COASTAL AND OCEANIC FISH LARVAE IN AN AREA OF UPWELLING OFF YAQUINA BAY, OREGON

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ABSTRACT

A 1½-yr survey of planktonic fish larvae collected from 2 to 111 km off the mid-Oregon coast in 1971-72 yielded 287 samples which contained 23,578 individuals in 90 taxonomic groups, 78 identified at the species level.

Two distinct faunal assemblages were found: a "coastal" assemblage 2 to 28 km offshore and an "offshore" assemblage 37 to 111 km from shore. The coastal group was dominated by Osmeridae, *Parophrys vetulus*, *Isopsetta isolepis*, and *Microgadus proximus*. The offshore group was dominated by *Sebastes* spp., *Stenobrachius leucopsarus*, *Tarletonbeania crenularis*, *Lyopsetta exilis*, and *Engraulis mordax*. Peak abundance in both assemblages occurred between February and July when >90% of all larvae were taken. Larval distribution patterns in each assemblage were similar in 1971 and 1972, but larval abundance was greater in 1971 than 1972.

Ninety-nine percent of the larvae in 53 taxa designated as coastal and 96% of the larvae in 31 taxa designated as offshore were taken 2 to 28 km or 37 to 111 km offshore respectively. This separation of coastal and offshore larvae may be explained, in part, by adult spawning locations and current circulation patterns.

The species of larvae present in the coastal assemblage were similar to those in Yaquina Bay, but dominant species were quite different. The coastal zone is an important spawning area for *P. vetulus*, which utilizes Yaquina Bay estuary as a nursery during part of its early life.

In this paper, distribution patterns, seasonality, species composition, dominance, and relative abundance of larval fishes in an upwelling area off Yaquina Bay, Oreg., are described. Included are the most comprehensive time series of data yet available on larval fishes in the northeast Pacific Ocean north of California, data on the greatest number of distinct larval taxa yet reported for this area, and the first quantitative information on coastal and offshore assemblages of larval fishes off the northwest coast of the United States.

Larval fish distributions are discussed in relation to current circulation patterns and spawning location of adults. Results are compared with Pearcy and Myers' (1974) study of larval fishes of Yaquina Bay. The data on fish larvae are compared with data on zooplankton (Peterson and Miller 1975, footnote 2), shrimp larvae (Rothlisberg 1975), and crab larvae (Lough 1975) collected at the same time and location. Distribution patterns of larval fishes off the mid-Oregon coast are discussed in relation to a broader geographic area in the northeast Pacific.

PREVIOUS STUDIES IN THE NORTHEAST PACIFIC

This review includes only studies of a general survey nature conducted in ocean waters from northern California to the Gulf of Alaska, excluding the Aleutian Chain and Bering Sea. Studies in sounds, bays, and estuaries are not considered.

Prior to 1972, data on ichthyoplankton in the northeast Pacific were sparse and essentially nonquantitative because of the gear used—Isaacs-Kidd Midwater Trawls and Northern Pacific area (NORPAC) nets (Motoda et al. 1957). Surveys were designed primarily for biomass estimates of pelagic invertebrates and fishes. The ancillary data on fish larvae, often not identified to species, were usually presented in the form of appendix tables [Aron[3] for northern Washington

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[2]Peterson, W. T., and C. B. Miller. 1976. Zooplankton along the continental shelf off Newport, Oreg., 1969-72: distribution, abundance, seasonal cycle and year to year variations. Oreg. State Univ. Sea Grant Coll. Prog. Publ. ORESU-T-76-002, 111 p.

[3]Aron, W. 1958. Preliminary report of midwater trawling studies in the Pacific Ocean. Univ. Wash. Dep. Oceanogr. Tech. Rep. 58, 64 p.

Manuscript accepted September 1976.
FISHERY BULLETIN: VOL. 75, NO. 1, 1977.

to southwest Alaska; Aron[4] for southern California to southwest Alaska; Pearcy[5] for Oregon; Porter (1964) for northern California (flatfish only); LeBrasseur[6,7] for the northeast Pacific; Day (1971) for Washington to British Columbia]. Two additional reports (Aron 1959; LeBrasseur[8]) briefly mentioned larval fishes in the text.

More recent reports have been based on surveys designed specifically to sample ichthyoplankton using meter nets and bongo nets [Waldron (1972) off Oregon, Washington, and British Columbia in April-May 1967; Richardson (1973) off Oregon from May to October 1969; Naplin et al.[9] off Washington and British Columbia in October-November 1971; Dunn and Naplin[10] off Alaska in April-May 1972; Pearcy and Myers (1974) off Yaquina Bay from June 1969 to June 1970]. Results were quantitative and more refined species lists were provided. However most of these studies were restricted in seasonal coverage to periods of less than 1 yr. Pearcy and Myers (1974) presented a year-long data set but listed only yearly mean abundances. Discussion of larval distribution patterns in all these papers was limited. Waldron (1972) arbitrarily divided his data into two groups located inshore or offshore of the 914-m contour and discussed larval abundances in each region. Pearcy and Myers (1974) discussed horizontal variations in larval distributions with respect to larvae that occurred offshore and those that occurred in Yaquina Bay. Vertical distribution and day-night differences have not been discussed, although Richardson (1973) compared deep (to 200 m) and shallow (upper 20 m) tows.

MATERIALS AND METHODS

Most data came from samples taken at 12 stations, located 2 to 111 km offshore along an east-west transect (lat. 44°39.1′N) off Newport, Oreg., just north of Yaquina Bay (Figure 1). The transect extended over the continental shelf and slope; depths ranged from 20 to 2,850 m. Samples were taken every month from January 1971 to August 1972 except in January and February 1972, although not every station was sampled

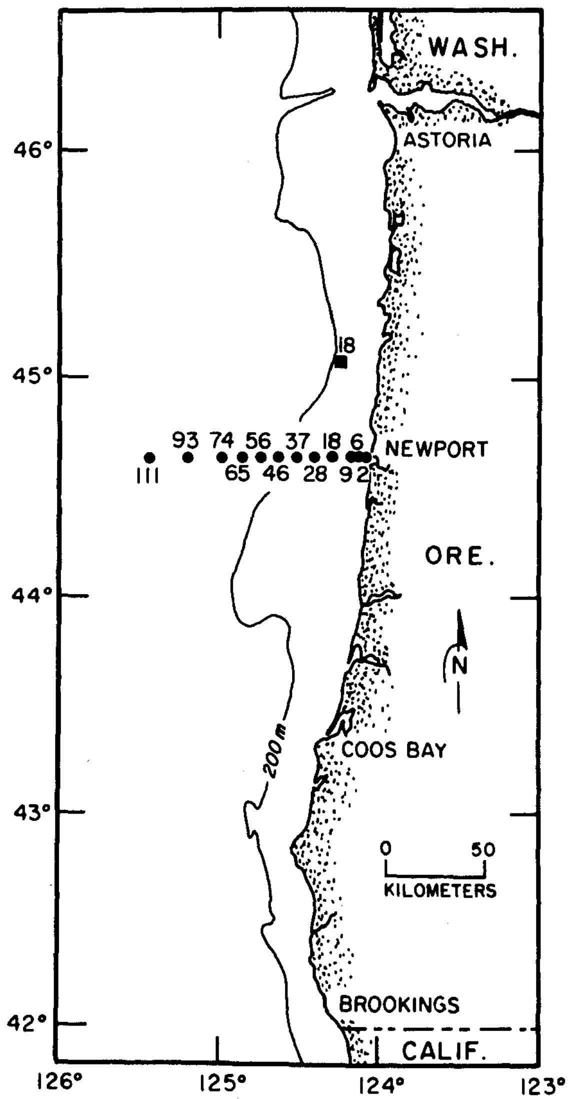

FIGURE 1.—Location of the major bongo net sampling stations (circles) along an east-west transect (lat. 44°39.1′N) off Yaquina Bay, Oreg., and a 24-h station (square) occupied in May 1972. Numbers are kilometers from the coast.

[4]Aron, W. 1960. The distribution of animals in the eastern north Pacific and its relationship to physical and chemical conditions. Univ. Wash. Dep. Oceanogr. Tech. Rep. 63, Ref. 60-55, 65 p. + 156 append.

[5]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.

[6]LeBrasseur, R. J. 1964. Data record: a preliminary checklist of some marine plankton from the northeastern Pacific Ocean. Fish. Res. Board Can., Manuscr. Rep. Ser. (Oceanogr. Limnol.) 174, 14 p.

[7]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.

[8]LeBrasseur, R. J. 1965. Seasonal and annual variations of net zooplankton at Ocean Station P, 1956-1964. Fish. Res. Board Can., Manuscr. Rep. Ser. (Oceanogr. Limnol.) 202, 162 p.

[9]Naplin, N.A., J. R. Dunn, and K. Niggol. 1973. Fish eggs, larvae and juveniles collected from the northeast Pacific Ocean, October-November 1971. NOAA-NMFS Northwest Fish. Cent., MARMAP Surv. I, Rep. 10, 39 p. + 121 tables.

[10]Dunn, J. R., and N. A. Naplin. 1974. Fish eggs and larvae collected from waters adjacent to Kodiak Island, Alaska, during April and May 1972. NOAA-NMFS, Northwest Fish. Cent., MARMAP Surv. I, Rep. 12, 61 p.

every month (Table 1). Of the 287 station occupancies, 219 were made during daylight, 50 at night, and 18 at dusk or dawn. In addition, a series of replicate tows was made on 28-30 June 1971, which included two daytime and two nighttime hauls at stations 2, 6, and 9 and one daytime and one nighttime haul at stations 46, 56, 65, and 74.

Samples were collected with a 70-cm (mouth diameter) bongo net without a closing mechanism. The bongos had two cylindrical-conical nets of 0.571-mm mesh Nitex[11] which were 4.6 m long and had a filtering area to mouth area ratio of about 10:1. Tsurumi-Seiki Kosakusho (TSK) flowmeters were positioned off center in the mouth of each net. A 40-kg multiplane kite-otter depressor (Colton 1959) was attached to the cable beneath the bongos which produced a 2:1 wire out to depth fished ratio. A time-depth recorder (bathykymograph) was attached to the cable above the bongos to record depth and path of tow.

The net was towed along depth contours parallel to the coast at a vessel speed of 2-3 knots. Tows were made obliquely through the water column in equal stepped intervals from the bottom or 150 m to the surface. Tow times ranged from 8 to 39 min and were usually between 10 and 30 min. Volume of water filtered ranged from 283 to 1,411 m^3 and was usually between 500 and 1,000 m^3.

At each station a bathythermograph (BT) cast was made to the bottom or 140 m, a surface bucket temperature was recorded, and surface and deep (bottom or 140 m) salinity samples were taken.

Plankton samples were preserved at sea in 10% buffered Formalin. One sample from each bongo pair (287 samples) was sorted for fish larvae except for the replicate series where both samples of each pair (7 of the 287 samples plus 33 additional samples) were sorted. All fish larvae were removed from each sample and were stored in 5% buffered Formalin. Larvae were identified to the lowest possible taxonomic group, enumerated, and measured (standard length). Numbers of larvae from each sample were standardized to number under 10 m^2 of sea surface. This standardized number was used in all analyses unless indicated otherwise.

