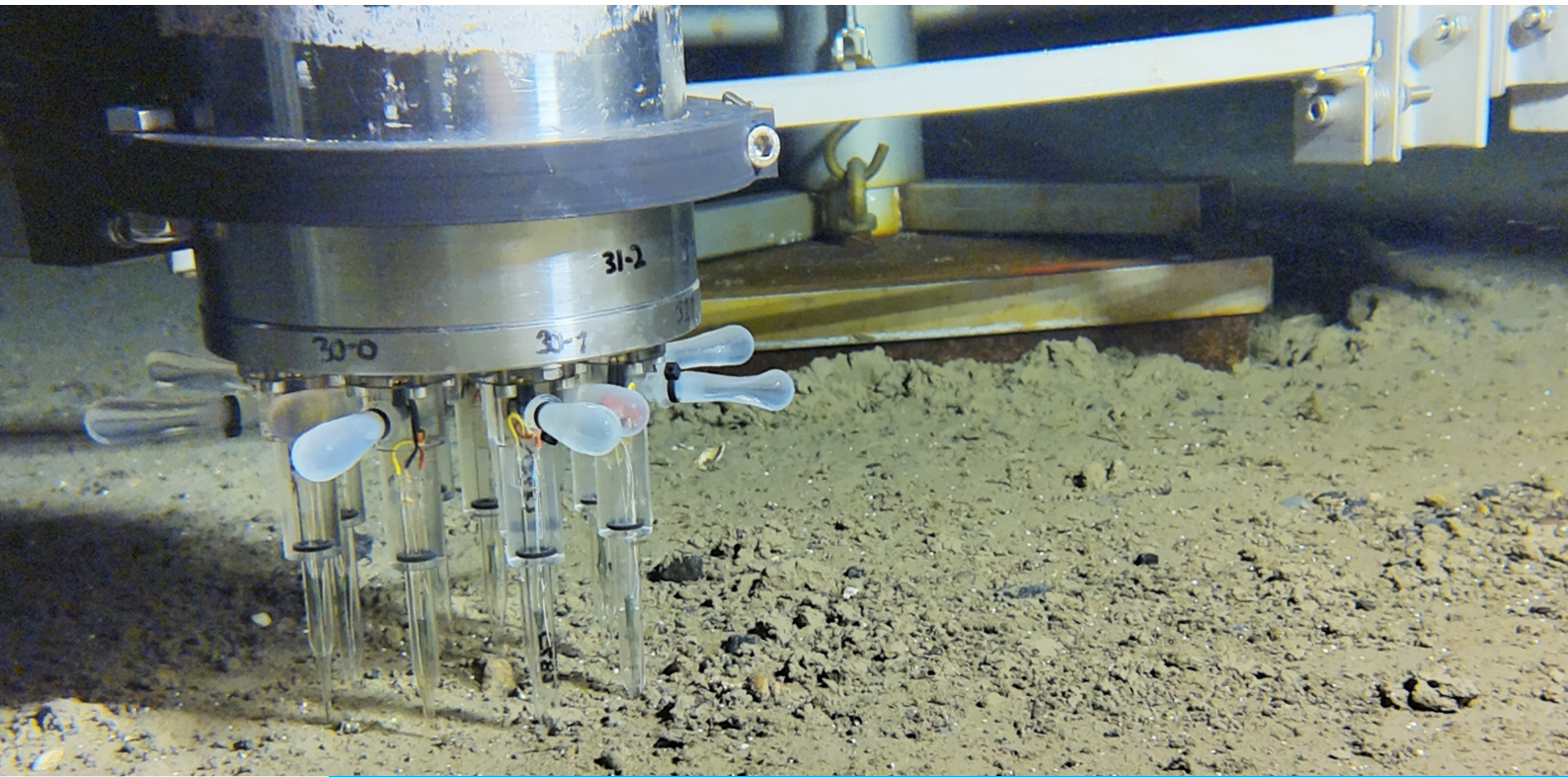




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Reports on Polar and Marine Research

**The Expedition PS143/1
of the Research Vessel POLARSTERN
to the Arctic Ocean in 2024**

Edited by

Frank Wenzhöfer

with contributions of the participants

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*Titel: In situ Mikrosensormessungen mit einem benthischen Landersystem
(Foto: Frank Wenzhöfer, AWI)*

*Cover: In situ microelectrode measurements using benthic lander
(Photo: Frank Wenzhöfer, AWI)*

The Expedition PS143/1 of the Research Vessel POLARSTERN to the Arctic Ocean in 2024

Edited by

**Frank Wenzhöfer
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PS143/1

07 June 2024 – 09 July 2024

Bremerhaven – Tromsø



**Chief scientist
Frank Wenzhöfer**

**Coordinator
Ingo Schewe**

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1. ÜBERBLICK UND EXPEDITIONSVERLAUF

Frank Wenzhöfer

DE.AWI

Die *Polarstern* Expedition PS143/1 begann am 7. Juni in Bremerhaven und führte in die Framstraße zwischen Spitzbergen und Grönland. Während dieser Reise wurden die 21 Stationen des LTER Observatorium HAUSGARTEN sowie zusätzliche Stationen wie z.B. im Molloy Deep aufgesucht, um interdisziplinäre Arbeiten von der Wassersäule bis zum Meeresboden durchzuführen (Abb. 1.1). Die Arbeiten am LTER Observatorium HAUSGARTEN stellen einen weiteren Beitrag zur Sicherstellung der Langzeitbeobachtungen dar, das in diesem Jahr sein 25-jähriges Jubiläum feiert, und in denen der Einfluss von Umweltveränderungen auf ein arktisches Tiefseeökosystem dokumentiert werden. Darüber hinaus wurde die Expedition genutzt, um weitere Installationen im Rahmen der HGF Infrastrukturmaßnahme FRAM (Frontiers in Arctic marine Monitoring) vorzunehmen. Hierzu zählte auch die Beprobung und Dokumentation von Experimenten und robotischen Plattformen am Meeresboden durch das ROV KIEL6000 (GEOMAR). Darüber hinaus leistete die Expedition Beiträge zu verschiedenen nationalen und internationalen Forschungsprojekten (MUSE, iFOODis, HADAL, HiAOOS, ICOS-D, SIOS, EPOC, AtlantEco, OBAMA-Next und Arctic PASSION). Im Rahmen des Helmholtz Forschungsprogramm "Changing Earth – Sustaining our Future" Topic 2, Subtopics 1, 3 und 4 und Topic 6, Subtopics 1, 2, 3 und 4 wurden die mit steigenden Wassertemperaturen und dem Rückgang des Meereises verbundenen Ökosystemverschiebungen im Pelagial und im tiefen Ozean ermittelt und quantifiziert. Die Hauptziele von LTER HAUSGARTEN, LTO West Spitzbergen Current und dem FRAM Ocean Observing System sind: (i) regelmäßige Beobachtung der benthischen und pelagischen Artenvielfalt und der biogeochemischen Prozesse in Abhängigkeit von den sich ändernden Umweltbedingungen und (ii) ständige Präsenz auf See zur Bereitstellung integrierter und interdisziplinärer Daten über physikalische, biogeochemische und biologische Variablen. Das FRAM-Ozeanbeobachtungssystem unterhält, entwickelt und implementiert hochmoderne synergetische Beobachtungsplattformen für die Polar-, Meeres- und Klimawandelforschung im Ozean und legt – als Prototyp für groß angelegte integrative, autonome Observatorien – die Grundlage für die nachhaltige Überwachung und das Management der ozeanischen Umwelt. Kontinuierliche Beobachtungen werden an der Schnittstelle zwischen Hydrosphäre, Kryosphäre und Atmosphäre sowie Hydrosphäre und Geosphäre durchgeführt.

Während der Expedition PS143/1 konnten alle Stationsarbeiten zur Beprobung der Wassersäule (CTD/Rosette, Multinetz) und des Meeresbodens (MUC, Kastengreifer, EBS) vollumfänglich durchgeführt werden. Hierzu zählt auch die umfangreiche Beprobung des Meeresbodens im Molloy Deep. Darüber hinaus, kamen aber auch komplexe (autonome) robotische Forschungsplattformen (Benthic Crawler, Lander, OFOBS) mehrfach und sehr erfolgreich zum Einsatz. Vor allem OFOBS konnte wiederholt und intensiv eingesetzt werden, um die unterschiedlichen Lebensräume an den LTER HAUSGARTEN Stationen wiederkehrend zu beproben, aber auch neue Lebensräume an Seeps und im Molloy Deep zu erkunden. Zusätzlich wurde das ROV (KIEL6000, GEOMAR) mehrfach eingesetzt. Hierzu erfolgte in etwa der Hälfte der Reise ein Austausch von Personal, um das ROV-Team an Bord zu nehmen. Technische Probleme und Meereisbedeckung beeinflussten zwar den Einsatz des ROV, dennoch konnten Langzeit-Experimente (Dropstones, larval traps) und der Einsatz robotischer Plattformen (Experimental-Lander, Crawler) am Meeresboden dokumentiert und

größtenteils gezielt beprobt werden. Insgesamt kann auf eine sehr erfolgreiche Expedition PS143/1 zurückgeblickt werden, die vor allem auf die gute Zusammenarbeit mit Kapitän Felix Kentges und der gesamten Besatzung der *Polarstern* zurückzuführen ist. Die Reise endete mit Einlaufen am 9. Juli in Tromsø.

SUMMARY AND ITINERARY

Polarstern Expedition PS143/1 started on June 7 in Bremerhaven and visited the Fram Strait between Spitsbergen and Greenland. During this expedition, the 21 stations of the LTER Observatory HAUSGARTEN as well as additional stations such as in the Molloy Deep were visited to conduct interdisciplinary research from the water column to the sea floor (Fig. 1.1). The studies at the LTER Observatory HAUSGARTEN represent a further contribution to the long-term observations, which are celebrating their 25th anniversary this year, and in which the influence of environmental changes on an Arctic deep-sea ecosystem are documented. In addition, the expedition was used to carry out further installations as part of the HGF infrastructure measure FRAM (Frontiers in Arctic marine Monitoring). This included the sampling and documentation of experiments and robotic platforms on the sea floor by the ROV KIEL6000 (GEOMAR). In addition, the expedition contributed to various national and international research projects (MUSE, iFOODis, HADAL, HiAOOS, ICOS-D, SIOS, EPOC, AtlantEco, OBAMA-Next and Arctic PASSION). As part of the Helmholtz research program “Changing Earth - Sustaining our Future” Topic 2, Subtopics 1, 3 and 4 and Topic 6, Subtopics 1, 2, 3 and 4, the ecosystem shifts in the pelagic and deep ocean associated with rising water temperatures and the retreat of sea ice were determined and quantified. The main objectives of LTER HAUSGARTEN, LTO West Spitsbergen Current and the FRAM Ocean Observing System are: (i) regular monitoring of benthic and pelagic biodiversity and biogeochemical processes in response to changing environmental conditions and (ii) permanent presence at sea to provide integrated and interdisciplinary data on physical, biogeochemical and biological variables. The FRAM Ocean Observing System maintains, develops and implements state-of-the-art synergistic observing platforms for polar, marine and climate change research in the ocean and lays the foundation for the sustainable monitoring and management of the oceanic environment as a prototype for large-scale integrative, autonomous observatories. Continuous observations are carried out at the interface between the hydrosphere, cryosphere and atmosphere as well as the hydrosphere and geosphere.

During PS143/1, all station work for sampling the water column (CTD/rosette, multi-net) and the seabed (MUC, box corer, EBS) was carried out in its entirety. This also includes the extensive sampling of the seabed in Molloy Deep. In addition, complex (autonomous) robotic research platforms (benthic crawler, lander, OFOBS) were also deployed several times and very successfully. OFOBS in particular was used repeatedly and intensively to map the different habitats at the LTER HAUSGARTEN stations, but also to explore new habitats at Seeps and in the Molloy Deep. In addition, the ROV (KIEL6000, GEOMAR) was deployed several times. For this purpose, personnel were exchanged about halfway through the voyage in order to take the ROV team on board. Although technical problems and sea ice cover affected the deployment of the ROV, long-term experiments (dropstones, larval traps) and the operation of robotic platforms (experimental lander, crawler) on the seafloor were documented and for the most part sampled. Overall, we can look back on a very successful expedition PS143/1, which was mainly due to the great cooperation with Captain Felix Kentges and the entire crew of *Polarstern*. The expedition ended in Tromsø on 9 July.

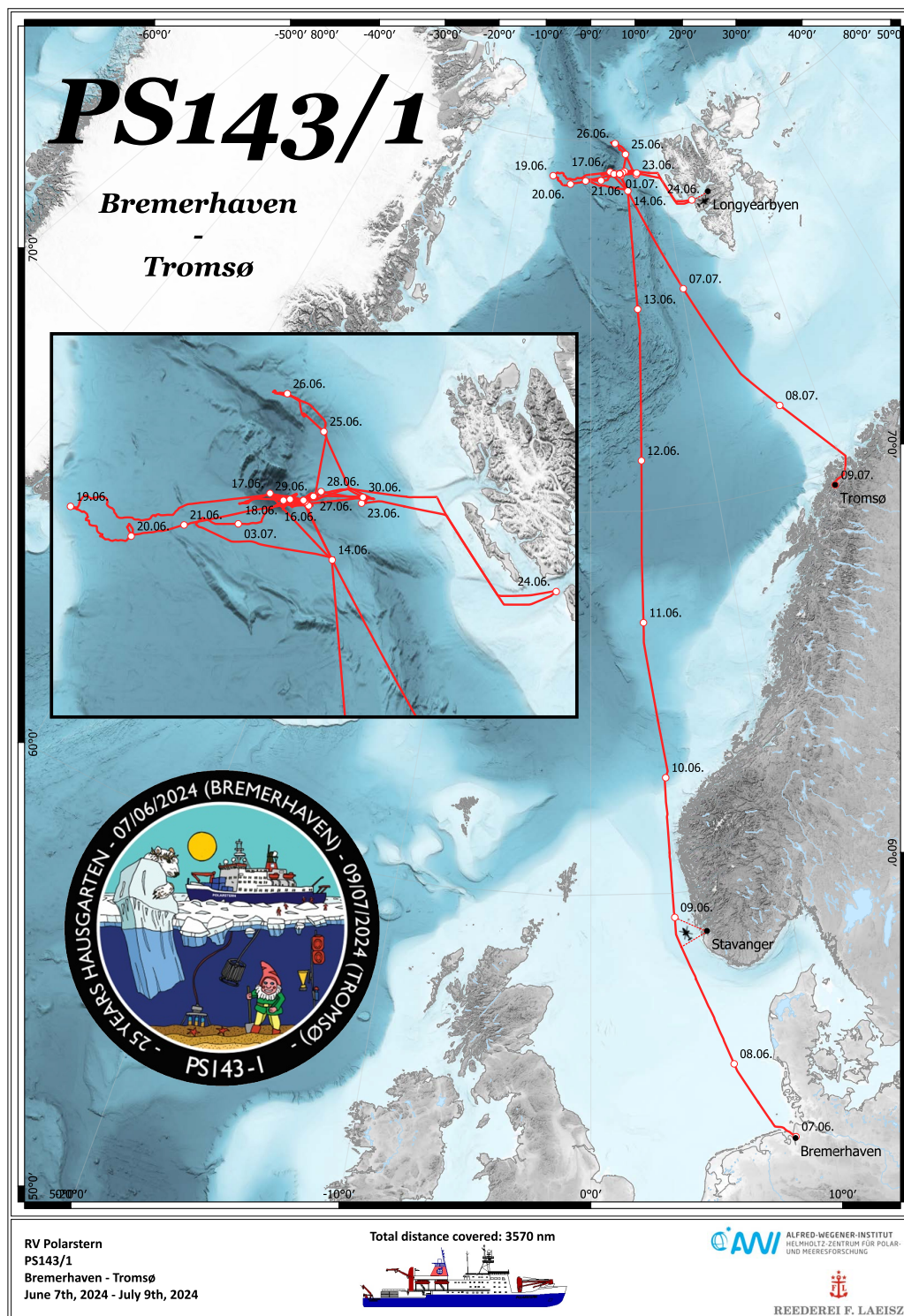


Abb. 1.1: Fahrtverlauf der Expedition PS143/1 vom Bremerhaven nach Tromsø. Siehe <https://doi.pangaea.de/10.1594/PANGAEA.972615> für eine Darstellung des Master tracks in Verbindung mit der Stationslisten für PS143/1.

Fig. 1.1: Cruise tack of expedition PS143/1 from Bremerhaven to Tromsø. See <https://doi.pangaea.de/10.1594/PANGAEA.972615> to display the master tracks in conjunction with the station list for PS143/1.

WEATHER CONDITIONS DURING PS143/1

Patrick Suter

DE.DWD

Transit Bremerhaven – Fram Strait

On the night to 8 June, *Polarstern* started from Bremerhaven and headed north. A low moved from the Shetland Islands to southern Scandinavia and intensified into a gale. After an initial cold front passage, the westerly current in the North Sea increased to 6 to 7 Bft by the evening of 8 June and to 8 Bft at night with strong gale-force gusts (9 Bft). The sea with swell increased to around 4 m. In the Utsira sea area, a temporary calm followed on 9 June with changeable weather and showers. Directly west of the gale, the northerly current intensified to strong gale-force (9 Bft) up to 45.5 kt in the northern part of Utsira during the night to 10 June, with heavy stormy gusts (10 Bft) up to 53 kt. The wind sea and swell from the north temporarily reached around 5 m, with higher individual waves. Subsequently, the gale over Scandinavia slowly weakened and a high-pressure zone was located near Iceland. On 11 June, *Polarstern* steamed between the pressure formations in the Norwegian Sea at the height of the Arctic Circle in an often strong (around 6 Bft) northerly current. A ridge of the high-pressure zone then shifted northeastwards into the sailing area, leading to calmer conditions. With higher pressure to the south and a low off the coast of East Greenland, the current turned to southwest on 13 June. Embedded in this, a warm front with precipitation and poor visibility crossed the sailing area in the Greenland Sea.

Fram Strait "Hausgarten"

On the morning of 14 June, *Polarstern* reached the eastern Fram Strait. Research work began at station S3 in the so-called "HAUSGARTEN" under the influence of an intermediate high, calm weather conditions and broken up stratus clouds. From 15 June, work took place in the area of HG stations IV and IX. A low moved from Greenland into the southwestern Fram Strait. Cool and dry air initially predominated downstream of it. However, with a slowly strengthening easterly current, warm air advection set in. This resulted in a weak frontal system and milder air on 16 June. By 17 June, a high-pressure system moved from the north to Svalbard and pushed the low southwards away. On the western flank of the high, *Polarstern* remained under the influence of weak to moderate winds from the south and mild, humid air. This led to light drizzle and, from the afternoon onwards, repeated fog.

The high subsequently moved slightly to the east. The cloud bases and visibility increased on 18 June. In the evening, *Polarstern* travelled into the western Fram Strait into the sea ice to the EG stations. In the transition area to the ice, the air temperature and consequently the cloud base dropped abruptly and individual showers formed temporarily. The high withdrew to the north and sunny weather followed temporarily. At the same time, a low-pressure zone between Jan Mayen and the North Cape intensified. As a result, a frontal system with strong warm air advection, nimbostratus clouds and precipitation as well as fresh easterly winds spread to the research area on 20 June. By 21 June, a high-pressure system near Franz Josef Land, with an associated ridge in the Fram Strait, took over. This led to a slow drying near the ground and consequently to a decrease in clouds and wind. Meanwhile, the research work in the western Fram Strait was completed and *Polarstern* moved eastwards again.

The high moved to Svalbard and then further into the Barents Sea. On its western flank, *Polarstern* came under the influence of a southeasterly current that strengthened to 5 Bft from 22 June, bringing in significantly more humid and milder air. After an abrupt transition to fog in the night to 22 June, the low-level clouds lifted again somewhat in the course of the day. However, with intermittent light drizzle and stratus clouds, moderate visibility repeatedly prevailed on 23 June.

By the morning of 24 June, *Polarstern* had moved southeast along Svalbard to the entrance of the Isfjord. From there, a personnel exchange took place and members of the ROV-team came on board with two helicopter flights to the airport in Longyearbyen. With the southeasterly flow direction towards Svalbard, the weather conditions in the Isfjord were favourable on the lee-ward side. With weak winds from variable directions, stratocumulus clouds in the fjord and individual flat cumuli on the mountain slopes were prevailing. Visibility was very good and in the course of the day the clouds in the fjord and from the south increasingly dissipated. In the evening, *Polarstern* travelled back north along Svalbard, where the research work continued in the northeastern part of the Fram Strait at the northernmost stations (N3 to N5), some of which were located in sea ice.

By 25 June, a low-pressure system moved into the Fram Strait from the south. This shovelled a lot of moisture and a frontal system to the north. The surface current turned northeast to east, increased to 5 Bft and the air became increasingly humidified and cooler. The nimbostratus clouds caused rain, drizzle and fog at times. The low slowly moved eastwards over the course of 26 June. Temperatures remained below freezing throughout the day. The cloud cover and visibility increased slightly, but the intermittent light rain was supercooled, although lead to no ice accumulation on the ship.

By 27 June, *Polarstern* was again travelling slightly southwards into the area of the HG stations. The weather situation changed in rapid succession. First, on 27 June, a high-pressure ridge moved from west to east and caused a temporary decrease in cloud cover. Directly behind it, a low formed over Northeast Greenland. By the evening, *Polarstern* was located on its downstream area, where the current turned back from northwest to southwest, increased to 6 to 7 Bft and temporarily brought in milder air. As a result, the swell from southwest increased to 2 m in the evening. The low moved eastwards just north of the ship during the night of 28 June, accompanied by warm- and cold fronts. On 28 June, a new high-pressure ridge followed from the west and the current turned northwest again and steadily decreased. The cooler air that flowed in with the cold front was displaced by slightly milder air in the course of the day. As a result, the low stratus clouds slowly dissipated and the stratocumulus made way for the sun in the night to 29 June.

By 29 June, the ridge had strengthened into an independent high over Svalbard. With a surface trough along the coast of Northeast Greenland, an increasingly strong (6 to 7 Bft) southwesterly current developed. This brought in low-level stratus again by the afternoon. In the meantime, an ice tongue running southwards had formed in the area of the HG stations at the water-sea ice transition zone. *Polarstern* repeatedly alternated between open water and loose ice until the end of the expedition. In the loose ice, as well as east of the ice tongue, the southwesterly swell of mostly around 1.5 m was significantly dampened. On 30 June, the high moved southeast into the Barents Sea. The surface trough on the coast of Northeast Greenland and the southerly wind weakened. The stratus and fog that still lay over the ice at the beginning dissipated by midday and then it was mostly sunny with few cirrus. From the beginning of July, the high-pressure zone over the Barents Sea weakened, but formed a ridge north of Svalbard. At the same time, a dissipating low slowly moved southwards from the western Fram Strait. On the night to 1 July, a moderate southerly current brought in significantly more humid air. Especially over ice due to the additional cooling in the boundary layer near the ground, but also partly over the milder water, fog and light drizzle occurred at times.

Until 3 July, there was still a weak high north of *Polarstern* and a high-pressure ridge over the western Fram Strait. As the current turned northwards in the meantime, a lee-side cyclone

developed over the southern part of Svalbard. This surface low moved slightly southwestwards and was only just south of the research area. As a result, the pressure gradient slowly intensified over the eastern Fram Strait. The north to northeasterly wind reached 4 to 5 Bft on 3 July and 6 to 7 Bft from the night to 4 July with gusts of up to 35 kt (8 Bft) at times. There was a repeated alternation of very low-lying stratus, which often directly overlay the ice and appeared as shallow fog, but also sunny episodes with few clouds. Outside the ice, the sea rose to 2 m with swell from northeast, while there was hardly any swell in the loose ice.

By 5 July, the lee-side low had detached from Svalbard and moved southwards, while filling up. Meanwhile, a new low was approaching from Franz Josef Land. After a temporary break-up of the clouds, a weak frontal system and moist air was brought in from the northeast until the evening. At the rear side of the frontal system, the northerly wind reached around 6 Bft. With it, slightly unstable and cooler air flowed into the lower layers during the following night, which led to cumulus clouds and isolated light snow showers. At the same time, the low slowly moved south-westwards over Svalbard and dissipated. Meanwhile, the research work was completed by the evening of 6 June and *Polarstern* set off on its transit to Tromsø.

Transit eastern Fram Strait – Tromsø

While *Polarstern* was travelling south, a strong low-pressure zone moved northwards from the North Cape, while deepening into a gale, and crossed the cruising area to the east. On the western flank of the low-pressure zone, the northerly current reached 5 to 6 Bft on 7 July within a frontal system. With swell from northeast to the east, the wave heights were 2.5 m. By 8 July, the large low-pressure zone had shifted to Svalbard. On its southern flank the current in the Norwegian Sea turned west to southwest and increased again to 7 to 8 Bft by the evening, just off the coast of Norway, with strong gale-force gusts up to 9 Bft. On open sea, the waves rose to 2,5 to 3 m. On the morning of 9 July, *Polarstern* docked in Tromsø, bringing the PS143/1 expedition to an end with a cloudy sky.

In summary, it can be said that the general weather pattern from past summer expeditions in the Fram Strait was similar on this trip. The sea level pressure varied between 997 and 1026 hPa. As usual, the weather was largely characterised by the constantly cold boundary layer, respectively especially over ice by a surface inversion and accordingly often by fog. Fog was registered on 13 of 23 days. The average temperature in the research area was 2,1°C, with an absolute maximum of 6,2°C and a minimum of -2,4°C.

2. LTER HAUSGARTEN: IMPACT OF CLIMATE CHANGE ON ARCTIC MARINE ECOSYSTEMS

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Objectives

The marine Arctic has played an essential role in the history of our planet over the past 130 million years and contributes considerably to the present functioning of the Earth and its life. The past decades have seen remarkable changes in key Arctic variables, including a decrease in sea-ice extent and sea-ice thickness, changes in temperature and salinity of Arctic waters, and associated shifts in nutrient distributions and pollution (Bergmann et al. 2022). Since Arctic organisms are highly adapted to extreme environmental conditions with strong seasonal forcing, the accelerating rate of recent climate change challenges the resilience of Arctic life. The stability of a number of Arctic populations and ecosystems is probably not strong enough to withstand the sum of these factors, which might lead to a collapse of subsystems.

Benthos, particularly in deep waters, is a robust ecological indicator for environmental changes, as it is relatively stationary and long-lived and reflects changes in environmental conditions in the oceans (e.g. organic flux to the seabed) at integrated scales (Gage and Tyler 1991; Piepenburg 2005). To detect and track the impact of large-scale environmental changes in the transition zone between the northern North Atlantic and the central Arctic Ocean, and to determine experimentally the factors controlling deep-sea biodiversity, the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI) established the deep-sea observatory HAUSGARTEN, which constitutes the first, and until now only open-ocean long-term observatory in a polar region (Soltwedel et al. 2016).

HAUSGARTEN is located in the eastern Fram Strait and comprises 21 permanent sampling stations along a depth transect (250 – 5,500 m) and along a latitudinal transect following the 2,500 m isobath crossing the central HAUSGARTEN station (Fig. 2.1). Multidisciplinary research activities at HAUSGARTEN cover almost all compartments of the marine ecosystem from the pelagic zone to the benthic realm, with a focus on benthic processes. Regular sampling as well as the deployment of moorings and different stationary and mobile free-falling systems (bottom lander, benthic crawler), which act as local observation platforms, have taken place since the observatory was established in 1999. Visual observations were regularly undertaken by towed photo/video systems to assess spatial patterns and temporal dynamics of epibenthic megafauna and habitat characteristics.

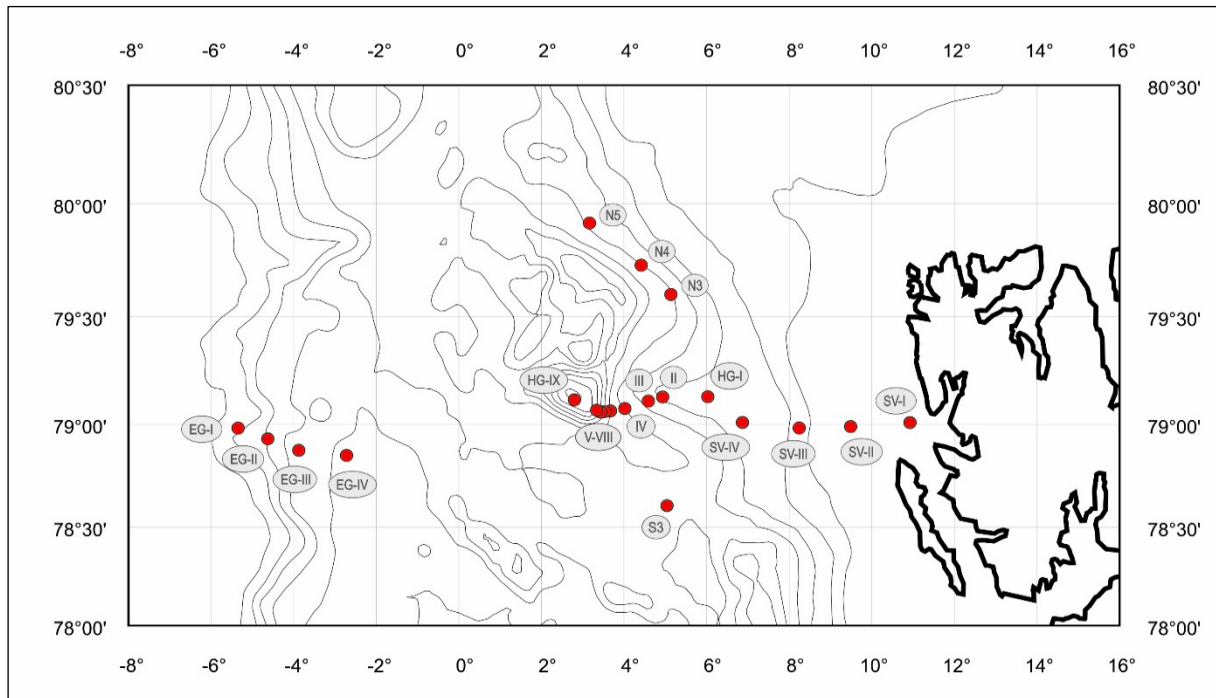


Fig. 2.1: Permanent sampling sites of the LTER (Long-Term Ecological Research) observatory HAUSGARTEN in Fram Strait, Arctic Ocean

Geographical features in the HAUSGARTEN area provide a variety of contrasting marine landscapes and landscape elements (e.g. banks, troughs [marine valleys], ridges and moraines, canyons and pockmarks) that generally shape benthic communities over a variety of different scales (Buhl-Mortensen et al. 2010, 2012). The habitat-diversity (heterogeneity) hypothesis states that an increase in habitat heterogeneity leads to an increase in species diversity, abundance and biomass of all fauna groups (Whittaker et al. 2001; Tews et al. 2004). Improved technologies, particularly the recent deployment of side-scan sonar systems within the Deep-Sea Research Group (Purser et al. 2019), towed across the seafloor by camera sleds, have highlighted the high-resolution topographic variability of many deep-sea areas, including HAUSGARTEN (Schulz et al. 2010; Taylor et al. 2016; Purser 2020). So far, the time-series stations maintained across the region do not capture the high degree of local heterogeneity (in terms of physical seafloor terrain variables such as slope, rugosity, aspect, depth). Therefore, targeted spatial data were collected during the *Polarstern* expedition PS143/1 to assess the role of this heterogeneity for species diversity and biomass estimation and to complement the studies on the temporal variability of the benthos in the HAUSGARTEN area. As these time-series photographs have also brought to light a sevenfold increase in marine debris between 2004 and 2017 (Parga Martínez et al. 2020) a pollution observatory has been added to HAUSGARTEN to assess plastic pollution in all ecosystem compartments. This research has shown particularly high microplastic concentrations in sediments (Tekman et al. 2020). To determine the exposure of sediment-dwelling biota to micro- and nanoplastic pollution, we thus aim to assess ingestion rates and the level of plastic additives in their tissues. In addition, ROV experiments initiated in 2015 to assess the impact of plastic-covered sediments on benthic biogeochemistry, bacterial and meiofaunal abundance were completed. Benthic communities are strictly dependent on carbon supply through the water column, which is determined by temporal and spatial variations in the vertical export flux from the euphotic zone but also lateral supply from shelf areas. Most organic carbon is recycled in the pelagic, but a significant fraction of the organic material ultimately reaches the seafloor, where it is either re-mineralized or retained in the sediment record. One of the central questions is to what

extent sea-ice cover controls primary production and subsequent export of carbon to the seafloor on a seasonal and interannual scale. Benthic oxygen fluxes provide the best and integrated measurement of the metabolic activity of surface sediments. They quantify benthic carbon mineralization rates and thus can be used to evaluate the efficiency of the biological pump. In order to link long-term variations in surface and sea-ice productivity and consequently in export flux to the seafloor, detailed investigation of the temporal variations in benthic oxygen consumption rates would be very valuable. Yearly measurements with benthic lander provide information on the interannual variations. Benthic crawler, mobile seafloor platforms capable to perform weekly oxygen gradient measurements for a 12-month period, provide information on the seasonal variations. In addition, long-term benthic lander systems equipped with sediment traps and cameras for time-lapse imaging of the seafloor record the supply of organic material throughout the year.

