Expedition Blog

Helmholtz Centre for Environmental Research
UFZ Leipzig (Germany)

written by *Roman Kroke*

during the MICRO-FATE Expedition SO 268/3 across the Pacific Ocean on board of the German research vessel SONNE

30 May 2019 - 5 July 2019
Vancouver (Canada) - Singapore

Roman Kroke was mandated by the UFZ Leipzig to accompany this scientific expedition as an artistic mediator: for details on his mandate see page 68-71 (under "10. Outreach") of the official

Cruise Report

One of his tasks consisted in disseminating the contents of the expedition to a broader public by writing the official UFZ Travel Blog[1]: not only about the scientific research questions, diverse ocean probes and daily challenges on board but also about the people behind the expedition: insights into the biographies of the scientists and the ship's crew. The following article is the English translation of the original text (written in German). You find the original article of Roman Kroke in the online archive of the UFZ Leipzig:

Mut zur Lücke!

By clicking in the following text on blue underlined words (like, on this page, "Cruise Report", "Mut zur Lücke!", "PRIZE") you will be led to online pages which are also hyperlinked for the readers of the original (online) article in German.

[1] The workshop concept developed on the basis of these articles was distinguished with an environmental-educational PRIZE.

27 August 2019

FLAT SHARE IN THE MICROCOSM

Loreley-Delilah, Liam-Noel, Karl-Johann or rather Norma Jean? Hipster parents certainly don't have it easy when looking for a suitable baby name. Giving your offspring a certain touch of individuality without ending up in the mainstream is easier said than done. Instead of searching the internet for the top 100 rankings of the most unusual baby names, a new source of inspiration could be found in a place that has so far been completely ignored: in the miniature world between the sand grains ...

Hooked weevil, pine mouth, corset wearer and hairy belly are just a few of the fancy (German) names belonging to the tiny species at home in the so-called *mesopsammon* - the "sand gap system". The watery, golden-brown piles of mud dripping in front of me onto the deck of our research vessel are also part of the habitat of these quirky fellows, measuring between 32 micrometres and one millimetre. *Meiofauna* is the scientific term to address these small benthic invertebrates. "There is hardly a place in the world that this very species-rich community has not populated," Gritta Veit-Köhler, a researcher at Senckenberg's German Centre for Marine Biodiversity Research in Wilhelmshaven, explains to me. "We don't just find them under our bathing towels on the North Sea and Baltic Sea. They are just as well at home in the dizzying heights of the Himalayas as they are at the thermal springs at the bottom of the deep sea, spewing water at over 300 degrees Celsius. They have been discovered in the brine channels of the Arctic sea ice, as well as high up in the treetops of the Amazon, where they share the water-filled calyxes of bromeliads with the tadpoles of poison dart frogs."

On our SONNE expedition, Gritta will take a closer look at the meiofauna located in the sediments of the Pacific Ocean at a depth of more than 5,000 metres. “Believe me Roman, it may dark down there. But they are not slumbering, it is teeming! We actually want to close a research gap that currently exists for our samples between the American West Coast and the deep-sea trenches near Japan," she explains. "Our colleagues at home in Wilhelmshaven are already eagerly waiting to examine the samples. Their genetic methods are very efficient and nowadays the means of choice for many questions. There is, for example, barcoding, the determination of the species of single individuals on the basis of their genetic information - as well as metabarcoding, the analysis of the complete animal community of a sediment sample in one go. I myself am interested in finding animal species that my students and I have described taxonomically, i.e. with pictures and drawings. My student Annabel Mathiske presented four new species of deep-sea copepops in her bachelor's thesis. It would be great if we could find these animals again in the middle of the Pacific too!"

In today's blog you will learn about a bizarre marine probe with five legs and 20 sediment tubes: the Multicorer (MUC). Here you see it returning from its night mission from a depth of more than 5000 metres.

