Larval Fish Diets in Shallow Coastal Waters off San Onofre, California

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ABSTRACT: Stomach contents were analyzed from the larvae of six common coastal fish taxa (*Atherinopsis californiensis, Leuresthes tenuis, Paralabrax* spp., *Genyonemus lineatus, Seriphus politus,* and *Paralichthys californicus*) collected near San Onofre, California. Samples were collected at night at approximately monthly intervals between September 1978 and September 1979 during a study of ichthyoplankton distributions in these shallow coastal waters.

***Paralabrax* spp. and *Paralichthys californicus* larvae apparently did not feed at night, but high feeding incidences for the atherinids and especially the sciaenids suggested that these larvae did feed during early evening hours. Important components of the diets of all six taxa included the tintinnid genus *Stenosomella*, mollusc veligers, and especially the copepod *Euterpina acutifrons*.**

The vertical distributions of the fish larvae differed from the reported distributions of some of their principal prey taxa, suggesting that factors in addition to, or other than, specific feeding habits are important determinants in the nearshore distributions of fish larvae. The avoidance of seaward dispersal away from the relatively productive and stable nearshore zone may be an important factor influencing larval distribution.

Most studies on the feeding habits of fish larvae in the Southern California Bight have focused on species whose larvae occur primarily beyond the continental shelf, or are broadly distributed across the shelf and beyond (Arthur 1956, 1976; Hunter and Kimbrell 1980; Lasker 1975; Sumida and Moser 1980, 1984; Theilacker 1986). Larval fish feeding in the shallow coastal zone (depth ≤75 m) has, until recently, received relatively little attention. Lasker (1975, 1981) examined the requisite conditions for the successful first feeding of larval northern anchovy and suggested that the shallow nearshore zone may provide a better larval feeding environment than offshore waters, largely because of the more stable nature of the nearshore zone.

It has become increasingly apparent in recent years that this shallow nearshore zone is a unique area supporting distinctive, stable assemblages of fish larvae and zooplankters (Brewer et al. 1981, 1984; Gruber et al. 1982; Barnett et al. 1984; Brewer and Kleppel 1986; Petersen et al. 1986; Barnett and Jahn 1987; Walker et al. 1987). Feeding studies are beginning to be reported for some of the fish larvae that are largely restricted to this zone (Brewer and Kleppel 1986; Jahn et al. 1988).

The purpose of this report is to document the food habits of the larvae of six fish taxa in the shallow coastal waters off southern California. These six taxa include larvae occupying all levels of the water column: larval jacksmelt, *Atherinopsis californiensis*, and grunion, *Leuresthes tenuis*, are largely restricted to the neuston and upper water column; California halibut, *Paralichthys californicus*, and kelp and sand bass, *Paralabrax* spp., larvae occur throughout the water column but tend to be most abundant in midwater; and larval queenfish, *Seriphus politus*, and white croaker, *Genyonemus lineatus*, occur principally in the lower water column and epibenthos (Schlotterbeck and Connally 1982; Barnett et al. 1984; Jahn and Lavenberg 1986). All six taxa occur principally near shore throughout life (Frey 1971; Miller and Lea 1972; Barnett et al. 1984; Lavenberg et al. 1986;).

METHODS

Plankton samples were collected between 25 July 1978 and 23 September 1979 near San Onofre, CA (lat. 33°20′N, long. 117°30′W). The plankton sampling methodology and rationale are detailed by Barnett et al. (1984) and Walker et al. (1987) and are only briefly summarized here.

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Two sample sets, both of which provided complete water column coverage, were utilized in this study. A small sample set, used to make a rough approximation of feeding chronology, consisted of plankton samples collected twice during the day and twice at night within a 24 h period, on two occasions (25 July and 21 September 1978). These samples were collected along the 8 m isobath 1 km south of the San Onofre Nuclear Generating Station (SONGS) (July) and along the 13 m isobath just north of SONGS (September). A larger sample set, used to examine larval diets, consisted of plankton samples collected at night at approximately monthly intervals between 6 September 1978 and 23 September 1979, along a randomly selected isobath within each of five offshore blocks. These blocks were defined by depth contours: (A) 6–9 m, (B) 9–12 m, (C) 12–22 m, (D) 22–45 m, and (E) 45–75 m. The blocks were arrayed between 0.5 and 7.2 km from shore, approximately 1 km south of SONGS.

SONGS Unit 1, a 500 megawatt power plant, operated throughout the study period. Unit 1 has been shown to have had only very localized effects (Marine Review Committee 1979[1]) and it is unlikely to have influenced the results of this study.

Three different types of gear were used to collect both sample sets: a Brown Manta net (Brown and Cheng 1981), to sample the neuston (top 16 cm); a Brown-McGowan opening-closing bongo net, to sample the midwater column; and an Auriga net[2], to sample the epibenthos (within approximately 67 cm of the bottom). All three types of nets were constructed of 0.333 mm mesh Nitex[3], fitted with flowmeters, and towed at ca. 1 m/s to sample a target volume of 400 m^3. All samples were fixed in 10% seawater-formalin.

In the laboratory, the plankton samples were subsampled with a folsom plankton splitter and the fish larvae were sorted from the subsamples at 6–10× magnification under dissecting microscopes. Larvae utilized in the feeding studies were randomly selected from among those sorted from a subsample; a maximum of 100 specimens was selected from any subsample. These larvae were measured to the nearest 0.1 mm notochord or standard length, separated by developmental stage (preflexion = Pr; notochord flexion plus postflexion = FP), placed in a glycerin-water solution, and dissected with fine insect pins. The gut contents of each specimen were identified to the lowest possible taxon using a dissecting (50×) or compound (100–450×) microscope, as appropriate, and enumerated. The number of specimens dissected is listed by species, survey, and sample in Table 1.

Feeding incidence (%FI = percentage of larvae examined that contained at least one food item) was calculated with 95% confidence limits for each larval stage of each taxon. The 95% confidence limits were approximated as $\pm 1.96 (pq/n)^{1/2} + 1/2n$, where p = the proportion containing at least one food item, $q = 1 - p$, and n = the sample size. Percent frequency of occurrence (%FO) and percent of the total number (%N) of prey ingested by each larval fish stage were calculated for each prey type.

RESULTS

Feeding Chronology

Feeding incidence was calculated for *Seriphus politus*, *Paralabrax* spp., and *Paralichthys californicus* which were collected in the day/night sample sets in order to examine feeding chronology (Table 2). Larval *Genyonemus lineatus* and *Atherinopsis californiensis* did not occur in these samples, and too few *Leuresthes tenuis* were available to warrant examination.

During the day, 82% of the *S. politus* larvae contained at least one food item, while at night, 72% contained food. Feeding incidence increased from the morning through the evening, reaching a maximum of 94% for the larvae collected between 2003 and 2101 PST. However, since the feeding incidences were all quite high, and the 95% confidence limits about %FI broadly overlapped for all three morning through evening sampling episodes, it seems likely that there were no real differences in feeding incidence over this period. After midnight, feeding incidence was reduced to 33%, and the 95% confidence limits did not overlap with either the morning or evening values, indicating that feeding incidence indeed was reduced after midnight (Table 2).

Paralabrax spp. feeding incidence was 68%

[1]Marine Review Committee. 1979. Interim report of the Marine Review Committee to the California Coastal Commission part 1: General summary of findings, predictions, and recommendations concerning the cooling system of the San Onofre Nuclear Generating Station. Mar. Rev. Comm. Doc. 79–02, p. 1–20. Marine Review Committee of the California Coastal Commission, 631 Howard Street, San Francisco, CA 94105.

[2]MBC Applied Environmental Sciences, 947 Newhall Street, Costa Mesa, CA 92627.

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

TABLE 1.—Number of fish larvae dissected on each survey date. Pr = preflexion stage larvae; FP = flexion and postflexion stage larvae.

Survey date	*Atherinopsis californiensis*		*Leuresthes tenuis*		*Paralichthys californicus*		*Paralabrax* spp.		*Genyonemus lineatus*		*Seriphus politus*	
	Pr	FP	Pr	FP	Pr	FP	Pr	FP	Pr	FP	Pr	FP
1978												
06 Sept.	0	0	0	24	2	3	30	9	0	0	107	86
02 Oct.	1	0	0	10	15	1	0	0	39	4	13	26
01 Nov.	0	0	0	0	49	1	1	3	17	5	3	2
26 Dec.	2	5	0	0	31	7	0	0	89	33	0	0
1979												
29 Jan.	0	0	0	0	10	0	0	0	138	94	0	0
26 Feb.	2	31	0	0	41	2	0	0	146	98	0	0
26 Mar.	20	21	0	0	0	0	0	0	161	180	23	0
25 Apr.	7	19	7	13	0	0	0	0	40	86	18	0
23 May	0	8	17	20	0	0	0	0	32	49	19	14
25 June	1	1	22	95	0	0	0	0	0	2	51	66
24 July	0	0	0	0	0	0	43	8	0	0	74	14
22 Aug.	0	0	0	9	3	0	13	2	0	0	58	32
20 Sept.	0	0	2	14	35	9	24	2	9	0	87	49
Total	33	85	48	185	186	23	111	24	671	551	453	289

TABLE 2.—Feeding chronology of larval *Paralabrax* spp., *Paralichthys californicus*, and *Seriphus politus*. Survey A samples were collected at the 8 m isobath on 25 July 1978; Survey B samples were collected at the 13 m isobath on 21 September 1978. The time of day when samples were collected is given as Pacific Standard Time. N_t = total number of specimens dissected; N_f = number of specimens containing food; % FI = percent feeding incidence (100 × N_t); 95% confidence limits (C.L.) are given for % FI.

Survey	Time (PST)	*Paralabrax* spp.			*Paralichthys californicus*			*Seriphus politus*		
		N_t	N_f	% FI ± C.L.	N_t	N_f	% FI ± C.L.	N_t	N_f	%FI ± C.L.
A	0547–0626							34	26	76.5 ± 15.7
B	0920–1024	20	11	55.0 ± 24.3	17	9	52.9 ± 26.7			
A	1103–1153							37	32	86.5 ± 12.4
B	1345–1420	14	12	85.7 ± 21.9	7	0	0.0 ± 7.1			
B	1900–1958	18	9	50.0 ± 25.9	26	7	26.9 ± 19.0			
A	2003–2101							70	66	94.3 ± 6.1
B	2354–0049	24	0	0.0 ± 2.1	20	3	15.0 ± 18.1			
A	0118–0150							39	13	33.3 ± 16.1

during the day and 12% at night. Feeding incidence was highest (86%) during midafternoon (1345–1420 PST), dropped to 50% within an hour after sunset, and was 0% by about midnight (Table 2). The 95% confidence limits about %FI were rather broad owing to the small sample sizes, and it is unclear whether there were any real differences in feeding incidence from morning through early evening. However, the large differences in %FI and nonoverlapping confidence limits between the morning through evening and midnight sampling episodes do indicate a real reduction in feeding incidence at night.

