GEOMAR
Helmholtz-Zentrum für
Ozeanforschung Kiel

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Cruise Report

Compiled by: Dipl. Biol. Burkhard von Dewitz, Carola Wagner

R.V. ALKOR **Cruise No.: AL 478**

Dates of Cruise: 16.05. – 28.05.2016

Areas of Research: Physical, chemical, biological and fishery oceanography

Port Calls: Klaipeda, Lithuania, 21.05. – 23.05.2016

Institute: GEOMAR, FB3 (Marine Ecology, Evolutionary Ecology of Marine Fishes)

Chief Scientist: Dipl. Biol. Burkhard von Dewitz

Number of Scientists: 12

Projects: BONUS BIO-C3

Cruise Report

This cruise report consists of 14 pages including the cover page:

1. Scientific crew

Name	Function	Institute	Leg
Burkhard von Dewitz	Chief Scientist	GEOMAR	Entire cruise
Svend Mees	Scientist	GEOMAR	Entire cruise
Carola Wagner	Scientist	GEOMAR	Entire cruise
Julie Nielsen	Scientist	DTU-Aqua	Entire cruise
Lili-Marie Beckmann	Scientist		Entire cruise
Lena Sophia Soumpasis	Student	GEOMAR	Entire cruise
Monica Mion	Research assistant	SLU	From Kiel to Klaipeda
Syrmalenia Kotronaki	Master Student	GEOMAR- CAU	Entire cruise
Xiaoqi Fang	Master student	GEOMAR	Entire cruise
Sofia Helena Nyberg	M.Sc.	University of Gothenburg	Entire cruise
Henrik Gross	Scientist	GEOMAR	Entire cruise
Dominik Alwardt	Student	CAU	Entire cruise
Serra Örey	Master Student	GEOMAR	From Klaipeda to Kiel
Total	**12**		

Chief scientist:

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2. Research program

This multidisciplinary cruise extended a long-term data series on (eco-)system composition and functioning of the Baltic Sea, with a focus on the deeper basins, collected since 1986 by the GEOMAR Helmholtz Centre for Ocean Research and its predecessors IFM-GEOMAR Kiel and IFM Kiel. The key characteristic of this series is the integration of oceanographic and biological information to enhance understanding of environmental and (fish) population fluctuations, and evolutionary processes in this system, in the context of climate change and anthropogenic stressors. The resulting datasets and samples are essential for a number of ongoing projects, including the large-scale international project BONUS BIO-C3 coordinated by GEOMAR. The spatial focus lies on the Bornholm Basin (the most important spawning area of Baltic cod), but also includes the Western Baltic Sea, Arkona and Gotland Basin and Gdansk Deep (Figure 1), thus covering ICES subdivisions 22, 24, 25, 26 and 28 (Figure 2).

