

DEVELOPMENT OF LARVAE AND JUVENILES OF THE ROCKFISHES
SEBASTES ENTOMELAS AND *S. ZACENTRUS* (FAMILY
SCORPAENIDAE) AND OCCURRENCE OFF OREGON, WITH NOTES ON
HEAD SPINES OF *S. MYSTINUS*, *S. FLAVIDUS*, AND *S. MELANOPS*¹

WAYNE A. LAROCHE AND SALLY L. RICHARDSON²

ABSTRACT

Developmental series of larvae and juveniles of two species of northeast Pacific rockfishes (Scorpaenidae: *Sebastes*) are described and illustrated: *S. entomelas* (9.9-74.5 mm standard length) and *S. zacentrus* (7.4-74.8 mm standard length). Descriptions include literature review, identification criteria, distinguishing features, general development, morphology, fin development, spination, scale formation, and pigmentation.

Ontogeny of *S. entomelas* is very similar to that of *S. flavidus* and *S. melanops* among species for which development is known. All have moderately slender bodies and moderately developed head spines. Pigment patterns develop similarly but pigmentation is less intense in *S. entomelas*. Larval and juvenile *S. entomelas* within the size range described are distinguished by presence of preocular and supraocular spines, pectoral fin rays usually 18, dorsal fin rays usually ≤ 8 , lateral line pores 52-56, and lack of melanophores at the articulation of dorsal and anal fin rays. Ontogeny of *S. zacentrus* is rather distinctive among species for which development is known. Larvae and juveniles are relatively deep bodied with large head spines. They are distinguished by presence of preocular and absence of supraocular spines, pectoral fin rays usually 17, dorsal fin rays usually 14, anal fin rays usually 7, lateral line pores 38-48, gill rakers 32-37, and relative lack of pigment.

Young of *S. entomelas* were taken March-July and *S. zacentrus* August-December off Oregon. Larvae of *S. zacentrus* seemed to have a more restricted offshore distribution than reported for most other species, possibly a function of seasonal wind and current regimes.

Additional new information concerning variation in supraocular spine patterns is presented as supplemental data to aid in identification and separation of four similar species, *S. entomelas*, *S. flavidus*, *S. melanops*, and *S. mystinus*.

The rockfish, *Sebastes* spp., resources of the northeast Pacific Ocean are being subjected to increasing fishing pressure. In 1978, trawl landings of rockfishes (all species) by the United States and Canada were 26,000 metric tons (t) or 38% of total Pacific landings (Pacific Marine Fisheries Commission 1964-78). This represents a sizable increase in the catch of "other rockfish" from previous years, e.g., 20,100 t in 1978 compared with 15,700 t in 1977 and 9,900 t in 1976 (Pacific Marine Fisheries Commission 1964-78). Since many rockfish species are long lived, living over 20 yr (Phillips 1964; Westrheim and Harling 1975), overfishing could have serious consequences. Rational

utilization of these important resources requires an understanding of the life history and biology of each species involved. Yet, such information is still lacking for most of the rockfishes.

This paper provides some of the first information on the early life history of *S. entomelas*, widow rockfish, and *S. zacentrus*, sharpchin rockfish. *Sebastes entomelas* was one of five principal species in Oregon bottom trawl landings of "other rockfish," composing 13% of the catch during the years 1963-71, although annual catches fluctuated from 168 to 1,074 t (Niska 1976). Introduction of midwater trawl fishing for rockfish has recently focused attention on *S. entomelas* since large catches have been landed, e.g., during a 4-mo period in 1979 >90% of the 909 t of rockfish landed in Oregon were *S. entomelas* (Barss³). *Sebastes*

¹From a final report for NOAA-NMFS Contract No. 79-ABC-00087 submitted to Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Boulevard East, Seattle, WA 98112, on 31 July 1979.

²School of Oceanography, Oregon State University, Corvallis, Oreg.; present address: Gulf Coast Research Laboratory, East Beach, Ocean Springs, MS 39564.

³William Barss, Fishery Biologist, Oregon Department of Fish and Wildlife, Marine Science Drive, Newport, OR 97365, pers. commun. July 1979.

zacentrus was landed in Oregon from 1963 to 1971 but never in large quantities (Niska 1976), possibly due to its reported preference for a rough bottom (Gunderson⁴).

Development of larvae and juveniles of *S. entomelas* and *S. zacentrus* is described and compared with other species of *Sebastes* for which young stages are known. Occurrence of young off Oregon is discussed. Additional new information is presented on head spine patterns and variability among the group of four similar species, *S. entomelas*, *S. flavidus*, *S. melanops*, and *S. mystinus*, which cooccur off Oregon. This information will aid in identification and separation of these species, particularly of specimens with variant head spine patterns.

METHODS

Specimens described in this paper came from collections in the School of Oceanography, Oregon State University. Most collections were obtained with 70 cm bongo nets, neuston nets, meter nets, purse seines, Isaacs-Kidd midwater trawls, beam trawls, otter trawls, and commercial midwater trawls off the Oregon coast since 1961. Samples were taken during all months of the year and along the entire Oregon coast but were concentrated along an east-west transect off Newport, Oreg. (lat. 44°39.1' N). Benthic juveniles of *S. entomelas* were taken from adjacent California waters (lat. 40°12.2' N, long. 124°23.4' W). All specimens were preserved in 5 or 10% Formalin⁵ and transferred to 40% isopropyl alcohol.

Our approach to identification, methods of making counts and measurements, and terminology for development and spination follow Richardson and Laroche (1979) and Laroche and Richardson (1980). Body parts measured include:

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.

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.

Caudal peduncle depth = shortest vertical distance between dorsal and ventral margins of caudal peduncle.

Caudal peduncle length = horizontal distance from base of posteriormost dorsal ray to posterior margin of hypural elements.

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).

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. When the two posteriormost dorsal and anal fin rays arise from the same pterygiophore, they are counted as one.

⁴Gunderson, D. 1976. Proceedings of the 1st rockfish survey workshop. Processed rep., 14 p. Northwest Fisheries Center, National Marine Fisheries Service, NOAA, Seattle, WA 98112.

⁵Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

SEBASTES ENTOMELAS
(JORDAN AND GILBERT)

Literature (Figures 1-3).—The pigment pattern of preextrusion *S. entomelas* larvae was described by Harling et al.,⁶ including a figure, and Westrheim (1975). Preextrusion larvae, mean 4.8, 5.0 mm TL, have a row of usually <16 melanophores along the ventral body midline which stops short of the anus by at least four myomeres. The gut is pigmented in the vicinity of

⁶Harling, W. R., M. S. Smith, and N. A. Webb. 1971. Preliminary report on maturity, spawning season, and larval identification of rockfishes (*Sebastes*) collected during 1970. Fish. Res. Board Can., Manusc. Rep. Ser. 1137, 26 p.

the anus. Pigment is absent from the dorsum, head, and hypural region. In reared larvae, the number of ventral midline melanophores increases to >16 (Westrheim 1975).

Identification (Tables 1-3; Appendix Table 1).—Fifty-three specimens of *S. entomelas* (9.9-74.5 mm) were selected for the development series from 444 larval and juvenile specimens identified. Juveniles were identified using the following combination of characters observed in juvenile and adult specimens examined:

Gill rakers = 34-39

Lateral line pores = 52-56

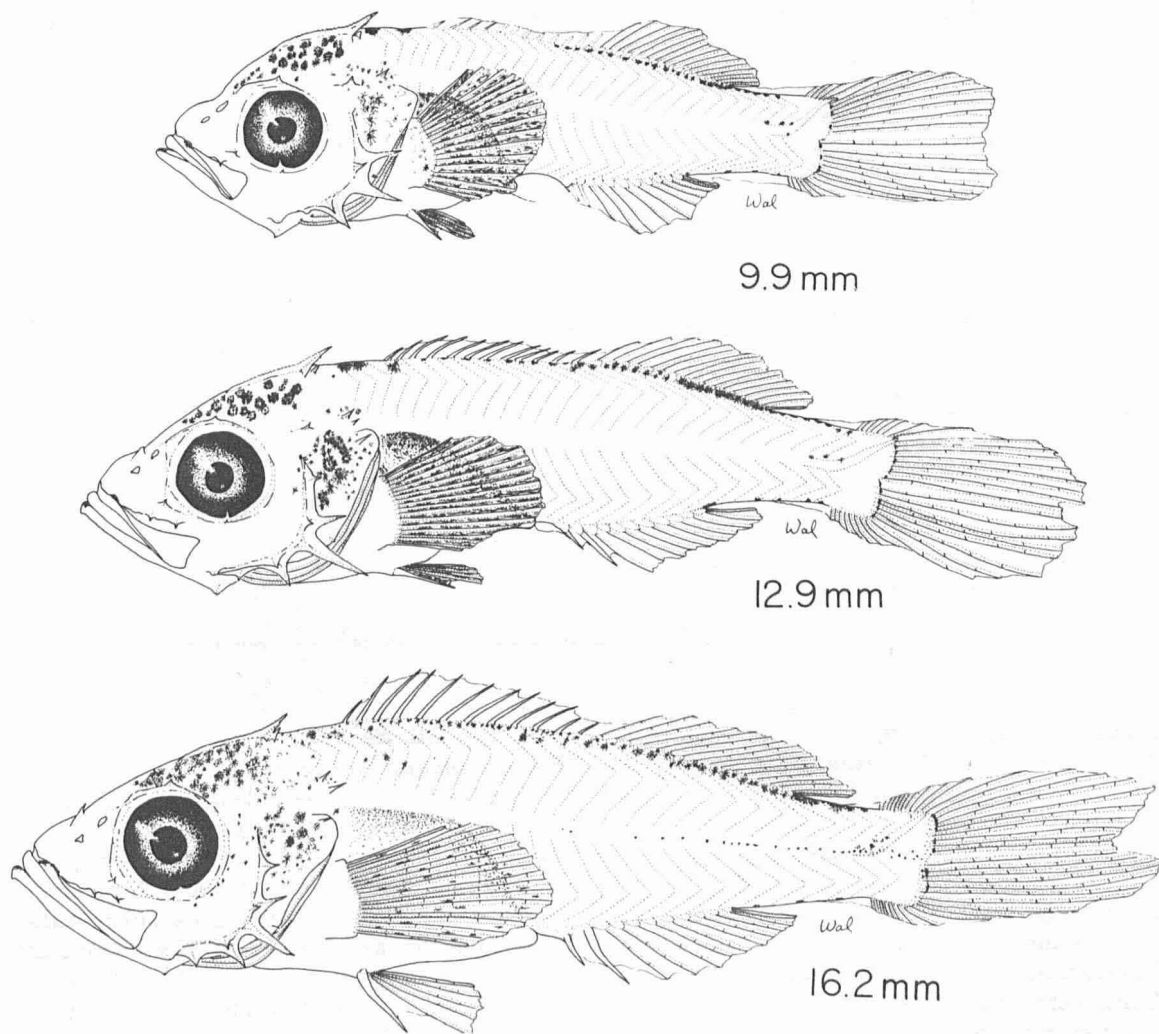


FIGURE 1.—Pelagic larvae of *Sebastes entomelas*.

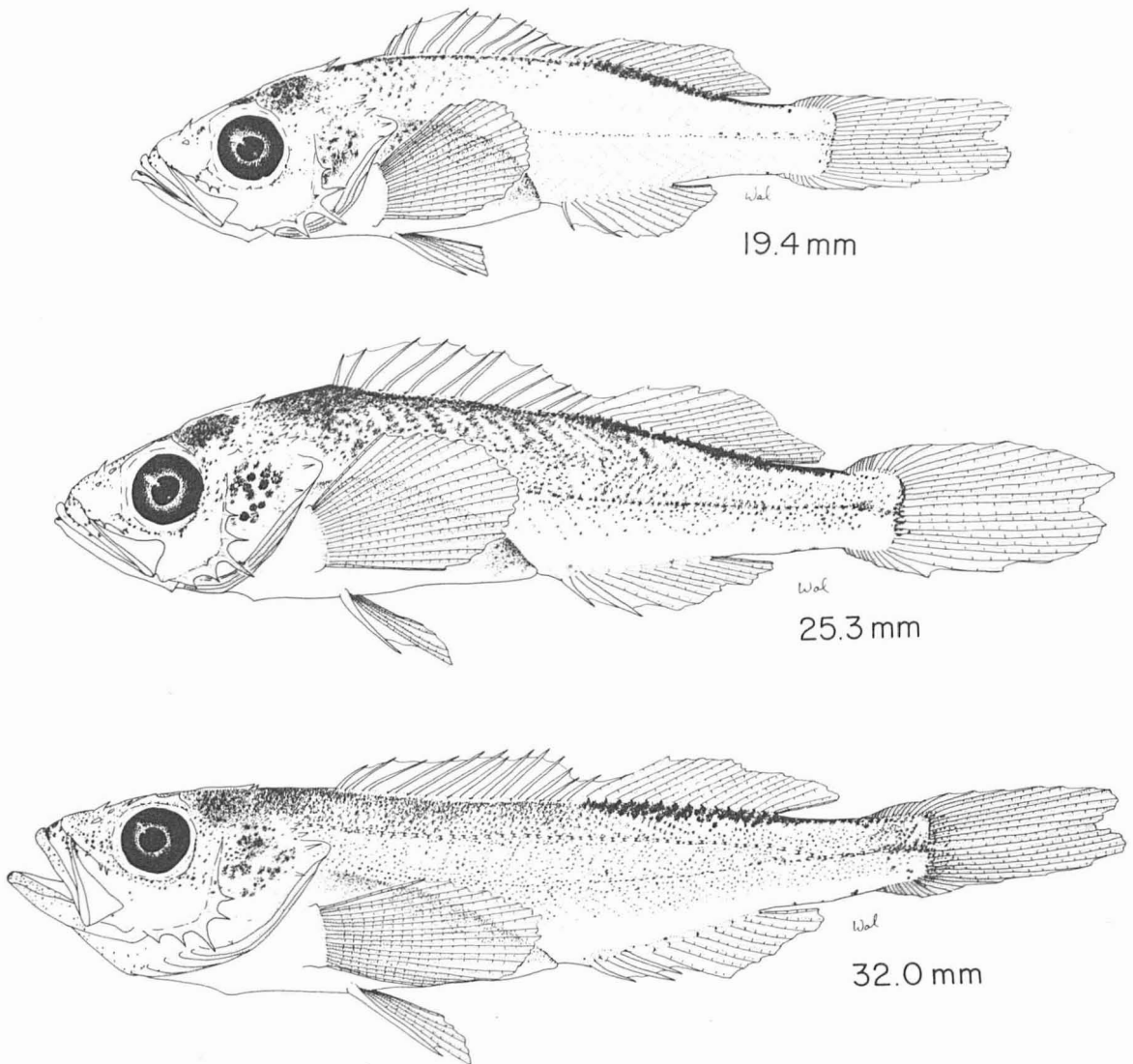


FIGURE 2.—Pelagic larvae (19.4, 25.3 mm) and pelagic juvenile (32.0 mm) of *Sebastes entomelas*.

Pectoral fin rays = 17-19, usually 18
 Anal fin soft rays = 7-9, usually 8
 Dorsal fin soft rays = 14-16, usually 15
 Vertebrae = 26
 Preocular spine = present (specimens
 <343 mm)
 Supraocular spine = present (specimens
 <343 mm)
 Interorbital space = flat to convex
 Black blotch at base of spinous dorsal fin = pres-
 ent as fringe along distal margin of fin mem-
 brane.

Of the 36 *Sebastes* species off Oregon (Richardson and Laroche 1979), *S. entomelas* has the best fit to the above characters. Larvae and juveniles of *S. entomelas* are similar to those of *S. flavidus*, *S. melanops*, and *S. mystinus*. Large larvae and juveniles of *S. flavidus* and *S. melanops* lack preocular and usually lack supraocular spines (Laroche and Richardson 1980) which are present in both *S. entomelas* and *S. mystinus*.

Dorsal and anal fin ray counts separate nearly all specimens of *S. entomelas* and *S. mystinus* based on count frequency statistics given by

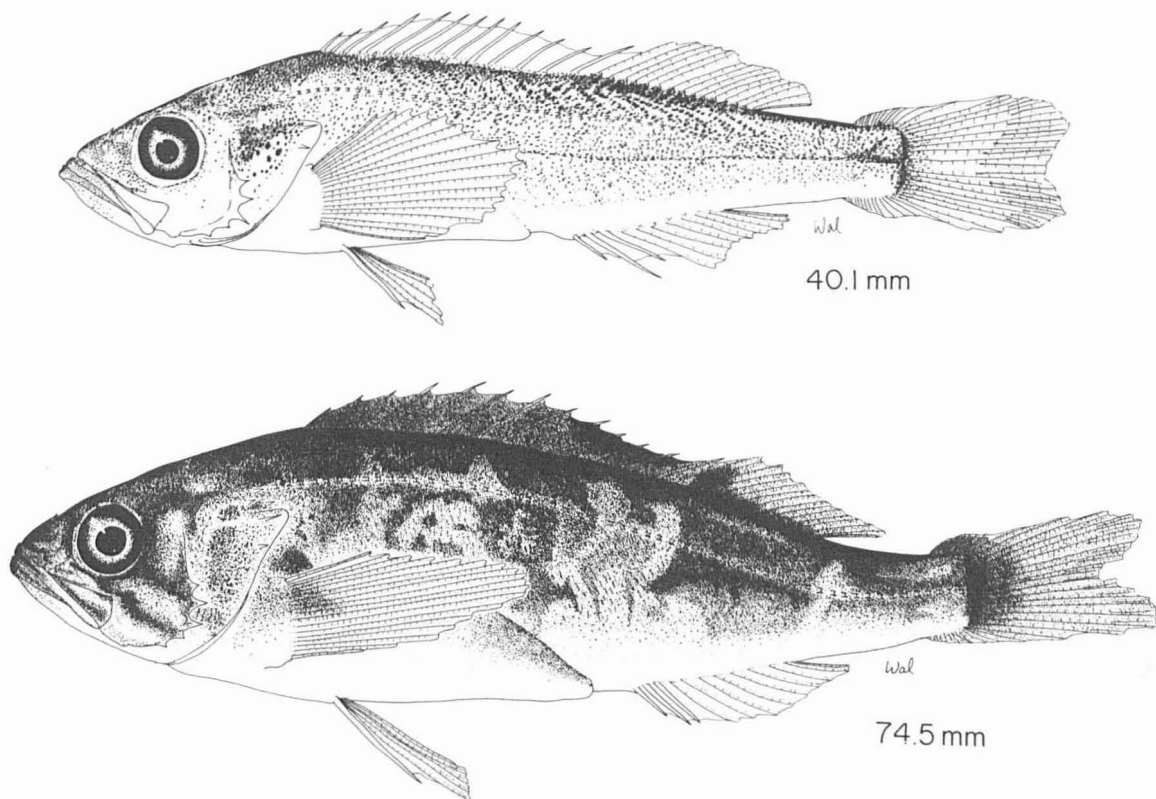


FIGURE 3.—Pelagic juvenile (40.1 mm) and benthic juvenile (74.5 mm) of *Sebastes entomelas*.

Laroche and Richardson (1980). Of 79 *S. entomelas* examined 94% had dorsal fin rays ≤ 15 and 96% had anal rays ≤ 8 . Of 62 *S. mystinus* examined 92% had dorsal fin rays ≥ 16 and 90% had ≥ 9 anal fin rays. Only one specimen of *S. entomelas* had >15 dorsal fin rays and >8 anal fin rays. No *S. mystinus* had <16 dorsal fin rays and <9 anal fin rays. In specimens with outlyer dorsal or anal fin ray counts, the numbers of lateral line pores and diagonal scale rows below the lateral line resolved any questions in all cases (see Laroche and Richardson 1980, appendix table 1). To insure that no *S. mystinus* were accidentally included in the developmental series of *S. entomelas*, specimens with either >15 dorsal fin rays or >8 anal fin rays were intentionally excluded.

