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BENTHIC MICROCRUSTACEA AND ECHINODERMS ON PALOS VERDES SHELF

Trawls taken along the Palos Verdes shelf in October 1979 brought up fish species not seen for many years. Stomach content analysis showed they were feeding on microcrustaceans (tiny shrimp-like creatures) that were also believed to be absent. This entirely unexpected development caused us to initiate a resampling program to discern the extent of biological changes. The study described here sought to identify those infaunal organisms that have returned to Palos Verdes from among all those that might be expected to be present. Benthic microcrustacea and echinoderms were selected for study because they are generally prevalent on the California coast and are believed to be sensitive to toxicants. The abundance and diversity of microcrustaceans at Palos Verdes is still low and echinoderms in the same area have not increased in abundance nor have any new species been seen. One possible explanation for the return of the microcrustaceans is the decrease in the concentration of chlorinated hydrocarbons on the surface and in the upper layers of the sediment.

Microcrustaceans and echinoderms are important members of the benthic marine community: microcrustacea are a preferred food resource for several demersal fishes, including California tonguefish, Yellowchin sculpin, and Dover sole (Kleppel et al., this volume) and echinoderms are the dominant organism at control locations along the coastal shelf of much of southern California (Word and Mearns 1979). Data gathered from 572 samplings off Palos Verdes from 1972 to 1979 indicate very few echinoderms (mean $\leq$1.0) and microcrustacea (mean $\leq$12) species are present and that these are in extremely low abundances. Sampling during the latter part of 1979 indicates that the abundance of microcrustacea at 152 m has increased 16-fold when compared to 1974 levels. At a depth of 60 m, a 6-fold increase is evident when compared to the peak values in 1974. The benthic echinoderms, however, show no change. The changes observed in the abundance of microcrustacea may be related to observations which indicate decreases in the levels of the sediment-bound insecticide DDT at 60 m.

Samples were collected with a 0.04-sq-m Shipek grab device. Either three or four replicate samples were collected at each station. All samples were sieved through 1.0-mm mesh screens and the organisms retained were identified to species. These data were compared to data on natural conditions (±95 percent confidence interval) as determined by a 60-m control survey of the southern California mainland shelf (Word and Mearns 1979). Twenty-nine stations from this control survey were included in this analysis as well as two stations located in the Point Conception shelf area. These two Point Conception stations are believed to have conditions much like those originally found at Palos Verdes because of similar exposure to ocean currents, similar depth profiles, rocky bottoms and the presence of kelp communities at shallower depths. As a result of these similarities these two stations were chosen as controls.

BENTHIC MICROCRUSTACEA

Benthic arthropods were very low in abundance throughout the entire sampling region (572 stations covering a depth range of 30 to 305 meters and an area of 62 sq km) during the 8-year sampling period. Of the 572 stations, only 37 had abundances equal to or greater than the abundances found at the 29 control stations of the 60-m survey. Only 6 of the 39 stations were at a depth of 60 m while 27 were at a depth of 152 m and the final four were at depths of 30 m. All 37 stations were dominated (≥90%) by a single genus of ostracod (*Euphilomedes*). Arthropod abundances at these stations averaged 1,278 ± 96 per sq m (mean ±SE, N = 37), which is well above natural levels (500-720 per sq m at 95 percent confidence limits). The large abundance values at these 37 stations doubled the summary statistics for the remaining 535 stations.

Number of Stations	Mean Number of Individuals
572	149
535	71
37	1,278

Six of the 572 stations contained enough species to be considered normal, if they had occurred at 60-m depths. However, none of these stations were located on this depth contour, but were at 30 m where the number of arthropod species is normally higher.

Table 1. compares the abundances and diversity of arthropods along the 30-, 60-, 152-, and 305-m depth contours throughout the sampling grid to natural conditions found at 60-m and to two stations located off of Point Conception. Palos Verdes stations contain between 3 and 20

percent of the expected number of benthic crustaceans. This particular group of invertebrates probably represents the most preferred and important source of food for the majority of benthic fishes. While fish may grow rapidly on other diets, it is probable that they do not obtain sufficient quantities of necessary amino acids which provide necessary precursors for the proper induction of spawning (Füchter and Trommsdorf 1974). Microcrustacea may provide these materials, and their absence off Palos Verdes may explain the observations of nonmaturation of gonads in Dover sole and in the longspine combfish.

