Northwest Atlantic Fisheries Organization

Serial No. N528

NAFO SCR Doc. 82/VI/39

SCIENTIFIC COUNCIL MEETING - JUNE 1982

Identity of the larval redfish (*Sebastes* spp.) population on Flemish Cap: Preliminary Report

by

R. W. Penney
Research and Resource Services
Department of Fisheries and Oceans
P. O. Box 5667
St. John's, Newfoundland A1C 5X1

ABSTRACT

A brief description of morphology and meristic development of head spines, ossification of fin rays, vertebrae, gill rakers and brachiostegal rays, numbers of sub-caudal melanophores and onset of notochord flexion of *Sebastes* spp. larvae from Flemish Cap is presented. Larvae extruded in April and early May had 30-31 vertebrae, 8-10 anal fin rays, typically none or only one subcaudal melanophore and initiated notochord flexion >11.00 mm S.L. Larvae extruded later than mid-May had 29 vertebrae, 7 anal fin rays, typically two sub-caudal melanophores and 95.6% had initiated notochord flexion <11.0 mm S.L. Justification that larvae extruded during April - early May are predominantly *Sebastes mentella* and *S. marinus* followed by *S. fasciatus* from late May to July is discussed.

INTRODUCTION

In depth analysis and interpretation of larval redfish, *Sebastes* spp., data collected during several research cruises since 1978 as part of the Flemish Cap Project are compromised by complications resulting from inability to differentiate between larvae of *Sebastes mentella* Travin, *S. marinus* L. and *S. fasciatus* Storer. Preliminary data from 1980 and 1981 probing this problem are presented. While the taxonomic status of these three members of the Northwest Atlantic *Sebastes* complex is controversial, no attempt is made herein to argue for or against the nomenclature.

MATERIALS AND METHODS

During 1980, three Canadian research cruises were made to Flemish Cap: 6-13 April, 20-26 May, 22-28 July. In 1981, five Canadian cruises were made: April 27-May 10, May 22-27, June 26-July 5, June 26-July 7, August 1-4. Sampling procedures were as described by Anderson (MS 1981). Larvae were cleared and stained for meristics by the method of Dingerkus and Uhler (1977). Larvae measured for stage of notochord flexion and sub-caudal melanophore counts were viewed with a stereomicroscope at 10X-20X. All body length measurements are standard lengths measured from tip of snout to end of notochord until notochord flexion is complete. Thereafter, standard length is measured to the end of the hypural plate. Terminology of head spines follows Richardson and LaRoche (1979) and Phillips (1957). A composite drawing showing the position and terminology of head spines in this paper is shown in Fig. 1. Terminology used for fin rays and spines follows Moser et al. (1977).

RESULTS

Head Spines (Table 1)

At extrusion, no spines are present in the head area of *Sebastes* spp. larvae from Flemish Cap. Spines first develop in larvae at 9.0-9.9 mm. Spines visible on the left side of the head of stained larvae in this length group include the nuchal, second and third posterior preopercular spines, second anterior preopercular spines, pterotic and postocular spine. At this stage the second anterior preopercular spine is only a bump and would not be visible externally in unstained specimens.

At 11.0-11.9 mm, the fourth anterior preopercular spine appears as a bump and the fourth posterior preopercular spine is visible. The first posterior preopercular spine appears in larvae 12.0-12.9 mm as does the third anterior preopercular spine, the supracleithral and superior posttemporal. The posterior preopercular series is complete at the 13.0-13.9 mm interval with the addition of the fifth spine. The anterior preopercular series is not complete until the 21.0-21.9 mm interval with the addition of the first spine. The opercular series with superior and inferior spines appear at 13.0-13.9 mm as does the nasal and parietal spines. The parietal spine forms a ridge at this stage and is finely serrated. In larvae >20 mm the parietal and nuchal spines tend to become progressively fused.

The orbital series, composed of the infraorbitals and suborbitals appear at 13.0-13.9 mm with the first infraorbital spine of the first series, first spine of the 3rd series and the first suborbital spine. The second suborbital spine appears at 14.0-14.9 mm but the next infraorbital spine, the second spine of the first series, does not appear until 20.00-20.9 mm. Both spines of the second infraorbital series appear in one individual in the 21.0-21.9 mm interval but they are not present in larger specimens.

Other spines in the ocular series, the preocular and supraocular are relatively late appearing. The preocular was present in one individual in the 16.0-16.9 mm interval but does not appear again until 22.0-22.9 mm. The supraocular appears in the 21.0-21.9 mm interval. Of the remaining spines, the inferior posttemporal appears in the 16.0-16.9 mm interval, the cleithral in the 23.0-23.9 mm interval and the tympanic in one individual at 32.00 mm. No coronal spines were present in any specimen in the size ranges examined.

Fin Rays and Spines (Table 2)

At extrusion, only the pectoral and caudal fins are present but none of their rays are ossified. The superior caudal fin rays first stained with alcian blue, indicating beginning cartilage development, in an individual at 9.2 mm. Ossification begins ≃ 10 mm coinciding with the start of notochord flexion. The adult complement of 8 superior principal caudal rays and 7 inferior principal caudal rays is attained at the end of the notochord flexion although all rays may not be ossified until shortly thereafter. Procurrent caudal rays do not appear until after notochord flexion begins. In one individual at 13.7 mm, 5 superior and 6 inferior procurrent rays are ossified. Ossification proceeds slowly thereafter with 12 superior and 12 inferior procurrent caudal rays being attained by 32 mm.

Ossification of fin rays in all other fins apparently does not occur until notochord flexion is complete. Except for one post-flexion individual at 12.00 mm which had 4 pectoral fin rays ossifying, all other fin ray ossification appeared in the post-flexion individuals at 13.7 mm or larger. At this time the pelvic fin and pectoral fin had reached their adult I-5 complement and 19-20 soft ray complement respectively. All rays of the anal and dorsal fins are apparently present at this stage but some prespines remain undifferentiated. The anal fin has two spines at this stage with the third remaining as a soft prespine until 23-32 mm. The dorsal fin also has 14-15 spines in specimens >14 mm, although the adult complement is probably 15. Soft rays, which are ossified in individuals > 16 mm, number 15-17 through the larval period. Three specimens with anal fin rays ossified, extruded later than day 134 (14 May) (see Table 3), had 8 anal fin rays (corresponds to adult complement of 7). All specimens extruded earlier than 14 May had 9-11 anal fin rays (correspond to adult complement of 8-10).