Gritta is supported by Merten Bohn, a biology student at the Carl-von-Ossietzky University of Oldenburg. He is currently writing his bachelor's thesis with her on a feeding experiment with meiofauna that Gritta conducted three years ago as part of an expedition on the research icebreaker *Polarstern* in Antarctica. "I wasn't there for the data collection on the Polarstern at the time," Merten explains to me. "It's true that the route of the SONNE expedition now takes us through climatically much warmer regions. Nevertheless, this experience allows me to get a better feel for the challenges scientists have to overcome when working in the field on a research vessel, also with a view to my bachelor's thesis." In the sediment samples freshly recovered from the Pacific, Gritta also hopes to track down previously unknown species that belong to her very personal favourites within the meiofauna: copepods. "In the Angola Basin we found 700 different species among 2000 specimens. That is quite incredible. Every third copepod belonged to a new species!" Gritta's eyes are gleaming. "Currently, about 3000 different species of bottom-dwelling copepods are known - but colleagues have estimated their total species diversity to be around 30,000!"

Gritta and Merten examine the yield of tonight's night shift.

In Gritta's work, however, there are not only a lot of new names to be given. Before that, it is important to pay attention to every detail when identifying them under the binoculars. "Sometimes the different species of copepods only differ by a single bristle on the third pair of webbed legs. It is obvious that this is not easy to find out in an animal that is only 0.3 millimetres in size. "We often have to dissect them with the help of a chemically sharpened needle," the meiofaunal specialist explains. But before the tiny fellows, for the moment still scurrying deep below our research vessel in the sediments, will be able to enjoy such treatment, they will first have to be transported from their muddy habitat to our deck. To do this, Gritta brought along a sampling device from the Senckenberg Institute that is specially designed for taking sediments in the deep sea: the Multicorer – called MUC for short. When the MUC floated in on our deck just a few minutes ago I couldn't help but to be struck: This bizarrely shaped iron frame, with its five legs, almost looked itself like a large-zoomed copepod about to hijack our research vessel! The MUC is equipped with twenty plexiglass tubes arranged in a square, which slowly bore into the sediments after landing on the seabed. Hoisting the device then triggers a mechanism that closes the top and bottom of the tubes with lids. "The careful recovery of the sediment cores is particularly important," Gritta emphasises. "Only in this way can we subsequently study an almost undisturbed biocoenosis in its natural state, since most animals are at home in the top centimetre, and in some cases even the top millimetre, of the subsurface."

Merten is in the process of removing the last plexiglass tubes from the anchorage of the MUC. Through the milky casing I see some black-brown lumps lying on top of the sediment core. "Manganese nodules," the biology student explains to me. "Amidst the marine mud, they provide a solid substrate for microorganisms. It will therefore be exciting to study whether certain species of meiofauna have settled on them."


