Journal of Micropalaeontology, **15**: 130.

MICROPALAEONTOLOGY NOTEBOOK

Recolonization of reef flat by larger foraminifera, Funafuti, Tuvalu

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The ecology of the larger foraminifera is poorly known for western Pacific atolls, despite the importance of these species to the sediment budgets of the atolls. Many beaches and islets (*motu*) are composed largely of foraminiferal tests derived from reef flat communities; however, populations of larger foraminifera are often under threat or may even have been eliminated by the effects of pollution and development of the reef flats. It is therefore important to understand the rates of response of foraminiferal populations to natural and human changes to their environments.

This note reports some observations arising from studies of foraminifera and sedimentation on Funafuti Atoll in the south-central Tuvalu Group, west central Pacific Ocean, at latitude 8°30′S and longitude 179°12′E. The atoll consists of some 39 small islets surrounding a *c.* 200 km^2 lagoon up to 55 m deep (Smith & Woodward, 1992), with reef flats up to several hundred metres wide surrounding the islets on both ocean and lagoon sides.

Foraminiferal faunas in the lagoon and on the reef flats are diverse, and include some 8 species of larger foraminifera. Although they do not usually make up more than 40% of the reef flat sediments, because of various concentrating processes, tests of the larger foraminifera (particularly *Baculogypsina sphaerulata* and *Amphistegina lobifera*) comprise up to 80% of the sediments forming the main island Fongafale. This foraminiferal component may be even higher for the sands of other atolls, and its significance to the carbonate sediment budget and to problems of coastal erosion is thus clear.

Tropical cyclone Bebe struck Funafuti Atoll in October 1972 (Maragos *et al.*, 1973). One of its effects was the formation of a nearly continuous rampart of coral debris along the eastern ocean reef flat (Maragos *et al.*, 1973). This was initially deposited on the outer edges of the reef flat, and averaged 37 m wide and 3.5 m high (well above mean high tide) over a distance of 18 km (Maragos *et al.*, 1973, fig. 2; Nunn, 1994, pl. 5.14). Over succeeding years waves moved the coral rampart inshore across the ocean reef flat (Baines & McLean, 1976) and it now forms the eastern shore for most of the eastern islets. The present study has shown that between June 1995 and June 1996, the shoreline moved inland approximately 1 m. Seaward of it now is a reef flat between 60 and 100 m wide.

Maragos *et al.* (1973) reported that the cyclone-induced waves and their entrained debris destroyed the normal reef biota; these effects, plus the emplacement and subsequent movement of the coral rampart across the reef flat, would certainly have killed and completely removed all living foraminifera. Even today, much of the ocean reef flat has a smooth, scoured surface largely lacking coral rubble, pools and hollows.

Repetitive sampling since mid-1995 has shown that the ocean reef flat has living populations of *Baculogypsina sphaerulata* with lesser numbers of *Amphistegina lessonii*, *A. lobifera*, *Marginopora vertebralis* and a varied fauna of smaller species. The species are living epiphytically on algae, particularly *Turbinaria ornata* and *Caulerpa racemosa*, and occur from the inner edge of the reef crest to within 1 m of the low tide mark (10 cm water depth at low tide). It is likely that the rate of recolonization is largely controlled by the rate at which the larger algae can regrow on the reef flat.

It is not known how much earlier than mid-1995 the foraminiferal populations were present, but it is apparent that recolonization of the reef flat by foraminifera has occurred in less than 20 years and probably in less than 10 years. Presumably recruitment was from surviving populations on the ocean side of the reef edge, from within the lagoon or from reef flats on the leeward side of the atoll. This is important information for those atolls where the populations of larger foraminifera have disappeared in recent years and where a major component of the sediment system is thus no longer being replenished. It suggests that once the source of a problem is removed, as long as there are populations of foraminifera surviving nearby and algae available to provide a habitat, the main sand-forming foraminifera can re-establish themselves within a short period.

ACKNOWLEDGEMENTS

I am grateful to the Australia and Pacific Science Foundation , the South Pacific Applied Geosciences Commission (SOPAC) and the Internal Grants Committee of Victoria University of Wellington for their financial support of these studies. Many people, and particularly Dr Russell Howorth of SOPAC, have provided important background information.

Manuscript received July 1996
Manuscript accepted July 1996

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