Paralichthys californicus larvae displayed a low feeding incidence: 38% during the day and 22% at night. More larvae contained food items during midmorning that at any other time; none contained food in the midafternoon samples (but only seven larvae were available for disssection in the afternoon samples). At night, feeding incidence decreased from 27% about an hour after sunset to 15% by about midnight (Table 2). However, owing to the small sample sizes and consequent broad confidence limits about %FI, it is unclear whether there were any real differences in feeding incidence over this period.

Composition of the Diet

Atherinopsis californiensis

Larval jacksmelt were collected almost exclusively in the neuston in the two sampling blocks (A and B) between the 6 and 12 m isobaths, from October 1978 to June 1979. In total, 118 specimens were dissected (Table 1); 47% of these contained food. The overall feeding inci-

TABLE 3.—Feeding incidence of fish larvae by block, depth stratum, and larval developmental stage. Blocks correspond and E = epibenthos. N_t = total number of larvae dissected; N_f = number of larvae containing food;

Block	Stratum	Number of larvae	*Atherinopsis californiensis*		*Leuresthes tenuis*		*Paralichthys californicus*	
			Preflexion	Flexion-postflexion	Preflexion	Flexion-postflexion	Preflexion	Flexion-postflexion
A	N	N_t	17	60	11	91	3	4
		N_f	10	31	3	48	2	0
		%FI	58.8 ± 26.3	51.7 ± 13.5	27.3 ± 18.0	52.7 ± 10.8	66.7 ± 70.0	0.0 ± 12.5
	M	N_t	2	1	0	2	5	3
		N_f	2	1	0	1	4	0
		%FI	100.0 ± 25.0	100.0 ± 50.0	—	50.0 ± 94.3	80.0 ± 45.1	0.0 ± 16.7
	E	N_t	0	0	0	0	2	1
		N_f	0	0	0	0	1	0
		%FI	—	—	—	—	50.0 ± 94.3	0.0 ± 50.0
B	N	N_t	11	25	13	31	8	1
		N_f	5	6	10	13	4	0
		%FI	45.5 ± 34.0	24.0 ± 18.7	76.9 ± 26.8	41.9 ± 19.0	50.0 ± 40.9	0.0 ± 50.0
	M	N_t	0	0	0	0	13	0
		N_f	0	0	0	0	2	0
		%FI	—	—	—	—	15.4 ± 23.5	—
	E	N_t	0	0	0	0	2	2
		N_f	0	0	0	0	1	0
		%FI	—	—	—	—	50.0 ± 94.3	0.0 ± 25.0
C	N	N_t	0	2	7	21	10	1
		N_f	0	0	6	3	1	0
		%FI	—	0.0 ± 25.0	85.7 ± 33.1	14.3 ± 17.4	10.0 ± 23.6	0.0 ± 50.0
	M	N_t	0	0	0	0	31	6
		N_f	0	0	0	0	12	2
		%FI	—	—	—	—	38.7 ± 18.8	33.3 ± 46.1
	E	N_t	0	0	0	0	15	0
		N_f	0	0	0	0	5	0
		%FI	—	—	—	—	33.3 ± 27.2	—
D	N	N_t	0	0	8	12	14	0
		N_f	0	0	0	1	4	0
		%FI	—	—	0.0 ± 6.3	8.3 ± 19.8	28.6 ± 27.2	—
	M	N_t	0	0	0	0	47	2
		N_f	0	0	0	0	11	0
		%FI	—	—	—	—	23.4 ± 13.2	0.0 ± 25.0
	E	N_t	0	0	0	0	9	0
		N_f	0	0	0	0	5	0
		%FI	—	—	—	—	55.6 ± 38.0	—
E	N	N_t	0	0	9	28	3	0
		N_f	0	0	0	0	0	0
		%FI	—	—	0.0 ± 5.6	0.0 ± 1.8	0.0 ± 16.7	—
	M	N_t	0	0	0	0	19	3
		N_f	0	0	0	0	3	2
		%FI	—	—	—	—	15.8 ± 19.0	66.7 ± 70.0
	E	N_t	0	0	0	0	4	0
		N_f	0	0	0	0	0	0
		%FI	—	—	—	—	0.0 ± 12.5	—

dence was a little higher for the Pr larvae (56.7 ± 19.4%) than for the older specimens (43.2 ± 10.9%). Both the younger and older larvae displayed a higher feeding incidence in the block nearest shore (Table 3). For the FP larvae summed over all strata, the 95% confidence limits about %FI barely overlapped between block A (52.5 ± 13.4%) and those farther seaward (22.2 ± 17.5%). For the Pr larvae, however, confidence limits broadly overlapped between block

to isobaths: A = 6–9 m; B = 9–12 m; C = 12–22 m; D = 22–45 m; E = 45–75 m. Strata are N = neuston; M = midwater; %FI = feeding incidence (100 × N_f/N_t). Ninety-five percent confidence limits are given for %FI.

			Paralabrax spp.		*Genyonemus lineatus*		*Seriphus politus*	
Block	Stratum	Number of larvae	Preflexion	Flexion-postflexion	Preflexion	Flexion-postflexion	Preflexion	Flexion-postflexion
A	N	N_t	0	3	25	7	2	0
		N_f	0	1	19	7	2	0
		%FI	—	33.3 ± 70.0	76.0 ± 18.7	100.0 ± 7.1	100.0 ± 25.0	—
	M	N_t	0	0	41	11	49	1
		N_f	0	0	35	11	41	1
		%FI	—	—	85.4 ± 12.0	100.0 ± 4.5	83.7 ± 11.4	100.0 ± 50.0
	E	N_t	1	0	53	185	122	153
		N_f	0	0	50	176	98	117
		%FI	0.0 ± 50.0	—	94.3 ± 7.2	95.1 ± 3.4	80.3 ± 7.5	76.5 ± 7.0
B	N	N_t	0	3	26	1	2	0
		N_f	0	0	17	1	1	0
		%FI	—	0.0 ± 16.7	65.4 ± 20.2	100.0 ± 50.0	50.0 ± 94.3	—
	M	N_t	1	0	41	3	44	3
		N_f	0	0	41	3	29	2
		%FI	0.0 ± 50.0	—	100.0 ± 1.2	100.0 ± 16.7	65.9 ± 15.1	66.7 ± 70.0
	E	N_t	2	1	84	168	45	80
		N_f	0	0	83	153	40	62
		%FI	0.0 ± 25.0	0.0 ± 50.0	98.8 ± 2.9	91.1 ± 4.6	88.9 ± 10.3	77.5 ± 9.8
C	N	N_t	3	6	20	1	12	0
		N_f	0	1	16	1	7	0
		%FI	0.0 ± 16.7	16.7 ± 38.2	80.0 ± 20.0	100.0 ± 50.0	58.3 ± 32.0	—
	M	N_t	8	0	34	10	34	9
		N_f	5	0	29	10	23	8
		%FI	62.5 ± 39.8	—	85.3 ± 13.4	100.0 ± 5.0	67.7 ± 17.2	88.9 ± 26.1
	E	N_t	3	1	83	102	18	36
		N_f	1	0	81	102	12	33
		%FI	33.3 ± 70.0	0.0 ± 50.0	97.6 ± 3.9	100.0 ± 0.5	66.7 ± 24.6	91.7 ± 10.4
D	N	N_t	12	0	9	0	29	0
		N_f	0	0	4	0	11	0
		%FI	0.0 ± 4.2	—	44.4 ± 38.0	—	37.9 ± 19.4	—
	M	N_t	57	1	82	13	41	2
		N_f	3	0	79	13	32	2
		%FI	5.3 ± 6.7	0.0 ± 50.0	96.3 ± 4.7	100.0 ± 3.8	78.0 ± 13.9	100.0 ± 25.0
	E	N_t	5	0	128	50	11	5
		N_f	0	0	126	50	7	4
		%FI	0.0 ± 10.0	—	98.4 ± 2.6	100.0 ± 1.0	63.6 ± 33.0	80.0 ± 45.1
E	N	N_t	2	0	11	0	24	0
		N_f	0	0	10	0	12	0
		%FI	0.0 ± 25.0	—	90.9 ± 21.5	—	50.0 ± 22.1	—
	M	N_t	16	6	20	0	20	0
		N_f	7	5	20	0	17	0
		%FI	43.8 ± 27.4	83.3 ± 38.2	100.0 ± 2.5	—	85.0 ± 18.1	—
	E	N_t	1	3	14	0	0	0
		N_f	0	1	13	0	0	0
		%FI	0.0 ± 50.0	33.3 ± 70.0	92.9 ± 17.0	—	—	—

A and those farther seaward. The Pr larvae contained similar average numbers of prey items per feeding individual in blocks A and B (8.8 and 9.2 items per larva, respectively, summed over the water column), but the FP larvae contained nearly twice as many items in block A as in block B (Table 4).

The diet of the jacksmelt larvae varied little with location or over time: except in March 1979, the principal prey for all larval stages was the small harpacticoid copepod *Euterpina acutifrons*. In the March 1979 survey, the Pr larvae fed almost exclusively on *Labidocera trispinosa* nauplii. *Labidocera trispinosa* nauplii also were an appreciable fraction (36%) of the diet of the older jacksmelt larvae on this survey, although *E. acutifrons* still dominated. Minor components of the diet for the Pr larvae included centric diatoms (*Coscinodiscus* spp.), bivalve veligers, tintinnids (*Stenosomella* spp.), cirriped nauplii, and other copepods, e.g., *Paracalanus parvus* (Table 4). The FP larvae consumed all of these items as well, in addition to cirriped cypris larvae and a wider variety of copepods (e.g., *Oncea*, *Oithona*, *Corycaeus*).

Leuresthes tenuis

Larval grunion were collected almost exclusively from the neuston, in all five cross-shelf blocks, in September and Ocotber 1978 and April through September 1979. In total, 233 specimens were dissected (Table 1); 36% contained prey. Overall, feeding incidence differed little between the Pr stage larvae (39.6 ± 14.9%) and older larvae (35.7 ± 7.2%). The FP larvae displayed a

TABLE 4.—Diet of larval *Atherinopsis californiensis*. Results for preflexion stage larvae are given above; those for flexion-postflexion stage larvae are below. A blank column indicates that no larvae containing food occurred in that stratum. Since larval *A. californiensis* occurred only in the blocks A–C neuston and block A midwater, only those strata are shown. Water column strata are N = neuston; M = midwater. %N = the percent of the total food items attributable to a given category; %FO = the percent of the larvae containing food items that contained prey of the given category. Copepods listed as prey species include both copepodites and adults.