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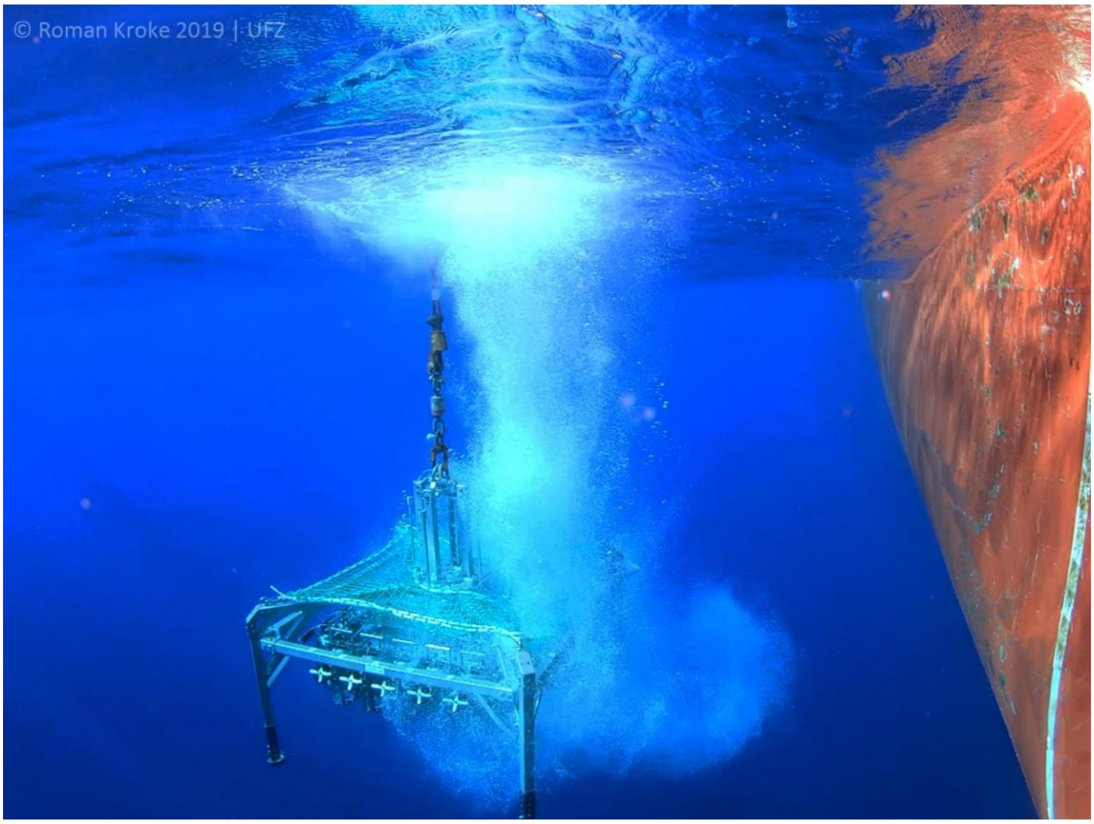
I remember. Only a few days ago, Melanie Bergmann (Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven) showed me photos of the seabed in this area, which is almost completely littered with manganese nodules; photos that our remote-controlled camera system OFOS (Ocean Floor Observation System), hovering 1.5 metres above the ocean bed, had taken. The inner structure of the nodules is comparable to that of an onion in terms of its spherically layered structure. However, they grow significantly slower than their relatives in our vegetable patch. Only about five millimetres in a million years. One should not be deceived by the inconspicuous appearance of the nodules. They contain the rare metals nickel, copper and cobalt, which can only be replaced to a limited extent. The latter is classified by the European Union as a so-called *critical raw material*. This includes those substances that are of high economic importance, but for which there is no free and fair access on the world market and no permanent supply from sources within Europe. Without cobalt, for example, there would be no lithium-ion batteries; the metal is therefore an important building block for smartphones, tablets, laptops and electric vehicles. It is therefore not surprising that the run by all major industrial nations for the mining rights of these marine nodules is in full swing. "The impact of the planned mining of manganese nodules on the deep-sea ecosystem would be considerable, as the seabed would be literally ploughed up during harvesting," Gritta predicts of developments in the coming years. "Simulations of mining since the late 1970s have shown that these regions recover only very slowly from interventions. The plough tracks of that time look like freshly dug up even after 40 years, and many microorganisms of the originally represented populations are still looked for in vain there today."

