Tropical Life Sciences Research, 27(Supp. 1), 39–44, 2016

Coastal Macroinvertebrate Study in Penang Island, Malaysia

Chee Su Yin* and Sim Yee Kwang

Centre for Marine and Coastal Studies, Universiti Sains Malaysia, 11800 USM, Pulau Pinang, Malaysia

Published date: 1 November 2016
To cite this article: Chee Su Yin and Sim Yee Kwang. (2016). Coastal macroinvertebrate study in Penang Island, Malaysia. *Tropical Life Sciences Research* 27(Supp. 1): 39–44. doi: 10.21315/tlsr2016.27.3.6
To link to this article: http://dx.doi.org/10.21315/tlsr2016.27.3.6

Abstract: Land reclamation in Penang began two decades ago and is still rampant with large reclamation projects planned to be executed in the near future. The present study provides the first information on effects of land reclamation in Penang towards the coastal macroinvertebrates. This study assessed the abundance, diversity, and evenness of coastal invertebrates assumed to be the foremost affected when land is reclaimed. Three kinds of areas were focused on: reclaimed, unclaimed (adjacent to reclaimed), and undisturbed. A total of 53 species of macroinvertebrates from 10 classes (Gastropoda, Bivalvia, Polychaeta, Malacostraca, Maxillopoda, Echinoidea, Polyplacophora, Branchiopoda, Scaphopoda, and Holothuroidea) were sampled. Reclaimed areas were moderately rich in species averaging 11 species compared to 7 species in adjacent and 14 in undisturbed areas. Species richness was the highest in Teluk Aling (an undisturbed area) with 22 species, and was the lowest in Gurney Drive (an adjacent area) with 2 species. The average species diversity and evenness on reclaimed land was the lowest with values of 1.9974 and 0.5787, respectively. The diversity was higher by 5.07% in adjacent areas and by 22.92% in undisturbed areas compared to reclaimed areas. Species evenness was 29.75% higher in unreclaimed areas and 17.87% higher in undisturbed areas compared to reclaimed areas. Land reclamation reduces species diversity and evenness, and to a lesser extent, species richness.

Keywords: Land reclamation, Coastal Biodiversity, Macroinvertebrate

INTRODUCTION

In cases where land is limited such as small islands like Penang Island, land developers build upwards (high-rise buildings) and outwards (via land reclamation) to cater for the rise in human population. Land reclamation in Penang began two decades ago and is still rampant with large reclamation projects planned to be executed in the near future. The effects of land reclamation on the coastal macroinvertebrates in Penang are poorly understood and resources are limited. However, baseline data is crucial in order to chart past

*Corresponding author: suyinchee@usm.my

and predict future paradigms. The present study provides the first information on effects of land reclamation in Penang towards the coastal benthic macroinvertebrates in terms of species diversity, abundance, and evenness. The findings of this research can be used to predict and foresee the potential effects as well as assist decision-making in future coastal development and mitigation plans in the Penang and beyond.

MATERIALS AND METHODS

Twelve sampling sites along the coast of Penang were sampled; four sites were on reclaimed areas: (i) Queensbay [5°19'55.28" N; 100°18'33.02" E], (ii) Lebuhraya Lim Chong Eu [5°23'56.85" N; 100°19'54.87" E], (iii) North Butterworth Container Terminal [5°25'12.43" N; 100°22'19.32" E], (iv) Bagan Ajam R&R [5°25'57.44" N; 100°22'32.62" E]; four were adjacent to reclaimed area: (i) Jambatan Pulau Pinang [5°21'27.97" N; 100°18'59.28" E], (ii) Tanjung Tokong [5°27'36.38" N; 100°18'52.42" E], (iii) Kuala Muda [5°34'33.09" N; 100°20'19.68" E], (iv) Gurney Drive [5°26'13.53" N; 100°18'43.58" E]; and four were in less disturbed areas: (i) Teluk Aling [5°28'04.05" N; 100°11'59.81" E], (ii) Kem Bina Negara [5°17'47.27" N; 100°11'03.11" E], (iii) Sungai Burung [5°20'17.20" N; 100°11'41.56" E], (iv) Pulau Gazumbo [5°21'52.00" N; 100°19'30.49" E]. Macroinvertebrates were collected from July to September 2014 during low tide via transect and coring methods. Three transect lines about 20 m apart were marked perpendicular to the sandy shores. A PVC corer was forced 20 cm into the sand and the contents were removed using a trowel into a 500 µm sieve. Samples were collected randomly and in three replicates at low, middle, and high tide levels. The values of species richness, species diversity (Shannon-Weaver Diversity Index, H') and species evenness (Pielou, J') for each sampling site were calculated and analysed.