Work at sea

The current cruise will complete the dataset over a 25-years time span and will serve to detect long-term changes of benthic communities. The composition, diversity, density and biomass of benthic communities will be analysed together with environmental data to detect changes due to environmental regime shifts in the deep sea of the Fram Strait. Within a complementary sampling design covering all size classes of benthic communities from bacteria to megafauna.

Long-term meiobenthic study

Virtually undisturbed sediment samples were taken using a video-guided multiple corer (MUC). Various biogenic compounds from these sediments were analysed to estimate the input of organic matter to the seafloor as well as activities (e.g. bacterial exoenzymatic activity) and the total biomass (i.e. particulate proteins, phospholipids) of the smallest sediment-inhabiting organisms (Tab. 2.1). Results will help to describe ecosystem changes in the benthos of the Arctic Ocean. Sediments retrieved by the MUC will also be analysed for the quantitative and qualitative assessment of the small benthic biota. Meiofauna spatial and temporal distribution patterns, with special focus on density and diversity of nematode community composition will be analysed.

Sediments are sampled to describe small-scale spatial patterns as vertical gradients within the sediment as well as large-scale patterns for different water depths. The first 15 years of the HAUSGARTEN time series are being evaluated as part of doctoral dissertations focusing on nematode community patterns. In order to continue this unique time series in the future, sediment cores are taken along the HAUSGARTEN depth transect for the analysis of the meiofaunal communities. These cores were also sub-sampled for various environmental parameters indicative of the food input to the deep seafloor. In addition, these samples will serve as background information for various biological experiments investigating the causes and effects of gradients on biodiversity patterns and community composition of benthic organisms to be installed at the central HAUSGARTEN station during future expeditions.

Sediment-bound chloroplastic pigments (chlorophyll *a* and its degradation products) represent a suitable indicator for the input of phytoplanktonic detritus to the seafloor, representing the major food source for benthic organisms. They can be analysed with high sensitivity by fluorometric methods. To estimate the potential heterotrophic activity of bacteria, we measured cleaving rates of extracellular enzymes using the model-substrate FDA (fluorescein-di-acetate) in incubation experiments. Results will help to describe ecosystem changes in the benthos of the Arctic Ocean.

Additional samples were taken to analyse the abundance and biomass of bacteria as well as meiofauna densities and the diversity patterns of nematodes.

Bacterial activities and chloroplastic pigments were analysed on board. All other sub-samples

were stored for later analyses of the meiobenthic fauna and various biochemical bulk parameters at the home lab.

Tab. 2.1: PS143/1 HAUSGARTEN stations with station ID, date, geographic position, and water depth. Stations were sampled with multiple corer (MUC) and box corer (BC).

Site	Station ID	Date	Latitude	Longitude	Depth [m]	Gear
HG-I	PS143/1_14-5	22/06/2024	79° 07.98' N	006° 05.59' E	1224	MUC
HG-I	PS143/1_14-9	23/06/2024	79° 07.99' N	006° 05.56' E	1224	BC
HG-II	PS143/1_24-5	28/06/2024	79° 07.81' N	004° 54.35' E	1498	BC
HG-II	PS143/1_24-6	28/06/2024	79° 07.77' N	004° 53.88' E	1507	MUC
HG-III	PS143/1_22-4	27/06/2024	79° 06.13' N	004° 33.75' E	1878	MUC
HG-III	PS143/1_22-5	27/06/2024	79° 06.12' N	004° 33.84' E	1953	BC
HG-IV	PS143/1_4-12	16/06/2024	79° 04.05' N	004° 17.92' E	2321	MUC
HG-IV	PS143/1_4-13	17/06/2024	79° 03.92' N	004° 10.94' E	2394	BC
HG-V	PS143/1_27-4	29/06/2024	79° 03.40' N	003° 46.32' E	2721	BC
HG-V	PS143/1_27-5	29/06/2024	79° 02.21' N	003° 41.42' E	2821	MUC
HG-VI	PS143/1_30-4	30/06/2024	79° 02.87' N	003° 37.42' E	3277	MUC
HG-VI	PS143/1_30-5	01/07/2024	79° 02.70' N	003° 34.83' E	3461	BC
HG-VII	PS143/1_11-4	21/06/2024	79° 03.52' N	003° 28.89' E	3322	MUC
HG-VII	PS143/1_11-5	22/06/2024	79° 03.53' N	003° 28.96' E	3821	BC
HG-IX	PS143/1_5-8	17/06/2024	79° 08.56' N	002° 45.61' E	5440	BC
HG-IX	PS143/1_5-9	18/06/2024	79° 08.57' N	002° 45.58' E	5437	MUC
N3	PS143/1_19-2	25/06/2024	79° 35.69' N	005° 12.53' E	2685	BC
N3	PS143/1_19-3	25/06/2024	79° 35.70' N	005° 12.57' E	2684	MUC
N4	PS143/1_20-5	26/06/2024	79° 44.39' N	004° 25.55' E	2534	MUC
N4	PS143/1_20-9	26/06/2024	79° 43.85' N	004° 27.87' E	2608	BC
N5	PS143/1_21-5	26/06/2024	79° 56.42' N	003° 13.13' E	2459	MUC
N5	PS143/1_21-9	26/06/2024	79° 55.36' N	003° 11.95' E	2482	BC
S3	PS143/1_2-3	14/06/2024	78° 36.48' N	005° 03.72' E	2344	MUC
S3	PS143/1_2-7	14/06/2024	78° 35.92' N	005° 04.82' E	2342	BC
EG-I	PS143/1_6-5	19/06/2024	79° 00.35' N	005° 16.94' W	1096	MUC
EG-I	PS143/1_6-8	19/06/2024	79° 00.75' N	005° 22.10' W	1035	BC
EG-II	PS143/1_7-4	19/06/2024	78° 56.19' N	004° 37.94' W	1502	MUC
EG-II	PS143/1_7-5	19/06/2024	78° 56.08' N	004° 39.70' W	1483	BC
EG-III	PS143/1_8-4	20/06/2024	78° 48.56' N	004° 00.75' W	1819	MUC
EG-III	PS143/1_8-5	20/06/2024	78° 48.18' N	004° 03.83' W	1775	BC
EG-IV	PS143/1_9-4	20/06/2024	78° 48.70' N	002° 54.35' W	2477	BC
EG-IV	PS143/1_9-5	20/06/2024	78° 49.28' N	002° 44.85' W	2507	MUC
Marmic	PS143/1_25-3	29/06/2024	79° 03.95' N	004° 11.23' E	2388	MUC

Long-term macrobenthic study

Macrobenthos in the HAUSGARTEN area has been studied only irregularly over the past 25 years. Sampling of the macrofauna during PS143/1 continues the time-series work to allow the assessment of long-term changes of benthic populations at HAUSGARTEN. The unique samples allow a continuation of the long-term series along depth gradients from the top to

deeper adjacent areas and a comparison between samples of ice-free zones and stations covered mainly by ice throughout most of the year.

We were able to take 16 box corer samples (Tab. 2.1) at 16 sites. Macrobenthic samples were obtained by USNEL box corer (0.25 m²; Fig. 3.2, left), a preferred sampling gear in deep waters, as it provides reliably deep and relatively undisturbed sediment samples adequate for macrofauna sampling.

For further processing, box corer samples were divided into eight equal subsamples. The upper 12 cm of each subsample sediment and the supernatant seawater to catch epibenthic animals from the fluffy layer on top of the sediment, were taken for further sample processing. Quantitative and qualitative samples were sifted over a 500 µm mesh size sieve and sieve residues were preserved in 4% buffered formalin. In the laboratory at AWI, species, such as the holothurians found at station N4 (Fig. 2.2), will be determined to the lowest possible taxonomic level, counted and wet mass will be determined per species.



Fig. 2.2: UNSEL box corer while setting out for station (left) and the sea cucumbers *Elpidia heckeri* (middle) and *Kolga hyalina* (right) found at station N4

The epibenthic sledge (EBS; Fig. 2.3) was used to enhance the recorded biodiversity collected by the box corer and as a complementary method to the biodiversity recorded in OFOBS video and picture material. In total, the EBS was deployed at five HAUSGARTEN stations (Tab. 2.2). During four stations, a Posidonia USBL transponder was attached to the sledge to allow precise tracking of the ground touchdown and take-off moment. Two of the EBS stations were repeating the stations from 2023 in the central HAUSGARTEN (HG-IV and HG-IX). To add knowledge, additional three stations, which had not been sampled in 2023, were chosen to complement the dataset: HG-I, HG-III and a site North-East of EG-IV. In 2023, the EBS was deployed South-West of EG-IV. Both EBS deployments in distance from EG-IV were over 20 nm away from the center point of EG-IV and therefore regarded as additional station.



Fig. 2.3: The Epibenthic Sledge 'Berta' (Brenke 2005) hoisted back on deck after successful deployment at the Molloy Hole station PS143/1_5-4 (HG-IX)

Epibenthic sledges (EBS) with a bottom shovel to open the sampler box doors on the seafloor only are proven sampling devices to collect macrofaunal organisms on and above the seafloor (Brenke 2005). The EBS was equipped with a bracket to hold a Posidonia USBL transponder on deployment. The sampler boxes are referred to as epi-net (lower box) and supra-net (upper box). The mesh size of the nets is 500 μm . The cod ends are equipped with net-buckets containing a 300- μm mesh window following the description of Brenke (2005). Additional to the supranet, an inner net layer of 65 μm mesh size in the size of one metal subframe ($\sim 30 \times 20 \text{ cm}$) was attached to the entrance of the samplers to collect potential larvae of deep-sea invertebrates.

The EBS deployment protocol was manually adjusted to sea ice conditions and vessel drift speed. In general, the gear was veered out with 1 m/s until 200 m above the ground. There, the winch veering speed was reduced to the vessel's drifting speed between 0.3 and 0.6 m/s to allow a smooth landing on the seafloor. After touchdown, between 100 and 300 m of cable wire were laid out on the seafloor with the same veering speed while the vessel kept drifting. To remove loops of the wire, the ship continued moving for a maximum of 10 minutes while the winch was stopped. The EBS was trawled over the ground with 0.3 to 0.7 m/s until it left the ground. Hoisting the gear on deck was carried out with 1.0 m/s.

The total trawling distance covered 4,662 m of the seafloor and was calculated with the following formula:

$$s = v_1 * t_1 + v_2 * t_2$$

s = trawling distance [m]; v_1 = vessel speed during trawling [m/s]; t_1 = vessel trawling time [sec];
 v_2 = winch hoisting speed [m/s]; t_2 = winch hoisting time [sec]

Tab. 2.2: EBS station list including the information about the total trawling distance. Start trawl is the position of the vessel when gear is on ground, end trawl is the position when the gear leaves bottom.

Area	Station	Date	Latitude [deg]	Longitude [deg]	Depth [m]	Trawling distance [m]
HG-IV (Central HAUSGARTEN)	PS143/1_4-1	15/06/24	Start trawl: 79.046829 End trawl: 79.051039	4.413203 4.393428	2367 2362	720
HG-IX (Molloy Hole)	PS143/1_5-4	17/06/24	Start trawl: 79.131505 End trawl: 79.128889	2.911277 2.938344	5427 5420	744
EG-IV (East Greenland)	PS143/1_10-1	21/06/24	Start trawl: 78.917879 End trawl: 78.918454	-0.620324 -0.610934	2580 2578	342
HG-III (Central HAUSGARTEN)	PS143/1_13-1	22/06/24	Start trawl: 79.093627 End trawl: 79.090227	4.661595 4.675832	1974 1979	690
HG-I (Methane seeps)	PS143/1_16-1	23/06/24	Start trawl: 79.049988 End trawl: 79.032303	6.648729 6.656012	1199 1226	2166

Sample treatment

Generally, each EBS sample was sieved over 300 µm meshsize at cool condition either at the sieving table outside (Überstand) or inside the cooling container at 0°C. The sieving in the cooling container allowed live picking of animals for different purpose in sheltered conditions and a gentle sample treatment to avoid damage of the animals. For the macrofauna live picked specimens, if >3 specimens were found of the same morphotype, one was fixed in 96% non-denaturated ethanol, one was frozen at -80°C and one preserved in RNA later, to enable additional transcriptome and genome studies.

In total, 35 kautex jars with 300 – 1,000 mL sample volume were collected, fixed in pre-cooled denaturated 96% ethanol and kept at -20°C. Selected samples were sorted directly on board following the protocol described in Riehl et al. (2014) given the importance of an undisturbed cooling chain. Remaining samples will be sorted in the home laboratories of the German Center for Marine Biodiversity Research (DZMB) in Hamburg. A first overview of live picked and sorted specimens is given in Figure 2.4.

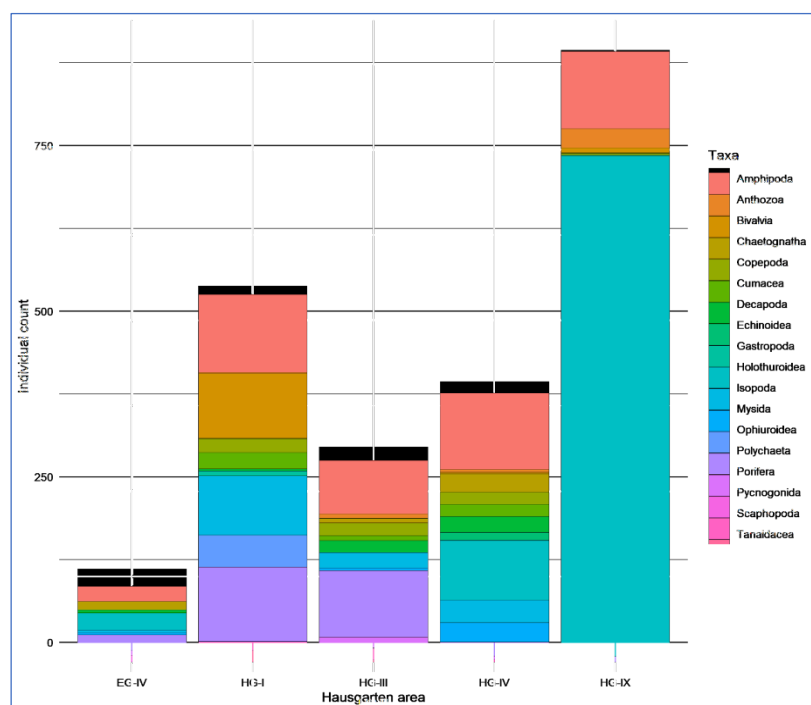


Fig. 2.4: First overview of live picked and sorted taxa on board sampled at five HAUSGARTEN areas

From the two repeated central HAUSGARTEN stations HG-IV and HG-IX, the EBS samples contributed mainly to the work of several research projects within the HADAL group of Ronnie Glud (SDU) and the INSPIRES PhD position for microplastic research led by Melanie Bergmann (AWI). The HADAL group received 19 specimen samples (in total 263 individuals) from HG-IV and HG-IX, collected for analyses of pressure effects on oxygen isotope ^{18}O enrichment and Persistent Organic Pollutant (POP) accumulation including the taxa Amphipoda, Mysida, Polychaeta, Decapoda, Echinoidea, Holothuroidea, Porifera, and Anthozoa. The INSPIRES microplastic research group received 98 specimen samples (in total 776 individuals) from all HAUSGARTEN sites for microplastic analyses including the taxa Amphipoda, Annelida, Anthozoa, Asteroidea, Bivalvia, Chaetognatha, Cnidaria, Crinoidea, Cumacea, Decapoda, Demospongiae, Echinoidea, Holothuroidea, Hydrozoa, Isopoda, Mysida, Ophiuroidea, Polychaeta, Porifera, Pycnogonida, Scaphopoda, Sipunculida. Specimens from these two stations were live picked within two hours after sample retrieval at 0-4°C in the cooling container and identified on the lowest possible taxonomic level using a Leica MZ12.5 stereomicroscope. Each specimen was photographed and catalogued via the DZMB on board database given an individual catalogue number. Specific interest in taxonomic identification was given on the methane seep station close to HG-I to describe the faunal communities. Furthermore, attention was on the taxa important for two PhD theses in the frame of the ALONGate project at the University of Hamburg and the University of Iceland (Ophiuroidea, Pantopoda, Cumacea) and a HECTOR project (Erasmus+) in cooperation of AWI and University of Bremen (Isopoda).

DNA extraction

Select samples over 1 cm in size were chosen for tissue subsampling and DNA extraction, resulting in 60 extractions of five taxa (Amphipoda, Ophiuroidea, Polychaeta, Pycnogonida, Sipunculida). Approximately 3 mm³ of soft tissue were removed, with care being taken to not

destroy taxonomically informative characters during tissue sampling. Extraction was performed on board the *Polarstern* using the Macherey-Nagel “Genomic DNA from Tissue” NucleoSpin® Tissue 250 preps kit (740952.250). The manufacturer’s standard protocol for human or animal tissue and cultured cells was followed with the following deviations: All tissue pre-lysis with Proteinase K was performed for a minimum of 12 hours, and for the final elution a high yield and high concentration variant protocol was performed, where half the Elution Buffer (50 μ l of 5 mM Tri/HCL, pH 8.5) was added at a time for an increased incubation time (3 min) with a centrifugation following each incubation. All extracts were finally stored at -80°C.

In general, the samples will allow a comparison to the EBS samples from recent expeditions in subarctic (www.iceage-project.org) and central arctic waters (PS138 ArcWatch in 2023) available at the DZMB complementing the long-term study approach of HAUSGARTEN and contributing to the ALONGate project (A Long-term observatory of the North Atlantic Gateway to the Arctic Ocean; 2024/25 -2029/30).

Larval collections with EBS

The EBS collected a number of specimens with the larval net in the supra compartment. The most common taxa were polychaetes and gastropods. The specimens collected are most likely not proper larvae but rather post-metamorphic juveniles. The smaller mesh size permitted collection of small, newly-settled individuals.

Long-term megabenthic study and seafloor mapping

The newly constructed Ocean Floor Observation and Bathymetry System II (OFOBS II; Purser et al. 2019) was field tested during the PS138 expedition during 2023. During PS143/1 the system was deployed along previously established and analyzed camera tracks to assess interannual dynamics of megafauna on the seafloor at selected stations (HG-I, HG-IV, N3, S3, but with potential changes made in response to ice and weather conditions). The OFOBS II was towed at 1.5 m altitude for 4-hours at each survey site. A subset of images will be analyzed and compared with previous data to assess interannual dynamics of megafaunal assemblages. The imagery will also be used to quantify litter on the seafloor. The AWI “Remora class” MiniROV was attached to OFOBS II for some deployments and used to close up imaging work, or equipment retrieval, as required.

The OFOBS II is equipped with a multibeam system allowing to collect spatial data to develop the high-resolution seafloor topographical maps of the HAUSGARTEN. During PS143/1 a newly developed sampling net device was mounted on OFOBS II behind the still camera. The aim of this net is to allow the directed sampling of fauna on the seafloor, such as small sponges or holothurians. This device was trialled during the expedition in expectation of extended use during the PS146 Antarctic expedition in December 2024.

All data collected with the OFOBS II will be used to test a new data archiving ingest protocol developed by Christopher Krämmer (AWI) and Lilian Boehringer (AWI), strictly following the guidelines and metadata schemes presented in Schoening et al. (2022).

Benthic flux study

Seafloor carbon mineralization was studied *in situ* at sites with varying sea-ice conditions (HG-IV, N4; Tab. 2.3) using a benthic lander system (Hoffmann et al. 2018). The benthic O₂ uptake is a commonly used measure for the benthic mineralization rate. Benthic oxygen consumption rates were measured at different spatial and temporal scales. The benthic lander was equipped with two different profiling instruments to investigate the oxygen penetration and distribution as well as the benthic oxygen uptake of Arctic deep-sea sediments: i) electrode-microprofiler, for high-resolution pore water profiles (O₂, resistivity) across the sediment-water interface, and ii) a deep-water optode-profiler, to measure the entire oxygen penetration depth. The overall

benthic reaction is followed by measurements of the sediment community oxygen consumption in incubation chambers to calculate carbon turnover rates.

At HG-IV, a benthic crawler system (Crawler III; Fig. 2.5) was deployed for its 12-month mission (recovery during a *Polarstern* expedition in 2025. The crawler system is pre-programmed to perform >50 measurements along a ca 1.0 km transect. Crawler III (similar with crawler NOMAD; Lemburg et al. 2018) uses oxygen optodes to measure vertical concentration profiles across the sediment-water interface (one set of profiles each week. Additionally, the crawler is equipped with benthic chambers and a seafloor imaging and scanning camera system to take images of the seafloor combined with a laser scan. From this information we are able to reconstruct the sediment surface at high resolution. When seafloor images and topography scans are overlaid, we will be able to identify hot spots of intensified organic matter accumulation. These two seafloor observations are performed during the 10 m long transect at the beginning of each measuring cycle. At the end of this transect, concentration profiles of oxygen are measured across the sediment water interface. From these profiles diffusive oxygen fluxes can be obtained. Chamber incubations, performed at the same time, provide the total oxygen demand of the seafloor. Both measurements provide information on the oxygen consumption related to carbon mineralization. These cycles are repeated every week for a period of 12-month.

Tab. 2.3: Lander deployments

Event label	Station	Date / time	Action	Latitude	Longitude	Depth (m)	Latitude (deg)	Longitude (deg)
PS143/1_4-2	HG-IV	15.06.24 19:39	deployed	79°04,714' N	004°20,866' E	2224	79.07857	4.347772
PS143/1_4-2	HG-IV	16.06.24 16:03	released	79°04,856' N	004°19,527' E	2224	79.080938	4.325456
PS143/1_19-1	N3	25.06.24 08:03	deployed	79°35,711' N	005°15,372' E	2644	79.59519	5.256201
PS143/1_19-1	N3	27.06.24 03:56	released	79°35,775' N	005°16,204' E	2626	79.596242	5.270061

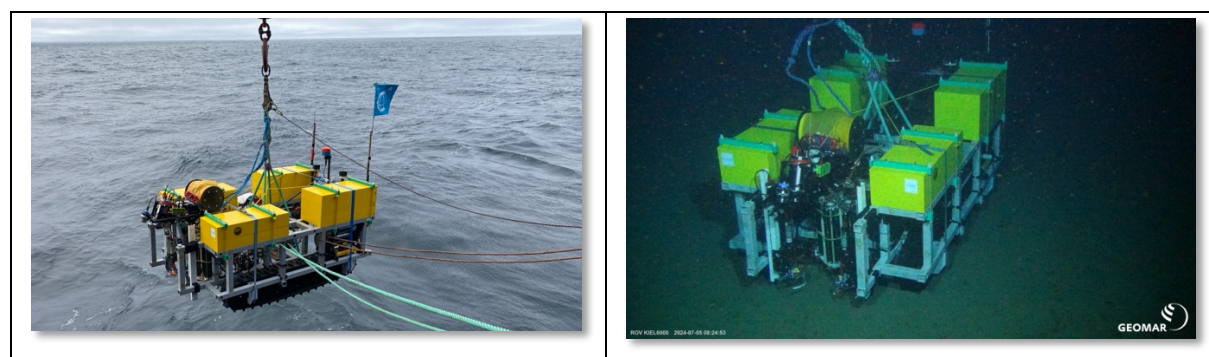


Fig. 2.5: Crawler-III deployment at HG-IV (left: Crawler being released at the surface and right: Crawler at the seafloor starting its first movement (Photo ROV KIEL6000 GEOMAR, Kiel)

Experimental work at LTER HAUSGARTEN

Carbon enrichment experiment

Ocean acidification has been identified as a risk to marine ecosystems, and substantial scientific effort has been expended on investigating its effects, mostly in laboratory manipulation experiments. Experimental manipulations of CO₂ concentrations in the field are difficult, and the number of field studies are limited to a few locales. The HAUSGARTEN observatory was extended with an experimental system to study impacts of ocean acidification on benthic organisms and communities for the first time in deep Arctic waters with an autonomous system. The arcFOCE (Arctic Free Ocean Carbon Enrichment) system was

developed to create semi-enclosed test areas on the seafloor where the seawater's pH (an indicator of acidity) can be precisely controlled for weeks or months at a time (Fig. 2.6). The implementation of an arcFOCE for long-term experiments will enable us to generate data on the resistance of arctic marine benthic organisms and communities to a reduction in ocean pH. The lander-based arcFOCE system was deployed during PS136 in 2023 at 1,500 m water depth in the eastern HAUSGARTEN area. For targeted sampling of the acidification experiment for benthic meiofaunal organisms a deep-diving work-class Remotely Operated Vehicle (ROV Kiel6000, GEOMAR, Kiel) was used (Tab. 2.4). Four sediment cores were taken from each test area (in total 12 cores) and four cores were taken outside the lander footprint from control sediments (Fig. 2.7). The sediment cores were subsampled for meiofauna analyses and for biogenic sediment compounds. All analyses will be done in the laboratory at AWI.

Tab. 2.4: ROV dives to sample the arcFOCE and the dropstone experiment with station ID, date, geographic position and water depth (m) of PS143/1. Stations were sampled with multiple corer (MUC) and box corer (BC).

ROV	Station ID	Date	Latitude	Longitude	Depth	Experiment
Dive I	PS143/1_24-1	28/06/2024	79° 08.13' N	004° 52.49' E	1495 m	arcFOCE
Dive V	PS143/1_33-1	02/07/2024	79° 04.48' N	004° 07.19' E	2430 m	dropstone
Dive VI	PS143/1_38-1	04/07/2024	79° 04.56' N	004° 07.78' E	2430 m	dropstone

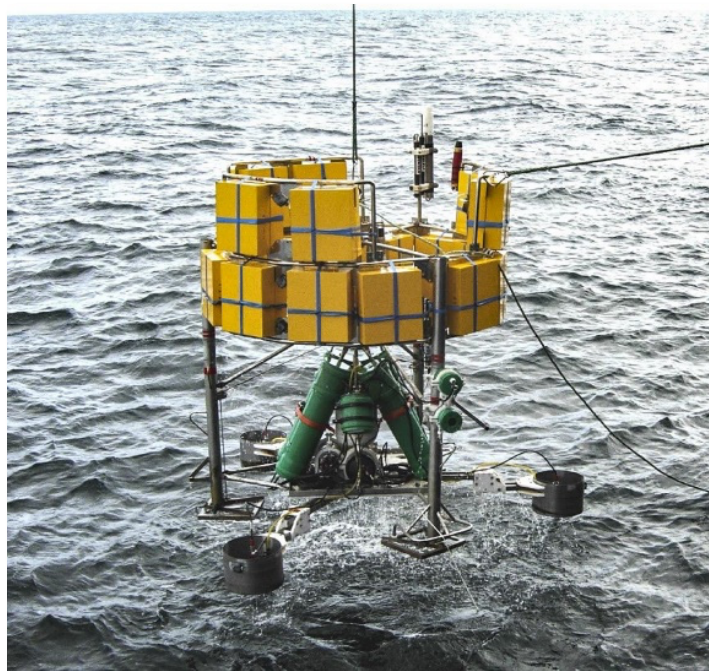


Fig. 2.6: The bottom-lander based arcFOCE (arctic Free Ocean Carbon Enrichment) experimental set-up

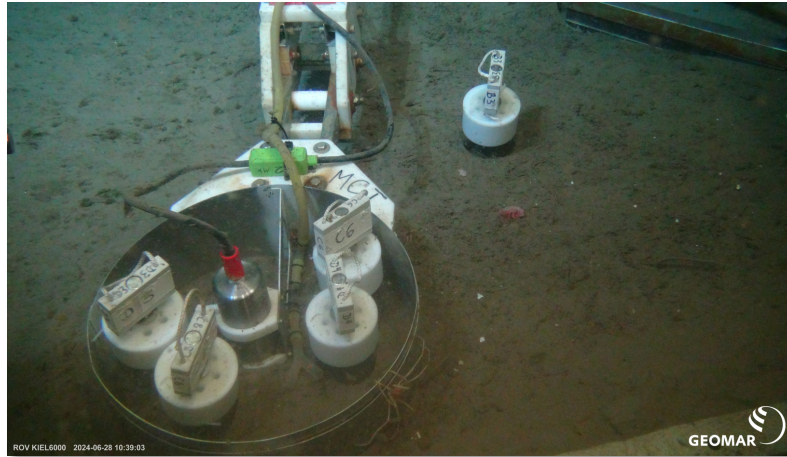


Fig. 2.7: Sediment sampling of the arcFOCE experiment by the ROV Kiel6000. Four sediment cores were taken inside the mesocosms and one core outside the test area as control (Photo ROV-team GEOMAR, Kiel)

Dropstone experiment

There is abundant evidence that habitat structures have important effects on spatial distribution patterns of meiofauna populations in deep-sea environments (Hasemann et al. 2013). A common feature in polar deep-sea regions is the occurrence of dropstones at the deep seafloor, which enhance topographic heterogeneity and alter related hydrodynamic patterns. Changed flow regimes around dropstones can have a direct effect on the colonisation and settlement of meiofauna individuals, and indirect effects on meiofauna communities by the amount of potential food trapped around dropstones and changing sediment characteristics.

To determine and characterise suspected differences in community structure and dynamics of nematode assemblages in relation to the confined flow regime and patchy food availability around dropstone, artificial dropstones with different shapes (rectangular, cylindrical and hemispheric; Fig. 2.8) were deployed at 2,500 m water depth at the central HAUSGARTEN station during HAUSGARTEN expedition PS108 in 2017. Sediment sampling around the dropstone was achieved using the ROV Kiel6000.



Fig. 2.8: Artificial dropstones (40x40x10 cm) of different shapes (cylindrical, spherical, rectangular)

We were able to sample seven of the nine dropstones (three rectangular, two cylindrical and two hemispheric). Depending on the direction of flow, one sediment core was taken in luv and lee of each dropstone (Fig. 2.9), as well as three cores from the unaffected sediment surface as control cores. The uppermost five sediment centimetres of each core were subsampled for meiofauna and biogenic sediment compounds. All analyses will be carried out at the home laboratory at AWI.