In addition to the above samples, a 24-h station was occupied 18 km offshore at a location 46 km north of the Newport transect at lat. 45°04.0′N (Figure 1) on 30-31 May 1972. Water depth ranged from 158 to 164 m. Four depth strata (0-10, 11-50, 51-100, and 101-150 m) were sampled. Tows were designed to filter approximately the same volume of water in each stratum ($\bar{x}$ = 912 m^3 ± 142). The nonclosing bongo gear was lowered rapidly to the maximum depth of the zone to be sampled, towed obliquely through the depth zone in equally spaced steps, and then retrieved quickly to minimize contamination. Two tows were made in each depth stratum in daylight and again at night, which yielded 32 (16 pairs) samples. All fish larvae were sorted, identified, and enumerated. Numbers

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

TABLE 1.—Summary of 287 station occupancies made on an east-west transect (lat. 44°39.1′N) off Yaquina Bay, Oreg., 1971-72.

	Station (km from coast)											
	2	6	9	18	28	37	46	56	65	74	93	111
	Bottom depth (m)											
Month	20	46	59	85	95	142	330	220	340	1,060	1,300	2,850
1971:												
Jan.	2	2	2	2	—	—	—	—	—	—	—	—
Feb.	2	2	2	2	—	2	—	2	—	1	1	1
Mar.	2	2	2	2	1	2	—	2	1	2	2	2
Apr.	—	—	1	1	1	1	1	1	—	1	1	—
May	3	3	3	3	3	3	3	3	2	2	2	2
June	2	2	2	2	2	2	2	2	2	2	2	2
July	2	2	2	2	1	1	1	1	1	1	1	1
Aug.	2	2	2	2	2	2	2	2	2	2	2	1
Sept.	1	1	1	1	1	1	1	1	1	1	1	1
Oct.	1	1	1	1	1	1	1	1	1	1	1	1
Nov.	1	1	1	1	1	1	1	1	1	1	1	1
Dec.	1	1	1	1	1	1	1	1	1	1	—	—
1972:												
Jan.	—	—	—	—	—	—	—	—	—	—	—	—
Feb.	—	—	—	—	—	—	—	—	—	—	—	—
Mar.	3	2	3	3	3	3	3	3	2	2	2	2
Apr.	2	1	2	2	1	1	1	1	—	—	—	—
May	1	1	1	1	1	1	1	1	1	1	1	1
June	2	2	2	2	2	2	2	2	2	2	2	2
July	1	1	1	1	1	1	1	1	1	1	1	1
Aug.	1	1	1	1	1	—	—	—	—	—	—	—

of larvae from each of these samples were standardized to numbers per 1,000 m^3 of water filtered.

TAXONOMIC PROBLEMS

The 287 samples yielded 23,578 fish larvae in 27 families and 1 order (Table 2). To date 90 taxonomic groups have been identified, 78 at the species level, although 17 of these, primarily in the Cottidae and Stichaeidae, are still only numbered "larval types"[12] which are considered to be identified at the level of distinct species. These larval types have not yet been named because large specimens needed for positive identification were absent from the collections. This is the greatest number of species recorded from a larval fish study in the northeast Pacific which reflects, in part, refinements in larval fish identification as well as the intensity of the sampling effort which yielded many complete developmental series. Many of these larvae, particularly the coastal forms, have not yet been described in detail in the literature.

While identification of many of the abundant larvae, particularly the pleuronectids and myctophids, has been accomplished with certainty, a few major taxonomic problems remain, most notably with the osmerids and the scorpaenids, primarily *Sebastes* spp. We have not yet been able to identify the larval osmerids (<30 mm) to species, of which there are five possibilities: *Allosmerus elongatus, Hypomesus pretiosus, Spirinchus starksi, Spirinchus thaleichthys,* and *Thaleichthys pacificus.* Available descriptions (Morris[13]; Yap-Chiongco 1941; DeLacy and Batts[14]; Dryfoos 1965; Moulton 1970) are inadequate to distinguish all five species. We have not even established "larval types" below the family level.

No attempt was made to separate *Sebastes* spp., another problem group, into "larval types" (species or species groups) although a few distinct kinds appeared to be present. Samples from Oregon waters may contain some 35 species and identification of the larvae is difficult (Moser 1967, 1972; Moser et al. in press).

One other problem group is the Cyclopteridae. Based on its broad distribution pattern, our Cyclopteridae spp. 1 probably represents a multispecies group, perhaps *Liparis* spp., but we have not yet been able to subdivide it on the basis of larval characters.

These identification problems impose limitations on analysis of ichthyoplankton data. Caution must be exercised in interpretation of results when multispecies groups constitute a major proportion of larvae taken, such as *Sebastes* spp. and osmerids off Oregon.

SAMPLING VARIABILITY

A series of replicate oblique tows (four day and four night samples at stations 2, 6, 9; two day and two night samples at stations 46, 56, 65, 74) made in June 1971 was examined to assess sampling variability. Species composition of day and night tows at a station was similar, based on common larvae collected and their relative rank abundance. Total larvae in night catches exceeded those in day catches at all stations except 65 and 74 (Figure 2). Large day-night differences occurred at stations 6 and 9. This was primarily due to increased catches of large (>23 mm) osmerid larvae at night (Figure 3), which presumably avoided the net by day or were deeper, although 76 to 87% of the water column was sampled in daytime. Even so, osmerids were the most abundant larvae captured in all samples from these two stations. At station 2, the increased night catches were due to an increase in the numbers of large larvae (including osmerids), as well as an increase in the number of species captured (7-10 in daytime vs. 13-14 at night). Both *Isopsetta isolepsis* (most >16.5 mm) and *Microgadus proximus* (most >29 mm), species common at stations 6 and 9 during day and night, were collected only at night at station 2. At stations 46 and 56, night catches yielded increased numbers of *Engraulis mordax* (4-10 mm) and *Stenobrachius leucopsarus* (4-15 mm) while night catches of *Sebastes* spp. (3-9 mm) were half the daytime numbers (3-12 mm). At station 65, *E. mordax* (6-10 mm) was again more abundant in night tows while *Stenobrachius leucopsarus* was much less abundant at night, composing only 10 and 34% of the numbers of larvae in the two nighttime tows (6-13 mm) but 61 and 54% in the two

[12]The term larval type used in this paper refers to a particular kind of larva which may be distinguished from other larvae on the basis of larval characters but which has not yet been named. The term does not necessarily denote identification to the species level and is not intended to have any taxonomic implications.

[13]Morris, R. Some notes on the early life history of the night surf smelt, *Spirinchus starski* (Fisk) 1913. Unpubl. manuscr., 37 p.

[14]DeLacy, A. C., and B. S. Batts. 1963. A search for racial characteristics in the Columbia River smelt. Res. Fish., Fish. Res. Inst. Univ. Wash. Contrib. 147:30-32.

TABLE 2.—Species composition[1] and abundance[2] of fish larvae taken 2 to 111 km off of Yaquina Bay, Oreg., from January 1971 to August 1972.

Taxa	Total standardized abundance[2] Coastal	Offshore
Clupeidae:		
+ *Clupea harengus pallasi* (c)	64.19	0
Engraulidae:		
+− *Engraulis mordax* (o)	13.39	1,000.70
Osmeridae:		
+− Undetermined spp. (c)	5,749.53	13.65
Bathylagidae:		
− *Bathylagus milleri* (o)	0	2.90
− *Bathylagus ochotensis* (o)	0	131.46
− *Bathylagus pacificus* (o)	0	34.18
Melanostomiatidae:		
− *Tactostoma macropus* (o)	0	2.05
Chauliodontidae:		
− *Chauliodous macouni* (o)	0	29.47
Paralepididae:		
− *Lestidiops ringens* (o)	0	5.78
Myctophidae:		
+− *Lampanyctus regalis* (o)	0.82	37.04
− *?Loweina rara*[3] (o)	0	1.15
− *Protomyctophum crockeri* (o)	0	34.03
+− *Protomyctophum thompsoni* (o)	9.97	173.77
+− *Stenobrachius leucopsarus* (o)	45.30	3,648.00
+− *Tarletonbeania crenularis* (o)	2.29	635.20
− Undetermined spp. (o)	0	7.24
Gadidae:		
+− *Microgadus proximus* (c)	580.28	5.44
Ophidiidae:		
− *Brosmophycis marginata* (o)	0	2.86
− Ophidiidae sp. 1 (o)	0	1.32
Scorpaenidae:		
+− *Sebastes* spp. (o)	180.66	3,967.82
+− *Sebastolobus* spp. (o)	0.60	19.21
Hexagrammidae:		
+− *Hexagrammos* spp. (o)	0.44	2.94
+− *Ophiodon elongatus* (c)	53.44	1.24
Anoplopomatidae:		
+− *Anoplopoma fimbria* (o)	0.93	7.34
Cottidae:		
+− *Artedius* sp. 1 (c)	189.26	7.94
+ *Artedius* sp. 2 (c)	139.96	0
+ *Chitonotus pugetensis* (c)	7.55	0
+ *Cottus asper* (c)	145.43	0
+− *Enophrys bison* (c)	60.65	6.63
+− *Hemilepidotus hemilepidotus* (c-o)	13.13	6.44
+− *Hemilepidotus spinosus* (c-o)	69.04	29.78
+− *Icelinus* sp. 1 (c)	54.46	1.94
+− *Leptocottus armatus* (c-o)	18.60	5.50
+ *Nautichthys oculofasciatus* (c)	0.77	0
+ *Oligocottus* sp. 1 (c)	3.15	0
+ *Paricelinus hopliticus* (c)	0.79	0
− *Psychrolutes*-like sp. 1 (o)	0	2.21
+− *Radulinus asprellus* (c)	58.45	9.19
+ *Rhamphocottus richardsoni* (c)	0.77	0
+ *Scorpaenichthys marmoratus* (c)	21.84	0
+ Cottidae sp. 1C (c)	5.94	0
+ Cottidae sp. 12 (c)	42.70	0
+ Cottidae sp. 19 (c)	0.33	0
+ Cottidae sp. 20 (c)	1.12	0
+ Undetermined spp. (c)	21.55	0
Agonidae:		
+ *Agonopsis emmelane* (c)	1.17	0
+− *Bathyagonus* spp. (c-o)	1.55	1.75
+ *Occella verrucosa* (c)	13.27	0
+ *Odontopyxis trispinosa* (c)	1.48	0
+ *Pallasina barbata* (c)	0.87	0
+ *Stellerina xyosterna* (c)	28.43	0
+ *Zeneretmus latifrons* (c)	1.16	0
+ Agonidae sp. 6 (c)	3.14	0
Cyclopteridae:		
+ *Liparis pulchellus* (c)	15.85	0
+− Cyclopteridae spp. 1 (c-o)	34.09	79.70
+ Cyclopteridae sp. 3 (c)	4.45	0
+− Undetermined spp. (c)	27.04	6.75
Bathymasteridae:		
+− *Ronquilus jordani* (c)	32.47	3.35
Blennioids:		
+ Undetermined spp. (c)	0.32	0
Clinidae:		
+ *Gibbonsia ?montereyensis* (c)	0.70	0
Stichaeidae:		
+ *Anoplarchus* sp. 1 (c)	33.81	0
+ *Chirolophis* sp. 1 (c)	37.80	0
+ *Lyconectes aleutensis* (c)	1.03	0
+ *Lumpenus sagitta* (c)	1.37	0
+ *Plectobranchus evides* (c)	1.12	0
+ Stichaeidae sp. 1 (c)	0.77	0
+− Stichaeidae sp. 2 (c)	5.53	1.04
+ Stichaeidae sp. 4 (c)	6.56	0
Ptilichthyidae:		
+ *Ptilichthys goodei* (c)	1.09	0
Pholidae:		
+ *Apodichthys flavidus* (c)	0.70	0
+ *Pholis* spp. (c)	71.17	0
Icosteidae:		
− *Icosteus aenigmaticus* (o)	0	15.60
Ammodytidae:		
+ *Ammodytes hexapterus* (c)	258.50	0
Gobiidae:		
+ *Clevelandia ios* (c)	2.31	0
Centrolophidae:		
− *Ichichthys lockingtoni* (o)	0	60.30
Bothidae:		
− *Citharichthys sordidus* (o)	0	1.80
+ *Citharichthys stigmaeus* (c)	2.59	0
+− *Citharichthys* spp.[4] (o)	7.53	57.19
Pleuronectidae:		
− *Atheresthes stomias* (o)	0	4.80
+− *Embassichthys bathybius* (o)	0.64	7.09
− *Eopsetta jordani* (o)	0	1.57
+− *Glyptocephalus zachirus* (o)	18.27	113.81
+− *Hippoglossoides elassodon* (c-o)	2.70	2.59
+− *Isopsetta isolepis* (c)	1,157.90	12.53
+− *Lepidopsetta bilineata* (c)	1.31	0
+− *Lyopsetta exilis* (o)	96.54	475.23
+− *Microstomus pacificus* (o)	8.24	81.74
+− *Parophrys vetulus* (c)	1,479.59	37.62
+− *Platichthys stellatus* (c)	187.40	1.72
+− *Psettichthys melanostictus* (c)	308.12	1.13
Unidentified larvae	16.84	17.22
Fragments	47.71	49.09
	11,474.46	10,868.04