Block:	A (6–9 m)				B (9–12 m)		C (12–22 m)
Stratum:	N		M		N		N
Prey item	%N	%FO	%N	%FO	%N	%FO	%N
Preflexion							
Coscinodiscus spp.	1.4	10.0	0	0	0	0	
Stenosomella spp.	11.0	30.0	15.2	50.0	0	0	
Bivalve veligers	4.1	20.0	0	0	0	0	
Paracalanus parvus	0	0	3.0	50.0	0	0	
Labidocera trispinosa (nauplii)	52.1	40.0	0	0	97.8	100.0	
Euterpina acutifrons	19.2	50.0	27.3	100.0	2.2	20.0	
E. acutifrons (nauplii)	9.6	30.0	54.5	100.0	0	0	
Cirriped nauplii	2.7	20.0	0	0	0	0	
Total food items	73		33		46		0
Mean prey/feeding larva	7.3		16.5		9.2		0
Flexion-Postflexion							
Coscinodiscus spp.	4.7	6.5	0	0	8.1	16.7	
Stenosomella spp.	4.2	9.7	9.1	100.0	0	0	
Bivalve veligers	1.7	12.9	0	0	0	0	
Paracalanus parvus	0.8	6.5	27.3	100.0	0	0	
Labidocera trispinosa (nauplii)	1.7	3.2	0	0	35.1	33.3	
Oithona oculata	0.3	3.2	0	0	0	0	
Oncea spp.	0	0	0	0	2.7	16.7	
Euterpina acutifrons	79.9	80.6	54.5	100.0	40.5	16.7	
E. acutifrons (nauplii)	5.8	6.5	9.1	100.0	5.4	16.7	
Unidentified copepods	0.8	6.5	0	0	5.4	33.3	
Unidentified	0	0	0	0	2.7	16.7	
Total food items	359		11		37		0
Mean prey/feeding larva	11.6		11.0		6.2		0

clear gradient of feeding incidence from highest nearshore to lowest offshore (Table 3). Feeding incidence for the Pr larvae was highest between about 1 and 3.8 km from shore, and lower both seaward and shoreward, with no overlap of confidence limits (Table 3). Both the Pr and FP larvae consumed more items per feeding individual in the most nearshore block than elsewhere (Table 5). This was especially striking for the Pr larvae.

The most important prey for both the Pr and FP larvae was *Euterpina acutifrons* (Table 5). The Pr larvae tended to utilize *E. acutifrons* nauplii only a little less than the copepodites and adults, while the older larvae showed a clear preference for the copepodites and adults (Table 5). *Coscinodiscus* spp. were important in the diet of the Pr larvae, but constituted only a minor fraction of the FP diet. Minor components of the diet for the Pr larvae included dinoflagellates (*Peridinium* spp.), tintinnids (*Stenosomella* spp.), and small copepods (*Paracalanus parvus* and unidentified nauplii). Older larvae also consumed these items, as well as cirriped nauplii, bivalve veligers, and a wider variety of copepods (e.g., *Oncea*, *Oithona*, *Microsetella*, and *Corycaeus*).

TABLE 5.—Diet of larval *Leuresthes tenuis*. Results for preflexion stage larvae are given above; those for flexion-postflexion stage larvae are below. A blank column indicates that no larvae containing food occurred in that stratum. Since larval *L. tenuis* occurred only in the neuston and midwater, only those strata are shown. Water column strata are N = neuston; M = midwater. %N = the percent of the total food items attributable to a given category; %FO = the percent of the larvae containing food items that contained prey of the given category. Copepods listed as prey species include both copepodites and adults.

Block:	A (6–9 m)				B (9–12 m)			C (12–22 m)			D (22–45 m)			E (45–75 m)	
Stratum:	N		M		N		M	N		M	N		M	N	M
Prey item	%N	%FO	%N	%FO	%N	%FO	%N	%N	%FO	%N	%N	%FO	%N	%N	%N
Preflexion															
Coscinodiscus spp.	33.3	33.3			0	0		0	0						
Peridinium spp.	3.0	33.3			0	0		0	0						
Stenosomella spp.	6.1	33.3			0	0		0	0						
Euterpina acutifrons	36.4	66.7			17.4	30.0		57.1	66.7						
E. acutifrons (nauplii)	18.1	33.3			0	0		0	0						
Unidentified copepods	3.0	33.3			65.2	80.0		0	0						
Unidentified copepod nauplii	0	0			13.0	10.0		0	0						
Unidentified Crustacea	0	0			0	0		28.6	33.3						
Unidentified	0	0			4.3	10.0		14.3	16.7						
Total food items	33		0		23		0	7		0	0		0	0	0
Mean prey/feeding larva	11.0		0		2.3		0	1.2		0	0		0	0	0
Flexion-postflexion															
Coscinodiscus spp.	1.9	10.0	0	0	0	0		0	0		0	0			
Peridinium spp.	0.1	2.1	0	0	0	0		0	0		0	0			
Stenosomella spp.	2.0	10.0	0	0	0	0		0	0		0	0			
Bivalve Veligers	0.1	2.1	0	0	0	0		0	0		0	0			
Acartia tonsa	0	0	100.0	100.0	0	0		0	0		0	0			
Paracalanus parvus	1.4	10.0	0	0	0.8	7.7		0	0		0	0			
Oithona oculata	0	0	0	0	9.2	15.4		0	0		0	0			
Corycaeus anglicus	0.3	2.1	0	0	0	0		0	0		0	0			
Oncea spp.	1.0	6.3	0	0	0	0		0	0		0	0			
Euterpina acutifrons	62.5	66.7	0	0	82.4	76.9		100.0	100.0		100.0	100.0			
E. acutifrons (nauplii)	15.5	37.5	0	0	0	0		0	0		0	0			
Microsetella rosea	0.1	2.1	0	0	0	0		0	0		0	0			
Unidentified copepods	13.2	20.8	0	0	4.2	38.5		0	0		0	0			
Ciiriped nauplii	0.3	4.2	0	0	0	0		0	0		0	0			
Unidentified	1.6	20.8	0	0	3.4	30.8		0	0		0	0			
Total food items	699		1		119		0	21		0	3		0	0	0
Mean prey/feeding larva	14.6		1.0		9.2		0	7.0		0	3.0		0	0	0

Paralichthys californicus

Two hundred and nine larval California halibut were examined from samples collected between September 1978 and February 1979, and in August and September 1979 (Table 1). Most larvae (89%) were Pr stage. The overall 28% feeding incidence was comparable to the 22% nighttime incidence noted in the day/night sample set. Although the feeding incidence for the Pr larvae was nearly 70% higher than that of the FP larvae (29.5 ± 6.9% vs. 17.4 ± 17.7%), it was well within the 95% confidence limits about the FP value. The Pr larvae displayed a higher feeding incidence in the most nearshore block, but only the confidence limits about the %FI values for the most nearshore and seaward blocks failed to overlap (block A: 70.0 ± 33.4%; block E: 11.5 ± 14.2%). The highest feeding incidence for the FP larvae occurred in the 45–75 m depth block, but all confidence limits broadly overlapped owing to the small sample sizes (Table 3). Among the FP larvae, all four specimens that contained food were collected in midwater. Pr larvae in the nearshore blocks typically contained more prey items per individual than did larvae in the most offshore blocks (Table 6).

Larval California halibut consumed few types of prey. Bivalve veligers, *Euterpina acutifrons* nauplii, the tintinnid genus *Stenosomella*, and unidentified material (including unidentified invertebrate eggs, and setae—presumably from polychaete larvae) accounted for most of the diet of the Pr larvae (Table 6). Young larvae consumed a narrower range of prey types near shore than they did farther seaward. Most of the diet near shore was composed of *Stenosomella* spp., while seaward of the 12 m isobath, *Euterpina acutifrons* nauplii, unidentified material, and bivalve veligers constituted the bulk of the diet. The few FP larvae with gut contents contained only unidentifiable material (Table 6).

Paralabrax spp.

Due to the difficulty and uncertainty in separating larval kelp and sand basses, identification was only to the level of genus. A total of 135 larval *Paralabrax* spp. were examined from samples collected between September and November 1978 and between July and Septem-

TABLE 6.—Diet of larval *Paralichthys californicus*. Results for preflexion stage larvae are given above; those for the column strata are N = neuston; M = midwater; E = epibenthos. %N = the percent of the total food items attributable to listed as prey species include both copepodites and adults.

Block:	A (6–9 m)						B (9–12 m)					
Stratum:	N		M		E		N		M		E	
Prey item	%N	%FO	%N	%FO	%N	%FO	%N	%FO	%N	%FO	%N	%FO
Preflexion												
Rhizosolenia spp.	0	0	0	0	0	0	0	0	0	0	0	0
Peridinium spp.	0	0	0	0	0	0	0	0	0	0	0	0
Radiolaria	0	0	0	0	0	0	0	0	0	0	0	0
Stenosomella spp.	90.9	100.0	90.6	25.0	100.0	100.0	77.3	25.0	98.2	50.0	0	0
Bivalve veligers	9.1	50.0	0	0	0	0	0	0	0	0	0	0
Euterpina acutifrons (nauplii)	0	0	0	0	0	0	0	0	1.8	50.0	0	0
Unidentified copepods	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified nauplii	0	0	0	0	0	0	0	0	0	0	100.0	100.0
Unidentified	0	0	9.4	75.0	0	0	22.7	75.0	0	0	0	0
Total food items	11		32		23		22		55		2	
Mean prey/feeding larva	5.5		8.0		23.0		5.5		27.5		2.0	
Flexion-postflexion												
Unidentified												
Total food item	0		0		0		0		0		0	
Mean prey/feeding larva	0		0		0		0		0		0	

ber 1979, mainly in midwater, seaward of the 12 m isobath (Table 1). Most of the larvae were Pr stage (82%). Eighteen percent of the larvae dissected contained food, similar to the 21% nighttime average noted in the day/night comparison. There was no clear cross-shelf pattern in feeding incidence (Table 3), but a vertical pattern may have been suggested by the lower incidence in the neuston (3.4 ± 8.3%) and higher incidences in midwater (22.5 ± 9.2%) and epibenthos (13.3 ± 20.5%). Although the average feeding incidence for the Pr larvae (14.7 ± 1.1%) was less than half that for the FP larvae (33.3 ± 20.9%), it still was contained within the broad confidence bounds about the FP value.

Tintinnids, bivalve veligers, and copepods were among the most important prey for larval *Paralabrax* spp. (Table 7). Unidentified items (including invertebrate eggs and setae—presumably from polychaete larvae) constituted the major dietary component for the Pr larvae. However, tintinnids (*Stenosomella* spp.) and bivalve veligers also were important. The FP larvae tended to consume larger items, especially copepods (e.g., *Acartia tonsa Euterpina acutifrons*, and *Oithona oculata*). Both the Pr and the FP larvae typically contained few prey items (Table 7).

Genyonemus lineatus

A total of 1,222 larval white croaker were examined from samples collected between October 1978 and June 1979, and in September 1979 (Table 1). Fifty-five percent of the larvae were Pr stage. Nearly all of the larvae contained food: feeding incidence was 92.8% (±2.0%) for the Pr larvae and 95.6% (±1.0%) for the FP larvae. Feeding incidence was high in all strata and all cross-shelf blocks (Table 3). For both larval stage categories, feeding incidence in the neuston was distinctly lower (75.0 ± 4.8%) than it was in midwater (94.5 ± 1.6%) and epibenthos (96.2 ± 0.7%). There was little evidence of a cross-shelf gradient in feeding incidence for either stage category (Table 3).

