ABUNDANCE AND DISTRIBUTION OF LARVAL FISHES IN WATERS OFF OREGON, MAY-OCTOBER 1969, WITH SPECIAL EMPHASIS ON THE NORTHERN ANCHOVY, *ENGRAULIS MORDAX*

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ABSTRACT

Quantitative information on larval fishes in waters off Oregon is presented. Three hundred fifty-four samples, containing 55,049 larvae, were taken from lat. 42°00′ to 46°30′N and from the coastline to long. 129°30′W during six cruises, May to October 1969. Catches by three types of gear—bongos, meter net, and Isaacs-Kidd midwater trawl—are compared. The midwater trawl captured the greatest number of taxa and had the greatest frequency of occurrence of major taxa while overall the bongos caught the most larvae per 1,000 m³ of water filtered. Shallow tows compared with deep tows from the same stations showed small anchovy larvae were concentrated near the surface while larvae of myctophids and scorpaenids were more common in deeper waters.

Species composition (40 taxa in 22 families from deep tows), frequency of occurrence, abundance, and dominance are discussed. Northern anchovy, *Engraulis mordax*; northern lampfish, *Stenobrachius leucopsarus*; blue lanternfish, *Tarletonbeania crenularis*, and *Sebastes* spp. were the most dominant taxa. Distributional features of species in the most important families are described. *E. mordax* larvae were concentrated in Columbia River plume waters from June to August.

Species composition, abundance, seasonal occurrence, and areal distribution of larval fishes in ocean waters of the northeast Pacific off Oregon are virtually unknown (Ahlstrom, 1968). Pearcy (1962)[2] and LeBrasseur (1970)[3] listed larval fishes from these waters collected only incidentally to major sampling goals. Waldron (1972) provided the first quantiative data on larvae off Oregon collected from 12 April to 11 May 1967. No additional comprehensive, quantitative information has been published.

From 10 May to 31 October 1969, the Department of Oceanography of Oregon State University conducted a series of cruises off Oregon to quantitatively study the chemical, physical, and biological interrelationships involved with two major oceanographic phenomena—the Columbia River plume and coastal upwelling. The area surveyed extended from lat. 42°00′ to 46°30′N and from the coastline to long. 129°30′W.

This extensive sampling effort yielded much quantitative information on abundance and distribution of larval fishes off Oregon. Three types of gear are compared for their effectiveness in catching fish larvae. Shallow tows are compared with deep tows made at the same stations on two cruises. Species composition, frequency of occurrence, abundance, and dominance are discussed. Occurrence and distribution patterns are described for species in the most important families.

MATERIALS AND METHODS

Six cruises were conducted at approximately monthly intervals from 10 May to 31 October 1969 in waters off Oregon. Inclusive cruise dates and stations occupied during these cruises are shown in Figure 1.

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[2] Pearcy, W. G. 1962. Species composition and distribution of marine nekton in the Pacific Ocean off Oregon. Oreg. State Univ., Dep. Oceanogr., A.E.C. Prog. Rep. 1, Ref. 62-8, 14 p. (Unpubl. manuscr.)

[3] LeBrasseur, R. 1970. Larval fish species collected in zooplankton samples from the northeastern Pacific Ocean, 1956-1959. Fish. Res. Board Can., Tech. Rep. 175, 47 p.

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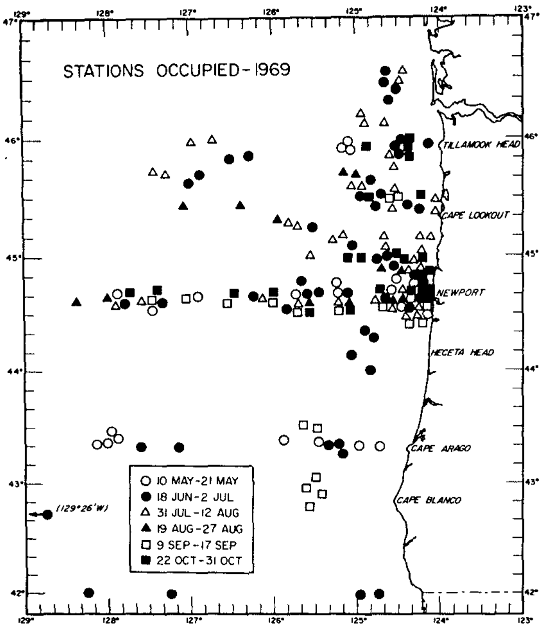


FIGURE 1.—Stations occupied during survey of waters off Oregon, May to October 1969.

Micronekton and zooplankton were sampled with a 6-foot Isaacs-Kidd midwater trawl (IKMT) equipped with a 5-mm mesh liner and a 0.571-mm mesh cod end, paired 0.7 m (mouth diameter) bongos with 0.571-mm mesh nets, and a 5-m long 1.0-m-mouth diameter net (MN) with a 0.571-mm mesh.

The bongos were located 3 m above the bridle of the IKMT on the same tow line. Hauls were made obliquely, usually from 200 m, depth permitting, to the surface at a tow speed of 5 knots. Eight hundred meters of wire, assuming a 4:1 wire length to depth fished ratio, was let out at 50 m/min and retrieved at 30 m/min. A usual haul required about 40 min effective towing time. Surface tows (upper 10-20 m) were made horizontally at the same stations as deep (200 m) oblique tows on the June and July-August cruises for comparison. Three of these surface tows did not have paired samples from deep hauls. For MN hauls, the ship remained stationary as the net was lowered at 10 m/min to 200 m on 200 m of wire, depth permitting, and hauled vertically to the surface at 30 m/min. Effective tow time was usually about 8 min. At depths < 400 m only the upper half of the water column was sampled by the IKMT and bongos. Bongos were not used on the May or August cruises. MN samples were not always taken in conjunction with IKMT samples. All tows were made between dusk and dawn.

A flow meter was situated inside the mouth of each net to record volume of water filtered. A depth distance recorder (Pearcy and Laurs, 1966) was also used in the IKMT to record the distance travelled vs. depth.

Temperature (BT) and salinity (induction salinometer) of surface waters were determined at each station.

All biological samples were preserved at sea in 10% buffered seawater Formalin.[4] Later the IKMT samples were transferred to 36% isopropyl alcohol. Fish larvae were sorted from bongo (one side only), MN (some of which had been split a varying number of times with a Folsom plankton splitter), and IKMT samples (not split). They were later identified and measured. Measurements, reported to the nearest millimeter, refer to standard length (SL = snout tip to notochord tip preceding development of caudal fin, then to end of hypural plate). For convenience, the term larvae in this paper sometimes includes early juvenile stages, e.g., anchovies, scorpaenids, and osmerids.

The taxonomic listings follow the scheme of Greenwood et al. (1966). Species names correspond to those listed by the American Fisheries Society (Bailey, 1970). The following discussion is based on the deep tows of the bongos and IKMT unless indicated otherwise.

RESULTS AND DISCUSSION

Comparison of Gear

The three types of gear were compared for the number of taxa taken, estimates of larval abundance, and frequency of occurrence of major taxa. The IKMT samples contained the greatest number of taxa followed by the bongos and MN (Table 1). Many of the bongo and MN samples, but not IKMT samples, had been split prior to removal of fish larvae. This process

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

TABLE 1.—Number of deep hauls taken, number of positive hauls, number of taxa taken, volume of water filtered, numbers of larvae originally in samples, number of larvae/1,000 m³ of total volume of water filtered according to type of gear and cruise.