[1]General distribution patterns are given for each taxon:
+ = taken 2 to 28 km offshore
− = taken 37 to 111 km offshore
c = coastal type (>80% of all larvae taken 2 to 28 km from coast)
o = offshore type (>80% of all larvae taken 37 to 111 km from coast)
c-o = neither c or o type (<80% of all larvae taken in either coastal or offshore area).

[2]The sum of the standardized numbers (number under 10 m² sea surface) of larvae from each sample in the coastal (2-28 km) and offshore (37-111) km assemblages (139 and 148 samples, respectively).

[3]Identification based on one partly mutilated specimen.

[4]Specimens too small to identify to species.

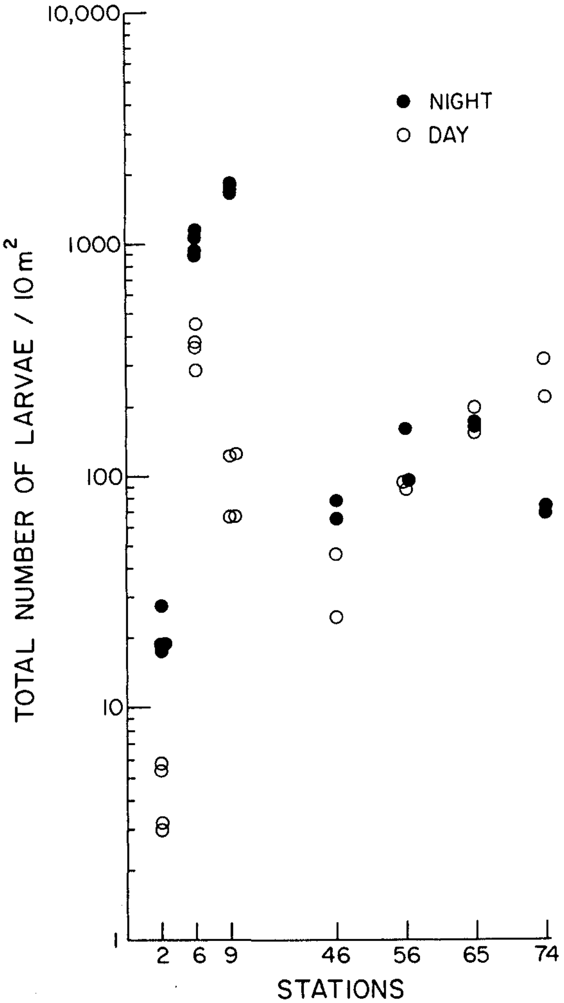

FIGURE 2.—Day and night catches of fish larvae on transect off Yaquina Bay, Oreg., June 1971.

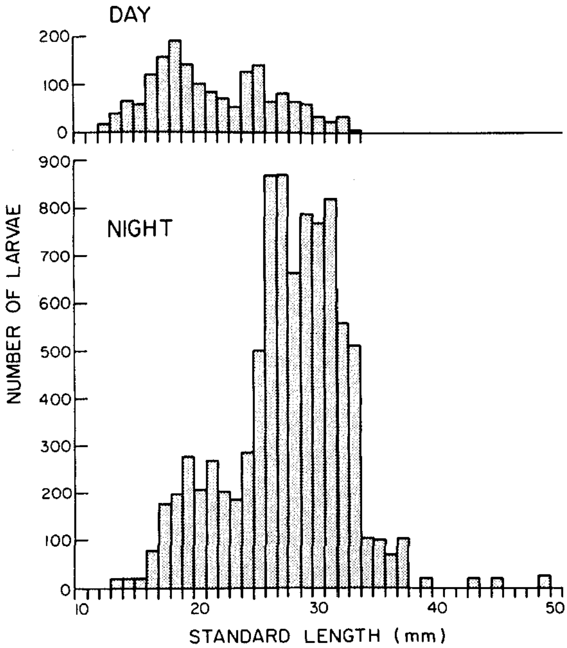

FIGURE 3.—Day and night length frequencies of osmerid larvae collected at 6 and 9 km off Yaquina Bay, Oreg., June 1971. Numbers of larvae were combined for both nets from four day and four night hauls.

daytime tows (4-16 mm). Decreased larval abundances at night at station 74 were due mainly to reduced numbers of *S. leucopsarus* (5-13 mm at night, 5-16 mm in day). Thus avoidance of the net by large larvae in daytime seemed to account for much of the day-night variation at the coastal stations 2, 6, and 9. Differences at the offshore stations may have been due to patchiness of small larvae.

Variability among repeated samples was examined at the three inshore stations where four day and four night replicate samples were taken at each station. Coefficients of dispersion were calculated for total larvae, osmerids, and total larvae minus osmerids (Table 3). Values were close to 1.0 for total larvae minus osmerids at stations 6 and 9 and for total larvae at station 2 where osmerids were not abundant suggesting that larvae were randomly distributed. Coefficients were large, however, for total larvae and for osmerids at 6 and 9 where smelt larvae were abundant, except at night at station 9. These large coefficients of dispersion indicate high contagion, possibly caused by schooling behavior of large osmerid larvae.

TABLE 3.—Coefficients of dispersion ($s^2/\bar{x}$) for total larvae, osmerids, and total larvae minus osmerids in replicate tow series made in June 1971 on the transect (lat. 44°39.1′N) off Yaquina Bay, Oreg.

Item	Station 2		Station 6		Station 9	
	Day	Night	Day	Night	Day	Night
Total larvae	0.49	0.97	12.44	11.96	11.56	0.57
Osmeridae			16.40	12.81	14.49	0.82
Total larvae minus Osmeridae			0.81	3.18	0.81	1.23

VERTICAL DISTRIBUTION

One attempt was made to study the vertical distribution patterns of larvae in the coastal zone 18 km offshore north of the Newport transect (Figure 1). Thirty-two samples were taken within four depth strata (0-10, 11-50, 51-100, and 101-150

m) during a 24-h period in May 1972. Essentially, the entire water column was sampled. The volume of water filtered by each type of tow was about the same and the number of day and night tows in each stratum was equal. Because the nets had no opening-closing device, samples from all but the 0- to 10-m stratum were contaminated with catches from overlying waters. However, the maximum tow time spent outside the desired stratum was 20% for the deepest tows and was usually <10% for the intermediate depths. Therefore, no correction factor was applied to the data.

The greatest number of larvae and taxa was taken near the surface both day and night (Table 4). The 51- to 100-m stratum yielded the fewest larvae and taxa while the 11- to 50- and 101- to 150-m strata were intermediate. More larvae were taken at night, primarily in the 0- to 10-m stratum where avoidance during the day would be expected to be greatest. Mean larval length in this stratum was much greater at night which also indicated daytime avoidance by large larvae in surface waters. Mean larval length was also high in the 101- to 150-m stratum day and night, primarily because of the abundance of large osmerids there.

Of the 22 taxa taken, those represented by more than 10 larvae were examined for trends in distribution (Table 4). *Clupea harengus pallasi* (25-31 mm, $\bar{x}$ 28), *Ammodytes hexapterus* (17-37 mm, $\bar{x}$ 33), and *Ronquilus jordani* (6-21 mm, $\bar{x}$ 13) were concentrated in the upper 10 m at night and were completely absent in daytime collections from all depths. They exhibited strong daytime avoidance, indicated by night/day ratios. Large *Sebastes* spp. larvae (9-11 mm, $\bar{x}$ 10) were only taken at night and perhaps avoided by day, whereas small larvae (3-4 mm, $\bar{x}$ 4) were taken both day and night in the upper two strata. *Stenobrachius leucopsarus* (5-11 mm, $\bar{x}$ 8) and *Isopsetta isolepis* (14-23 mm, $\bar{x}$ 20) occurred predominantly in the upper two strata but showed no evidence of daytime avoidance. Mean larval lengths were about the same by day and night.

Of the remaining taxa, *Radulinus asprellus* (9-15 mm, $\bar{x}$ 12) appeared to occur throughout the water column in similar numbers and lengths during both day and night. Cyclopteridae spp. 1 (4-8 mm, $\bar{x}$ 5) occurred mainly near the surface in daytime but only in the 51- to 100-m stratum at night, possibly a result of patchiness or contamination of the deeper hauled net in the surface stratum. Only osmerids occurred primarily near the bottom (101-150 m), by day and night. Some were taken near the surface at night which may indicate vertical migration by some individuals or avoidance by day. Preliminary examination of specimens did not reveal the surface- and bottom-occurring osmerid larvae to be different species. Mean lengths for deep- and surface-caught osmerids were about the same, 21 and 23 mm.

ASSEMBLAGES

Two separate assemblages of fish larvae were distinguished, using a similarity coefficient matrix based on Sander's (1960) dominance-affinity index ($\sum$ lowest percent of all larvae in common between two stations). In 1971 a coastal assemblage occurred at stations 2 to 28 km offshore, which was distinct from another assemblage occurring at stations farther offshore (Figure 4). A similar pattern was found in 1972 during the 6 mo for which data were available. In 1971, the mean affinity value among stations 2, 6, 9, 18, and 28 was 65.81 and among stations 46, 56, 65, 74, 93, and 111 it was 60.61. In 1972, the mean affinity values for these same sets of stations were 43.21 and 56.61, respectively. *Sebastes* spp. were

TABLE 4.—Number/1,000m³, number of taxa, and mean length of fish larvae by day, night, and depth strata taken during a 24-h period 18 km off the mid-Oregon coast (lat. 45°04.0′N) in May 1972. N/D = night to day ratio. Each number is the sum of four replicate samples.