Brachiostegal Rays (Table 2)

Brachiostegals begin to ossify ≃ 9.0 mm but the adult complement of 7 is not reached until after the completion of notochord flexion. While the adult complement in Sebastes genus is almost always 7, it is interesting to note that two individuals at 14.5 mm and 16.2 mm had 8 brachiostegals. Both of these were extruded later than day 134 (14 May) (see Table 3).

Gill Rakers (Table 2)

Gill rakers on the lower arm of the gill arch begin to ossify ≃ 9.0 mm. The number increases steadily throughout the larval period reaching 24 at 32.0 mm. Gill rakers on the upper arm do not appear until near the completion of notochord flexion at 13-14 mm. Individuals >18 mm have 9-10 gill rakers on the upper arm of the gill arch.

Vertebrae (Table 2)

Ossification of vertebrae does not begin until near the end of notochord flexion at 13-14 mm proceeding rapidly to the adult complement of 29-31 vertebrae. All post-flexion larvae > 14 mm apparently have the adult complement. Three specimens showing all vertebrae ossified and extruded later than day 134 (14 May) (see Table 3), had 29 vertebrae. All specimens extruded earlier than 14 May had 30-31 vertebrae.

Sub-caudal Melanophores (Fig. 2)

The occurrence of sub-caudal melanophores was found to vary for larvae 5-8 mm according to time of capture and hence time of extrusion. Examination of 108 larvae captured during a cruise from

6-13 April 1980, revealed that 83% had no sub-caudal melanophores. The remaining 17% had just one sub-caudal melanophore for an overall mean of 0.16 sub-caudal melanophores per larva. Of 137 larvae captured during a cruise from 22-26 May 1980, 79% had no sub-caudal melanophores, 12% had one, 7% had two and 2% had 3 sub-caudal melanophores, for an overall mean of 0.31 sub-caudal melanophores per larvae. Of 86 larvae captured during a cruise from 22-28 July 1980, no larvae were found without sub-caudal melanophores. Most larvae (66%) had 2 sub-caudal melanophores with 23% with one and 11% with 3 for an overall mean of 1.86 sub-caudal melanophores per larva. T-tests indicated these means were significantly different ($t_{April-May} = 2.04$, $P < 0.05$; $t_{April-July} = 22.05$, $P < 0.001$; $t_{May-July} = 8.75$, $P < 0.001$).

The form of individual melanophores also differed with time of capture. Sub-caudal melanophores in larvae with a single melanophore caught in April and May were typically smaller than those in larvae caught in July. Sub-caudal melanophores in larvae caught in July were often elongated as a slash of pigment suggesting that two or more discrete melanophores might have grown together, thus giving a false count. None of the larvae with sub-caudal melanophores caught in April and May had this shape. Some larvae caught in July with two sub-caudal melanophores sometimes had one small melanophore of the usual shape and one was an elongate slash shape.

Notochord Flexion

Larvae collected during 1981 (>31,000 fish) were measured for length and categorized relative to notochord flexion as pre-flexion, in flexion and post-flexion larvae. Examination of the data indicated that fish length at onset of notochord flexion varied with time of capture. Larvae (see Fig. 3 and Table 4) captured during April 27-May 10, 1981 ranged from 5-12.9 mm. No larvae in flexion were observed <9.0 mm. Of larvae in the size interval 9.0-9.9 mm <1% were in flexion. Of larvae in the size interval 10.0-10.9 mm, only 4.9% were in flexion but nearly 47% of larvae 11.0-11.9 mm and 100% of larvae >12.0 mm were in flexion.

Larvae captured during 22-27 May, 1981 (see Fig. 4 and Table 5) ranged from 6.0-15.9 mm. No larvae in flexion were observed <9.0 mm. However a trend towards slightly smaller length at flexion was noted. Of larvae in the size interval 9.0-9.9 mm, 2% were in flexion. Of larvae in the size interval 10.0-10.9 mm, nearly 20% were in flexion while 64% and 88% of the 11.0-11.9 mm and 12.0-12.9 mm size groups respectively were in flexion. All larvae in the size interval 13.0-13.9 mm were in flexion and all larvae >14.0 mm were post-flexion.

Larvae captured during a two vessel cruise from June 26-July 7, 1981 (see Fig. 5 and Table 6) ranged from 6-21.9 mm. No larvae <8.0 mm were observed in flexion. However, the trend towards smaller length at flexion was more pronounced. Nearly 10% of larvae in the size interval 8.0-8.9 mm were in flexion and more than 87% of larvae in the 9.0-9.9 mm length interval were in flexion. Virtually all larvae 10.0-12.9 mm were in flexion with the proportion of post-flexion larvae steadily increasing thereafter such that all larvae >17 mm were post-flexion.

Larvae captured during a cruise from August 1-4, 1981 (see Fig. 6 and Table 7) ranged from 6-25 mm. Although only 15 specimens <10 mm were captured, a trend similar to the previous two vessel survey was indicated. Nearly 67% of larvae in the 9.0-9.9 mm size interval were in flexion. All larvae >13.0 mm were post-flexion.

DISCUSSION

Barsukov and Zakharov (1972), Templeman (1980) and Ni (1981) have identified a meristic pattern of 29 vertebrae and 7 anal fin rays as being typical of *Sebastes fasciatus* rather than *S. marinus* or *S. mentella*, which typically have 30-31 vertebrae and 8-9 anal fin rays, although each of these authors recognize significant overlapping between species based on just these two characters.

Barsukov and Zakharov (1972) and Templeman (1980) also indicate the occurrence of adults of all three *Sebastes* species on Flemish Cap. Templeman (1980), in his study of morphology and meristics of *Sebastes* adults with pre-extrusion larvae states that pre-extrusion larvae from the different *Sebastes* species differed on numbers of sub-caudal melanophores present with 79% of *S. marinus*, 89% of *S. mentella* and 13% of *S. fasciatus* larvae having no sub-caudal melanophores. Of those which did have sub-caudal melanophores *S. marinus* and *S. mentella* larvae typically had one while *S. fasciatus* larvae typically had 3 but often 2 or 4 sub-caudal melanophores. Templeman (1980) also noted that in late March, adult females of *S. mentella* contained larvae in a more advanced stage of development than larvae in adult females of either of the other two species suggesting that subsequent extrusion of *S. mentella* larvae would occur earlier than extrusion of either of the other two species.

