Cruise Report R.V. METEOR 48/5

Institution: Baltic Sea Research Institute Warnemünde, Germany

Date: 13 October – 3 November 2000

Area: Benguela Current waters off Namibia and South Africa

Objectives:

The objective of cruise leg 48/5 was for a better understanding of the impact of meso-scale physical structures and processes on zooplankton production with reference to fish recruitment. Studies were carried out within the "*Small Pelagic Fishes and Climate Change" (SPACC)* programme of *GLOBEC* and the regional *BENEFIT* programme (Benguela Environment Fisheries Interactions and Training) and focussed on four main questions:

1. What is the impact of the nutrients generated by the Lüderitz upwelling cell on primary production and the development of pelagic food webs up to the level of ichthyoplankton in regions north of Lüderitz
2. What is the role of the two-cell cross-shelf circulation in the northern Benguela for zooplankton production and survival of fish larvae?
3. To what effect do physically contrasting environments in the Benguela Current influence plankton production?
4. What is the variability of the bio-optical properties of water masses in the Benguela ecosystem and the impact on ocean colour?

Participants:

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3.	Laws, Andrea	nutrients	IOW
4.	Schütz, Ulrike	zooplankton	IOW
5.	Feistel, Rainer, Dr.	cruise planning	IOW
6.	Möllmann, Christian	ichthyoplankton	IfMK
7.	Kraus, Gerd	ichhyoplankton	IfMK
8.	Diekmann, Rabea	Ichthyoplankton	IfMK
9.	Jarosch, Dirk	ichthyoplankton, technician	IfMK
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11.	Schweikert, Michael	phytoplankton	US
12.	Irigoien, Xavier, Dr.	zooplankton	SL
13.	Moore, Gerald, Dr.	undulator	PML
14.	Coombs, Steve, Dr.	ichthyoplankton	MBA
15.	Verheye, Hans, Dr.	zooplankton	MCM
16.	Risien, Craig	physical oceanography	UCT
17.	Tanci, Tembaletu	zooplankton, technician	MCM
18.	Barlow, Ray, Dr.	satellite data	MCM
19.	Balarin, Marianne	primary production	UCT
20.	Whittle, Christo	physical oceanography	UCT
21.	Iita, Aina	physical oceanography	NatMIRC
22.	Kemp, Alan	CTD, technician	NatMIRC
23.	Cloete, Rudi	zooplankton	NatMIRC
24.	Botha, Janet	phytoplankton	NatMIRC
25.	Hanghome, Matthew	nutrients, technician	NatMIRC
26.	Dundee, Benedict	nutrients, technician	NatMIRC
27.	Klingelhoeffer, Ekkeh.	zooplankton	NatMIRC
28.	Liolios, Andreas	documentary film	FH

(IOW – Baltic Sea Research Institute, Warnemünde, Germany; IFMK – Institute for Marine Research, Kiel University, Germany; FIS – Forschungsinstitut Senckenberg, Wattenmeerstation List, Sylt, Germany; US – Universität Stuttgart, Germany; SL – Southampton Laboratory, UK; PML – Plymouth Marine Laboratory, UK; MBA – Marine Biological Association, Plymouth, UK; MCM – Marine and Coastal Management, Cape Town, South Africa; UCT – University of Cape Town, South Africa; NatMIRC – National Marine Information and Research Centre, Swakopmund, Namibia, FH – Fachhochschule Hamburg)

Sampling Programme:

Intensive biological measurements and sampling were carried out on 5 transects perpendicular to the Namibian coast (Fig. 1) to sample in a range of contrasting environments from newly upwelled to oceanic waters. The location of the transects and the sampling stations were determined using remote sensing and UOR (undulator) data. SeaWiFS and SST images were transmitted daily to METEOR. Unfortunately, during cruise leg 48/5, the entire region north of Walvis Bay was permanently cloud covered. Thus, remote sensing information could be used in the second part of the cruise only, in waters south of Walvis Bay. The UOR was towed behind the ship with a speed of about 10 knots and was set to undulate between 5 and 50 m depth. It carried a package of sensors recording depth, temperature, salinity, fluorescence and light attenuation. The data were analysed directly after each tow and yielded a synoptic picture of the biophysical conditions along the transect.

