Cruise report Alkor AL544

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GEOMAR

Helmholtz-Zentrum für

Ozeanforschung Kiel

Date: 15.10.2020

Cruise Report

Compiled by: Dr. Cornelia Jaspers

R.V. ALKOR **Cruise No.: AL 544**

Dates of Cruise: 1.9. – 15.8.2020

Areas of Research: Physical, chemical, biological oceanography

Port Calls: none

Institute: GEOMAR, FB3 (Marine Evolutionary Ecology)

Chief Scientist: Dr. Cornelia Jaspers

Number of Scientists: 6 (reduced by 50% to 6 due to Corona restrictions)

Number of Observers: none

Projects: Teaching cruise

Cruise Report

This cruise report consists of 23 pages including the cover page:

C: Scientific content of cruise report

1. Scientific crew

Name	**Function**	**Institute**	**Leg**
Cornelia Jaspers	Chief Scientist	GEOMAR/DTU Aqua	Entire cruise
Magnus Heide Andreasen	PhD student	DTU Aqua	Entire cruise
Julia K. Throm	M.Sc. Student	GEOMAR	Entire cruise
Chantal M. Mudlaff	M.Sc. Student	GEOMAR	Entire cruise
Hannah Gaber	M.Sc. Student	GEOMAR	Entire cruise
Sarah Rühmkorff	M.Sc. Student	GEOMAR	Entire cruise
Total	**6**		

1.1 Observer

Name	Function	Institution	Leg
none			

Chief scientist:

Dr. Cornelia Jaspers, GEOMAR Helmholtz Centre for Ocean Research
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and
National Institute of Aquatic Resources, Technical University of Denmark
Centre leader for gelatinous plankton ecology and evolution
Kemitorvet 202, 2800 Kgs. Lyngby, DK
Phone: +45-93511774
E-Mail: coja@aqua.dtu.dk

2. Research program

Physical, biological oceanography:

This multidisciplinary cruise extends a long-term data series on (eco-)system composition and functioning of the Baltic Sea, with a focus on the deeper basins. The series has been collected in similar form since 1986. However, due to the corona pandemic, which made a scientist reduction to 50% of the planned scientific staff necessary and very difficult weather conditions, the initially anticipated cruise track had to be adjusted and focused on the SW Baltic Sea instead of central and northern Baltic areas. Irrespectively, a key characteristic of the cruise was the integration of oceanographic and biological information to enhance our understanding of environmental and zooplankton (especially jellyfish) population fluctuations, and evolutionary processes in this system. The resulting datasets and samples are not only used for teaching purposes but will also contribute to the long term data series.