Barsukov and Zakharov (1972) noted that, in the Newfoundland-Labrador area, spawning of *S. mentella* begins early in April, peaks in May and is virtually complete by June. *S. marinus* spawn from late April to early May. In contrast, *S. fasciatus* in the Grand Bank area, St. Pierre Bank area, and Scotian Shelf begin spawning in early June to peak in July. Thus, in an area such as Flemish Cap, where all three species occur, one might except two or possibly three peaks in redfish spawning in a single year.

Ichthyoplankton surveys carried out since 1978 on Flemish Cap have indicated the occurrence of at least two and possibly three identifiable peaks of larval extrusion (Anderson and Akenhead 1981, Anderson MS 1981). A survey taken July 16-23 1978 indicated the presence of two modes: 5-6.9 mm and 18-19.9 mm. A survey taken July 22-28, 1980 showed the larval Sebastes population at that time had three distinct modes: 6.0-6.9 mm; 10.0-10.9 mm; 18.0-18.9 mm although it is not certain that the extrusion indicated by larvae in the 6.0-6.9 mm mode had peaked at that time.

Direct age determination of field caught fish larvae by otolith daily ring analysis permits the determination of the larval spawning patterns by back-calculation of age-length data.

Back-calculation of the modal length intervals observed from July 22-28, 1980 based on the 1980 larval otolith age-fish length equation (Penney and Anderson MS 1981) indicated these modes correspond to peak extrusion periods of late July, June 22-29 and April 22-29, assuming there has been no selective mortality against relatively early or late extruding individuals in either of the three extrusion periods.

The three extrusion modes observed in 1980 may correspond to extrusion peaks of the three different Sebastes species. Analysis of morphological and meristic patterns in larvae from different extrusion periods is continuing.

Data available at present indicate some interesting trends which may substantiate a later extrusion period for at least S. fasciatus. Back-calculation of the 1980 individuals used for the meristics in Table 2, indicated that larvae extruded prior to May 14 all have 30-31 vertebrae and 8-10 anal fin rays, a pattern consistent with S. marinus and S. mentella while larvae extruded after May 14 (at least those large enough for meristic determination) have 29 vertebrae and 7 anal fin rays, a pattern consistent with S. fasciatus.

Larvae captured during April and May 1980 had an overall mean of 0.16 and 0.31 sub-caudal melanophores per larvae respectively with 83% of larvae in April and 79% of larvae in May having no sub-caudal melanophores, a pattern again consistent with S. marinus and S. mentella. Larvae captured during July had a overall mean of 1.86 sub-caudal melanophores per larva with 66% having 2 subcaudal melanophores and none were without melanophores. Sub-caudal melanophores present in July were also larger and often shaped like an elongate slash. These patterns are also consistent with S. fasciatus.

Analysis of length and stage of notochord flexion in larvae from 1981 indicates a trend of increasingly smaller length at onset of notochord flexion with time of extrusion. Of the larvae captured on a cruise April 27-May 10, 1981, only 0.6% of larvae in the length interval 8.0-10.9 mm were in flexion. During the period May 22-27, 1981, this had increased to 5.8% in flexion. Larvae caught on three cruises in the period June 26 - Aug. 4 had 95.6% of all larvae from 8.0-10.9 mm in flexion. Overall, notochord flexion occurred at progressively shorter lengths in larvae extruded later in the year. Relatively shorter length at which notochord flexion occurs is indicative of relatively more advanced development generally in Sebastes spp. larvae.

Drawings by Taning (1961) of Sebastes viviparous, the inshore European redfish and S. marinus indicate S. viviparous had much more pronounced posterior preopercular spines at a relatively shorter length than S. marinus possibly indicating an earlier development pattern for S. viviparous. Magnusson and Magnusson (MS 1977) also note this pattern. Barsukov and Zakharov (1972) comment that the many similarities between S. fasciatus and S. viviparous suggest they are more closely related to each other than to either of S. marinus or S. mentella. Thus, S. fasciatus might be expected to have an earlier development pattern similar to S. viviparous.

This pattern of 29 vertebrae, 7 anal fin rays, 2 sub-caudal melanophores and shorter size at notochord flexion all may be regarded as circumstantial evidence supporting the identification of the June-July spawning population, or a great proportion thereof, on Flemish Cap as S. fasciatus. Further work on morphology, morphometrics and meristics of larvae extruded at different times throughout the spawning season is continuing. Other analyses underway at present but not included in this paper include changes with size in the pigmentation pattern on the dorsum, ventral body midline, dorso-lateral surface of the gut and top of the head, relative lengths of all fins and preopercular spines, and correlations between myomere numbers and numbers of vertebrae.

REFERENCES

Anderson, J. T. MS 1981. Larval fish surveys on Flemish Cap, 1980. NAFO SCR Doc. 81/IX/116, Ser. No. N422.

Anderson, J. T., and S. A. Akenhead. 1981. Distribution and abundance of redfish and cod larvae on Flemish Cap in 1978 and 1979. NAFO Sci. Coun. Studies. 1: 57-63.

Barsukov, V. V., and G. P. Zakharov. 1972. Morphological and biological characteristics of the American redfish. Trudy PINRO 28: 143-173 (F.R.B. Can. Trans. Ser. 2488, 1973).

Dingerkus, G., and L. D. Uhler. 1977. Enzyme clearing of alcian blue stained whole small vertebrates for demonstration of cartilage. Stain Tech. 52(4): 229-232.

Magnusson, J. V., and J. Magnusson. 1977. On the distinction between larvae of S. marinus and S. mentella, preliminary report. ICES CM 1977/F:48.

Moser, H. G., E. H. Ahlstrom, and E. M. Sandknop. 1977. Guide to the identification of scorpion fish larvae (Family Scorpaenidae) in the Eastern Pacific with comparative notes on species of Sebastes and Helicolenus from other oceans. NOAA Tech. Rep. NMFS Circ. 402, 71 p.

Ni, I. H. 1981. Numerical classification of sharp-beaked redfishes, Sebastes mentella and S. fasciatus, from Northeastern Grand Bank. J. Fish . Aquat. Sci. 38(8): 873-879.

