Anthropogenic Impacts on Mangrove Crab Diversity, Relative Abundance and Zonation

Frankie Gerraty

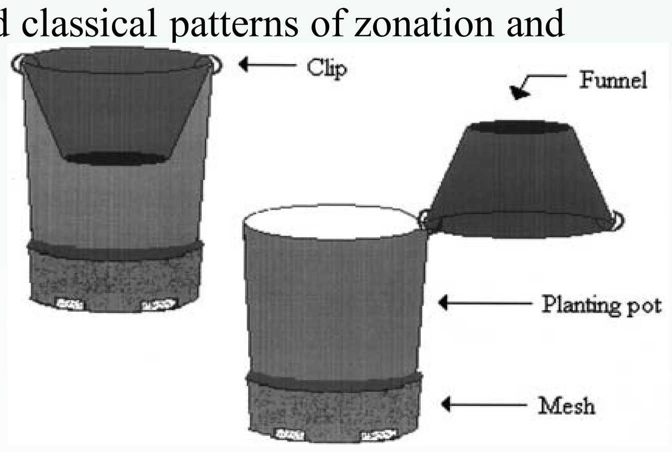
School for Field Studies, Panama; Whitman College, WA, USA

Introduction

- "Mangrove" refers to a taxonomically diverse assemblage of dicotyledonous trees and shrubs that form the dominant plant communities in tidal, saline wetlands between latitudes 25° N and 30° S (Blasco et al. 1996).
- Mangrove forests occupy the inhospitable boundary zone between land and sea, thus serving as an ecological connector between terrestrial and marine ecosystems.
- High salinity, wave action, fluctuating water levels, waterlogging, anoxic soil and frequently high temperatures are challenging mangrove conditions in the intertidal zone (Hogarth 2015). Mangroves are one of two angiosperm assemblages that, along with seagrasses, have successfully overcome these environmental challenges and returned to the sea.
- Anthropogenic damage to mangrove ecosystems is rarely reported by the mass media and scientific press, despite a 35% global loss in mangrove area in only two decades (Valiela et al. 2001).
- Large-scale mangrove deforestation, driven primarily by the pressures of mariculture, agriculture and urban development, dramatically increases the storm and flood vulnerability of coastal populations and property.
- Anthropogenic damage to mangrove forest ecosystems directly impact fisheries and other ecosystem services provided by mangroves, such as the maintenance of water quality and landscapes for ecotourism. (Valiela et al. 2001).
- Decapod crabs are one of the most abundant groups of fauna inhabiting mangrove forests in terms of numbers and biomass, and are known to play vital roles in soil aeration, nutrient enrichment and propagule establishment within mangrove forest ecosystems (Smith et al. 1991).
- Despite large-scale mangrove deforestation globally, little is known about the impacts of anthropogenic coastal development on the diversity, relative abundance and zonation of mangrove crab communities.
- To my knowledge, this exploratory study is the first quantitative description of crab communities in human-disturbed and undisturbed mangrove forests in Bocas del Toro, Panama.

Methods

- Four study sites (2 human-disturbed, 2 undisturbed) in Bocas Del Toro, Panama, were selected for this investigation because they showed classical patterns of zonation and forest structure.
- Pitfall traps equipped with funnels were deployed in three distinct ecological zones within each fringing mangrove forest (Kent and McGuinness 2006).
- Traps were left in place for four days but checked for crab captures every 24 hours.
- Captured crabs were photographed and identified to species when possible using field and taxonomic guides (Abele and Kim 1986, McLaughlin 1980, Paulay et al. 2017).
- Captured crabs were released at least 5 m away from the study plot when alive.
- To account for the influence of weather variation on crab catchability between the two sampling periods, crab traps were deployed in one human-disturbed and one human-undisturbed study site each week.
- At each study site, four traps were randomly placed in each zone (4 traps/night x 3 zones). This provided (12 traps/night x 8 nights x 2 sites) 192 trap nights total.



