ALKOR-Berichte

Multidisciplinary teaching cruise MNF-bioc-301
Plankton along the Baltic Sea salinity gradient

Cruise No. AL618

August 18th – August 30th 2024

Kiel (Germany) – Kiel (Germany)

MNF-bioc-301

Prof. Dr. David Needham

GEOMAR Helmholtz Centre for Ocean Research Kiel

2025

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1 Cruise Summary

1.1 Summary in English

The multidisciplinary teaching cruise AL618 was part of the curriculum of the master "Biological Oceanography" at the Christian-Albrechts-University Kiel and the GEOMAR Helmholtz Centre for Ocean Research. During this mandatory part of the MNF-bioc-301 module the students were able to gain hands-on experience of the scientific operation on-board a modern multidisciplinary research vessel. Methods in physical, biological and chemical oceanography were taught based on biodiversity changes in several functional plankton groups along the Baltic Sea salinity gradient as a main subject. The students performed tasks such as deploying state-of-the-art measuring and sampling gear, data and sample collection as well as first on-board analyses and curation of data and samples for later use. The on-board analyses included taxonomic identification, measurements and counts of plankton organisms, and chlorophyll A concentrations and recording of CTD profiles. Further samples were collected for later analyses during other practical courses in the master curriculum such as seawater samples for eDNA and viral plankton analyses. The work with the crew onboard ALKOR was outstanding.

1.2 Zusammenfassung

Die multidisziplinäre Lehrfahrt AL618 war Teil des Lehrplans für den Masterstudiengang "Biologische Ozeanographie" an der Christian-Albrechts-Universität zu Kiel und dem GEOMAR Helmholtz-Zentrum für Ozeanforschung. Während dieses obligatorischen Moduls (MNF-bioc-301) konnten die Studierenden praktische Erfahrungen zu dem wissenschaftlichen Betrieb an Bord eines modernen, multidisziplinären Forschungsschiffes sammeln. Methoden der physikalischen, biologischen und chemischen Ozeanographie wurden anhand von Biodiversitätsveränderungen verschiedener funktioneller Planktongruppen entlang des Salinitätsgradienten der Ostsee als Hauptthema vermittelt. Die Studierenden übernahmen Aufgaben wie z.B. die Bedienung modernster Mess- und Probenahmegeräte, die Daten- und Probensammlung sowie erste Analysen an Bord und die Aufbereitung von Daten und Proben für die spätere Verwendung. Zu den Analysen an Bord gehörten die taxonomische Identifizierung, Messungen und Zählungen von Planktonorganismen, und Chlorophyll A, sowie die Aufzeichnung von CTD-Profilen. Weitere Proben wurden für spätere Analysen während anderer Praktika im Rahmen des Masterstudiengangs entnommen, z.B. Meerwasserproben für eDNA- und Virusplanktonanalysen. Die Zusammenarbeit mit der Besatzung an Bord der ALKOR war hervorragend.

2 Participants

2.1 Principal Investigators

Name	Institution
Needham, David M, Prof.	GEOMAR

2.2 Scientific Party

Name	Discipline	Institution
Dr. David Needham	Chief Scientist	GEOMAR
Dr. Kristin Bergauer	Scientist	GEOMAR
Ralf Schoppenhauer	Technician	GEOMAR
Josephine Lorenzen	Student	GEOMAR
Anneke Meißner	Student	GEOMAR
Levke Jasper	Student	GEOMAR
Samantha Schmidt	Student	GEOMAR
Samira Linder	Student	GEOMAR
Hanna Rudnick	Student	GEOMAR
Maria Fernández Altimira	Student	GEOMAR
Zoe Krause	Student	GEOMAR
Jana Hinz	Student	GEOMAR

2.3 Participating Institutions

GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel

3 Research Program

3.1 Description of the Work Area

The Baltic Sea has been chosen as a working area for a number of reasons. The Baltic Sea being the larges brackish body of water in the world allows us to study the hydrography and ecology along an environmental gradient. This characterizing salinity gradient, both vertically and horizontally, created by surface run off and irregular saltwater inflows has created a unique environment with vertically and horizontally structured saltwater, brackish and freshwater habitats. In addition, the Baltic Sea is under heavy anthropogenic impact due to over 85 million people living in is catchment area and has been the object of many studies and time series sampling.