Penney, R. W., and J. T. Anderson. MS 1981. Otolith analysis of age and growth of larval redfish (Sebastes sp.) on Flemish Cap, 1979 and 1980. NAFO SCR Doc. 81/IX/117, Ser. No. N423.

Phillips, J. B. 1957. A review of the rockfishes of California (Family Scorpaenidae). Cal. Dept. Fish and Game, Fish. Bull. 104, 158 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. 77(1): 1-46.

Taning, A. V. 1961. Larval and post-larval stages of Sebastes species and Helicolenus dactylopterus. Rapp. P.-v. Cons. Perm. Explor. Mer 150: 234-240.

Templeman, W. 1980. Incidence of sub-caudal melanophores in pre-extrusion larvae of redfish species in the Newfoundland Labrador area. J. Northw. Atl. Fish. Sci. 1: 7-19.

Table 1. Development of spines in the head area of cleared and stained Sebastes spp. larvae caught in July 1980. Length groups between the dashed line are undergoing notochord flexion. + denotes spine present and - denotes spine absent.

S.L. (mm)	Nuchal	Parietal	Posterior Preoperculars 1	2	3	4	5	Anterior Preoperculars 1	2	3	4
7	-	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-
9	+	-	-	+	+	-	-	-	+	-	-
10	+	-	-	+	+	-	-	-	+	-	-
11	+	-	-	+	+	+	-	-	+	-	+
12	+	-	+	+	+	+	-	-	+	+	+
13	+	+	+	+	+	+	+	-	+	+	+
14	+	+	+	+	+	+	+	-	+	+	+
15											
16	+	+	+	+	+	+	+	-	+	-	+
17	+	+	+	+	+	+	+	-	+	+	+
18	+	+	+	+	+	+	+	-	+	+	+
19											
20	+	+	+	+	+	+	+	-	+	+	+
21	+	+	+	+	+	+	+	+	+	+	+
22	+	+	+	+	+	+	+	+	+	+	+
23	+	+	+	+	+	+	+	+	+	+	+
32	+	+	+	+	+	+	+	+	+	+	+

Table 1 (continued)

S.L. (mm)	Operculars Superior	Operculars Inferior	Nasal	Coronal	Tympanic	Pterotic	Supracleithral	Cleithral
7	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-
9	-	-	-	-	-	+	-	-
10	-	-	-	-	-	+	-	-
11	-	-	-	-	-	+	-	-
12	-	-	-	-	-	+	+	-
13	+	+	+	-	-	+	-	-
14	+	+	+	-	-	+	+	-
15								
16	+	+	+	-	-	+	+	-
17	+	+	+	-	-	+	+	-
18	+	+	+	-	-	-	+	-
19								
20	+	+	+	-	-	+	+	-
21	+	+	+	-	-	+	+	-
22	+	+	+	-	-	+	+	-
23	+	+	+	-	-	+	+	+
32	+	+	+	-	+ ?	-	+	+

S.L. (mm)	Posttemporals Superior	Posttemporals Inferior	Infraorbitals 1st 1	Infraorbitals 1st 2	Infraorbitals 2nd 1	Infraorbitals 2nd 2	Infraorbitals 3rd	Suborbitals 1	Suborbitals 2	Preocular	Supraocular	Postocular
7	-	-	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	+
10	-	-	-	-	-	-	-	-	-	-	-	+
11	-	-	-	-	-	-	-	-	-	-	-	+
12	+	-	-	-	-	-	-	-	-	-	-	+
13	+	-	+	-	-	-	+	+	-	-	-	+
14	+	-	+	-	-	-	-	+	+	-	-	+
15												
16	+	-	+	-	-	-	-	+	+	+	-	+
17	+	+	+	-	-	-	+	+	+	-	-	+
18	+	-	+	-	-	-	+	+	+	-	-	+
19												
20	+	-	+	+	-	-	+	+	+	-	-	+
21	+	+	+	+	+	+	+	+	+	-	+	+
22	+	+	+	+	-	-	+	+	+	+	+	+
23	+	+	+	-	-	-	+	+	+	+	+	+
32	+	+	+	+	-	-	+	+	+	+	+	+

Table 2. Meristics from cleared and stained larvae of Sebastes spp. larvae caught in 1980. (Numbers in brackets refer to counts of cartilaginous members.)

S.L. (mm)		Dorsal spines (#)	Dorsal rays (#)	Anal spines (#)	Anal rays (#)	Pectoral rays (#)	Pelvic spines (#)	Pelvic rays (#)	Caudal rays (#) Superior Principal	Caudal rays (#) Superior Procurrent	Caudal rays (#) Inferior Principal	Caudal rays (#) Inferior Procurrent	Vertebrae #	Gill Rakers (#) Upper	Gill Rakers (#) Lower	Brachiostegals (#)
7.4		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7.5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7.7		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8.5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9.2	Pr[1]	-	-	-	-	-	-	-	(5)	-	(5)	-	-	-	8	4
9.5	Pr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(1)
9.7	Pr	-	-	-	-	-	-	-	(4)	-	(4)	-	-	-	-	2(1)
10.0	Pr	-	-	-	-	-	-	-	(4)	-	(6)	-	-	-	(9)	(4)
10.1	F[2]	-	-	-	-	-	-	-	5(1)	-	4(1)	-	-	-	8	2
10.5	P[3]	-	-	-	-	-	-	-	(6)	-	(7)	-	-	-	10	4(1)
12.2	F	-	-	-	-	-	-	-	7(1)	-	6(1)	(1)	-	-	12	5(1)
12.3	F	-	-	-	-	-	-	-	4(2)	-	4(3)	-	-	-	10	4(1)
12.7	Pr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(5)
12.0	P	-	-	-	-	4	-	-	6(2)	-	6(1)	(1)	-	-	14	6
13.0	F	-	-	-	-	-	-	-	5(1)	-	5(2)	(1)	-	-	10	5
13.3	F	-	-	-	-	-	-	-	6(1)	-	6(1)	(1)	-	1	12	5
13.7	P	VII (6)	16(1)	II	8	19	I	5	8	5(1)	7	6	29	8	20	7
14.5	P	XV	13(1)	II	8	19	I	5	8	7	7	7	29	7	21	8
16.2	P	XIV	15	II	8	19	I	5	8	6(1)	7	7(1)	29	7	21	8
16.3	P	XIV	16	II	11	20	I	5	8	8	7	8	30	7	20	7
17.6	P	XV	15	II	9	19	I	5	8	8	7	8(1)	31	7	22	7
17.7	P	XIV	16	III	10	19	I	5	8	7(1)	7	8	30	8	22	7
18.1	P	XV	16	II	9	19	I	5	8	9	7	9	30	10	22	7
20.0	P	XIV	16	II	9	19	I	5	8	9(1)	7	10(1)	30	9	23	7
21.1	P	XIV	15	II	10	20	I	5	8	10	7	10	30	10	23	7
21.2	P	XIV	16	II	10	20	I	5	8	10	7	10	30	9	21	7
21.3	P	XIV	15	II	10	20	I	5	8	10(2)	7	10	31	9	24	7
22.8	P	XV	16	III	8	19	I	5	8	11	7	11	30	10	22	7
23.7	P	XIV	15	II	9	19	I	5	8	10(1)	7	10(2)	30	10	24	7
32.0	P	XIV	17	III	9	19	I	5	8	12	7	12	30	10	24	7

