parietal spine length/HL:</i>			
Flexion	6.5 ± 1.01(5.4-7.4)	24.4 ± 0.35(24.2-24.4)	27.4 ± 4.19(22.9-31.2)
Postflexion	6.6 ± 1.06(5.2-8.5)	19.5 ± 7.17(8.8-23.5)	18.5 ± 2.24(15.9-20.0)
Transforming	6.0 ± 1.24(3.7-7.4)	10.2 ± 3.07(3.9-12.9)	12.6 ± 2.39(9.0-16.3)
Pelagic Juvenile	2.9 ± 0.98(1.8-4.2)	7.1 ± 2.66(5.4-10.2)	5.6 ± 3.31(1.1-9.5)
Benthic Juvenile	—	—	3.1 ± 0.00(3.1)
<i>Nuchal spine length/HL:</i>			
Flexion	1.1 ± 0.00(1.1)	—	1.8 ± 0.85(1.2-2.4)
Postflexion	4.1 ± 0.73(3.4-5.8)	4.4 ± 1.63(2.5-6.9)	4.3 ± 1.51(2.6-5.0)
Transforming	4.4 ± 0.88(3.1-6.0)	4.8 ± 1.57(2.3-7.2)	4.6 ± 0.78(3.0-4.9)
Pelagic Juvenile	3.2 ± 1.03(2.0-5.0)	3.1 ± 0.96(1.9-5.4)	3.5 ± 1.13(1.7-5.2)
Benthic Juvenile	1.7 ± 0.64(0.7-2.8)	1.4 ± 0.64(1.0-2.1)	—
<i>Preopercular spine length/HL:</i>			
Flexion	17.6 ± 3.84(12.0-20.5)	34.4 ± 2.83(32.4-36.4)	27.4 ± 4.19(22.9-31.2)
Postflexion	17.0 ± 1.09(15.5-18.5)	31.8 ± 4.86(25.0-39.0)	31.2 ± 0.64(30.8-31.7)
Transforming	18.3 ± 1.53(16.0-19.7)	23.6 ± 2.09(21.2-29.1)	20.2 ± 3.58(16.2-26.5)
Pelagic Juvenile	12.0 ± 2.85(8.6-16.2)	12.8 ± 3.96(9.1-22.2)	11.8 ± 6.29(2.5-15.9)
Benthic Juvenile	7.2 ± 2.72(3.1-11.4)	4.8 ± 1.39(4.0-6.4)	1.6 ± 1.34(0.6-2.5)

<sup>1</sup>Usually third or fourth in larvae, fifth or sixth in juveniles.

<sup>2</sup>Usually midfin.

<sup>3</sup>The second spine.

develop strong serrations. Spines in the anterior preopercular series are much shorter than those in the posterior series. The second or middle spine is present only in larvae prior to completion of notochord flexion, <10 mm. Its appearance as a spine changes to a small bump which then fuses with the ridges connecting it to the third preopercular spine of the posterior series. The first and third anterior spines are present on larvae through pelagic juveniles of ≈23 mm and then are no longer visible.

The superior and inferior opercular spines and the interopercular spine appear by the time the larvae reach 12 mm, although precursor bumps may be seen as early as 9 mm. These spines persist into the juvenile stage. The subopercular spine is present in juveniles >78 mm.

Around the eye, the ridge anterior to the postocular spine becomes serrated at 10.6 mm. These

serrations disappear at the time of supraocular spine formation, >21 mm. The preocular spine begins to appear in transforming specimens >16 mm and is strongly formed by the time fish are 20 mm. Beneath the eye the second spine of the inferior infraorbital series forms in larvae >10 mm. The fourth spine of the superior infraorbital series develops under the posterior third of the eye on larvae >13.6 mm and it persists through the juvenile stage as do the two inferior infraorbital spines. The second and third superior and third inferior infraorbital spines never develop. Tiny serrations appear along a ridge between the first and fourth superior infraorbital spines in specimens 14.4 to 38.2 mm. The first spine of the superior infraorbital series disappears in specimens >50 mm. The nasal spine develops in larvae of ≈10 mm and persists in juveniles.



*Scale Formation.*—Lateral line pores are visible on transforming specimens >18.2 mm. Developing scales are first visible on unstained specimens ≈20 mm on the posterodorsal region of the head and anterodorsal region of the trunk above the gut cavity. Scale development proceeds posteriorly with the body being covered by 29 mm.

*Pigmentation.*—Melanistic pigment on 8.0 mm specimens of *S. crameri* (similar to the 9 mm

specimen illustrated) is present on the head over the brain. Melanophores line the inside tip of the lower jaw and may also be present along the anteroventral margin of the maxillary. In the abdominal region internal melanophores are densely concentrated on the dorsal surface of the gut and more sparsely distributed laterally and ventrally. Additional external melanophores are present on the body wall over the gut cavity. A heavy concentration of external melanophores and some in-

TABLE 6.—Development of spines in the head region of *Sebastes crameri* larvae and juveniles. Specimens above dashed line are undergoing notochord flexion. + denotes spine present and - denotes spine absent.

Standard length (mm)	Parietal	Nuchal	Preopercular (anterior series)			Preopercular (posterior series)				Opercular		Inter-opercular	Sub-opercular	Pre-ocular	Supra-ocular	Post-ocular
			1st	2d	3d	1st	2d	3d	4th	5th	Superior					
8.0	+	-	+	+	+	-	+	+	+	-	-	-	-	-	-	+
8.0	+	+	+	+	+	-	+	+	+	-	-	-	-	-	-	+
9.0	+	+	+	+	+	-	+	+	+	-	-	-	-	-	-	+
9.0	+	-	+	+	+	-	+	+	+	-	-	-	-	-	-	+
9.3	+	+	-	( <sup>1</sup> )	+	-	+	+	+	-	+	-	-	-	-	+
-----																
10.6	+	+	+	-	+	+	+	+	+	+	+	-	-	-	-	+
10.6	+	+	+	-	+	+	+	+	+	+	+	-	-	-	-	+
12.2	+	+	+	-	+	+	+	+	+	+	+	+	-	-	-	+
12.6	+	+	+	-	+	+	+	+	+	+	+	+	-	-	-	+
12.8	+	+	+	-	+	+	+	+	+	+	+	+	-	-	-	+
13.6	+	+	+	-	+	+	+	+	+	+	+	+	-	-	-	+
13.8	+	+	+	-	+	+	+	+	+	+	+	+	-	-	-	+
14.4	+	+	+	-	+	+	+	+	+	+	+	+	-	-	-	+
14.7	+	+	+	-	+	+	+	+	+	+	+	+	-	-	-	+
15.4	+	+	+	-	+	+	+	+	+	+	+	+	-	-	-	+
<sup>2</sup> 16.0	+	+	+	-	+	+	+	+	+	+	+	+	-	-	-	+
<sup>2</sup> 16.3	+	+	+	-	+	+	+	+	+	+	+	+	-	( <sup>3</sup> )	-	+
<sup>2</sup> 17.3	+	+	+	-	+	+	+	+	+	+	+	+	-	( <sup>3</sup> )	-	+
<sup>2</sup> 17.4	+	+	+	-	+	+	+	+	+	+	+	+	-	( <sup>3</sup> )	-	+
<sup>2</sup> 18.2	+	+	+	-	+	+	+	+	+	+	+	+	-	( <sup>3</sup> )	-	+
<sup>2</sup> 18.4	+	+	+	-	+	+	+	+	+	+	+	+	-	( <sup>3</sup> )	-	+
<sup>2</sup> 18.6	+	+	+	-	+	+	+	+	+	+	+	+	-	( <sup>3</sup> )	-	+
<sup>2</sup> 19.0	+	+	+	-	+	+	+	+	+	+	+	+	-	( <sup>3</sup> )	-	+
<sup>2</sup> 20.0	+	+	+	-	+	+	+	+	+	+	+	+	-	( <sup>3</sup> )	-	+
<sup>2</sup> 20.3	+	+	+	-	+	+	+	+	+	+	+	+	-	+	-	+
<sup>2</sup> 21.0	+	+	+	-	+	+	+	+	+	+	+	+	-	+	( <sup>3</sup> )	+
<sup>2</sup> 22.7	+	+	+	-	+	+	+	+	+	+	+	+	-	+	( <sup>3</sup> )	+
<sup>2</sup> 23.5	+	+	( <sup>1</sup> )	-	( <sup>1</sup> )	-	+	+	+	+	+	+	-	+	( <sup>3</sup> )	+
<sup>2</sup> 24.2	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>2</sup> 25.6	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>2</sup> 28.6	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>2</sup> 30.0	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>3</sup> 31.8	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>3</sup> 35.7	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>3</sup> 38.2	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>3</sup> 56.9	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>4</sup> 46.8	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>4</sup> 49.2	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>4</sup> 58.9	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>4</sup> 63.0	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>4</sup> 63.2	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>4</sup> 65.0	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>4</sup> 67.6	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>4</sup> 78.8	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>4</sup> 86.1	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>4</sup> 91.8	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>4</sup> 94.4	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>4</sup> 94.7	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>4</sup> 96.2	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>4</sup> 105.6	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>5</sup> 125.7	<sup>5</sup>	<sup>5</sup>	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>5</sup> 130.5	<sup>5</sup>	<sup>5</sup>	-	-	-	+	+	+	+	+	+	+	-	+	+	+

<sup>1</sup>Bump indicates beginning of spine formation.  
<sup>2</sup>Transforming.  
<sup>3</sup>Pelagic juvenile.  
<sup>4</sup>Benthic juvenile.  
<sup>5</sup>Parietal and nuchal spines fused.  
<sup>6</sup>Spine is bifid.

TABLE 6.—Continued.

Standard length (mm)	Infraorbitals							Nasal	Coronal	Tympanic	Pterotic	Posttemporal		Supra-cleithral	Cleithral
	Interior			Superior								Superior	Inferior		
	1st	2d	3d	1st	2d	3d	4th								
8.0	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
8.0	+	-	-	+	-	-	-	-	-	-	+	-	+	-	-
9.0	+	-	-	+	-	-	-	-	-	-	+	-	+	-	-
9.0	-	-	-	+	-	-	-	-	-	-	+	-	+	-	-
9.3	-	-	-	+	-	-	-	-	-	-	+	-	+	-	-
10.6	+	-	-	+	-	-	-	(!)	-	-	+	-	+	-	-
10.6	+	+	-	+	-	-	-	(!)	-	-	+	-	+	+	-
12.2	+	+	-	+	-	-	-	+	-	-	+	-	+	+	-
12.6	+	+	-	+	-	-	-	+	-	-	+	-	+	+	-
12.8	+	+	-	+	-	-	-	+	-	-	+	-	+	+	-
13.6	+	+	-	+	-	-	-	+	-	-	+	-	+	+	-
13.8	+	+	-	+	-	-	-	(!)	+	-	+	-	+	+	-
14.4	+	+	-	+	-	-	-	+	+	-	+	-	+	+	-
14.7	+	+	-	+	-	-	-	+	+	-	+	-	+	+	-
15.4	+	+	-	+	-	-	-	+	+	-	+	-	+	+	-
<sup>2</sup> 16.0	+	+	-	+	-	-	-	+	+	-	+	-	+	+	-
<sup>2</sup> 16.3	+	+	-	+	-	-	-	+	+	-	+	-	+	+	-
<sup>2</sup> 17.3	+	+	-	+	-	-	-	+	+	-	+	-	+	+	-
<sup>2</sup> 17.4	+	+	-	+	-	-	-	+	+	-	+	-	+	+	-
<sup>2</sup> 18.2	+	+	-	+	-	-	-	+	+	-	+	-	+	+	-
<sup>2</sup> 18.4	+	+	-	+	-	-	-	+	+	-	+	+	+	+	-
<sup>2</sup> 18.6	+	+	-	+	-	-	-	+	+	-	+	-	+	+	-
<sup>2</sup> 19.0	+	+	-	+	-	-	-	+	+	-	+	-	+	+	-
<sup>2</sup> 20.0	+	+	-	+	-	-	-	+	+	-	+	+	+	+	-
<sup>2</sup> 20.3	+	+	-	+	-	-	-	+	+	-	+	(!)	+	+	-
<sup>2</sup> 21.0	+	+	-	+	-	-	-	+	+	-	+	+	+	+	-
<sup>2</sup> 22.7	+	+	-	+	-	-	-	+	+	-	+	+	+	+	-
<sup>2</sup> 23.5	+	+	-	+	-	-	-	+	+	-	+	+	+	+	-
<sup>2</sup> 24.2	+	+	-	+	-	-	-	+	+	-	+	+	+	+	-
<sup>2</sup> 25.6	+	+	-	+	-	-	-	+	+	-	+	+	+	+	-
<sup>2</sup> 28.6	+	+	-	-	-	-	-	+	+	-	+	+	+	+	-
<sup>3</sup> 30.0	+	+	-	+	-	-	-	+	+	-	+	+	+	+	-
<sup>3</sup> 31.8	+	+	-	-	-	-	-	+	+	-	+ <sup>6</sup>	+	+	+	+
<sup>3</sup> 35.7	+	+	-	+	-	-	-	+	+	-	+ <sup>6</sup>	+	+	+	+
<sup>3</sup> 38.2	+	+	-	+	-	-	-	+	+	-	+	+	+	+	+
<sup>3</sup> 56.9	+	+	-	-	-	-	-	+	+	-	+	+	+	+	+
<sup>4</sup> 46.8	+	+	-	+	-	-	-	+	+	-	+	+	+	+	+
<sup>4</sup> 49.2	+	+	-	+	-	-	-	+	+	-	+ <sup>6</sup>	+	+	+	+
<sup>4</sup> 58.9	+	+	-	-	-	-	-	+	+	-	+	-	+	+	+
<sup>4</sup> 63.0	+	+	-	-	-	-	-	+	+	-	+	+	+	+	+
<sup>4</sup> 63.2	+	+	-	-	-	-	-	+	+	-	+	-	+	+	+
<sup>4</sup> 65.0	+	+	-	-	-	-	-	+	+	-	+ <sup>6</sup>	-	+	+	+
<sup>4</sup> 67.6	+	+	-	-	-	-	-	+	+	-	+ <sup>6</sup>	-	+	+	+
<sup>4</sup> 78.8	+	+	-	-	-	-	-	+	+	-	+ <sup>6</sup>	-	+	+	+
<sup>4</sup> 86.1	+	+	-	-	-	-	-	+	+	-	+	-	+	+	+
<sup>4</sup> 91.8	+	+	-	-	-	-	-	+	+	-	+ <sup>6</sup>	-	+	+	+
<sup>4</sup> 94.4	+	+	-	-	-	-	-	+	+	-	+	-	+	+	+
<sup>4</sup> 94.7	+	+	-	-	-	-	-	+	+	-	+	-	+	+	+
<sup>4</sup> 96.2	+	+	-	-	-	-	-	+	+	-	+	-	+	+	+
<sup>4</sup> 105.6	+	+	-	-	-	-	-	+	+	-	+	-	+	+	+
<sup>4</sup> 125.7	+	+	-	-	-	-	-	+	+	-	+	-	+	+	+
<sup>4</sup> 130.5	+	+	-	-	-	-	-	+	+	-	+	-	+	+	+

ternal pigment is present in the nape region although the dorsal midline is pigmentless. A few large stellate melanophores extend laterally from the nape to the gut cavity. A series of 10 or 11 distinct melanophores is visible along the ventral midline of the tail, the anterior five of which are embedded in musculature dorsal to the developing anal fin. A few small melanophores may be present on the notochord tip. The pectoral fins are distinctively and heavily pigmented. A dense concentration of melanophores occurs on the proximal surface of the fin base but the distal surface is unpigmented. Elongate melanophores line the inner and outer surfaces of the fin blades creating

a striated appearance. The developing pelvic fins are also pigmented.

As larvae develop, pigment increases on the head over the brain. Melanophores persist along the tip of the lower jaw and the anteroventral margin of the maxillary. Several melanophores develop around the bases of the posttemporal and supracleithral spines in larvae >10.5 mm and on the dorsal part of the operculum anterior to the opercular spines in larvae >13.5 mm.

Pigmentation within the gut cavity remains intense through larval development and external melanophores remain scattered on the body wall over the gut. In larvae >10.5 mm, as dorsal fin



spines develop, melanophores are added to the nape patch along the dorsal midline and posteriorly along the dorsolateral body surface. The large stellate melanophores extending from the nape patch to the gut disappear by 12 mm. A few external melanophores appear along the anterior margin of the middle of the cleithrum beneath the gill cover in 12 or 13 mm larvae.

In the tail region the ventral midline melanophores gradually become embedded, anterior ones first, and are obscured by overlying musculature by the time larvae are 13 mm long. A melanophore is sometimes present near the tip of the notochord.

The pigmentation of the paired fins increases in intensity throughout the larval period, although the distal base of the pectoral fin remains unpigmented. As the pelvic fins develop, melanophores line the rays giving a striated appearance similar to that of the pectoral fins.

Melanophores appear on the anterior portion of the spinous dorsal fin by the time larvae are 11 mm long, and the anterior two-thirds of the fin remains rather heavily pigmented throughout larval development. The soft dorsal and anal fins remain unpigmented.

One to several internal, vertically elongate melanophores appear at the base of the caudal fin posterior to the hypural elements on most larvae >9 mm long, but the fin base is never completely lined with pigment.

During the transformation period, 16 to 21 mm, pelagic juvenile pigmentation begins to develop. On the head, pigment increases around the post-temporal spines and joins with the nape pigment. Internal and external melanophores are added on the dorsal part of the opercle forming a patch which expands ventrally on specimens >19 mm. Scattered melanophores appear along the dorsal surface of the snout and the anterior portion of the upper lip (internal and external) on specimens >18.5 mm long. Pigment increases around the orbit, lining the dorsal, posterior, and ventral margin of the orbit by 19 mm. In the abdominal region, an increase in musculature over the gut cavity obscures the internal gut pigment although scattered external melanophores persist. The nape patch extends anteriorly joining the head pigment, laterally toward the body midline, and posteriorly to the 12th dorsal spine. Two saddles of intensified melanistic pigment begin to develop beneath the first dorsal fin late in the transformation period. An anterior saddle joins the head pigment and another saddle located midfin expands

ventrolaterally. Melanophores are added dorsally and ventrally along the anterior margin of the cleithrum beneath the gill cover, eventually appearing as a line of pigment. In the tail region, melanophores appear beneath the middle of the second dorsal fin in 16 mm specimens. They expand anteriorly to join the pigment beneath the spinous dorsal, posteriorly over the caudal peduncle, and laterally towards the body midline appearing as a saddle by 20 mm. Some melanophores at the base of the second dorsal fin become concentrated along muscles surrounding the dorsal pterygiophores giving the appearance of vertical lines of pigment by 20 mm. An additional melanophore may appear at the point of articulation of each dorsal soft ray 4 through 10 beginning on 18 mm specimens. Pigment is added internally and externally along the lateral midline of the caudal peduncle. On the first dorsal fin pigmentation increases extending posteriorly to the 11th or 12th dorsal spine.

In pelagic juveniles >22 mm long, small melanophores appear over the surface of the head. Melanophores almost entirely ring the orbit by 31 mm. Pigment increases on the snout and upper and lower jaws. The two pigment saddles beneath the first dorsal fin become more pronounced and extend more ventrolaterally. A third saddle forms beneath the first dorsal fin posterior to the first two in specimens about 22 to 25 mm long. In the tail region, the saddle beneath the second dorsal fin extends to the lateral midline by 24 mm and eventually reaches the ventral body margin in a 57 mm specimen. The number of melanophores increases on the caudal peduncle until dorsal and lateral pigment are joined forming a fifth pigment saddle in juveniles about 25 mm long. This fifth saddle eventually extends to the ventral body margin as does the saddle beneath the spinous dorsal fin. An increase in the number of melanophores occurs along the lateral midline of the caudal peduncle giving the appearance of a distinguishable, but not heavy, line of pigment. Small melanophores are added between saddles 3 and 4 and 4 and 5, along the myosepta first. The pectoral and pelvic fins remain heavily pigmented, although the amount of pigment on the base of the rayed portion of the pectoral fin decreases. Pigmentation on the spinous dorsal fin decreases in intensity between spines III and V, and between spines VIII and IX, corresponding to areas between the first, second, and third pigment saddles on the body. On specimens >38 mm long, pigment on the dorsal fin

above the third saddle darkens into a distinct black blotch. Melanophores are added to the basal half of the second dorsal fin above the fourth saddle, appearing continuous with it on specimens >29 mm long. Melanophores are also added to the basal half of the anal fin eventually extending from the second anal spine to the posteriormost anal fin ray on all specimens >38 mm. Specimens >36 mm have a melanophore at the point of articulation of each soft anal fin ray, although these melanophores soon become obscured by musculature and scales. Three to seven small external melanophores are added near the bases of the caudal fin rays forming an indistinct line.