Pigment pattern and body morphology were also useful in linking smaller specimens to the developmental series.

Distinguishing Features.—Characters useful to distinguish *S. entomelas* larvae (9.9–18 mm) from those of other *Sebastes* species are fin element

counts, gill raker counts, moderate pigmentation on pectoral and pelvic fins, presence of pigment along the dorsal body surface beneath the dorsal fin, internal and/or external melanophores above the notochord near the point of flexion, and melanophores along the dorsal and ventral margins of the caudal peduncle. The lack of melanophores at the articulation of anal fin rays helps distinguish *S. entomelas* from *S. flavidus* and *S. melanops* larvae within this size range. The smaller caudal peduncle depth/caudal peduncle length ratio and presence of 18 pectoral fin rays also help to distinguish *S. entomelas* from *S. melanops*. For larvae and juveniles >18 mm, meristic characters, presence of preocular (specimens >22 mm) and supraocular (specimens >18 mm) spines, flat to convex interorbital space, body and fin pigmentation, and body morphometry together serve to distinguish *S. entomelas* from other Oregon species.

General Development.—Notochord flexion is completed by ≈ 14 mm in *S. entomelas*. Transformation

TABLE 1.—Meristics from larvae and juveniles of *Sebastes entomelas* based on unstained specimens. Counts of left and right pelvic fin rays (1,5; 1,5), superior and inferior principal caudal rays (8,7), and left and right branchiostegal rays (7,7) were constant throughout the series. Specimens above dashed line are undergoing notochord flexion.

Standard length (mm)	Dorsal fin spines and rays	Anal fin spines and rays	Pectoral fin rays		Gill rakers (first arch)		Lateral line pores		Diagonal scale rows	
			Left	Right	Left	Right	Left	Right	Left	Right
9.9	IV+ ¹ , 15	II ¹ , 8	18	18	21+ 8=29	—	—	—	—	—
10.0	(²)	(²)	18	18	20+ 7=27	20+ 6=26	—	—	—	—
10.9	XIII ¹ , 14	III ¹ , 7	18	18	22+ 9=31	22+ 8=30	—	—	—	—
11.0	XIII ¹ , 15	III ¹ , 8	18	18	22+ 8=30	21+ 8=29	—	—	—	—
11.9	XIII ¹ , 15	III ¹ , 8	18	18	22+ 8=30	23+ 8=31	—	—	—	—
12.0	XIII ¹ , 14	III ¹ , 8	18	18	22+ 7=29	22+ 8=30	—	—	—	—
12.9	XIII ¹ , 15	III ¹ , 8	18	18	23+ 8=31	22+ 8=30	—	—	—	—

13.7	XIII ¹ , 15	III ¹ , 8	18	18	24+ 8=32	24+ 8=32	—	—	—	—
14.0	XIII ¹ , 15	III ¹ , 8	18	18	23+ 8=31	23+ 8=31	—	—	—	—
14.9	XIII ¹ , 15	III ¹ , 8	18	18	25+ 9=34	24+ 9=33	—	—	—	—
15.2	XIII ¹ , 15	III ¹ , 8	18	18	24+ 9=33	23+ 9=32	—	—	—	—
16.2	XIII ¹ , 15	III ¹ , 8	18	18	24+10=34	23+ 9=32	—	—	—	—
16.8	XIII ¹ , 15	III ¹ , 8	18	18	25+10=35	25+10=35	—	—	—	—
17.2	XIII ¹ , 15	III ¹ , 8	18	18	25+10=35	25+10=35	—	—	—	—
18.4	XIII ¹ , 15	III ¹ , 8	18	18	25+10=35	25+10=35	—	—	—	—
18.5	XIII ¹ , 15	III ¹ , 8	18	18	24+ 9=33	25+ 9=34	—	—	—	—
19.4	XIII ¹ , 15	III ¹ , 8	18	18	24+10=34	24+10=34	—	—	—	—
20.4	XIII ¹ , 15	III ¹ , 8	18	18	26+10=36	25+10=35	—	—	—	—
20.8	XIII ¹ , 14	III ¹ , 8	18	18	25+10=35	25+10=35	—	—	—	—
21.0	XIII ¹ , 15	III ¹ , 8	18	18	26+10=36	26+10=36	—	—	—	—
² 21.7	XIII ¹ , 15	III ¹ , 8	18	18	25+ 9=34	24+ 9=33	—	—	—	—
² 22.3	XIII ¹ , 15	III ¹ , 8	18	18	26+ 9=35	25+ 9=34	—	—	—	—
² 22.9	XIII ¹ , 15	III ¹ , 8	18	18	25+10=35	26+10=36	—	—	—	—
² 23.9	XIII ¹ , 15	III ¹ , 8	18	18	26+10=36	26+10=36	—	—	—	—
² 24.5	XIII ¹ , 15	III ¹ , 8	18	18	26+10=36	26+ 9=35	—	—	—	—
² 24.5	XIII ¹ , 15	III ¹ , 8	18	18	25+10=35	25+10=35	—	—	—	—
² 25.3	XIII ¹ , 15	III ¹ , 8	18	18	26+10=36	26+10=36	—	—	—	—
² 25.9	XIII ¹ , 15	III ¹ , 8	18	18	24+ 9=33	25+ 9=34	—	—	—	—
² 26.5	XIII ¹ , 15	III ¹ , 8	18	18	27+10=37	26+ 9=35	—	—	—	—
² 26.7	XIII ¹ , 15	III ¹ , 8	18	18	25+10=35	25+ 9=34	—	—	—	—
² 27.2	XIII, 15	III ¹ , 8	18	18	26+10=36	26+10=36	—	—	—	—
² 27.9	XIII, 15	III ¹ , 8	18	18	26+10=36	25+10=35	—	—	—	—
² 28.5	XIII, 15	III ¹ , 8	18	18	26+10=36	25+10=35	—	—	—	—
² 29.1	XIII, 15	III ¹ , 8	18	18	26+10=36	26+10=36	—	—	—	—
² 29.7	XIII, 15	III ¹ , 8	18	18	25+10=35	26+10=36	—	—	—	—
² 30.6	XIII, 15	III ¹ , 8	18	18	26+ 9=35	25+10=35	—	—	—	—
⁴ 30.8	XIII, 15	III, 8	18	18	26+11=37	26+11=37	—	54	—	—
⁴ 31.6	XIII, 15	III, 8	18	18	27+10=37	26+10=36	—	—	53	—
⁴ 32.0	XIII, 15	III, 8	18	18	26+10=36	26+10=36	—	—	52	—
⁴ 33.4	XIII, 14	III, 8	18	18	25+10=35	25+10=35	—	—	51	—
⁴ 35.7	XIII, 15	III, 8	18	18	26+10=36	26+10=36	—	—	53	—
⁴ 36.8	XIII, 15	III, 8	18	17	24+10=34	26+10=36	—	—	—	—
⁴ 40.1	XIII, 15	III, 8	18	18	26+10=36	26+11=37	—	—	52	—
⁵ 45.0	XIII, 14	III, 8	18	18	24+11=35	24+11=35	56	54	—	—
⁵ 47.7	XIII, 14	III, 7	18	18	27+11=38	28+11=39	52	54	—	—
⁵ 55.5	XIII, 14	III, 8	18	18	26+11=37	27+11=38	55	54	—	—
⁵ 55.7	XIII, 15	III, 8	18	18	26+11=37	26+10=36	56	55	—	—
⁵ 64.4	XIII, 15	III, 8	18	18	26+10=36	26+10=36	53	52	—	—
⁵ 65.0	XIII, 15	III, 8	18	18	27+11=38	27+11=38	53	53	64	63
⁵ 66.1	XIII, 15	III, 8	18	18	26+11=37	27+10=37	54	56	61	65
⁵ 71.2	XIII, 15	III, 8	18	18	26+11=37	26+11=37	54	54	62	66
⁵ 74.1	XIII, 15	III, 8	18	18	26+10=36	26+11=37	54	52	66	62
⁵ 74.5	XIII, 15	III, 8	19	19	27+11=38	27+10=37	53	56	64	68

¹Posteriormost dorsal or anal spine appears as a soft ray.

²Forming.

³Transforming.

⁴Pelagic juvenile.

⁵Benthic juvenile.

from postflexion larvae to pelagic juveniles occurs between ≈ 22 and 31 mm as indicated by structural change of the dorsal and anal fin "prespines" to sharp, hard spines. Melanistic pigmentation gradually increases over the body through the larval and transformation periods and does not change markedly during transformation. Transition from pelagic to benthic habitat, based on all specimens examined, probably occurs chiefly between 55 and 75 mm. The largest pelagic juvenile

was 40.1 mm, and the smallest juvenile taken in a beam trawl was 42 mm long.

Morphology (Tables 2, 3).—Various body parts were measured on 53 selected specimens of *S. entomelas* (9.9-74.5 mm). Relative growth trends are summarized in Table 2.

Perhaps the most distinctive morphometric aspect of larval and small juvenile *S. entomelas* is the relatively slender body. Body depth decreases

TABLE 2.—Body proportions of larvae and juveniles of *Sebastes entomelas* and *S. zacentrus*. Values given are percent of standard length (SL) and head length (HL) including mean, standard deviation, and range in parentheses. Number of specimens measured may be derived from number of measurements listed by stage, indicated in footnotes, in Tables 3 and 6.

Item	<i>Sebastes entomelas</i>	<i>Sebastes zacentrus</i>	Item	<i>Sebastes entomelas</i>	<i>Sebastes zacentrus</i>
Body depth at pectoral fin base/SL:			Longest anal spine length/HL:		
Flexion	29.0±0.87(27.9-30.0)	35.2±1.36(33.8-36.5)	Flexion	10.2±2.25(7.4-12.9)	13.6±0.92(12.9-14.2)
Postflexion	27.5±1.56(24.5-29.9)	34.4±1.07(33.1-35.9)	Postflexion	21.4±4.76(13.8-26.8)	22.4±4.79(16.7-31.5)
Transforming	25.2±0.80(23.9-26.3)	32.5±1.49(30.4-35.0)	Transforming	25.5±3.52(18.8-31.4)	35.3±3.44(30.5-41.6)
Pelagic juvenile	23.9±0.48(23.1-24.4)	30.0±1.02(27.7-32.0)	Pelagic juvenile	31.9±1.25(30.8-34.2)	41.1±1.96(37.9-44.8)
Benthic juvenile	27.8±2.44(24.1-31.3)	32.0±1.08(31.1-33.8)	Benthic juvenile	35.1±3.73(28.2-39.7)	50.7±4.29(46.1-54.9)
Body depth at anus/SL:			Pectoral fin length/SL:		
Flexion	22.3±1.01(20.9-23.9)	24.7±1.53(23.0-25.9)	Flexion	17.1±1.34(15.0-18.6)	15.3±2.30(13.0-17.6)
Postflexion	22.4±1.48(20.2-24.8)	25.8±1.33(23.3-27.4)	Postflexion	21.9±1.45(19.3-24.0)	21.5±1.18(20.2-23.6)
Transforming	20.6±0.56(19.3-21.8)	26.1±1.07(25.0-28.4)	Transforming	23.1±1.11(21.5-25.3)	25.2±1.88(21.4-28.1)
Pelagic juvenile	19.7±0.55(18.6-20.2)	24.3±0.82(22.8-25.8)	Pelagic juvenile	24.2±0.33(23.7-24.6)	26.7±1.27(24.9-29.0)
Benthic juvenile	23.1±1.31(21.1-24.6)	25.8±1.04(24.3-26.7)	Benthic juvenile	25.6±1.23(23.4-26.8)	26.4±0.68(25.4-26.9)
Snout to anus length/SL:			Pectoral fin base depth/SL:		
Flexion	56.5±2.09(53.0-58.8)	52.5±1.78(50.6-54.1)	Flexion	10.0±0.77(9.2-11.0)	13.0±1.07(11.8-13.9)
Postflexion	58.5±2.10(54.8-61.2)	57.0±2.34(53.8-62.4)	Postflexion	8.8±0.58(8.2-10.2)	10.6±0.69(9.8-12.0)
Transforming	59.4±1.72(55.3-62.3)	60.4±1.84(57.0-62.4)	Transforming	8.0±0.22(7.6-8.4)	9.3±0.39(8.7-10.0)
Pelagic juvenile	61.0±1.24(59.8-62.7)	60.9±1.76(57.4-64.1)	Pelagic juvenile	7.6±0.16(7.3-7.8)	8.8±0.44(7.9-9.8)
Benthic juvenile	61.5±2.18(59.4-65.1)	58.7±1.62(56.9-61.3)	Benthic juvenile	8.4±0.63(7.3-9.1)	9.8±0.25(9.6-10.2)
Snout to pelvic fin origin/SL:			Pelvic fin length/SL:		
Flexion	39.4±1.55(37.0-41.2)	38.7±0.61(38.0-39.2)	Flexion	10.3±1.34(8.6-11.8)	13.7±1.68(11.9-15.2)
Postflexion	37.7±2.12(35.1-40.9)	40.6±1.48(37.8-42.4)	Postflexion	13.8±1.19(11.4-15.7)	17.5±1.75(15.2-21.0)
Transforming	36.8±1.49(33.3-39.5)	40.8±1.85(38.1-44.8)	Transforming	14.5±0.89(12.7-16.0)	20.1±1.27(17.9-21.7)
Pelagic juvenile	36.3±3.19(33.2-41.9)	39.4±1.43(36.2-42.3)	Pelagic juvenile	16.1±0.34(15.7-16.6)	19.5±0.93(17.3-21.0)
Benthic juvenile	37.0±1.83(34.8-40.3)	40.9±1.01(40.2-42.5)	Benthic juvenile	17.5±1.03(16.4-20.0)	21.3±1.04(20.3-22.6)
Head length/SL:			Pelvic spine length/SL:		
Flexion	39.7±2.09(37.2-43.1)	41.9±2.75(39.2-44.7)	Flexion	6.0±1.82(3.7-8.4)	9.0±3.46(6.5-11.4)
Postflexion	36.3±1.82(34.1-39.4)	42.6±2.08(40.2-45.6)	Postflexion	12.0±1.30(10.0-13.6)	15.9±1.80(13.9-19.4)
Transforming	35.0±1.75(32.4-38.4)	40.4±1.53(37.6-43.1)	Transforming	12.2±1.60(9.9-14.4)	19.7±0.80(18.4-20.7)
Pelagic juvenile	32.5±1.40(31.2-35.0)	37.5±1.70(34.4-40.4)	Pelagic juvenile	13.7±0.51(13.0-14.6)	17.7±1.52(15.3-20.0)
Benthic juvenile	32.2±1.90(29.5-35.6)	36.9±0.98(35.8-37.7)	Benthic juvenile	12.7±0.56(11.7-13.4)	15.5±0.92(14.7-16.9)
Eye diameter/HL:			Parietal spine length/HL:		
Flexion	31.2±1.90(28.0-33.3)	33.1±2.08(31.6-35.5)	Flexion	10.2±1.80(8.4-13.3)	22.6±5.12(16.8-26.5)
Postflexion	30.1±1.38(28.4-32.7)	32.0±2.13(28.3-34.8)	Postflexion	8.7±2.56(6.4-11.6)	14.3±2.24(11.9-17.3)
Transforming	26.8±1.28(25.0-29.1)	29.4±1.74(26.2-32.4)	Transforming	3.8±1.30(2.8-5.6)	10.4±1.83(7.7-14.1)
Pelagic juvenile	26.7±0.92(25.2-28.2)	29.1±1.40(26.7-32.6)	Pelagic juvenile	—	6.9±2.42(3.8-10.7)
Benthic juvenile	25.8±0.92(24.3-27.3)	31.1±1.96(29.1-33.2)	Benthic juvenile	0.9±0.47(0.35-1.9)	2.6±0.98(1.6-4.0)
Upper jaw length/HL:			Nuchal spine length/HL:		
Flexion	35.3±4.30(31.2-41.0)	45.9±1.27(45.2-47.4)	Flexion	1.4±1.70(0.0-4.4)	1.5±1.61(0.0-3.7)
Postflexion	41.5±2.61(38.4-45.9)	43.7±2.31(38.6-45.7)	Postflexion	3.4±0.65(2.2-4.1)	5.1±1.36(2.3-7.4)
Transforming	39.5±1.90(36.5-43.1)	41.3±2.68(36.4-46.3)	Transforming	2.0±0.47(1.4-3.0)	4.6±1.74(0.0-6.2)
Pelagic juvenile	42.1±1.59(40.2-43.8)	41.0±2.54(35.6-45.3)	Pelagic juvenile	1.7±0.33(1.5-2.1)	3.3±1.30(1.2-5.6)
Benthic juvenile	39.2±2.57(35.7-43.2)	42.2±2.48(39.7-46.1)	Benthic juvenile	0.0±0.00(0.0-0.0)	0.0±0.00(0.0-0.0)
Snout length/HL:			Preopercular spine length/HL:		
Flexion	28.3±3.27(22.6-32.0)	26.2±3.27(23.2-29.7)	Flexion	20.3±0.69(19.6-21.3)	32.9±8.20(27.1-38.7)
Postflexion	27.4±1.79(23.9-29.6)	27.9±1.23(26.2-29.6)	Postflexion	20.1±2.79(15.5-24.1)	25.3±2.35(22.2-29.5)
Transforming	27.7±1.77(24.4-31.7)	26.4±1.72(24.2-28.8)	Transforming	10.8±1.31(8.8-12.3)	22.3±2.96(16.0-25.9)
Pelagic juvenile	27.2±1.53(26.1-29.8)	26.2±2.12(22.0-31.4)	Pelagic juvenile	5.3±1.60(3.8-7.0)	12.7±4.37(6.7-19.5)
Benthic juvenile	25.4±2.68(21.1-28.2)	21.8±3.13(18.4-25.2)	Benthic juvenile	4.2±0.95(3.4-6.5)	4.0±0.87(3.1-5.1)
Interorbital distance/HL:			Caudal peduncle depth/SL:		
Flexion	30.9±2.04(28.0-33.3)	29.4±2.00(27.7-31.6)	Flexion	12.4±0.83(10.9-13.6)	11.8±1.06(10.8-12.9)
Postflexion	28.8±1.18(25.7-30.1)	28.0±1.76(24.5-31.0)	Postflexion	11.1±0.71(10.1-12.4)	11.0±0.50(9.9-11.6)
Transforming	25.1±1.30(23.0-26.7)	25.5±1.85(23.0-29.6)	Transforming	9.6±0.37(8.9-10.1)	10.6±0.49(9.8-11.5)
Pelagic juvenile	23.4±0.79(22.7-24.7)	21.5±1.48(19.1-23.8)	Pelagic juvenile	8.7±0.53(7.8-9.2)	9.6±0.41(8.6-10.3)
Benthic juvenile	22.6±1.22(20.6-25.0)	16.6±0.81(16.2-17.7)	Benthic juvenile	9.1±0.34(8.8-9.9)	9.3±0.24(9.0-9.6)
Angle gill raker length/HL:			Caudal peduncle length/SL:		
Flexion	10.5±1.52(9.0-12.8)	9.4±1.48(8.4-10.5)	Flexion	15.6±0.78(14.5-16.7)	16.0±0.62(15.3-16.5)
Postflexion	13.4±0.92(11.9-15.1)	13.3±1.16(10.9-14.8)	Postflexion	15.3±0.58(14.3-16.2)	14.5±0.86(12.9-15.2)
Transforming	13.2±0.94(11.7-14.7)	15.1±0.95(13.5-16.9)	Transforming	15.4±0.70(14.1-16.7)	14.7±0.68(14.0-15.7)
Pelagic juvenile	14.4±0.75(13.1-15.5)	15.6±1.07(13.3-17.5)	Pelagic juvenile	15.5±0.98(14.2-16.6)	14.0±0.99(12.4-16.5)
Benthic juvenile	15.9±1.53(13.5-18.0)	16.0±0.32(15.6-16.4)	Benthic juvenile	14.6±0.68(13.7-15.7)	13.9±0.33(13.5-14.4)
Longest dorsal spine length/HL:			Caudal peduncle depth/caudal peduncle length:		
Flexion	12.2±3.00(7.7-15.8)	12.4±5.58(6.1-16.8)	Flexion	0.80±0.085(0.70-0.94)	0.74±0.095(0.67-0.85)
Postflexion	24.8±5.64(17.4-32.4)	25.6±3.83(20.9-31.5)	Postflexion	0.73±0.051(0.67-0.81)	0.76±0.061(0.67-0.88)
Transforming	28.5±2.64(25.0-31.0)	36.6±3.21(28.8-39.4)	Transforming	0.63±0.030(0.58-0.67)	0.72±0.040(0.68-0.83)
Pelagic juvenile	34.8±2.09(32.8-36.8)	38.0±2.57(33.9-42.9)	Pelagic juvenile	0.57±0.055(0.47-0.63)	0.69±0.048(0.59-0.79)
Benthic juvenile	32.9±2.20(30.0-36.5)	37.7±2.54(34.2-40.2)	Benthic juvenile	0.63±0.028(0.58-0.66)	0.67±0.022(0.65-0.70)
Longest dorsal ray length/HL:					
Flexion	25.5±7.58(10.8-35.7)	24.9±6.54(20.0-32.3)			
Postflexion	33.6±4.45(25.5-42.5)	31.1±3.40(27.3-37.0)			
Transforming	35.8±2.93(29.8-39.6)	38.4±3.22(33.9-42.9)			
Pelagic juvenile	39.8±2.26(36.4-43.3)	40.8±2.56(37.0-45.2)			
Benthic juvenile	39.2±2.46(35.7-42.8)	44.6±2.38(40.9-47.0)			