	Gear	Cruise May	June	July-Aug.	Aug.	Sept.	Oct.	Total
Number of hauls taken	Bongo	—	23	23	—	8	8	62
	MN[1]	14	20	10	13	17	25	99
	IKMT[2]	19	34	23	14	14	22	127
	Total	33	77	56	35	39	47	287
Number of positive hauls	Bongo	—	17	15	—	6	6	44
	MN	9	17	7	7	6	1	47
	IKMT	19	29	20	14	14	20	116
	Total	28	63	42	21	26	27	207
Number of taxa taken	Bongo	—	20	12	—	8	7	25
	MN	11	11	7	6	4	2	18
	IKMT	16	23	29	21	20	12	38
	Total	27	27	30	21	22	16	40
Volume of water filtered (1,000 m³)	Bongo	—	44.58	43.30	—	17.11	20.56	125.55
	MN	1.59	2.54	1.02	1.52	1.90	2.80	11.37
	IKMT	173.49	469.21	312.23	154.08	193.43	636.38	1,938.82
	Total	175.08	516.33	356.55	155.60	212.44	659.74	2,075.74
Numbers of larvae originally in samples	Bongo	—	499	13,138	—	214	15	13,866
	MN	159	295	43	45	42	4	588
	IKMT	691	343	10,100	2,184	438	279	14,035
	Total	850	1,137	23,281	2,229	694	298	28,489
Numbers of larvae per 1,000 m³ of total water filtered	Bongo	—	11.19	303.42	—	12.50	0.72	110.44
	MN	100.00	116.14	42.15	29.60	22.10	1.42	51.71
	IKMT	3.98	0.73	32.35	14.17	2.26	0.43	7.24
	Total	4.85	2.20	65.29	14.32	3.27	0.45	13.72

[1] MN = Meter net.
[2] IKMT = Isaacs-Kidd midwater trawl

results in a loss of rare taxa in the split fraction. The IKMT was towed the longest and filtered the greatest volume of water which increased the probability of capturing rare taxa. This factor outweighed the loss of larvae by escapement through the 5-mm mesh liner which would be expected to be great.

Bongo samples gave the largest estimate of larval abundance (individuals/1,000 m³) for combined cruises. (Although not done in this paper, subsequent data on larval fishes will be standardized to numbers under a unit area of sea surface as encouraged by E. H. Ahlstrom.) Bongos captured a large number of anchovies on the July-August cruise which mainly accounted for the large estimate for combined cruises. MN samples gave the largest estimates of abundance for five of the six periods sampled. The bongos were towed at a speed of 5 knots which may have resulted in extrusion of small larvae. This would explain the low estimates of abundance on three of the four cruises compared with the MN which was hauled more slowly and primarily took small larvae. The IKMT gave the smallest estimates of abundance of larval fishes for each cruise and for the combined cruises probably because of a high degree of escapement through the net by small forms.

Numbers of taxa occurring in 5% or more of the samples for each gear were: 7 for the bongos, 5 for the MN, and 19 for the IKMT (Table 2). For each gear the four taxa taken most frequently were northern anchovy, *Engraulis mordax*; northern lampfish, *Stenobrachius leucopsarus*; blue lanternfish, *Tarletonbeania crenularis*, and *Sebastes* spp. (*Sebastes* spp. was fifth in bongo samples preceded slightly by *Protomyctophum thompsoni*.) However, percent frequency of occurrence of each of the four, except *S. leucopsarus*, varied considerably among types of gear (Table 2). Percent occurrence of *E. mordax* was similar in bongo and IKMT samples but much lower in MN samples. The IKMT took *T. crenularis* and *Sebastes* spp. much more often than either the bongos or the MN. The greater frequency of occurrence of

TABLE 2.—Frequency of occurrence (%) of fish larvae in deep samples according to type of gear and cruise.

Taxa	Bongos					Meter net							Isaacs-Kidd midwater trawl						
	June	July-Aug.	Sept.	Oct.	Total	May	June	July-Aug.	Aug.	Sept.	Oct.	Total	May	June	July-Aug.	Aug.	Sept.	Oct.	Total
EEL LEPTOCEPHALUS																			
Unidentified 1	0	0	0	0	0	0	0	0	0	0	0	0	5.3	0	0	0	0	0	0.8
ENGRAULIDAE																			
Engraulis mordax	8.7	56.5	75.0	12.5	35.5	0	25.0	40.0	30.8	0	0	13.1	0	0	69.6	92.8	64.3	54.8	39.7
OSMERIDAE																			
Undetermined spp.	4.3	4.3	0	0	3.2	0	0	0	0	0	0	0	0	2.9	17.4	7.1	0	18.2	7.9
BATHYLAGIDAE																			
Bathylagus milleri	4.3	0	0	0	1.6	0	0	0	0	0	0	0	0	8.8	4.4	0	0	0	3.2
Bathylagus ochotensis	8.7	0	12.5	0	4.8	28.6	5.0	10.0	7.7	0	0	7.1	21.0	11.8	22.2	14.3	7.1	0	12.7
Bathylagus pacificus	8.7	0	0	0	3.2	7.1	5.0	0	0	0	0	2.0	0	5.9	4.4	7.1	7.1	0	4.0
Leuroglossus stilbius	0	0	0	0	0	0	0	0	0	0	0	0	5.3	0	0	0	0	0	0.8
GONOSTOMATIDAE																			
Danaphos sp.	4.3	0	0	0	1.6	0	0	0	0	0	0	0	5.3	0	0	0	0	0	0.8
Diplophos sp.	0	0	0	0	0	0	0	10.0	0	0	0	1.0	0	0	0	0	0	0	0
MELANOSTOMATIDAE																			
Tactostoma macropus	0	0	0	0	0	0	0	0	0	0	0	0	5.3	0	4.4	7.1	14.3	0	4.0
CHAULIODONTIDAE																			
Chauliodus macouni	8.7	4.3	0	12.5	6.4	7.1	5.0	0	7.7	0	0	0	15.8	14.7	26.1	57.1	14.3	0	19.0
ALEPOCEPHALIDAE																			
Sagamichthys abei	0	0	0	0	0	0	0	0	0	0	0	0	5.3	0	0	0	0	0	0.8
PARALEPIDIAE																			
Lestidium ringens	4.3	4.3	0	0	3.2	0	0	0	0	0	0	0	47.4	8.8	22.2	14.3	0	0	15.1
SCOPELARCHIDAE																			
Benthabella dentatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4.4	7.1	7.1	0	2.4
MYCTOPHIDAE																			
Diaphus theta	0	4.3	0	0	1.6	0	0	0	0	0	0	0	0	0	13.0	14.3	7.1	0	4.8
Lampanyctus regalis	0	13.0	0	0	4.8	0	20.0	0	0	0	0	4.0	0	2.9	30.4	28.6	14.3	0	11.1
Lampanyctus ritteri	0	0	0	0	0	0	10.0	0	0	0	0	2.0	0	0	0	0	0	0	0
Protomyctophum crockeri	0	4.3	12.5	0	3.2	0	0	0	0	0	0	0	10.5	5.9	4.4	21.4	0	0	6.3
Protomyctophum thompsoni	21.7	4.3	37.5	12.5	16.1	0	5.0	10.0	0	0	0	2.0	15.8	29.4	26.1	57.1	35.7	0	25.4
Stenobrachius leucopsarus	26.1	47.8	62.5	0	35.5	50.0	70.0	50.0	38.5	29.4	0	36.4	21.0	41.2	65.2	92.8	71.4	0	44.4
Tarletonbeania crenularis	21.7	17.4	62.5	12.5	24.2	28.6	45.0	0	30.8	11.8	0	19.2	15.8	26.5	56.5	85.7	64.3	0	36.5
MACROURIDAE																			
Unidentified 1	0	0	0	0	0	0	0	0	0	0	0	0	5.3	0	0	0	0	0	0.8
MELAMPHAEIDAE																			
Melamphaes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	5.9	4.4	0	0	0	2.4
TRACHIPTERIDAE																			
Trachipterus sp.	0	0	0	12.5	1.6	0	0	0	0	0	0	0	0	0	13.3	0	0	0	2.4
SCORPAENIDAE																			
Sebastes spp.	8.7	8.7	37.5	25.0	14.5	28.6	30.0	10.0	15.4	5.9	4.0	15.2	84.2	29.4	43.5	57.1	64.3	45.4	50.0
Sebastolobus spp.	0	0	0	12.5	1.6	0	0	0	0	0	0	0	5.3	5.9	4.4	0	14.3	18.2	7.9
COTTIDAE																			
Undetermined spp.	4.3	0	0	0	1.6	0	0	0	0	0	0	0	21.0	2.9	4.4	14.3	0	0	6.3
AGONIDAE																			
Undetermined spp.	0	0	0	0	0	0	0	0	0	0	0	0	15.8	0	0	0	0	0	2.4
CYCLOPTERIDAE																			
Undetermined spp.	21.7	8.7	0	0	11.3	0	0	10.0	0	0	0	1.0	31.6	35.3	34.8	42.8	21.4	9.1	29.4
STICHAEIDAE																			
Plectobranchus evides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13.3	14.3	7.1	0	4.8
NOMEIDAE																			
Icichthys lockingtoni	0	0	0	0	0	0	5.0	0	0	0	4.0	2.0	0	5.9	8.7	0	0	9.1	4.8
BOTHIDAE																			
Citharichthys sordidus	8.7	0	0	0	3.2	0	0	0	0	5.9	0	1.0	21.0	8.8	4.4	7.1	0	4.5	7.9
Citharichthys stigmaeus	13.0	0	0	0	4.8	7.1	0	0	0	0	0	1.0	21.0	17.6	8.7	0	35.7	22.7	12.5

TABLE 2.—Continued.