Benthic juveniles >60 mm long retain essentially the same melanistic pigment pattern as pelagic juveniles except the intensity decreases resulting in a somewhat faded appearance. Additional light scatterings of melanophores appear in the lower jaw and gular region, second dorsal and anal fins, and body in general. Two bars of pigment radiate ventrally from the posteroventral margin of the eye. The basic banding pattern and black blotch at the base of the dorsal fin remain evident in the largest juvenile, 130 mm, examined. This is the same banding pattern apparent in adults, however, the black blotch on the spinous dorsal fin disappears.

In life (Moser<sup>8</sup>) a juvenile (122 mm) is reddish-brown dorsally, with white on the belly and five brownish bars on the body. The first four bars

extend ventrally to slightly below the lateral line and dorsally onto the dorsal fins as diffuse dark areas. The head is reddish-brown and pale below eye level, with three brownish transverse bars: one at the anterior level of the orbit, one at the posterior level of the orbit, and one between and posterior to the parietal ridges. A large spot is on the opercle dorsally, and the axillary region has a dusky blotch. Except for the dark bars, the first and second dorsal fins are dusky at the base, grading to pale orange or yellowish with vermilion or deep red at the margin. The basal half of the anal and pelvic fins is whitish and the distal half grades from reddish to dark orange-red at the tips. The outer pelvic ray has a milky white lateral margin. The pectorals and caudal fins are pale orange, the pectorals with dark orange-red tips and the caudal with a faint dusky band on its posterior half.

*Occurrence* (Figures 5, 6).—*Sebastes crameri* ranges from Santa Catalina Island off southern California to the Bering Sea (Miller and Lea 1972). Off Oregon, Washington, and British Columbia it is primarily an outer shelf/upper slope species generally occurring in depths of 150 to 300 m (Snytko and Fadeev 1974). Distinct population clumps have been found off the Oregon coast between lat. 44°30' and 45°20' N (Snytko and Fadeev 1974). Most of our collections containing young *S. crameri* were taken along a transect off Newport (lat. 44°39.1' N) off the central Oregon coast. The smallest larvae and the greatest numbers of larvae and pelagic juveniles were taken at stations 83 and 93 km offshore (water depths 700-1,300 m). The nearest inshore station on this transect at

<sup>8</sup>H. G. Moser, Fishery Biologist (Research), Southwest Fisheries Center, National Marine Fisheries Service, NOAA, P.O. Box 271, La Jolla, CA 92038, pers. commun. 1977.

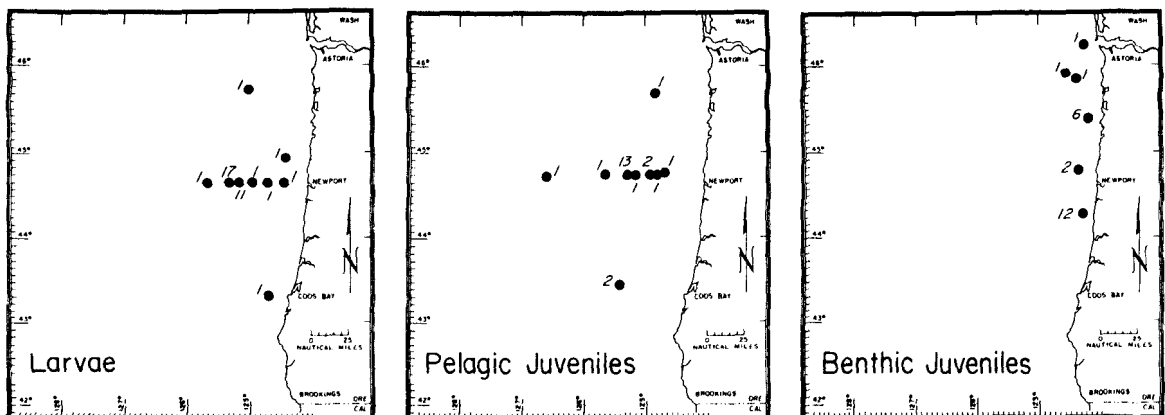


FIGURE 5.—Number of specimens and location of capture of larvae and juveniles of *Sebastes crameri* off Oregon (1961-75) described in this paper.

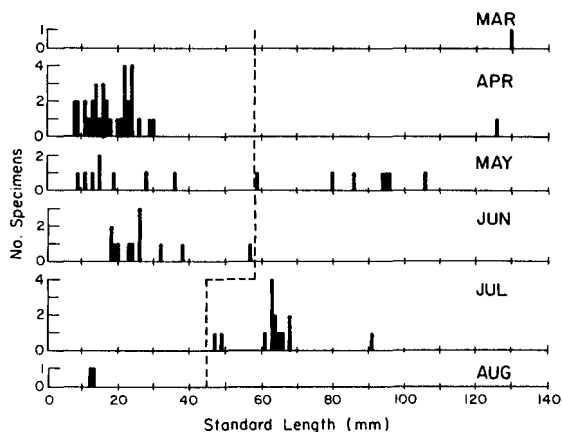


FIGURE 6.—Seasonal occurrence of larvae and juveniles of *Sebastes crameri* off Oregon. Data from 1961 to 1975 combined. Dashed line separates pelagic and benthic stages.

which a larva (15.7 mm) was taken was 28 km (depth 95 m). The farthest offshore occurrence on this transect was a 26 mm pelagic juvenile 194 km offshore. Benthic juveniles were generally taken nearer to shore than larvae or pelagic juveniles at depths of 55 to 200 m. Most pelagic specimens came from Isaacs-Kidd midwater trawls towed obliquely through the water column. Four specimens, 17.7, 24.0, 38.2, and 56.9 mm, were collected in a neuston net in June, 56 to 65 km off Newport.

Spawning times reported for *S. crameri* are November through March off California (Phillips 1964) and primarily February off Oregon, Washington, and British Columbia (Westrheim 1975; Westrheim et al. see footnote 7). However, mature females with ovaries containing embryos have been collected in February, March, April, and June (Westrheim et al.,<sup>9</sup> see footnote 7; Harling et al.<sup>10</sup>). Pelagic specimens in our collections were taken primarily in April, May, and June although two postflexion larvae were taken in August. Larvae under 10 mm were only taken in April and May. No specimens were taken September through February. Because of a lack of information on larval growth, parturition time

cannot be inferred. The wide range of lengths of pelagic specimens, 8 to 30 mm in April, 9 to 36 mm in May, 18 to 57 mm in July, indicates spawning may be variable and protracted. Benthic juveniles were taken March through July.

In trawl surveys off Oregon, adults ranked second in biomass only to *S. diploproa* of all rockfishes collected over the continental slope and fifth or sixth on the continental shelf (Demory et al. 1976). Snytko and Fadeev (1974) reported it to be one of the most abundant trawl-caught rockfish species over the slope together with *S. alutus*, *S. saxicola*, and *S. diploproa*. This species was one of the three major contributors to the 1963-71 Oregon landings of the Pacific ocean perch fishery exceeding *S. alutus* in 1971 (Niska 1976). Although little can be said about the actual abundance of larvae and juveniles off Oregon because of the various kinds of samples examined and irregular nature of the sampling effort, they were one of the more common kinds relative to the other species of *Sebastes* in the samples.

### *SEBASTES PINNIGER* (GILL) (Figures 7, 8, 9)

*Literature*.—Pigmentation of preextrusion larvae of *S. pinniger* was listed in tabular form by Westrheim (1975). Newborn to 2-wk-old larvae were described by Waldron (1968) and the older larva was redrawn by Moser et al. (1977). Mean length of larvae at hatching is 3.6 mm SL. Newborn larvae have an irregular double row of pigment (usually <16 melanophores) along the ventral midline between the 18th and 22d myomere and some pigment above the yolk sac near the anus. After 2 wk additional melanophores are present at the tip of the lower jaw, on the ventral part of the yolk sac, on the pectoral fins, along the dorsal midline in an irregular double row between the 19th and 21st myomeres, and in the hypural region. The ventral midline melanophores may extend as far forward as the 14th myomere.

*Identification* (Table 7, Appendix Tables 2-6).—A total of 269 specimens of *S. pinniger*, 7.9 to 181 mm long, were identified. Juveniles were identified using the following combination of characters compiled from specimens in our collections:

Gill rakers = 40-45, left arch; 38-46, right arch  
Lateral line pores = 40-45  
Pectoral fin rays = 16-18, usually 17

<sup>9</sup>Westrheim, S. J., W. R. Harling, D. Davenport, and M. S. Smith. 1968. Preliminary report on maturity, spawning season, and larval identification of rockfishes (*Sebastes*) collected off British Columbia in 1968. Fish. Res. Board Can., Manusc. Rep. 1005, 28 p.

<sup>10</sup>Harling, W. R., M. S. Smith, and N. A. Webb. 1971. Preliminary report on maturity, spawning season, and larval identification of rockfishes (*Scorpaenidae*) collected during 1970. Fish. Res. Board Can. Manusc. Rep. 1137, 26 p.

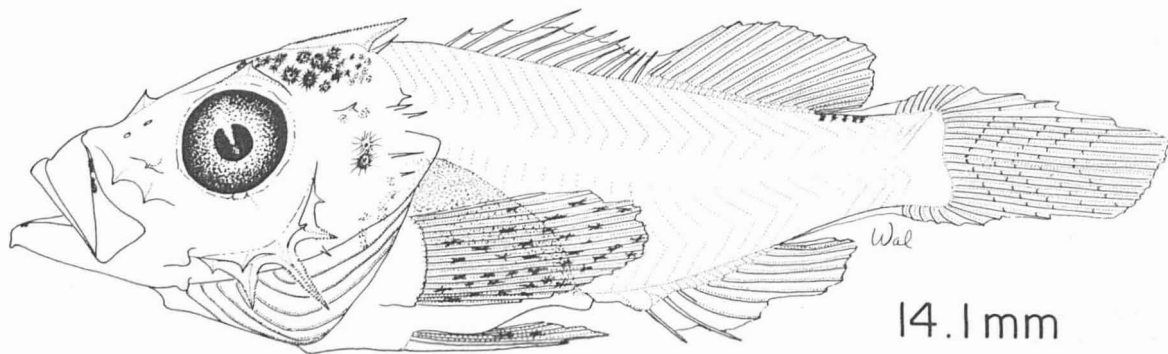
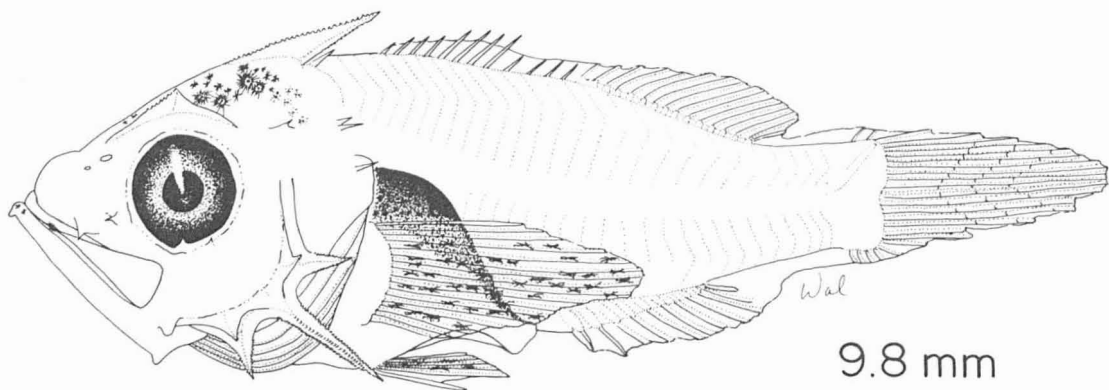
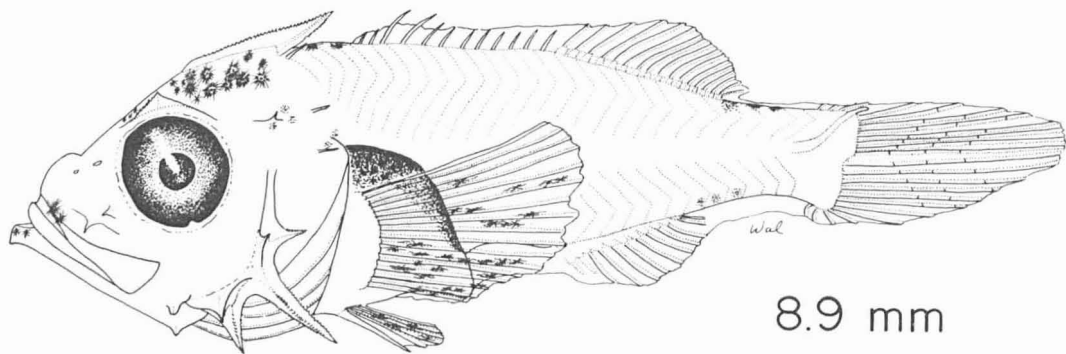


FIGURE 7.—Planktonic larvae (8.9, 9.8 mm) and transforming specimen (14.1 mm) of *Sebastes pinniger*.

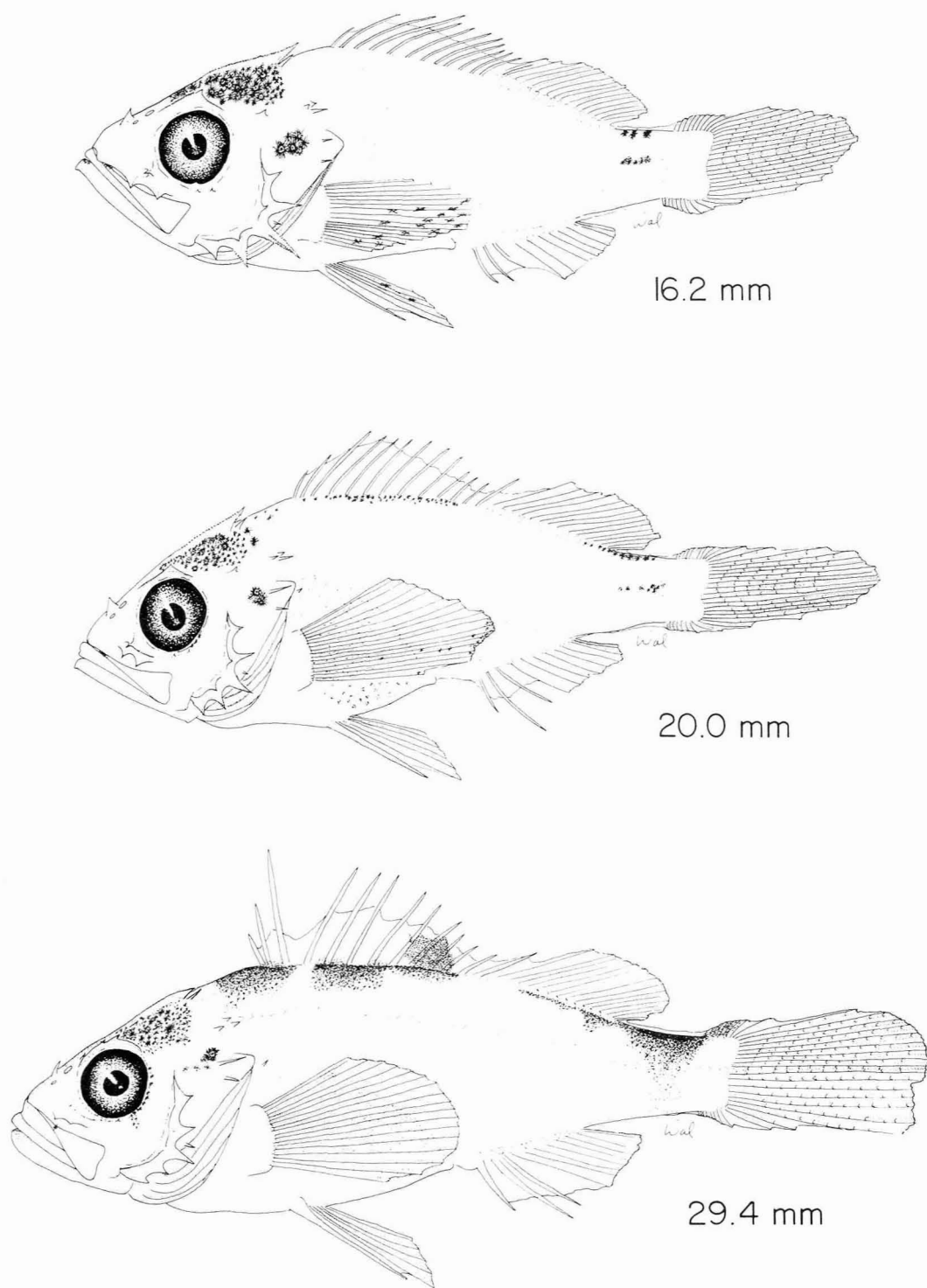


FIGURE 8.—Transforming specimen (16.2 mm) and pelagic juveniles (20.0, 29.4 mm) of *Sebastes pinniger*.

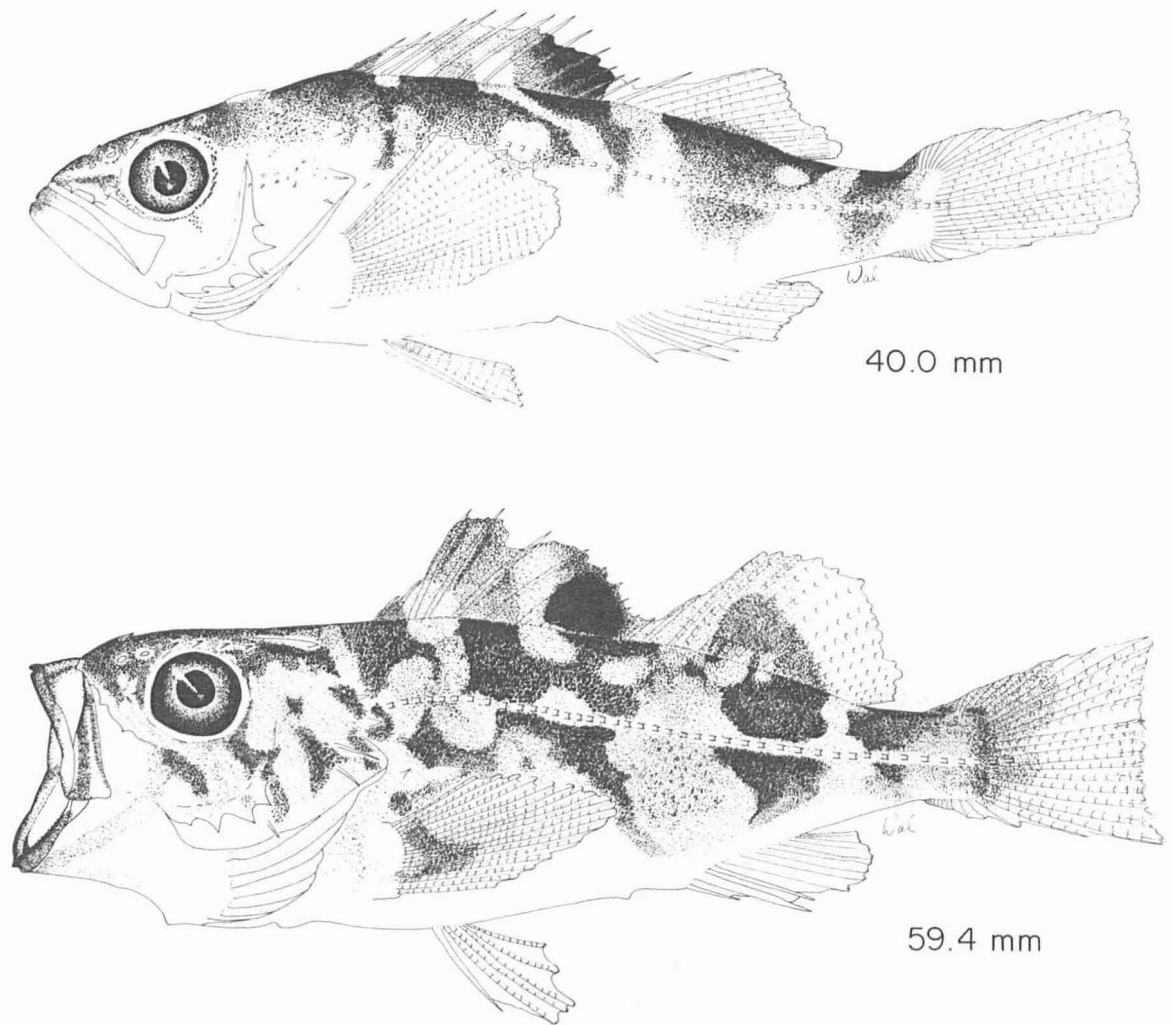


FIGURE 9.—Pelagic juvenile (40.0 mm) and benthic juvenile (59.4 mm) of *Sebastes pinniger*.

