

## **Cruise Report**

**R.V. ALKOR**

**Cruise No.: AL507**

**Compiled by:** Dr. Jan Dierking

**Dates of Cruise:** 16.04. – 29.04.2018

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

**Port Calls:** Visby, Sweden, 21. - 22.04.2018

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

**Chief Scientist:** Dr. Jan Dierking

**Number of Scientists:** 10 (plus 1 journalist and 1 observer)

**Projects:** EU Horizon 2020 GoJelly, EU BONUS BLUEWEBS, German Science Foundation Collaborative Research Center “Metaorganisms” (SFB1182), US NSF Project “Evolutionary Responses to Global Changes in Salinity and Temperature”

### **Cruise Report**

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**1. Scientific crew**

<b>Name</b>	<b>Function</b>	<b>Institute</b>	<b>Leg</b>
Jan Dierking	Chief scientist	GEOMAR	Entire cruise
Svend Mees	Technician	GEOMAR	Entire cruise
Hendrik Hampe	Technician	GEOMAR	Entire cruise
Dörthe Müller-Navarra	Scientist	University of Hamburg	Entire cruise
David Stern	Scientist	Wisconsin University	Entire cruise
Juanita Diaz	PhD student	Wisconsin University	Entire cruise
Ina Stoltenberg	MSc student	GEOMAR	Entire cruise
Annika Schindel	MSc student	GEOMAR	Entire cruise
Marvin Lehmann	MSc student	GEOMAR	Entire cruise
Paulina Urban	MSc student	GEOMAR	Kiel – Visby
Christian Pawlitzki	Bsc student	GEOMAR	Entire cruise
Tycjan Wodzinowski	Observer, Scientist	NMFRI, Gdynia, Polen	Entire cruise
Ulrich Grünewald	Journalist	WDR („Quarks“)	Visby – Kiel
Total per leg	12/12		

*Chief scientist:*

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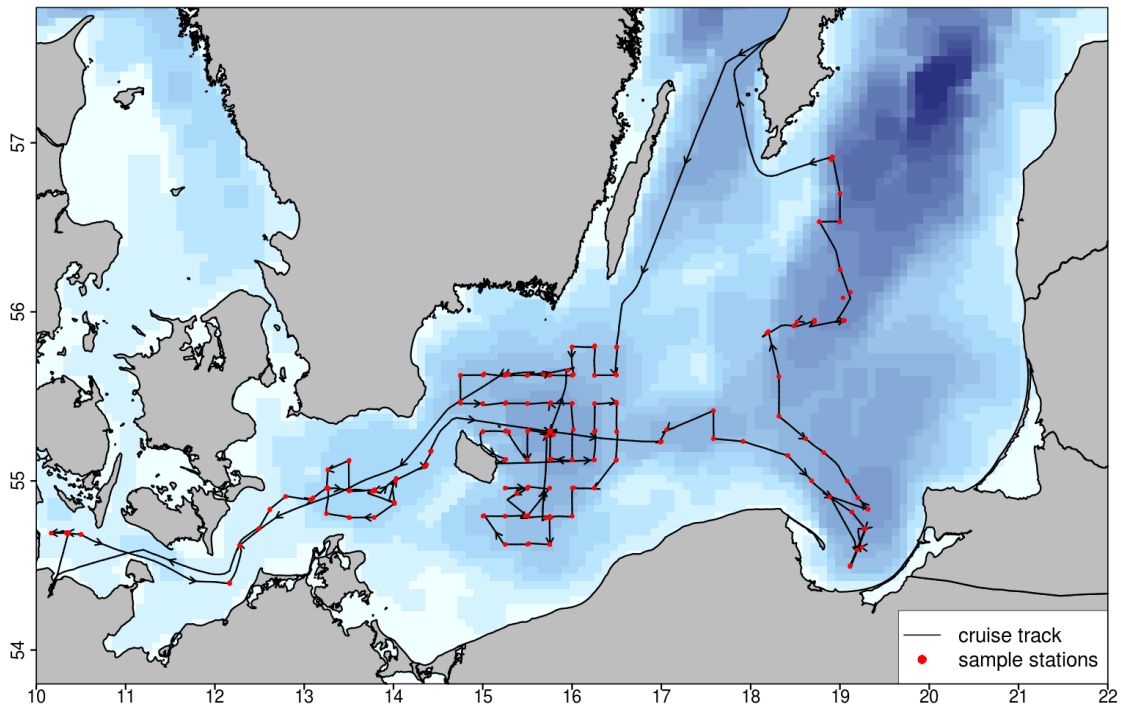
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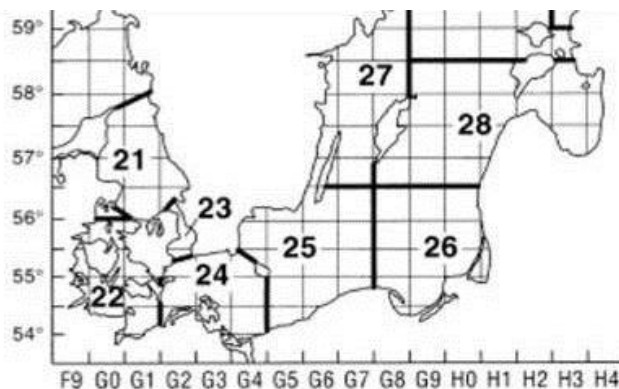
## 2. Research program