TABLE 3.—Measurements (millimeters) of larvae and juveniles of *Sebastes entomelas*. 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	Caudal peduncle depth	Dorsal-lythural distance	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 ¹	Longest dorsal ray length ²	Longest anal spine length ³	
9.9	12.5	5.4	3.9	1.0	—	1.2	1.2	2.8	2.1	1.2	1.6	1.8	1.0	0.50	0.90	3.8	0.52	0.04	—	0.36	0.30	0.92	0.24	
10.0	12.5	5.3	3.9	0.88	1.6	1.3	1.3	3.0	2.2	1.2	—	1.5	1.1	0.39	0.86	3.7	0.36	(*)	0.80	0.36	—	0.42	—	
10.9	13.7	6.3	4.7	1.3	1.9	1.5	1.4	3.2	2.6	1.4	1.7	1.8	1.0	0.98	1.2	4.4	0.45	0.04	1.0	0.47	0.58	1.4	0.50	
11.0	14.0	6.4	4.2	1.3	1.4	1.4	1.4	3.3	2.5	1.5	1.6	1.8	1.2	0.72	1.0	4.2	0.48	0.10	0.84	0.38	0.50	1.5	0.32	
11.9	15.2	7.0	5.0	1.6	1.7	1.4	1.4	3.5	2.7	1.5	1.8	2.2	1.2	1.0	1.4	4.9	0.42	0.22	0.98	0.60	0.76	1.3	0.54	
12.0	15.3	6.8	4.7	1.4	1.5	1.4	1.5	3.4	2.7	1.5	2.0	2.0	1.1	0.76	1.4	4.9	0.44	(*)	0.92	0.60	0.50	1.2	0.56	
12.9	16.2	7.3	4.8	1.4	1.5	1.5	1.4	3.6	2.7	1.4	2.0	2.4	1.2	1.0	1.4	5.1	—	—	1.0	0.54	0.76	1.3	0.62	

13.7	17.5	8.1	5.4	1.4	2.1	1.6	1.6	4.1	3.4	1.7	2.1	2.9	1.4	1.4	1.8	5.6	0.66	0.22	1.3	0.64	0.94	1.5	0.81	
14.0	17.3	8.5	5.5	1.6	2.2	1.7	1.5	3.9	2.9	1.6	2.0	2.7	1.2	1.4	1.6	5.7	0.62	0.22	1.2	0.75	—	1.4	0.76	
14.9	19.2	9.1	5.4	1.6	2.3	1.7	1.6	4.2	3.6	1.8	2.3	3.1	1.3	1.7	1.8	5.7	0.36	0.22	1.1	0.76	1.3	1.8	1.2	
15.2	19.0	9.3	5.5	1.6	2.3	1.8	1.6	4.5	3.7	1.8	2.4	3.0	1.4	—	2.0	6.1	0.64	0.12	1.2	0.72	0.96	1.7	0.82	
16.2	20.7	9.4	6.1	1.8	2.7	1.9	1.8	4.7	3.8	1.8	2.5	3.4	1.5	—	2.2	6.3	—	0.22	—	0.74	—	1.9	—	
16.8	21.0	9.9	6.2	1.7	2.8	1.8	1.8	4.6	3.7	1.9	2.6	3.6	1.5	—	2.3	6.6	—	—	—	0.88	—	—	—	
17.2	22.1	10.3	6.1	1.7	2.8	1.9	1.8	4.7	3.9	1.9	2.5	4.0	1.6	2.2	2.6	6.3	0.50	0.22	1.3	0.86	1.7	2.3	1.5	
18.4	23.4	10.6	7.0	1.8	2.8	2.0	1.8	5.2	4.2	2.0	2.9	4.2	1.5	2.5	2.7	6.8	0.45	0.18	1.2	0.92	1.8	2.4	1.4	
18.5	23.6	10.2	6.3	1.8	2.5	1.8	1.8	4.7	3.9	2.0	3.0	4.2	1.6	2.3	2.5	6.5	0.42	0.24	1.2	0.84	1.8	2.2	1.5	
19.4	24.7	10.9	6.7	1.8	2.6	1.9	1.9	5.2	4.2	2.0	3.0	4.4	1.6	2.5	2.7	6.8	—	0.26	—	0.84	—	2.3	1.6	
20.4	25.6	12.0	7.3	1.9	2.9	2.2	2.1	5.4	4.3	2.1	3.1	4.9	1.7	—	3.0	7.6	—	0.20	—	0.94	—	2.6	1.8	
20.3	26.5	11.4	7.1	1.7	3.1	2.2	2.1	5.1	4.2	2.1	3.0	4.8	1.7	—	3.0	7.3	0.46	0.22	1.1	1.0	2.3	2.5	1.9	
21.0	26.4	12.3	7.3	1.9	2.8	2.1	2.2	5.6	4.6	2.2	3.3	4.8	1.8	2.6	3.3	7.6	—	0.22	—	1.1	—	3.1	1.9	
² 21.7	² 27.0	13.1	8.0	2.2	3.1	2.1	2.1	5.6	4.5	2.2	3.5	4.9	1.8	2.5	3.2	8.4	0.45	0.24	—	1.0	—	2.7	1.5	
² 22.3	—	13.9	8.4	2.2	3.2	2.4	2.1	5.7	4.7	2.2	3.4	4.8	1.8	—	3.3	8.8	0.24	0.16	1.0	1.1	2.1	2.5	1.9	
² 22.9	29.1	13.6	8.1	2.1	3.1	2.2	2.1	6.0	4.8	2.3	3.5	5.2	1.8	2.5	3.1	8.5	0.32	0.22	1.0	0.96	—	2.7	1.9	
² 23.9	30.0	14.3	8.3	2.2	3.5	2.4	2.0	6.0	4.8	2.4	3.7	5.8	1.9	3.2	3.6	8.6	—	0.16	0.90	1.2	2.5	2.9	—	
² 24.5	30.8	14.5	8.7	2.5	3.5	2.2	2.3	6.3	5.1	2.4	4.1	5.7	2.0	2.5	3.5	9.2	—	—	—	1.2	—	3.0	2.0	
² 24.5	30.8	14.5	9.4	2.6	3.7	2.4	2.2	6.4	5.1	2.4	3.7	5.6	1.9	3.0	3.4	9.2	—	0.16	—	1.2	2.7	—	2.6	
² 25.3	32.0	14.9	8.6	2.1	3.2	2.3	2.3	6.4	5.1	2.5	4.1	5.9	2.0	2.5	3.7	9.3	—	—	—	1.2	—	3.4	2.5	
² 25.9	33.9	15.1	9.3	2.8	—	2.4	2.4	6.4	5.3	2.3	4.0	5.9	2.1	—	3.8	9.6	—	—	—	1.3	—	3.1	2.1	
² 26.5	33.2	16.2	8.6	2.4	—	2.5	2.3	6.5	5.4	2.5	4.2	—	2.1	3.2	3.6	10.1	—	—	—	1.2	—	—	—	
² 26.7	33.0	15.1	9.4	2.6	3.8	2.5	2.4	6.5	5.5	2.5	4.1	5.8	2.2	—	3.4	9.8	0.26	0.18	1.1	1.1	2.4	3.2	2.4	
² 27.2	—	16.6	8.8	2.3	3.6	2.4	2.3	6.5	5.4	2.6	4.0	—	2.2	—	3.8	9.6	—	0.20	—	1.1	2.7	3.4	2.4	
² 27.9	33.4	16.7	10.0	2.9	—	2.5	2.3	7.2	5.8	2.8	4.2	6.6	2.2	4.0	4.3	10.4	—	0.14	0.94	1.2	3.1	3.6	2.8	
² 28.5	35.8	16.9	9.6	2.8	3.5	2.5	2.4	7.5	6.2	2.8	4.5	7.2	2.4	—	4.5	10.2	—	—	—	1.3	—	3.8	—	
² 29.1	35.8	16.1	9.7	2.7	3.9	2.7	2.4	7.2	5.9	2.6	4.1	6.5	2.2	3.8	4.1	9.7	—	—	0.18	—	1.3	—	3.7	—
² 29.7	—	17.5	10.4	3.3	4.0	2.7	2.5	7.3	6.1	2.8	4.2	6.6	2.3	—	—	10.5	—	0.22	1.1	1.3	—	3.8	2.8	
² 30.6	36.9	18.7	10.2	2.8	4.4	2.8	2.4	7.3	5.9	2.9	4.8	7.6	2.5	4.4	4.9	11.0	—	0.16	0.90	1.5	—	4.0	3.2	
² 30.8	38.5	18.5	9.7	—	—	2.6	2.4	7.4	6.1	2.8	5.1	7.3	2.3	4.2	5.1	11.3	—	0.18	—	1.4	—	4.2	3.0	
² 31.6	39.1	19.8	10.7	2.8	4.3	2.7	2.5	7.3	6.1	2.7	4.5	7.6	2.4	4.6	5.0	11.4	—	0.19	—	1.4	—	3.9	3.3	
² 32.0	39.7	19.4	10.3	2.8	4.2	2.7	2.4	7.6	6.3	2.7	5.1	7.7	2.4	4.4	5.2	10.9	—	0.22	—	1.6	—	4.2	3.2	
² 33.4	41.9	20.9	11.7	—	—	3.3	2.6	8.1	6.2	2.6	5.5	8.2	2.6	4.4	5.5	14.0	—	0.18	—	1.7	3.9	4.6	3.7	
² 35.7	44.0	21.9	11.4	3.4	4.8	3.1	2.7	8.7	7.1	3.3	5.2	—	2.6	4.9	5.6	13.9	—	0.18	0.80	1.6	4.2	—	3.9	
² 36.8	45.7	22.0	11.5	3.0	5.0	3.1	2.7	8.7	7.4	3.3	5.4	9.0	2.8	4.8	5.9	12.2	—	0.24	0.60	1.7	4.2	4.6	3.8	
² 40.1	—	24.0	12.8	3.4	5.6	3.4	2.9	9.8	8.1	3.7	6.4	9.8	3.1	5.5	6.4	13.4	—	0.16	0.48	1.9	4.2	5.0	4.1	
² 45.0	54.2	28.2	15.0	4.2	5.8	4.1	3.3	11.0	9.5	4.2	6.7	11.0	3.3	—	7.6	16.3	0.06	—	0.98	2.2	5.3	5.4	4.6	
² 47.7	58.2	30.9	17.0	4.7	6.5	4.3	3.5	12.4	10.9	4.7	7.1	11.7	3.8	6.1	8.0	18.9	0.06	—	0.84	2.3	5.3	6.5	4.8	
² 55.5	66.7	33.2	17.0	4.8	6.5	4.3	3.8	13.4	12.0	4.9	8.5	13.0	4.3	6.5	9.1	20.2	0.16	—	0.80	2.8	5.5	7.0	5.5	
² 55.7	67.2	34.9	18.5	5.0	6.6	4.6	4.1	14.0	12.0	5.0	8.4	13.7	4.5	6.8	9.3	21.4	0.18	—	0.78	2.5	5.7	6.6	6.8*	
² 64.4	78.9	38.5	19.4	4.1	8.3	5.1	4.6	17.3	15.0	5.7	8.8	16.9	5.7	8.0	11.0	23.6	0.24	—	0.66	3.5	6.4	8.3	7.7*	
² 65.0	79.2	42.3	22.0	5.4	8.3	5.6	5.0	19.7	16.0	6.1	9.6	17.2	5.9	8.5	13.0	26.2	0.16	—	0.80	3.7	6.6	8.1	7.5*	
² 66.1	81.1	39.4	21.7	5.0	8.7	5.8	5.0	19.3	16.2	6.1	10.4	17.7	5.8	8.6	11.9	23.0	0.20	—	0.88	3.4	7.1	8.9	7.7	
² 71.2	86.1	42.3	22.0	5.6	9.5	5.8	5.0	20.5	16.7	6.3	9.9	18.9	6.1	9.6	12.7	25.4	0.24	—	0.80	3.8	7.8	9.1	8.4	
² 74.1	89.1	45.6	23.9	6.6	8.6	5.8	5.1	20.4	17.6	6.6	10.4	19.4	6.6	9.1	12.9	26.2	0.10	—	0.92	3.9	7.5	9.5	8.8	
² 74.5	90.5	44.7	22.0	4.8	9.0	5.8	5.5	21.9	18.2	6.8	10.4	20.0	6.8	9.8	13.1	27.2	0.24	—	0.78	3.8	8.4	9.1	8.9*	

¹Usually fourth or fifth spine.²Usually in anterior one-fourth of fin.³Where indicated by (*) second and third spines equal or the third, otherwise the second measured.⁴Bump.⁵Transforming.⁶Pelagic juvenile.⁷Benthic juvenile.

from 29 to 24% through the pelagic juvenile period after which it deepens to 28% SL.

Fin Development (Tables 1-3).—The adult complement of 17-19 (usually 18) pectoral fin rays is present in the smallest larva (9.9 mm). Pectoral fin length increases from 17 to 26% SL between flexion and benthic juvenile stages. The smallest

larvae (≈ 10 mm) have the adult pelvic fin complement (I,5). Pelvic fin length is moderate, increasing from 10 to 18% SL between flexion and benthic juvenile stages. Pelvic spine length increases from 6 to 12-14% SL.

The adult complement of 8 + 7 principal caudal fin rays can be counted on the smallest (9.9 mm) flexion larva. Seven benthic juvenile *S. entomelas*,

59-73 mm, had superior and inferior secondary rays: 12/13 (two specimens), 13/13 (three specimens), and 13/14 (two specimens), as determined from radiographs.

Adults' complements of dorsal and anal fin spines and rays can be counted by ≈ 11 mm, although ray bases can be counted in the smallest specimen. The dorsal and anal fin prespines become spines by ≈ 27 and 31 mm, respectively.

Spination (Tables 2, 4).—Spines on the left side of the head of the smallest *S. entomelas* include the parietal; nuchal; first and third anterior preopercular spines; first (as a bump), second, third, and fourth posterior preopercular spines; superior opercular spine (as a bump); postocular; first inferior infraorbital spine; first and fourth superior infraorbital spines; pterotic; and the inferior posttemporal spine.

The parietal spine and ridge are finely serrated on all specimens < 33 mm long. Parietal spine length decreases with development becoming overgrown in large juveniles and adults. The nuchal spine, always shorter than the parietal, is usually present in larvae and pelagic juveniles. It begins to fuse with the parietal spine at ≈ 26 mm and is fused and not recognizable in benthic juveniles (≥ 45.0 mm).

All five spines of the posterior preopercular series are present on larvae by ≈ 11 mm and persist through adults. The third spine is always longest but decreases from 20% HL in flexion larvae to 4% HL in benthic juveniles. The second, third, and fourth posterior preopercular spines and the anterior edge of the first spine of the anterior preopercular series are weakly serrated in specimens < 30 mm long. Serrations persist on the third posterior preopercular spine to ≈ 33 mm. The second anterior preopercular spine was present on the left side only in one flexion larva (12.0 mm). The first and third anterior preopercular spines are present on all flexion and postflexion larvae, are reduced to blunt bumps in ≈ 25 mm transforming larvae, and are no longer recognizable by ≈ 30 mm.

The superior opercular spine appears well developed and sharp tipped between 10 and 14 mm. The inferior opercular spine appears as a blunt bump at 15 mm, and as a sharp spine in specimens > 21 mm. The interopercular spine appears as a blunt bump at ≈ 11 mm, as a small sharp spine by 22 mm, and is usually reduced to a blunt bump in benthic juveniles > 44 mm.

The ridge anterior to the postocular spine is finely serrated on specimens < 28 mm. The supraocular spine appears as a bump at ≈ 18 mm and as a sharp spine by ≈ 19 mm. The preocular spine appears as a blunt bump at ≈ 22 mm and as a sharp spine in all specimens > 31.6 mm. The first inferior infraorbital spine is present in all specimens < 55 mm, and is absent in specimens > 56 mm. The second inferior infraorbital spine appears between 10 and 12 mm, is present in all specimens to ≈ 35 mm, appears only as a blunt bump between ≈ 33 and 55 mm, and is no longer visible in specimens > 55 mm. The third inferior infraorbital spine appears at ≈ 15 mm, is present between 35 and ≈ 55 mm, and is usually absent in specimens > 55 mm. The first superior infraorbital spine is present in all specimens < 26 mm, is present as a blunt bump between 25 and 32 mm, and is absent in specimens > 32 mm long. The second superior infraorbital spine is occasionally present between 16 and ≈ 30 mm and is absent in larger and smaller specimens. The third superior infraorbital spine is usually present in specimens $\approx 13-31$ mm and usually absent in other sized specimens. The fourth superior infraorbital spine is usually present as a sharp spine in specimens < 32 mm, as a sharp spine or blunt bump between 32 and 41 mm, and is usually absent in specimens > 41 mm. The nasal spine appears as a bump between 11 and 12 mm and as a sharp spine in all specimens > 12 mm.

The tympanic spine appears as a blunt bump between ≈ 28 and 35 mm and usually as a small sharp spine in specimens > 35 mm. The pterotic spine is present as a sharp spine in all specimens < 25 mm, as a blunt bump in specimens 25-37 mm, and is absent in specimens > 37 mm. The inferior posttemporal spine is present in all specimens of the series. The supracleithral spine appears at ≈ 12 mm and is present in all larger specimens. The superior posttemporal spine appears as a blunt bump at ≈ 16 mm and as a sharp spine in all specimens > 17 mm. The cleithral spine is present in most specimens > 40 mm as a weak, flexible spine.

Scale formation.—Lateral line organs, indicated by a row of light colored spots on the flesh, are visible on the smallest larva and on most larger larvae which lack scales. Developing scales are first visible on unstained specimens at ≈ 22 mm in the region above the pectoral fin, near the posttemporal and supracleithral spines. The body is scale covered by ≈ 26 mm.