Anal fin soft rays = 7  
 Dorsal fin soft rays = 13-15, usually 14 or 15  
 Supraocular spine = present  
 Interorbital space = flat to convex.

Large juveniles (>26 mm SL) have the black blotch at the base of the posterior half of the spinous dorsal fin characteristic of adults. Other *Sebastes* juveniles which have a black blotch, e.g., *S. melanops*, *S. flavidus*, *S. crameri*, do not agree with the characters given above. Of the *Sebastes* species occurring off Oregon, *S. pinniger* has the best fit to all these characters. *Sebastes miniatus* and *S. emphaeus* also agree with many of the counts. However, juvenile *S. miniatus* and *S. em-*

*phaeus* lack a black blotch at the posterior base of the spinous dorsal fin. *Sebastes miniatus* usually has 18 rather than 17 pectoral rays, and *S. emphaeus* lacks supraocular spines. The larvae and juveniles in the series in question were among the most abundant in our collections. Adult *S. pinniger* are known to be abundant in trawlable areas offshore whereas *S. miniatus* are not commonly taken (Demory et al. 1976; Niska 1976). *Sebastes emphaeus*, although not previously reported from Oregon, is well represented in our samples. Pigment pattern, general body shape, time of occurrence, and constancy in number of anal fin soft rays and pectoral rays helped link the developmental series together.

TABLE 7.—Meristics from larvae and juveniles of *Sebastes pinniger* off Oregon, based on unstained specimens. Specimens above dashed line are undergoing notochord flexion. All specimens had 8 superior and 7 inferior principal caudal fin rays and 7 branchiostegal rays on each side.

Standard length (mm)	Dorsal fin spines and rays	Anal fin spines and rays	Pectoral fin rays		Pelvic fin spines and rays		Gill rakers (first arch)		Lateral line pores		Diagonal scale rows
			Left	Right	Left	Right	Left	Right	Left	Right	
7.8	( <sup>1</sup> )	( <sup>1</sup> )	—	17	( <sup>1</sup> )	( <sup>1</sup> )	—	—	—	—	—
7.8	( <sup>1</sup> )	( <sup>2</sup> )	17	—	1, ( <sup>1</sup> )	1, ( <sup>1</sup> )	—	—	—	—	—
<hr/>											
8.8	VIII+I <sup>3</sup> , 14	III <sup>3</sup> , 7	17	17	1, 5	1, 5	—	—	—	—	—
8.9	IX+I <sup>3</sup> , 15	III <sup>3</sup> , 7	17	17	1, 5	1, 5	—	—	—	—	—
9.3	XIII <sup>3</sup> , 14	III <sup>3</sup> , 7	18	17	1, 5	1, 5	—	—	—	—	—
9.8	XIII <sup>3</sup> , 14	III <sup>3</sup> , 7	17	17	1, 5	1, 5	—	—	—	—	—
10.7	XIII <sup>3</sup> , 14	III <sup>3</sup> , 7	17	17	1, 5	1, 5	—	—	—	—	—
10.7	XIII <sup>3</sup> , 15	III <sup>3</sup> , 7	17	17	1, 5	1, 5	—	—	—	—	—
10.9	XIII <sup>3</sup> , 15	III <sup>3</sup> , 7	17	17	1, 5	1, 5	—	—	—	—	—
12.3	XIII <sup>3</sup> , 15	III <sup>3</sup> , 7	17	17	1, 5	1, 5	—	—	—	—	—
12.3	XIII <sup>3</sup> , 14	III <sup>3</sup> , 7	17	17	1, 5	1, 5	—	—	—	—	—
<sup>4</sup> 12.8	XIII <sup>3</sup> , 15	III <sup>3</sup> , 7	17	17	1, 5	1, 5	—	—	—	—	—
<sup>4</sup> 13.0	XIII <sup>3</sup> , 14	III <sup>3</sup> , 7	17	17	1, 5	1, 5	—	—	—	—	—
<sup>4</sup> 14.1	XIII <sup>3</sup> , 14	III <sup>3</sup> , 7	17	17	1, 5	1, 5	—	27 + 12 or 13 = 39 or 40	—	—	—
<sup>4</sup> 14.2	XIII <sup>3</sup> , 14	III <sup>3</sup> , 7	17	17	1, 5	1, 5	—	—	—	—	—
<sup>4</sup> 15.2	XIII <sup>3</sup> , 15	III <sup>3</sup> , 7	17	17	1, 5	1, 5	—	—	—	—	—
<sup>4</sup> 16.0	XIII <sup>3</sup> , 14	III <sup>3</sup> , 7	17	17	1, 5	1, 5	—	28 + 13 = 41	—	—	—
<sup>4</sup> 16.0	XIII <sup>3</sup> , 14	III <sup>3</sup> , 7	17	17	1, 5	1, 5	—	—	—	—	—
<sup>4</sup> 16.2	XIII <sup>3</sup> , 15	III <sup>3</sup> , 7	17	17	1, 5	1, 5	—	27 + 13 = 40	—	—	—
<sup>4</sup> 16.8	XIII <sup>3</sup> , 14	III <sup>3</sup> , 7	17	17	1, 5	1, 5	—	—	—	—	—
<sup>4</sup> 17.8	XIII <sup>3</sup> , 15	III <sup>3</sup> , 7	18	18	1, 5	1, 5	—	27 + 12 = 39	—	—	—
<sup>4</sup> 18.4	XIII <sup>3</sup> , 14	III <sup>3</sup> , 7	17	17	1, 5	1, 5	—	—	—	—	—
<sup>5</sup> 18.6	XIII, 15	III, 7	17	18	1, 5	1, 5	27 + 14 = 41	28 + 14 = 42	—	—	—
<sup>5</sup> 18.9	XIII, 15	III, 7	17	17	1, 5	1, 5	29 + 13 = 42	28 + 13 = 41	—	—	—
<sup>5</sup> 19.4	XIII, 15	III, 7	17	17	1, 5	1, 5	27 + 13 = 40	26 + 12 = 38	—	—	—
<sup>5</sup> 19.5	XIII, 14	III, 7	18	18	1, 5	1, 5	27 + 13 = 40	27 + 12 = 39	—	—	—
<sup>5</sup> 20.0	XIII, 14	III, 7	17	17	1, 5	1, 5	27 + 14 = 41	28 + 13 = 41	44	—	—
<sup>5</sup> 20.8	XIII, 14	III, 7	17	17	1, 5	1, 5	28 + 13 = 41	28 + 13 = 41	—	—	—
<sup>5</sup> 22.4	XIII, 14	III, 7	18	18	1, 5	1, 5	28 + 13 = 41	29 + 13 = 42	—	≈ 44	—
<sup>5</sup> 23.4	XIII, 14	III, 7	17	17	1, 5	1, 5	29 + 13 = 42	28 + 14 = 42	≈ 44	—	—
<sup>5</sup> 26.4	XIII, 14	III, 7	17	17	1, 5	1, 5	29 + 15 = 44	29 + 14 = 43	≈ 43	≈ 40	—
<sup>5</sup> 26.4	XIII, 14	III, 7	17	17	1, 5	1, 5	28 + 14 = 42	28 + 13 = 41	—	—	—
<sup>5</sup> 26.6	XIII, 15	III, 7	17	17	1, 5	1, 5	28 + 13 = 41	29 + 14 = 43	—	—	—
<sup>5</sup> 28.6	XIII, 14	III, 7	17	17	1, 5	1, 5	28 + 13 = 41	29 + 14 = 43	≈ 42	≈ 44-45	—
<sup>5</sup> 28.8	XIII, 15	III, 7	17	17	1, 5	1, 5	29 + 13 = 42	28 + 13 = 41	—	—	—
<sup>5</sup> 29.4	XIII, 14	III, 7	17	17	1, 5	1, 5	28 + 13 = 41	28 + 14 = 42	≈ 44	—	—
<sup>5</sup> 30.4	XIII, 13	III, 7	17	17	1, 5	1, 5	28 + 13 = 41	28 + 13 = 41	≈ 44	—	—
<sup>5</sup> 30.9	XIII, 14	III, 7	17	18	1, 5	1, 5	31 + 14 = 45	31 + 15 = 46	—	—	—
<sup>5</sup> 34.1	XIII, 14	III, 7	16	17	1, 5	1, 5	29 + 14 = 43	29 + 14 = 43	≈ 44	≈ 44	—
<sup>5</sup> 38.0	XIII, 14	III, 7	17	18	1, 5	1, 5	28 + 14 = 42	29 + 14 = 43	—	≈ 42	—
<sup>5</sup> 38.7	XIII, 15	III, 7	17	17	1, 5	1, 5	27 + 13 = 40	29 + 13 = 42	≈ 42	≈ 44	—
<sup>5</sup> 39.2	XIII, 14	III, 7	17	17	1, 5	1, 5	29 + 14 = 43	29 + 14 = 43	≈ 41	≈ 41	—
<sup>5</sup> 40.0	XIII, 14	III, 7	17	17	1, 5	1, 5	28 + 14 = 42	29 + 13 = 42	≈ 40	—	—
<sup>5</sup> 41.0	XIII, 14	III, 7	17	17	1, 5	1, 5	30 + 14 = 44	30 + 14 = 44	—	43	—
<sup>5</sup> 42.4	XIII, 15	III, 7	17	17	1, 5	1, 5	29 + 14 = 43	29 + 14 = 43	40	40	—
<sup>5</sup> 59.4	XIII, 14	III, 7	17	18	1, 5	1, 5	29 + 14 = 43	29 + 14 = 43	40	43	≈ 51
<sup>6</sup> 117.7	XIII, 14	III, 7	17	17	1, 5	1, 5	29 + 14 = 43	29 + 13 = 42	45	44	—
<sup>6</sup> 181	XIII, 15	III, 7	17	17	1, 5	1, 5	30 + 14 = 44	28 + 14 = 42	43	43	≈ 50

<sup>1</sup>Forming.<sup>2</sup>Not formed.<sup>3</sup>Posteriormost dorsal or anal spine appears as a soft ray.<sup>4</sup>Transforming.<sup>5</sup>Pelagic juvenile.<sup>6</sup>Benthic juvenile.

**Distinguishing Features.**—Characters useful in distinguishing the smallest larvae (7.8 mm) of *S. pinniger* identified from our collections are the presence of remnants of both dorsal and ventral midline melanophores the anterior of which are internal, the lightly pigmented pectoral fins, melanophores at the tip of the lower jaw and on the anteroventral margin of the maxillary, the presence of one or two large external stellate melanophores on the dorsum just posterior to the parietal

spines, the relatively deep body (40% SL), long parietal spines (24% HL), and long pectoral fins (25% SL). Later stage larvae are characterized by their relative lack of pigment on the trunk except over the gut, together with the relatively deep body and long parietal and third posterior preopercular spines. Meristics, presence of the supraocular spine, flat to convex shape of the interorbital space, and dark blotch at the base of the spinous dorsal serve to distinguish the juveniles.

*General Development.*—The smallest larvae of *S. pinniger* identified, 7.8 mm, are in the final stage of notochord flexion. By the time larvae are 8.8 mm long, flexion is complete. Transformation to pelagic juvenile begins in larvae >12.5 mm long with the initiation of spine formation in the dorsal and anal fin “prespines” and the appearance of a patch of melanophores on the dorsum immediately posterior to the second dorsal fin. Transformation of the “prespines” to spines is complete in specimens >18.6 mm and some pigment has been added beneath the first dorsal fin marking the beginning of pelagic juvenile pigmentation. The dorsal pigmentation becomes more pronounced during the pelagic juvenile period which lasts until  $\approx$ 40 to 50 mm. The largest pelagic juvenile taken was 42.4 mm and the smallest benthic juvenile was 59.4 mm.

*Morphology* (Tables 4, 8).—Forty-eight specimens of *S. pinniger*, 7.8 to 181.0 mm long, were measured for developmental morphology. Larvae appear quite deep bodied, but body depth at the pectoral fin base decreases considerably during the pelagic period from 40 to 33% SL. In comparison, body depth at the anus/SL changes relatively little, decreasing slightly then increasing. Snout to anus length increases from 59 to 64% SL while snout to pelvic fin distance increases to a lesser degree.

Head length decreases from 43 to 37% SL during development as more marked changes occur in eye diameter, decreasing from 37-39 to 27% HL, and interorbital distance, decreasing from 37 to 20% HL. Upper jaw length/HL first decreases and then increases while snout length/HL increases then decreases. The length of the angle gill raker increases with respect to head length from 11 to 14 or 15%.

Larvae and young juveniles up to 24 mm have a prominent symphyseal knob directed anteroventrally. It becomes less obvious with development and is barely noticeable by the time juveniles are 29 mm long.

*Fin Development* (Tables 4, 7, 8).—Pectoral fins are present and the adult complement of 16 to 18 (usually 17) rays can be counted in 7.8 mm larvae of *S. pinniger*, although the ventral rays are not fully formed until >8 mm. The pectoral fins are relatively long in flexion and postflexion larvae averaging 25% SL and they maintain this approximate proportion through development. Depth of

the pectoral fin base decreases from 15 to 9% SL.

Developing pelvic fins are visible on 7.8 mm larvae and the adult complement of I, 5 is countable in postflexion larvae of 8.8 mm. The pelvic fins are rather long, averaging 14% SL in flexion larvae and increasing to a maximum of 23% SL in transforming specimens. Length of the pelvic spine, always less than the fin itself, increases from 5% SL in flexion larvae to 20% in transforming specimens then decreases to 13% in benthic juveniles.

The adult complement of principal caudal rays can be counted in 7.8 mm larvae, before the completion of notochord flexion at 8.8 mm. Counts of secondary caudal rays were 11 superior and 12 inferior rays on each of two stained juveniles, 29.5 and 33.4 mm.

Bases of some of the dorsal and anal fin ray and spine elements are visible on the 7.8 mm larvae. The adult complement of ray and spine elements is present in postflexion larvae >9 mm and the rays and spines (with “prespines”) appear fully formed by 9.3 mm. Transformation of “prespines” to spines is completed by 18.5 mm. The longest dorsal spine increases from 20 to 38% HL during the pelagic period. The longest dorsal ray increases from 32 to 42 or 43%. The longest anal spine increases from 19 to 37% HL during pelagic development.

*Spination* (Tables 4, 9).—Spines present on the left side of the head of the two smallest specimens of *S. pinniger*, 7.8 mm, include the parietal; the nuchal; the first and third anterior preopercular; the second, third, and fourth posterior preopercular; the postocular, the pterotic, the inferior post-temporal; the first spine of the inferior infraorbital series; and the first spine of the superior infraorbital series.

The parietal spine and ridge are heavily and relatively deeply serrated in small larvae and the spine is relatively long, averaging 24% HL in flexion larvae. Its relative length decreases with development to 20% HL in flexion larvae, 10% in transforming specimens, and 7% in early pelagic juveniles, <20 mm. The much smaller nuchal spine averages 4 or 5% HL in postflexion and transforming larvae, decreasing to 1% in benthic juveniles. The parietal and nuchal spines fuse together, beginning in pelagic juveniles >20 mm until only the nuchal tip is visible in juveniles >40 mm. Serrations along the parietal ridge can be seen on specimens up to 39 mm.





The superior opercular spine is present on larvae by 9 mm and the inferior opercular spine appears later in larvae ≈12 or 13 mm. Both spines are present on juveniles. An interopercular spine develops on the edge of the gill cover, usually in larvae >10 mm. A subopercular spine was not present on any of the specimens examined.

The ridge anterior to the postocular spine is heavily serrated and remains so until preocular spine formation. The preocular appears first as a bump in transforming larvae ≈16.0 mm long and develops into a spine in pelagic juveniles >19 mm.

Development of the supraocular follows a similar pattern appearing at about the same time as the preocular. Beneath the eye the fourth spine of the superior infraorbital series is present in larvae >9 mm and the third spine of this series is present in all larvae >13 mm. The second superior infraorbital spine never forms. All three superior infraorbital spines disappear by 43 mm. The second spine of the inferior infraorbital series is present on specimens >10 mm and the two spines in this series persist in juveniles. The third inferior infraorbital spine never develops. The nasal spine develops

TABLE 9.—Development of spines in the head region of *Sebastes pinniger* larvae and juveniles. Specimens above dashed line are undergoing notochord flexion. + denotes spine present and - denotes spine absent.

