

PLASTICS IN THE ARCTIC?



TOPtoTOP Arctic Research Expedition 2021

Analysing Origin, Quality and Ecological Impacts of Microplastic Pollution in the Arctic in an exemplary, environmental-friendly way: from the highest volcano in the Arctic to the pack ice and the Arctic Ocean, we EXPLORE – INSPIRE – ACT. Join our campaign “SAVE the ARCTIC”!

Exposé

The Arctic is facing increasing stressors under global change. Plastic pollution is starting to become a major threat to pristine Arctic environments. Yet, research concerning the quality and quantity of pollution, as well as public awareness on this issue, remains scarce. We intend to change this with our research expedition and combined outreach work!

Project Description

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TOPtoTOP Arctic Expedition 2021

Our research will be part of the “TOPtoTOP Global Climate Expedition” (toptotop.org) led by Dario Schwörer. He and his family sailed around the globe by fair means (wind- and muscle-powered) on a mission to educate the younger generation about the rising climate crisis and ways to prevent it. They already sailed more than 120.000 nautical miles, reaching more than 100 countries, and teaching more than 150.000 students about climate change. They hope to inspire change for a better future not only by presenting nature’s beauty and resiliency, but also by educating about ways to mitigate this global crisis.

Together we plan an expedition around the Barents-, Greenland-, and Norwegian Sea this summer, that will be environmentally friendly from start to finish. The 15m sailboat “Pachamama” will take our team from Tromsø to Svalbard and from there onwards to Jan Mayen, Greenland and finally down to Iceland. This expedition will take place from May to end of July 2021. On route we try to sample terrestrial locations with differing anthropogenic impacts (Jan Mayen and Greenland being less impacted and Svalbard and Iceland more impacted), as well as the marine environments along the route. One of our main expedition goals will be an ascent and a first ever Microplastic (MP) sampling of the Beerenberg on Jan Mayen. Sampling this extremely remote, northernmost, 2277m high volcano will give new insights into the microplastic (MP) burden of the Arctic. With our expedition we will be able to gather comparable data around the Greenland Sea concerning the distribution vectors of microplastic particles in terrestrial habitats, including some of the effects they have on biota living there, as well as distribution patterns and composition of these particles for marine ecosystems.

We believe that science and knowledge drive change. That is why we intend to couple our research with comprehensive outreach work. We want to spread the word about the increasing plastic problem we are globally facing. This expedition-adventure does not only give us the opportunity to sample remote areas in a sustainable way, but also helps us ignite a spark in the younger generation: The spark to be curious, to care about the world, to research problems and to strive for solutions!

Scientific Research Projects

We plan to conduct two major research projects during this expedition. The first one focuses on the terrestrial microplastic pollution, the distribution vectors of the particles and the effects they have on biota in cryospheric habitats. The second one is an on-going project that aims to understand the localization, concentration, and composition of microplastics in Arctic waters, as well as the role the North Atlantic and Norwegian Coastal Currents in particular may play in transporting plastics into the Arctic, which is presumed to be a dead-end for the debris.

[\[Project 1\] Microplastic Pollution in Arctic Cryospheric Habitats: Origin, Quality and Ecological Implications](#)

Primary and secondary objectives of the project

(1) quantification and qualification of microplastic burden in cryospheric habitats along transects from glaciers to the fjords in different geographic sites with varying level of anthropogenic impact, (2) investigation of potential vectors of microplastic dispersal by analysis of snow, ice, water, sediments, bird guano and air samples, (3) assessment of the ecological impact on microbial living communities

Motivation for the research work

Generally, it is thought that industrial pollutants would not reach remote areas such as the High Arctic. However, it is fact that stressors such as microplastics are to be found even in this pristine environment. The origin thereof is still not resolved to full extent: Local sources such as anthropogenic activities or long-

range transport via wind distribution or birds can be the cause for the deposition and can affect the cryobiota in aquatic and terrestrial habitats substantially. In detail we distinguish between the level of anthropogenic impact, as we sail around the Arctic (route: Jan Mayen - Svalbard - Arctic Ice Shelf - Greenland - Iceland): Svalbard and Iceland are characterized by a higher number of population, high level of touristic activities and increased ship traffic which can result in more marine debris being washed ashore. Contrary, Jan Mayen and the east- coast of Greenland are underlying less environmental stress. To get an insight of the amount of pollution we sample along a transect of the respective field sites reaching from a glacier down to the tributary of glacial melt rivers into the fjord or the sea. Samples: snow, ice, water, sediments, bird guano from adjacent bird colonies and air. The latter is crucial to check for wind-driven dispersal including back trajectories.