Results

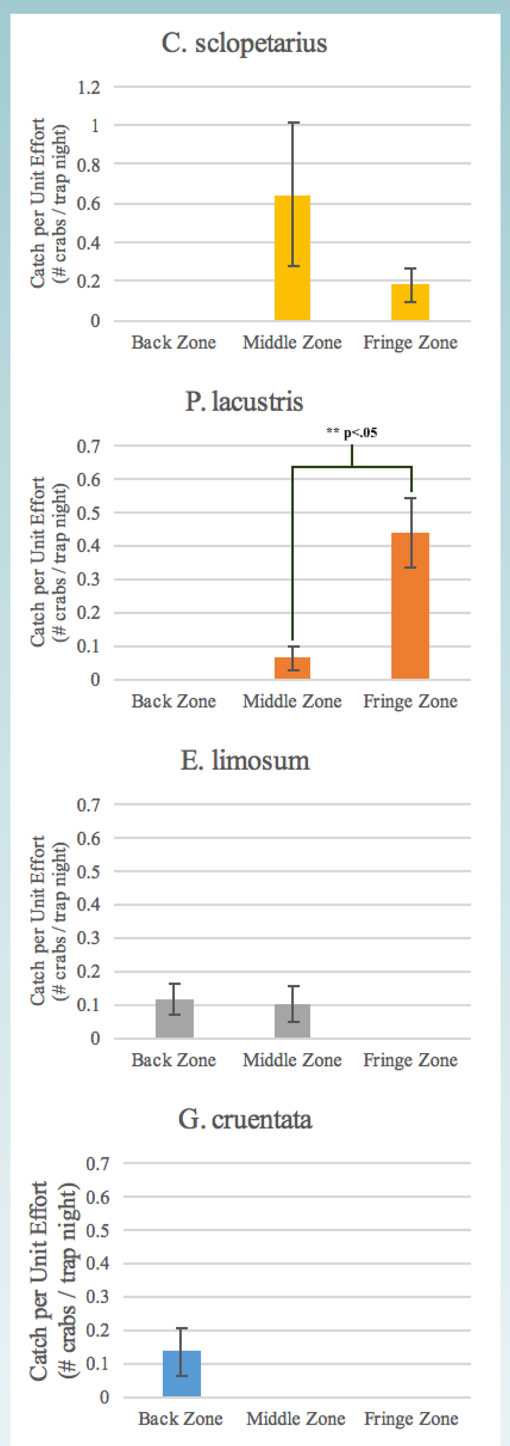
Summary

In total, 96 mangrove crabs were caught using pitfall traps throughout the two-week study period; 73 crabs were caught in human-disturbed mangrove forests and 23 crabs were caught in human-undisturbed forests. There were four primary mangrove crab species that were captured in this study (n≥8): *Clibanarius sclopetarius, Panopeus lacustris, Eurytium limosum, Goniopsis cruentata.*

All mangrove crab families and species identified throughout this study.

Family	Species	Number Individuals in Disturbed Mangroves	Number Individuals in Undisturbed Mangroves
Diogenidae	*Clibanarius sclopetarius*	40	0
Panopeidae	*Panopeus lacustris*	15	10
	Eurytium limosum	3	9
Grapsidae	*Goniopsis cruentata*	8	0
Ocypodidae	*Uca rapax*	1	1
Ucididae	*Ucides cordatus*	1	0

Zonation



Abundance

To account for variation in trap deployment success, Catch Per Unit Effort (CPUE) was used to estimate relative abundance. CPUE = # Crabs Caught / (Trap x Night)

Relative abundance (CPUE) of all crabs, regardless of species, between zones in disturbed and undisturbed mangrove forests. Significance levels denoted as: *p < 0.1, **p < 0.05, ***p<0.005

	Back Zone	Middle Zone	Fringe Zone	Total
Disturbed (Outside MPA)	0.464	1.29	0.925	0.890 *1
Undisturbed (Inside MPA)	0.156	0.315	0.5217	0.311 *1
Total	0.293 *2	1.19 *2	0.755	

1. Disturbed vs. Undisturbed – Mann-Whitney U=2554, n_d=82, n_u=74, p=0.0891 two-tailed
2. Forest Zone Comparison - Kruskal-Wallace, χ^2=5.7, p=0.0559, df=2

Diversity

Diversity measurements of intertidal mangrove crabs in BDT. (S: species number, H': Shannon diversity, J': Pielou's Evenness, $(1 - \lambda')$: Simpson Index. T-tests based on diversity values of respective sites were done to elucidate differences between disturbed and undisturbed crab communities. Significance levels denoted as: *p < 0.1, **p < 0.05, ***p<0.005)

	S	H'	J'	$1 - \lambda'$
Disturbed (overall)	6	1.2	0.65	0.59
Undisturbed (overall)	3	0.86	0.78	0.55

Conclusion

- Despite the large discrepancy in crab capture numbers, the relative abundance of benthic mangrove crabs was not significantly different between human-disturbed and undisturbed mangrove forest sites.
- In addition, human-disturbed mangrove forest sites showed higher measures of crab community diversity (species number, Shannon diversity, Simpson index) and lower measures of evenness (Pielou's evenness) than undisturbed sites.
- These findings reinforce previous indications that crab community analysis is not an effective tool for mangrove environmental assessment.
- However, abundance and diversity comparisons between disturbed and undisturbed sites in this study are likely non-descriptive of disturbance impacts on crab communities. This is because human disturbance, especially pollution and wood-cutting, was ubiquitous in mangroves throughout the Bocas del Toro region; all sites were influenced to varying extents by these anthropogenic factors.
- To reveal deeper insights into the use of crab community analysis as a measure of environmental analysis and ecosystem health, knowledge of a "natural" state of biodiversity, evenness and dominance in Panamanian mangrove crab communities is necessary.
- The distribution patterns of captured crab species show two major trends: (1) population decrease towards the land: *Panopeus lacustris, Clibanarius sclopetarius,* (2) population decrease towards the lagoon: *Eurytium limosum, Goniopsis cruentata*. Within this framework, each species showed distinct patterns of capture and varying degrees of penetration towards the land or lagoon.
- There was a significant difference in the relative abundance of *P. lacustris* between the fringe and non-fringe zones, indicating that *P. lacustris* preferentially inhabits the lagoon edge ("fringe zone") of mangrove forests. This zonation pattern was observed at every study site investigated and has never been documented in previous scientific literature.
- Future study that includes alternative crab capture methods, more zones and a greater variety of human disturbance levels would be essential in providing a more holistic description of anthropogenic impacts on mangrove crab abundance, zonation and diversity in Bocas del Toro.

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