Standard length (mm)	Parietal	Nuchal	Preopercular (anterior series)			Preopercular (posterior series)					Opercular		Interopercular	Subopercular	Preocular	Supraocular	Postocular
			1st	2d	3d	1st	2d	3d	4th	5th	Superior	Inferior					
7.8	+	+	+	-	+	-	+	+	+	-	-	-	-	-	-	-	+
7.8	+	+	+	-	+	-	+	+	+	-	-	-	-	-	-	-	+
8.8	+	+	+	-	+	-	+	+	+	-	+	-	-	-	-	-	+
8.9	+	+	+	-	+	-	+	+	+	-	+	-	-	-	-	-	+
9.3	+	+	+	-	+	-	+	+	+	-	+	-	-	-	-	-	+
9.8	+	+	+	-	+	-	+	+	+	-	+	-	-	-	-	-	+
10.7	+	+	+	-	+	-	+	+	+	+	+	-	+	-	-	-	+
10.7	+	+	+	-	+	-	+	+	+	+	+	-	+	-	-	-	+
10.9	+	+	+	-	+	-	+	+	+	+	+	-	+	-	-	-	+
12.3	+	+	+	-	+	-	+	+	+	+	+	-	+	-	-	-	+
12.3	+	+	+	-	+	-	+	+	+	+	+	-	+	-	-	-	+
<sup>1</sup> 12.8	+	+	+	-	+	-	+	+	+	+	+	-	+	-	-	-	+
<sup>1</sup> 13.0	+	+	+	-	+	-	+	+	+	+	+	-	+	-	-	-	+
<sup>1</sup> 14.1	+	+	+	-	+	-	+	+	+	+	+	-	+	-	-	-	+
<sup>1</sup> 14.2	+	+	+	-	+	-	+	+	+	+	+	-	+	-	-	-	+
<sup>1</sup> 15.2	+	+	+	-	+	-	+	+	+	+	+	-	+	-	-	-	+
<sup>1</sup> 16.0	+	+	+	-	+	-	+	+	+	+	+	-	+	-	-	-	+
<sup>1</sup> 16.0	+	+	+	-	+	-	+	+	+	+	+	-	+	-	( <sup>2</sup> )	+	+
<sup>1</sup> 16.2	+	+	+	-	+	-	+	+	+	+	+	-	+	-	( <sup>2</sup> )	( <sup>2</sup> )	+
<sup>1</sup> 16.8	+	+	+	-	+	-	+	+	+	+	+	-	+	-	-	+	+
<sup>1</sup> 17.8	+	+	+	-	+	-	+	+	+	+	+	-	+	-	( <sup>2</sup> )	+	+
<sup>1</sup> 18.4	+	+	+	-	+	-	+	+	+	+	+	-	+	-	( <sup>2</sup> )	+	+
<sup>3</sup> 18.6	+	+	+	-	+	-	+	+	+	+	+	-	+	-	( <sup>2</sup> )	( <sup>2</sup> )	( <sup>2</sup> )
<sup>3</sup> 18.9	+	+	+	-	+	-	+	+	+	+	+	-	+	-	( <sup>2</sup> )	( <sup>2</sup> )	( <sup>2</sup> )
<sup>3</sup> 19.4	+	+	+	-	+	-	+	+	+	+	+	-	+	-	+	-	+
<sup>3</sup> 19.5	+	+	+	-	+	-	+	+	+	+	+	-	+	-	+	+	+
<sup>3</sup> 20.0	+	+	+	-	+	-	+	+	+	+	+	-	+	-	+	+	+
<sup>3</sup> 20.8	+	+	+	-	+	-	+	+	+	+	+	-	+	-	+	+	+
<sup>3</sup> 22.4	+	+	+	-	+	-	+	+	+	+	+	-	+	-	+	+	+
<sup>3</sup> 23.4	+	+	+	-	+	-	+	+	+	+	+	-	+	-	+	+	+
<sup>3</sup> 26.4	+	+	+	-	+	-	+	+	+	+	+	-	+	-	+	+	+
<sup>3</sup> 26.4	+	+	+	-	+	-	+	+	+	+	+	-	+	-	+	+	+
<sup>3</sup> 26.4	+	+	+	-	+	-	+	+	+	+	+	-	+	-	+	+	+
<sup>3</sup> 26.6	+	+	+	-	+	-	+	+	+	+	+	-	+	-	+	+	+
<sup>3</sup> 26.6	+	+	+	-	+	-	+	+	+	+	+	-	+	-	+	+	+
<sup>3</sup> 28.8	+	+	+	-	+	-	+	+	+	+	+	-	+	-	+	+	+
<sup>3</sup> 29.4	+	+	+	-	+	-	+	+	+	+	+	-	+	-	+	+	+
<sup>3</sup> 30.4	+	+	+	-	+	-	+	+	+	+	+	-	+	-	+	+	+
<sup>3</sup> 30.9	+	+	+	-	+	-	+	+	+	+	+	-	+	-	+	+	+
<sup>3</sup> 34.1	+	+	+	-	+	-	+	+	+	+	+	-	+	-	+	+	+
<sup>3</sup> 38.0	+	+	+	-	+	-	+	+	+	+	+	-	+	-	+	+	+
<sup>3</sup> 38.7	+	+	+	-	+	-	+	+	+	+	+	-	+	-	+	+	+
<sup>3</sup> 39.2	+	+	+	-	+	-	+	+	+	+	+	-	+	-	+	+	+
<sup>3</sup> 40.0	+	+	+	-	+	-	+	+	+	+	+	-	+	-	+	+	+
<sup>3</sup> 41.0	<sup>5</sup>	<sup>5</sup>	-	-	-	-	+	+	+	+	+	-	+	-	+	+	+
<sup>3</sup> 42.4	<sup>5</sup>	<sup>5</sup>	-	-	-	-	+	+	+	+	+	-	+	-	+	+	+
<sup>6</sup> 59.4	<sup>5</sup>	<sup>5</sup>	-	-	-	-	+	+	+	+	+	-	+	-	+	+	+
<sup>6</sup> 117.7	<sup>5</sup>	<sup>5</sup>	-	-	-	-	+	+	+	+	+	-	+	-	+	+	+
<sup>6</sup> 181	<sup>5</sup>	<sup>5</sup>	-	-	-	-	+	+	+	+	+	-	+	-	+	+	+

<sup>1</sup>Transforming.  
<sup>2</sup>Bump indicates beginning of spine formation.  
<sup>3</sup>Pelagic juvenile.  
<sup>4</sup>Spine is bifid.  
<sup>5</sup>Parietal and nuchal spines fused.  
<sup>6</sup>Benthic juvenile.  
<sup>7</sup>Spine has become rounded, no sharp tip.

TABLE 9.—Continued.

Standard length (mm)	Infraorbitals							Nasal	Coronal	Tympanic	Pterotic	Posttemporal		Supra-cleithral	Cleithral
	Inferior			Superior								Superior	Inferior		
	1st	2d	3d	1st	2d	3d	4th								
7.8	+	-	-	+	-	-	-	-	-	-	+	-	+	-	-
7.8	+	-	-	+	-	-	-	-	-	-	+	-	+	-	-
8.8	+	-	-	+	-	-	-	-	-	-	+	-	+	-	-
8.9	+	-	-	+	-	-	-	-	-	-	+	-	+	-	-
9.3	+	-	-	+	-	-	+	( <sup>2</sup> )	-	-	+	-	+	-	-
9.8	+	-	-	+	-	-	+	( <sup>2</sup> )	-	-	+	-	+	-	-
10.7	+	+	-	+	-	-	+	+	-	-	+	-	+	+	-
10.7	+	+	-	+	-	+	+	+	-	-	+	-	+	+	-
10.9	+	+	-	+	-	-	+	+	-	-	+	-	+	+	-
12.3	+	+	-	+	-	+	+	+	-	-	+	-	+	+	-
12.3	+	+	-	+	-	-	+	+	-	-	+	-	+	+	-
<sup>1</sup> 12.8	+	+	-	+	-	-	+	+	-	-	+	-	+	+	-
<sup>1</sup> 13.0	+	+	-	+	-	+	+	+	-	-	+	-	+	+	-
<sup>1</sup> 14.1	+	+	-	+	-	+	+	+	-	-	+	+	+	+	-
<sup>1</sup> 14.2	+	+	-	+	-	+	+	+	-	-	+	-	+	+	-
<sup>1</sup> 15.2	+	+	-	+	-	+	+	+	-	-	+	+	+	+	-
<sup>1</sup> 16.0	+	+	-	+	-	+	+	+	-	-	+	+	+	+	-
<sup>1</sup> 16.0	+	+	-	+	-	+	+	+	-	-	+	+	+	+	-
<sup>1</sup> 16.2	+	+	-	+	-	+	+	+	-	-	+	+	+	+	-
<sup>1</sup> 16.8	+	+	-	+	-	+	+	+	-	-	+	+	+	+	-
<sup>1</sup> 17.8	+	+	-	+	-	+	+	+	-	-	+	+	+	+	-
<sup>1</sup> 18.4	+	+	-	+	-	+	+	+	-	-	+	+	+	+	-
<sup>3</sup> 18.6	+	+	-	+	-	+	+	+	-	-	+	+	+	+	-
<sup>3</sup> 18.9	+	+	-	+	-	+	+	+	-	-	+	+	+	+	-
<sup>3</sup> 19.4	+	+	-	+	-	+	+	+	-	-	+	-	+	+	-
<sup>3</sup> 19.5	+	+	-	+	-	+	+	+	-	-	+	+	+	+	+
<sup>3</sup> 20.0	+	+	-	+	-	+	+	+	-	-	+	+	+	+	+
<sup>3</sup> 20.8	+	+	-	+	-	+	+	+	-	-	+	+	+	+	+
<sup>3</sup> 22.4	+	+	-	+	-	+	+	+	-	-	+	+	+	+	+
<sup>3</sup> 23.4	+	+	-	+	-	+	+	+	-	-	+	+	+	+	+
<sup>3</sup> 26.4	+	+	-	+	-	+	+	+	-	-	+	+	+	+	+
<sup>3</sup> 26.4	+	+	-	+	-	+	+	+	-	-	+	+	+	+	+
<sup>3</sup> 26.6	+	+	-	+	-	( <sup>2</sup> )	( <sup>2</sup> )	+	-	-	+	+	+	+	+
<sup>3</sup> 28.6	+	+	-	+	-	+	+	+	-	-	+	+	+	+	+
<sup>3</sup> 28.8	+	+	-	?	-	?	?	+	-	-	+	+	+	+	+
<sup>3</sup> 29.4	+	+	-	( <sup>2</sup> )	-	( <sup>2</sup> )	-	+	-	-	+	+	+	+	+
<sup>3</sup> 30.4	+	+	-	-	-	-	-	+	-	-	+	+	+	+	+
<sup>3</sup> 30.9	+	+	-	-	-	-	-	+	-	-	+	+	+	+	+
<sup>3</sup> 34.1	+	+	-	-	-	-	-	+	-	-	+	+	+	+	+
<sup>3</sup> 38.0	+	+	-	-	-	-	-	+	-	-	+	+	+	+	+
<sup>3</sup> 38.7	+	+	-	-	-	-	-	+	-	+	+	+	+	+	+
<sup>3</sup> 39.2	+	+	-	-	-	-	-	+	-	+	+	+	+	+	+
<sup>3</sup> 40.0	+	+	-	-	-	-	-	+	-	+	+	+	+	+	+
<sup>3</sup> 41.0	+	+	-	-	-	-	-	+	-	+	+	+	+	+	+
<sup>3</sup> 42.4	+	+	-	-	-	-	-	+	-	+	+	+	+	+	+
<sup>6</sup> 59.4	+	+	-	-	-	-	-	+	-	+	-	+	+	+	+
<sup>6</sup> 117.7	+ <sup>7</sup>	+	-	-	-	-	-	+	-	+	( <sup>2</sup> )	-	+	+	+
<sup>6</sup> 181	+ <sup>7</sup>	+	-	-	-	-	-	+	-	+	-	-	+	+	+

first as a bump in larvae >9 mm and is present in juveniles.

The tympanic spine appears on specimens >35 mm SL. This spine forms at the anterior edge of a foramen of the cephalic lateral line system. The pterotic spine, present in the smallest larvae, disappears in benthic juveniles. The supra-cleithral spine develops posterior to the inferior posttemporal on larvae >9.5 mm and the superior posttemporal spine is present dorsal to these in specimens >14 or 15 mm. This latter spine is occasionally bifid. The inferior posttemporal disappears in benthic juveniles. Posterior to the opercle the cleithral spine is visible in pelagic juveniles of 19.5 mm and persists in benthic juveniles.

*Scale Formation.*—Lateral line pores are visible on specimens >17 mm. Scale formation has begun on juveniles >23 mm.

*Pigmentation.*—The smallest larvae of *S. pinniger* examined, 7.8 mm (similar to the 8.9 mm specimen illustrated), have pigment on the head over the brain. Melanophores line the inner tip of the lower jaw and a few are present along the antero-ventral margin of the maxillary. In the abdominal region, an internal melanistic shield covers the dorsal half of the gut, appearing darkest on the dorsal surface. A few additional melanophores are present along the ventral midline of the gut cavity. Two or three large stellate melanophores are

on the dorsum immediately posterior to the parietal spines. In the tail region several embedded melanophores, sometimes fused, are on the dorsal and ventral body midlines near the caudal peduncle. These midline melanophores are present in the same region as the midline pigment shown on Waldron's (1968) reared 2-wk-old larva. The pectoral fin blades are lightly pigmented with elongate melanophores. Melanophores are also present on the inner side of the pectoral fin base but not on the outer side. The pelvic fins also have a light scattering of melanophores. The caudal fin base is unpigmented.

During larval development, pigment increases on the head over the brain. Occasionally one or two melanophores are present on the snout. Melanophores lining the inner tip of the lower jaw and those on the anteroventral margin of the maxillary remain throughout the larval period.

The melanistic shield over the gut intensifies laterally and melanophores on the ventral midline disappear. The two to three stellate melanophores on the dorsum posterior to the parietal spines disappear by the time larvae are 9 mm long.

In the tail region, the dorsal and ventral midline melanophores near the caudal peduncle are no longer visible on larvae >9 mm.

The rayed portions of the pectoral and pelvic fins remain lightly pigmented during the larval period but melanophores are no longer present on the inner side of the pectoral fin base in larvae >10 mm.

During the transformation period, 12.8 to 18.6 mm, the amount of pigment increases gradually. In the head region, internal pigment is added to the opercle dorsally until a patch of 6 to 10 melanophores is visible on specimens >16 mm. Internal gut pigmentation decreases in intensity due to overgrowth by musculature. A few melanophores sometimes appear on the nape and beneath spines V to XI of the first dorsal fin, although not consistently until late in the transformation period in specimens >17 mm. The most prominent addition of pigment occurs dorsally in the tail region just posterior to the soft dorsal fin. Melanophores are added along the dorsolateral surface of the caudal peduncle. Directly below these melanophores, three or four internal and one to four external melanophores are added along the lateral midline in specimens >15 mm. The amount of pigment on the pectoral and pelvic fins decreases during this period.

During the pelagic juvenile period, 18.9 to 42.4 mm, new pigment is added over the dorsal surface of the head, interorbital, snout, premaxillary (specimen >26 mm), and on the lower jaw (specimen >35 mm). The opercular patch enlarges. Around the eye, melanophores are added first on the posteroventral margin of the orbit in specimens 19 to 23 mm, and eventually line the orbit. A radiating bar of melanophores begins to extend from the posteroventral margin of the orbit on specimens >28 mm, extending onto the preopercle on specimens >30 mm. In the abdominal region, melanophores are added dorsolaterally to the nape and beneath spines V to X of the first dorsal fin forming two pigment patches connected by a dorsal row of melanophores by 23 mm. The nape patch expands forming a saddle (first in position) extending from the parietal spine to the third dorsal spine and ventrally to the superior posttemporal spine by 28 mm. Two saddles (second and third) develop from the pigment patch beneath the spinous dorsal fin, midfin beneath spines IV to VI and posteriorly beneath spines VIII to XI. These two saddles are separated by a relatively unpigmented area on the dorsum. As they extend more ventrolaterally, they fuse together in two places just above and below the lateral line creating a second, circular, less pigmented area on specimens >39 mm. These two saddles eventually extend to the dorsal portion of the gut cavity by 42 mm. A single external melanophore may occur on the midanterior margin of the cleithrum beneath the gill cover. In the tail region, the dorsal patch of pigment on the caudal peduncle extends to the lateral line forming another saddle by 23 mm which reaches the ventral body margin by 27 mm. Beneath the second dorsal fin melanophores increase in number and become concentrated along the muscles surrounding the dorsal pterygiophores appearing as vertical lines of pigment by 23 mm. Melanophores also develop at the point of articulation of all but the anteriormost three or four dorsal soft rays. A melanistic saddle (fourth in position) develops beneath soft dorsal rays 3 to 12 or 13 extending ventrolaterally to the body midline by 34 mm and three-fourths the distance to the ventral margin by 42 mm. The pectoral and pelvic fins are no longer pigmented in specimens >21 mm. Pigment develops on the first dorsal fin membrane between spines IX and XI in juveniles >26 mm, eventually forming the "black blotch" characteristic of larger juveniles and adults. Melanistic bars form on the first dorsal fin between spines I to III

and V to VIII above the first and second saddles. By 39 mm the outer half of the fin is completely pigmented, while two unpigmented areas remain on the proximal half of the fin between the two pigment bars. Melanophores are added on the second dorsal fin above the fourth saddle until the proximal one-fourth of the fin between rays 2 and 13 or 14 is pigmented. The base of the caudal fin never becomes outlined with melanophores, but some melanophores develop on the dorsal secondary caudal rays.

Recently preserved pelagic juveniles of *S. pinniger*, 32 to 35 mm, are covered with orange chromatophores which are lost during prolonged preservation. They are present on the dorsal part of the head, on the snout, around the orbit, and on the opercle. On the body they are concentrated along the myosepta and lateral midline, with greater numbers on the dorsal half of the body but also extending to the ventral margin. Orange chromatophores are also concentrated on the spinous dorsal fin, along the basal one-fourth of the caudal fin, and the anal fin membrane around the anal spines.

A general increase in melanistic pigmentation occurs in benthic juveniles >59 mm. On the head, the two pigment bars beneath the orbit remain distinct and extend over the operculum. Pigment increases between the saddles obscuring the pattern seen on pelagic juveniles. Melanophores are added to both the inner and outer surfaces of the pectoral fin base and on the basal one-third of the pectoral fin blade. The pelvic fin remains unpigmented. The addition of melanophores to the spinous dorsal fin obscures the pattern seen on

pelagic juveniles although the black blotch remains intense and distinct. The entire caudal fin is lightly pigmented with more intense pigment occurring over the bases of the primary rays and all upper secondary rays.

*Occurrence* (Figures 10, 11).—Adults of *S. pinniger* occur between Cape Colnett, Baja California, and southeast Alaska (lat. 56° N, long. 134° W) (Hart 1973). Off Oregon they are most common on the continental shelf between 100 and 200 m (Snytko and Fadeev 1974). A major population concentration has been found between lat. 44°30' and 45° N off Oregon (Snytko and Fadeev 1974).

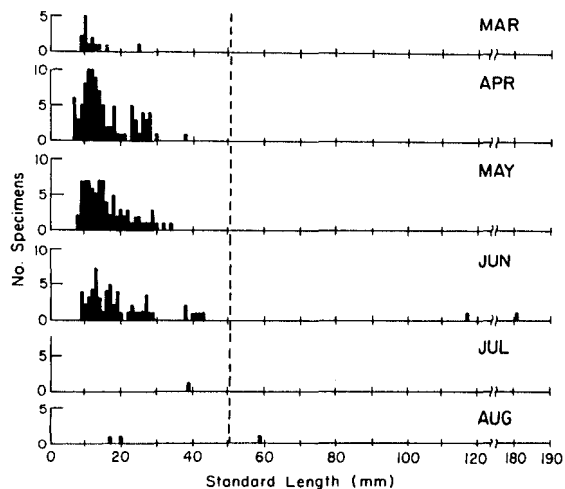


FIGURE 11.—Seasonal occurrence of larvae and juveniles of *Sebastes pinniger* off Oregon. Data from 1964 to 1975 combined. Dashed line separates pelagic and benthic stages.

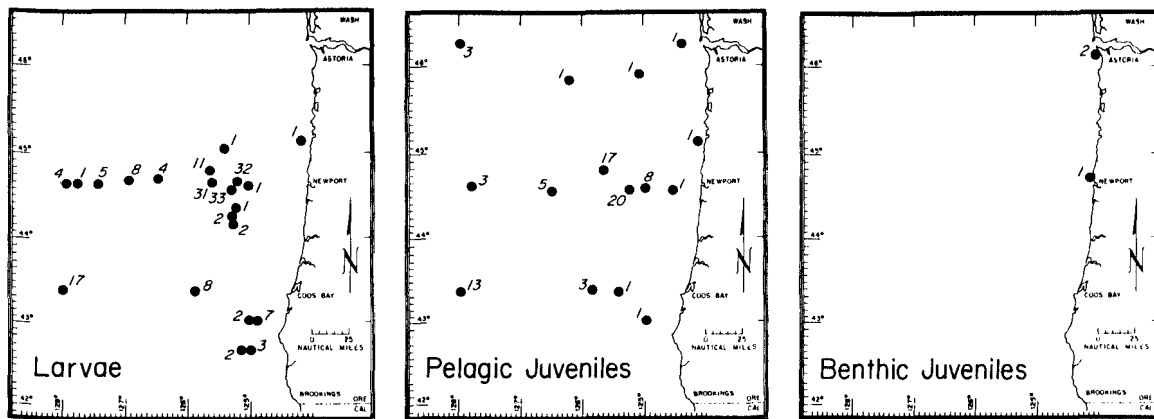


FIGURE 10.—Number of specimens and location of capture of larvae and juveniles of *Sebastes pinniger* off Oregon (1964-75) described in this paper.

Larvae, including transforming specimens, of *S. pinniger* in our collections were captured at a wide range of stations from 13 to 306 km offshore. The largest numbers and smallest larvae (<8.8 mm) were taken at stations 83 to 120 km off Newport beyond the continental shelf break. This may partly be a reflection of increased sampling effort in that area. Pelagic juveniles occurred at a similar wide range of stations, mostly beyond the continental shelf. Interestingly, 30 specimens, ranging in length from 8.9 to 18.6 mm were captured 306 km off Coos Bay, Oreg., well beyond the continental shelf. Perhaps this wide ranging offshore occurrence of larvae and pelagic juveniles is related to their morphology. The larvae are quite stubby and deep bodied with particularly long head spines, features which could contribute to increased flotation and dispersal by currents. Most specimens were captured in oblique midwater trawl and bongo net tows. Three benthic juveniles were taken close to the coast in depths of 30 to 35 m.

