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(Note)

Diatom bloom associated with gorgonian mortality in the Gulf of Oman, northwestern Indian Ocean

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Abstract—We identify the gorgonian *Echinomuricea* sp. as a keystone species in subtidal benthic communities in the Gulf of Oman, this being the first record of *Echinomuricea* in the northwestern Indian Ocean. An otherwise undisturbed *Echinomuricea* dominated community at Qalhat (Gulf of Oman) underwent a marked change in community structure over a two year period. Upon the onset of marine construction activities, an outbreak of the diatom *Chrysanthemodiscus floriatus* Mann was an early indicator of a change in community structure. *C. floriatus* is a wide-spread yet enigmatic tropical species, and is a common component in damselfish gardens. Diatoms are generally overlooked in monitoring studies but here we demonstrate their potential value in monitoring hard-bottom benthic communities following sudden environmental changes, including natural disasters like tsunamis.

Although records are few, *Chrysanthemodiscus floriatus* Mann is a widespread benthic diatom in tropical coastal communities (Round et al. 1990), where it forms a common component in turf gardens cultivated by damselfish (Lobban n.d.). The identification of the species is unequivocal as it grows in macroscopic filaments consisting of large cells, characterized by a diagnostic set of morphological features that are easily recognized under a scanning electron microscope (Figs 1, 2). Within the framework of a monitoring program at a marine construction project, we observed this diatom smothering deep benthic communities at Qalhat (Oman), a site close to the sharp biogeographical transition between the Gulf of Oman and the Arabian Sea (Schils & Wilson 2006). The benthic community (Fig. 3) in question is characterized by a number

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of species at the northern limit of their range and a number of regionally rare scleractinian corals with discontinuous distributions (*e.g.*, *Cycloseris curvata*, *Diaseris fragilis*, and *Euphyllia* sp.; Claereboudt 2006). A predominant species in the community is the as yet undescribed gorgonian *Echinomuricea* sp., which has distinctive yellow and blue morphs. The species is also very common and prominently present in other parts of the Gulf of Oman at depths of 10–20 m.

During our first monitoring survey (February 2003) all subtidal communities along the permanent transects were in a healthy condition (Fig. 4). Upon the onset of blasting activities (September 2003; Fig. 5), we observed a bloom of *C. floriatus* smothering *Echinomuricea* on transects at 17 - 20 m depth. Dense diatom filaments covered gorgonian colonies (Fig. 5), sponges (Fig. 6) and bare substrate, but not soft or hard corals. Unfortunately, nutrient analyses (nitrates, ammonia, nitrite and phosphorus) of the water column were anomalous due to the inclusion of plankton in the seawater samples. Since the area is subject to moderate levels of upwelling, nutrients in the water column are known to vary between the northeast and southwest monsoon (Wilson 2000). Dredging, however, can induce strong pulses of increased levels of dissolved inorganic nutrients previously bound to sediments (PBS&J 2008). Elevated nutrient levels are known to reduce calcification rates and reproductive success of corals and stimulate macroalgal growth (Fabricius 2005). It appears that such nutrient pulses can also trigger blooms of generally inconspicuous diatoms. A post-construction survey in September 2005 showed that the diatom infestation had either induced or indicated a change in community structure, and turf algae (e.g., *Polysiphonia* and *Heterosiphonia* spp.) and macroalgae (e.g., *Bryopsis pennata* and *Caulerpa racemosa*) overgrowing benthic elements and damaging gorgonian colonies (Figs 8, 9). By October 2006, the extent of the *C. floriatus* bloom was reduced but algal overgrowth on *Echinomuricea* colonies had proceeded (K. Pauly pers. comm).

These observations suggests that *C. floriatus* is an opportunist in the Gulf of Oman that can bloom following strong nutrient pulses, and may be an early indication of a shift from gorgonian-dominated to algal-dominated communities. Similarly, Chavanich et al. (2005) reported on an unidentified diatom overgrowing corals after the tsunami disaster of 2004. As with storms and hurri-

