

Summary Report

M48-5 RV Meteor

Post Cruise Workshop

**Cruise leader: Dr. Juergen Alheit
(IOW)**

1 – 8 November 2000

M48-5 Post Cruise Workshop

**National Marine
Information and Research Centre
(NatMIRC)**

**Box 912
Swakopmund
Republic of Namibia**

All results presented in this report are preliminary and should not be cited without prior reference to the authors and the cruise leader Dr. J. Alheit, of the Baltic Sea Research Institute, Warnemuende (IOW), Germany

Compiled and edited by Frank Hansen (IOW) and Ekkehard Klingelhoefter (NatMIRC)

Date: 14 November 2000

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Draft Summary Report

M48-5 Post Cruise Workshop 1- 8 November 2000

National Marine Information and Research Centre (NatMIRC) Swakopmund, Namibia

Introduction

The objective of cruise leg 48-5 was to get 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 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?

The cruise leg also served for training of young scientists and technicians from Namibia, South Africa and Germany in modern methodologies.

Directly after the cruise, a one-week post cruise workshop was held at the National Marine Information and Research Centre (NatMIRC) in Swakopmund, Namibia. The aim of this workshop was a first analysis of samples and data obtained at the cruise and to discuss the preliminary results among the participants. This was done by regular meetings in which every workgroup presented its daily achievements to all workshop participants and put forward to discussion. In addition, the cruise leader Juergen Alheit (IOW) gave an overview and feedback on the cruise, and the leader of the Sub-Division Environment at the NatMIRC gave a lecture on the history and structure of Namibian marine research within the Ministry of Fisheries and Marine Resources. At the workshop, the training of young scientists and technicians continued.

Station overview

The CTD station net of the cruise was designed by Rainer Feistel (IOW). For orientation purposes, a map (Figure 1a) with perpendicular transect lines is provided. Station numbers per transect line are provided in Figures 1b-e.

A brief description on the physical and biological properties of the stations sampled appears in the Annex.

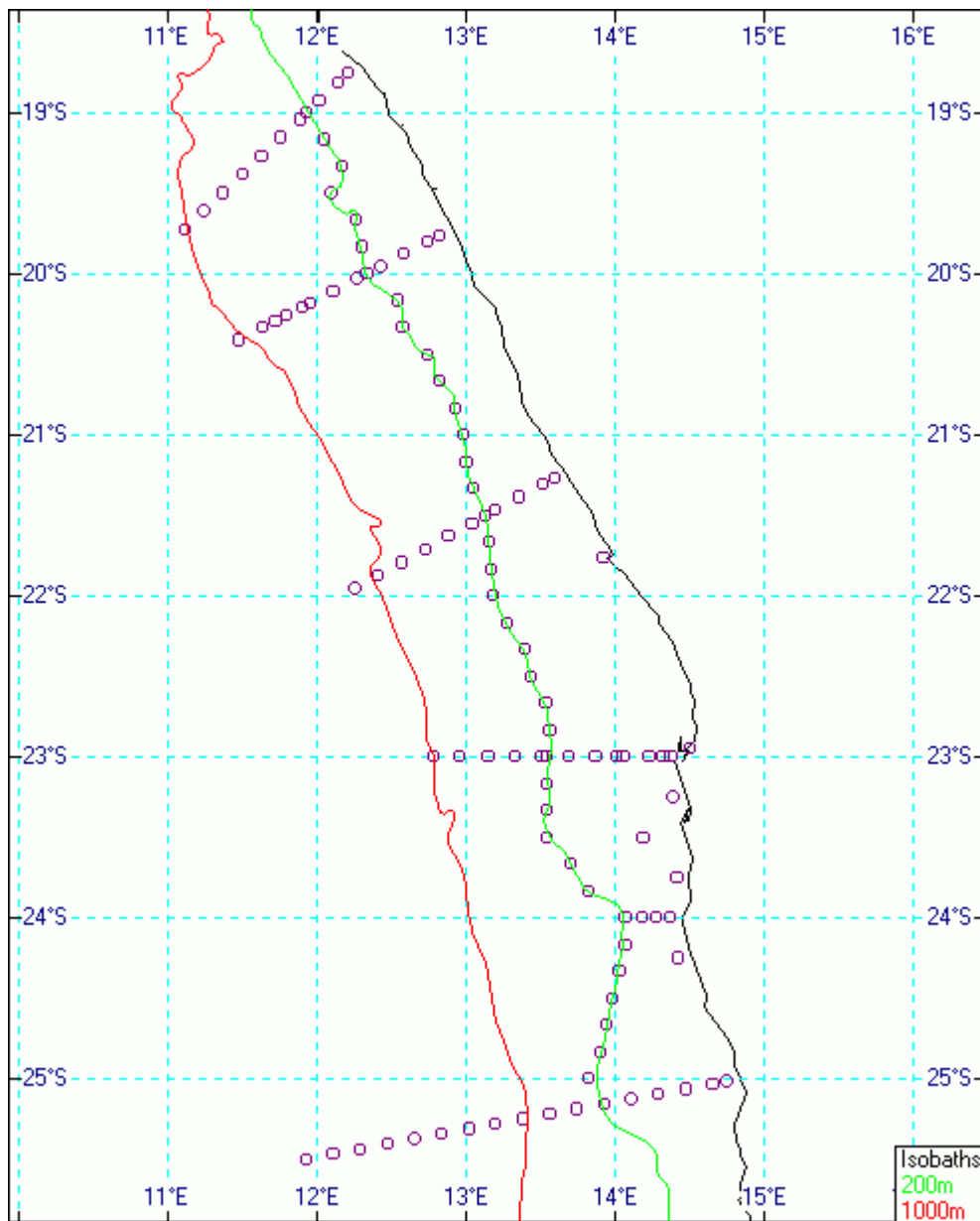


Figure 1a: Map overview with transects and stations, October 2000, Namibia.

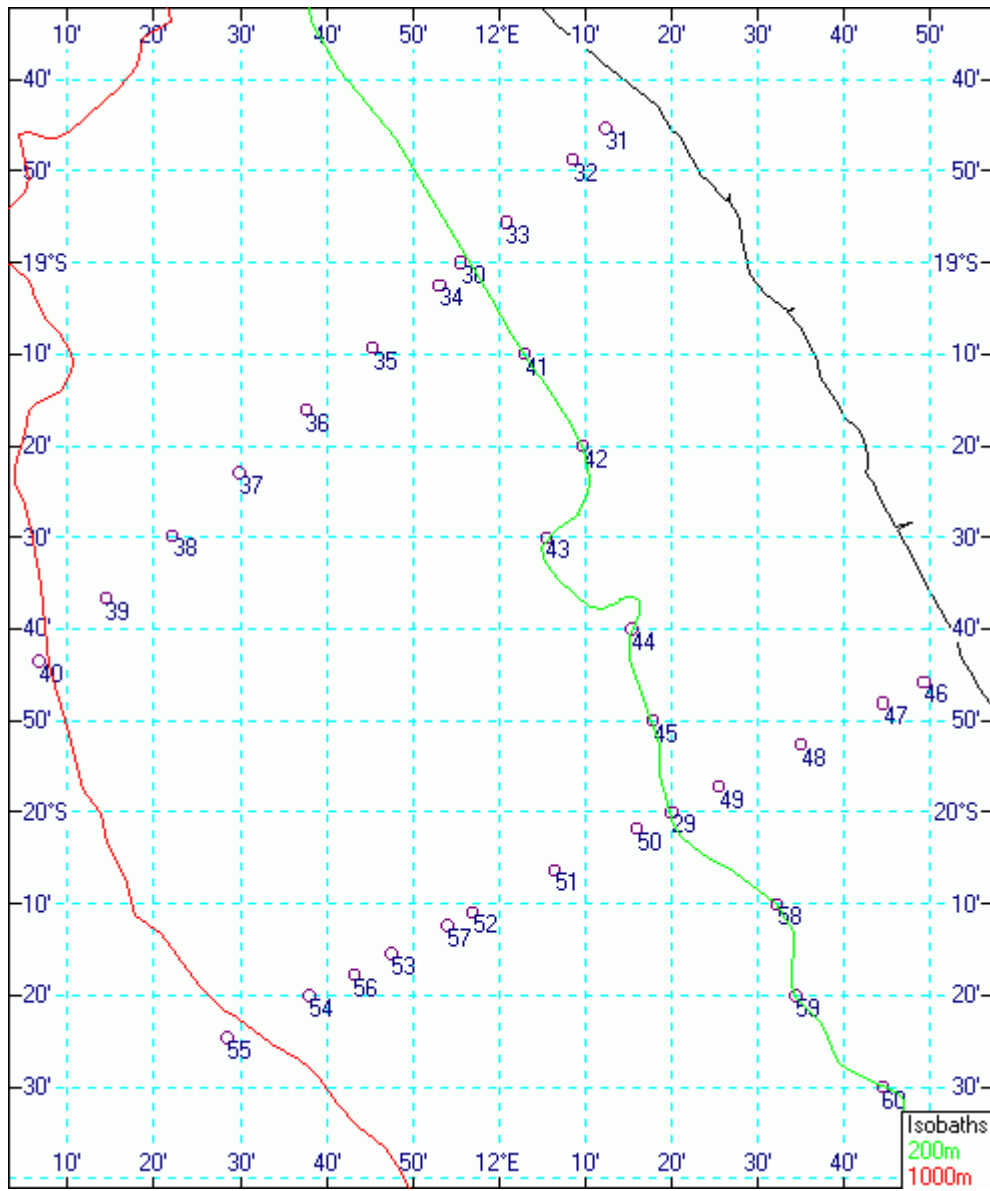


Figure 1b: Map indicating transect 1 and 2 with station numbers, October 2000, Namibia

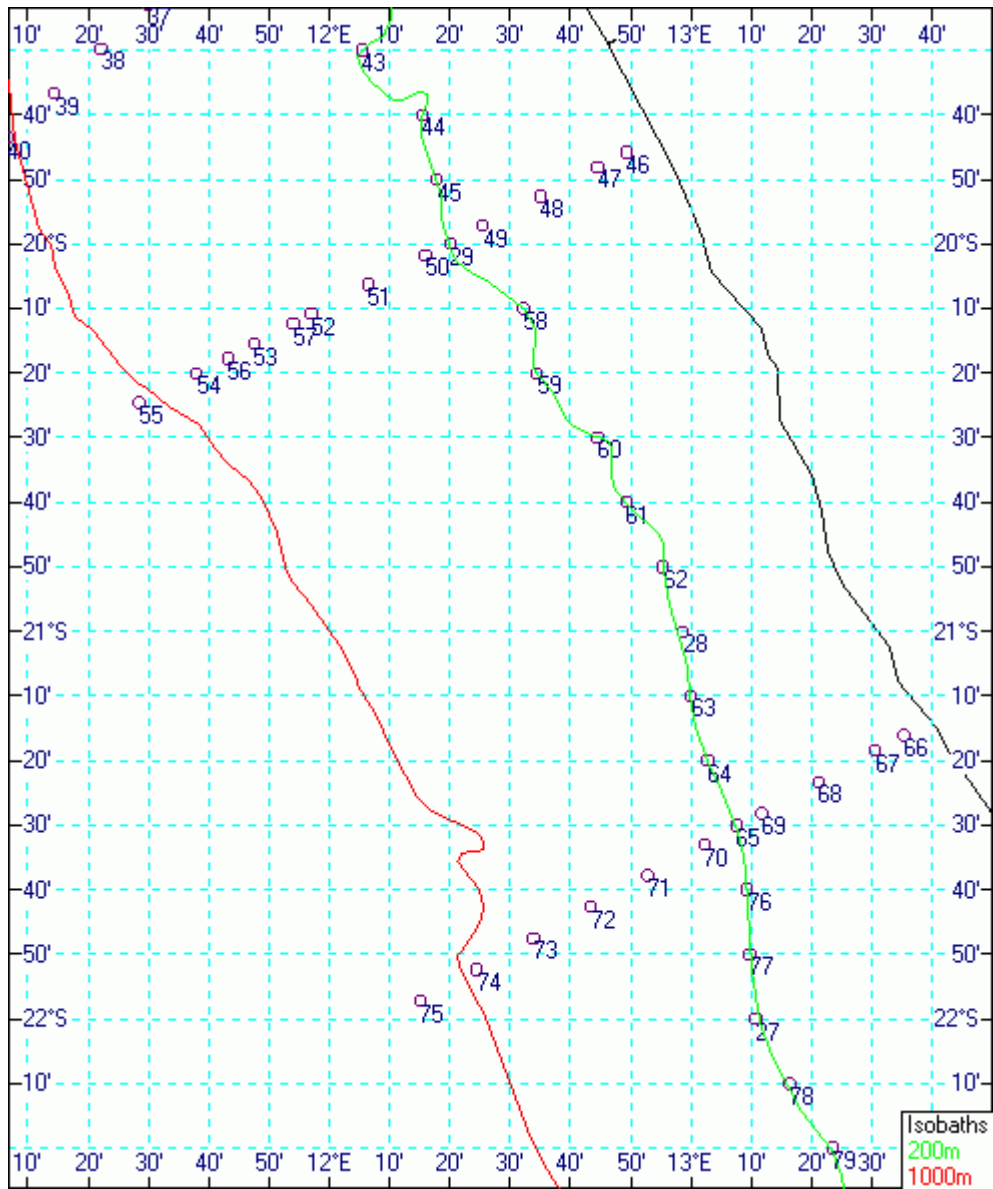


Figure 1c: Map indicating transect 2 and 3 with station numbers, October 2000, Namibia

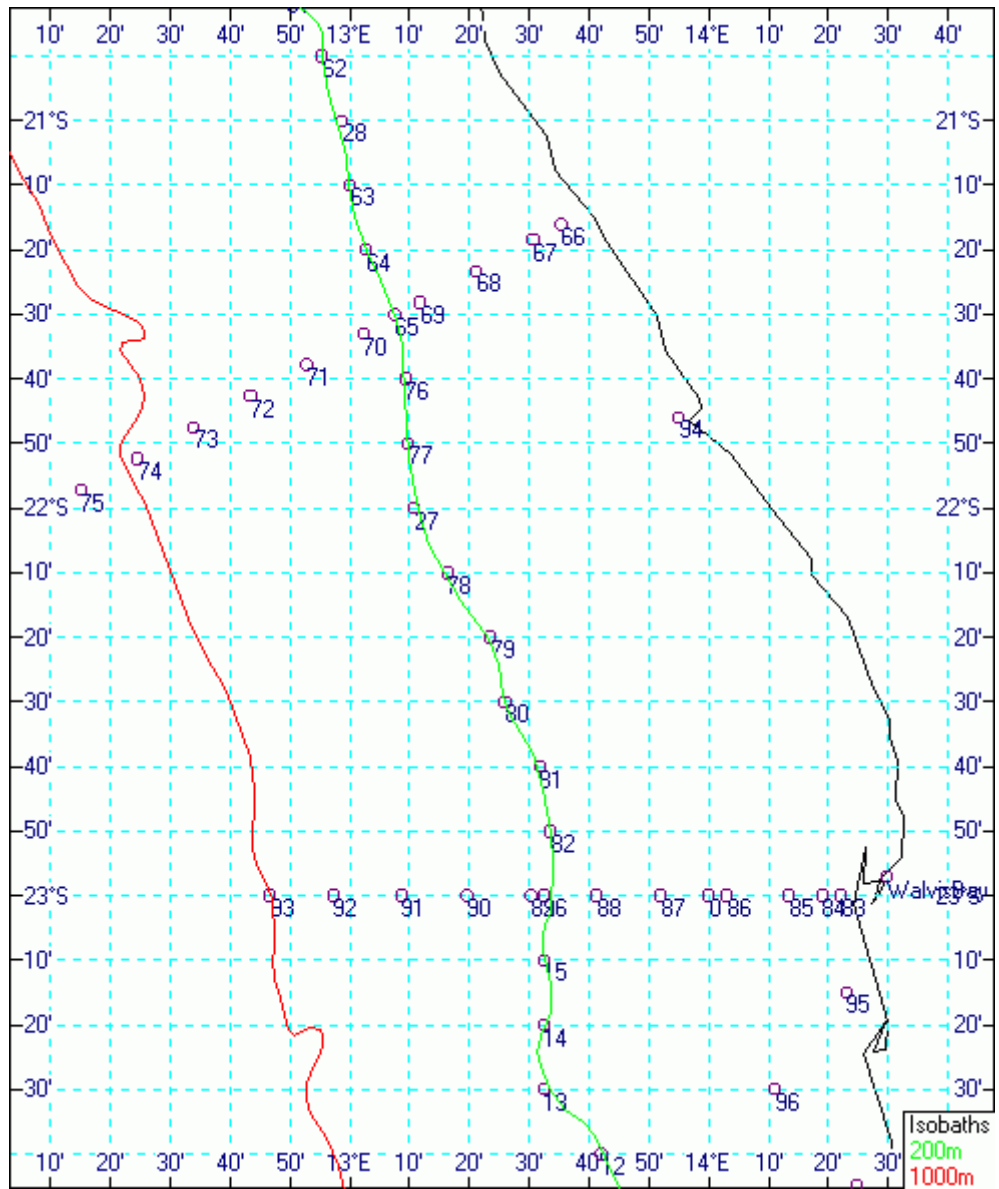


Figure 1d: Map indicating transect 3 and 4 with station numbers, October 2000, Namibia

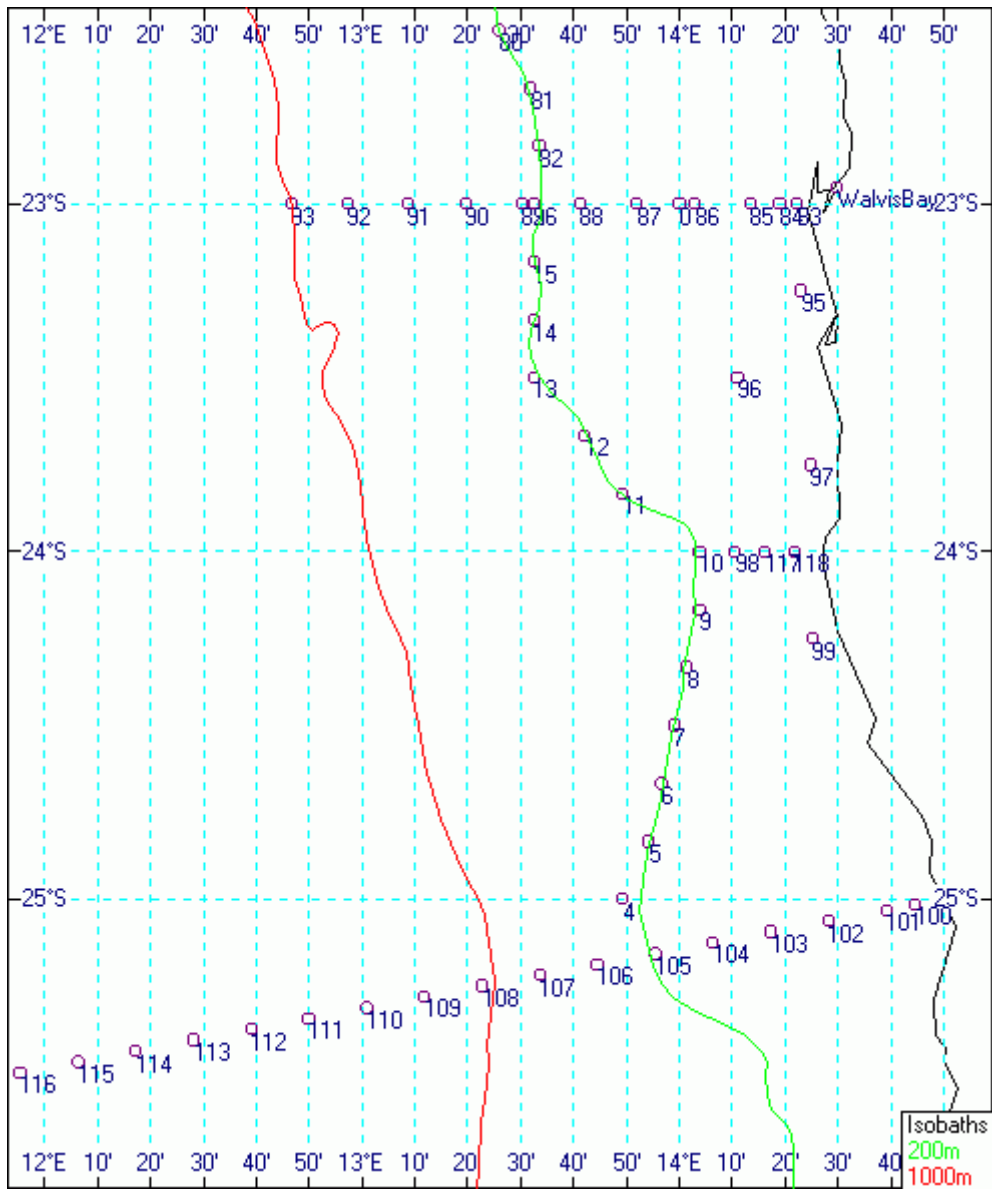


Figure 1e: Map indicating transects 4-6 with station numbers, October 2000, Namibia

Meteorology

Dawid Mouton: NatMIRC

The data presented in the graphs (Figures 2a-b, 3a-b, 4a-b, 5a-b) for wind direction and wind speed, is taken from the land based Automatic Weather Stations at Cape Frio, Meob Bay and Kerbe Hoek and the Buoy which is located 5nm west of Swakopmund.

The data provided, is averaged wind speed and direction values for every hour for the entire month of October 2000.

At the AWS the following data is recorded and averaged every hour:

- Wind speed and wind direction
- Air temperature
- Humidity
- Air pressure
- Solar radiation

At the Buoy off Swakopmund, in addition to the above data sea temperature is recorded at the following depths:

- 3 m
- 10 m
- 15 m
- 20 m
- 25 m

The above data can be accessed directly at IOW. Contact person: Toralf Heene.

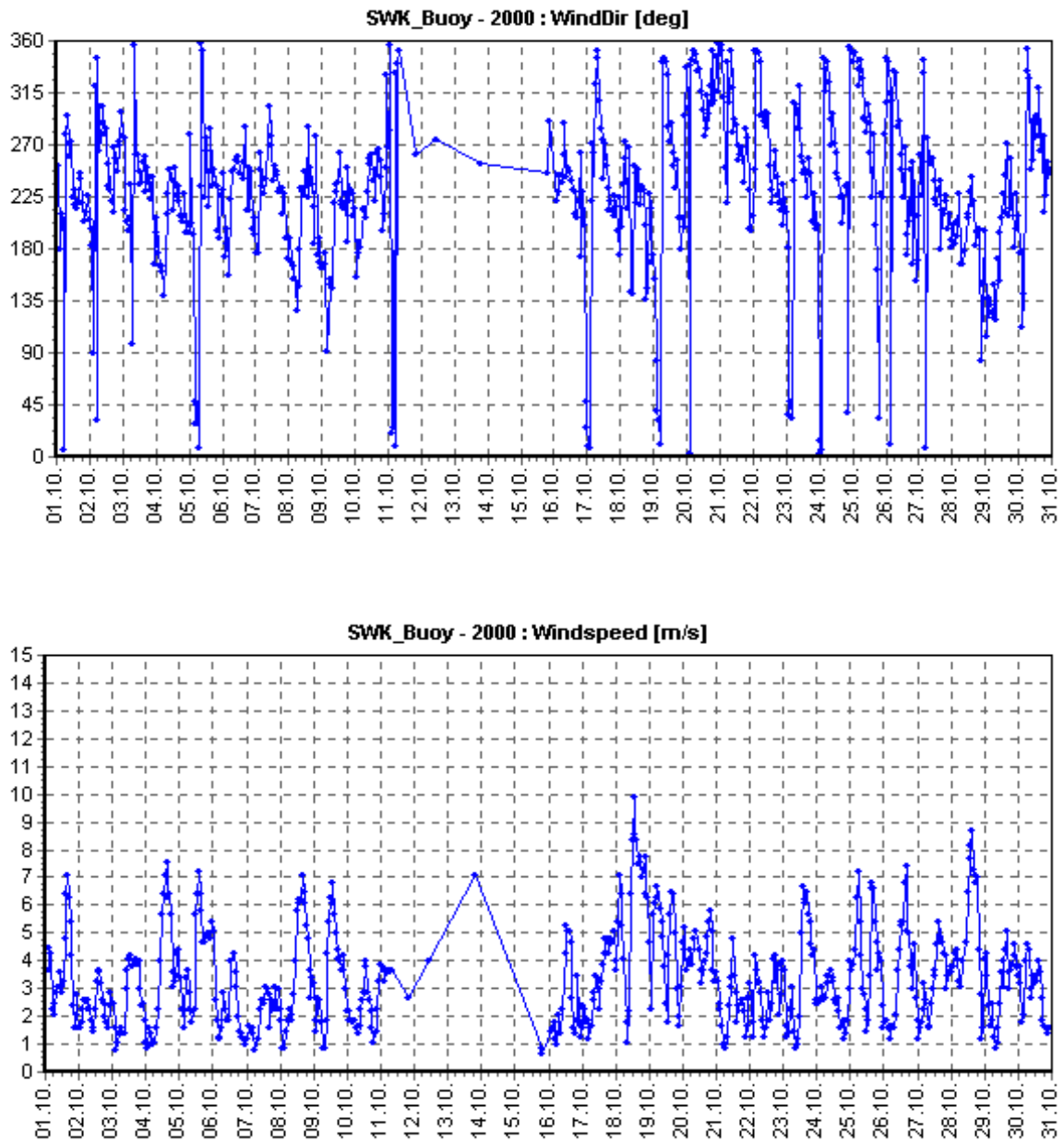


Figure 2a-b: Wind direction and wind speed recorded at the Buoy, 5 nm west of Swakopmund, Namibia, 1-31 October 2000

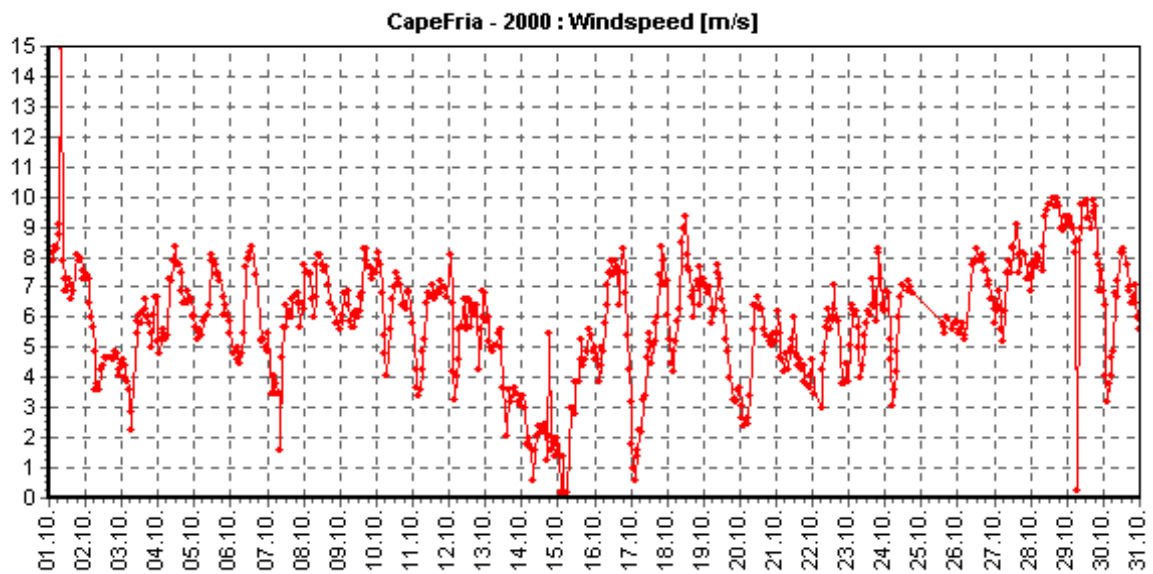
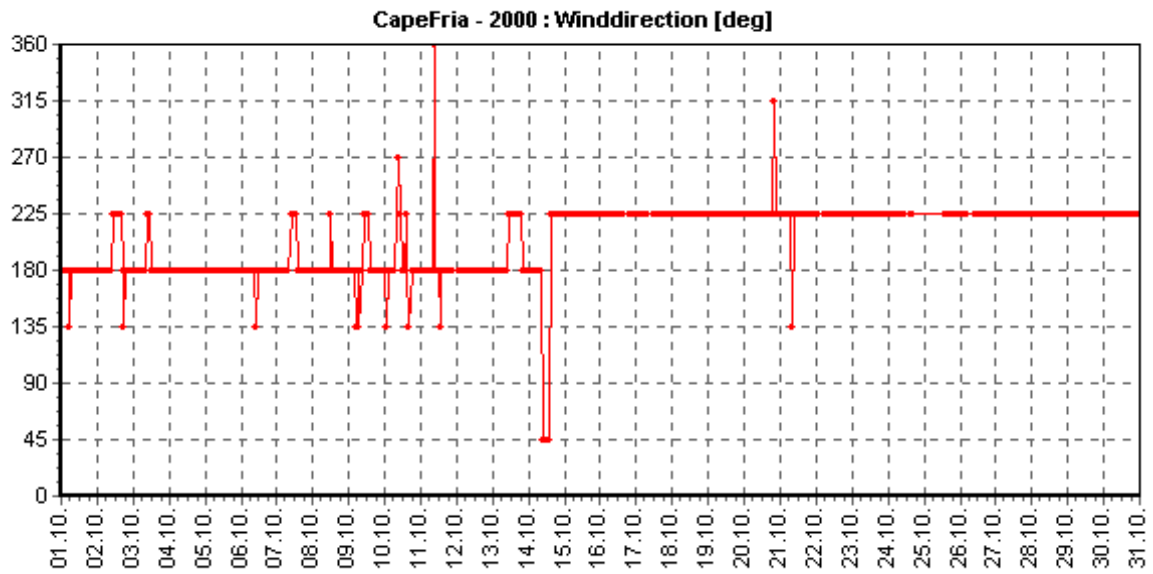


Figure 3a-b: Wind direction and wind speed recorded by the AWS at the Cape Frio (close to the Cunene River), Namibia, 1-31 October 2000.