Reported spawning times for *S. pinniger* are November to March off California (Phillips 1964) and January to March off Oregon, Washington, and British Columbia (Westrheim 1975). Larvae <10 mm were taken March through June, and larger pelagic specimens were taken March through August. The wide range in lengths, 9 to 25 mm in March, 7 to 38 mm in April, 8 to 34 mm in May, 9 to 43 mm in June, may be indicative of protracted and variable spawning. Benthic juveniles were taken in June and August.

*Sebastes pinniger* is one of the most abundant trawl-caught rockfish species on the continental shelf off Oregon together with *S. flavidus* and *S. entomelas* (Snytko and Fadeev 1974). In trawl surveys off Oregon it ranked either first or second only to *S. entomelas* in biomass over the shelf (Demory et al. 1976). It was one of the major contributors to "other rockfish" landings in Oregon during 1963-71 (Niska 1976). Larvae and juveniles were the most numerous in available collections of the three species described in this paper.

### SEBASTES HELVOMACULATUS AYRES (Figures 12, 13)

*Literature.*—Westrheim et al. (see footnote 9) presented a schematic illustration of a preextrusion larva of *S. helvomaculatus* and described the

pigment pattern in a tabular form. The latter was also in Westrheim (1975). Preextrusion larvae (mean total length = 4.1 mm) have a midline row of usually <16 (83% of 120) melanophores which stop short of the anus by as much as four myomeres. Pigment is from the dorsal midline, the head, nape, and jaw, and is usually not in the hypural region. Illustration shows some melanophores on hindgut and ventrally beneath the yolk sac. Westrheim (1975) added that larvae of *S. helvomaculatus*, along with 10 other species had been reared for several days, developing spots on the head, nape, and/or lower jaw.

*Identification* (Table 10, Appendix Tables 1-3).—Twenty-six specimens of *S. helvomaculatus* 183 mm long, were identified. Juveniles were identified using the following combination of characters obtained from specimens examined in this study:

Gill rakers = 28-31  
Lateral line pores = 35-43  
Pectoral fin rays = 15-17, usually 16  
Anal fin soft rays = 5-6, usually 6  
Dorsal fin soft rays = 12-14, usually 13  
Supraocular spine = present  
Interorbital space = concave.

Of the *Sebastes* species occurring off Oregon, *helvomaculatus* has the best fit to the characters. *Sebastes aurora* and *S. elongatus* agree with many of these characters, but *S. aurora* was eliminated since it has 24 to 28 gill rakers and *S. elongatus* was eliminated since it does not have a supraocular spine. Larval and juvenile specimens of *S. elongatus* identified from our collections are noticeably more slender than specimens of *S. helvomaculatus* and also are pigmented differently. Pigment pattern, body shape, time of occurrence, and constancy in number of anal fin rays and pectoral fin rays helped link together the developmental series.

*Distinguishing Features.*—Characters used to distinguish the smallest larva of *S. helvomaculatus* identified, 7.7 mm, are the mented fringes of the pectoral and pelvic fins; general lack of body pigment; melanophores on the side the tip of the lower jaw; narrow interorbital distance (31% HL); long, deeply serrated, pelvic spines (27% HL); and relatively long pectoral

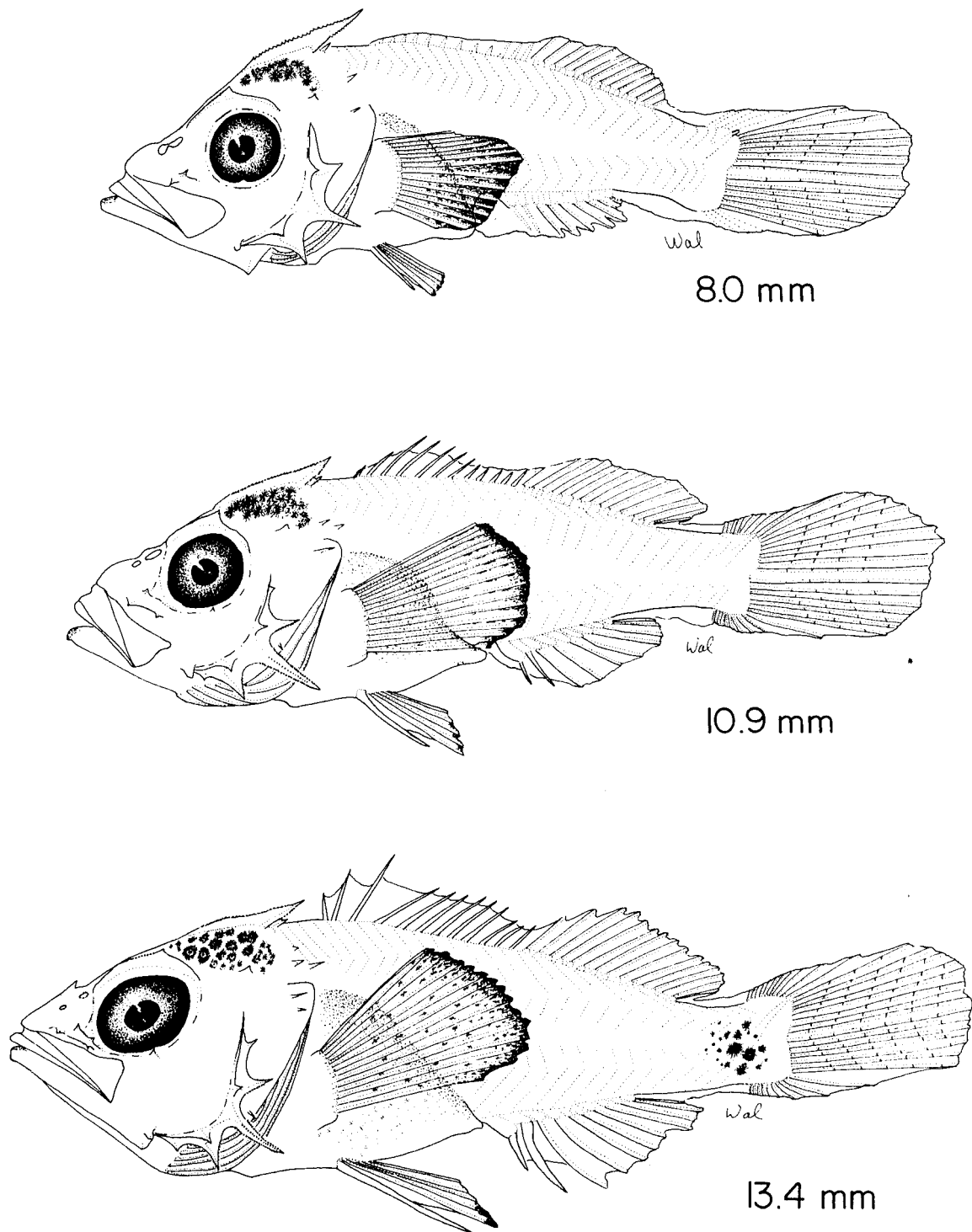


FIGURE 12.—Planktonic larvae (8.0, 10.9 mm) and transforming specimen (13.4 mm) of *Sebastes helvomaculatus*.

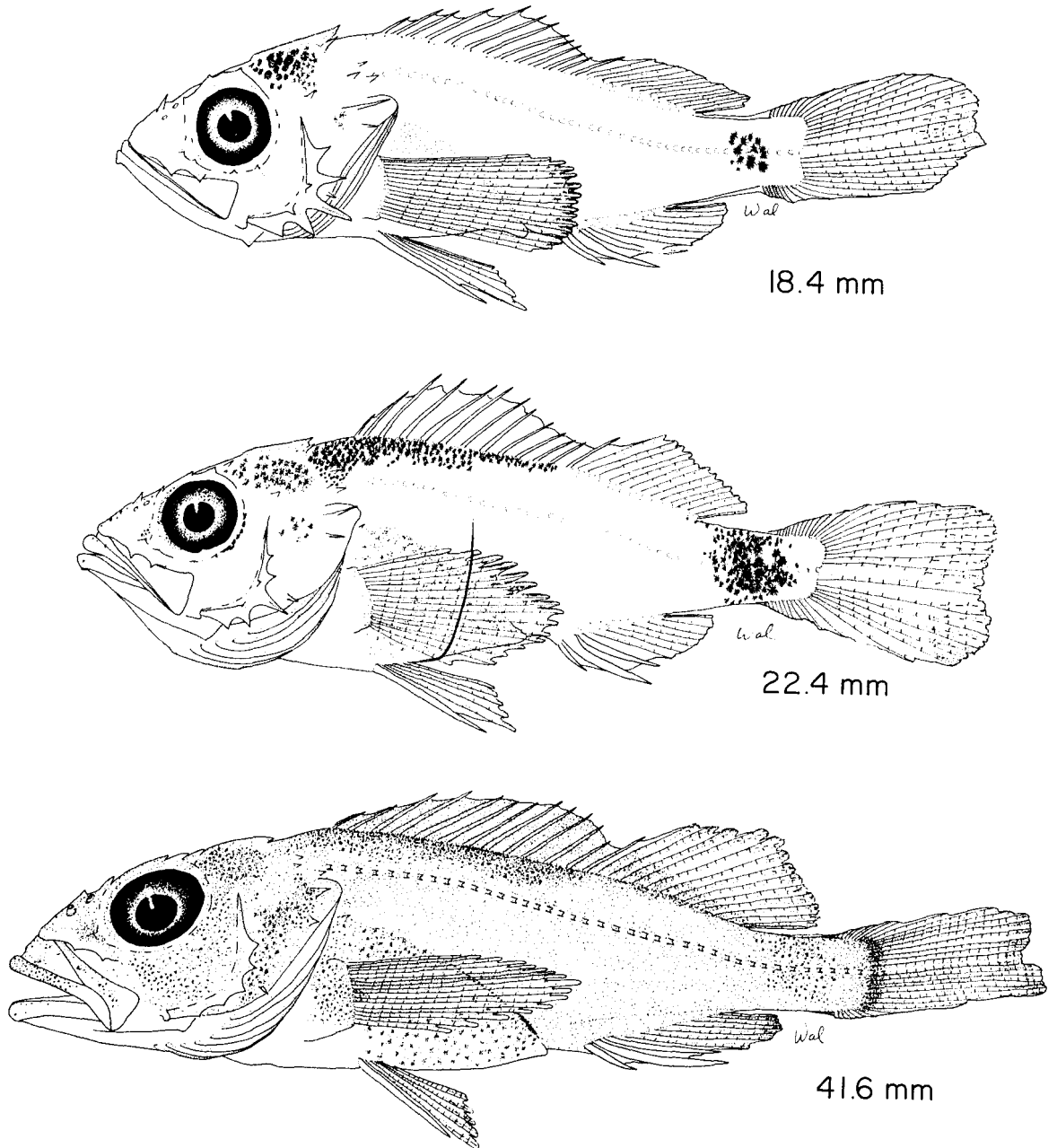


FIGURE 13.—Transforming specimen (18.4 mm) and pelagic juveniles (22.4, 41.6 mm) of *Sebastes helvomaculatus*.

(24% SL). Later stage larvae change very little in appearance from the smallest larva, except for an increase of dorsolateral internal gut pigment. A distinctive pigment patch appears on the caudal peduncle during the period of transformation from

larva to pelagic juvenile. Meristics, presence of a supraocular spine, the concave shape and narrow width of the interorbital space, the patch of melanophores on the caudal peduncle, and the single melanistic pigment saddle extending pos-



TABLE 10.—Meristics from larvae and juveniles of *Sebastes helvomaculatus* off Oregon, based on unstained specimens. Specimens above dashed line are undergoing notochord flexion. All specimens had 8 superior and 7 inferior principal caudal fin rays and 7 branchiostegal rays on each side.

Standard length (mm)	Dorsal fin spines and rays	Anal fin spines and rays	Pectoral fin rays		Pelvic fin spines and rays		Gill rakers (first arch)		Lateral line pores		Diagonal scale rows
			Left	Right	Left	Right	Left	Right	Left	Right	
7.7	—	—	16	16	1, (1)	1, (1)	—	—	—	—	—
8.0	—	III <sup>2</sup> , 7	16	16	1, (1)	1, (1)	—	—	—	—	—
8.0	—	III <sup>2</sup> , 7	16	16	1, (1)	1, (1)	—	—	—	—	—
8.8	—	III <sup>2</sup> , 6	16	16	1, 5	1, 5	—	—	—	—	—
9.9	XIII <sup>2</sup> , 13	III <sup>2</sup> , 6	16	16	1, 5	1, 5	—	—	—	—	—
10.9	XIII <sup>2</sup> , 13	III <sup>2</sup> , 6	16	16	1, 5	1, 5	—	—	—	—	—
<sup>3</sup> 12.0	XIII <sup>2</sup> , 13	III <sup>2</sup> , 6	16	16	1, 5	1, 5	—	—	—	—	—
<sup>3</sup> 12.0	XIII <sup>2</sup> , 13	III <sup>2</sup> , 6	16	16	1, 5	1, 5	—	—	—	—	—
<sup>3</sup> 13.4	XIII <sup>2</sup> , 13	III <sup>2</sup> , 7	16	16	1, 5	1, 5	—	—	—	—	—
<sup>3</sup> 13.4	XIII <sup>2</sup> , 13	III <sup>2</sup> , 6	16	16	1, 5	1, 5	—	—	—	—	—
<sup>3</sup> 13.6	XIII <sup>2</sup> , 13	III <sup>2</sup> , 6	16	16	1, 5	1, 5	—	21+9=30	—	—	—
<sup>3</sup> 17.8	XIII <sup>2</sup> , 12	III <sup>2</sup> , 6	16	16	1, 5	1, 5	21+9=30	22+9=31	≈42	—	—
<sup>3</sup> 17.9	XIII <sup>2</sup> , 12	III <sup>2</sup> , 6	16	16	1, 5	1, 5	21+9=30	21+9=30	—	—	—
<sup>3</sup> 18.4	XIII <sup>2</sup> , 13	III <sup>2</sup> , 6	16	16	1, 5	1, 5	21+9=30	20+8=28	—	—	—
<sup>3</sup> 18.4	XIII <sup>2</sup> , 12	III <sup>2</sup> , 6	16	16	1, 5	1, 5	21+9=30	21+9=30	42	—	—
<sup>3</sup> 18.6	XIII <sup>2</sup> , 13	III, 6	16	17	1, 5	1, 5	19+8=27	19+8=27	—	—	—
<sup>4</sup> 19.8	XIII, 13	III, 6	16	16	1, 5	1, 5	21+8=29	21+8=29	≈40	—	—
<sup>4</sup> 20.3	XIII, 14	III, 6	16	16	1, 5	1, 5	21+9=30	20+8=28	≈39	—	—
<sup>4</sup> 21.6	XIII, 13	III, 6	16	16	1, 5	1, 5	21+8=29	21+8=29	≈39	—	—
<sup>4</sup> 22.1	XIII, 14	III, 6	16	16	1, 5	1, 5	20+9=29	20+8=28	≈40	≈40	—
<sup>4</sup> 22.2	XIII, 13	III, 6	16	16	1, 5	1, 5	20+8=28	20+8=28	≈38	≈38	—
<sup>4</sup> 22.4	XIII, 13	III, 6	16	15	1, 5	1, 5	21+9=30	21+9=30	≈41	≈41	—
<sup>4</sup> 23.8	XIII, 12	III, 5	16	16	1, 5	1, 5	20+9=29	20+9=29	≈43	≈43	—
<sup>4</sup> 41.6	XIII, 13	III, 6	16	16	1, 5	1, 5	22+9=31	22+8=30	39	38	—
<sup>5</sup> 136.4	XIII, 13	III, 6	16	15	1, 5	1, 3	21+9=30	21+9=30	35	35	—
<sup>5</sup> 183	XIII, 14	III, 6	17	16	1, 5	1, 5	22+9=31	22+9=31	40	39	≈43

<sup>1</sup>Not formed.<sup>2</sup>Posterior dorsal or anal spine appears as a soft ray.<sup>3</sup>Transforming.<sup>4</sup>Pelagic juvenile.<sup>5</sup>Benthic juvenile.

teriorly from the nape to dorsal spine XI and ventrally about one-half the distance to the lateral line, all serve to distinguish pelagic juveniles.

**General Development.**—The smallest larva of *S. helvomaculatus* identified, 7.7 mm, is in the final stage of notochord flexion, which is completed by 8.8 mm. Transformation to pelagic juvenile begins in larvae ≈12 mm long with the initiation of spine formation in the dorsal and anal fin "prespines" and the appearance of a lateral pigment patch on the caudal peduncle. Transformation of the "prespines" to spines is completed in specimens >19 mm at which time some pigment appears beneath the spinous dorsal fin and pigment is added to the dorsal margin of the caudal peduncle pigment patch marking the beginning of pelagic juveniles pigmentation. More pigment is added beneath the first dorsal fin during the pelagic juvenile period although the saddle never becomes pronounced. Additional small external melanophores cover most of the fish by the end of the pelagic juvenile period, which probably lasts until ≈40-60 mm. The largest pelagic juvenile examined was 41.6 mm and the smallest benthic juvenile was 136.4 mm.

**Morphology** (Tables 4, 11).—Twenty-six specimens of *S. helvomaculatus*, 7.7 to 183 mm long, were measured for developmental morphology. Relative body depth/SL changes little at the pectoral fin base, decreasing slightly then increasing while it generally increases at the anus. Snout to anus distance increases from 56 to 63 or 64% SL and the snout to pelvic fin distance increases somewhat then decreases.

Head length increases slightly (41-42%) then decreases (38%) with respect to standard length. Eye diameter decreases (39-32% HL), as do the interorbital distance (31-15% HL) and snout length (32 or 33-27% HL). Upper jaw length increases from 44-46 to 52% HL. The length of the angle gill raker first increases (13-15% HL) then decreases (11%).

Larvae and juveniles <24 mm have a weak symphyseal knob which becomes less obvious with development.

**Fin Development** (Tables 4, 10, 11).—The adult complement of 15 to 18 (usually 16) pectoral fin rays can be counted on the smallest larva, 7.7 mm, of *S. helvomaculatus* although the ventralmost rays are not fully developed. Pectoral fins are

TABLE 11.—Measurements (millimeters) of larvae and juveniles of *Sebastes helvomaculatus* from waters off Oregon. Specimens above dashed line are undergoing notochord flexion.