Millions of years old deep-sea onions: Manganese nodules

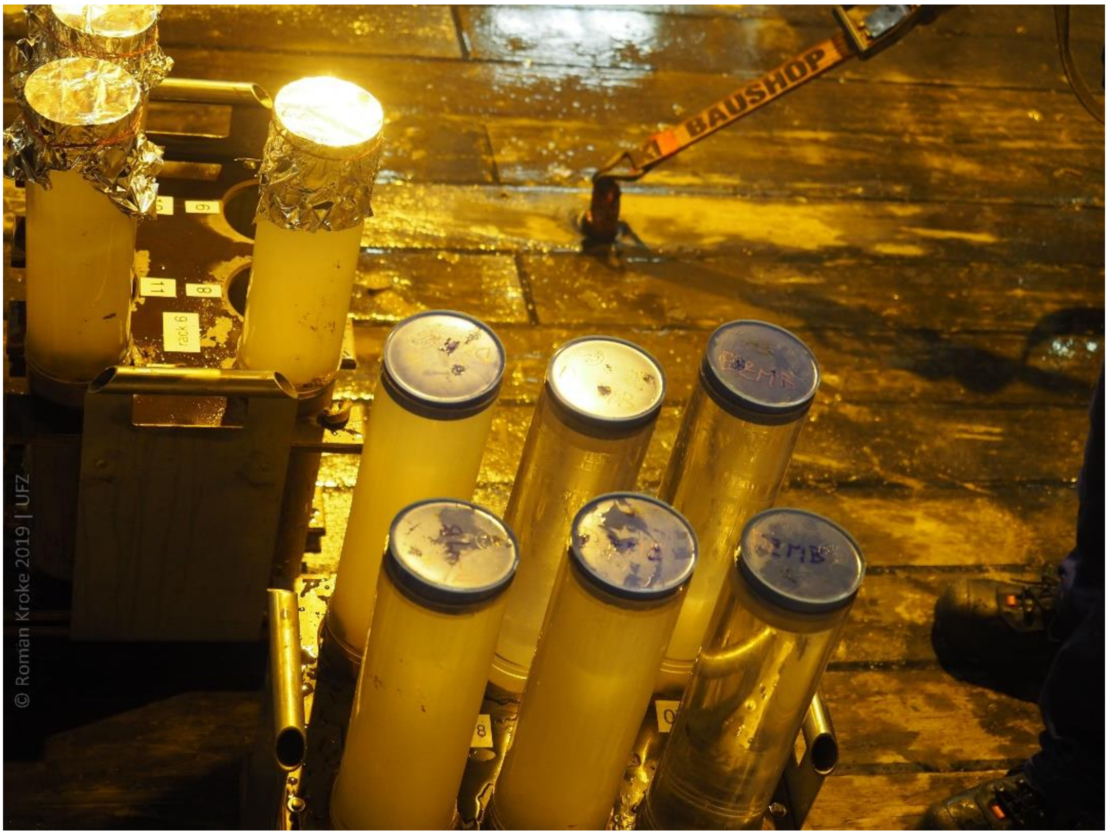
The inhabitants of the deep sea have adapted over thousands of years of evolution to the fact that the central living conditions such as food availability and temperature hardly change, one sediment layer after the other is superimposed in a slow process. "The furrows dug and sediment clouds stirred up by deep-sea mining pose the risk of burying a large number of the sensitive sediment dwellers beneath them," explains Gritta. "The representatives of the meiofauna grow extremely slowly and have few offspring. In addition, most species are characterised by benthonic development: They are bound to the seabed. Unlike a large part of the macrofauna, they do not release their larvae freely into the water and thus cannot use currents to spread over long distances. Dispersal is exclusively on foot."



The Multicorer (MUC) returns from the bottom of the sea.

Particular caution also seems to be called for in planned deep-sea mining because the seabed can justifiably be described as the "compost heap" of the oceans. As we learned in connection with the deployment of our Marine Snow Catcher, biomass from dead zoo-, phytoplankton and faeces trickles down to the bottom of the deep sea all year round as so-called marine snow. The sediment dwellers decompose this "waste" and convert it into inorganic nutrients, which in turn serve as fertiliser for primary producers such as microalgae. Because of this remineralisation, deep-sea organisms play a very important role in the marine nutrient cycle. "Our role as scientists, especially in this area, to generate new knowledge for the public, is a bit ambivalent," Gritta points out. "Of course, it is possible that corporations use parts of our research to advance their planning processes for the commercial mining of manganese nodules. On the other hand, we naturally hope that our research content will be taken up to define environmental standards and regulate mining: What is the maximum size of contiguous mining areas, what distance do they have to be from each other?" Our previous expedition on SONNE, the European JPI Oceans project MiningImpact, which we replaced in Vancouver at the end of May, was also specifically dedicated to these questions. The legal framework for commercial mining of ores in the high seas is currently being negotiated between the EU and the 167 member states of the International Seabed Authority (ISA). By 2020, this mining code should be in place. One last hurdle before we humans will also leave our mark on this patch of almost untouched nature.

While in my mind's eye armies of caterpillar vehicles sink to the seabed to begin harvesting tubers, two six-person carriers on the ship's deck have filled with the Multicorer's sediment samples. One difference is immediately obvious: in one of the carriers the tubes are closed with plastic lids, while in the other they are sealed with aluminium foil. This is a clear indication that the path of the samples will bifurcate at this point. While the first sediment group is destined for Gritta and Merten, the latter will go to another group of scientists on our expedition who want to examine the samples for microplastics - the aluminium foil prevents the results from being falsified by plastic abrasion of the plugs.