Larval white croaker consumed a wide variety of prey types (Tables 8, 9). Pr larvae tended to eat smaller items, particularly tintinnids, bivalve and gastropod veligers, and small copepods, especially all stages of *Euterpina acutifrons* (Table 8). The FP larvae consumed these

flexion-postflexion stage larvae are below. A blank column indicates that no larvae contained food occurred in that stratum. Water a given food category; %FO = the percent of larvae containing food items that contained prey of the given category. Copepods

Block:	C (12–22 m)						D (22–45 m)						E (45–75 m)			
Stratum:	N		M		E		N		M		E		N	M		E
Prey item	%N	%FO	%N	%FO	%N	%FO	%N	%FO	%N	%FO	%N	%FO	%N	%N	%FO	%N
Preflexion																
Rhizosolenia spp.	0	0	1.7	8.3	0	0	0	0	0	0	0	0		0	0	
Peridinium spp.	0	0	1.7	8.3	0	0	0	0	3.3	9.1	0	0		0	0	
Radiolaria	0	0	0	0	0	0	0	0	3.3	9.1	0	0		0	0	
Stenosomella spp.	0	0	5.0	8.3	0	0	0	0	0	0	0	0		0	0	
Bivalve veligers	0	0	1.7	8.3	8.3	20.0	20.0	50.0	16.7	9.1	50.0	20.0		0	0	
Euterpina acutifrons (nauplii)	0	0	78.3	58.3	50.0	80.0	70.0	75.0	36.7	36.4	20.0	20.0		0	0	
Unidentified copepods	0	0	0	0	16.7	20.0	0	0	0	0	0	0		33.3	33.3	
Unidentified nauplii	0	0	0	0	0	0	0	0	0	0	0	0		0	0	
Unidentified	100.0	100.0	11.7	58.3	25.0	40.0	10.0	25.0	40.0	90.9	30.0	60.0		66.7	66.7	
Total food items	1		60		12		10		30		10		0	3		0
Mean prey/feeding larva	1.0		5.0		2.4		2.5		2.7		2.0		0	1.0		0
Flexion-postflexion																
Unidentified			100.0	100.0										100.0	100.0	
Total food item	0		2		0		0		0		0		0	2		0
Mean prey/feeding larva	0		1.0		0		0		0		0		0	1.0		0

TABLE 7.—Diet of larval *Paralabrax* spp. Results for preflexion stage larvae are given above; those for the flexion-postflexion stage larvae are below. A blank column indicates that no larvae contained food in that stratum. Water column strata are N = neuston; M = midwater; E = epibenthos. %N = the percent of the total food items attributable to a given food category; %FO = the percent of larvae containing food items that contained prey of the given category. Copepods listed as prey include both copepodites and adults.

Block:	A (6–9 m)				B (9–12 m)			C (12–22 m)					
Stratum:	N		M	E	N	M	E	N		M		E	
Prey item	%N	%FO	%N	%N	%N	%N	%N	%N	%FO	%N	%FO	%N	%FO
Preflexion													
Stenosomella spp.										43.8	20.0	0	0
Bivalve veligers										6.3	20.0	0	0
Paracalanus parvus										0	0	0	0
Euterpina acutifrons										12.5	20.0	0	0
E. acutifrons (nauplii)										6.3	20.0	0	0
Unidentified copepods										0	0	0	0
Cirriped nauplii										6.3	20.0	0	0
Unidentified										25.0	80.0	100.0	100.0
Total food items	0	0	0	0	0	0	0	0		16		2	
Mean prey/feeding larva	0	0	0	0	0	0	0	0		3.2		2.0	
Flexion-postflexion													
Acartia tonsa	0	0						100.0	100.0				
Corycaeus anglicus	0	0						0	0				
Oithona oculata	0	0						0	0				
Euterpina acutifrons	0	0						0	0				
Unidentified copepods	0	0						0	0				
Euphausid calyptopis	0	0						0	0				
Unidentified	100.0	100.0						0	0				
Total food items	1	0	0	0	0	0	0	1		0		0	
Mean prey/feeding larva	1.0	0	0	0	0	0	0	1.0		0		0	

Block:	D (22–45 m)				E (45–75 m)				
Stratum:	N	M		E	N	M		E	
Prey item	%N	%N	%FO	%N	%N	%N	%FO	%N	%FO
Preflexion									
Stenosomella spp.		0	0			0	0		
Bivalve veligers		80.0	67.7			9.1	14.3		
Paracalanus parvus		0	0			18.2	14.3		
Euterpina acutifrons		0	0			0	0		
E. acutifrons (nauplii)		0	0			0	0		
Unidentified copepods		20.0	33.3			0	0		
Cirriped nauplii		0	0			0	0		
Unidentified		0	0			72.7	85.7		
Total food items	0	5		0	0	11		0	
Mean prey/feeding larva	0	1.7		0	0	1.6		0	
Flexion-postflexion									
Acartia tonsa						14.3	20.0	0	0
Corycaeus anglicus						0	0	33.3	100.0
Oithona oculata						42.9	20.0	0	0
Euterpina acutifrons						14.3	20.0	33.3	100.0
Unidentified copepods						14.3	20.0	33.3	100.0
Euphausid calyptopis						14.3	20.0	0	0
Unidentified						0	0	0	0
Total food items	0	0		0	0	7		3	
Mean prey/feeding larva	0	0		0	0	1.4		3.0	

small items as well, but in addition consumed larger items such as larger copepod species and mysids (Table 9). Cross-shelf patterns in dietary composition were apparent; for example, tintinnids in the Pr diet shifted from *Stenosomella* spp. near shore to predominantly *Condonaria* spp. farthest from shore (Table 8). Pr larvae also tended to consume more bivalve veligers more frequently in the blocks farthest from shore, but more gastropod veligers nearer shore (Table 8). The FP larvae likewise consumed most gastropod veligers nearer shore, but did not display clear evidence of a cross-shelf pattern in the consumption of bivalve veligers (Table 9). The average number of prey items consumed by the Pr larvae ranged from 2.9 to 8.8 per feeding individual (Table 8), while for the FP larvae the number of items consumed ranged from 2.0 to 8.3 (Table 9). Cross-shelf patterns in the number of items consumed were not apparent. The FP larvae contained more prey items per feeding individual in midwater and epibenthos than in the neuston. There were no consistent differences between strata for the Pr larvae or between midwater and epibenthos samples for the older larvae (Tables 8, 9).

Seriphus politus

A total of 742 larval queenfish (61% Pr stage) were examined from samples collected between September and November 1978 and between March and September 1979 (Table 1). The overall 67% feeding incidence was comparable to the 72% night incidence noted in the day/night sample set. Feeding incidence differed little between the Pr larvae (73.5 ± 4.2%) and the FP larvae (79.2 ± 4.8%). Relatively few larvae were available for dissection from the neuston samples, and overall these larvae displayed the lowest feeding incidence (48.5 ± 12.6% for the Pr larvae; no FP larvae occurred in the neuston). Feeding incidence differed little between midwater (76.4 ± 6.1%) and epibenthos (79.4 ± 3.8%). The feeding incidence for the Pr larvae was highest in block A (81.5 ± 6.1%) where larval abundance was highest, and ranged between about 62 and 68% in the remaining blocks. Confidence limits about the means for blocks B (63.1 ± 9.4%) and D (61.7 ± 11.2%) did not overlap the confidence limits about the mean for block A, but those about the means for blocks C (66.7 ± 12.4%) and E (65.9 ± 15.1%) did overlap the confidence limits about the block A mean. The lowest feeding incidences for the FP larvae occurred in blocks A (76.6 ± 7.0%) and B (77.1 ± 9.6%) where larval abundance was highest, and the highest feeding incidences occurred in blocks C (91.1 ± 9.4%) and D (85.7 ± 33.1%) where larval abundance was low. However, the confidence bounds about these estimates overlapped in all cases.

Larval queenfish consumed a wide variety of prey types (Tables 10, 11). Pr larvae consumed mainly small items, especially bivalve veligers and small copepods such as *Paracalanus parvus* and *Euterpina acutifrons* (Table 10). The FP larvae also consumed these small items in addition to larger items, especially mysids and gammarid amphipods (Table 11). Cross-shelf patterns in dietary composition and number of items consumed were not clear. For the Pr larvae, feeding specimens contained fewer prey items per individual in block E than elsewhere (Table 10), but for the FP larvae no pattern was apparent (Table 11). Both the Pr and FP larvae tended to consume slightly more prey items per feeding individual in midwater than in epibenthos. Smaller prey contributed larger fractions of the diet in midwater than in the epibenthos for both larval stage classes.

DISCUSSION

Both the limited day/night sample series and the much larger night-only sample set indicated that larvae contained food well into the night. A nonzero feeding incidence does not necessarily imply recent feeding, however, but only indicates the presence of food in the gut. For example, a slow digestion and evacuation rate might result in the appearance of nocturnal feeding even if the larvae in fact were not feeding. On the other hand, a low feeding incidence does not necessarily imply nonfeeding, especially for taxa that have a straight gut, since these larvae frequently void their gut contents during capture and fixation (June and Carlson 1971; Hay 1981). Hunter (1981) noted that fish larvae are visual feeders lacking rods and retinomotor pigment migration (e.g., Blaxter 1968) and are probably largely restricted to feeding in daylight hours. The low feeding incidences noted for larval *Paralabrax* spp. in the night samples suggests that they do feed only during the day. Similarly, *Paralichthys californicus* larvae may feed only during the day, although their day-night differences in feeding incidence were smaller and less convincing owing to the broad confidence limits about the %FI values. Both

TABLE 8.—Diet of preflexion stage larvae of *Genyonemus lineatus*. A blank column indicates that no larvae contained food in that stratum. Water column strata are N = neuston; M = midwater; E = epibenthos. %N = the percent of the total food items attributable to a given food category; %FO = the percent of the larvae containing food items that contained prey of the given category. Copepods listed as prey species include both copepodites and adults.