RESULTS

A total of 56 species from 47 families were collected. Forty four species from 28 families were collected from reclaimed areas. Twenty nine species from 24 families were collected from adjacent areas. Fifty three species from 28 families were collected from undisturbed areas. Maxillopods and polychaetes can be found in all sampling sites whereas, *Nerita* spp.*, Ischinocerithium rostratum, Solen* sp.*, Stichopus* sp., *Umbonium* sp.*,* and *Zeuxis* sp., were found only in undisturbed sites. The results of species richness, diversity and evenness are presented in Figure 1. Species richness was the highest in Teluk Aling (undisturbed area) with 22 species and the lowest in Gurney Drive (adjacent area) with 2 species. Adjacent areas had both the highest and lowest readings for species diversity: Jambatan Pulau Pinang had the highest species diversity (3.0798) and Gurney Drive had the lowest (0.8113). Species evenness was the highest in adjacent area, Kuala Muda (0.8796), and the lowest in reclaimed area,

Bagan Ajam R&R (0.4126). In average, species richness was the highest in undisturbed areas and the lowest in adjacent areas. Species diversity was the highest in undisturbed areas and the lowest in reclaimed areas. Contrastingly, species evenness was the highest in adjacent areas and lowest in reclaimed areas.

DISCUSSION

Reclaimed areas were moderately rich in species compared to adjacent and undisturbed areas. Land reclamation changes the natural shape and soil characteristics of the coast which in turn changes current movement and water quality (Ramly 2008). Alteration of current movement could have carried debris away from the reclaimed areas post-development creating unfavourable conditions for some species to thrive in adjacent areas. The clearing of debris could have renewed the conditions in reclaimed areas and encouraged re-population of benthic macroinvertebrates giving rise to higher values in species richness compared with adjacent areas. The average species evenness in reclaimed land was lower compared with adjacent and undisturbed areas. Coastal developments directly disturb the substrates and microenvironments that benthic macroinvertebrates depend on to survive. Evidently, land reclamation does cause disjunctions in the consistency of suitable habitats for these organisms which we predict will affect organisms higher in the food chain. Species richness and diversity was the lowest in Gurney Drive. This site is situated just 0.5 km from reclaimed land towards its north. In a coastal development project which commenced 12 years ago, 240 acres (971, 000 sqm) of land was reclaimed to pave the way for retail outlets and luxury condominiums there (Tee 2014). The first DEIA of this project cited no adverse environmental impacts but consequences such as siltation has been detected in areas adjacent to it namely, Gurney Drive (Jalleh 2013). Although other views exists regarding the cause of this siltation (such as the tsunami in 2004); conservationists, environmental organisations, and consumers' associations still believe land reclamation was the main cause for the large amounts of mud accumulating on the once sandy beach. The results of this study supports the views of the latter two parties as species richness in Gurney Drive was at least 4 times lower than the species richness in reclaimed land and at least 5 times lower than undisturbed sites.

Based on the discussion above, an area which is predominantly disturbed by development activities is oftentimes expected to have lower values of species diversity, richness, and evenness, compared to an area minimally affected these activities. Threats to coasts could also encompass a wide ambit of processes, ranging from widespread habitat loss and modifications, to over-extraction of resources, and shore armouring (Schlacher & Thompson 2012). However, this was not the case in the current study where species diversity and evenness was the highest in sampling sites adjacent to reclaimed areas.