Taxa	Bongos June	Bongos July-Aug.	Bongos Sept.	Bongos Oct.	Bongos Total	Meter net May	Meter net June	Meter net July-Aug.	Meter net Aug.	Meter net Sept.	Meter net Oct.	Meter net Total	Isaacs-Kidd midwater trawl May	Isaacs-Kidd midwater trawl June	Isaacs-Kidd midwater trawl July-Aug.	Isaacs-Kidd midwater trawl Aug.	Isaacs-Kidd midwater trawl Sept.	Isaacs-Kidd midwater trawl Oct.	Isaacs-Kidd midwater trawl Total
PLEURONECTIDAE																			
Eopsetta jordani	0	0	0	0	0	0	0	0	0	0	0	0	21.0	0	0	0	0	0	3.2
Glyptocephalus zachirus	13.0	0	0	0	4.8	0	0	0	0	0	0	0	5.3	2.9	4.4	7.1	21.4	27.3	10.3
Isopsetta isolepis	0	0	0	0	0	7.1	0	0	0	0	0	1.0	15.8	2.9	0	0	0	0	3.2
Lyopsetta exilis	4.3	0	0	0	1.6	14.3	0	0	0	0	0	2.0	10.5	5.9	4.4	14.3	7.1	4.5	7.1
Microstomus pacificus	4.3	0	12.5	0	3.2	0	0	0	0	0	0	0	10.5	5.9	4.4	0	7.1	4.5	5.6
Parophrys vetulus	0	0	0	0	0	7.1	0	0	0	0	0	1.0	10.5	0	0	0	0	0	1.6
Psettichthys melanostictus	4.3	0	0	0	1.6	7.1	0	0	0	0	0	1.0	5.3	0	4.4	0	7.1	9.1	4.0
Miscellaneous fragments																			
Unidentified myctophid	0	0	12.5	0	1.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified pleuronectid	0	0	0	12.5	1.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified fragments	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4.4	0	0	0	0.8

taxa in the IKMT samples is probably due to the greater volume of water filtered.

Shallow vs. Deep Tows

Shallow tows of the IKMT and bongos made on the June and July-August cruises were compared with the standard deep tows from the same stations. Volume of water filtered was approximately the same for each shallow and deep pair. In shallow tows, positive samples (47 out of 64) yielded 20,629 fish larvae compared with 18,087 larvae in 50 out of 64 samples from deep tow pairs (Table 3). A total of 31 taxa were taken; 17 occurred in both shallow and deep samples, 3 occurred only in shallow samples, and 11 were only in deep samples (Table 4). Ninety-eight percent of all larvae were distributed in three families for shallow and deep tows:

Shallow tows:
89.4% Engraulidae in 35.9% of all samples
5.7% Myctophidae in 31.2% of all samples
2.9% Osmeridae in 14.1% of all samples

TABLE 3.—Comparison of shallow and deep hauls from June and July-August cruises according to gear.

	Gear	Cruise: June Shallow	Cruise: June Deep	Cruise: July-August Shallow	Cruise: July-August Deep	Total Shallow	Total Deep
Number of hauls taken	Bongo	15	15	16	16	31	31
	IKMT[1]	17	17	16	16	33	33
	Total	32	32	32	32	64	64
Number of positive hauls	Bongo	8	12	10	10	18	22
	IKMT	15	15	14	13	29	28
	Total	23	27	24	23	47	50
Number of taxa taken	Bongo	7	17	5	11	9	21
	IKMT	11	15	14	23	18	25
	Total	16	21	14	24	20	28
Volume of water filtered (1,000 m^3)	Bongo	35.73	28.87	30.26	27.35	65.99	56.22
	IKMT	304.12	245.40	222.94	199.46	527.06	444.86
	Total	339.85	274.27	253.20	226.81	593.05	501.08
Numbers of larvae originally in samples	Bongo	1556	257	13,823	10,668	15,379	10,925
	IKMT	93	81	5,157	7,081	5,250	7,162
	Total	1649	338	18,980	17,749	20,629	18,087
Numbers of larvae per 1,000 m^3 of total water filtered	Bongo	43.55	8.90	456.81	390.05	233.05	194.32
	IKMT	0.30	0.33	23.13	55.50	9.96	16.10
	Total	4.85	1.23	74.96	78.82	34.78	36.10

[1] IKMT = Isaacs-Kidd midwater trawl.

TABLE 4.—Frequency of occurrence (%) of fish larvae in shallow vs. deep samples taken in June and July-August.

	Bongos						Isaacs-Kidd midwater trawl						Grand total	
	June		July-Aug.		Total		June		July-Aug.		Total			
Taxa	Shal.	Deep	Shal.	Deep	Shal.	Deep	Shal.	Deep	Shal.	Deep	Shal.	Deep	Shal.	Deep
ENGRAULIDAE:														
Engraulis mordax	13.3	6.7	56.2	56.2	35.5	32.2	—	—	75.0	62.5	36.4	30.3	35.9	31.2
OSMERIDAE:														
Undetermined spp.	6.7	6.7	6.2	6.2	6.4	6.4	17.6	5.9	43.8	43.8	21.2	15.2	14.1	10.9
BATHYLAGIDAE:														
Bathylagus milleri	—	6.7	—	—	—	3.2	—	5.9	—	6.2	—	6.1	—	4.7
Bathylagus ochotensis	—	6.7	—	—	—	3.2	—	—	—	18.8	—	9.1	—	6.2
Bathylagus pacificus	—	13.3	—	—	—	6.4	—	11.8	—	6.2	—	9.1	—	7.8
GONOSTOMATIDAE:														
Danaphos sp.	—	6.7	—	—	—	3.2	—	—	—	—	—	—	—	1.6
CHAULIODONTIDAE:														
Chauliodus macouni	—	—	—	6.2	—	3.2	—	—	—	18.8	—	9.1	—	6.2
PARALEPIDIDAE:														
Lestidium ringens	—	—	—	6.2	—	3.2	5.9	11.8	6.2	18.8	6.1	15.2	3.1	9.4
MYCTOPHIDAE:														
Diaphus theta	—	—	—	6.2	—	3.2	—	—	—	12.5	—	6.1	—	4.7
Lampanyctus regalis	—	—	—	12.5	—	6.4	—	—	12.5	25.0	6.1	12.1	3.1	9.4
Protomyctophum crockeri	—	—	—	—	—	—	—	5.9	—	6.2	—	6.1	—	3.1
Protomyctophym thompsoni	—	20.0	—	6.2	—	12.9	—	17.6	12.5	25.0	6.1	21.2	3.1	17.2
Stenobrachius leucopsarus	26.7	26.7	12.5	43.8	19.4	35.5	11.8	29.4	37.5	56.2	24.2	42.4	21.9	39.1
Tarletonbeania crenularis	—	13.3	—	25.0	—	19.4	—	5.9	12.5	43.8	6.1	24.2	3.1	21.9
TRACHIPTERIDAE:														
Trachipterus sp.	—	—	—	—	—	—	—	—	6.2	18.8	3.0	9.1	1.6	4.7
SCORPAENIDAE:														
Sebastes spp.	—	6.7	—	12.5	—	9.7	35.3	47.0	12.5	31.2	24.2	39.4	12.5	26.0
Sebastolobus spp.	—	—	—	—	—	—	—	—	—	6.2	—	3.0	—	1.6
COTTIDAE:														
Undetermined spp.	—	6.7	6.2	—	3.2	3.2	5.9	5.9	12.5	6.2	9.1	6.1	6.2	4.7
CYCLOPTERIDAE:														
Undetermined spp.	—	20.0	—	6.2	—	12.9	23.5	47.0	—	25.5	12.1	36.4	6.2	25.0
BATHYMASTERIDAE:														
Ronguilus jordani	—	—	—	—	—	—	5.9	—	—	—	3.0	—	1.6	—
STICHAEIDAE:														
Plectobranchus evides	—	—	—	—	—	—	—	—	—	6.2	—	3.0	—	1.6
Unidentified 1	6.7	—	—	—	3.2	—	—	—	—	—	—	—	1.6	—
AMMODYTIDAE:														
Ammodytes hexapterus	6.7	—	—	—	3.2	—	—	—	—	—	—	—	1.6	—
NOMEIDAE:														
Icichthys lockingtoni	—	—	—	—	—	—	—	—	12.5	6.2	6.1	3.0	3.1	1.6
BOTHIDAE:														
Citharichthys sordidus	—	13.3	—	—	—	6.4	23.5	11.8	—	—	12.1	6.1	6.2	6.2
Citharichthys stigmaeus	20.0	20.0	—	—	9.7	9.7	58.8	17.6	6.2	6.2	33.3	12.1	21.9	10.9
PLEURONECTIDAE:														
Glyptocephalus zachirus	—	13.3	—	—	—	6.4	5.9	—	—	—	3.0	—	1.6	3.1
Isopsetta isolepis	6.7	—	—	—	3.2	—	11.8	5.9	6.2	—	9.1	3.0	6.2	1.6
Lyopsetta exilis	—	6.7	—	—	—	3.2	—	—	—	—	—	—	—	1.6
Microstomus pacificus	—	—	—	—	—	—	—	5.9	—	6.2	—	6.1	—	3.1
Psettichthys melanostictus	—	6.7	6.2	—	3.2	3.2	—	—	12.5	6.2	6.1	3.0	4.7	3.1
Unidentified	6.7	—	—	—	3.2	—	—	—	—	6.2	—	3.0	1.6	1.6