Block:	A (6–9 m)						B (9–12 m)						C (12–22 m)					
Stratum:	N		M		E		N		M		E		N		M		E	
Prey item	%N	%FO	%N	%FO	%N	%FO	%N	%FO	%N	%FO	%N	%FO	%N	%FO	%N	%FO	%N	%FO
Coscinodiscus spp.	0	0	0	0	0	0	0	0	0	0	0.6	2.4	0	0	0	0	0.9	4.9
Peridinium spp.	3.8	10.5	0.7	2.9	0	0	1.3	5.9	2.0	9.8	0.1	1.2	0	0	3.6	10.3	1.1	4.9
Radiolaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stenosomella spp.	37.7	10.5	43.3	25.7	4.4	8.0	21.8	23.5	18.1	24.4	0.6	1.2	0	0	0.7	3.4	0	0
Condonaria spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalve veligers	6.6	26.3	4.6	17.1	3.2	8.0	12.8	35.3	8.3	31.7	7.5	20.5	5.4	6.3	3.6	13.8	9.4	24.7
Gastropod veligers	2.8	15.8	1.3	8.6	0.6	2.0	3.8	17.6	3.1	7.3	1.7	6.0	0	0	1.5	6.9	1.1	6.2
Spionidae	0	0	0	0	0	0	0	0	0	0	0.3	1.2	0	0	0	0	0	0
Polychaete trochophores	0	0	0.3	2.9	5.7	18.0	0	0	0.4	2.4	0.6	2.4	1.8	6.3	1.5	6.9	1.1	6.2
Cyphonautes, uniden.	0	0	0	0	0	0	0	0	0	0	0.6	1.2	0	0	0	0	0.2	1.2
Penilia avirostris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cladocerans, uniden.	0	0	0	0	0	0	1.3	5.9	0	0	0	0	0	0	0	0	0	0
Paracalanus parvus	0	0	3.9	17.1	10.1	18.0	0	0	0.4	2.4	1.7	7.2	0	0	0	0	1.1	4.9
Oithona oculata	0	0	1.0	8.6	1.3	4.0	1.3	5.9	0	0	5.8	14.5	0	0	2.2	3.4	2.5	6.2
O. oculata nauplii	0	0	0	0	0	0	0	0	0.4	2.4	1.7	6.0	0	0	2.2	6.9	0.9	4.9
Corycaeus anglicus	0	0	0	0	1.3	4.0	0	0	0.4	2.4	0.9	3.6	0	0	0	0	6.2	16.0
Oncea spp.	0	0	0.3	2.9	0	0	0	0	0	0	0.9	3.6	0	0	1.5	3.4	3.9	4.9
Euterpina acutifrons	16.1	36.8	18.9	60.0	27.8	48.0	17.9	35.3	15.7	61.0	38.9	42.2	5.4	18.8	24.1	44.8	32.5	64.2
E. acutifrons nauplii	6.6	15.8	13.0	28.6	7.6	12.0	15.4	23.5	25.2	39.0	2.9	9.6	46.4	50.0	17.5	34.5	12.1	29.6
Microsetella rosea	0	0	0.3	2.9	0	0	5.1	17.6	3.9	14.6	3.5	8.4	0	0	9.5	20.7	10.5	19.8
M. rosea nauplii	0	0	0	0	0	0	0	0	0.8	4.9	0	0	0	0	0	0	0.2	1.2
Longipedia spp. nauplii	1.9	10.5	0	0	0	0	3.8	11.8	3.1	9.8	0	0	3.6	12.5	2.9	10.3	1.6	8.6
Copepods, unidentified	0	0	0	0	12.7	18.0	0	0	0.8	2.4	5.2	9.6	3.6	6.3	2.9	10.3	1.6	4.9
Copepod nauplii, uniden.	0	0	0	0	0.6	2.0	0	0	0	0	0	0	0	0	0	0	0.5	1.2
Ostracods, uniden.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cumaceans, uniden.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euphausids, calyptopis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified	24.5	78.9	12.4	60.0	24.6	46.0	15.4	58.8	17.3	48.8	26.5	55.4	33.9	68.8	26.3	58.6	12.4	44.4
Total food items	106		307		158		78		254		347		56		137		437	
Mean prey/feeding larva	5.6		8.8		3.2		4.6		6.2		4.2		3.5		4.7		5.4	

TABLE 8.—*Continued.*

Block:	D (22–45 m)						E (45–75 m)					
Stratum:	N		M		E		N		M		E	
Prey item	%N	%FO	%N	%FO	%N	%FO	%N	%FO	%N	%FO	%N	%FO
Coscinodiscus spp.	0	0	1.0	3.8	0.9	2.4	0	0	0	0	0	0
Peridinium spp.	0	0	8.0	13.9	0.6	2.4	6.9	10.0	6.4	25.0	0	0
Radiolaria	0	0	0.5	1.3	0	0	0	0	0	0	0	0
Stenosomella spp.	0	0	0	0	0	0	0	0	3.8	5.0	3.6	7.7
Condonaria spp.	0	0	1.5	5.1	0	0	24.1	30.0	5.1	20.0	0	0
Bivalve veligers	22.7	25.0	40.5	62.0	19.4	35.7	24.1	50.0	19.2	60.0	16.4	38.5
Gastropod veligers	0	0	0.8	3.8	1.2	5.6	0	0	0	0	0	0
Spionidae	0	0	0	0	0	0	0	0	0	0	0	0
Polychaete trochophores	0	0	0	0	0.6	3.2	0	0	2.6	10.0	1.8	7.7
Cyphonautes, uniden.	0	0	0.5	2.5	0.5	1.6	0	0	0	0	0	0
Penilia avirostris	0	0	0	0	0.2	0.8	0	0	0	0	0	0
Cladocerans, uniden.	0	0	0	0	0	0	0	0	0	0	0	0
Paracalanus parvus	0	0	0	0	0.5	2.4	0	0	0	0	0	0
Oithona oculata	0	0	0	0	2.9	9.5	0	0	0	0	0	0
O. oculata nauplii	4.5	25.0	1.5	7.6	0	0	0	0	0	0	0	0
Corycaeus anglicus	0	0	0.5	2.5	1.7	5.6	0	0	0	0	0	0
Oncea spp.	0	0	1.5	5.1	0.8	3.2	0	0	3.8	10.0	3.6	15.4
Euterpina acutifrons	4.5	25.0	21.6	39.2	57.9	80.2	0	0	0	0	1.8	7.7
E. acutifrons nauplii	13.6	50.0	10.3	22.8	1.2	4.0	3.4	10.0	5.1	10.0	0	0
Microsetella rosea	13.6	25.0	5.0	16.5	3.5	9.5	0	0	2.6	10.0	0	0
M. rosea nauplii	0	0	0	0	0	0	13.8	40.0	2.6	10.0	5.5	15.4
Longipedia spp. nauplii	22.7	25.0	0	0	0	0	3.4	10.0	0	0	0	0
Copepods, unidentified	0	0	0	0	0.6	2.4	0	0	1.3	5.0	0	0
Copepod nauplii, uniden.	0	0	0.5	1.3	0	0	3.4	10.0	1.3	5.0	0	0
Ostracods, uniden.	0	0	0	0	0.2	0.8	0	0	0	0	1.8	7.7
Cumaceans, uniden.	0	0	0	0	0.2	0.8	0	0	0	0	0	0
Euphausids, calyptopis	0	0	0	0	0.5	2.4	0	0	0	0	0	0
Unidentified	18.2	50.0	6.3	15.2	6.6	23.8	20.7	60.0	46.2	65.0	65.5	61.5
Total food items	22		398		648		29		78		55	
Mean prey/feeding larva	5.5		5.0		5.1		2.9		3.9		4.2	

TABLE 9.—Diet of flexion-postflexion stage larvae of *Genyonemus lineatus*. Since none of these larvae occurred in block Water column strata are N = neuston; M = midwater; E = epibenthos. %N = the percent of the total food items the given category. Copepods listed as prey include both copepodites and adults.

Block:	A (6–9 m)						B (9–12 m)					
Stratum:	N		M		E		N		M		E	
Prey item	%N	%FO	%N	%FO	%N	%FO	%N	%FO	%N	%FO	%N	%FO
Coscinodiscus spp.	0	0	0	0	0.2	0.6	0	0	6.3	33.3	0	0
Rhizosolenia spp.	0	0	0	0	0.1	0.6	0	0	0	0	0	0
Peridinium spp.	0	0	0	0	0	0	0	0	0	0	0	0
Radiolaria	0	0	0	0	0	0	0	0	0	0	0	0
Sagitta spp.	0	0	0	0	0.4	1.1	0	0	0	0	0.2	1.3
Bivalve veligers	6.3	14.3	9.1	63.6	2.3	7.4	0	0	0	0	5.8	19.0
Gastropod veligers	12.5	28.6	1.3	9.1	0.5	2.3	0	0	0	0	1.9	5.2
Spionidae	6.3	14.3	1.3	9.1	0.5	2.3	0	0	0	0	0	0
Polychaete larvae	0	0	9.1	27.3	2.3	5.7	0	0	6.3	33.3	9.5	26.1
Membranipora spp. cyphonautes	0	0	0	0	0.1	0.6	0	0	0	0	0.1	0.7
Cyphonautes, uniden.	0	0	0	0	0.8	4.0	0	0	0	0	1.0	3.9
Penilia avirostris	0	0	0	0	0.2	1.1	0	0	0	0	0	0
Acartia tonsa	0	0	0	0	0.1	0.6	0	0	0	0	2.1	9.8
Paracalanus parvus	37.5	28.6	32.5	63.6	54.1	48.9	0	0	18.8	66.7	29.5	51.0
Labidocera trispinosa	0	0	1.3	9.1	4.5	9.7	0	0	12.5	33.3	1.2	4.6
Pontellopsis spp.	0	0	0	0	0	0	0	0	0	0	2.6	7.8
Candacia spp.	0	0	0	0	0	0	0	0	0	0	0	0
Oithona oculata	0	0	3.9	27.3	1.1	3.4	0	0	0	0	0.6	2.6
O. oculata nauplii	0	0	0	0	0	0	0	0	0	0	0	0
O. plumifera	0	0	0	0	0	0	0	0	0	0	0.2	1.3
Corycaeus anglicus	0	0	2.6	9.1	0.6	2.3	0	0	0	0	1.1	5.9
Oncea spp.	0	0	0	0	0.2	1.1	0	0	0	0	0.3	2.0
Euterpina acutifrons	18.8	42.9	31.2	81.8	12.0	30.1	0	0	50.0	100.0	30.3	54.2
E. acutifrons nauplii	6.3	14.3	0	0	1.7	6.3	0	0	0	0	0.2	1.3
Microsetella rosea	0	0	0	0	0.1	0.6	0	0	0	0	0.3	2.0
Longipedia spp. nauplii	0	0	0	0	0.1	0.6	0	0	0	0	0	0
Copepods, uniden.	0	0	0	0	11.3	32.4	0	0	0	0	4.3	14.4
Copepod nauplii, uniden.	6.3	14.3	1.3	9.1	0	0	0	0	0	0	0	0
Cirriped nauplii	0	0	0	0	0.1	0.6	0	0	0	0	0.5	2.0
Cirriped cypris	0	0	0	0	0.1	0.6	0	0	0	0	0.2	1.3
Nebalia spp.	0	0	1.3	9.1	0	0	0	0	0	0	0.1	0.7
Ostracods, uniden.	0	0	0	0	0	0	0	0	0	0	0.1	0.7
Metamysidopsis elongata	0	0	0	0	0	0	0	0	0	0	0.1	0.7
Mysidopsis californica	0	0	0	0	0	0	0	0	0	0	0.3	2.0
M. intii	0	0	0	0	0	0	0	0	0	0	0.2	0.7
Neomysis rayii	0	0	0	0	0	0	0	0	0	0	0.3	2.0
Neomysis spp. juveniles	0	0	0	0	1.4	5.1	0	0	0	0	0.3	1.3
Siriella pacifica	0	0	0	0	0	0	0	0	0	0	0.1	0.7
Mysids, uniden.	0	0	0	0	0.8	2.3	0	0	0	0	0.7	3.9
Gammarids, uniden.	0	0	0	0	1.4	5.7	0	0	0	0	0.3	2.0
Euphausids, calyptopis	0	0	0	0	0.1	0.6	0	0	0	0	0	0
Caridean zoeae	0	0	0	0	0.1	0.6	0	0	0	0	0	0
Brachyuran zoeae	0	0	0	0	0	0	0	0	0	0	0.1	0.7
Brachyuran megalopae	0	0	0	0	0.1	0.6	0	0	0	0	0	0
Fish larvae	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified	6.3	14.3	5.2	27.3	2.6	9.1	100.0	100.0	6.3	33.3	5.0	24.8
Total food items	16		77		844		2		16		884	
Mean prey/feeding larva	2.3		7.0		4.8		2.0		5.3		5.8	