BENTHIC ECHINODERMS

Benthic echinoderms are the most abundant organisms on southern California's natural shelf environment. While they are eaten by various fishes they do not appear to be important members in food webs. They are, however, excellent examples of sensitive marine organisms that have been selectively lost to benthic communities around the Palos Verdes discharge. Even species normally attracted to other discharge sites (eg: *Astropectin*, *Lytechinus*, and *Parastichopus*, spp.) are drastically reduced along the entire Palos Verdes shelf. The total number of species and mean abundance of each at depths of 30, 60, 152, and 305 m is compared to data from the 60-m control survey and from the two Point Conception stations (Table 2). In all instances, the numbers of species and thus abundances along these depth contours are lower than those observed on the 60-m contour. Throughout the 8-year period, none of the data from the stations contained values within the 95 percent confidence limits established for a depth of 60 m (Word and Mearns 1979).

CHANGES IN MICROCRUSTACEAD POPULATIONS THROUGH TIME

Data showing changes in abundance and in the number of species of microcrustacea during the sampling period are shown in Figure 1. The abundance and diversity of microcrucstacea at a depth of 305 m did not change significantly over the last 7 years, thus indicating that whatever changes have occurred to improve conditions in shallower waters are not operating at this depth. The diversity at 152 m fluctuated, but the abundances of these animals showed a dramatic 16-fold increase when compared to 1974 levels. At 60 m the diversity also fluctuated but did show an increasing trend over the last 3 years. Abundances did not increase as much as at 152 m, but there was a 6-fold increase from 1974 to the peak values in 1978. From 1971 to 1978, the number of species at 30 m appeared to decrease; in

Table 1. Abundances and numbers of species of microcrustacea in the Palos Verdes region throughout the years 1972-1979 and at control stations from the 60m survey (mean ± SE)

	No. of Stations	No. of Species/ 0.12-0.16 sq m	Abundance/ sq m
All Stations	572 (535)	3.5	149 (71)
Palos Verdes			
30 m	131	7.9 ± 0.4	193 ± 15
60 m	169	3.4 ± 0.3	105 ± 19
152 m	144	1.8 ± 0.14	281 ± 49
305 m	128	1.0 ± 0.1	11 ± 2
Controls			
60 m	29	21 ± 2*	610 ± 55
C_0	1	29*	760
C_1	1	41*	2220

*Values are for 0.1 sq m

Table 2. Abundances and numbers of species of echinoderms in the Palos Verdes region throughout the years 1972-1979 and at control stations from the 60m survey (mean ± SE)

	No. of Stations	No. of Species/ 0.12-0.16 sq m	Abundance sq m
All Stations	568	0.25	3.1
Palos Verdes			
30 m	127	0.6 ± 0.08	9.5 ± 1.6
60 m	169	0.17 ± 0.04	1.7 ± 0.5
152 m	144	0.15 ± 0.04	0.9 ± 0.21
305 m	128	0.13 ± 0.05	1.12 ± 0.4
Controls			
60 m	29	5 ± 0.4*	1410 ± 183
C_0	1	5*	420
C_1	1	10*	450

*Values are for 0.1 sq m

1978, this decreasing trend stopped, and the numbers began increasing slightly. The abundance pattern at 30 m also varied, however, the abundance in 1978 was approximately twice the average abundance recorded for the period from 1974 through 1977.

The overall abundance and diversity off Palos Verdes was dramatically reduced compared to control conditions. However, during the past few years, the overall conditions at certain depths appear to be improving. This is most evident at depths of 60 and 152 m; a small amount of improvement seems to be occurring at 30 m. Stations at 305 m remain relatively unchanged.

CHANGES IN ECHINODERM POPULATIONS THROUGH TIME

Data for the echinoderm populations in the Palos Verdes shelf area are presented in Figure 2. Table 2 indicates an even more dramatic reduction of these animals in this region than was seen for the microcrustacea populations. Up until 1974, few echinoderms were observed in the sediments. Since that time no consistent patterns have emerged, but there are fluctuations in abundances and in the number of species. Therefore, trends showing improving or deteriorating conditions affecting these species are not evident at the present time. However, this may be due in part to (1) the absence of those echinoderms normally captured by grab samples, (2) the patchiness of the distributions of the larger species and (3) the inefficiency of rates of capture by grab devices for these echinoderms.

The most frequently encountered species in Palos Verdes grab samples were not the typical ophiuroids and small holothuroids but *Astropectin verrilli*, *Lytechinus anamesus* and *Allocentrotus fragilis*. All of these species are better sampled with trawls or observed with submarine-towed television. Television surveys of other discharge sites (e.g., Hyperion and Orange County discharge pipes) show hundreds of these organisms in relatively small areas near one side of the discharge pipe, while the other side has few or none of these species. Grab devices are probably not effective samplers for showing distribution patterns for these species unless numerous samples are taken. Their presence, however, may indicate that conditions of the benthos are beginning to improve.

The remaining benthic echinoderms (ophiuroids, small holothuroids) normally captured by grab samples have been greatly reduced in numbers in the Palos Verdes area, throughout the entire sampling period, and there is no evidence suggesting improvement that would accelerate their return.