The Baltic Sea is comparatively speaking species poor, yet it provides enormous ecosystems services to the Baltic nations. At the same time, it is one of the systems most affected by the combination of global (including climate) and local anthropogenic changes, and has undergone strong hydrographic and biological shifts in the past decades. Cruise AL507 extends a 31-year integrative long-term data series of the deep basins of the central Baltic Sea collected since 1987 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 allow the analysis of Baltic pelagic food webs and (fish) species across the environmental gradients of the Baltic Sea, and under changing environmental conditions and human exploitation.

The datasets and samples obtained during cruise AL507 are essential for a number of projects, including the large-scale international projects EU Horizon 2020 GoJelly and BONUS BLUEWEBS, and collaborations with various institutions, including the Technical University of Denmark, National Institute of Aquatic Resources (DTU Aqua) and the University of Wisconsin. The spatial focus lies on the Bornholm Basin as 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).

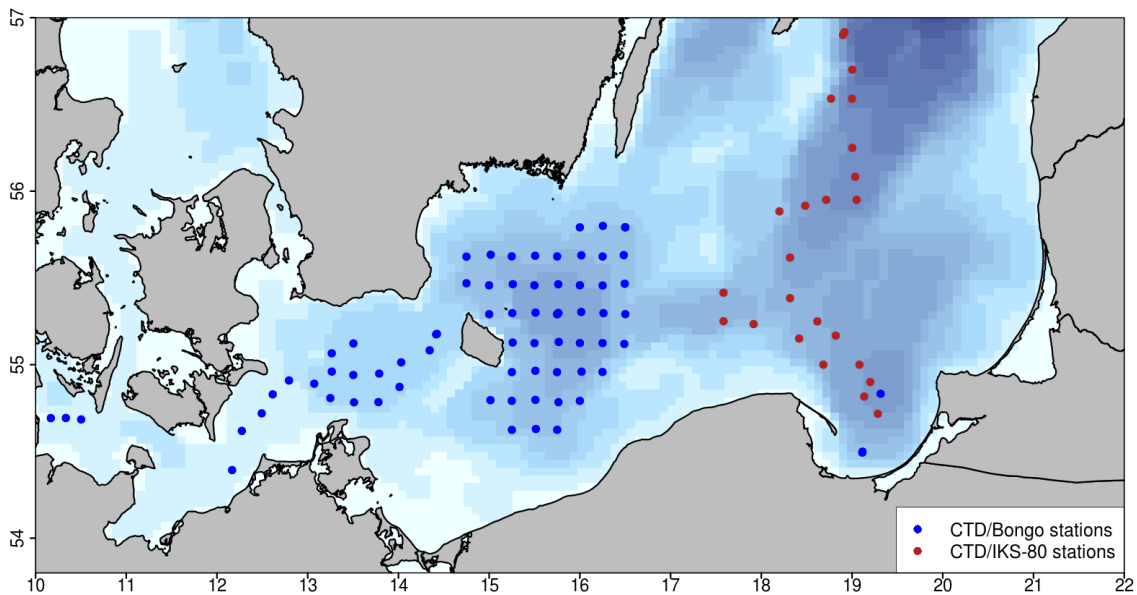


**Figure 1** Cruise track of AL507. Sampling stations are marked by red dots.

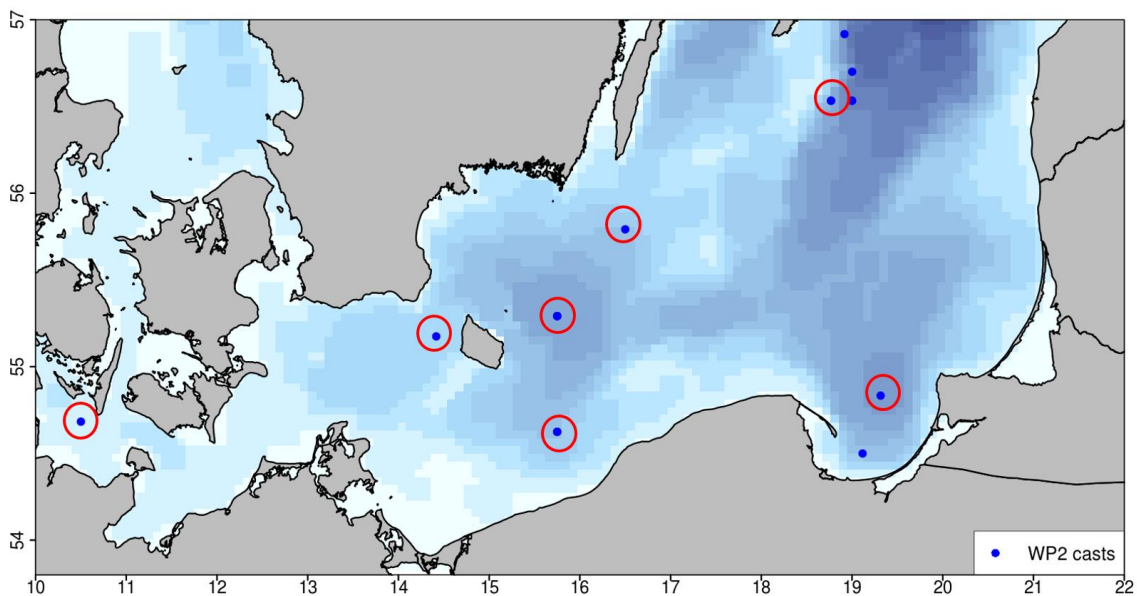


**Figure 2** ICES subdivisions in the Baltic Sea area (Source: ICES). ICES SD22 corresponds to Kiel Bight = KB, SD24 to Arkona Basin = AB, SD25 to Bornholm Basin = BB and Stolpe Trench = SR, SD26 to Gdansk Deep = GD and Southern Gotland Basin (GB).