Methodology

After collection of sufficient samples from the respective environments we will investigate the samples for microplastic particles via the following measures: Snow and ice samples are melted and filtered onto GF/F filters. Melt water samples from glacial runoffs must be filtered on site (portable filtration manifold operated by a hand-pump) due to the high amount of water required for a sophisticated result. Sediment samples will be analyzed via a microscope where MPs are separated from sediment grains manually. Filters from air samplers, as well as the bird guano samples, will be prepared for transport for a thorough analysis in the home laboratories. The transport of the samples will follow the necessary MP guidelines to prevent involuntary contamination of the samples. MPs will be investigated in Innsbruck, Austria, at the collaborating Institute of Material Sciences by a hyperspectral camera and FTIR (Fourier-Transform-Infrared Spectrometry). In order to study the ecological impact on the cryobiota, possible biofilm production in context with the presence of MPs is observed via laboratory experiments.

Outcomes and impacts

The abundance of microplastic particles on European mainland glaciers has been studied to some extent, as well as the abundance of MPs in the Arctic ocean. Yet, there still is little knowledge about how far and by which means MPs are transported. As a novelty, colleagues at the University of Innsbruck are conducting a similar approach for alpine areas – with the study in the Arctic we are able to span the bow from “high latitude to high altitude” with differing degrees of pollution. The study will provide an inventory of microplastic pollutants in remote areas of which the data are extremely scarce. To our knowledge, this is the first study dealing with a comparison of differing terrestrial Arctic sites along a transect from a glacier to the fjord. Moreover, the transport vectors are still not well described.

[\[Project 2\] Mapping the exposure of Arctic marine fauna to microplastics](#)

Primary and secondary objectives of the project

(1) quantification and qualification of microplastic burden in Arctic waters, (2) assessment of species most likely to encounter the recorded debris, (3) investigation of the ecological impact on vertebrate living communities via gut analysis

Motivation for the research work

Plastic production is still increasing annually. This causes growing concern for the vast amounts of inadequately disposed debris entering the oceans globally. Plastic debris that enters the oceans is broken down by UV radiation and wave action over time. These smaller fragments are increasingly bio-available to marine species. Due to the remote and seemingly pristine nature of the Arctic, low levels of plastic pollution were expected. However, the few studies measuring plastics in the Arctic have recorded the presence of microplastics throughout the water column, in sediments, soil, snow and ingested by seabird and a few fish species. Studies at a greater spatial scale however are largely missing, as well as the knowledge of the exact origins and transportation pathways.

Methodology

Two data sets will be produced by circumnavigating the Norwegian-, Barents- and Greenland Sea in 2020 (1st data set) and then in 2021 (2nd data set) In order to achieve this, the study will have several aspects:

1) Macro plastic data collection: Macro plastic is usually categorized as any pieces of debris over 5mm in size. Washed up plastic debris gives insights on the transportation pathways of plastic and possibly its origin (e.g a Stornoway fishing crate). Exposed beaches in line with major currents tend to have large accumulations of plastic fragments and pieces. Svalbard and Jan Mayen are key places to study this due to their few inhabitants and remoteness, suggesting most of the debris originates elsewhere. On the beaches where access is granted, systematic surveys of macro plastic on shore will be conducted. Along the OSPAR marine litter monitoring guidelines, any plastic found will be categorized into size, type, colour and potential former use. Several organisations such as AECO and “Aktiv i friluft” already do beach clean-ups around Svalbard in collaboration with the Governor. This project hopes to add to the data from these prior and ongoing projects.