TABLE 4.—Development of spines in the head region of *Sebastes entomelas* larvae and juveniles. Specimens

Standard length (mm)	Preopercular																
	Parietal	Nuchal	Anterior			Posterior					Opercular		Interopercular	Subopercular	Preopercular	Supraopercular	Postopercular
			1st	2d	3d	1st	2d	3d	4th	5th	Superior	Inferior					
9.9	+	+	+	-	+	(¹)	+	+	+	-	(¹)	-	-	-	-	-	+
10.0	+	(¹)	+	-	+	(¹)	+	+	+	-	(¹)	-	-	-	-	-	+
10.9	+	+	+	-	+	+	+	+	+	-	+	-	(¹)	-	-	-	+
11.0	+	+	+	-	+	+	+	+	+	(¹)	+	-	(¹)	-	-	-	+
11.9	+	+	+	-	+	+	+	+	+	+	+	-	(¹)	-	-	-	+
12.0	+	(¹)	+	+	²	(¹)	+	+	+	(¹)	(¹)	-	(¹)	-	-	-	+
12.9	+	+	+	-	+	+	+	+	+	+	(¹)	-	(¹)	-	-	-	+
13.7	+	+	+	-	+	+	+	+	+	+	+	-	(¹)	-	-	-	+
14.0	+	+	+	-	+	+	+	+	+	+	+	-	(¹)	-	-	-	+
14.9	+	+	+	-	+	+	+	+	+	+	+	-	(¹)	-	-	-	+
15.2	+	+	+	-	+	+	+	+	+	+	+	(¹)	(¹)	-	-	-	+
16.2	+	+	+	-	+	+	+	+	+	+	+	(¹)	(¹)	-	-	-	+
16.8	+	+	+	-	+	+	+	+	+	+	+	(¹)	(¹)	-	-	-	+
17.7	+	+	+	-	+	+	+	+	+	+	+	(¹)	(¹)	-	-	-	+
18.4	+	+	+	-	+	+	+	+	+	+	+	(¹)	(¹)	-	-	(¹)	+
18.5	+	+	+	-	+	+	+	+	+	+	+	(¹)	(¹)	-	-	+	+
19.4	+	+	+	-	+	+	+	+	+	+	+	(¹)	(¹)	-	-	(¹)	+
20.4	+	+	+	-	+	+	+	+	+	+	+	(¹)	(¹)	-	-	+	+
20.8	+	+	+	-	+	+	+	+	+	+	+	(¹)	(¹)	-	-	+	+
21.0	+	+	+	-	+	+	+	+	+	+	+	(¹)	(¹)	-	-	(¹)	+
³ 21.7	+	+	+	-	+	+	+	+	+	+	+	(¹)	(¹)	-	-	+	+
³ 22.3	+	+	+	-	+	+	+	+	+	+	+	+	+	-	(¹)	+	+
³ 22.9	+	+	+	-	+	+	+	+	+	+	+	+	+	-	(¹)	+	+
³ 23.9	+	+	+	-	(¹)	+	+	+	+	+	+	+	+	-	(¹)	+	+
³ 24.5	+	+	+	-	+	+	+	+	+	+	+	+	+	-	(¹)	+	+
³ 24.5	+	+	+	-	+	+	+	+	+	+	+	+	+	-	(¹)	+	+
³ 25.3	+	-	(¹)	-	-	+	+	+	+	+	+	+	+	-	(¹)	+	+
³ 25.9	+	+	+	-	-	+	+	+	+	+	+	+	+	-	(¹)	+	+
³ 26.5	+	+	(¹)	-	-	+	+	+	+	+	+	+	+	-	(¹)	+	+
³ 26.7	+	+	(¹)	-	(¹)	+	+	+	+	+	+	+	+	-	(¹)	+	+
³ 27.2	+	+	(¹)	-	(¹)	+	+	+	+	+	+	+	+	-	(¹)	+	+
³ 27.9	+	+	(¹)	-	(¹)	+	+	+	+	+	+	+	+	-	(¹)	+	+
³ 28.5	+	+	(¹)	-	-	+	+	+	+	+	+	+	+	-	(¹)	+	+
³ 29.1	+	+	(¹)	-	-	+	+	+	+	+	+	+	+	-	(¹)	+	+
³ 29.7	+	+	(¹)	-	-	+	+	+	+	+	+	+	+	-	(¹)	+	+
³ 30.6	+	+	-	-	-	+	+	+	+	+	+	+	+	-	(¹)	+	+
³ 30.8	+	+	-	-	-	+	+	+	+	+	+	+	+	-	(¹)	+	+
⁵ 31.6	+	+	-	-	-	+	+	+	+	+	+	+	+	-	+	+	+
⁵ 32.0	+	+	-	-	-	+	+	+	+	+	+	+	+	-	+	+	+
⁵ 33.4	+	+	-	-	-	+	+	+	+	+	+	+	+	-	+	+	+
⁵ 35.7	+	+	-	-	-	+	+	+	+	+	+	+	+	-	+	+	+
⁵ 36.8	+	+	-	-	-	+	+	+	+	+	+	+	+	-	+	+	+
⁵ 40.1	+	+	-	-	-	⁶	+	+	+	+	+	+	+	-	+	+	+
⁷ 45.0	⁸	⁸	-	-	-	⁶	+	+	+	+	+	+	(¹)	-	+	+	+
⁷ 47.7	⁸	⁸	-	-	-	⁶	+	+	+	+	+	+	(¹)	-	+	- ⁹	+
⁷ 55.5	⁸	⁸	-	-	-	⁶	+	+	+	+	+	+	(¹)	-	+	+	+
⁷ 55.7	⁸	⁸	-	-	-	⁶	+	+	+	+	+	+	(¹)	-	+	+	+
⁷ 64.4	⁸	⁸	-	-	-	⁶	+	+	+	+	+	+	(¹)	-	+	+	+
⁷ 65.0	⁸	⁸	-	-	-	⁶	+	+	+	+	+	+	+	(¹)	+	+	+
⁷ 66.1	⁸	⁸	-	-	-	(¹)	+	+	+	+	+	+	+	+	+	+	+
⁷ 71.2	⁸	⁸	-	-	-	⁶	+	+	+	+	+	+	+	(¹)	+	+	+
⁷ 74.1	⁸	⁸	-	-	-	⁶	+	+	+	+	+	+	+	+	+	+	+
⁷ 74.5	⁸	⁸	-	-	-	⁶	+	+	+	+	+	+	(¹)	(¹)	+	+	+

¹Bump, indicating beginning of spine formation or last stage before spine is overgrown.²- on the right side.³Transforming.⁴Spine is bifid.⁵Pelagic juvenile.⁶Spine tip directed posteriorly.⁷Benthic juvenile.⁸Parietal and nuchal spines fused, only one tip visible.⁹+ on the right side.

Pigmentation.—The smallest larval *S. entomelas* has melanistic pigment on the head over the brain. Melanophores are present on the inside tip of the lower jaw, along the anterior margin of the maxillary, around the pterotic and posttemporal spines, and on the operculum. An internal melanistic shield covers the gut appearing darkest on the dorsal surface. Melanophores are present dorsally on the nape, beneath the posterior one-third of the spinous dorsal fin, beneath the soft dorsal fin, and

along the dorsal surface of the caudal peduncle. Internal and external melanophores are present on the lateral midline of the caudal peduncle in the vicinity of notochord flexure, above the posterior portion of the anal fin, and along the ventral margin of the caudal peduncle. Melanophores line the margin of the hypural elements. The pectoral and pelvic fin blades are moderately pigmented with expanded, somewhat elongated melanophores. External and a few internal melanophores are

above dashed line are undergoing notochord flexion. + denotes spine present and - denotes spine absent.

Standard length (mm)	Intraorbital								Nasal	Coronal	Tympanic	Pterotic	Posttemporal		Supra-cleithral	Cleithral
	Inferior			Superior				Superior					Inferior			
	1st	2d	3d	1st	2d	3d	4th									
9.9	+	-	-	+	-	-	+	-	-	-	+	-	+	-	-	
10.0	(!)	-	-	+	-	-	(!)	-	-	-	+	-	+	-	-	
10.9	+	+	-	+	-	-	(!)	-	-	-	+	-	+	-	-	
11.0	+	-	-	+	-	-	-	(!)	-	-	+	-	+	-	-	
11.9	+	+	-	+	-	-	+	(!)	-	-	+	-	+	+	-	
12.0	+	+	-	+	-	-	+	(!)	-	-	+	-	+	+	-	
12.9	+	+	-	+	-	-	+	+	-	-	+	-	+	+	-	

13.7	+	+	-	+	-	+	+	+	-	-	+	-	+	+	-	
14.0	+	+	-	+	-	+	+	+	-	-	+	-	+	+	-	
14.9	+	+	+	+	-	+	+	+	-	-	+	-	+	+	-	
15.2	+	+	+	+	-	+	+	+	-	-	+	-	+	+	-	
16.2	+	+	+	+	-	+	+	+	-	-	+	(!)	+	+	-	
16.8	+	+	+	+	+	+	+	+	-	-	+	(!)	+	+	-	
17.7	+	+	+	+	+	+	+	+	-	-	+	(!)	+	+	-	
18.4	+	+	+	+	-	+	+	+	-	-	+	+	+	+	-	
18.5	+	+	+	+	-	+	+	+	-	-	+	+	+	+	-	
19.4	+	+	+	+	-	+	+	+	-	-	+	+	+	+	-	
20.4	+	+	+	+	-	+	+	+	-	-	+	+	+	+	-	
20.8	+	+	+	+	-	+	+	+	-	-	+	+	+	+	-	
21.0	+	+	+	+	+	+	+	+	-	-	+	+	+	+	-	
³ 21.7	+	+	+	+	+	+	+	+	-	-	+	+	+	+	-	
³ 22.3	+	+	+	+	+	+	+	+	-	-	+	+	+	+	-	
³ 22.9	+	+	+	+	-	+	+	+	-	-	+	+	+	+	-	
³ 23.9	+	+	+	+	+	+	+	+	-	-	+	+	+	+	-	
³ 24.5	+	+	+	+	+	+	+	+	-	-	(!)	+	+	+	-	
³ 24.5	+	+	+	+	+	+	+	+	-	-	+	+	+	+	-	
³ 25.3	+	+	+	+	-	(!)	+	+	-	-	+	+	+	+	-	
³ 25.9	+	+	+	(!)	-	(!)	+	+	-	-	+	+	+	+	-	
³ 26.5	+	+	+	(!)	+	+	+	+	-	-	(!)	+	+	+	-	
³ 26.7	+	+	+	(!)	+	+	+	+	-	-	(!)	+	+	+	-	
³ 27.2	+	+	+	(!)	+	+	+	+	-	-	+	+	+	+	-	
³ 27.9	+	+	+	(!)	+	+	+	+	-	(!)	+	+	+	+	-	
³ 28.5	+	+	+	(!)	+	+	+	+	-	(!)	(!)	+	+	+	-	
³ 29.1	+	+	+	(!)	-	+	+	+	-	(!)	(!)	+	+	+	-	
³ 29.7	+	+	+	(!)	+	+	+	+	-	(!)	(!)	+	+	+	-	
³ 30.6	+	+	+	(!)	-	-	(!)	+	-	(!)	(!)	+	+	+	-	
⁵ 30.8	+	+	+	(!)	-	+	+	+	-	(!)	(!)	+	+	+	-	
⁵ 31.6	+	+	+	(!)	-	-	+	+	-	(!)	(!)	+	+	+	-	
⁵ 32.0	+	+	+	(!)	-	-	(!)	+	-	(!)	(!)	+	+	+	-	
⁵ 33.4	+	+	+	-	-	-	(!)	+	-	(!)	(!)	+	+	+	-	
⁵ 35.7	+	(!)	(!)	-	-	-	+	+	-	(!)	-	+	+	+	-	
⁵ 36.8	+	+	+	-	-	(!)	+	+	-	+	(!)	+	+	+	-	
⁵ 40.1	+	+	+	-	-	-	+	+	-	+	-	+	+	+	(!)	
⁷ 45.0	+	-	(!)	-	-	-	-	+	-	+	-	+	+	+	+	
⁷ 47.7	+	(!)	(!)	-	-	-	-	+	-	(!)	-	+	+	+	+	
⁷ 55.5	(!)	(!)	(!)	-	-	-	(!)	+	-	+	-	+	+	+	+	
⁷ 55.7	(!)	(!)	-	-	-	-	-	+	-	+	-	+	+	+	+	
⁷ 64.4	-	-	-	-	-	-	-	+	-	+	-	+	+	+	+	
⁷ 65.0	-	-	(!)	-	-	-	-	+	-	+	-	+	+	+	+	
⁷ 66.1	-	-	-	-	-	-	-	+	-	+	-	+	+	+	+	
⁷ 71.1	-	-	-	-	-	-	-	+	-	+	-	+	+	+	+	
⁷ 74.1	-	-	-	-	-	-	-	+	-	+	-	+	+	+	-	
⁷ 74.5	-	-	-	-	-	-	-	+	-	+	-	+	+	+	-	

present on the underside of the pectoral fin base. A discrete melanophore is present at the articulation of each of several dorsal fin rays near the center of the soft dorsal fin.

As larvae develop, pigment increases over the brain. Melanophores are added on the snout, interorbital region, tips of the upper and lower lips, along the maxillary, and on the cheek and operculum. Pigment increases around the orbit and around the posttemporal spine, extending anteriorly over the head. Melanophores line the anterior margin of the cleithrum beneath the oper-

culum. Pigment on the gut becomes less obvious as body musculature increases. The dorsal body surface is pigmented from nape to caudal peduncle by ≈ 11 mm. Large stellate melanophores beneath the soft dorsal fin increase in number and are aligned along the muscles surrounding the dorsal pterygiophores. This is the densest pigmentation on larvae. Internal and external melanophores are added along the body midline anteriorly from the caudal peduncle forming a line along the notochord which extends to the head by ≈ 16.5 mm. Melanophores extend ventrolaterally from the

nape to the lateral midline by ≈ 16.5 mm and are added posteriorly along the dorsolateral body surface with development. The melanophores located above the posterior portion of the anal fin disappear by ≈ 18 mm. Discrete melanophores are added at the articulation of dorsal fin rays and spines until most soft rays have an associated melanophore by ≈ 14 mm and most spines have one by ≈ 19 mm. Melanophores are added along the caudal fin base, sometimes appearing as a line of pigment, and onto the fin membrane. Pigment decreases and then disappears on the pelvic fin and underside of the pectoral fin base by ≈ 18 mm and on the pectoral fin by ≈ 20 mm.

During transformation, ≈ 22 -31 mm, pigment gradually continues to increase over the head and body. External melanophores are added on the lips, lower jaw, snout, and dorsolateral areas of the head. Pigment becomes continuous around the orbit by ≈ 30 mm. Melanophores over the dorsolateral surfaces of the body often appear aligned along the myosepta, but this pattern becomes obscured as melanophores are added between the myosepta, particularly along the dorsal one-third of the body.

Pelagic juveniles, 31-40 mm, undergo a general increase in pigment with development. The upper head, snout, lips, lower jaw, maxillary, cheek, and gular region become increasingly pigmented with small melanophores. Melanophores are added ventrolaterally on the body until all but the ventral one-eighth is pigmented. Pigment distinctly lines the caudal fin base.

Benthic juveniles, >44 mm, become increasingly pigmented as small melanophores are added

on the head and appear on the scales and fins. Pigmentation at the anterior tips of the lips and along the maxillary intensifies. By ≈ 55.5 mm a dark bar of pigment extends the length of the maxillary, and two other bars extend from the posteroventral margin of the eye across the cheek. The most dorsal cheek bar extends completely across the opercle. Dark blotches appear on the dorsal surfaces of the body as scale-borne melanophores overlie the body pigment which developed during the transformation and pelagic juvenile stages. In small benthic juveniles these blotches appear as indistinct bands as melanophores are added ventrolaterally to them. However, a mottled pattern appears over the dorsal half of the body by ≈ 66 mm. Melanophores are added anteriorly and proximally on the first dorsal fin and are eventually scattered over the entire fin. A dark blotch develops in the posterior portion of the spinous dorsal fin by ≈ 45 mm and persists in the largest juveniles observed; however, as development proceeds the blotch becomes less intensely pigmented and more of a pigment fringe, rather than a blotch. The membranes of the spinous and soft dorsal fins and caudal fin become lightly covered with small melanophores by ≈ 56 mm. Also by ≈ 56 mm, a small patch of melanophores appears on the dorsal half of the pectoral fin ray bases and adjacent fin base.

Occurrence (Figures 4, 5).—Adult *S. entomelas* occur from Todos Santos Bay, Baja California, to Kodiak Island, Alaska (Miller and Lea 1972). Off Oregon they are reported to be most common on the continental shelf between 100 and 200 m depth

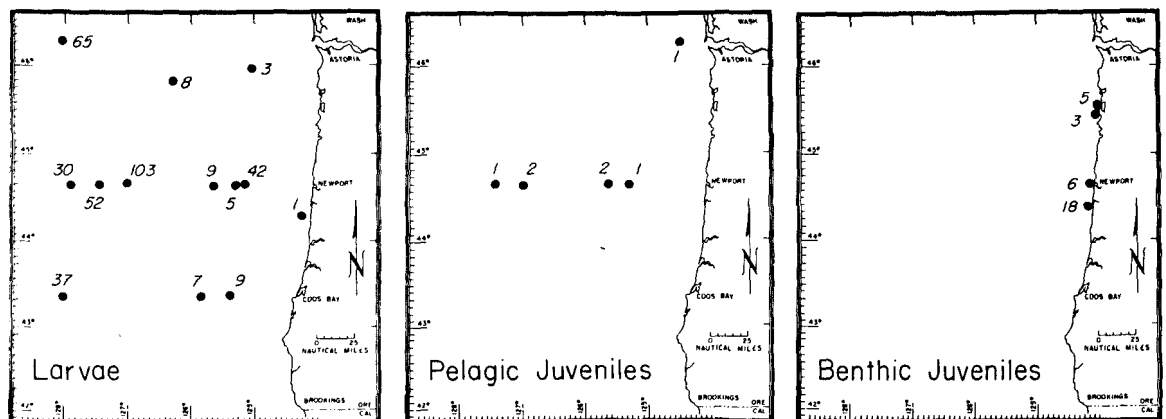


FIGURE 4.—Number of specimens and location of capture of larvae and juveniles of *Sebastes entomelas* off Oregon (1961-78) described in this paper.

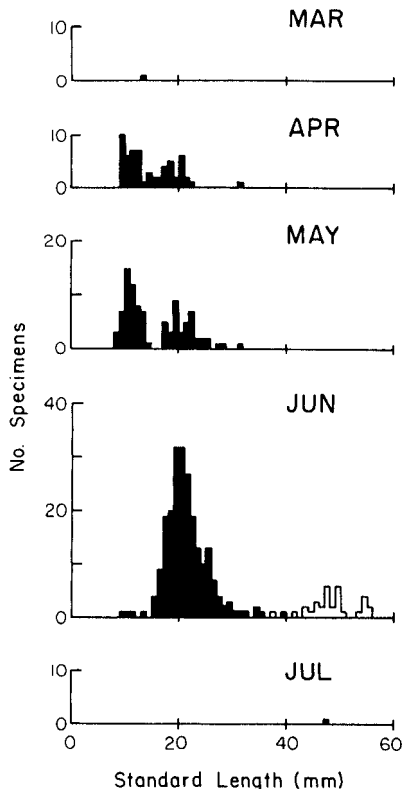


FIGURE 5.—Seasonal occurrence of larvae and juveniles of *Sebastes entomelas* off Oregon. Data from 1961 through 1978 combined. Solid bars indicate pelagic stages, open bars indicate benthic stages.

(Snytko and Fadeev⁷). Data from Niska (1976) show that $\approx 91\%$ of the total Oregon trawl catch of *S. entomelas* landed from 1963 through 1971 was taken from depths of 110-218 m. Highest concentrations of *S. entomelas* found during the 1977 rockfish survey between Pt. Hueneme, Calif., lat. $34^{\circ}00' N$, and Cape Flattery, Wash., lat. $48^{\circ}29' N$, were at depths of 91-181 m between Cape Blanco, Oreg., lat. $43^{\circ}00' N$, and Cape Flattery (Gunderson and Sample⁸). Larval and transforming *S. entomelas*, in our collections were captured at stations ≈ 9 -306 km offshore. Pelagic juveniles ap-

peared to range as extensively as larvae. Benthic juveniles were taken close to the coast at depths of 9-37 m.