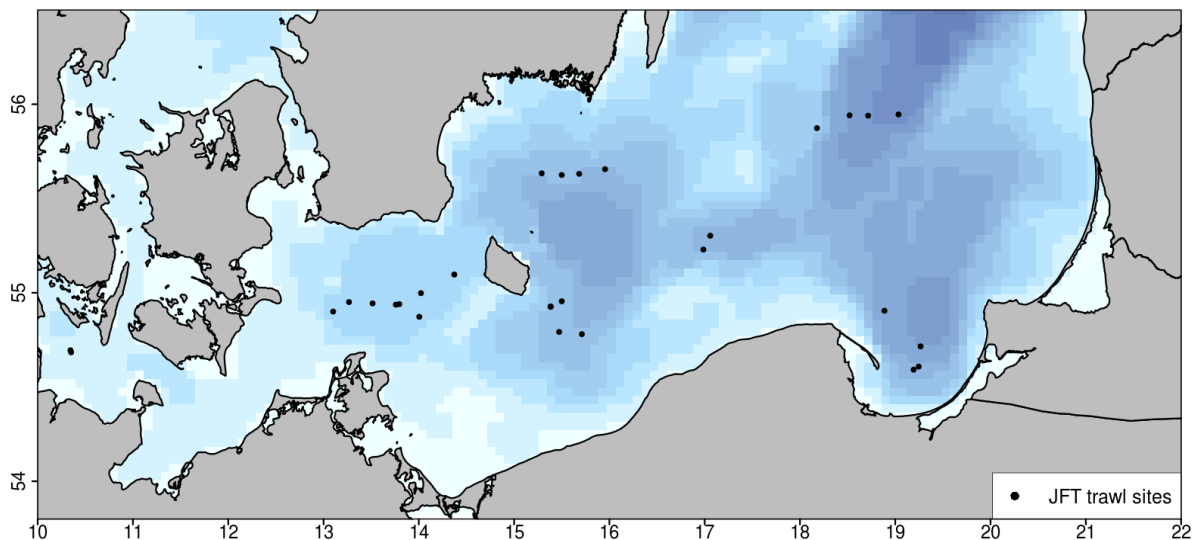
Specific investigations during AL507 included a detailed hydrographic survey (oxygen, salinity, temperature, light intensity) (Figure 3), zoo- and ichthyoplankton surveys (Figure 3) to determine the composition, abundance, vertical and horizontal distribution and nutritional status of species as well as patterns of plankton phenology, whole food web sampling including nutrients, seston, phyto-, zoo- (including jellyfish) and ichthyoplankton (Figure 4), and pelagic fishery hauls (Figure 5). The latter served firstly 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 flatfishes including flounder (*Plathichthys flesus*). Secondly, various samples for more detailed analyses were obtained, including cod gonads and stomachs, herring and sprat stomachs and whole samples for dietary analyses, cod otoliths for aging, and tissue samples of cod, flounder, whiting, plaice and other species for genetic and stable isotope analysis. In addition, hydroacoustic data were collected continuously along the cruise track for later analysis of fish abundance and distribution.



**Figure 3** Plankton sampling and CTD stations covered by AL507.



**Figure 4** WP2 net casts for food web (marked by red circles) and *Eurytemora affinis* sampling.



**Figure 5** Pelagic fishery trawl stations covered by AL507.

### 3. Narrative of cruise with technical details

RV ALKOR was loaded on the days prior to the onset of the cruise. ALKOR then departed from the GEOMAR Westshore pier on April 15 2018 at 08:00 am (all times board time) and headed to the first research area in the Kiel Bight (SD22). In the following, all work laid out in the original cruise program was accomplished as planned, benefiting from optimum working conditions on board without any equipment problems. Weather over the duration of the cruise made for challenging working conditions, with winds rarely if at all calmer than 4-5 Beaufort, but at the same time, no ship time was lost due to storms.

Specifically, over the course of the cruise, pelagic fishery hauls, zooplankton hauls with Bongo/IKS-80 nets, water sampler, and CTD hauls were carried out following a large-scale spatial sampling design covering Kiel Bight (SD22) on April 15, Arkona Basin (SD24) on April 16-17, Bornholm Basin (SD25) on April 18 and 23-28, Stolpe Trench (SD25) on April 18, Gdansk Deep (SD26) on April 19, and Gotland Basin (SD26) on April 20 (Figure 3, 5). In addition, hydroacoustic data obtained with four different echosounder frequencies (38, 70, 120 and 200 kHz) were continuously recorded. The scientific work was interrupted by a harbor stay in Visby, Sweden on April 21-22 to disembark one scientist and embark a visiting journalist.

In addition to the program above, the central deep station BB23 in Bornholm Basin was intensively sampled on two occasions, early in the cruise on April 18 12:25-16:40 (including CTD casts, zooplankton sampling with Bongo, Apstein and WP-2 nets, oxygen measurements of water samples obtained with the rosette water sampler using the Winkler method, phytoplankton sampling using the same water samples) and late in the cruise on April 27 05:59 – April 28 06:50 (same sampling as on April 18, followed by the detailed vertically and temporally resolved sampling of plankton communities by four towed Multinet MAXI and four vertical Multinet MIDI hauls over a 24 hour period, covering the water column in 5 m and 10 m depth layers, respectively).