Sediment samples sealed with aluminium foil for the "polymer scientists" (top left).
Plastic-screwed research food for the meiofaunal specialists (middle).

As the samples are now prescribed a few hours of rest, thus enabling copepods and microplastic particles to settle on the bottom in a relaxed manner, I also decide to head down in my ship's cabin. After today, the sandman and his grains appear to me in a completely different light ...

When I arrive on the deck of the ship the next morning, I find our deep-sea treasures surrounded by the coordinator of our MICRO-FATE project Annika Jahnke, her colleague from the UFZ Leipzig Stefan Lips, and Mine Banu Tekman, PhD student at the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI). Further processing of the sediment samples is already in full swing:

„Mach doch keinen Leckmeck, sonst schleck ich dich vom Fleck weg.“ Some of you may remember Ed von Schleck, the cult ice cream of the 80s which you had to push up from below within its plastic tube with the help of a little stick – feel invited to enjoy this historical piece of publicity as a nostalgic refresher of your taste bud memory (minutes 0:34-0:35 and 1:24-1:25). Ed may have disappeared from the range of our freezers by now. My joy is therefore all the greater when I witness the resurrection of its serving principle in the middle of the Pacific Ocean:

To get the sediments out of the tubes, the three scientists put the Plexiglas cylinder on a plunger and use it to carefully push the sediment upwards. Unlike the Ed von Schleck icecream, the slowly emerging sediment is not licked off, but transferred to a separate, five-centimetre-high plastic glass segment that Mine holds directly over the opening of the glass cylinder.

The "Ed von Schleck" method. Mine (right), Annika (centre) and Stefan coring the plexiglass tubes.

With a spatula-like scoop, she then pushes into the separating crack between the two plastic segments and, in this way, separates the part intended for further analysis from the rest of the sample.

"First of all, we want to determine the content of environmental pollutants in the total sediment," Annika describes the further procedure at the UFZ Leipzig. "A particular challenge will probably arise here from the enormous depth of the sampling and the associated low pollutant concentrations. Are we still within the measurable range to detect pollutants with this material?" Stephan Wagner's team from the UFZ Department of Analytics will then take over the separation of microplastic particles from the sediment and examine them for number, type and size. "In the next step, we will also check these isolated plastic particles for their pollutant content. If we succeed in detecting them, we could draw conclusions about the distribution of pollutants between the sediment and the microplastics it contains," Annika explains. In this comparison, the scientists want to determine to what extent environmental pollutants from the sediment accumulate in the plastic - plastic as a passive collector - or in the opposite direction: to what extent pollutants are released from the plastic into the sediment - so-called leaching. Annika sums up their research question: "Is the plastic in deep-sea sediments a source and/or a sink for environmental pollutants?"

Following on from these sediment analyses, comparisons are to be made with the pollutant detections that her UFZ colleague Elisa Rojo Nieto has obtained with the LV-SPE (Large-Volume Solid Phase Extraction) device from the water column adjacent to the seabed. "Analogous to our sediment studies, we again want to add the pollutant concentrations that we hope to detect in those plastic particles that were isolated from this very segment of the water column with the in situ pumps," Annika specifies. "Once again, we are concerned with the central research question of the extent to which plastic acts as a passive collector or donor - only this time in relation to the water column." Finally, the following method validation measure was important to the researchers: the AWI institute in Bremerhaven has also received triplicates of the sediment samples and will examine them independently for microplastic particles. Will different institutions with different methods and personnel come to similar results?

In order to find their place in the miniature world between the sand grains, many animals have shrunk over the millennia to become microscopic creatures. Scientists attribute this process of *dwarfing* in particular to the need of finding better protection from predators in the sand gap system, furthermore to a lack of food. If we should not succeed in using our natural resources more responsibly, the meiofauna may show mankind a last evolutionary way out of this mess: Let's prepare for a future flat share with hooked weevils, pine mouths, corset wearers and hairy bellies!