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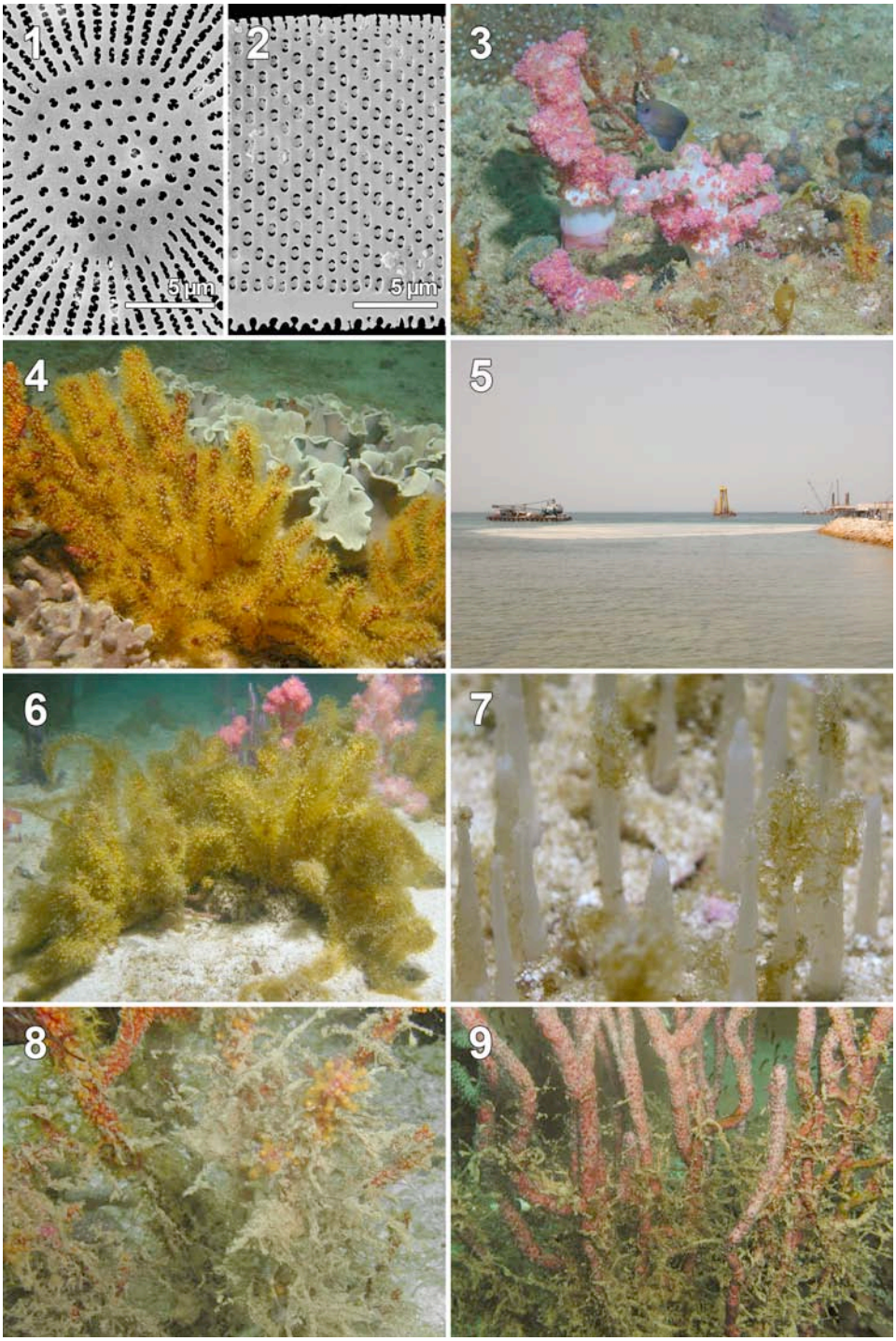
Fig. 1. Valve face of a *Chrysanthemodiscus floriatus* cell, showing round areolae within the annulus and elongated areolae radiating from the annulus. Fig. 2. Areolated girdle band (copula) of *C. floriatus* with fimbriate edges. Fig. 3. The unusual coral community off Qalhat: the slender damselfish *Pomacentrus leptus* amidst the gorgonian (*Echinomuricea* sp.), *Dendronephthya, Goniopora* and *Stylocoeniella* colonies. Fig. 4. Healthy gorgonian community in February 2003. Fig. 5. Blasting during construction activities in September 2003. Fig. 6. *C. floriatus* overgrowing gorgonians in September 2003. Fig. 7. *C. floriatus* smothering a *Ciocalypta* sponge in September 2003. Fig. 8. Epibiotic algae covering gorgonians in September 2005. Fig. 9. Decaying gorgonians infested with algae in September 2005.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canes, tsunami bring sediments in suspension and can induce deep water mixing that might explain the similarity in diatom response between periodic upwelling and tsunami events. It is possible that the diatom bloom also induced changes that contributed to the successional process. We conclude that the biological impact of short-term nutrient fluxes is currently underestimated. Pulsed nutrient inputs, released from marine sediments or terrestrial run-off, or induced by tsunamis or extreme upwelling events, can trigger benthic diatom blooms that have a harmful long-term effect on gorgonian communities.

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