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For quality of life

Marine Animal
Ecology Group

Fieldwork May-June 2016
Marine Lakes of Indonesia

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1 Introduction

Despite threats to marine ecosystems on a global scale (1), there is a significant gap in our knowledge on species diversity and patterns of distribution of marine organisms (2,3). Multiple studies have been done on the discrepancy in species richness between terrestrial and marine realms (4,5). They found that in contrast to terrestrial habitats, marine areas have less physical barriers. Consequently, this implies that marine species have few limits to dispersal, and thus large effective population sizes. This means there is little opportunity for speciation to occur (6-8). Recently, however, genetic population studies suggest that there is more genetic structure for marine invertebrates than assumed, even at small spatial scales (9-11). Isolation at small scales may thus play an important role in forming patterns of genetic diversity within species. Documentation of structure in natural populations calls for the uncovering of the temporal, spatial and environmental processes behind them.

We use the clearly defined spatio-temporal context of marine lakes of Indonesia. Marine lakes are bodies of seawater, which have no surface connection to the surrounding ocean. They maintain their salt to brackish character through subterranean fissures, pores, or caves. They have originated after the last Glacial Maximum, when sea level rose and the karstic islands which have marine lakes filled up with seawater. It is estimated that depending on their depth, marine lakes are approximately 7,000-10,000 years old (14-15).

With these unique systems we aim to study the mechanisms underlying speciation, adaptation, and resilience of marine populations in light of environmental variation. Marine lakes are particularly suitable systems to study these questions since, in contrast to the open ocean, they have clearly defined boundaries. This makes them function as 'natural laboratories': replicate experiments that have been running for thousands of years. Marine lakes share many analogies with terrestrial island systems (14-16): they are geographically well-defined, have known ages, harbour biota with a high degree of endemism, and have populations that appear to be evolving rapidly, comparable to Northern sticklebacks (17). Interestingly, environmental conditions in marine lakes already are comparable to the predictions of the IPCC report (high temperature and low pH). Concluding, these marine ecosystems represent a unique combination of multiple heterogeneous environments with varying connections to the open sea, thus providing a powerful system to

text complex ecological and evolutionary processes in the marine realm (18).

1.1 Research questions

We aim to study how marine communities and populations adapt in response to past and current environmental conditions. By taking a multi-level approach we try to answer the following research questions:

- What is the relative importance of environmental regimes in forming marine species assemblages?
- What determines the presence and survival of species in marine lakes? In other words, what is the relative importance of distance between marine lakes, amount of gene flow, and environmental regime in determining species communities?

1.2 Participants of fieldwork expedition 2016

Here, we provide names and pictures of all who were involved in the fieldwork expedition of May-June 2016.

Figure 1: Team in North Misool. From left to right: ms. Maria Meijer, ms. Diede Maas, mr. Ali Alioherenan, mrs. Gandi Purba, mr. Adi Mukti, mr. Christiaan de Leeuw.

Figure 2: Support from The Nature Conservancy in North Misool. Left: mr. Purwanto, right: mr. Wawan Mangile.

Figure 3: Team of Baseftin rangers in South Misool.

Figure 4: Support in South Misool. Left: mr. Hery Yusamandra, right: mr. Rajak.

Figure 5: Part of the team of Conservation International in Wayag.

Figure 6: Support from RARCC staff in Wayag. Left: mr. Piter, right: mr. Misel.

Figure 7: Team in Gam. From left to right: mr. Christiaan de Leeuw, ms. Diede Maas, boatman RARCC, ms. Maria Meijer, mr. Ludi Aji.

Figure 8: Support in Gam. Left: mr. Max Ammer, right: mr. Tertius Kammeyer.

2 Research Area

During the fieldwork period in May-June 2016, we visited Raja Ampat, West-Papua (Figure 9).