Moreover, whole food web samples (nutrients, seston, phyto- and zooplankton including jellyfish and fish larvae) were obtained at 7 stations, using a combination of water sampler, Bongo and WP-2 hauls, and plankton stations spanning the spatial gradient covered by the cruise where sampled with Bongo and WP-2 nets and scanned for the copepod *Eurytemora affinis* (Figure 4).

**Table 1** Overview of gear deployment. Mesh sizes are given in brackets. For location designations (combination of ICES SD and abbreviated name), see Figure 2.

Gear	22-	24-	25-	25-	26-	26-	Total
	KB	AB	BB	SR	GD	GB	
ADM-CTD vertical	1	18	47	4	12	12	94
Water sampler + CTD	1	1	5		1		8
Bongo, Babybongo (150µm, 335µm, 500µm)	1	19	49		3	2	74
IKS-80 plankton net (500µm)				3	10	11	24
Apstein (50µm) plankton hauls			6				6
WP-2 (100µm)			7				7
WP-2 (200µm)	1	1	6		2	6	16
WP-3 (1000µm)	1		1				2
Multinet MIDI vertical (50µm)			8				8
Multinet MAXI horizontal (335µm)			8				8
Pelagic fishery trawl	2	8	10	2	4	4	30
Total	7	47	147	9	32	35	277

## 4. Scientific report and first results

Cruise AL507 accomplished all objectives of the original work program. Specific work lines are described in the following.

### 4.1 Ichthyo- and zooplankton sampling

Bongo- and Babybongo hauls covered Kiel Bight (1 haul), Arkona Basin (17 hauls), and Bornholm Basin including the western part of Stolpe Trench (49 hauls) (Figure 3, Table 1). Larvae of sprat (*Sprattus sprattus*; n = 500), flounder (*Plathichthys flesus*; n = 270), sculpin (*Myoxocephalus scorpius*, n = 4), common seasnail (*Liparis liparis*; n = 65) and gunnels (Polidae; n = 7) were picked from the 500 µm bongo-samples as well as 300 µm Multinet samples and conserved at -80 °C for subsequent RNA/DNA, stable isotope and genetic analyses. No cod (*Gadus morhua*) larvae were found, which is in line with very low abundances observed on our spring cruises in previous years, and with observations over past decades that have shown a temporal shift in the reproductive period and the subsequent occurrence of cod larvae in the Bornholm Basin from spring to summer months.

All of the 500 µm Bongo und the 300 µm Multinet samples were also checked for the presence of gelatinous zooplankton. The jellyfish species *Aurelia aurita*, *Cyanea capillata*, *Obelia spp.* and the invasive combjelly *Mnemiopsis leidyi* were found in unusually low numbers (n<sub>total</sub> for both ephyra and adult specimens of all species combined = 10) compared to previous April cruises in the same cruise area. At the same time adult, small adult *Cyanea capillata* were regularly recovered from the pelagic fishery hauls. A possible explanation lies in the unusually cold water temperatures above the halocline for an April cruise, following a late cold period in March-April 2018 (Fig. 4.3.1). This may have delayed the phenology of species in the plankton and led to a lack of ephyra stages of jellyfish, whereas the adult



individuals in the fishery hauls may have been overwintering. 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 3) 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 (300  $\mu\text{m}$ , towed, sampling of the water column in 5 m layers) and MIDI (50  $\mu\text{m}$ , vertical, sampling of the water column in 10 m layers) casts were done over a 24 hour period on April 27-28 on the central deep Bornholm Basin station BB23 to assess diurnally resolved vertical distributions of ichthyo- and zooplankton. In addition, WP-2 (100  $\mu\text{m}$ , 200  $\mu\text{m}$ ) and Apstein (55  $\mu\text{m}$ ) nets and the rosette water sampler were deployed to obtain additional samples, including nano- and micro-phytoplankton samples in the context of plankton phenology work (collaboration with Dr. Jörg Dutz, IOW).