Reported parturition times for *S. entomelas* are January through March off central California (Phillips 1958). Larvae <15 mm long were taken March through June, although most were taken in April and May. Larvae and pelagic juveniles >15 mm were taken April through June. Benthic juveniles were taken only in June. Lack of benthic juveniles in our collections from other months is probably due to inadequate sampling.

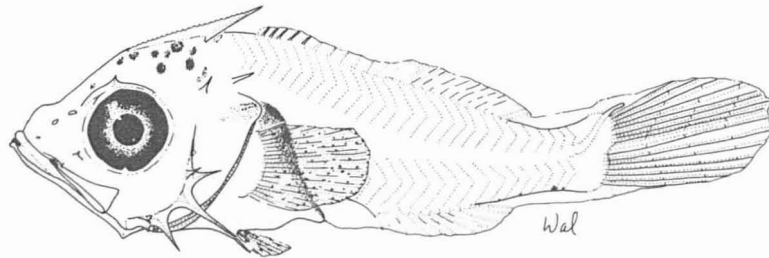
SEBASTES ZACENTRUS (GILBERT)

Literature (Figures 6-8).—The pigment pattern of *S. zacentrus* preextrusion larvae was described by Efremenko and Lisovenko (1970), including a figure; Westrheim (1975); Westrheim et al.⁹; and Harling et al. (footnote 6), including figures. Descriptions by Efremenko and Lisovenko (1970), Westrheim (1975), and Westrheim et al. (footnote 9) agree that preextrusion larvae (mean 4.2, 4.3, and 4.5 mm TL, respectively) have a postanal ventral row of melanophores (15-21, usually >16 , and 15-20, respectively) which usually stops short of the anus by at least four myomeres with usually at least one melanophore in the hypural region. Melanophores also appear over the gut. No dorsal row of pigment is present. Harling et al. (footnote 6) described and illustrated two forms of *S. zacentrus* preextrusion larvae, both with mean 5.0 mm TL. One form had 15-18 ventral midline melanophores which stopped short of the anus by four myomeres, a hypural spot, and gut pigment. The second form had 18-21 ventral midline melanophores which did not stop short of the anus by four myomeres, 9-12 dorsal midline melanophores, considerable pigment encircling the yolk, a large lateral melanophore midway between the anus and tail tip, and several melanophores in the hypural region. It seems quite unlikely that the latter form is the same as the former and merely a result of within species variation as suggested by Harling et al. (footnote 6). Possibly it may reflect misidentification of the adult from which the larvae were taken. Since the two forms described by Harling et al. were consid-

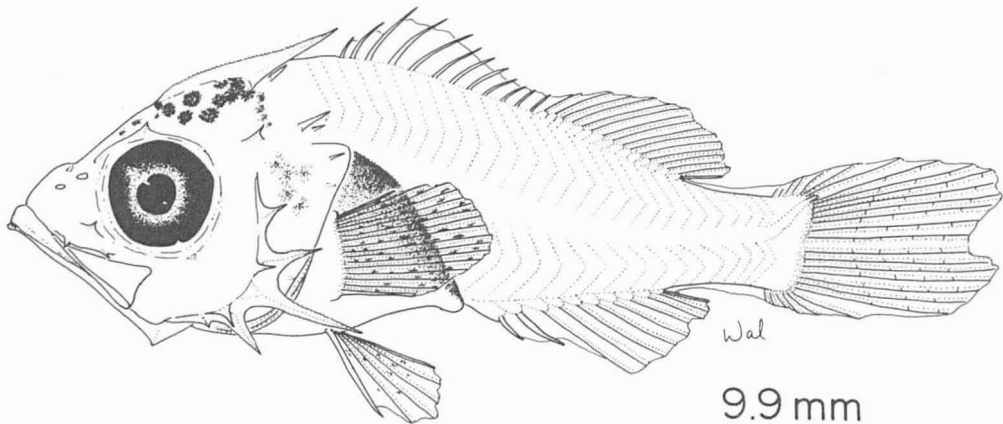
⁷Snytko, V. A., and N. S. Fadeev. 1974. Data on distribution of some species of sea perches along the Pacific coast of North America during the summer-autumn seasons. Document submitted at the Canada-USSR meeting on fisheries in Moscow-Batumi, USSR-November 1974, 14 p. (Transl. 3436, Can. Transl. Ser.)

⁸Gunderson, D. R., and T. M. Sample. 1978. Distribution and abundance of rockfish off Washington, Oregon and California during 1977. Unpubl. rep., 45 p. Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, Seattle, WA 98112.

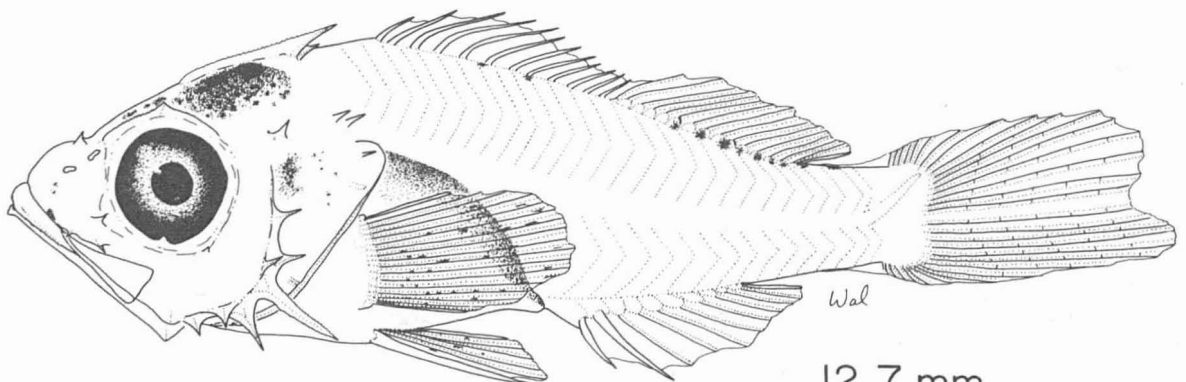
⁹Westrheim, S. J., W. R. Harling, D. Davenport, and M. S. Smith. 1968. Preliminary report on maturity, spawning season and larval identification of rockfishes (*Sebastes*) collected off British Columbia in 1968. Fish. Res. Board Can., Manusc. Rep. Ser. 1005, 28 p.



7.4 mm



9.9 mm



12.7 mm

FIGURE 6.—Pelagic larvae of *Sebastes zacentrus*.

erably larger than those described by other workers (see above), there is some question about the identification of both.

Identification (Tables 5-7; Appendix Table 1).—Fifty-one specimens of *S. zacentrus* (7.4-74.8 mm) were selected for the developmental series from

181 larval and juvenile specimens identified. Juveniles were identified using the following combination of characters observed in juvenile and adult specimens examined:

Gill rakers = 32-37, usually 34-37

Lateral line pores = 38-48, usually 38-44

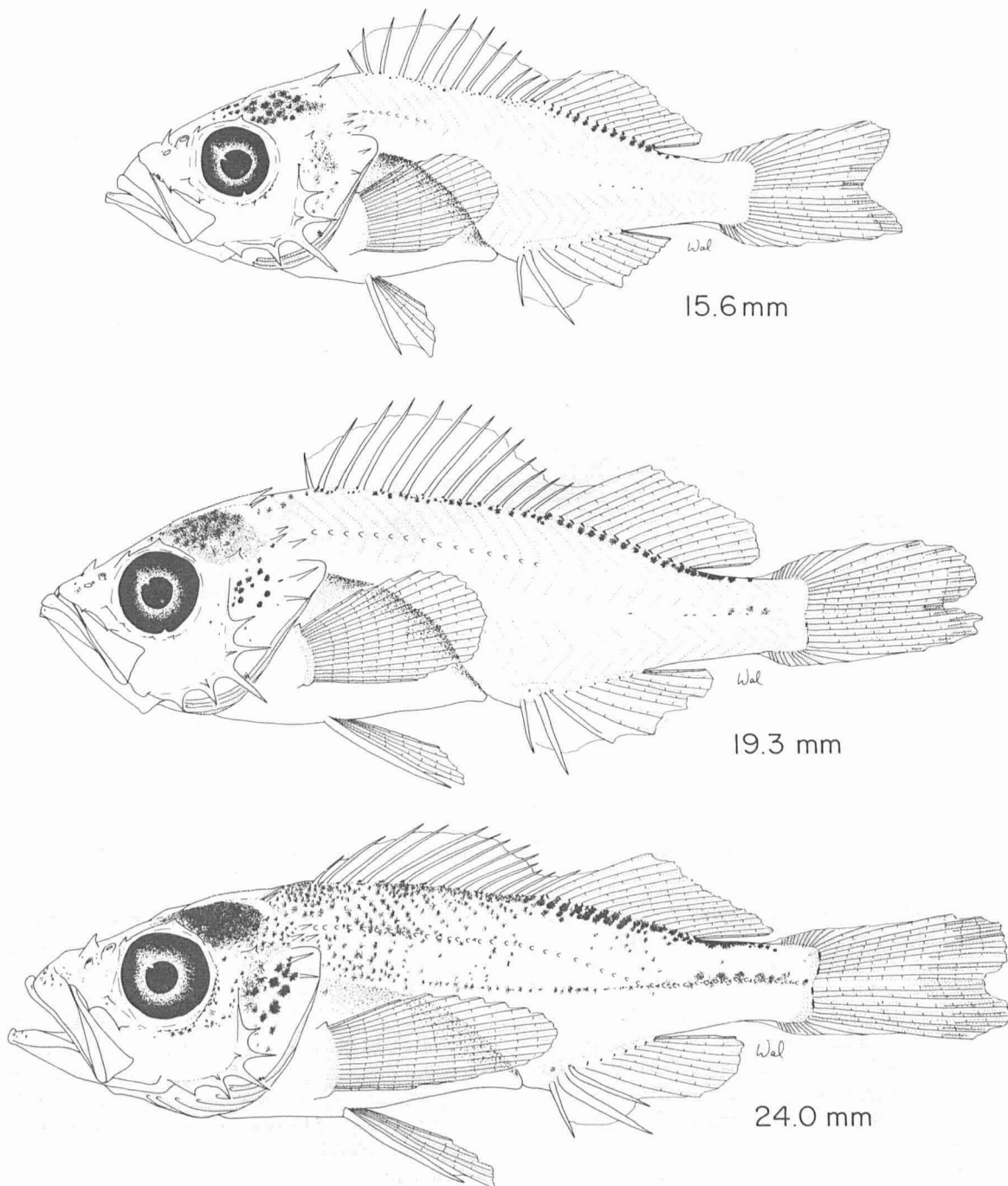


FIGURE 7.—Transforming larvae (15.6, 19.3 mm) and pelagic juvenile (24.0 mm) of *Sebastes zacentrus*.

Pectoral fin rays = 16-18, usually 17
Anal fin soft rays = 6 or 7, usually 7
Dorsal fin soft rays = 13-16, usually 14

Vertebrae = 27
Preocular spine = present (strong)
Supraocular spine = usually absent

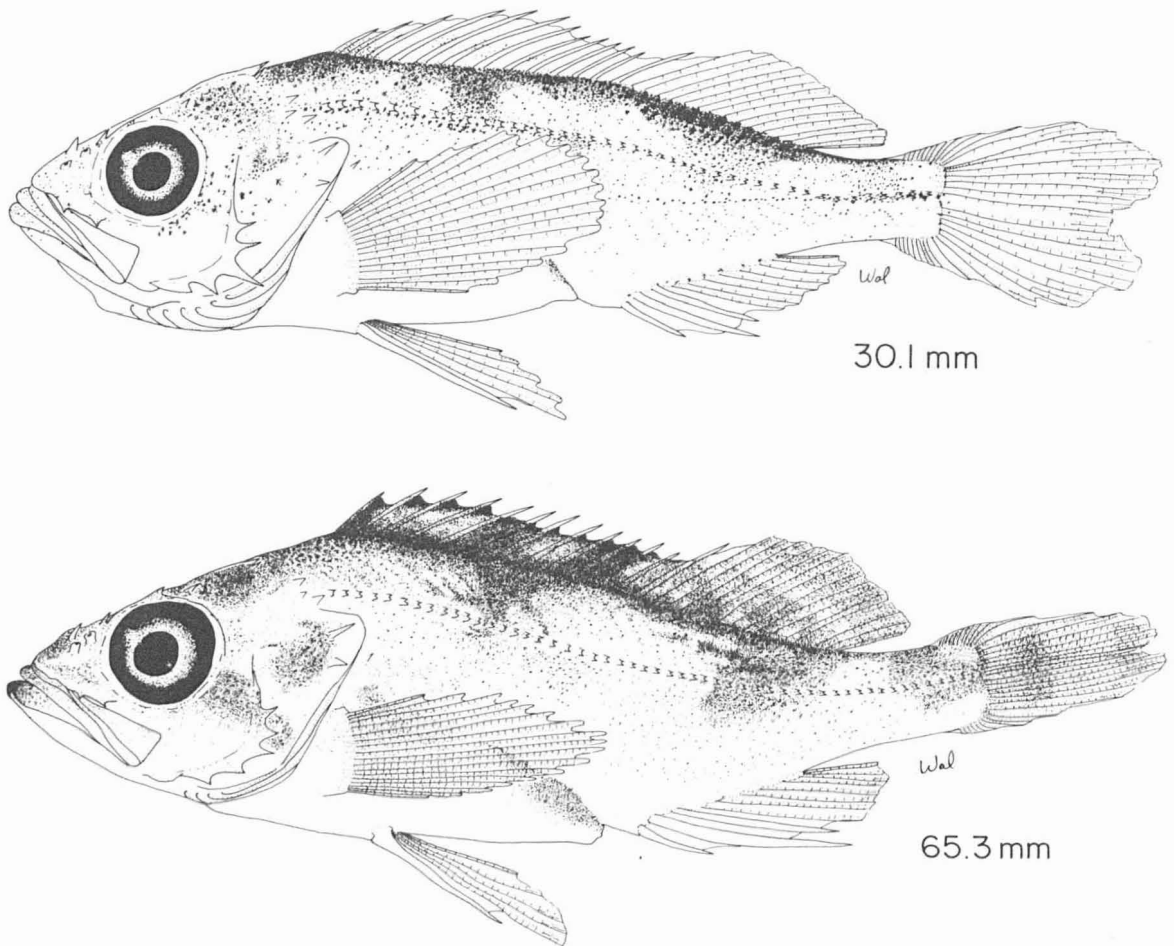


FIGURE 8.—Pelagic juvenile (30.1 mm) and benthic juvenile (65.3 mm) of *Sebastes zacentrus*.

Interorbital space = flat-convex
 Black blotch at base of spinous dorsal fin =
 absent.

Of the 36 *Sebastes* species off Oregon (Richardson and Laroche 1979), *S. zacentrus* has the best fit to the above characters. Other species occurring off Oregon which agree with many of these characters are *S. brevispinis*, *S. emphaeus*, *S. proriger*, and *S. wilsoni*.

Sebastes emphaeus and *S. wilsoni* are eliminated since they have 39-43 and 38-42 gill rakers, respectively (see Appendix Table 1). *Sebastes wilsoni* also differs from *S. zacentrus* in soft anal fin ray count, usually 6 vs. usually 7, respectively (see Appendix Table 1). *Sebastes proriger* can be eliminated based on count frequency distributions (see Appendix Table 1): number of gill rakers on the

first arch $\bar{x} = 38.3 \pm 0.35$ (95% confidence intervals, C. I.) vs. 35.3 ± 0.32 (95% C. I.) for *S. zacentrus*; diagonal scale rows below the lateral line $\bar{x} = 56.0 \pm 0.82$ (95% C. I.) vs. 50.2 ± 0.56 (95% C. I.) for *S. zacentrus*; lateral line pores $\bar{x} = 47.9 \pm 0.93$ (95% C. I.) vs. 41.8 ± 0.70 (95% C. I.) for *S. zacentrus*. Frequency distributions for dorsal fin soft rays also differ between *S. proriger*, 50% ≥ 15 rays, and *S. zacentrus*, 88% < 14 rays. Although *S. brevispinis* differs considerably from *S. zacentrus* in body morphology, pigmentation, and relative strength and length of head and fin spines, the fin, scale, and lateral line pore count ranges are reported to overlap (Phillips 1957; Miller and Lea 1972; Hart 1973). Since count-frequency data have not been published for *S. brevispinis* and since we had only four large juvenile and adult specimens available for examination, it was necessary to rely on a

TABLE 5.—Meristics from larvae and juveniles of *Sebastes zacentrus* based on unstained specimens. Counts of left and right pelvic fin rays (1,5; 1,5), superior and inferior principal caudal rays (8,7), and left and right branchiostegal rays (7,7) were constant throughout the series. Specimens above dashed line are undergoing notochord flexion.

Standard length (mm)	Dorsal fin spines and rays	Anal fin spines and rays	Pectoral fin rays		Gill rakers (first arch)		Lateral line pores		Diagonal scale rows	
			Left	Right	Left	Right	Left	Right	Left	Right
7.4	V+I ¹ , 14	III ¹ , 7	17	17	—	—	—	—	—	—
7.9	XIII ¹ , 13	III ¹ , 7	17	17	18+ 7=25	17+ 7=24	—	—	—	—
8.5	XIII ¹ , 14	III ¹ , 7	17	17	18+ 8=26	19+ 8=27	—	—	—	—