Deep tows:

73.1% Engraulidae in 31.2% of all samples
23.8% Myctophidae in 95.3% of all samples
1.7% Scorpaenidae in 26.6% of all samples

Deep tows consistently yielded a greater number of taxa because they sampled more completely the vertical range of larval fishes. The taxa most frequently taken (>20% of samples) in shallow tows were *E. mordax*, *S. leucopsarus*, and speckled sanddab, *Citharichthys stigmaeus*. In deep tows they were *S. leucopsarus*, *E. mordax*, *Sebastes* spp., Cyclopteridae, and *T. crenularis*. Frequency of occurrence of *E. mordax* in samples was generally higher in shallow tows than in deep tows (the same in shallow and deep bongo samples from July-August). On both the June and July-August cruises the bongos took more anchovies in surface tows than in deep tows. The IKMT took no anchovy larvae in June and in July-August captured more anchovies in deep tows than in surface tows. The IKMT is more selective for larger forms because small larvae can escape through the net. Thus small anchovy larvae appear to be concentrated in surface waters, with larger larvae occurring deeper. Myctophids, scorpaenids, bathylagids, and cyclopterids had a much higher frequency of occurrence in deep tows.

Species Composition

Positive samples (207 out of 287) yielded 28,489 fish larvae from all deep tows (Table 1). Of the 40 taxa, 28 were identified to species and 6 to genus. Twenty-two families were represented.

Ninety-eight percent of all larvae (individuals/1,000 m^3) in combined samples were in four families:

68.4% Engraulidae in 29.6% of all samples
25.3% Myctophidae in 96.9% of all samples
4.2% Scorpaenidae in 34.1% of all samples
0.4% Osmeridae in 4.2% of all samples

Other families represented in over 5% of the samples were: Pleuronectidae, 19.5% of all samples; Cyclopteridae, 15.7%; Bathylagidae, 14.3%; Bothidae, 13.6%; Chauliodontidae, 9.8%; and Paralepididae, 7.3%.

During the sampling period, abundance of larvae per 1,000 m^3 estimated from combined samples (Table 1) peaked in July-August and was lowest in October. Results from the MN indicated greatest abundance in May and June. The MN collected many small *E. mordax* in June and *S. leucopsarus* in May and June (Table 5). By the July-August cruise, larvae of these two species were still abundant, however the larger specimens were not as readily captured by the more slowly hauled MN.

Dominance

Dominant taxa for each type of gear during each cruise were determined by a ranking system (biological index, BI) modified from Fager (1957). By this method, the most numerous species in each sample is given 5 points, the next 4, etc. Scores for each taxa are summed for all positive samples for each cruise and each type of gear and divided by the total number of samples (positive and negative) on that cruise by that gear. Both abundance and frequency of occurrence are considered in this determination.

BI values from each type of gear and all gear combined for combined cruises indicated the same four taxa were most dominant, *E. mordax*, *S. leucopsarus*, *T. crenularis*, and *Sebastes* spp., although not necessarily in that order (Table 6). *S. leucopsarus* had a higher BI value than *E. mordax* in MN samples and combined samples. *Sebastes* spp. ranked above *T. crenularis* in IKMT samples. A drop in BI value, indicating a lower degree of dominance, existed between the fourth and fifth highest ranked taxa for each gear, particularly MN and IKMT, and combined gears. Only the bongos agreed with taxa shown to be in the top 11 by combined gears, although not in the same order.

Some of the discrepancy among gear types may be explained by size of organisms captured. The high BI values of osmerids; rex sole, *Glyptocephalus zachirus;* and *Lestidium ringens* in IKMT samples was in part due to the large size of most specimens which would avoid the smaller types of gear. None of these taxa was captured by the MN and generally few were taken by the bongos. Some of the higher ranked taxa from bongo and MN samples, Pacific viperfish, *Chauliodus macouni*, and *Bathylagus ochotensis*, are very slender forms which may escape readily through the IKMT net. Specimens of pinpoint lampfish, *Lampanyctus regalis*, taken by the MN in June were small, mostly 3 to 4 mm, and may have been extruded out of the bongos because of the fast tow speed. BI values indicate that the IKMT captured more large organisms, the MN captured more small or slender forms, and the bongos were intermediate.

The most dominant (BI) taxa in May (all gear combined) were *Sebastes* spp. and *S. leucopsarus*; in June, *S. leucopsarus* and *T. crenularis*; in July-August, *E. mordax* and *S. leucopsarus*; in August and September, *S. leucopsarus*, *E. mordax*, *T. crenularis*; and in October, *Sebastes* spp. and *E. mordax* (Table 7). All had a BI$>$1. All taxa below these had a BI$<$1, usually with a considerable drop in BI value from the most dominant taxa. *S. leucopsarus*, *T. crenularis*, and *Sebastes* spp. consistently ranked in the top five from May through September (Table 5). *E. mordax* became the most dominant species in July-August and remained dominant through October.

TABLE 5.—Numbers of larvae per 1,000 m³ of total volume of water filtered in deep hauls according to type of gear and month of cruise. (M = <0.01/1,000 m³.)