2) Microplastic sampling: There is still little known about the behaviour and full impact of microplastics. Microplastics conventionally defined as anything under 5mm in size, are often hard to see by eye. These fragments, fibers, films or nurdles are ubiquitous and their interaction with contaminants is yet to be fully understood. Two methods will be used for the sampling of microplastics: Water samples in bottles and Manta net trawls. These techniques differ in that the bottles give an idea of point-based concentrations, while Manta nets collect particles floating on the surface across transects giving an idea of concentrations along that distance. Trawls are done off the side of the vessel using a spinnaker boom. This reduces contamination as the net is trawled several meters from the boat and always at or a little forward of the boats widest point to ensure no wash from the boat enters the trawl.

3) Environmental DNA (eDNA): All species shed DNA as they move in their environments, just as we lose dry skin or hair, fish species lose scales. Collecting these fragments from an area and sequencing them will allow species lists to be made without any need for invasive trawls or energy intensive dives. By simultaneously running eDNA sampling and microplastic trawls this study will be able to detect which species may be interacting with microplastics and what concentrations of microplastics they are exposed to in the waters around them. Water will be filtered through a peristaltic pump and filtration capsule to collect any traces of organismal DNA in these waters. Water filtration will be of the same duration as the Manta net trawls.

Outcomes and impacts

As an area of rapid environmental change due to warming, species' range shifts, altering seasons, increasing extreme weather patterns and the loss of sea ice, Arctic species are particularly vulnerable. Further stressors acting on this ecosystem may have a disproportionate impact. To that effect, the aim of this project is to both quantify concentrations of marine debris and assess which species are most likely to encounter the recorded debris. Filtering environmental DNA simultaneously to the microplastics trawls will show which species co-occur with the microplastics and gut analysis will show if the debris is indeed being taken-up into the food web. Combining these methods will allow the mapping of species presence and areas of high concentration which can highlight areas at higher risk and inform mitigation efforts.

Outreach and Awareness

Scientific research builds the foundation for understanding the world we live in. Yet, problems that arise in and out of a pluralistic society can only be solved by communal effort. To support this effort, we intend to couple the research from our sustainable expedition with comprehensive outreach work. We especially aim to motivate the younger generation to learn about problem-solving capabilities. Our expedition will give us this opportunity, and we intend to use it, to create a better future.

The TOPtoTOP-Crew is already experienced in community science and community education projects and while we join forces for the expedition trip, Sebastian Pohl and Max Kortmann will feed the already existent online expedition school (adventure.ch) with live reports from the field, as well as status updates.

Multiplication and Environmental Education

By combining field work and educational work and involving the younger generation in this research project, we want to show the already visible effects of the climate crisis and motivate the most important group for future change to take action.

The field work will be accompanied by a travel blog consisting of videos and reports live from the Arctic. The content we will create will be uploaded to online video platforms and social media and can be used for educational purposes at any time in the future. The professional TOPtoTOP film-maker and photographer Mario Greenway will support us in this process. We will post status updates and live reports from the field to the expedition school website from TOPtoTOP (adventure.ch) and use the digital classroom to interact with students around the globe. Through our documentation, coupled with our outreach work at schools, we hope to work as multipliers for a younger generation, as well as a broader public, that might not yet be aware of the global consequences of our local actions.

Ultimately, we hope to help communities not only to change their own consumption behaviour but to motivate them to advocate for a clean nature. We want to give people an in-depth look into the work as an environmental scientist, and how this work can be used to find solutions for the arising problems of global change. Planning our expedition in the most environmentally friendly way (travelling only by train, sailboat, foot / having a non-invasive research approach), will support our goals for a better future!

Workshops with Schools from Austria, Liechtenstein and Switzerland

One of the projects we will work with is exclusively laid out to conduct experiments and scientific communication in schools of various education types (grammar school to higher technical schools). The focus is "microplastics in the alpine area" which fits with the context to high latitudes. The project will benefit largely from the experience of Arctic investigations and input of data from remote areas. Moreover, it would ease the kids to get involved in this topic by hearing live stories of a team of scientists being in an exciting field-environment where kids normally have no access. The planned outreach work will include workshops held at multiple schools in the different countries before and after the expedition.