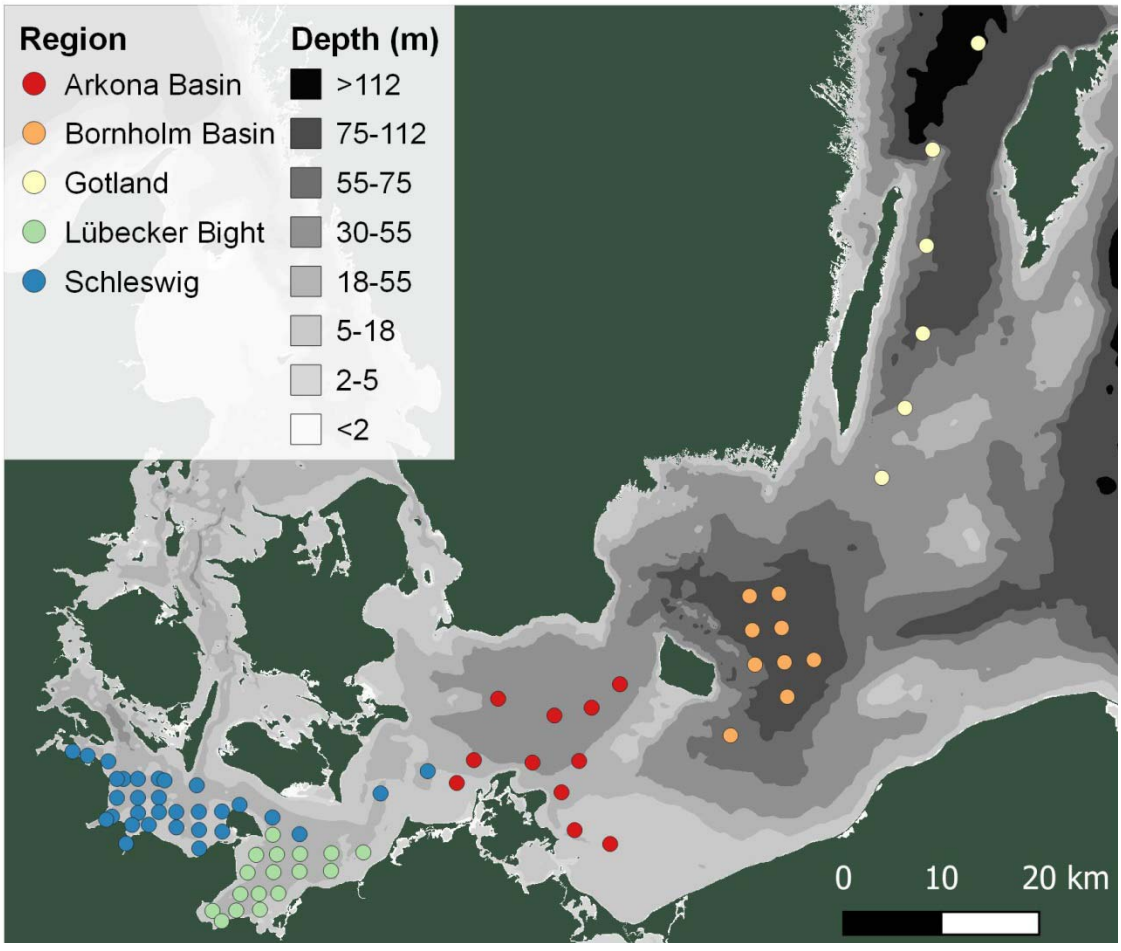

Fig. 1: Investigation area of the Baltic Sea with all 74 stations sampled during the cruise.

In detail, specific investigations during the cruise included a detailed hydrological survey (oxygen, salinity, temperature) of the entire investigation area as well as plankton surveys, focusing on gelatinous macrozooplankton, ichthyoplankton as well as the general zooplankton community composition. Data acquisition also included hydroacoustic methods and this will allow for estimating

abundance and distribution pattern of jellyfish via this non-invasive method, although data analyses is not planned at the moment due to financial constraints. The specific investigation areas visited during the cruise including station names are outlined in Fig. 2 and the ICES Sub-devisions those data are contributing to in Fig. 3.

This cruise is a dedicated education cruise as part of the Biological Oceanography Master Program at GEOMAR, Helmholtz Centre for Ocean Research Kiel. It contributes with sea going experience and fulfillment of hands-on learning objectives for future Biological Oceanographers.

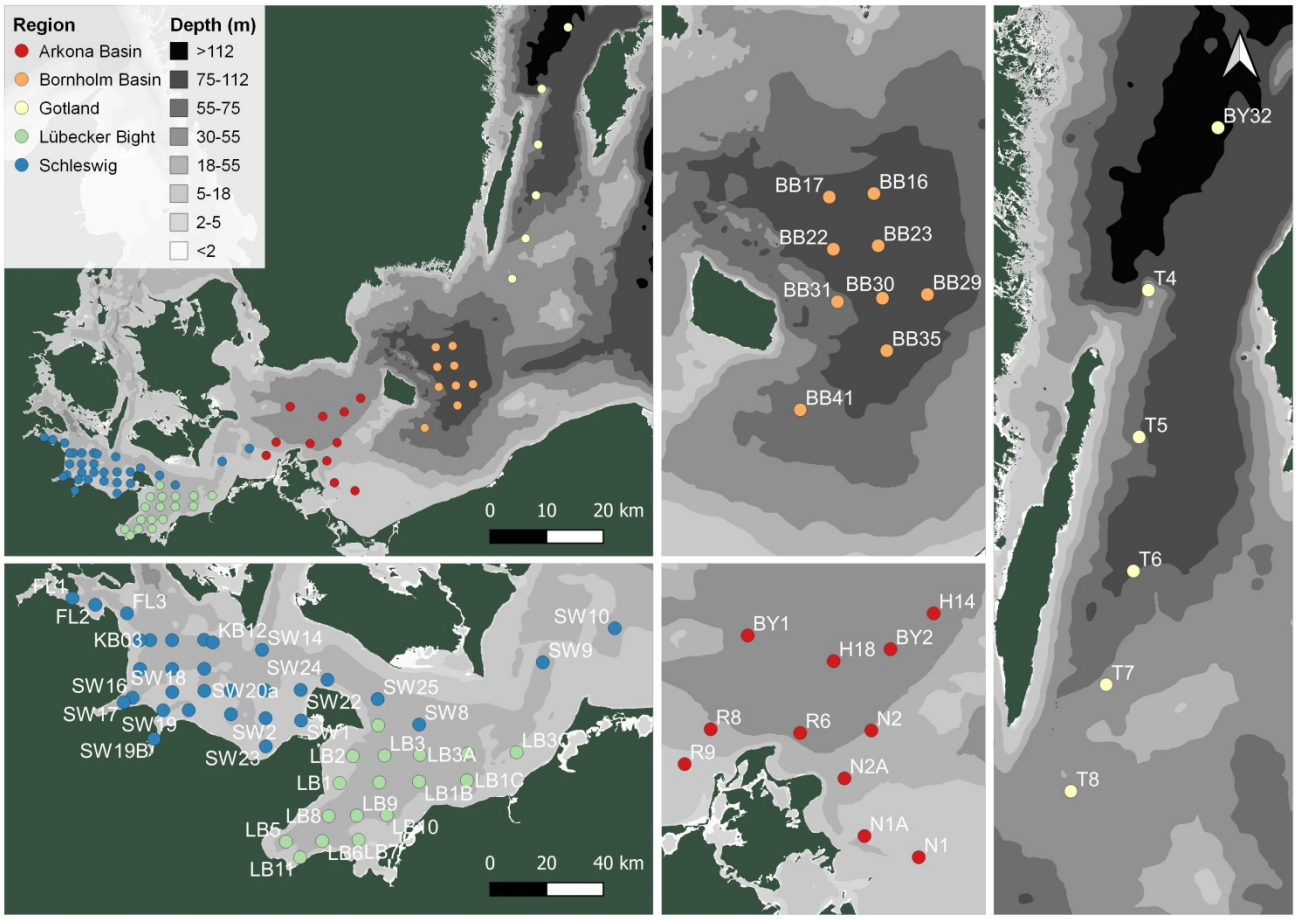

Fig. 2: Specific investigation areas with station names of all 74 stations sampled.