3.2 Aims of the Cruise

This research cruise is part of the M.Sc. program Biological Oceanography curriculum GEOMAR and Kiel University. The students will study the environmental parameters and the distribution of various plankton groups and microbial diversity along the salinity gradient of the Baltic Sea using different approaches (nets and eDNA. Hydrographic measurements to ground-truth modelling of currents and hydrographic regimes. Sampling of different plankton species for genetic, stable isotope analysis/food web/genetic analyses.

3.3 Agenda of the Cruise

The agenda of Research Cruise AL618, conducted from August 18 to August 30, 2024, aboard the Research Vessel ALKOR, centers on a 12-day exploration of the marine food web across approximately 10 stations in the Skagerrak and Gotland Basin, with a focus on sampling from microbes to fish larvae alongside biogeochemical and physical measurements. The cruise plan integrates sampling with diel cycles at key stations M6 (Skagerrak) and BY15 (Gotland Basin), where continuous sampling every 4 to 6 hours. Starting at Boknis Eck, the cruises progresses through a mix of transit and rotational work at various stations, including M03 (Skagerrak), POS_C (Kattegat), H21 (Arkona Basin), GB96 and GB84 (Gotland Basin), and BB23 (Bornholm Basin), before concluding with a return to Boknis Eck. The research targets biological oceanography (nutrients, chlorophyll, phytoplankton), microbial ecology (seawater fractionation, preservation), and zooplankton/ichthyoplankton sampling, leveraging water samplers, CTDs, Bongo Nets, and in-situ pumps to achieve a comprehensive ecological snapshot of these marine regions.

The research during this cruise has been performed in accordance with the declarations on responsible marine research stated in the cruise proposal.

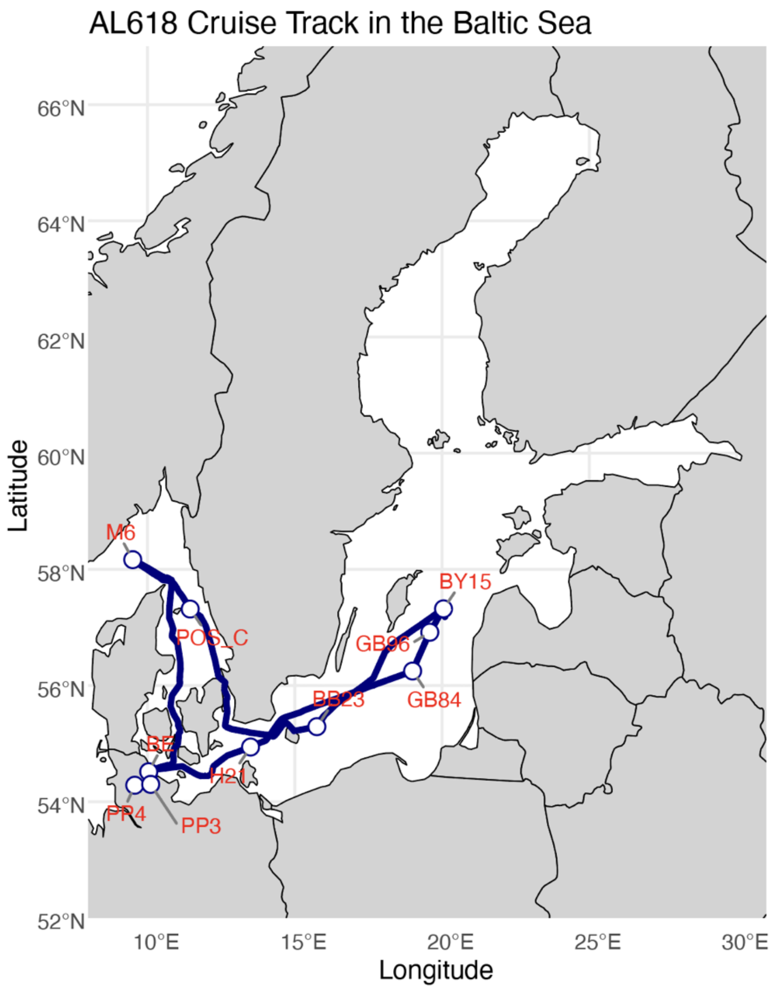


Fig. 3.1 Stations sampled as part of AL618.

4 Narrative of the Cruise

The cruise commenced with preliminary test operations on August 18, 2024, at station M06 in the Kiel Bight (54.3099° N, 10.248° E), at a depth of 25 meters. Sampling events utilized multiple gear configurations (e.g., 1-1, 2-1, 1-4-1) to optimize data collection across various depths and regions. The WS-CTD was deployed extensively to measure conductivity, temperature, and depth, providing high-resolution profiles of the water column. Biological sampling involved the WP2, Bongo, and Apstein nets to capture plankton at depths ranging from 25 meters in the Kiel Bight to 611 meters in the Gotland Basin (station BY15). A total of 10 stations were sampled, with intensive sampling (multiple sample points across a diel cycle) at M6, POS_C, GB96, and BB23..