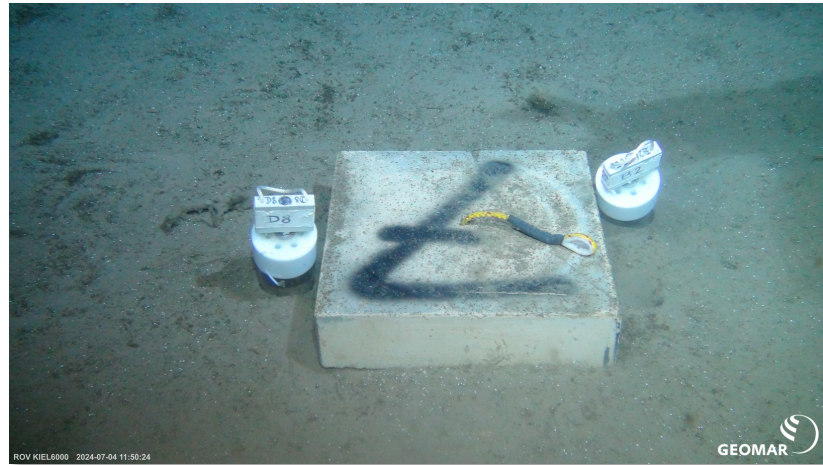


Fig. 2.9: Sediment sampling of dropstone experiment using the ROV Kiel6000. Depending on the flow direction, one sediment core was taken in luv and one in lee of a rectangular artificial dropstone (Photo ROV-team GEOMAR, Kiel)

Larval biology

The hard-bottom-obligate fauna that inhabit dropstones and other solid substrata in the deep Arctic Ocean are severely understudied. Basic parameters such as growth rates and the dynamics of populations and communities are poorly understood.

During PS143/1, we completed a ROV dive using Kiel6000 to complete experiments at a rocky reef (station "Senke"). Larval traps and panels revealed some specimens, including tube worms and sponges that had settled during the 5-year experiment. Community composition and organism size in marked panels were used to assess recruitment and growth rates of hard-bottom fauna (Fig. 2.10). All marked stones were photographed to show changes in the size and community composition of hard-bottom fauna over 5 years, and the cages and frames that were used to mark the stones were recovered. There was very little difference in stones between 2019 and 2024 (Fig. 2.11). These results support the previous long-term experiment by showing that Arctic deep-sea communities have low recruitment, slow growth, and are relatively static over long time-periods (Meyer-Kaiser et al. 2019). Due to these characteristics, Arctic deep-sea communities are very vulnerable to disturbance.

Additional samples of settled fauna were collected from the plastic experiment (2015 – 2024). Sponges, tube worms, and anemones were observed living on the plastic films. The results help fill in our understanding of recruitment in the Arctic deep sea over various time scales.

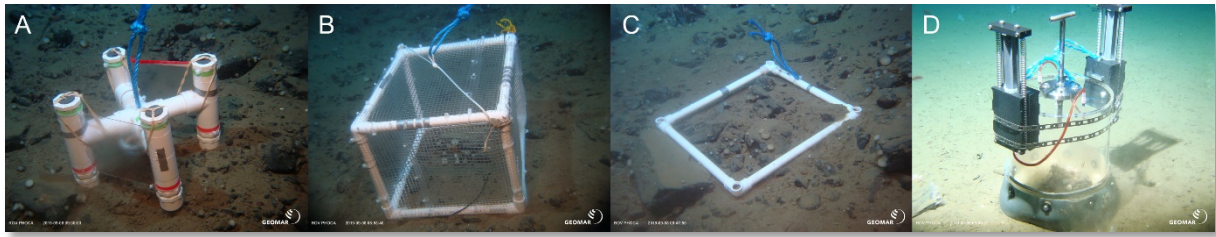


Fig. 2.10: Experiments deployed on the seafloor in 2019. A, larval traps with attached recruitment panels; B, a cage used in the predator-exclusion experiment; C, a control frame in the predator-exclusion experiment; D, the stainer used to dye organisms on a rock (Photos ROV-team GEOMAR, Kiel)

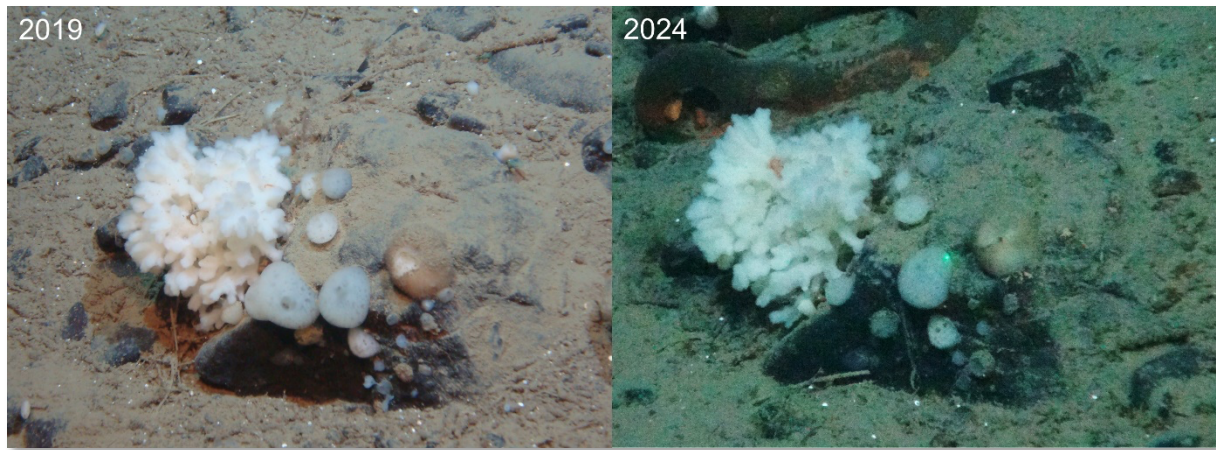


Fig. 2.11: The same rock, photographed 5 years apart. There is no change in the community (Photos ROV-team GEOMAR, Kiel)

A key component of organisms' resilience to change is reproduction. Previous studies have revealed temperate-boreal species from the North Atlantic dispersing into the Fram Strait (Berge et al. 2005, Descoteaux et al. 2022), which could lead to species expanding their ranges from lower latitudes into the Arctic basin as temperatures continue to warm. Much less is understood about the reproduction and dispersal of Arctic deep-sea species. We used a hand net (0.5 m diameter, 63 μ m mesh) deployed opportunistically from *Polarstern* during CTD casts to collect larvae.

Hand net collections showed a strong influence of oceanographic conditions, including temperature and salinity, on the larval community. There were strong differences between larvae collected in the West Spitsbergen Current and the East Greenland Current. The highest number of larvae was collected at station HG-I, and the highest species richness was observed at HG-I and N3 (Tab. 2.5).

Tab. 2.5: Number of hand net csks, species and individuals found in the samples

Station	No. hand nets	No. species	No. individuals
EG-I	2	1	189
EG-II	1	1	27
EG-III	1	1	40
EG-IV	2	1	26
HG-I	2	15	280
HG-II	1	1	1
HG-III	1	4	5
HG-IV	2	10	111
HG-V	1	3	5
HG-VI	1	2	3
HG-VII	1	1	9
HG-VIII	1	3	7
HG-IX	4	3	4
N3	1	15	254
N4	2	7	54
N5	2	9	75
S3	2	1	4
SV-II	1	8	275
SV-III	1	13	106
SV-IV	1	4	21
0°	1	2	3

Pollution Observatory

Previous analysis of seafloor photographs taken by OFO(B)S for the epibenthic megafauna time series at three stations of the HAUSGARTEN observatory indicate that litter rose almost 30-fold between 2004 and 2017 at the northernmost station and reached densities similar to those reported from a canyon near the Portuguese capital Lisbon (Parga Martínez et al. 2020). Since little is known about the effects of plastics on seafloor communities, we aim to assess the impact of plastics on biogeochemistry, sediment oxygen profiles, bacterial numbers and meiofauna organisms by revisiting plastics laid out on the seafloor of HAUSGARTEN IV in 2015 with the ROV.

The observed increase in plastic debris on the seafloor has prompted research on plastic debris and microplastic pollution in different ecosystem compartments and repeated sampling campaigns to observe temporal trends. This research is embedded in FRAM infrastructure under the header FRAM Pollution Observatory and has highlighted that Arctic sea ice, sea surface, water column and deep-sea sediments harbour high levels of MP pollution, especially the seafloor, with up to ~13,000 microplastics per kg sediment at the northernmost station.

The aim of our work during PS143/1 is to assess to what extent MP have penetrated the benthic food web and if there are differences between trophic groups and regions subject to different levels of ice coverage. Assessments of MP in organisms and sediments will allow us to assess if biota enrich MP relative to their environment. Analyses of body burdens of plastic chemicals in animal tissues will enable us to assess longer-term effects.

To obtain benthic specimens for the analysis of micro- and nanoplastic ingestion, 785 specimen samples were taken from five deployments of the epibenthic sledge (EBS), three ROV dives using the slurp gun or collection by the ROV's manipulator arm and three multiple

corer casts (Tab. 2.6. These samples will complement and allow a comparison to EBS samples taken in 2023 in the central Arctic Ocean and at HAUSGARTEN. The nanoplastic and additive burden will be analysed in collaboration with colleagues at UFZ (A. Jahnke, D. Materic. Additionally, sediment samples were taken from 3-4 cores of multiple corer deployments conducted at 11 HAUSGARTEN stations to assess the microplastic and additive concentrations in sediments, allowing comparison with biota and thus determining bioaccumulation. Samples were also taken for biomarker studies to assess sediment properties and sources.

Tab. 2.6: List of stations and samples taken for microplastic and chemical analyses during expedition PS143/1

Station name	Station No.	Gear	Longitude	Latitude	Depth [m]	Sample type	No. of specimen
HG-IV	PS143/1_4_1	EBS	79°02.787'N	004°24.922'E	2367	Specimens	202
HG-IV	PS143/1_4_12	MUC	79°04.048'N	004°17.921'E	2321	Specimens	12
HG-IX	PS143/1_5_4	EBS	79°07.890'N	002°54.677'E	5427	Specimens	313
EG-I	PS143/1_6_5	MUC	79°00.350'N	005°16.936'W	1095	Specimens	1
EG-I	PS143/1_6_8	BC	79°00.746'N	005°22.098'W	1035	Specimens	1
EG-IV	PS143/1_9-5	MUC	78°49.283'N	002°44.851'W	2506	Specimens	1
Ice edge	PS143/1_10-1	EBS	78°55.073'N	000°37.219'W	2580	Specimens	126
HG-III	PS143/1_13-1	EBS	79°05.618'N	004°39.696'E	1973	Specimens	60
Methane field	PS143/1_16-1	EBS	79°02.999'N	006°38.924'E	1198	Specimens	8
N3	PS143/1_19-3	MUC	79°35.696'N	005°12.569'E	2684	Specimens	2
HG-II	PS143/1_24-1	ROV	79°08.129'N	004°52.442'E	1495	Specimens	41
HG-IV	PS143/1_42-2	ROV	79°04.746'N	004°06.835'E	2430	Specimens	2
HG-IV	PS143/1_31-1	ROV	79°04.774'N	004°08.653'E	2395	Specimens	16
S3	PS143/1_2-3	MUC	78°36.482'N	005°03.722'E	2343	Sediment	
HG-IV	PS143/1_4-12	MUC	79°04.048'N	004°17.921'E	2321	Sediment	
HG-IX	PS143/1_5-9	MUC	79°08.567'N	002°45.577'E	5436	Sediment	
EG-I	PS143/1_6-5	MUC	79°00.350'N	005°16.936'W	1095	Sediment	
EG-IV	PS143/1_9-5	MUC	78°49.283'N	002°44.851'W	2506	Sediment	
HG-I	PS143/1_14-5	MUC	79°07.976'N	006°05.587'E	1223	Sediment	
N3	PS143/1_19-3	MUC	79°35.696'N	005°12.569'E	2684	Sediment	
EG-II	PS143/1_7-4	MUC	78°56.192'N	004°37.944'W	1501	Sediment	
EG-III	PS143/1_8-4	MUC	78°48.558'N	004°00.751'W	1819	Sediment	
N4	PS143/1_20-5	MUC	79°44.389'N	004°25.551'E	2533	Sediment	
N5	PS143/1_21-5	MUC	79°56.415'N	003°13.134'E	2458	Sediment	

Three ROV-based experiments were initiated at HG-IV in 2015 to simulate plastic coverage of sponges (*Caulophacus arcticus*, *Cladorhiza gelida*) and sediments by plastic bag material and heavy rigid plastic plates (Fig. 2.12). These experiments were revisited during PS143/1 by the ROV 6000.



Fig. 2.12: ROV-based experiments to simulate the effects of plastic debris on seafloor communities. (Left) Microprofiler taking a measurement in the sediments covered by a plastic cover deployment. (Middle) Push cores taken after removal of the rigid plastic plate. (Right) Plastic bag covering sponge (Photos ROV-team GEOMAR, Kiel)

A microprofile (MIC) measurement was taken underneath one of the plastic covers to assess the oxygen profile under plastics by placing the MIC on one of the plastic covers. All plastic cover experiments were gently pushed aside by the ROV and push cores taken in the sediments that had been covered by plastics and in sediments from a nearby area for comparison. The sponges were uncovered and photographed to assess their health. One sponge (*Cladorhiza gelida*) was sampled by the ROV. All plastics but one sponge and one plate experiment (time constraints at the end of the ROV dive) were retrieved by the ROV to avoid pollution. During the dive, 18 push cores were taken in total and subject to subsampling, freezing and preservation in 4% formalin for assessments of bacterial numbers, meiofauna and biogeochemical parameters.

In addition, the new seafloor footage (OFOBS) will be analysed to assess if marine debris quantities continue to accumulate at HAUSGARTEN and continue this time series (s. above).

Long-term megabenthic study and seafloor mapping

The newly constructed Ocean Floor Observation and Bathymetry System II (OFOBS; Purser et al. 2019) (Fig. 2.13) was field tested during the PS138 expedition during 2023. During PS143-1 the system was deployed along previously established HAUSGARTEN transects, with the aim of the collected data being used to assess interannual dynamics of megafauna on the seafloor at selected stations (HG-I, HG-IV, N3, S3, HG-IX), as well as several additional times on the flanks to the Molloy Deep and along the hydrate ridge feature partially mapped during the MSM95 (Purser et al. 2020) and PS108 expeditions (Table 2.7). The OFOBS was towed at 1.5 m altitude for 4 + hours at each survey site. The AWI “Remora class” MiniROV was attached to OFOBS for one deployment.

The imagery will also in the future be used to quantify litter on the seafloor. The OFOBS II is equipped with a multibeam system allowing to collect spatial data to develop the high-resolution seafloor topographical maps of the HAUSGARTEN. An additional CTD was mounted on OFOBS for all dives.

Images from the Molloy Deep Stations PS143_1_5_10, PS143_1_23_2, and PS143_1_43_1 will be analyzed by Ming Khan at the University of Cambridge to study the population ecologies of the highly abundant sea anemone *Bathypheilia margaritacea*, and the slightly less abundant sponge *Caulophacus articus*. Using spatial point process analyses, Ming will investigate biological interactions between and within the most abundant sessile taxa on the centimeter scale.

All data collected with the OFOBS II will be used to test a new data archiving ingest protocol developed by C. Krämmer and L. Boehringer, strictly following the guidelines and metadata schemes presented in Schoening et al. (2022).

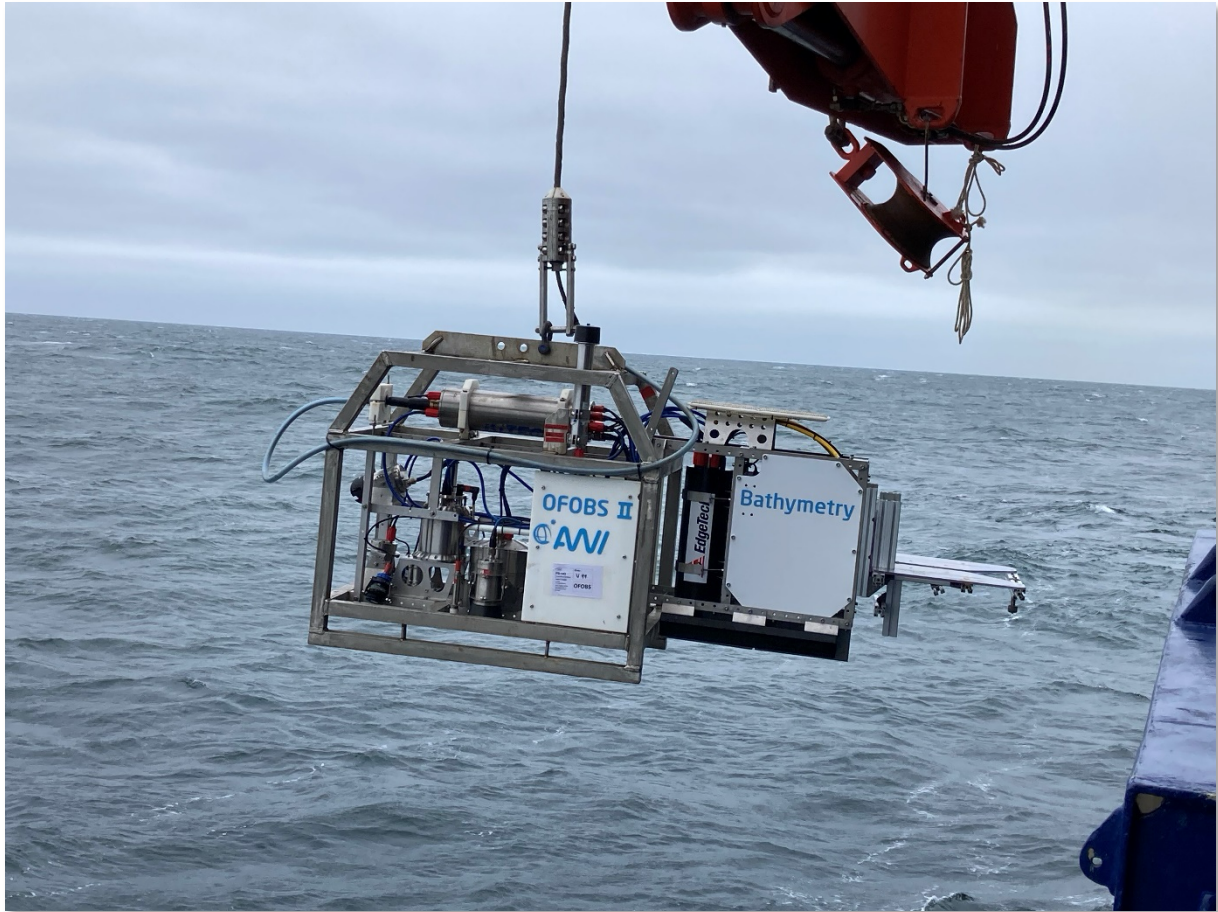


Fig. 2.13: The Ocean Floor Observation and Bathymetry System II (OFOBS), being deployed during PS143_1. PHOTO: Melanie Bergmann

Tab. 2.7: OFOBS deployments conducted during expedition PS143/1

Station	Date Time	Region	Action	Latitude	Longitude	Depth [m]
HG143_1_4_5	16/06/2024 03:31	HG-IV	Transect start	79° 04.055' N	004° 16.352' E	2338.3
HG143_1_4_5	16/06/2024 07:57	HG-IV	Transect end	79° 02.315' N	004° 08.173' E	2562.8
HG143_1_5_10	18/06/2024 07:23	HG-IX	Transect start	79° 06.520' N	003° 12.919' E	5267.5
HG143_1_5_10	18/06/2024 11:16	HG-IX	Transect end	79° 05.179' N	003° 18.405' E	5261.6
HG143_1_9_6	20/06/2024 20:51	EG-IV	Transect start	78° 54.227' N	002° 57.569' W	2434.5
HG143_1_9_6	20/06/2024 23:57	EG-IV	Transect end	78° 53.342' N	002° 59.612' W	2435.8
HG143_1_19_4	25/06/2024 14:39	N3	Transect start	79° 34.248' N	005° 15.068' E	2580.3
HG143_1_19_4	25/06/2024 19:03	N3	Transect end	79° 36.242' N	005° 08.789' E	2716.2
HG143_1_23_1	27/06/2024 16:44	HG-1	Transect start	79° 08.026' N	005° 46.537' E	1269.6

Station	Date Time	Region	Action	Latitude	Longitude	Depth [m]
HG143_1_23_1	27/06/2024 20:56	HG-1	Transect end	79° 07.890' N	005° 59.803' E	1246.0
HG143_1_23_2	27/06/2024 22:52	Ridge	Transect start	79° 03.815' N	006° 30.506' E	1206.7
HG143_1_23_2	28/06/2024 03:16	Ridge	Transect end	79° 02.138' N	006° 41.922' E	1201.3
HG143_1_28_1	30/06/2024 01:39	NW 'Senke'	Transect start	79° 07.634' N	004° 30.251' E	2417.2
HG143_1_28_1	30/06/2024 04:01	NW 'Senke'	Transect end	79° 07.250' N	004° 32.810' E	2321.3
HG143_1_35_1	02/07/2024 20:12	M. Deep flank	Transect start	79° 08.026' N	003° 53.401' E	2434.8
HG143_1_35_1	03/07/2024 06:07	M. Deep flank	Transect end	79° 05.846' N	003° 23.860' E	5038.8
HG143_1_37_1	04/07/2024 02:32	S3	Transect start	78° 37.012' N	005° 09.825' E	2287.6
HG143_1_37_1	04/07/2024 04:59	S3	Transect end	78° 36.956' N	005° 03.175' E	2288.3
HG143_1_43_1	05/07/2024 15:31	M. Deep flank	Transect start	79° 07.266' N	003° 25.478' E	5012.7
HG143_1_43_1	06/07/2024 01:34	HG-IIX	Transect end	79° 04.181' N	003° 19.191' E	5148.8

Example images of seafloor taken during OFOBS deployments during PS143/1

From the 10 OFOBS deployments made during PS143/1 a representative image from each is given below. In all cases, the three red dots near the centre of each image have a spacing of 50 cm.

HG143_1_4_5



Fig. 2.14: SW_RELEASER_2024_06_16 at 05_01_50 IMG_0259. Typical image from Station HG IV; soft substrates dotted with large numbers of benthic foraminifera, with occasional clumps of green (algal? Bacterial?) detritus. Dropstones are sometimes present, which are usually colonized by epibenthos. Common fauna include the sponges *Caulophacus articus* and *Cladorhiza cf. gelidha*, the stalked crinoid *Bathycrinus carpenterii*, the decapod *Bythocaris sp.* (not pictured). This central Hausgarten station had large quantities of plastic debris.

HG143_1_5_1



Fig. 2.15: SW_RELEASER_2024_06_18 at 09_50_00 IMG_0672. Typical image from Station HG IX, the Molloy Deep. Large swaths of very fine muddy sediments, on which hundreds of the sea pig *Elpidia cf. heckeri* are visible, and occasionally the larger holothurian *Kolga hyaline* (not pictured). There are large aggregations of the sea anemone *Bathypheilia margaritacea*. Natural and anthropogenically derived litter in the Molloy Deep include pieces of wood and feathers.

HG143_1_9_6



Fig. 2.16: SW_RELEASER_2024_06_20 at 21_29_55 IMG_0221. Typical image from Station PS143_1_9_6. Fine, muddy sediments that are dotted with large numbers of benthic foraminifera. Typical fauna include the stalked crinoid *Bathycrinus carpensterii*, the sea anemones NAME and *Bathypheilia margaritacea*.

HG143_1_19_4



Fig. 2.17: SW_RELEASER_2024_06_25 at 15_37_45 IMG_0329. Typical image from Station PS143_1_19_4; soft substrates dotted with large numbers of benthic foraminifera. Small gastropods are sometimes visible in photographs. Common fauna include the sponge *Caulophacus articus*, the stalked crinoid *Bathycrinus carpensterii* and the decapod *Bythocaris* sp.

HG143_1_23_1



*Fig. 2.18: SW_RELEASER_2024_06_27 at 19_27_02 IMG_0724. Typical image from HG-1. Large numbers of the brittle star genus *Ophiocten* are present on the muddy seafloor. Pockmarks, likely formed by the degassing of fluids were sometimes imaged.*

HG143_1_23_2



Fig. 2.19: SW_RELEASER_2024_06_27 at 23_48_08 IMG_0207. Typical image from the ridge feature running SE from HG-1. Bacterial mats (blue areas) are present in sections of the seafloor. Patches of detritus occur in large areas. Amphipods and fish likely graze on the detrital matter.

HG143_1_28_1



Fig. 2.20: SW_RELEASER_2024_06_30 at 02_28_37 IMG_0292. PS143_1_28_1. Soft substrates dotted with large numbers of benthic foraminifera. Dropstones are often present. Common fauna include several sponge species, the stalked crinoid *Bathycrinus carpenterii* and the decapod *Bythocaris* sp.

HG143_1_35_1



Fig. 2.21: SW_RELEASER_2024_07_02 at 20_36_19 IMG_0214. Soft substrates dotted with large numbers of benthic foraminifera. Dropstones are often present. Common fauna include several sponge species, such as *Cladorhiza cf. gelidha* (pictured), the stalked crinoid *Bathycrinus carpenterii*, cerianthids and anemones, and the decapod *Bythocaris* sp.

HG143_1_37_1



Fig. 2.22: SW_RELEASER_2024_07_04 at 04_58_06 IMG_0711. Soft substrates dotted with large numbers of benthic foraminifera. Sponges, such as *Cladorhiza* cf. *gelidha* (pictured), and the decapod *Bythocaris* sp. are sometimes present.

HG143_1_43_1



Fig. 2.23: TIMER_2024_07_06 at 01_15_35 IMG_2372. The Molloy Deep slope contained highly variable and complex topography. Heavily consolidated muds and broken igneous rocks were often colonized by the sea anemone *Bathypheilia margaritacea*. Small pieces of wood were often imaged. Prominent ripples were visible on the sediment.

Preliminary results

Biogenic sediment compounds measured during the cruise

We were able to successfully sample all planned HAUSGARTEN stations (i.e. 16 stations along the bathymetric and the latitudinal transect). Comparing the concentrations of sediment-bound pigments and potential bacterial activities along the bathymetric transect across the Fram Strait and along the latitudinal transect with stations at different distances from the ice edge in the northern parts of the strait, we found conspicuous differences (Fig. 2.24). Irrespective of the depth of the station, all sites on the East Greenland continental margin generally had lower pigment concentrations than the stations off Svalbard. Neglecting station

HG-VI, pigment concentrations and bacterial activities showed a general trend of decreasing values with increasing water depth along the bathymetric transect off Svalbard. However, the deepest station along this depth transect (HG-IX) showed conspicuously elevated pigment values.

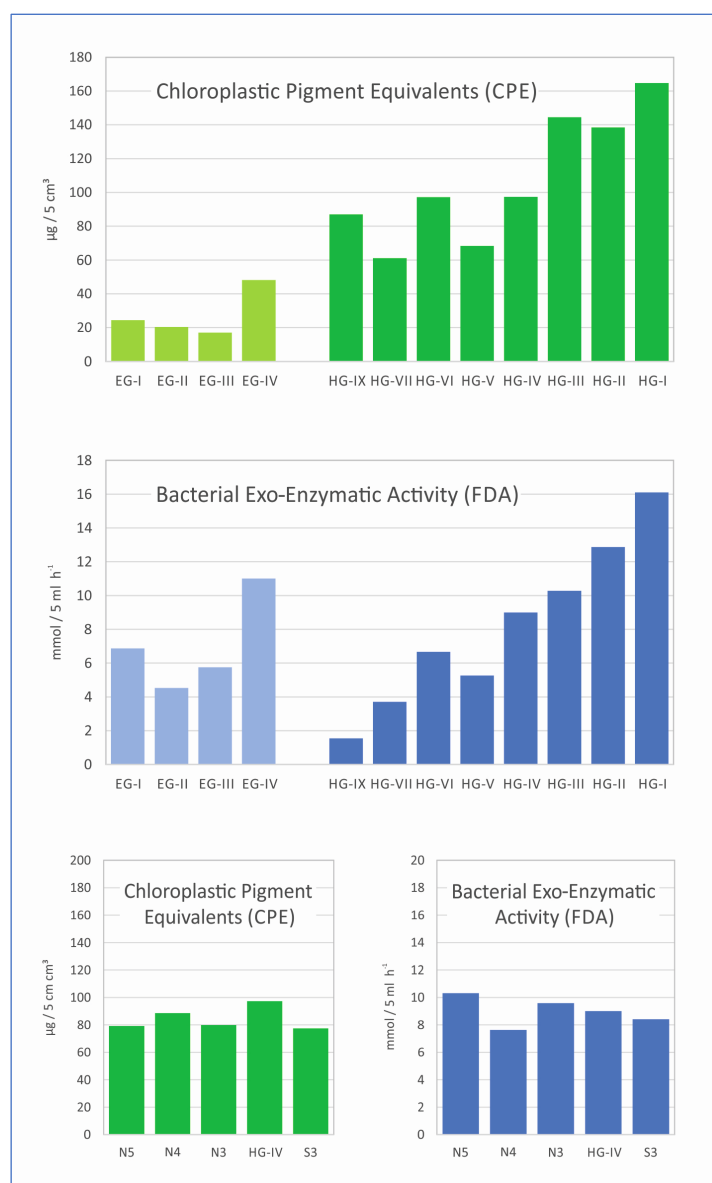


Fig. 2.24: Preliminary results from on-board pigment measurements (Concentrations of chloroplasic pigment equivalents, CPE) and bacterial activity assessments (degradation of the artificial substrate fluorescein-di-acetate, FDA) along and the East Greenland shelf (EG-I - EG-IV) and the HAUSGARTEN bathymetric (HG-I - HG-IX) and latitudinal transect (N5, N4, N3, HG-IV, S3)

Station HG-IX is located at Molloy Hole, a deep depression with a maximum water depth of 5,600 m. Increased values in biogenic sediment compounds at great depth is a feature that has also been observed in other deep trenches. The Molloy Hole appears to be a depositional centre for organic matter, suggesting that it acts as a huge natural trap for organic matter at abyssal depths in the Fram Strait. On the East Greenland continental shelf, the highest values for pigment concentrations and bacterial activity were observed at the deepest station EG-IV,

which may be explained by its location close to the ice edge in the western parts of the Fram Strait. Generally increased primary production in the Marginal Ice Zone (MIZ) and subsequent increased sedimentation of phytodetritus, a potential food source for benthic organisms, could explain the increased pigment and activity values found at EG-IV. Values along the latitudinal transect showed no clear trend (Fig. 2.24, bottom).

Our assessments of benthic biodiversity, function and biogeochemistry will contribute significantly to the existing knowledge of the deep sea and polar regions. By continuing this unique time-series work at HAUSGARTEN in the Arctic deep sea, we expect not only to improve our understanding of the dynamic diversity and distribution of benthic communities, but also to shed light on how these ecosystems respond to changing environmental conditions over decades (Soltwedel et al. 2016 in times of rapid climate warming).