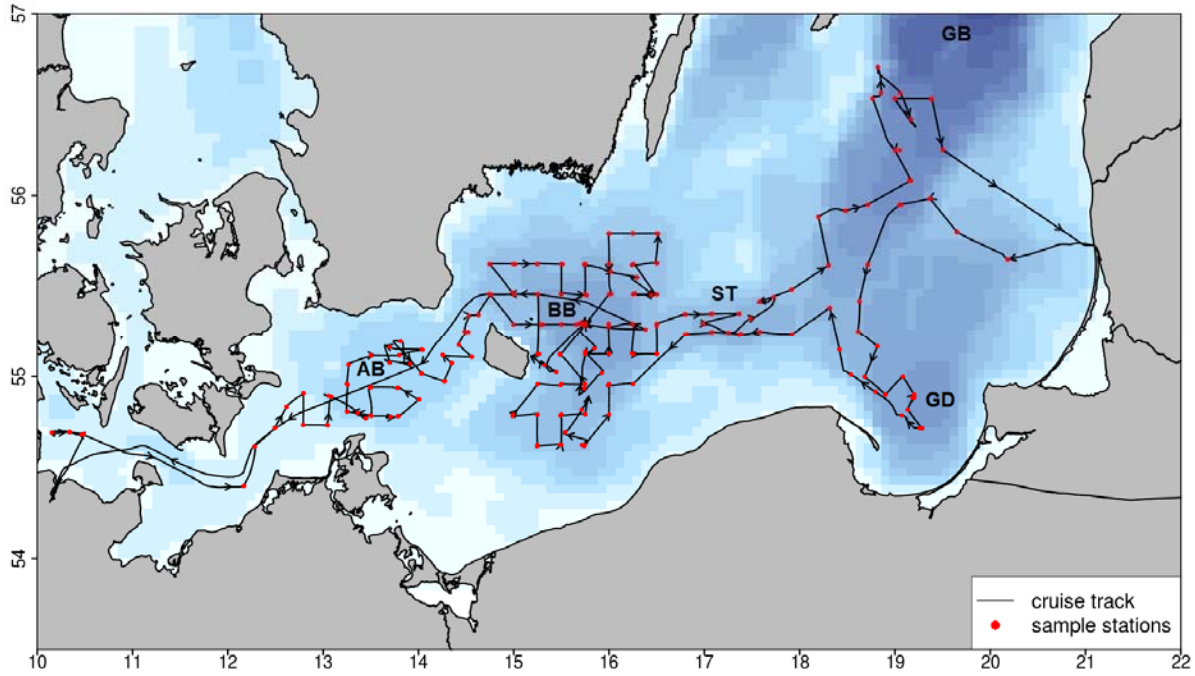

Figure 1 Cruise track of AL 478. KB = Kiel Bight, AB= Arkona Basin, BB = Bornholm Basin, ST = Stolpe Trench, GD = Gdansk Deep, GB = Gotland Basin

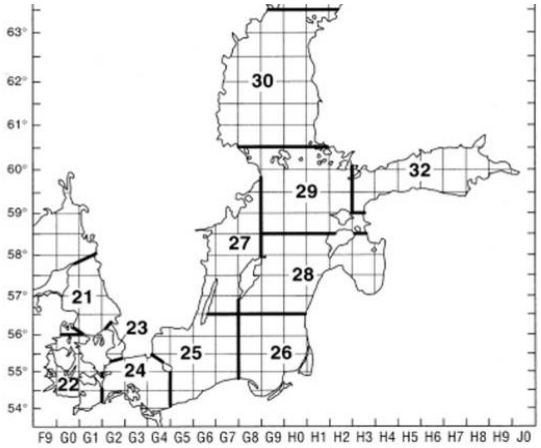

Figure 2 ICES subdivisions in the Baltic Sea area. Source: ICES

Specific investigations included a detailed hydrographic survey (oxygen, salinity, temperature, light intensity) (Figure 3), plankton surveys (zoo- and ichthyplankton, with the goal to determine the composition, abundance, vertical and horizontal distribution, and nutritional status of species, and to address questions regarding plankton phenology) (Figure 4a), and pelagic fishery hauls (Figure 4b). The latter served to determine size distributions, maturity status, and length – weight relationships of the three dominant fish species in the pelagic system of the Baltic, cod (*Gadus morhua*), herring (*Clupea harengus*) and sprat (*Sprattus sprattus*), as well as the benthic flatfish flounder (*Plathichthys flesus*). Secondly, various different samples were obtained for more detailed analyses, including gonad samples of cod, stomachs of cod, herring and sprat for dietary analyses, otoliths of cod for aging, and tissue samples of cod, flounder, whiting, plaice and others for genetic analyses. In addition, along the cruise track, hydroacoustic (echosounder) data were collected continuously for later analysis of fish abundance and distribution.

While these analyses and samples mainly stood in the context of the continuation of the long-term data series, cod and plankton samples were also taken for new research lines, e.g., by DTU Aqua in Silkeborg, Denmark, and the IOW in Warnemünde, Germany, in the context of the project BIO-C3. In addition, cruise AL 478 included the continuation of work of the previous year on board. In cooperation with DTU Aqua tissue samples of cod gonads were sampled in histo formalin for later histology and lipid content analysis to determine maturity and fecundity (see 5., section special projects).

