Exploring the diversity of foreign particles in Indonesian marine sponges: potential bioindicators for microplastic pollution?

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Period you were on Bangka: March 17th to April 12th 2019

Introduction

The ocean as well as coral reefs are faced with increasing plastic pollution, including omnipresent plastic microparticles and microfibres (< 5mm in size). However, plastic concentrations in the marine realm are until today very difficult to estimate (Hall et al. 2015). Microplastics present in the marine realm are accidentally ingested, making them an alarming vector of diseases and toxins, threatening marine life at all depths (Courtene-Jones et al. 2019). The main question driving this research is whether sponges are potential bioindicators for microplastic pollution. Sponges have a filtration system sensitive to fine particles, use foreign particles for strength and growth, and are geographically widely distributed. Therefore, it appears relevant to engage in detailed field studies on sponge microparticle incorporation, especially in Indonesia since it is known to be a hotspot for plastic pollution in the middle of the Coral Triangle (Eriksen et al. 2014). Moreover, this study is the only to date investigating the diversity of incorporated particles in sponges. I hypothesize that, due to the presence of abundant foreign particles in keratose demosponges, these taxa are likely to accumulate also microplastics amongst other naturally occurring particles in their vicinity, such as sand grains.

Material and methods

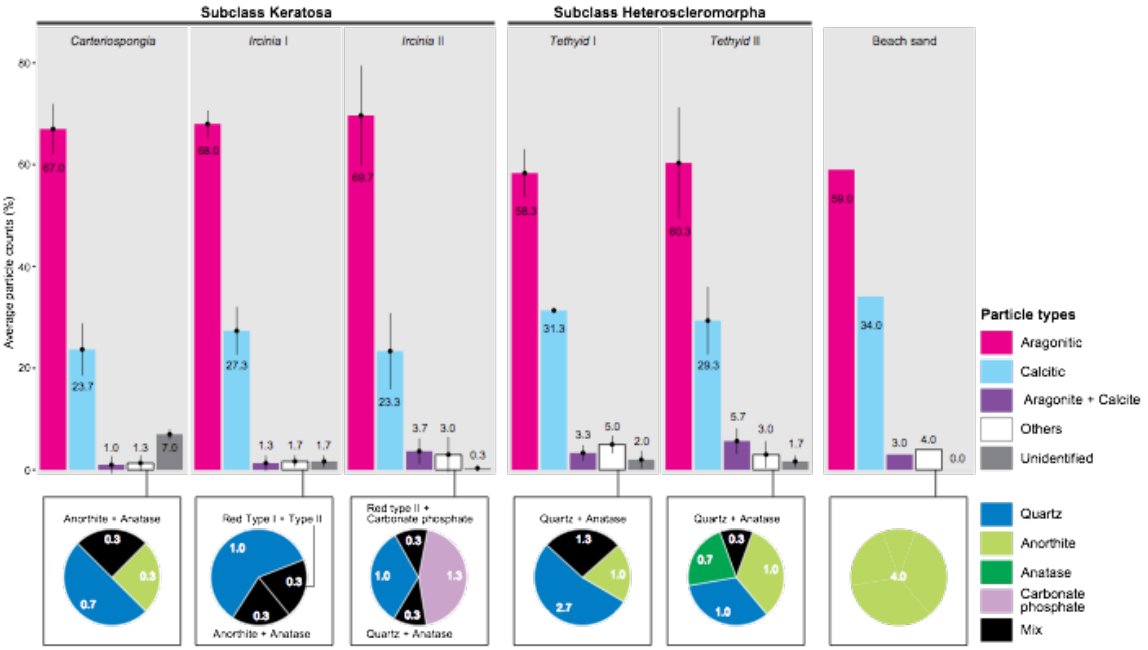
The field work took place near Manado city on the west coast of Bangka Island at Coral Eye Resort, Sulawesi Utara, to assess the plastic contamination in marine sponges. Non-lethal samples were taken on a wide variety of marine sponge species and sizes while snorkelling. A superficial inspection of the collected samples was done at Coral Eye Resort laboratory in order to assess the presence of foreign particles in the sponge tissue, potentially containing microplastics. Only samples with foreign particles were selected for further analysis at the Molecular Geobiology and Paleobiology laboratory of the Department of Earth & Environmental Sciences, Paleontology & Geobiology, LMU Munich.

Specimens were genetically identified to the best taxonomic level possible, by the means of DNA barcoding in Munich. Meanwhile, an histological analysis was performed on the samples to identify in which structures sponges accumulated the foreign particles. Then, 15 of the 27 selected samples were scrutinized with Raman spectroscopy to identify what particles accumulated in sponges at the Crystallography Section of the Department of Earth

& Environmental Sciences, LMU Munich. Two-photon excitation 3D reconstructions were also performed to confirm the particles were embedded within the tissue of the sponge.

Results and discussion

Particles were observed in the ectosome and spongin fibres, where they presumably provide strength and support growth to sponges, especially to those from the Subclass Keratosa (Teragawa 1986a). The mesohyl appears as a transit zone where particles are transported from the ectosome to sites of skeletogenesis as well as for egestion (Teragawa



1986b).

Figure 1. Particle diversity in 15 sponges and the sand sample, representing the most abundant ones (all numbers are in %).

Ca. 90% of all particles were $CaCO_3$ (calcite and aragonite) in correlation with sand ratio at Coral Eye (fig. 1). On a total of 24 different particle types, degraded man-made products, such as titanium oxides and automotive blue paints (ca. 0.100 particle/mg of dry sponge), were incorporated by six specimens. The uptake of particles, however, appears independent of the material, which suggests that the fluctuation in material ratios is due to the spatial variation of surrounding sediments. It is not possible to confidently conclude that sponges have a potential to biomonitor microplastics, because no microplastic could be detected. However, it is very likely that sponges incorporate microplastics, simply at a lower concentration than the detection threshold of the method. Nonetheless, this study narrows the knowledge gap on particle incorporation processes and provides the only document to date describing in detail the variety of particles incorporated by sponges.

Literature

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Publications

This project is now the finished Master's thesis of Elsa Girard (not online). It is plan to publish the findings of the Master's thesis in the coming months.