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Burrow dynamics of crabs in subtropical estuarine mangrove forest

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ABSTRACT

Several ecological and biogeochemical processes in mangroves are influenced by crab activities through bioturbation, leaf litter consumption, or fecal deposition. Bioturbation might be influenced by crab burrow dynamics or surrounding abiotic and biotic factors or both. Therefore, it is necessary to examine burrow dynamics under different abiotic and biotic conditions. This study was conducted in the estuarine mangroves of Fukido River in the northern part of Ishigaki Island, Japan. Two transects consisting of five and seven 14-m diameter circular plots were established perpendicular to the mangrove/ocean interface. Spatial and seasonal burrow dynamics data were collected from five randomly chosen quadrates within each plot. Burrow density, renewed burrows per day, and collapsed burrows per day significantly varied spatially and seasonally. Burrow density strongly depended on sediment bulk density. Numbers of renewed and collapsed burrows per day were the same ($R^2 = 0.86$) though they significantly differed among the four seasons with being lowest in the winter season. This suggests that temperature, precipitation and crabs occurrence might control seasonal burrow dynamics. Proportion of collapsed burrows were strongly and significantly correlated to sediment bulk density, salinity and sediment temperature, which suggests that sediment properties provide structural support for burrows maintenance. On the other hand, vegetation cover and sediment characteristics influence the proportion of renewed burrows. Burrow depth was significantly controlled by sediment particle size, which suggests that crabs do not create deeper burrow if sediments contain higher amount of coarse sand. Entrance diameter was correlated to percentage organic matter, salinity, fine sand and distance from the river that means seaward sites are occupied by smaller and shallow burrows. Our results suggest that the burrow dynamics depend on abiotic and biotic factors and are useful for understanding spatial and seasonal variations for estimating bioturbation effects on mangroves biogeochemical cycle.

1. Introduction

Burrowing benthic invertebrates are important ecosystem engineers that significantly influence various biogeochemical and ecological functions in mangrove forests. Burrows increase the amount of sediment surface area exposed to the atmosphere at low tide. This can increase oxygen diffusion into anaerobic sediments that then oxidizes elements toxic to plants (i.e., iron and sulfur) (Mitsch and Gosselink, 1993), increases decomposition of organic matter (Kostka et al., 2002; Kristensen and Holmer, 2001), and may potentially increase above and belowground tree productivity (Kristensen and Alongi, 2006; Smith III et al., 1991) as well as carbon (C) burial (Andreetta et al., 2014). Sesarmid crabs also play an important role in the C dynamics of mangrove forests. Bioturbation by burrowing crabs can also affect nutrient cycling in mangroves. Mechanical fragmentation of mangrove leaves by sesarmid feeding breaks leaves down into smaller particles with greater surface areas that can be colonized by microbes (Lee, 1997, 2008). This increases leaf litter decomposition and releases nutrients that can be incorporated into mangrove sediments (Andreetta et al., 2014), utilized by mangrove trees (Wang et al., 2010) or lost through outwelling to nearshore waters (Lee, 1995). Crabs also directly transfer C to sediments through the transport of leaf litter, propagules, algae, feces, and exuviae into their burrows (Alongi et al., 2002; Lee, 1997).

Bioturbation refers to the physical displacement of sediments at the sediment water interface within burrows or at their openings and can increase the transport of nutrients to the water column from mangrove

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