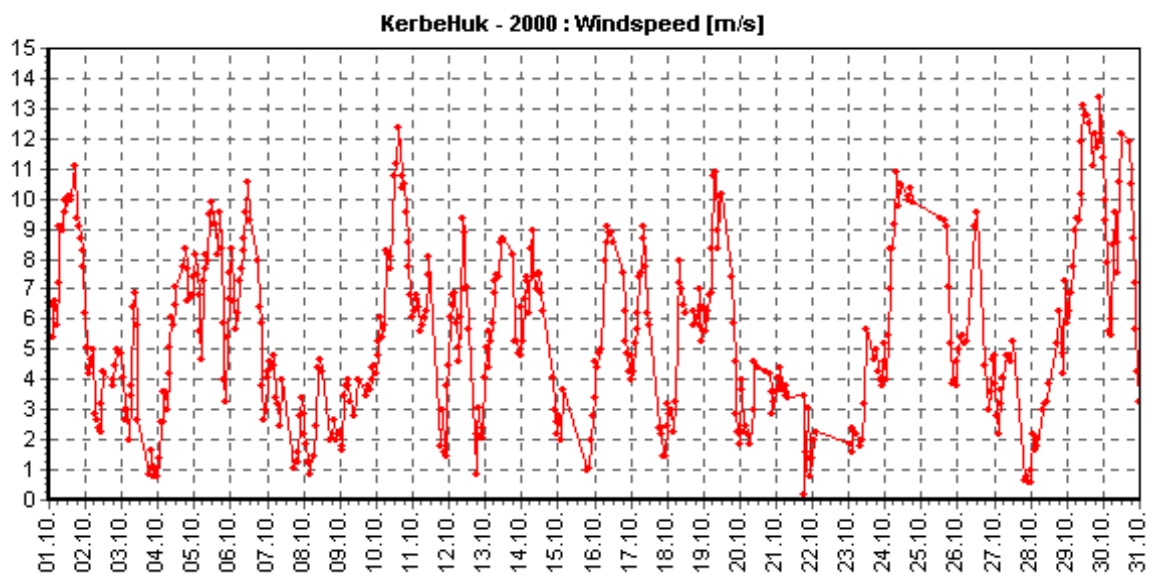
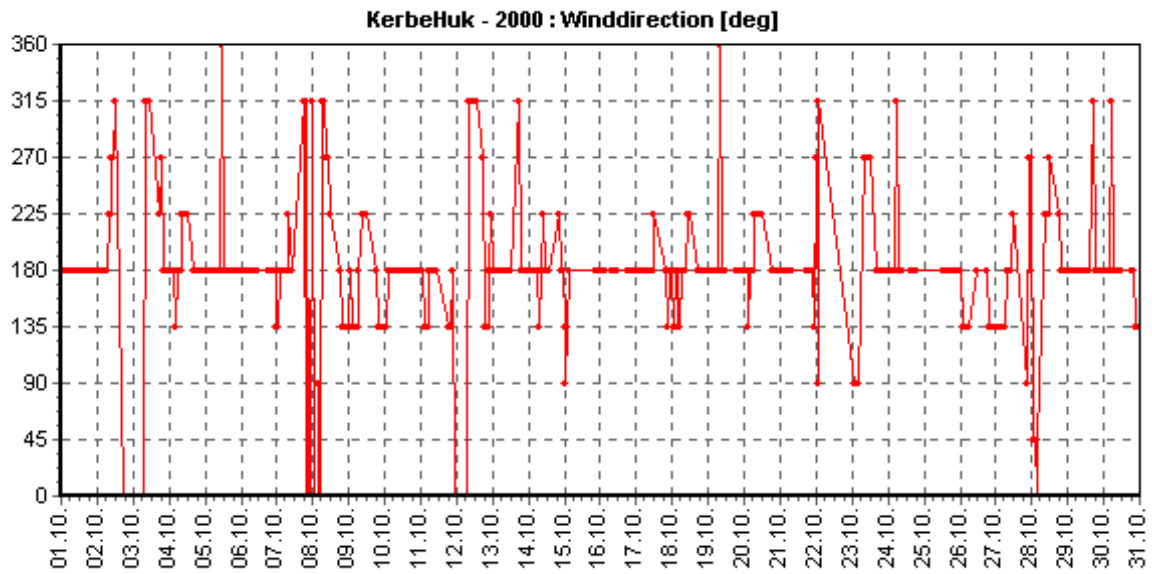


Figure 4a-b: Wind direction and wind speed recorded by the AWS at the Kerbe Hoek (close to the Orange River), Namibia, 1-31 October 2000.

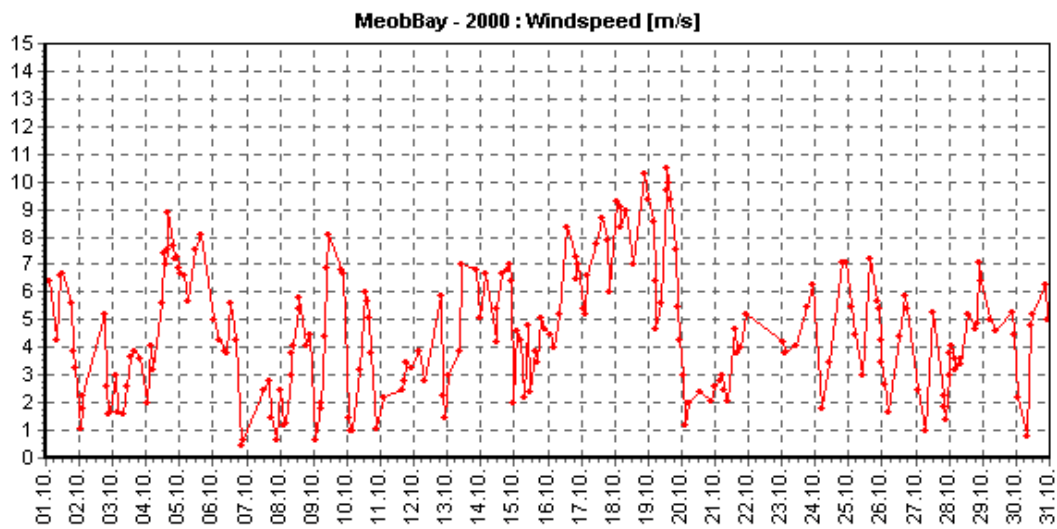
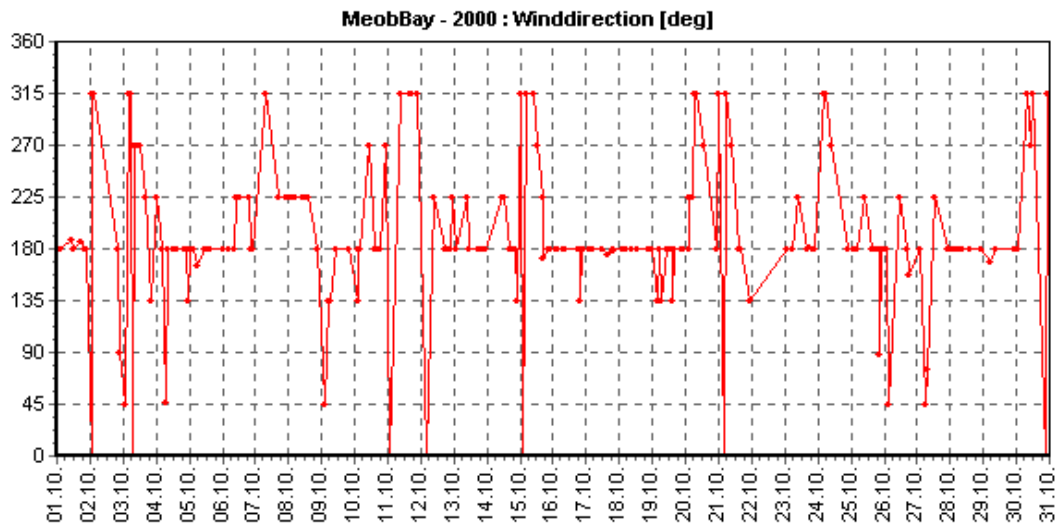


Figure 5a-b: Wind direction and windspeed recorded by the AWS at the Meob Bay (close to Walvis Bay), Namibia, 1-31 October, 2000.

Physical Oceanography

Aina Iita: NatMIRC; Christo Whittle: UCT; Craig Risien: UCT

For a deeper evaluation of the various cruise results by CTD casts, literature reviews are compiled on different aspects of the Benguela upwelling system. They are to include primary & secondary literature, textbook references, and lists of possible expeditions which dealt with that particular problem: Which were the very first and most recent scientific investigations in that field? What is known by now, what is still unknown and why?

1. Review (Christo Whittle, UCT):

What is known about the origin and properties (T,S,O₂, Density) of Benguela Current waters (surface and undercurrent separately) ?

2. Review (Aina Iita, NatMIRC):

What is known about the mass transport alongshore and offshore in the different vertical layers of the current? What is the annual cycle and its interannual variability (e.g. Benguela Ninos)? What is the meridional variability?

3. Review (Aina Iita, NatMIRC):

What is known about the oxygen minimum, H₂S formation and sudden eruptions on the Namibian shelf? Why is the water not ventilated? What is H₂S on the shelf important for, if at all? What is known about the sediments and the history of such events?

4. Review (Craig Risien, UCT):

What is known about the role of tides and sea level for upwelling? What is the annual cycle and its interannual variability? What are the physical reasons for level fluctuations?

5. Review (Christo Whittle, UCT):

What is known about upwelling filaments in the Benguela region? How do they vary in position, shape, and strength? Are they relevant for biological production or fishery? Are there responsible topographical ridges or canyons, are there special currents or fronts?

6. Review (Craig Risien, UCT):

What is known about the driving forces for Benguela upwelling (climatological High/Low, trade winds), its annual cycles, its interannual variability? Sketch the Namibian Climate.

7. Review (Christo Whittle, UCT):

Compute and discuss the meaning of T-S-plots and T-O₂ plots all over the cruise. Give a brief introduction to this method.

Oxygen minimum and H₂S

Aina lita

The water overlying the seabed of the Namibian coast is characterized by hypoxic and anoxic conditions. This is a seasonal coastal feature occurring, more during summer and autumn. During these seasons the upwelling in central and northern Namibia is less intense hence primary production, then it get flushed out with the onset of the spring upwelling. However during the anomalous years such as (Benguela Ninos years, 1994) the period of these anoxia conditions seems to be prolonged.

This condition is found along most of the northern and central Namibia stretching between Cape Cross down to Conception Bay. Earlier findings suggested that, there are two sources of the oxygen-depleted water, however with a different depth distribution (Chapman and Shannon, 1987). The oxygen minimum found at the depth of 100-150m is believed to be formed locally by decomposition of organic matters. Whilst the 300-400m minimum is possibly originates from the Angola Dome (Chapman and Shannon, *op. cit*) and transported poleward by the counter current, and sometimes seen penetrating up to Luderitz.

These conditions have a dramatic effect in the marine life living along the Namibian coast. For fish like juvenile Cape Hake, anoxia could be catastrophic, as they can be easily trapped in this water and died due to lack of oxygen. The condition might as well cause displacement of fish moving far offshore subjecting themselves to more predation. It is also well known that rock lobster are limited by low oxygen concentration, and bottom oxygen plays a very crucial role on the growth of these animals.

Under severe conditions of anoxia, hydrogen sulphide is produced. This is a toxic gas released in the water column when the organic matters decomposed in the absence of oxygen. This gas has a nasty smell, can cause the water to change to milky like color. The sulphide eruption along the Namibian coast has been observed as early as 1880. These events are usually short-lived, up to three days. The effect of these eruptions on marine animal is very severe if not fatal. A number of rock lobster and other marine animals can be affected and washed ashore during these eruptions.

During the Meteor cruise M48-2, hydrogen sulphide was found to be in the water column in the core of oxygen minimum (see M48-2 cruise report).

Chemical Oceanography

Anja van der Plas: NatMIRC; Andrea Laws: IOW; Benedict Dundee: NatMIRC; Mathew Hanghome: NatMIRC

Nutrient chemistry

The group working on nutrient chemistry consisted of Benedict Dundee (NatMIRC), Matthew Hanghome (NatMIRC), Andrea Laws (IOW) and Anja van der Plas (NatMIRC). The workshop offered a first opportunity to calculate nutrient concentrations from the shipboard readings, to perform autoanalyzer measurements on samples taken from the 200m isobath 24° South to 23° South and the 23° South transect and to start with data processing. From the data obtained, several graphs were produced in order to get a first impression on the development of nutrient concentrations along the 200 m isobath line (longshore) and the 6 transects perpendicular to the coastline (see Figures. 6 - 14). Further processing, validation and interpretation of the nutrient data will be carried out at the Baltic Sea Research Institute (IOW) by Günther Nausch and his workgroup.

Note: graphs for transects 1-6 and the 200m isobath from 25° S to 19° S appear below. However, the 1st isobath at 200m bottom depth from 19° to 20° South is not available. Isobath at 200 m bottom depth is presented in Table 1 i.e. provides raw data for nutrients on the 200m isobath 24° S to 23° S.

Meteor 48/5 : profile - nutrients - 1st transect 19 S

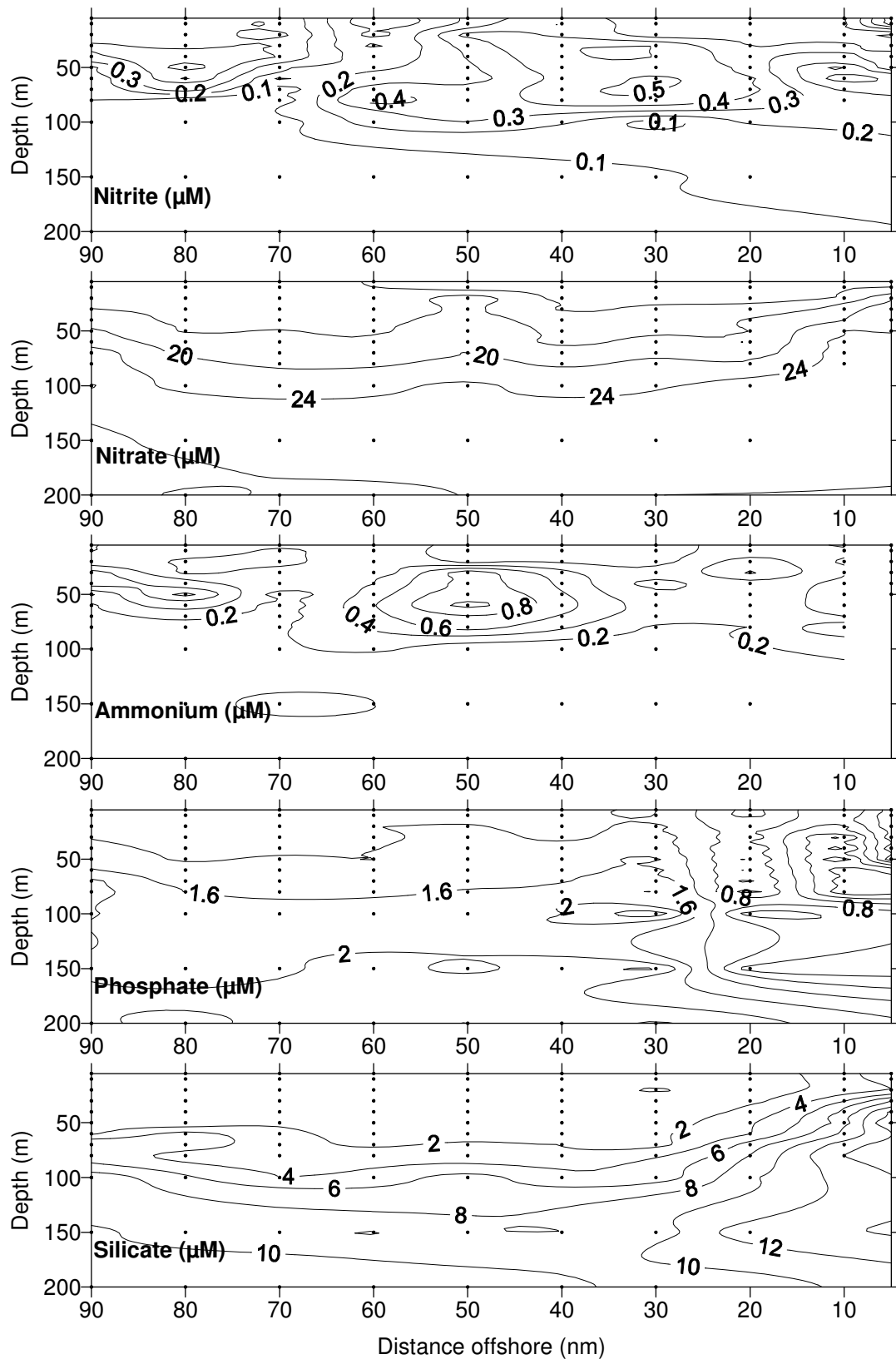


Figure 6: Vertical distribution of silicate, phosphate, nitrate, nitrite and ammonium along transect 1 (inshore to offshore), October 2000, Namibia.

Meteor 48/5 : profile - nutrients
2nd isobath 200 m / 20 S - 21,5 S

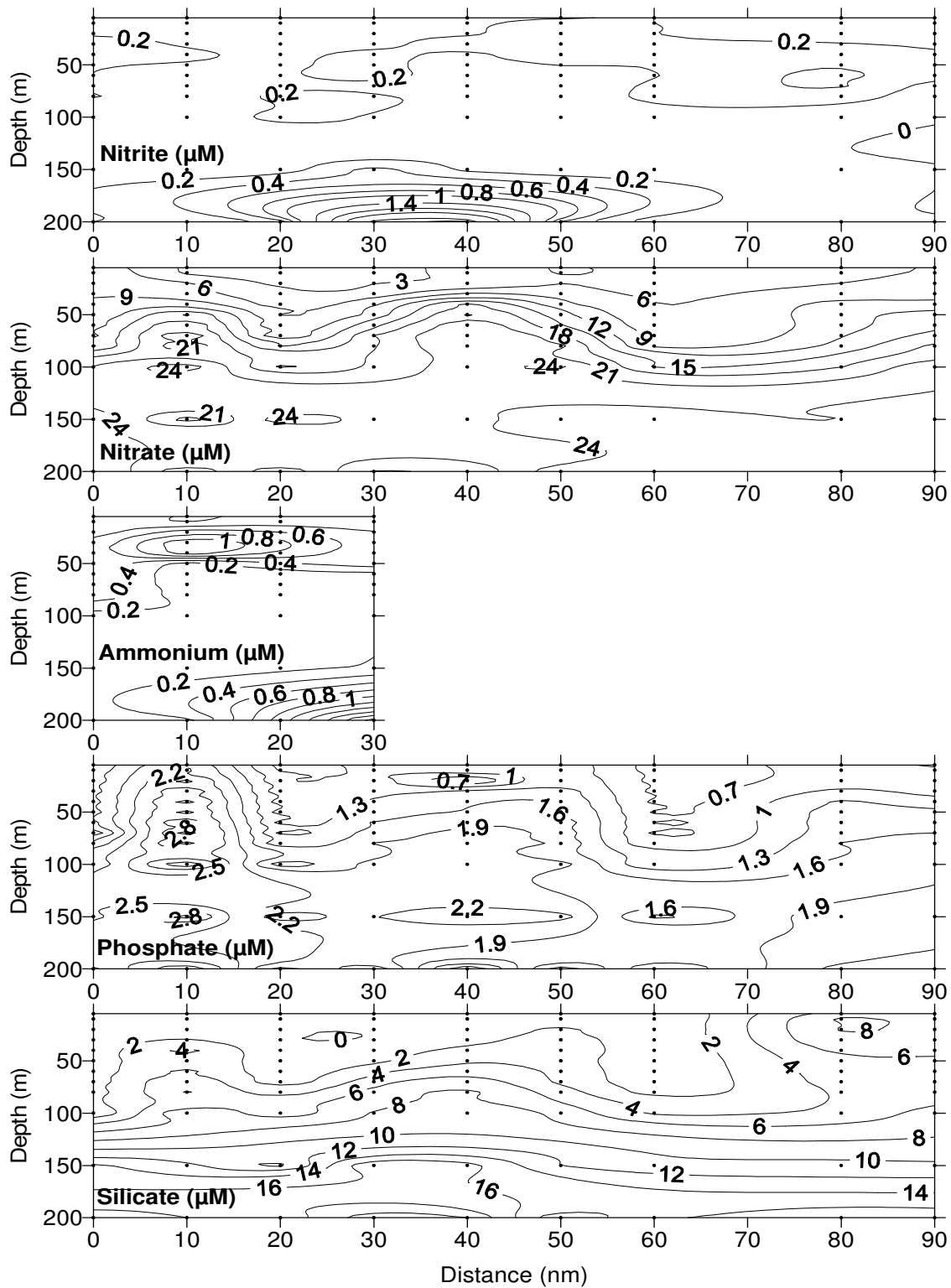


Figure 7: Vertical distribution of silicate, phosphate, nitrate, nitrite and ammonium along the 200m isobath, 20° - 21°50' South, October 2000, Namibia.

Meteor 48/5 : profile - nutrients - 2nd transect 20 S

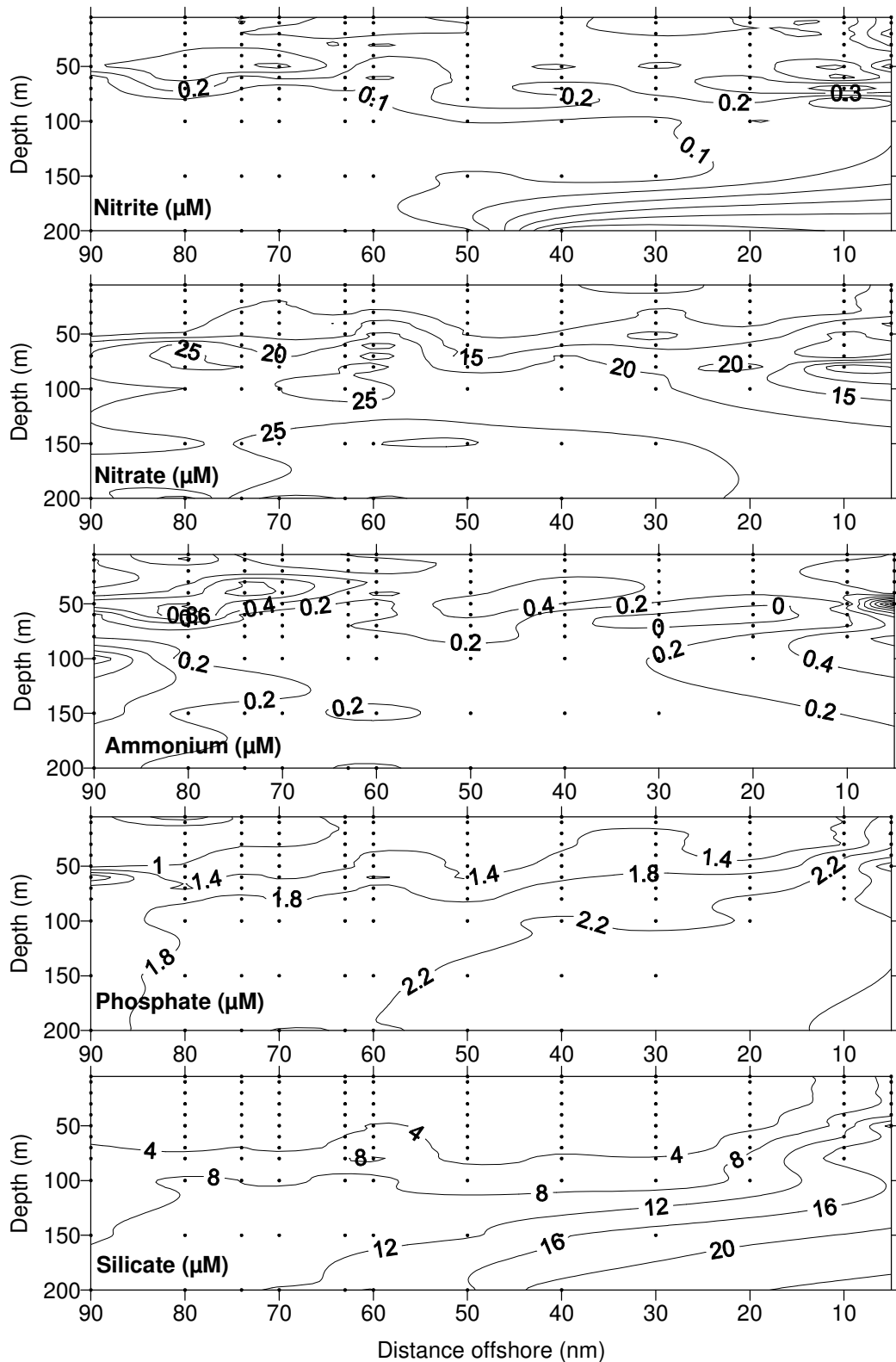


Figure 8: Vertical distribution of silicate, phosphate, nitrate, nitrite and ammonium along transect 2 (inshore to offshore), October 2000, Namibia.

Meteor 48/5 : profile - nutrients
3rd isobath 200 m / 21,5 S - 23 S

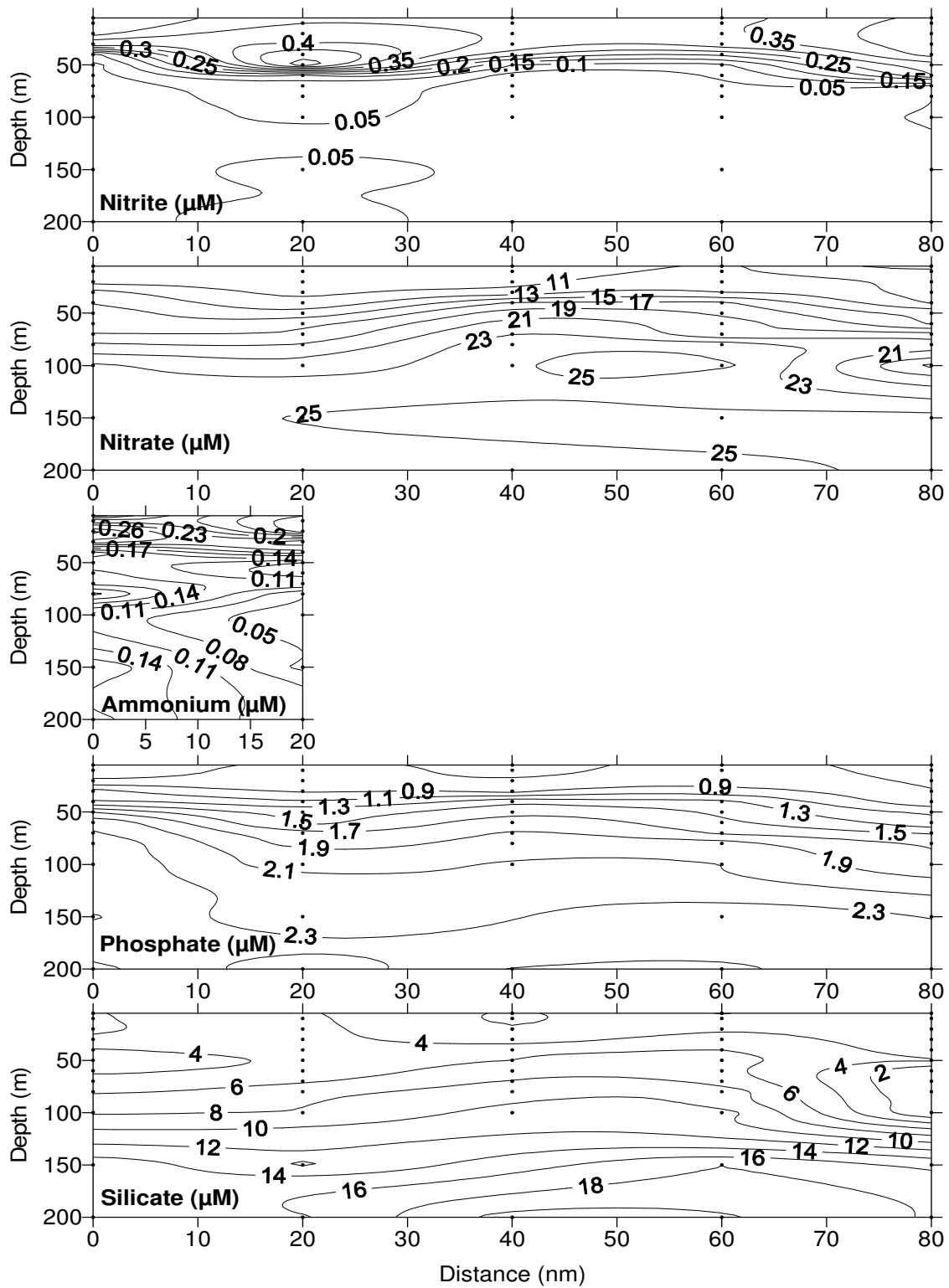


Figure 9: Vertical distribution of silicate, phosphate, nitrate, nitrite and ammonium along the 200m isobath, 21°50' - 23° - South, October 2000, Namibia.