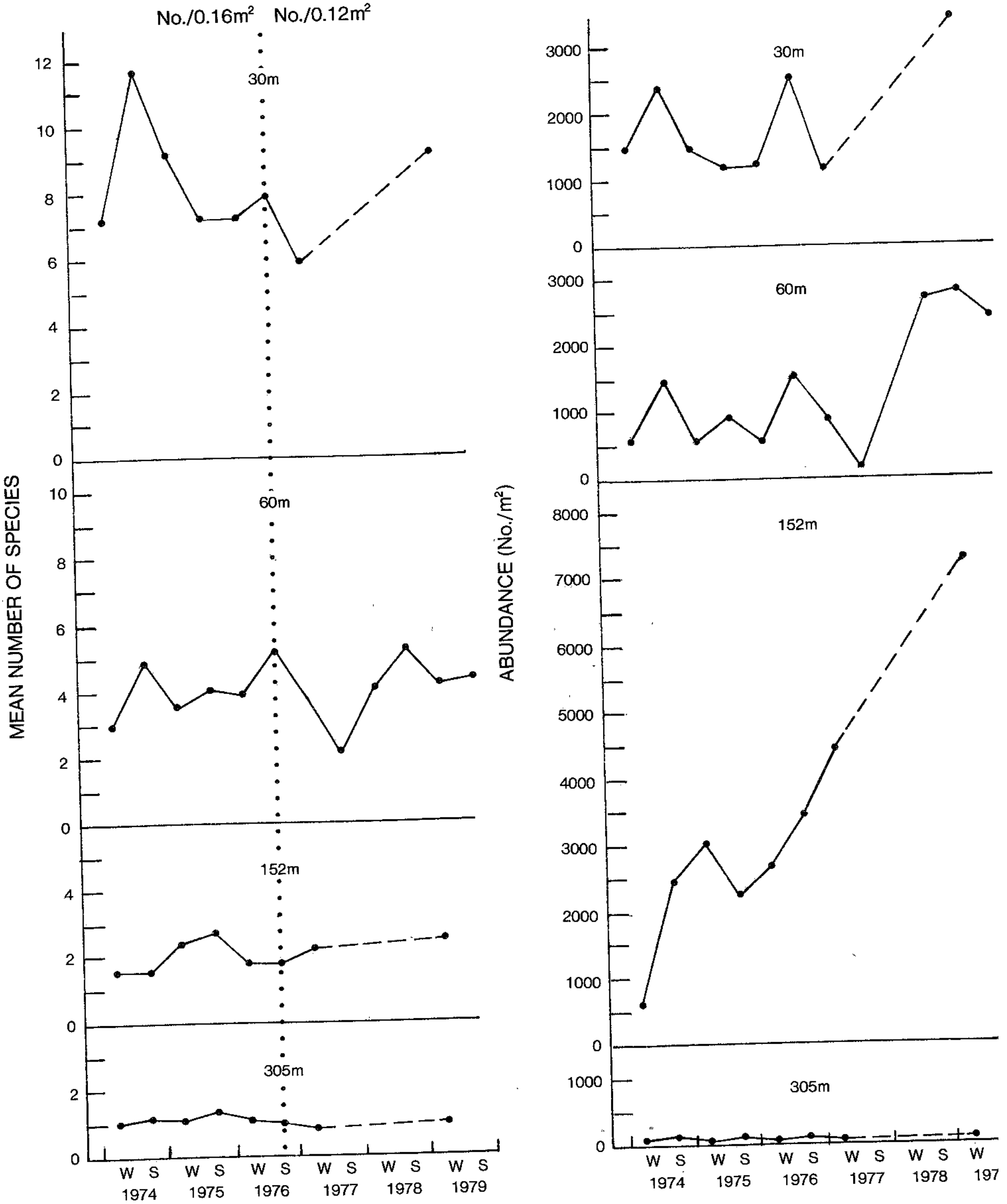

Figure 1. Mean benthic microcrustacea populations at four depth transects off Palos Verdes from 1974 to 1979. Abundances are No./M^2 for all stations at one depth (11 stations). The dashed line indicates a period of discontinuous sampling.