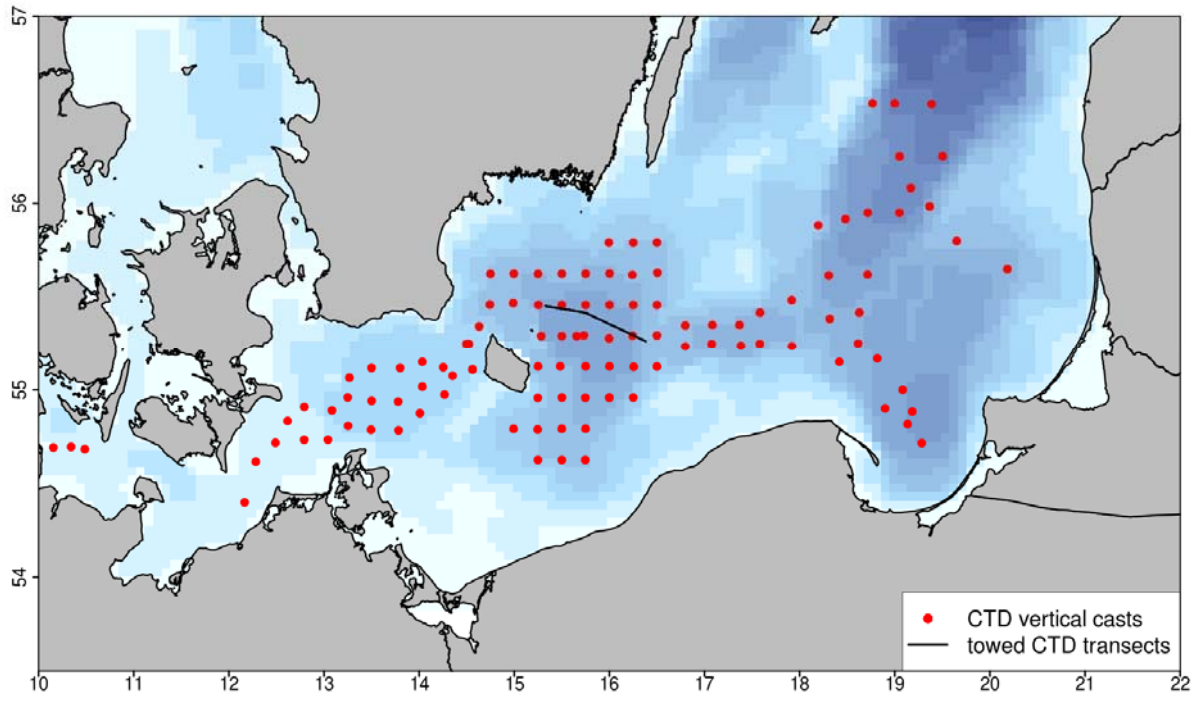

Figure 3 Stations with vertical CTD profiles on AL478 (red dots) and transect of towed CTD recordings (black line).

3. Narrative of cruise with technical details

Cruise AL 478 successfully accomplished the ambitious work program that had been planned, except one day of fishing in the Bornholm Basin. Wind conditions prohibited working in the area on the 16th May. The Planned plankton and CTD sampling stations could be rescheduled but not the fishing effort limited to day light.

The RV ALKOR was equipped with heavy gear and scientific sampling gear on May 10th 2016 on the institutes East-shore storing pier.

On May 13th 2016 7:30 (all times board time) remaining scientific gear was loaded on RV ALKOR and first preparations of gear and laboratories started. As all preparations showed sufficient progress to ensure operational capability on arrival at the first station, RV ALKOR departed from GEOMAR pier at 9:00 heading to the first research area in the Kiel Bight.

Over the duration of the cruise, hydroacoustic data obtained with four different echosounder frequencies (38, 70, 120 and 200 kHz) were continuously recorded. In addition, work for the cod maturity fecundity (see 5. Special projects) took place in parallel to the standard program throughout the duration of the cruise whenever suitable samples were available.

In the Kiel Bight (SD22) the first working area of the cruise 3 Stations were covered during the first day (May 13th) with Bongo and CTD casts. Additionally 3 fishery hauls with a pelagic trawl were performed in the Kiel Bight. All 3 Stations were placed in the deeper ditch in the central Bight running from Maasholm eastward to the Fehmarn Belt. This area is frequently used as fishing ground from surrounding ports and is therefore suitable for sampling of fishery related projects. During the evening RV Alkor steamed to the next operational area the Arkona Basin.

The next Day May 14th 2016 0:14 station work continued in the Arkona Basin (SD 24) for two days until the 16th of May 2:05. 28 Stations of the previously set Station grid in this Area were covered with CTD and Bongo net hauls (Figure 3,4a) starting in the east with station H31. Additionally 8 pelagic fishery trawls where performed between 8:00 and 17:00 of May 14th and 15th. The fishery stations were chosen to obtain a suitable sample size of Cod individuals in this area and therefore were oriented on the current commercial fishery activities in the area and the previously recorded echosounder information (Figure 4b). Station work in the Arkona Basin was continued during the nights until sampling was continued towards the Bornholm Basin area in the night from 15th to 16th of May.

Following the completed station work in the Arkona Basin the main working Area in the Bornholm Basin (SD 25) was started to be sampled on the 16th of May at 2:56 with CTD and Bongo hauls on 5 stations starting with BB01 in the west until BB23 in the middle of the basin. Due to strong winds the scheduled Apstein and WP-2 cast on this central station could not be performed. The more robust water sampler was deployed and oxygen measurements of water samples using the Winkler method and the first samples of micro-/nanoplankton were taken at 9:55. Although efforts were put into 2 fisheries hauls in the central basin, work was interrupted because the weather conditions prevented productive and for sampling usable hauls. There was no other option than to wait for the weather conditions to improve. In the evening station work was resumed and between 19:03 on May 16 and 2:31 on the 19th of May 29 stations were covered with Bongo and CTD casts. The pending Apstein and WP-2 hauls on the central station of the basin were realized in the early morning of the 18th of May and 7 fishery hauls were performed during the day light period on the 17th and 18th of May on 7 stations in the southern and central Bornholm Basin (Figure 4b).

