Weekly Report 1

FS Alkor cruise AL534-2: RiverOceanPlastic

Fahrtleitung: Aaron Beck (GEOMAR)

Background

The coastal and open oceans represent a major, but yet unconstrained, sink for plastics. It is likely that plastic-biota interactions are a key driver for the fragmentation, aggregation, and vertical transport of plastic litter from surface waters to sedimentary sinks. However, the magnitude of the plastic flux as well as the flux rates from the rivers to coastal waters and the open ocean, and from the surface to deep waters, are very poorly constrained, as is the impact of plastic-biota interactions on transport and ecological health. Cruise AL534-2 integrates riverine source observations and shelf sea sampling to build a mechanistic understanding of MP transport and its biological impact reaching from rivers to the coastal water column and sinks at the seabed.

Cruise AL534-2 serves as a second cruise of a number of connected research cruises to build an understanding of the transport pathways of plastic and microplastic debris in the North Atlantic from the input through rivers and air across coastal seas into the accumulation spots in the North Atlantic gyre and the vertical export to its sink at the seabed. The first cruise (POS536) was conducted during August-September 2019 and visited the inner accumulation zone of the North Atlantic garbage patch (in the North Atlantic gyre) and focused on vertical transport processes. The current cruise will focus on land-ocean transfer of MPs and determine the fate of plastics (including larger size classes (>5 mm, MP, but also sub-MP) during transfer from rivers to coastal waters and towards ocean waters.

The cruise is an international effort as part of the JPI Oceans project HOTMIC. The cruise forms a joint effort of HOTMIC researchers from a range of countries and institutes. The institutes involved are: GEOMAR (Germany): water column biogeochemistry (Prof. Dr. Eric Achterberg, Dr. Aaron Beck), benthic ecology (Dr. Mark Lenz), sediment biogeochemistry (Dr. Matthias Haeckel), physical oceanography (Prof. Dr. Arne Biastoch, Dr. Marcus Dengler). The Institute of Water Chemistry & Chemical Balneology, Technical University of Munich (Germany): analytical measurements of MPs and sub-MPs (Dr. Natalia P. Ivleva). University of Pisa (Italy): nanoparticle and MP measurements using advanced analytical techniques (Prof. Valter Castelvetro). University of Southern Denmark (Denmark) plankton ecology (Prof. Jamileh Javidpour). Portuguese Institute for Marine and Atmospheric Science (Portugal): Investigating MP distribution in ocean (Dr. Miguel Caetano). Marine and Environmental Science Centre (Portugal): Marine litter mapping (Dr. João Canning Clode). Ghent University (Belgium): benthic biology (Prof. Ann Vanreusel). University of Tartu (Estonia): MP and marine biodiversity (Prof. Jonne Kotta).

Cruise progress Week 1: Mediterranean Sea to Atlantic Ocean

The scientific team arrived in Malaga and boarded FS Alkor on the morning of 04 March (Fig. 1). The participants include researchers from GEOMAR Helmholtz Centre for Ocean Research Kiel (Germany), University of Southern Denmark (SDU, Denmark), Portuguese Institute for Marine and Atmospheric Science (IPMA, Portugal), Ghent University (Belgium), University of Tartu (Estonia), Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG, Germany), and Universität Köln (Germany).

Figure 1. Scientific team of AL534-2. L-R, back row: J. Javidpour (SDU), A. Peterson (U Tartu), J. Goldstein (SDU), G. Pantò (U Ghent), S. Hamisch (GEOMAR), E. Kossel (GEOMAR), S. Wittmann (HZG). L-R, front row: C. Lopes (IPMA), K. Weber (GEOMAR), A. Saupe (U Köln), A. Beck (GEOMAR).

Labs and sampling equipment were set up immediately the afternoon of the 4th, and ready to begin the scientific program the following day. A delay due to bad weather kept us in port on the 5th, but we departed on the 6th, and arrived at our first station a few hours from port. The first station was near the Spanish coast inside the Mediterranean Sea (Fig. 2). Sampling work at this station was very smooth and successful, setting the rhythm for the coming stations. It helps very much that the Alkor crew is experienced with all the equipment we deploy, and their enthusiastic support is the basic foundation of our success.

We have similar work at most of the stations: we start with a CTD cast to get basic information about the water column structure (especially temperature and salinity) and collect water samples for dissolved organic compounds (including plastic leachates and UV stabilizers), microplastic particles, and major ions.