Sampling activities spanned multiple sub-regions, with sustained efforts in the Kattegat (stations POS-C, 74 m depth), Bornholm Basin (stations BB23, 96 m depth), Gotland Basin (stations BY15, up to 242 m depth), and Arkona Basin (station H21). The WS-CTD deployments provided critical data on water column properties, particularly in deeper stations such as BY15, where maximum depths reached 611 meters. Plankton sampling with the WP2 and Bongo nets was concentrated in the upper water column, with the Apstein net used selectively for targeted depth profiles. Station PP3 and PP4 as well as Boknis Eck in the Kiel Bight marked the final sampling event on August 29 concluding the cruise's operational phase.

Table 4.1 Overview of gear deployments during AL618. Mesh sizes of all nets are given in brackets. Abbreviations: CTD = probe measuring salinity, temperature, oxygen concentration and depth. WS-CTD = Rosette water sampler coupled with CTD probe. MN Maxi = large multinet.

Gear	# of deployments
WS-CTD	35
Bongo (150, 335, 500 µm)	12
Apstein (50 µm)	12
WP2	18
In situ pump	10

5 Preliminary Results

5.1 Chlorophyll

Water samples were taken with the rosette water sampler at stations along the salinity gradient, from the surface and chlorophyll maximum. The water was immediately filter onto a GF/F filter and frozen for later onboard analysis. Samples ranged from ~0.5 µg/L to 3.5 µg/L. Samples were taken across the diel cycle, but in general there was no obvious pattern over the course of the day.