Between 23° and 19° S, a transect was set parallel to the coast following the 200 m isobath. In northern Namibian waters, in the known spawning grounds of anchovy and sardine, 3 transects were laid approximately perpendicular to the coast starting at the coast at about the latitudes 19°, 20° and 21° S. The locations of the transects were selected as representative of the contrasting environments off northern Namibia. Each transect extended from the coast to 100 miles offshore and was first sampled by an UOR tow starting near the coast. On return to the coast, intensive biological sampling for phyto-, zoo- and ichthyoplankton was carried out at stations along the transect selected on the basis of the UOR data. The criteria for selection of these stations were their contrasting characteristics. Another transect perpendicular to the coast was set at 23° S latitude, also extending offshore for 100 miles. Namibian monitoring for physical parameters and plankton is carried out on a monthly basis along this 23° S latitude line. The line was therefore selected so that the METEOR results can be compared with the equivalent Namibian long-term data from this line. A fifth transect was selected at 25° S latitude which extended from the coast to 160 miles offshore. The objective of this transect was to follow an upwelling filament extending offshore originating from the Lüderitz upwelling cell. Throughout the cruise, ADCP measurements were carried out continuously. At all stations, temperature, salinity, oxygen and chlorophyll a were determined by CTD casts.

To determine the relationship between primary production, photosynthetic pigments and light, samples were taken from CTD bottles for the analysis of pigments by HPLC, Gelbstoff and particle absorption. *In-situ* optical measurements were performed with a bio-optical profiler equipped with sensors measuring reflectance at the SeaWiFS and MERIS wavelengths, a fast repetition rate fluorometer to measure photosynthetic parameters, and a CTD to verify alignment of the water samples with the bio-optical profiles. Water samples were collected at each CTD station to determine the changing nutrient concentrations within the upper 200m of the water column. The standard colourimetric methods were used to manually analyse the samples for silicate, phosphate, nitrate, nitrite and ammonium content.
Phytoplankton was collected with the micro net of 20 µm mesh size. The samples served to study species composition and to determine indicator species communities for different upwelling scenarios. Taxonomic studies focused on dinoflagellates which have been rarely studied in Namibian waters. Dinoflagellates have different nutritional strategies, some are phototrophic, others are heterotrophic or even parasites. Also, the hypothesis was tested that heterotrophic dinoflagellates show a larger abundance in upwelled waters with a high diatom biomass than in diatom-poor waters where phototrophic species should dominate.

In order to determine species composition, distribution and abundance of zoo- and ichthyoplankton a suite of different multiple opening/closing plankton samplers with differing mesh sizes was deployed. The Multinet of 200 µm mesh size equipped with 5 separate nets was hauled vertically for catching meso-zooplankton and was deployed on each station of the perpendicular transects. The BIOMOC, a modified MOCNESS with 9 nets of 335 µm mesh size, was used to collect ichthyo- and larger zooplankton on oblique hauls. The Longhurst-Hardy-Plankton-Recorder (LHPR) was used to investigate the concurrent fine-scale vertical distribution of microzooplankton (53 µm mesh system) and ichthyoplankton (200 µm mesh system . On the perpendicular transects, BIOMOC and LHPR collections were carried out at selected stations representing different bio-physical regimes.

Daily egg production and moulting rates of copepods were measured in contrasting areas of thermal (inshore *vs* offshore) and food conditions (i.e. low *vs* high Chl *a*, dinoflagellate *vs* diatom assemblages) to estimate secondary production. Hatching success of copepod eggs was assessed under contrasting feeding conditions (diatom-dominated *vs* non-diatom food assemblages) to test the hypothesis whether diatoms have a deleterious effect (toxic or nutritionally insufficient) on hatchability of eggs.