9.2	XIII ¹ , 14	III ¹ , 7	17	17	20+ 8=28	19+ 8=28	—	—	—	—
9.9	XIII ¹ , 14	III ¹ , 7	17	17	20+ 9=29	21+ 9=30	—	—	—	—
10.1	XIII ¹ , 14	III ¹ , 7	16	17	21+ 9=30	21+ 8=29	—	—	—	—
10.6	XIII ¹ , 14	III ¹ , 7	17	17	22+ 8=30	21+ 9=30	—	—	—	—
11.2	XIII ¹ , 14	III ¹ , 7	17	17	21+ 9=30	21+ 9=30	—	—	—	—
11.7	XIII ¹ , 14	III ¹ , 7	18	17	21+ 9=30	23+ 9=32	—	—	—	—
12.4	XIII ¹ , 13	III ¹ , 7	17	17	22+ 9=31	22+ 10=32	—	—	—	—
12.7	XIII ¹ , 14	III ¹ , 7	17	17	24+ 9=33	23+ 9=32	—	—	—	—
13.3	XIII ¹ , 14	III ¹ , 7	17	17	23+ 9=32	22+ 9=31	—	—	—	—
² 13.7	XIII, 15	III, 7	17	17	23+ 9=32	24+ 9=33	—	—	—	—
² 14.0	XIII ¹ , 14	III ¹ , 6	18	17	24+ 9=33	24+ 9=33	—	—	—	—
² 14.8	XIII ¹ , 14	III ¹ , 7	17	17	23+ 9=32	23+ 10=33	—	—	—	—
² 15.0	XIII ¹ , 14	III ¹ , 7	17	17	24+ 10=34	24+ 10=34	—	—	—	—
² 15.6	XIII, 13	III, 7	17	17	23+ 9=32	23+ 9=32	—	—	—	—
² 16.3	XIII, 14	III, 7	17	17	24+ 10=34	23+ 10=33	—	—	—	—
² 16.8	XIII, 14	III, 7	17	17	23+ 10=33	23+ 10=33	—	—	—	—
² 17.3	XIII, 14	III, 7	17	17	24+ 10=34	24+ 10=34	—	—	—	—
² 17.9	XIII, 14	III, 7	17	17	24+ 10=34	24+ 10=34	—	—	—	—
² 18.0	XIII, 14	III, 7	17	17	24+ 10=34	24+ 10=34	—	—	—	—
² 18.9	XIII, 14	III, 7	17	17	25+ 10=35	24+ 10=34	—	—	—	—
² 19.3	XIII, 14	III, 7	17	17	25+ 10=35	24+ 10=34	—	—	—	—
² 19.6	XIII, 14	III, 7	17	17	26+ 10=36	25+ 10=35	—	—	—	—
³ 20.3	XIII, 14	III, 7	17	17	26+ 10=36	25+ 10=35	—	—	—	—
³ 20.6	XIII, 14	III, 7	17	17	24+ 10=34	25+ 10=35	—	—	—	—
³ 21.0	XIII, 14	III, 7	17	17	25+ 10=35	25+ 10=35	—	—	—	—
³ 21.5	XIII, 14	III, 7	18	17	24+ 10=34	24+ 10=34	—	—	—	—
³ 22.0	XIII, 14	III, 7	17	17	25+ 10=35	24+ 11=35	—	—	—	—
³ 22.6	XIII, 14	III, 7	17	17	25+ 10=35	25+ 10=35	—	—	—	—
³ 23.3	XIII, 13	III, 7	17	17	25+ 10=35	25+ 10=35	—	41	—	—
³ 23.5	XIII, 14	III, 7	17	17	25+ 10=35	25+ 11=36	—	43	—	—
³ 24.0	XIII, 14	III, 7	17	17	26+ 10=36	25+ 10=35	—	43	—	—
³ 24.4	XIII, 14	III, 7	17	18	25+ 11=36	25+ 10=35	—	42	—	—
³ 25.6	XIII, 14	III, 7	17	18	24+ 10=34	25+ 10=35	42	—	52	—
³ 25.9	XIII, 14	III, 7	17	17	25+ 10=35	26+ 10=36	—	—	—	—
³ 26.3	XIII, 14	III, 7	17	17	24+ 10=34	25+ 10=35	43	41	48	50
³ 26.6	XIII, 14	III, 7	17	17	24+ 10=34	25+ 10=35	40	—	—	—
³ 27.6	XIII, 14	III, 7	17	17	25+ 10=35	24+ 10=34	—	—	—	—
³ 28.3	XIII, 14	III, 7	17	17	26+ 10=36	26+ 10=36	40	40	—	—
³ 30.1	XIII, 14	III, 7	17	17	25+ 10=35	25+ 10=35	42	41	—	—
³ 30.7	XIII, 14	III, 7	17	17	25+ 10=35	25+ 10=35	—	41	—	52
³ 31.2	XIII, 14	III, 7	17	17	25+ 10=35	24+ 10=34	40	—	—	—
³ 33.7	XIII, 14	III, 7	17	17	24+ 10=34	25+ 10=35	40	40	—	—
³ 35.3	XIII, 14	III, 7	17	17	25+ 10=35	25+ 10=35	44	43	—	—
⁴ 65.0	XIII, 14	III, 7	17	17	25+ 10=35	26+ 10=36	44	45	—	—
⁴ 65.3	XIII, 13	III, 7	17	16	25+ 10=35	26+ 10=36	41	43	—	—
⁴ 70.8	XII, 14	III, 7	17	17	24+ 10=34	26+ 10=36	44	43	—	—
⁴ 73.7	XIII, 13	III, 7	17	17	26+ 11=37	25+ 11=36	43	47	—	—
⁴ 74.8	XIII, 14	III, 7	17	17	24+ 10=34	24+ 10=34	43	42	—	—

¹Posterior-most dorsal or anal spine appears as a soft ray.²Transforming.³Pelagic juvenile.⁴Benthic juvenile.

number of characters for elimination of *S. brevispinis*. Characters useful for separating *S. brevispinis* from *S. zacentrus* are: weak or absent vs. strong supraorbital spines; 58-70 vs. 43-54 diagonal scale rows below the lateral line; 44-53 vs. 38-48, usually 38-44, lateral line pores; 26 vs. 27 vertebrae and myomeres; second anal spine about equal in strength and length to the third anal spine vs. second anal spine stouter and longer than the third anal spine. Larvae and small juveniles of 16 specimens, 14.9-28.1 mm, identified as *S. brevispinis* were found to have denser

melanistic pigment over the head and body than *S. zacentrus* of similar length and more slender bodies at the pectoral fin base, averaging 26.1, 24.6, and 26.8% SL for larvae, transforming larvae, and pelagic juveniles vs. 35.2, 34.4, and 32.5% SL for comparable stages of *S. zacentrus*.

Distinguishing Features.—Characters useful to distinguish the smallest identified *S. zacentrus* larva, 7.4 mm, are fin counts; the moderately pigmented pectoral and pelvic fins; the general lack of body pigment; melanophores inside the tip of the

TABLE 6.—Measurements (millimeters) of larvae and juveniles of *Sebastes zacentrus*. 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	Caudal peduncle depth	Dorsal-hypural distance	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 ¹	Longest dorsal ray length ²	Longest anal spine length ³	
7.4	9.1	4.0	3.1	0.92	1.4	1.0	0.86	2.5	1.7	0.80	1.2	0.96	0.98	0.48	0.88	2.9	0.82	0.04	0.84	—	0.19	0.69	(⁴)	
7.9	10.0	4.0	3.1	0.72	1.4	1.1	0.98	2.8	2.0	0.92	1.3	1.2	1.1	0.90	1.2	3.0	0.76	(⁵)	1.2	0.26	0.52	1.0	0.40	
8.5	10.9	4.5	3.8	0.98	1.8	1.2	1.1	3.1	2.2	1.1	1.3	1.5	1.0	—	1.2	3.3	0.64	0.12	—	0.40	0.54	0.76	0.54	
9.2	11.8	5.2	4.2	1.1	1.8	1.3	1.2	3.3	2.5	1.0	1.4	1.9	1.1	1.3	1.5	3.8	—	0.22	—	0.55	0.90	1.2	0.70	
9.9	12.8	5.6	4.4	1.2	1.7	1.4	1.2	3.5	2.6	1.1	1.5	2.0	1.1	1.4	1.5	4.2	0.76	0.20	0.98	0.58	0.92	1.2	0.78	
10.1	13.0	5.6	4.2	1.1	1.8	1.4	1.3	3.4	2.6	1.0	1.5	2.1	1.1	1.4	1.6	4.1	0.68	0.24	1.1	0.52	1.0	1.4	0.88	
10.6	13.3	5.7	4.4	1.3	2.0	1.5	1.2	3.6	2.7	1.2	1.6	2.2	1.1	1.6	1.9	4.2	0.75	0.10	1.3	0.48	1.1	1.2	0.92	
11.2	14.4	6.4	4.6	1.3	2.1	1.6	1.3	4.0	3.0	1.3	1.7	2.4	1.1	1.8	1.9	4.7	0.66	0.21	1.2	0.68	1.3	1.7	1.2	
11.7	14.9	6.8	5.3	1.5	—	1.5	1.3	4.0	3.0	1.3	1.6	2.4	1.2	1.9	2.0	4.9	0.66	0.30	1.3	0.72	1.3	1.5	1.1	
12.4	15.9	7.0	5.4	1.5	2.4	1.7	1.5	4.3	3.4	1.4	1.6	2.8	1.3	2.4	2.6	4.9	0.64	0.28	1.2	0.73	1.7	1.8	1.7	
12.7	16.2	7.2	5.1	1.4	2.3	1.7	1.5	4.2	3.1	1.4	1.8	3.0	1.3	2.2	2.4	4.8	0.64	0.29	1.3	0.72	—	1.6	—	
13.3	16.9	8.3	5.4	1.6	2.4	1.6	1.5	4.4	3.1	1.4	1.9	3.0	1.3	2.2	2.4	5.4	0.68	0.40	1.4	0.78	1.6	1.8	1.3	
⁶ 13.7	17.0	8.5	5.9	1.7	2.3	1.7	1.5	4.6	3.5	1.5	1.8	3.2	1.3	2.6	2.6	5.5	0.62	0.30	—	0.90	1.7	2.0	1.8	
⁶ 14.0	17.9	8.0	5.4	1.5	2.5	1.6	1.6	4.9	3.9	1.5	2.2	3.4	1.4	2.9	3.0	5.7	0.76	0.32	1.4	0.87	1.9	—	1.8	
⁶ 14.8	18.9	8.9	6.1	1.6	2.6	1.6	1.7	5.1	4.2	1.7	2.3	3.6	1.4	2.9	3.0	5.7	0.70	0.38	1.4	0.91	—	—	2.0	
⁶ 15.0	18.0	8.8	6.1	1.5	2.6	1.7	1.6	5.1	4.0	1.6	2.2	3.7	1.4	3.0	3.1	5.9	0.70	0.37	1.5	0.88	—	—	2.1	
⁶ 15.6	19.7	9.3	6.6	1.9	2.4	1.8	1.7	5.2	4.1	1.7	2.4	3.7	1.5	—	—	6.7	—	0.30	—	0.89	—	—	2.3	
⁶ 16.3	20.8	10.0	6.6	1.6	2.8	2.1	1.7	5.1	4.3	1.7	2.4	4.1	1.6	3.0	3.0	7.3	0.62	—	1.5	0.96	2.4	2.6	2.3	
⁶ 16.8	21.0	10.2	6.6	1.9	—	1.9	1.7	5.1	4.2	1.7	2.5	3.6	1.5	—	3.0	6.8	0.78	—	—	0.94	2.4	2.6	2.3	
⁶ 17.3	—	10.8	6.9	1.7	2.7	2.0	1.7	5.4	4.4	1.9	2.5	4.4	1.5	—	—	7.4	0.64	0.22	1.6	1.1	—	—	2.5	2.3
⁶ 17.9	22.7	11.0	7.4	1.9	3.1	2.2	1.7	5.8	4.7	1.9	2.6	4.9	1.7	3.6	3.7	7.4	0.70	0.34	1.6	1.2	2.8	3.1	2.8	
⁶ 18.0	22.8	11.1	7.5	1.9	3.2	2.3	1.8	5.7	4.5	2.0	2.7	4.9	1.7	3.7	3.9	7.4	—	—	1.2	1.1	2.9	2.9	3.0	
⁶ 18.9	—	11.8	7.1	1.8	3.1	2.3	1.7	6.1	4.8	1.9	2.8	5.0	1.7	3.7	3.8	7.2	—	0.36	1.5	1.1	2.8	—	—	
⁶ 19.3	24.4	11.0	7.5	1.9	3.0	2.3	2.0	6.0	4.9	1.9	2.7	5.1	1.7	3.6	—	7.7	0.58	0.32	—	1.1	2.9	—	—	
⁶ 19.6	25.2	11.9	7.7	2.1	3.0	2.3	1.8	6.1	5.0	2.0	2.8	5.5	1.8	4.0	4.1	7.9	0.70	0.39	—	1.3	2.9	3.3	3.2	
⁶ 20.3	25.6	12.0	8.1	2.1	3.4	2.3	1.9	6.3	5.1	2.1	3.0	5.4	1.8	—	4.2	8.1	0.66	0.37	1.4	1.3	3.1	3.0	—	
⁶ 20.6	25.6	12.1	7.7	1.9	3.4	2.4	1.8	6.3	5.2	2.0	3.4	5.2	1.9	4.1	4.1	8.1	0.70	0.42	1.5	1.2	3.2	—	3.2	
⁶ 21.0	25.7	13.2	8.4	2.1	3.6	2.4	2.0	6.3	5.0	2.0	2.8	6.1	1.9	—	—	8.4	0.62	0.34	1.2	1.4	3.6	—	3.3	
⁶ 21.5	26.9	12.6	8.6	2.7	—	2.3	2.0	6.5	5.2	2.1	2.8	5.4	2.0	4.2	4.2	8.7	0.92	0.48	—	1.3	—	—	3.4	
⁶ 22.0	—	13.5	8.5	2.5	3.2	2.5	1.8	6.8	5.3	2.1	2.9	—	1.9	—	—	9.3	0.57	0.30	—	1.2	3.2	—	3.3	
⁶ 22.6	28.4	13.6	8.6	2.1	3.9	2.6	2.0	6.9	5.7	2.3	3.4	—	2.1	4.2	4.1	8.6	—	—	1.4	1.4	3.6	—	3.7	
⁶ 23.3	29.6	13.9	9.0	2.4	3.6	2.6	1.9	6.7	5.5	2.2	3.2	6.3	2.1	4.2	4.7	9.2	—	—	1.5	1.2	3.6	3.6	3.7	
⁶ 23.5	—	14.3	8.7	2.1	3.5	2.5	2.0	7.1	6.0	2.4	3.3	6.3	2.1	4.7	4.7	9.2	—	0.44	1.5	1.4	—	—	3.6	
⁶ 24.0	30.5	14.8	9.7	2.7	4.0	2.9	2.0	7.2	5.9	2.4	3.6	6.6	2.2	4.2	4.7	9.7	—	0.32	—	1.4	3.5	3.6	—	
⁶ 24.4	—	14.0	9.5	2.5	4.0	2.8	2.1	7.8	6.3	2.1	3.5	6.1	2.4	—	—	9.4	0.52	0.30	—	1.4	—	—	3.6	3.6
⁶ 25.6	32.0	16.4	9.4	2.5	4.0	2.8	2.1	7.7	6.0	2.4	3.9	6.8	2.2	4.3	4.9	10.4	0.36	0.24	1.0	1.6	3.6	4.0	3.9	
⁶ 25.9	32.1	15.7	10.1	2.7	3.6	2.8	2.1	7.7	6.1	2.5	3.5	6.7	2.3	4.6	4.9	10.3	—	0.42	1.1	1.5	3.6	4.0	3.8	
⁶ 26.3	32.7	15.6	9.6	2.7	4.0	2.8	2.1	8.3	6.6	2.5	3.6	—	2.3	4.6	5.1	10.4	0.38	0.24	—	1.6	3.6	4.0	4.3	
⁶ 26.6	—	16.3	9.5	2.7	3.6	2.8	2.1	8.1	6.5	2.6	3.3	7.2	2.3	4.3	—	10.4	—	0.15	—	1.4	3.4	—	4.0	
⁶ 27.6	34.7	16.3	10.0	2.2	4.2	3.1	2.1	7.8	6.6	2.7	3.9	7.5	2.4	—	5.8	10.0	—	0.16	—	1.5	3.8	—	4.3	
⁶ 28.3	34.9	17.5	10.4	2.8	—	2.8	2.1	8.5	7.0	2.6	3.6	—	2.4	4.9	5.4	11.3	—	0.32	1.1	1.6	3.8	—	4.4	
⁶ 30.1	37.4	18.6	10.9	2.7	4.6	3.1	2.2	9.2	7.1	3.0	4.4	8.6	2.7	4.6	6.1	11.9	—	0.36	—	1.7	4.2	4.5	4.7	
⁶ 30.7	37.7	19.4	11.4	3.1	4.7	3.4	2.2	8.5	7.0	2.8	4.0	8.2	2.7	4.8	5.9	12.0	—	0.32	1.2	2.0	4.0	4.8	4.5	
⁶ 31.2	39.1	19.2	11.5	2.7	5.0	3.5	2.2	9.4	7.3	2.9	4.6	8.8	2.6	—	6.2	12.0	—	0.30	0.82	1.9	3.9	5.2	4.8	
⁶ 33.7	41.3	20.8	11.6	3.0	4.5	3.3	2.4	9.8	7.9	3.1	4.7	8.7	2.7	—	—	12.2	—	0.14	0.88	1.9	—	—	4.9	
⁶ 35.3	42.6	22.3	12.3	3.1	4.6	3.4	2.4	10.3	8.5	3.4	4.8	8.8	2.8	—	6.1	14.6	—	0.24	0.82	1.8	—	—	5.2	—
⁶ 65.0	80.5	37.0	23.2	4.5	10.7	7.7	4.1	22.0	17.0	6.1	8.8	17.5	6.3	11.0	14.7	26.0	0.92	(⁸)	1.1	3.8	—	10.9	12.7	
⁶ 65.3	79.7	40.0	23.4	4.3	10.0	7.5	4.0	20.7	16.4	6.3	9.0	17.2	6.3	10.4	14.5	27.0	0.60	(⁸)	1.2	3.8	9.4	10.8	12.0	
⁶ 70.8	86.3	41.1	26.9	6.7	10.9	8.3	4.2	22.0	17.2	6.4	9.8	19.2	6.8	10.4	15.0	30.1	0.44	(⁹)	0.92	4.2	9.2	11.0	12.4	
⁶ 73.7	89.7	43.5	27.8	7.0	11.7	8.1	4.6	23.5	19.6	7.0	10.6	18.7	7.5	11.4	15.0	29.7	0.46	(⁹)	1.0	4.4	10.5	12.2	12.9	
⁶ 74.8	91.3	43.7	27.7	5.8	11.0	8.1	4.5	23.4	20.0	6.9	10.4	19.5	7.4	11.0	15.2	30.1	0.80	(⁹)	0.86	4.4	10.7	12.5	15.2	

¹Usually fourth or fifth.²Usually midfin.³The second spine.⁴Forming.⁵Bump.⁶Transforming.⁷Pelagic juvenile.⁸Benthic juvenile.⁹Nuchal spine overgrown.

lower jaw; narrow interorbital distance (27.7% HL); and long, deeply serrated, parietal spine (26.5% HL). Later stage larvae change little in overall appearance from the smallest larva, except for addition of melanophores along the dorsal body surface beneath the spinous and soft dorsal fins, along the dorsal surface of the caudal peduncle, and at the articulation of some dorsal soft fin rays of specimens >12.5 mm. A row of melanophores along the lateral midline and a

strong, sharp preopercular spine develop during the transformation period. Meristic characters, presence of a preopercular and lack of a supraopercular spine, the flat-convex shape and narrow width of the interorbital space, and stout, relatively long, second anal spine serve to distinguish pelagic and benthic juveniles.

General Development.—The smallest specimens (7.4–8.5 mm) of *S. zacentrus* are undergoing the

final stage of notochord flexion, which is completed by ≈ 9 mm. Transformation from postflexion larva to pelagic juvenile occurs between ≈ 13.5 and 20 mm as indicated by structural change of the dorsal and anal fin prespines to sharp, hard spines. Melanistic pigmentation gradually increases along the dorsal body surface under the dorsal fins and along the lateral midline of the caudal peduncle through the larval and transformation periods. A more rapid increase in pigment over the body, progressing anterior to posterior, is initiated at the beginning of the pelagic juvenile stage (≈ 20 mm). Transition from pelagic to benthic habitat takes place at lengths somewhere between 35 and 65 mm. The largest pelagic juvenile was 65.0 mm. Because of the long-term pelagic sampling effort off Oregon and the lack of specimens in the 35-65 mm length range, it seems likely that this species transforms at a relatively small size (≈ 35 -40 mm). Small benthic juveniles would not be retained in the large mesh bottom trawls. The smallest benthic juvenile observed was 65.0 mm long.

Morphology (Tables 2, 6).—Various body parts were measured on 51 selected specimens of *S. zacentrus* (7.4-74.8 mm). Relative growth trends are summarized in Table 2.

This is a relatively deep-bodied form with body depth 35% SL in flexion larvae, decreasing to 30% in pelagic juveniles. It also has a rather large head, averaging 40-43% SL during the larval and transforming periods.

Fin Development (Tables 2, 5, 6).—The adult complement of 16-18, usually 17, pectoral fin rays is present in the smallest larva (7.4 mm). The pectoral fin is of moderate length, increasing from 15.3% SL in flexion larvae to 26.7 and 26.4% SL in pelagic and benthic juveniles, respectively.

The adult complement of pelvic fin spine and rays (I,5) is present on the smallest larva. The pelvic fin is moderately long increasing from 13.7 to 21.3% SL between flexion and benthic juvenile stages. The pelvic spine is also of moderate length, reaching 20% SL in transforming larvae.

The adult complement of 8+7 principal caudal fin rays can be counted on the smallest larva. Five benthic juveniles, ≈ 65 -75 mm, had superior and inferior secondary caudal fin rays, respectively: 10/11 (three specimens) and 11/10 (two specimens), as determined from radiographs.