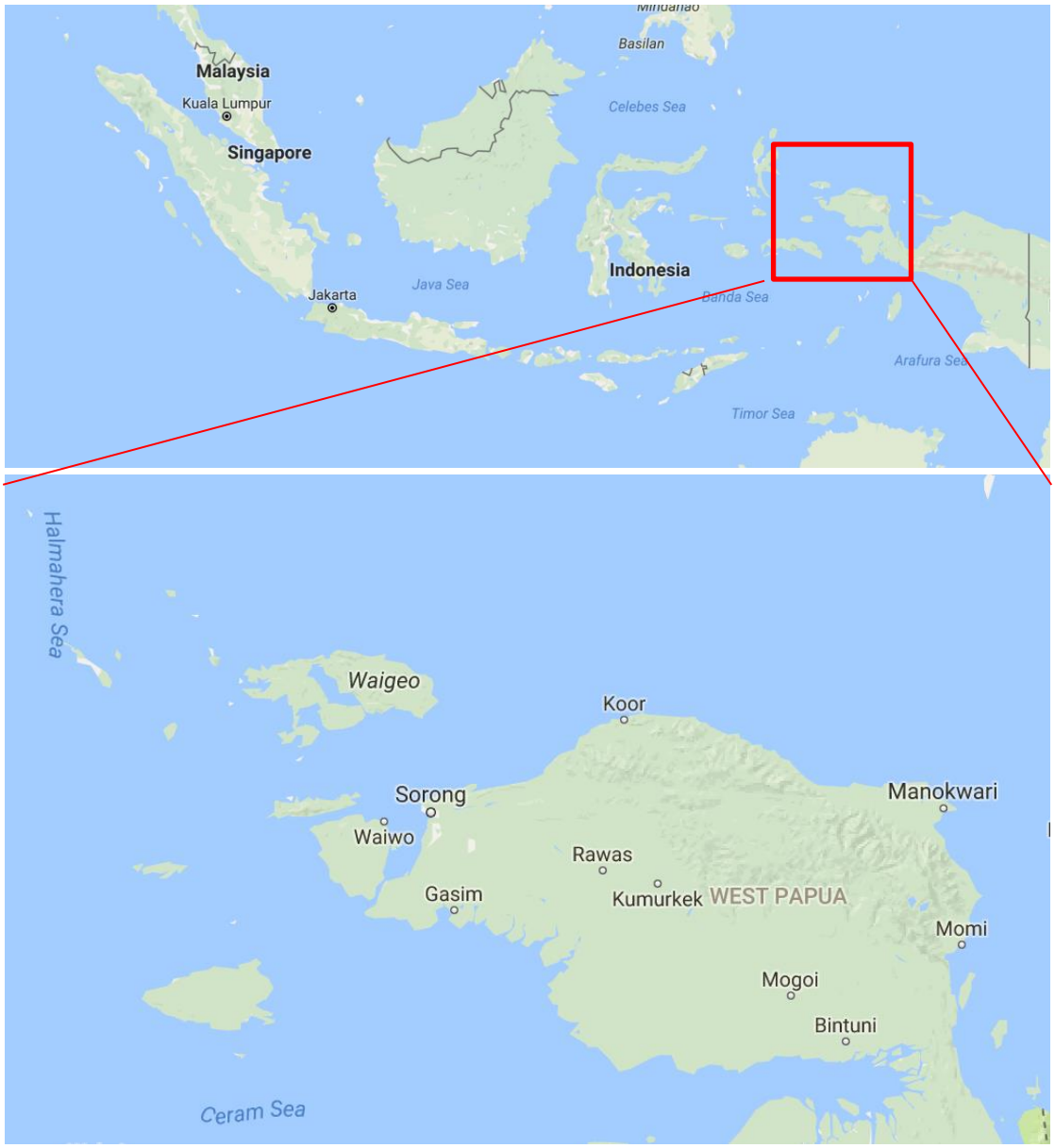

Figure 9: Research area in West-Papua, Indonesia.

3 Methodology

We measured water quality characteristics and other physical aspects of the marine lakes in the research area, in order to link our genetic findings to these environmental data. For the community assembly we sampled all sponge and mollusc species from each lake for DNA analysis. Also, for two lakes we sampled all species present to make a food web. For our questions on ecological adaptation, we sampled 30 individuals from one mollusc species, one sponge species and one jellyfish species for DNA and RNA analysis. In the subsequent sections we will elaborate on the methodology of each particular part.

3.1 Environmental data

Marine lakes vary in their habitat, species assemblages and environmental regimes. In order to quantify these environmental conditions, we took several measurements in each lake. We used HOBO water loggers and a YSI multimeter to measure temperature, pH, salinity and dissolved oxygen (Figure 10).