Depth strata (m)	*Clupea harengus pallasi*		Osmeridae		*Stenobrachius leucopsarus*		*Sebastes* spp.		*Radulinus asprellus*		Cyclopteridae spp. 1		*Ronquilus jordani*		*Ammodytes hexapterus*		*Isopsetta isolepis*		Other spp.		Total		No. taxa taken		Mean length (mm)	
	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N
0-10	0	46	0	4	9	3	3	10	7	1	14	0	0	29	0	22	31	8	14	8	78	131	13	13	13	21
11-50	0	1	0	1	0	4	1	2	3	5	3	0	0	0	0	0	12	12	5	5	24	30	9	9	15	15
51-100	0	2	0	0	0	0	0	0	3	2	0	8	0	0	0	1	1	1	2	0	6	14	3	5	11	12
101-150	0	1	21	13	0	0	0	0	2	5	0	0	0	0	0	1	3	2	1	3	27	25	4	8	20	20
Total	0	50	21	18	9	7	4	12	15	13	17	8	0	29	0	24	47	23	22	16	135	200	16	18	15	20
N/D	∞		0.86		0.78		3.00		0.87		0.47		∞		∞		0.49		0.73		1.48					

1971

	2	6	9	18	28	37	46	56	65	74	93	111
2		70.12	67.87	59.18	50.66	28.40	2.51	3.10	0.84	1.49	0.84	0.73
6			92.31	83.84	50.85	23.65	2.99	4.09	1.64	2.16	1.67	2.35
9				87.90	49.64	26.44	3.17	4.09	1.70	2.13	1.77	1.72
18					45.69	29.64	6.86	6.71	4.29	4.94	4.09	2.88
28						47.79	28.65	30.19	26.11	24.04	22.28	21.39
37							32.42	29.04	24.10	19.76	17.79	15.94
46								69.92	48.44	36.46	34.96	32.45
56									67.43	55.11	55.00	53.27
65										60.31	62.48	61.90
74											94.06	86.56
93												90.87
111												

1972

	2	6	9	18	28	37	46	56	65	74	93	111
2		74.34	51.32	43.17	9.88	15.60	7.19	5.64	1.78	1.97	1.27	1.85
6			57.77	43.80	20.06	22.31	12.52	9.13	4.92	5.39	4.92	4.92
9				66.36	25.58	20.58	11.94	8.70	3.49	4.06	3.22	3.41
18					39.79	26.53	19.58	11.36	6.83	5.73	7.49	2.59
28						31.81	40.68	19.54	18.94	11.17	8.28	8.27
37							68.09	48.23	41.49	25.77	34.06	32.05
46								58.71	47.70	32.34	37.64	38.49
56									69.62	46.43	67.68	66.06
65										41.80	59.69	76.66
74											74.10	56.86
93												75.41
111												

■ > 70.00 ▨ 50.00-69.99 ▩ 30.00-49.99 □ < 30.00

FIGURE 4.—Station to station similarity-coefficient matrices for 1971 and 1972 data on larval fishes based on Sander's (1960) dominance affinity index. All taxa except *Sebastes* spp. were included in the analysis.

excluded from the analysis to minimize masking effects that might have arisen because of the multispecies nature of the group. Since osmerids were known to be essentially coastal forms, they were not excluded.

Peaks in larval abundances were associated with the location of these two assemblages with an apparent transitional zone of low larval abundance between them (Figure 5). In both 1971 and 1972 abundance was relatively high inshore, dropped to a low at 28 km, and then increased seaward.

Larval taxa were determined to be associated with the coastal or offshore zone on the basis of whether 80% or more of all larvae were taken at stations 2 to 28 (coastal = C) or stations 37 to 111 (offshore = O). Using these criteria, 84 of the 90 taxa (93%) could be designated as coastal or offshore (Table 2). Fifty-three taxa in 16 families and 1 order were coastal. Of these, 49 were identified to species, 3 to family, and 1 to order. Ninety-nine percent of all larvae in these 53 taxa were taken in the coastal zone 2 to 28 km offshore. Thirty-one taxa in 15 families were offshore. Of these, 26 were identified to species, 4 to genus, and 1 to family. Ninety-six percent of all larvae in these 31 taxa were taken 37 to 111 km offshore.

Only six taxa could not be designated as coastal or offshore. This was probably due in part to rarity, e.g., *Hippoglossoides elassodon* (total standardized number = 5.29; 51% were C and 49% were O), *Bathyagonus* spp. (3.30; 47% C and 53% O), and to multispecies groups, e.g., Cyclopteridae spp. 1 (30% C and 70% O) and *Bathyagonus* spp. Interestingly, 96% of all *Sebastes* spp. larvae were taken in the offshore area. *Leptocottus armatus* was primarily coastal since 77% of all larvae were taken there. Only one sample outside the coastal area (Station 37, in February 1971) contained *L. armatus* larvae, but they were present in moderate numbers. *Hemilepidotus hemilepidotus* (67% C and 33% O) and *H. spinosus* (70% C and 30% O) distributions are more difficult to explain. *Hemilepidotus spinosus* larvae in the coastal area were smaller (4-9 mm, $\bar{x}$ 5.3) than those farther offshore (6-12 mm, $\bar{x}$ 8.9) as were *H. hemilepidotus* (4-6 mm, $\bar{x}$ 5.2 in the coastal area and 8-11 mm, $\bar{x}$ 9.3 offshore). *Hemilepidotus spinosus* larvae are sometimes abundant (>600 larvae/15 min tow) in the neuston (upper 15 cm of the water column), particularly at night (Richardson unpubl. data). These data suggest that larvae which are associated with surface waters may undergo some kind of offshore transport which does not affect nonneustonic species.

Modes of reproduction differ considerably between those species designated as coastal and those designated as offshore. Of the 53 coastal taxa

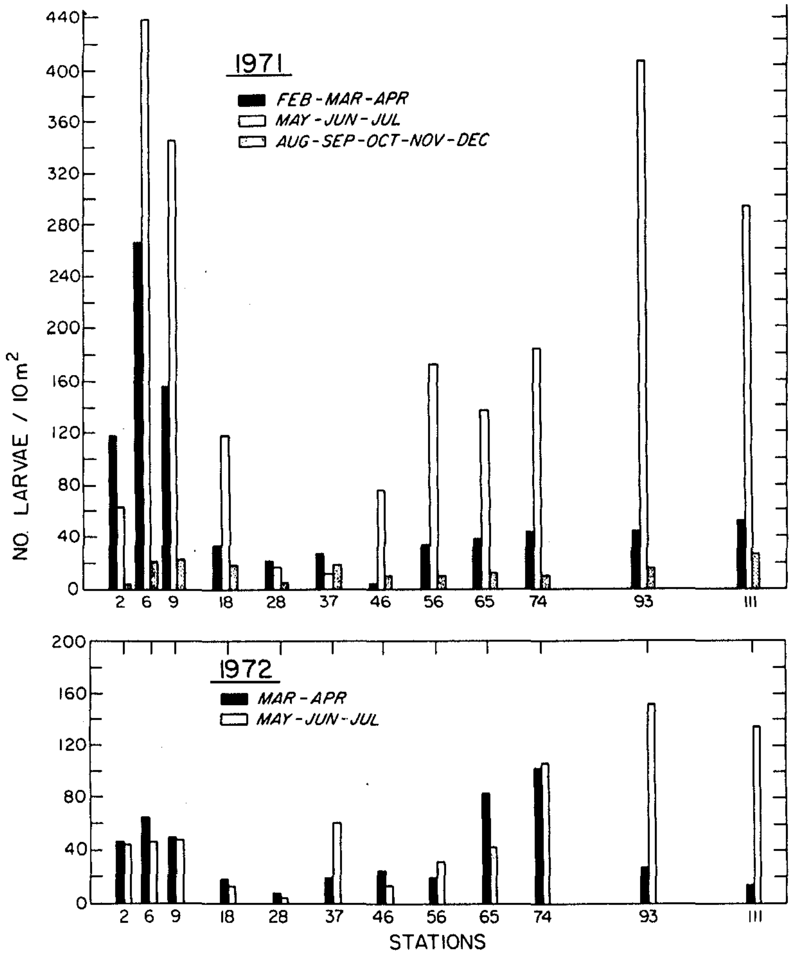

FIGURE 5.—Mean standardized abundance of fish larvae by station in 1971 and 1972.

(Table 2), 87% presumably come from demersal eggs (Breder and Rosen 1966) including all the osmerids, cottids, agonids, cyclopterids, and blennioids as well as *Clupea harengus pallasi, Ophiodon elongatus, Ronquilus jordani, Ammodytes hexapterus,* and *Clevelandia ios.* The eggs of *Microgadus proximus* are unknown but may also be demersal, as are those of *M. tomcod* in the Atlantic. Those not derived from demersal eggs, i.e., the six coastal flatfishes, come from small (~1 mm or less in diameter) planktonic eggs. Of the 31 offshore taxa, 81% presumably come from planktonic eggs. Eggs of the bathylagids, myctophids, bothids, and *Engraulis mordax* are probably all relatively small (~1 mm or less) whereas those of *Chauliodus macouni, Anoplopoma fimbria, Icosteus aenigmaticus, Atheresthes stomias, Embassichthys bathybius, Glyptocephalus zachirus,* and *Microstomus pacificus* are large, usually >2 mm. Eggs of *Tactostoma macropus, Icichthys lockingtoni, Eopsetta jordani,* and *Lyopsetta exilis* are intermediate in size. Eggs of *Sebastolobus* spp., also of intermediate size, occur in floating masses rather than individually (Pearcy 1962). Larvae of the live-bearers *Brosmophycis marginata, Sebastes* spp., and possibly Ophidiidae sp. 1 are extruded. Of the offshore taxa, only *Hexagrammos* spp. and perhaps *Psychrolutes*-like sp. 1 come from demersal eggs.

Coastal Assemblage

One hundred thirty-nine samples were taken in the coastal assemblage, five at night, four at dusk or dawn, and the rest during daylight. All but four samples contained larvae, yielding 16,197 specimens or a standardized total [$\sum$ (number of larvae under 10 m² sea surface in each sample)] of 11,474.

Species Composition and Dominance

Seventy-three taxa assigned to 19 families and 1 order were taken in the coastal samples (Table 2). Of these, 62 were identified to species including unnamed numbered larval types considered to be distinct species, 7 to genus, 3 to family, and 1 to order. Margalef's (1958) formula for diversity ($D = S - 1/\ln N$, where S = number of species, N = total number of individuals), which provides a measure of species richness, yielded a value of 7.43 for the coastal assemblage, which was higher than that for the offshore assemblage.

Dominant taxa within the coastal assemblage were determined by a ranking method (Biological Index = BI) modified from Fager (1957), which takes into account both abundance and frequency of occurrence. By this method, the most abundant species in each sample is given five points, the next four, etc. Scores for each taxon are summed for all positive samples and divided by the total number of samples taken. The top 13 coastal dominants[15] (Table 5) accounted for 91.8% of the total larvae captured within 28 km of the coast over the entire sampling period. These same 13 taxa were also the 13 most abundant, although not always in the same order as dominance.

Osmerids were overwhelmingly the most dominant taxonomic group making up 50% of the total larval catch. They were the most abundant and most frequently taken larvae in the coastal assemblage. *Parophrys vetulus* and *Isopsetta isolepis* were also important in terms of abundance. These three taxa, together with fourth ranked *Microgadus proximus*, composed 78% of all larvae taken.

[15]Data on distribution and abundance of all 90 taxa will be available in an Oregon State University Sea Grant College Program Technical Report by the senior author in 1976-77.

