From smallest to largest -
Microplastic contamination in different trophic levels

Research project report from Bangka Island, North Sulawesi
March 16th to April 13th 2019

Name of student: M.Sc. Magdalena Wilde (LMU Munich) – wilde@genzentrum.lmu.de
Supervisor: Prof. Dr. Gert Wörheide (LMU Munich)
Field Supervisor: Prof. Dr. Markus T. Lasut (UNSRAT Manado)

Introduction

The increasing plastic contamination of the oceans poses a major threat to marine life. As plastic particles and their associated toxins can biomagnify throughout the marine food chain, the associated long-term effects on marine organisms, and also on us humans as seafood consumers, are not fully understood yet. In this project we quantified plastic pollution in the very beginning of the food chain, the plankton, and derived insight in potential sources of microplastic particles, such as fibres coming from rope abrasion around jetties. We tested and reviewed different methods for analysing microplastic in different trophic levels and provide suggestions for future improvement.

Material and methods

During my stay on Bangka Island I took three different types of samples. Planctonic, pelagic fish and sediment samples.

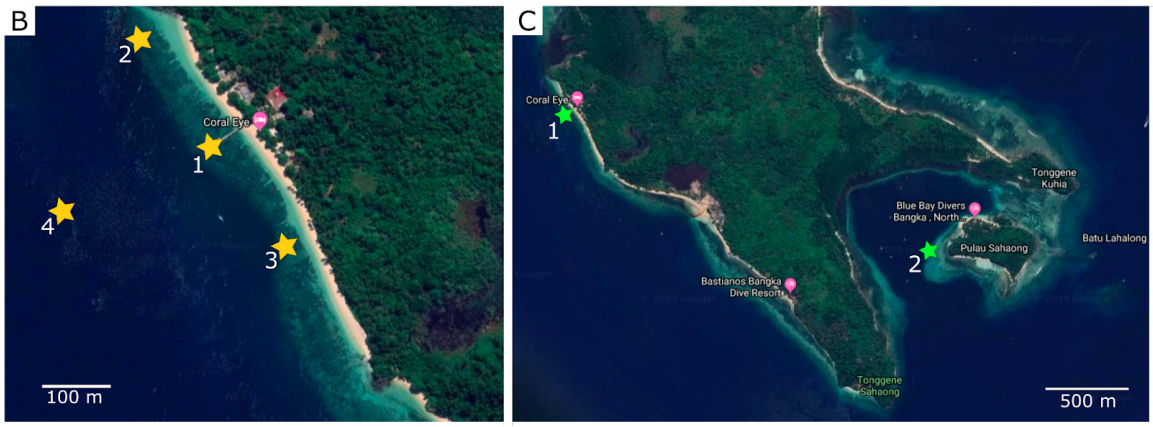

Fig. 1. Sample sites on Bangka Island, North Sulawesi, Indonesia (modified from original report). **B.** Four sampling sites for plankton sampling. 1) Jetty, 2) ca. 200m north from the jetty, 3) ca. 200m south of the jetty, 4) pelagic. **C.** Two sampling sites with installed sediment traps. 1) House reef Coral Eye, 2) In the bay of the village Lihunu.

Plankton samples

Plankton samples were taken in four different sampling areas in front of Coral Eye Resort. A standard plankton net with 55 µm mesh size was used for collecting horizontal and vertical plankton samples, in combination with a mechanical flow meter. After collection, all plankton samples were filtered on glass fibre filter paper using a vacuum pump. The dried filter papers were then examined under a dissecting microscope.

Pelagic fish
11 juvenile yellowfin tuna (*Thunnus albacares*) were bought at the local fish market in Likupang. The fish was then dissected, the stomach was opened and the content was washed through a 500 µm sieve. The sieve was then analyzed under the stereo microscope.

Sedimentation traps
6 sediment traps were built out of 40 cm long PVC pipes pieces with a diameter of 8cm. One opening of the trap was sealed with a cap, the other side was covered with a mesh. Two sets of 3 sediment traps each were deployed and fixed to underwater constructions, first set in 5-8 m the second set in 20 m water depth. The sediment traps were left under water for 7 days. Back in the lab the mesh was removed and the whole content was poured through a 500 µm sieve and analysed under a stereo microscope.

FTIR
Back in Germany I determined the plastic type of a randomly chosen subset of 20 microplastic particles across all locations and habitats using Attenuated Total Reflectance-FTIR (ATR FTIR).