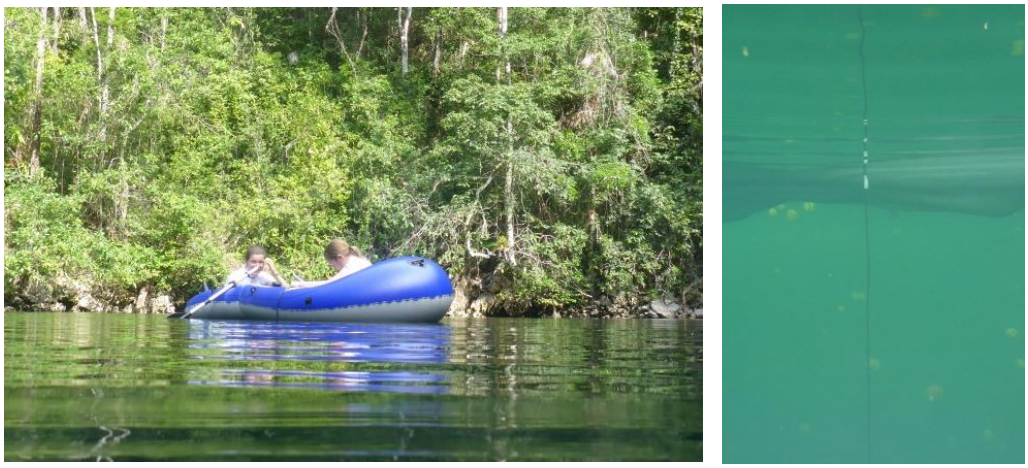

Figure 10: Measuring water quality data in the field. Left: working from the inflatable boat, right: letting down the probes of the multi-meter on a cable.

3.2 Community assembly

We chose to focus on mollusc and sponge species when studying community assembly. Both these groups are present in most marine lakes, usually with high species diversity and total biomass. From each sponge and mollusc species we sampled one individual and preserved it in RNAlater or 96% ethanol. DNA and morphological analyses will be performed on this tissue later. We also monitored benthic cover and biodiversity by taking pictures along transect lines.

3.3 Ecological adaptation

With community assembly analyses we can compare how communities vary between marine lakes, and link this to environmental data. We also want to know when particular populations came into the lake, if they still have a connection to the ancestral population from the sea, or whether there is exchange, or gene flow, between different marine lakes with different distances from each other. Furthermore, we want to see how populations of the same species have adapted to the very variable environmental conditions of marine lakes. In order to do this, we selected different species and from each species we sampled multiple specimens per population and preserved them for later DNA extraction.

4 Collaboration and outreach

We were happy to collaborate with a vast amount of people. Mrs. Gandi Purba joined us in Misool, and mr. Ludi Aji joined us in Gam. Mrs. Purba is a PhD student at Gadjah Mada in Yogyakarta, Java. Here, she is working on the genesis of marine lakes. In Misool, we joined her to several marine lakes where she had placed data loggers in the years before. Mrs. Purba is originally from Manokwari, and also a lecturer there at the University of Papua (UNIPA). Mr. Adi Mukti is a Bachelor's student, and was supervised during this field trip by mrs. Purba. We aided each other during this field trip and shared our knowledge.

Mr. Ludi Aji is currently working as a junior researcher at the Technical Implementation Unit for Marine Conservation in Biak, West-Papua, which is a branch of the Indonesian Institute for Sciences (LIPI). Here, he is an expert in Mollusc morphology and taxonomy. Mr. Aji joined us for a week in the Gam area, where he helped us with identifying mollusc species for our community assembly work. He also conducted monitoring measurements both in marine lakes and on the reefs outside, to compare species diversity. We worked together very well, and hope this was the start of the collaboration between Wageningen and LIPI.

Furthermore, we are greatly indebted to the local non-governmental organisations (NGOs) that helped us logistically during the field work period. The Nature Conservancy (TNC) helped us arranging boats and fuel, and send one of their employees, mr. Ali Alioherenan, with us to be our guide in the marine lakes of North Misool. The NGO Baseftin provided support and guidance while we were in South Misool. Conservation International (CI) let us stay at their ranger post at Wayag, which made it possible for us to visit the marine lakes there. The Raja Ampat Research and Conservation Center (RARCC) located at Kri, provided logistical support and aided with the construction of research equipment.

5 Conclusions and Acknowledgements

In conclusion, we had a very fruitful period during our field work in May-June of 2016. Not only did the sample collection go well, we also had the opportunity to collaborate with people from UNIPA and LIPI.

We would like to thank RISTEK and LIPI for endorsing this field work trip. Dr. Lisa Becking has been setting up this project since 2009, and we would like to thank her for the opportunity in joining her work. Also, we would like to thank all the people who gave us logistical and technical support while in the field: The Nature Conservancy, Baseftin, Conservation International, and Raja Ampat Research and Conservation Center. In particular, we would like to thank mrs. Gandi Purba and mr. Ludi Aji for joining us in the field and sharing their knowledge.

This trip would also not have been possible without financial aid. Therefore, we would like to thank the Royal Netherlands Academy of Arts and Sciences, Ecology Fund (KNAW), and the TREUB fund for Scientific Research in the Tropics. For the jellyfish lakes specifically, we would like to thank the World Wildlife Fund (WWF).

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