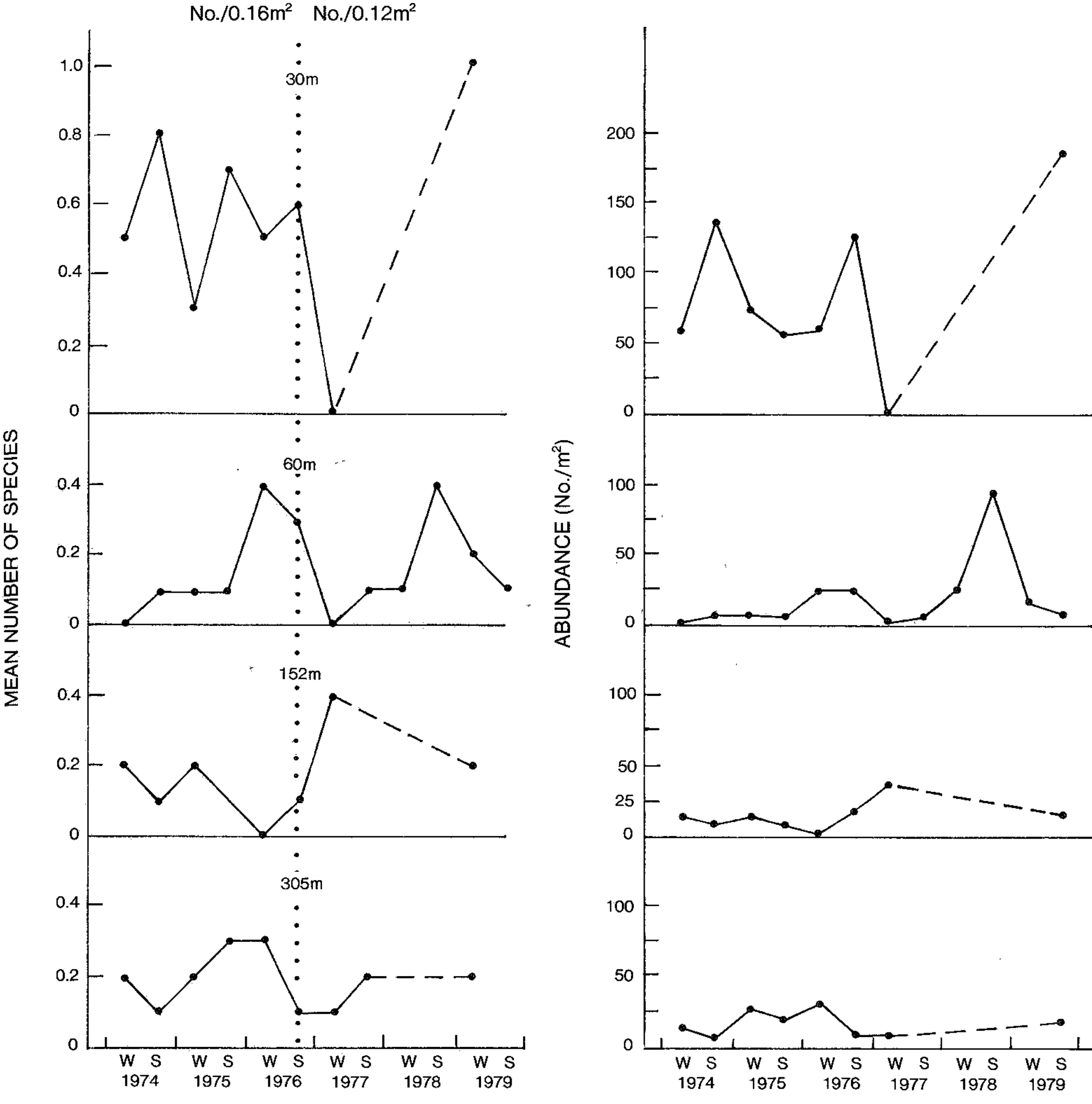

Figure 2. Benthic echinoderm populations at four depth transects off Palos Verdes through the period 1974-1979. The dashed line indicates a period of discontinuous sampling.

CONCLUSION

The Palos Verdes shelf area has been a poor habitat for infaunal arthropods and echinoderms. However, the present data indicate that conditions are improving for benthic arthropods at depths of 60 and 152 m. Less convincing improvements are seen at 30 m; none were documented at depths of 305 m. Benthic echinoderms are rare off Palos Verdes and do not appear to be returning in significant numbers to this area. The possible return of grab-caught species in the future may be forecasted by the occasional sampling of trawl-caught echinoderms that do appear to be recruiting into the area. This process of recruitment should be studied in further research of the area.

The return of the microcrustacea to this area was first noticed with the appearance of small crustaceans in the stomach contents of a fish species previously thought to feed primarily on polychaetes (Kleppel et al., this volume). Subsequent resampling of the area with grab samplers that capture microcrustacea more efficiently indicated that these organisms were returning to the area more rapidly than indicated by the information from the long-term sampling program with Shipek device. It will be important to observe changes in fish species and patterns of abundances as microcrustacea and echinoderms increase in abundance in the Palos Verdes region.

A possible reason for the return of these organisms to the Palos Verdes benthos may be recent decreasing levels of the sediment-bound insecticide DDT at depths of 60 m. A program to investigate thoroughly these preliminary observations on DDT has been initiated, and a report will soon follow that will describe DDT concentrations vertically through the sediments throughout the Palos Verdes shelf area.

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