Seasonality

Obvious trends in seasonality were apparent from the 1971 data, which included samples from every month (Figure 6). Ninety-three percent of all larvae were taken during the 6-mo period from February through July. Two abundance peaks occurred within that period, one in February-March (24% of all larvae) before upwelling, and one in May-July (68% of all larvae) during the upwelling season. Larval abundance decreased greatly in August and remained low through December. Mean number of larvae under 10 m² was 142 in February-March, 202 in May-July, and

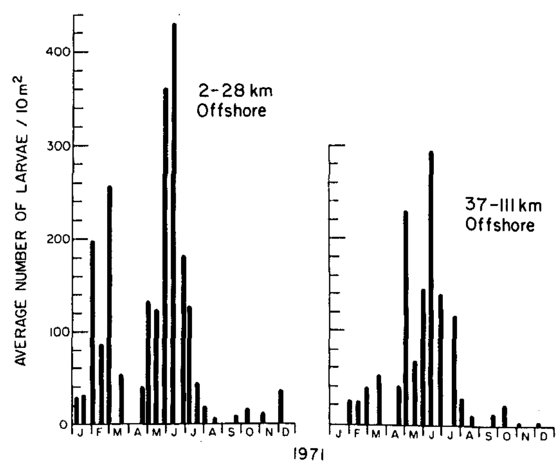

FIGURE 6.—Mean standardized abundance of fish larvae by cruise in 1971 in the coastal assemblage (stations 2 to 28) and the offshore assemblage (stations 37 to 111).

TABLE 5.—Coastal dominants based on all larvae collected 2 to 28 km offshore in 1971 and 1972. [BI = Biological Index modified from Fager (1957)].

Taxa	BI	Rank order of abundance	Total standardized abundance¹	% of total abundance	Positive tows out of 139	Total standardized abundance¹ / Positive tows	Months of occurrence
1. Osmeridae	2.49	1	5,749.53	50.1	90	63.88	I-VIII, X-XII
2. *Parophrys vetulus*	1.41	2	1,479.59	12.9	60	24.66	I-VI, IX-XII
3. *Isopsetta isolepis*	1.39	3	1,157.90	10.1	71	16.31	I-VIII, X
4. *Microgadus proximus*	0.97	4	580.28	5.1	62	9.36	II-VIII
5. *Sebastes* spp.	0.77	9	180.66	1.6	57	3.17	I-XII
6. *Psettichthys melanostictus*	0.71	5	308.12	2.7	55	5.60	I-XI
7. *Artedius* sp. 1	0.50	7	189.26	1.6	66	2.87	I-VIII
8. *Platichthys stellatus*	0.39	8	187.40	1.6	30	6.25	III-VI, IX
9. *Lyopsetta exilis*	0.34	12	96.54	0.8	41	2.35	III-VIII
10. *Artedius* sp. 2	0.32	11	139.96	1.2	48	2.92	I-VIII
11. *Ammodytes hexapterus*	0.31	6	258.50	2.2	22	11.75	II-V
12. *Hemilepidotus spinosus*	0.29	13	69.04	0.6	21	3.34	I-III
13. *Cottus asper*	0.24	10	145.43	1.3	22	6.61	III-VII

¹The sum of the standardized numbers (number under 10 m² sea surface) of larvae from each sample.

13 during August-December. Since samples were taken only during 6 mo in 1972 and larval abundances were greatly reduced, trends in seasonality could not be assessed.

In 1971, 42 taxa were taken in the February-March period and 46 taxa were taken from May to July. Of these, 10 occurred only during the winter period, 14 occurred only in the spring, and 32 were taken in both periods. Dominant taxa (with BI>1) in the February-March period were *P. vetulus* (BI = 4.09), *Ammodytes hexapterus* (BI = 1.76), *I. isolepis* (BI = 1.73), and Osmeridae (BI = 1.51). Together they made up 70% of the total larvae. *Parophrys vetulus* alone accounted for 44%. Dominant taxa from May to July 1971 were Osmeridae (BI = 4.12), *I. isolepis* (BI = 2.21), *M. proximus* (BI = 2.03), and *Lyopsetta exilis* (BI = 1.07). Together they made up 90% of the total number of larvae in those months. Osmerids accounted for 71% of the total in that period.

Thus the two abundance peaks in 1971 were not made up of completely different species. Some were common to both (Table 6). Some species occurred in the plankton collections during only a few months. For example, *Platichthys stellatus* larvae occurred over a restricted period of time (Table 6), small larvae were taken only during a few months mainly in spring, and they transformed and settled out at a small size (~8 to 9 mm). *Hemilepidotus spinosus* and *A. hexapterus* also were taken during a short-time period, primarily in winter. Larger *A. hexapterus* larvae avoid plankton nets and may have been present for a longer period than the data suggested. On the other hand, some species, such as *Parophrys vetulus* and *Psettichthys melanostictus*, occurred over a longtime period because of protracted spawning seasons and relatively long planktonic life (Table 6). *Parophrys vetulus* spawned primarily from January through March. Increases in larval lengths indicated that spawning stopped and larvae had settled out by July. Spawning began again in September and continued at least through December. Small larvae of *Psettichthys melanostictus* were taken in most months except July, August, and December. An increase in modal length occurred from June through August and again from September through November.

Other species showed trends in seasonal occurrence somewhere between the two extremes. *Isopsetta isolepis* apparently spawned from February through May. Modal lengths increased in successive months and large larvae were no longer available to our gear by August. *Microgadus proximus* also appeared to spawn from February through June and the larvae were not caught after August. *Lyopsetta exilis* apparently spawned from March through June and larvae were absent in collections from September through February. *Artedius* sp. 1 and *Artedius* sp. 2 were taken over an 8-mo period and small larvae occurred almost every month. *Cottus asper* was taken from February through July, but larval lengths showed no trends by month. Although taxonomic problems exist with the osmerids, two groups (possibly two species) were apparent from

TABLE 6.—Ranges and modal lengths (mm) for dominant fish larvae in the coastal assemblage (stations 2-28) in 1971. Asterisks indicate month in which average abundance per cruise was greatest. Parentheses are used where more than one modal peak occurred.

Taxa	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1A. Osmeridae (group 1)	5-6-10	6-11-21	15-19-24*	0	0	0	0	0	0	6-12	6	5-8-25
1B. Osmeridae (group 2)	0	0	4-6-11	0	5-15-32	7-25-35*	$10\text{-}\binom{24}{27}\text{-}36$	5-29-37	0	0	0	0
2. *Parophrys vetulus*	2-3-9	2-4-18*	3-8-21	$4\text{-}\binom{12}{13}\text{-}18$	5-8-22	14-21	0	0	2-3-6	2-10-17	3-5-14	2-5-14
3. *Isopsetta isolepis*	0	2-4-6	3-7-16	3-9-17	3-13-21*	6-16-21	10-11-19	0	0	2	0	0
4. *Microgadus proximus*	0	3-3-5	3-4-9	3-7-19	4-7-19	3-6-33*	6-16-24	$14\text{-}\binom{20}{21}\text{-}31$	0	0	0	0
5. *Sebastes* spp.	3-4-4*	3-3-4	3-4-4	4-4-7	3-4-5	4-4-9	16	$3\text{-}\binom{3}{4}\text{-}17$	3-3-14	0	9	6
6. *Psettichthys melanostictus*	3	2-3-4	5	5	3-13-23*	5-6-23	8-11-21	14-22	$4\text{-}\binom{4}{5}\text{-}8$	2-9-13	3-11-26	0
7. *Artedius* sp. 1	2-3	2-3-4*	$3\text{-}\binom{8}{10}\text{-}10$	$4\text{-}\binom{4}{5}\text{-}9$	3-6-13	4-7-12	4-6-12	$3\text{-}\binom{10}{11}\text{-}11$	0	0	0	0
8. *Platichthys stellatus*	0	0	3-3-5	3-4	3-7-9*	5-7-9	0	0	3	0	0	0
9. *Lyopsetta exilis*	0	0	5	4-4-7	4-5-11	5-10-21*	9-11-21	11-19	0	0	0	0
10. *Artedius* sp. 2	2-3	2-4-6	2-6-9*	8	3-6-13	3-3-13	6-7-10	3-4-9	0	0	0	0
11. *Ammodytes hexapterus*	0	4-4-9	4-10-19*	14-19	11-12	0	0	0	0	0	0	0
12. *Hemilepidotus spinosus*	5-5-8	4-5-6	4-5-6*	0	0	0	0	0	0	0	0	0
13. *Cottus asper*	0	5	4-5-8*	0	6-9-9	5-6	6-7-9	0	0	0	0	0

length-frequency data (Table 6). Two distinct length modes occurred in March, which suggested the presence of both a winter-spawned and a spring-spawned group.

Distribution Trends

Peak abundances for dominant species within the coastal assemblage generally occurred at stations 6 and 9 (Figure 7) for those larvae that were most abundant before the usual months of upwelling (e.g., *P. vetulus, Ammodytes hexapterus*) and also for those most abundant during the upwelling season (e.g., Osmeridae, *I. isolepis, M. proximus*). Abundance usually decreased toward the coast and farther offshore. However, on two winter cruises, osmerids were most abundant at the 2-km station. A few species, such as *C. asper*, were always most abundant at the 2-km station, and numbers decreased with distance from shore. *Cottus asper* is known to spawn in Yaquina Bay where it is the third most abundant larval species (Pearcy and Myers 1974). It is found in greatest numbers in the upper part of the Bay, and its occurrence offshore probably is a result of tidal flushing.

Year to Year Variation

The mean standardized number of larvae per station during the winter and spring-summer periods was considerably higher in 1971 than in

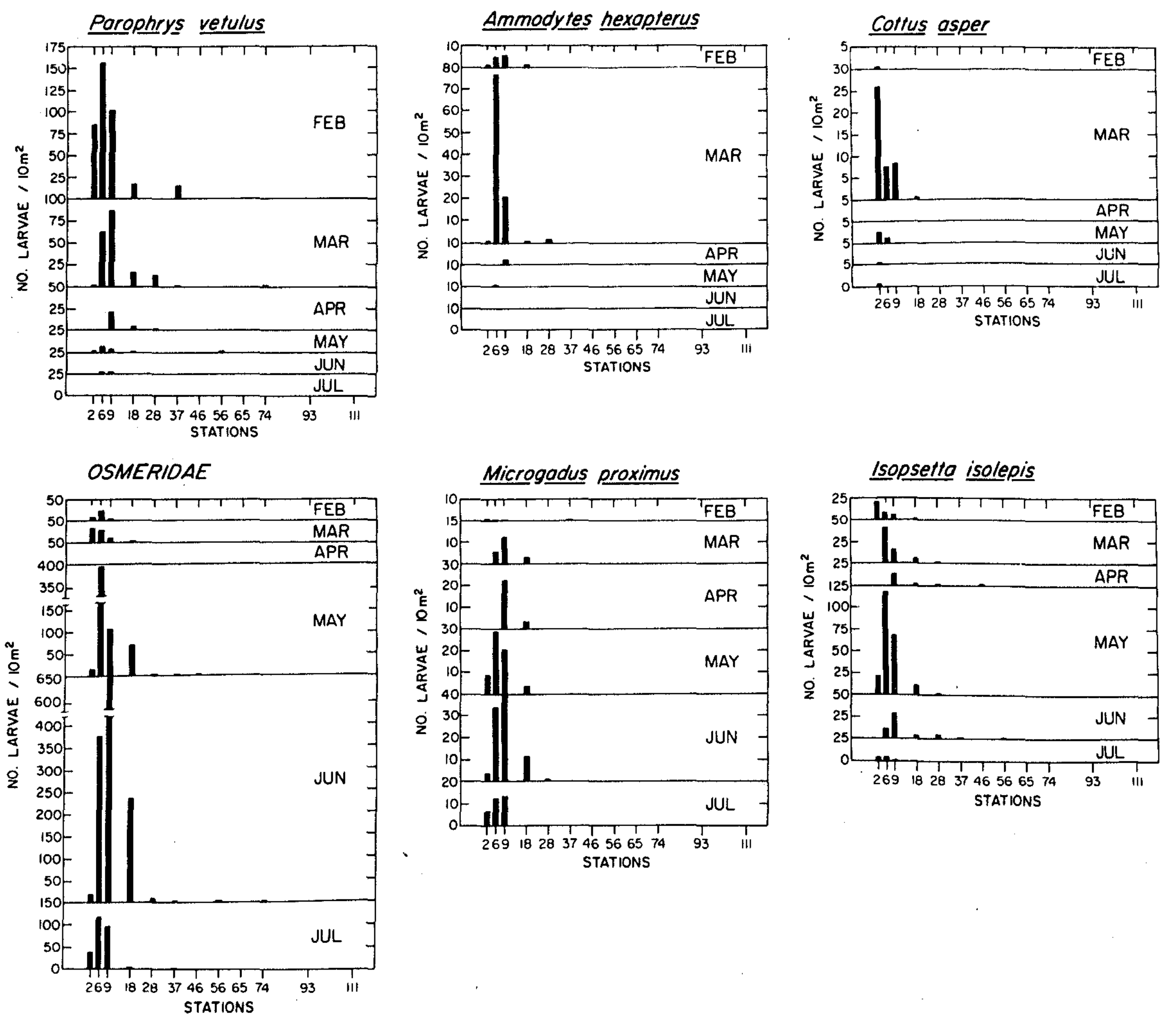

FIGURE 7.—Distribution patterns of fish larvae in the coastal assemblage (stations 2 to 28) during months of peak abundance in 1971. Abundances are monthly means.