Standard length	Total length	Snout to anus length	Head length	Snout length	Upper jaw length	Eye diameter	Interorbital distance	Body depth at pectoral fin base	Body depth at anus	Pectoral fin length	Pectoral fin base depth	Pelvic spine length	Pelvic fin length	Snout to pelvic fin origin	Parietal spine length	Nuchal spine length	Preopercular spine length	Angle gill raker length	Longest dorsal spine length	Longest dorsal ray length <sup>2</sup>	Longest anal spine length <sup>3</sup>
7.7	9.5	4.3	3.2	1.1	1.5	1.2	1.0	2.5	1.6	1.9	0.96	0.64	1.0	3.0	1.0	0	1.0	—	( <sup>4</sup> )	( <sup>5</sup> )	( <sup>4</sup> )
8.0	9.8	4.4	3.2	0.96	1.5	1.3	1.0	2.8	1.7	2.0	1.0	0.68	1.2	3.3	0.90	0.04	0.90	—	( <sup>4</sup> )	( <sup>5</sup> )	( <sup>4</sup> )
8.0	9.9	4.6	3.4	1.1	1.4	1.3	1.0	2.6	1.6	1.7	1.0	0.66	1.0	3.3	0.78	0.08	0.78	—	( <sup>4</sup> )	( <sup>5</sup> )	( <sup>4</sup> )
-----																					
8.8	10.9	5.2	3.9	1.3	1.4	1.4	1.2	2.9	1.9	2.2	1.1	0.40	1.3	3.6	0.78	0.10	1.2	0.48	( <sup>5</sup> )	0.80	( <sup>4</sup> )
9.9	12.3	5.8	4.1	1.3	1.6	1.5	1.3	3.3	2.6	2.4	1.1	1.2	1.6	4.0	0.80	0.22	1.3	0.56	0.88	1.2	0.60
10.9	13.4	6.5	4.4	1.5	1.8	1.6	1.4	3.7	2.8	2.6	1.2	1.6	1.7	4.5	0.70	0.22	—	0.62	0.82	1.3	0.76
<sup>6</sup> 12.0	14.9	7.4	4.9	1.6	2.4	1.8	1.5	4.1	3.0	3.0	1.2	1.9	2.0	5.2	0.80	0.24	1.3	0.78	1.1	1.8	1.1
<sup>6</sup> 12.0	14.4	7.1	4.9	1.5	2.6	1.9	1.5	4.3	3.1	3.4	1.3	2.1	2.4	5.2	0.72	0.24	—	0.88	—	1.9	1.2
<sup>6</sup> 13.4	16.8	8.5	5.4	1.6	2.7	2.0	1.6	4.1	3.4	3.3	1.3	2.4	2.9	6.0	0.66	0.30	—	0.82	—	1.9	1.4
<sup>6</sup> 13.4	16.8	8.5	5.6	1.8	2.6	2.0	1.6	4.7	3.6	3.6	1.5	2.4	2.6	5.7	0.72	0.26	1.3	0.72	—	1.9	1.3
<sup>6</sup> 13.6	16.8	8.5	5.8	2.2	2.4	2.0	1.5	4.4	3.3	3.3	1.3	2.2	2.4	6.2	—	0.28	1.1	0.80	1.4	1.9	1.4
<sup>6</sup> 17.8	22.1	10.7	7.5	2.7	3.2	2.4	1.8	5.7	4.5	4.5	1.6	3.4	3.8	7.2	1.0	0.32	—	1.1	2.3	2.6	2.3
<sup>6</sup> 17.9	22.2	11.2	7.3	2.6	2.9	2.4	1.7	5.7	4.2	4.5	1.7	3.1	3.2	8.0	0.80	0.28	1.3	1.1	—	2.8	2.2
<sup>6</sup> 18.4	22.9	11.0	6.7	2.1	3.0	2.5	1.9	5.9	4.3	4.9	1.8	3.2	3.7	7.0	0.96	0.36	1.4	1.1	2.1	—	1.9
<sup>6</sup> 18.4	23.0	11.0	7.2	1.8	3.4	2.7	1.8	5.7	4.4	5.2	1.8	3.4	3.7	7.0	0.70	0.34	1.3	1.1	2.7	3.0	2.6
<sup>6</sup> 18.6	21.1	12.0	8.0	2.7	3.4	2.6	1.9	5.8	4.3	4.8	1.8	3.4	3.4	8.8	0.72	0.24	1.3	1.1	—	2.6	—
<sup>6</sup> 19.8	24.6	12.0	8.2	2.8	3.3	2.8	2.1	6.4	4.6	5.2	1.8	3.1	3.6	8.2	—	0.36	1.3	1.2	—	2.6	2.2
<sup>6</sup> 20.3	25.3	12.8	8.4	2.8	4.0	2.8	2.0	6.2	4.7	5.3	1.8	—	4.1	9.0	0.80	0.34	1.3	1.2	—	3.0	2.0
<sup>6</sup> 21.6	26.4	13.0	8.4	2.5	4.0	2.8	2.0	7.1	5.2	5.7	2.0	—	4.0	8.6	—	0.14	—	1.2	—	3.2	3.0
<sup>6</sup> 22.1	26.4	14.2	8.9	3.0	4.2	3.0	1.9	7.2	5.3	5.9	2.0	3.4	4.4	9.8	0.72	0.26	—	1.4	2.8	3.2	2.7
<sup>6</sup> 22.2	27.7	14.6	9.3	3.0	4.2	3.0	1.9	6.7	5.1	5.9	2.0	4.2	4.4	10.7	0.46	0.32	—	1.3	2.6	3.1	3.1
<sup>6</sup> 22.4	27.7	13.4	8.4	2.6	3.8	3.1	2.0	7.2	5.6	6.0	2.0	4.1	4.8	8.8	—	0.44	1.1	1.3	3.0	3.2	3.2
<sup>6</sup> 23.8	29.1	15.7	9.4	3.1	4.3	2.9	1.9	7.2	5.2	6.4	2.2	3.9	4.3	10.7	0.40	0.30	—	1.2	2.8	3.4	—
<sup>6</sup> 41.6	49.8	26.2	16.5	4.4	7.0	5.7	2.2	11.8	8.8	7.0	3.4	5.6	7.2	16.6	0.18	—	0.42	2.1	4.9	6.1	6.4
<sup>6</sup> 136.4	169	86.0	51.8	14.0	26.7	18.3	6.7	44.0	32.3	37.6	12.0	19.7	30.0	53.8	1.6	—	1.3	5.7	17.4	20.7	27.0
<sup>6</sup> 183	219	118.1	68.1	18.0	35.8	18.9	11.2	63.3	49.4	48.4	18.0	28.2	42.9	74.5	—	—	0.32	7.0	27.6	31.0	31.0

<sup>1</sup>Usually third or fourth in larvae, fifth or sixth in juveniles.<sup>2</sup>Usually midfin.<sup>3</sup>The second spine.<sup>4</sup>Not formed.<sup>5</sup>Forming.<sup>6</sup>Transforming.<sup>7</sup>Pelagic juvenile.<sup>8</sup>Benthic juvenile.

rather long, averaging 24-26% SL during the pelagic period. Depth of the pectoral fin decreases from 12% in flexion larvae to 9% in benthic juveniles.

Pelvic fin spines and developing rays are visible on the 7.7 mm larva. The adult complement of I, 5 is countable on the smallest postflexion larva, 8.8 mm. The relative length of the pelvic fin increases from 14 to 23% SL with development. The pelvic spine, always shorter than the pelvic fin rays, increases from 8% SL in flexion larvae to 18% in transforming larvae and then decreases to 15% in benthic juveniles.

The adult complement of 8 + 7 principal caudal fin rays can be counted on the 7.7 mm preflexion larva. Flexion is completed by 8.8 mm. Superior and inferior secondary caudal rays on two stained juveniles 22.4 and 23.8 mm long, were 12 + 12 and 11 + 11, respectively.

Bases of dorsal and anal fin spines and rays are visible on the 7.7 mm larva. Rays and spines (including "prespines") are fully formed by 9.9 mm and the adult complements can be counted. "Pre-

spines" become spines in specimens >19 mm. The longest dorsal spine increases from 19% HL in postflexion larvae to 37% in benthic juveniles. The longest dorsal ray, always longer than the longest dorsal spine, increases from 23 to 43% HL during development. The longest anal spine increases from 16 to 49% HL.

*Spination* (Tables 4, 12).—Spines on the left side of the head of the smallest *S. helvomaculatus* (7.7 mm) include the parietal; first and third anterior preopercular spines; second, third, and fourth posterior preopercular spines; postocular; pterotic; inferior posttemporal; and first spine of the superior infraorbital series.

The parietal spine and ridge are deeply serrated in larvae and pelagic juveniles, but the serrations are no longer visible by 41.6 mm. The parietal spine is very long in flexion larvae, averaging 27% HL. Its length decreases with development to 3% HL in benthic juveniles. The much smaller nuchal spine, which appears by 8 mm, averages 2% HL in flexion larvae and increases to 4 or 5% in postflex-

TABLE 12.—Development of spines in the head region of *Sebastes helvomaculatus* larvae and juveniles. Specimens above dashed line are undergoing notochord flexion. + denotes spine present and - denotes spine absent.

Standard length (mm)	Parietal	Nuchal	Preopercular (anterior series)			Preopercular (posterior series)				Opercular		Inter-opercular	Sub-opercular	Pre-ocular	Supra-ocular	Post-ocular
			1st	2d	3d	1st	2d	3d	4th	5th	Superior					
7.7	+	-	+	-	+	-	+	+	+	-	-	-	-	-	-	+
8.0	+	-	+	-	+	-	+	+	+	-	-	-	-	-	-	+
8.0	+	+	+	-	+	-	+	+	+	-	-	-	-	-	-	+
-----																
8.8	+	+	+	-	+	+	+	+	+	+	+	+	-	-	-	+
9.9	+	+	+	-	+	+	+	+	+	+	+	+	-	-	-	+
10.9	+	+	+	-	+	+	+	+	+	+	+	+	-	-	-	+
<sup>1</sup> 12.0	+	+	+	-	+	+	+	+	+	+	+	+	-	-	-	+
<sup>1</sup> 12.0	+	+	+	-	+	+	+	+	+	+	+	+	-	-	-	+
<sup>1</sup> 13.4	+	+	+	-	+	+	+	+	+	+	+	+	-	-	-	+
<sup>1</sup> 13.4	+	+	+	-	+	+	+	+	+	+	+	+	-	(?)	(?)	+
<sup>1</sup> 13.6	+	+	+	-	+	+	+	+	+	+	+	+	-	(?)	(?)	+
<sup>1</sup> 17.8	+	+	+	-	+	+	+	+	+	+	+	+	-	+	+	+
<sup>1</sup> 17.9	+	+	+	-	+	+	+	+	+	+	+	+	-	+	+	+
<sup>1</sup> 18.4	+	+	+	-	+	+	+	+	+	+	+	+	-	+	+	+
<sup>1</sup> 18.4	+	+	+	-	+	+	+	+	+	+	+	+	-	+	+	+
<sup>1</sup> 18.6	+	+	+	-	+	+	+	+	+	+	+	+	-	+	+	+
<sup>1</sup> 18.6	+	+	+	-	+	+	+	+	+	+	+	+	-	+	+	+
<sup>3</sup> 19.8	+	+	+	-	+	+	+	+	+	+	+	+	-	+	+	+
<sup>3</sup> 20.3	+	+	+	-	+	+	+	+	+	+	+	+	-	+	+	+
<sup>3</sup> 21.6	+	+	+	-	+	+	+	+	+	+	+	+	-	+	+	+
<sup>3</sup> 22.1	+	+	+	-	+	+	+	+	+	+	+	+	-	+	+	+
<sup>3</sup> 22.2	+	+	(?)	-	(?)	+	+	+	+	+	+	+	-	+	+	+
<sup>3</sup> 22.4	+	+	(?)	-	(?)	+	+	+	+	+	+	+	-	+	+	+
<sup>3</sup> 23.8	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>4</sup> 41.6	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>4</sup> 136.4	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+
<sup>4</sup> 183	+	+	-	-	-	+	+	+	+	+	+	+	-	+	+	+

TABLE 12.—Continued.

Standard length (mm)	Intraorbitals							Nasal	Coronal	Tympanic	Pterotic	Posttemporal		Supra-cleithral	Cleithral	
	Inferior			Superior								Superior	Inferior			
	1st	2d	3d	1st	2d	3d	4th									
7.7	-	-	-	+	-	-	-	-	-	-	+	-	+	-	-	
8.0	-	-	-	+	-	-	-	-	-	-	+	-	+	-	-	
8.0	-	-	-	+	-	-	-	-	-	-	+	-	+	-	-	
-----																
8.8	+	+	-	+	-	-	+	-	-	-	+	-	+	+	-	
9.9	+	+	-	+	-	-	+	(?)	-	-	+	-	+	+	-	
10.9	+	+	-	+	-	-	+	(?)	-	-	+	-	+	+	-	
<sup>1</sup> 12.0	+	+	-	+	-	-	+	+	-	-	+	-	+	+	-	
<sup>1</sup> 12.0	+	+	-	+	+	-	+	+	-	-	+	-	+	+	-	
<sup>1</sup> 13.4	+	+	-	+	+	-	+	+	-	-	+	+	+	+	-	
<sup>1</sup> 13.4	+	+	-	+	+	+	+	+	-	-	+	+	+	+	-	
<sup>1</sup> 13.6	+	+	-	+	+	+	+	+	-	-	+	+	+	+	-	
<sup>1</sup> 17.8	+	+	-	+	+	+	+	+	-	-	+	+	+	+	-	
<sup>1</sup> 17.9	+	+	-	+	+	+	+	+	-	-	+	+	+	+	-	
<sup>1</sup> 18.4	+	+	-	+	+	+	+	+	-	-	+	+	+	+	(?)	
<sup>1</sup> 18.4	+	+	-	+	+	+	+	+	-	-	+	+	+	+	-	
<sup>1</sup> 18.6	+	+	-	+	+	+	+	+	-	-	+	+	+	+	-	
<sup>3</sup> 19.8	+	+	-	+	+	+	+	+	-	-	+	+	+	+	-	
<sup>3</sup> 20.3	+	+	-	+	+	+	+	+	-	-	(?)	+	+	+	(?)	
<sup>3</sup> 21.6	+	+	-	+	+	+	+	+	-	-	(?)	+	+	+	(?)	
<sup>3</sup> 22.1	+	+	-	+	+	+	+	+	-	-	(?)	+	+	+	(?)	
<sup>3</sup> 22.2	+	+	-	+	(?)	+	+	+	-	-	(?)	+	+	+	-	
<sup>3</sup> 22.4	+	+	-	+	(?)	(?)	(?)	+	-	-	(?)	+	+	+	+	
<sup>3</sup> 23.8	+	+	-	-	-	-	-	+	-	-	(?)	+	+	+	+	
<sup>4</sup> 41.6	+	+	-	-	-	-	-	+	-	+	-	+	+	+	+	
<sup>4</sup> 136.4	+	+	-	-	-	-	-	+	-	+	-	+	+	+	+	
<sup>4</sup> 183	+	+	-	-	-	-	-	+	-	+	-	+	+	+	-	

<sup>1</sup>Transforming.  
<sup>2</sup>Bump indicating beginning of spine formation.  
<sup>3</sup>Pelagic juvenile.  
<sup>4</sup>Benthic juvenile.

ion, transforming, and pelagic juvenile stages. The nuchal and parietal spines are fused together by the time juveniles are 42 mm long.

The posterior preopercular spine series is prominent in *S. helvomaculatus* larvae. The third spine

of the series is weakly serrated in larvae >8 mm up to pelagic juveniles. It is relatively long in larvae averaging 27 to 31% HL in flexion and postflexion stages. Its length decreases to 2% in benthic juveniles when it is no longer serrated.

Very weak serrations appear on the second and fourth posterior preopercular spines of most larger larvae and smaller pelagic juveniles. All five posterior preopercular spines are present on specimens >8.0 mm. The first and third anterior preopercular spines seen on the smallest larva are no longer visible on specimens >23 mm. The second anterior preopercular spine never develops.

The superior and inferior opercular spines are present on all specimens >8 mm. The interopercular spine is present at 8.8 mm and persists into benthic juveniles. The subopercular spine is present just above the interopercular spine on the largest benthic juvenile, 183 mm.

The supraocular ridge and the anterior margin of the postocular spine are serrated on specimens up to 23.8 mm. The preocular and supraocular spines are first seen as bumps in a 13.4 mm specimen. Serrations are present on the supraocular spine but disappear along with those on the supraocular ridge on larger pelagic juveniles.

The first superior infraorbital spine is visible up to 23 mm. The second superior infraorbital spine appears on specimens 12 to 23 mm. The fourth superior infraorbital spine is present on larvae >8 mm and the third superior infraorbital spine is present on larvae >13.4 mm. The third and fourth spines both disappear by 23 mm. The first and second spines of the inferior infraorbital series are present on all specimens >8 mm but appear only as blunt projections on benthic juveniles. The third inferior infraorbital spine never develops. The nasal spine appears as a bump by 9 mm and becomes strong and sharp during the larval period.

The tympanic spine develops by 41.6 mm and appears as a strong sharp spine on benthic juveniles. The pterotic spine is present on all specimens >41.6 mm. The inferior posttemporal spine is present on all specimens examined but is minute on the two benthic juveniles, 136 and 183 mm, and probably disappears in larger specimens. The supracleithral spine is present on all specimens >8.0 mm. The superior posttemporal appears at 13.4 mm and is present on all larger specimens. Posterior to the opercle the cleithral spine appears on all specimens >19 mm.

**Scale Formation.**—Lateral line pores first appear anteriorly and are visible on specimens >17 mm. Scale formation begins on pelagic juveniles >23 mm.

**Pigmentation.**—The smallest larva of *S. helvomaculatus*, 7.7 mm (similar to the 8.0 mm specimen illustrated), has pigment on the head over the brain. Melanophores line the inner tip of the lower jaw. In the abdominal region, an internal melanistic shield is present over the dorsolateral surface of the gut. No other pigment is visible on the body. The pectoral and pelvic fins are fringed with expanded and fused melanophores and have a light scattering of more contracted, elongate melanophores on the fin blades. Both inner and outer pectoral fin base surfaces are unpigmented.

During larval development, pigment over the brain becomes obscured. At 13.4 mm pigment inside the lower jaw disappears. Specimens >17 mm develop two to six internal melanophores dorsally on the opercle.

During the transformation period, 12.0 to 18.6 mm, two or three melanophores may appear just posterior to the orbit on specimens >18 mm. Internal gut pigment increases ventrolaterally reaching the ventral surface of the gut by 17.9 mm. The anterior margin of the cleithrum is usually unpigmented. A patch of 9 to 10 large stellate melanophores appears laterally on the caudal peduncle at 12.0 mm at the beginning of the transformation period. Melanophores are added to this patch until it extends to the dorsal body surface at ≈18 mm. Melanophores in this patch often appear expanded and fused. The pectoral and pelvic fins remain fringed with pigment although this may not be obvious if the fins are frayed. The number of melanophores on the fin blades generally decreases.

During the pelagic juvenile period, 19.8 to 41.6 mm, pigment appears over the head surface, snout, and upper lip of specimens >22 mm. Melanophores are added along the posteroventral margin of the orbit and a patch of melanophores appears just dorsal to the first superior infraorbital spine. The internal pigment patch on the operculum remains distinguishable. Internal gut pigment becomes increasingly obscured by musculature. A single saddle of melanophores develops on the dorsal surface of the body over the nape and beneath the spinous dorsal fin anterior to dorsal spine XI. The first melanophores generally appear there at the onset of the pelagic juvenile stage, although a few may develop earlier. This saddle extends ventrolaterally from the nape to the vicinity of the supracleithral spine and from the spinous dorsal fin halfway to the lateral line by 22

mm. By 41.6 mm small external melanophores cover all but the ventralmost one-fourth of the abdominal region including most of the pectoral fin base and the dorsal one-fourth of the gut region. The dorsal saddle and internal gut pigmentation still appear as more darkly pigmented areas. The caudal peduncle patch expands to the dorsal and ventral body margins. Specimens >20 mm have a few melanophores extending anteriorly from the peduncle patch along the dorsal body margin under the posteriormost dorsal rays. By 41.6 mm the entire tail region of the body is also covered with small external melanophores, although the caudal peduncle patch and dorsal midline melanophores remain visible. Pectoral and pelvic fins lose all pigment by 41.6 mm, except for a patch of small melanophores on the base of the central pectoral rays. The spinous dorsal fin becomes completely covered with small melanophores by 41.6 mm and small melanophores cover the proximal one-fourth of the soft dorsal fin. Small melanophores extend onto the bases of the caudal fin rays by 41.6 mm.

Melanistic pigment is inconspicuous on the benthic juveniles examined, 136 and 183 mm. The caudal peduncle pigment patch is no longer visible.

**Occurrence** (Figures 14, 15).—*Sebastes helvomaculatus* ranges from Coronado Bank, off San Diego, Calif., to Albatross Bank, Gulf of Alaska, and occurs in depths from 133 to 456 m (Chen 1971). It is apparently primarily a deepwater species judging by some of the older common names given to it, "deep-water scacciatole" and

"deep-water scratch-tail" (Phillips 1957). The largest numbers and smallest larvae were taken 83 and 120 km off Newport beyond the continental shelf break. Most pelagic juveniles were taken at the same locations as the larvae, probably reflecting the increased sampling effort in that area. One benthic juvenile, 136 mm, was taken in an otter trawl at a depth of 370 m (lat. 44°47.9' N, long. 124°40.9' W). A second juvenile, 183 mm, was collected after a seismic profiling explosion on Stonewall Bank (≈lat. 44°30' N, long. 124°25' W).