During the 19th of May station work continued in the adjacent ditch the Stolpe Trench (SD25) toward the east. Here all 5 northern stations of the scheduled grid were covered with CTD casst and Bongo or IKS-80 casts, respectively, and additionally 4 fishery hauls on 4

stations.

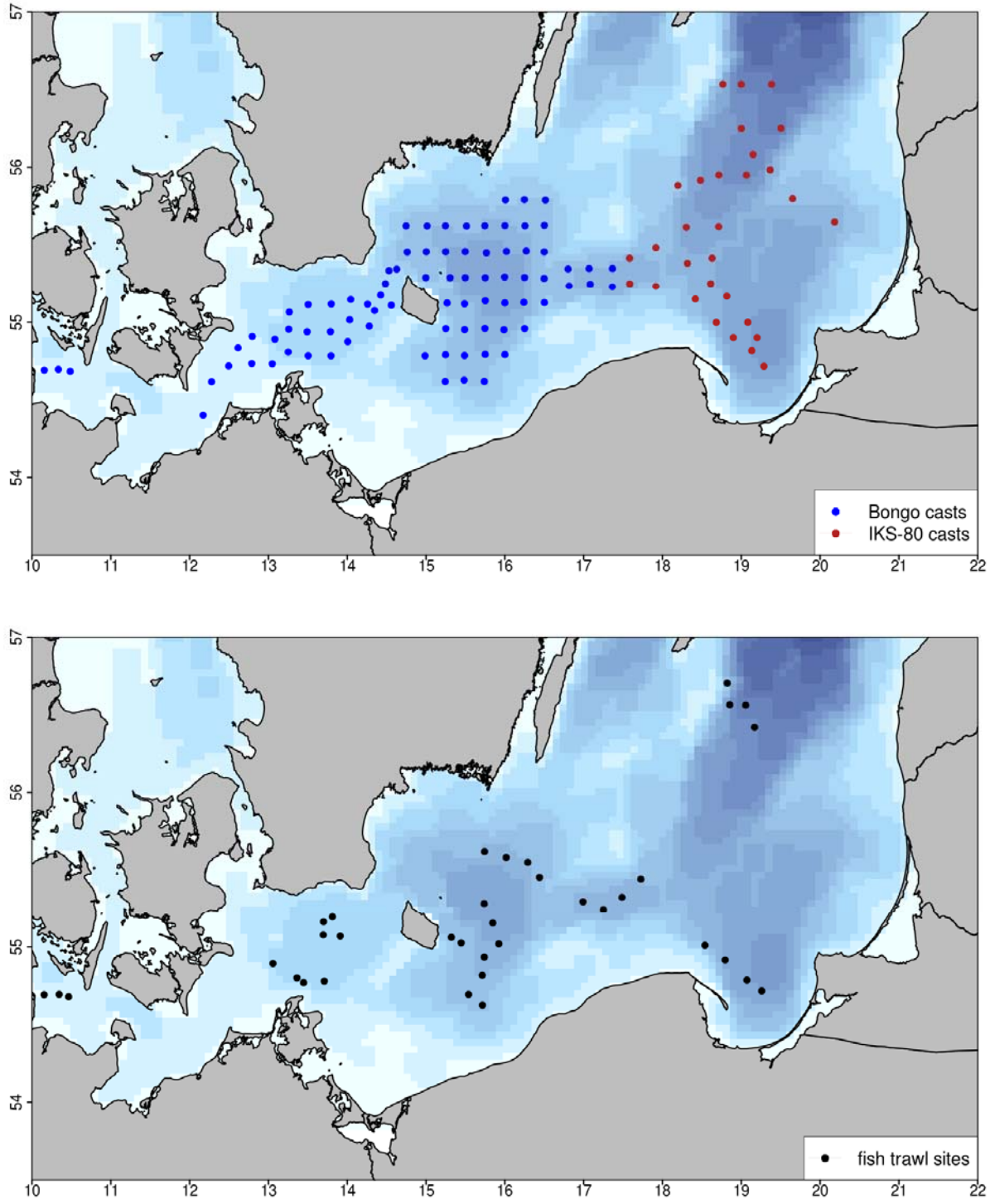

Figure 4 Stations covered during cruise AL 478. a.) Plankton sampling with Bongo (blue circles) and IKS-80 (red circles) net casts. b.) Fishery stations covered with pelagic trawls.

