held back for freshwater rearing. Approximately 38% of the fish in saltwater were found to have the gallbladder condition by mid-October. The condition did not develop in those remaining in freshwater.

In all cases observed thus far, affected fish were young (<2 yr) salmon that had been reared exclusively on commercially prepared pellets. With the exception of the occurrence in Oregon, all cases of the abnormality have occurred in saltwater net pens.

With dietary adjustments the condition is apparently reversible. In an unrelated nutrition study, 75% of the subsamples of one lot of 1,800 coho salmon that had been fed a ration of OMP for several months had impacted gallbladders. These test fish were divided into two lots. One group (1,400) was fed a laboratory prepared moist pellet diet and the remaining fish (400) were continued on the commercial OMP diet. After 4 mo, subsamples indicated that incidence of abnormal gallbladders in fish on the laboratory diet had been reduced to 5%. Incidence of the condition in the test group maintained on the OMP diet remained at 75%.

Discussion

I have found no published information relative to gallbladder abnormalities in fishes. The pathological features described for this condition do not resemble any infectious disease currently described for fishes and are more suggestive of a toxic or nutritional disorder.

The biliary system is an integral part of the digestive apparatus, playing an important role in lipid digestion. It also provides a mechanism for recycling certain metabolic byproducts of hepatic origin through the digestive system. Many of these metabolic byproducts are excretory wastes while others can be salvaged for reuse by redigestion. Studies as yet do not prove a major detrimental effect of this condition on the fish. Knowing the importance of the biliary system, however, it is inconceivable that it does not have an adverse effect on the animals' nutritional status, particularly in relation to systems dependent upon adequate and diverse lipid supply.

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TIMING OF THE SURFACE-TO-BENTHIC MIGRATION IN JUVENILE ROCKFISH, *SEBASTES DIPLOPROA*, OFF SOUTHERN CALIFORNIA

Species of the genus *Sebastes* lead a pelagic existence as larvae, transforming to pelagic prejuveniles and finally benthic juvenile stages at varying sizes (Moser 1967, 1972). Pelagic prejuveniles of some species often congregate under drifting objects (Hitz 1961); off the coast of southern California, *Sebastes diploproa* (Gilbert 1890) is the dominant rockfish species found under drifting kelp (Mitchell and Hunter 1970). Adults of this species inhabit a bathymetric range of 91–578 m and a latitudinal range from Alaska to Baja California (Hart 1973). Little is known about the movement of this rockfish from surface to benthic waters. This paper provides information on the disappearance from surface waters and the appearance in the benthic habitat based on seasonal size distribution from the two habitats.

Materials and Methods

Surface prejuveniles were collected by dip net off San Diego, Calif. (lat. 32°52′N, long. 117°30′W), from beneath drifting kelp (primarily *Macrocystis pyrifera*) during 1975 and 1976. Benthic juveniles were sampled in standard 10-min bottom trawls with a 7.6-m (25-ft) otter trawl (12.7-mm stretch mesh cod end liner) in 1972 through 1976. Most trawls were made in and around the Los Angeles Bight from Point Dume (lat. 34°00′N, long. 118°48′W) to Dana Point (lat. 33°28′N, long. 117°43′W) at depths from 92 to 183 m, although small *S. diploproa* were captured as shallow as 46 m. This does not encompass the entire adult bathymetric range, but younger stages of *Sebastes* generally tend to occupy shallower parts of the adult range (Kelly and Barker 1961; Moser 1967, 1972; Westrheim 1970). Only those trawls containing one or more specimens of *S. diploproa* were considered, a total of 96 trawls.

Results

Surface dip net collections consisted of 873 prejuveniles, the largest of which was 58.7 mm standard length (SL). A total of 2,418 benthic juveniles were taken in the trawl collections, with the following size breakdown: <30mm, 2; 30–39 mm, 84; 40–49 mm, 892; and 50–59 mm, 1,440. Few prejuveniles larger than 50 mm SL were captured in surface collections (Figure 1); thus they appear to settle out at a size under 50 mm. At this size prejuveniles are about 1 yr old according to laboratory growth measurements (unpublished data) and the growth curve determined by Phillips (1964); this is well within the range of published values for other members of the genus. Age of settlement has been estimated to be 6 mo for *S. umbrosus* (Chen 1971), 4 or 5 mo for *S. marinus* (Kelly and Barker 1961), and 6-12 mo for *S. alutus* (Westrheim 1973; Carlson and Haight 1976).

