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Persistent effects of physical disturbance on meiobenthos in mangrove sediments

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Abstract

Disturbance is an important factor in structuring ecological communities, exerting its influence through changes to the physical environment and to the trajectories of successional processes. Marine environments are subject to a wide range of disturbances and while much is known about the effects of disturbance on macrobenthos in unconsolidated sediments, little is known about the responses of meiobenthos to disturbance in consolidated sediments, such as mangroves. Trampling was used to study the response of meiobenthos to disturbance in mangrove sediments. Even light trampling appeared to break up the mangrove root mat and increased the proportion of fine sediment. Densities of meiobenthos increased 2–3-fold in disturbed sediments, but there was no evidence of disproportionate abundance. Temporal variability was similar in all treatments, but spatial variability increased 4–5-fold in disturbed sediments. Effects persisted for at least 24 months, with little evidence of convergence of treatments. Meiobenthos may have exploited the increase in habitat resulting from loss of the root mat and possibly benefited from increased food from the decomposition of root material. These effects are likely to persist for several years because of the minimal recovery of the root mat.

Keywords: Mangroves; Meiobenthos; Disturbance; Temporal variability; Resilience; New South Wales

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1. Introduction

Much of the heterogeneity that characterizes natural marine communities is the result of physical, chemical and/or biotic disturbance acting at different temporal and spatial scales (Probert, 1984; Sousa, 1984; Hall, 1994). While disturbance is often considered to be deleterious, in that it directly or indirectly reduces the diversity and abundance of species (Brown and Wilson, 1997; Ramsay and Kaiser, 1998; Dernie et al., 2003), it can also increase abundance and diversity and may even be essential for the survival of some species (Dayton and Hessler, 1972; Connell, 1978; Thistle, 1981; Sousa, 1984).

Integral to understanding the role of disturbance is the notion of recovery, which embodies the idea that once the disturbance has passed, communities return to their pre-disturbed state, or to a state indistinguishable from that of an undisturbed community (Underwood, 1989; Dernie et al., 2003). The extent to which this happens and how long it takes depends not only on the type of disturbance, its timing, frequency and intensity, but also on the nature of the community (Schratzberger and Warwick, 1999). There is also a possibility that species able to exploit resources, such as food or space created by disturbance, or which experience reduced competition as a result, may become more abundant relative to undisturbed areas, at least in the initial stages of recovery (Grassle and Sanders, 1973; Alongi, 1985).

Mangrove forests and their associated soft-sediments are common coastal habitats in tropical and warm temperate latitudes. They are susceptible to natural disturbances, such as storms, and are under threat from rising sea levels resulting from climatic change (Ellison and Farnsworth, 1996). Many are close to coastal cities or areas with large human populations and disturbances from human activities are considered to be major factors structuring and modifying mangrove communities (Ong, 1995). These disturbances include pollution (Levings et al., 1994), cutting of trees for wood products (Rasolofo, 1997; Dahdouh-Guebas et al., 2000), clearing of forest for aquaculture (Primavera, 1995; Kairo et al., 2001) and fishing and collecting of shellfish or bait (De Graaf and Xuan, 1998). Such activities frequently result in mangroves being subject to trampling, a form of disturbance known to influence ecological processes by altering the structure of sediments (Chandresekara and Frid, 1996; Skilleter, 1996).

This paper presents the results of a manipulative experiment using trampling of various intensities as physical disturbances in a fringing forest of the grey mangrove *Avicennia marina* in Botany Bay, New South Wales. The work, which is part of a larger study of the effects of disturbance in mangroves, focuses on the meiobenthos, a diverse group of organisms which are ubiquitous in marine sediments and make significant contributions to a number of ecological processes, including re-mineralization of organic matter and stimulation of microbial activity (Tietjen, 1980; Tietjen and Alongi, 1990; Castel, 1992; Coull, 1999). Despite their importance, relatively little is known about the effects of disturbance on meiobenthos, particularly in mangroves.

This study tested the hypothesis that, after a relatively short period of time, the composition, abundance and spatial variability of meiobenthos in sediments subjected to different intensities of disturbance would not differ significantly from that in undisturbed sediments. Unless exposed to continuous disturbance (Gheskiere et al., 2005), their great productivity and turnover should enable meiobenthos to recover rapidly after physical disturbance (Sherman and Coull, 1980; Reidenauer and Thistle, 1981; Sherman et al., 1983). Studies have also shown that resuspension and dispersal by tidal currents is also an important