Results and discussion

Plankton

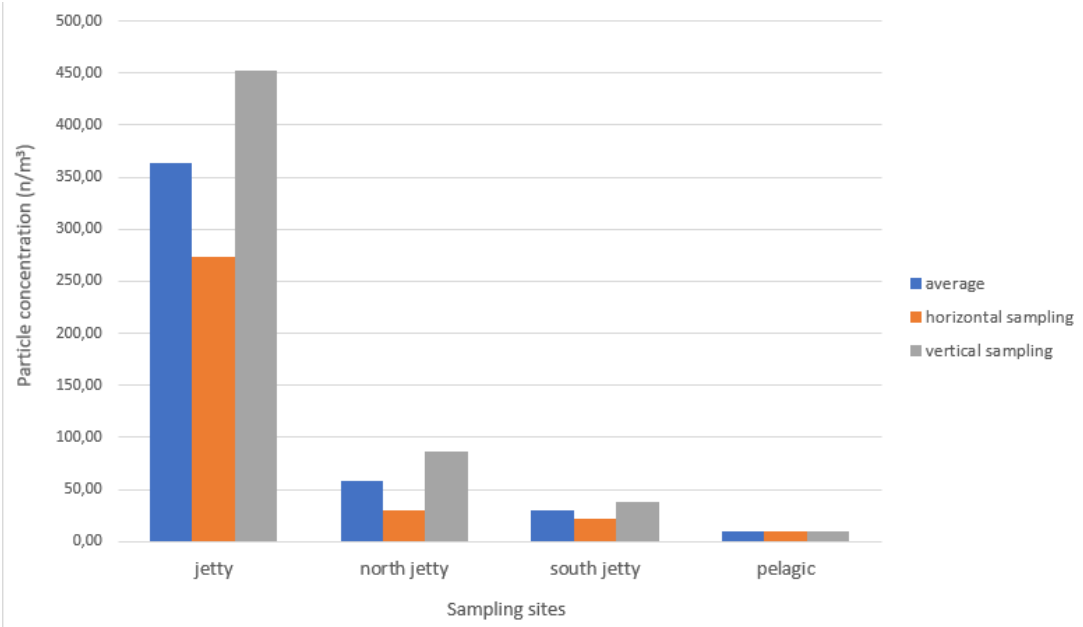

Fig. 3. Comparison of the plastic particle concentration (n/m³) found at the four different sampling sites. In blue is the total amount (both sampling methods united), in orange is the amount for horizontal sampling and in grey the amount for vertical sampling.

The concentrations recorded around Coral Eye differ strongly, depending on the sampling site. So is the average concentration for all sampling sites 115.34 n/m³, but when the jetty, which has a nearly one magnitude higher concentration as the rest, is excluded the concentration drop down to 32.67 n/m³. The outstanding values measured around the Jetty could possibly be a result of docking rope abrasion at this site. To confirm this hypothesis, it would be interesting to compare fibres collected in the water column around the jetty with fibre samples taken from the different docking ropes, via FT-IR.

The occurrence and accumulation of marine litter is affected by many factors, like wind, ocean currents, river input or shipping lanes (Pruter 1987; Claessens et al. 2011; Kukulka et al. 2012). But observed microplastic concentrations depend not only on the local surrounding circumstances (river influx, water current, etc.) but also on the used sample procedures, e.g. clean air conditions.

Fish

From the 11 tunas, 10 fish guts were empty. Only in one tuna, the gut was filled with 5 small fishes, shrimps and larva. But in none of the eleven fish, microplastic was found. For future studies, a larger sampling size and a better distribution of fish sources (e.g. different markets, different days, different booths) should be pursued.

Sediment traps

In the traps placed in the Coral Eye house reef no plastic particles larger than 500 µm were found. In one of the sediment traps placed in 20m depth on the second sampling site, one black fibre was found. In our case the time span of one week was not long enough to produce viable data. But after this first test we can testify that this very simple-built traps are easy to handle and work properly. For future research a minimum time span of one-month deployment would be more desirable. Also, a broader distribution of traps around different sampling sites as well as in variable depths would be interesting.

Conclusion

We were able to count the plastic load of plankton in different sampling locations and habitats and observed differences in the amount of microplastic across different sampling locations and water depths. As well as gain a first insight in the origin of some of the found particles. To determine plastic ingestion rates in pelagic fish, the sampling methods should be adjusted in future studies according to published, standardized methods. It would further be interesting to improve and conduct more experiments at several places, at the same time around Coral Eye, to have comparable results and track the fate of plastic particles through the different trophic levels.

Literature

Claessens M, De Meester S, Van Landuyt L, De Clerck K, Janssen CR (2011) Occurrence and distribution of microplastics in marine sediments along the Belgian coast. Mar Pollut Bull 62:2199–2204

Kukulka T, Proskurowski G, Morét-Ferguson S, Meyer DW, Law KL (2012) The effect of wind mixing on the vertical distribution of buoyant plastic debris. Geophysical Research Letters 39

Pruter AT (1987) Sources, quantities and distribution of persistent plastics in the marine environment. Marine Pollution Bulletin 18:305–310