Meteor 48/5 : profile - nutrients - 3rd transect 21 S

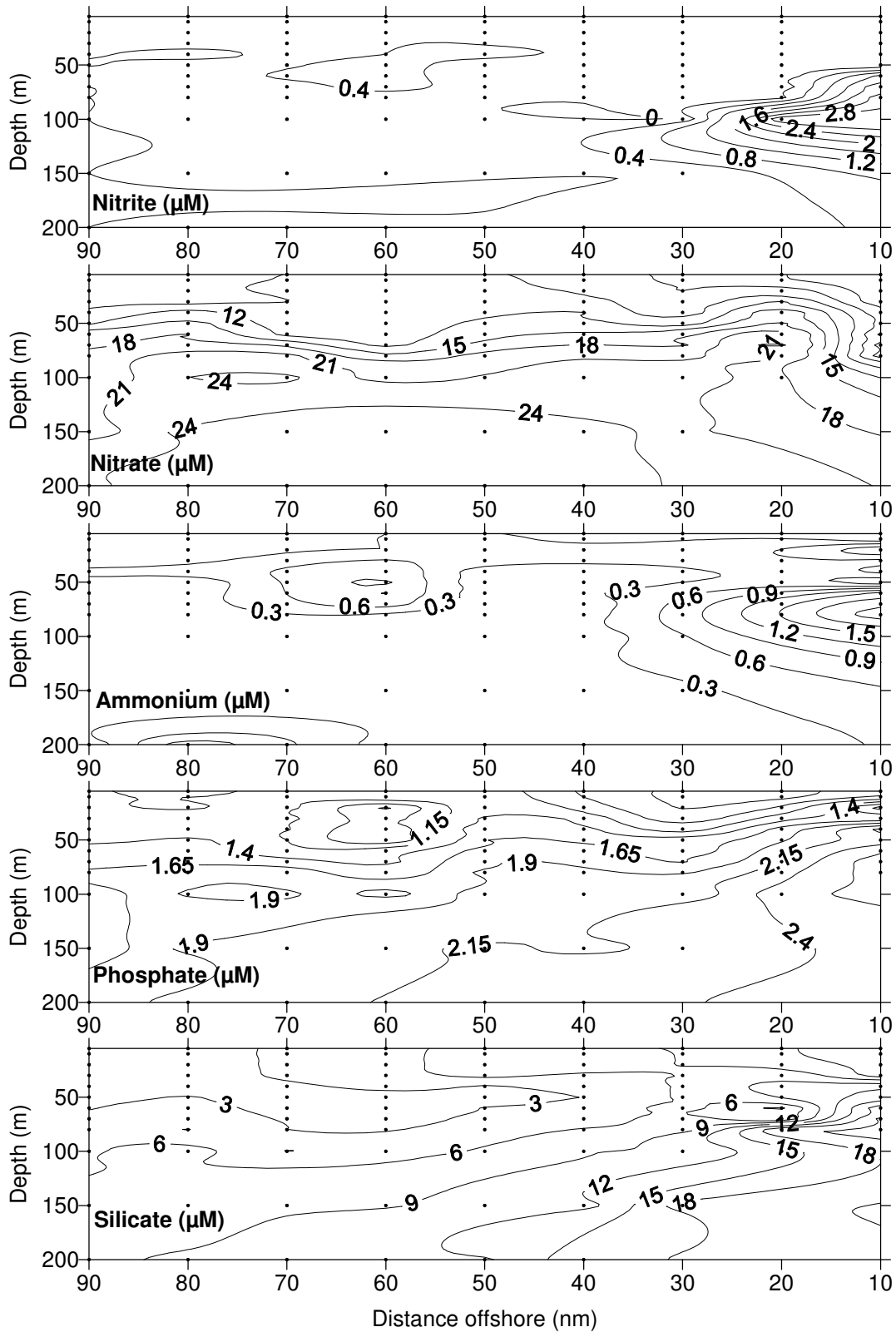


Figure 10: Vertical distribution of silicate, phosphate, nitrate, nitrite and ammonium along transect 3 (inshore to offshore), October 2000, Namibia.

Meteor 48/5 : profile - nutrients
4th isobath 200m / 25 S - 24 S

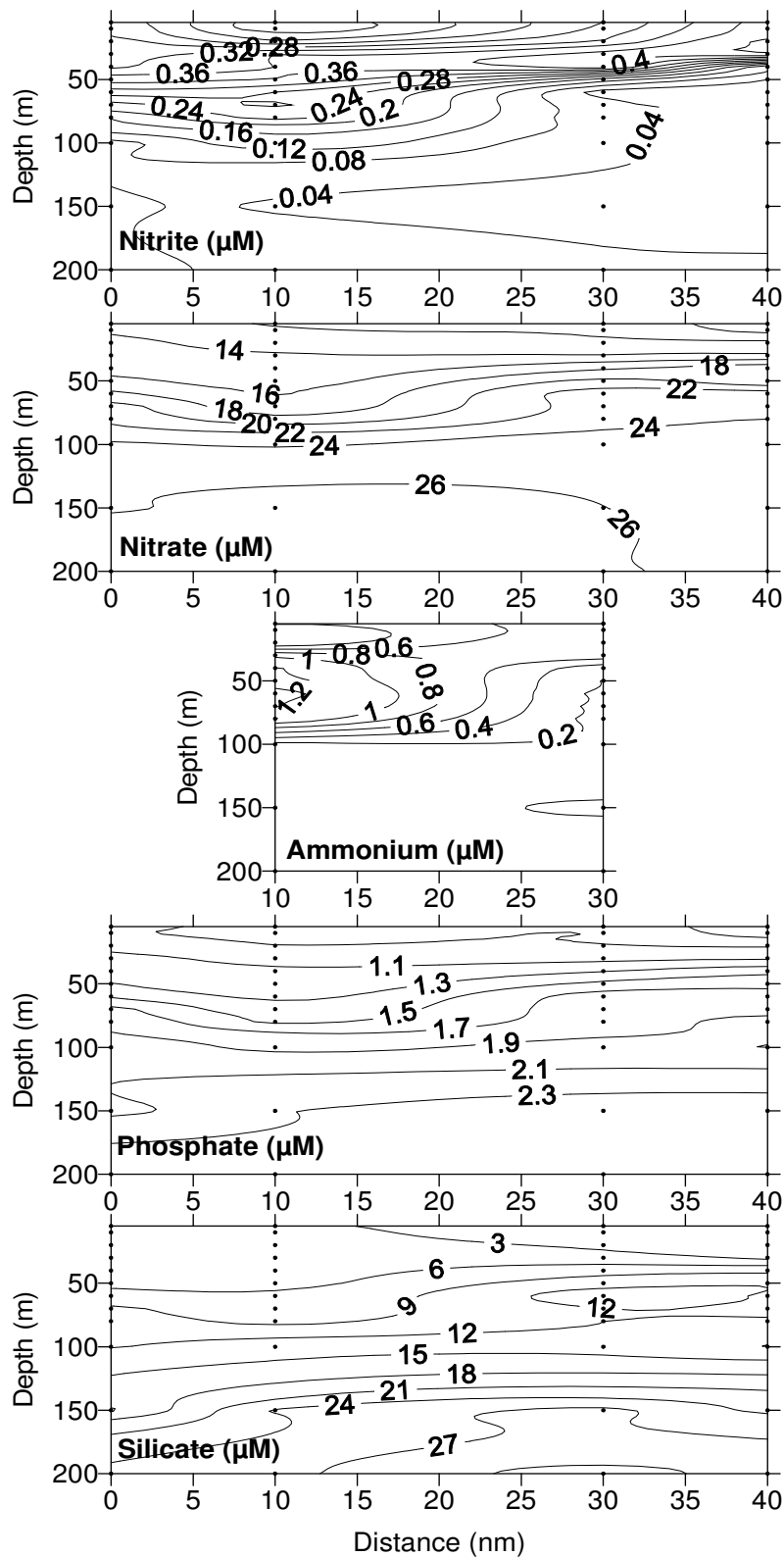


Figure 11: Vertical distribution of silicate, phosphate, nitrate, nitrite and ammonium along the 200m isobath, 25° - 24° - South, October 2000, Namibia.

Meteor 48/5 : profile - nutrients- 4th transect 23 S

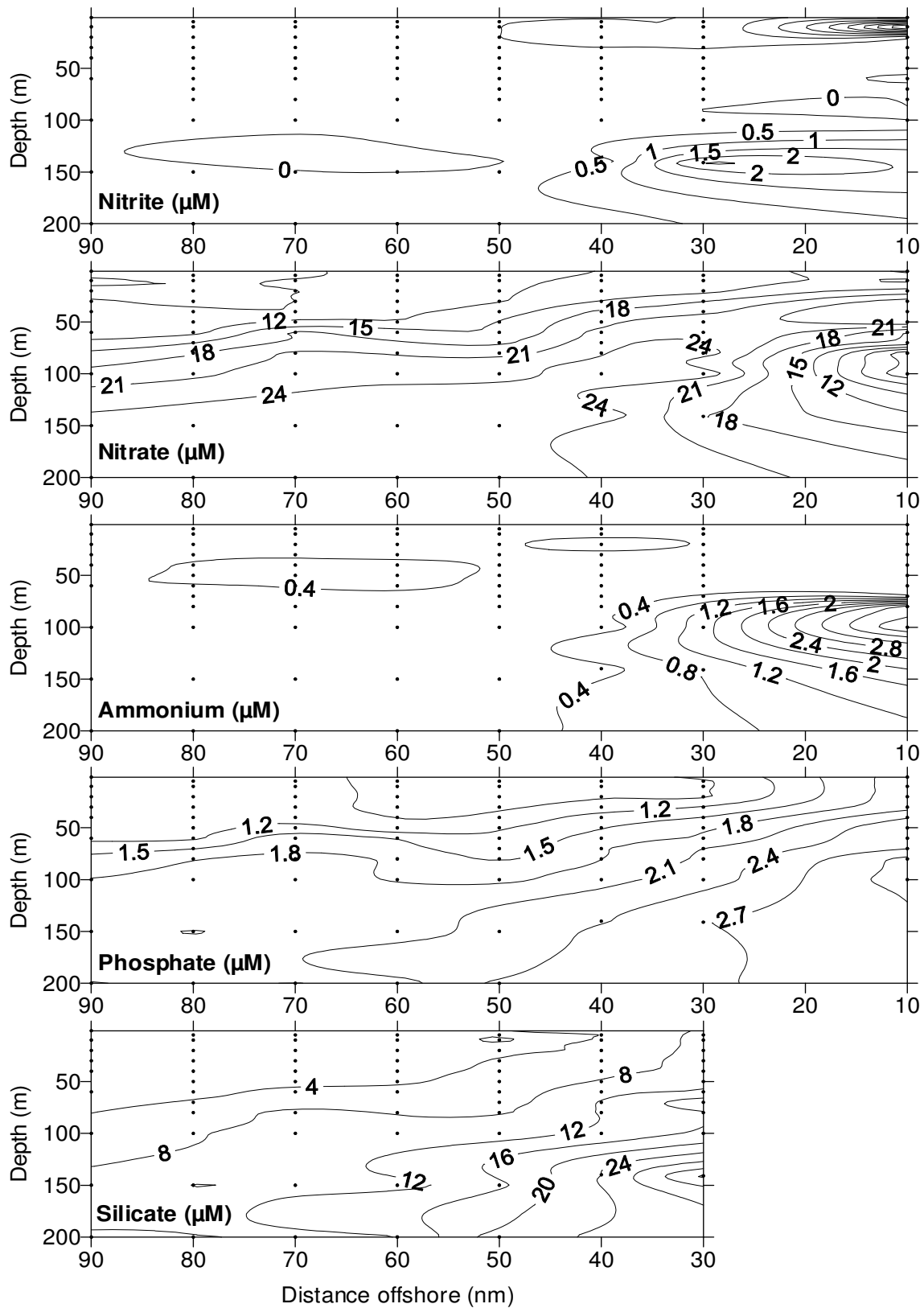


Figure 12: Vertical distribution of silicate, phosphate, nitrate, nitrite and ammonium along transect 4 (inshore to offshore), October 2000, Namibia.

Meteor 48/5 : profile - nutrients - 5th transect 25 S

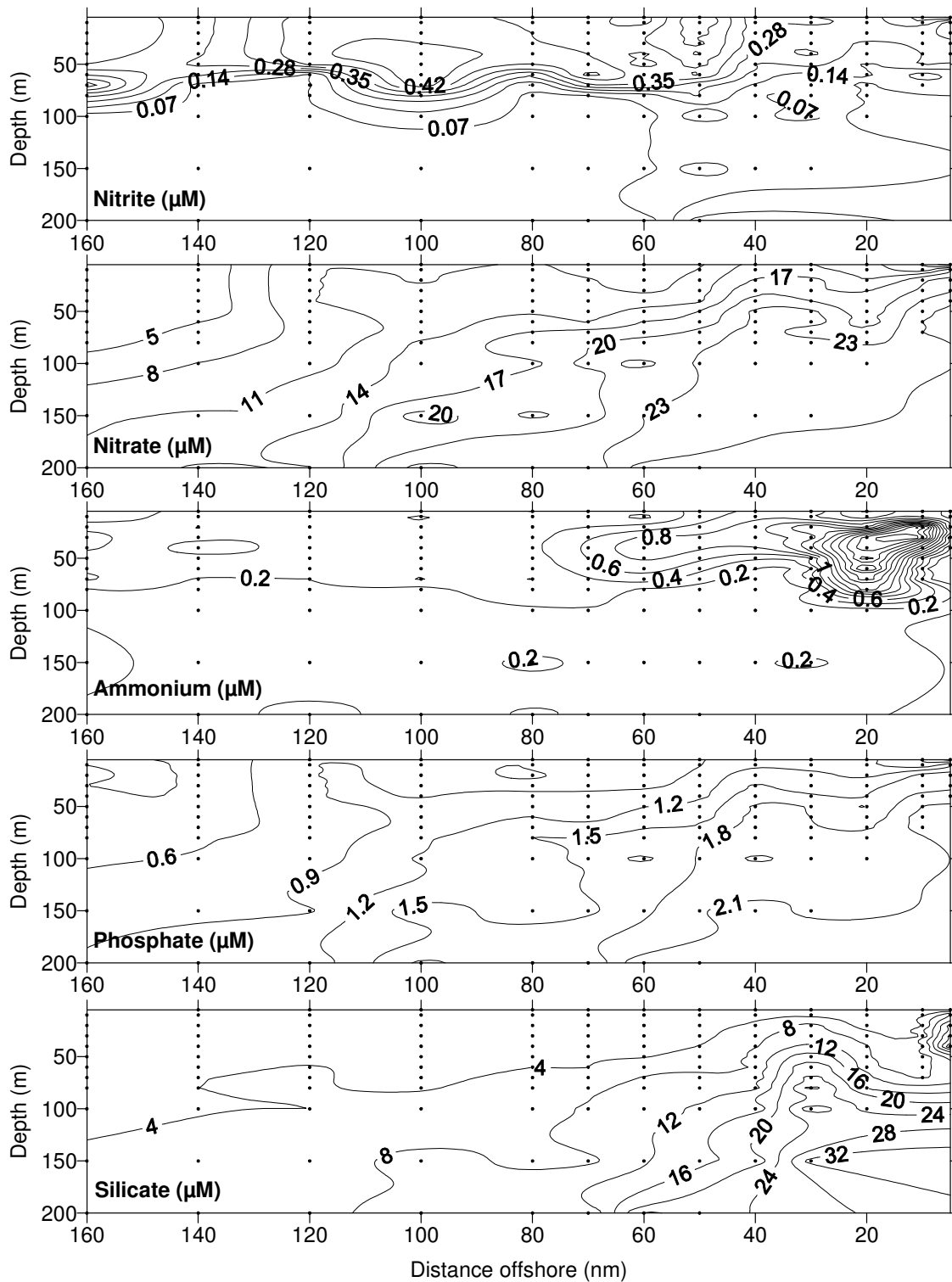


Figure 13: Vertical distribution of silicate, phosphate, nitrate, nitrite and ammonium along transect 5 (inshore to offshore), October 2000, Namibia.

Meteor 48/5 : profile - nutrients - 6th transect 24 S

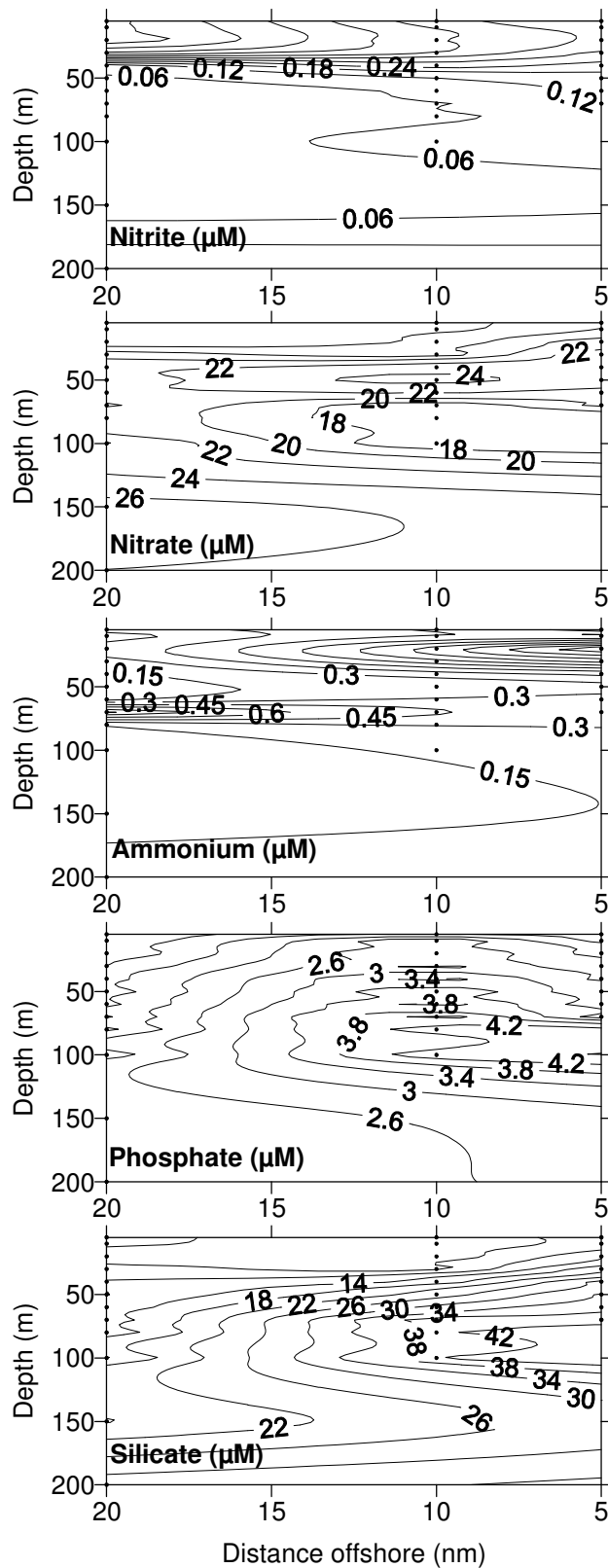


Figure 14: Vertical distribution of silicate, phosphate, nitrate, nitrite and ammonium along transect 6 (inshore to offshore), October 2000, Namibia.

Table 1 Analyses of Meteor M48-5 Nutrient samples done per TRAACS Auto Analyzer

Station Label	Depth (m)	Silicate	Phosphate	NO3 + NO2	Nitrite	Nitrate	Ammonium
12	5	0.354	0.079	15.191	0.441	14.750	0.000
	10	0.635	0.037	15.264	0.429	14.835	0.000
	20	0.620	0.047	15.381	0.444	14.937	0.122
	30	0.873	0.450	15.020	0.468	14.552	0.115
	40	2.456	0.706	20.481	0.008	20.473	0.000
	50	3.118	0.747	21.751	0.000	21.751	0.001
	60	3.711	0.952	22.261	0.000	22.261	1.215
	70	3.527	0.877	22.116	0.000	22.116	1.248
	80	3.652	0.921	22.418	0.000	22.418	0.960
	100	3.623	0.803	22.330	0.000	22.330	1.014
	150	7.153	0.944	25.058	0.000	25.058	0.632
	200	17.779	2.004	33.497	0.015	33.482	1.000
14	5	0.672	0.598	15.364	0.495	14.869	2.124
	10	0.664	0.306	15.950	0.496	15.454	0.740
	20	0.408	0.000	15.080	0.544	14.536	0.691
	30	0.284	0.000	15.131	0.510	14.621	0.640
	40	0.000	0.048	15.890	0.488	15.402	0.000
	50	0.503	0.125	17.563	0.326	17.236	0.000
	60	2.181	0.366	20.944	0.021	20.923	0.000
	70	3.312	0.535	22.836	0.000	22.836	0.000
	80	3.572	0.722	23.901	0.000	23.901	0.000
	100	4.462	0.949	26.095	0.000	26.095	0.064
	150	13.540	1.921	32.506	0.000	32.506	0.365
	200	19.695	2.600	32.418	0.027	32.391	0.482
89	5	1.730	0.463	16.306	0.540	15.766	0.308
	10	1.510	0.000	15.795	0.535	15.260	0.059
	20	1.593	0.000	15.694	0.542	15.152	0.000
	30	1.470	0.000	15.677	0.548	15.129	0.000
	40	1.359	0.000	15.768	0.544	15.224	0.000
	50	0.820	0.000	17.087	0.514	16.573	0.000
	60	1.952	0.000	20.494	0.111	20.384	0.000
	70	4.055	0.487	23.518	0.014	23.505	0.000
	80	6.071	0.913	27.315	0.047	27.268	0.000
	100	9.966	1.581	32.000	0.025	31.975	0.085
	150	19.434	2.225	30.748	0.000	30.748	0.157
	200	20.221	2.459	30.753	0.015	30.738	0.261

Biological Oceanography

Phytoplankton

Malte Elbraechter: Senckenberg Institute; Michael Schweikert: Ulm University; Deon Louw: NatMIRC

During the Benefit-workshop, a literature survey on papers dealing with the phytoplankton of the Benguela current was started together with Deon Louw from the institute (NatMIRC) in Swakopmund. Also a first introduction to qualitative and quantitative phytoplankton studies was given to Deon Louw and Ali Gumbo, using samples from METEOR-cruise 48/5.

Phytoplankton - Literature on the Benguela current

Compiled by M. Elbraechter and D. Louw

ARMSTRONG, M.J.; JAMES, A.G.; VALDES SZEINFELD, E.S (1991): Estimates of annual consumption of food by anchovy and other pelagic fish species off South Africa during the period 1984- 1988. - South African Journal of Marine Science **11** : 251-266.

Barnes, M. (Ed.) : Oceanography and marine Biology. An annual review **24** Volume apparently dedicated to the Benguela upwelling System

Boden, B.P. (1950) : Some marine plankton diatoms from the West Coast of South Africa. – Transactions of the Royal Society of South Africa, Cape Town 32(4) : 321-434. (Check whether relevant for Benguela Current System)

Braarud, T. (1957) : A red water organism from Walvis Bay. – Galathea Report **1** : 137-138.

Brown, P.C. (1982) : Phytoplankton production measured in situ and under simulated in situ conditions in the southern Benguela upwelling region. – Fish Bull. S. Afr. **16** : 31-37.

Chapman, P.; Mitchell-Innes, B.A.; Walker, D.R. (1994): Microplankton ETS measurements as a means of assessing respiration in the Benguela ecosystem. South African journal of marine science **14** : 297-312.

Copenhagen, W.J. (1953) : The periodic mortality of fish in the Walvis Bay Region. A phenomenon within the Benguela Current . – Investl. Rep. Div. Sea Fish. South Africa **14** : 1-35.

De Jager, B.v.D. (1954) : The South African Pilchard (*Sardinopsis ocellata*) and Maasbanker (*Trachurus trachurus*); Variation in the phytoplankton of the St. Helena Bay area during 1954. – Invet. Rep. S. Afr. Div. Fish., Pretoria **25**.

- Estrada, M. and C. Marrase (1987) : Phytoplankton biomass and productivity off the Namibian Coast. – South African Journal of Marine Science 5: 347-356.
- Giraudeau, J.; Monteiro, P.M.S.; Nikodemus, K. (1993): Distribution and malformation of living coccolithophores in the northern Benguela upwelling system off Namibia. Marine micropaleontology. Amsterdam 22(1-2) : 93-110.
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- Kollmer, W.E. (1963) : The Pilchard of South West Africa (*Sardinopsis ocellata* Pappe). Notes on zooplankton and phytoplankton collections made off Walvis Bay. – Administration of South West Africa, Marine Research Laboratory, Investigational Report 8(1) : 1-24.
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- MOLONEY, C.L.; FIELD, J.G. (1985): USE OF PARTICLE-SIZE DATA TO PREDICT POTENTIAL PELAGIC-FISH YIELDS OF SOME SOUTHERN AFRICAN AREAS. South African Journal of Marine Science .3: 119-128.
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- Shillington, F.A.; Peterson, W.T.; Hutchings, L.; Probyn, T.A.; Waldron, H.N.; Agenbag, J.J. (1990): A cool upwelling filament of Namibia, southwest Africa: Preliminary measurements of physical and biological features. Deep-sea research. Part A. Oceanographic research papers. **37(11A)** : 1753-1772.
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Chlorophyll a

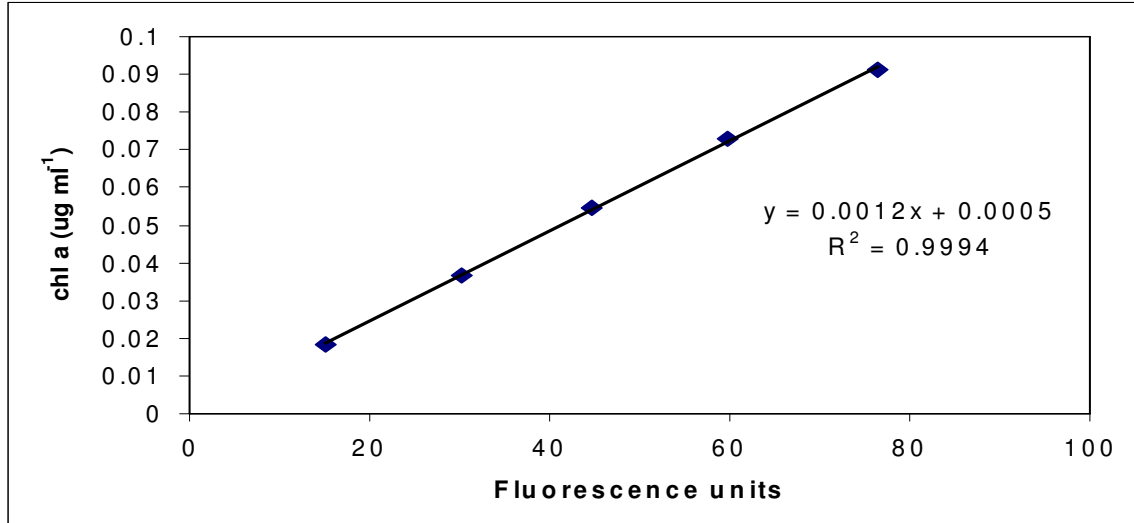
Janet Botha (NatMIRC) and Jeremia Titus (NatMIRC)

NOTE: Chlorophyll a readings still outstanding on day of binding this draft report. However, all the samples have been analyzed by Janet Botha and Jeremia Titus on the 14 November 2000.

As soon as the data has been tabulated it will be made available to all participants.