1 pre-flexion
2 in flexion
3 post-flexion

Table 3. Date of capture, expected age and back-calculated date of extrusion of cleared and stained larvae used for meristics based on equation Fish Length = [(0.135)(otolith count) - 6.32]-3 (see Penney & Anderson, MS 1981).

S.L.	Date of Capture	Expected age (days)	Back-calculated date of extrusion	
32.0	206	192	19 (Jan 19)	
23.7	206	129	80	
22.8	204	122	85	
21.3	203	111	95	
21.2	205	110	98	Vertebrae = 30-31
21.1	205	109	99	Anal fin rays = 8-10
12.7	143	47	99	
13.3	148	52	99	
13.0	147	49	101	
12.3	144	44	193	
20.0	205	101	107	
12.0	149	42	110	
18.1	204	87	120	
10.5	149	31	121	
17.7	206	84	125	
17.6	205	84	124	
10.1	149	28	124	
9.5	145	24	124	
9.7	150	25	128	
16.3	208	74	134	
16.2	205	73	135	Vertebrae = 29
14.5	206	61	148	Anal fin rays = 7
13.7	206	55	154	
12.2	206	44	165	
10.0	208	27	184	Not ossified
9.2	208	22	189	
8.5	208	16	195	Sub-caudal
7.7	206	10	199	Melanophores = 2
7.5	207	9	201	
7.4	207	8	202	

STATISTICAL ANALYSIS SYSTEM 9:14 FRIDAY, MAY

CRUISE=50

TABLE OF LENGTH BY COND

LENGTH / COND FREQUENCY ROW PCT	7	8	TOTAL
5	1 100.00	0 0.00	1
6	197 100.00	0 0.00	197
7	2789 100.00	0 0.00	2789
8	7018 100.00	0 0.00	7018
9	4472 99.53	21 0.47	4493
10	1125 95.10	58 4.90	1183
11	32 53.33	28 46.67	60
12	0 0.00	3 100.00	3
TOTAL	15634	110	15744

Table 4. Number and percent of pre-flexion (cond = 7), in-flexion (cond = 8), and post-fluxion (cond = 9) larvae per unit standard length for Sebastes spp. caught on cruise # 50, April 27-May 10, 1981.

STATISTICAL ANALYSIS SYSTEM 9:14 FRIDAY, MAY 14, 198

CRUISE=51

TABLE OF LENGTH BY COND

LENGTH / COND FREQUENCY ROW PCT	7	8	9	TOTAL
6	17 100.00	0 0.00	0 0.00	17
7	341 100.00	0 0.00	0 0.00	341
8	2217 100.00	0 0.00	0 0.00	2217
9	2898 97.94	61 2.06	0 0.00	2959
10	1366 80.31	335 19.69	0 0.00	1701
11	154 36.15	272 63.85	0 0.00	426
12	6 12.00	44 88.00	0 0.00	50
13	0 0.00	4 100.00	0 0.00	4
14	0 0.00	0 0.00	1 100.00	1
15	0 0.00	0 0.00	1 100.00	1
TOTAL	6999	716	2	7717

Table. 5. Number and percent of pre-flexion (cond = 7), in-flexion (cond = 8), and post-flexion (cond = 9) larvae per unit standard length for Sebastes spp. caught on cruise # 51, May 22-27, 1981.

CRUISE=9003 + 9005

TABLE OF LENGTH BY COND   12:29 MONDAY, MAY 17, 1982   1

LENGTH / FREQUENCY / ROW PCT	COND 7	8	9	TOTAL
6	141 100.00	0 0.00	0 0.00	141
7	160 100.00	0 0.00	0 0.00	160
8	28 90.32	3 9.68	0 0.00	31
9	19 12.50	133 87.50	0 0.00	152
10	9 0.82	1085 99.18	0 0.00	1094
11	3 0.13	2259 99.87	0 0.00	2262
12	0 0.00	2022 100.00	0 0.00	2022
13	0 0.00	1118 98.85	13 1.15	1131
14	0 0.00	355 87.22	52 12.78	407
15	0 0.00	69 44.81	85 55.19	154
16	0 0.00	8 16.00	42 84.00	50
17	0 0.00	0 0.00	11 100.00	11
18	0 0.00	0 0.00	8 100.00	8
19	0 0.00	0 0.00	4 100.00	4
20	0 0.00	0 0.00	2 100.00	2
21	0 0.00	0 0.00	1 100.00	1
TOTAL	360	7052	218	7630

Table 6. Number and percent of pre-flexion (cond = 7), in-flexion (cond = 8), and post-flexion (cond = 9) larvae per unit standard length for *Sebastes* spp. caught on the two vessel cruises # 9003 and 9005, June 26-July 7, 1981.