Dorsal fin spines and rays, including prespines, are completely formed by ≈ 8 mm but developing elements are countable in the smallest larva (7.4 mm). The dorsal and anal fin prespines become spines by ≈ 15.5 and 20 mm, respectively, marking the beginning of the pelagic juvenile stage.

Spination (Tables 2, 7).—Spines on the left side of the head of the smallest *S. zacentrus* include the parietal; nuchal; first and third anterior preopercular spines; first, second, third, fourth, and fifth (as a bump) posterior preopercular spines; superior opercular spine (as a bump); postocular; first inferior infraorbital; first superior infraorbital; pterotic; and the inferior posttemporal spine.

The parietal spine and ridge are serrated on all specimens < 36 mm long. The relatively long (23% HL) parietal spine decreases in prominence to $\approx 3\%$ HL by the benthic juvenile stage. The nuchal spine is always smaller than the parietal and is completely fused to it in benthic juveniles.

All five posterior preopercular spines are present as sharp spines by 8.5 mm and persist in adults. The third spine is relatively long (33% HL in flexion larvae) and decreases in length with development to 4% HL in benthic juveniles. Serrations are present on the first anterior preopercular spine of specimens < 22 mm long, on the first and second posterior preopercular spines on specimens < 26.5 mm, and on the third posterior preopercular spine to ≈ 34 mm. The first and third anterior preopercular spines are reduced to blunt bumps by ≈ 25 mm and are absent on all specimens > 26.3 mm.

The superior opercular spine is sharp tipped by ≈ 8 mm. The inferior opercular spine appears as a blunt bump at ≈ 8 mm and becomes a sharp tipped spine by ≈ 13 mm. The interopercular spine appears as a blunt bump by ≈ 8 mm and as a small, sharp spine in all specimens > 12 mm. The subopercular spine appears as a blunt bump by ≈ 13 mm, is usually present as a short, sharp spine between 13 and 23 mm, is reduced to a blunt bump on specimens 23-26 mm, and is usually absent on specimens > 26 mm.

The ridge anterior to the postocular spine is serrated on specimens < 27 mm. The preocular spine appears as a blunt bump at 14 mm and usually as a moderately strong, sharp spine on most specimens > 15 mm. The first inferior infraorbital spine is present as a sharp spine on all specimens to 35 mm and as a blunt bump in the benthic juveniles examined (65.0-74.8 mm). The second

TABLE 7.—Development of spines in the head region of *Sebastes zacentrus* larvae and juveniles. Specimens

Standard length (mm)	Preopercular															Interopercular	Subopercular	Preopercular	Supraopercular	Postopercular
	Parietal	Nuchal	Anterior			Posterior					Opercular									
			1st	2d	3d	1st	2d	3d	4th	5th	Superior	Inferior								
7.4	+	+	+	-	+	+	+	+	+	(¹)	(¹)	-	-	-	-	-	+			
7.9	+	(¹)	+	-	+	+	+	+	+	(¹)	+	-	(¹)	-	-	-	+			
8.5	+	+	+	-	+	+	+	+	+	+	+	(¹)	(¹)	-	-	-	+			
9.2	+	+	+	-	+	+	+	+	+	+	+	(¹)	(¹)	-	-	-	+			
9.9	+	+	+	-	+	+	+	+	+	+	+	(¹)	(¹)	-	-	-	+			
10.1	+	+	+	-	(¹)	+	+	+	+	+	+	(¹)	(¹)	-	-	-	+			
10.6	+	+	+	-	+	+	+	+	+	+	+	(¹)	(¹)	-	-	-	+			
11.2	+	+	+	-	+	+	+	+	+	+	+	(¹)	-	-	-	-	+			
11.7	+	+	+	-	+	+	+	+	+	+	+	(¹)	+	-	-	-	+			
12.4	+	+	+	-	+	+	+	+	+	+	+	(¹)	(¹)	-	-	-	+			
12.7	+	+	+	-	+	+	+	+	+	+	+	+	(¹)	(¹)	-	-	+			
13.3	+	+	+	-	+	+	+	+	+	+	+	+	+	+	-	-	+			
² 13.7	+	+	+	-	+	+	+	+	+	+	+	+	+	+	-	-	+			
² 14.0	+	+	+	-	+	+	+	+	+	+	+	+	+	+	-	-	+			
² 14.8	+	+	+	-	+	+	+	+	+	+	+	+	+	+	(¹)	-	+			
² 15.0	+	+	+	-	+	+	+	+	+	+	+	+	+	+	(¹)	-	+			
² 15.6	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+			
² 16.3	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+			
² 16.8	+	(¹)	+	-	+	+	+	+	+	+	+	+	+	+	(¹)	-	+			
² 17.3	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+			
² 17.9	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+			
² 18.0	+	+	+	-	+	+	+	+	+	+	+	+	+	+	-	-	+			
² 18.9	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+			
² 19.3	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+			
² 19.6	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+			
³ 20.3	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+			
³ 20.6	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+			
³ 21.0	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+			
³ 21.5	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+			
³ 22.0	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+			
³ 22.6	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+			
³ 23.3	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+			
³ 23.5	+	+	+	-	+	+	+	+	+	+	+	+	+	(¹)	+	-	+			
³ 24.0	+	+	+	-	+	+	+	+	+	+	+	+	(¹)	(¹)	+	-	+			
³ 24.4	+	+	+	-	(¹)	+	+	+	+	+	+	+	(¹)	(¹)	+	-	+			
³ 25.6	+	+	(¹)	-	(¹)	+	+	+	+	+	+	+	+	(¹)	+	-	+			
³ 25.9	+	+	(¹)	-	+	+	+	+	+	+	+	+	+	(¹)	+	-	+			
³ 26.3	+	+	(¹)	-	(¹)	+	+	+	+	+	+	+	(¹)	(¹)	+	-	+			
³ 26.6	+	+	-	-	-	+	+	+	+	+	+	+	(¹)	-	+	-	+			
³ 27.6	+	+	-	-	-	+	+	+	+	+	+	+	(¹)	-	+	-	+			
³ 28.3	+	+	-	-	-	+	+	+	+	+	+	+	(¹)	-	+	-	+			
³ 30.1	+	+	-	-	-	+	+	+	+	+	+	+	(¹)	-	+	-	+			
³ 30.7	+	+	-	-	-	+	+	+	+	+	+	+	(¹)	-	+	-	+			
³ 31.2	+	+	-	-	-	+	+	+	+	+	+	+	(¹)	(¹)	+	-	+			
³ 33.7	+	+	-	-	-	+	+	+	+	+	+	+	(¹)	-	+	-	+			
³ 35.3	+	+	-	-	-	+	+	+	+	+	+	+	(¹)	-	+	-	+			
⁴ 65.0	⁵	⁵	-	-	-	+	+	+	+	+	+	+	(¹)	-	+	-	+			
⁴ 65.3	⁵	⁵	-	-	-	+	+	+	+	+	+	+	(¹)	-	+	-	+			
⁴ 70.8	⁵	⁵	-	-	-	+	+	+	+	+	+	+	(¹)	-	+	-	+			
⁴ 73.7	⁵	⁵	-	-	-	+	+	+	+	+	+	+	(¹)	-	+	-	+			
⁴ 74.8	⁵	⁵	-	-	-	+	+	+	+	+	+	+	(¹)	-	+	-	(¹)			

¹Bump, indicating beginning of spine formation or last stage before spine is overgrown.²Transforming.³Pelagic juvenile.⁴Benthic juvenile.⁵Parietal and nuchal spines fused, only one tip visible.

inferior infraorbital spine appears as a blunt bump at ≈ 8 mm and as a sharp spine in larger specimens. The first superior infraorbital spine is present as a sharp spine on all specimens < 23 mm, as either a sharp spine or a blunt bump between 23 and 35 mm, and was absent in the benthic juveniles examined (65.0-74.8 mm). The second superior infraorbital spine is occasionally present between 15 and 30 mm. The third superior infraorbital spine is usually present as a sharp spine in larvae and pelagic juveniles 14 to 35 mm. Smaller larvae and benthic juveniles examined lacked

this spine. The fourth superior infraorbital spine usually appears as a blunt bump in larvae 8-10 mm long and as a sharp spine in all larvae and pelagic juveniles > 10 mm. This spine was absent in benthic juveniles. The nasal spine appears as a blunt bump in larvae ≈ 10 -11 mm long and as a sharp spine in all larger specimens.

The tympanic spine appears as a blunt bump between 17 and 18 mm and as a sharp spine in all larger specimens. The pterotic spine is reduced to a blunt bump by 30 mm and is absent on benthic juveniles. The inferior posttemporal spine is pres-

above dashed lines are undergoing notochord flexion. + denotes spine present and - denotes spine absent.

Standard length (mm)	Intraorbital							Nasal	Coronal	Tympanic	Pterotic	Posttemporal		Supra-cleithral	Cleithral
	Inferior			Superior								Superior	Inferior		
	1st	2d	3d	1st	2d	3d	4th								
7.4	+	-	-	+	-	-	-	-	-	-	+	-	+	-	-
7.9	+	-	-	+	-	-	-	-	-	-	+	-	+	-	-
8.5	+	(!)	-	+	-	-	(!)	-	-	-	+	-	+	+	-

9.2	+	+	-	+	-	-	+	-	-	-	+	-	+	+	-
9.9	+	+	-	+	-	-	(!)	(!)	-	-	+	-	+	+	-
10.1	+	+	-	+	-	-	(!)	(!)	-	-	+	-	+	+	-
10.6	+	+	-	+	-	-	+	(!)	-	-	+	-	+	+	-
11.2	+	+	-	+	-	-	+	+	-	-	+	-	+	+	-
11.7	+	+	-	+	-	-	+	+	-	-	+	-	+	+	-
12.4	+	+	-	+	-	-	+	+	-	-	+	-	+	+	-
12.7	+	+	-	+	-	-	+	+	-	-	+	-	+	+	-
13.3	+	+	-	+	-	-	+	+	-	-	+	-	+	+	-
² 13.7	+	+	-	+	-	-	+	+	-	-	+	-	+	+	-
² 14.0	+	+	-	+	-	+	+	+	-	-	+	-	+	+	-
² 14.8	+	+	-	+	+	+	+	+	-	-	+	-	+	+	-
² 15.0	+	+	-	+	+	+	+	+	-	-	+	-	+	+	-
² 15.6	+	+	-	+	+	+	+	+	-	-	+	-	+	+	-
² 16.3	+	+	-	+	+	+	+	+	-	-	+	-	+	+	-
² 16.8	+	+	-	+	+	+	+	+	-	-	+	-	+	+	-
² 17.3	+	+	-	+	+	+	+	+	-	(!)	+	(!)	+	+	-
² 17.9	+	+	-	+	+	+	+	+	-	(!)	+	-	+	+	-
² 18.0	+	+	-	+	(!)	+	+	+	-	(!)	+	+	+	+	-
² 18.9	+	+	-	+	(!)	+	+	+	-	+	+	(!)	+	+	-
² 19.3	+	+	-	+	+	+	+	+	-	-	+	+	+	+	-
² 19.6	+	+	-	+	(!)	+	+	+	-	+	+	+	+	+	(!)
³ 20.3	+	+	-	+	(!)	+	+	+	-	+	+	+	+	+	(!)
³ 20.6	+	+	-	+	-	+	+	+	-	+	+	+	+	+	+
³ 21.0	+	+	-	+	-	+	+	+	-	+	+	+	+	+	+
³ 21.5	+	+	-	+	-	+	+	+	-	+	+	+	+	+	(!)
³ 22.0	+	+	-	+	-	+	+	+	-	+	+	+	+	+	-
³ 22.6	+	+	-	+	-	+	+	+	-	+	+	+	+	+	-
³ 23.3	+	+	-	(!)	+	+	+	+	-	+	+	+	+	+	+
³ 23.5	+	+	-	(!)	-	+	+	+	-	+	+	+	+	+	+
³ 24.0	+	+	-	(!)	-	+	+	+	-	+	+	+	+	+	(!)
³ 24.4	+	+	-	+	+	+	+	+	-	+	+	+	+	+	+
³ 25.6	+	+	-	+	+	+	+	+	-	+	+	+	+	+	+
³ 25.9	+	+	-	+	+	+	+	+	-	+	+	+	+	+	+
³ 26.3	+	+	-	+	+	+	+	+	-	+	+	+	+	+	+
³ 26.6	+	+	-	+	+	+	+	+	-	+	+	+	+	+	(!)
³ 27.6	+	+	-	+	-	+	+	+	-	+	+	+	+	+	+
³ 28.3	+	+	-	(!)	-	+	+	+	-	+	+	+	+	+	+
³ 30.1	+	+	-	+	(!)	+	+	+	-	+	(!)	+	+	+	+
³ 30.7	+	+	-	(!)	-	+	+	+	-	+	(!)	+	+	+	+
³ 31.2	+	+	-	(!)	-	+	+	+	-	+	(!)	+	+	+	+
³ 33.7	+	+	-	(!)	-	(!)	+	+	-	+	(!)	+	+	+	+
³ 35.3	+	+	-	(!)	-	+	+	+	-	+	(!)	+	+	+	+
⁴ 65.0	(!)	+	-	-	-	-	-	+	-	+	-	+	+	+	+
⁴ 65.3	(!)	+	-	-	-	-	-	+	-	+	-	+	+	+	+
⁴ 70.8	(!)	+	-	-	-	-	-	+	-	+	-	+	+	+	+
⁴ 73.7	(!)	+	-	-	-	-	-	+	-	+	-	+	+	+	+
⁴ 74.8	(!)	+	-	-	-	-	-	+	-	+	-	+	+	+	+

ent in all specimens examined. The supracleithral spine appears by ≈ 8 mm and is present as a sharp spine on all larger specimens. The superior posttemporal spine appears as a blunt bump at ≈ 17 mm and is present as a sharp spine on all specimens >19 mm long. The cleithral spine appears as a blunt bump at ≈ 20 mm and is usually present as a sharp spine in specimens >23 mm.

Scale Formation.—Lateral line organs, indicated by a row of light colored spots on the flesh, are visible on the smallest larva and most larger larvae before scales form. Developing scales are visible on unstained specimens at 19.6 mm in the

region above the pectoral fin, near the posttemporal and supracleithral spines. The body is scale covered by ≈ 30 mm.

Pigmentation.—The smallest *S. zacentrus* larva has melanistic pigmentation on the head over the brain, inside the tip of the lower jaw, and along the anteroventral margin of the maxillary. Melanophores are densely concentrated on the dorsal surfaces of the gut and are present in lesser concentrations on the body wall over the gut cavity. Four small melanophores are present along the ventral midline of the caudal peduncle. The pectoral and pelvic fin membranes are covered with

moderately large and elongate melanophores. Melanophores are also present along the ventral margin and underside of the pectoral fin base.

As larvae develop, pigment increases on the head over the brain, and a few small melanophores may appear on the snout in larvae >12 mm. Melanophores appear on the opercle by ≈ 8 mm and increase in number with development. By ≈ 12 mm, melanophores appear just above the opercle near the pterotic and inferior posttemporal spines. About one-half of larvae observed have at least one melanophore along the anterior margin of the cleithrum beneath the opercle. Gut pigmentation remains intense through the larval period. Melanophores begin to appear on the nape and along the dorsal surface of the body beneath the spinous and soft dorsal fins by ≈ 12 mm. This pigmentation beneath the soft dorsal fin is composed of large, expanded melanophores and always appears as the most densely pigmented area on larvae. The small melanophores along the ventral midline of the caudal peduncle usually disappear by ≈ 10 mm; two specimens, 12.4 and 13.3 mm, had one and two melanophores in this region, respectively. A single larva (11.7 mm) had one melanophore on the margin of the hypural plate. The pectoral and pelvic fin membranes are usually pigmented in larvae although the intensity and number of melanophores decreases with development. By 12 mm, melanophores entirely disappear from the pectoral fin base.

Early in the transformation period (≈ 14 -20 mm), melanistic pigmentation rapidly appears over the dorsal surfaces of the snout, head, nape, body, and caudal peduncle and then continues to increase gradually ventrolaterally with development. Melanophores appear on the cheek, posteroventral to the eye by 14 mm, and begin to extend around the posteroventral portion of the orbit by ≈ 16 mm. Melanophores extend from the nape anteriorly joining the head pigment and laterally toward the body midline at the same time that pigment extends ventrolaterally from beneath the spinous dorsal fin. By ≈ 16 mm, some melanophores appear aligned along the myosepta over the anterior one-fourth of the body but never appear very distinct. By ≈ 15.5 mm, internal and external melanophores appear along the lateral midline anterior to the point of notochord flexion and just posterior to the head on specimens greater than ≈ 16 mm. Melanophores appear along the margin of the hypural elements in most specimens >16 mm. A melanophore appears at the point of

articulation of most dorsal fin rays on specimens >15 mm, occasionally of some anal rays on specimens 13.5-19 mm, and of most anal fin rays on all specimens >19 mm. Melanophores are usually absent on the pelvic fin membrane on transforming larvae. Specimens >14 mm usually lack melanophores on the pectoral fin membrane. A single larva (19.3 mm) had a few small melanophores near the anterior base of the spinous dorsal fin membrane.

Melanistic pigmentation continues to intensify and increase gradually on pelagic juveniles, 20-35 mm. Melanophores cover the dorsal surface of the head and appear at the tips of the upper and lower lips by ≈ 24 mm. By ≈ 28 mm, melanophores extend over the cheek and around the posterior half of the orbit which becomes completely encircled by pigment at ≈ 30 mm. Melanophores appear on the gular region by ≈ 30 mm. Internal and external melanophores form a continuous irregular row along the lateral body midline by ≈ 20 mm. Melanophores also cover the ventrolateral area anterior to the soft dorsal fin between the dorsal margin and the lateral midline. At ≈ 21 mm, the large, expanded melanophores under the soft dorsal become concentrated along muscles surrounding the dorsal pterygiophores giving the appearance of vertical lines of pigment. Pigmentation on the body and caudal peduncle extends nearly to the ventral surface on specimens >28 mm. Areas of somewhat intensified pigmentation extend posteroventrally from the nape and spinous and soft dorsal fin bases appearing as faint saddles. A few small melanophores are occasionally present along the anterior portion of the spinous dorsal fin membrane near its base on pelagic juveniles <35 mm. The largest pelagic juvenile (35.3 mm) has melanophores scattered over the proximal two-thirds of the spinous dorsal membrane. Small melanophores appear on the caudal fin near its base by ≈ 25 mm.

Benthic juveniles, 65.0-74.8 mm, have about the same pigment pattern as that of the largest pelagic juvenile. However, they are more darkly pigmented due to the addition of numerous small melanophores over most surfaces of the head, body, and fins. The added pigmentation over the upper areas of the head and opercle, and on the body results from development of melanophores borne on the scales and skin tissue surrounding the scale pockets. This pigmentation overlies the larval and pelagic juvenile pigment which persists on benthic juveniles most obviously beneath the soft

dorsal fin where large melanophores remain. Melanophores on the dorsal portion of the opercle increase in number and intensify appearing as a patch of darker pigment. A single bar of pigment extends from the posteroventral margin of the eye across the cheek and opercle. Five faint saddles extend, one from the nape, two under the spinous dorsal fin, one under the soft dorsal fin, and one across the caudal peduncle, ventrolaterally from the dorsal surface of the body to just beneath the lateral midline. Spinous and soft dorsal fin membranes are covered by small melanophores with bands of more intense pigmentation extending across the fins as extensions of the body saddles. The largest benthic juvenile (74.8 mm) also has moderately intense pigmentation along the distal edge of the spinous dorsal fin membrane, concentrated immediately posterior to each dorsal spine. The caudal fin of benthic juveniles is lightly covered by small melanophores with sometimes a slightly darker bar of pigment apparent in the proximal third of the fin. A few small melanophores are present on the proximal half of the anal fin membrane, and small melanophores lightly cover the proximal half of the dorsalmost pectoral fin rays and the adjacent pectoral fin base.