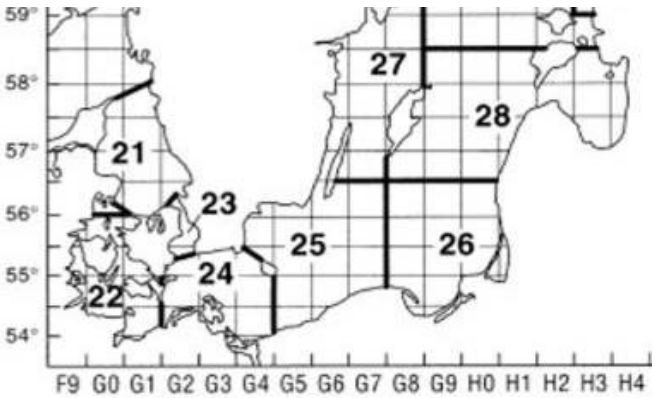

Fig. 3: ICES subdivisions in the Baltic Sea area with hydrography data delivering to SD 22, 24, 25, 26, 27, 28. Source: ICES

3. Narrative of cruise with technical details

Daily activities are outlined below and include operation of different gear, both from a practical and theoretical perspective, analyzing samples alive for macrozooplankton and ichthyoplankton as well as teaching basic principals in sample handling, analyses and preservation. Practical work has been followed up by lectures and student presentations. Each student was holding a 15-30 min presentation about a selected topic which was prepared before the cruise. All students gave excellent presentations and have fulfilled all requirements for gaining credit for this practical.

1.9.2020 Tuesday

8:00 Boarding of students after negative corona test and departure to Kiel Bight for station work.

Station SW4: 9:30 Start with work program at SW4

- CTD (small with fast oxygen sensor)
- Calibration of pressure unit
- Plankton net cast: Bongo

Station KB03

- Plankton net cast: Bongo
- CTD (small with fast oxygen sensor)

Station KB12

- CTD (small with fast oxygen sensor)
- Plankton net cast: Bongo

Station SW14

- Plankton net cast: Bongo
- CTD (small with fast oxygen sensor)

Station work in SW Baltic finished and cruising towards Arkona Basin

Wednesday 2.9.2020

station work started at 6:00 in the Arkona Basin

Station **BY1**

- CTD
- Bongo

Station **H18**

- Bongo
- CTD

Station **BY2**

- CTD
- Wasserschöpfer
- Bongo

Station **H14**

- Bongo
- Water rousette collecter
- CTD

Thursday 3.9.2020

Due to heavy weather, overnight stay off SW Bornholm and continuation towards northern Gotland Basin at 6:00 – first station off south western Øland at 14:00

During the moring 8:00-13:00 was used to deepen the understanding about the physical and biological oceanography of the Baltic Sea with lectures and student presentations.

Station **T8**

- CTD
- Multinetz midi (towed)

Station **T7**

- Multinetz midi (towed)
- CTD

Station **T6**

- CTD
- Multinetz midi (towed)

After station work continuation to HELCOM monitoring station BY32, north east of Gotland.

Friday 4.9.2020 station work started at 6:00 on

Station **BY32** (205m bottom depth)

- Multinet **Maxi** (towed) – to 190m
- Water rousette collecter – up to bottom
- CTD small with fast oxygen sensor (only up to 100m)

Station **T4**

- CTD (small) with fast oxygen sensor
- Multinet **midi** (towed)

Station **T5**

- CTD (small) with fast oxygen sensor
- Multinetz **maxi** (towed)

Due to bad weather and worsening of the situation, northern Stations were skipped, eastern Gotland stations as well and instead SW Baltic Sea targeted as intensive working area. The successful transect along the Swedish coast was extremely timely due to large anoxic events in bottom waters in the extended investigation area. Steeming after successful conduction of Station T5 to SW Arkona Basin, arrival around noon.

Afternoon and evening was used to conduct Chl a extractions/measurements. The students also got familiar with oxygen measurements and winkler titration for CTD calibrations.

Saturday 5.9.2020 with station work at

Station SW10
- CTD
- WP2
- Multinetz midi (towed)

Station SW9
- Multinetz midi (towed)
- CTD
- WP2

Station SW8
- WP2
- CTD
- Multinetz midi (towed)

Sunday 6.9.2020 with station work at Stations within the SW Baltic Sea as outlined on Fig. 1

Station LB1
- Multinetz midi (towed)
- CTD
- WP2

Station LB3
- Multinetz midi (towed)
- WP2

- CTD

Station LB2
- Multinetz midi (towed)
- CTD
- WP2

Station LB4
- Multinetz midi (towed)
- WP2
- CTD

Station SW25
- Multinetz midi (towed)
- CTD
- WP2

Station SW 24
- Multinetz midi (towed)
- WP2
- CTD

Lectures in the evening along with student presentations.