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   9:14 FRIDAY, MAY 14, 1982   4

CRUISE=9004

TABLE OF LENGTH BY COND

LENGTH   COND

FREQUENCY / ROW PCT	7	8	9	TOTAL
6	5 100.00	0 0.00	0 0.00	5
7	3 100.00	0 0.00	0 0.00	3
8	3 100.00	0 0.00	0 0.00	3
9	1 33.33	2 66.67	0 0.00	3
10	0 0.00	1 100.00	0 0.00	1
13	0 0.00	0 0.00	1 100.00	1
14	0 0.00	0 0.00	1 100.00	1
15	0 0.00	0 0.00	1 100.00	1
16	0 0.00	0 0.00	4 100.00	4
TOTAL	12	3	38	53

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M   9:14 FRIDAY, MAY 14, 1982   5

CRUISE=9004

TABLE OF LENGTH BY COND

LENGTH   COND

FREQUENCY / ROW PCT	7	8	9	TOTAL
17	0 0.00	0 0.00	2 100.00	2
18	0 0.00	0 0.00	2 100.00	2
19	0 0.00	0 0.00	4 100.00	4
20	0 0.00	0 0.00	7 100.00	7
21	0 0.00	0 0.00	6 100.00	6
22	0 0.00	0 0.00	5 100.00	5
23	0 0.00	0 0.00	3 100.00	3
24	0 0.00	0 0.00	1 100.00	1
25	0 0.00	0 0.00	1 100.00	1
TOTAL	12	3	38	53

Table 7. Number and percent of pre-flexion (cond = 7), in-flexion (cond = 8), and post-flexion (cond = 9) larvae per unit standard length for Sebastes spp. caught on cruise # 9004, August 1-4, 1981.

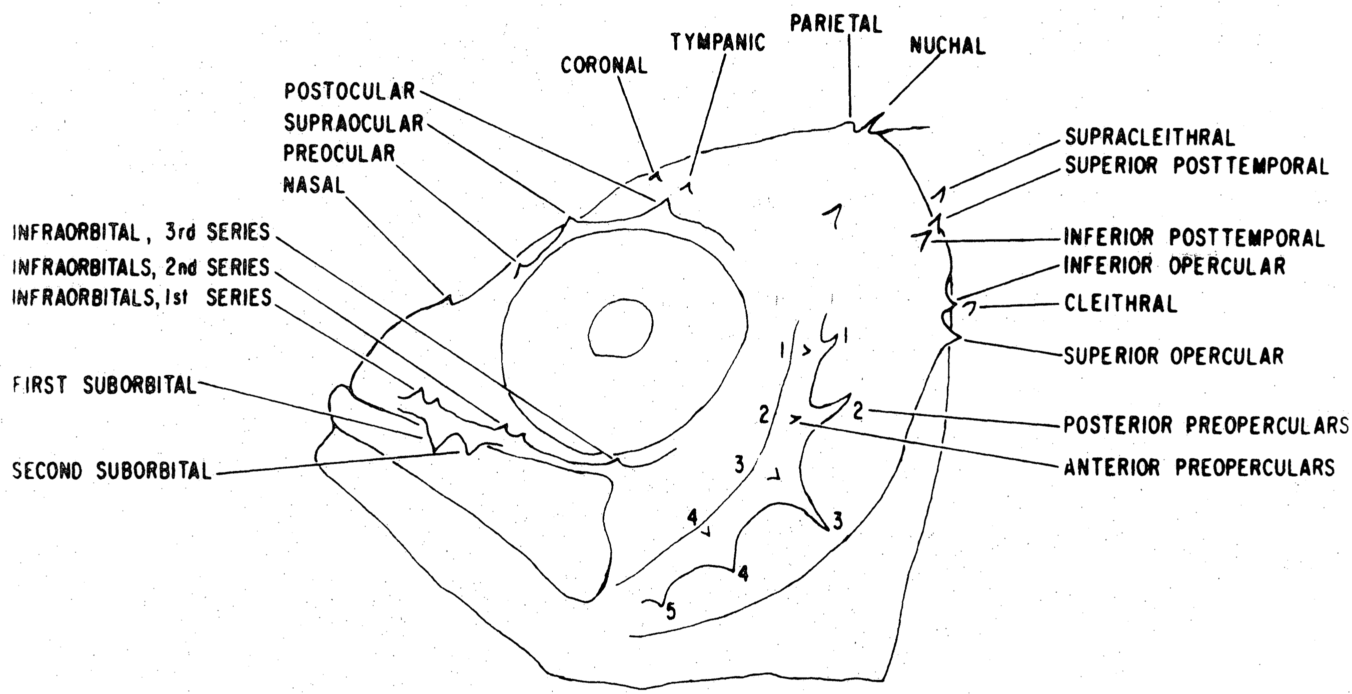

Figure 1. Composite diagram of spines present in the head area of larval Sebastes spp. including terminology used in this paper.