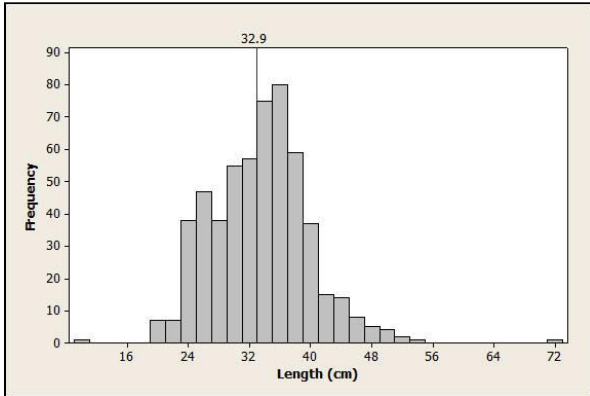
## 4.2 Fishery

Pelagic fishery hauls were conducted in the Kiel Bight (2 hauls), Arkona Basin (8 hauls), Bornholm Basin (12 hauls), Gotland Basin (4 hauls) and Gdansk Deep (4 hauls) (Figure 5). Catches of cod were very low compared to previous years, likely due to lack of oxygen near the bottom leading a more dispersed distribution throughout the water column (Fig. 4.3.1). In parallel to the fishery hauls, hydroacoustic measurements of fish distribution patterns were recorded continuously. The overall catch composition is shown in Table 4.2.1.

**Table 4.2.1** Fish catch composition AL507. For cod, the number of individuals for which single fish measurement and samples were taken was 453, for whiting 203.

Latin name	Common name	n	mass (kg)
<i>Sprattus sprattus</i>	sprat	196,094	1,938.5
<i>Clupea harengus</i>	herring	10,624	587.2
<i>Gadus morhua</i>	cod	552	198.4
<i>Merlangius merlangus</i>	whiting	364	72.5
<i>Platichthys flesus</i>	flounder	204	36.1
<i>Limanda limanda</i>	common dab	7	0.6
<i>Pleuronectes platessa</i>	plaice	5	1.2
<i>Gasterosteus aculeatus</i>	three-spined stickleback	218	0.4
<i>Rhinonemus cimbrius</i>	four bearded rockling	5	0.3
<i>Gaidropsarus vulgaris</i>	three bearded rockling	1	0.1
	Total	208,074	2,835

For each haul, catch weight and length frequencies of all species (illustrated in Figure 4.2.1 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 453 individuals (see Figure 4.2.2 for illustration), whereas length and weight were measured for an additional 99 individuals. The low mean size of individuals of only 32.9 cm confirmed observation from recent years that large individuals >45 cm, which were frequently observed in past decades, are now mostly missing from the population.



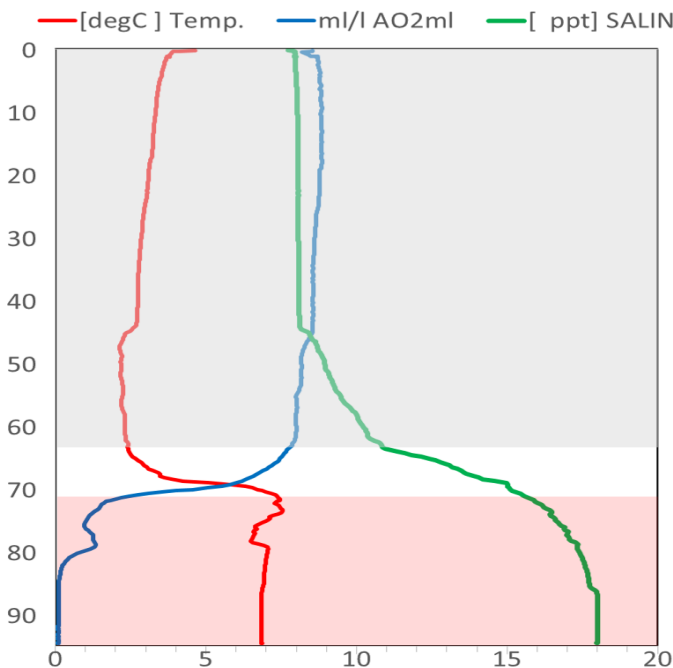
**Figure 4.2.1** Length frequency distribution of cod sampled during AL507 (n = 552). The mean size of individuals, 32.9 cm, is marked on the x-axis.