Monday 7.9.2020 with station work at

Station SW23
- Multinetz midi (towed)
- CTD
- WP2

Station SW1
- Multinetz midi (towed)
- WP2
- CTD

Station SW2
- Multinetz midi (towed)
- CTD
- WP2

Station SW22
- Multinetz midi (towed)
- WP2

- CTD

Station SW21
- Multinetz midi (towed)
- CTD
- WP2

Station SW 3
- Multinetz midi (towed)
- WP2
- CTD

Station SW20
- Multinetz midi (towed)
- CTD
- WP2

Tuesday 8.9.2020 with station work Flensburg Fjord

Station FL1
- Multinetz midi (towed)
- WP2
- CTD

Station FL2
- Multinetz midi (towed)
- CTD
- WP2

Station FL3
- Multinetz midi (towed)
- WP2
- CTD

Station KB03A
- Multinetz midi (towed)
- CTD
- WP2

Station KB03
- Multinetz midi (towed)

- WP2
- CTD

Station KB03B

- Multinetz midi (towed)
- CTD
- WP2

Station KB06

- Multinetz midi (towed)
- WP2
- CTD

Station SW13

- Multinetz midi (towed)
- CTD
- WP2

Station SW14

- Multinetz midi (towed)
- WP2
- CTD

Due to heavy weather conditions, the investigation area changed slightly and includes now a station grid in the SW Baltic Sea (see Fig. 1).

9.9.2020 Wednesday

Finishing up work in the SW Baltic Sea. Special focus was devoted towards occurrence of the invasive hydromedusae *Blackfordia virginica* – which was caught on station SW19B.

Station SW17

- Multinetz midi (towed)
- CTD
- WP2

Station SW15

- Multinetz midi (towed)
- WP2
- CTD

Station SW14A

- Multinetz midi (towed)
- CTD
- WP2

Station SW18

- Multinetz midi (towed)
- WP2
- CTD

Station SW20A

- Multinetz midi (towed)
- CTD
- WP2

Station SW 19

- Multinetz midi (towed)
- WP2
- CTD

Station SW19B

- Multinetz midi (towed)
- CTD
- WP2

Continuation along the German Baltic Sea coast covering the Lübecker- and Mecklenburger Bight (see Fig.4 for updated Station grid).

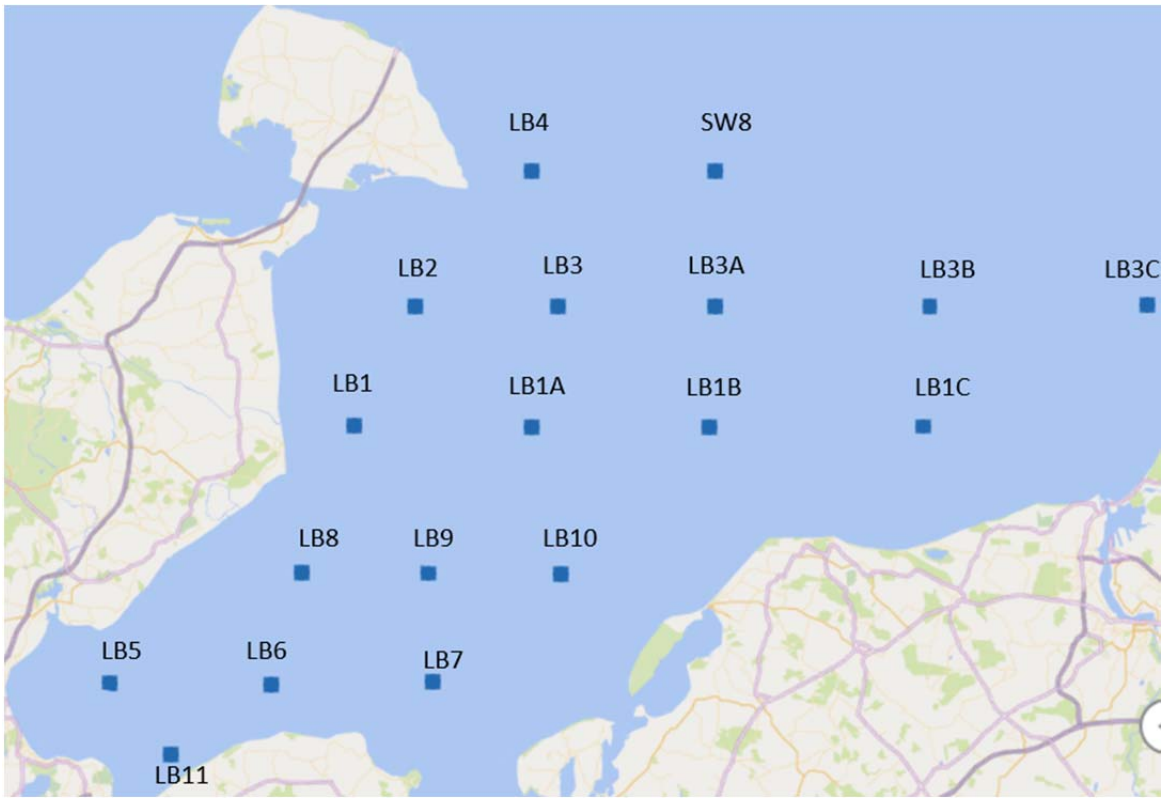

Fig. 4: Station grid in the Lübecker Bight / Mecklenburger Bight which was conducted due to heavy weather conditions in Northern and Eastern parts of the Baltic Sea, which made a change in the cruise plan necessary.