Calibration

Fluorescence units	Chl a ($\mu\text{g} / \text{ml}$)
76.4	0.09125
59.8	0.073
44.7	0.05475
30.2	0.0365
15.1	0.01825



Template for Chlorophyll a readings

Station	Depth	Range	Fluorescence	Dilution	Extract Vol (ml)	Filt Vol ml	Chl a $\mu\text{g l}^{-1}$
			0	0	0	0	0 #DIV/0!
			0	0	0	0	0 #DIV/0!
			0	0	0	0	0 #DIV/0!
			0	0	0	0	0 #DIV/0!
			0	0	0	0	0 #DIV/0!
			0	0	0	0	0 #DIV/0!
			0	0	0	0	0 #DIV/0!
			0	0	0	0	0 #DIV/0!
			0	0	0	0	0 #DIV/0!

Procedure for chl a measurement by fluorometry: (Xabier Irigoien)

Note: compiled for training purposes

Sample collection:

- Filter a known volume through a 25 mm GFF filter.
 - For this area 50 to 250 ml must be enough. I would recommend 50 ml for the stations with high diatom concentrations and 100 ml for the rest.
 - Use moderate vacuum pressure for filtration.
- Place the filters in labelled tubes and freeze. Liquid nitrogen if possible but -20 oC is also ok. Store in the darkness.

Extraction:

- Place filter in a extraction tube (glass or "acetone proof" plastic) and add 9 ml of 90 % acetone. Cover tube to avoid acetone evaporation. Place tubes in the freezer for 24 h. (4oC fridge is also ok).

Notes: An alternative procedure is to grind the filters and centrifuge after the extraction but the difference between both methods is less than 5 %. Practically most cells are broken when frozen in liquid nitrogen and defrozen.

Anyway the strongest cells, cyanobacteria, are no broken by mechanical grinding.

Practically 90 % of the extraction occurs in the first 2 h. Therefore in case of necessity a few hours extraction can be enough. Often, for practical reasons the extraction is done overnight.

Measurement

- Pour the extract from the extraction tubes into clean borosilicate tubes. Slowly and carefully to avoid filter particles to enter the measuring tube. If solid particles enter the tube let them settle before measurement.

- Remove finger marks from the measuring tube surface using a tissue.

- Place the tube in the measuring compartment. Wait until the reading is stabilised, it rarely will stop at a number but move around it. Write down the reading.

The fluorometer is setup in an automatic mode, so it will change scale automatically according with the concentration. Just for information: the low range goes from 0 to 1, medium from 1 to 10 and high from 10 to 100.

In terms of precision the ideal is to do your measurements in the medium range (not in the extremes of the calibration courbe). Once you know more or less the ecosystem you can adjust the filtration volume to get that, but do not get too worried about it.

- Rinse the used tubes with clean acetone.

- If the concentration in the tube is too high the instrument will give an over message at the high scale (wait a little to be sure). Then you need to dilute your sample. Use an automatic pipette to place 1 ml of the extract in another borosilicate tube and add 9 ml of acetone to have a 1/10 dilution and measure again (a typical mistake I do is to forget writing down the dilution). Repeat dilution if necessary (then you really have a lot of Chl a).

Avoid doing dilutions if possible, you lose time and add error to the measurement. Filtering 100 ml you should be ok for most of the stations. For the ones with diatom blooms is always difficult to estimate.

Once you have finished with your samples measure some blanks with only acetone (the tubes you have been using with the acetone used for the extraction). The value should be very close to 0. If not there is contamination somewhere !! In principle you should remove the value from the blanks to the measurements, but as it is likely to be very close to 0 you can forget it, it won't change the results.

- Use the spreadsheet to calculate the chl a concentration. The formula is ready. Basically you multiply your reading by the calibration coefficient (slope of the fluo-chl regression), to get the concentration in the measuring tube, multiply by the extraction volume to get the total amount of chl a in the sample, multiply it by the dilution factor if diluted, and from your filtered volume bring it back to a per liter concentration.

Note: Fluorescence is a robust and very sensitive technique, it allows you to measure quickly and easily very low concentrations of chl a (even chl a inside copepods), therefore is ideal for surveys and large amounts of samples. However is not a high precision method, other pigments (phaeopigments or different chlorophylls) and compounds (humic acids and yellow substances) can interfere with the measurement. Therefore do not pay too much attention to the decimals.

Avoid brilliant light in all procedures.

Save your numbers, you never know !!!

Zooplankton

Multinet and WP-2 samples

Frank Hansen: IOW, Rudi Cloete: NatMIRC, Ali Gumbo: NatMIRC, Ulrike Schütz: IOW and Tembaletu Tanci: MCM.

Objectives and programme

The group working on the samples taken with the two vertically deployed nets consisted of Rudi Cloete (NatMIRC), Ali Gumbo (NatMIRC), Frank Hansen (IOW), Ulrike Schütz (IOW) and Tembaletu Tanci (MCM). The routine of sample processing and microscopic analysis was explained to the group participants. Hans Verheye (MCM) helped to broaden our knowledge on Benguela zooplankton taxonomy and explained the stage analysis of the important calanoid copepod *Calanoides carinatus*. All WP-2 samples taken on this cruise along the 23^o South transect were analyzed in order to provide an overview of the zooplankton abundance and composition from inshore to offshore. Since NatMIRC has monitored this 23^o line for the last 11 months, including WP-2 sampling at the same stations, it was possible to compare the results of this cruise with data from the previous months. In order to get a first idea on the vertical distribution of zooplankton, the Multinet samples of the station 85, situated 10 nautical miles offshore on the 23^o South transect, were analyzed and the data were compared with the results gained from the WP-2.

Preliminary results

Along the 23^o South transect, zooplankton abundance increased from offshore to inshore. Notably, the maximum was found 20 nm miles offshore (Fig. 15). At the innermost station zooplankton abundance was as low as at stations situated 50-90 nm from the shore. Copepods by far dominated the zooplankton composition at all stations. Compared with the data from previous months, abundances were rather low in October.

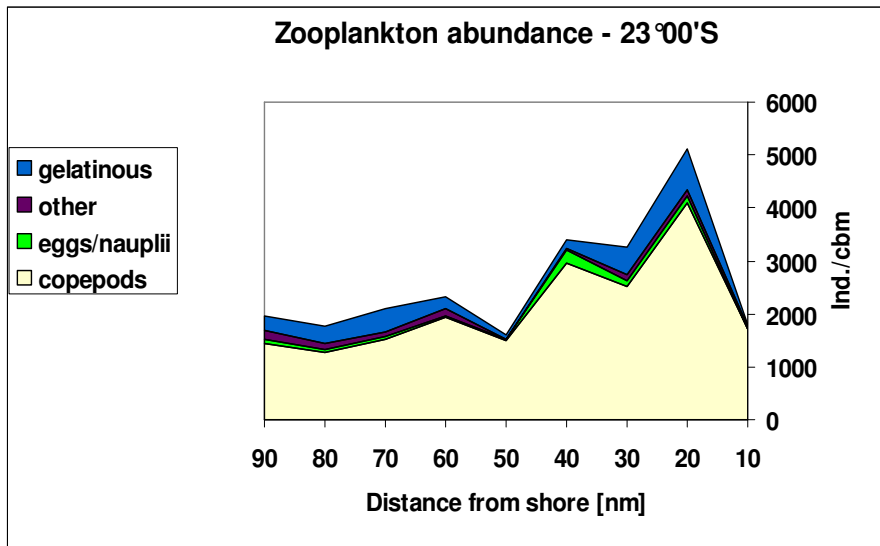


Figure 15: Abundance of major zooplankton groups along the 23°S transect in October 2000 (WP-2)

The species composition (Figure 16) of the calanoid copepods shows a large fraction of *Calanoides carinatus* at 30 nautical miles offshore. *C. carinatus* is a herbivorous copepod, which is a typical indicator species for recently upwelled water.

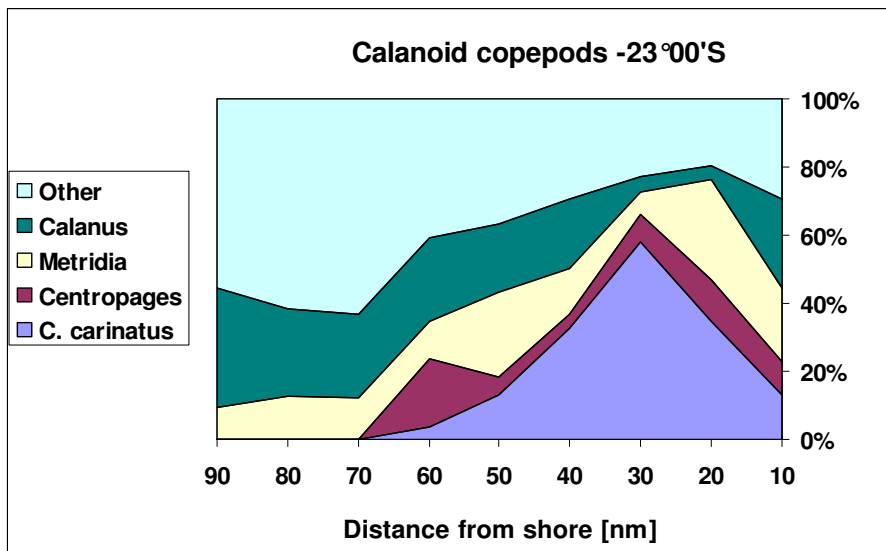


Figure 16: Calanoid copepod composition along the 23°S transect in October 2000, (WP-2).

An analysis of the depth distribution from the Multinet-samples reveals a zooplankton maximum in the intermediate water layer (Fig. 17). Adult copepods were mostly found in the upper 50 meters, whereas the sample below 50 meters consisted almost exclusively of smaller calanoid copepodites and cyclopoids. These samples were taken at about 3 o'clock at night (local time). A possible explanation for the

observed distribution pattern might be the stronger daily vertical migration in adult calanoids.

When comparing the catch efficiencies of the WP-2 and the Multinet, both nets retained about the same total number of zooplankton organisms. However, there were obvious differences in the zooplankton composition. The WP-2 was more efficient in catching adult copepods, in particular larger species, whereas the Multinet retained more eggs, nauplii, mero- and gelatinous plankton. It seems that the WP-2 was more effective in collecting zooplankton with higher swimming velocities. Possible explanations for this might be the higher winch speed of 0.75 m/s (Multinet: 0.5 m/s) and less gear in front of the net opening.

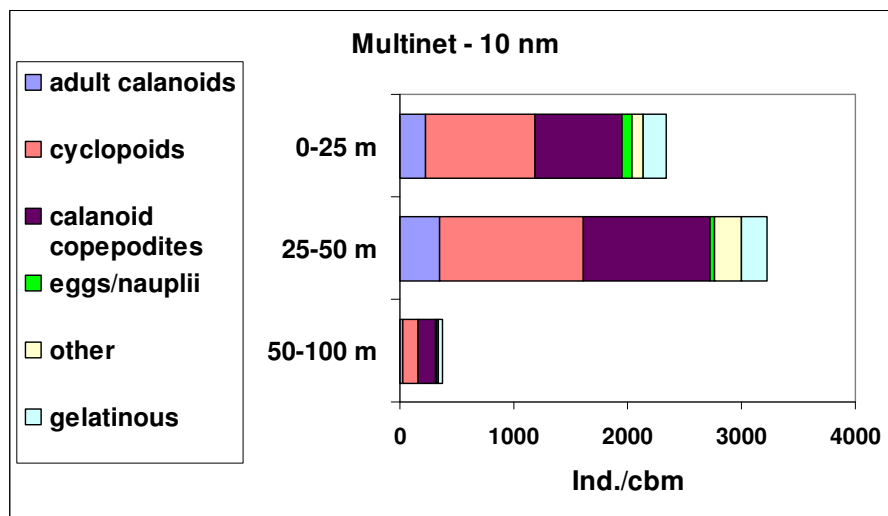


Figure 17: Vertical distribution of major zooplankton groups at 10 nautical miles offshore on the 23°S transect in October 2000

Biomoc samples

**Gerd Kraus, Christian Möllmann, Rabea Diekmann and Dirk Jarosch,
Institute of Marine Sciences in Kiel**

The Institute of Marine Sciences in Kiel, Germany, Marine Ecology Division, participated in the cruise in order to describe the distribution and abundance of zoo- and ichthyoplankton in relation to upwelling events. A group of four scientists (Dirk Jarosch, Gerd Kraus, Christian Möllmann and Rabea Diekmann), experienced with ichthyoplankton sampling procedures, was responsible for the running of the BIOMOC, a modified Mocness (Multiple Opening Closing Environmental Sensing System) with a 1 m² opening rack. Nine different nets (335 µm mesh size) could be successively used. Additionally 50µm liners with an opening size of 40mm² to sample microzooplankton were applied in the centre of each net. In general eight discrete depth layers of 25m width were sampled from 200m depth to the surface (Fig. 18). Only on the shelf edge the first net was lowered to a depth of approximately 350m

directed on the sampling of larvae of demersal fish. The gear was towed with a ship speed of 3 knots and the maximum hauling speed was 0.5m/s. Samples were taken at selected stations along five transects perpendicular to the coast from 19°S to 25°S. In total 35 hauls were conducted (Appendix 1: which follows directly after this section of the report). Samples were preserved on board in a 4% borax-buffered formalin/ freshwater solution because this provides an optimum osmotic pressure for the conservation of fish larvae.

On board 335µm samples were roughly inspected by eye and data derived by this simple method were analysed during the workshop (see below).

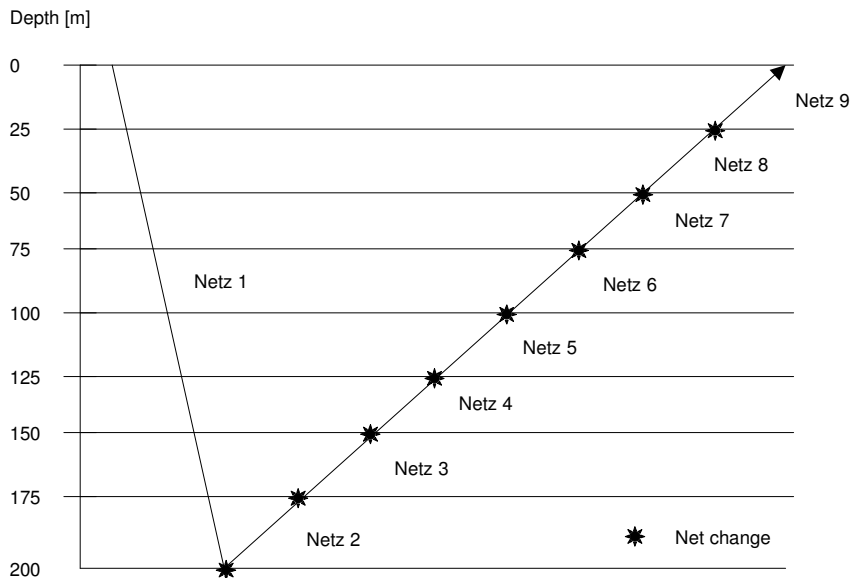


Figure 18. Schematic of the Biomoc-hauls

Workshop programme

During the workshop the group focused on the analysis of above described rough inspections of the samples, as these at the end of the cruise had to be directly shipped to Kiel, Germany. For preliminary results see below.

Additionally the group performed a literature review directed on available studies on ichthyo- and zooplankton distribution and ecology in the Northern Benguela Current Region off Namibia as well as similar studies from the Southern Benguela Current System off South Africa. Comparable studies from upwelling regions off South- and North America were identified additionally. The literature work served as a basis for a project proposal to the German Science Foundation (DFG), directed on the analysis of above described samples, which set-up was started during the workshop.

Preliminary results

As a first step in sample analysis, biovolumes of the samples divided by estimated proportions of phytoplankton (mainly *Coscinodiscus*, Diatomeae), euphausiids and other zooplankton organisms have been analysed. Jellyfish of the phylum Cnidaria were not preserved and thus, not considered in the biovolume estimations; other gelatinous plankton was included in the zooplankton fraction. For a further specification of the samples see Appendix 2 (immediately following this section).

Transect 1 (19°S)

Depth on stations of the 1st transect ranged between 664m and 209m. All 3 major groups were regularly observed in the samples (Figure 19). Maximum biovolumes of phytoplankton (*Coscinodiscus*) were found on stations 494/37 and 496/35. Euphausiids constituted in almost all samples the largest proportion of the biovolume and had a tendency to a shallower distribution at daylight (e.g. station 498/33) compared to the night time (e.g. station 495/36). No clear trends were obvious for the mixed zooplankton-group.

Transect 2 (20°S)

Water depth of the second transect ranged between 89m and 1077m. Phytoplankton (*Coscinodiscus*) was only observed on the two near coast stations (89m and 137m water depth) with the highest displacement volume on the shallowest station (Figure 20). Sample composition of the other four stations covered mainly consisted of zooplankton with relatively low abundances of euphausiids. No clear trends in the depth distribution of euphausiids and other zooplankton could be observed.

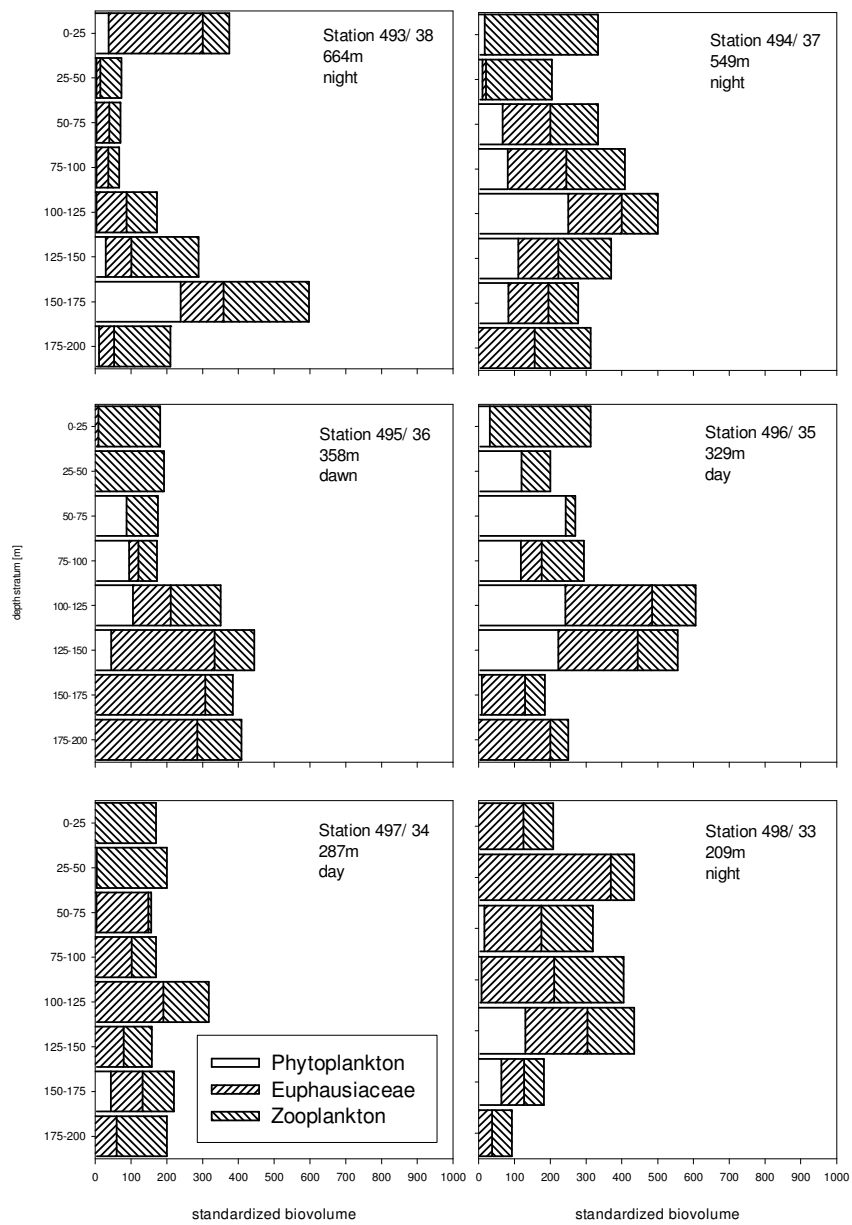


Figure 19: Rough taxonomic composition and vertical distribution on stations of transect 1.

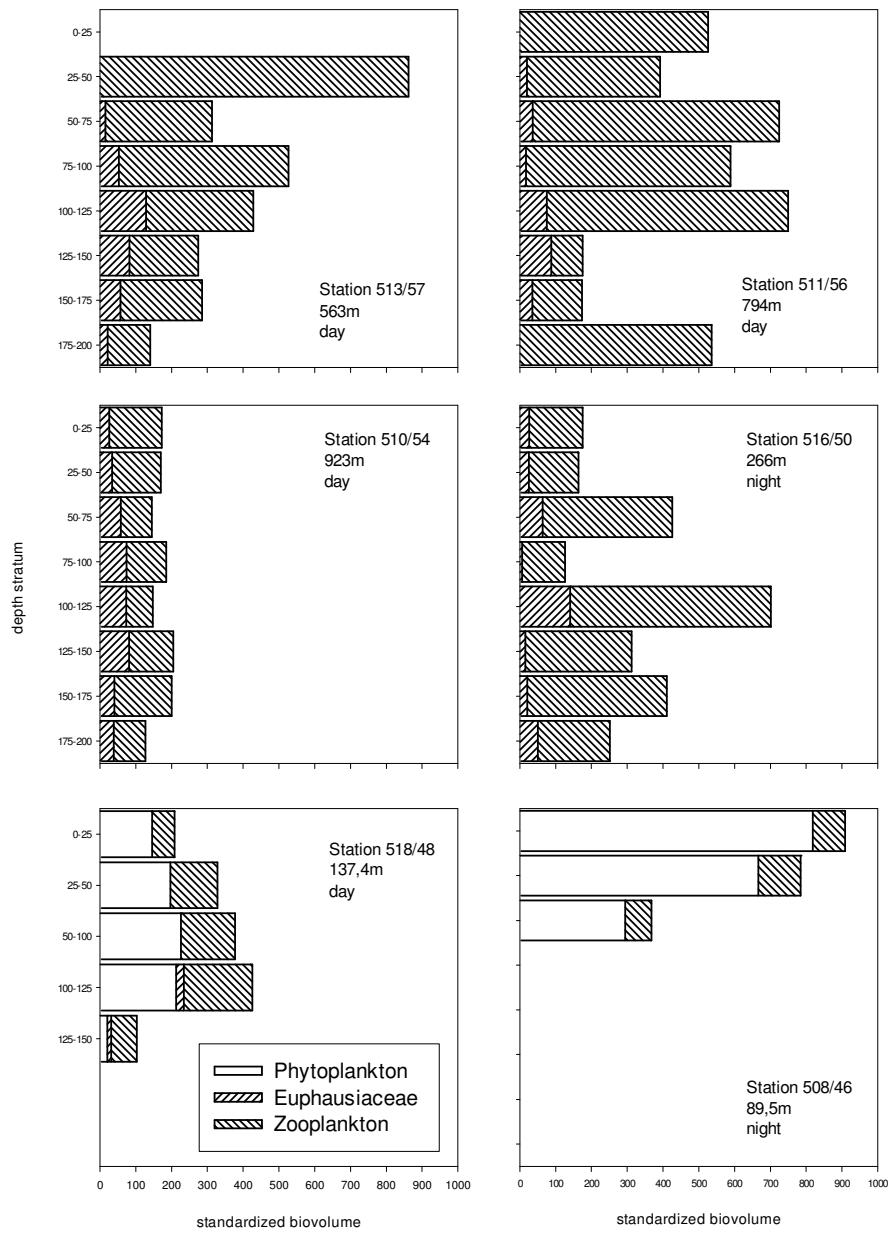


Figure 20: Rough taxonomic composition and vertical distribution on stations of transect 2.

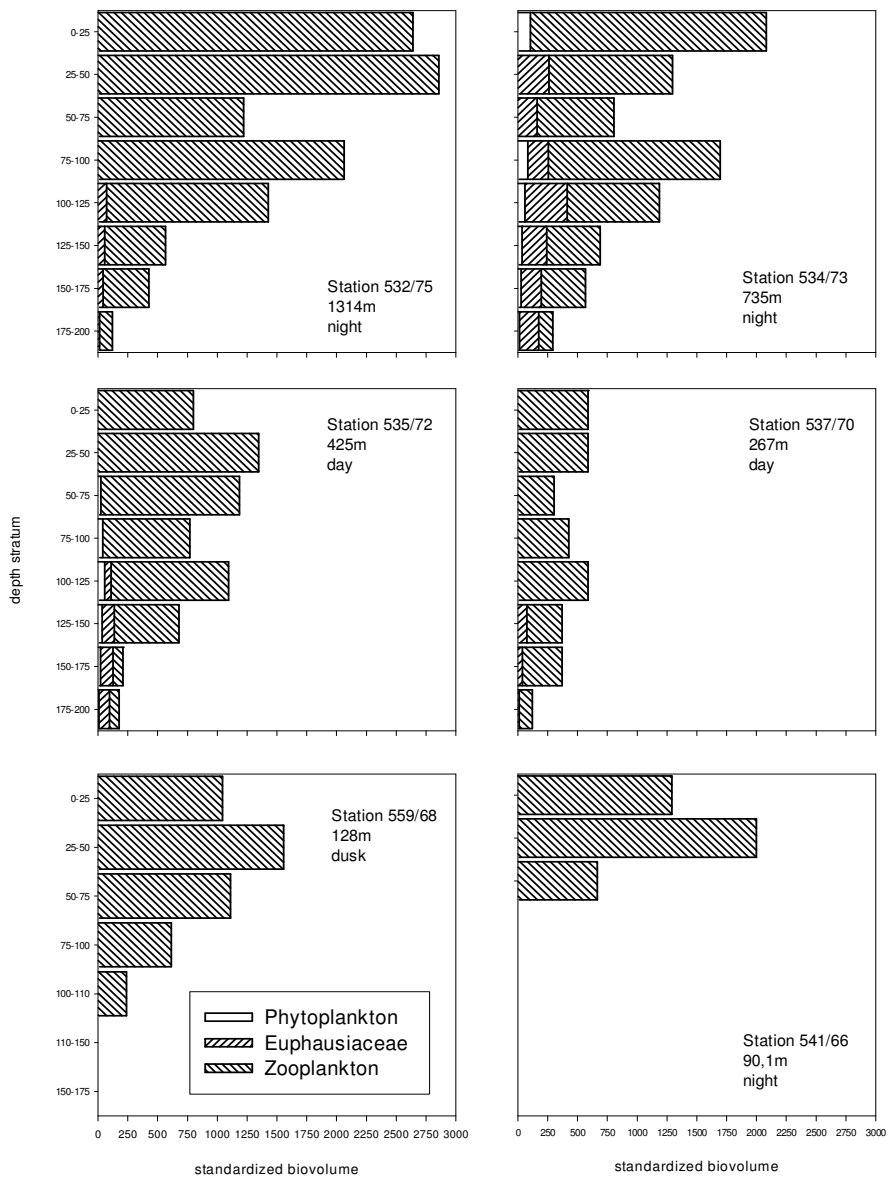


Figure 21: Rough taxonomic composition and vertical distribution on stations of transect 3.

Transect 3 (21 °S)

The third transect covered a depth range from 90m to 1314m (Figure 21). Phytoplankton was only observed on stations 534/73 displaying very low biovolumes. In contrast to transects 1 and 2 station 535/72 showed despite phyto- and zooplankton a low abundance of radiolarians (included in the phytoplankton column of Figure 4). A considerable proportion of euphausiids within the zooplankton was only found on station 534/73. On the average biovolumes were highest in the upper water layers.

Station 545/94

One biomoc haul was done apart from the transects, in shallow water (50m depth) near to Cape Cross (graph not shown). 10m depth strata were sampled to a maximum of 40m. Very high displacement volumes were measured, especially in the near bottom layers (more than 2800 units). No euphausiids and hardly any phytoplankton were found.

Transect 4 (23 °S)

Six Biomoc stations were performed on this transect covering a depth range from 919m to 98m (Figure 22). Biovolumes were not estimated on station 560/87 because nets were clogged with jellyfish of the genera *Aequorea* and *Chrysaora*. Displacement volumes were low in the oceanic stations, but reached high values at the station near the shore (St. 563/84). The abundance of euphausiids on this station was the highest observed in all samples. Phytoplankton, i.e. *Coscinodiscus*, did not appear in remarkable quantities on the whole transect.

Transect 5 (25 °S)

Stations on transect 5 covered a depth range between 71.8 and 3684m (Figure 23). Phytoplankton was only found on station 578/110 in deeper depth strata. Regularly zooplankton constituted the main fraction of the samples, whereas euphausiids were especially found in the middle of the transect.