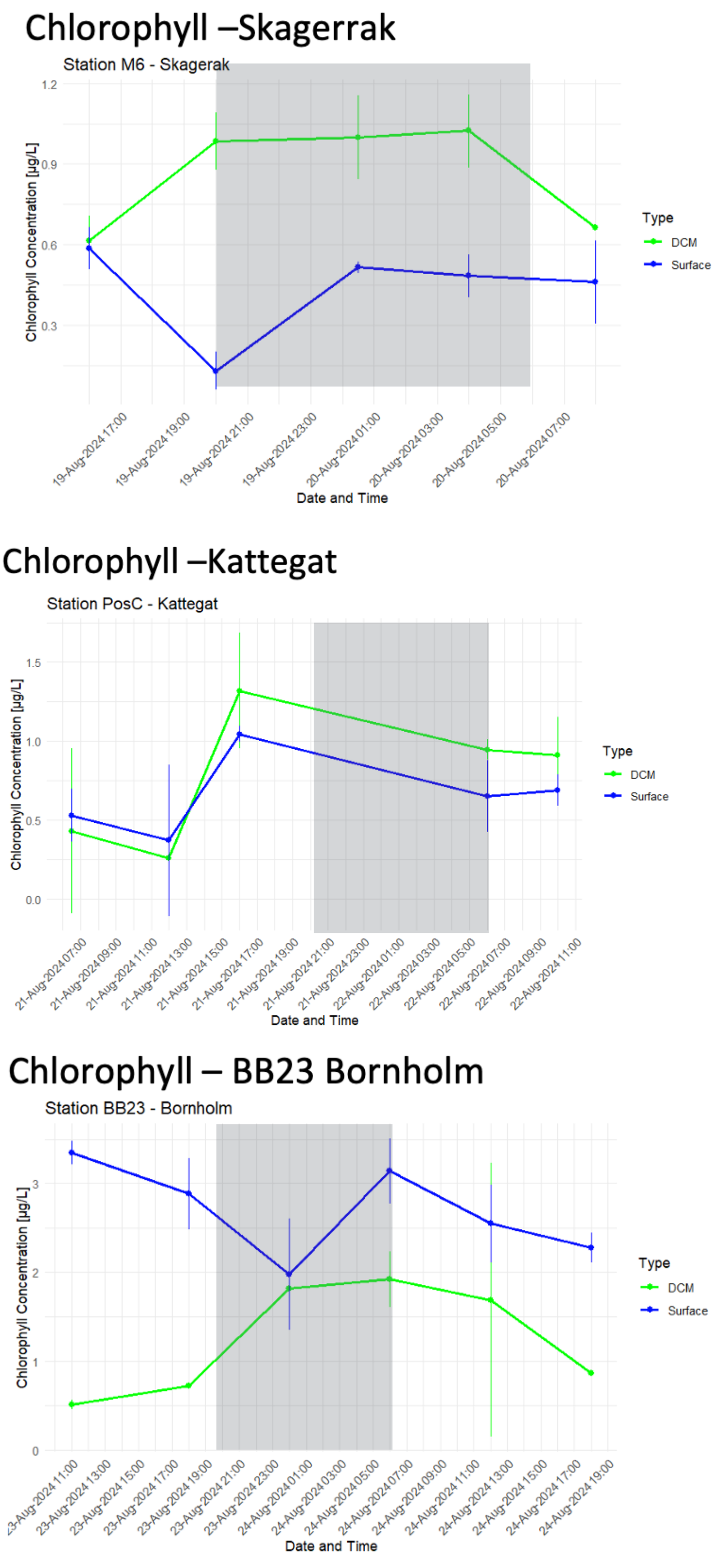


Fig. 5.2 Concentration of Chlorophyll A at three separate locations.

5.2 CTD Measurements

CTD measurements were made with Sea-Bird SBE 9. The Baltic Sea surface salinity gradient was reconstructed as expected with approximately 33 PSU in the Skaggerak to <5 PSU in the Gotland Basin. The bottom salinity was up to similarly high of 35 PSU in the Skaggerak and ~10 in the

Gotland basin. Surface temperatures were around 17C at all stations in the surface, and around 7 in the deep waters. The dissolved oxygen concentration (DO) varied between the basins with 0 in the Gotland Basin deep waters, while the Skagerrak was fully oxygenated. Finally fluorewscnce was lowest in Gotland basin and highest at Boknis Eck.

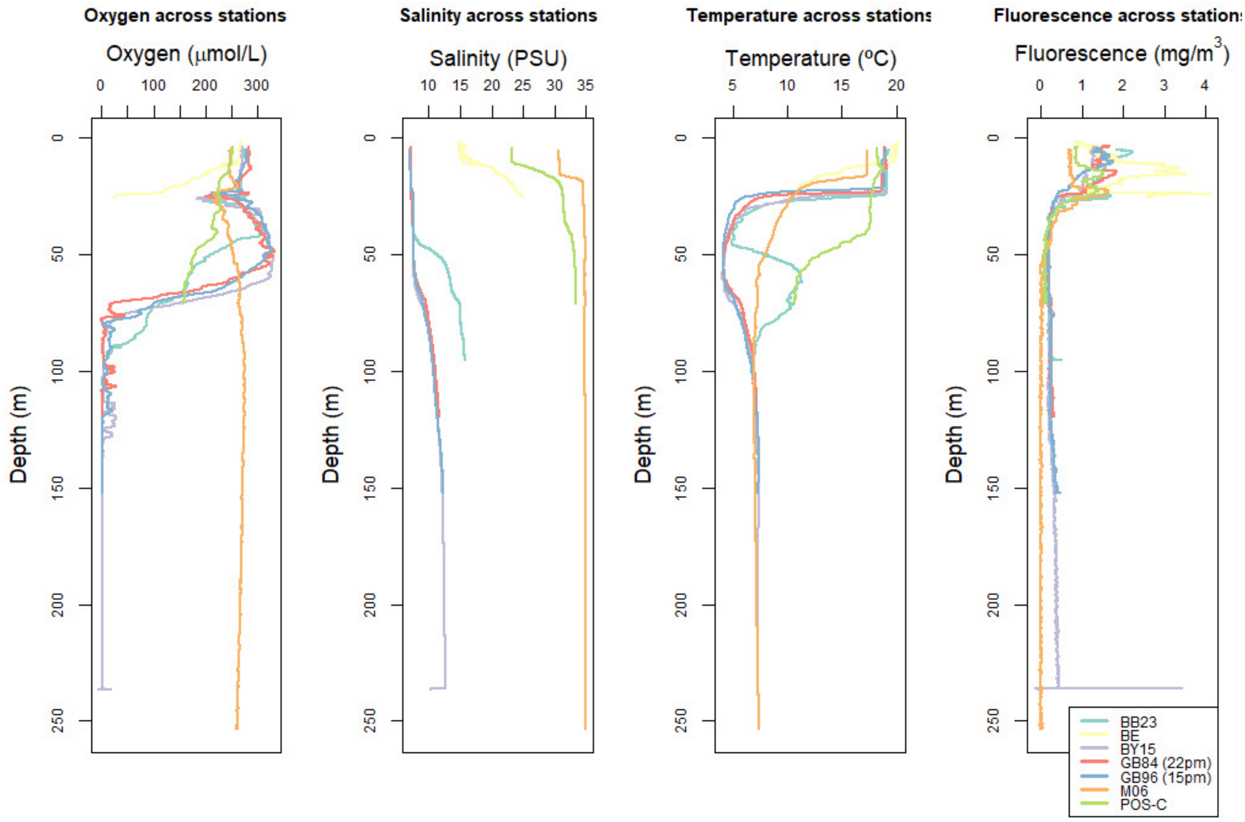
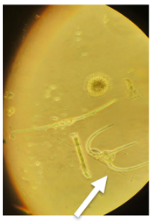