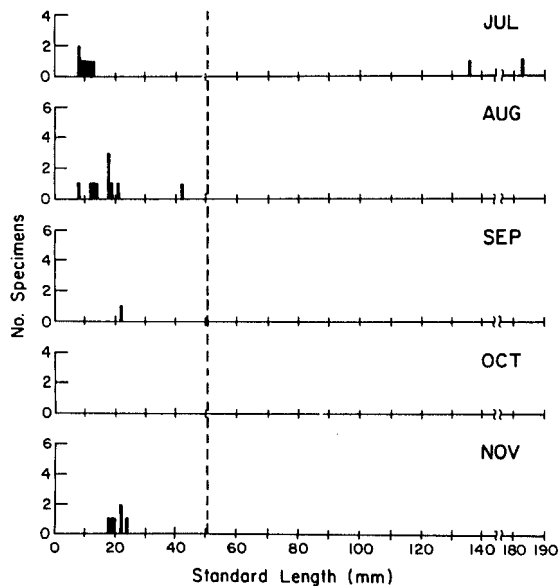


FIGURE 15.—Seasonal occurrence of larvae and juveniles of *Sebastes helvomaculatus* off Oregon. Data from 1961 to 1976 combined. Dashed line separates pelagic and benthic stages.

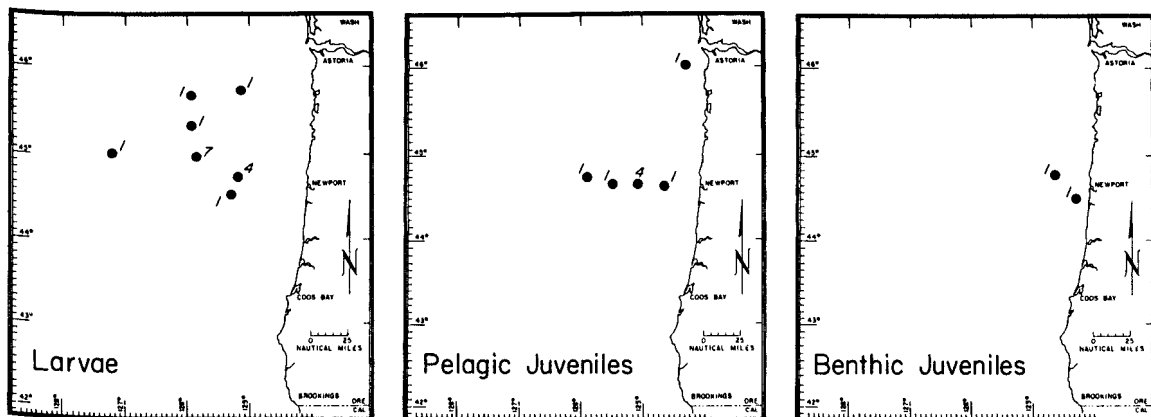


FIGURE 14.—Number of specimens and location of capture of larvae and juveniles of *Sebastes helvomaculatus* off Oregon (1961-76) described in this paper.

Based on examination of gonads, Westrheim (1975) reported that parturition of *S. helvomaculatus* takes place primarily in June from Oregon to British Columbia. We took small larvae >10 mm only in July and August. Pelagic juveniles were captured in August, September, and November. The two benthic juveniles were taken in July.

Adults of *S. helvomaculatus* are uncommon in Oregon trawl landings (Niska 1976). They ranked 9th and 16th in biomass in trawl surveys on the Oregon continental shelf and 8th on the continental slope together with *S. elongatus* and *S. zacentrus* (Demory et al. 1976). Larvae and juveniles were not common in our collections.

### COMPARISONS (TABLE 13)

Prior to this paper, developmental series of 7 of the 69 northeast Pacific (including the Gulf of Cal-

ifornia) species of *Sebastes* had been described: *S. cortezi*, *S. sp. Gulf Type A*, *S. jordani*, *S. levis*, *S. macdonaldi*, *S. melanostomus*, and *S. paucispinis* (Moser 1967, 1972; Moser et al. 1977; Moser and Ahlstrom 1978). While pelagic stages of these species exhibit some similarities to the three described by us, they also differ in a number of characters. The most notable of these are discussed here in a comparative sense.

Flexion and postlarvae of *S. pinniger* are quite deep bodied (38-40% SL) although body depth at the pectoral fin base decreases considerably (33% SL) by the pelagic juvenile stage. Larvae and juveniles of *S. melanostomus* are also deep bodied. Pelagic stages of *S. jordani* are comparatively slender (17-24% SL). Prior to completion of notochord flexion, *S. paucispinis* is also relatively slender bodied. Pelagic stages of *S. crameri*, *S. helvomaculatus*, *S. levis*, and *S. macdonaldi* are somewhat intermediate in body depth. Snout to

TABLE 13.—Morphometric comparison of larvae and juveniles of nine species of *Sebastes* from the northeast Pacific. Values are mean percentages of body proportions related to standard length (SL) or head length (HL). Numbers in italics represent values for two developmental stages combined.

Item	<i>S. cortezi</i> <sup>1</sup>	<i>S. crameri</i>	<i>S. Gulf Type A</i> <sup>1</sup>	<i>S. helvomaculatus</i>	<i>S. jordani</i> <sup>1</sup>	<i>S. levis</i> <sup>1</sup>	<i>S. macdonaldi</i> <sup>1</sup>	<i>S. melanostomus</i> <sup>1</sup>	<i>S. paucispinis</i> <sup>1</sup>	<i>S. pinniger</i>
<i>Body depth at pectoral fin base/SL:</i>										
Preflexion	—	—	—	—	17	—	23	—	20	—
Flexion	—	32	—	33	21	28	32	36	23	40
Postflexion	—	32	—	33	24	34	34	39	30	38
Transforming	—	32	—	33	—	—	—	—	—	36
Pelagic juvenile	—	33	—	31	22	35	31	37	27	33
Benthic juvenile	—	34	—	33	—	—	—	—	—	35
<i>Snout to anus length/SL:</i>										
Preflexion	—	—	—	—	36	—	42	—	41	—
Flexion	—	54	—	56	42	49	52	57	45	59
Postflexion	—	60	—	59	51	59	60	59	57	60
Transforming	—	61	—	62	—	—	—	—	—	61
Pelagic juvenile	—	62	—	63	53	63	64	64	62	61
Benthic juvenile	—	65	—	64	—	—	—	—	—	64
<i>Pectoral fin length/SL:</i>										
Preflexion	7-9	—	6-9	—	7	9	8	—	—	—
Flexion	9-12	17	—	24	8	35	13	20	27	25
Postflexion	—	21	20	24	11	45	19	22	36	25
Transforming	—	27	—	26	20	—	—	—	—	27
Pelagic juvenile	23	32	—	27	22	41	30	26	28	26
Benthic juvenile	—	30	—	27	—	—	—	—	—	24
<i>Pelvic fin length/SL:</i>										
Preflexion	—	—	—	—	—	—	4	—	—	—
Flexion	—	7	—	14	1	6	6	12	14	14
Postflexion	—	15	—	16	—	—	—	—	—	17
Transforming	—	21	—	19	9	21	14	16	35	23
Pelagic juvenile	—	21	—	19	14	24	22	20	25	22
Benthic juvenile	—	21	—	23	—	—	—	—	—	21
<i>Parietal spine length/HL:</i>										
Preflexion	—	—	—	—	—	—	—	—	—	—
Flexion	—	6	—	27	—	—	—	—	—	24
Postflexion	21-22	7	25-34	18	—	—	20-23	—	—	20
Transforming	—	6	—	13	—	—	—	—	—	10
Pelagic juvenile	—	3	—	6	—	—	—	—	—	7
Benthic juvenile	—	—	—	3	—	—	—	—	—	—
<i>Preopercular spine length/HL:</i>										
Preflexion	—	—	—	—	—	—	—	—	—	—
Flexion	—	18	—	27	—	—	—	—	—	34
Postflexion	—	17	—	31	—	—	35	—	—	32
Transforming	—	18	—	20	—	—	—	—	—	24
Pelagic juvenile	—	12	—	12	—	—	—	—	—	13
Benthic juvenile	—	7	—	2	—	—	—	—	—	5

<sup>1</sup>Values from Moser et al. (1977) and Moser and Ahlstrom (1978).

anus distance is markedly shorter in larvae and juveniles of *S. jordani* (36-53% SL) compared with the other species.

The pectoral fins in *S. jordani* remain comparatively short (7-22% SL) during pelagic development while those of *S. levis* attain an exceptional size (to 45% SL). Late larval stages of *S. paucispinis* also have outstandingly long pectoral fins (36% SL). Fin lengths among the other species are intermediate by comparison and vary to a lesser degree during development. The pelvic fins of *S. paucispinis* also become extraordinarily long (35% SL) during the late larval period whereas those of *S. jordani* remain relatively short.

Parietal spine length varies among species with the largest spines appearing in early larvae of *S. helvomaculatus* (27% HL) and *S. sp. Gulf Type A* (25-34% HL). This spine is noticeably short on *S. crameri* (3-7% HL) during the entire pelagic phase. The third preopercular spine is outstandingly long on early larvae of *S. macdonaldi* (35% HL) and *S. pinniger* (34% HL) but is comparatively short on *S. crameri* (17% HL) as is the parietal.

Pigmentation on the paired fins varies from the unpigmented condition in *S. jordani* to the heavily pigmented fins of *S. macdonaldi* and *S. crameri*. The pectoral fins of *S. cortezi* are pigmented at the fin base but not the outer margin, while pigment is primarily concentrated on the outer margin of the fins in *S. paucispinis*, *S. levis*, and *S. helvomaculatus* at least during the early pelagic period. Pectoral fins of *S. pinniger*, *S. melanostomus*, and *S. sp. Gulf Type A* are lightly pigmented.

General body pigmentation differs among the species considered. Larvae of *S. pinniger* have a characteristic lack of body pigment. A patch of nape pigment develops early in *S. crameri* and *S. macdonaldi*, appearing more pronounced in the former species. Postflexion larvae of both *S. crameri* and *S. macdonaldi* develop pigment on the entire spinous dorsal fin. A characteristic black blotch develops on the posterior portion of the first dorsal fin in pelagic juveniles of *S. pinniger*. Larvae of *S. melanostomus*, *S. paucispinis*, and *S. macdonaldi* have a characteristically low number of ventral midline melanophores, 4 to 11 (mean 8), 6 to 14 (mean 9), and 6 to 14 (mean 8), respectively. A patch of pigment forms on the caudal peduncle of *S. helvomaculatus*, *S. paucispinis*, *S. jordani*, and *S. cortezi*. The form of the patch varies with the species and is most pronounced in *S. helvomaculatus*. One characteristic melanophore ap-

pears at the base of the caudal fin in *S. cortezi*, while melanophores form a line of pigment at the base of the caudal fin in *S. jordani*, but not in any of the other species.

Pelagic juveniles of *S. helvomaculatus* develop only one melanistic pigment saddle beneath the spinous dorsal fin. Five distinct saddles form on *S. macdonaldi*, *S. crameri*, *S. levis*, *S. paucispinis*, and *S. pinniger* in comparable locations on the body although a more blotchy pattern develops on *S. pinniger*. On *S. melanostomus*, three pronounced melanistic bars develop on the body. Apparently no obvious saddles or bars develop on pelagic juveniles of *S. jordani* or *S. cortezi*.

These comparisons together with distinguishing features of each species given by us, Moser (1972), Moser et al. (1977), and Moser and Ahlstrom (1978), and range of occurrence should aid in identification of all but the smallest larvae. As additional species are described, such comparisons may also provide insight into relationships within the genus *Sebastes*.

## ACKNOWLEDGMENTS

We thank H. Geoffrey Moser for helpful advice and for the use of unpublished data on color pattern in a live juvenile of *S. crameri*. Stuart G. Poss offered useful advice on head spine terminology. During the course of this study the following people provided helpful information on *Sebastes* spp.: Carl Bond, Jerry Butler, William N. Eschmeyer, Colin Harris, Michael Hosie, Andy Lamb, Bruce M. Leaman, Alex E. Peden, Jay C. Quast, David Stein, Arthur D. Welander, Sigurd J. Westrheim, Norman J. Wilimovsky. Range Bayer, Robert A. Behrstock, Carl Bond, Jerry Butler, Colin Harris, Michael Hosie, Robert Lea, Lawrence Moulton, and Alex Peden provided additional specimens of *Sebastes* to examine. Special thanks are extended to William G. Percy for allowing us to use his extensive midwater trawl collections from waters off Oregon. Lo-Chai Chen, H. Geoffrey Moser, Stuart G. Poss, and Sigurd J. Westrheim reviewed an earlier draft of the manuscript. This research was supported by a 1-yr (16 June 1976-15 June 1977) contract No. 03-6-208-35343.

## LITERATURE CITED

- AHLSTROM, E. H.  
1961. Distribution and relative abundance of rockfish

- (*Sebastes* spp.) larvae off California and Baja California. Rapp. P.-V. Réun. Cons. Int. Explor. Mer 150:169-176.
1965. Kinds and abundance of fishes in the California Current region based on egg and larval surveys. Calif. Coop. Oceanic Fish. Invest. Rep. 10:31-52.
- BAILEY, R. M., J. E. FITCH, E. S. HERALD, E. A. LACHNER, C. C. LINDSEY, C. R. ROBINS, AND W. B. SCOTT.
1970. A list of common and scientific names of fishes from the United States and Canada. Am. Fish. Soc. Spec. Publ. 6, 149 p.
- BARSUKOV, V. V.
1973. A systematic analysis of the group *Sebastes wakiyai*-*S. paradoxus*-*S. steindachneri*. Communication 2 (containing a redescription of *S. wakiyai*). J. Ichthyol. (Engl. Transl. Vopr. Ikhtiol.) 13:824-833.
- CHEN, L.-C.
1971. Systematics, variation, distribution, and biology of rockfishes of the subgenus *Sebastomus* (Pisces, Scorpaenidae, *Sebastes*). Bull. Scripps Inst. Oceanogr., Univ. Calif. 18, 115 p.
1975. The rockfishes, genus *Sebastes* (Scorpaenidae), of the Gulf of California, including three new species, with a discussion of their origin. Proc. Calif. Acad. Sci. 40:109-141.
- DELACY, A. C., C. R. HITZ, AND R. L. DRYFOOS.
1964. Maturation, gestation, and birth of rockfish (*Sebastes*) from Washington and adjacent waters. Wash. Dep. Fish., Fish. Res. Pap. 2(3):51-67.
- DEMORY, R. L., M. J. HOSIE, N. TEN EYCK, AND B. O. FORSBERG.
1976. Marine resource surveys on the continental shelf off Oregon, 1971-74. Oreg. Dep. Fish. Wildl., Completion Rep., July 1, 1971 to June 30, 1975, 49 p.
- EFREMENKO, V. N., AND L. A. LISOVENKO.
1970. Morphological features of intraovarian and pelagic larvae of some *Sebastes* species inhabiting the Gulf of Alaska. In P. A. Moiseev (editor), Soviet fisheries investigations in the northeast Pacific. Part V, p. 267-286. (Transl. Isr. Program Sci. Transl.; available Clearinghouse Fed. Sci. Tech. Inf., Springfield, Va., as TT71-50127).
- EIGENMANN, C. H.
1892. The fishes of San Diego, California. Proc. U.S. Natl. Mus. 15:123-178.
- FOLLETT, W. I., AND D. G. AINLEY.
1976. Fishes collected by pigeon guillemots, *Cephus columba* (Pallas), nesting on Southeast Farallon Island, California. Calif. Fish Game 62:28-31.
- HART, J. L.
1973. Pacific fishes of Canada. Fish. Res. Board Can. Bull. 180, 740 p.
- LEA, R. N., AND J. E. FITCH.
1972. *Sebastes rufinanus*, a new scorpaenid fish from Californian waters. Copeia 1972:423-427.
- MATSUBARA, K.
1943. Studies on the scorpaenoid fishes of Japan. Anatomy, phylogeny and taxonomy. I and II. Trans. Sigenkagaku Kenkyusyo, Tokyo, 486 p.
- MERKEL, T. J.
1957. Food habits of the king salmon, *Oncorhynchus tshawytscha* (Walbaum), in the vicinity of San Francisco, California. Calif. Fish Game 43:249-270.
- MILLER, D. J., AND R. N. LEA.
1972. Guide to the coastal marine fishes of California. Calif. Dep. Fish Game, Fish Bull. 157, 235 p.
- MORRIS, R. W.
1956. Early larvae of four species of rockfish, *Sebastes*. Calif. Fish Game 42:149-153.
- MOSER, H. G.
1967. Reproduction and development of *Sebastes paucispinis* and comparison with other rockfishes off southern California. Copeia 1967:773-797.
1972. Development and geographic distribution of the rockfish, *Sebastes macdonaldi* (Eigenmann and Beeson, 1893), family Scorpaenidae, off southern California and Baja California. Fish. Bull., U.S. 70:941-958.
- MOSER, H. G., E. H. AHLSTROM, AND E. M. SANDKNOP.
1977. Guide to the identification of scorpionfish larvae (family Scorpaenidae) in the eastern Pacific with comparative notes on species of *Sebastes* and *Helicolenus* from other oceans. U.S. Dep. Commer., NOAA Tech. Rep. NMFS Circ. 402, 71 p.
- MOSER, H. G., AND E. H. AHLSTROM.
1978. Larvae and pelagic juveniles of blackgill rockfish, *Sebastes melanostomus*, taken in midwater trawls off southern California and Baja California. J. Fish. Res. Board Can. 35:981-996.
- NISKA, E. L.
1976. Species composition of rockfish in catches by Oregon trawlers 1963-71. Oreg. Dep. Fish. Wildl., Inf. Rep. 76-7, 80 p.
- PACIFIC MARINE FISHERIES COMMISSION.
- 1964-1976. Data series: Bottom or trawl fish section. Pac. Mar. Fish. Comm., Portland, Oreg., p. 1-472, 500-510.
- PHILLIPS, J. B.
1957. A review of the rockfishes of California (family Scorpaenidae). Calif. Dep. Fish Game, Fish Bull. 104, 158 p.
1964. Life history studies on ten species of rockfish (genus *Sebastes*). Calif. Dep. Fish Game, Fish Bull. 126, 70 p.
- POWELL, D. E., D. L. ALVERSON, AND R. LIVINGSTONE, JR.
1952. North Pacific albacore tuna exploration—1950. U.S. Fish Wildl. Serv., Fish. Leaf. 402, 56 p.
- PRITCHARD, A. L., AND A. L. TESTER.
1944. Food of spring and coho salmon in British Columbia. Fish. Res. Board Can. Bull. 65, 23 p.
- QUAST, J. C., AND E. L. HALL.
1972. List of fishes of Alaska and adjacent waters with a guide to some of their literature. U.S. Dep. Commer., NOAA Tech. Rep. NMFS SSRF-658, 47 p.
- RICHARDSON, S. L.
1977. Larval fishes in ocean waters off Yaquina Bay, Oregon: abundance, distribution and seasonality January 1971 to August 1972. Oreg. State Univ. Sea Grant Coll. Prog. Publ. ORESU-T-77-003, 73 p.
- RICHARDSON, S. L., AND W. G. PEARCY.
1977. Coastal and oceanic fish larvae in an area of upwelling off Yaquina Bay, Oregon. Fish. Bull., U.S. 75:125-145.
- ROSENBLATT, R. H., AND L.-C. CHEN.
1972. The identity of *Sebastes babcocki* and *Sebastes rubrivinctus*. Calif. Fish Game 58:32-36.
- SILLIMAN, R. P.
1941. Fluctuations in the diet of the chinook and silver salmon (*Oncorhynchus tshawytscha* and *O. kisutch*) off Washington, as related to the troll catch of salmon. Copeia 1941:80-87.
- SNYTKO, V. A., AND N. S. FADEEV.
1974. Data on distribution of some species of sea perches along the Pacific coast of North America during the sum-



RICHARDSON and LAROCHE: DEVELOPMENT AND OCCURRENCE OF ROCKFISHES

- mer - autumn season. Doc. Subm. Canada-USSR Meet. on Fish. in Moscow-Batumi, USSR, November 1974, 14 p. (Transl. 3436, Can. Transl. Ser.)
- TAYLOR, W. R.  
1967. An enzyme method of clearing and staining small vertebrates. Proc. U.S. Natl. Mus. 122(3596), 17 p.
- VERHOEVEN, L. A. (editor).  
1976. 28th annual report of the Pacific Marine Fisheries Commission for the year 1975. Pac. Mar. Fish. Comm., Portland, Oreg., 46 p.
- WALDRON, K. D.  
1968. Early larvae of the canary rockfish, *Sebastes pinniger*. J. Fish. Res. Board Can. 25:801-803.
- WALES, J. H.  
1952. Life history of the blue rockfish, *Sebastes mystinus*. Calif. Fish Game 38:485-498.
- WEITZMAN, S. H.  
1962. The osteology of *Brycon meeki*, a generalized characid fish, with an osteological definition of the family. Stanford Ichthyol. Bull. 8(1), 77 p.
- WESTRHEIM, S. J.  
1966. Northern range extensions for three species of rockfish (*Sebastes flavidus*, *S. paucispinis* and *S. pinniger*) in the North Pacific Ocean. J. Fish. Res. Board Can. 23:1469-1471.  
1975. Reproduction, maturation, and identification of larvae of some *Sebastes* (Scorpaenidae) species in the north-east Pacific Ocean. J. Fish. Res. Board Can. 32:2399-2411.
- WESTRHEIM, S. J., AND H. TSUYUKI.  
1967. *Sebastes reedi*, a new scorpaenid fish in the north-east Pacific Ocean. J. Fish. Res. Board Can. 24:1945-1954.  
1972. Synonymy of *Sebastes caenaematicus* with *Sebastes borealis*, and range extension record. J. Fish. Res. Board Can. 29:606-607.
- WHITNEY, J. P.  
1893. Salmon in salt water. Forest Stream 41:120-121.
- YOUNG, P. H.  
1969. The California partyboat fishery 1947-1967. Calif. Dep. Fish Game, Fish Bull. 145, 91 p.