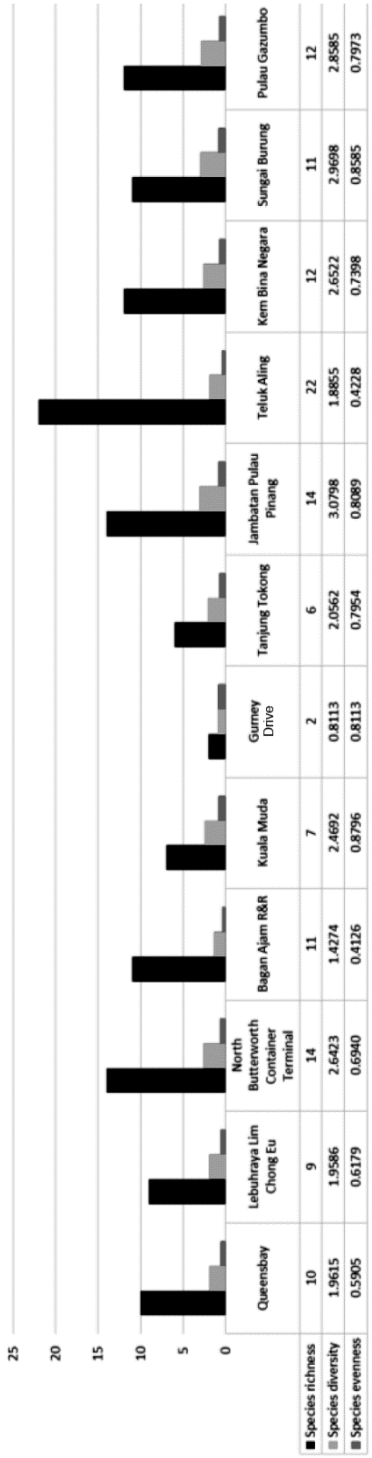

Figure 1: Benthic macroinvertebrate species richness, diversity and evenness along the coasts of Penang.

The sampling site at Kuala Muda produced the highest value for species evenness. Species evenness here was higher than species evenness in undisturbed sites. Species evenness is affected by habitat fragmentation and the degree of vegetation cover (Symonds & Johnson 2008). Habitat fragmentation can be caused by several factors including nutrient availability, environmental stress, and landscape patterns (Hensgen *et al*. 2014). Because landscape patterns of all sampling sites were almost the same (all were muddy, sandy, and occasionally rocky beaches), we discount the fact that the evenness was due to this factor. The abundant and continuous availability of nutrients is most likely the cause. Kuala Muda possesses mangrove forests which not only provide food and nutrients but also suitable breeding and hiding grounds for its organisms making it suitable for macrobenthic organisms to thrive and provide optimal conditions for the recovery of species under stress hence, increasing species evenness.

Polychaetes and amphipods were found in almost all sampling sites. This indicates the organisms' robustness in tolerating and adapting to variant conditions from the highly disturbed to undisturbed environments. Macroinvertebrates such as the *Nerita* spp.*, Ischinocerithium rostratum, Solen* sp.*, Umbonium* sp.*,* and *Zeuxis* sp., were only found in undisturbed areas indicating their sensitivity to stressful surroundings. These species can be used as indicator species in this region in the future.

CONCLUSION

Land reclamation at shore areas undoubtedly affects the benthic macroinvertebrate richness, diversity, and evenness. In some cases, adjacent areas are more affected than the reclaimed areas themselves. However, given the right conditions, most of the organisms can re-populate these areas.

ACKNOWLEDGEMENT

Science officers, laboratory assistants and industrial trainees at CEMACS, USM assisted with sampling. Input to experimental design and ideas were contributed by Dr. Louise Firth (Plymouth University, UK). This project was funded by CEMACS KPI Grant and Geran Penyelidikan Jangka Pendek (304/PPANTAI/6313144).

REFERENCES

Hensgen G M, Holt G J, Holt S A, Williams J A and Stunz G W. (2014). Landscape pattern influences nekton diversity and abundance in seagrass meadows. *Marine Ecology Progress Series* 507: 139–152. http://dx.doi.org/10.3354/meps10818

Jalleh J. (2013). RM25bil project in Penang. http://www.thestar.com.my/News/Nation/2013/08/25/RM25bil-project-in-Penang-307ha-manmade-island-to-be-created-in-the-sea-in-Tanjong-Tokong/ (accessed on 6 January 2015).

Ramly S. (2008). Impact on the coastal areas of Tanjung Tokong land reclamation project, Penang, Malaysia. Effects of wave transformation, sediment transport, and coastal evolution. Masters diss., Lund University.

Schlacher T A and Thompson L. (2012). Beach recreation impacts benthic invertebrates on ocean-exposed sandy shores. *Biological Conservation* 147(1): 123–132. http://dx.doi.org/10.1016/j.biocon.2011.12.022

Symonds M R and Johnson C N. (2008). Species richness and evenness in Australian birds. *The American Naturalist* 171(4): 480–490. http://dx.doi.org/10.1086/528960

Tee L S. (2014). E&O crosses major hurdle. http://www.thestar.com.my/Business/Business-News/2014/04/15/EO-crosses-major-hurdle-Conditional-approval-to-develop-phase-two-of-STP-project/?style=biz (accessed on 6 January 2015).