Taxa	Bongos					Meter net							Isaacs-Kidd midwater trawl						
	June	July-Aug.	Sept.	Oct.	Total	May	June	July-Aug.	Aug.	Sept.	Oct.	Total	May	June	July-Aug.	Aug.	Sept.	Oct.	Total
EEL LEPTOCEPHAULUS:																			
Unidentified 1	0	0	0	0	0	0	0	0	0	0	0	0	M	0	0	0	0	0	M
ENGRAULIDAE:																			
Engraulis mordax	3.61	204.13	7.94	0.19	72.79	0	26.77	13.72	3.94	0	0	7.73	0	0	28.69	5.65	1.24	0.25	5.28
OSMERIDAE:																			
Undetermined spp.	0.04	0.37	0	0	0.14	0	0	0	0	0	0	0	0	M	0.26	M	0	0.01	0.05
BATHYLAGIDAE:																			
Bathylagus milleri	0.02	0	0	0	0.01	0	0	0	0	0	0	0	0	0.01	M	0	0	0	M
Bathylagus ochotensis	0.40	0	0.05	0	0.15	6.91	0.78	0.98	1.31	0	0	1.40	0.04	0.01	0.01	0.04	M	0	0.02
Bathylagus pacificus	0.02	0	0	0	0.01	2.51	0.78	0	0	0	0	0.52	0	M	M	M	M	0	M
Leuroglossus stilbius	0	0	0	0	0	0	0	0	0	0	0	0	M	0	0	0	0	0	M
GONOSTOMATIDAE:																			
Danaphos sp.	0.36	0	0	0	0.13	0	0	0	0	0	0	0	M	0	0	0	0	0	M
Diplophos sp.	0	0	0	0	0	0	0	0.98	0	0	0	0.08	0	0	0	0	0	0	0
MELANOSTOMATIDAE:																			
Tactostoma macropus	0	0	0	0	0	0	0	0	0	0	0	0	M	0	M	M	0.01	0	M
CHAULIODONTIDAE:																			
Chauliodus macouni	0.11	0.05	0	0.04	0.06	1.25	1.57	0	1.31	0	0	0.70	0.02	0.02	0.04	0.10	0.01	0	0.02
ALEPOCEPHALIDAE:																			
Sagamichthys abei	0	0	0	0	0	0	0	0	0	0	0	0	M	0	0	0	0	0	M
PARALEPIDIDAE:																			
Lestidium ringens	0.02	0.76	0	0	0.27	0	0	0	0	0	0	0	0.06	0.01	0.04	0.01	0	0	0.01
SCOPELARICHIDAE:																			
Benthabella dentatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	M	M	M	0	M
MYCTOPHIDAE:																			
Diaphus theta	0	0.02	0	0	0.01	0	0	0	0	0	0	0	0	0	0.01	0.01	M	0	M
Lampanyctus regalis	0	2.48	0	0	1.03	0	4.33	0	0	0	0	0.96	0	M	0.18	0.03	0.01	0	0.01
Lampanyctus ritteri	0	0	0	0	0	0	2.36	0	0	0	0	0.52	0	0	0	0	0	0	0
Protomyctophum crockeri	0	0.02	0.05	0	0.02	0	0	0	0	0	0	0	0.01	M	0.01	0.01	0	0	M
Protomyctophum thompsoni	0.25	0.05	0.35	0.04	0.15	0	0.39	0.98	0	0	0	0.17	0.04	0.03	0.07	0.23	0.04	0	0.05
Stenobrachius leucopsarus	5.34	84.57	2.45	0	31.39	59.74	55.51	23.52	13.81	15.78		27.35	0.02	0.35	0.41	6.23	0.47	0	1.02
Tarletonbeania crenularis	0.16	5.24	1.28	0.04	2.05	3.77	10.23	0	5.92	1.57	0	3.86	0.04	0.11	0.37	0.94	0.23	0	0.19
MACROURIDAE:																			
Unidentified 1	0	0	0	0	0	0	0	0	0	0	0	0	M	0	0	0	0	0	M
MELAMPHAEIDAE:																			
Melamphaes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	M	0	0	0	M
TRACHIPTERIDAE:																			
Trachipterus sp.	0	0	0	0.04	0.01	0	0	0	0	0	0	0	0	0	0.02	0	0	0	M
SCORPAENIDAE:																			
Sebastes spp.	0.04	5.17	0.23	0.09	1.98	15.72	12.59	0.98	3.28	4.21	1.07	6.50	3.32	0.07	0.09	0.73	0.08	0.10	0.43
Sebastolobus spp.	0	0	0	0.04	0.01	0	0	0	0	0	0	0	M	M	M	0	0.03	M	0.01
COTTIDAE:																			
Undetermined spp.	0.02	0.01	0	0	0.01	0	0	0	0	0	0	0	0.03	M	0.01	0.01	0	0	M
AGONIDAE:																			
Undetermined spp.	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	M
CYCLOPTERIDAE:																			
Undetermined spp.	0.18	0.05	0	0	0.08	0	0	0.98	0	0	0	0.08	0.05	0.05	0.03	0.07	0.01	M	0.03
STICHAEIDAE:																			
Plectobranchus evides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01	M	0	M
NOMEIDAE:																			
Icichthys lockingtoni	0	0	0	0	0	0	0.78	0	0	0	0.35	0.26	0	M	0.02	0	0	M	M

TABLE 5.—*Continued.*

Taxa	Bongos June	Bongos July-Aug.	Bongos Sept.	Bongos Oct.	Bongos Total	Meter net May	Meter net June	Meter net July-Aug.	Meter net Aug.	Meter net Sept.	Meter net Oct.	Meter net Total	Isaacs-Kidd midwater trawl May	Isaacs-Kidd midwater trawl June	Isaacs-Kidd midwater trawl July-Aug.	Isaacs-Kidd midwater trawl Aug.	Isaacs-Kidd midwater trawl Sept.	Isaacs-Kidd midwater trawl Oct.	Isaacs-Kidd midwater trawl Total
BOTHIDAE:																			
Citharichthys sordidus	0.04	0	0	0	0.02	0	0	0	0	0.52	0	0.08	0.06	0.01	M	M	0	M	0.01
Citharichthys stigmaeus	0.07	0	0	0	0.02	0.62	0	0	0	0	0	0.08	0.03	0.02	0.01	0	0.02	0.01	0.02
PLEURONECTIDAE:																			
Eopsetta jordani	0	0	0	0	0	0	0	0	0	0	0	0	0.02	0	0	0	0	0	M
Glyptocephalus zachirus	0.07	0	0	0	0.02	0	0	0	0	0	0	0	0.04	M	M	M	0.02	0.01	0.01
Isopsetta isolepis	0	0	0	0	0	2.50	0	0	0	0	0	0.35	0.04	M	0	0	0	0	M
Lyopsetta exilis	0.02	0	0	0	0.01	3.77	0	0	0	0	0	0.52	0.01	0.01	M	0.01	M	M	0.01
Microstomus pacificus	0.02	0	0.05	0	0.02	0	0	0	0	0	0	0	0.01	0.01	M	0	M	M	M
Parophrys vetulus	0	0	0	0	0	2.51	0	0	0	0	0	0.35	0.01	0	0	0	0	0	M
Psettichthys melanostictus	0.02	0	0	0	0.01	0.62	0	0	0	0	0	0.08	M	0	M	0	M	M	M
Miscellaneous fragments:																			
Unidentified myctophid	0	0	0.05	0	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified pleuronectid	0	0	0	0.19	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified fragments	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	M
Total	11.9	303.42	12.50	0.72	110.44	100.0	116.14	42.15	29.60	22.10	1.42	51.71	3.98	0.73	32.35	14.17	2.26	0.43	7.24

Comments on Major Families

Discussion is limited to the most important families. Numbers of larvae refer to total numbers taken during the sampling period. Comments on distribution focus on inshore-offshore aspects as no north-south differences were evident except for *E. mordax*. Trends in seasonality can be determined from Tables 2 and 5.

Engraulidae (43,191 larvae in 110 samples)

E. mordax larvae were taken first on the June cruise. At that time, larval lengths ranged from 3 to 12 mm with a median at 8 mm (Figure 2A). Some were newly hatched. Spawning probably occurred from June until August in 1969 if growth rates (to 10.2 mm in 20 days after fertilization) given by Lasker et al. (1970) are comparable for this area. Surface water temperatures were cooler (14°-17°C) than the 17.5°C temperature used in their experiments and would result in a longer development time. The smallest larvae collected after August were 18 mm which suggests the spawning period was limited. Larval growth throughout the study period is indicated in Figure 2. Ranges of SL overlapped considerably in July-August and August, probably because of continued spawning into August. By September spawning appeared to be over and a marked increase in median length was shown from September to October.

