Meiofaunal Recolonization Experiment with Oiled Sediments: Major Meiofauna Taxa

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An in situ experiment was initiated in 1990 in Herring Bay, Prince William Sound, to study the effects of the *Exxon Valdez* oil spill on recolonization by meiobenthos (small, bottom-dwelling organisms). The study site (60°28′0″N latitude, 147°41′12″W longitude) was on a section of shoreline designated as heavily oiled by the Alaska Department of Environmental Conservation; oil remaining from the *Exxon Valdez* spill was obviously present. Temperature and salinity were measured with a self-contained sensing device mounted on a tripod at an elevation of -0.1 m; both remained relatively constant over the first 28 days of the experiment at 8.0±0.1°C and 29.1±0.1 ppt.

Exxon Valdez crude oil was added and mixed into azoic sediments resulting in two concentrations, 0.5% and 1.7% crude oil, and the resulting mixture was added to triplicate colonization trays (all 13 x 28 x 33 cm). In addition, non-oiled azoic sediments treated similarly were added to triplicate trays, and samples were also collected from untreated surrounding sediments to examine treatment effects and the ambient meiofauna community which would probably be the origin of colonizers.

Trays were placed flush with the sediment surface on beaches along a transect paralleling the -0.6 m tidal level, along the upper margins of an eel grass bed. Triplicate samples were collected with hand-held corers (modified 60 ml plastic syringes) at random locations along X and Y axes within each tray during aerial exposure at low tide on days 0, 1, 2, 29, 90 and 443 after initiation on April 25, 1990.

Cores for meiofauna analysis were preserved in 10% buffered formalin and returned to the laboratory. Hydrocarbon samples were collected with a 3-cm-diameter chrome plated brass tube and placed into hydrocarbon-free glass jars with Teflon lids and frozen until analysis. In the laboratory, meiofauna passing through a 0.500 mesh sieve but retained on a 0.063 mesh sieve were separated from detritus with a sucrose flotation/centrifugation technique (Fleeger, 1979).

All organisms were identified to major taxon with a stereo dissection microscope and enumerated with ruled trays. Predominant taxa (mainly nematodes) were subsampled when they occurred in high densities using a technique which employs a triply-balanced square design (Sherman et al., 1984). Here, we report on the predominant meiofauna taxa from these collections, particularly the nematodes, harpacticoid copepods, copepod nauplii, ostracods and bivalve larvae. Other meiofauna taxa that occurred in substantial numbers on some dates include turbellarians, halocarid mites, gastropod larvae and polychaetes.

Hydrocarbon concentrations in the sediments correlated well with the percent oil added to the treatments. Hydrocarbon, aromatic and alkane concentrations declined rapidly during the first 30 days of the experiment and became asymptotic. The unoiled sediment treatments were contaminated with very small quantities of hydrocarbons, which also declined over time. Hydrocarbon concentrations in ambient sediments were similar to those in the unoiled treatments.

The experiment was initiated during the late spring, which generally is a period of active meiofauna recruitment in Alaska (Fleeger et al., 1989; Fleeger and Shirley, 1990; McGregor, 1990). Colonization was rapid for many true meiofaunal taxa (but not macrobenthic larvae) which occur in the surface sediments, as densities in trays were not significantly different from surrounding sediment collections by day two, except in the high oil sediments. Generally, high oil treatments had a reduced density compared to low and control sediments until day 29.

After initial colonization, experimental effects independent of treatment were apparent for most taxa. The effects resulted in densities (for most meiofauna taxa) higher in the experimental treatments than densities measured synoptically in the surrounding sediments. Modifications of biotic interactions generated by colonization of an azoic habitat, or emigration/immigration phenomena, may be responsible for the experimental effects.

The type of competitive, agonistic or predator-prey interaction which were altered may explain the variation in magnitude and timing of experimental effects among taxa. The azoic colonization trays may have decreased competition for some taxa, provided others an escape from predation, or influenced both interactions for some taxa. Some predatory meiofauna may have had altered prey availability, while bactivorous meiofauna may have experienced increased prey in the oiled sediments.

