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Opportunistic benthic foraminifera are superior to polychaetes for monitoring anthropogenic eutrophication on the Eastern Mediterranean oligotrophic shallow shelf

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The ultra-oligotrophic shallow water environment of the southeastern Mediterranean off Palmahim, Israel, is being disturbed by dumping of activated sewage sludge. Marine benthic biotas are subjected to elevated levels of organic matter and nutrients, which have been monitored for two decades. Episodes of severe O_2 depletion leads to elimination of all benthic groups close to the sewage outfall, but peripheral eutrophication leads to blooming of the opportunistic polychaete family Capitellidae that has been used as an indicator for organic pollution. In this study, we checked the response of benthic foraminifera to dumping of activated sewage sludge in two stations PL3 (hyper-eutrophic) and PL29 (oligotrophic) that were sampled at $\sim$36m between January 2003 and May 2004. Polychaetes tended to vary in both stations, peaking in spring but to very great numbers at PL3. Diversity is high at PL29 and low at PL3. A different seasonality is shown by the foraminifera, with highest numbers occurring at PL29 in late summer/fall and lowest in mid-winter, while at PL3 maximal numbers are in January and May coinciding with events of intensive sludge winnowing by storms. Species richness at PL29 is significantly higher than at PL3. The benthic foraminiferan *Ammonia tepida* and the capitellid polychaetes are opportunists. In the Palmahim stations *A. tepida* often comprises up to 70% of the assemblage. Capitellid polychaetes comprise $\sim$99% of the polychaetes at PL3 but only $\sim$40% at PL29, where

they are accompanied by paraonids and cirratulids.

Abundance of *A. tepida* at PL3 tracks the changes in the sludge accumulation, with highest numbers coinciding with periods of total sludge dispersion during winter (01/04) and spring (05/03, 05/04) (Fig. 1). In fall, the hyper-eutrophic PL3 station became azoic due to high organic matter injection and water stratification. *A. tepida* opportunistically recolonizes newly exposed sea floor each time sludge is dispersed by winnowing. Capitellid polychaetes only respond to the spring event of sludge dispersal, at which time they occur in extremely high numbers.

We conclude that *A. tepida* is a more sensitive monitor of recurring sea floor aeration trajectories in severely disturbed stations, and has potential for more general monitoring of the environmental health of coastal regions.