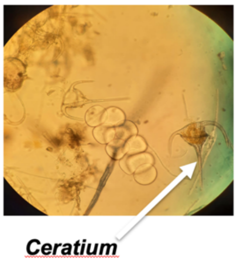
Fig. 5.3 Concentration of Chlorophyll A at three separate locations.

5.3 Microscopy

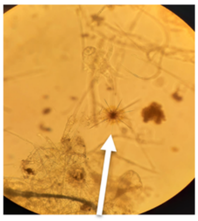
We stained seawater with Lugols and visualized plankton with light microscopy. We found that the dominant species varied along a salinity gradient from more dinoflagelaltes and diatoms in the Skagerrak and more filamentous nitrogen fixers and diatoms in the Gotland and Bornhom Basins.



Ceratium fusus
mixotroph

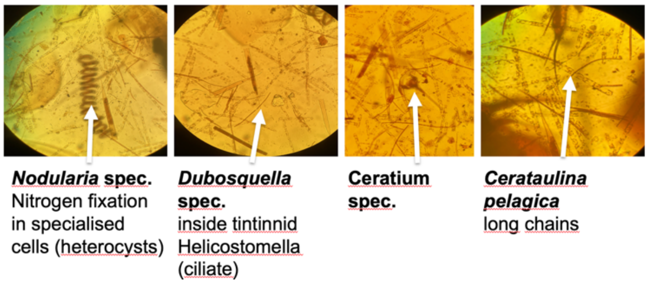


Ceratium horridum
mixotroph

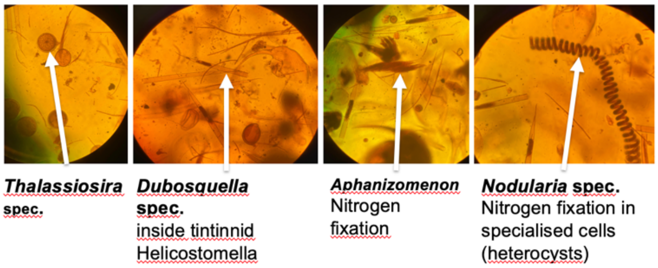


***Aulacautha* spec.**
Radiolaria

Skagerrak



Bornholm Basin



Gotland Basin

Fig. 5.4 Representative images of light micrscopy of lugols stained plankton from the Baltic Sea salinity gradient.

5.4 Microbial Community

Microbial community composition varied over the salinity gradient with more Actinobacteria found in the