Ranges, medians, and median quartiles of SL of larvae differed somewhat according to gear type for each cruise (Figure 2A). Some of the apparent differences may be a result of small numbers of larvae measured. The IKMT did not catch any anchovies until July-August when larvae were larger. The MN did not catch any after August probably because the larger forms avoided the net. By October, only the IKMT took anchovies (except for one specimen taken by the bongos) which had a median length of 43 mm.

Anchovy larvae were most abundant in Columbia River plume waters in June and July-August. Larvae were not taken north of the Columbia River or south of the major influence of plume waters. They were not abundant near

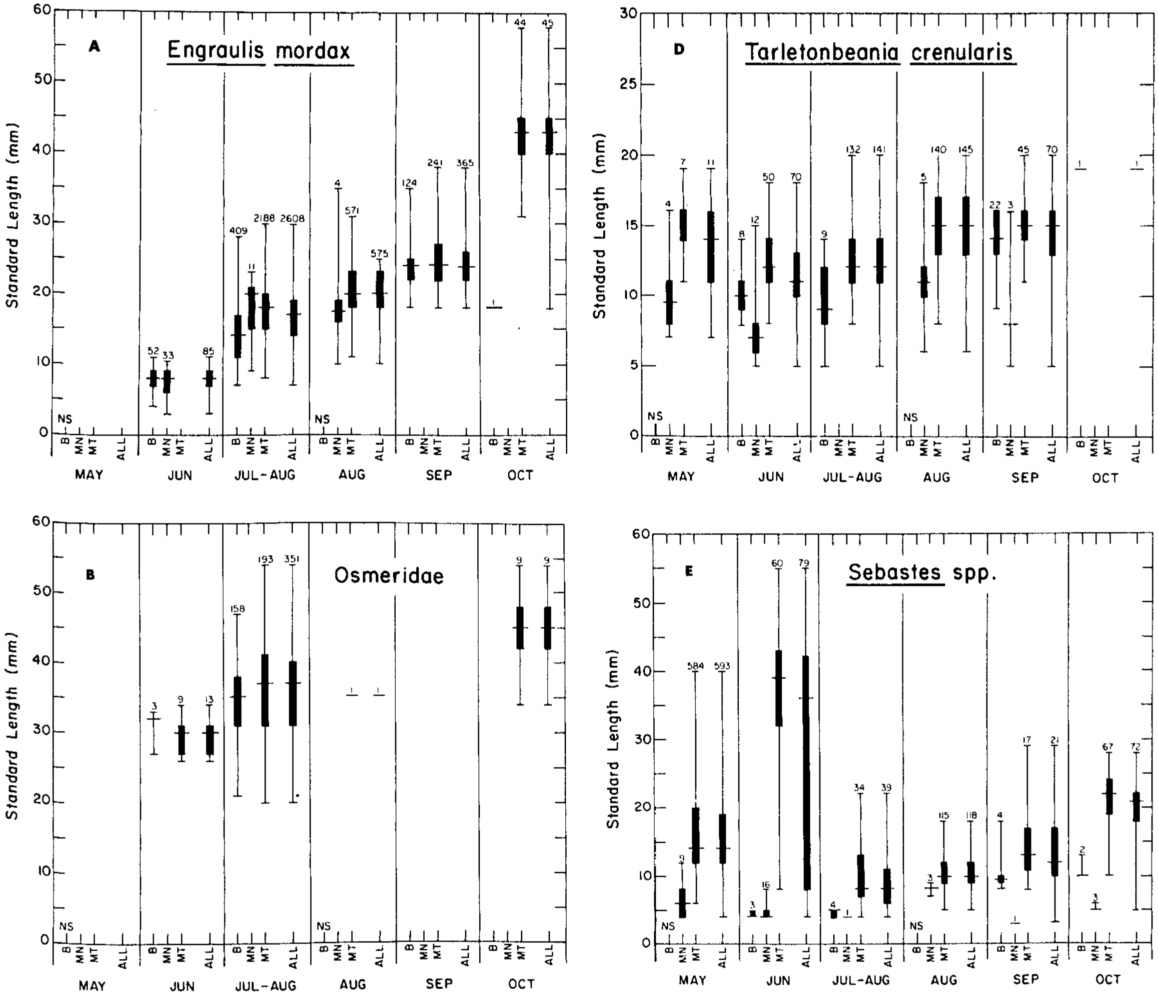
TABLE 6.—Ranks (biological index) of most dominant taxa by gear for each cruise and for all cruises combined, and for combined gears and cruises. (*denotes top 10 taxa for each gear, cruises combined, and combined gears and cruises.)

	Bongos					Meter net						
Taxa	June	July-Aug.	Sept.	Oct.	Combined cruises	May	June	July-Aug.	Aug.	Sept.	Oct.	Combined cruises
Engraulis mordax	0.22	2.74	3.44	0.63	1.86*	—	1.12	1.80	1.46	—	—	0.73
Stenobrachius leucopsarus	1.30	2.04	2.00	—	1.34*	2.32	3.32	2.35	1.88	1.41	—	1.88*
Tarletonbeani crenularis	0.70	0.48	2.19	0.63	1.00*	0.86	1.62	—	1.15	0.53	—	0.69*
Sebastes spp.	0.20	0.22	0.64	1.19	0.56*	1.00	1.10	0.35	0.23	0.24	0.20	0.52*
Protomyctophum thompsoni	0.67	0.02	0.64	0.33	0.42*	—	0.18	0.35	—	—	—	0.09*
Cyclopteridae	1.02	0.13	—	—	0.29*	—	—	0.50	—	—	—	0.08*
Chauliodus macouni	0.39	0.02	—	0.63	0.26*	0.21	0.22	—	0.12	—	—	0.09*
Bathylagus ochotensis	0.20	—	0.32	—	0.13*	0.93	0.18	0.40	0.12	—	—	0.27*
Glyptocephalus zachirus	0.50	—	—	—	0.12*	—	—	—	—	—	—	—
Osmeridae	0.22	0.22	—	—	0.11*	—	—	—	—	—	—	—
Citharichthys stigmaeus	0.43	—	—	—	0.11*	0.36	—	—	—	—	—	0.06*
Sebastolobus spp.	—	—	—	0.33	0.08	0.08	—	—	—	—	—	0.01
Lampanyctus regalis	—	0.30	—	—	0.08	—	0.78	—	—	—	—	0.13*
Cottidae	0.20	—	—	—	0.05	—	—	—	—	—	—	—
Citharichthys sordidus	0.24	—	—	—	0.04	—	—	—	—	0.29	—	0.05
Lestidium ringens	—	0.09	—	—	0.02	—	—	—	—	—	—	—
Isopsetta isolepis	—	—	—	—	—	—	—	—	—	—	—	—

	Isaacs-Kidd midwater trawl							
Taxa	May	June	July-Aug.	Aug.	Sept.	Oct.	Combined cruises	Combined gears
Engraulis mordax	—	—	3.43	3.57	2.66	2.50	2.03*	1.54*
Stenobrachius leucopsarus	0.45	1.68	2.65	4.11	2.78	—	1.94*	1.72*
Tarletonbeania crenularis	0.42	1.00	1.48	2.34	2.14	—	1.40*	1.03*
Sebastes spp.	4.03	1.15	0.51	1.36	1.78	2.00	1.80*	0.96*
Protomyctophum thompsoni	0.47	1.09	0.26	1.04	0.52	—	0.56*	0.36*
Cyclopteridae	0.63	1.26	0.65	0.39	0.51	0.11	0.59*	0.32*
Chauliodus macouni	0.16	0.25	0.04	0.38	0.16	—	0.16	0.17*
Bathylagus ochotensis	0.66	0.21	0.16	—	—	—	0.17	0.19*
Glyptocephalus zachirus	0.21	0.06	—	—	0.46	1.04	0.30*	0.14*
Osmeridae	—	0.13	0.76	0.14	—	0.59	0.27*	0.13
Citharichthys stigmaeus	0.42	0.63	0.15	—	0.97	0.75	0.49*	0.22*
Sebastolobus spp.	0.10	0.15	—	—	0.43	0.73	0.22	0.10
Lampanyctus regalis	—	0.02	0.43	—	—	—	0.08	0.10
Cottidae	0.46	0.13	0.17	0.50	—	—	0.21	0.09
Citharichthys sordidus	0.71	0.25	—	—	—	0.16	0.19	0.09
Lestidium ringens	1.22	0.18	0.28	—	—	—	0.28*	0.10
Isopsetta isolepis	0.79	0.12	—	—	—	—	0.15	0.06

TABLE 7.—Ranks (biological index) of most dominant taxa by cruise, all gear combined. (* denotes top 5 taxa for each cruise.)