E, that block is not included on the table. A blank column indicates that no larvae contained food in that stratum.
attributable to a given food category; %FO = the percent of the larvae containing food items that contained prey of

Block:	C (22–45 m)						D (45–75 m)				
Stratum:	N		M		E		N	M		E	
Prey item	%N	%FO	%N	%FO	%N	%FO	%N	%N	%FO	%N	%FO
Coscinodiscus spp.	0	0	0	0	0.5	2.9		0	0	0.6	4.0
Rhizosolenia spp.	0	0	0	0	0	0		0	0	0	0
Peridinium spp.	0	0	0	0	0.6	2.0		0	0	0.3	2.0
Radiolaria	0	0	0	0	0.1	1.0		0	0	0	0
Sagitta spp.	0	0	0	0	0	0		0	0	0.3	2.0
Bivalve veligers	0	0	7.4	30.0	2.1	12.7		6.2	23.1	4.5	22.0
Gastropod veligers	0	0	3.7	20.0	1.2	9.8		0	0	2.9	18.0
Spionidae	0	0	0	0	0	0		0	0	0.3	2.0
Polychaete larvae	0	0	0	0	6.1	25.5		0	0	0.3	2.0
Membranipora spp. cyphonautes	0	0	0	0	0	0		0	0	0	0
Cyphonautes, uniden.	0	0	0	0	0.5	2.0		0	0	0.3	2.0
Penilia avirostris	0	0	0	0	0	0		0	0	0	0
Acartia tonsa	0	0	0	0	0	0		0	0	0	0
Paracalanus parvus	0	0	7.4	30.0	18.0	37.3		0	0	1.9	6.0
Labidocera trispinosa	0	0	0	0	0	0		0	0	0	0
Pontellopsis spp.	0	0	0	0	4.0	18.6		0	0	0	0
Candacia spp.	0	0	1.9	10.0	0	0		0	0	0	0
Oithona oculata	0	0	9.3	10.0	0.7	5.9		4.9	7.7	4.2	10.0
O. oculata nauplii	0	0	0	0	0.2	2.0		1.2	7.7	0	0
O. plumifera	0	0	1.9	10.0	0	0		0	0	0	0
Corycaeus anglicus	0	0	1.9	10.0	6.3	28.4		1.2	7.7	4.2	16.0
Oncea spp.	0	0	27.8	50.0	15.2	33.3		2.5	7.7	1.0	4.0
Euterpina acutifrons	33.3	100.0	29.6	40.0	31.4	61.8		65.4	92.3	70.2	86.0
E. acutifrons nauplii	0	0	0	0	0	0		9.9	15.4	0.3	2.0
Microsetella rosea	0	0	3.7	20.0	2.4	12.7		1.2	7.7	1.6	8.0
Longipedia spp. nauplii	0	0	0	0	0	0		0	0	0	0
Copepods, uniden.	66.7	100.0	0	0	1.3	4.9		0	0	2.9	10.0
Copepod nauplii, uniden.	0	0	0	0	3.8	2.0		0	0	0	0
Cirriped nauplii	0	0	0	0	0	0		0	0	0	0
Cirriped cypris	0	0	0	0	0	0		0	0	0	0
Nebalia spp.	0	0	0	0	0	0	0	0	0	0	0
Ostracods, uniden.	0	0	0	0	0	0	0	0	0	0.3	2.0
Metamysidopsis elongata	0	0	0	0	0	0	0	0	0	0	0
Mysidopsis californica	0	0	0	0	0	0		0	0	0	0
M. intii	0	0	0	0	0	0		0	0	0	0
Neomysis rayii	0	0	0	0	0.5	3.9		0	0	1.0	6.0
Neomysis spp. juveniles	0	0	0	0	0	0		0	0	0	0
Siriella pacifica	0	0	0	0	0	0		0	0	0	0
Mysids, uniden.	0	0	0	0	0	0		0	0	0	0
Gammarids, uniden.	0	0	0	0	0	0		0	0	0	0
Euphausids, calyptopis	0	0	0	0	0.2	2.0		1.2	7.7	0	0
Caridean zoeae	0	0	0	0	0.2	2.0		0	0	0	0
Brachyuran zoeae	0	0	0	0	0.1	1.0		0	0	0	0
Brachyuran megalopae	0	0	0	0	0	0		0	0	0	0
Fish larvae	0	0	0	0	0.1	1.0		0	0	0	0
Unidentified	0	0	5.6	20.0	4.0	25.5		6.2	23.1	2.6	14.0
Total food items	3		54		846		0	81		309	
Mean prey/feeding larva	3.0		5.4		8.3		0	6.2		6.2	

TABLE 10.—Diet of preflexion stage larvae of *Seriphus politus*. A blank column indicates that no larvae contained food in that stratum. Water column strata are N = neuston; M = midwater; E = epibenthos. %N = the percent of the total food items attributable to a given food category; %FO = the percent of the larvae containing food items that contained prey of the given category. Copepods listed as prey include both copepodites and adults.

Block:	A (6–9 m)						B (9–12 m)						C (12–22 m)					
Stratum:	N		M		E		N		M		E		N		M		E	
Prey item	%N	%FO	%N	%FO	%N	%FO	%N	%FO	%N	%FO	%N	%FO	%N	%FO	%N	%FO	%N	%FO
Radiolaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stenosomella spp.	0	0	0	0	0	0	0	0	20.0	10.3	0	0	20.5	14.3	12.3	13.0	0	0
Condonaria spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tintinnids, uniden.	0	0	4.2	7.3	0	0	0	0	1.4	3.4	0	0	0	0	0	0	0	0
Bivalve veligers	7.7	50.0	7.1	19.5	3.0	8.2	0	0	2.9	3.4	1.5	7.5	7.7	28.6	8.6	30.4	4.8	16.7
Gastropod veligers	0	0	1.8	7.3	1.7	4.1	0	0	1.4	3.4	0.5	2.5	0	0	0	0	2.4	8.3
Polychaete larvae	0	0	0	0	0	0	0	0	1.4	3.4	0	0	0	0	0	0	0	0
Evadne nordmanni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acartia tonsa	0	0	0	0	0.3	1.0	0	0	0	0	0	0	0	0	2.5	8.7	0	0
Paracalanus parvus	0	0	6.5	22.0	17.2	31.6	0	0	4.3	10.3	5.4	25.0	0	0	0	0	2.4	8.3
Oithona oculata	0	0	5.4	4.9	8.9	14.3	0	0	5.7	3.4	1.5	7.5	2.6	14.3	22.2	17.4	0	0
O. plumifera	0	0	0	0	0	0	0	0	0	0	0.5	2.5	0	0	0	0	2.4	8.3
Corycaeus anglicus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.4	8.3
Euterpina acutifrons	0	0	56.0	75.6	46.8	55.1	0	0	41.4	69.0	69.8	82.5	5.1	14.3	6.2	21.7	45.2	33.3
E. acutifrons nauplii	69.2	50.0	4.8	14.6	0.6	2.0	0	0	2.9	6.9	0.5	2.5	41.0	28.6	21.0	21.7	11.9	33.3
Microsetella rosea	0	0	0	0	0	0	0	0	0	0	1.0	5.0	0	0	0	0	0	0
M. rosea nauplii	0	0	0	0	0	0	0	0	0	0	0	0	2.6	14.3	0	0	0	0
Copepods, uniden.	0	0	1.8	7.3	10.0	23.5	0	0	7.1	13.8	3.9	17.5	5.1	28.6	7.4	21.7	7.1	16.7
Copepod nauplii, uniden.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	8.7	0	0
Longipedia spp. nauplii	15.4	100.0	1.8	7.3	0	0	0	0	0	0	0	0	0	0	4.9	8.7	0	0
Holmesimysis costata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.4	8.3
Neomysis spp., juveniles	0	0	0	0	0.3	1.0	0	0	0	0	0	0	0	0	0	0	0	0
Mysids, uniden.	0	0	0	0	0.6	2.0	0	0	0	0	0.5	2.5	0	0	0	0	0	0
Cumaceans, uniden.	0	0	0	0	0	0	0	0	0	0	0.5	2.5	0	0	0	0	2.4	8.3
Gammarids, uniden.	0	0	0	0	0.8	3.1	0	0	0	0	0	0	0	0	0	0	7.1	16.7
Crustaceans, uniden.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified	7.7	50.0	10.7	43.9	10.0	35.7	100.0	100.0	11.4	27.6	14.6	75.0	15.4	57.1	12.3	43.5	9.5	33.3
Total food items	13		168		361		1		70		205		39		81		42	
Mean prey/feeding larva	6.5		4.1		3.7		1.0		2.4		5.1		5.6		3.5		3.5	