List of Stations

Station Label	Station Nr.	Date	Latitude	Longitude
0	484	13.10.2000	-22°60.00'	13°60.00'
26	485	13.10.2000	-22°59.88'	13°30.90'
27	486	14.10.2000	-21°59.97'	13°10.42'
28	487	14.10.2000	-21°00.04'	12°56.72'
29	488	14.10.2000	-19°59.98'	12°20.00'
30	489	14.10.2000	-18°59.80'	12°00.13'
31	490	15.10.2000	-18°45.29'	12°12.42'
40	491	15.10.2000	-19°43.56'	11°06.70'
39	492	15.10.2000	-19°36.57'	11°14.49'
38	493	15.10.2000	-19°29.82'	11°22.21'
37	494	16.10.2000	-19°22.98'	11°29.93'
36	495	16.10.2000	-19°16.09'	11°37.58'
35	496	16.10.2000	-19°09.28'	11°45.35'
34	497	16.10.2000	-19°02.44'	11°52.98'
33	498	16.10.2000	-18°55.54'	12°00.80'
32	499	16.10.2000	-18°48.75'	12°08.56'
31	500	16.10.2000	-18°45.26'	12°12.38'
30	501	17.10.2000	-18°59.97'	12°00.91'
41	502	17.10.2000	-19°10.00'	12°06.61'
42	503	17.10.2000	-19°20.08'	12°10.95'
43	504	17.10.2000	-19°29.99'	12°14.23'
44	505	17.10.2000	-19°40.02'	12°16.43'
45	506	17.10.2000	-19°49.97'	12°18.75'
29	507	17.10.2000	-20°00.01'	12°23.41'
46	508	17.10.2000	-19°45.23'	12°50.33'
55	509	18.10.2000	-20°24.56'	11°28.43'
54	510	18.10.2000	-20°19.98'	11°37.88'
56	511	18.10.2000	-20°17.71'	11°43.14'
53	512	18.10.2000	-20°15.43'	11°47.48'
57	513	18.10.2000	-20°12.57'	11°54.05'
52	514	18.10.2000	-20°10.89'	11°57.00'
51	515	18.10.2000	-20°06.38'	12°06.62'
50	516	19.10.2000	-20°01.73'	12°16.20'
49	517	19.10.2000	-19°57.15'	12°25.56'
48	518	19.10.2000	-19°52.61'	12°35.03'
47	519	19.10.2000	-19°48.06'	12°44.49'
46	520	19.10.2000	-19°45.18'	12°50.28'
29	521	19.10.2000	-19°59.95'	12°23.73'
58	522	19.10.2000	-20°10.00'	12°30.42'
59	523	19.10.2000	-20°19.96'	12°35.74'
60	524	19.10.2000	-20°30.03'	12°42.93'
61	525	19.10.2000	-20°40.01'	12°48.32'
62	526	20.10.2000	-20°50.04'	12°52.64'
28	527	20.10.2000	-21°00.02'	12°57.26'
63	528	20.10.2000	-21°10.00'	13°00.04'
64	529	20.10.2000	-21°19.99'	13°01.92'
65	530	20.10.2000	-21°30.06'	13°05.14'
66	531	20.10.2000	-21°15.89'	13°35.30'
75	532	20.10.2000	-21°57.21'	12°15.12'
74	533	21.10.2000	-21°52.31'	12°24.48'
73	534	21.10.2000	-21°47.54'	12°33.90'
72	535	21.10.2000	-21°42.71'	12°43.32'
71	536	21.10.2000	-21°37.80'	12°52.91'
70	537	21.10.2000	-21°32.98'	13°02.25'
69	538	21.10.2000	-21°28.14'	13°11.70'
68	539	21.10.2000	-21°23.33'	13°21.13'