1972, sometimes by an order of magnitude (Figure 5). These differences are exemplified further by the mean standardized number of larvae per tow (Table 7).

In March-April, five of the six dominant (BI ⩾ 1) taxa were more abundant in 1971 than 1972 (Table 7). The exception was *Sebastes* spp., which was 6.5 times more abundant in 1972 based on mean standardized number per tow. The greatest decrease occurred for *P. vetulus,* which was 24.9 times more abundant in 1971. The low numbers of *P. vetulus* in 1972 may have been partly due to an early spawning; small larvae were taken as early as September and October 1971 (Table 6) and many larvae may have settled out by the March-April 1972 period. Or 1972 may have been a year of reduced larval survival for *P. vetulus. Ammodytes hexapterus* was also more abundant in 1971 with 12.2 times more larvae being taken than in 1972. Dominance shifted from *P. vetulus* in 1971 to the Osmeridae in 1972 even though osmerids were less abundant in 1972 than 1971. The number of taxa taken was similar each year although the species richness value was higher in 1972 (Table 7).

During the May-July period, the five dominant taxa were all more abundant in 1971 than in 1972 (Table 7). The largest decline occurred in *M. proximus* where 13.5 times more larvae were taken in 1971. Osmerids were 10.6 times more abundant in 1971. Their decline in numbers had a major impact on overall abundance in 1972. In 1971, an average of 143 osmerids were taken per tow and they contributed 71% to the total larval abundance. While still the dominant taxon in May-July 1972, they were less abundant and made up 57% of the total. Considerably fewer taxonomic groups were taken in 1972. This may have been a result of fewer samples taken and a corresponding reduction in numbers of rare taxa.

TABLE 7.—Comparison of data on larval fishes collected off Oregon in 1971 and 1972. [BI = Biological Index modified from Fager (1957)].

Taxa (dominants listed separately)	No. samples 1971	No. samples 1972	BI 1971	BI 1972	Mean no./10 m² 1971	Mean no./10 m² 1972	Mean no./10 m² 1971/1972	% total abundance 1971	% total abundance 1972	Species richness ($D = S - 1/\ln N$) 1971	Species richness ($D = S - 1/\ln N$) 1972
March-April 2-28 km	12	22								5.24	6.41
Parophrys vetulus			4.25	<1	31.13	1.25	24.90	26.6	4.0		
Isopsetta isolepis			1.85	1.63	12.17	3.16	3.85	10.4	10.1		
Ammodytes hexapterus			1.68	<1	16.83	1.38	12.20	14.4	4.4		
Microgadus proximus			1.25	<1	5.59	2.12	2.64	4.8	6.8		
Osmeridae			<1	2.00	11.41	8.50	1.34	9.7	27.2		
Sebastes spp.			<1	1.39	0.33	2.13	0.16	0.3	6.8		
All other species			—	—	39.69	12.72	3.12	33.9	40.7		
Total (41 in 1971; 48 in 1972)			—	—	117.14	34.82	3.36	100.1	100.0		
May-July 2-28 km	34	20								4.94	3.30
Osmeridae			4.12	3.33	143.23	13.51	10.60	70.8	57.4		
Isopsetta isolepis			2.21	1.88	23.10	2.85	8.10	11.4	12.1		
Microgadus proximus			2.03	<1	12.59	0.93	13.54	6.2	4.0		
Lyopsetta exilis			1.07	<1	2.31	0.37	6.24	1.1	1.6		
Artedius sp. 1			<1	1.03	2.04	0.86	2.37	1.0	3.6		
All other species			—	—	18.99	5.02	3.78	9.4	21.3		
Total (46 in 1971; 24 in 1972)			—	—	202.14	23.55	8.59	99.9	100.0		
March-April 37-111 km	16	20								2.52	2.48
Sebastes spp.			3.97	4.32	26.05	29.12	0.89	58.7	85.9		
Stenobrachius leucopsarus			2.53	1.20	8.48	1.90	4.46	19.1	5.6		
Tarletonbeania crenularis			1.34	<1	2.94	0.54	5.44	6.6	1.6		
Hemilepidotus spinosus			<1	1.30	0.48	0.93	0.52	1.1	2.7		
All other species			—	—	6.43	1.41	4.56	14.5	4.2		
Total (16 in 1971; 16 in 1972)			—	—	44.40	33.80	1.31	100.0	100.0		
May-July 37-111 km	38	28								3.66	3.35
Stenobrachius leucopsarus			3.10	2.82	76.78	15.11	5.08	43.8	19.6		
Sebastes spp.			3.08	3.50	56.50	22.55	2.51	32.2	29.3		
Lyopsetta exilis			1.96	<1	10.99	4.78	2.30	6.3	2.3		
Tarletonbeania crenularis			1.47	1.11	9.56	4.84	1.98	5.4	6.3		
Engraulis mordax			<1	2.00	4.68	28.06	0.17	2.7	36.4		
All other species			—	—	16.79	4.74	3.54	9.6	6.2		
Total (32 in 1971; 25 in 1972)			—	—	175.30	76.98	2.27	100.0	100.1		

The species richness value in 1972 (Table 7) was lower than in 1971, indicating that fewer species were present.

Offshore Assemblage

During the sampling period, 148 samples were taken (45 at night, 14 at dusk or dawn, 89 in daylight) in the offshore assemblage. The 141 positive samples yielded 7,381 larvae or a standardized total [Σ (number of larvae under 10 m^2 sea surface in each sample)] of 10,868.

Species Composition and Dominance

Fifty-two taxa in 21 families were taken in the offshore samples (Table 2). Of these, 43 were identified to species, 6 to genus, and 3 to family. The species richness value, based on Margalef's (1958) formula for diversity, was 5.73 for the offshore assemblage, which was lower than the value of 7.43 for the coastal assemblage.

The top 10 dominant (BI) taxa (see footnote 15) in the offshore assemblage accounted for 94.3% of the total number of larvae in this assemblage (Table 8). Nine of these 10 taxa also were among the 10 most abundant although in different order, with *Microstomus pacificus* (total standardized abundance 81.74) replacing *Hemilepidotus spinosus*.

The two major dominants were *Sebastes* spp. and *Stenobrachius leucopsarus,* which together accounted for 70% of all larvae taken offshore. *Tarletonbeania crenularis* and *Lyopsetta exilis* were also dominant in the offshore assemblage in terms of overall abundance and frequency of occurrence. Fifth ranked *Engraulis mordax* occurred in concentrations (standardized numbers per positive tow) equivalent to *Sebastes* spp. and *Stenobrachius leucopsarus* (Table 8) although it was less frequently taken. The top six dominant taxa composed 91% of the total larval abundance compared with 13 taxa contributing that percentage in the coastal area.

Seasonality

In 1971, 94% of all larvae were taken between February and July, as in the coastal area, and 83% were taken during the 3-mo period from May to July (Figure 6). The winter (February-March) peak of abundance noted in the coastal area was absent offshore. Larval abundance decreased in August and remained low for the rest of the year. The minor increase in numbers in October was solely due to small *Citharichthys* (probably *sordidus*) larvae 37 to 46 km offshore. Since only 5 mo of data were available for the offshore assemblage in 1972, seasonal trends could not be assessed.

Dominant taxa (BI>1) within the May-July peak abundance period in 1971 were essentially the same as those (Table 8) for the entire 1½-yr sampling period. These were *S. leucopsarus* (BI = 3.10), *Sebastes* spp. (BI = 3.08), *L. exilis* (BI = 1.96), and *T. crenularis* (BI = 1.47). Together they made up 88% of the total larvae taken in that spring-summer period.

As in the coastal zone, some taxa had restricted spawning periods and their larvae were present in the plankton for a relatively short time, e.g., *E. mordax* and *L. exilis* (Table 9). Both species showed distinct growth trends. *Hemilepidotus spinosus* was also present during a short period although the larvae in the offshore zone were usually larger than those in the coastal area (Table 6). *Glyptocephalus zachirus* was taken as small larvae only in April to June indicating a rather restricted spawning period, but large larvae were present through September. The larvae grow

TABLE 8.—Offshore dominants based on all larvae collected 37 to 111 km offshore in 1971 and 1972. [BI = Biological Index modified from Fager (1957)].

Taxa	BI	Rank order of abundance	Total standardized abundance[1]	% of total abundance	Positive tows out of 148	Total standardized abundance[1] / Positive tows	Months of occurrence
1. *Sebastes* spp.	3.24	1	3,967.82	36.5	112	35.43	I-XII
2. *Stenobrachius leucopsarus*	2.28	2	3,648.00	33.6	87	41.93	I-X
3. *Tarletonbeania crenularis*	1.27	4	635.20	5.8	64	9.92	II-X, XII
4. *Lyopsetta exilis*	0.73	5	475.23	4.4	41	11.59	V-VIII
5. *Engraulis mordax*	0.67	3	1,000.70	9.2	25	40.03	VI-VIII
6. *Protomyctophum thompsoni*	0.67	6	173.77	1.6	52	3.34	III-XII
7. Cyclopteridae spp. 1	0.51	10	79.70	0.7	38	2.10	II-IX
8. *Glyptocephalus zachirus*	0.26	8	113.81	1.0	27	4.21	III-IX
9. *Hemilepidotus spinosus*	0.22	13	29.78	0.3	12	3.26	II-IV
10. *Bathylagus ochotensis*	0.19	7	131.46	1.2	31	4.24	III-VIII

[1]The sum of the standardized numbers (number under 10 m^2 sea surface) of larvae from each sample.

TABLE 9.—Ranges and modal lengths (mm) for dominant fish larvae in the offshore assemblage (stations 37 to 111) in 1971. Asterisks indicate month in which average abundance per cruise was greatest. Parentheses are used where more than one modal peak occurred.