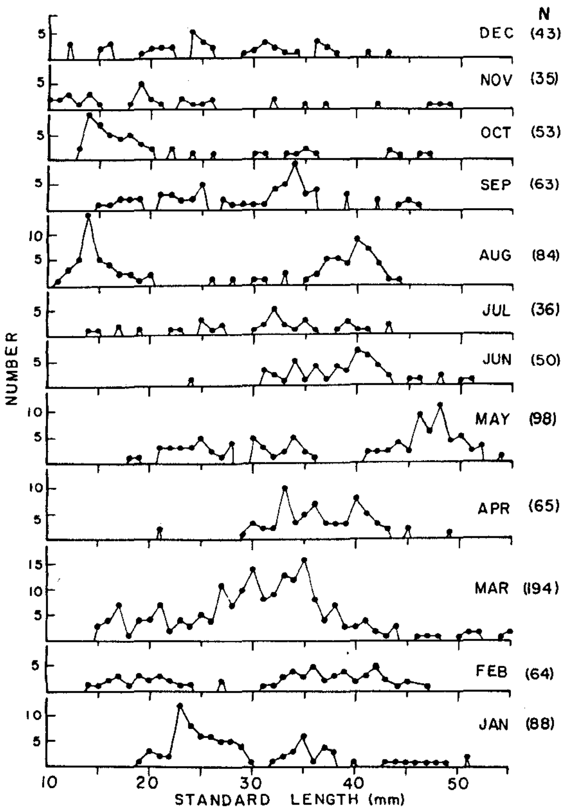

FIGURE 1.—Monthly size distribution for surface prejuvenile *Sebastes diploproa* from the combined dip net collections of 1975–76. Parenthetical numbers indicate numbers of fish collected in that month.

Female *S. diploproa* are ovoviviparous, releasing yolk sac larvae from February to July off California (Phillips 1964). The abundance of newly transformed prejuveniles (10–14 mm SL) in August through December indicates that the principal parturition season occurred in the latter part of this interval (Figure 1). The presence of small individuals in February and March, however, may indicate that there were two principal parturition seasons. Westrheim (1975) provided evidence for two parturition seasons in 1973 off British Columbia (July and October–December) and suggested that this species might release larvae throughout the year.

Surface prejuveniles in the correct size category for settlement were present throughout the year but their abundance was greatest in late spring to early summer. The percentage of specimens larger than 40 mm SL peaked in May and dropped off rapidly thereafter (Figure 2), suggesting that emigration from surface waters occurred primarily in May and June. For comparison, seasonal abundance of pelagic prejuveniles of three other *Sebastes* species are shown (Figure 3). Emigration from surface waters occurred in January to February for *S. rubrivinctus*, May to June for *S. paucispinis*, and July to August for *S. serriceps*.

Benthic juvenile *S. diploproa* occurred in a highly clumped distribution (variance exceeded mean number of fish per trawl for all months with more than one trawl). Since several months were undersampled or lacked a sufficient number of trawls, data were combined by 2-mo intervals (Figure 4). Small benthic juveniles first appeared in July–August; abundance peaked in November–December and tapered off thereafter.

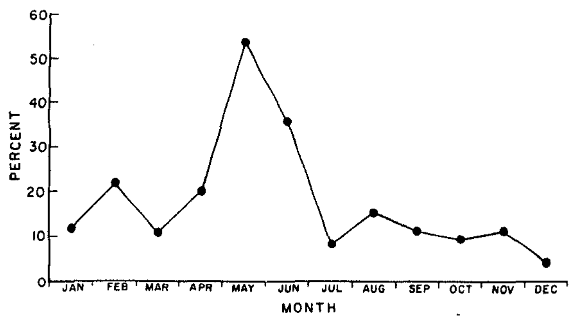

FIGURE 2.—Percentage of surface prejuvenile *Sebastes diploproa* >40 mm SL from the combined dip net collections of 1975–76.