Taxa	May	June	July-Aug.	Aug.	Sept.	Oct.
Engraulis mordax	—	0.45	2.66*	2.52*	2.03*	1.04*
Stenobrachius leucopsarus	1.39*	2.10*	2.36*	3.00*	2.06*	—
Tarletonbeania crenularis	0.64*	1.11*	0.65*	1.75*	1.62*	0.21
Sebastes spp.	2.52*	0.82*	0.36*	0.80*	0.89*	1.13*
Protomyctophum thompsoni	0.24	0.65*	0.21	0.52*	0.39*	0.11
Cyclopteridae	0.32	0.83*	0.43*	0.20	0.17	0.04
Chauliodus macouni	0.19	0.29	0.02	0.25	0.05	0.21
Bathylagus ochotensis	0.80*	0.20	0.19	0.06	0.11	—
Glyptocephalus zachirus	0.11	0.19	—	—	0.15	0.35*
Osmeridae	—	0.12	0.33	0.07	—	0.20
Citharichthys stigmaeus	0.39	0.35	0.05	—	0.32	0.25*
Sebastolobus spp.	0.04	0.05	—	—	0.14	0.35*
Lampanyctus regalis	—	0.27	0.24	—	—	—
Cottidae	0.23	0.11	0.06	0.25	—	—
Citharichthys sordidus	0.36	0.16	—	—	0.10	0.05
Lestidium ringens	0.61*	0.06	0.12	—	—	—
Isopsetta isolepis	0.45	0.04	—	—	—	—
Psettichthys melanostictus	0.26	0.01	—	—	0.09	0.05



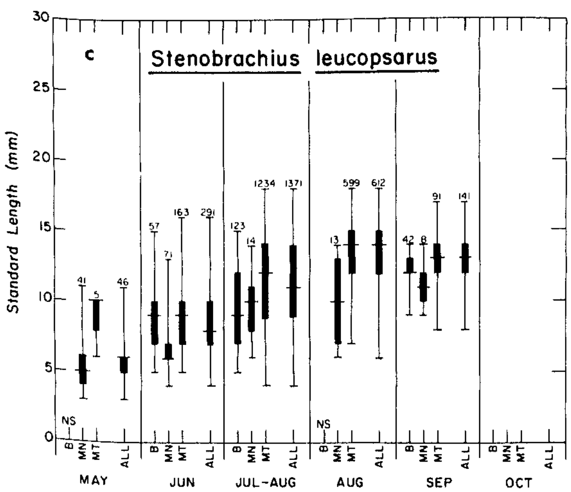


FIGURE 2.—Ranges, medians, and median quartiles of lengths of *Engraulis mordax*, Osmeridae, *Stenobrachius leucopsarus*, *Tarletonbeania crenularis*, and *Sebastes* spp. according to type of gear and cruise. Numbers of larvae measured are at the top of each bar. (B = bongo, MN = meter net, MT = Isaacs-Kidd midwater trawl, All = combined samples, NS = not sampled.)

the coastline or offshore beyond the bounds of the plume. Their distribution showed a closer correlation with temperature than salinity. Plots of larval abundance, which ranged from <1 to 62/1,000 m³, 210 to 451/1,000 m³, and 14 to 252/1,000 m³ in positive tows in deep bongo, shallow bongo, and MN samples respectively in June, are in Figure 3. Larvae were associated with water >14°C which agrees with Ahlstrom's (1959) findings off California. Plots of abundance (2 to 840/1,000 m³ and <1 to 4,493/1,000 m³ in deep and shallow bongo samples) for July-August (Figure 4) again show larvae concentrated in water >14°C. Upwelling was prevalent at that time with colder water near shore. The Columbia River plume was not clearly distinguishable although the warm waters offshore were probably a result of the plume (Pearcy and Mueller, 1969). After the July-August cruise, fewer larvae were taken and distribution was scattered throughout the area sampled.

Small anchovy larvae were concentrated in surface waters which agrees with Ahlstrom's (1959) results on vertical distribution of anchovies off California.

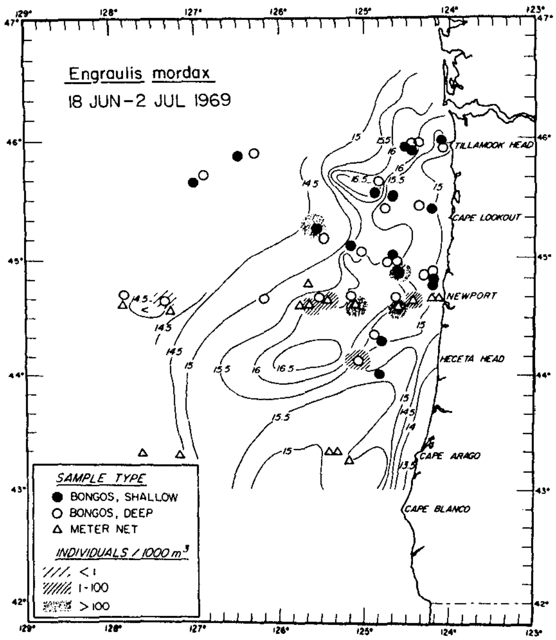


FIGURE 3.—Distribution of *Engraulis mordax* larvae and surface temperature, June 1969.

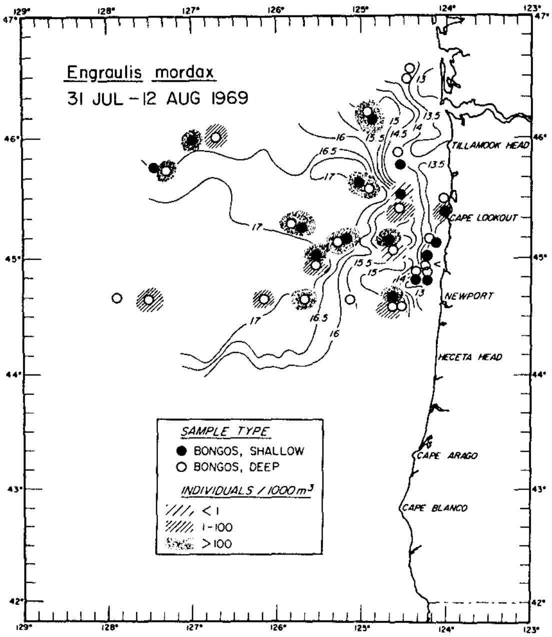


FIGURE 4.—Distribution of *Engraulis mordax* larvae and surface temperature, July-August 1969.

Results of meristics and blood genetics studies have indicated at least three distinct anchovy subpopulations exist off Oregon, California, and Baja California (Vrooman and Smith, 1972). The present results together with previous studies offer support for the existence of a separate stock off Oregon. Anchovy larvae were abundant in Columbia River plume waters in the upper 10 to 20 m in 1969. Waters of the Columbia River plume have a strong vertical density gradient and a shallow mixed layer depth (Owen, 1968). Anchovies spawn mostly in the upper 10 m at temperatures >14°C (Ahlstrom, 1959). Adult anchovies were reported in unusually large concentrations near the coast of northern California and Oregon in 1969 (Frey, 1971). The adults were probably spawning. CalCOFI (California Cooperative Oceanic Fisheries Investigations) sampling has indicated a high abundance of anchovy larvae off southern California with a substantial drop in abundance from southern to northern California. In 1949 and 1950, anchovy larvae were found in moderate abundance off Oregon (Ahlstrom, 1968). Thus, a separate spawning stock of anchovies seems to exist off Oregon associated with the warm, near surface waters of the Columbia River plume. The spawning period seems to be correlated with the time when warm plume water is a dominant oceanographic feature, before the rest of the ocean surface water warms to >14°C. Additional sampling for eggs as well as larve with even more extensive coverage is needed to determine areal extent of spawning and extent of yearly variation caused by changing oceanographic conditions.