10.9.2020 Thursday

Station LB1A

- Multinetz midi (towed)
- CTD
- WP2

Station LB9

- Multinetz midi (towed)
- WP2
- CTD

Station LB8

- Multinetz midi (towed)
- CTD
- WP2

Station LB5

- Multinetz midi (towed)
- WP2
- CTD

Station LB11

- Multinetz midi (towed)
- CTD
- WP2

Station LB6

- Multinetz midi (towed)
- WP2
- CTD

Station LB7

- Multinetz midi (towed)
- CTD
- WP2

Station LB10

- Multinetz midi (towed)
- WP2
- CTD

Steaming towards the Bornholm Basin to continue station work on the most important spawning ground for cod in the Baltic Sea to investigate the spatial and temporal overlap between gelatinous macrozooplankton and ichthyoplankton – especially considering cod and sprat larvae. To contribute

to ongoing monitoring activities and convey the importance of spatial and temporal high resolution investigations for addressing scientific questions. The students also received a theoretical introduction to most important species being present, their taxonomy, morphological identification and recruitment processes.

11.9.2020 Friday

Investigation of 9 stations in the central Baltic Sea on the BB station grid (BB41/35/29/30/23/16/17/22/31). On each station, CTD and Bongo tows have been conducted. Additionally, the depth distribution of zooplankton was studied in depth on station BB30 - with 18 discrete multinet samples as outlined below:

Station BB30 (Cod larvae focus station)

- Water rosette sampler for discrete water samples to conduct O_2 titration and Chl a determination.
- CTD
- Multinetz Maxi (towed in 5m depth intervals with 18 nets in total to get depth stratified fish larvae avundance data as well as distribution of gelaitnous macrozooplankton and general zooplankton community composition)
- Bongo

Leaving Bornholm Basin at 22:30 to finish the high resolution investigation of the German Baltic Sea coast for gelatinous macrozooplankton and ichthyoplankton – east of Rügen (Fig. 5).

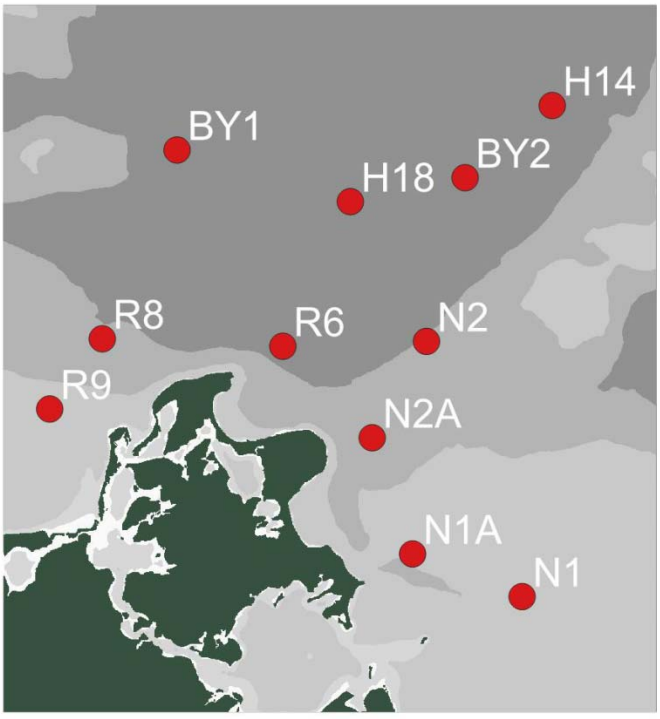

Fig. 5: Investigation area in the eastern part of the German Baltic Sea coast around Rügen.

12.9.2020 Saturday

Station N1

- Multinetz midi (towed)
- CTD
- WP2

Station N1A

- Multinetz midi (towed)
- WP2
- CTD

Station N2A

- Multinetz midi (towed)
- CTD
- WP2

Station N2

- Multinetz midi (towed)
- WP2
- CTD

Station R6

- Multinetz midi (towed)
- CTD
- WP2

Station R8

- Multinetz midi (towed)
- WP2
- CTD

Station R9

- Multinetz midi (towed)
- CTD
- WP2

13.9.2020 Sunday

Finishing station work in the Arkona and Meckenburger Bight. In total 75 stations have been covered with 50+ depth resolved multinet stations, which has in this breath never been conducted in the SW Baltic Sea before.

Station LB3C

- Multinetz midi (towed)
- CTD
- WP2

Station LB3B

- Multinetz midi (towed)
- WP2
- CTD

Station LB1C

- Multinetz midi (towed)
- CTD
- WP2

Station LB1B

- Multinetz midi (towed)
- WP2
- CTD

Station LB3A

- Multinetz midi (towed)
- CTD
- WP2

14.9.2020 Monday

Toll inspection and unloading of scientific equipment. Cleaning and finishing up of field work.

15.9.2020 Tuesday

Sorting and unloading of all frozen samples and organization of storage and transport to the cooperating institutions.

End of the cruise.

Table 1 Overview of gear deployment. Mesh sizes are given in brackets.

