Impacts of Disturbances on Species Specific Interactions between Crabs and Plants in Mangrove Ecosystems

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Summary

Impacts of Mangrove Disturbances on the Crab-Plants Species Specific Interactions

The vegetation dynamics and biogeochemistry of mangrove ecosystems is closely associated to the density and activity of crabs. Crabs can positively affect the primary productivity of mangrove ecosystems by litter consumption and nutrient recycling, while more recently also potential negative impacts through leaf herbivory have been acknowledged. Mangrove crabs consume up to 70-80% of the annual production of leaf litter, green leaves and propagules. However, a comprehensive understanding on the importance of crab species identity, plant species identity, different substrate identities (leaf litter, green leaf and propagules) and their interactions on substrate consumption in mangrove ecosystems has been lacking. Moreover, the impacts of these factors and their interactions on nutrient recycling and productivity are unknown. In addition, many mangrove ecosystems are increasingly disturbed through anthropogenic disturbances, e.g. by tree cutting. Little is known about the functioning of disturbed mangrove ecosystems and the ecological consequences of disturbance in mangrove ecosystems in general, and in relation to mangrove crab-vegetation interactions in particular. This thesis aimed to provide an increased understanding on the functioning of mangrove ecosystems, and specifically of mangrove crab-vegetation interactions, upon disturbance.

To reach this aim, we performed a novel combination of a field survey, field manipulation experiments as well as lab and mesocosms experiments to comprehensively determine crab-vegetation interactions as well as their impacts on mangrove ecosystem functioning. The field survey (Chapter 2) showed that severely disturbed mangrove ecosystems contained a significantly lower mangrove tree cover, higher understory cover, more open (no vegetation) areas and lower crab abundances compared to the undisturbed systems. At the same time though, no significant differences in total vegetation cover, in plant species richness or in crab species richness had occurred. Further multivariate analysis of our field data also provided the first hints about the importance of species-specific crab-vegetation interactions, as some of the sympatric crab species of the same genus, e.g. *Perisesarma indiarum* and *Perisesarma semperi* or *Episesarma versicolor* and *Episesarma singaporense* had opposite co-occurrences with certain mangrove plant species, occurring at either disturbed or to undisturbed ecosystems. Our feeding experiments (Chapter 3) provided a deeper understanding of the drivers leading to these species-specific preferences. Plant species identity was a major driver of the variation in the consumption of mangrove leaf litter and green mangrove leaves, while propagule predation was driven by mangrove plant-crab species specific interactions. The results of the feeding experiments in the laboratory coincided with the results of our field survey and provide an explanation for why certain crab species seem to relate to particular plant species or why certain plant species attract particular mangrove crab species. Further field experimentation in different disturbance

mediated gaps (Chapter 4) confirmed the importance of mangrove plant-crab species-specific interactions in propagule predation at field conditions, despite a significant role of crab presence itself on propagule availability. Due to this species-specific propagule predation, the dominant vegetation of the disturbed areas, *Derris trifoliata*, was favored, which may strongly hamper the natural restoration of the severely disturbed mangrove ecosystems. And finally, the design of our mesocosms experiment (Chapter 5) enabled differentiating between the significant impacts of crab presence on, on the one hand increasing mangrove litter decomposition from, on the other hand, the impacts of grazing of mangrove green leaves (causing a loss of vegetation biomass). Prevailing theory suggests that increased litter decomposition would increase nutrient availability to sustain vegetation growth, but we found no significant impact of crab presence on mangrove productivity.

This study indicates that the inability of the severely disturbed mangrove ecosystem to recover seems to be the result of several interconnected factors related to mangrove plant-crab interactions: Under undisturbed conditions, mangrove plant-crab interactions seem to promote nutrient recycling through higher decomposition rates of mangrove leaf litter and the grazing of green mangrove leaves. On the other hand, the increasing mangrove understory cover under the disturbed condition inversely correlated to mangrove crab abundance in the field suggesting lower leaf litter consumption rates and therefore lower nutrient recycling. Moreover, mangrove crab-plant species specific interactions drive propagule predation and favor mangrove understory species that are dominantly present after severe disturbances. This finding indicates that mangrove plant-crab species specific interactions could prevent the natural recovery of the disturbed system and even cause the disturbed system to go further away from its original undisturbed state. All together our results indicate the importance of maintaining mangrove plant and crab diversity as the first step to preserve mangrove ecosystem functioning.