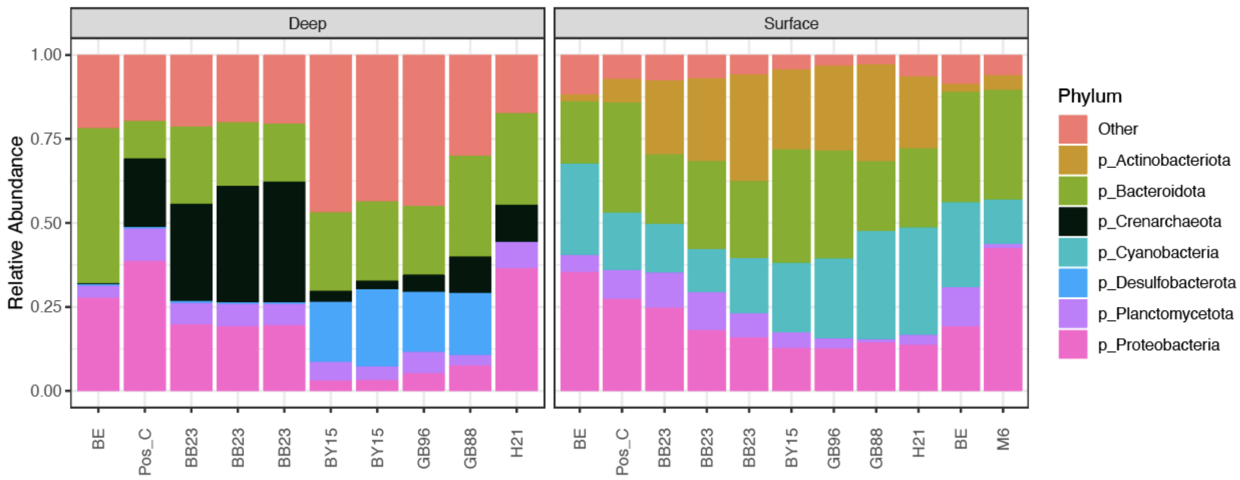


Fig. 5.5 Prokaryotic community diversity from deep and surface samples via 16S rRNA gene sequencing from the Baltic Sea salinity gradient.

6 Ship's Meteorological Station

Does not apply for cruise AL618.

7 Station List AL618

Table 7.1 Station list with all gear deployments during of AL618. Gear abbreviations: WS-CTD with water sampler = Rosette water sampler coupled with CTD probe. Apstein and WP-2 represent different plankton nets. Times refer to "board time", representing Central European Time (CET). Latitude and longitude are given in degrees decimal minutes format.

Gear	Event	depth	station_ID	Time	Latitude	Longitude
Apstein	AL618_2-1	25	BE	2024-08-18 7:55	54.5165 N	10.415 E
WP2	AL618_3-1	25	BE	2024-08-18 8:12	54.5165 N	10.416667 E
Bongo	AL618_4-1	25	BE	2024-08-18 8:24	54.519167 N	10.4 E
WS-CTD	AL618_5-1	25	BE	2024-08-18 10:08	54.516667 N	10.416667 E
WS-CTD	AL618_6-1	611	M06	2024-08-19 14:04	56.166833 N	9.4995 E
ISP	AL618_6-2	611	M06	2024-08-19 15:35	56.1665 N	9.501 E
WS-CTD	AL618_7-1	611	M06	2024-08-19 18:00	58.166667 N	9.500167 E
Apstein	AL618_8-1	611	M06	2024-08-19 18:27	58.166667 N	9.500333 E
WP2	AL618_9-1	611	M06	2024-08-19 18:32	58.166667 N	9.499667 E
WP2	AL618_10-1	611	M06	2024-08-19 18:42	58.166667 N	9.500333 E
Bongo	AL618_11-1	611	M06	2024-08-19 19:03	58.167167 N	9.501833 E
WS-CTD	AL618_12-1	611	M06	2024-08-20 22:03	58.166633 N	9.5004 E
WS-CTD	AL618_12-2	611	M06	2024-08-20 2:01	58.166683 N	9.333833 E
WS-CTD	AL618_12-3	611	M06	2024-08-20 6:00	58.166667 N	9.5005 E
Apstein	AL618_13-1	611	M06	2024-08-20 9:22	58.167 N	9.499667 E
WP2	AL618_13-2	611	M06	2024-08-20 9:29	58.167 N	9.4995 E
WP2	AL618_13-3	611	M06	2024-08-20 9:38	58.167167 N	9.500167 E
Bongo	AL618_13-4	611	M06	2024-08-20 9:47	58.166167 N	9.510667 E
Bongo	AL618_14-1	611	M06	2024-08-20 18:57	58.173833 N	9.499333 E
WS-CTD	AL618_15-1	74	POS-C	2024-08-21 4:07	57.317167 N	11.4495 E
WS-CTD	AL618_17-1	74	POS-C	2024-08-21 0:00	57.317167 N	11.4495 E
Apstein	AL618_18-1	74	POS-C	2024-08-21 6:33	57.3165 N	11.449667 E