Osmeridae (687 larvae in 21 samples)

Larvae of osmerids were collected in June, July-August, August, and October at the nearshore stations shown in Figure 5. The nearshore area was heavily sampled on the July-August cruise, perhaps explaining why few or no specimens were taken on other cruises. Similarly, no samples were taken near shore south of Newport (Figure 1). Distribution appears to be restricted to near shore when upwelling was prominent.

All specimens have not yet been identified to species, although some are known to be *Thaleichthys pacificus*. The trend in growth in Figure 2B might indicate all the larvae were products of one major spawning and therefore one species.

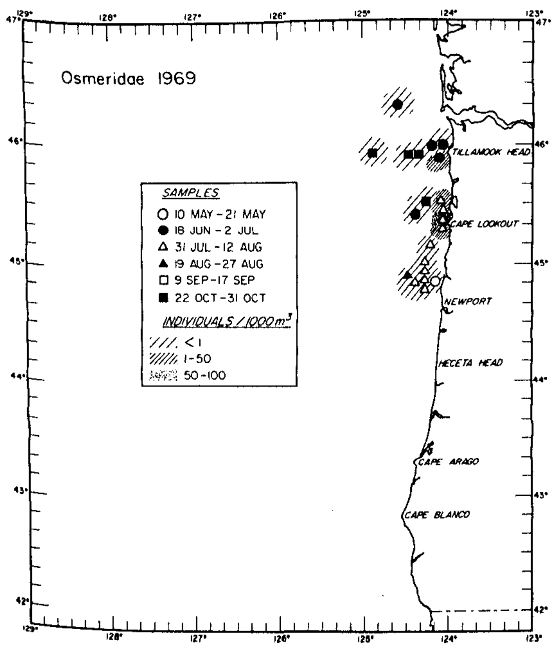


FIGURE 5.—Distribution of osmerids collected from June to October 1969.

Mycthophidae (8,694 larvae in 152 samples)

Larvae of *S. leucopsarus* (7,683 specimens) were taken from May to September in moderate numbers. Capture of 3-mm individuals in May (Figure 2C) indicated spawning may have occurred recently, although early growth rates have not yet been established. The occurrence of 4-mm larvae as late as July-August appears to extend the spawning period off Oregon beyond the December to March range estimated by Smoker and Pearcy (1970). The smallest larvae taken in September were 8 mm. No larvae were taken in October which supports the idea that *S. leucopsarus* does not spawn throughout the year off Oregon.

The IKMT generally captured larger larvae than the bongos or MN (Figure 2C). An increase in median length of larvae occurred from May through August. Individuals about to undergo metamorphosis, which occurs around 18 mm (Smoker and Pearcy, 1970), were taken from July-August to September. By October, all larvae apparently had begun the process of metamorphosis, which takes place at depths greater than we sampled (Fast, 1960).

Larvae of *S. leucopsarus* were more abundant west of long. 124°30′W (about 20 nautical miles off Newport, Oreg.) than closer to shore (Table 8) although a few specimens did occur in nearshore samples. North-south distribution was scattered. Larvae were never taken around the mouth of the Columbia River where lower salinity water fans out into the ocean. Larvae were more frequently taken in deep (200 m) tows than in shallow tows (Table 4) during the June and July-August cruises.

Larvae of *T. crenularis* (714 specimens) were collected on all cruises. Larval lengths ranged from 5-7 mm to 19-20 mm on each cruise from May to September (Figure 2D). From these data, *T. crenularis* appears to spawn at least throughout the period sampled, although collection of only one specimen in October cannot be explained.

TABLE 8.—Numbers of individuals/1,000 m³ of water filtered in deep hauls of *Stenobrachius leucopsarus* and *Tarletonbeania crenularis* taken east (near shore) and west (offshore) of long. 124°30′W.

Species		Bongos		Meter net		Isaacs-Kidd midwater trawl	
		East	West	East	West	East	West
Stenobrachius leucopsarus	May	—	—	0	65.97	0	0.03
	June	0	6.04	25.00	57.76	0.02	0.40
	July-Aug.	0	89.95	0	26.67	0.15	2.72
	Aug.	—	—	11.76	14.07	0.14	6.84
	Sept.	0	2.58	0	17.86	0	0.49
	Oct.	0	0	0	0	0	0
Tarletonbeania crenularis	May	—	—	0	4.17	0	0.04
	June	0	0.20	0	10.92	0	0.12
	July-Aug.	0	5.90	0	0	0	0.42
	Aug.	—	—	11.76	5.19	0.14	1.03
	Sept.	0	0.01	0	1.79	0	0.24
	Oct.	0	0.05	0	0	0	0

Distribution of *T. crenularis* larvae was more predominantly offshore than that of *S. leucopsarus* (Table 8). In August, two specimens each were collected with the IKMT and MN at long. 124°24.5′W. No additional *T. crenularis* were found closer to shore than long. 124°30′W. Distribution was scattered from north to south within the area sampled. During the June and July-August cruises, capture of *T. crenularis* larvae was almost entirely restricted to deep tows (Table 4.)

Other myctophids were captured in smaller numbers. *Lampanyctus regalis* (151 specimens) ranged from 3 to 19 mm in length and occurred mainly west of long. 125°W; only one specimen was taken nearer shore. Six *L. ritteri*, all 5 mm, were taken in two samples west of long. 127°30′W in June. *Protomyctophum thompsoni* (117 specimens, 6-20 mm) occurred somewhat closer to shore than *L. regalis*, with a moderate number between long. 124°30′W and 125°W. None was found closer to shore than long. 124°30′W. The distribution of flashlightfish, *P. crockeri*, (11 specimens, 6-20 mm) was similar to that of *P. thompsoni*. All 12 California headlightfish, *Diaphus theta*, (8-13 mm) were taken west of long. 125°30′W.

Scorpaenidae (1,205 larvae in 102 samples)

Sebastes spp. (1,189 specimens) were captured throughout the sampling period. Individual species were not identified so interpretation of data is limited. In May and June products of an earlier spawning were captured (individuals 40-55 mm) along with newly hatched (4 mm) larvae (Figure 2E). Growth of the smaller larvae can be observed from June to October in Figure 2E. Distribution of *Sebastes* spp. larvae was scattered throughout the area studied with no discernible pattern.

Larvae of *Sebastolobus* spp. (16 specimens, 10-40 mm) exhibited a scattered distribution similar to that of *Sebastes* spp.

Bothidae (93 larvae, 48 samples)

Pacific sanddab, *Citharichthys sordidus*, (25 specimens, 8-45 mm) occurred from long. 124°30′W to farther offshore. Distribution of *C. stigmaeus* (68 specimens, 17-44 mm) was concentrated closer to shore than that of *C. sordidus*, although some specimens were taken west of long. 126°W.

Pleuronectidae (123 larvae in 52 samples)

Four petrale sole, *Eopsetta jordani*, (13-21 mm) were collected in May: one off Tillamook Head at long. 125°W, one off Newport at long. 125°W, and two off Cape Arago—one at long. 125°W and the other at long. 126°W. *Glyptocephalus zachirus* (31 specimens, 22-89 mm) occurred throughout the sampling period from near shore to far offshore in no discernible pattern. All 33 butter sole, *Isopsetta isolepis*, (12-22 mm) were captured east of long. 125°W. Most larvae were close to shore. Slender sole, *Lyopsetta exilis*, (21 specimens, 10-23 mm) occurred east of long. 125°30'W, but were not concentrated as close to shore as *I. isolepis*. Dover sole, *Microstomus pacificus*, (10 specimens, 12-61 mm) were all collected west of long. 125°W. The six English sole, *Parophrys vetulus*, (18-22 mm) taken in May occurred off Newport (2) and Cape Arago (4) between the coast and long. 125°W. Sand sole, *Psettichthys melanostictus*, (18 specimens, 15-26 mm) also occurred mainly between the coast and long. 125°W; two of the specimens were taken at long. 125°30'W.

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