67	540	21.10.2000	-21°18.49'	13°30.72'
66	541	21.10.2000	-21°15.91'	13°35.23'
65	542	22.10.2000	-21°30.00'	13°05.20'
76	543	22.10.2000	-21°40.01'	13°07.52'
77	544	22.10.2000	-21°50.02'	13°08.20'
94	545	22.10.2000	-21°45.36'	13°54.78'
27	546	22.10.2000	-21°60.00'	13°10.84'
78	547	22.10.2000	-21°60.00'	13°10.84'
79	548	22.10.2000	-22°19.98'	13°23.45'
80	549	22.10.2000	-22°29.86'	13°27.31'
81	550	23.10.2000	-22°39.88'	13°30.33'
82	551	23.10.2000	-22°49.96'	13°31.18'
26	552	23.10.2000	-22°59.99'	13°32.10'
83	553	23.10.2000	-23°00.01'	14°22.19'
93	554	23.10.2000	-22°59.95'	12°46.74'
92	555	24.10.2000	-22°59.98'	12°57.25'
91	556	24.10.2000	-22°59.95'	13°08.59'
90	557	24.10.2000	-22°59.93'	13°19.62'
89	558	24.10.2000	-22°59.96'	13°30.23'
88	559	24.10.2000	-22°59.99'	13°41.18'
87	560	24.10.2000	-23°00.04'	13°52.05'
86	561	24.10.2000	-22°59.99'	14°03.05'
85	562	25.10.2000	-22°59.97'	14°13.52'
84	563	25.10.2000	-23°00.02'	14°18.95'
83	564	25.10.2000	-23°00.04'	14°22.17'
95	565	25.10.2000	-23°14.96'	14°22.10'
96	566	25.10.2000	-23°30.02'	14°10.91'
97	567	25.10.2000	-23°44.99'	14°24.76'
98	568	25.10.2000	-24°00.05'	14°10.56'
99	569	25.10.2000	-24°15.03'	14°19.72'
100	570	26.10.2000	-25°00.88'	14°44.60'
106	571	26.10.2000	-25°11.21'	13°44.44'
116	572	26.10.2000	-25°29.97'	11°55.31'
115	573	26.10.2000	-25°28.07'	12°06.28'
114	574	27.10.2000	-25°26.12'	12°17.20'
113	575	27.10.2000	-25°24.30'	12°28.06'
112	576	27.10.2000	-25°22.39'	12°39.00'
111	577	27.10.2000	-25°20.53'	12°49.98'
110	578	27.10.2000	-25°18.69'	13°00.70'
109	579	27.10.2000	-25°16.83'	13°11.70'
108	580	27.10.2000	-25°15.01'	13°22.62'
107	581	27.10.2000	-25°13.17'	13°33.62'
106	582	27.10.2000	-25°11.51'	13°44.74'
105	583	28.10.2000	-25°09.37'	13°55.47'
104	584	28.10.2000	-25°07.50'	14°06.33'
103	585	28.10.2000	-25°05.74'	14°17.31'
102	586	28.10.2000	-25°03.74'	14°28.18'
101	587	28.10.2000	-25°01.86'	14°39.12'
100	588	28.10.2000	-25°00.95'	14°44.55'
105	589	28.10.2000	-25°09.32'	13°57.00'
4	590	28.10.2000	-24°59.89'	13°52.29'
5	591	28.10.2000	-24°49.94'	13°54.55'
6	592	29.10.2000	-24°39.94'	13°56.72'
7	593	29.10.2000	-24°29.94'	13°57.56'
8	594	29.10.2000	-24°19.95'	14°00.61'
9	595	29.10.2000	-24°10.00'	14°01.48'
10	596	29.10.2000	-23°59.97'	14°01.60'
98	597	29.10.2000	-24°00.02'	14°10.59'
117	598	29.10.2000	-24°00.02'	14°16.24'
118	599	29.10.2000	-23°59.97'	14°21.72'

10	600	29.10.2000	-23°59.91'	14°01.70'
11	601	29.10.2000	-23°50.01'	13°55.28'
12	602	29.10.2000	-23°40.05'	13°44.25'
13	603	29.10.2000	-23°30.02'	13°35.42'
14	604	29.10.2000	-23°20.02'	13°32.52'
15	605	29.10.2000	-23°09.95'	13°32.38'
89	606	30.10.2000	-22°59.94'	13°32.07'