Apstein	AL618_19-1	74	POS-C	2024-08-21 6:37	57.3165 N	11.449667 E
WP2	AL618_20-1	74	POS-C	2024-08-21 6:42	57.316333 N	11.449833 E
WP2	AL618_21-1	74	POS-C	2024-08-21 6:48	57.316333 N	11.449833 E
Bongo	AL618_22-1	74	POS-C	2024-08-21 6:59	57.316333 N	11.452833 E
WS-CTD	AL618_23-1	74	POS-C	2024-08-21 9:59	57.316333 N	11.452833 E
WS-CTD	AL618_24-1	74	POS-C	2024-08-21 15:57	57.318 N	11.449833 E
WS-CTD	AL618_26-1	74	POS-C	2024-08-21 0:00	57.316333 N	11.45 E
WP2	AL618_26-2	74	POS-C	2024-08-21 22:11	57.3165 N	11.450167 E
Bongo	AL618_26-3	74	POS-C	2024-08-21 22:19	57.316667 N	11.449833 E
WS-CTD	AL618_27-1	74	POS-C	2024-08-22 3:56	57.03166 N	11.044983 E
WS-CTD	AL618_29-1	74	POS-C	2024-08-22 4:16	57.316633 N	11.044983 E
WS-CTD	AL618_31-1	74	POS-C	2024-08-22 5:56	57.316633 N	11.044983 E
WS-CTD	AL618_32-1	96	BB23	2024-08-23 8:51	55.292 N	15.75 E
Apstein	AL618_28-3	96	BB23	2024-08-23 10:59	55.292333 N	15.750167 E
Apstein	AL618_28-4	96	BB23	2024-08-23 11:06	55.292167 N	15.750333 E
WP2	AL618_28-5	96	BB23	2024-08-23 11:15	55.292 N	11.750167 E
WP2	AL618_28-6	96	BB23	2024-08-23 11:23	55.292 N	11.750167 E
Bongo	AL618_28-7	96	BB23	2024-08-23 11:32	55.291833 N	11.750333 E
WS-CTD	AL618_33-1	96	BB23	2024-08-23 15:57	55.292 N	11.75 E
WS-CTD	AL618_34-1	96	BB23	2024-08-23 21:56	55.291833 N	15.749833 E
WP2	AL618_34-2	96	BB23	2024-08-23 22:17	55.292 N	15.7505 E
Bongo	AL618_34-3	96	BB23	2024-08-23 22:25	55.291833 N	15.749833 E
WS-CTD	AL618_35-1	96	BB23	2024-08-24 3:57	55.29195 N	15.75005 E
WS-CTD	AL618_36-1	96	BB23	2024-08-24 4:32	55.29195 N	15.75005 E
WS-CTD	AL618_37-1	96	BB23	2024-08-24 9:58	55.292 N	15.750067 E
WP2	AL618_37-2	96	BB23	2024-08-24 10:15	55.292167 N	15.749833 E
WS-CTD	AL618_38-1	96	BB23	2024-08-24 16:01	55.292017 N	15.7501 E
WS-CTD	AL618_40-1	96	BB23	2024-08-24 21:59	55.291983 N	15.750033 E
WP2	AL618_40-2	96	BB23	2024-08-24 22:09	55.292167 N	15.7495 E
WS-CTD	AL618_41-1	96	BB23	2024-08-25 4:00	55.292 N	15.75 E

WS-CTD	AL618_42-1	96	BB23	2024-08-25 9:59	55.292167 N	15.750667 E
WS-CTD	AL618_43-1	242	BY15	2024-08-26 9:57	57.3205 N	20.049 E
Apstein	AL618_43-2	242	BY15	2024-08-26 10:38	57.320167 N	20.049667 E
Apstein	AL618_43-3	242	BY15	2024-08-26 10:46	57.320167 N	20.049667 E
WP2	AL618_43-4	242	BY15	2024-08-26 10:53	57.321333 N	20.049667 E
WP2	AL618_43-5	242	BY15	2024-08-26 11:01	57.320333 N	20.049 E
Bongo	AL618_43-6	242	BY15	2024-08-26 11:12	57.319667 N	20.081667 E
WS-CTD	AL618_44-1	242	BY15	2024-08-26 16:01	57.320267 N	20.049933 E
WS-CTD	AL618_46-1	242	BY15	2024-08-26 21:59	57.320383 N	20.04935 E
WS-CTD	AL618_47-1	242	BY15	2024-08-27 3:56	57.320267 N	20.049167 E
WS-CTD	AL618_48-2	242	BY15	2024-08-27 0:49	57.320267 N	20.04915 E
WS-CTD	AL618_49-1	156	GB96	2024-08-27 13:12	56.917433 N	19.58295 E
Apstein	AL618_49-2	156	GB96	2024-08-27 13:32	56.917167 N	19.583167 E
WP2	AL618_49-3	156	GB96	2024-08-27 13:38	56.917167 N	19.583167 E
Bongo	AL618_49-4	156	GB96	2024-08-27 13:48	56.917217 N	19.583333 E
WS-CTD	AL618_50-1	123	GB84	2024-08-27 20:16	56.250283 N	19.0005 E
Apstein	AL618_51-1	123	GB84	2024-08-27 20:33	56.25 N	19.000167 E
WP2	AL618_52-1	123	GB84	2024-08-27 20:40	56.250167 N	19 E
Bongo	AL618_53-1	123	GB84	2024-08-27 20:52	56.250833 N	19.001167 E
WS-CTD	AL618_56-1	47	H21	2024-08-28 18:27	54.942 N	13.493 E
Apstein	AL618_57-1	47	H21	2024-08-28 18:39	54.942333 N	13.500667 E
WP2	AL618_58-1	47	H21	2024-08-28 18:52	54.942 N	13.500333 E
Bongo	AL618_59-1	47	H21	2024-08-28 19:03	54.942667 N	13.497333 E
WS-CTD	AL618_60-1	24	PP4	2024-08-29 9:17	54.473033 N	9.947267 E
WS-CTD	AL618_61-1	27	BE	2024-08-29 10:04	54.530133 N	10.0408 E
WS-CTD	AL618_62-1	22	PP3	2024-08-29 10:56	54.497917 N	10.180067 E