Gear	Deployments (n)
ADM-CTD vertical:	75
Hydroacoustic transect (continuous):	1
Watersampler + CTD:	4
Bongo, Babybongo (150µm, 335µm, 500µm):	17
WP2 net casts	52
Multinet MAXI (9 nets) horizontal towed (335µm):	4
Multinet MIDI (5 nets) horizontal towed (335µm):	56

4. Scientific report and first results

4.1 Summary: Goal of the cruise was to investigate the biological oceanography of the Baltic Sea along the extended salinity gradient from intermediate saline SW Baltic Sea waters towards low saline north eastern stations in the Gotland Basin. Apart from teaching a diverse set of biological oceanographic sampling techniques, the aim was to characterize the macro-zooplankton and ichthyo-plankton community. We observed large accumulations of native and invasive macrozooplankton species in different areas of the Baltic Sea as well as extended anoxia in bottom waters. Due to unstable weather conditions, we had to modify the cruise plan along the way and instead of investigating the northern and eastern Gotland Basin, we focused on an intensified station grid in the SW Baltic Sea. In short, we conducted a station grid covering 74 stations (one station sampled twice, hence 75 operational stations) of which >60 were investigated with a depth stratified sampling design using the hydrobios multinets midi and maxi with 5 and 9 discrete net samplings per station, respectively. Additionally, Bongo and WP2 nets were employed to characterize the micro and mesozooplankton community. Data were supplemented with CTD casts to characterize the physical environment and gain a proxy for the phytoplankton community via fluorescence profiles. In the SW Baltic Sea, we observed large quantities of the invasive comb jelly *Mnemiopsis leidyi*, while at northern stations we found the native moon jellyfish *Aurelia aurita*. We did not observe *M. leidyi* at stations north of the Bornholm Basin.

In summary, large parts of the salinity gradient of the Baltic Sea have been investigated, with very interesting results, especially concerning anoxic conditions in bottom waters. Also, the high resolution investigation of the SW Baltic Sea has to date not been conducted before, where we investigated stations with a depth stratified sampling design. The students received a sophisticated training to conduct biological oceanographic investigations, covering the physical and chemical oceanography as well as biological aspects, especially focusing on life analyses of plankton samples and putting biological and physical observations into context of species distribution ranges and consequences of oxygen deficiency on marine life.

Note: Due to the current Corona Pandemic, the scientific staff had been reduced by 50%, which makes 24h work impossible and the teaching and work program very demanding. The cruise has been conducted by 1 chief scientist without technician and 5 students. Given that the situation

remains for the coming year, I am skeptical that a teaching cruise is feasible to be conducted with 5 students. Hence my recommendation to increase the number of participants to at least 10 scientists/students with self-quarantine and testing before departure.

4.2 Gelatinous macro-zooplankton sampling

Key gelatinous zooplankton member encountered during the cruise was the invasive comb jelly *Mnemiopsis leidyi*. All life stages (see Fig. 6) have been investigated and were common in the SW Baltic Sea.

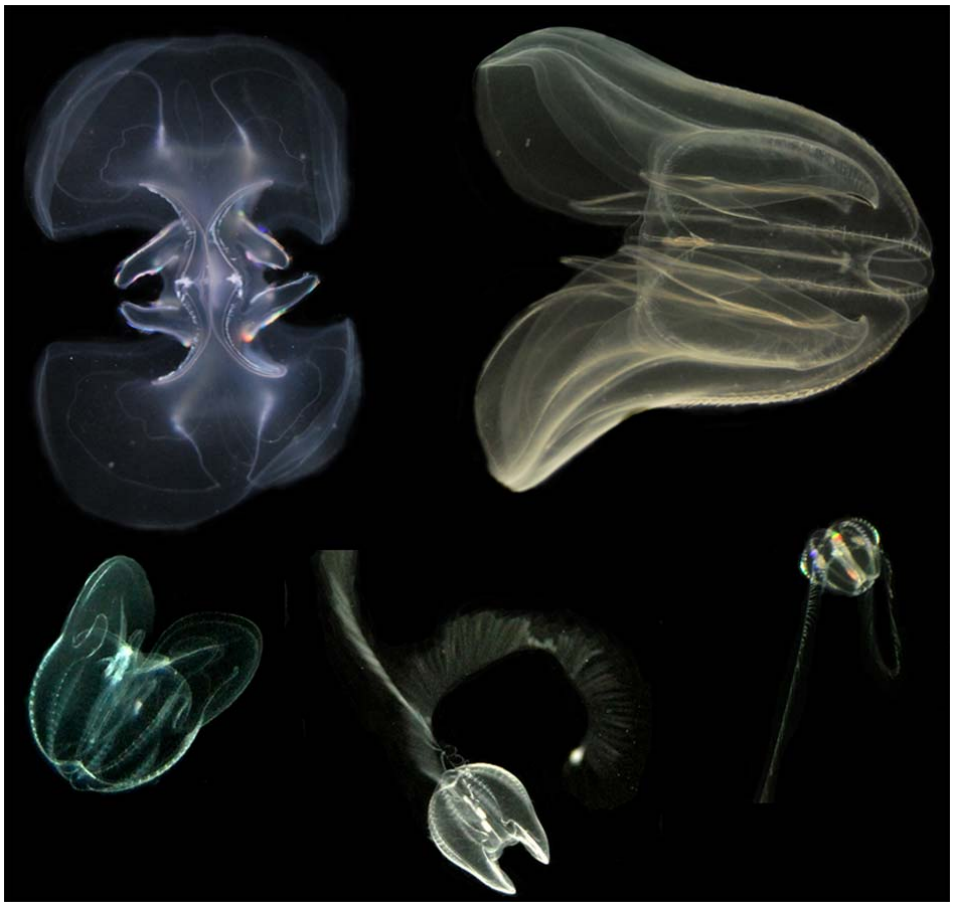

Fig. 6: Different life stages of the non-native comb jelly *Mnemiopsis leidyi*.