The sampling of long-term biological experiments at HAUSGARTEN provides a valuable opportunity to investigate the complex interactions between benthic organisms and their environment in the context of rapid environmental change in the Arctic. Through *in situ* experimental manipulations, we aim to deepen our understanding of the drivers of deep-sea biodiversity and to shed light on the impact of anthropogenic influences on the Arctic ecosystem.

The results will add to our (Piepenburg et al. 2024 and various other databases in relation to the Arctic fauna and thus will feed into international networks such as CBMP (Circumpolar Biodiversity Monitoring Program) and ADBO (Atlantic-Arctic Distributed Biological Observatory), as well as panels for scientific advice such as the Conservation of Arctic Flora and Fauna (CAFF) in the Arctic Council and the Arctic Monitoring and Assessment Program (AMAP).

Data management

Environmental, image, video and acoustic mapping data will be archived, published and disseminated according to international standards by the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (<https://www.pangaea.de>) within two years after the end of the expedition at the latest. By default, the CC-BY license will be applied.

Currently, all available data of the last years macrofauna and meiofauna data are compiled in the ecological data information system CRITTERBASE. The macrofauna data from EBS samples are in a first step entered to the Senckenberg DZMB Hamburg local database to allow further processing and curating of the EBS samples in the DZMB laboratories in Hamburg after expedition. All data from all EBS contributions of HAUSGARTEN expeditions will be entered in CRITTERBASE after sorting.

Molecular data (DNA and RNA data) will be archived, published and disseminated within one of the repositories of the International Nucleotide Sequence Data Collaboration (INSDC, www.insdc.org) comprising of EMBL-EBI/ENA, GenBank, and DDBJ.

Any other data will be submitted to an appropriate long-term archive that provides unique and stable identifiers for the datasets and allows open online access to the data.

This expedition was supported by the Helmholtz Research Programme “Changing Earth – Sustaining our Future” Topic 6, Subtopic 1 and 3.

In all publications based on this expedition, the **Grant No. AWI_PS143/1_01** will be quoted and the following publication will be cited:

Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung (2017) Polar Research and Supply Vessel POLARSTERN Operated by the Alfred-Wegener-Institute. Journal of large-scale research facilities, 3, A119. <http://dx.doi.org/10.17815/jlsrf-3-163>.

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3. PLANKTON ECOLOGY AND BIOGEOCHEMISTRY IN A CHANGING ARCTIC OCEAN

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Outline

The PEBCAO group (Plankton Ecology and Biogeochemistry in a Changing Arctic Ocean) is a collaboration between colleagues from AWI and GEOMAR and focusses on plankton community ecology and the microbial processes relevant for biogeochemical cycles of the Arctic Ocean. This is timely research since the Arctic Ocean is currently undergoing considerable environmental change particularly with the pronounced decrease in sea ice and increase in temperature, with the latter rising at twice the rate as the global average. In addition, the chemical equilibrium and the elemental cycling in the surface ocean are likely to alter e.g. due to ocean acidification. These environmental changes will have consequences for the biogeochemistry and ecology of the Arctic pelagic system and therefore detailed monitoring of existing conditions is vital. PEBCAO has therefore carried out an integrated monitoring programme of biological (bacterial and eukaryotic phytoplankton as well as zooplankton) and biogeochemical parameters in the HAUSGARTEN area since 2009 to document and better understand the projected changes.

For instance, biogeographical studies of PEBCAO based on 18S metabarcoding indicate that a year-round semi-stationary sea-ice edge serves as a strong biogeographical boundary between Atlantic conditions to the southeast and polar conditions to the Northwest of Fram Strait (Metfies et al. 2016). In 2017, the MIZ extended further eastwards and southwards into Fram Strait than in average years, with profound impacts on the ecosystems. Sea ice melt in a sub-mesoscale filament, characterized by a thin surface meltwater layer, led to comprehensive changes in plankton-biodiversity, carbon export and primary production in vicinity of the filament (Fadeev et al. 2021). Here, a combination of the latest biological and physical underway-measurements has proven very useful to map the physical environment and eukaryotic microbial community composition in a sub-mesoscale filament with high spatial resolution (Weiss et al. 2024 accepted). Considerable impacts of such filaments were also demonstrated for the biogeography of zooplankton and were considered as a potential accelerator of atlantification (Kaiser et al.2021).

PEBCAO contributed to year-round interdisciplinary observations indicating that increased meltwater-stratification during spring/summer of 2017 slowed down the biological carbon pump in AW the central Fram Strait with significant impacts for on pelagic and benthic communities in comparison to the warmer year 2018 (von Appen et al. 2021). The data suggest, that sea-

ice melt might serve as a barrier for a northward movement of temperate phytoplankton taxa in Fram Strait (Oldenburg et al. 2024; accepted). Furthermore, based on our year-round automated water-sampling we characterized the annual succession of microbial communities at a station in West Spitsbergen Current (WSC and East Greenland Current (EGC. The ice-free WSC displayed a marked separation into a productive summer (dominated by diatoms and carbohydrate-degrading bacteria) and regenerative winter state (dominated by heterotrophic Syndiniales, radiolarians, chemoautotrophic bacteria, and archaea. In the EGC, deeper sampling depth, ice cover and polar water masses concurred with weaker seasonality and a stronger heterotrophic signature. Low ice cover and advection of Atlantic Water coincided with diminished abundances of chemoautotrophic bacteria while others such as *Phaeocystis* increased, suggesting that Atlantification alters microbiome structure and eventually the biological carbon pump (Wietz et al. 2021).

Furthermore, recent results indicate, that a change in microbiome structure might also affect the biological carbon pump. For instance, we found, strong correlations between *Phaeocystis* and transparent exopolymer particle concentration (TEP, which are known to play a crucial role in the biological carbon pump (Engel et al. 2017). Moreover, although concentrations of dissolved organic carbon (DOC) were relatively stable over the last two decades, we observed a slight decrease in the particulate organic carbon (POC) during the summer months (Engel et al. 2019). While these results point to inter annual changes in the Fram Strait, von Jackowski et al. (2022) additionally observed an intra annual (seasonal) succession of prokaryotic microbes, that was related to a succession in the biopolymer pool, indicating seasonally distinct metabolic regimes.

Mycoplankton (defined here as saprotrophic and parasitic fungi and pseudofungi (oomycetes) has not yet been a focus of these investigations. This is although their ecological impact can be considerable, e. g. by controlling the population size of bloom-forming species (Buaya et al. 2019), and this group is still considerably under-investigated in the marine realm. Even in well-studied areas such as the North Sea new species are being described (Buaya et al. 2017), but in polar regions, with few exceptions the diversity and dynamics of the mycoplankton remain to be discovered (Hassett et al. 2019 a,b). PS143/1 will be used to carry out an intensive sampling campaign for this taxon group (co-ordinated with PS 143/2 to investigate the diversity and distribution of this group or organisms and to bring both true fungi and oomycete into culture for later analysis. This work is carried out in collaboration with the group of Dr Marlis Reich at the University of Bremen who participates in the second Leg of PS143.

Objectives

The PEBCAO group investigates the long-term dynamics in water column processes in the FRAM Strait, including phyto- and zooplankton diversity and more recently the diversity of parasitic plankton, as well as the links between these communities and environmental (physical chemical and biochemical parameters and processes). There will be several specific objectives:

- (1) Co-ordinated sampling campaign between PS143/1 and PS143/2 to sample 15 HAUSGARTEN stations for an intensive analysis of mycoplankton diversity
- (2) The assessment of the biodiversity and biogeography of Arctic eukaryotic microbes, including phytoplankton and their linkages to prokaryotic microbial communities based on analyses of eDNA via 16S and 18S meta-barcoding, and quantitative PCR. A suite of automated sampling devices in addition to classical sampling via Niskin bottles attached to a CTD-rosette will be used to collect samples for eDNA analyses. This includes the automated filtration device AUTOFIM deployed on *Polarstern* for underway filtration, automated Remote Access Samplers (RAS) and long-term sediment traps deployed on the FRAM-moorings for year-round sampling.

- (3) Deployment of multiple net samplers, which integrate depth intervals of up to several hundred meters in conjunction with the zooplankton recorder LOKI (Light frame On-sight Key species Investigations). LOKI continuously takes pictures of the organisms during vertical casts from 1,000 m to the surface. Linked to each picture, hydrographical parameters are being recorded, i.e. salinity, temperature, oxygen concentration, and fluorescence. This will allow us to identify distribution patterns of key taxa in relation to environmental conditions. We will also use the UVP5 (Underwater Vision Profiler), which is mounted on the ship's CTD to also tackle zooplankton distribution patterns, albeit with much less taxonomic resolution than with LOKI.
- (4) Establishment of cultures of oomycete parasites as well as potential diatom hosts on PS143/1 (on PS143 cultures will be initiated for fungal plankton). Co-cultures of parasites and their hosts will be used for experiments planned in the upcoming INDIFUN-AI BMBF project in which we wish to investigate the utility of using parasites and saprotrophic fungi as indicators of environmental change.
- (5) To identify climate-induced changes in carbon cycling and sequestering and improve the mechanistic understanding of biogeochemical and microbiological feedback processes in the changing Arctic Ocean, we will assess organic carbon and nitrogen both in dissolved and particulate form with a special focus on (gel-) particles and their associated bacterial communities. In addition, we will measure the productivity of phytoplankton and bacteria using labelled isotope incorporation.

Work at sea

CTD samples

At each station samples were taken from the CTD-Rosette and processed for a range of biological and biogeochemical parameters:

Biogeochemistry

Throughout the cruise, discrete seawater samples were systematically collected to investigate the microbial and biogeochemical processes influencing organic matter turnover in the Arctic Ocean. A total of 21 stations were sampled using a CTD/Rosette, targeting a range of chemical and biological parameters related to organic matter composition and microbial activity.

The euphotic zone was sampled at each station using a "shallow" cast, collecting samples from the surface, chlorophyll a maximum (Chl a max), below Chl a max., 50 m and 100 m depths. Additionally, at selected stations, samples for amino acids, carbohydrates, and gel particles were collected at five depths ranging from 200 m to the seafloor to investigate carbon export into the deep sea.

Dissolved Biogeochemical Parameters:

- **Dissolved Organic Carbon (DOC/TDN):** Seawater was filtered through 0.45 µm GMF syringe filters into combusted glass vials, acidified with hydrochloric acid (Suprapur), and stored at 4 °C until analysis via High-Performance Liquid Chromatography (HPLC).
- **Dissolved Amino Acids (DAA) and Combined Carbohydrates (DCHO):** These samples were filtered using 0.45 µm Acrodisc filters, stored in combusted glass vials, and kept at -20 °C.
- **Dissolved Inorganic Carbon (DIC):** Samples were treated with mercury (II) chloride and stored at 4 °C.
- **Nutrients (NUT):** These samples were filtered through 0.4 µm cellulose acetate filters and stored at -20 °C.

- **Total Alkalinity (TA):** Samples were filtered through 0.45 µm Acrodisc filters and stored at 4 °C.

Particulate Biogeochemical Parameters:

- **Transparent Exopolymer Particles (TEP) and Coomassie Stainable Particles (CSP):** Seawater samples were filtered using 0.4 µm polycarbonate filters, stained with Alcian Blue and Coomassie Brilliant Blue dyes respectively, and stored at -20 °C until microscopic and colorimetric analyses.
- **Confocal Laser Scanning Microscopy (CLSM) and CLASI-FISH:** Samples to analyze gel particle-associated bacterial community structure were filtered through black 0.4 µm polycarbonate filters and stored at -20 °C.
- **Lipid Analysis:** Samples were filtered using 0.2 µm hydrophilic Durapore filters, flash-frozen in liquid nitrogen, and stored at -80 °C.

Phytoplankton and bacterial parameters:

- **Bacterial (BA) and Picophytoplankton (PA) Abundance:** Samples were fixed with GDA 25% and frozen at -80 °C. Analysis by flow cytometry will be conducted at GEOMAR.
- **Phytoplankton Primary Production (PP) and Bacterial Biomass Production (BBP):** These rates were determined onboard using radioactive tracers ¹⁴C sodium bicarbonate and ³H-leucine, respectively. Due to technical issues with the incubation cabinet, PP measurements were only taken at 0 °C.
- **Arctic Bacterioplankton Function (RNAmetaT):** Samples were collected at all stations from the surface, DCM, 50 m, and 100 m depths, preserved with RNALater, flash-frozen, and stored at -80 °C until further processing in the home laboratory.

An overview of all samples taken is provided in Table 3.1.

Tab. 3.1: Biogeochemical parameters sampled from the CTD/ Rosette Water Sampler. Abbreviations as follows: DOC: dissolved organic carbon; DCHO: dissolved carbohydrates; DAA: dissolved amino acids; NUT: inorganic nutrients; TEP: transparent exopolymer particles; CSP: Coomassie stainable particle; RNAmetaT: bacterial RNA for metatranscriptomic analysis; LIP: lipids; BA/PA: bacterial and picophytoplankton abundance; BBP: bacterial biomass production; PP: phytoplankton primary production; DIC: dissolved inorganic carbon; TA: total alkalinity.

Station	ID	DOC/ DCHO/ DAA	NUT	TEP/ CSP	CLS M	RNA meta T	LIP	BA/ PA	BBP	PP/ DIC/ TA
PS143/1_1-1	Test	X	X	X	-	X	-	X	-	-
PS143/1_2-1	S3 shallow	X	X	X	-	X	X	X	X	-
PS143/1_2-5	S3 deep	X	X	X	-	-	-	X	-	-
PS143/1_4-3	HG-IV deep	X	X	X	X	-	-	X	-	-

Station	ID	DOC/ DCHO/ DAA	NUT	TEP/ CSP	CLS M	RNA meta T	LIP	BA/ PA	BBP	PP/ DIC/ TA
PS143/1_4-9	HG-IV shallow	X	X	X	X	X	X	X	X	-
PS143/1_5-1	HG-IX deep	X	X	X	-	-	-	X	-	-
PS143/1_5-5	HG-IX shallow	X	X	X	-	X	X	X	X	-
PS143/1_6-1	EG-I shallow	X	X	X	X	X	X	X	X	-
PS143/1_6-6	EG-I deep	X	X	X	X	-	-	X	-	-
PS143/1_7-1	EG-II shallow	X	X	X	-	X	X	X	X	-
PS143/1_8-1	EG-III shallow	X	X	X	-	X	X	X	X	-
PS143/1_9-1	EG-IV shallow	X	X	X	-	X	X	X	X	-
PS143/1_9-8	EG-IV deep	X	X	X	-	-	-	X	-	-
PS143/1_11-1	HG-VII shallow	X	X	X	-	X	X	X	X	-
PS143/1_14-1	HG-I shallow	X	X	X	-	X	X	X	X	-
PS143/1_14-6	HG-I deep	X	X	X	-	-	-	X	-	-
PS143/1_15-1	SV-IV shallow- deep	X	X	X	X	X	X	X	X	-
PS143/1_17-1	SV-II shallow	X	X	X	X	X	X	X	X	-
PS143/1_18-1	SV-III shallow	X	X	X	-	X	X	X	X	-
PS143/1_19-5	N3 shallow	X	X	X	-	X	X	X	X	-
PS143/1_20-1	N4 deep	X	X	X	X	-	-	X	-	-
PS143/1_20-6	N4 shallow	X	X	X	X	X	X	X	X	-
PS143/1_21-1	N5 shallow	X	X	X	-	X	X	X	X	-
PS143/1_21-6	N5 deep	X	X	X	-	-	-	X	-	-

Station	ID	DOC/ DCHO/ DAA	NUT	TEP/ CSP	CLS M	RNA meta T	LIP	BA/ PA	BBP	PP/ DIC/ TA
PS143/1_22-1	HG-III shallow	X	X	X	-	X	X	X	X	-
PS143/1_24-2	HG-II shallow	X	X	X	-	X	X	X	X	-
PS143/1_27-1	HG-V shallow	X	X	X	-	X	X	X	X	-
PS143/1_30-1	HG-VI shallow	X	X	X	-	X	X	X	X	-
PS143/1_34-1	HG-VIII shallow	X	X	X	-	X	X	X	X	-
PS143/1_36-1	0° shallow- deep	X	X	X	X	X	X	X	X	X
PS143/1_40-1	1.5° E shallow- deep	X	X	X	X	X	X	X	X	-

To investigate the influence of anthropogenic pollution on the microbial community and biogeochemistry we tried to collect microplastic particles ($> 300 \mu\text{m}$) at selected stations by filtering seawater, which was continuously drawn from the ship's "Spargel" 10 m below the surface (Fig. 3.1).



Fig. 3.1: Sieve tower ($300 \mu\text{m}$) drawing water from the ship's "Spargel", an opening 10 m below the surface

As no particles were found during the cruise, an incubation experiment was started on SV-II with water from 10m depth collected from the CTD rosette. A total of 24 glass jars were filled with one litre of seawater each and seven different types of plastic were incubated in triplicates at 4°C . The experiment will be completed during the PS143/2. Metatranscriptomic and 16S amplicon sequencing will be used to investigate the biodiversity and function of plastic-associated bacteria focusing on potential pathogens and their resistome.

Finally, for continuous underway surface sampling a Single Turnover Active Fluorometry system (LabSTAF, Chelsea Technologies, UK) was used to obtain data on phytoplankton photosynthesis, fitness and primary productivity (Fig. 3.2). Measurements were taken every 25 minutes.

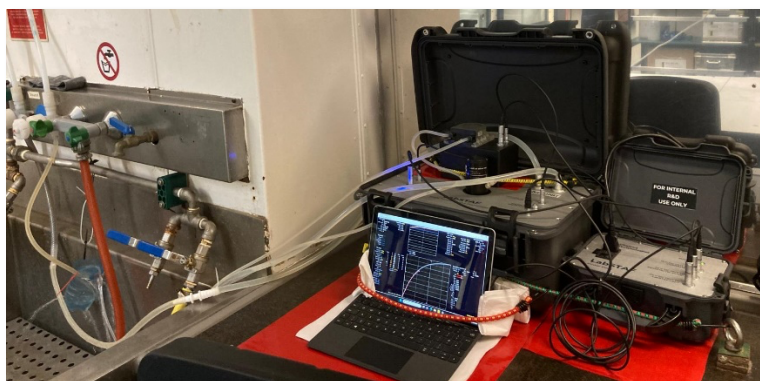


Fig. 3.2: Setup of the LabSTAF system

Nutrients and oxygen

To address our objectives described in the PS143-1 expedition program, we collected seawater samples from CTD/Rosette Water Sampler casts (Tab. 3.2) for the onboard analysis of dissolved oxygen and for the later analysis of dissolved nutrients (nitrate + nitrite, nitrite, ammonium, total dissolved nitrogen, phosphate, total dissolved phosphorus, and silicate). Here, we describe the associated sampling methods and present preliminary results. At each CTD cast, we took duplicate samples (for both oxygen and nutrient analysis) from two randomly selected depths.

Tab. 3.2: Events sampled for the collection and analysis of dissolved nutrients and dissolved oxygen (DO) during PS143-1. Sample collection included two random duplicates per cast.

Event	Deepest sample	# Depths	# Nutrient samples	# DO samples
PS143/1_2-1	200 m	8	11	12
PS143/1_2-5	2270 m	10	11	13
PS143/1_4-3	2240 m	13	15	15
PS143/1_4-8	200 m	9	11	11
PS143/1_5-1	5370 m	13	15	16
PS143/1_5-5	200 m	8	12	11
PS143/1_6-1	200 m	8	11	11
PS143/1_6-6	1050 m	8	10	10
PS143/1_7-1	200 m	9	11	11
PS143/1_8-1	200 m	8	12	12
PS143/1_9-1	200 m	8	10	10
PS143/1_9-8	2450 m	12	14	14
PS143/1_11-1	200 m	7	9	9
PS143/1_14-1	200 m	9	11	11
PS143/1_14-6	1180 m	10	11	12

Event	Deepest sample	# Depths	# Nutrient samples	# DO samples
PS143/1_15-1	1200 m	11	12	13
PS143/1_17-1	200 m	9	10	11
PS143/1_18-1	200 m	9	11	11
PS143/1_19-5	200 m	9	11	11
PS143/1_20-1	2500 m	13	16	15
PS143/1_20-6	200 m	9	11	11
PS143/1_21-1	200 m	9	11	11
PS143/1_21-6	2420 m	12	14	14
PS143/1_22-1	200 m	9	11	11
PS143/1_24-2	200 m	9	11	11
PS143/1_27-1	200 m	9	11	11
PS143/1_30-1	200 m	9	11	11
PS143/1_34-1	200 m	9	11	11
PS143/1_36-1	1200 m	10	12	12
PS143/1_40-1	500 m	8	11	11

Nutrients

40 mL-samples were collected directly into 50 mL sterile Falcon tubes for the analysis of nutrients. Tubes were rinsed three times with seawater before the sample was drawn. Two duplicate samples were randomly collected from each cast. All these samples will be analyzed within the following 6 months upon return of Polarstern to Bremerhaven at the end of the 2024 Arctic season. Data processing will be done within 2 months of sample analysis.

Oxygen

Dissolved oxygen was determined following the amperometric Winkler titration method as described by Langdon (2010), adopting GO-SHIP best practice recommendations. Soon after laboratory set up (see Fig. 4.1), 1 L of thiosulphate solution (titrant) was prepared (50 g/L) and let to stabilise for about two days. Thiosulphate calibrations were carried out using 1.667 mM OSIL Scientific certified Iodate Standards; first, five blanks (involving 2 x 1 mL additions of iodate standard, each titrated one at a time) were measured followed by five standards (each with 10 mL of iodate standard). A first calibration was carried one day after the thiosulphate solution was prepared and a second calibration was carried out the following day to confirm the solution was stable and results from calibrations were consistent. There on, calibrations were carried out approximately every 4-5 days, with a total of seven calibrations carried out during PS143/1 (see Table 3.3).

Tab. 3.3: Thiosulphate titration calibrations for the determination of dissolved oxygen. Blank (Blk), Standard (STD), difference between STD and Blk, and calculated Thiosulphate molarity

Calibration Date	Blank	Standard	STD - Blk	Thiosulphate Molarity
11 June 2024	0.0017	0.4956	0.4939	0.2025
12 June 2024	0.0023	0.4960	0.4938	0.2026
17 June 2024	0.0016	0.4962	0.4946	0.2022
21 June 2024	0.0029	0.4954	0.4925	0.2031
25 June 2024	0.0033	0.4953	0.4921	0.2033
29 June 2024	0.0031	0.4980	0.4949	0.2021
03 July 2024	0.0025	0.4993	0.4968	0.2013
<i>Average</i>	<i>0.0025</i>	<i>0.4965</i>	<i>0.4941</i>	<i>0.2024</i>
<i>Standard Deviation</i>	<i>0.0007</i>	<i>0.0015</i>	<i>0.0016</i>	<i>0.0007</i>



Fig. 3.3: The fully automated filtration module AUTOFIM is installed on POLARSTERN in the “Bugstrahlruderraum” close to the inflow of the ships-pump system. AUTOFIM is suitable for collecting samples with a maximum volume of 5 Liters. Filtration can be triggered on-demand or after fixed intervals.

Molecular Observatory

We collected water and suspended particles for eDNA analyses of the microbial communities close to the surface (~ 10 m) with the automated filtration system for marine microbes AUTOFIM (Fig. 3.3) and at 5-6 different depth in the photic zone using Niskin-bottles mounted on a CTD rosette. Using AUTOFIM, we will collect seawater samples at regular intervals (~ 1°

longitude/latitude on the way to the study area starting as soon as possible after *Polarstern* has left Bremerhaven, while the CTD will be deployed at the permanent stations of the HAUSGARTEN observatory.

Phytoplankton/mycoplankton analyses by microscopy

At all stations samples from 4-5 depths (surface, 10, above chlorophyll maximum, chlorophyll maximum and below the chlorophyll maximum) were collected from the CTD Rosette and fixed in Formalin (for overall diversity as well as Lugol iodine solution (for detailed assessments of fungal particles respectively). These will be analysed post-cruise in Bremerhaven using a Planktoscope, a modular device for the high-throughput analysis of phytoplankton samples. For quality control purposes selected samples will also be analysed using inverted and scanning electron microscopy. The Formalin-fixed samples will be additionally used for CARD-FISH analysis.

In addition, net samples (20 µm mesh size) were collected at all stations (several net tows were carried out at stations with shallow and deep CTDs resulting in a total of 29 net tows).

Net samples (Phyto/Zoo/Mycoplankton)

Phyto/Mycoplankton

At each station we will carry out net hauls with a 20 µm hand net to assess the diversity of live phytoplankton, including parasitic plankton (oomycetes; Fig. 3.4 A). The samples will be screened semi-quantitatively onboard to generate a preliminary. An aliquot of the raw sample will be fixed in formalin for more detailed counts and taxonomic evaluation in the home laboratory after the cruise. In addition, the live samples will be used for the establishment of phytoplankton cultures (see below).

Zooplankton

The mesozooplankton community composition and depth distribution were investigated at six HAUSGARTEN stations, two stations in the East Greenland Current and one additional Station at 0°. To analyse the large-scale zooplankton distribution in the upper 1,500 m of the water column, we used a Multi-net midi (Hydrobios, Kiel Germany) equipped with five nets of 150 µm mesh size (Fig. 3.4 B). The net was towed vertically at HAUSGARTEN sites S3, HG-I, HG-IV, HG-IX, N3, N4, EG-I, EG-IV, and at an additional Station at 0° to sample five depths layers (i.e. 1,500, 1,000, 500, 200, 50, 0 m). At HG-I and EG-I, the bottom depth was shallower than 1,500 m, and here the depth intervals were adjusted, yielding a higher resolution of the upper water column. All samples were immediately preserved in 4% formalin buffered with hexamethylenetetramine. In the laboratories at AWI, these samples will be digitized, and the organisms on the images will be determined to the lowest taxonomical level possible via the internet application EcoTaxa. From these data, together with the data from the flowmeter attached to the net opening, we will determine zooplankton species composition and abundance. EcoTaxa also automatically provides the sizes of the organisms, and they will be used to calculate biomasses according to Cornils et al. (2022).

At each deep CTD station, we also deployed an UVP5 (Underwater Vision profiler, Fig. 3.4 C) that takes images of particles and zooplankton, allowing us to get a better spatial distribution of zooplankton abundances in the entire HAUSGARTEN area.

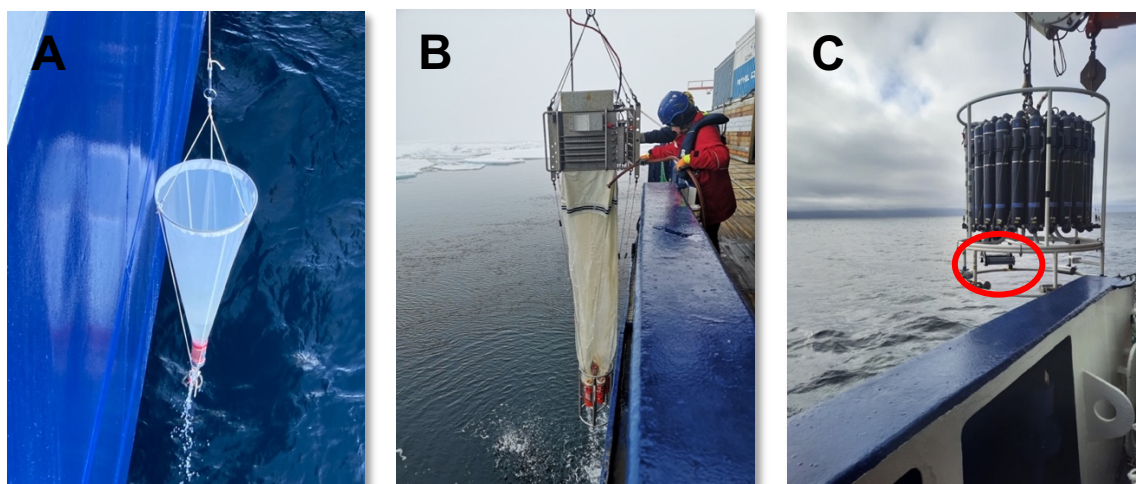


Fig. 3.4: Deployment of gear to address community composition and biomass of plankton. The Handnet (A), the Multi-net mid (B), and the UVP (Underwater Vision Profiler, C) attached to bottom of the CTD/Rosette Water Sampler (red circle) to study plankto biodiversity and depth distribution in the Fram Strait

Cultivation work

In preparation for the BMBF project INDIFUN-AI (to start in September 2024), all net samples were screened for oomycetes and fungal particles. A focus was placed on the diatoms *Pseudo-nitzschia* and *Melosira arctica* and their associated parasites as they were already observed to carry parasites on previous HAUSGARTEN cruises. However, any oomycete detected were of interest and to be taken into culture using different concentrations of the F/2 medium.

In summary, the following parameters are sampled as part of the long-term PEBCAO sampling campaign:

- Chlorophyll a concentration
- Dissolved organic carbon (DOC)
- Dissolved organic phosphorus (DOP)
- Particulate organic carbon (POC)
- Total dissolved nitrogen (TDN)
- Particulate organic nitrogen (PON)
- Inorganic nutrients
- Transparent exopolymer particles (TEP)
- Coomassie-stainable particles (CSP)
- Total alkalinity (TA)
- Hydrolysable amino acids (dAA)
- RNA
- CLSM/ CLASI-FISH
- Dissolved combined carbohydrates (dCCHO)
- lipids
- Phytoplankton, bacterial and virus abundance (Flow Cytometry)
- Primary production (C-14 method)

- Heterotrophic bacterial production (3H-Leucin)
- Analysis of phytoplankton net hauls (20 µm mesh size) and Utermöhl samples
- Analysis of zooplankton taxon composition
- Molecular information on distributional patterns of protists and bacteria
- Microscopy-based data on the phytoplankton community composition

Preliminary (expected) results

The PEBCAO group sampled all HAUSGARTEN sites apart from Svalbard 1. In addition, 3 stations between HG-IX and EG-IV were also included to better capture the hydrographic features in the area (Tab. 3.4).

Tab. 3.4: Overview of sampled stations

Station	Latitude	Longitude	Event number
S3 shallow	78.608019	5.063073	PS143/1_2-1
S3 deep	78.600748	5.078422	PS143/1_2-5
HG-I shallow	79.192359	6.092914	PS143/1_14-1
HG-I deep	79.192359	6.092914	PS143/1_14-6
HG-II	79.129	4.9	PS143/1_24-2
HG-III	79.107856	4.603182	PS143/1_22-1
HG-IV shallow	79.072781	4.340065	PS143/1_4-9
HG-IV deep	79.072713	4.340432	PS143/1_4-3
HG-V	79-056	3.756	PS143/1_27-1
HG-VI	79.0439	3.605136	PS143/1_30-1
HG-VII	79.058689	3.481109	PS143/1_11-1
HG-VIII	79.052032	3.299451	PS143/1_34-1
HGIX shallow	79.142552	2.760618	PS143/1_5-5
HGIX deep	79.142471	2.760289	PS143/1_5-1
SV-2	78.980331	9.514501	PS143/1_17-1
SV-3	79.018363	8.321006	PS143/1_18-1
SV-4	79.0298	6.9989	PS143/1_15-1
N3	79.595001	5.209127	PS143/1_19-5
N-IV shallow	79.740982	4.44544	PS143/1_20-6
N-IV deep	79.740982	4.44544	PS143/1_20-1
N5-shallow	79.937236	3.186747	PS143/1_21-1
N5-deep	79.937236	3.186747	PS143/1_21-6
EG-I shallow	79.000737	-5.198929	PS143/1_6-1
EG-I deep	79.006902	-5.311453	PS143/1_6-6
EG-II	78.936856	-4.617404	PS143/1_7-1
EG-III shallow	78.812926	-3.974368	PS143/1_8-1
EG-IV-shallow	78.814148	-2.793771	PS143/1_9-1
EG-IV-deep	78.82273	-2.772781	PS143/1_9-8
HG-0	78.93617	-0.033892	PS143/1_36-1
HG-1.5	79.077176	1.498273	PS143/1_40-1
HG-2deg	79.098715	1.966714	PS143/1_41-1

Hydrography

We here provide a short summary of the CTD measurements along the 79 degree latitude transect as a basis for the description of the biological and biogeochemical results. A more detailed report is provided in the oceanography section. Figure 3.5 shows the results for temperature and salinity for the regular EG, HG and Svalbard stations and additionally 3 CTD casts at 0 degrees longitude as well as 1.5 and 2 degree East.