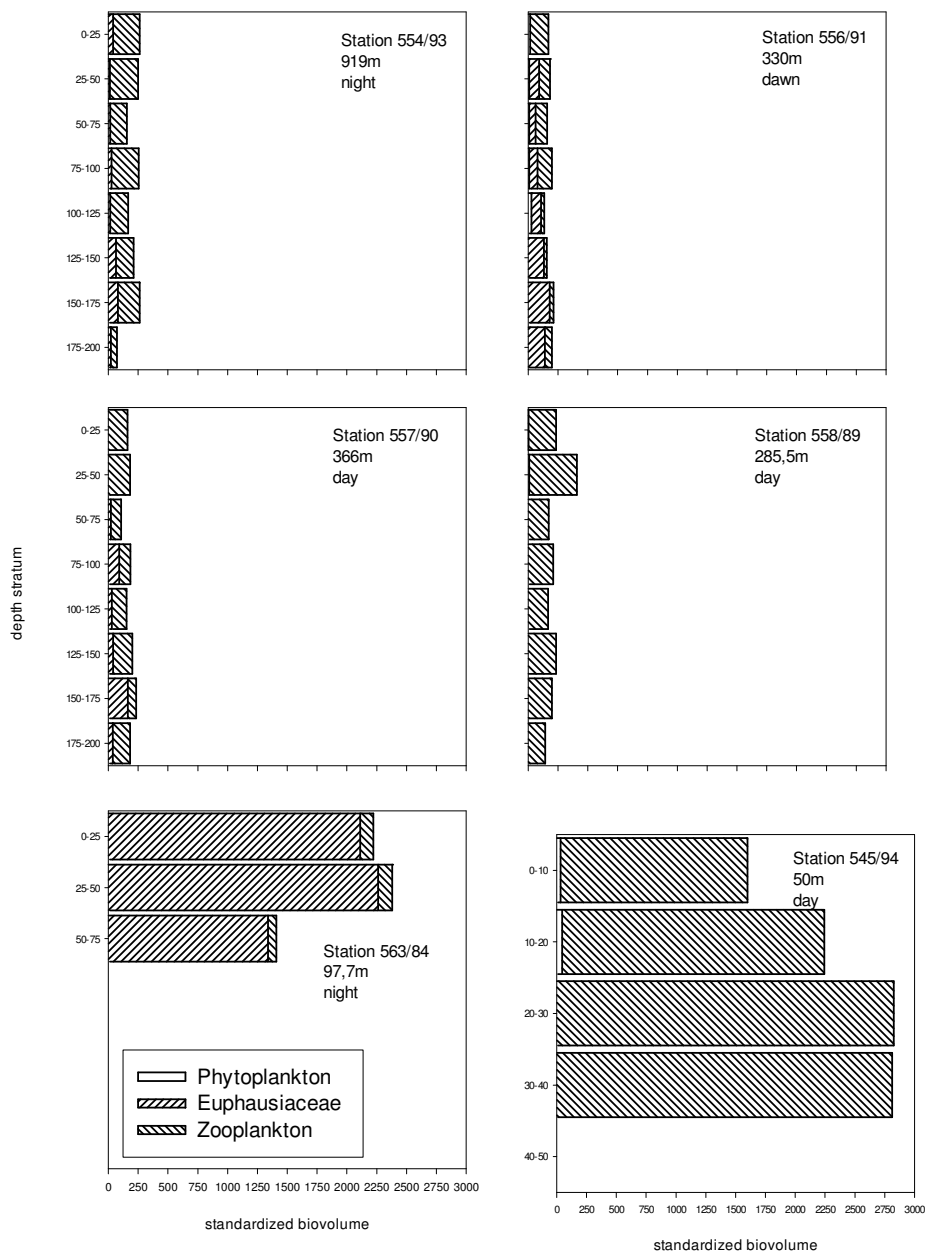


Figure 22: Rough taxonomic composition and vertical distribution on stations of transect 4.

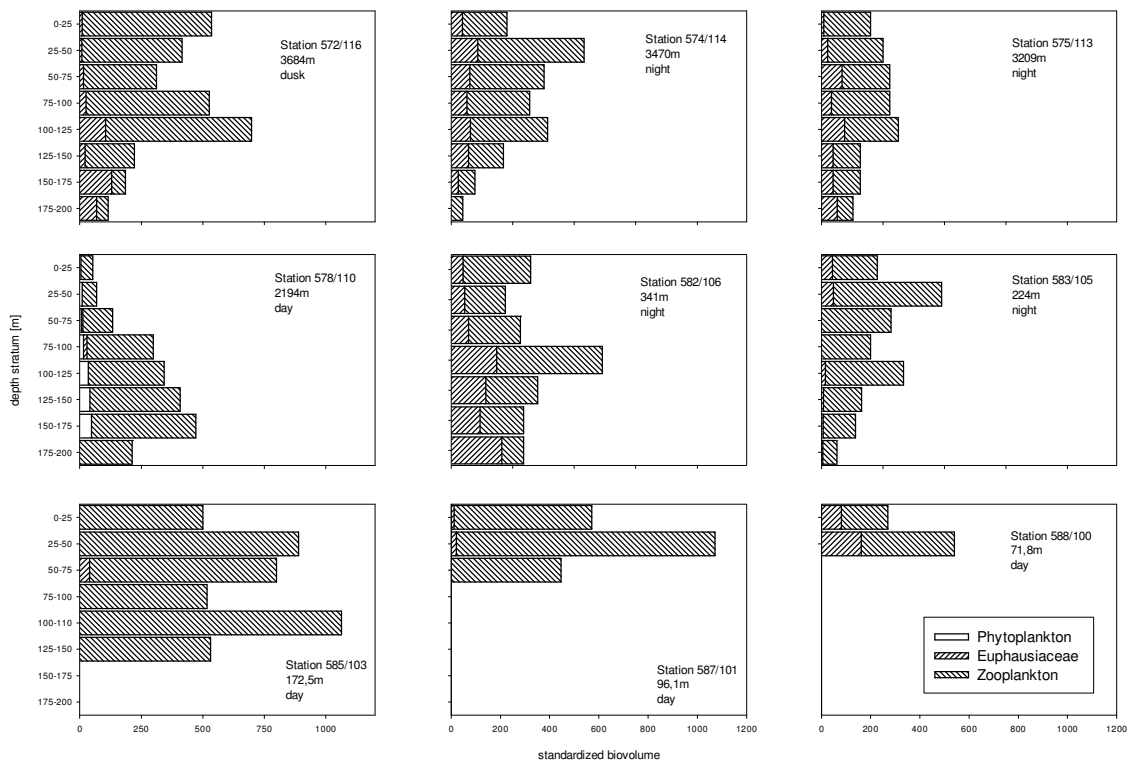


Figure 23: Rough taxonomic composition and vertical distribution on stations of transect 5.

Appendix 1. Station-specific information of BIOMOC-sampling.

Transect	Shipstation	Int. Station	Haul	date (UTC)	Start UTC	daytime	~nm from coast	Start Latitude (S)	Start Longitude (N)	water depth [m]	catch time [min:sec]
1	493	38	1	15.10.00	22:54	night	70	19°29.74`	11°22.8`	664	86:00
1	494	37	2	16.10.00	00:54	night	60	19°25.`	11°28.`	549	51:40
1	495	36	3	16.10.00	04:28	dawn	50	19°16.2`	11°37.5`	358	46:54
1	496	35	4	16.10.00	09:47	day	40	19°11.08`	11°43.22`	329	46:06
1	497	34	5	16.10.00	13:15	day	30	19°04.`	11°51.`	287	46:03
1	498	33	6	16.10.00	19:15	night	20	18°57.64`	11°58.48`	209	32:00
2	508	46	7	17.10.00	19:25	night	5	19°47.2`	12°46.68`	89.5	10:27
2	509	55	8	18.10.00	02:55	night	9	20°23.37`	1130°90.`	1077	
2	510	54	9	18.10.00	09:17	day	80	20°19.88`	11°39.23`	923	31:37
2	511	56	10	18.10.00	12:05	day	75	20°17.7`	11°43.6`	794	37:40
2	513	57	11	18.10.00	15:10	day	65	20°13.78`	11°51.08`	563	39:56
2	516	50	12	18.10.00	22:32	night	40	20°03.85`	12°12.89`	266	40:23
2	518	48	13	19.10.00	04:25	dawn	20	19°53.83`	12°32.55`	137.4	19:52
3	532	75	14	20.10.00	20:36	night	90	21°55.8`	12°17.52`	1314	34:43
3	534	73	15	21.10.00	03:01	night	70	21°49.05`	12°30.97`	735	37:07
3	535	72	16	21.10.00	06:28	day	60	21°44.08`	12°40.75`	425	34:45
3	537	70	17	21.10.00	12:15	day	40	21°34.31`	12°59.44`	267	37:48
3	539	68	18	21.10.00	17:47	dusk	20	21°24.58`	13°18.64`	128	19:50
3	541	66	19	21.10.00	22:48	night	5	21°17.32`	13°32.81`	90.1	13:22
3	545	94	20	22.10.00	13:53	day	<5	21°46.7`	13°51.79`	50	11:17
4	554	93	21	23.10.00	21:48	night	90	22°59.98`	12°47.69`	919	34:30
4	556	91	22	24.10.00	04:23	dawn	70	22°59.96`	13°05.`	330	40:31
4	557	90	23	24.10.00	08:42	day	60	22°59.96`	13°16.44`	366	41:28
4	558	89	24	24.10.00	12:03	day	50	22°59.93`	13°26.89`	285.5	36:23
4	560	87	25	24.10.00	19:15	night	30	23°00.01`	13°48.8`	146	21:53
4	563	84	26	25.10.00	02:00	night	10	22°59.99`	14°15.82`	97.7	11:48
5	572	116	27	26.10.00	17:20	dusk	160	25°29.52`	11°57.88`	3684	31:20
5	574	114	28	26.10.00	23:18	night	140	25°26.9`	12°13.75`	3470	34:18
5	575	113	29	27.10.00	02:02	night	130	25°24.91`	12°24.82`	3209	30:21
5	578	110	30	27.10.00	09:06	day	100	25°19.23`	12°57.72`	2194	37:57
5	582	106	31	27.10.00	21:10	night	60	25°11.7`	13°41.48`	341	37:10
5	583	105	32	28.10.00	01:12	night	50	25°09.81`	13°52.18`	224	36:45
5	585	103	33	28.10.00	06:03	day	30	25°06.17`	14°14.06`	172.5	20:12
5	587	101	34	28.10.00	11:08	day	10	25°02.41`	14°35.9`	96.1	09:27
5	588	100	35	28.10.00	13:46	day	5	25°01.45`	14°41.42`	71.8	05:39

Appendix 2a. Specification of BIOMOC-samples on transect 1

Station	Haul	nm	from coast	Net-No.	depth stratum	flow	towing time	Biovolume		Percentage [%]		
					[m]	[units]	[sec]	ranking	ml/ min	ml/100units	Phytoplankton	Euphausiacea
493/38	1	70	1	0-25	80	258	3	69.8	375	10	70	20
			2	25-50	136	453	1	13.2	73.5	5	15	80
			3	50-75	141	419	1	14.3	70.9	5	50	45
			4	75-100	150	420	1	14.3	66.7	5	50	45
			5	100-125	116	346	2	34.7	172.4	2	49	49
			6	125-150	104	326	3	55.2	288.5	10	25	65
			7	150-175	134	420	8	114.3	597.0	40	20	40
			8	175-200	143	451	3	39.9	209.8	5	20	75
494/37	2	60	9	0-25	30	80	1	75.0	333.3	5	0	95
			8	25-50	49	125	1	48.0	204.1	5	5	90
			7	50-75	60	158	2	75.9	333.3	20	40	40
			6	75-100	49	113	2	106.2	408.2	20	40	40
			5	100-125	60	146	3	123.3	500.0	50	30	20
			4	125-150	54	132	2	90.9	370.4	30	30	40
			3	150-175	72	172	2	69.8	277.8	30	40	30
			2	175-200	64	162	2	74.1	312.5	0	50	50
495/36	3	50	9	0-25	32	79	1	75.9	312.5	10	0	90
			8	25-50	50	132	1	45.5	200.0	60	0	40
			7	50-75	74	203	2	59.1	270.3	90	0	10
			6	75-100	68	188	2	63.8	294.1	40	20	40
			5	100-125	66	168	4	142.9	606.1	40	40	20
			4	125-150	54	127	3	141.7	555.6	40	40	20
			3	150-175	108	260	2	46.2	185.2	5	65	30
			2	175-200	80	205	2	58.5	250.0	0	80	20
496/35	4	40	9	0-25	55	170	1	35.3	181.8	0	5	95
			8	25-50	52	148	1	40.5	192.3	0	0	100
			7	50-75	57	204	1	29.4	175.4	50	0	50
			6	75-100	58	171	1	35.1	172.4	55	15	30
			5	100-125	57	175	2	68.6	350.9	30	30	40
			4	125-150	45	132	2	90.9	444.4	10	65	25
			3	150-175	52	170	2	70.6	384.6	0	80	20
			2	175-200	49	130	2	92.3	408.2	0	70	30
497/34	5	30	9	0-25	59	156	1	38.5	169.5	0	0	100
			8	25-50	50	124	1	48.4	200.0	2	0	98
			7	50-75	64	194	1	30.9	156.3	2	93	5
			6	75-100	59	166	1	36.1	169.5	0	60	40
			5	100-125	63	180	2	66.7	317.5	0	60	40
			4	125-150	63	178	1	33.7	158.7	0	50	50
			3	150-175	91	249	2	48.2	219.8	20	40	40
			2	175-200	50	215	1	27.9	200.0	0	30	70
498/33	6	20	8	0-25	48	145	1	41.4	208.3	0	60	40
			7	25-50	69	197	3	91.4	434.8	0	85	15
			6	50-100	94	265	3	67.9	319.1	5	50	45
			5	100-125	74	198	3	90.9	405.4	2	50	48
			4	125-150	69	179	3	100.6	434.8	30	40	30
			3	150-175	55	132	1	45.5	181.8	35	35	30
2	175-200	108	242	1	24.8	92.6	0	40	60			

Appendix 2b. Specification of BIOMOC-samples on transect 2

Station	Haul	nm from coast	Net-No.	depth stratum [m]	flow [units]	towing time [sec]	Biovolume			Percentage [%]		
							ranking	ml/ min	ml/100units	Phytoplankton	Euphausiaceae	other (zoopl.)
508/ 46	7	5	4	0-25	55	148	5.00	202.70	909.09	90	0	10
			3	25-50	51	136	4.00	176.47	784.31	85	0	15
			2	50-75	68	190	2.50	78.95	367.65	80	0	20
510/ 54	9	80	9	0-25	58	142	1.00	42.25	172.41		15	85
			8	25-50	59	120	1.00	50.00	169.49	0	20	80
			7	50-75	69	190	1.00	31.58	144.93	0	40	60
			6	75-100	54	132	1.00	45.45	185.19	0	40	60
			5	100-125	68	158	1.00	37.97	147.06	0	50	50
			4	125-150	49	116	1.00	51.72	204.08	0	40	60
			3	150-175	50	110	1.00	54.55	200.00	0	20	80
511/ 56	10	75	2	175-200	157	336	2.00	35.71	127.39	0	30	70
			9	25-50	57	147	3.00	122.45	526.32	0	0	100
			8	50-75	51	133	2.00	90.23	392.16	0	5	95
			7	75-100	69	183	5.00	163.93	724.64	0	5	95
			6	100-125	68	157	4.00	152.87	588.24	0	3	97
			4/5	125-150	60	139	4.50	194.24	750.00	0	10	90
			3	150-175	57	144	1.00	41.67	175.44	0	50	50
513/ 57	11	65	2	175-200	115	285	2.00	42.11	173.91	0	20	80
			9	0-25	56	143	3.00	125.87	535.71	0	0	100
			8	25-50	58	156	5.00	192.31	862.07	0	0	100
			7	50-75	64	172	2.00	69.77	312.50	0	5	95
			6	75-100	57	148	3.00	121.62	526.32	0	10	90
			5	100-125	70	158	3.00	113.92	428.57	0	30	70
			4	125-150	73	175	2.00	68.57	273.97	0	30	70
516/ 50	12	40	3	150-175	70	175	2.00	68.57	285.71	0	20	80
			2	175-200	213	541	3.00	33.27	140.85	0	15	85
			9	0-25	57	133	1.00	45.11	175.44	0	15	85
			8	25-50	61	149	1.00	40.27	163.93	0	15	85
			7	50-75	47	115	2.00	104.35	425.53	0	15	85
			6	75-100	79	197	1.00	30.46	126.58	0	5	95
			5	100-125	57	142	4.00	169.01	701.75	0	20	80
518/ 48	13	20	4	125-150	64	164	2.00	73.17	312.50	0	5	95
			3	150-175	73	200	3.00	90.00	410.96	0	5	95
			2	175-200	159	392	4.00	61.22	251.57	0	20	80
			6	0-25	48	134	1.00	44.78	208.33	70	0	30
			5	25-50	61	166	2.00	72.29	327.87	60	0	40
			4	50-100	53	136	2.00	88.24	377.36	60	0	40
			3	100-125	47	114	2.00	105.26	425.53	50	5	45
			2	125-150	97	226	1.00	26.55	103.09	20	10	70

Appendix 2c. Specification of BIOMOC-samples on transect 3.

Station	Haul	nm from coast	Net-No.	depth stratum [m]	flow [units]	towing time [sec]	Biovolume			Percentage [%]		
							ranking	ml/ min	ml/100units	Phytoplankton	Euphausiacea	other (zoopl.)
532/75	14		9	0-25	53	175	14	480.0	2641.509434	0	0	100
			8	25-50	49	128	14	656.3	2857.1	0	0	100
			7	50-75	82	196	10	306.1	1219.5	0	0	100
			6	75-100	63	142	13	549.3	2063.5	0	0	100
			5	100-125	70	168	10	357.1	1428.6	0	5	95
			4	125-150	53	133	3	135.3	566.0	0	10	90
			3	150-175	47	115	2	104.3	425.5	0	10	90
			2	175-200	166	332	2	36.1	120.5	0	10	90
		534/73	15		9	0-25	48	118	10	508.5	2083.3	5
	8			25-50	54	129	7	325.6	1296.3	0	20	80
	7			50-75	62	164	5	182.9	806.5	0	20	80
	6			75-100	53	141	9	383.0	1698.1	5	10	85
	5			100-125	59	165	7	254.5	1186.4	5	30	65
	4			125-150	58	163	4	147.2	689.7	5	30	65
	3			150-175	53	136	3	132.4	566.0	5	30	65
	2			175-200	102	247	3	72.9	294.1	5	55	40
535/72	16				9	0-25	50	148	4	162.2	800.0	0
			8	25-50	52	142	7	295.8	1346.2	0	0	100
			7	50-75	59	168	7	250.0	1186.4	2	0	98
			6	75-100	65	182	5	164.8	769.2	5	0	95
			5	100-125	73	176	8	272.7	1095.9	5	5	90
			4	125-150	59	146	4	164.4	678.0	5	15	80
			3	150-175	48	122	1	49.2	208.3	10	50	40
			2	175-200	114	238	2	50.4	175.4	5	50	45
		537/70	17		9	0-25	51	154	3	116.9	588.2	0
	8			25-50	51	132	3	136.4	588.2	0	0	100
	7			50-75	66	174	2	69.0	303.0	0	0	100
	6			75-100	47	112	2	107.1	425.5	0	0	100
	5			100-125	51	121	3	148.8	588.2	0	0	100
	4			125-150	54	134	2	89.6	370.4	0	20	80
	3			150-175	54	135	2	88.9	370.4	0	10	90
	2			175-200	167	395	2	30.4	119.8	0	10	90
559/68	18				6	0-25	48	146	5	205.5	1041.7	0
			5	25-50	45	149	7	281.9	1555.6	0	0	100
			4	50-75	36	122	4	196.7	1111.1	0	0	100
			3	75-100	49	148	3	121.6	612.2	0	0	100
			2	100-110	84	203	2	59.1	238.1	0	0	100
		541/66	19		4	0-25	31	104	4	230.8	1290.3	0
	3			25-50	35	87	7	482.8	2000.0	0	0	100
	2			50-75	120	289	8	166.1	666.7	0	0	100

Appendix 2d. Specification of BIOMOC-samples on transect 4.

Station	Haul	nm from coast	Net-No.	depth stratum [m]	flow [units]	towing time [sec]	Biovolume			Percentage [%]		
							ranking	ml/ min	ml/100units	Phytoplankton	Euphausiaceae	other (zoopl.)
545/94	20		5	0-10	50	149	8	322.1	1600.0	2	0	98
			4	10-20	49	136	11	485.3	2244.9	2	0	98
			3	20-30	46	136	13	573.5	2826.1	0	0	100
			2	30-40	32	117	9	461.5	2812.5	0	0	100
554/93	21		9	0-25	38	111	1	54.1	263.1578947	0	15	85
			8	25-50	40	108	1	55.6	250.0	0	5	95
			7	50-75	65	175	1	34.3	153.8	0	10	90
			6	75-100	39	111	1	54.1	256.4	0	10	90
			5	100-125	60	196	1	30.6	166.7	0	10	90
			4	125-150	47	147	1	40.8	212.8	0	30	70
			3	150-175	38	118	1	50.8	263.2	0	30	70
			2	175-200	138	382	1	15.7	72.5	0	30	70
556/91	22		9	0-25	59	144	1	41.7	169.5	10	0	90
			8	25-50	55	141	1	42.6	181.8	5	45	50
			7	50-75	63	174	1	34.5	158.7	5	35	60
			6	75-100	50	126	1	47.6	200.0	5	35	60
			5	100-125	74	195	1	30.8	135.1	20	60	20
			4	125-150	64	174	1	34.5	156.3	0	85	15
			3	150-175	94	244	2	49.2	212.8	0	85	15
			2	175-200	50	135	1	44.4	200.0	0	70	30
557/90	23		9	0-25	62	213	1	28.2	161.3	0	0	100
			8	25-50	55	135	1	44.4	181.8	0	0	100
			7	50-75	93	222	1	27.0	107.5	0	20	80
			6	75-100	54	148	1	40.5	185.2	0	50	50
			5	100-125	66	170	1	35.3	151.5	0	20	80
			4	125-150	50	141	1	42.6	200.0	0	20	80
			3	150-175	43	110	1	54.5	232.6	0	70	30
			2	175-200	55	140	1	42.9	181.8	0	20	80
558/89	24		9	0-25	43	108	1	55.6	232.6	2	0	98
			8	25-50	49	118	2	101.7	408.2	2	0	98
			7	50-75	58	162	1	37.0	172.4	0	0	100
			6	75-100	48	127	1	47.2	208.3	0	0	100
			5	100-125	60	161	1	37.3	166.7	0	0	100
			4	125-150	43	107	1	56.1	232.6	0	0	100
			3	150-175	50	124	1	48.4	200.0	0	0	100
			2	175-200	140	322	2	37.3	142.9	0	0	100
560/87	25		6	0-25	61	166	-	-	-	0	0	100
			5	25-50	54	158	-	-	-	0	0	100
			4	50-75	60	166	-	-	-	0	0	100
			3	75-100	51	136	-	-	-	0	0	100
563/84	26		2	100-110	100	224	-	-	-	0	0	100
			4	0-25	45	111	10	540.5	2222.2	0	95	5
			3	25-50	42	109	10	550.5	2381.0	0	95	5
			2	50-75	71	188	10	319.1	1408.5	0	95	5

Appendix 2e. Specification of BIOMOC-samples on transect 5.

Station	Haul	nm from coast	Net-No.	depth stratum [m]	flow [units]	towing time [sec]	ranking	Biovolume		Phytoplankton	Percentage [%]	
								ml/min	ml/100units		Euphausiacea	other (zoopl.)
572/116	27	160	9	0-25	56	175	3	102.9	535.7142857	0	2	98
			8	25-50	48	128	2	93.8	416.7	0	2	98
			7	50-75	64	176	2	68.2	312.5	0	5	95
			6	75-100	57	156	3	115.4	526.3	0	5	95
			5	100-125	43	114	3	157.9	697.7	0	15	85
			4	125-150	45	124	1	48.4	222.2	0	10	90
574/114	28	140	3	150-175	54	148	1	40.5	185.2	0	70	30
			2	175-200	87	208	1	28.8	114.9	0	60	40
			9	0-25	44	140	1	42.9	227.3	0	20	80
			8	25-50	37	91	2	131.9	540.5	0	20	80
			7	50-75	53	158	2	75.9	377.4	0	20	80
			6	75-100	47	126	1.5	71.4	319.1	0	20	80
			5	100-125	51	135	2	88.9	392.2	0	20	80
			4	125-150	47	130	1	46.2	212.8	0	33	67
			3	150-175	52	150	0.5	20.0	96.2	0	30	70
			2	175-200	108	262	0.5	11.5	46.3	0	0	100
			9	0-25	50	146	1	41.1	200.0	0	5	95
			8	25-50	40	110	1	54.5	250.0	0	10	90
			7	50-75	54	154	1.5	58.4	277.8	0	30	70
			6	75-100	36	97	1	61.9	277.8	0	15	85
			5	100-125	48	132	1.5	68.2	312.5	0	30	70
			4	125-150	63	167	1	35.9	158.7	0	30	70
			3	150-175	63	169	1	35.5	158.7	0	30	70
			2	175-200	78	189	1	31.7	128.2	0	50	50
578/110	30	100	9	0-25	94	210	0.5	14.3	53.2	10	0	90
			8	25-50	73	188	0.5	16.0	68.5	15	0	85
			7	50-75	75	184	1	32.6	133.3	5	5	90
			6	75-100	67	178	2	67.4	298.5	5	5	90
			5	100-125	73	214	2.5	70.1	342.5	10	0	90
			4	125-150	49	134	2	89.6	408.2	10	0	90
			3	150-175	53	150	2.5	100.0	471.7	10	0	90
			2	175-200	117	276	2.5	54.3	213.7	0	0	100
			9	0-25	62	162	2	74.1	322.6	0	15	85
			8	25-50	91	222	2	54.1	219.8	0	25	75
			7	50-75	71	177	2	67.8	281.7	0	25	75
			6	75-100	57	160	3.5	131.3	614.0	0	30	70
			5	100-110	57	165	2	72.7	350.9	0	40	60
			4	125-150	68	202	2	59.4	294.1	0	40	60
			3	150-175	34	105	1	57.1	294.1	0	70	30
			2	175-200	41	121	1	49.6	243.9	0	60	40
			9	0-25	44	123	1	48.8	227.3	0	20	80
			8	25-50	41	117	2	102.6	487.8	0	10	90
			7	50-75	53	157	1.5	57.3	283.0	0	0	100
			6	75-100	50	135	1	44.4	200.0	0	0	100
			5	100-110	60	153	2	78.4	333.3	0	5	95
			4	125-150	61	153	1	39.2	163.9	0	5	95
			3	150-175	72	182	1	33.0	138.9	0	5	95
			2	175-200	159	382	1	15.7	62.9	0	10	90
585/103	33	30	7	0-25	60	148	3	121.6	500.0	0	0	100
			6	25-50	45	108	4	222.2	888.9	0	0	100
			5	50-75	50	112	4	214.3	800.0	0	5	95
			4	75-100	58	134	3	134.3	517.2	0	0	100
			3	100-110	47	112	5	267.9	1063.8	0	0	100
			2	125-150	94	208	5	144.2	531.9	0	0	100
587/101	34	10	4	0-25	35	92	2	130.4	571.4	0	2	98
			3	25-50	28	70	3	257.1	1071.4	0	2	98
			2	50-75	56	149	2.5	100.7	446.4	0	0	100
			3	0-25	37	92	1	65.2	270.3	0	30	70
			2	25-50	37	98	2	122.4	540.5	0	30	70

SECONDARY PRODUCTION

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Introduction

In contrast to primary production, which has been measured in aquatic systems for several decades, the measurement of productivity by zooplankton, especially in marine environments, is a comparatively new field of research. It has been argued that the only way to measure zooplankton production accurately is by estimation of species-specific growth rates. Field-based research on the growth rate of copepods has focussed on female egg production, rather than juvenile growth, because of its ease of measurement using bottle incubations.

Identifying factors that control growth of copepods is essential to understand nutrient and carbon fluxes in the marine environment. There has been considerable debate in the literature about the relative importance of the two main factors that control copepod growth, viz. temperature and food. On the one hand, copepods grow at maximum rates in the sea, with an exponential increase in growth rate with temperature over a wide range of habitats (Huntley & Lopez 1992). On the other hand, copepod growth has been found to be more related to food (in terms of both quantity and quality, i.e. nutritional value and particle size of the phytoplankton) rather than temperature, and in the southern Benguela region, the lack of dependence of growth on temperature was attributed to slower growth at warm (18-22°C) temperatures (Richardson & Verheye 1998), a consequence of very low (usually $<2 \text{ mg Chl.m}^{-3}$) food concentrations at these temperatures. Moreover, it has been suggested that food may also be limited in a body-size dependent way, with larger individuals being more food limited (Hirst & Sheader 1997, Richardson & Verheye 1999, Richardson *et al.* in press).

Recent laboratory experiments have shown that diatoms have a deleterious effect on the hatching success of copepod eggs (Ban *et al.* 1996). This effect has been attributed to the toxicity of some amino compounds produced by diatoms (Miralto *et al.* 2000) but controversy remains on whether diatoms are really toxic or just nutritionally insufficient (Jonasdottir *et al.* 1998). The suggested toxic effect being concentration dependent, the distinction between toxicity or insufficiency is extremely important in upwelling areas where the diatoms can reach very high biomasses. If diatoms were nutritionally insufficient, alternative food sources such as microzooplankton can provide the necessary basic compounds (aminoacids or lipids) for copepods. However, if diatoms were toxic, our basic understanding of the trophic energy flow in upwelling systems, viz. diatom \rightarrow copepod \rightarrow fish, is flawed and a new interpretation of the productivity transfer from diatoms to fish will be required.

