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Benthic macrofaunal assemblages in multispecific seagrass meadows of the southern Philippines: Variation among vegetation dominated by different seagrass species

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ABSTRACT

Although the influence of seagrasses on the diversity and abundance of associated fauna is generally well understood, the effects of seagrass specific identity are not. To determine whether benthic epifaunal and infaunal assemblage patterns vary by the identity of dominant seagrass species in shallow water meadows, we compared quantitative measures of faunal species richness, abundance, and assemblage structure among beds dominated by *Cymodocea rotundata*, *Enhalus acoroides*, and *Thalassia hemprichii*; the study site was at Lopez Jaena, Misamis Occidental Province in the southern Philippines. The *Cymodocea*-dominated vegetation had higher seagrass shoot density and lower seagrass biomass than those dominated by *Enhalus* and *Thalassia*. Across vegetation types, we encountered 30 and 15 species of epifauna and infauna at average densities of 1.73 and 0.82 animals/core (0.0314 m^2), respectively. Neither densities and species richnesses of epifauna and infauna nor species composition varied significantly by vegetation type. Multivariate analyses of macrofaunal assemblage structure and abiotic/biotic environmental factors demonstrated that seagrass aboveground biomass explained a significant proportion of the multivariate variation in epifaunal species composition (39%); none of the potential explanatory variables was related to variation in ecological parameters of the infauna. Thus, seagrass specific identity is not a good predictor of either macrofaunal abundance or diversity patterns. Although the ecological parameters of the benthic macrofauna may be influenced by seagrass biomass and structure, responses differ between epifauna and infauna.

1. Introduction

Seagrasses are marine flowering plants that grow on sedimentary substrata in the shallow waters of tropical, temperate, and boreal regions (den Hartog and Kuo, 2006). Compared to the striking numbers of other marine taxa (e.g., fishes, corals), seagrass diversity is relatively low, with only about 60 species worldwide. Nevertheless, the extent of individual seagrass meadows can be very large; some occupy kilometers of coastline, although others occur in small fragmented patches (Orth et al., 2006). Seagrass beds provide physical structure for complex assemblages of associated species, and along with phytoplankton, periphyton, and macroalgae, they provide many essential ecosystem services. Seagrass meadows are among the most productive ecosystems on the planet (Costanza et al., 1998; Short et al., 2007). While the meadows function as major natural sinks of blue carbon in the ocean (Fourqurean et al., 2012), they are also important in carbon production and export (Eyre and Ferguson, 2002; Ziegler and Benner, 1999), nutrient cycling (Flindt et al., 1999; Hemminga et al., 1991), sediment stabilization (Fonseca, 1989), and trophic transfers (Heck et al., 2008). Finally, seagrass beds enhance biodiversity. For example, more faunal elements are attracted to seagrass vegetated areas than to bare sand or non-vegetated estuarine seabed plots (Ferrell and Bell, 1991; Hossack et al., 2006; Lee et al., 2001). Despite the many ecosystem services that seagrass beds provide, a growing realization indicates that seagrasses are declining worldwide due to increases in natural and human-induced disturbances (Duarte, 2002; Orth et al., 2006; Short and Wyllie-Echeverria, 1996; Waycott et al., 2009). The link between biodiversity and ecosystem functions in seagrass ecosystems (Duffy, 2006) implies that accelerating the decline of seagrass beds will threaten the sustainability of their ecosystem services (Duarte, 2000). Efforts to maintain, protect, and conserve coastal biodiversity should be especially focused on the conservation and management of seagrasses.

The effect of seagrasses on associated fauna is generally well understood; seagrass beds enhance faunal diversity by providing structural habitat, food, nursery grounds, protection from predators, and a much larger range of available niches than areas devoid of vegetation. Much of the previous works on plant–animal interactions in seagrass beds

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has focused on epifauna, including fish and epibenthic invertebrates (e.g., Gillanders, 2006; Jenkins et al., 1997; Pollard, 1984); however, it is becoming increasingly clear that infaunal assemblages of seagrass beds have important roles in the ecological processes operating in the meadows (e.g., Blackburn and Orth, 2013; Johnson et al., 2002; Peterson and Heck, 2001; van der Heide et al., 2012). Because the emergent structures of seagrass beds are readily observable, the aboveground benthic epifauna has been subjected to more intense investigation (e.g., Bell and Westoby, 1986; Edgar, 1990; Nakaoka et al., 2001) than infaunal assemblages associated with seagrass belowground structures (root–rhizome complex; e.g., Harrison, 1987; Berkenbusch et al., 2007; see also the review by Orth et al., 1984 and references therein). Are infaunal elements as dependent on seagrass structures as epifaunal taxa; do positive and negative interactions belowground depend on diverse interacting factors, including environmental conditions and biological traits of component species (see review by Nakaoka, 2005)? The current knowledge base is insufficient to provide comprehensive answers to these questions. One approach to resolving the issues is a comparative analysis of epifaunal and infaunal diversity structures in seagrass beds. In particular, it is essential to determine the ecological responses of epifauna and infauna in mixed meadows dominated by different seagrass species. Different seagrass species in mixed meadows have diverse above- and belowground structures (Duarte, 1991; Hori et al., 2009; Kuo and den Hartog, 2006). If the responses of associated faunas differ among seagrass species, then seagrass identity within a meadow may directly or indirectly determine the structure of the benthic faunal communities, and may be a good predictor of faunal abundance and biodiversity patterns (see Gillanders, 2006).