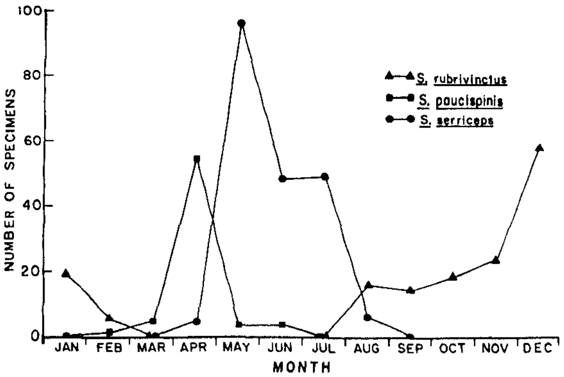

FIGURE 3.—Monthly abundance of surface prejuveniles of *Sebastes rubrivinctus*, *S. paucispinis*, and *S. serriceps* from the combined dip net collections of 1975–76.

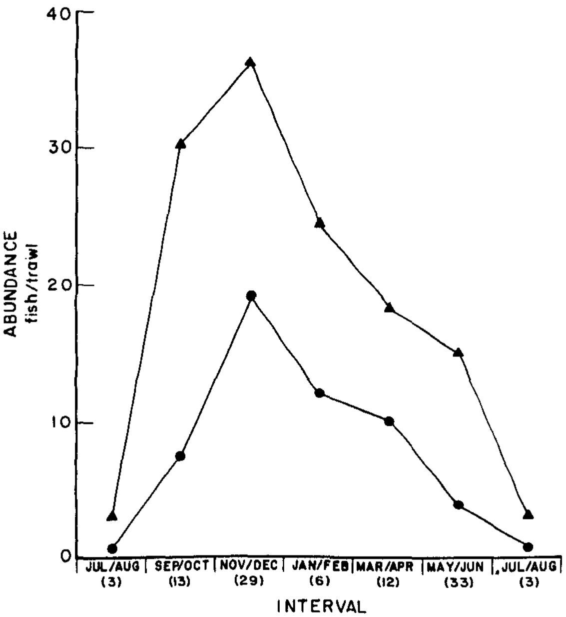

FIGURE 4.—Bimonthly abundance (number caught per trawl) of benthic juvenile *Sebastes diploproa* from trawl collections of 1972 through 1976. Circles represent abundance of all specimens <50 mm; triangles, all <60 mm. Parenthetical numbers indicate the number of trawls made per interval.

Discussion

Surface size distribution and abundance data indicate that the bulk of emigration from the surface occurred in late spring to early summer (Figures 1, 2), whereas appearance of benthic juveniles began in midsummer and continued over a period of several months (Figure 4). The temporal discrepancy between disappearance from the surface and peak benthic appearance suggests that migrant juveniles may occupy an intermediate habitat between emigration and settlement. During this period, the juveniles are probably in midwater, as shown for *S. macdonaldi* by Moser (1972). Four specimens of *S. diploproa* have been taken in two discrete-depth midwater trawls by the RV *Velero IV* and are presently in the fish collection of the Natural History Museum of Los Angeles County (LACM). Three of these specimens (43, 47, 48 mm SL) were captured in October 1970 at a depth of 250 m off San Clemente Island (lat. 32°39′N, long. 118°11′W; LACM 36315-1); the fourth specimen (43 mm SL) was taken in December 1970 at a depth of 200 m off Santa Catalina Island (lat. 33°21′N, long. 118°46′W; LACM 36307-1). Both tows were taken between 0200 and 0430 (local time) over bottom depths of 1,915 and 1,280 m, respectively. Since these bottom depths greatly exceed the bathymetric range for *S. diploproa*, time may be spent in horizontal movement to benthic habitat of suitable depth. Early migrants may come from nearshore areas, such as those sampled in the dip net collections, whereas those appearing later in the year may come from offshore prejuvenile populations; larval *Sebastes* are known to be distributed hundreds of kilometers offshore (Ahlstrom 1961).

Southern California is near the southern end of the geographic range for *S. diploproa* (Phillips 1964); no information was available on the surface prejuveniles of this species from the center or northern parts of its range. Extension of the timing of emigration and subsequent appearance in the benthic habitat is probably a direct result of the long parturition season off California. Westrheim (1975) has shown that two parturition seasons may occur per year off British Columbia and has suggested that limited year-round spawning may take place. In general, however, as one goes further north, the principal parturition season is progressively shorter and later; off Oregon, the season is mid-May to June (Hitz 1962), June to July off Washington (DeLacy et al. 1964), and July off British Columbia (Westrheim 1975). I would expect surface prejuvenile year classes to be more distinct in the north than shown in my data (Figure 1), and that timing of emigration from surface waters would be more precise.

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