Objectives

The objectives of this project, as part of the zooplankton studies conducted during RV *Meteor* cruise M48-5 in the northern Benguela region (13-31 October 2000), are twofold:

1. to estimate daily egg production and moulting rates of a number of common copepod species (over an as wide as possible range of body size) in contrasting areas of thermal (inshore vs offshore) and food conditions (e.g. low vs high Chl *a*, small-cell (dinoflagellates) vs large-cell (diatoms) dominated assemblages), and
2. to assess the hatching success of copepod eggs produced under contrasting feeding conditions (diatom-dominated vs non-diatom food assemblages).

Methodology

1. Copepod production

Daily production (P ; grams per m^2 per day) of copepods is the product of copepod biomass (B , grams per m^2 ; to be obtained from various zooplankton samplers such as the MultiNet) and daily growth rate (g , per day; obtained from incubation experiments on board):

$$P = B \times g$$

Daily growth rates of copepods were derived from daily rates of egg production of adult females (= reproductive growth) and daily moulting rates of juvenile stages (= somatic growth) estimated using simple, but laborious (!) bottle incubation techniques. Copepods were collected using a 300- μ m mesh drift net, fitted with a 2-litre plastic bottle as a cod-end and allowed to drift for 5 minutes at a depth usually between 5 and 10 m. Alternatively, a WP-2 net (500 μ m), hauled at a very slow rate through the upper 100 m of the water column, was also used for collections of copepods from deeper water layers. Upon retrieval the sample was transferred into a bucket of ambient surface water. Copepods were gently removed from this bucket using a sieve and washed into a petri dish, and lively and undamaged specimens of dominant species were selected with a wide-mouthed dropper under a dissecting microscope.

For egg production experiments, usually 1-2 females per species were placed in a 1-litre bottle (usually 5 replicates per station) containing 80- μ m filtered seawater from the surface and incubated in a plankton wheel (0.2 rpm) in a temperature-controlled room (14-16 °C) for 24 hours. After 24 hours, the contents of each incubation bottle were poured through a 37(or 50) μ m mesh, the condition of the females checked and the eggs and hatched nauplii enumerated (N_e). Experiments with dead or moribund females were discarded from further analyses. Where eggs were spawned in sufficient numbers, they were re-incubated for subsequent assessment of their hatchability (see below). Daily egg production (E ; eggs per female per day) over the incubation time (T) was calculated as:

$$E = N_e \times 24/T$$

To enable direct comparison of female growth rates of different species, instantaneous weight-specific female growth rates (g_f , per day) were calculated from published data of female body mass (W_f) and egg mass (W_e), and the number of eggs (E) spawned per female during the 24-hour incubation experiments as:

$$g_f = (E \times W_e)/W_f$$

For moulting rate experiments (mainly using the dominant copepod *Calanoides carinatus* – cf. ease of recognition of its juvenile stages amongst those of other species), at least 15 individuals of a particular stage i were incubated in a 2-litre bottle filled with 80- μ m filtered ambient surface water. After 24 hours, the contents of the incubation bottle were preserved and the number of individuals that had moulted (N_{i+1}) and not moulted (N_i) to the next stage $i+1$ were counted. The moulting ratio (MR_i) of each juvenile stage i was calculated as:

$$MR_i = N_{i+1}/(N_i + N_{i+1})$$

Exoskeletons were also counted and experiments were excluded from analyses if the difference between the moulting ratio calculated from the exoskeletons and that from the animals themselves was >10%. The daily stage-specific growth rate (g_i ; per day) was calculated from the moulting ratio using published average body masses W_i and W_{i+1} of successive developmental stages i and $i+1$ respectively, as:

$$g_i = \ln(W_{i+1}/W_i) \times MR_i \times 24/T$$

At each station, the concentration of Chl a in the surface water (but screened through a 80- μ m mesh), which was used for the incubations, was considered as a measure of ambient food availability for the copepods. Samples for future detailed taxonomic and quantitative analysis of the ambient phytoplankton assemblage were also collected from selected depths of the CTD Rosette cast.

2. Hatching success of copepod eggs

In addition to the eggs harvested from the above egg production incubation experiments, eggs were also obtained from 24-hour incubations containing 20-40 females of dominant species. These were placed in 1-litre beakers with a built-in 500- μ m screen which separates the females from their eggs produced, thus preventing possible egg cannibalism under high densities of female copepods.

All eggs thus harvested were then isolated in batches of up to 100 individuals and incubated in filtered seawater for a further 24- or 48-hour period. At the end of these experiments, unhatched eggs and nauplii were preserved. The proportion of the number of eggs hatched (i.e. nauplii) to that of the total number of eggs incubated is an index of the hatchability or hatching success of the eggs. This index will be determined during the post-cruise workshop held at NatMIRC in Swakopmund, Namibia.

Preliminary results.

In total, 281 incubation experiments were performed with 1 462 females of dominant copepod species including *Calanoides carinatus*, *Rhincalanus nasutus*, *Metridia lucens*, *Centropages brachiatus*, *Nannocalanus minor*, *Eucalanus elongatus/hyalinus*, *Pleuromamma robusta*, *Pleuromamma* sp., *Aetideus* sp., in addition to a few as yet unidentified species. These yielded a total of 12 247 eggs, most of which were subsequently incubated for 24-48 hours to establish hatching success (i.e. 107 hatching experiments in total)..

The results of onboard analyses of daily egg production thus far obtained indicate a clear inshore-offshore trend (Fig. 24), with increased rates near the coast, associated with dense blooms of diatoms (e.g. *Skeletonema*, *Chaetoceros*, *Coscinodiscus*), whereas rates were near-zero at the offshore extent of the transects, where dinoflagellates predominated.

Samples for the estimation of hatching rate of copepod eggs still need to be analysed in conjunction with detailed taxonomic analyses of the ambient and experimental phytoplankton communities.

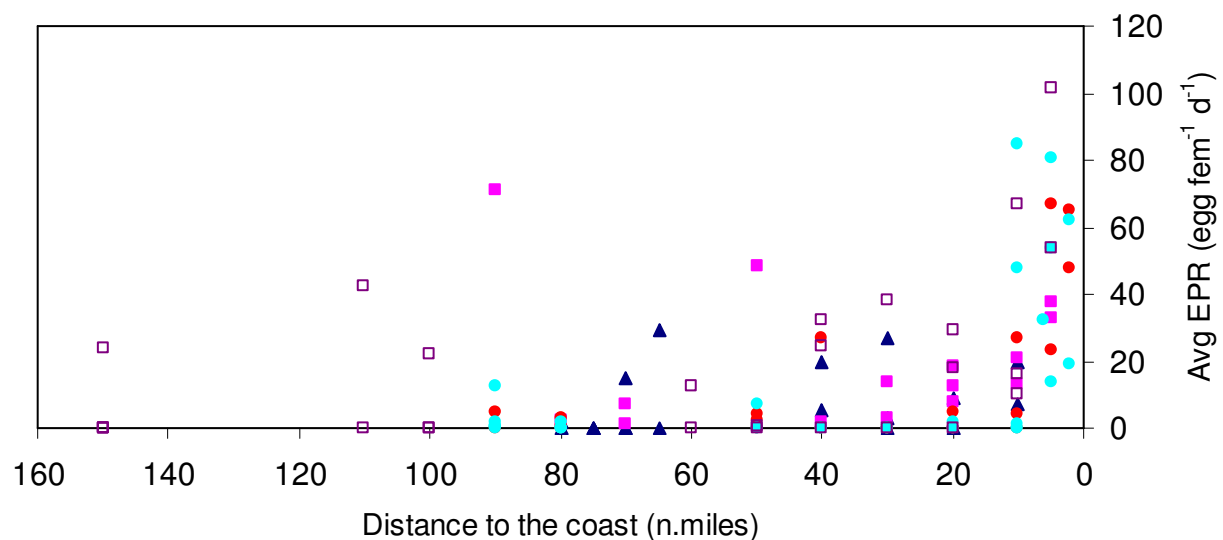


Fig. 24: Cross-shelf distribution of daily egg production determined from bottle incubation experiments (all 5 transects combined).

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ANNEX 1 : STATION OVERVIEW

All **physical CTD data** mentioned below are invalidated and therefore only preliminary (compiled by Rainer Feistel). Time is given in UTC. Positions are actual GPS positions which may deviate from the plan positions. Depths are echo sounding depths at GPS positions. Surface properties are taken from the uppermost CTD sample, taken usually between 5m and 10m depth.

Characterisation of upwelling compiled by Malte Elbraechter and Michael Schweikert.

- 1) This list is a preliminary characterization of possible upwelling events based only on the species composition and physiological stage as revealed by light microscopy on board the ship of the microplankton caught by the 20 µm micronet, towed from about 20 m water depth to the surface. The characterisation has been made without looking at the location of the stations.

The species names used are only preliminary :

- 2) exact determination of many species can be made only after sophisticated species analysis with scanning electron microscopy and/or dissection of the plates, especially for thecate dinoflagellates. Recent publications of new described species have to be used. On board the ship only the ancient determination books of Hustedt (1930) for diatoms and Schiller (1931-37) for dinoflagellates have been used but new names have been used in some cases, e.g., *Pseudo-nitzschia* instead of *Nitzschia* or *Protoperidinium* instead of *Peridinium*.
- 3) Accordingly, some of the used names are now no longer regarded as correct, and these have to be replaced with the according literature.

Abbreviations : **sp.** means : species not identified; **ssp.** means : two or more species of the same genus;

Multinet samples (Frank Hansen): On our first transect at approximately 19 degrees South, we took samples with the Multinet at ten stations, starting from the most offshore station (491/40). The Multinet is a multiple opening closing net, equipped with 5 separate nets of 200 µm mesh-size and a depth sensor. If water depth was permitting, samples were collected from 5 different depth ranges: 0-25 m , 25-50 m, 50-100 m, 100-150 m and 150-200 m and the collected plankton was preserved in buffered freshwater-formalin of 4% final concentration. Samples were characterized by noting the estimated volume of the plankton in the sample, the colour of the sample, the amount of diatoms and the presence of larger copepods and makrozooplankton taxa as it could be seen with the naked eye. In general, samples with a considerable amount of diatoms looked green. Exceptions are noted below.

On our second transect at approximately 20 degrees South, we took samples with the Multinet at twelve stations, starting from the most offshore station (509/55). On our third transect at approximately 22 degrees South, we took samples with the Multinet at nine stations, starting from the most offshore station (533/74). A additional sample from 20 meter depth to the surface was taken close inshore off Cape Cross (545/94). On our fourth transect at 23 degrees South, we took samples with the Multinet at eleven stations, starting from the most offshore station (554/93). The 25 degrees South transect has been longer than the previous transects, extending to approximately 160 nautical miles offshore. The transect contained 16 stations (572/116-588/100) where Multinet-samples have been taken.

Test Station

Station Label: 0	Number: 484	File: 0484F01.cnv
Date: 13.10.2000	Time: 14:33:47	
Latitude:-22°60.00'	Longitude: 13°60.00'	Depth[m]: 140.4
Surface Temp [°C]: 13.99	Salinity [PSU]: 35.01	Density [kg/m ³]: 1026.22
Oxygen [ml/l]: 10.62	Chlorophyll: 23.46	Turbidity: 0.09

Dominant species : Diatoms : *Skeletonema costatum*, several *Thalassiosira*-species, *Corethron* sp., *Asterionellopsis glacialis*, *Pseudo-nitzschia* ssp.

Characterisation : Upwelled water, not very recent, as diatoms with parasites

Transect 200m Northward 23°S to 19°S

Station Label: 26 Number: 485 File: 0485F01.cnv
Date: 13.10.2000 Time: 19:07:53
Latitude:-22°59.88' Longitude: 13°30.90' Depth[m]: 222.1
Surface Temp [°C]: 14.23 Salinity [PSU]: 35.02 Density [kg/m³]: 1026.18
Oxygen [ml/l]: 8.74 Chlorophyll: 1.73 Turbidity: 0.08

Dominant species : Copepods and their faeces, many heterotrophic dinoflagellates, tintinnids (Ciliata), planktonic foraminifera and radiolaria, very few diatoms

Characterisation : late succession of upwelling

Station Label: 27 Number: 486 File: 0486F01.cnv
Date: 14.10.2000 Time: 2:11:24
Latitude:-21°59.97' Longitude: 13°10.42' Depth[m]: 205.8
Surface Temp [°C]: 14.86 Salinity [PSU]: 35.13 Density [kg/m³]: 1026.12
Oxygen [ml/l]: 7.81 Chlorophyll: 2.53 Turbidity: 0.08

Dominant species : many copepods and faeces, fewer tintinnids, few diatoms and dinoflagellates

Characterisation : later succession stage than station 485

Station Label: 28 Number: 487 File: 0487_01.cnv
Date: 14.10.2000 Time: 9:11:47
Latitude:-21°00.04' Longitude: 12°56.72' Depth [m]: 214.1
Surface Temp [°C]: 15.04 Salinity [PSU]: 35.17 Density [kg/m³]: 1026.11
Oxygen [ml/l]: 7.54 Chlorophyll: 2.76 Turbidity: 0.08

Dominant species : many copepods and their faeces, also the diatom *Coscinodiscus wailesii*

Characterisation : two possibilities : 1) as station 487 with mixing of an other water body (origin of *Coscinodiscus*, see next station) or 2) late stage of another upwelling event

Station Label: 29 Number: 488 File: 0488F01.cnv
Date: 14.10.2000 Time: 16:45:28
Latitude:-19°59.98' Longitude: 12°20.00' Depth [m]: 215.8
Surface Temp [°C]: 15.05 Salinity [PSU]: 35.23 Density [kg/m³]: 1026.15
Oxygen [ml/l]: 8.76 Chlorophyll: 7.88 Turbidity: 0.08

Dominant species : Diatoms : *Coscinodiscus wailesii*, *Pseudo-nitzschia* ssp., *Thalassiosira* ssp.; *Bacteriastrum hyalina* ; many heterotrophic dinoflagellates and tintinnids

Characterisation : older upwelled water as many heterotrophic dinoflagellates and tintinnids are present

Station Label: 30 Number: 489 File: 0489F01.cnv
Date: 14.10.2000 Time: 23:55:30
Latitude:-18°59.80' Longitude: 12°00.13' Depth[m]: 206.9
Surface Temp [°C]: 14.28 Salinity [PSU]: 35.26 Density [kg/m³]: 1026.34
Oxygen [ml/l]: 6.19 Chlorophyll: 4.2 Turbidity: 0.08

Dominant species : diatoms : *Coscinodiscus wailesii* and others, *Pseudo-nitzschia* ssp. Including the *P. pungens* group including potential toxic species; *Thalassiosira* ssp, „*Coscinosira polychorda*„, heterotrophic dinoflagellates, tintinnids

Characterisation : not recent upwelled water, due to microscopic appearance of the diatoms, they are in a bad physiological state, perhaps due to silicate or other nutrient limitation. This is supported by the presence of heterotrophic dinoflagellates including *Noctiluca* which caused brilliant bioluminescence and tintinnids.

Transect 19°S, 5 nm offshore

Station Label: 31 Number: 490 File: 0490_01.cnv
Date: 15.10.2000 Time: 2:30:31
Latitude:-18°45.29' Longitude: 12°12.42' Depth [m]: 57.1
Surface Temp [°C]: 14.11 Salinity [PSU]: 35.24 Density [kg/m³]: 1026.37
Oxygen [ml/l]: 4.93 Chlorophyll: 2.64 Turbidity: 0.08

Only surface bucket, brilliant bioluminescence caused by *Noctiluca scintillans*

Transect 19°S Eastward 90 nm to 5 nm offshore

Station Label: 40 Number: 491 File: 0491F01.cnv
Date: 15.10.2000 Time: 11:29:59
Latitude:-19°43.56' Longitude: 11°06.70' Depth[m]: 1128.1
Surface Temp [°C]: 16.12 Salinity [PSU]: 35.46 Density [kg/m³]: 1026.09
Oxygen [ml/l]: 7.58 Chlorophyll: 0.71 Turbidity: 0.08

Dominant species : phototrophic dinoflagellates : *Ceratium furca* and several other species, *Gonyaulax polygramma* and oceanic coccolithophorids but few diatoms.

Characterisation : coastal waters with oceanic influence.

Generally low plankton volume with gelatinous taxa present (small medusae and chaetognaths), except for the 50-100 m depth range where a considerable amount of diatoms (50 ml) was present. Some larger copepods in the upper 25 m.

Station Label: 39 Number: 492 File: 0492F01.cnv
Date: 15.10.2000 Time: 18:09:38
Latitude:-19°36.57' Longitude: 11°14.49' Depth[m]: 905.9
Surface Temp [°C]: 16.66 Salinity [PSU]: 35.48 Density [kg/m³]: 1025.98
Oxygen [ml/l]: 7.77 Chlorophyll: 3.69 Turbidity: 0.09

Dominant species : phototrophic dinoflagellates *Gonyaulax polygramma* and other *Gonyaulax*-species, *Ceratium furca* and other *Ceratium*-species; several *Chrysochromulina*-species (Prymnesiophyceae); very few diatoms, tintinnids and radiolaria.

Characterisation : eutrophic coastal water

Very low plankton volume at all depths with medusae, comb-jellies and chaetognaths. Diatoms in the 50-100 m depth range and some euphausiids between 100 and 150 meter.

Station Label: 38 Number: 493 File: 0493F01.cnv
Date: 15.10.2000 Time: 21:36:05
Latitude:-19°29.82' Longitude: 11°22.21' Depth [m]: 675.9
Surface Temp [°C]: 16.21 Salinity [PSU]: 35.45 Density [kg/m³]: 1026.06
Oxygen [ml/l]: 7.59 Chlorophyll: 3.16 Turbidity: 0.09

Dominant species : *Gonyaulax polygramma*, similar to station 492 but less *Ceratium furca*

Characterisation : see station 492.

Very low plankton volumes at all depths, mainly copepods, chaetognaths and euphausiids and no significance of diatoms. Some salps occurred between 50 and 100 meter.

Station Label: 37 Number: 494 File: 0494F01.cnv
Date: 16.10.2000 Time: 2:13:33
Latitude:-19°22.98' Longitude: 11°29.93' Depth [m]: 506.5
Surface Temp [°C]: 15.74 Salinity [PSU]: 35.34 Density [kg/m³]: 1026.09
Oxygen [ml/l]: 7.72 Chlorophyll: 0.88 Turbidity: 0.08

Dominant species : many copepods, ciliate *Tiarina fusus* (no tintinnid); dinoflagellate *Ceratium furca*, few *Gonyaulax polygramma*; few diatoms with *Coscinodiscus wailesii*

Characterisation : see stations 492 and 493, later stage of succession

Little amount of plankton with copepods in the upper 25 meter. High plankton volumes between 25 and 150 m with medusae, comb-jellies and chaetognaths. Many diatoms present with a maximum in the 50-100 m depth range.

Station Label: 36 Number: 495 File: 0495F01.cnv
Date: 16.10.2000 Time: 5:56:14
Latitude:-19°16.09' Longitude: 11°37.58' Depth [m]: 356.8
Surface Temp [°C]: 15.83 Salinity [PSU]: 35.35 Density [kg/m³]: 1026.08
Oxygen [ml/l]: 7.92 Chlorophyll: 3.21 Turbidity: 0.09

Similar to station 494

Little amount of plankton with copepods in the upper 25 meter. High plankton volumes between 25 and 150 m with medusae, comb-jellies and chaetognaths. Most jellyfish below 100 m. Many diatoms present with a maximum in the 50-100 m depth range

Station Label: 35 Number: 496 File: 0496F01.cnv
Date: 16.10.2000 Time: 10:54:37
Latitude:-19°09.28' Longitude: 11°45.35' Depth[m]: 320.6
Surface Temp [°C]: 15.87 Salinity [PSU]: 35.36 Density [kg/m³]: 1026.07
Oxygen [ml/l]: 6.9 Chlorophyll: 2.28 Turbidity: 0.08

Similar to station 495 but more Noctiluca; fish-eggs

Little amount of plankton with copepods in the upper 25 meter, some chaetognaths in the upper 50 m and below 150 m. Diatoms below 25 m, totally dominating the plankton samples taken between 50 and 150 m with 150 ml volume of diatoms.

Station Label: 34 Number: 497 File: 0497F01.cnv
Date: 16.10.2000 Time: 14:18:04
Latitude:-19°02.44' Longitude: 11°52.98' Depth [m]: 270.8
Surface Temp [°C]: 16.26 Salinity [PSU]: 35.46 Density [kg/m³]: 1026.06
Oxygen [ml/l]: 7.46 Chlorophyll: 3.94 Turbidity: 0.08

Similar to station 496, but phototrophic dinoflagellates *Ceratium furca* and *Gonyaulax polygramma* more or less equal in number

Little amount of plankton with copepods in the upper 25 meter, some chaetognaths in the upper 50 m and below 150 m. Diatoms below 50 m, dominating the plankton samples taken between 50 and 150 m with 75 ml diatom volume. Some euphausiids between 25 and 50 m.

Station Label: 33 Number: 498 File: 0498F01.cnv
Date: 16.10.2000 Time: 18:18:12
Latitude:-18°55.54' Longitude: 12°00.80' Depth [m]: 174.5
Surface Temp [°C]: 14.79 Salinity [PSU]: 35.28 Density [kg/m³]: 1026.26
Oxygen [ml/l]: 6.76 Chlorophyll: 3.2 Turbidity: 0.08

Dominant species : Diatoms *Pseudo-nitzschia fraudulenta* and *P. pungens*-group (potentially toxic), *Coscinodiscus wailesii*, *Coscinodiscus gigass*, „*Coscosira polychorda*“ and other *Thalassiosira*-species; *Rhizosolenia robusta* ; subdominant :dinoflagellates : *Ceratium furca*

Characterisation : relatively fresh upwelled water, may be mixed with water from the previous stations (*Ceratium furca*)

Larger amount of plankton with copepods and euphausiids in the upper 25 meter, comb-jellies between 25-50 m and jellyfish below 150 m. Diatoms present at all depths, dominating the samples from 25-150 m and with a very large amount (200 ml) at the 50-100 m depth range.

Station Label: 32 Number: 499 File: 0499F01.cnv
Date: 16.10.2000 Time: 21:50:47
Latitude:-18°48.75' Longitude: 12°08.56' Depth [m]: 90
Surface Temp [°C]: 14.68 Salinity [PSU]: 35.27 Density [kg/m³]: 1026.27
Oxygen [ml/l]: 6.41 Chlorophyll: 2.8 Turbidity: 0.08

Similar to station 498 but significant less *Pseudo-nitzschia* and more *Noctiluca scintillans* (heterotrophic dinoflagellate) many of them in final succession stage, already dying.

Samples totally dominated by diatoms at all depths (100 ml), dark-brown coloured in the upper 25 meter.

Station Label: 31 Number: 500 File: 0500F01.cnv
Date: 16.10.2000 Time: 23:57:44
Latitude:-18°45.26' Longitude: 12°12.38' Depth[m]: 56.02
Surface Temp [°C]: 14.38 Salinity [PSU]: 35.25 Density [kg/m³]: 1026.32
Oxygen [ml/l]: 5.84 Chlorophyll: 5.66 Turbidity: 0.09

Similar to station 498, that means more *Pseudo-nitzschia* in comparison to station 499

Samples totally dominated by diatoms, with a maximum (120 ml) and dark-brown colour between 25 and 50 meters.

Transect 200m Southward 19°S to 20°S

Station Label: 30 Number: 501 File: 0501_01.cnv
Date: 17.10.2000 Time: 3:08:59
Latitude:-18°59.97' Longitude: 12°00.91' Depth [m]: 201.83
Surface Temp [°C]: 14.86 Salinity [PSU]: 35.28 Density [kg/m³]: 1026.23
Oxygen [ml/l]: 3.86 Chlorophyll: 2.67 Turbidity: 0.09

Station Label: 41 Number: 502 File: 0502F01.cnv
Date: 17.10.2000 Time: 4:59:03
Latitude:-19°10.00' Longitude: 12°06.61' Depth [m]: 201.45
Surface Temp [°C]: 14.89 Salinity [PSU]: 35.26 Density [kg/m³]: 1026.21
Oxygen [ml/l]: 6.65 Chlorophyll: 5.02 Turbidity: 0.09

Station Label: 42 Number: 503 File: 0503F01.cnv
Date: 17.10.2000 Time: 6:41:33
Latitude:-19°20.08' Longitude: 12°10.95' Depth [m]: 202.88
Surface Temp [°C]: 15.34 Salinity [PSU]: 35.29 Density [kg/m³]: 1026.14
Oxygen [ml/l]: 6.81 Chlorophyll: 3.93 Turbidity: 0.09

Station Label: 43 Number: 504 File: 0504F01.cnv
Date: 17.10.2000 Time: 8:31:59
Latitude:-19°29.99' Longitude: 12°14.23' Depth[m]: 202.22
Surface Temp [°C]: 14.9 Salinity [PSU]: 35.24 Density [kg/m³]: 1026.2
Oxygen [ml/l]: 6.46 Chlorophyll: 3.07 Turbidity: 0.08

Dominant species : diatoms *Coscinodiscus wailesii*, *Pseudonitzschia spp*, *Rhizosolenia robusta*, „*Coscinosira polychorda*„, and other *Thalassiosira*-species, copepod nauplia

Characterisation : recent upwelled water with full development of diatoms, already few parasites in diatoms, that means not really fresh upwelled water.

Station Label: 44 Number: 505 File: 0505F01.cnv
Date: 17.10.2000 Time: 9:59:37
Latitude:-19°40.02' Longitude: 12°16.43' Depth [m]: 200.64
Surface Temp [°C]: 15.28 Salinity [PSU]: 35.27 Density [kg/m³]: 1026.13
Oxygen [ml/l]: 6.57 Chlorophyll: 2.14 Turbidity: 0.08

Station Label: 45 Number: 506 File: 0506F01.cnv
Date: 17.10.2000 Time: 11:47:50
Latitude:-19°49.97' Longitude: 12°18.75' Depth [m]: 201.13
Surface Temp [°C]: 15.61 Salinity [PSU]: 35.24 Density [kg/m³]: 1026.04
Oxygen [ml/l]: 6.65 Chlorophyll: 1.92 Turbidity: 0.08

Station Label: 29 Number: 507 File: 0507F01.cnv
Date: 17.10.2000 Time: 14:04:47
Latitude:-20°00.01' Longitude: 12°23.41' Depth [m]: 203.64
Surface Temp [°C]: 15.29 Salinity [PSU]: 35.26 Density [kg/m³]: 1026.12
Oxygen [ml/l]: 6.39 Chlorophyll: 0.74 Turbidity: 0.08

Dominant Species :The diatoms *Coscinodiscus wailesii* *Skeletonema costatum*, *Pseudo-nitzschia* spp including those of the potential toxic *P. pungens* complex, *Guinardia flaccida*; dinoflagellates : heterotrophic species including *Noctiluca scintillans*; Copepods and their nauplii, fish-egg

Characterisation : Later stage of upwelled water, the diatoms are already grazed by heterotrophic dinoflagellates, copepods which are already producing eggs from which nauplia have hatched; some diatom cells are infected by parasites.

Transect 20°S, 5 nm offshore

Station Label: 46 Number: 508 File: 0508F01.cnv
Date: 17.10.2000 Time: 18:18:38
Latitude:-19°45.23' Longitude: 12°50.33' Depth[m]: 56.27
Surface Temp [°C]: 14.81 Salinity [PSU]: 35.2 Density [kg/m³]: 1026.19
Oxygen [ml/l]: 6.31 Chlorophyll: 4.81 Turbidity: 0.09

Dominant species : The diatoms *Coscinodiscus wailesii*, *Coscosira polychorda*, small *Thalassiosira* species, and the dinoflagellate *Noctiluca scintillans*

Characterisation : Not freshly upwelled water phytoplankton community,

Transect 20°S Eastward 90 nm to 5 nm offshore

Station Label: 55 Number: 509 File: 0509F01.cnv
Date: 18.10.2000 Time: 3:47:34
Latitude:-20°24.56' Longitude: 11°28.43' Depth [m]: 1113.6
Surface Temp [°C]: 16.81 Salinity [PSU]: 35.49 Density [kg/m³]: 1025.95
Oxygen [ml/l]: 6.02 Chlorophyll: 1.67 Turbidity: 0.08

Dominant species : few larger phytoplankton organisms, but some copepods and their faeces, many coccolithophorids

Characterisation : oceanic influenced water , no signal from upwelling

Generally low plankton volume, especially below 150 m, with gelatinous taxa present (small medusae and chaetognaths),. Some larger copepods and euphausiids. No diatoms were observed. Up to 150 m many gastropod veliger larvae.