Occurrence (Figures 9, 10).—Adult *S. zacentrus* occur from San Diego, Calif., to the Sanak Islands, Alaska, lat. 54.13° N, long. 161.37° W (Miller and Lea 1972; Hart 1973). Data from Niska (1976) show that 95% of the total Oregon trawl catch of *S. zacentrus* landed from 1963 through 1971 was taken from depths of 181-416 m. Highest concen-

trations of *S. zacentrus* found during a rockfish survey in 1977 between Pt. Hueneme and Cape Flattery were at depths of 183-272 m between Cape Blanco and the Columbia River, lat. 43°00'-47°30' N (Harling et al. footnote 7). Larval *S. zacentrus*, including transforming specimens, in our collections were captured at stations ranging from 46 to 148 km offshore, ≈270-2,800 m depth. The data seem to indicate a more restricted offshore distribution for *S. zacentrus* larvae than for some other rockfish species: i.e., *S. entomelas*, 9-306 km; *S. pinniger*, 13-306 km; *S. flavidus*, 24-266 km; and *S. melanops*, 5-266 km (Richardson and Laroche 1979; Laroche and Richardson 1980). This is of interest as presumably the morphology of *S. zacentrus*, i.e., large head spines, stubby and deep body, would tend to enhance larval transport as suggested for *S. pinniger* (Richardson and Laroche 1979). The more restricted offshore occurrence of larvae may reflect the season of occurrence and associated wind regimes which are from the south and towards the coast in fall and winter. This would tend to minimize offshore dispersal. Pelagic juveniles occurred in about the same offshore area, 9-148 km offshore, as larvae. All demersal juveniles were taken from a single otter trawl haul made ≈40 km offshore, 91 m depth.

Reported parturition time for *S. zacentrus* is July off Oregon (Westheim 1975). Larvae <10 mm were taken in August only, and larger pelagic specimens were taken August through December. Demersal juveniles were taken from a single October collection.

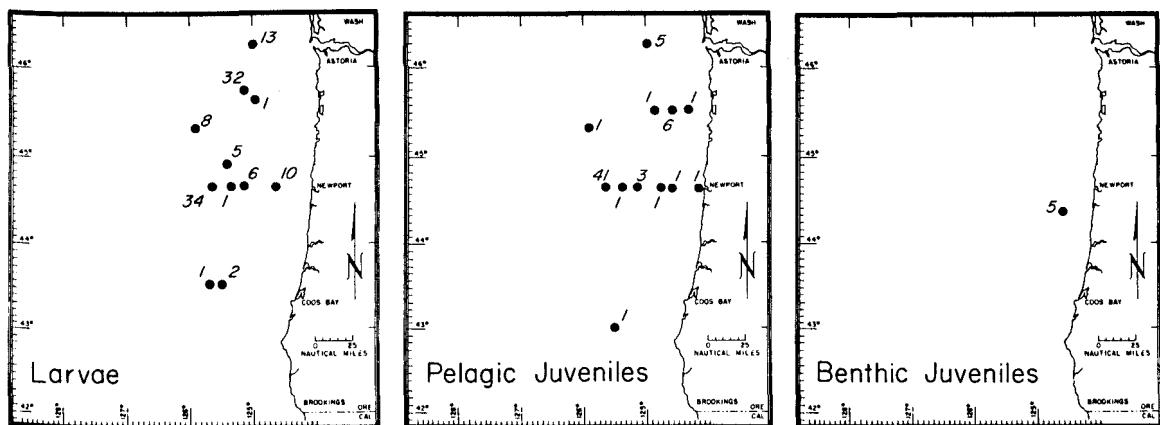


FIGURE 9.—Number of specimens and location of capture of larvae and juveniles of *Sebastes zacentrus* off Oregon (1961-78) described in this paper.

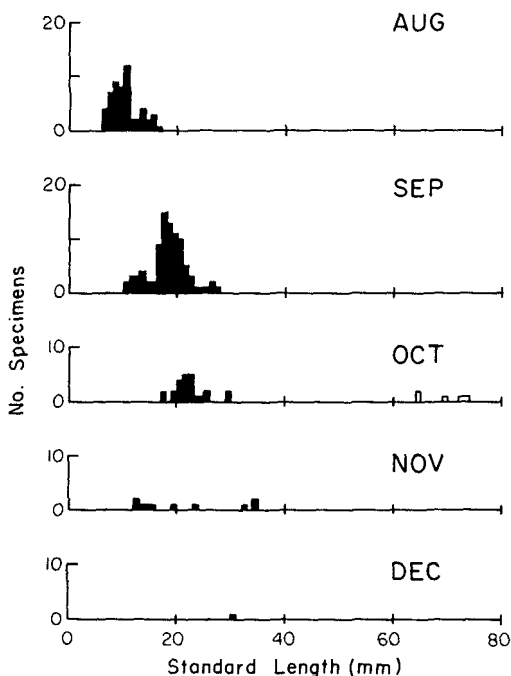


FIGURE 10.—Seasonal occurrence of larvae and juveniles of *Sebastes zacentrus* off Oregon. Data from 1961 through 1978 combined. Solid bars indicate pelagic stages, open bars indicate benthic stages.

COMPARISONS

Prior to this paper, developmental series of 12 of the 69 northeast Pacific (including Gulf of California) species of *Sebastes* had been described: *S. cortezi*, *S. crameri*, *S. Gulf Type A*, *S. flavidus*, *S. helvomaculatus*, *S. jordani*, *S. levis*, *S. macdonaldi*, *S. melanops*, *S. melanostomus*, *S. paucispinis*, and *S. pinniger* (Moser 1967, 1972; Moser et al. 1977; Moser and Ahlstrom 1978; Richardson and Laroche 1979; Laroche and Richardson 1980). Comparisons among a number of these species were discussed by Richardson and Laroche (1979) and Laroche and Richardson (1980).

Young stages of *S. entomelas* are relatively slender, with relatively light pigmentation, only moderate head spines, and pectoral and pelvic fins of moderate length. The ontogeny of *S. entomelas* is very similar to that of *S. flavidus* and *S. melanops* which also are moderately slender with only moderate head spines. Pigmentation develops in similar fashion in all three species, i.e., along the dorsal and lateral midlines, although it is less intense in *S. entomelas*. None of the three species develop

pigment saddles. Larvae and juveniles of the three are separable by meristic characters.

Young *S. zacentrus* are comparatively deep bodied, with relatively large head and head spines, rather light pigmentation, moderately long pectoral fins, and relatively long pelvic fins especially in the early stages. Other deep-bodied (>30% SL) forms include *S. crameri*, *S. melanostomus*, and *S. pinniger*. Among these species, head spines are pronounced in all but *S. crameri*. The early lack of pigmentation and later development of five pigment saddles in *S. zacentrus* is shared with *S. crameri*, *S. helvomaculatus*, *S. levis*, *S. melanostomus*, *S. paucispinis*, and *S. pinniger*, although the saddles of *S. zacentrus* are less distinct than in the other species. The presence of pigment along the dorsal body surface beneath the dorsal fins of postflexion larvae and pelagic juveniles of *S. zacentrus* is also seen in *S. flavidus*, *S. jordani*, and *S. melanops*. These three species develop a dense dorsolateral covering of melanophores that is not restricted to saddles. Larvae and juveniles of *S. zacentrus* are distinguishable from all of these species on the basis of meristic characters.

HEAD SPINE NOTES

A group of four similar species, *S. entomelas*, *S. flavidus*, *S. melanops*, and *S. mystinus* occur off Oregon and are difficult to identify and separate as larvae and juveniles. We have discovered that literature describing head spine patterns among this group of species is inaccurate and contradictory. After completion of our work on *S. flavidus* and *S. melanops* (Laroche and Richardson 1980) and during the course of our present work on *S. entomelas*, we found undescribed variation in head spine patterns among the species of this group. To insure accurate identification of variant specimens, we quantified and compiled data on spine pattern variation among this group of species. This new information is summarized here. It will aid in identification and separation of the species within the group, particularly of variant specimens.

The original description of *Sebastes entomelas* (Jordan and Gilbert 1880) described the preocular, supraocular, and postocular spines as minute, sharp, and concealed by scales. Phillips (1957) reported the above spines plus the tympanic spine were present on specimens "under about eight inches ..." (203 mm) long and become "nearly all obsolete" in large specimens with occasionally the

tips of the preocular spine weakly present. Hitz (1965) indicated that only the preocular spine is present. Hart (1973) stated that head spines are absent or weakly present, represented by the tip of the preocular spine. The original description of *S. mystinus* (Jordan and Gilbert 1881) stated that the "top of head" is without spines, with the exception of a very small nasal spine and sometimes a preocular spine present. Phillips (1957) and Hitz (1965) also reported this spine pattern. Miller and Lea's (1972) key to the rockfishes of California placed *S. mystinus* in the category of having head spines "weak or obsolete." Hart (1973) reported nasal and "... occasionally minute preopercular [sic = preocular] spines present" with other spines usually obsolete.

Supraorbital spines are small even in juveniles and have often been overlooked on *S. entomelas* and *S. mystinus*. We found that preocular, supraocular, postocular, and tympanic spines are usually present in both *S. entomelas* and *S. mystinus*, although the first two spines may be absent on one side of the head. The only exception observed was one juvenile *S. mystinus* which lacked both preocular spines. These spines eventually become overgrown by scales, tissue, and bone but using a dissecting microscope they are visible on all specimens examined including adults to 342 mm. However, scales and tissue must first be probed away before observation in *S. mystinus* >150 mm. In *S. entomelas* (115 pelagic juveniles, 49-78 mm) from Oregon, 4% lacked one preocular spine and 4% lacked one supraocular spine. In *S. mystinus* (135 pelagic juveniles, 51-71 mm) from Oregon, 6% lacked one preocular spine, and no specimen lacked a supraocular spine.

During our previous study of *S. flavidus* and *S. melanops* (Laroche and Richardson 1980) some variation in supraorbital head spine patterns (i.e., occasional presence of preocular and supraocular spines) was observed which could potentially

cause confusion with *S. entomelas*. Although similar, *S. mystinus* has distinctive fin and scale counts (Laroche and Richardson 1980). Because we lacked material to quantify the spine variations, we excluded any variants (i.e., any specimens having preocular or supraocular spines) from the *S. flavidus* and *S. melanops* selected for the developmental series to insure positive identification. New data quantifying spine pattern variation in juveniles of these two species are presented here (Table 8). Presence of a preocular spine is quite rare but occurrence of a supraocular spine is more variable particularly in specimens from Oregon. Separation of *S. entomelas* from these two species is still possible for most specimens based on presence or absence of the preocular spine since >96% of *S. entomelas* and <2% of *S. flavidus* and *S. melanops* have one. Scale and fin ray counts further distinguish these species as described by Laroche and Richardson (1980).

ACKNOWLEDGMENTS

We wish to thank the following people for providing specimens for examination: William Barss, Carl Bond, Tina Eschevera, William Eschmeyer, Wendy Gabriel, Gary Hettman, Michael Hosie, Howard Jones, Earl Krygier, Robert Lea, Jerry Lucas, Lawrence Moulton, William Percy, and Jose Sepulveda-Vidal. Special thanks are extended to William G. Percy for allowing us to use his extensive midwater trawl collections from waters off Oregon and to Joan Newman for typing the tables and somehow maintaining good humor.

LITERATURE CITED

- 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.

TABLE 8.—Percentage occurrence of preocular and supraocular spines in juvenile *Sebastes flavidus* and *S. melanops*.

Species	Preocular spines			Supraocular spines		
	Absent both sides	Absent one side	Present both sides	Absent both sides	Absent one side	Present both sides
<i>S. flavidus</i> :						
¹ British Columbia (N = 37;42-56 mm)	100	0	0	95	5	0
² Oregon (offshore) (N = 72;47-59 mm)	98	2	0	64	28	8
<i>S. melanops</i> :						
¹ British Columbia (N = 98;45-66 mm)	100	0	0	96	4	0
² Oregon (offshore) (N = 105;43-60 mm)	98	1	1	51	30	18
¹ Oregon (tidepools) (N = 101;43-60 mm)	100	0	0	69	23	8
¹ California (tidepools) (N = 80;41-53 mm)	80	0	0	70	9	1

¹Benthic juveniles.
²Pelagic juveniles.

- (Transl. Isr. Program Sci. Transl.; available Clearinghouse Fed. Sci. Tech. Inf., Springfield, Va., as TT71-50127.)
- HART, J. L.
1973. Pacific fishes of Canada. Fish. Res. Board Can., Bull. 180, 740 p.
- HITZ, C. R.
1965. Field identification of the northeastern Pacific rockfish (*Sebastes*). U.S. Fish Wildl. Serv. Circ. 203, 58 p.
- JORDAN, D. S., AND C. H. GILBERT.
1880. Descriptions of two new species of *Sebastichthys* (*Sebastichthys entomelas* and *Sebastichthys rhodochloris*) from Monterey Bay, California. Proc. U.S. Natl. Mus. 3:142-146.
1881. Description of *Sebastichthys mystinus*. Proc. U.S. Natl. Mus. 4:70-72.
- LAROCHE, W. A., AND S. L. RICHARDSON.
1980. Development and occurrence of larvae and juveniles of the rockfishes *Sebastes flavidus* and *Sebastes melanops* (Scorpaenidae) off Oregon. Fish. Bull., U.S. 77:901-924.
- 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.
- 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., 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.
- 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.
- 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.
1964-78. Data series: Groundfish section (formerly bottom or trawl fish section). Pac. Mar. Fish. Comm., Portland, Oreg., 561 p.
- PHILLIPS, J. B.
1957. A review of the rockfishes of California (family Scorpaenidae). Calif. Dep. Fish Game, Fish Bull. 104, 158 p.
1958. Rockfish review. In The marine fish catch of California for the years 1955 and 1956 with rockfish review, p. 7-25. Calif. Dep. Fish Game, Fish Bull. 105.
1964. Life history studies on ten species of rockfish (genus *Sebastes*). Calif. Dep. Fish Game, Fish Bull. 126, 70 p.
- RICHARDSON, S. L., AND W. A. LAROCHE.
1979. Development and occurrence of larvae and juveniles of the rockfishes *Sebastes crameri*, *Sebastes pinniger*, and *Sebastes helvomaculatus* (family Scorpaenidae) off Oregon. Fish. Bull., U.S. 77:1-46.
- WESTRHEIM, S. J.
1975. Reproduction, maturation, and identification of larvae of some *Sebastes* (Scorpaenidae) species in the northeast Pacific Ocean. J. Fish. Res. Board Can. 32:2399-2411.
- WESTRHEIM, S. J., AND W. R. HARLING.
1975. Age-length relationships for 26 scorpaenids in the northeast Pacific Ocean. Environ. Can. Fish. Mar. Serv. Tech. Rep. 565, 12 p.

APPENDIX TABLE 1.—Frequency distributions of soft fin rays, lateral line pores, diagonal scale rows below the lateral line, and gill rakers for juvenile and adult *Sebastes emphaeus*, *S. proriger*, *S. wilsoni*, and *S. zacentrus*.

Species	Side	Pectoral fin rays			Dorsal fin soft rays				Anal fin soft rays			Lateral line pores											N	\bar{x}	SD							
		16	17	18	13	14	15	16	6	7	8	37	38	39	40	41	42	43	44	45	46	47				48	49	50	51	52	53	
<i>S. emphaeus</i> ¹	Left	—	35	2	2	33	2	—	—	35	2	—	—	1	7	5	10	5	3	4	1	1	—	—	—	—	—	—	37	42.3	1.9	
	Right	—	35	2	—	—	—	—	—	—	—	—	—	—	1	5	7	7	8	4	3	2	—	—	—	—	—	—	37	42.4	1.8	
<i>S. proriger</i> ²	Left	3	44	—	1	22	22	1	2	44	—	—	—	—	—	—	—	—	—	1	—	—	—	9	8	6	10	8	5	47	50.2	1.9
	Right	—	46	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	6	5	9	10	8	2	6	47	49.8	1.9	
<i>S. wilsoni</i> ³	Left	1	18	—	2	15	2	—	17	2	—	1	—	—	3	4	5	3	3	—	—	1	—	—	—	—	—	20	42.0	2.1		
	Right	1	18	—	—	—	—	—	—	—	—	1	—	—	7	1	3	3	3	1	—	—	—	—	—	—	—	19	41.6	2.0		
<i>S. zacentrus</i> ⁴	Left	2	36	2	5	30	4	1	3	37	—	—	3	2	8	8	3	6	7	1	1	1	—	—	—	—	—	40	41.8	2.2		
	Right	2	35	3	—	—	—	—	—	—	—	—	—	1	1	8	8	7	6	4	2	—	1	1	—	1	—	40	42.2	2.4		

Species	Side	Diagonal scale rows below lateral line											N	\bar{x}	SD															
		41	42	43	44	45	46	47	48	49	50	51				52	53	54	55	56	57	58	59	60	61					
<i>S. emphaeus</i>	Left	1	2	2	9	8	8	5	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	37	45.0	1.6
	Right	—	—	2	4	6	13	4	3	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	34	45.9	1.6
<i>S. proriger</i>	Left	—	—	—	—	—	—	—	—	—	—	—	—	1	4	5	5	4	2	1	—	—	—	—	—	—	—	23	56.0	1.9
	Right	—	—	—	—	—	—	—	—	—	1	—	—	1	3	2	4	2	3	3	1	1	—	—	—	—	—	21	56.4	2.6
<i>S. wilsoni</i>	Left	—	—	1	1	1	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7	46.0	2.2
	Right	—	—	—	2	1	—	—	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6	46.0	2.3
<i>S. zacentrus</i>	Left	—	—	—	—	4	4	2	4	5	3	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	24	47.9	2.2
	Right	—	—	1	1	4	4	3	2	5	3	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	25	47.6	2.7

Species	Side	Gill rakers on lower bar of 1st gill arch									Gill rakers on upper bar of 1st gill arch					Total gill rakers on 1st gill arch											N	\bar{x}	SD	
		23	24	25	26	27	28	29	30	31	9	10	11	12	13	32	33	34	35	36	37	38	39	40	41	42				43
<i>S. emphaeus</i>	Left	—	—	—	—	—	5	13	15	4	—	—	17	17	2	—	—	—	—	—	—	—	4	6	12	11	3	36	41.1	1.1
	Right	—	—	—	—	—	5	7	22	3	—	—	18	16	3	—	—	—	—	—	—	—	4	3	14	13	3	37	41.2	1.1
<i>S. proriger</i>	Left	—	—	—	11	17	18	1	—	—	—	7	32	8	—	—	—	—	—	1	11	18	12	4	1	1	—	48	38.3	1.2
	Right	—	—	—	8	23	12	2	1	—	—	9	35	2	—	—	—	—	—	2	11	18	13	1	—	—	—	45	38.0	0.9
<i>S. wilsoni</i>	Left	—	—	—	2	9	8	1	—	—	—	18	2	—	—	—	—	—	—	—	2	8	8	2	—	—	—	20	39.5	0.8
	Right	—	—	—	—	1	10	7	2	—	—	16	4	—	—	—	—	—	—	—	1	10	4	4	1	—	—	20	39.7	1.0
<i>S. zacentrus</i>	Left	1	7	17	14	1	—	—	—	—	1	34	5	—	—	1	—	6	18	10	5	—	—	—	—	—	—	40	35.3	1.0
	Right	1	3	17	18	1	—	—	—	—	3	34	3	—	—	1	—	4	16	16	3	—	—	—	—	—	—	40	35.4	1.0

¹Thirty-five *S. emphaeus* collected at lat. 40°12.9' N, long. 124°23.7' W off northern California, and two specimens were collected from Hein Bank (lat. 48°21.5' N, long. 123°02.5' W).²All *S. proriger* were collected off Oregon between lat. 43°59' and 45°09' N.³*Sebastes wilsoni* were collected off Oregon and California between lat. 36°52' and 45°56' N.⁴All *S. zacentrus* were collected off Oregon between lat. 43°23.7' and 45°09' N.