However, along the salinity gradient towards central and northern areas of the Baltic Sea, the *M. leidyi´*s depth distribution changed to deeper waters and to the north-east of the Bornholm Basin, no *M. leidyi* were caught at all. This patter is in accordance with previously published range expansions of *M. leidyi* in the Baltic Sea (Jaspers et al. 2018) and confirms that so far no adaptation to low salinity levels are observed, as it has been shown that the current population cannot actively reproduce at salinities below 10 (Jaspers et al. 2011). In accordance, we observed a no *M. leidyi* larvae in the Bornholm Basin.

In contrast to *M. leidyi*, the native jellyfish species Aurelia aurita was present in north-eastern waters, where *M. leidyi* was not present. A. aurita was characterized by a distribution pattern which was restricted to surface waters. No A. aurita were encountered in the SW Baltic Sea due to the late

timing of the cruise (September), where bloom abundances as observed during June/July 2020 (C. Jaspers pers. Observation) already disappeared for the year.

Fig. 7: Bongo net with Baby bongo, primarily used for ichthyoplankton surveys.

Depth distribution analyses are underway as well as other biological samples related to zooplankton community composition and larval condition factors are underway.

4.3 Ichthyoplankton sampling

Ichthyoplankton has primarily been caught with the Bongo net (Fig. 7). In total 6 fish larvae, with 3 cod larvae (Fig. 8) were caught at the 9 investigated Bornholm Basin stations. These larvae were sorted from the Bongo net samples alive under a stereo microscope. This relatively low abundance is primarily associated with the late timing of the cruise. Estimation of cod larvae abundances is crucial since latest results indicate that the eastern Baltic Cod stock is impossible to assess due to large

uncertainties in the age determination. Therefore, published relationships found between age group zero recruits and larvae abundances as well as well as age group zero recruits and 1 year age group recruits (Köster et al. 2003) could be an alternative way for stock assessment of eastern Baltic cod for the future This highlight the importance of cod larvae abundances for future fisheries assessments of one of the commercially most important fish species in the Baltic Sea, which is only possible due to the unique data availability currently present at GEOMAR, Helmholtz Centre for Ocean Research Kiel and its international collaboration network e.g. with the National Institute of Aquatic Resources, DTU Aqua, Technical University in Denmark, the University of Hamburg and the National Marine Fisheries Research Institute (NMFRI) in Gdynia, Poland.

Fig. 8: Development sequence of eastern Baltic Cod (*Gadus morhua callaris*) from newly fertilized eggs to 9 days post hatch. Picture credit: C.

4.4 Hydrography

Physical water column profiles showed typical vertical structure of the Baltic Sea with a fresh water body lying on a more saline, denser bottom water layer, as displayed in Fig. 8. Re-current high saline water inflow events are essential for the regeneration of oxygen conditions in the deep basins. Fig. 9 shows a typical central Baltic Sea (Bornholm Basin) profile where bottom water oxygen concentrations are heavily reduced. It is noted that we observed extended anoxia in the entire SW Baltic Sea. Data analyses is underway.