APPENDIX TABLE 1.—Ranges of eastern North Pacific species of *Sebastes*.<sup>1</sup> This list does not include one new species being described by Lea and Fitch (Chen 1975). Asterisk indicates species in the subgenus *Sebastomus*.

Species	Southern range limit	Gulf of Calif.	Baja	South. Calif.	North. Calif.	Oreg.	Wash.	B.C.	S.E. Alaska	Gulf of Alaska	Aleutians	Bering Sea	Japan	Northern range limit
<i>S. aleutianus</i>	Monterey, Calif.													Aleutians and Japan
<i>S. alutus</i>	La Jolla, Calif.													Bering Sea and Japan
<i>S. atrovirens</i>	Pt. San Pablo, Baja													Timber Cove, Sonoma Co., Calif.
<i>S. auriculatus</i>	Hipolito Bay, Baja													S.E. Alaska
<i>S. aurora</i>	San Diego, Calif.													Amphriddle Pt., Vancouver I., B.C.
<i>S. babcocki</i>	San Diego, Calif.													Amchitka I., Alaska
<i>S. borealis</i>	Eureka, Calif.													S.E. Kamchatka
<i>S. brevispinis</i>	Santa Barbara I., Calif.													Bering Sea
<i>S. carnatus</i>	San Roque, Baja													Eureka, Calif.
* <i>S. caurinus</i> <sup>2</sup>	San Benito I., Baja													Gulf of Alaska
<i>S. chlorostictus</i>	Cedros I., Baja													Copalis Head, Wash.
<i>S. chrysomelas</i>	Natividad I., Baja													Eureka, Calif.
<i>S. ciliatus</i>	Dixon Entrance, B.C.													Bering Sea
* <i>S. constellatus</i>	Thetis Bank, Baja													San Francisco, Calif.
<i>S. cortezi</i>	Gulf of Calif.													Gulf of Calif.
<i>S. crameri</i>	Santa Catalina I., Calif.													Bering Sea
<i>S. dalli</i>	Sebastian Viscaino Bay, Baja													San Francisco, Calif.
<i>S. diploproa</i>	San Martin I., Baja													Alaska Peninsula
<i>S. elongatus</i>	Cedros I., Baja													Green I., Montague I., Gulf of Alaska
<i>S. emphaeus</i>	Punta Gorda, Calif. <sup>3</sup>													Kenai Peninsula, Gulf of Alaska
* <i>S. ensifer</i>	Ranger Bank, Baja													San Francisco, Calif.
<i>S. entomelas</i>	Todos Santos Bay, Baja													Kodiak, Alaska
* <i>S. eos</i>	Sebastian Viscaino Bay, Baja													San Francisco, Calif. (?Wash.)
* <i>S. exsul</i>	Gulf of Calif.													Gulf of Calif.
<i>S. flavidus</i>	San Diego, Calif.													Kodiak, Alaska
<i>S. gilli</i>	Ensenada, Baja													Monterey, Calif.
<i>S. goodei</i>	Magdalena Bay, Baja													Cape Scott, Vancouver I., B.C.
* <i>S. helvomaculatus</i>	Coronado Bank, Calif.													Albatross Bank, Gulf of Alaska
<i>S. hopkinsi</i>	Guadalupe I., Baja													Farallon I., Calif.
<i>S. jordani</i>	Cape Colnett, Baja													Le Prouse Bank, Vancouver I., B.C.
* <i>S. lentiginosus</i>	Los Coronados I., Baja													Santa Catalina I., Calif.
<i>S. levis</i>	Ranger Bank, Baja													Usal, Mendicino Co., Calif.
<i>S. macdonaldi</i>	Gulf of Calif.													Pt. Sur, Calif.
<i>S. maliger</i>	Pt. Sur, Calif.													Gulf of Alaska
<i>S. melanops</i>	Paradise Cove, Baja													Amchitka I., Alaska
<i>S. melanostomus</i>	Cedros I., Baja													Wash. (?Bering Sea)
<i>S. miniatus</i>	San Benito I., Baja													Vancouver I., B.C.
<i>S. mystinus</i>	Pt. Santo Tomas, Baja													B.C. (?Bering Sea)
<i>S. nebulosus</i>	San Miguel I., Baja													S.E. Alaska
<i>S. nigrocinctus</i>	Pt. Buchon, Baja													S.E. Alaska
* <i>S. notius</i>	Uncle Sam Bank, Baja													Guadalupe I., Baja
<i>S. ovalis</i>	Cape Colnett, Baja													San Francisco, Calif.
<i>S. paucispinis</i>	Pt. Blanco, Baja													Kodiak, Alaska
<i>S. penduncularis</i>	Gulf of Calif.													Gulf of Calif.
<i>S. phillipsi</i>	Newport, Calif.													Monterey Bay, Calif.
<i>S. pinniger</i>	Cape Colnett, Baja													S.E. Alaska
<i>S. polyspinis</i>	S.E. Alaska													Eastern Kamchatka
<i>S. proriger</i>	San Diego, Calif.													Bering Sea
<i>S. rastrelliger</i>	Playa Mario Bay, Baja													Yaquina Bay, Oreg.
<i>S. reedi</i>	Crecent City, Calif.													Sitka, Alaska
* <i>S. rosaceus</i>	Turtle Bay, Baja													San Francisco, Calif. (?Puget Sd., Wash.)
* <i>S. rosenblatti</i>	Ranger Bank, Baja													Avila, Calif. (?San Francisco, Calif.)
<i>S. ruberrimus</i>	Ensenada, Baja													Gulf of Alaska
<i>S. rubrivinctus</i>	Cape Colnett, Baja													San Francisco, Calif.
<i>S. rufinanus</i>	San Clementi I., Calif.													San Clementi I., Calif.
<i>S. rufus</i>	Guadalupe I., Baja													Mad River, Calif.
<i>S. saxicola</i>	Sebastian Viscaino Bay, Baja													S.E. Alaska
<i>S. semicinctus</i>	Sebastian Viscaino Bay, Baja													Pt. Pinos, Monterey Co., Calif.
<i>S. serranoides</i>	San Benito I., Baja													Redding Rock, Del Norte Co., Calif.
<i>S. serriceps</i>	Cedros I., Baja													San Francisco, Calif.
* <i>S. simulator</i>	Guadalupe I., Baja													San Pedro, Calif. (?Pt. Conception, Calif.)
<i>S. sinensis</i>	Gulf of Calif.													Gulf of Calif.
<i>S. spinorbis</i>	Gulf of Calif.													Gulf of Calif.
* <i>S. umbrosus</i>	Pt. San Juanico, Baja													Pt. Conception, Calif.
<i>S. variegatus</i>	Queen Charlotte Sd., B.C.													Unimak Pass, Aleutian I.
<i>S. varispinis</i>	Gulf of Calif.													Gulf of Calif.
<i>S. wilsoni</i>	Cortez Bank, Calif.													S.E. Alaska
<i>S. zacentrus</i>	San Diego, Calif.													Sanak I., Aleutians

<sup>1</sup>Compiled from Bailey et al. (1970), Chen (1971), Lea and Fitch (1972), Miller and Lea (1972), Quast and Hall (1972), Rosenblatt and Chen (1972), Barsukov (1973), Hart (1973), and Chen (1975), and original data for *S. emphaeus*. No records from the Sea of Okhotsk.<sup>2</sup>Includes *S. vexillaris* (Chen 1975; W. N. Eschmeyer, Senior Curator for Research, California Academy of Sciences, Golden Gate Park, San Francisco, CA 94118, pers. commun. November 1976).<sup>3</sup>Based on data obtained during this study.

APPENDIX TABLE 2.—Chart showing interorbital curvature and presence or absence of the supraocular spine for rockfishes (*Sebastes* spp.) occurring off Oregon.<sup>1</sup> x indicates usual condition; o indicates occasional occurrence.

Species	Interorbital				Species	Interorbital			
	Flat-convex		Concave			Flat-convex		Concave	
	Supraocular spine		Supraocular spine			Supraocular spine		Supraocular spine	
	Present	Absent	Present	Absent		Present	Absent	Present	Absent
<i>S. aleutianus</i>	x				<i>S. jordani</i>		x		
<i>S. alutus</i>	x	o			<i>S. maliger</i>	o	x	o	x
<i>S. auriculatus</i>		x			<i>S. melanops</i>		x		
<i>S. aurora</i>	x		x		<i>S. melanostomus</i>	x		x	
<i>S. babcocki</i>				x	<i>S. miniatus</i>	x			
<i>S. borealis</i>	x		x		<i>S. mystinus</i>		x		
<i>S. brevispinis</i>	o	x			<i>S. nebulosus</i>				x
<i>S. caurinus</i>		x		x	<i>S. nigrocinctus</i>			o	x
<i>S. chlorostictus</i>			x		<i>S. paucispinis</i>		x		
<i>S. crameri</i>	x				<i>S. pinniger</i>	x			
<i>S. diploproa</i>		x		x	<i>S. proriger</i>		x		
<i>S. elongatus</i>				x	<i>S. rastrelliger</i>		x		
<i>S. emphaeus</i>		x			<i>S. reedi</i>	x	o		
<i>S. entomelas</i>	o	x			<i>S. rosaceus</i> <sup>2</sup>			x	
<i>S. eos</i> <sup>2</sup>			x		<i>S. ruberrimus</i>			x	
<i>S. flavidus</i>		x			<i>S. saxicola</i>		x		x
<i>S. goodei</i>		x			<i>S. wilsoni</i>	o	x	o	x
<i>S. helvomaculatus</i>			x		<i>S. zacentrus</i>	o	x	o	x

<sup>1</sup>Compiled from Phillips (1957), Westheim and Tsuyuki (1967, 1972), Chen (1971), Miller and Lea (1972), and Hart (1973), and original data for *S. emphaeus*.  
<sup>2</sup>Species may be rare off Oregon.

APPENDIX TABLE 3.—Numbers of dorsal, anal, and pectoral fin soft rays for rockfishes (*Sebastes* spp.) occurring off Oregon.<sup>1</sup> x indicates usual numbers, o indicates occasional occurrence.

Species	Dorsal fin rays							Anal fin rays					Pectoral fin rays									
	11	12	13	14	15	16	17	5	6	7	8	9	10	11	15	16	17	18	19	20	21	22
<i>S. aleutianus</i>			o	x	x	o			o	x	o						o	x	x			
<i>S. alutus</i>			o	x	x	x	x		o	o	x	x			o	o	o	x	o			
<i>S. auriculatus</i>			o	x	o	o		o	o	x	o			o	o	o	x	o				
<i>S. aurora</i>			o	x	o			o	x						o	o	o	o				
<i>S. babcocki</i>				o	x	o			x	x							o	o	x	o		
<i>S. borealis</i>			o	x	o	o			o	x	o						o	o	o	o	o	
<i>S. brevispinis</i>					o	o	o			x	o				o	o	o					
<i>S. caurinus</i>			o	o	x	o		o	x	o					o	x	o					
<i>S. chlorostictus</i>			o	x	o	o		o	x	o					o	x	o					
<i>S. crameri</i>			o	x	x			o	o	x							o	x	o			
<i>S. diploproa</i>			o	x	x	o			x	x	o						o	x	o			
<i>S. elongatus</i>			o	x	o				x	o					x	x	o					
<i>S. emphaeus</i>					x	x				x	o						x	o				
<i>S. entomelas</i>					o	x	x				x	o	o				x	o	o			
<i>S. eos</i> <sup>2</sup>			o	x	x				x	o							o	o				
<i>S. flavidus</i>					x	x	o			o	x	o					o	x	o			
<i>S. goodei</i>					o	x					x	o					o	x	o			
<i>S. helvomaculatus</i>			o	x	o				x	o					o	x	o	o				
<i>S. jordani</i>				o	o	o	o				o	x	x	o					x	x	x	o
<i>S. maliger</i>			o	x	x				o	x							o	x				
<i>S. melanops</i>				o	x	x	o			o	x	o						o	x	o		
<i>S. melanostomus</i>			o	x	o	o			o	x	o						o	o	o	o		
<i>S. miniatus</i>				o	x	o			o	x	o						o	o	x			
<i>S. mystinus</i>						x	x	o			x	x	o				o	x	x			
<i>S. nebulosus</i>			o	x	o				o	x	o						o	o	x			
<i>S. nigrocinctus</i>					o	x	o		o	x									o	o	o	
<i>S. paucispinis</i>			o	x	o						o	x	o		x	o						
<i>S. pinniger</i>				o	x	x				x							o	x	o			
<i>S. proriger</i>				o	x	x			o	x							o	x	o			
<i>S. rastrelliger</i>			o	x	o					x									o	o	o	
<i>S. reedi</i>				o	x	x				x	x								o	x	o	
<i>S. rosaceus</i> <sup>2</sup>			o	o	x	o		o	x	o							o	x	o			
<i>S. ruberrimus</i>				o	o	x	o	o	o	x	o							o	x	o		
<i>S. saxicola</i>			o	x	o			o	o	x	o				o	x	o					
<i>S. wilsoni</i>				x	x				x	o					o	x						
<i>S. zacentrus</i>				o	x	x			o	x	o							x	o	o		

<sup>1</sup>Compiled from Phillips (1957), Westheim (1966), Westheim and Tsuyuki (1967, 1972), Chen (1971), Miller and Lea (1972), and Hart (1973), and original data for *S. emphaeus*.  
<sup>2</sup>Species may be rare off Oregon.

APPENDIX TABLE 4.—Total numbers of gill rakers on first gill arch for rockfishes (*Sebastes* spp.) occurring off Oregon.<sup>1</sup>

Species	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47				
<i>S. alutianus</i>									x	x	x	x	x	x																
<i>S. alutus</i>									x	x	x	x	x	x	x	x	x													
<i>S. auriculatus</i>				x	x	x	x	x	x																					
<i>S. aurora</i>		x	x	x	x	x																								
<i>S. babcocki</i>								x	x	x	x	x																		
<i>S. borealis</i>						x	x	x	x	x																				
<i>S. brevispinis</i>													x	x	x	x														
<i>S. caurinus</i>					x	x	x	x	x	x	x																			
<i>S. chlorostictus</i>											x	x	x	x	x															
<i>S. crameri</i>									x	x	x	x	x																	
<i>S. diplopora</i>											x	x	x	x	x															
<i>S. elongatus</i>							x	x	x	x	x																			
<i>S. emphaeus</i>																		x	x	x	x	x	x	x						
<i>S. entomelas</i>														x	x	x	x													
<i>S. eos</i> <sup>2</sup>					x	x	x	x	x	x																				
<i>S. flavidus</i>													x	x	x	x	x	x												
<i>S. goodei</i>														x	x	x	x	x	x											
<i>S. helvomaculatus</i>								x	x	x	x	x																		
<i>S. jordani</i>																								x	x	x	x	x	x	x
<i>S. maliger</i>									x	x	x	x																		
<i>S. melanops</i>													x	x	x	x	x	x												
<i>S. melanostomus</i>						x	x	x	x	x	x	x																		
<i>S. miniatus</i>														x	x	x	x	x	x											
<i>S. mystinus</i>													x	x	x	x	x													
<i>S. nebulosus</i>						x	x	x	x	x	x																			
<i>S. nigrocinctus</i>							x	x	x	x	x																			
<i>S. paucispinis</i>								x	x	x	x																			
<i>S. pinniger</i>																									x	x	x	x	x	
<i>S. proriger</i>																														
<i>S. rastrelliger</i>		x	x	x	x																									
<i>S. reedi</i>										x	x	x	x	x	x															
<i>S. rosaceus</i> <sup>2</sup>									x	x	x	x	x																	
<i>S. ruberrimus</i>					x	x	x	x	x																					
<i>S. saxicola</i>											x	x	x	x																
<i>S. wilsoni</i>																									x	x	x	x	x	
<i>S. zacentrus</i>											x	x	x	x	x	x														

<sup>1</sup>Compiled from Phillips (1957), Westrheim and Tsuyuki (1967, 1972), Chen (1971), Miller and Lea (1972), and Hart (1973), and original data for *S. emphaeus*.

<sup>2</sup>Species may be rare off Oregon.

APPENDIX TABLE 5.—Numbers of lateral line pores for rockfishes (*Sebastes* spp.) occurring off Oregon.<sup>1</sup>

Species	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63			
<i>S. aleutianus</i>			x	x	x	x	x	x																																
<i>S. alutus</i>																			x	x	x	x	x	x	x	x	x	x												
<i>S. auriculatus</i>																		x	x	x	x	x	x	x																
<i>S. aurora</i>	x	x	x	x	x																																			
<i>S. babcocki</i>															x	x	x	x	x	x	x	x																		
<i>S. borealis</i>			x	x	x	x	x																																	
<i>S. brevispinis</i>																			x	x	x	x	x	x	x	x	x	x												
<i>S. caurinus</i>												x	x	x	x	x	x	x	x	x																				
<i>S. chlorostictus</i>									x	x	x	x	x	x	x	x	x																							
<i>S. crameri</i>																			x	x	x	x	x	x	x	x														
<i>S. diploproa</i>								x	x	x	x	x	x	x	x	x																								
<i>S. elongatus</i>																			x	x	x	x	x	x																
<i>S. emphaeus</i>														x	x	x	x	x	x	x	x																			
<i>S. entomelas</i>																																								
<i>S. eos</i> <sup>2</sup>								x	x	x	x	x	x	x	x	x											x	x	x	x	x	x	x	x	x					
<i>S. flavidus</i>																									x	x	x	x	x	x	x	x	x	x	x	x	x	x		
<i>S. goodei</i>																								x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
<i>S. helvomaculatus</i>									x	x	x	x	x	x	x	x	x	x	x																					
<i>S. jordani</i>																																								
<i>S. maliger</i>									x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x	x	x	x	x	x	x	x	x				
<i>S. melanops</i>																																								
<i>S. melanostomus</i>			x	x	x	x	x																																	
<i>S. miniatus</i>																																								
<i>S. mystinus</i>																																								
<i>S. nebulosus</i>												x	x	x	x	x	x	x	x	x	x	x																		
<i>S. nigrocinctus</i>																																								
<i>S. paucispinis</i>																																								
<i>S. pinniger</i>																																								
<i>S. proriger</i>																																								
<i>S. rastrelliger</i>																																								
<i>S. reedi</i>																																								
<i>S. rosaceus</i> <sup>2</sup>																																								
<i>S. ruberrimus</i>																																								
<i>S. saxicola</i>																																								
<i>S. wilsoni</i>																																								
<i>S. zacentrus</i>																																								

<sup>1</sup>Compiled from Phillips (1957), Westrheim (1966), Westrheim and Tsuyuki (1967, 1972), Chen (1971), Miller and Lea (1972), and Hart (1973), and original data for *S. emphaeus*.<sup>2</sup>Species may be rare off Oregon.