The temperature and salinity profiles showed the typical patterns expected for the Fram Strait with colder, less saline surface waters dominating the western section and warmer saltier surface waters dominating the eastern part of the transect. Salinity varied greatly with depth in the eastern section of the Fram Strait but not in the Western section where salinities of 34 and higher predominated throughout the water column.

Microscopy data and cultivation work

Live samples were analysed semi-quantitatively onboard and documented with images to produce a preliminary taxon list for the phytoplankton taxa found in the different stations. The preliminary taxonomic data set based on net hauls, was subjected to a multidimensional scaling analysis to investigate geographic differences between the species composition at the different stations (Fig. 3.6). This analysis revealed a clear separation of stations based on their location in the FRAM Strait with the stations in the East Greenland current separated from those in the North and those in the central HAUSGARTEN and the Svalbard stations 2-4 in the east. This matches the hydrographic features described briefly above, with the colder low salinity waters in the Western Fram Strait characterised by low biomass and diversity and the warmer higher salinity water masses in the Eastern Fram Strait (Fig. 3.7a-b). The HAUSGARTEN Stations with the exception of HGIX clustered very closely together with the exception of HGIX (actually located closest to the EG stations). The two samples of this station fell between the central HAUSGARTEN cluster and Svalbard 2 and to some extent the Northern Stations (N3-5). These clustered somewhat apart from the other stations and were also not very closely related to each other in terms of species composition.

In addition to the analysis of biodiversity patterns in live plankton, the live samples were used for the establishment of phytoplankton cultures. Of these 25 were set up onboard. From these raw cultures, clonal isolates will be established back in the home laboratory.

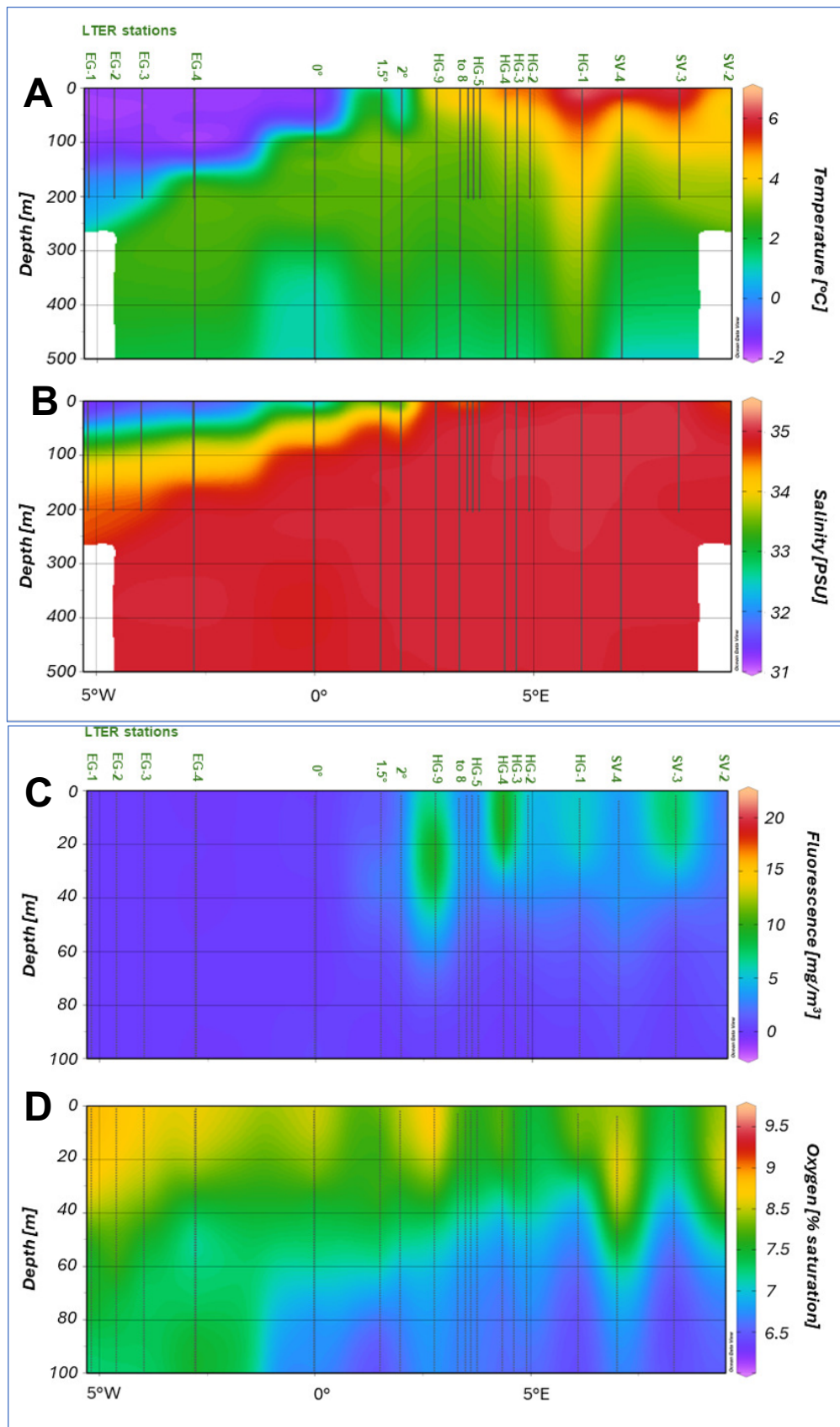
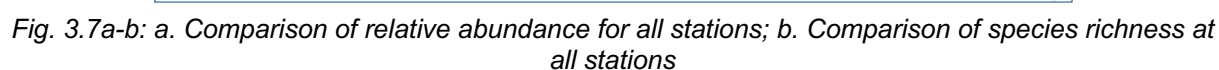
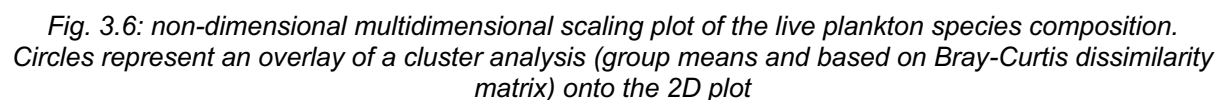


Fig. 3.5a-d: Temperature (a) and salinity profiles (b), fluorescence (c) and oxygen (d)



Parasitism

All net samples were screened for parasites in diatom, especially in *Pseudo-nitzschia* and the centric ice alga *Melosira arctica*. None of which were found to be parasitised in any of the samples. However, members of the centric genera *Chaetoceros* and *Thalassiosira* showed evidence of potential chytrid infections and these were therefore also targeted for isolation work (Fig. 3.8)



Fig. 3.8: Suspected (possibly possibly a chytrid) in a species of the centric diatom genus *Thalassiosira* collected at Station EG III

Nutrients and Oxygen

Here we present preliminary results for the dissolved oxygen concentrations analysed onboard and processed during the expedition. These results still need to be finalised and subjected to quality control measures.

Broadly, there are no clear trends in calibration titration values across the expedition's duration (Fig. 3.9). However, Fig. 3.9 B shows that the titration volumes of standards were elevated towards the end of the cruise. The last calibration titration value (03 July 2024) was particularly high, being more than two standard deviations greater than the cruise mean. Similarly, Figure 3.9 C shows that the last measurement of thiosulphate molarity (03 July 2024) was also significantly lower than previous values (lower than the cruise mean molarity by more than two standard deviations).

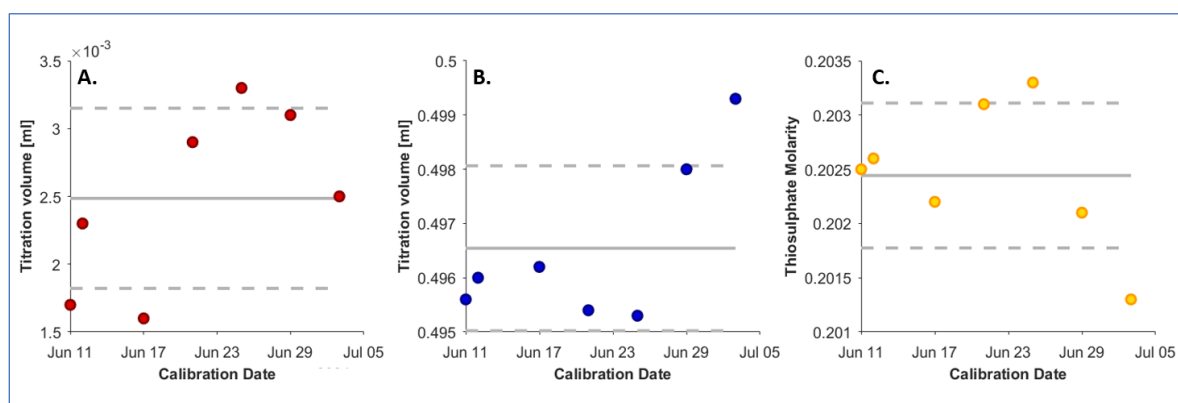


Fig. 3.9: Thiosulphate calibrations conducted during PS143/1 for the determination of dissolved oxygen in seawater. [A] Blanks, [B] Standards, and [C] Thiosulphate molarity. Grey solid and dashed lines show the mean ± 1 standard deviation.

Values of dissolved oxygen concentration for epipelagic (< 100 m) and lower-mesopelagic (> 1,000 m) depths were within a similar range (~300–400 $\mu\text{mol L}^{-1}$) tending towards 300 $\mu\text{mol L}^{-1}$ for depths exceeding 1,000 m (Fig. 3.10). In the upper-mesopelagic (200–500 m), values were consistently lower at all east Greenland stations compared to other sites (Fig. 3.10). The outliers from S3 at ~ 2,000 m (Fig 3.9) are due to sampling errors and are not reflective of natural conditions.

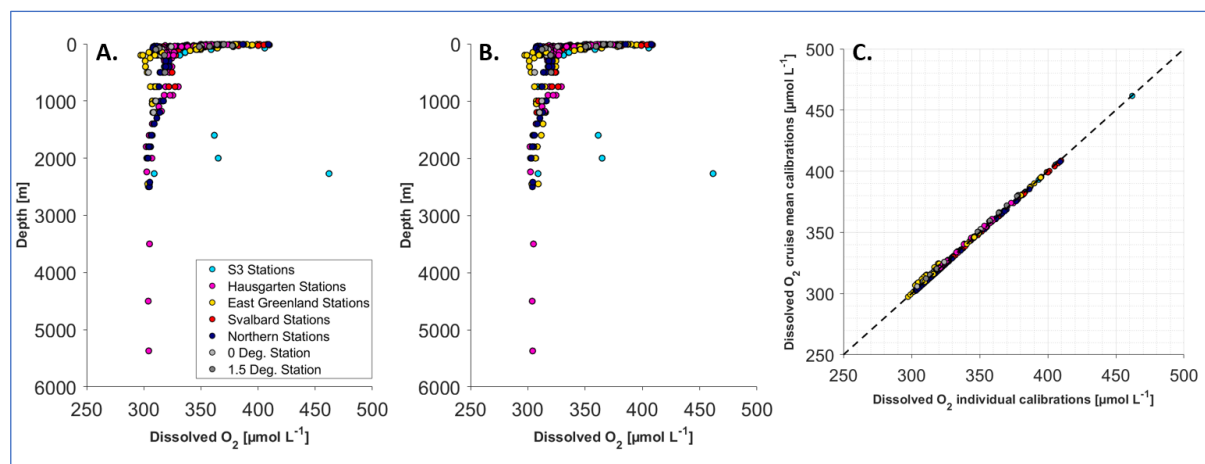


Fig. 3.10. Depth profiles of dissolved oxygen concentration for all CTD casts calculated using [A] individual calibration values and [B] the cruise mean calibration values (for blanks and standard titration volumes). [C] shows the correlation between these two calculation methods.

A total of 63 duplicate samples were taken during the expedition for the analysis of dissolved oxygen concentration and the variability in the absolute difference between these duplicates is presented in Figure 4. Most duplicates were good (66 % with differences < 1 $\mu\text{mol L}^{-1}$) and 49 % with differences $\leq$ 0.5 $\mu\text{mol L}^{-1}$. 21 of duplicates (33 %) were classified as outliers exceeding 1 $\mu\text{mol L}^{-1}$ and the difference between duplicate samples was exceptionally high during some of the casts at S3 (duplicates 2, 5 and 9 in particular; see Fig. 3.11).

These are due to errors when collecting the water samples at the CTD. Additionally, during the analysis of samples from HGI 014-006, the thiosulfate burette tip was damaged and lost its valve, causing erroneous dispensing of thiosulphate solution. This problem was identified and resolved (by replacing the burette tip) prior to the analysis of samples from N3 19-5; but because of this, titers and dissolved oxygen values are for the affected sample sets (HGI 14-6 to SVIII 18-1. See Table 3.1 for all affected CTD casts) should be interpreted with caution. The potential reduction in the accuracy of our dissolved oxygen measurements is shown by the significant discrepancies among duplicates taken from the affected samples (Fig. 3.10 duplicate numbers 31-40).

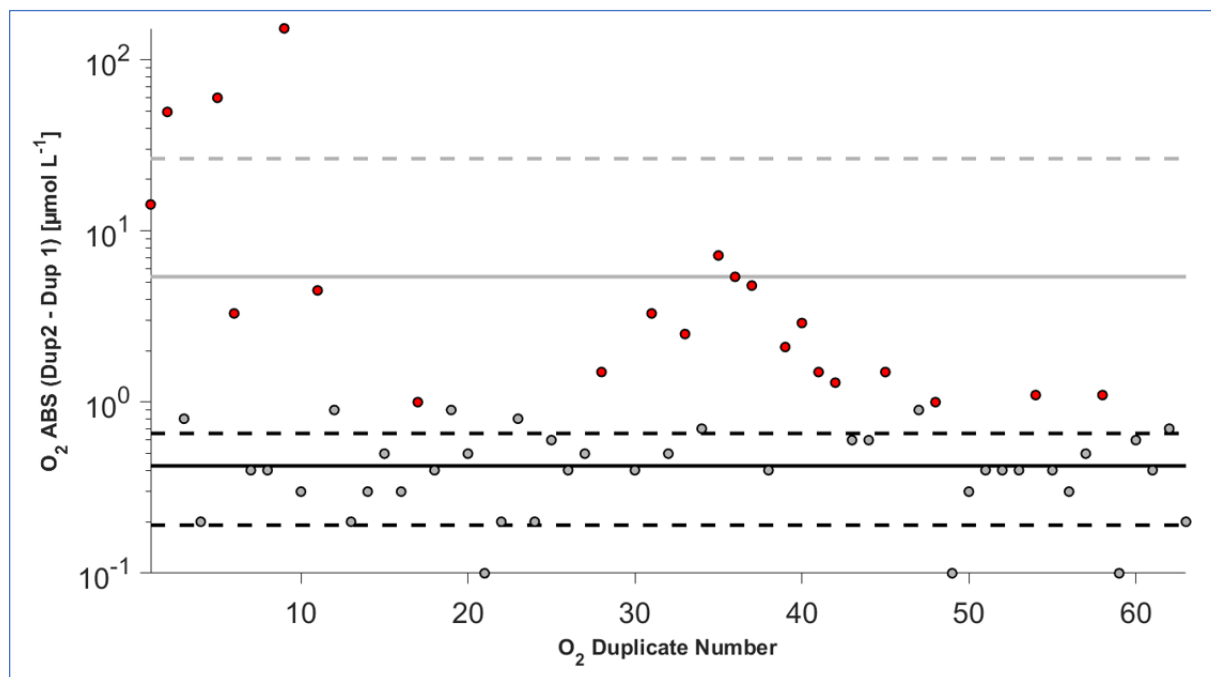


Fig. 3.11. Absolute difference between duplicate samples taken on PS143/1. Red points show outliers ($> \mu\text{mol L}^{-1}$). The black solid and dashed lines show the mean difference and standard deviation respectively between duplicates (excluding outliers). The grey lines show the mean absolute difference (+ 1 std; grey dashed line) between duplicates for all samples including outliers.

Biogeochemistry

Bacterial biomass production (BBP) was determined on board via radioisotope incubations (Fig. 3.12). Preliminary results on bacterial biomass production (BBP) suggest the highest heterotrophic activity between 6° and 8° East, restricted to the upper 40 m of the water column, which is about one degree further east than observed at previous cruises (e.g., PS126, PS136).

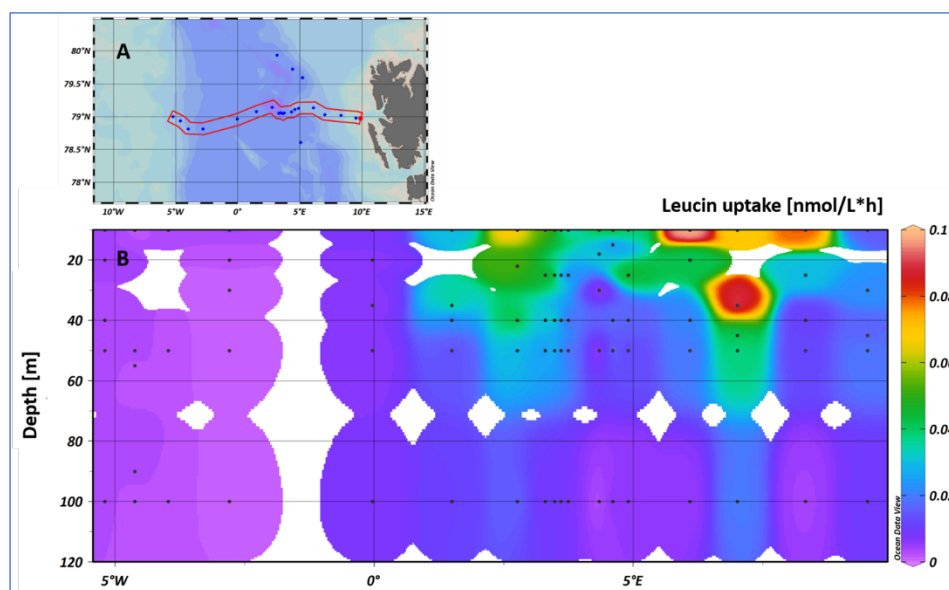


Fig 3.12: Bacterial biomass production (BBP) along a West-East transect at 79°N: West-East transect marked in red (A) and BBP expressed as leucine uptake at in-situ temperature in the upper 100 m (B). Actual depths from where discrete seawater samples were obtained are marked with black dots.

A preliminary assessment of the stained suspended gel particles showed, similar to the BBP, very low abundances at the stations located in the East Greenland Current (EG). For both transparent exopolymer particles (TEP) and coomassie stainable particles (CSP), up to 75 times higher volumes of seawater had to be filtered at EG stations to achieve a particle density on the filters comparable to that at the central HAUSGARTEN stations. The abundance of TEP and CSP is strongly linked to phytoplankton abundance (Engel et al. 2017). Figure 3.13 illustrates two diatom species surrounded by TEP particles and filaments stained by Alcian Brilliant Blue.

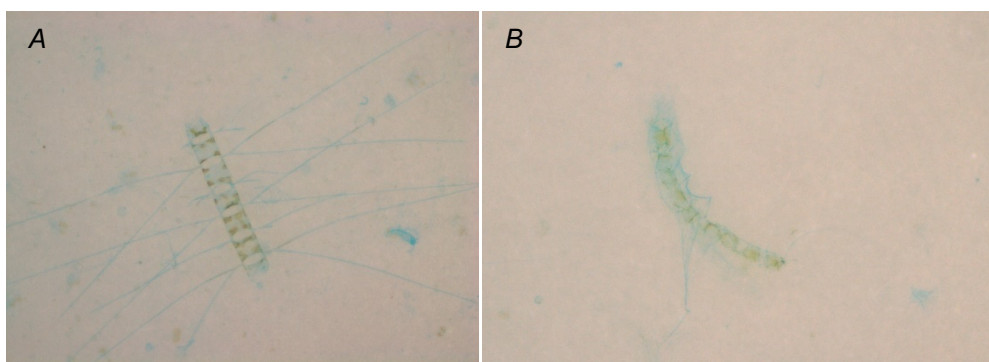


Fig. 3.13: Microscopic picture of TEP-particles stained with Alcian Blue: TEP attached to *Chaetoceros decipiens* found at SVII at 30 m depth (A) and a dying diatom surrounded by TEP found at HGIV at 10 m depth (B).

Interestingly, a peak in abundance of TEP and CSP was observed at 100m depth at 0°. This station was the only one where TEP and CSP abundance did not peak either at the surface or in the chlorophyll a maximum layer.

Data management

Environmental data will be archived, published and disseminated according to international standards by the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (<https://www.pangaea.de>) within two years after the end of the expedition at the latest. By default, the CC-BY license will be applied.

Molecular data (DNA and RNA data) will be archived, published and disseminated within one of the repositories of the International Nucleotide Sequence Data Collaboration (INSDC, www.insdc.org) comprising of EMBL-EBI/ENA, GenBank and DDBJ).

Any other data will be submitted to an appropriate long-term archive that provides unique and stable identifiers for the datasets and allows open online access to the data.

This expedition was supported by the Helmholtz Research Programme “Changing Earth – Sustaining our Future” Topic 6, Subtopic 1 and 3.

In all publications based on this expedition, the **Grant No. AWI_PS143/1_02** will be quoted and the following publication will be cited:

Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung (2017) Polar Research and Supply Vessel POLARSTERN Operated by the Alfred-Wegener-Institute. Journal of large-scale research facilities, 3, A119. <http://dx.doi.org/10.17815/jlsrf-3-163>.

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4. PHYSICAL OCEANOGRAPHY

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Objectives

The physical conditions that lead to enhanced primary and export production in the Arctic Ocean remain unclear. With both, rapid increases in ocean temperatures amplified in the Arctic region and sea ice retreat of the past two decades, the connection between these physical changes and the effect on polar marine ecosystem only increases in importance.

The intermittent presence of sea ice and meltwater affects both the physical and biochemical vertical structure of the water column but also limits *in situ* observations to summer months when the ice has retreated. The effects of changes in the environmental conditions on the polar marine biodiversity can only be detected through long-term observation of the species and processes. The FRAM multidisciplinary observatory attempts to observe the coupling across the system atmosphere, upper ocean, pelagic, and benthic environments.

The LTER (Long-Term Ecological Research) observatory HAUSGARTEN includes CTD water sampling stations in the Atlantic-influenced West Spitsbergen Current towards the East of Fram Strait, in the Arctic-influenced East Greenland Current to the West, and in the transition regions in the central and northern parts of the region. The FRAM observatory includes moored year-round observations for sensor data and sample collection in representative stations of those contrasting water masses. These observations span the whole water column with an emphasis on the upper euphotic zone.

Work at sea

The CTD/Rosette Water Sampler (on board CTD) used during PS143/1 (see Fig. 4.1) has been deployed at three extra stations (0°, 1.5° and 2°) in addition to the standard HAUSGARTEN stations (see Tab. 4.1).

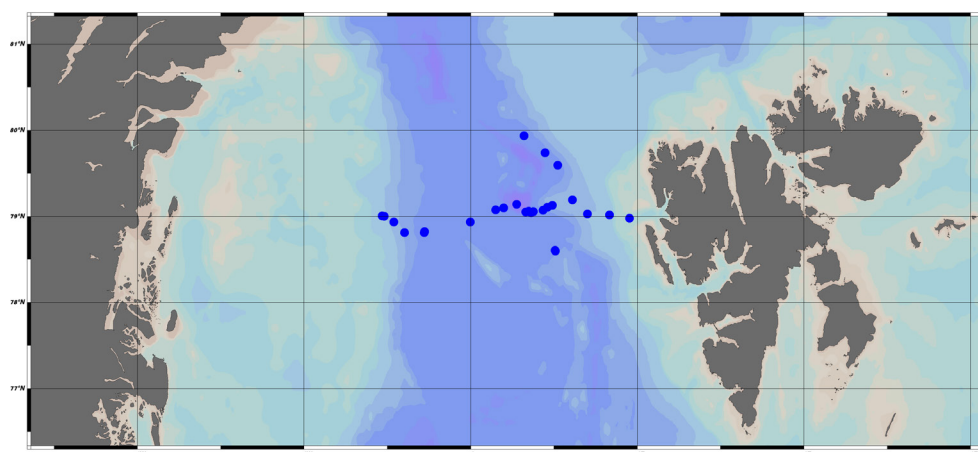


Fig. 4.1: Map of all CTD stations during PS143/1, including HAUSGARTE N and extra stations.

Tab. 4.1: Chronological order of CTD casts conducted during PS143/1 separated in station number, profile, date, station, longitude, latitude, water depth and CTD depth.

Station Number	Profile	Date	Station	Longitude	Latitude	Water depth [m]	CTD Depth [m]
PS143_001_01	Shallow	13.06.2024	Test	004° 59.12' E	74° 43.79' N	3284	150
PS143_002_01	Shallow	14.06.2024	S3	005° 03.75' E	78° 36.48' N	2344	200
PS143_002_05	Deep	14.06.2024	S3	005° 04.62' E	78° 36.03' N	2342	2270
PS143_003_01	Deep	14.06.2024	HG-9	002° 45.60' E	79° 08.56' N	5598	5440
PS143_004_03	Deep	15.06.2024	HG-4	004° 20.51' E	79° 04.36' N	2256	2240
PS143_004_08	Shallow	16.06.2024	HG-4	004° 20.45' E	79° 04.37' N	2256	200
PS143_005_01	Deep	17.06.2024	HG-9	002° 44.75' E	79° 08.66' N	5430	5370
PS143_005_05	Shallow	17.06.2024	HG-9	002° 45.64' E	79° 08.56' N	5437	200
PS143_006_01	Shallow	19.06.2024	EG-1	005° 11.51' W	79° 00.09' N	1151	200
PS143_006_06	Deep	19.06.2024	EG-1	005° 17.67' W	79° 00.41' N	1078	1050
PS143_007_01	Shallow	19.06.2024	EG-2	004° 36.92' W	78° 56.22' N	1513	200
PS143_008_01	Shallow	20.06.2024	EG-3	003° 58.29' W	78° 48.81' N	1852	200
PS143_009_01	Shallow	20.06.2024	EG-4	002° 47.53' W	78° 48.85' N	2500	200
PS143_009_08	Deep	21.06.2024	EG-4	002° 46.20' W	78° 49.61' N	2501	2450
PS143_011_01	Shallow	21.06.2024	HG-7	003° 28.79' E	79° 03.52' N	3835	200
PS143_014_01	Shallow	22.06.2024	HG-1	006° 05.51' E	79° 07.99' N	1631	200
PS143_015_06	Deep	22.06.2024	HG-1	006° 05.58' E	79° 07.98' N	1224	1180
PS143_016_01	Deep	23.06.2024	SV-4	007° 00.25' E	79° 01.82' N	1256	1200
PS143_017_01	Deep	24.06.2024	SV-2	009° 30.90' E	78° 58.82' N	219	200
PS143_018_01	Shallow	24.06.2024	SV-3	008° 19.37' E	79° 01.05' N	806	200
PS143_019_05	Shallow	25.06.2024	N3	005° 12.60' E	79° 35.70' N	2684	200
PS143_020_01	Deep	25.06.2024	N4	004° 29.21' E	79° 44.25' N	2528	2500
PS143_020_06	Shallow	26.06.2024	N4	004° 25.13' E	79° 43.51' N	2624	200
PS143_021_01	Shallow	26.06.2024	N5	003° 11.22' E	79° 56.24' N	2477	200
PS143_021_06	Deep	26.06.2024	N5	003° 13.04' E	79° 56.18' N	2469	2420
PS143_022_01	Deep	27.06.2024	HG-3	004° 36.22' E	79° 06.47' N	1845	1825
PS143_024_02	Shallow	28.06.2024	HG-2	004° 54.02' E	79° 07.75' N	1509	200
PS143_027_01	Shallow	29.06.2024	HG-5	003° 44.51' E	79° 03.27' N	2763	200
PS143_030_01	Shallow	30.06.2024	HG-6	003° 36.03' E	79° 02.61' N	3172	200
PS143_032_01	Shallow	01.07.2024	HG-9	002° 45.64' E	79° 08.61' N	5448	100
PS143_034_01	Deep	02.07.2024	HG-8	003° 19.86' E	79° 03.69' N	5079	4900
PS143_036_01	Deep	03.07.2024	Extra Station at 0°	000° 00.83' E	78° 58.32' N	2477	2460
PS143_040_01	Shallow	04.07.2024	Extra Station at 1.5°E	001° 29.95' E	79° 04.56' N	2557	500
PS143_041_01	Shallow	05.07.2024	Extra Station at 2°E	001° 58.44' E	79° 05.85' N	2707	500

Depth profiles were measured using multiple sensors mounted on the CTD and operated by the standard SeaBird SBE911plus/917plus. The CTD was equipped with two temperature-, two

conductivity-, a pressure-, two oxygen-, and one fluorescence sensor as well as a transmissometer (for sensor specifications see Tab. 4.2. An altimeter was mounted to monitor the distance to the seafloor and an Underwater Vision Profiler (UVP) was operated by Barbara Dörmbach (PEBCAO working group on profiles deeper than 500 m. The Rosette Water Sampler consisted of 24 bottles, each holding 12 liters and was used to collect water samples at different depth levels on the upcast. During the expedition, data from 34 casts were collected. Depth profile measurements and water samples have been collected throughout the whole water column (deep stations and on profiles to only 200 m depth (shallow stations. The water samples were mainly taken for the PEBCAO group as well as the HADAL group. For selected water levels also salinity samples have been collected but not yet analysed. The samples are listed in Table 4.3.

The PC regularly used for CTD data recording and processing was facing some yet unknown issues such, that the standard data processing was not working. Usually, CTD data is processed with the AWI software package ManageCTD in conjunction with SbeDataProcessing software. A new installation of the involved software did not solve the issue. Finally, next to the regular PC, a new PC for data processing was set up on which the processing is running smoothly.

In addition, *Polarstern* was equipped with a 150 kHz ADCP (Acoustic Doppler Current Profiler). Due to technical problems, the ADCP was not recording between 7:34 UTC and 15:06 UTC on the 02.07.2024.