During the night to the 20th of May station work was continued towards the north in the southern Gotland Basin (SD26 and SD28) followed by 4 fishery hauls during the day (Figure 4b) in the Gotland Basin in SD28. After completion of fishery efforts two more CTD and IKS-80 stations could be covered and a double WP-2 haul performed before the first leg was completed with a scheduled visit to Klaipeda, Lithuania (May 21 9:00 – May 23 9:00) to

debark one scientist and embark the replacement on May 22 2016.

On the second leg of the cruise station work was continued on May 23 12:49 along the Russian border with the destination inner Gdansk Deep (SD26). Until fishing efforts were resumed on the 24th of May at 8:28, 14 stations were covered with CTD and IKS-80 alternating between Gdansk Deep and Gotland Basin. 4 fishery hauls were performed in the central and western Gdansk Deep before the station work continued with the 5 southern stations of the Stolp Trench (CTD, IKS-80 or Bongo) left out for this purpose on the way through this area into the east 5 days ago. After completion RV Alkor steamed back to the Bornholm Basin.

During the period of May 25 3:44 to May 26 4:27 all 14 remaining stations of the scheduled grid in the Bornholm Basin were covered with CTD and Bongo net casts, together with 3 pelagic fishery hauls in the North Eastern part of the basin (Figure 4).

To add a second time point to the first intensive sampling of the central Bornholm Basin on May 16 (CTD, water sampler) and May 18 (Apstein and WP-2 net), same sampling efforts including CTD casts, zoo- and phytoplankton sampling with Apstein and WP-2 nets and oxygen measurements and micro-/nanoplankton sampling were repeated from 6:15 to 8:48 on May 26 at the same station BB23 in the center of the Basin.

In the following from May 26 2016 12:02 to May 27 09:27 sampling efforts were dedicated to the intensive vertically and temporally resolved sampling of plankton communities by four towed Multinet MAXI and four vertical Multinet MIDI double hauls over a 22 hour period, covering the water depth in 5 m and 10 m depth layers, respectively, at the previous mentioned station BB23. Sampling efforts on the cruise were completed with a towed CTD transect to record hydrographic properties of the vertical stratified Bornholm Basin in high detail and to quantify influences of inflow events and the oxygen conditions in the deeper parts of the basin. It was started on May 27 at 11:38 on the eastern end of the basin and towed through the deepest point into the north western entry point of inflowing water. The transect was completed at 21.54.

Following the completion of the research program on May 27 at 21:54, RV ALKOR steamed for Kiel harbor and reached port on May 28 at 14:00. After unloading, the cruise ended at 17:00. Additional detail on the cruise timeline and track (Figure 1), the station list (Appendix E1) and an overview of gear deployments (Table 1) are provided below.

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

Gear	Deployments (n)
ADM-CTD vertical	112
ADM-CTD towed	1
Hydroacoustic transect (continuous along cruise track)	1
Watersampler + CTD	2
Bongo, Babybongo (150µ, 335µ, 500µ)	82
IKS-80 (500µ)	30
WP-2 (100µ)	13
WP-2 (200 µ)	6
Apstein (55µ)	6
Multinet MAXI horizontal (335µ)	8
Multinet MIDI vertical (50µ)	8
pelagic trawl (Jungfischtrawl)	36

4. Detailed cruise timeline (all times board time)**:**

Tuesday 10/05/2016 Loading equipment.

Friday 13/05/2016 0745 Leaving GEOMAR Westshore pier, steaming to Kiel Bight. 1030 Start of station work in Kiel Bight with pelagic fishery, CTD, Bongo.

Saturday 14/05/2016 Station work in the Arkona Basin. CTD, Bongo, fishing, WP-2.

Sunday 15/05/2016 Station work in the Arkona Basin. CTD, Bongo, fishing.

Monday 16/05/2016 Station work in the Arkona Basin. CTD, Bongo. 0300 Begin station work Bornholm Basin with CTD, Bongo, pelagic fishery. Water sampler at station BB23. WP-2 and Apstein at BB23 postponed due to weather conditions.

Tuesday 17/05/2016 1030 Station work Bornholm Basin. CTD, Bongo, pelagic fishery.

Wednesday 18/05/2016 Station work Bornholm Basin. CTD, Bongo, pelagic fishery. WP-2 and Apstein at BB23.