TABLE 10.—*Continued.*

Block:	D (22–45 m)						E (45–75 m)					
Stratum:	N		M		E		N		M		E
Prey item	%N	%FO	%N	%FO	%N	%FO	%N	%FO	%N	%F	%N
Radiolaria	0	0	0	0	0	0	0	0	3.0	5.9	
Stenosomella spp.	0	0	14.2	18.8	0	0	42.9	16.7	12.1	11.8	
Condonaria spp.	0	0	1.5	6.3	0	0	0	0	0	0	
Tintinnids, uniden.	0	0	0	0	0	0	0	0	0	0	
Bivalve veligers	12.1	18.2	25.4	37.5	0	0	0	0	27.3	29.4	
Gastropod veligers	0	0	0.7	3.1	0	0	0	0	0	0	
Polychaete larvae	3.0	9.1	0	0	0	0	0	0	0	0	
Evadne nordmanni	0	0	0.7	3.1	0	0	0	0	0	0	
Acartia tonsa	0	0	0.7	3.1	0	0	0	0	0	0	
Paracalanus parvus	12.1	18.2	1.5	6.3	0	0	0	0	0	0	
Oithona oculata	0	0	20.9	21.9	5.9	14.3	0	0	3.0	5.9	
O. plumifera	0	0	0	0	0	0	0	0	0	0	
Corycaeus anglicus	0	0	0	0	0	0	0	0	0	0	
Euterpina acutifrons	27.3	18.2	5.2	18.8	5.9	14.3	4.8	8.3	0	0	
E. acutifrons nauplii	0	0	1.5	6.3	5.9	14.3	0	0	3.0	5.9	
Microsetella rosea	0	0	0	0	0	0	0	0	0	0	
M. rosea nauplii	0	0	0	0	0	0	0	0	0	0	
Copepods, uniden.	18.2	36.4	5.2	18.8	41.2	42.9	0	0	0	0	
Copepod nauplii, uniden.	3.0	9.1	0	0	17.6	14.3	0	0	6.1	11.8	
Longipedia spp. nauplii	0	0	0	0	0	0	0	0	0	0	
Holmesimysis costata	0	0	0	0	0	0	0	0	0	0	
Neomysis spp., juveniles	0	0	0	0	0	0	0	0	0	0	
Mysids, uniden.	0	0	0.7	3.1	0	0	0	0	0	0	
Cumaceans, uniden.	0	0	0	0	0	0	0	0	0	0	
Gammarids, uniden.	0	0	0	0	0	0	0	0	0	0	
Crustaceans, uniden.	0	0	0	0	0	0	4.8	8.3	0	0	
Unidentified	24.2	54.5	21.6	40.6	23.5	57.1	47.6	83.3	45.5	54.7	
Total food items	33		134		17		21		33		0
Mean prey/feeding larva	3.0		4.2		2.4		1.8		1.9		0

TABLE 11.—Diet of flexion-postflexion stage larvae of *Seriphus politus*. A blank column indicates that no column strata are N = neuston; M = midwater; E = epibenthos. %N = the percent of the total food items prey of the given category. Copepods listed as prey include both copepodites and adults.

Block:	A (6–9 m)					B (9–12 m)				
Stratum:	N	M		E		N	M		E	
Prey item	%N	%N	%FO	%N	%FO	%N	%N	%FO	%N	%FO
Sagitta spp.		0	0	0.5	0.9		0	0	0.6	1.6
Bivalve veligers		0	0	0.5	0.9		0	0	0	0
Gastropod veligers		0	0	0	0		0	0	0.6	1.6
Polychaete larvae		0	0	2.6	4.3		0	0	3.1	8.1
Cyphonautes, uniden.		0	0	0	0		0	0	0	0
Evadne nordmanni		0	0	0	0		20.0	50.0	0	0
Acartia tonsa		0	0	8.3	8.5		0	0	3.7	9.7
Paracalanus parvus		0	0	1.6	2.6		0	0	12.3	14.5
Labidocera trispinosa		0	0	0	0		0	0	0.6	1.6
Pontellopsis spp.		0	0	3.6	4.3		0	0	0	0
Oithona oculata		50.0	100.0	1.0	1.7		0	0	0	0
Corycaeus anglicus		0	0	0.5	0.9		0	0	0	0
Oncea spp.		0	0	1.0	0.9		0	0	0	0
Euterpina acutifons		0	0	14.6	13.7		20.0	50.0	32.5	25.8
Microsetella rosea		0	0	0.5	0.9		0	0	0	0
Copepods, uniden.		0	0	9.4	9.4		60.0	100.0	9.8	11.3
Cirriped nauplii		0	0	0	0		0	0	0.6	1.6
Holmesimysis costata		0	0	4.2	6.0		0	0	0.6	1.6
Metamysidopsis elongata		0	0	2.6	3.4		0	0	0	0
Neomysis rayii		0	0	4.2	6.8		0	0	4.9	12.9
Siriella pacifica		0	0	0	0		0	0	1.2	1.6
Mysids, uniden.		12.5	100.0	14.6	19.7		0	0	11.7	25.8
Gammarids, uniden.		12.5	100.0	18.2	22.2		0	0	5.5	14.5
Caridean zoeae		0	0	3.1	5.1		0	0	0.6	1.6
Callianassa spp. zoeae		0	0	0	0		0	0	1.2	3.2
Crustaceans, uniden.		0	0	2.6	4.3		0	0	0.6	1.6
Unidentified		25.0	100.0	6.3	10.3		0	0	9.8	24.2
Total food items	0	8		192		0	5		163	
Mean prey/feeding larva	0	8.0		1.6		0	2.5		2.6	

taxa develop a coil in the gut during the preflexion stage, reducing the likelihood that the low night feeding incidences reflected voiding of the gut contents during capture. The *Paralabrax* spp. feeding incidence was relatively high in the day samples, further suggesting that voiding of the gut contents did not contribute appreciably to the low feeding incidence observed at night.

The higher night feeding incidences for the remaining species, especially *Genyonemus lineatus* and *Seriphus politus*, suggest that they may have continued to feed after dark, at least during the early evening hours. Bagarinao and Hunter (1983) noted that older (≥10 mm) *Engraulis mordax* larvae feed in the dark if prey densities are high enough, and suggested that the full moon provides sufficient illumination for these larvae to feed near the surface at lower prey densities. Other reports of apparent larval fish feeding at night include, for example, Brewer and Kleppel's (1986) report of high feeding incidence until midnight for larval *G. lineatus* collected near shore in Santa Monica Bay, and the reports of Sumida and Moser (1980) and Jenkins (1987) that larval *Merluccius productus* off southern California and *Rhombosolea tapirina* in Port Phillip Bay, Australia, respectively, had high feeding incidences throughout much of the day and night. Brewer and Kleppel (1986) and Sumida and Moser (1980) attributed the high night feeding incidences in their studies to slow digestion rather than to nocturnal feeding, and this cannot be discounted as an alternative explanation for the high nocturnal feeding incidences noted in the present study. This alternative interpretation may be supported by the observation that feeding incidences tended to be lower during the August and September 1979

larvae contained food in that stratum. Block E is not shown because no larvae occurred there. Water
attributable to a given food category; %FO = the percent of the larvae containing food items that contained

Block:	C (12–22 m)					D (22–45 m)				
Stratum:	N	M		E		N	M		E	
Prey item	%N	%N	%FO	%N	%FO	%N	%N	%FO	%N	%FO
Sagitta spp.		0	0	0	0		0	0	0	0
Bivalve veligers		0	0	0	0		0	0	0	0
Gastropod veligers		0	0	0	0		0	0	0	0
Polychaete larvae		0	0	0	0		0	0	0	0
Cyphonautes, uniden.		0	0	1.9	3.0		0	0	0	0
Evadne nordmanni		0	0	0	0		0	0	0	0
Acartia tonsa		52.6	50.0	11.1	12.1		0	0	0	0
Paracalanus parvus		0	0	1.9	3.0		0	0	0	0
Labidocera trispinosa		0	0	7.4	9.0		0	0	0	0
Pontellopsis spp.		0	0	1.9	3.0		0	0	0	0
Oithona oculata		0	0	0	0		0	0	0	0
Corycaeus anglicus		0	0	3.7	6.0		0	0	0	0
Oncea spp.		0	0	0	0		0	0	0	0
Euterpina acutifons		0	0	5.6	9.0		0	0	0	0
Microsetella rosea		0	0	0	0		0	0	0	0
Copepods, uniden.		15.8	25.0	5.6	6.0		100.0	100.0	0	0
Cirriped nauplii		0	0	0	0		0	0	0	0
Holmesimysis costata		0	0	5.6	9.0		0	0	0	0
Metamysidopsis elongata		0	0	1.9	3.0		0	0	0	0
Neomysis rayii		0	0	1.9	3.0		0	0	0	0
Siriella pacifica		0	0	0	0		0	0	0	0
Mysids, uniden.		15.8	37.5	13.0	21.2		0	0	25.0	25.0
Gammarids, uniden.		15.8	25.0	27.8	24.2		0	0	25.0	25.0
Caridean zoeae		0	0	0	0		0	0	0	0
Callianassa spp. zoeae		0	0	0	0		0	0	0	0
Crustaceans, uniden.		0	0	0	0		0	0	0	0
Unidentified		0	0	11.1	18.2		0	0	50.0	50.0
Total food items	0	19		54		0	6		4	
Mean prey/feeding larva	0	2.4		1.6		0	3.0		1.0	

surveys. In both cases, sampling was mainly after midnight, in contrast to all other surveys when sampling was mainly before midnight. The potential influence of moonlight on feeding incidence could not be addressed in this study, since all samples were collected within five days of new moon. However, as noted above, the study by Bagarinao and Hunter (1983) suggests that nocturnal feeding is possible during full moon, at least near the surface.

Cross-shelf differences in feeding incidence were apparent for 5 of the 12 stage-taxon categories examined; for 4 of these, feeding incidence was higher near shore and lower in seaward blocks. This may reflect a higher level of feeding intensity near shore, but since the nearshore blocks were always sampled earlier than the offshore blocks during each survey, the alternative explanation that these patterns merely reflected the cessation of larval feeding at night cannot be dismissed. The results for *Atherinopsis californiensis*, and perhaps for *Leuresthes tenuis*, are more likely to represent real, but small-scale differences in feeding incidence since these two species were collected mainly in the two or three shallowest blocks, and relatively little time elapsed between samples.

The composition of the larval diets described in this study is similar to the diet described for many larval marine teleosts (e.g., Arthur 1976; Sumida and Moser 1980; Hunter 1981) in that major fractions were contributed by copepod nauplii and copepodites. In the present study, the harpacticoid copepod *Euterpina acutifrons* was an important component of the diets of all six taxa examined. This copepod species has not been noted in other studies as being such an important dietary component and the reason for its importance at San Onofre is unknown. *Euterpina acutifrons* may be more abundant near San Onofre than elsewhere (mean density 10,640/m^3—range 1,078–37,314/m^3—between the 9 and 100 m isobaths during a microzooplankton study conducted at San Onofre during the year prior to the feeding study), or it might have been unusually abundant during the year when the feeding studies were done, but appropriate data from long-term and larger scale studies that would allow evaluation of these suggestions are unavailable. Other particularly important copepods were the cyclopoid *Oithona oculata* and the calanoid *Labidocera trispinosa*. However, copepods were not the only important food items in the nearshore zone and were not the dominant prey for some of the Pr stage larvae. Other consistently important prey included tintinnids, especially *Stenosomella* spp., and mollusc veligers (principally bivalves, but also gastropods in some cases). Older sciaenid larvae consumed appreciable numbers of mysids. The diets of the older larvae did not exclude small items such as mollusc veligers or copepod nauplii; instead, the small items continued to be consumed, and larger items such as larger copepod species (e.g., Barnett and Jahn 1987: table 3) were added as well. This is consistent with Hunter's (1981) observation that although the maximum prey size selected increases more or less rapidly with increasing larval fish size, the minimum prey size increases very slowly. Thus larger larvae can select from among a wider range of prey sizes, consuming the energetically more valuable larger items when those are available, and perhaps maintaining on smaller items when large prey are unavailable (Hunter 1976; Hunter and Kimbrell 1980).