Tab. 4.2: List of sensors mounted to the CTD

Sensor	Serial numbers
Temperature 1	2685
Temperature 2	2423
Conductivity 1	2446
Conductivity 2	2078
Pressure	0485
WET_LabsCStar	CST_946R
FluoroWetlabECO_AFL_FL_Sensor	1670
Altimeter	1228
Oxygen 1	0880
Oxygen 2	4274

Tab. 4.3: Overview of salinity samples taken from selected depth intervals during PS143/1

Station number	Station	Date	Depth [m]
PS143_1_002_01	S3_shallow	14.06.2024	200
PS143_1_002_01	S3_shallow	14.06.2024	200
PS143_1_002_01	S3_shallow	14.06.2024	100
PS143_1_002_01	S3_shallow	14.06.2024	100
PS143_1_002_05	S3_deep	14.06.2024	1000
PS143_1_002_05	S3_deep	14.06.2024	1000
PS143_1_002_05	S3_deep	14.06.2024	2000
PS143_1_002_05	S3_deep	14.06.2024	2000
PS143_1_004_03	HG-4_deep	15.06.2024	1800
PS143_1_004_03	HG-4_deep	15.06.2024	1800
PS143_1_004_03	HG-4_deep	15.06.2024	1400
PS143_1_004_03	HG-4_deep	15.06.2024	1400
PS143_1_006_06	EG-1_deep	19.06.2024	400
PS143_1_006_06	EG-1_deep	19.06.2024	400
PS143_1_006_06	EG-1_deep	19.06.2024	750
PS143_1_006_06	EG-1_deep	19.06.2024	750
PS143_1_009_08	EG-4_deep	21.06.2024	1800
PS143_1_009_08	EG-4_deep	21.06.2024	1800
PS143_1_009_08	EG-4_deep	21.06.2024	1200
PS143_1_009_08	EG-4_deep	21.06.2024	1200
PS143_1_015_06	HG-1_deep	22.06.2024	1100
PS143_1_015_06	HG-1_deep	22.06.2024	1100
PS143_1_015_06	HG-1_deep	22.06.2024	750
PS143_1_015_06	HG-1_deep	22.06.2024	750
PS143_1_020_01	N4_deep	25.06.2024	2500
PS143_1_020_01	N4_deep	25.06.2024	2500
PS143_1_020_01	N4_deep	25.06.2024	1800
PS143_1_020_01	N4_deep	25.06.2024	1800
PS143_1_020_01	N4_deep	25.06.2024	1400
PS143_1_020_01	N4_deep	25.06.2024	1400

Preliminary (expected) results

For on board use the data was preprocessed using the AWI software package ManageCTD in conjunction with SbeDataProcessing software. From the stations near Svalbard (SV stations) to the stations near Greenland (EG stations) a latitudinal transect was defined to measure the stratification of temperature, salinity, oxygen, and fluorescence with depth. Stations that were included in the section plots can be seen in figure 2. In order to achieve a better understanding of the physical water properties in the central Fram strait, three additional stations between the HG and the EG stations were taken at approximately 0 °E, 1.5 °E and 2 °E.

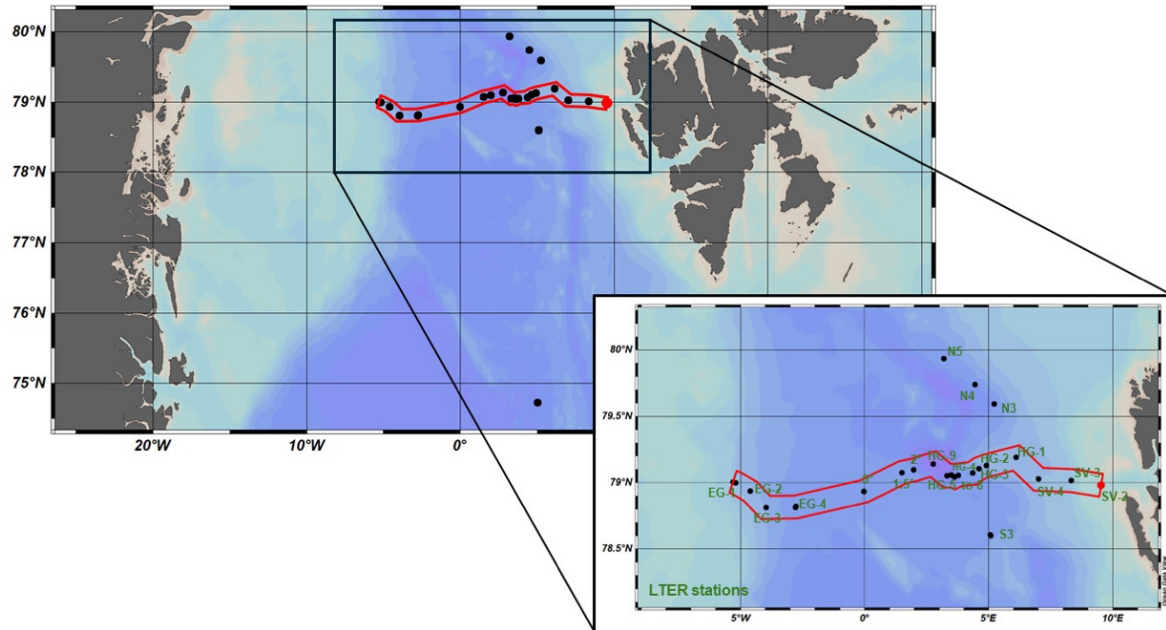


Fig. 4.2: Defined transect including HAUSGARTEN Stations and three additional stations at 0°, 1.5° and 2° in the Fram Strait

At the SV stations where the Spitzbergen Current influence is expected to be measured the values in both temperature and salinity were higher in the top 200m compared to the EG stations. Maximum values of 6.8°C were measured at the near-surface in the eastern part of the Fram Strait. Here, a stratification of warmer temperature at the top to colder temperature with increasing depth was detected. In contrast, the EG stations further west revealed a reversed stratification pattern. At the EG stations, a cold (-1.8°C) water mass was found in the top 100 m with temperatures increasing to 3.2°C with depth (see Fig. 4.3).

A stratification of the water column can be seen in the salinity values at the EG stations, as well as partly in the additional stations conducted at 0°E, 1.5°E and 2°E. At the stations furthest to the east, the salinity values are more homogenous over depth (see Fig. 4.3).

Fluorescence measurements revealed intensified values in the top 20 m to top 40 m at stations HG-9, HG-4, HG-3, HG-1, and SV-3 (see Fig. 4.4). Generally, oxygen levels show higher saturation in the upper water layers throughout the whole transects (see Fig. 4.4).

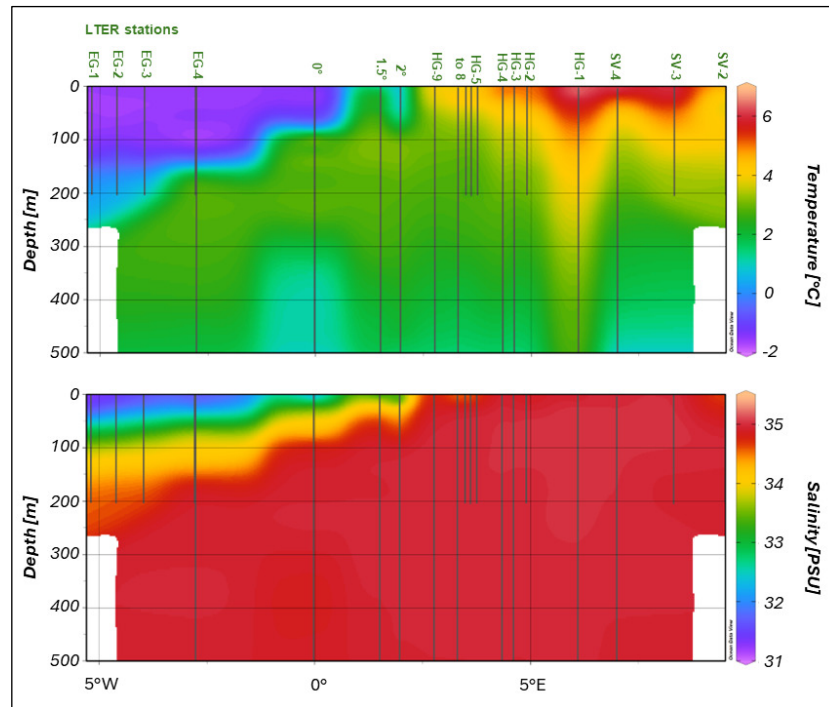


Fig. 4.3: Section plot with measured and interpolated values of the temperature and salinity (b) over distance and 500 m depth.

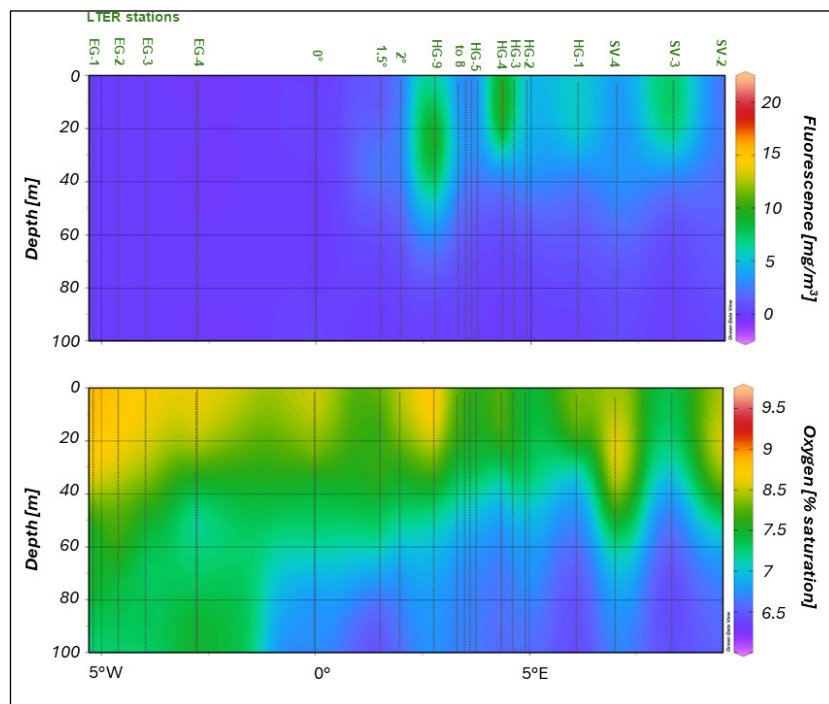


Fig. 4.4: Section plot with measured and interpolated values of fluorescence and oxygen over distance and 100 m depth.

Data management

CTD data will be archived, published and disseminated according to international standards by the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (<https://www.pangaea.de>) within two years after the end of the expedition at the latest. By default, the CC-BY license will be applied.

This expedition was supported by the Helmholtz Research Programme “Changing Earth – Sustaining our Future” Topic 2, Subtopic 1 and Topic 6, Subtopic 3.

In all publications based on this expedition, the Grant No. AWI_ PS143/1_03 will be quoted and the following publication will be cited:

Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung (2017 Polar Research and Supply Vessel POLARSTERN Operated by the Alfred-Wegener-Institute. Journal of large-scale research facilities, 3, A119. <http://dx.doi.org/10.17815/jlsrf-3-163>.

5. PELAGIC BIOGEOCHEMISTRY: NUTRIENTS

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Grant-No. AWI_PS143/1_04

Objectives

Since PS114 (2018) we have been deploying remote access samplers (RAS) equipped with several sensors (SUNA nitrate, pH, pCO₂, CTD-O₂, PAR and Eco-triplet) and carrying out dissolved nutrient measurements in Fram Strait as part of the FRAM/HAUSGARTEN LTO activities. The rationale of our work has already been described in previous booklets and cruise reports (e.g., von Appen 2018; Metfies 2019, 2020; Soltwedel 2021a,b; Kanzow 2022), but our aim is to use data from sensors and RAS deployments, in combination with data from CTD casts to assess temporal variability of biogeochemical variables associated with inflowing and outflowing water masses in Fram Strait. This, will allow us to evaluate the role of water property exchange in the deepest gateway of the Arctic, within the context of Arctic Ocean nutrient budgets. As in previous expeditions, we carry out these deployments in collaboration colleagues within the FRAM community; the Microbial Observatory (Katja Metfies, Christina Bienhold, Anja Nicolaus and Mathias Wietz), Physical Oceanography of Polar Oceans (Wilken von-Appen, Mario Hoppmann, Matthias Monsees, Torsten Kanzow) and Deep-Sea Ecology and Technology (Normen Lochtofen). For expeditions PS136 and now PS143_1/2 we also started a new collaboration with colleagues (Adrian Martin and Peter Brown) from the National Oceanography Centre, Southampton (UK) as part of their BIPOLE programme (<https://biopole.ac.uk/>). They have provided an extra RAS to complement our work and this RAS will be recovered on PS143/2. Since PS131 (2022) we have also started measuring dissolved oxygen in seawater samples collected from CTD casts with the aim of generating calibrated CTD-O₂.

Work at sea

During PS143/1:

- We collected water samples from CTD-Rosette casts for the analysis onboard of dissolved oxygen in seawater. These data will be used to calibrate the CTD-O₂ sensor.
- We also collected samples from CTD-Rosette casts for later analysis of dissolved nutrients.

Preliminary (expected) results

Data from dissolved oxygen measurements onboard will be processed for further quality controlled after the expedition and then will be made available to the physical oceanography team for the calibration of the CTD-O₂ sensors.

Samples collected for dissolved nutrient observations will be analysed within the following 6 months upon return of *Polarsten* to Bremerhaven at the end of the 2024 Arctic season. Data processing will be done within 2 months of sample analysis.

Data management

Environmental data will be archived, published and disseminated according to international standards by the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (<https://www.pangaea.de>) within two years after the end of the cruise at the latest. By default, the CC-BY license will be applied.

Any other data will be submitted to an appropriate long-term archive that provides unique and stable identifiers for the datasets and allows open online access to the data.

This expedition was supported by the Helmholtz Research Programme "Changing Earth – Sustaining our Future" Topic 6, Subtopic 6.2 and 6.3, Topic 2, Subtopic 2.1.

In all publications based on this expedition, the **Grant No. AWI_PS143/1_04** will be quoted and the following publication will be cited:

Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung (2017 Polar Research and Supply Vessel POLARSTERN Operated by the Alfred-Wegener-Institute. Journal of large-scale research facilities, 3, A119. <http://dx.doi.org/10.17815/jlsrf-3-163>..

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6. BIOGEOCHEMISTRY AND MICROBIAL ECOLOGY OF MOLLOY DEEP

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Grant-No. AWI_PS143/1_05

Objectives

The amount of organic material that escapes mineralization and is retained in the sediment record is the single most important factor determining the O₂ levels of the global ocean. Today we have a reasonably good understanding of the processes that are responsible for the mineralization of organic material. But many areas of the deep sea are still poorly explored.

Deep-sea (or hadal) trenches, for example, only account for less than 2% of the global seabed area, but could via sediment focusing act as regionally important but unexplored traps for organic material. Benthic mineralization is mainly driven by vast numbers of bacteria and archaea, with direct or indirect contributions by viruses, fungi, protists, and meiofauna.

Currently, even the most basic information on abundance and distribution of microbes and small eukaryotes in deep sea and trench sediments are missing. We wanted to quantify the carbon mineralization-efficiency of sediments in the Molloy Deep (5.5 km) and at adjacent shallower reference sites, identify the key players for the processing and compare process rates and microbial communities with other deep sea and trench ecosystems.

Our work targeted two sites covering a depth range of 2.4 to 5.5 km within and around the Molloy Deep in the Fram Strait (Arctic Ocean). The specific research goals included:

Quantification of the pelagic export and benthic mineralization of organic carbon

Using state-of-the-art lander technology, we measured *in situ* benthic oxygen consumption rates within and around the Molloy Deep. The data obtained provide a unique assessment of the regional benthic carbon mineralization rates and fill data gaps in the current global data base.

The involved diagenetic pathways were quantified from porewater profiles and the distribution of solid-state iron and manganese, and dissolved inorganic nitrogen as well as onboard measurements of sulfate reduction, denitrification, and anammox. The site-specific turn-over rates determined will be linked to the pelagic activity and sedimentation rates derived from the distribution of natural radionuclides, but will also be linked to long-term assessments of pelagic productivity at the respective sites estimated from remote sensing (Wenzhöfer and Glud 2002; Jørgensen et al. 2022). Thereby we will assess the quantitative link between surface primary production and underlying benthic activity, and evaluate the potential

importance of horizontal transport of organic material in the complex benthic seascape of the region.

Characterization of the quantity and quality of deposited organic material

Recovered sediment cores were used to assess the source, quantity and quality of organic material deposited at the respective sites. Beside basic quantification of total organic carbon (TOC and the sedimentary C:N ratio, the analyses will include detailed pyrolysis for assessing lability, stable isotopes ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$ signatures) and biomarkers using procedures that we have applied in other deep-sea and hadal settings. Photopigments will be quantified by the Deep-Sea Ecology group at AWI. Additionally, bacterial and archaeal tetraether lipid biomarkers will be analyzed to relate their composition and distribution to *in situ* benthic oxygen consumption rates, water depth, and hydrostatic pressure.

To assess the effect of turbidites on geochemical and microbial succession, sediment cores and water samples were collected for a long-term laboratory experiment at the HADAL Center.

Exploring microbial communities in relation to food supply, depth, and hydrostatic pressure

Benthic viral, bacterial, archaeal, fungal, microalgal, and meiofaunal abundances were targeted using different techniques. Novel virus-host systems will be isolated from sediment samples in the laboratory. The phylogenetic composition of the microbial communities will be analyzed through next-generation sequencing (metagenomics and amplicon sequencing).

To that end, DNA will be extracted from recovered sediment cores and water samples applying procedures we have used in other deep-sea and hadal settings. The biodiversity and biogeography of nematodes and other meiofaunal groups will be studied in the collected sediment samples using molecular (DNA metabarcoding and traditional taxonomical techniques (morphological identification).

To assess the effect of hydrostatic pressure on marine microbes, on-board pressure-tank experiments were carried out: 1 Rates of benthic microbial processes like aerobic respiration, nitrification, denitrification, anammox, and sulfate reduction were measured at different pressure levels. 2 Mineralization efficiency and microbial community succession of diatom-dominated marine snow were studied under increasing pressure levels, which simulates the descent of marine snow into a high-pressure environment. 3 Viability of diatoms settled onto deep-sea sediments was assessed in on-board light incubations; identity and pressure tolerance of the revived diatom species will later be determined through 18S amplicon sequencing and pressure-tank incubations, respectively.

Exploring the biogeochemical function and community composition in the deep sea

The study we carried out was essential for understanding carbon and nitrogen cycling, pelagic-benthic coupling and benthic community structures in this very important region of the Arctic Ocean. However, the work should also be seen in the context of a wider ambition of exploring life and biogeochemical function of the deep sea. Our work in the productive region of the Molloy Deep within the Fram Strait will greatly complement investigations on hadal systems of different biogeographic provinces. The combined data will provide generic insights on the biogeochemical function and life in deep-sea and hadal trench systems underlying different productivity regimes. The analysis of community structures explores the extent by which deep basins and trench systems act as isolated biogeographic habitats dominated by unique co-evolving communities or if they represent interconnected extreme environments.

Work at sea

Ecosystem functions, such as benthic respiration, remineralization and organic matter transport, microbial and meiofaunal biodiversity, were studied in the Molloy Deep (HG IX, 5500 m) and a shallower reference site (HG IV, 2,400 m) (Tab. 6.1). The main focus was on *in situ* benthic flux measurements and sediment sampling. The results of these efforts will be added to the existing scarce data base of deep sea and hadal data. *In situ* measurements were made with a new Hadal-benthic Flux Lander (Fig. 6.1; rated to 11,000 m) to study benthic oxygen uptake and fluxes at the sediment water interface (Wenzhöfer and Glud 2002; Glud et al. 2013) at the same sites (Tab. 6.2)

The Lander was equipped with a 2-axis microprofiler. For further information see chapter. 7.



Fig. 6.1: Hadal-Flux-Lander deployed at Molloy Deep (HG-IX)

A multiple corer (MUC) was used to retrieve undisturbed sediment samples. Sediments will be analyzed for various biogenic sediment compounds indicating the input of organic matter to the seafloor as well as the activity and biomass of the small sediment-inhabiting biota. Due to the limited number of personnel on board sediment cores were sectioned (1 cm slices to 10 cm, then in 2 cm slices to 20 cm and then in 5 cm slices to the bottom of the core) and samples stored according to the analyses performed later in the home laboratory.

Tab. 6.1: MUC casts received and processed by the HADAL team

Event	Station	Area	Device	MUC-No.	Date+Time (Start)	Date+Time (End)	Latitude	Longitude	Depth [m]
PS143/1_3-3	HG IX	Molloy Deep	TV-MUC	MUC1	2024-06-15T02:14:20	2024-06-15T06:25:07	79.1422	2.7620	5601
PS143/1_3-4	HG IX	Molloy Deep	TV-MUC	MUC2	2024-06-15T06:26:11	2024-06-15T10:57:18	79.1427	2.7591	5441
PS143/1_12-1	HG IV	Reference site	TV-MUC	MUC1	2024-06-22T09:15:33	2024-06-22T11:15:45	79.0652	4.1841	2405
PS143/1_12-2	HG IV	Reference site	TV-MUC	MUC2	2024-06-22T11:17:09	2024-06-22T13:24:18	79.0655	4.1828	2408

Event	Station	Area	Device	MUC-No.	Date+Time (Start)	Date+Time (End)	Latitude	Longitude	Depth [m]
PS143/1_25-1	HG IV	Reference site	TV-MUC	MUC3	2024-06-28T21:47:27	2024-06-29T00:06:27	79.0650	4.1826	2393
PS143/1_25-4	HG IV	Reference site	TV-MUC	MUC4	2024-06-29T03:36:35	2024-06-29T05:30:57	79.0661	4.2007	2389
PS143/1_32-3	HG IX	Molloy Deep	TV-MUC	MUC3	2024-07-01T19:42:26	2024-07-01T23:45:45	79.1491	2.7619	5447
PS143/1_32-4	HG IX	Molloy Deep	TV-MUC	MUC4	2024-07-01T23:54:36	2024-07-02T03:54:58	79.1425	2.7600	5449
PS143/1_39-1	HG IX	Molloy Deep	TV-MUC	MUC5	2024-07-04T15:46:43	2024-07-04T20:23:32	79.1422	2.7616	5550

Tab. 6.2: Lander deployments by the HADAL team

Event label	Station	Date / time	Action	Latitude	Longitude	Depth (m)
PS143/1_5-11	HG-IX	18.06.24 14:14	deployed	79°08,581' N	002°45,282' E	5438
PS143/1_5-11	HG-IX	22.06.24 04:46	released	79°08,612' N	002°44,536' E	5438
PS143/1_25-2	HG-IV	29.06.24 00:54	deployed	79°02,405' N	004°07,562' E	2400
PS143/1_25-2	HG-IV	01.07.24 04:19	released	79°02,638' N	004°07,335' E	2400

Preliminary (expected) results

The retrieved sediment cores were sampled on board for total organic carbon (TOC) contents as well as for abundances of microorganisms and fauna. The X-Y microprofiler was used to perform multiple vertical oxygen profiles across the sediment-water interface. It is equipped with up to 9 O₂ electrodes, 1 conductivity sensor and 1 temperature sensor capable to perform multiple vertical sets of concentration profiles along a horizontal distance of 50 cm. Measurements across the water-sediment interface and within the upper sediment layer were performed with a vertical resolution of 100 µm and extending over a total length of 15–25 cm. The X-Y microprofiler was used to quantify the diffusive oxygen uptake (DOU), which is generally assigned to microbial respiration.

A multiple corer (MUC) was used to retrieve undisturbed sediment samples. The retrieved sediments will be analyzed for various biogenic sediment compounds indicating the input of organic matter to the seafloor as well as the activity and biomass of the small sediment-inhabiting biota (Tab. 6.3). The sediment cores were sectioned in 1 cm slices to 10 cm depth, then in 2 cm slices to 20 cm depth and then in 5 cm slices to the bottom of the core. All sediment samples were stored according to the analyses performed later in the home laboratory.

Tab. 6.3: Sediment analyses to be made by the HADAL team

Geochemistry	Biogeochemistry	Process rates	Biology
Porosity	<i>In situ</i> O ₂ profiles	Enzymatic activities	Bacterial abundance
Density	Porewater profiles (NO ₃ ⁻ , NO ₂ ⁻ , NH ₄ ⁺ , DIC, Fe(II), Mn (II), SO ₄ ²⁻)	O ₂ respiration	Viral abundance
Grain size distribution	Solid-state profiles (Fe, Mn)	Nitrification	Nematode diversity
Organic carbon content	Lipid biomarkers for bacteria and archaea	Denitrification	Diversity of viable diatoms

Geochemistry	Biogeochemistry	Process rates	Biology
Organic carbon characteristics C & N stable isotopes Trace metals Sediment accumulation (^{210}Pb , ^{137}Cs) Core imaging	Persistent organic pollutants (POPs) Turbidite experiment	Anammox Sulfate reduction O ₂ respiration by marine snow particles Dependence of rates on hydrostatic pressure	Sequencing (amplicon, metagenomic, mitogenomic)

Data management

Environmental data will be archived, published and disseminated according to international standards by the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (<https://www.pangaea.de>) within two years after the end of the expedition at the latest. By default, the CC-BY license will be applied.

Molecular data (DNA and RNA data) will be archived, published and disseminated within one of the repositories of the International Nucleotide Sequence Data Collaboration (INSDC, www.insdc.org) comprising of EMBL-EBI/ENA, GenBank and DDBJ).

Any other data will be submitted to an appropriate long-term archive that provides unique and stable identifiers for the datasets and allows open online access to the data.

This expedition was supported by the Helmholtz Research Programme “Changing Earth – Sustaining our Future” Topic 6, Subtopic 3; and the Center of Excellence; “Danish Center for Hadal Research – HADAL (DNRF145)”.

In all publications based on this expedition, the **Grant No. AWI_ PS143/1_05** will be quoted and the following publication will be cited:

Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung (2017) Polar Research and Supply Vessel POLARSTERN Operated by the Alfred-Wegener-Institute. Journal of large-scale research facilities, 3, A119. <http://dx.doi.org/10.17815/jlsrf-3-163>.

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7. ROV KIEL6000 DEPLOYMENTS

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Grant-No. AWI_PS143/1_00

Objectives

ROV KIEL6000 (Fig. 7.1) is a 6000 m rated deep diving platform manufactured by Schilling Robotics LLC, Davis, USA. It is based on commercially available ROVs, but customized to research demands, e.g. being truly mobile. As a truly versatile system it

has been operated from a variety of different national and international research vessels (*RV Sonne (old and new)*, *N/O l'Atalante*, *RV Maria S. Merian*, *RV Meteor*, *RV Celtic Explorer*, *RRS James Cook*, and *Polarstern*). It is an electrically driven, work class ROV of the type QUEST, build No. 7. ROV KIEL6000 is based at the Helmholtz Centre for Marine Sciences GEOMAR in Kiel, Germany.

ROV KIEL6000 is standardly equipped with two manipulators (seven function ORION (proportional), and five function RIGMASTER (rate controlled)), a Seabird 49 CTD, and two drawers which can be adapted to demand. Cameras include two Kongsberg/Imenco SD cameras, one AlphaC HDTV and photo camera (with integrated lasers), and one Sulis HDTV camera (Fig. 7.2). Footage from the latter four cameras is permanently recorded.

For navigation at the seafloor, a ship based POSIDONIA system was used. Navigation is visualised within the OFOP (Ocean Floor Observation Protocol) software (© Jens Greinert). Science protocols, as well as ROV immanent navigation protocols, and digital still images are saved and provided directly after each dive.



*Fig. 7.1: ROV
KIEL6000 in A
Frame of Polarstern
during deployment.
Photo: M. Bergmann*

Including this cruise, ROV KIEL6000 has accomplished 382 dives during 30 missions. During PS143/1, 8 scientific dives (Tab. 7.1) could be accomplished. Maximum diving depth was approximately 2,450 m and maximum bottom time was 06:31 hours. In total, bottom time accumulated to approximately 29,5 hours (total dive time approx. 47,5 hours).



Fig. 7.2: Frontal view of ROV KIEL6000 after recovery, carrying recovered cages. Photo: P. Striewski.

Work at sea

During PS143/1, tasks of ROV KIEL6000 included sediment sampling (mainly using pushcores), faunal sampling with the slurpgun, handnets and the ORION manipulator, and recovery and handling of experimental tools (Tab. 7.1).

The standard sampling configuration included 16 (+ 3 or 6) pushcores in/on the portside drawer and the large Senckenberg Biobox on the starboard drawer.

Tab. 7.1: ROV station list PS143/1

Station Number PS143-1	Dive No.	Date [UTC]	Time Start [UTC]	At Bottom [UTC]	Off Bottom [UTC]	Time End (UTC)	Location	Depth [m]	ROV Bottom Time
024-1ROV01	375	28.06.24	08:26	09:25	15:05	16:04	HG II	1500	05:40
026-1ROV02	376	29.06.24	08:00	09:14	14:45	15:23	"Senke"	1800	05:31
029-1ROV03	377	30.06.24	09:41	10:53	15:25	16:09	Mud Volcano	1250	04:32
031-1ROV04	378	01.07.24	07:10	08:30	15:01	16:08	HGIV Plastic	2400	06:31

Station Number PS143-1	Dive No.	Date [UTC]	Time Start [UTC]	At Bottom [UTC]	Off Bottom [UTC]	Time End (UTC)	Location	Depth [m]	ROV Bottom Time
033-1ROV05	379	02.07.24	07:07	08:19	11:10	12:16	HGIV Dropstones	2450	02:51
038-1ROV06	380	04.07.24	09:00	10:53	12:41	13:40	HGIV Dropstones	2450	01:48
042-2ROV07	381	05.07.24	06:59	08:13	09:33	10:39	HGIV Crawler	2450	01:20
044-2ROV08	382	06.07.24	06:50	08:01	09:21	10:31	HGIV Crawler	2450	01:20
Total: 8 scientific dives									29:33 h

Tools used during PS143-1 / handled/ observed by the ROV:

- Slurp gun w/ 8 sampling containers (ROV KIEL 6000)
- Push cores (ROV KIEL 6000)
- Handnets (ROV KIEL 6000)
- Lasers (integrated) (Alpha Cam, ROV KIEL 6000)
- “Senckenberg” Biobox (large) (ROV KIEL 6000)
- Pfahlkratzer (M. Bergmann, AWI)
- Profiler (AWI))
- Litter Experiment (plastic boards, plastic foil, plastic bags placed over sponges) (AWI)
- Artificial Dropstones (AWI)
- Larval traps, frames and cages (K. Meyer-Kaiser, WHOI)
- Crawler (AWI)

Preliminary (expected) results

The ROV (KIEL6000, GEOMAR) was deployed a total of 8 times. Although technical problems and the sea ice cover affected the deployment of the ROV and above all the bottom time, it was possible to successfully perform operations on the sea floor during 6 dives. Long-term experiments (dropstones, larval traps) and the operation of robotic platforms (experimental lander, crawler) on the seafloor were documented and for the most part sampled. Sediment samples were taken at the ArcFace Lander, at plastic experiments and at artificial drop stones as well as in bacterial mats on the mud volcano (see also Chap 2).

The suction sampler (slurpgun) was used to sample various fauna, including amphipods, from the seafloor and either suck them into a slurpgun container or “spit” them into a closed bio box (2-compartmented large Senckenberg Biobox on the starboard drawer).

Several experimental setups were retrieved (traps, frames, cages, plastics, HOMER Beacons), or relocated (artificial dropstones). A microprofiler was deployed and retrieved during dive 31-1ROV04.

During the last 2 dives, the new AWI crawler was to be observed. During the first deployment, an emergency release line was pulled by the ROV.

Dives 05 and 06 had to be aborted due to loss of compensation oil. Dives 07 and 08 were used to observe the performance of a new built Crawler.

Data management

Environmental data will be archived, published and disseminated according to international standards by the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (<https://www.pangaea.de>) within two years after the end of the expedition at the latest. By default, the CC-BY license will be applied.