Thursday 19/05/2016 Station work Bornholm Basin CTD, Bongo, pelagic fishery. 0330 Begin station work at Stolpe Trench. CTD, Bongo, pelagic fisheries, IKS-80. 2130 Begin station work at Gotland Basin. CTD, IKS-80.

Friday 20/05/2016 Station work at Gotland Basin. CTD, IKS-80, WP-2, pelagic fishery.

Saturday 21/05/2016 0900 Arrival at port of Klaipeda, Lithuania. Debarking of one scientist, embarking of one scientist.

Monday 23/05/2016 0900 departure from Klaipeda heading to first station in Gdansk Deep. 1300 Start of station work in Gdansk Deep. CTD, IKS-80.

Tuesday 24/05/2016 Station work Gdansk Deep. CTD, IKS-80, pelagic fishery, WP-2. 2000 Start station work at Stolpe Trench. CTD, IKS-80, Bongo.

Wednesday 25/05/2016 Station work at Stolpe Trench. CTD, Bongo. 0400 Start station work Bornholm Basin. CTD, Bongo, pelagic fishery.

Thursday 26/05/2016 Station work Bornholm Basin. CTD, Bongo. 0615 Station work at BB23. Water sampler, WP-2 and Apstein. 1200 Start of 24h sampling with towed multinet MAXI, vertical multinet MIDI.

Friday 27/05/2016 1000 End of 24h sampling with towed multinet MAXI, vertical multinet MIDI. 1130 Start of towed CTD transect from east to west. 2130 Steaming for Kiel harbor.

Saturday 28/05/2016 1400 Arrival Kiel East shore pier, unloading; 15:45 relocation to GEOMAR west shore berth. 17:00 unloading completed; end of cruise.

5. Scientific report and first results

Ichthyo– and zooplankton sampling

Bongo- and Babybongo hauls covered Kiel Bight (3 hauls), Arkona Basin (28 hauls), and Bornholm Basin including the western part of the Stolpe Trench (51 hauls) (Figure 4a). Larvae of cod (*Gadus morhua*) (n = 4 in total), sprat (*Sprattus sprattus*) (n = 80), flounder (*Plathichthys flesus*) (n = 41), common seasnail (*Liparis liparis*) (n = 17) and other species (n = 19) were picked from the 500 µm bongo-samples and conserved at -80 °C for subsequent RNA/DNA analysis. All the 500 µm Bongo samples were also checked for the presence of gelatinous zooplankton. The jellyfish species *Aurelia aurita*, *Cyanea capillata* and the invasive combjellies *Mnemiopsis leidyi* and *Bolinopsis infundibulum* were present regularly. The lower number of *Mnemiopsis* individuals found in the samples (n = 35) compared to the last year (n = 69) might be a lagged result of a second combjelly invasion possibly connected to the major Baltic inflow event in January 2015. Following these initial on board steps, all Bongo samples were conserved in formol, and will be used for the determination of species composition and abundance of zooplankton and ichthyoplankton.

Stations in the eastern part of Stolpe trench and the Gdansk Deep and Southern Gotland Basin were covered with IKS-80 instead of Bongo hauls (Figure 4a) to ensure compatibility of data with a long-term IKS-80 sampling series maintained by the Latvian Fish Resources Agency (LATFRA; Andrei Makarcuks).

Repeated Multinet MAXI (335µ, towed, sampling of the water column in 5 m layers) and MIDI (50µ, vertical, sampling of the water column in 10 m layers) (HYDROBIOS, Kiel) casts were done over a 24 hour period on May 26/ May 27 on the central deep Bornholm Basin station BB23 to reveal the vertical distribution of ichthyo- and zooplankton. In addition, WP-2 (100 µm) and Apstein (55 µm) nets and the rosette water sampler were deployed to obtain additional samples, including nano/micro phytoplankton samples in the context of plankton phenology work within the BONUS BIO-C3 project (Dr. Jörg Dutz, IOW) and the determination of vertical oxygen profiles using Winkler titration.

Fishery

Pelagic fishery was conducted in the Kiel Bight (3 hauls), Arkona Basin (8 hauls), Bornholm Basin (13 hauls), Stolpe Trench (4 hauls), Gotland Basin (4 hauls) and Gdansk Deep (4 hauls) (Figure 4b). In parallel to the fishery hauls, hydroacoustic measurements of fish distribution patterns were recorded continuously. Catches were dominated by sprat (*Sprattus sprattus*) and herring (*Clupea hargenus*) followed by cod (*Gadus morhua*) (n = 2226), whiting (*Merlangius merlangus*) (n = 289) and flatfishes. The latter were comprised mainly of flounder (*Platichthys flesus*) (n = 36) and plaice (*Pleuronectes platessa*) (n = 25) and in western parts common dab (*Limanda limanda*) (n = 106). One four-bearded rockling (*Enchelyopus cimbrius*), 11 three-bearded rocklings (*Gaidropsarus vulgaris*), 52 three-spined sticklebacks (*Gasterosteus aculeatus*), three lumpsuckers (*Cyclopterus lumpus*), one hooknose (*Agonus cataphractus*), one sand goby (*Pomatoschistus minutu*) and one sand eel (*Ammodytes tobianus*) completed the catches.