8 Data and Sample Storage and Availability

Data obtained during the cruise have been backed up on a GEOMAR virtual drive that is backed up daily. In addition, data are stored on different hard drives in different locations. Paper protocols filled out during the cruise were entered electronically continuously throughout the cruise, and thus fall under the electronic back-up scheme, but have also been conserved as hard copies to resolve possible data entry errors later on if needed.

All cruise meta-data – including output of the on board DSHIP-System - have been entered in the GEOMAR Ocean Science Information System (OSIS), managed by the Data technologies Team at GEOMA’s Ocean Research and Technology Center, and intended for permanent archiving of such data. The data are freely available via the link https://osis.geomar.de/ (keyword “AL618”).

We aim to ultimately make all data accumulated during the cruise publicly available.

All hydrographic (CTD) data will be submitted to the ICES database. Moreover, the DT team will assist with the publication of data in the public data repository PANGAEA to provide long-term archival and access. Some of the data are intended for specific publications, and will be published openly with the appearance of the underlying peer-review article. In these cases, please contact the person responsible for the data in case earlier access to the data is desired (Table 8.1).

Table 8.1 Overview of data availability

Type	**Database**	**Available**	**Free Access**	**Contact**
Hydrography (CTD data)	ICES database	Submission pending. Available upon request (see contact e-mail).		dneedham@geomar.de
Plankton samples		Publicly at time of acceptance of the underlying peer-reviewed publication; alternatively. via request (see contact e-mail).		dneedham @geomar.de
Ichthyoplankton samples		Publicly at time of acceptance of the underlying peer-reviewed publication; alternatively. via request (see contact e-mail).		fmittermayer@geomar.de
eDNA sampling	PANGAEA/ NCBI	Publicly at time of acceptance of the underlying peer-reviewed publication; alternatively. via request (see contact e-mail).		dneedham@geomar.de
Chlorophyll data	PANGAEA	Publicly at time of acceptance of the underlying peer-reviewed publication; alternatively. via request (see contact e-mail).		dneedham@geomar.de

9 Acknowledgements

I want to thank Captain Klaus Bergmann and the entire crew of RV ALKOR for their outstanding support and for the excellent and constructive working atmosphere throughout the cruise. Further I would like to thank Ralf Schoppenhauer for his technical support in planning. preparation and all the help during the cruise. I also thank Felix Mittermeyer for his help with cruise preparations and planning. Further I would like to thank GEOMARs export and customs team and data technologies team as well as the ship coordination and logistics group. Last of all I would like to acknowledge the enthusiasm and motivation of the students' participation in AL618.

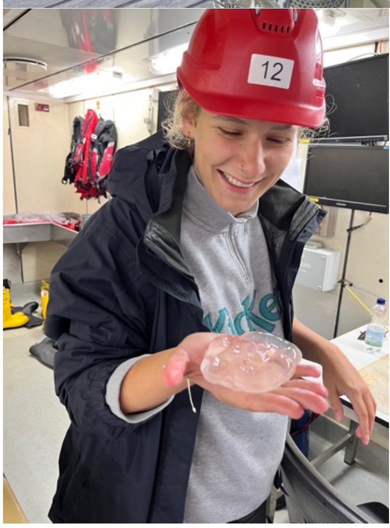
10 References

11 Abbreviations

12 Appendices

12.1 Selected Pictures of Samples

12.2 Selected Pictures of Shipboard Operations



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