Molecular data (DNA and RNA data) will be archived, published and disseminated within one of the repositories of the International Nucleotide Sequence Data Collaboration (INSDC, www.insdc.org) comprising of EMBL-EBI/ENA, GenBank and DDBJ).

Any other data will be submitted to an appropriate long-term archive that provides unique and stable identifiers for the datasets and allows open online access to the data.

In all publications based on this expedition, the **Grant No. AWI_ PS143/1_00** will be quoted and the following publication will be cited:

Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung (2017) Polar Research and Supply Vessel POLARSTERN Operated by the Alfred-Wegener-Institute. Journal of large-scale research facilities, 3, A119. <http://dx.doi.org/10.17815/jlsrf-3-163>..



ROV KIEL 6000

Cruise: PS143-1

Dive Plan 1

Area Name: HAUSGARTEN Station HG-II, Vestnesa Ridge, Eastern Fram Strait

Station Name: **ROV01**

Approx. Water depth: 1495 m

Required Tools (please tick and note the quantity required if applicable)

Pushcores (x) **16** corers, plus 3 extra/spare cores
 Biobox (x)
 Slurp Gun (x)
 Pfahlkratzer (x) will be provided by Melanie Bergmann

Deployment Position: **79°08,097'N, 04°52,819'E** (Bottom-Lander deployed in 2023)
 Sea Floor Start Point: **arcFOCE Bottom-Lander** with Homer-Beacon Type 7835-00
 S/N 262874, ID: /8-2 (24)

Sea Floor End Point: ?

Responsible Scientists: Christiane Hasemann, Saskia Brix

 Protocol Scientists: Thomas Soltwedel, Melanie Bergmann
 (Showroom protocol by Saskia Brix/Carolin Uhlir/Lydia Schmidt)

Bathymetric Map provided by Autun Purser

 Deployment Time: ?

Descent (approx. 1 h)

Orientation at the seafloor (approx. 10-20 min)

Action 1

Go to arcFOCE-Lander (Fig. 1), take images of the entire system and close-ups

Action 2
 Push-coring of the three mesocosms (open metal rings) with 4 cores each (Fig. 2);
 take one Control core at 1-2 m next to each mesocosm; take photos
Action 3
 Fly 10 transects of 200 m each resulting in a square, transect can be interrupted for
 collection of animals. Alternatively, fly the 10 transects first and return to animals to be
 collected afterwards.

 Take photos and collect megafauna with the Slurp Gun and/or the manipulator arm,
 Potentially use hand nets or tool provided by Melanie (Pfahlkratzer)
 and (in the latter case) store them in the Biobox

 Ascent (approx. 1 h)

Time on Deck: ?



ROV KIEL 6000

Cruise: Dive Plan 2

Area Name: HAUSGARTEN Station "Senke", Vestnesa Ridge, Eastern Fram Strait

Station Name: ROV02

Approx Water depth: 1800 m

Required Tools (please tick and note the quantity required if applicable)

Pushcores	()
Niskins	()
ICBM / Senckenberg Biobox	(X)
Drawers	(X) Enough space for 3 larval traps 24 x 24 x 24 cm and one stone
Slurpgun	(X)
Pfahlkratzer	(X)

Deployment Position (Lat Long): 79 6' N, 4 30' E

Sea Floor Start Point (Lat Long): Homer beacon ID16 (from Frank Wenzhöfer)

See protocol from PS121/48-1, ROV05, Phoca dive #140, 8Sep2019

Sea Floor End Point (Lat Long): ?

Responsible Scientists: Kirstin Meyer-Kaiser, Saskia Brix

Protocol Scientists: Johanna Weston, Lydia Schmidt, Carolin Uhlia

Bathymetric Map will be provided by Autun Purser

Deployment Time: ~6:00 on 30 June 2024 (UTC)

Descent (approx. 90 min?)

Orientation at the seafloor (approx. 10-20 min)

Action 1: Collect the stone that was stained with alizarin red in 2019. This stone should be marked by a small white/reflective float.

Action 2: Locate the first cage (#4) and larval trap (#7), 10 m from the stained stone at bearing 70°. Collect the larval trap. Photograph the cage. Remove the cage from the stone it is covering and photograph the community on the stone.

Action 3: Locate the next cage (#2) and larval trap (#10), 10 m from the first set at bearing 70°. Collect the larval trap. Photograph the cage. Remove the cage from the stone it is covering and photograph the community on the stone.

Action 4: Locate the next reference frame (#1) and larval trap (#6), at bearing 100° from the last set. Collect the larval trap. Photograph the stone in the frame.



Action 5: Locate the next cage (#3), at bearing 120° from the last set. Photograph the cage. Remove the cage from the stone it is covering and photograph the community on the stone.

Action 6: Locate frame #2, at bearing 120° from the last set. Photograph the stone in the frame.

Action 7: Locate frame #3, at bearing 45° from the last set. Photograph the stone in the frame.

Action 8: Locate frame #4, at bearing 90° from the last set. Photograph the stone in the frame.

Action 9: Depending on pilot discretion, either collect all frames and cages in one area for later pick-up OR recover all frames and cages with the ROV.

Action 10: Transition dive leadership from Kirstin Meyer-Kaiser to Saskia Brix. Remaining dive time will be used to collect stones with attached fauna or directly collect fauna with nets/Pfahlkratzer or manipulator arms. Targets will include sponges and any unknown species.

Action 11: Recover homer beacon.

Ascent (2 hr? ROV will be heavy!)

Time On Deck: ~16:00 on 30 June 2024 (UTC)

Cages are 45 x 36 x 28 cm

Frames are 42 x 36 cm

Larval traps are 24 x 24 x 24 cm

Total: 4 cages, 5 frames, 3 larval traps, 1 stained stone, and 1 homer beacon



ROV KIEL 6000

Cruise: PS143-1

Dive Plan 3

Area Name: HAUSGARTEN Station Seeps, Vestnesa Ridge, Eastern Fram Strait

Station Name: **ROV03**

Approx. Water depth: 1250 m

Required Tools (please tick and note the quantity required if applicable)

Pushcores	(x)	16 corers
Slurp Gun	(x)	
Hand nets	(x)	
ICBM / Senckenberg Biobox	(x)	
Pfahlkratzer	(x)	

Deployment Position: **79°03,552'N, 06°33,392'E**Sea Floor Start Point: **79°03,552'N, 06°33,392'E**

Sea Floor End Point: ?

Responsible Scientists: Autun Purser, Saskia Brix, Frank Wenzhöfer

Protocol Scientists:

Bathymetric Map provided by Autun Purser

Deployment Time: 11:30 (ship time)

Descent (approx. 1 h)

Orientation at the seafloor (approx. 10-20 min)

Actions

- search for seep structures (e.g. black sediment, mud hills, gas outleeds (inactive and/or active)
- take close-up images
- take push-core(s) or net samples
- collect fauna with Slurp Gun or hand nets or Pfahlkratzer
- explore area and map seep structures

Ascent (approx. 1 h)

Time on Deck: 18:30 (ship time)



ROV KIEL 6000

Cruise: PS143-1

Dive Plan 4

Area Name: HAUSGARTEN Station HG-IV, Eastern Fram Strait

Station Name: **ROV04**

Approx. Water depth: 2432 m

Required Tools (please tick and note the quantity required if applicable)

Pushcores (x) **18** corers + 3 extra corers if possible (s. Action 10)
 Biobox (x)
 Slurp Gun (x)
 Deep-Profiler

Deployment Position: Cage 1 (4.1425 / 79.0816)

 Sea Floor Start Point: **79.0815285 / 4.1420141** (plastic plate 2, deployed 2015)
 or Homer-Beacon 20150728_103509

Sea Floor End Point: near 79.0815285 / 4.1420141

Responsible Scientists: Melanie Bergmann, Frank Wenzhöfer,

 Protocol Scientists: Melanie Bergmann, Thomas Soltwedel
 (Showroom protocol by ###)

Bathymetric Map provided by Autun Purser

 Deployment Time: ?

Descent (approx. 2 h)

Orientation at the seafloor (approx. 10-20 min)

Action 1

Do an overflight to film experimental area (79.0813441 / 4.1405879 -> 79.0815968 / 4.1419339). (10 min)

Action 2
 Fly to Plastic cover (#2: 79.0815285 / 4.1420141). Take photo. Deploy **microprofiler** (MIC). Start profile. Take photos. (30 min)
Action 3
 Fly to Plastic cover (#3: 79.0815421 / 4.142). Take photos. Very carefully move plate to the side (using Affenfaust?). Take Photos. Take **3 push cores**. Take Photos. Move plastic item to ROV. Take Photos of uncovered surface. (30 min)
Action 4
 Fly to Plastic cover (#4: 79.081549 / 4.1419859). Take photos. Very carefully move plate to the side (using Affenfaust?). Take Photos. Take **3 push cores**. Take Photos. Move plastic item to ROV. Take Photos of uncovered surface. (30 min)

**Action 5**

Fly to Plastic Plate (#5: 79.0815558 / 4.1419778). Take photos. Very carefully move plate to the side (using Affenfaust?). Take Photos. Take **3 push cores**. Take Photos. Move plastic item to ROV. Take Photos of uncovered surface. (30 min)

Action 6

Fly to Plastic Plate (#6: 79.0815968 / 4.1419339). Take photos. Very carefully move plate to the side (using Affenfaust?). Take Photos. Take **3 push cores**. Take Photos. Move plastic item to ROV. Take Photos of uncovered surface. (30 min)

Action 7

Take photo of seafloor to be sampled by **3 push cores** (controls). Take cores within ROV's current reach (no repositioning). Take Photo. (20 min)

Action 8

Fly to Sponge Cover #5 (79.0814738 / 4.1420688). Take photos. Try retrieve device with sponge inside and put into bio box or box behind push corers. If successful, repeat action with Sponge covers #4 - #1) located at: #4: 79.0814875 / 4.1417759
#3: 79.0813304 / 4.1413652
#2: 79.0813236 / 4.1413734
#1: 79.0813441 / 4.1405879

If not possible: Take photos. Uncover sponge using the device's metal grip or plastic tip. Take photos of uncovered sponge from various angles. Leave devices behind to be collected during next dive at this site (unless enough space is available to return them to ship). (2 h)

Action 9

Fly to microprofiler (#2: 79.0815285 / 4.1420141). Move MIC from plate. Very carefully move plate aside (using Affenfaust?) and transfer plastic cover to ROV. Take photos of uncovered surface. Assess disturbance of sediments by MIC. If sufficiently large area is undisturbed by MIC, take **3 push cores**. Take photos. (30 min)

(Tentative Action 10)

Time-permitting: faunal sampling in close vicinity. Take photos and collect megafauna with Slurp Gun and/or the manipulator arm unless biobox is used for storage of sponge devices. Take additional **push cores** if algal fluff is in the vicinity for microplastic analysis.

Action 10 or 11

Return to MIC and transfer MIC to ROV porch. Start ascent. (15 min)

Ascent (approx. 2 h)

Time on Deck: ?



ROV KIEL 6000

Cruise: PS143-1

Dive Plan 5

Area Name: HAUSGARTEN Station HG-IV, Vestnesa Ridge, Eastern Fram Strait

Station Name: **ROV05**

Approx. Water depth: 2491 m

Required Tools (please tick and note the quantity required if applicable)

- Pushcores (x) **22** corers
 Slurp Gun (x)
 Pfahlkratzer (x) will be provided by Melanie Bergmann

Deployment Position: **79°04,55'N, 04°07,76'E**

Sea Floor Start Point: Dropstone D1

79.0758 N, 04.1293 E (see ROV protocol PS108, 06ROV02)

Homer-Beacons ID63 at the start and ID65 at the end of the dropstone transect

Sea Floor End Point: ?

Responsible Scientists: Christiane Hasemann, Saskia Brix,
 Protocol Scientists: Thomas Soltwedel, Melanie Bergmann

Bathymetric Map will be provided by Autun Purser

Deployment Time: ?

Descent (approx. 2 h)

Orientation at the seafloor (approx. 10-20 min)

Action 1

Go to dropstone D1 (see Figs), take close-up images of the stone, take 1 push-core each at luv and lee of the dropstone, lift and replace the dropstone at ~5 m distance; Go to dropstone D2 - D9 and repeat the imaging, sampling and replacement; Pick up the homer beacons on the way and store them on the vehicle, and deploy a new homer beacon (at any time, preferably at start or end point of the transect).

Action 2

Fly 10 transects of 200 m each resulting in a square, transect can be interrupted for collection of animals. Alternatively, fly the 10 transects first and return to animals to be collected afterwards.

Take photos and collect megafauna with the Slurp Gun and/or the manipulator arm, Potentially use hand nets or tool provided by Melanie (Pfahlkratzer)

Ascent (approx. 2 h)

Time on Deck: ?



ROV KIEL 6000

Cruise: PS143-1

Dive Plan 6

Area Name: HAUSGARTEN Station HG-IV, Vestnesa Ridge, Eastern Fram Strait

Station Name: **ROV06**

Approx. Water depth: 2491 m

Required Tools (please tick and note the quantity required if applicable)Pushcores (x) min. **12** corers

Slurp Gun (x)

Pfahlkratzer (x) will be provided by Melanie Bergmann

Deployment Position: **79°04,56'N, 04°08,07'E**Sea Floor Start Point: Homer-Beacon ID65 at **79,076004 N, 4,1344457 E**

(see ROV protocol PS108, 06ROV02)

Sea Floor End Point: ?

Responsible Scientists: Christiane Hasemann, Saskia Brix,

Protocol Scientists: Thomas Soltwedel, Melanie Bergmann

Bathymetric Map provided by Autun Purser

Deployment Time: ?

Descent (approx. 2 h)

Orientation at the seafloor (approx. 10-20 min)

Action 1

Go to homer beacon (position see above), store homer beacon in ROV box;

Go to dropstones D6 - 9 (see Fig.) and take close-up images of the stone,

take 1 push-core each at luv and lee of the dropstone,

lift and replace the dropstone at ~5 m distance,

Sampling order: D8 → D7 → D9 → D6**Action 2 (only if there is time available)**

Collect megafauna with the Slurp Gun and/or the manipulator arm, take photos.

Potentially use hand nets or tool provided by Melanie (Pfahlkratzer)

Ascent (approx. 2 h)

Time on Deck: ?



ROV KIEL 6000

Cruise: PS143-1

Dive Plan 7

Area Name: HAUSGARTEN Station HG-IV, Eastern Fram Strait

Station Name: **ROV07**

Approx. Water depth: 2500 m

Required Tools (please tick and note the quantity required if applicable)Pushcores (x) **16** corers

Slurp Gun (x)

Pfahlkratzer (x)

Deployment Position: **79°04,661'N, 004°06,636'E**Sea Floor Start Point: **79°04,661'N, 004°06,636'E**

Sea Floor End Point: ?

Responsible Scientists: Frank Wenzhöfer, Johannes Maring, Frank Weichert

Protocol Scientists: Yick Hang Kwan, Lisbeth Fürst-Sorensen,

Bathymetric Map provided by Autun Purser

Deployment Time: 08:30

Descent (approx. 2 h)

Orientation at the seafloor (approx. 10-20 min)

Action 1

Go to crawler

Take photos and video

Action 2

Wait until crawler starts moving (ca 11:00)

Take photos and video

Action 3

Take Push core(s) from green fluff

Ascent (approx. 2 h)

Time on Deck: 14:30 (ship time)



ROV KIEL 6000

Cruise: PS143-1

Dive Plan 8

Area Name: HAUSGARTEN Station HG-IV, Eastern Fram Strait

Station Name: **ROV08**

Approx. Water depth: 2500 m

Required Tools (please tick and note the quantity required if applicable)Pushcores (x) **16** corers

Slurp Gun (x)

Pfahlkratzer (x)

Deployment Position: **79°04,649'N, 004°06,209'E**Sea Floor Start Point: **79°04,649'N, 004°06,209'E**

Sea Floor End Point: ?

Responsible Scientists: Frank Wenzhöfer, Johannes Maring, Frank Weichert

Protocol Scientists: Yick Hang Kwan, Lisbeth Fürst-Sorensen,

Bathymetric Map provided by Autun Purser

Deployment Time: 08:30

Descent (approx. 2 h)

Orientation at the seafloor (approx. 10-20 min)

Action 1

Go to crawler

Take photos and video

Action 2

Wait until crawler starts moving (ca 11:00)

Take photos and video

Action 3

Take Push core(s) from green fluff

Ascent (approx. 2 h)

Time on Deck: 14:30 (ship time)

CR_ROV

APPENDIX

A.1 TEILNEHMENDE INSTITUTE / PARTICIPATING INSTITUTES

A.2 FAHRTTEILNEHMER:INNEN / CRUISE PARTICIPANTS

A.3 SCHIFFSBESATZUNG / SHIP'S CREW

A.4 STATIONSLISTE / STATION LIST

A.1 TEILNEHMENDE INSTITUTE / PARTICIPATING INSTITUTES

Affiliation	Address
On board	
CH.UNIBE	Universität Bern Hochschulstrasse 6 3012 Bern Switzerland
DE.AWI	Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung Postfach 120161 27515 Bremerhaven Germany
DE.CAU	Christian-Albrechts-Universität zu Kiel 24118 Kiel Germany
DE.DRF	DRF Luftrettung gAG Laval Avenue E312 77836 Rheinmünster Germany
DE.DWD	Deutscher Wetterdienst Seewetteramt Bernhard Nocht Str. 76 20359 Hamburg Germany
DE.GEOMAR	GEOMAR Helmholtz-Zentrum für Ozeanforschung Wischofstr. 1 – 3 24148 Kiel Germany
DE.HS-Bremerhaven	Hochschule Bremerhaven An der Karlstadt 8 27568 Bremerhaven Germany
DE.MPIMM	Max-Planck-Institut für Marine Mikrobiologie Celsiusstraße 1 28359 Bremen Germany
DE.NHC	Northern HeliCopter GmbH Gorch-Fock-Str. 103 26721 Emden Germany
DE.SENCKENBERG	Senckenberg am Meer Martin-Luther-King-Platz 3 20146 Hamburg Germany Senckenberg Forschungsinstitut und Naturmuseum Senckenberganlage 25 60325 Frankfurt am Main Germany

Affiliation	Address
On board	
DE.TUBR	Technische Universität Braunschweig Langer Kamp 19C 38106 Braunschweig Germany
DE.UNI-Bremen	Universität Bremen Bibliothekstrasse 1 28359 Bremen Germany
DE.UNI-HAMBURG	Universität Hamburg Bundesstraße 55 20146 Hamburg Germany
DE.UNI-Hannover	Leibniz Universität Hannover Welfengarten 1 30167 Hannover Germany
DE.UNI-Oldenburg	Carl von Ossietzky Universität Oldenburg Carl-von-Ossietzky-Straße 9-13 26132 Oldenburg Germany
DE.UNI-Rostock	Universität Rostock Universitätsplatz 10 18055 Rostock Germany
DK.SDU	University of Southern Denmark Campusvej 55 5230 Odense Danmark
EDU.WHOI	Woods Hole Oceanographic Institution 266 Woods Hole Road 02543 Woods Hole, MA United States
IS.HI	University of Iceland Sturlugata 7 102 Reykjavik Iceland
IS.MFRI	Marine & Freshwater Research Institute Fornbúðir 5 220 Hafnarfjörður Iceland
UK.CAM	University of Cambridge Downing Street CB2 3EJ Cambridge United Kingdom
UK.NOC	National Oceanography Centre European Way SO14 3ZH Southampton United Kingdom

Affiliation	Address
On board	
UK.UNI-SOUTHAMPTON	University of Southampton University Road SO17 1BJ Southampton United Kingdom
Not on board / Not in the field	
DK.KU	Københavns Universitet Nørregade 10 1165 København Danmark
FR.Université du Littoral Côte d'Opale	Université du Littoral Côte d'Opale 220 Av. de l'Université 59140 Dunkerque France
SE.SU	Stockholms Universitet Svante Arrhenius vag 20A 10691 Stockholm Sweden

A.2 FAHRTTEILNEHMER:INNEN / CRUISE PARTICIPANTS

Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession	Fachrichtung/ Discipline
Aehle	Moritz	DE.UNI-Hamburg	Student (Master)	Biology
Bauer	Leonie Claudia	DE.UNI-Hamburg	Student (Bachelor)	Oceanography
Bergmann	Melanie	DE.AWI	Scientist	Biology
Bierbaum	Lisann Sofie Martha	DE.UNI-Oldenburg	Student (Bachelor)	Oceanography
Böckmann	Kyra Marie	DE.AWI	Technician	Biology
Brix-Elsig	Saskia Bianca	DE.SENCKENBERG	Scientist	Biology
Chen	Yen-Ting	DK.SDU	PhD student	Biology
Cuno	Patrick	DE.GEOMAR	Engineer	Engineering Sciences
Dannheim	Jennifer	DE.AWI	Scientist	Biology
Dieckvoß	Katrina	DE.AWI	HiWi	Biology
Dörmbach	Barbara	DE.UNI-Oldenburg	Student (Master)	Biology
Farrell	Eilish	DE.AWI	PhD student	Biology
Fuchs	Daniel	DE.DRF	Technician	Helicopter Service
Fürst Soerensen	Lisbeth	DK.SDU	PhD student	Biology
Glud	Ronnie	DK.SDU	Scientist	Oceanography
Gober	Emilie	DE.HS-Bremerhaven	Student (Master)	Biology
Hasemann	Christiane	DE.AWI	Scientist	Biology
Hirschmann	Sophia Carolin	DE.GEOMAR	PhD student	Biology
Hoge	Ulrich	DE.AWI	Engineer	Engineering Sciences
Huusmann	Hannes	DE.GEOMAR	Engineer	Engineering Sciences
Khan	Tasnuva Ferdous Ming	UK.CAM	PhD student	Biology
Kraber	Alexandra	DE.AWI	Scientist	Biology
Krauß	Florian	DE.AWI	Scientist	Oceanography
Kurbjuhn	Torge	DE.GEOMAR	Technician	Data
Kwan	Yick Hang	DK.SDU	PhD student	Biology
Láruson	Áki Jarl	IS.MFRI	Scientist	Biology
Malz	Amelie	DE.UNI-Hannover	Student (Master)	Biology
Maring	Johannes	DE.AWI	Technician	Engineering Sciences
Matthiessen	Torge	DE.GEOMAR	Technician	Engineering Sciences
Meyer-Kaiser	Kirstin Sage	EDU.WHOI	Scientist	Biology
Nordhausen	Axel	DE.MPIMM	Technician	Engineering Sciences
Otte	Frank	DE.DWD	Scientist	Meteorology

Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession	Fachrichtung/ Discipline
Pérez Rodríguez	Marta	DE.TU-Braunschweig	Scientist	Geology
Pieper	Martin	DE.GEOMAR	Engineer	Engineering Sciences
Purser	Autun	DE.AWI	Scientist	Biology
Schaubensteiner	Stefan	DE.NHC	Pilot	Helicopter Service
Schewe	Ingo	DE.AWI	Scientist	Biology
Schmidt	Lydia Anastasia	DE.SENCKENBERG	Student (Master)	Biology
Schnier	Jannik	DE.AWI	PhD student	Biology
Seifert	Michael	DE.DRF	Technician	Helicopter Service
Silberberg	Jona	DE.CAU	Student (Master)	Biology
Soltwedel	Thomas	DE.AWI	Scientist	Biology
Stief	Peter Herbert	DK.SDU	Scientist	Biology
Striewski	Peter	DE.GEOMAR	Engineer	Engineering Sciences
Suck	Inken	DE.GEOMAR	Scientist	Biology
Suter	Patrick	DE.DWD	Scientist	Meteorology
Taylor	James	DE.GEOMAR	Scientist	Biology
Uhlir	Carolyn Diana	DE.AWI	Scientist	Biology
Vaupel	Lars	DE.NHC	Pilot	Helicopter Service
vom Hagen	Tina	DE.AWI	HiWi	Biology
Weichert	Frank	DE.AWI	Engineer	Engineering Sciences
Wenzhöfer	Frank	DE.AWI	Scientist	Biology
Weston	Johanna	EDU.WHOI	Scientist	Biology
Weyand	Philipp	DE.GEOMAR	Scientist	Biology
Williams	James Alexander Bowen	UK.UNI-SOUTHAMPTON	PhD student	Oceanography
Xiao	Wenjie	DK.SDU	Scientist	Oceanography

A.3 SCHIFFSBESATZUNG / SHIP'S CREW

No	Dienstgrad	Rank	Nachname / Last name	Vorname / First name
1	Kapitän	Master	Kentges	Felix
2	1. Offizier	Chief Mate	Langhinrichs	Jacob
3	1. Offizier Ladung	Chief Mate Cargo	Janik	Michael
4	2. Offizier	2nd Mate	Hering	Igor
5	2. Offizier	2nd Mate	Rathke	Wulf Jannik
6	Schiffsärztin	Doctor	Gößmann- Lange	Petra
7	Leitender Ingenieur	Chief Engineer	Grafe	Jens
8	2. Ingenieur	2nd Engineer	Farysch	Tim
9	2. Ingenieur	2nd Engineer	Brose	Thomas Christian Gerhard
10	2. Ingenieurin	2nd Engineer	Bähler	Stefanie
11	Schiffselektrotechnik er Maschine	Ship Electrotechnical Officer Engine	Redmer	Jens
12	Elektroniker Winden	Electrotechnical Engineer Winches	Jäger	Vladimir
13	Elektroniker Netzwerk	Electrotechnical Engineer Network	Müller	Andreas
14	Elektroniker Brücke	Electrotechnical Engineer Bridge	Kliemann	Olaf
15	Elektroniker Labor	Electrotechnical Engineer Labor	Hüttebräucker	Olaf
16	Elektroniker System	Electrotechnical Engineer System	Pliet	Johannes
17	Bootsmann	Bosun	Sedlak	Andreas
18	Zimmermann	Carpenter	Neisner	Winfried
19	Schiffsmechaniker Deck	Multi Purpose Rating Deck	Klee	Philipp
20	Schiffsmechaniker Deck	Multi Purpose Rating Deck	Burzan	Gerd-Ekkehard
21	Schiffsmechaniker Deck	Multi Purpose Rating Deck	Rhau	Lars-Peter
22	Schiffsmechaniker Deck	Multi Purpose Rating Deck	Klähn	Anton
23	Schiffsmechaniker Deck	Multi Purpose Rating Deck	Heisterkamp	Ole Louca

No	Dienstgrad	Rank	Nachname / Last name	Vorname / First name
24	Schiffsmechaniker Deck	Multi Purpose Rating Deck	Fisahn	Paul
25	Schiffsmechaniker Deck	Multi Purpose Rating Deck	Siemon	Leon Anton
26	Schiffsmechaniker Deck	Multi Purpose Rating Deck	Ellner	Leopold
27	Decksmann/Matrose	Able Seaman	Meier	Jan
28	Lagerhalter	Storekeeper	Preußner	Jörg
29	Schiffsmechaniker Maschine	Multi Purpose Rating Engine	Hänert	Ove
30	Schiffsmechanikerin Maschine	Multi Purpose Rating Engine	Klinger	Dana
31	Schiffsmechaniker Maschine	Multi Purpose Rating Engine	Münzenberger	Börge
32	Schiffsmechaniker Maschine	Multi Purpose Rating Engine	Juszczyk	Michal Stanislaw
33	1. Koch	1st Cook	Hofmann	Werner
34	2. Köchin	2nd Cook	Hammelmann	Louisa
35	2. Koch	2nd Cook	Loibl	Patrick
36	1. Steward	1st Steward	Pieper	Daniel
37	2. Stewardess	2nd Stewardess	Brändli	Monika
38	2. Steward	2nd Steward	Dibenau	Torsten
39	2. Stewardess	2nd Stewardess	Wartenberg	Irina
40	2. Stewardess / Krankenschwester	2nd Stewardess / Nurse	Schwantes	Andrea
41	2. Steward / Wäscherei	2nd Steward / Laundry	Arendt	Rene
42	2. Steward / Wäscherei	2nd Steward / Laundry	Cheng	Qi
43	2. Steward / Wäscherei	2nd Steward / Laundry	Chen	Dansheng

A.4 STATIONSLISTE / STATION LIST PS143/1

Station list of expedition PS143/1 from Bremerhaven – Tromsø; the list details the action log for all stations along the cruise track.

See <https://www.pangaea.de/expeditions/events/PS143/1> to display the station (event) list for expedition PS143/1.

This version contains Uniform Resource Identifiers for all sensors listed under <https://sensor.awi.de>. See <https://www.awi.de/en/about-us/service/computing-centre/data-flow-framework.html> for further information about AWI's data flow framework from sensor observations to archives (O2A).