Inclusion of the local communities

One of our main goals will be, to also include the local communities and work together with students from Arctic areas most affected by the plastic pollution. The TOPtoTOP Team has already worked with local students, teaching them valuable outdoor skills, and thus inspiring them to become outdoor guides, focused on protecting the pristine Arctic nature. We will continue this work and plan to also engage the locals in the sampling activities. The greater idea being, that people from these remote communities could work as guides or scientific assistants in the future, performing sampling activities for researchers. This can help secure their livelihoods, which are under threat due to climate change. After our expedition we will f.e. attend the ITCA world event in Ireland (itcaworld.org) due to a partnership focused on teaching Inuit youngsters how to sail. We hope our personal interactions can excite kids and inspire solutions to mitigate the increasing problems of global change on their communities and their homeland.

Financing the outreach work

We are working on cooperations with the "Liechtensteinische Gesellschaft für Umweltschutz (LGU)" as well as the "Österreichische Forschungsförderungsgesellschaft (FFG)" and, hopefully in the near future, with the upcoming "Sparkling Science 2.0" program by the "Österreichische Austauschdienst (OeAD), focus on cooperation with schools". These cooperations will help us plan and finance our educational outreach work with the schools and students from Austria, Liechtenstein and Switzerland.

Additional Information about the research projects

Added value of the field work

Around the Arctic Sea, there are areas with different levels of pollution due to varying anthropogenic impact. To our knowledge, this is the first study dealing with a comparison of multiple differing sites. The first project focuses on multiple transects, each from a glacier to an adjacent fjord, whereas the second project focuses on sampling a large amount of coastal areas around the Arctic. To date, neither the transport vectors of MP particles on Arctic terrestrial habitats, nor the exposure of certain marine species to MP concentrations in the Arctic Sea have been well described. Hence, the research projects will help to shed light on the extent of the rising plastic pollution problem the Arctic is facing.

AMAP and OSPAR Monitoring Guidelines

Our projects shall be conducted following the guidelines of the AMAP Litter and Microplastics Expert Group concerning the monitoring of microplastics and litter in the Arctic environment, as well as the OSPAR marine litter monitoring guidelines. Thus, our research will contribute to the on-going broadscale monitoring of macro- and microplastics and help identify the scale of the problem, as well as future research goals.

Environmental footprint

The expedition will be conducted as sustainable as possible. We plan to travel from Austria to Norway by train and bus and from there on we will sail to our sampling sites. The return-journey from Iceland to Austria is planned to be by boat and train as well. We want to lead by setting a good example ourselves and use this environmentally conscious approach to also support our planned outreach work.

The research will be within the span of legal regulations of each site/island. No helicopter is required. All planned fieldwork will be conducted by foot and needs no other means of transport. Since the fieldwork does not need to follow a strict timeline, we are able to coordinate with other groups to bundle forces at the respective study sites. There is no handling with/terminating animals. As of now, the study designs are based on methods that will not have any negative impacts on the Arctic environment. We plan to implement non-invasive methods except sampling for snow, ice, water, and sediments.

Risks

Risks can arise – as in all field operations in Arctic environments – e.g. by roaming polar bears. Hence, it is crucial to get polar bear training before field trips. The team would avoid days with bad conditions (e.g. fog) to minimize the risks. Crevasses and moulins on the sampled glaciers can be avoided by following strict rules for where not to access the glacier (e.g. side moraines) and search advice from experienced personnel. The team is experienced and trained in glacier travelling and crevasse rescue and Dario Schwörer is a fully certified UIAGM mountain guide.

Feasibility

For our comprehension, the expedition is reasonably planned with included time buffer to bridge bad weather days. The locations are suitable for our planned research projects and we can count on backup by many supporters. Dario Schwörer is extremely skilled in navigating his research vessel through the Arctic Sea, as well as conducting field work in extreme environments. Birgit Sattler has spent more than 10 seasons in Ny Alesund on Svalbard and can give helpful advice on the location and possible risks. There is still some equipment stored from Sattler's working group in Ny Alesund (Arctic Station, UK) which supports the research. Furthermore, the TOPToTOP-Team already has an established network of supporters that will help guarantee the success of the expedition.

The team is familiar with natural hazards. Dario Schwörer is a fully certified UIAGM mountain-guide, Max Kortmann has experience from his work as a ski guide in the Austrian Alps, and Sebastian Pohl brings vital

medical experience from his work as a paramedic in Austria. The expedition team consists of people with a lot of combined mountaineering and outdoor experience, which is helpful for a safe assessment, as well as a productive approach in extreme areas.