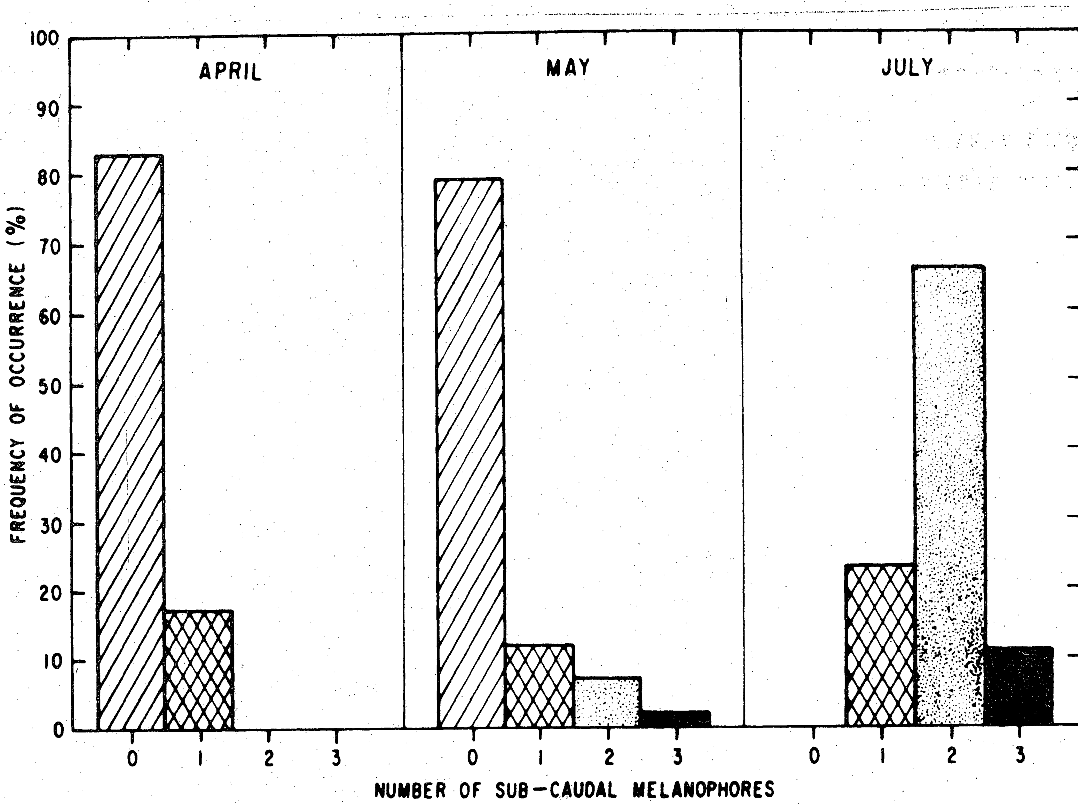

Figure 2. Numbers of sub-caudal melanophores and their frequency of occurrence in larval Sebastes spp. 5-8 mm S.L. during cruises to Flemish Cap in April, May and July 1981.

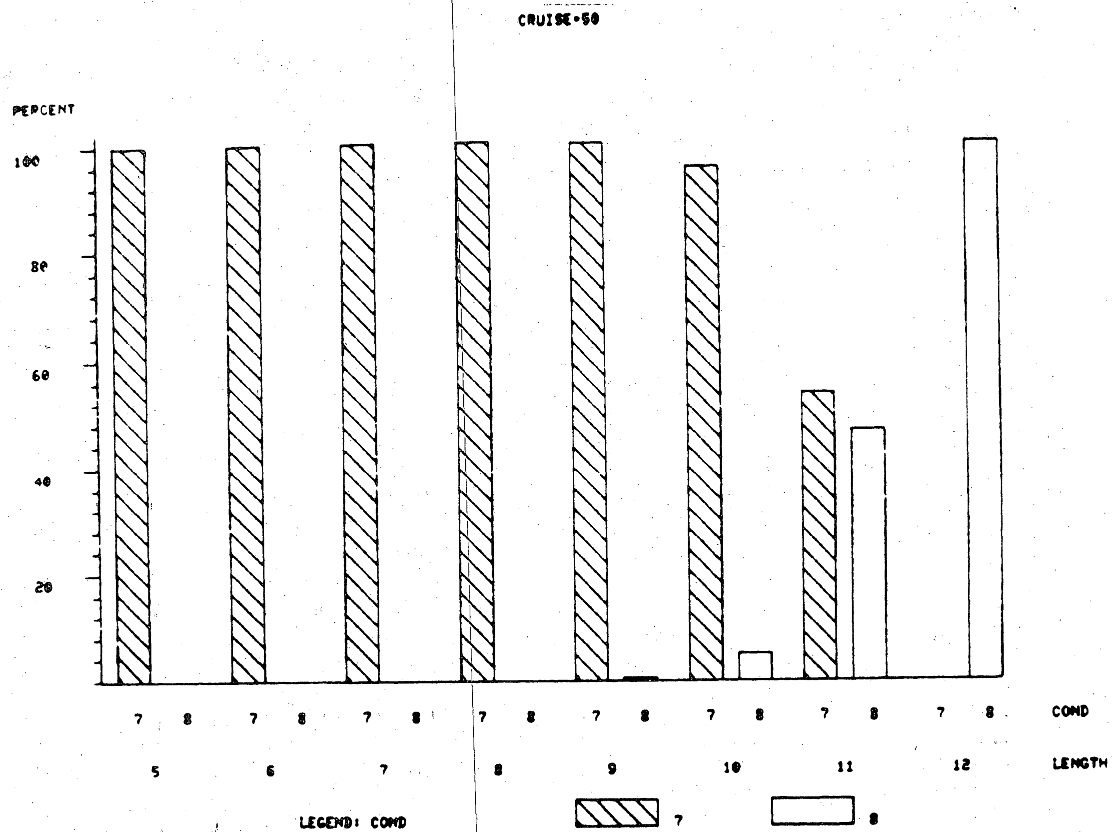

Figure 3. Occurrence by percent of pre-flexion larvae (cond = 7), inflection larvae (cond = 8), and post-flexion larvae (cond = 9) per unit standard length for Sebastes spp. caught on cruise #50, April 27-May 10, 1981.