Taxa	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1. *Sebastes* spp.	3-5-5	3-4-9	6-7-7	3-4-8*	3-4-20	3-4-14	3-3-8	3-14	2-3-14	0	3-5-5
2. *Stenobrachius leucopsarus*	4-5-5	4-5-7	4-6-6	3-7-17	4-7-18*	4-9-15	$5\text{-}\begin{pmatrix}7\\8\\9\end{pmatrix}\text{-}16$	7-13-14	9-10-15	0	0
3. *Tarletonbeania crenularis*	7-11	5-11-15	11-15	8-12-16	4-8-20*	$3\text{-}\begin{pmatrix}7\\8\end{pmatrix}\text{-}17$	5-8-17	9-10-15	4-11	0	9-10
4. *Lyopsetta exilis*	0	0	0	3-5-17*	4-14-19	5-14-21	$15\text{-}\begin{pmatrix}19\\22\end{pmatrix}\text{-}22$	0	0	0	0
5. *Engraulis mordax*	0	0	0	0	9	4-5-16*	4-10-25	0	0	0	0
6. *Protomyctophum thompsoni*	0	$3\text{-}\begin{pmatrix}3\\8\end{pmatrix}\text{-}13$	0	6-13-18*	5-11-16	11-13	8-12-17	5-14-16	5-14-18	8	5-14
7. Cyclopteridae spp. 1	4-5-5*	9	14	5-20	5-11	11	6-14-14	15-19	0	0	0
8. *Glyptocephalus zachirus*	0	0	8-8-9	4-8-20*	4-54	45	32	67	0	0	0
9. *Hemilepidotus spinosus*	6*	7-10-10	0	0	0	0	0	0	0	0	0
10. *Bathylagus ochotensis*	0	5-6-20	9	$5\text{-}\begin{pmatrix}5\\11\end{pmatrix}\text{-}22$	4-11-30*	15-24	13-22	0	0	0	0

quite large (>40 mm) before metamorphosis and have an extended pelagic life (Pearcy et al. 1977). Some taxa were taken throughout most of the year and showed no strong evidence for a definite spawning period, e.g., the multispecies group *Sebastes* spp., *T. crenularis,* and *Protomyctophum thompsoni* (Table 9). Intermediate to these were species which occurred over a rather long period but did show some indication of seasonality based on larval lengths, e.g., *Stenobrachius leucopsarus* and *Bathylagus ochotensis.* Cyclopteridae spp. 1 was taken over a long time period from February through September. No trends in growth were evident probably because it is a multispecies group.

Distribution Trends

Peak abundances occurred 46 to 65 km offshore for some species, e.g., *L. exilis, G. zachirus,* and some *Sebastes* spp. (Figure 8). Spawning presumably took place near the outer shelf-upper slope region where depths were ~200-300 m. *Sebastes* spp. also had an abundance peak further offshore, possibly the result of offshore drift of larvae.

A more oceanic distribution was characteristic of larvae of mesopelagic fishes such as the myctophids *Stenobrachius leucopsarus, T. crenularis,* and *P. thompsoni* (Figure 8). Peak abundances occurred at the 74- to 111-km stations with a decline in abundance toward the coast, although a few myctophid larvae were taken over the shelf at 18 to 28 km offshore.

Larvae of *E. mordax* occurred in large numbers (147/under 10 m^2) only once in 1971, at the 65-km station in July. In 1972, peak abundance also occurred in July but at 74, 93, and 111 km offshore (236, 297, and 124/under 10 m^2, respectively). These peaks may be associated with spawning in the relatively warm waters of the Columbia River plume (Richardson 1973).

Year to Year Variation

In March-April, no major differences in abundance or species richness occurred between 1971 and 1972 (Figure 5, Table 7). The dominant taxa were reasonably similar, although there was some decline in abundance in *S. leucopsarus* and *T. crenularis* and some increase in *Sebastes* spp. and *Hemilepidotus spinosus* in 1972.

In the May-July period, however, mean larval abundance was higher in 1971 (Figure 5, Table 7). Four of the five dominant taxa were more abundant in 1971. A major decline occurred in *S. leucopsarus* catches in 1972. A major increase in abundance occurred in *Engraulis mordax* in 1972; six times more larvae were taken than in 1971. This may have been due to increased sampling in Columbia River plume water (Richardson 1973). Species richness values were similar in both years.

DISCUSSION

Coastal and Offshore Larval Fish Distributions

There was a marked inshore-offshore separation of larval fish assemblages. Little overlap in distribution occurred between coastal and offshore larvae. Most (99%) larvae designated as coastal were collected within 28 km of shore and most (96%) larvae designated as offshore were found beyond 28 km. The 28-km station consistently had low larval abundances (Figure 5) and appeared to be a transitional zone between coastal and offshore waters. The biomass of fishes, shrimps,

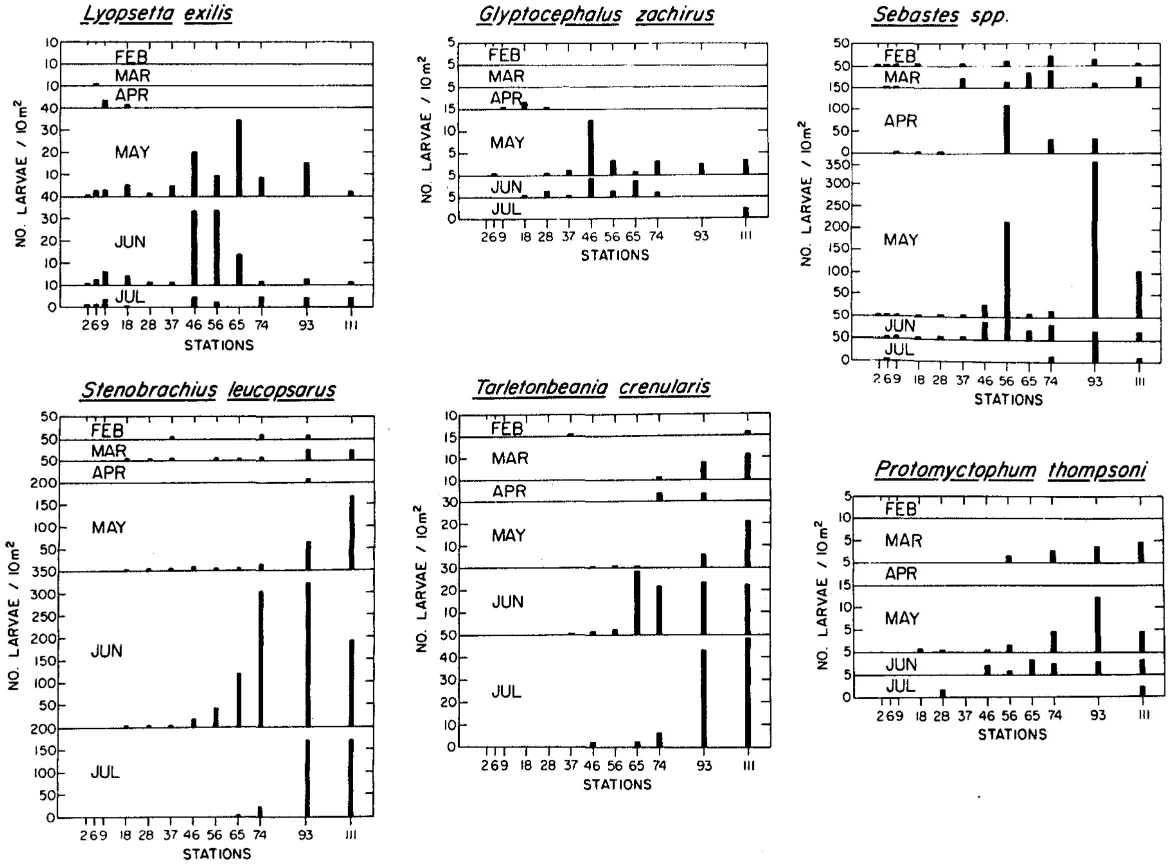

FIGURE 8.—Distribution patterns of fish larvae in the offshore assemblage (stations 37 to 111) during months of peak abundance in 1971. Abundances are monthly means.

and cephalopods caught in plankton nets and mid-water trawls was also low at this station compared with offshore stations (Pearcy 1976). Interestingly, this region is located over midshelf where water depth is about 95 m rather than at the shelf break.

Explanations for this observed phenomenon are severalfold. Certainly peak concentrations of coastal and offshore larvae are related in part to the spawning location of adults. Most larvae that are taken in plankton collections are small, have not been in the water column for an extended period of time, and thus occur near the area in which they were spawned. Possibly few adult fish spawn near 28 km offshore although data to substantiate this are not available.

Circulation patterns also help to explain the observed larval distributions. General seasonal trends of currents over the continental shelf, shoreward of the California Current, have been described by Smith et al. (1971), Wyatt et al. (1972), Huyer (1974), Smith (1974), Huyer et al. (1975), and others. The predominant currents, those of greatest velocity, are alongshore. In winter, October through February, when winds are predominantly from the southwest, the main flow is northward (Davidson Current) at all depths, with an onshore drift component at the surface. A strong alongshore flow occurs within 28 km of the coast. In summer, May through August, winds are predominantly from the northwest and the main current flow is southward, with an offshore drift component at the surface. Southward flow is greatest in a coastal jet located 15 to 20 km offshore. In spring, deeper water (bottom third of the water column) flows south but at a slower speed than the surface water (upper third of the water column). In summer, this deeper water flows northward. There is also a shoreward drift component in these deeper and intermediate waters which produces upwelling, a process which taken place mainly within 10 to 20 km of the coast.

Spring (March, April) and fall (September) are usually periods of transition with variable winds and currents. Since the predominant currents are north-south (perhaps 10 times stronger than east-west), transport of larvae is also predominantly north-south rather than inshore-offshore. Thus, the greatest concentrations of larvae spawned in the coastal and offshore areas would be retained along zones parallel to the coast. Perhaps the strong north or south flow (coastal jet) reported to occur around 15 to 28 km offshore serves as some kind of barrier to inshore or offshore transport of larvae. The presence of an actual persistent front in this region, which would help explain the faunal break at 28 km, has not been demonstrated. The strongest front that has been observed in this region is associated with Columbia River Plume water, which flows south off Oregon in summer. However, its position is not stable and it is not present off Oregon in winter. The presence of a surface front around 28 km offshore has been demonstrated during upwelling when upward sloping isopycnals break the surface. This occurs only during upwelling, usually in summer.

The extent of north-south transport is unknown. However, evidence suggests that shoreward of 11 km, because of current reversals, the mean north-south current velocity (alongshore flow) may be approximately zero over the summer (Huyer 1974; Huyer et al. 1975) and possibly also over the winter (Huyer pers. commun.). Thus, at least in the coastal zone, circulation patterns may explain maintenance of larvae in specific areas with respect to north-south as well as inshore-offshore. If this apparent retention of coastal larvae in the coastal area is persistent with respect to north-south and east-west transport, it would seem that other factors, most notably food, may be more critical to early survival than transport away from favorable areas (Hjort 1926). We have no evidence that predators of fish eggs and larvae are concentrated at the 28-km station (Pearcy 1976).

Comparison of Coastal Larvae With Yaquina Bay Larvae

Similarities exist between the species composition of fish larvae in the coastal area and in Yaquina Bay (Pearcy and Myers 1974). The cottids and the pleuronectids were the most speciose families in both areas (not considering the potential number of *Sebastes* spp.). Families in the Bay not represented offshore were Gobiesocidae, Gasterosteidae, and Syngnathidae. Families from the coastal region not represented in the Bay were Myctophidae, Anoplopomatidae, Bathymasteridae, and Clinidae.

