



Nutrient enrichment caused by marine cage culture and its influence on subtropical coral communities in turbid waters

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ABSTRACT: The scale and intensity of marine cage culture have increased in the Asian-Pacific region, particularly in oligotrophic waters where coral reef organisms flourish. In this study, the influence of marine cage culture on subtropical coral communities in turbid waters was evaluated by measuring environmental parameters and benthic community compositions at Magongwan in the Penghu Islands, Taiwan. A canonical discriminant analysis of environmental parameters revealed that elevated levels of ammonium, nitrite, and chlorophyll *a* (chl *a*) released from the cages were the main pollution indicators that, in addition to sedimentation and turbidity, distinguished Impact Zone 1 (cage-culture zone) from the other 2 zones — Impact Zone 2 (800 m away from the cages) and the reference zone — in these turbid waters. Results of the canonical correlation analysis indicated that the coverage extents of macroalgae, sponges, and zoanthids were strongly correlated with levels of ammonium, nitrite, phosphate, chl *a*, and dissolved oxygen. Coral communities in Impact Zone 1 were mostly composed of stress-tolerant massive and submassive corals, but were lacking branching *Acropora* corals. In contrast, coral communities in the other zones, with high habitat complexity and species richness, were dominated by coral species with diverse morphologies, including branching *Acropora* coral communities. These results suggest that marine cage culture has been causing chronic nutrient enrichment in the surrounding waters at Magongwan, which may have resulted in a deterioration of suitable habitats for coral reef organisms. Nevertheless, intermediate levels of nutrients and particulate organic matter relative to the other zones might have been caused by the adjacent cage culture, resulting in the high coral coverage and diversity in the Impact Zone 2 in particular.

KEY WORDS: Marine cage culture · Benthic communities · Nutrient enrichment · Stress-tolerant corals · Eutrophication

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INTRODUCTION

During the last 2 decades, marine cage culture adjacent to coastal coral reefs has become a prosperous industry and is increasing in scale and intensity in the Asian-Pacific region (Chen & Hsu 2006). Eutrophica-

tion caused by marine cage culture is a major environmental influence affecting conditions in the adjacent water column and sediments, even to the extent of altering benthic assemblages (Wu 1995, Karakassis et al. 2002, Yucel-Gier et al. 2007, Holmer et al. 2008). For example, massive amounts of waste feed and fecal

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