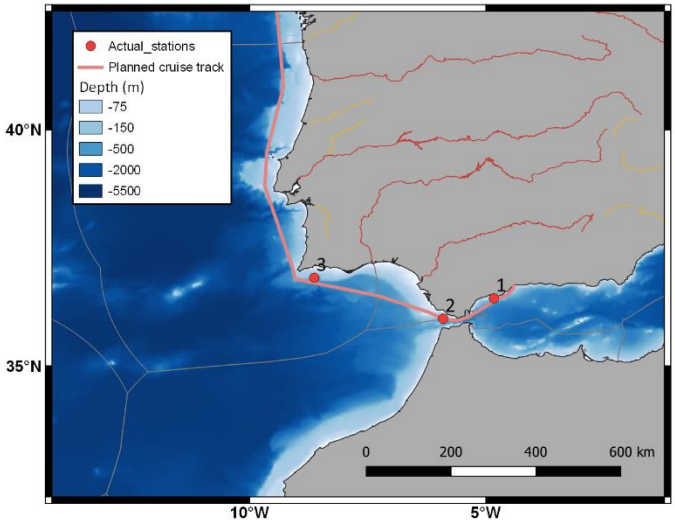

Figure 2. Map of stations completed during Week 1. The light red line shows the planned cruise track.

The CTD cast is followed by sediment sampling with a Van Veen grab for surface sediments (microplastics and related chemical, benthic infauna, and benthic foraminifera). The grab samples are also used to gauge the sediment type and prepare the mini-multi corer (mini-MUC) for core sampling (Fig. 3). The mini-MUC is deployed three times to collect enough cores for the various groups. Cores are sampled for microplastics, meiofauna, foraminifera, and basic geochemical parameters.

After the sediment work is completed, we deploy a number of net samplers for suspended particles and zooplankton. A large ring net (WP3, 1.5 m diameter; Fig. 4) is towed vertically from 100 m to sample intact gelatinous zooplankton (jellyfish) for identification and abundance determination, as well as ingested microplastics. We then tow a Bongo net at ~50 m depth to collect suspended microplastics and zooplankton from the water column (Fig. 4). Last, if weather permits, we tow a catamaran neuston trawl (Fig. 4). The catamaran trawl samples floating and near-surface particles and zooplankton. When waves are too high, they wash over the top of the net opening, and sampling is not quantitative.

At station 1, we were able to deploy all our planned equipment, except the catamaran trawl due to windy conditions.

Station 2 was on the Atlantic side of the Gibraltar Strait, and we were able to deploy all gear, including the catamaran trawl. Sediment sampling was mostly unsuccessful due to the hard bottom. We also tried deploying the small box corer, but it collected only a few rock and shells. These were useful for foraminifera investigation, but not for our general sediment studies. At Station 2, we also deployed in situ pumps (ISPs). These are suspended on a cable at depths between the seafloor and water surface, and pump water continuously through 10 µm stainless steel filters to collect suspended microplastic particles.

Station 3 was occupied on 08.03, near the Portugal coast at Sagres. We had good weather, and were able to complete our full “normal” program (no ISPs).

Figure 3. Removing sediment cores collected with the mini-MUC.

Figure 4. (Left) WP3 net being retrieved and rinsed. (Right, top) Bongo net being deployed. (Right, bottom) Catamaran trawl during sampling.

We have also started performing visual litter surveys during transits between stations. These litter surveys follow protocols from colleagues at the Alfred Wegener Institute for Polar and Marine Research (AWI), and will be shared for integration into their global litter database. We consistently see numerous floating macroplastic objects every hour during transit. These may be a source of some of the microplastics we sample in the water column and sediments.

Initial results

Most of the samples collected during AL534-2 cannot be analyzed on board ship, so results will mostly follow post-cruise laboratory work. Qualitatively, we have seen few visible microplastics in our samples. The only exception was one of our three catamaran trawls, which crossed an accumulation zone formed at the sea surface by Langmuir circulation. That trawl sample contained many micro/meso-plastic objects (Fig. 5). The identifiable objects appear to derive from fishing line, synthetic rope, foam, and pellets.

Figure 5. Floating plastic objects sampled by the catamaran trawl. The petri dish diameter is 8 cm.

Table 1. Overview of device deployments and samples collected

Device name	**Number**
CTD/Niskin rosette	3
Van Veen Grab	9
Mini-MUC sediment cores	33
WP3 Net tows (500 µm)	9
Bongo Net tows (100 µm)	9
Catamaran Trawls (300 µm)	6
In situ pumps	2
Total	*71*

With greetings from the eastern North Atlantic Ocean on behalf of the cruise participants,

Aaron Beck, GEOMAR Helmholtz Centre for Ocean Research Kiel

(38° 32’ N, 9° 18’ W) Monday, 09 March 2020