Larval distributions described by Pearcy and Myers (1974) as "bay" or "offshore" are generally supported by the present study. Major differences in dominant taxa were found between the Bay fauna and the coastal assemblage in this paper. The two most abundant Bay species, which accounted for 90% of all larvae, were either not taken in the coastal assemblage, i.e., *Lepidogobius lepidus*, or were relatively uncommon, i.e., *Clupea harengus pallasi*. The only goby taken in the coastal assemblage was *Clevelandia ios*, which was designated Gobiidae type 1 from the Bay. Two of the three taxa listed by Pearcy and Myers (1974) as "bay only" types, *Lumpenus sagitta* and *Anoplarchus* spp., were taken in the coastal assemblage. The most abundant larvae in the coastal assemblage, Osmeridae, *Parophrys vetulus*, *Isopsetta isolepis*, and *Microgadus proximus*, did not contribute significantly to the larval fish fauna of Yaquina Bay.

Seasonal patterns of larval abundance were similar in both areas with the peak occurring February to June in the Bay and February to July in the coastal area. The egg abundance peak of July to October in the Bay, which was primarily attributed to northern anchovy, *Engraulis mordax*, corresponds somewhat with the peak abundance of anchovy larvae offshore in this study. The eggs may have been spawned in the Bay or carried into the Bay from coastal areas. Whichever is the case, the fact that anchovy larvae were not abundant in the Bay indicates development there was unsuccessful. Additional evidence for the lack of developmental success of anchovy eggs and larvae in northern estuarine areas was given by Blackburn (1973). Anchovy eggs were taken in plankton collections in Puget Sound from May through August during a year-long survey. Larvae were never captured in ½-m plankton nets (0.5-mm mesh), but a few anchovy larvae (presumably large) and juveniles were captured in larger tow nets (3 × 6 m mouth diameter, 6-mm mesh cod end and 1 × 2 m mouth diameter, 3-mm mesh cod end). In another year-long study in the Columbia River estuary (Misitano 1977), only large (22-55 mm) anchovy larvae were taken in low numbers from October through March. Similarly, anchovy larvae were rare in

Humboldt Bay (Eldridge and Bryan 1972). Data from this study and Richardson (1973; unpubl. data) provide evidence that at least off Oregon major anchovy spawning occurs and early development is successful offshore beyond 28 km rather than in coastal areas.

Pearcy and Myers (1974) reported Yaquina Bay was an important spawning area only for *Clupea harengus pallasi* and numerous cottids, gobies, and stichaeids. It was, however, an important nursery area for juvenile *Parophrys vetulus, Hypomesus pretiosus, Platichthys stellatus, Citharichthys stigmaeus,* and embiotocids. The present study has shown that the coastal area 2 to 28 km offshore is important as a spawning area for *P. stellatus* and *Parophrys vetulus* which utilize Yaquina Bay estuary during part of their early life.

Comparison With Other Planktonic Components

Results from studies on zooplankton (Peterson and Miller 1975, see footnote 2), pink shrimp, *Pandalus jordani,* larvae (Rothlisberg 1975), and crab larvae (Lough 1975) off Oregon indicate that trends in seasonality and inshore-offshore distribution do not always correspond with those found for fish larvae. These planktonic components were all studied from the same sets of samples (70- and 20-cm bongos, 0.571- and 0.233-mm mesh nets, collected from June 1969 to August 1972 off Newport).

Seasonal abundance peaks of certain components of the meroplankton, i.e., larvae of shrimp, crabs, and fishes, appear to be similar but do not correspond as well with those of zooplankton. Total zooplankton (predominantly copepods) abundance in the coastal zone is high in summer during upwelling, with peaks usually in late June and July, and low in winter (November-January). A secondary winter-spring peak may develop around February-April, but it is an order of magnitude lower than the summer peak. Larvae of the pink shrimp first occur in March and are in the plankton through June. Larvae of most species of crabs occur between February and July with peak abundances in May and June, although a few species are present all year; lowest abundances are in December and January. Fish larvae are most abundant between February and July. Those larvae that are present during the summer zooplankton peaks tend to be of advanced developmental stages. Since the 0.233-mm mesh used for zooplankton did not adequately sample smaller animals such as copepod nauplii, it may be that peak abundances of such potential food items actually coincide with larval abundance peaks.

Inshore-offshore distribution trends appear to differ among the various planktonic constituents with crab larvae being most similar to fish larvae. Total zooplankton abundance, which is influenced mainly by copepods, is consistently greatest (often by an order of magnitude) in both summer and winter at the 2-km station, grades to lows at 18 km; and according to Cross (1964), copepod abundances continue to decrease farther from shore. However, within the coastal zone (2-18 km) abundance of individual species may not follow that pattern, e.g., some may be more abundant offshore of 2 km. Larvae of the pink shrimp first occur (March) within 37 km of shore with greatest concentrations at 9 to 28 km. Later (April-May) the larvae are much more widely dispersed, occurring from 2 to 111 km; abundance peaks may occur coastally at 9 km as well as offshore at 93 km. Later in the season (June) when they are ready to settle, peak abundances occur around 28 to 46 km offshore, apparently over favorable settling areas. Larvae of most species of crabs which are coastal forms as adults occur within 18 km of the coast. Highest densities are at 2 and 6 km with a dramatic decrease between 9 and 18 km. Larvae of slope species occur primarily in the offshore area beyond 28 km. These distributions are similar to the coastal and offshore distributions of larval fishes. However, larvae of a few crab species which are coastal as adults are found at all stations from 2 to 111 km and are abundant in the coastal area as well as offshore. Larvae of at least one of these species, *Cancer oregonensis,* have been found in great abundance (~11 liters of megalopa in one 15-min night surface tow) in the neuston 65 km offshore (Richardson unpubl. data). This type of distribution is similar to that found for larvae of the fish *Hemilepidotus spinosus,* which are also neustonic. This apparent offshore transport of larvae spawned in the coastal zone inside 28 km suggests that those which spend at least part of their early life in surface waters may be subjected to different dispersal mechanisms than those which do not occur in the neuston. Offshore flow of surface waters occurs during the upwelling season, providing a mechanism of transport.

Comparison to the Northeast Pacific

Direct comparisons between results from this study and most previous reports on larval fishes in the northeast Pacific with respect to species composition, seasonality, and inshore-offshore distribution patterns are difficult to make for several reasons. Cruise tracks differed with respect to distance of stations from shore and proximity of stations to each other. Duration of sampling effort and types of gear used were not the same. Aron's (see footnote 4) data came from mid-water trawl samples taken on long oceanic cruise tracks between southern California and southwest Alaska from July through October. LeBrasseur's (see footnote 7) report was based on mid-water trawl and NORPAC net collections taken in the northeast Pacific at a broad array of stations from 1956 to 1959. Waldron's (1972) results, excluding Puget Sound, came from meter net collections made in a grid pattern with transects on each degree of latitude between 42° and 51° (Oregon to British Columbia) and stations extending from the 55-m isobath to 550 km offshore. His samples covered only a 1-mo period in April and May. Naplin et al. (see footnote 8) reported on samples collected with 60-cm bongos along three widely spaced transects off Washington and British Columbia in October and November. Richardson's (1973) data came from 70-cm bongo, meter net, and mid-water trawl samples collected off Oregon at a wide array of stations from May to October. However, some trends are evident.

The most abundant, most dominant, and most frequently taken taxa in the above mentioned studies (which included few or no samples from nearshore areas) were myctophids, mainly *Stenobrachius leucopsarus, Tarletonbeania crenularis,* and sometimes *Protomyctophum thompsoni* (and *Diaphus theta* in southern areas), and scorpaenids, mainly *Sebastes* spp. (particularly over shelf and slope areas). This is similar to the offshore assemblage in this study. Richardson (1973) also found *Engraulis mordax* to be important as it was in our offshore assemblage. Those studies which included samples from shelf areas showed increased importance of pleuronectid larvae, e.g., *Isopsetta isolepis, Parophrys vetulus, Platichthys stellatus,* and *Psettichthys melanostictus* (Waldron 1972). None of the above studies included intensive sampling in the nearshore zone (e.g., within 9 km of the coast) to allow detailed comparison with our coastal assemblage. However, Aron (1959) stated that large numbers of capelin, *Mallotus villosus,* larvae were taken in northerly inshore waters. Also, osmerids and *Ammodytes hexapterus* were among the 10 most abundant larvae taken in Waldron's (1972) samples. Richardson (1973) showed that osmerid larvae were taken in moderate numbers at nearshore stations although they were not top dominants when all samples were combined. More recent samples from 12 transects 2 to 56 km off Oregon (Laroche and Richardson[16]) have shown that osmerids, *Parophrys vetulus, I. isolepis, Microgadus proximus,* and some cottids are dominant in the coastal waters from the Columbia River to Cape Blanco in spring months, which is similar to our coastal assemblage.

The only available information on seasonality based on one or more years of data was presented by LeBrasseur (see footnote 7). The greatest number of larvae per sample (1.0) was taken in the March-May quarter, with 0.3 in June-August, 0.1 in September-November, and 0.05 in December-February. The May-October data discussed by Richardson (1973) showed an abundance peak in May in 1-m net samples and a peak in July-August in bongo and mid-water trawl samples with low abundances after August. The data of Naplin et al. (see footnote 9) showed low abundances (except for myctophids) and low numbers of species in October-November. These trends are similar to those found in this study.

No previous studies have demonstrated actual coastal and offshore assemblages of fish larvae although mention has been made of a break in species composition, abundance, and frequency of occurrence between shelf and oceanic areas. Aron (1959) stated that, in oceanic regions, the larvae of inshore fishes disappeared and myctophid larvae became common. LeBrasseur (see footnote 7) indicated larvae were taken in 5% of the samples within 100 miles of the coast but in only 1% of the samples from farther offshore. Waldron (1972) reported a greater number of larvae were taken inside the 914-m isobath than beyond it. More recent data (Laroche and Richardson see footnote 16) have shown that coastal and offshore assemblages of fish larvae, similar to those described in this paper for the mid-Oregon coast, occur along

[16]Laroche, J. L., and S. L. Richardson. Spring patterns of larval fish distributions from the Columbia River to Cape Blanco, Oregon, 1972-1975, with emphasis on English sole, *Parophrys vetulus*. Manuscr.

the entire Oregon coast from the Columbia River to Cape Blanco at least in spring (March-April). Thus it seems likely that similar species composition, seasonality, and inshore-offshore assemblages of larval fishes may occur over a much broader shelf-slope area in the northeast Pacific.

ACKNOWLEDGMENTS

We thank the many people who helped with collecting, sorting, identifying, enumerating, measuring, and data reduction. R. Gregory Lough and Peter Rothlisberg were responsible for collecting most of the samples. Elbert H. Ahlstrom, James Blackburn, Carl Bond, Jean Dunn, Joanne Laroche, April McLean, H. Geoffrey Moser, Karl Niggol, Sharon Roe, Elaine Sandknop, and Kenneth Waldron have all helped at one time or another with larval fish identifications. Wayne Laroche provided names for our agonid larval types. James Rybock did the preliminary analysis of the vertical distribution data for a class project. Michael Richardson gave much advice on data analysis and offered many helpful comments. Jane Huyer provided information on physical oceanography off the Oregon coast. This research was supported by NOAA (U.S. Department of Commerce) Sea Grant Institutional Grant No. 04-6-158-44004. Ship operations support was provided by the National Science Foundation.

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