**Figure 4.2.2** Samples (otoliths, fin clips, stomach contents, gonads) and measures (total length, weight, gutted weight, liver and gonad weight) taken from 453 out of 552 cod individuals during the cruise (illustrated here for a 38 cm female, maturity stage IV, with full stomach, from Bornholm Basin). Photo: Nickel

### 4.3 Hydrography

CTD profiles from 102 stations were obtained with the ADM-CTD and the HYDROBIOS water sampler with attached CTD (Figure 3). Two additional vertical oxygen profiles were obtained for calibration purposes at the deep central Bornholm Basin station BB23, by determining oxygen concentrations in depth resolved water samples taken with the water sampler using the Winkler method.



**Figure 4.3.1** CTD profile taken at the central deep Bornholm Basin station BB23 on April 18 2018. Red box: depths with hypoxic conditions (<2 ml/l oxygen concentration), not fit for cod egg survival. Grey box: depths where salinity < 11 psu, insufficient for cod eggs to be buoyant. White area: “reproductive volume”, i.e., water layer suitable for cod egg development, with salinity sufficient for cod eggs to be buoyant and oxygen concentrations sufficient for survival.

Compared to previous years, oxygen concentrations in the deeper layers of Bornholm Basin but also Gdansk Deep showed noticeable declines. Anoxic (0 ml/l) conditions prevailed at depths below of 80 m down to the seafloor, and hypoxic (< 2 ml/l) conditions prevailed below depths of 70 m, leading to a reduced reproductive volume for cod (see Figure 4.3.1 for an example from the central Bornholm Basin). The relief from low oxygen conditions provided after the major Baltic inflow event in the winter of 2014/2015 and the subsequent smaller





*affinis* obtained along the salinity and temperature gradient of the Baltic Sea, to test these populations for local adaptations to different environmental conditions.

The corresponding objective during cruise AL507 was to obtain samples of *E. affinis* along the cruise track (Figure 4). Unfortunately, this effort failed because *E. affinis* was absent in all plankton samples, including stations with reduced salinities in the Bay of Gdansk and in Northern Gotland Basin that had been chosen specifically for this purpose based on previous reports indicating presence in high abundances of the species in April.

As for other compartments of the plankton on this cruise, it seems likely that the relatively cold water temperatures observed above the halocline (Fig. 4.3.1) following a cold period in March-April 2018 may have been responsible for a delay in the phenology and the onset of bloom conditions for *E. affinis* compared to previous years.

## 5. Scientific equipment: instruments and gear

### *Hydrography:*

- ADM-CTD with additional oxygen sensor
- Hydrobios Water Sampler with CTD and oxygen sensor

### *Zooplankton:*

- Baby-Bongo and Bongo-Net (150 µm, 300 µm, 500 µm)
- WP-2 nets (100 µm, 200 µm)
- Apstein net (50 µm)

### *Ichthyoplankton:*

- Bongo net (300 µm and 500 µm)
- Hydrobios Multinet MAXI (300 µm horizontal hauls)
- Hydrobios Multinet MIDI (50 µm vertical hauls)
- IKS-80 (500 µm)

### *Fish:*

- Jungfisch Trawl (pelagic trawl net (0.5 cm mesh size))

### *Hydroacoustics:*

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

## 6. Acknowledgements

I want to thank Captain Jan Lass and the entire crew of RV ALKOR for their outstanding support throughout the cruise, Svend Mees for his unwavering support in all technical matters for the cruise, and Burkhard von Dewitz for the compilation of maps for this report. Finally, thank you to the scientific personal and student assistants on AL507 for their enthusiasm and motivation, and to Ulrich Grünewald for the insightful “Quarks” (WDR television science show) episode on the cruise and the GoJelly project..

## 7. Appendix E1: Station list of AL507

Supplied with the report in electronic form as Excel table,  
“Appendix\_E1\_AL507\_station\_list.xlsx”