For each haul and the entire catch, catch weight and length frequencies of all species (illustrated in Figure 5 for cod) were taken. Stomach samples were taken from sprat (10 per 1 cm length class) and herring (10 per 2 cm length class). For cod, single fish data (length, weight, sex and maturity stage) and samples (otoliths, fin clips for genetic analysis, stomachs

and gonads) were obtained for 1235 individuals (see Figure 6 for illustration), whereas only length and weight were measured for the remaining individuals.

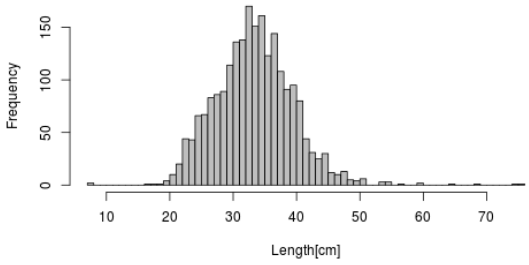

Figure 5 Relative length frequency distribution of individual sampled cod during AL 478 (n = 2226).

Figure 6 Samples (otoliths, fin clips, stomach contents, gonads) and measures (total length, weight, gutted weight, liver and gonad weight) taken from 1200 out of 1892 cod individual during the cruise (illustrated here for a 38 cm female, maturity stage IV, with full stomach, from Bornholm Basin). Photo: Nickel

Hydrography

CTD profiles from 112 stations were obtained with the ADM-CTD and the HYDROBIOS water sampler with attached CTD (Figure 3). In the Bornholm Basin one transects was covered with a towed ADM-CTD for a higher resolution cross section of the hydrographic situation (Figure 3). Conditions varied depending on the basin and location of the Baltic sampled, and will be analyzed in depth in context of the long-term data series on hydrographic conditions.

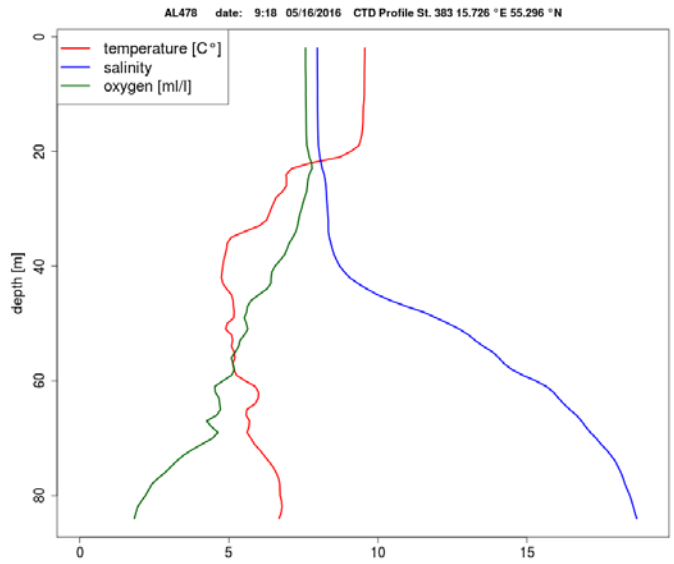

Figure 7 CTD profile of station BB23 in the central Bornholm Basin in May 2016. Temperature red line, salinity blue line and oxygen green line.

Oxygen concentrations at the bottom in the Bornholm Basin were found to be reduced to half of the concentration measured last year in spring. In May 2016 hypoxic conditions of about 1.5 to 1.8 ml/l oxygen were found at the bottom of all sampled stations with water depths >81m (see Figure 7). But from water depths of 81m upward no hypoxia could be observed