Station Label: 54 Number: 510 File: 0510F01.cnv
Date: 18.10.2000 Time: 7:52:26
Latitude:-20°19.98' Longitude: 11°37.88' Depth[m]: 928.9
Surface Temp [°C]: 16.52 Salinity [PSU]: 35.44 Density [kg/m³]: 1025.99
Oxygen [ml/l]: 3.84 Chlorophyll: 0.74 Turbidity: 0.08

Dominant species : Salps, 3 amphipods; few phytoplankton, see station above

Characterisation : as station 509

Low plankton volume at all depths with copepods and chaetognaths. No diatoms were observed. Salps in the upper 50 m and gastropod veliger larvae between 50 and 150 meters depth.

Station Label: 56 Number: 511 File: 0511F01.cnv
Date: 18.10.2000 Time: 10:33:49
Latitude:-20°17.71' Longitude: 11°43.14' Depth [m]: 804.5
Surface Temp [°C]: 16.64 Salinity [PSU]: 35.49 Density [kg/m³]: 1025.99
Oxygen [ml/l]: 6.09 Chlorophyll: 1.18 Turbidity: 0.08

Dominant species : the phototrophic dinoflagellate *Gonyaulax polygramma*; diatoms very rare

Characterisation : see station 509-510

Very low plankton volume at all depths with copepods and chaetognaths. No diatoms were observed. Small jellyfish in the upper 50 m and gastropod veliger larvae between 50 and 150 meters depth.

Station Label: 53 Number: 512 File: 0512F01.cnv
Date: 18.10.2000 Time: 13:19:18
Latitude:-20°15.43' Longitude: 11°47.48' Depth [m]: 676.2
Surface Temp [°C]: 16.6 Salinity [PSU]: 35.48 Density [kg/m³]: 1025.99
Oxygen [ml/l]: 6 Chlorophyll: 1.9 Turbidity: 0.08

Dominant species : the dinoflagellate *Gonyaulax polygramma*; Foraminifera : Globigerins; Coccolithophorids

Characterisation : see stations 509-511.

Very low plankton volume at all depths, containing many chaetognaths.. Most copepods found between 50 and 150 meters depth.

Station Label: 57 Number: 513 File: 0513F02.cnv
Date: 18.10.2000 Time: 17:13:08
Latitude:-20°12.57' Longitude: 11°54.05' Depth [m]: 467.6
Surface Temp [°C]: 15.59 Salinity [PSU]: 35.31 Density [kg/m³]: 1026.1
Oxygen [ml/l]: 5.88 Chlorophyll: 3.06 Turbidity: 0.09

Dominant species : The dinoflagellate *Ceratium furca* and the diatoms *Coscinodiscus wailesii*, *Bacteriastrum hyalinum*, several species of *Pseudo-nitzschia*, *Skeletonema costatum*, *Chaetoceros spp.* A special feature of this station is the apparent bloom of small (about 5 µm long) chrysophyte flagellates.

Characterisation : not freshly upwelled phytoplankton community with already many phototrophic and heterotrophic dinoflagellates.

Low plankton volume, especially below 150 m, with copepods, chaetognaths and small jellyfish. No diatoms were observed. Euphausids in the upper 25 m and salps found in the 50-150 m depth range..

Station Label: 52 Number: 514 File: 0514F01.cnv
Date: 18.10.2000 Time: 19:00:49
Latitude:-20°10.89' Longitude: 11°57.00' Depth[m]: 0
Surface Temp [°C]: 15.58 Salinity [PSU]: 35.31 Density [kg/m³]: 1026.1
Oxygen [ml/l]: 5.86 Chlorophyll: 2.93 Turbidity: 0.09

Dominant species : Diatom-dinoflagellate plankton; diatoms : *Coscinodiscus wailesii*, *Bacteriastrum hyalinum*, *Rhizosolenia robusta*, several *Pseudonitzschia*-species; the phototrophic dinoflagellates : *Ceratium azoricum*, *C. furca*, *C. fusus*, *Gonyaulax polygramma* and the heterotrophic species *Noctiluca scintillans*

Characterisation : see station 513

Very low plankton volume, except for the upper 25 m with copepods and chaetognaths.. Diatoms present in the upper 50 m of the water column. Euphausids present down to 100 m, jellyfish between 25 and 50 meters.

Station Label: 51 Number: 515 File: 0515F01.cnv
Date: 18.10.2000 Time: 21:06:26
Latitude:-20°06.38' Longitude: 12°06.62' Depth [m]: 305.3
Surface Temp [°C]: 15.25 Salinity [PSU]: 35.26 Density [kg/m³]: 1026.13
Oxygen [ml/l]: 5.82 Chlorophyll: 2.59 Turbidity: 0.09

Dominant species : the diatoms *Bacteriastrum hyalinum*, *Coscinodiscus wailesii*, *Rhizosolenia robusta*, *Chaetoceros socialis*, *Skeletonema costatum*, *Pseudo-nitzschia ssp.*

Characterisation : Earlier succession stage of upwelling than station 514.

Larger amount of plankton with jellyfish and diatoms, the latter dominating the samples (50-100 ml) in the upper 100 meter. Many copepods in the upper 25 m, *Aequoraea* medusae between 25 and 100 m depth, *Chrysaora* medusae below 150 meters.

Station Label: 50 Number: 516 File: 0516F02.cnv
Date: 19.10.2000 Time: 0:18:43
Latitude:-20°01.73' Longitude: 12°16.20' Depth [m]: 246.4
Surface Temp [°C]: 15.21 Salinity [PSU]: 35.26 Density [kg/m³]: 1026.15
Oxygen [ml/l]: 5.55 Chlorophyll: 1.59 Turbidity: 0.09

very similar to station 515

Moderate amount of plankton with a maximum of 50 ml in the 50-150 meter depth range. Diatoms and jellyfish at all depths. Very many diatoms between 50 and 150 meters.

Station Label: 49 Number: 517 File: 0517F01.cnv
Date: 19.10.2000 Time: 2:51:08
Latitude:-19°57.15' Longitude: 12°25.56' Depth [m]: 166.5
Surface Temp [°C]: 14.97 Salinity [PSU]: 35.24 Density [kg/m³]: 1026.18
Oxygen [ml/l]: 5.79 Chlorophyll: 2.98 Turbidity: 0.09

Dominant species : The diatoms *Coscinodiscus wailesii*, *Bacteriastrum hyalina*, *Coscinosira polychorda* and other *Thalassiosira*-species, *Skeletonema costatum*, *Pseudo-nitzschia* species; the dinoflagellate *Noctiluca scintillans*

Characterisation : see stations 515 – 516.

Samples totally dominated by diatoms at all depths, with a maximum of 170 ml between 100 and 150 m. Copepods between 25 and 150 m..

Station Label: 48 Number: 518 File: 0518F01.cnv
Date: 19.10.2000 Time: 5:14:51
Latitude:-19°52.61' Longitude: 12°35.03' Depth [m]: 131.8
Surface Temp [°C]: 14.85 Salinity [PSU]: 35.24 Density [kg/m³]: 1026.21
Oxygen [ml/l]: 5.42 Chlorophyll: 1.01 Turbidity: 0.09

Dominant species : The diatoms *Coscinodiscus wailesii*, *Coscinosira polychorda* and other *Thalassiosira* species, *Guinardia flaccida*, *Rhizosolenia robusta*, but *Bacteriastrum* is rare; the dinoflagellate *Noctiluca scintillans*

Characterisation : More recent upwelled water than the previous stations.

Samples totally dominated by diatoms, with a maximum of 100 ml at the 25-50 meter depth range.

Small jellies in the upper 25 m, larger medusae between 25 and 100 m. *Aequoraea* medusae between 50 and 100 m depth.

Station Label: 47 Number: 519 File: 0519F01.cnv
Date: 19.10.2000 Time: 7:36:52
Latitude:-19°48.06' Longitude: 12°44.49' Depth[m]: 99.7
Surface Temp [°C]: 14.25 Salinity [PSU]: 35.2 Density [kg/m³]: 1026.31
Oxygen [ml/l]: 4.89 Chlorophyll: 3.15 Turbidity: 0.09

Dominant species : *Coscinodiscus wailesii*, *Coscinosira polychorda* and other *Thalassiosira* species, *Guinardia flaccida*, but *Rhizosolenia robusta* is rare and *Bacteriastrum* is totally missing; the dinoflagellate *Noctiluca scintillans*

Characterisation : More recent upwelled water than the previous stations.

Samples totally dominated by diatoms, with a maximum of 125 ml at the 25-50 meter depth range. Small jellyfish present between 50 and 100 m.

Station Label: 46 Number: 520 File: 0520F01.cnv
Date: 19.10.2000 Time: 9:46:43
Latitude:-19°45.18' Longitude: 12°50.28' Depth [m]: 56.22
Surface Temp [°C]: 14.03 Salinity [PSU]: 35.15 Density [kg/m³]: 1026.32
Oxygen [ml/l]: 3.45 Chlorophyll: 2.08 Turbidity: 0.09

Dominant species : *Coscinodiscus wailesii*, *Coscinosira polychorda* and other *Thalassiosira* species, *Guinardia flaccida*, but *Rhizosolenia robusta* and *Bacteriastrum* are totally missing; the dinoflagellate *Noctiluca scintillans* is rare

Characterisation : Even more recent upwelled water than the previous station.

Samples totally dominated by diatoms with sample volumes of 200 ml.

Transect 200m Southward 20°S to 21°30'S

Station Label: 29 Number: 521 File: 0521F02.cnv
Date: 19.10.2000 Time: 14:24:19
Latitude:-19°59.95' Longitude: 12°23.73' Depth [m]: 201.48
Surface Temp [°C]: 15.38 Salinity [PSU]: 35.26 Density [kg/m³]: 1026.11
Oxygen [ml/l]: 5.8 Chlorophyll: 1.82 Turbidity: 0.09

Station Label: 58 Number: 522 File: 0522F02.cnv
Date: 19.10.2000 Time: 16:53:55
Latitude:-20°10.00' Longitude: 12°30.42' Depth [m]: 200.02
Surface Temp [°C]: 15.25 Salinity [PSU]: 35.23 Density [kg/m³]: 1026.11
Oxygen [ml/l]: 6.71 Chlorophyll: 5.89 Turbidity: 0.09

Station Label: 59 Number: 523 File: 0523F01.cnv
Date: 19.10.2000 Time: 18:47:19
Latitude:-20°19.96' Longitude: 12°35.74' Depth [m]: 199.37
Surface Temp [°C]: 15.19 Salinity [PSU]: 35.21 Density [kg/m³]: 1026.11
Oxygen [ml/l]: 6.77 Chlorophyll: 10.05 Turbidity: 0.1

Station Label: 60 Number: 524 File: 0524F01.cnv
Date: 19.10.2000 Time: 21:15:03
Latitude:-20°30.03' Longitude: 12°42.93' Depth[m]: 209.4
Surface Temp [°C]: 15.11 Salinity [PSU]: 35.21 Density [kg/m³]: 1026.12
Oxygen [ml/l]: 5.98 Chlorophyll: 5.9 Turbidity: 0.09

Dominant species : The diatom *Skeletonema costatum*; *Coscinodiscus wailesii*, Copepods, Nauplia, few *Noctiluca* and heterotrophic dinoflagellates, mainly genus *Protopteridinium*;

Characterisation : upwelled water, later stage than station 520

Station Label: 61 Number: 525 File: 0525F01.cnv
Date: 19.10.2000 Time: 23:00:53
Latitude:-20°40.01' Longitude: 12°48.32' Depth [m]: 203.24
Surface Temp [°C]: 15.16 Salinity [PSU]: 35.22 Density [kg/m³]: 1026.14
Oxygen [ml/l]: 5.59 Chlorophyll: 2.99 Turbidity: 0.09

Station Label: 62 Number: 526 File: 0526F01.cnv
Date: 20.10.2000 Time: 0:44:27
Latitude:-20°50.04' Longitude: 12°52.64' Depth [m]: 199.37
Surface Temp [°C]: 15.33 Salinity [PSU]: 35.22 Density [kg/m³]: 1026.09
Oxygen [ml/l]: 5.45 Chlorophyll: 3.89 Turbidity: 0.1

Dominant species : The diatom *Skeletonema costatum*; *Coscinodiscus wailesii*; Copepoda, Harpactoid and calanoid Nauplii, few *Noctiluca*

Characterisation : see station 524

Station Label: 28 Number: 527 File: 0527F01.cnv
Date: 20.10.2000 Time: 2:26:17
Latitude:-21°00.02' Longitude: 12°57.26' Depth [m]: 200.26
Surface Temp [°C]: 15.11 Salinity [PSU]: 35.19 Density [kg/m³]: 1026.11
Oxygen [ml/l]: 5.55 Chlorophyll: 4.7 Turbidity: 0.1

Dominant species : The diatom *Skeletonema costatum*; subdominant : *Coscinodiscus wailesii*, Copepod nauplii but few adults; few *Noctiluca*

Characterization : Characterization : see station 524-526

Station Label: 63 Number: 528 File: 0528_01.cnv
Date: 20.10.2000 Time: 4:14:54
Latitude:-21°10.00' Longitude: 13°00.04' Depth[m]: 196.23
Surface Temp [°C]: 15.23 Salinity [PSU]: 35.18 Density [kg/m³]: 1026.09
Oxygen [ml/l]: 5.26 Chlorophyll: 2.73 Turbidity: 0.09

Station Label: 64 Number: 529 File: 0529F01.cnv
Date: 20.10.2000 Time: 6:05:16
Latitude:-21°19.99' Longitude: 13°01.92' Depth [m]: 198.62
Surface Temp [°C]: 15.28 Salinity [PSU]: 35.16 Density [kg/m³]: 1026.05
Oxygen [ml/l]: 5.44 Chlorophyll: 3.41 Turbidity: 0.09

Station Label: 65 Number: 530 File: 0530F02.cnv
Date: 20.10.2000 Time: 8:09:45
Latitude:-21°30.06' Longitude: 13°05.14' Depth [m]: 201.65
Surface Temp [°C]: 15.29 Salinity [PSU]: 35.16 Density [kg/m³]: 1026.05
Oxygen [ml/l]: 5.54 Chlorophyll: 4.6 Turbidity: 0.1

Dominant species : Copepods (many harpacticoids), nauplii, globigerinoid Foraminifera, Radiolaria in dissecting microscope nearly no phytoplankton, but the coccolithophorid *Emiliania huxleyii* and small (about 4-5 µm long Cryptophyceae present

Characterization : very late succession stage of upwelling or not effected by upwelling

Transect 21°30' S, 5 nm offshore

Station Label: 66 Number: 531 File: 0531F01.cnv
Date: 20.10.2000 Time: 11:49:19
Latitude:-21°15.89' Longitude: 13°35.30' Depth [m]: 49.43
Surface Temp [°C]: 14.16 Salinity [PSU]: 35.16 Density [kg/m³]: 1026.3
Oxygen [ml/l]: 3.98 Chlorophyll: 22.74 Turbidity: 0.13

Dominant species : The diatom *Skeletonema costatum*; the dinoflagellate *Noctiluca scintillans*

Characterization : fully developed diatom bloom of recent upwelled water

Transect 21°30' S Eastward 90 nm to 5 nm offshore

Station Label: 75 Number: 532 File: 0532F02.cnv
Date: 20.10.2000 Time: 22:14:47
Latitude:-21°57.21' Longitude: 12°15.12' Depth[m]: 1412.8
Surface Temp [°C]: 15.99 Salinity [PSU]: 35.31 Density [kg/m³]: 1026.01
Oxygen [ml/l]: 5.75 Chlorophyll: 0.97 Turbidity: 0.09

Dominant species : Copepods and their nauplii, some dinoflagellates : *Gonyaulax polygramma* and others; few diatoms, no *Noctiluca*

Characterization : very late succession stage of upwelling or not effected by upwelling

Station Label: 74 Number: 533 File: 0533F01.cnv
Date: 21.10.2000 Time: 0:27:32
Latitude:-21°52.31' Longitude: 12°24.48' Depth [m]: 1058.3
Surface Temp [°C]: 16.09 Salinity [PSU]: 35.35 Density [kg/m³]: 1026.01
Oxygen [ml/l]: 5.73 Chlorophyll: 0.93 Turbidity: 0.09

similar to station 532

Generally low plankton volume, but exceptional high amount of plankton (250 ml) in the upper 25 m, consisting of jellyfish, many salps, copepods and euphausids. No diatoms were observed. Copepods at all depths, salps in the upper 100 m, below 100 m euphausids and chaetognaths below 150 m.

Station Label: 73 Number: 534 File: 0534F01.cnv
Date: 21.10.2000 Time: 4:03:08
Latitude:-21°47.54' Longitude: 12°33.90' Depth [m]: 690.5
Surface Temp [°C]: 15.89 Salinity [PSU]: 35.29 Density [kg/m³]: 1026.01
Oxygen [ml/l]: 5.73 Chlorophyll: 0.95 Turbidity: 0.09

similar to station 532, but in addition few more dinoflagellates : *Ceratium furca* and *C. fusus*

High plankton volumes in the upper 50 m (200-300 ml), low volumes below 50 m. No diatoms were observed. Many salps at all depths, except below 150 m, where chaetognaths were obvious. Between 50 and 100 m euphausiids were present. Copepods between 50 and 150 m.

Station Label: 72 Number: 535 File: 0535F01.cnv
Date: 21.10.2000 Time: 7:26:57
Latitude:-21°42.71' Longitude: 12°43.32' Depth [m]: 367.3
Surface Temp [°C]: 15.66 Salinity [PSU]: 35.25 Density [kg/m³]: 1026.04
Oxygen [ml/l]: 5.61 Chlorophyll: 1.38 Turbidity: 0.1

Dominant species : Zooplankton: copepods, ciliates : tintinnids; radiolaria; many *Stycholonche zanclea* (Heliozoa); the diatoms *Coscinodiscus wailesii*, *Rhizosolenia robusta*, *Thalassionema nitzschioides* few dinoflagellates

Characterization : similar to station 532-534

High plankton volumes in the upper 50 m (100-150 ml), low volumes below 50 m. No diatoms were observed. Many salps in the upper 100 m, especially between 25 and 50 meters depth. Copepods were present at all depths, euphausiids below 150 m.

Station Label: 71 Number: 536 File: 0536F02.cnv
Date: 21.10.2000 Time: 10:52:50
Latitude:-21°37.80' Longitude: 12°52.91' Depth[m]: 303.4
Surface Temp [°C]: 15.59 Salinity [PSU]: 35.22 Density [kg/m³]: 1026.03
Oxygen [ml/l]: 5.57 Chlorophyll: 1.81 Turbidity: 0.1

Dominant species : Tintinnid ciliates, harpacticoid copepods; the diatom *Thalassionema nitzschioides*; few dinoflagellates, no *Noctiluca*

Characterization : similar to station 532-535

Low plankton volumes at all depths, consisting mostly of copepods. Low amount of diatoms at all depths. Chaetognaths were present in the upper 25 meters.

Station Label: 70 Number: 537 File: 0537F02.cnv
Date: 21.10.2000 Time: 13:50:43
Latitude:-21°32.98' Longitude: 13°02.25' Depth [m]: 242.4
Surface Temp [°C]: 15.4 Salinity [PSU]: 35.17 Density [kg/m³]: 1026.03
Oxygen [ml/l]: 5.65 Chlorophyll: 5.45 Turbidity: 0.1

Dominant species : harpacticoid and other copepods, many faeces, many small >10 µm long cryptomonads, the prymnesiophytes *Emiliana huxleyii* and several species of *Chrysochromulina*; few larger phytoplankton cells

Characterization : similar to station 532-536

Moderate volumes of plankton with highest values in the upper 50 meters, consisting of copepods a significant amount of jellyfish and also chaetognaths. Large numbers of jellyfish with 5 e were found between 150 and 200 meters. In general, no diatoms were observed. A striking exception at this station was the plankton sample from the 50-150 m depth range: the sample contained diatoms, but no jellyfish.

Station Label: 69 Number: 538 File: 0538F01.cnv

Date: 21.10.2000 Time: 16:25:30
Latitude:-21°28.14' Longitude: 13°11.70' Depth [m]: 148.1
Surface Temp [°C]: 15.43 Salinity [PSU]: 35.15 Density [kg/m³]: 1026.01
Oxygen [ml/l]: 5.55 Chlorophyll: 4.45 Turbidity: 0.1

see station 537, but tintinnids are missing except few species with very hyaline shell

Low plankton volume in the upper 50 meters, moderate amount of plankton below 50 m. Diatoms present at all depths, but they never dominated the samples. Copepods at all depths. Chaetognaths present below 25 m. Small jellyfish and one *Aequorea* medusa present in the 50-100 m depth range.

Station Label: 68 Number: 539 File: 0539F01.cnv
Date: 21.10.2000 Time: 18:40:05
Latitude:-21°23.33' Longitude: 13°21.13' Depth [m]: 119
Surface Temp [°C]: 15.48 Salinity [PSU]: 35.14 Density [kg/m³]: 1025.99
Oxygen [ml/l]: 5.8 Chlorophyll: 4.32 Turbidity: 0.1

Dominant species : Harpacticoid and other copepods, Chaetognaths; but very few tintinnids; the diatoms *Skeletonema costatum* and *Chaetoceros* species, very few dinoflagellates

Characterization : apparently mixture of upwelled water with a diatom *Skeletonema costatum* bloom with offshore water like that of the preceding stations.

Moderate plankton volumes, containing mainly copepods and chaetognaths. In addition many jellyfish between 25 and 50 meters, low amounts of diatoms occurred in the samples below 50 meters depth.

Station Label: 67 Number: 540 File: 0540F02.cnv
Date: 21.10.2000 Time: 21:57:50
Latitude:-21°18.49' Longitude: 13°30.72' Depth [m]: 90.5
Surface Temp [°C]: 14.66 Salinity [PSU]: 35.16 Density [kg/m³]: 1026.18
Oxygen [ml/l]: 6.08 Chlorophyll: 10.47 Turbidity: 0.11

Dominant species : The diatoms *Skeletonema costatum* and *Coscinodiscus wailesii*; cyclopoid copepods

Characterization : fully developed diatom bloom of upwelled water, advanced stage as already copepods are abundant

Large plankton volumes with many diatoms, which totally dominated the upper 25 meter sample (100 ml) but less amounts of diatoms in deeper samples. Copepods were numerous at all depths. In the upper 25 m larger jellyfish and euphausids, between 25 and 50 m chaetognaths, and below 50 m jellyfish and chaetognaths present.

Station Label: 66 Number: 541 File: 0541F01.cnv
Date: 21.10.2000 Time: 23:40:54
Latitude:-21°15.91' Longitude: 13°35.23' Depth[m]: 50.49
Surface Temp [°C]: 14.6 Salinity [PSU]: 35.16 Density [kg/m³]: 1026.19
Oxygen [ml/l]: 6.01 Chlorophyll: 27.78 Turbidity: 0.14

Large plankton volumes with diatoms, which totally dominated in the upper 25 m. Copepods at all depths. Small jellyfish present below 25 meters.

Transect 200m Southward, 21°30'S to 23°S

Station Label: 65 Number: 542 File: 0542F01.cnv
Date: 22.10.2000 Time: 3:23:38
Latitude:-21°30.00' Longitude: 13°05.20' Depth [m]: 200.1
Surface Temp [°C]: 15.34 Salinity [PSU]: 35.17 Density [kg/m³]: 1026.05
Oxygen [ml/l]: 5.21 Chlorophyll: 3.69 Turbidity: 0.1

Station Label: 76 Number: 543 File: 0543F01.cnv
Date: 22.10.2000 Time: 5:12:43
Latitude:-21°40.01' Longitude: 13°07.52' Depth [m]: 200.04
Surface Temp [°C]: 15.46 Salinity [PSU]: 35.19 Density [kg/m³]: 1026.03
Oxygen [ml/l]: 5.19 Chlorophyll: 2.86 Turbidity: 0.1

Station Label: 77 Number: 544 File: 0544F01.cnv
Date: 22.10.2000 Time: 6:53:44
Latitude:-21°50.02' Longitude: 13°08.20' Depth [m]: 201.32
Surface Temp [°C]: 15.42 Salinity [PSU]: 35.17 Density [kg/m³]: 1026.03
Oxygen [ml/l]: 4.74 Chlorophyll: 4.55 Turbidity: 0.1

Excursion to Cape Cross

Station Label: 94 Number: 545 File: 0545F01.cnv
Date: 22.10.2000 Time: 12:18:34
Latitude:-21°45.36' Longitude: 13°54.78' Depth[m]: 0
Surface Temp [°C]: 14.65 Salinity [PSU]: 35.14 Density [kg/m³]: 1026.17
Oxygen [ml/l]: 7.46 Chlorophyll: 33.22 Turbidity: 0.14

Dominant species : The diatom *Skeletonema costatum*; the phototrophic ciliate *Mesodinium rubrum* (a ciliate with cryptophyte endosymbionts, common in upwelling plankton communities)

Characterization : fully developed diatom bloom of recent upwelled water

Sample totally dominated by diatoms (150 ml), in addition small jellyfish were present.

Continued along 200 m

Station Label: 27 Number: 546 File: 0546F01.cnv
Date: 22.10.2000 Time: 18:18:31
Latitude:-21°60.00' Longitude: 13°10.84' Depth [m]: 201.43
Surface Temp [°C]: 15.33 Salinity [PSU]: 35.14 Density [kg/m³]: 1026.03
Oxygen [ml/l]: 5.31 Chlorophyll: 3.76 Turbidity: 0.11

Dominant species : many copepods including harpacticoids, many tintinnids (loricate ciliates); few dinoflagellates *Gonyaulax polygramma*, very few diatoms; but many *Emiliana huxleyi* and other small (< 10 µm) prymnesiophytes; small cryptomonads;

Characterisation : very late stage of upwelling plankton succession or not influenced by upwelling

Station Label: 78 Number: 547 File: 0547_01.cnv
Date: 22.10.2000 Time: 20:06:22
Latitude:-22°09.98' Longitude: 13°16.55' Depth [m]: 207.34
Surface Temp [°C]: 15.06 Salinity [PSU]: 35.12 Density [kg/m³]: 1026.07
Oxygen [ml/l]: 5.21 Chlorophyll: 3.44 Turbidity: 0.11

Station Label: 79 Number: 548 File: 0548F01.cnv
Date: 22.10.2000 Time: 21:53:35
Latitude:-22°19.98' Longitude: 13°23.45' Depth [m]: 203.02
Surface Temp [°C]: 14.94 Salinity [PSU]: 35.11 Density [kg/m³]: 1026.09
Oxygen [ml/l]: 5.19 Chlorophyll: 2.33 Turbidity: 0.1

Dominant species : many copepods including harpacticoids, many tintinnids (loricate ciliates) and *Stycholonche zanclea* (Heliozoa); diatoms : *Pseudo-nitzschia cf delicatissima*, *Rhizosolenia alata* and others

Characterization : difficult to characterise, similar to station 546 with some mixing of upwelling community ?

Station Label: 80 Number: 549 File: 0549_01.cnv
Date: 22.10.2000 Time: 23:48:39
Latitude:-22°29.86' Longitude: 13°27.31' Depth [m]: 206.93
Surface Temp [°C]: 14.68 Salinity [PSU]: 35.1 Density [kg/m³]: 1026.14
Oxygen [ml/l]: 5 Chlorophyll: 2.08 Turbidity: 0.1

Station Label: 81 Number: 550 File: 0550F01.cnv
Date: 23.10.2000 Time: 1:28:43
Latitude:-22°39.88' Longitude: 13°30.33' Depth [m]: 204.02
Surface Temp [°C]: 14.57 Salinity [PSU]: 35.08 Density [kg/m³]: 1026.14
Oxygen [ml/l]: 5.55 Chlorophyll: 3.34 Turbidity: 0.1

Dominant species : many copepods including harpacticoids; globigerinoid foraminifera,; radiolaria; few dinoflagellates, very few diatoms; *Emiliania huxleyi* (Prymnesiophyte)

Characterization : similar to station 546.

Station Label: 82 Number: 551 File: 0551_01.cnv
Date: 23.10.2000 Time: 3:09:20
Latitude:-22°49.96' Longitude: 13°31.18' Depth [m]: 203.45
Surface Temp [°C]: 14.33 Salinity [PSU]: 35.06 Density [kg/m³]: 1026.18
Oxygen [ml/l]: 5.67 Chlorophyll: 2.27 Turbidity: 0.1

Station Label: 26 Number: 552 File: 0552F01.cnv
Date: 23.10.2000 Time: 4:51:36
Latitude:-22°59.99' Longitude: 13°32.10' Depth[m]: 198.87
Surface Temp [°C]: 14.3 Salinity [PSU]: 35.05 Density [kg/m³]: 1026.18
Oxygen [ml/l]: 5.62 Chlorophyll: 2.19 Turbidity: 0.1

Dominant species : many copepods including harpacticoids, many tintinnids (loricate ciliates); few dinoflagellates, very few diatoms

Characterization : similar to stations 546 and 550.