Data Usage and Copyright

The data collected will belong to the participating members of the project. It will be openly shared with other scientists working in the same research field. Institutions or Organisations that would like to use our data and findings will be asked to contact us beforehand. This way, we can prevent misinterpretations and offer support, if certain aspects of the research seem unclear.

Financing the participation of Austrian researchers Max and Sebastian

Our overall budget for the sailboat expedition is calculated for a duration of 8 weeks. The expenses for the vessel are at least 100€ per person per day. This is mainly due to the fact, that the research vessel must be maintained for the whole year, even though it is mainly used during the summer months.

We (Max Kortmann and Sebastian Pohl) are planning to attain funding from the "Förderungsstipendium" as well as the "Kurzfristige Wissenschaftliche Arbeiten im Ausland (KWA) Förderung" from our home university (University of Innsbruck (UIBK), Institute of Ecology, Austria).

We already attained 1000€ of funding from the "Deutsche Gesellschaft für Polarforschung (DGP)", consisting of two individual backings of 500€ for each researcher. Furthermore, we applied for the Svalbard Environmental Protection Fund (will be notified of the outcome of our application beginning of May 2021), the "International Communications" program of the "Österreichische Forschungsgemeinschaft" (will be notified of the outcome of our application beginning of April), as well as the 5Gyres Action fund / Microgrant (will be notified of the outcome of our application end of April). We also started a crowdfunding campaign (donorbox.org).

Funding request

Including all expenditures (costs for the boat, material, travel, shipment of samples, life-suits, etc.), we calculate with roughly 7'500€ per person for an 8-week expedition. This brings our overall budget needs to around 15'000€. So far, we expect funding from our home university to range somewhere between 1'500-4'000€. We already attained funding over 1'000€ from the "Deutsche Gesellschaft für Polarforschung". As we have not yet been notified of the outcome of our other funding requests, we are still looking for additional funding in the range of approximately 12'000€. We would therefore like to ask you for financial support for our research project. If necessary, we can supply you with a detailed budget plan. All expenditures will be documented so you will have a clear overview of what your grant money will have been spent on.

Time Schedule of the project

Set up of methodology, literature research	01.03.2021	31.05.2021
Creating partnerships with schools for outreach work	01.05.2021	15.06.2021
Training period on Austrian glacier or at Expedition Base Lyngen	13.05.2021	18.05.2021
10-day Covid-19 Quarantine, incl. preparation at Exped- Base Lyngen	22.05.2021	31.05.2021
Arctic Sailboat Expedition including all field work	01.06.2021	23.07.2021
Outreach workshops at schools @ ITCA in Ireland	24.07.2021	30.07.2021
Evaluation of samples	10.08.2021	30.11.2021
Outreach workshops at schools in Liechtenstein, Austria, Switzerland	01.10.2021	28.02.2022
Writing of thesis, publications	01.12.2021	27.03.2022
Defense	28.03.2022	31.03.2022

Supporters of the Expedition

We are happy to share the network of supporters from the TOPToTOP Global Climate Expedition. They include the following institutions and organisations:

Western Norway University of Applied Sciences, Norwegian Research Centre AS (NORCE), Austrian Polar Research Institute, University of Innsbruck, ETH Zürich, University of Akureyri, Liechtensteinische Gesellschaft für Umweltschutz (LGU), Swiss Polar Institute, International Pacific Research Center, Schweizer Alpen-Club, United Nations Environment Programme

The main sponsor of the TOPToTOP foundation is Victorinox. Many more institutions and outfitters are supporting the expedition - like MyClimate, Patagonia, etc. (for a complete list of supporters see toptotop.org)

We hope to gather not yet existent data about the microplastic pollution on arctic cryospheric, terrestrial and marine habitats and use this data, as well as the documentation and reports from our research stay, to raise awareness and ignite a change of actions concerning the global plastic pollution problem.

Making our research stay available to a broader public, we hope, will help people understand global consequences of local actions and motivate them to strive for a better world - in our specific case: a world with far less plastic! Join our campaign "SAVE the ARCTIC" (adventure.ch)!

If you have any questions or would like to have additional information concerning our project, please feel free to contact us, or have a look at our website (toptotop.org)!

Sincerely,

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