We examined effects of the identities of different seagrass species on associated benthic macrofauna through quantitative comparative studies of meadow epifaunas and infaunas. Our premise was that the benthic epifaunal assemblage depends more strongly on seagrass structure than the infaunal assemblage (see Orth et al., 1984 and Nakaoka, 2005 for extensive reviews). Thus, we postulated that interspecific differences in the aboveground structures of seagrass beds will affect the assemblage structure of the benthic epifauna, but not the assemblage structure of the benthic infauna. To test this postulate, we made quantitative comparisons among benthic epifaunas and infaunas in tropical seagrass vegetation types dominated by three different seagrass species: *Cymodocea rotundata* Ehrenb. & Hempr. ex Aschers., *Enhalus acoroides* (L.f.) Royle, and *Thalassia hemprichii* (Ehrenb) Aschers. The study was conducted in the southern Philippines.

2. Material and methods

2.1. Study area

We sampled in the months of September and December 2010 in Lopez Jaena municipality, Misamis Occidental Province (southern Philippines; Fig. 1). This municipality was previously reported to have 526.2 ha of aggregated seagrass meadows (de Guzman et al., 2009). We sampled three sites in these meadows (Mansabay Bajo, Danlugan, and Capayas; Fig. 1). The sites differed by topography. Mansabay was located in a beach area where the fine sandy sediments were mostly dominated by pioneer seagrasses such as *Halodule* spp. and *C. rotundata*. In contrast, Danlugan had a muddy seagrass area dominated by *E. acoroides* and *T. hemprichii*; this site was located in the vicinity of mangrove stands and an old wharf left standing in an abandoned fishing port. Capayas, a marine protected area near Capayas Island, was located approximately 0.32 km offshore; the water depth ranged from about 20 cm at low tide to about 200 cm at high tide. The substratum comprised coarse sediments and supported at least five seagrass species dominated (in no particular order) by *T. hemprichii*, *C. rotundata*, and *E. acoroides*. Although all of the locations had

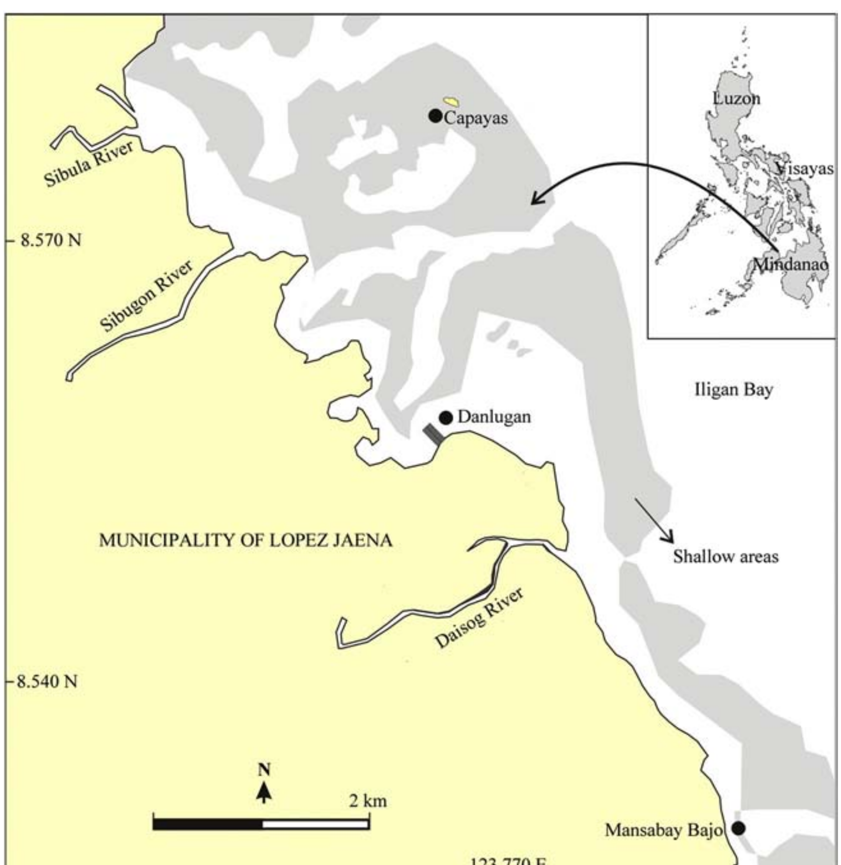

Fig. 1. Map of the study sites at Lopez Jaena, Misamis Occidental Province, southern Philippines. de Guzman et al. (2009) provided the base map.