Harpacticoid copepods are important food items for the early life history stages of many marine fish and crustaceans; because of their importance in marine food webs, they are treated in detail in a separate presentation (Fleeger et al., 1993). In our study, harpacticoids were diverse with > 40 species encountered. Species analysis of the harpacticoid community indicated that sediments and colonization trays were inhabited primarily by phytal copepods associated with the adjacent eel grass and algal mats habitats. We assume the same relationship may have occurred with other surface meiofauna taxa, although they were not identified to species.

The average density of combined live copepods and copepodites were similar in all treatments by day 29, but averaged two to three times higher in experimental treatments than in surrounding natural sediments by day 90. The elevated densities in the experimental treatments persisted on day 443 the following year. The biotic mechanism(s) responsible for the increased densities cannot be determined by our single-factorial experiment. Copepods may have actively selected the experimental trays, or may have had enhanced survival and production after immigration.

Copepods which were assumed to be dead (as determined by deterioration or missing appendages) at the time of collection were counted separately. Dead copepods were present in the sediments used in the experiments as a result of the repeated freezing and thawing technique used to render the sediments azoic, and created some methodological problems.

Dead copepods were present in all samples through day 90, but were higher in experimental trays and rare in ambient sediments. The highest density of dead copepods were found in the high oil treatment on day 29, but few significant differences existed among the treatments throughout the experiment due to high variance.

Decreased availability or active selection against immigration into the experimental trays by copepod nauplii was evident early in the experiment. Nauplii occurred in highest density in the ambient sediments on day 2 (124±79.core-1), while at the same time nauplii densities in the treatments were extremely low (4.8±5.8, 7.4±5.2 and 22.3±18.9 in high oil, low oil and unoiled sediments, respectively). Higher densities in the experimental treatments were not found until day 29, when no significant differences occurred among the treatments (142±136, 103±80, 84±73 and 74±75.core-1 for high oil, low oil, unoiled and ambient sediments, respectively).

Nematodes were the numerically predominant taxon on most sampling dates in all treatments, with average densities varying from a minimum of not significantly more than zero at the beginning of the experiment, to a maximum average of 698.core-1 on day 443 in the unoiled trays. As with many other taxa, nematodes had higher average densities in experimental trays in comparison to ambient sediments after day 90, with lowest values in the high oil and highest values in the unoiled treatments.

Ostracods occurred in low average densities in all treatments and colonized rapidly. By day 2, no significant differences occurred among the treatments or ambient sediments. Densities remained low in the high oil treatment through day 443, The highest densities encountered were an order of magnitude higher, in the low oil treatment on day 443, which was also the date of highest density of ostracods in the unoiled treatment and in ambient sediments. Lower densities of ostracods have also been found in some heavily oiled bays in Prince William Sound the year following the oil spill (Shirley et al., 1993).

Halocarid mites, which are often predatory and sometimes predominate in meiofaunal communities in the high intertidal among algae, responded almost identically as the ostracods. They colonized rapidly, had higher densities in the experimental pans than in the ambient sediments, but never attained high densities in any treatment.

Pronounced seasonal changes in density occurred for all taxa in the ambient natural sediments and in the experimental treatments. The seasonal changes varied among taxa in timing and magnitude and reflect seasonal recruitment and mortality events. Natural seasonal and interannual (between years) variation in meiofaunal community composition and density, as is common for most marine metazoans, confound analysis of treatment effects.

Changes in density of temporary meiofauna (the larvae of macrobenthic invertebrates, e.g., bivalves, gastropods and polychaets) occur in pulses related to planktonic settlement in the intertidal zone in Alaska (McGregor, 1990). Bivalve larvae were rare in our cores until day 90, when they were abundant in all treatments and in ambient sediments. Average density of bivalve larvae was 3-4 times higher in the experimental trays than in ambient sediments, suggesting active selection by the larvae or higher post-settlement survival rates.

Our data demonstrate that over small spatial scales, meiofauna recolonize azoic sediments in the intertidal rapidly following an oil spill, but highly oiled sediments reduce recolonization rates of major meiofauna taxa and have effects that are persistent for more than a year for some taxa.

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