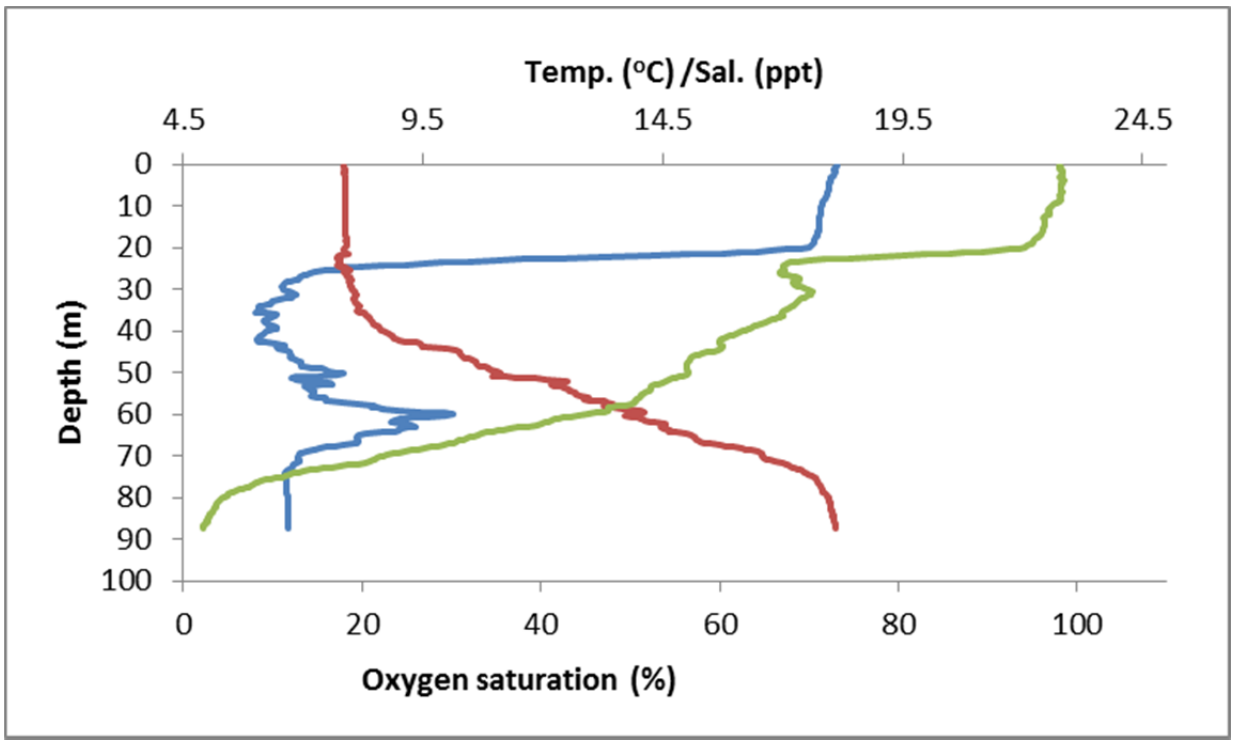

Fig. 9: CTD Profiles for a deep station in the central Baltic Sea, here Bornholm Basin, where bottom water oxygen concentration reaches zero.

5. Scientific equipment

List of major scientific equipment used:

- BONGO/BABYBONGO: 500, 300 and 150µm meshed nets with flowmeters.
- Multiple opening and closing net (Multinet Hydrobios, Kiel, Germany) Multinetz MIDI with mesh size 335µm
- Multiple opening and closing net (Multinet Hydrobios, Kiel, Germany) Multinetz MAXI with mesh sizes 335µm
- Standard plankton nets: WP2
- AMD-CTD, mit AMT-Oxygenmeasuring device and light sensor
- Hydro-Bios-Sonde CTD with water bottle collector and Multifluorescencesonde

- Thermosalinograph: Data collection via Datadis-System.
- Chl a extraction unit and flurometer
- 5 Stereomicroscopes with up to 40x magnification and 2 camera systems
- 1 Inverted microscope for qualitative Phytoplankton analyses

6. Acknowledgements

Special thanks go to the captain Jan Peter Lass for his excellent leadership ensuring the success of this cruise as well as the entire crew of RV Alkor for their outstanding support during the cruise. Thanks go to Svend-Olof Meeves, Richard Klinger and Henrik Hampe for lending technical equipment and Dr. Miotr Margonski for his support with the polish authorities.

7. Station list

Station	Area	Latitude (N; dec.)	Longitude (E; dec.)
KB03	SW	54.692	10.155
KB03A	SW	54.692	10.099
KB03B	SW	54.692	10.275
KB06A	SW	54.692	10.45
KB12	SW	54.683	10.498
FL1	SW	54.824	9.729
FL2	SW	54.804	9.854
FL3	SW	54.777	10.028
SW1	SW	54.433	10.975
SW2	SW	54.442	10.782
SW3	SW	54.455	10.594
SW4	SW	54.469	10.364
SW8	SW	54.413	11.617
SW9	SW	54.600	12.300
SW10	SW	54.700	12.700
SW13	SW	54.600	10.450
SW14	SW	54.658	10.767
SW14A	SW	54.600	10.275
SW15	SW	54.600	10.099
SW16	SW	54.509	10.058
SW17	SW	54.494	10.010
SW18	SW	54.527	10.275
SW19	SW	54.469	10.225
SW19B	SW	54.378	10.175
SW20	SW	54.530	10.594
SW20a	SW	54.530	10.450
SW21	SW	54.530	10.782
SW22	SW	54.530	10.975
SW23	SW	54.352	10.782
SW24	SW	54.561	11.122
SW25	SW	54.497	11.394
LB1	SW	54.232	11.179
LB1A	LB	54.232	11.394
LB1B	LB	54.232	11.609
LB1C	LB	54.232	11.869
LB2	LB	54.317	11.253
LB3	LB	54.317	11.425
LB3A	LB	54.317	11.617
LB3B	LB	54.317	11.877

Station	Area	Latitude (N; dec.)	Longitude (E; dec.)
LB3C	LB	54.317	12.142
LB4	LB	54.413	11.394
LB5	LB	54.050	10.885
LB6	LB	54.050	11.080
LB7	LB	54.052	11.276
LB8	LB	54.129	11.117
LB9	LB	54.129	11.269
LB10	LB	54.129	11.430
LB11	LB	53.999	10.960
R6	AK	54.720	13.579
R8	AK	54.744	13.090
R9	AK	54.637	12.939
N1	AK	54.306	14.188
N1A	AK	54.382	13.900
N2	AK	54.715	13.970
N2A	AK	54.568	13.808
BY1	AK	55.036	13.317
BY2	AK	54.970	14.100
H14	AK	55.075	14.350
H18	AK	54.942	13.783
BB16	BB	55.458	15.750
BB17	BB	55.458	15.500
BB22	BB	55.292	15.500
BB23	BB	55.292	15.750
BB29	BB	55.125	16.000
BB30	BB	55.125	15.750
BB31	BB	55.125	15.500
BB35	BB	54.958	15.750
BB41	BB	54.792	15.250
BY32	Gotland	58.020	17.978
T4	Gotland	57.531	17.459
T5	Gotland	57.071	17.314
T6	Gotland	56.650	17.200
T7	Gotland	56.300	16.978
T8	Gotland	55.974	16.719

8. References:

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