anymore. In contrary oxygen conditions even increased slightly compared to 2015 within this water body below the halocline. Also the position of the halocline was found to be about 5 to 6 m higher in the water column. We assume, that the last inflow event in the winter 2015/16 which followed a major inflow event the year before even increased the salinity and oxygen conditions below the halocline in the Bornholm Basin further but did not impact the bottom layer lacking the sufficient density to sink below 81m. The Stolpe Trench connecting the Bornholm Basin with the Gdansk Deep was found still oxygenated down to the bottom (~3ml/l) and also slightly enriched in salinity (increase of ~1PSU). The Gdansk Deep showed again mostly hypoxic conditions below the halocline in the central basin and a 5-6 m deeper position of the halocline. But on the western entrance of the basin an increase in oxygen was found on the bottom on some CTD stations giving the possibility that oxygen rich water could flow into the basin in the next months. But if the amount of oxygen rich water reaching the Gdansk Deep is large enough to significantly change the hypoxic conditions within the large basin area is doubtful. Further into the Gotland Basin no effect of increasing oxygen concentrations could be observed during the cruise. Overall the state of oxygen distribution within the basins of the Baltic Proper was found to be still in a poor condition. This stresses the fact, that also big inflow events like the one observed for the winter 2014/15 are solitary not able to change the course of spreading hypoxia and anoxia in the Baltic Sea and that other factors like eutrophication and changes in ecosystem functioning processes are contributing to this development.

Special projects

The additional line of work carried out in parallel to the above cruise program as "special project" successfully completed the planned sampling. Short summary of this project and the work realized on board is given below.

Special project working with cod female gonads on AL478:
During AL478 there were two parties interested with Eastern Baltic Cod fecundity. One group (Monica Mion-SLU supervised by Michele Casini-SLU) was working with several stages of maturity to focus more into single fish reproductive physiology. Second group was Serra Örey-GEOMAR (supervised by Jan Dierking-GEOMAR, Jonna Tomkiewicz-DTU and Gerd Kraus-TU) together with Julie Nielsen-DTU that project was part of the long-term analysis of the temporal development of fecundity in the Eastern Baltic cod stock. Details for the later are given below. Both parties carried out sampling for autodiametric fecundity analysis and for histology from the same lobe of the ovaries.

Fecundity of Eastern Baltic Cod over the Years with Condition Decline (Serra Örey, Geomar-Kiel)
Baltic cod (*Gadus morhua*) due to its high trophic level in the food web and economic value for humans, has been a very important species for scientific research in the Baltic Sea. For improving stock assessment techniques and estimation of recruitment, it is crucial to have a good understanding of the temporal development of fecundity of the species. This information is crucial for Eastern Baltic cod since the condition of the individuals has shown a major decline over the past decade, however there is still no study that focuses on recent years. With this project, we will assess whether the strong decline in cod condition has negatively affected fecundity. As part of the general fisheries sampling during this time series cruises, data was collected over the course of the last two decades to assess stock structure, gonadal maturation and egg production of cod. As explained above, to later calculate annual fecundity, pre-spawning female stage 4 ovaries were sampled and stored in -20°C. These samples are

giving us the possibility to go back in time to assess the temporal development of fecundity. However, current fecundity analysis methodology is established for formalin preserved gonadal sub-samples. Therefore we have to adapt the autodiametric method to the frozen gonad samples for comparing recent samples to earlier sampled years within the analysis of the data. To pick the most appropriate approach, we will test various preparation methods for ovarian whole mounts that would not interfere with oocyte counting and size measurement using particle analysis.
After deciding on a rapid and reliable method, we will focus on the fish from the years where there was a condition decline (2000-2007) and also to cod "recovery" period (2007-2016). We plan to sample 30 gonads per year with random selection over the different size classes. As our primary interest is limited with temporal range, we will focus on the principle spawning ground, Bornholm Basin.
Obtained results of the fecundity data analysis from this study will provide valuable long-term information for better management strategies of this important species.

6. Scientific equipment: instruments and gear

Hydrography:
- ADM-CTD with additional O2 sensor
- Hydrobios Water Sampler with CTD and O2 sensor

Zooplankton:
- Baby Bongo-Net (150 µm)
- Bongo-Net (335 µm)
- Bongo Net (500 µm)
- WP-2 (100 µm)
- WP-2 (200 µm)
- Apstein net (55 µm)

Ichthyoplankton:
- Bongo-Net (335 µm and 500 µm)
- Hydrobios Multinet MAXI (335 µm horizontal tows)
- Hydrobios Multinet MIDI (50 µm vertical hauls)
- IKS-80 (500 µm)

Fish:
- Jungfisch Trawl (pelagic trawls) (0.5 cm)

Hydroacoustic:
- 38, 70, 120 and 200 kHz-echosounder EK60

7. Acknowledgements

Thanks to Captain von Staa and the entire crew of RV ALKOR for their outstanding support during the cruise and to Rudi Lüthje and Svend Mees for their support in preparing the cruise!

8. Appendix E1: Station list of AL 478

Supplied with the report in electronic form as Excel table, "Appendix E1 – AL478_station_list.xlsx