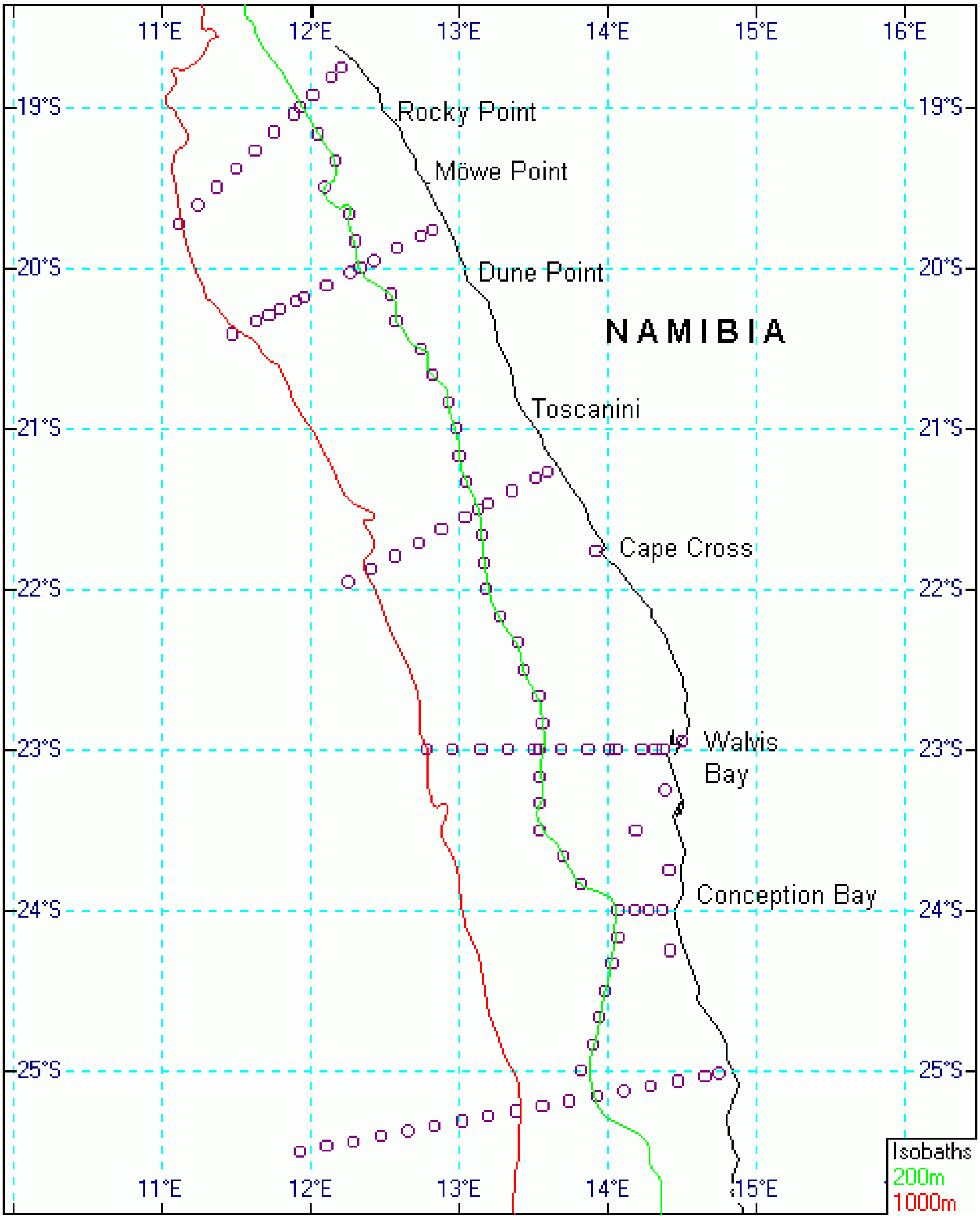

Fig.1: Map with transects and