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1-track		2024-06-07T00:00:00	53.56750	8.55480		CT	Station start	Bremerhaven - Tromsø
PS143/1-track		2024-07-09T00:00:00	69.67800	18.98980		CT	Station end	Bremerhaven - Tromsø
PS143/1_0_Underway-1		2024-06-09T14:04:40	59.74700	4.17729	267.4	AUTOFIM	max depth	no end was logged
PS143/1_0_Underway-2		2024-06-08T08:59:59	55.07677	6.70977	25.4	MYON	max depth	no end was logged
PS143/1_0_Underway-3		2024-06-08T09:14:35	55.11556	6.67527	27.6	FBOX	max depth	no end was logged

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1_0_Underway-5		2024-06-08T07:58:23	54.91886	6.84980	25.3	MAG	max depth	no end was logged
PS143/1_0_Underway-6		2024-06-08T07:58:04	54.91805	6.85052	25.6	GRAV	max depth	no end was logged
PS143/1_0_Underway-8		2024-06-08T09:00:22	55.07778	6.70888	25.4	NEUMON	max depth	no end was logged
PS143/1_0_Underway-15		2024-06-08T07:36:50	54.86415	6.89791	21.1	SNDVELPR	max depth	no end was logged
PS143/1_0_Underway-16		2024-06-08T07:14:06	54.80639	6.94832	22.2	TSG	max depth	no end was logged
PS143/1_0_Underway-17		2024-06-08T07:14:35	54.80765	6.94726	21.9	TSG	max depth	no end was logged
PS143/1_0_Underway-19		2024-06-07T08:00:00	53.56396	8.55896		SWEAS	max depth	no end was logged
PS143/1_0_Underway-20		2024-06-08T06:42:09	54.72383	7.02062	20.3	ADCP	max depth	no end was logged
PS143/1_1-2		2024-06-13T07:10:04	74.72983	4.98536	3062.5	HN	Station start	
PS143/1_1-2		2024-06-13T07:20:13	74.72994	4.98586	3177.3	HN	Station end	
PS143/1_1-1		2024-06-13T07:18:10	74.72987	4.98562	2866.1	CTD-RO	max depth	
PS143/1_2-2		2024-06-14T06:37:33	78.60804	5.06273	2344.0	HN	Station start	
PS143/1_2-2		2024-06-14T06:42:16	78.60808	5.06257	2343.8	HN	Station end	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1_2-1		2024-06-14T06:45:10	78.60802	5.06307	2343.6	CTD-RO	max depth	
PS143/1_2-3		2024-06-14T08:31:26	78.60803	5.06204	2343.8	TVMUC	max depth	
PS143/1_2-4		2024-06-14T09:43:32	78.60039	5.07371	2342.5	MSN	Station start	
PS143/1_2-4		2024-06-14T12:23:51	78.60067	5.07708	2342.0	MSN	Station end	
PS143/1_2-6		2024-06-14T12:39:49	78.60044	5.07717	2341.9	HN	Station start	
PS143/1_2-6		2024-06-14T12:48:36	78.60055	5.07808	2341.9	HN	Station end	
PS143/1_2-5		2024-06-14T13:36:36	78.60075	5.07842	2341.7	CTD-RO	max depth	
PS143/1_2-7		2024-06-14T16:30:51	78.59870	5.08039	2342.0	GKG	max depth	
PS143/1_3-2		2024-06-14T21:44:46	79.14259	2.75999		HN	Station start	
PS143/1_3-2		2024-06-14T21:50:47	79.14267	2.75937	3016.8	HN	Station end	
PS143/1_3-1		2024-06-14T23:43:09	79.14252	2.75862	5598.3	CTD-RO	max depth	
PS143/1_3-3		2024-06-15T04:30:45	79.14221	2.76202	5600.7	TVMUC	max depth	
PS143/1_3-4		2024-06-15T08:49:21	79.14274	2.75907	5440.6	TVMUC	max depth	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1_4-1		2024-06-15T13:13:45	79.03045	4.49074	2382.5	EBS	Station start	
PS143/1_4-1		2024-06-15T17:10:14	79.07229	4.30056	2289.5	EBS	Station end	
PS143/1_4-2		2024-06-15T17:11:24	79.07246	4.30541	2283.9	B_LANDER	Station start	Flux-Lander deployment
PS143/1_4-2		2024-06-16T16:55:15	79.07909	4.33066		B_LANDER	Station end	Flux-Lander deployment
PS143/1_4-4		2024-06-15T20:21:27	79.07256	4.34092	2256.2	HN	Station start	
PS143/1_4-4		2024-06-15T20:26:32	79.07262	4.34086	2256.1	HN	Station end	
PS143/1_4-5		2024-06-15T20:26:52	79.07262	4.34085	2256.1	HN	Station start	
PS143/1_4-5		2024-06-15T20:35:44	79.07266	4.34045	2255.8	HN	Station end	
PS143/1_4-3		2024-06-15T20:52:16	79.07271	4.34043	2255.7	CTD-RO	max depth	
PS143/1_4-6		2024-06-16T03:31:02	79.06759	4.27253	2338.3	OFOBS	Station start	
PS143/1_4-6		2024-06-16T07:57:41	79.03858	4.13622	2562.8	OFOBS	Station end	
PS143/1_4-7	FatBoy	2024-06-16T10:12:35	79.03283	4.31227	2479.6	MOOR	Station start	Recovery of mooring FatBoy unsuccessful, not found
PS143/1_4-7	FatBoy	2024-06-16T15:20:50	79.03338	4.32491	2472.5	MOOR	Station end	Recovery of mooring FatBoy unsuccessful, not found

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1_4-8		2024-06-16T17:15:05	79.07327	4.33606	2256.3	MSN	Station start	
PS143/1_4-8		2024-06-16T19:38:08	79.07266	4.34037	2256.4	MSN	Station end	
PS143/1_4-10		2024-06-16T20:04:11	79.07285	4.34078	2255.1	HN	Station start	
PS143/1_4-10		2024-06-16T20:09:17	79.07276	4.34060	2256.0	HN	Station end	
PS143/1_4-11		2024-06-16T20:09:40	79.07275	4.34059	2256.0	HN	Station start	
PS143/1_4-11		2024-06-16T20:12:40	79.07276	4.34044	2255.9	HN	Station end	
PS143/1_4-9		2024-06-16T20:14:25	79.07278	4.34007	2255.9	CTD-RO	max depth	
PS143/1_4-12		2024-06-16T22:33:09	79.06746	4.29869	2321.1	TVMUC	max depth	
PS143/1_4-13		2024-06-17T01:41:09	79.06534	4.18226	2394.2	BC	max depth	
PS143/1_5-2		2024-06-17T04:40:52	79.14412	2.74837	5433.2	HN	Station start	
PS143/1_5-2		2024-06-17T04:50:05	79.14395	2.74889	5432.8	HN	Station end	
PS143/1_5-1		2024-06-17T06:22:21	79.14247	2.76029	5429.4	CTD-RO	max depth	
PS143/1_5-3		2024-06-17T08:36:16	79.14266	2.76129	5442.1	MSN	Station start	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1_5-3		2024-06-17T11:25:09	79.14228	2.76037	5439.4	MSN	Station end	
PS143/1_5-4		2024-06-17T11:42:09	79.14705	2.77277	5442.2	EBS	Station start	
PS143/1_5-4		2024-06-17T17:24:35	79.11456	3.08711	5324.2	EBS	Station end	
PS143/1_5-6		2024-06-17T19:26:09	79.14263	2.76036	5439.8	HN	Station start	
PS143/1_5-6		2024-06-17T19:30:14	79.14266	2.76036	5439.8	HN	Station end	
PS143/1_5-5		2024-06-17T19:34:04	79.14255	2.76062	5439.9	CTD-RO	max depth	
PS143/1_5-7		2024-06-17T19:34:13	79.14255	2.76061	5440.0	HN	Station start	
PS143/1_5-7		2024-06-17T19:37:14	79.14256	2.76041	5439.0	HN	Station end	
PS143/1_5-8		2024-06-17T22:05:36	79.14258	2.76011	5439.6	GKG	max depth	
PS143/1_5-9		2024-06-18T03:00:28	79.14278	2.75961	5436.8	TVMUC	max depth	
PS143/1_5-10		2024-06-18T07:23:30	79.10867	3.21532	5267.5	OFOBS	Station start	
PS143/1_5-10		2024-06-18T13:13:09	79.08698	3.31420		OFOBS	Station end	
PS143/1_5-11		2024-06-18T14:00:45	79.14422	2.75880	5438.4	BFL	Station start	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1_5-11		2024-06-22T07:22:04	79.13954	2.73744	5363.8	BFL	Station end	
PS143/1_6-2		2024-06-19T06:39:37	79.00122	-5.19442	1155.0	HN	Station start	
PS143/1_6-2		2024-06-19T06:42:34	79.00101	-5.19633	1153.0	HN	Station end	
PS143/1_6-3		2024-06-19T06:42:57	79.00098	-5.19662	1152.7	HN	Station start	
PS143/1_6-3		2024-06-19T06:46:47	79.00067	-5.19960	1150.1	HN	Station end	
PS143/1_6-1		2024-06-19T06:45:55	79.00074	-5.19893	1150.8	CTD-RO	max depth	
PS143/1_6-4		2024-06-19T07:28:47	78.99884	-5.21783	1133.3	MSN	Station start	
PS143/1_6-4		2024-06-19T08:55:42	78.99937	-5.26191	1101.7	MSN	Station end	
PS143/1_6-5		2024-06-19T09:43:00	79.00584	-5.28227	1095.7	TVMUC	max depth	
PS143/1_6-7		2024-06-19T10:22:09	79.00680	-5.29885	1086.2	HN	Station start	
PS143/1_6-7		2024-06-19T10:29:45	79.00674	-5.30389	1082.5	HN	Station end	
PS143/1_6-6		2024-06-19T10:42:09	79.00690	-5.31145	1077.7	CTD-RO	max depth	
PS143/1_6-8		2024-06-19T12:27:52	79.01243	-5.36831	1035.0	BC	max depth	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1_7-2		2024-06-19T17:31:48	78.93697	-4.61578	1514.1	HN	Station start	
PS143/1_7-2		2024-06-19T17:33:14	78.93694	-4.61632	1513.6	HN	Station end	
PS143/1_7-3		2024-06-19T17:36:26	78.93688	-4.61712	1512.9	HN	Station start	
PS143/1_7-3		2024-06-19T17:38:42	78.93686	-4.61743	1512.8	HN	Station end	
PS143/1_7-1		2024-06-19T17:38:31	78.93686	-4.61740	1512.7	CTD-RO	max depth	
PS143/1_7-4		2024-06-19T18:41:48	78.93653	-4.63241	1501.9	MUC	max depth	
PS143/1_7-5		2024-06-19T20:07:03	78.93464	-4.66161	1482.5	GKG	max depth	
PS143/1_8-1		2024-06-20T02:23:07	78.81293	-3.97437	1851.8	CTD-RO	max depth	
PS143/1_8-2		2024-06-20T02:23:37	78.81286	-3.97479	1851.6	HN	Station start	
PS143/1_8-2		2024-06-20T02:26:25	78.81274	-3.97627	1850.0	HN	Station end	
PS143/1_8-3		2024-06-20T02:27:00	78.81272	-3.97635	1850.0	HN	Station start	
PS143/1_8-3		2024-06-20T02:28:33	78.81262	-3.97702	1849.4	HN	Station end	
PS143/1_8-4		2024-06-20T03:30:22	78.80930	-4.01251	1819.3	MUC	max depth	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1_8-5		2024-06-20T04:12:09	78.80636	-4.03762	1797.0	BC	max depth	
PS143/1_9-2		2024-06-20T10:17:36	78.81402	-2.79331	2499.8	HN	Station start	
PS143/1_9-2		2024-06-20T10:24:15	78.81430	-2.79400	2499.5	HN	Station end	
PS143/1_9-1		2024-06-20T10:21:45	78.81415	-2.79377	2499.6	CTD-RO	max depth	
PS143/1_9-3		2024-06-20T10:45:09	78.81509	-2.80078	2498.2	MSN	Station start	
PS143/1_9-3		2024-06-20T12:59:45	78.81276	-2.87383	2483.8	MSN	Station end	
PS143/1_9-4		2024-06-20T13:57:35	78.81160	-2.90586	2477.1	BC	max depth	
PS143/1_9-5		2024-06-20T16:51:24	78.82138	-2.74752	2506.5	TVMUC	max depth	
PS143/1_9-6		2024-06-20T19:37:02	78.91054	-2.95212	2434.1	OFOBS	Station start	
PS143/1_9-6		2024-06-20T23:57:36	78.88903	-2.99354	2435.8	OFOBS	Station end	
PS143/1_9-7		2024-06-21T02:43:15	78.83010	-2.78321	2499.8	MSN	Station start	
PS143/1_9-7		2024-06-21T05:03:27	78.82757	-2.77077	2501.3	MSN	Station end	
PS143/1_9-9		2024-06-21T05:09:06	78.82725	-2.77085	2501.3	HN	Station start	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1_9-9		2024-06-21T05:11:43	78.82718	-2.77113	2501.1	HN	Station end	
PS143/1_9-10		2024-06-21T05:12:54	78.82717	-2.77109	2501.2	HN	Station start	
PS143/1_9-10		2024-06-21T05:14:53	78.82714	-2.77084	2501.3	HN	Station end	
PS143/1_9-8		2024-06-21T06:28:24	78.82273	-2.77278	2501.3	CTD-RO	max depth	
PS143/1_10-1		2024-06-21T11:45:09	78.91459	-0.74180	2567.9	EBS	Station start	
PS143/1_10-1		2024-06-21T15:37:24	78.92812	-0.49350	2569.5	EBS	Station end	
PS143/1_11-2		2024-06-21T20:24:26	79.05873	3.48003	3270.3	HN	Station start	
PS143/1_11-2		2024-06-21T20:28:11	79.05871	3.48107	3811.5	HN	Station end	
PS143/1_11-3		2024-06-21T20:28:27	79.05871	3.48107	3827.3	HN	Station start	
PS143/1_11-3		2024-06-21T20:32:17	79.05869	3.48106	3837.9	HN	Station end	
PS143/1_11-1		2024-06-21T20:33:01	79.05869	3.48111	3838.6	CTD-RO	max depth	
PS143/1_11-4		2024-06-21T22:34:36	79.05868	3.48152	3321.5	TVMUC	max depth	
PS143/1_11-5		2024-06-22T02:05:14	79.05876	3.48260	3821.2	BC	max depth	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1_12-1		2024-06-22T10:20:09	79.06520	4.18411	2371.0	TVMUC	max depth	
PS143/1_12-2		2024-06-22T12:23:18	79.06549	4.18280	2371.0	TVMUC	max depth	
PS143/1_13-1		2024-06-22T14:05:12	79.10470	4.61384	2054.5	EBS	Station start	
PS143/1_13-1		2024-06-22T17:11:02	79.08762	4.70028	1957.4	EBS	Station end	
PS143/1_14-2		2024-06-22T19:01:15	79.13328	6.09209	1508.9	HN	Station start	
PS143/1_14-2		2024-06-22T19:06:23	79.13352	6.09206	1500.5	HN	Station end	
PS143/1_14-3		2024-06-22T19:06:40	79.13353	6.09213		HN	Station start	
PS143/1_14-3		2024-06-22T19:11:01	79.13345	6.09198	1500.3	HN	Station end	
PS143/1_14-1		2024-06-22T19:08:40	79.13353	6.09219	1630.8	CTD-RO	max depth	
PS143/1_14-4		2024-06-22T19:25:44	79.13317	6.09233		MSN	Station start	
PS143/1_14-4		2024-06-22T21:24:11	79.13472	6.07754	1224.6	MSN	Station end	
PS143/1_14-5		2024-06-22T22:05:36	79.13293	6.09312	1223.7	TVMUC	max depth	
PS143/1_14-7		2024-06-22T22:58:09	79.13296	6.09291	1223.6	HN	Station start	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1_14-7		2024-06-22T23:02:26	79.13294	6.09357	1223.4	HN	Station end	
PS143/1_14-8		2024-06-22T23:03:15	79.13294	6.09367	1223.5	HN	Station start	
PS143/1_14-8		2024-06-22T23:05:16	79.13293	6.09384	1223.5	HN	Station end	
PS143/1_14-6		2024-06-22T23:24:36	79.13361	6.09286	1224.3	CTD-RO	max depth	
PS143/1_14-9		2024-06-23T01:15:45	79.13312	6.09258	1224.2	BC	max depth	
PS143/1_14-10		2024-06-23T02:47:53	79.13426	6.08808	1224.5	BCRAWL	Station start	
PS143/1_14-10		2024-06-25T04:34:37	79.12731	6.03458	1234.9	BCRAWL	Station end	
PS143/1_15-2		2024-06-23T04:54:36	79.03050	7.00290	1254.5	HN	Station start	
PS143/1_15-2		2024-06-23T04:57:08	79.03019	7.00295	1253.9	HN	Station end	
PS143/1_15-3		2024-06-23T04:58:55	79.02994	7.00332	1253.6	HN	Station start	
PS143/1_15-3		2024-06-23T05:00:26	79.02983	7.00387	1253.5	HN	Station end	
PS143/1_15-1		2024-06-23T05:19:33	79.03097	7.00875	1256.0	CTD-RO	max depth	
PS143/1_16-1		2024-06-23T07:14:12	79.07501	6.64840	1282.4	EBS	Station start	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1_16-1		2024-06-23T11:29:45	79.01189	6.52363	1331.2	EBS	Station end	
PS143/1_17-2		2024-06-24T21:36:23	78.98029	9.51494	218.8	HN	Station start	
PS143/1_17-2		2024-06-24T21:40:33	78.98035	9.51446	218.9	HN	Station end	
PS143/1_17-3		2024-06-24T21:40:00	78.98034	9.51445	218.9	HN	Station start	
PS143/1_17-3		2024-06-24T21:43:27	78.98036	9.51465	218.9	HN	Station end	
PS143/1_17-1		2024-06-24T21:45:03	78.98033	9.51450	218.9	CTD-RO	max depth	
PS143/1_18-2		2024-06-24T23:38:09	79.01746	8.32278	802.0	HN	Station start	
PS143/1_18-2		2024-06-24T23:41:56	79.01777	8.32307	801.5	HN	Station end	
PS143/1_18-3		2024-06-24T23:42:24	79.01784	8.32310	801.7	HN	Station start	
PS143/1_18-3		2024-06-24T23:45:18	79.01820	8.32303	802.2	HN	Station end	
PS143/1_18-1		2024-06-24T23:50:45	79.01836	8.32101	805.1	CTD-RO	max depth	
PS143/1_19-1		2024-06-25T07:36:11	79.59489	5.25385	2646.5	BFL	Station start	
PS143/1_19-1		2024-06-27T05:02:05	79.60017	5.26131	2632.9	BFL	Station end	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1_19-2		2024-06-25T09:21:35	79.59485	5.20883	2684.6	GKG	max depth	
PS143/1_19-3		2024-06-25T12:16:45	79.59494	5.20948	2684.2	TVMUC	max depth	
PS143/1_19-4		2024-06-25T14:39:28	79.57080	5.25113	2580.3	OFOBS	Station start	
PS143/1_19-4		2024-06-25T20:05:05	79.60883	5.14250		OFOBS	Station end	
PS143/1_19-6		2024-06-25T20:38:05	79.59496	5.20998	2682.6	HN	Station start	
PS143/1_19-6		2024-06-25T20:42:11	79.59482	5.20988	2683.0	HN	Station end	
PS143/1_19-7		2024-06-25T20:42:34	79.59482	5.20985	2683.1	HN	Station start	
PS143/1_19-7		2024-06-25T20:44:54	79.59487	5.20955	2683.4	HN	Station end	
PS143/1_19-5		2024-06-25T20:47:23	79.59500	5.20914	2683.6	CTD-RO	max depth	
PS143/1_20-2		2024-06-25T22:56:27	79.73745	4.48598	2569.5	HN	Station start	
PS143/1_20-2		2024-06-25T23:00:45	79.73770	4.48254	2566.5	HN	Station end	
PS143/1_20-3		2024-06-25T23:01:18	79.73773	4.48207	2566.2	HN	Station start	
PS143/1_20-3		2024-06-25T23:05:09	79.73798	4.47865	2562.7	HN	Station end	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1_20-1		2024-06-25T23:48:09	79.74098	4.44544	2528.9	CTD-RO	max depth	
PS143/1_20-4		2024-06-26T01:03:09	79.74926	4.38609	2573.1	MSN	Station start	
PS143/1_20-4		2024-06-26T03:55:44	79.73962	4.40594	2544.7	MSN	Station end	
PS143/1_20-5		2024-06-26T05:12:41	79.73982	4.42585	2533.7	TVMUC	max depth	
PS143/1_20-7		2024-06-26T06:38:14	79.72522	4.41851	2619.2	HN	Station start	
PS143/1_20-7		2024-06-26T06:43:12	79.72486	4.41587	2621.8	HN	Station end	
PS143/1_20-8		2024-06-26T06:43:35	79.72481	4.41555	2622.3	HN	Station start	
PS143/1_20-8		2024-06-26T06:46:31	79.72451	4.41329	2624.3	HN	Station end	
PS143/1_20-6		2024-06-26T06:45:40	79.72456	4.41388	2624.0	CTD-RO	max depth	
PS143/1_20-9		2024-06-26T08:40:04	79.73079	4.46446	2607.5	GKG	max depth	
PS143/1_21-2		2024-06-26T13:18:18	79.93697	3.18406	2474.5	HN	Station start	
PS143/1_21-2		2024-06-26T13:22:09	79.93660	3.18111	2476.0	HN	Station end	
PS143/1_21-3		2024-06-26T13:22:55	79.93654	3.18061	2476.5	HN	Station start	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1_21-3		2024-06-26T13:25:48	79.93633	3.17877	2477.4	HN	Station end	
PS143/1_21-1		2024-06-26T13:24:09	79.93644	3.17975	2476.8	CTD-RO	max depth	
PS143/1_21-4		2024-06-26T13:47:45	79.93435	3.16550	2484.4	MSN	Station start	
PS143/1_21-4		2024-06-26T16:02:26	79.92430	3.11019	2507.6	MSN	Station end	
PS143/1_21-5		2024-06-26T17:49:52	79.94025	3.21890	2458.7	MUC	max depth	
PS143/1_21-7		2024-06-26T18:54:43	79.93623	3.21724	2464.1	HN	Station start	
PS143/1_21-7		2024-06-26T19:00:13	79.93585	3.21699	2464.6	HN	Station end	
PS143/1_21-8		2024-06-26T19:00:32	79.93583	3.21697	2464.6	HN	Station start	
PS143/1_21-8		2024-06-26T19:05:25	79.93548	3.21674	2465.0	HN	Station end	
PS143/1_21-6		2024-06-26T19:45:35	79.93257	3.21451	2469.0	CTD-RO	max depth	
PS143/1_21-9		2024-06-26T21:55:45	79.92268	3.19912	2481.8	GKG	max depth	
PS143/1_22-2		2024-06-27T09:02:01	79.10786	4.60364	1844.5	HN	Station start	
PS143/1_22-2		2024-06-27T09:05:57	79.10786	4.60388	1845.1	HN	Station end	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1_22-3		2024-06-27T09:06:20	79.10786	4.60393	1845.2	HN	Station start	
PS143/1_22-3		2024-06-27T09:09:34	79.10785	4.60417	1845.1	HN	Station end	
PS143/1_22-1		2024-06-27T09:46:21	79.10787	4.60344	1845.4	CTD-RO	max depth	
PS143/1_22-4		2024-06-27T11:50:45	79.10221	4.56253	1878.3	MUC	max depth	
PS143/1_22-5		2024-06-27T13:34:36	79.10204	4.56403	1952.8	GKG	max depth	
PS143/1_23-1		2024-06-27T16:10:25	79.13494	5.75561	1269.3	OFOBS	Station start	
PS143/1_23-1		2024-06-27T21:24:35	79.12892	6.01865	1240.8	OFOBS	Station end	
PS143/1_23-2		2024-06-27T22:52:09	79.06359	6.50844	1206.7	OFOBS	Station start	
PS143/1_23-2		2024-06-28T03:16:55	79.03563	6.69871	1201.3	OFOBS	Station end	
PS143/1_24-1		2024-06-28T06:04:36	79.13550	4.87952	1491.6	ROV_KIEL6000	Station start	
PS143/1_24-1		2024-06-28T16:15:23	79.13699	4.86153	1497.7	ROV_KIEL6000	Station end	
PS143/1_24-3		2024-06-28T16:39:16	79.12909	4.89936	1508.8	HN	Station start	
PS143/1_24-3		2024-06-28T16:39:16	79.12909	4.89936	1508.8	HN	Station end	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1_24-4		2024-06-28T16:39:35	79.12908	4.89936	1508.7	HN	Station start	
PS143/1_24-4		2024-06-28T16:42:21	79.12903	4.89963	1508.8	HN	Station end	
PS143/1_24-2		2024-06-28T16:43:03	79.12901	4.89972	1508.9	CTD-RO	max depth	
PS143/1_24-5		2024-06-28T17:44:01	79.13011	4.90577	1498.3	BC	max depth	
PS143/1_24-6		2024-06-28T19:55:53	79.12955	4.89807	1507.1	TVMUC	max depth	
PS143/1_25-1		2024-06-28T22:54:45	79.06504	4.18256	2393.1	TVMUC	max depth	
PS143/1_25-2		2024-06-29T00:08:18	79.06505	4.18254	2393.1	BFL	Station start	
PS143/1_25-2		2024-07-01T05:46:59	79.05075	4.12004	2513.2	BFL	Station end	
PS143/1_25-3		2024-06-29T02:29:06	79.06579	4.18712	2387.9	TVMUC	max depth	
PS143/1_25-4		2024-06-29T04:29:20	79.06609	4.20074	2378.5	TVMUC	max depth	
PS143/1_26-1		2024-06-29T06:48:47	79.09956	4.49818	1715.7	ROV_KIEL6000	Station start	
PS143/1_26-1		2024-06-29T16:10:26	79.10862	4.55397	1763.5	ROV_KIEL6000	Station end	
PS143/1_27-2		2024-06-29T17:44:53	79.05509	3.74363	2767.2	HN	Station start	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1_27-2		2024-06-29T17:48:04	79.05522	3.74456	2765.8	HN	Station end	
PS143/1_27-3		2024-06-29T17:48:11	79.05523	3.74461	2765.4	HN	Station start	
PS143/1_27-3		2024-06-29T17:51:03	79.05562	3.74619	2762.0	HN	Station end	
PS143/1_27-1		2024-06-29T17:50:49	79.05558	3.74602	2762.1	CTD-RO	max depth	
PS143/1_27-4		2024-06-29T19:22:04	79.05674	3.77207	2721.3	GKG	max depth	
PS143/1_27-5		2024-06-29T22:13:09	79.03684	3.69035	2820.7	MUC	max depth	
PS143/1_28-1		2024-06-30T01:39:36	79.12723	4.50418	2417.2	OFOBS	Station start	
PS143/1_28-1		2024-06-30T04:01:49	79.12083	4.54683	2321.3	OFOBS	Station end	
PS143/1_29-1		2024-06-30T09:29:26	79.05569	6.54054	1736.4	ROV_KIEL6000	Station start	
PS143/1_29-1		2024-06-30T16:30:00	79.05921	6.55949	1206.7	ROV_KIEL6000	Station end	
PS143/1_30-2		2024-06-30T20:22:04	79.04369	3.60156	2801.8	HN	Station start	
PS143/1_30-2		2024-06-30T20:24:57	79.04373	3.60202	3219.2	HN	Station end	
PS143/1_30-3		2024-06-30T20:27:23	79.04376	3.60335	3142.8	HN	Station start	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1_30-3		2024-06-30T20:30:38	79.04399	3.60530	3171.4	HN	Station end	
PS143/1_30-1		2024-06-30T20:29:52	79.04390	3.60514		CTD-RO	max depth	
PS143/1_30-4		2024-06-30T23:06:09	79.04790	3.62366		MUC	max depth	
PS143/1_30-5		2024-07-01T01:47:36	79.04503	3.58045		GKG	max depth	
PS143/1_31-1		2024-07-01T06:25:03	79.08130	4.14189	2393.5	ROV_KIEL6000	Station start	
PS143/1_31-1		2024-07-01T16:31:26	79.08704	4.14141	2381.0	ROV_KIEL6000	Station end	
PS143/1_32-2		2024-07-01T19:05:46	79.14340	2.76015	5449.5	HN	Station start	
PS143/1_32-2		2024-07-01T19:09:45	79.14291	2.75638	5448.5	HN	Station end	
PS143/1_32-1		2024-07-01T19:14:09	79.14257	2.75269	5447.6	CTD-RO	max depth	
PS143/1_32-3		2024-07-01T21:33:39	79.14907	2.76188	5447.6	TVMUC	max depth	
PS143/1_32-4		2024-07-02T01:40:18	79.14249	2.75996	5448.8	TVMUC	max depth	
PS143/1_33-1		2024-07-02T06:57:24	79.07748	4.13477	2413.7	ROV_KIEL6000	Station start	
PS143/1_33-1		2024-07-02T12:28:09	79.07488	4.09126	2448.2	ROV_KIEL6000	Station end	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1_34-2		2024-07-02T13:57:58	79.06104	3.32986	4300.3	HN	Station start	
PS143/1_34-2		2024-07-02T14:00:37	79.06071	3.32885	4194.5	HN	Station end	
PS143/1_34-3		2024-07-02T14:01:12	79.06067	3.32862	4217.8	HN	Station start	
PS143/1_34-3		2024-07-02T14:03:28	79.06128	3.32679	4018.6	HN	Station end	
PS143/1_34-1		2024-07-02T15:43:02	79.05203	3.29945	5084.6	CTD-RO	max depth	
PS143/1_35-1		2024-07-02T19:10:59	79.13429	3.89080	2437.4	OFOBS	Station start	
PS143/1_35-1		2024-07-03T06:07:25	79.09743	3.39767	5038.8	OFOBS	Station end	
PS143/1_36-2		2024-07-03T14:13:14	78.97139	0.00883	2507.8	HN	Station start	
PS143/1_36-2		2024-07-03T14:15:45	78.97106	0.00686	2509.3	HN	Station end	
PS143/1_36-3		2024-07-03T14:15:56	78.97102	0.00672	2508.1	HN	Station start	
PS143/1_36-3		2024-07-03T14:21:38	78.97017	0.00039	2506.1	HN	Station end	
PS143/1_36-1		2024-07-03T15:00:39	78.96372	-0.03389	2476.9	CTD-RO	max depth	
PS143/1_36-4		2024-07-03T16:05:31	78.95378	-0.10272	2442.3	MSN	Station start	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1_36-4		2024-07-03T18:23:23	78.92590	-0.24997	2426.0	MSN	Station end	
PS143/1_37-1		2024-07-04T01:46:54	78.61566	5.16522	5.7	OFOBS	Station start	
PS143/1_37-1		2024-07-04T05:54:35	78.61496	5.02859	2300.9	OFOBS	Station end	
PS143/1_38-1		2024-07-04T08:43:51	79.07820	4.13106	2422.5	ROV_KIEL6000	Station start	
PS143/1_38-1		2024-07-04T14:18:14	79.08037	4.13119	2419.8	ROV_KIEL6000	Station end	
PS143/1_39-1		2024-07-04T17:57:06	79.14220	2.76158	5550.1	TVMUC	max depth	
PS143/1_40-1		2024-07-04T23:03:36	79.07718	1.49837	2560.1	CTD-RO	max depth	
PS143/1_41-1		2024-07-05T00:45:45	79.09871	1.96617	2706.0	CTD-RO	max depth	
PS143/1_42-1		2024-07-05T03:56:03	79.07462	4.13440	2427.0	BCRAWL	Station start	
PS143/1_42-1		2024-07-05T05:45:19	79.07492	4.11861	2436.8	BCRAWL	Station end	
PS143/1_42-2		2024-07-05T06:47:16	79.07893	4.11314	2432.4	ROV_KIEL6000	Station start	
PS143/1_42-2		2024-07-05T10:48:45	79.07789	4.11211	2435.4	ROV_KIEL6000	Station end	
PS143/1_42-3		2024-07-05T10:51:09	79.07759	4.11240	2437.4	BCRAWL	Station start	

Event label	Optional label	Date/Time	Latitude	Longitude	Depth [m]	Gear	Action	Comment *
PS143/1_42-3		2024-07-05T12:24:18	79.07689	4.10422	2443.3	BCRAWL	Station end	
PS143/1_43-1		2024-07-05T15:31:00	79.12109	3.42463	5012.7	OFOBS	Station start	
PS143/1_43-1		2024-07-06T03:25:38	79.06812	3.28876	5160.0	OFOBS	Station end	
PS143/1_44-1		2024-07-06T04:30:00	79.07636	4.12471	2432.9	BCRAWL	Station start	
PS143/1_44-1		2024-07-06T05:49:58	79.07485	4.10235	2447.7	BCRAWL	Station end	
PS143/1_44-2		2024-07-06T06:40:06	79.07905	4.10561	2437.8	ROV_KIEL6000	Station start	
PS143/1_44-2		2024-07-06T10:36:36	79.07615	4.09610	2451.3	ROV_KIEL6000	Station end	

*Comments are limited to 130 characters. See <https://www.pangaea.de/expeditions/events/PS143/1> to show full comments in conjunction with the station (event) list for expedition PS143/1.

Abbreviation	Method/Device
ADCP	Acoustic Doppler Current Profiler
AUTOFIM	Automated Filtration for Marine Microbes
BC	Box corer
BCRAWL	Benthic Crawler
BFL	Benthic flux lander
B_LANDER	Bottom lander
CT	Underway cruise track measurements
CTD-RO	CTD/Rosette
EBS	Epibenthic sledge
FBOX	FerryBox
GKG	Giant box corer
GRAV	Gravimetry
HN	Hand net
MAG	Magnetometer
MOOR	Mooring
MSN	Multiple opening/closing net
MUC	MultiCorer
MYON	DESY Myon Detector
NEUMON	Neutron monitor
OFOBS	Ocean Floor Observation and Bathymetry System
ROV_KIEL6000	Remote operated vehicle KIEL 6000
SNDVELPR	Sound velocity probe
SWEAS	Ship Weather Station
TSG	Thermosalinograph
TVMUC	Multicorer with television

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