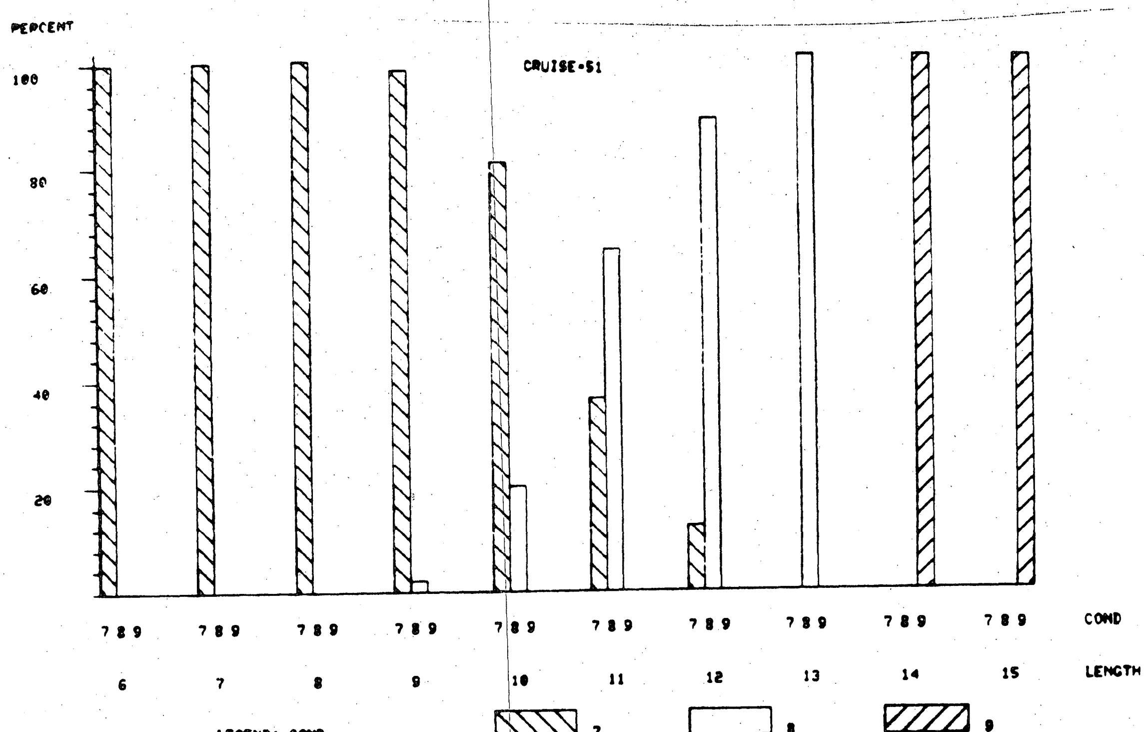

Figure 4. Occurrence by percent of pre-flexion (cond = 7), in-flexion (cond = 8), and post-flexion larvae (cond = 9) per unit standard length for Sebastes spp. caught on cruise # 51, May 22-27, 1981.

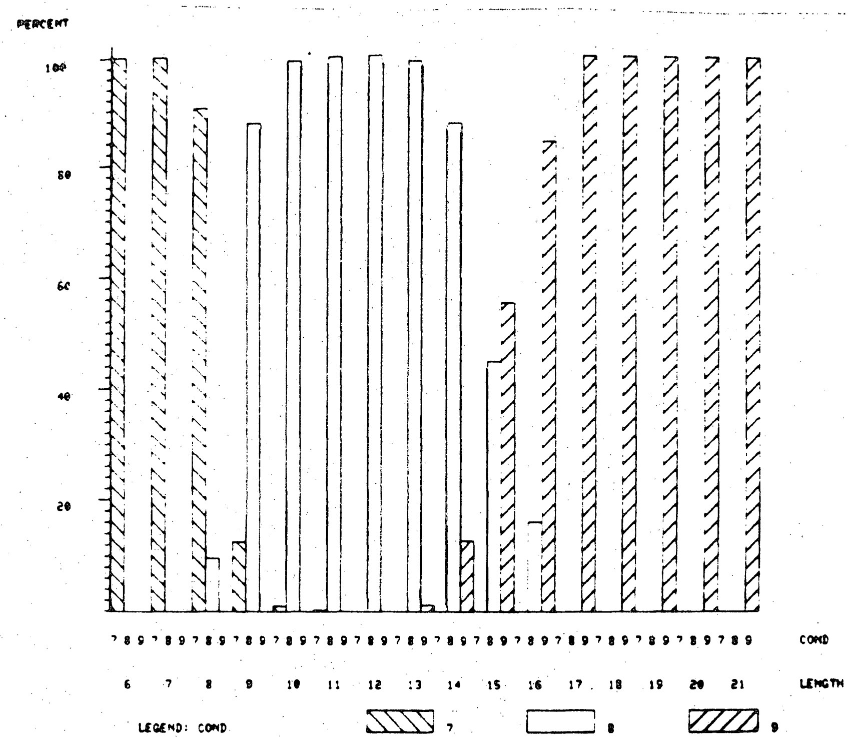

Figure 5. Occurrence by percent of pre-flexion (cond = 7), in-flexion (cond = 8), and post-flexion (cond = 9) larvae per unit standard length for *Sebastes* spp. caught on the two vessel cruises = 9003 and 9005, June 26-July 7, 1981.

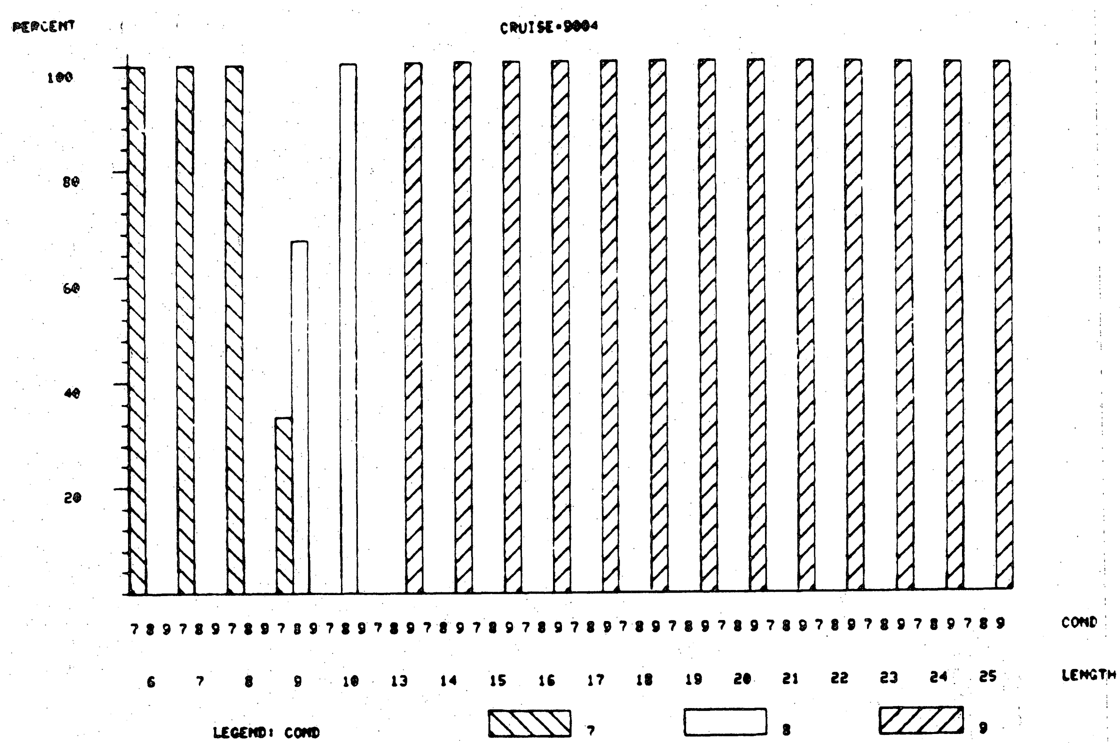

Figure 6. Occurrence by percent of pre-flexion (cond = 7), in-flexion (cond = 8), and post-fluxion (cond = 9) larvae per unit standard length for Sebastes spp. caught on cruise # 9004, August 1-4, 1981.