Concurrent plankton sampling that would allow comparisons of the spatial distributions of the fish larvae and their prey species was not part of the present study. However, other studies did examine the distribution and abundance of the zooplankton during the day in the same area from 1977 through 1980 (Barnett and Jahn 1987), and spatial patterns of the fish larvae and their prey can be compared in a general way on the basis of these studies. The majority of the most important prey categories occurred in highest concentrations near shore (e.g., Barnett and Jahn 1987). For example, *Oithona oculata* was most abundant in the epibenthos shoreward of the 13 m isobath (Barnett and Jahn 1987), while *Paracalanus parvus* was abundant throughout the water column shoreward of the 30 m isobath (Fig. 1). The Marine Review Committee's unpublished count data, from samples collected at San Onofre on 31 October 1978 indicated that *Euterpina acutifrons* nauplii were approximately 4–34 times more abundant in samples taken at the 9, 13, and 30 m isobaths than in samples from the 100 m isobath (maximum abundance 141,200/m^3, averaged over the water column at 13 m), while the copepodites and adults were 1.5–19 times more abundant at the shallow stations than at the 100 m station (maximum abundance 11,600/m^3, averaged over the water column at 13 m). *Labidocera trispinosa* nauplii were restricted to the very nearshore zone, shoreward of the 13 m isobath, where they occurred throughout the water column (Fig. 1). Bivalve veligers were abundant throughout the water column between the 13 and 30 m isobaths, while gastropod veligers occurred throughout the nearshore zone and seaward to at least the 100 m isobath (Fig. 1). The most frequently occurring mysid taxa in the larval diets—*Holmesimysis costata*, *Neomysis rayii*, and *Neomysis* spp. juveniles—all were most abundant in the epibenthos shoreward of the 15 m isobath (Bernstein and Gleye 1981[4]). Clutter (1967) reported that *H. costata*, as well as several other mysid species, was restricted to the nearshore zone off La Jolla, CA.

Barnett et al. (1984) described the cross-shelf and vertical distributions of the larvae of five of the six fish taxa considered here. All five were most abundant shoreward of the 45 m isobath; larvae of the sixth taxon, *Paralabrax* spp., occur principally shoreward of the 36 m isobath (Lavenberg et al. 1986). The atherinid larvae are almost exclusively neustonic; *Paralichthys californicus* and the *Paralabrax* spp. larvae occur throughout the water column (especially in midwater); and the *Genyonemus lineatus* and *Seriphus politus* larvae are located mainly in the lower water column and epibenthos (Schlotterbeck and Connally 1982; Barnett et al. 1984; Jahn and Lavenberg 1986). Ontogenetic redistributions occur during the larval phase for at least some of the taxa: the flexion and postflexion stage larvae of *G. lineatus* and *S. politus* are more nearshore and epibenthic than the preflexion stage larvae (Barnett et al. 1984), while the transforming postflexion larvae of *Paralichthys californicus* occur most frequently and in

[4]Bernstein, B. B. and L. G. Gleye. 1981. The ecology of mysids in the San Onofre region. Volume II: New reports. Rep. Mar. Rev. Comm., Rep. No. MEC01281999.

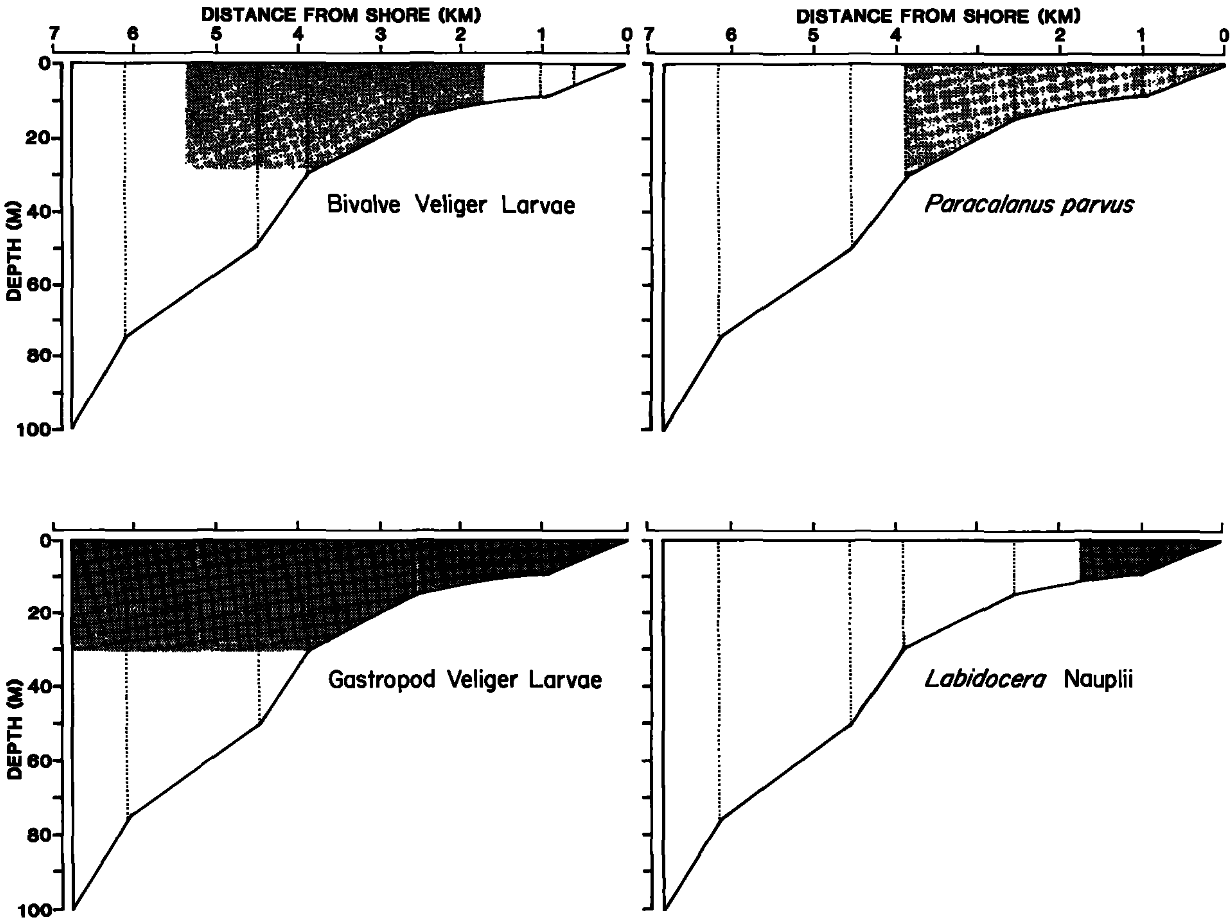

FIGURE 1.—Zones of significantly higher concentration of four zooplankton taxa near SONGS. Shaded areas represent higher concentration as determined by nonparametric one-way ANOVA ($P < 0.05$) on number per m^3 data. Redrawn from Marine Review Committee Document 78–01, Annual report to the California Coastal Commission, September 1977–August 1978: Updated estimated effects of SONGS Unit 1 on marine organisms. August 1978.

highest abundance in the neuston shoreward of the 9 m isobath.

Thus the distributions of the fish larvae and their prey are broadly similar. However, the sharp vertical gradients in abundance patterns for the atherinids and the older sciaenid larvae apparently do not closely match the vertical patterns of their prey. In discussing the results of their respective larval fish feeding studies, both of which utilized concurrent larval fish and zooplankton sampling during the day and night, Brewer and Kleppel (1986) and Jahn et al. (1988) remarked on this lack of a close match between the vertical distributions of fish larvae and their prey in the shallow nearshore zone. They suggested that factors other than, or in addition to, feeding must be important in determining larval distributions in the nearshore zone. Avoidance of dispersal seaward, away from the shallow coastal zone, is likely to be one of the most important factors (e.g., Brewer and Kleppel 1986).

Nearshore currents off southern California are mainly parallel to shore, tend to reverse at roughly tidal frequency, and have only a weak cross-shelf component (e.g., Winant and Bratkovich 1981; Jackson 1986). A comparison of the variances of the longshore and cross-shelf current speeds off San Onofre (the variance of the current speed is a good measure of the energy of the coastal current) indicates that the variance of the longshore current (102 cm^2/s^2) is about four times that of the cross-shelf current (25 cm^2/s^2) (Elwany et al. in press). This stronger longshore current has a net southerly motion, while the weak cross-shelf current has a net shoreward motion (Marine Review Committee 1977[5]). Thus

[5]Marine Review Committee. 1977. Annual report to the California Coastal Commission, August 1976—August 1977, summary of the estimated effects on marine life of Unit 1,

plankters occupying the nearshore zone in the San Onofre vicinity will, on average, tend to be transported alongshore, but not out of the nearshore zone. Those plankters occupying the epibenthos, where currents are minimal, are especially likely to be retained in the nearshore zone (e.g., Barnett et al. 1984; Jahn and Lavenberg 1986; Barnett and Jahn 1987). At times, the nearshore plankton distributions at San Onofre are disrupted (Barnett and Jahn 1987), and during those times the neritic fish larvae may be transported seaward.

Tidal mixing and nutrient recycling in the nearshore zone allows high rates of phytoplankton production near shore (Petersen et al. 1986; Barnett and Jahn 1987). This production can be utilized directly by fish larvae (e.g., Lasker 1975, 1981), or indirectly in the form of microzooplankton and small macrozooplankton, both of which occur in high concentrations near shore (e.g., Lasker 1978; Barnett and Jahn 1987). The nearshore zone appears to provide a good feeding environment for fish larvae, on average. However, it appears that this resource is largely utilized only by the nearshore species, since the larvae of more offshore species are relatively rare in the shallow coastal waters (e.g., Gruber et al. 1982; Barnett et al. 1984). Lasker (1975) demonstrated that the food resources of the nearshore zone may be critical to the first-feeding larvae of the broadly distributed species *Engraulis mordax*, and Theilacker (1986) showed that first-feeding larval *Trachurus symmetricus*, a more offshore species, were less vulnerable to starvation in nearshore habitats around the islands off the California coast than they were in offshore waters. However, larval *T. symmetricus* are uncommon in shallow coastal waters and in general there is little evidence that the shallow coastal zone provides an important feeding resource for the larvae of offshore fish species.

The observations that the larvae of the offshore fish species apparently make little use of the food resources of the nearshore zone, and that among the larvae of the neritic species the distributions of the larvae and their prey do not closely correspond, suggest that food is not the primary influence in determining nearshore larval fish distributions. What the primary influence (or influences) is remains to be determined. It does seem reasonable to conclude, at least, that larval fish distributions within the nearshore zone are a function of the advantages conferred by remaining in this environment.

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