Transect 23°S, 2 nm offshore

Station Label: 83 Number: 553 File: 0553F01.cnv
Date: 23.10.2000 Time: 12:37:21
Latitude:-23°00.01' Longitude: 14°22.19' Depth [m]: 43.42
Surface Temp [°C]: 14.46 Salinity [PSU]: 35.09 Density [kg/m³]: 1026.17
Oxygen [ml/l]: 8.01 Chlorophyll: 33.29 Turbidity: 0.13

Dominant species : The diatoms *Skeletonema costatum* with subdominant *Stephanopyxis turris* and *Bacteriastrium hyalinum* form a heavy brown discoloration of the water; few other species but some copepods

Characterization : stage of upwelling plankton succession, but not very early stage as diatoms are infected by parasites

Transect 23°S, Eastward from 90 nm to 2 nm offshore (NatMIRC monitoring)

Station Label: 93 Number: 554 File: 0554F02.cnv
Date: 23.10.2000 Time: 23:44:40
Latitude:-22°59.95' Longitude: 12°46.74' Depth [m]: 954.6
Surface Temp [°C]: 16.08 Salinity [PSU]: 35.34 Density [kg/m³]: 1026.01
Oxygen [ml/l]: 5.35 Chlorophyll: 1.1 Turbidity: 0.1

Dominant species : The diatoms *Pseudo-nitzschia* ssp, *Thalassionema nitzschioides*, *Thalassiotrix* sp.

Characterization : aged upwelled water, may be mixed with more recent upwelled water

Generally low plankton volume, with a maximum of 15 ml between 100-150 m.

No diatoms were observed. Copepods dominated at all depths, euphausiids were present in the upper 50 m and below 150 m. Chaetognaths occurred in the upper 25 m and below 100m. Salps were present between 100 and 150 meters depth.

Station Label: 92 Number: 555 File: 0555F01.cnv
Date: 24.10.2000 Time: 2:19:00
Latitude:-22°59.98' Longitude: 12°57.25' Depth [m]: 586.2
Surface Temp [°C]: 16.06 Salinity [PSU]: 35.33 Density [kg/m³]: 1026
Oxygen [ml/l]: 6 Chlorophyll: 1.53 Turbidity: 0.1

Dominant species : as on Station 554

Low plankton volumes at all depths with copepods dominating, except for the 150-200 m layer, where euphausiids and a jellyfish of 150 ml dominated the sample. No diatoms were observed. Chaetognaths present between 50 m and 150 m and euphausiids below 100 meters.

Station Label: 91 Number: 556 File: 0556F01.cnv
Date: 24.10.2000 Time: 5:40:30
Latitude:-22°59.95' Longitude: 13°08.59' Depth [m]: 316.9
Surface Temp [°C]: 16.11 Salinity [PSU]: 35.33 Density [kg/m³]: 1026
Oxygen [ml/l]: 5.99 Chlorophyll: 1.06 Turbidity: 0.1

Dominant species : As Stations 554-555, but less phytoplankton.

Low plankton volumes at all depths with copepods dominating. Euphausiids up to 150 meters. No diatoms were observed. A large comb-jelly was found in the 50 to 100 meter layer.

Station Label: 90 Number: 557 File: 0557F02.cnv

Date: 24.10.2000 Time: 10:39:04
Latitude:-22°59.93' Longitude: 13°19.62' Depth [m]: 355.9
Surface Temp [°C]: 14.58 Salinity [PSU]: 35.08 Density [kg/m³]: 1026.14
Oxygen [ml/l]: 6.07 Chlorophyll: 2.78 Turbidity: 0.1

Dominant species : As Stations 554-556.

Low plankton volumes at all depths, consisting mostly of copepods. No diatoms were observed. Chaetognaths were present in the 25-50 meter layer and euphausiids in the 25-50 meters layer.

Station Label: 89 Number: 558 File: 0558F02.cnv
Date: 24.10.2000 Time: 13:46:48
Latitude:-22°59.96' Longitude: 13°30.23' Depth[m]: 234.8
Surface Temp [°C]: 14.43 Salinity [PSU]: 35.02 Density [kg/m³]: 1026.13
Oxygen [ml/l]: 6.1 Chlorophyll: 3.98 Turbidity: 0.1

Dominant species : Copepods, some Foraminifera: more or less no phytoplankton, diatoms very very few; dinoflagellates : *Ceratium candrelabrum*.

Characterization : late stage of upwelled water , the copepods have consumed the diatoms, the presence of *Ceratium candelabrum* may indicate an influence of more oceanic waters. (This characterization is in contrast to the temperature signal (!!))

Low plankton volumes at all depths, consisting mostly of copepods. No diatoms were observed. Chaetognaths were present between 50 and 150 meters and euphausiids below 100 meters.

Station Label: 88 Number: 559 File: 0559F02.cnv
Date: 24.10.2000 Time: 17:17:36
Latitude:-22°59.99' Longitude: 13°41.18' Depth [m]: 152.4
Surface Temp [°C]: 14.31 Salinity [PSU]: 35.03 Density [kg/m³]: 1026.17
Oxygen [ml/l]: 5.72 Chlorophyll: 2.91 Turbidity: 0.1

Dominant species : Calanoid, cyclopoid and harpacticoid copepods, Foraminifera, very few diatoms (2 cells *Coscinodiscus wailesii*; many Prymnesiophyceae, Cryptophyceae, Prasinophyceae.

Characterization : as Station 558 but may be mixed with upwelled water due to the presence of the many flagellates, or with oceanic influenced waters

Moderate plankton volumes, containing mainly copepods. No diatoms were observed. Chaetognaths were present below 50 meters depth.

Station Label: 87 Number: 560 File: 0560F01.cnv
Date: 24.10.2000 Time: 20:39:44
Latitude:-23°00.04' Longitude: 13°52.05' Depth [m]: 144.9
Surface Temp [°C]: 14.2 Salinity [PSU]: 35.03 Density [kg/m³]: 1026.19
Oxygen [ml/l]: 5.45 Chlorophyll: 1.68 Turbidity: 0.1

Dominant species : as Station 559: but fewer „net-phytoplankton,, many Prymnesiophyceae *Chrysochromulina*, *Emiliana huxleyi*, *Coccolithus pelagicus*.

Characterization : see Station 559

Large amounts of plankton between 25 and 100 meters, with a maximum of 150 ml below 50 meters depth. Moderate plankton volumes above 25 m and below 100 m. No diatoms were observed. Samples were dominated by copepods. In addition chaetognaths (100-150 m) and euphausiids (0-25 m, 50-100 m) were present. One *Aequoraea* was sampled between 50 and 100 meters depth.

Station Label: 86 Number: 561 File: 0561F01.cnv
Date: 24.10.2000 Time: 22:38:35
Latitude:-22°59.99' Longitude: 14°03.05' Depth [m]: 132.2
Surface Temp [°C]: 14.51 Salinity [PSU]: 35.05 Density [kg/m³]: 1026.14
Oxygen [ml/l]: 5.7 Chlorophyll: 1.66 Turbidity: 0.1

Dominant species : as Station 559-560: even less „net-phytoplankton,, many Prymnesiophyceae *Chrysochromulina*, *Emiliania huxleyi*, *Coccolithus pelagicus*. Several dead cells of the diatoms *Coscinodiscus* and *Actinocyclus*.

Characterization : see Station 559

Moderate plankton volumes at all depths. No diatoms were observed. Copepods were numerous in all samples. Chaetognaths were present in the 25-50 m layer.

Station Label: 85 Number: 562 File: 0562F01.cnv
Date: 25.10.2000 Time: 1:10:49
Latitude:-22°59.97' Longitude: 14°13.52' Depth [m]: 109.2
Surface Temp [°C]: 13.44 Salinity [PSU]: 35.08 Density [kg/m³]: 1026.38
Oxygen [ml/l]: 3.43 Chlorophyll: 2.63 Turbidity: 0.1

Mud and H₂S was observed above the bottom.

Dominant species : as Station 559-561: but more „net-phytoplankton,, the diatom *Corethron* sp. many Prymnesiophyceae *Chrysochromulina*, *Emiliania huxleyi*, *Coccolithus pelagicus*. Dead cells of the diatoms *Coscinodiscus* and *Actinocyclus* disappeared, therefore many ciliates (Tintinnidae).

Characterization : see Station 559

Moderate plankton volumes, containing mainly copepods, with a distinct maximum (60 ml) between 25 and 50 meters depth. No diatoms were observed in the upper 50 meters, but some diatoms occurred below 50 meters depth. Euphausiids and small jellyfish in the upper 25 m, chaetognaths between 25 and 50 m

Station Label: 84 Number: 563 File: 0563F01.cnv
Date: 25.10.2000 Time: 2:50:05
Latitude:-23°00.02' Longitude: 14°18.95' Depth[m]: 74.6
Surface Temp [°C]: 13.73 Salinity [PSU]: 35.1 Density [kg/m³]: 1026.33
Oxygen [ml/l]: 5.16 Chlorophyll: 25.2 Turbidity: 0.13

Dominant species : thick soup of diatoms, mainly *Skeletonema costatum*, few *Stephanopyxis*, *Asterionellopsis glacialis*, *Stephanopyxis turris* and *Coscinosira polychorda*.

Characterization : full development of diatom bloom in upwelled water

Moderate sample volumes up to 50 m, low sample volumes below 50 m. Diatoms at all depths, totally dominating the upper 25 meters. Below 25 meters many copepods, between 25 and 50 meters also amphipods, chaetognaths and euphausiids.

Station Label: 83 Number: 564 File: 0564F01.cnv
Date: 25.10.2000 Time: 4:09:43
Latitude:-23°00.04' Longitude: 14°22.17' Depth [m]: 42.5
Surface Temp [°C]: 13.59 Salinity [PSU]: 35.09 Density [kg/m³]: 1026.36
Oxygen [ml/l]: 4.83 Chlorophyll: 14.68 Turbidity: 0.14

Dominant species : as Station 563 but more Tintinnidae

Characterization : see Station 563, but a few days older as tintinnids have developed and the diatom Bacteriastrum is already infected by parasites

One sample from 0-25 m water depth was taken (120 ml). It was dominated by diatoms and also contained several jellyfish.

Near Shore south of Walvis Bay

Station Label: 95 Number: 565 File: 0565F01.cnv
Date: 25.10.2000 Time: 6:28:31
Latitude:-23°14.96' Longitude: 14°22.10' Depth [m]: 63.4
Surface Temp [°C]: 13.19 Salinity [PSU]: 35.05 Density [kg/m³]: 1026.41
Oxygen [ml/l]: 3.77 Chlorophyll: 1.97 Turbidity: 0.1

Station Label: 96 Number: 566 File: 0566F01.cnv
Date: 25.10.2000 Time: 9:00:47
Latitude:-23°30.02' Longitude: 14°10.91' Depth [m]: 138.2
Surface Temp [°C]: 13.34 Salinity [PSU]: 35.03 Density [kg/m³]: 1026.37
Oxygen [ml/l]: 4.1 Chlorophyll: 1.75 Turbidity: 0.1

Station Label: 97 Number: 567 File: 0567F01.cnv
Date: 25.10.2000 Time: 11:50:09
Latitude:-23°44.99' Longitude: 14°24.76' Depth [m]: 52.4
Surface Temp [°C]: 12.83 Salinity [PSU]: 35.03 Density [kg/m³]: 1026.47
Oxygen [ml/l]: 2.67 Chlorophyll: 1.89 Turbidity: 0.13

No micronet station but net from Zooplankton-group (Xavier) is full of the long chain-forming diatom cf. *Fragilaria.*, *Chaetoceros* ssp., *Stephanopyxis turris* and Cryptophyceae.

Characterization : recent upwelled water with total different species composition than Station 563, must be an other water body.

Station Label: 98 Number: 568 File: 0568F01.cnv
Date: 25.10.2000 Time: 14:41:48
Latitude:-24°00.05' Longitude: 14°10.56' Depth [m]: 140.3
Surface Temp [°C]: 13.46 Salinity [PSU]: 35 Density [kg/m³]: 1026.36
Oxygen [ml/l]: 4.58 Chlorophyll: 1.64 Turbidity: 0.1

Dominant species : many copepods and ciliates (Tintinnidae) and the photosynthetic *Mesodinium rubrum*, The diatoms *Chaetoceros* ssp, *Skeletonema costatum*, *Thalassiosira* ssp.

Characterisation : late stage of upwelling succession as many consumers like copepods and tintinnids, but presence of *Corethron* sp. May indicate mixing with recent upwelled water

Station Label: 99 Number: 569 File: 0569F01.cnv
Date: 25.10.2000 Time: 17:32:14

Latitude:-24°15.03' Longitude: 14°19.72' Depth [m]: 90.9
Surface Temp [°C]: 12.85 Salinity [PSU]: 34.93 Density [kg/m³]: 1026.39
Oxygen [ml/l]: 6.7 Chlorophyll: 14.65 Turbidity: 0.12

Dominant species : very dense diatom soup, various *Chaetoceros*-ssp. Including *Ch. cf. socialis*, *Skeletonema costatum*, *Coscinodiscus gigas*, *Pseudo-nitzschia* ssp.

Characterization : recent upwelled water with first development of succession as already some heterotrophic dinoflagellates are present.

Transect 25°S, 5 nm offshore

Station Label: 100 Number: 570 File: 0570F01.cnv
Date: 26.10.2000 Time: 0:31:06
Latitude:-25°00.88' Longitude: 14°44.60' Depth [m]: 53.4
Surface Temp [°C]: 11.85 Salinity [PSU]: 34.89 Density [kg/m³]: 1026.55
Oxygen [ml/l]: 6.03 Chlorophyll: 10 Turbidity: 0.13

Dominant species : very dense diatom soup, various *Chaetoceros*-ssp. Including *Ch. cf. socialis* and *Ch. diadema*, *Skeletonema costatum*, *Coscinodiscus gigas*, *Pseudo-nitzschia* ssp. *Fragilaria* sp.

Characterization : more recent upwelled water than Station 569

Transect 25°S, 60 nm offshore

Station Label: 106 Number: 571 File: 0571_01.cnv
Date: 26.10.2000 Time: 7:18:07
Latitude:-25°11.21' Longitude: 13°44.44' Depth [m]: 293.4
Surface Temp [°C]: 12.91 Salinity [PSU]: 34.92 Density [kg/m³]: 1026.37
Oxygen [ml/l]: 6.19 Chlorophyll: 6.14 Turbidity: 0.11

Dominant species : very similar to Station 570, but fewer *Chaetoceros diadema*, much less *Fragilaria*, but more *Coscinodiscus gigas* and heterotrophic dinoflagellates; large colonies of Choanoflagellatae.

Characterization : later stage of succession than on Station 570.

Transect 25°S Eastward, from 160 nm to 5 nm offshore

Station Label: 116 Number: 572 File: 0572F01.cnv
Date: 26.10.2000 Time: 18:15:17
Latitude:-25°29.97' Longitude: 11°55.31' Depth [m]: 3717.4
Surface Temp [°C]: 16.42 Salinity [PSU]: 35.27 Density [kg/m³]: 1025.88
Oxygen [ml/l]: 5.4 Chlorophyll: 1.2 Turbidity: 0.1

Dominant species : many copepods, Ciliates (Tintinnidae), Radiolaria, Acantharia: few diatoms : *Pseudo-nitzschia* ssp.

Characterization : late stage of upwelling phytoplankton succession, only few diatoms are not consumed by the abundant zooplankton population: the presence of Radiolaria and Acantharia indicates an oceanic influence

Small plankton volumes were found at all depths, mainly copepods, chaetognaths and euphausiids. No diatoms were observed. Gastropod veliger-larvae occurred in the upper 50 meters and some small jellyfish between 25 and 50 meters.

Station Label: 115 Number: 573 File: 0573F01.cnv

Date: 26.10.2000 Time: 21:30:11
Latitude:-25°28.07' Longitude: 12°06.28' Depth [m]: 3601.1
Surface Temp [°C]: 16.31 Salinity [PSU]: 35.27 Density [kg/m³]: 1025.91
Oxygen [ml/l]: 3.46 Chlorophyll: 0.99 Turbidity: 0.1

Dominant species : as Station 572 but more diatoms

Characterization :as Station 572 but mixed with late succession stage of upwelling water, as many phototrophic and heterotrophic dinoflagellates are present

Small plankton volumes were found at all depths. The samples consisted mainly of copepods, and euphausiids as well as chaetognaths below 50 meters. No diatoms were observed. Hyperiid amphipods occurred in the upper 25 meters and small jellyfish were present between 25 and 50 meters.

Station Label: 114 Number: 574 File: 0574F01.cnv
Date: 27.10.2000 Time: 0:19:02
Latitude:-25°26.12' Longitude: 12°17.20' Depth [m]: 3405.9
Surface Temp [°C]: 16.08 Salinity [PSU]: 35.27 Density [kg/m³]: 1025.95
Oxygen [ml/l]: 4.22 Chlorophyll: 0.85 Turbidity: 0.1

Dominant species : few „net-phytoplankton,, but many cells of the chrysophyte cf. *Aureococcus* (about 2 µm in diameter)

Characterization : no idea

Small plankton volumes were found at all depths, consisting mainly of copepods, chaetognaths and euphausiids, except between 100 and 150 meters. There, instead, amphipods were present. No diatoms were observed. A fish larva was found between 50 and 100 meters.

Station Label: 113 Number: 575 File: 0575F01.cnv
Date: 27.10.2000 Time: 2:59:25
Latitude:-25°24.30' Longitude: 12°28.06' Depth[m]: 3116.7
Surface Temp [°C]: 15.43 Salinity [PSU]: 35.15 Density [kg/m³]: 1026.01
Oxygen [ml/l]: 4.17 Chlorophyll: 1.38 Turbidity: 0.1

Small plankton volumes were found at all depths, mainly copepods and chaetognaths. Euphausiids occurred below 50 meters. No diatoms were observed. Gastropod veliger-larvae were found in the upper 50 meters and some salps between 100 and 150 meters. A fish larva was found between 50 and 100 meters.

Station Label: 112 Number: 576 File: 0576F01.cnv
Date: 27.10.2000 Time: 5:11:34
Latitude:-25°22.39' Longitude: 12°39.00' Depth [m]: 2698.5
Surface Temp [°C]: 14.92 Salinity [PSU]: 35.08 Density [kg/m³]: 1026.08
Oxygen [ml/l]: 5.67 Chlorophyll: 1.52 Turbidity: 0.1

Dominant species : few zooplankton, much detritus: diatoms : „needle-plankton,, *Pseudo-nitzschia* cf. *delicatissima*, *Rhizosolenia alata*, *Rh.* cf. *hebetata*, *Rh. robusta*, cryptophytes, coccolithophorids *Emiliania huxleyi*, many dinoflagellate species.

Characterization : mixture of late upwelling succession and oceanic water ?

Small plankton volumes were found at all depths, except for the 25-50 m layer. No diatoms were observed. The samples consisted mainly of copepods and chaetognaths. Decapod shrimp larvae and small polychaetes were found between 25 and 50 meters. Gastropod veliger larvae occurred in the 50-100 meter range.

Station Label: 111 Number: 577 File: 0577F01.cnv

Date: 27.10.2000 Time: 7:22:29
Latitude:-25°20.53' Longitude: 12°49.98' Depth [m]: 2478.4
Surface Temp [°C]: 14.85 Salinity [PSU]: 35.09 Density [kg/m³]: 1026.09
Oxygen [ml/l]: 5.67 Chlorophyll: 1.37 Turbidity: 0.1

Small plankton volumes were found at most depths, with mainly copepods and chaetognaths, but moderate volumes were found between 25 and 100 meters. No diatoms were observed. Small jellyfish occurred between 25 and 150 m. Gastropod veliger-larvae were restricted to the 50-100 meter layer.

Station Label: 110 Number: 578 File: 0578F01.cnv
Date: 27.10.2000 Time: 10:11:03
Latitude:-25°18.69' Longitude: 13°00.70' Depth [m]: 2018.2
Surface Temp [°C]: 14.98 Salinity [PSU]: 35.08 Density [kg/m³]: 1026.06
Oxygen [ml/l]: 5.98 Chlorophyll: 0.68 Turbidity: 0.1

Dominant species : similar to Station 576 but less phytoplankton, more dinoflagellates, mainly *Ceratium azoricum*.

Characterization : see Station 576

Plankton volumes increased from 4 ml in the upper 25 m to 30 ml below 150 meters. No diatoms were observed. Copepods, chaetognaths and small jellyfish (except 0-25 m) were the main components at all depths. Fish larvae occurred in the upper 25 meters.

Station Label: 109 Number: 579 File: 0579_01.cnv
Date: 27.10.2000 Time: 14:01:46
Latitude:-25°16.83' Longitude: 13°11.70' Depth [m]: 1495
Surface Temp [°C]: 14.43 Salinity [PSU]: 34.97 Density [kg/m³]: 1026.09
Oxygen [ml/l]: 6.05 Chlorophyll: 0.88 Turbidity: 0.11

Dominant species : very many cells of the coccolithophorids *Coccolithus pelagicus* and *Emiliana huxleyi*, Some colonies of *Phaeocystis* sp. (Prymnesiophyceae); in 17 m water depth is the chlorophyll maximum caused apparently only by *Emiliana huxleyi*.

Characterization : upwelled water but no diatoms, later succession stage ?, what about silicate ?

Small plankton volumes were found at all depths, except below 150 meters. No diatoms were observed. Copepods and chaetognaths dominated, some euphausiids were present between 25 and 100 meters. Fish larvae occurred between 25 and 100 meters, small jellyfish were present below 100 meters.

Station Label: 108 Number: 580 File: 0580F01.cnv
Date: 27.10.2000 Time: 17:08:34
Latitude:-25°15.01' Longitude: 13°22.62' Depth[m]: 1085.6
Surface Temp [°C]: 14.19 Salinity [PSU]: 34.92 Density [kg/m³]: 1026.11
Oxygen [ml/l]: 5.23 Chlorophyll: 2.82 Turbidity: 0.11

Dominant species : the diatoms *Chaetoceros* ssp. and *Pseudo-nitzschia* sp., the prymnesiophyte *Phaeocystis* sp.

Characterisation : similar to Station 579 but more diatoms,; more recent ?

Small plankton volumes were found below 100 meters, somewhat higher volumes (10 ml) above 100 meters. No diatoms were observed. Copepods and chaetognaths dominated at all depths. Small jellyfish were present from 25 to 100 meters. Some euphausiids occurred below 150 m and fish larvae between 25-50 m and 100-150 meters.

Station Label: 107 Number: 581 File: 0581F01.cnv
Date: 27.10.2000 Time: 19:24:49

Latitude:-25°13.17' Longitude: 13°33.62' Depth [m]: 628.9
Surface Temp [°C]: 13.9 Salinity [PSU]: 34.95 Density [kg/m³]: 1026.19
Oxygen [ml/l]: 6.37 Chlorophyll: 4.76 Turbidity: 0.11

Dominant species : many diatoms : *Chaetoceros socialis* and others, *Pseudo-nitzschia* ssp., *Cerataulina bergonii*, *Corethron* sp. *Skeletonema costatum* and the coccolithophorid *Coccolithus pelagicus*.

Characterization : upwelled but not freshly upwelled water as already development of dinoflagellates: or mixing with other water body but not with that from the last stations as there are key species missing

Small plankton volumes were found below 25 meters, consisting mainly of copepods, chaetognaths , as well as some euphausiids below 50 meters. No diatoms were observed. Pteropods (Gastropoda) occurred in the 50-100 meter range and some small jellyfish between 100 and 150 meters. In the upper 25 meters a larger amount of copepods (50 ml) plus a large comb-jelly was sampled.

Station Label: 106 Number: 582 File: 0582F02.cnv
Date: 27.10.2000 Time: 22:45:32
Latitude:-25°11.51' Longitude: 13°44.74' Depth [m]: 291.2
Surface Temp [°C]: 13.89 Salinity [PSU]: 34.93 Density [kg/m³]: 1026.17
Oxygen [ml/l]: 6.39 Chlorophyll: 4.05 Turbidity: 0.11

Dominant species : Zooplankton, many faeces, ciliates (Tintinnidae): the diatoms *Coscinodiscus gigas*, *Pseudo-nitzschia* ssp., *Cerataulina bergonii*, *Rhizosolenia stolterfothii* and other diatoms; the prymnesiophyte *Phaeocystis* sp. and many heterotrophic dinoflagellates.

Characterization : older upwelled water with zooplankton and heterotrophic dinoflagellate development, may be that the diatoms indicate a mixing with other, more recent upwelled water

Moderate plankton volumes were found in the upper 100 meters (20-50 ml), small volumes at deeper strata. No diatoms were observed. Samples were dominated by copepods, accompanied by chaetognaths in the upper 25 meters and below 150 meters. Small jellyfish medusae and euphausiids in the layers 25-150 meters.

Station Label: 105 Number: 583 File: 0583F02.cnv
Date: 28.10.2000 Time: 2:46:30
Latitude:-25°09.37' Longitude: 13°55.47' Depth [m]: 208
Surface Temp [°C]: 13.1 Salinity [PSU]: 34.91 Density [kg/m³]: 1026.32
Oxygen [ml/l]: 4.52 Chlorophyll: 4.15 Turbidity: 0.11

Dominant species : as Station 582, more zooplankton in particular more nauplii, less diatoms

Characterization : as Station 582 apparently older as more copepod nauplii

Small plankton volumes in the upper 50 meters, somewhat higher values (10-20 ml) below 50 meters water depth. No diatoms were observed. In all samples a high percentage of copepods was present, especially below 150 meters. Small jellyfish and comb-jellies were found in the upper 25 m and between 50 and 200 meters.

Station Label: 104 Number: 584 File: 0584F01.cnv
Date: 28.10.2000 Time: 4:38:49 Latitude:-25°07.50' Longitude: 14°06.33' Depth [m]: 186.8
Surface Temp [°C]: 12.61 Salinity [PSU]: 34.9 Density [kg/m³]: 1026.41
Oxygen [ml/l]: 5.41 Chlorophyll: 2.43 Turbidity: 0.1

Dominant species : as Station 583, diatoms *Coscinodiscus gigas*, *Pseudo-nitzschia* sp., *Cerataulina bergonii*, many heterotrophic dinoflagellates of the genus *Protoberidinium*, mainly of the section PARA

Characterization may be a mixture of water from station 583 with recent upwelled water.

The samples of this and the following inner stations differ much from the previously described more offshore stations. Large plankton volumes were sampled in the upper 50 meters. Many diatoms were present down to 100 meters, dominating the samples taken in the upper 50 meters. Apart from diatoms, the samples contained very many copepods.

Station Label: 103 Number: 585 File: 0585F01.cnv
Date: 28.10.2000 Time: 6:56:13
Latitude:-25°05.74' Longitude: 14°17.31' Depth [m]: 161
Surface Temp [°C]: 12.77 Salinity [PSU]: 34.9 Density [kg/m³]: 1026.38
Oxygen [ml/l]: 4.74 Chlorophyll: 3.73 Turbidity: 0.11

Dominant species : many copepods, naupia and faeces, many eggs of *Calanoides carinatus*; thick diatom soup : *Coscinodiscus gigas*, *Pseudo-nitzschia* sp., *Chaetoceros* cf. *socialis* and other species; few dinoflagellates

Characterization : the presence of copepods, eggs and nauplii indicate late stage of upwelling succession but presence of the diatoms and Phaeocystis indicate a mixture with early stage of upwelled water.

Large plankton volumes below 25 meters (100 ml), but a small volume in the upper 25 m sample (3 ml). No diatoms were observed. All samples were dominated by copepods. A large jellyfish medusa was present in the 25-50 meter sample. Some euphausiids were found in the 50-100 meter range.

Station Label: 102 Number: 586 File: 0586F02.cnv
Date: 28.10.2000 Time: 9:47:45
Latitude:-25°03.74' Longitude: 14°28.18' Depth [m]: 124.7
Surface Temp [°C]: 12.75 Salinity [PSU]: 34.91 Density [kg/m³]: 1026.39
Oxygen [ml/l]: 6 Chlorophyll: 5.15 Turbidity: 0.1

Dominant species : as Station 585, but less phytoplankton, more *Coscinodiscus gigas* (diatom).

Characterization : similar to Station 585

Moderate plankton volumes with diatoms and copepods were found at all depths. Most diatoms occurred in the upper 25 meters.

Station Label: 101 Number: 587 File: 0587F01.cnv
Date: 28.10.2000 Time: 11:51:46
Latitude:-25°01.86' Longitude: 14°39.12' Depth [m]: 81.66
Surface Temp [°C]: 13.25 Salinity [PSU]: 34.89 Density [kg/m³]: 1026.27
Oxygen [ml/l]: 9.2 Chlorophyll: 22.45 Turbidity: 0.12

Dominant species : the diatoms *Chaetoceros* cf. *socialis* and several other *Chaetoceros* species; *Pseudo-nitzschia* ssp, *Coscinodiscus gigas*, many heterotrophic dinoflagellates of the genus *Protoberidinium*, sectio PARA.

Characterization : succession stage of upwelled water with diatoms and heterotrophic dinoflagellates

Large plankton volume in the upper 25 meters, moderate volumes found below 25 meters. Very many diatoms in the upper 25 meters, here dominating the sample, and some diatoms below 50 meters. Many copepods in all samples, totally dominating between 25 and 50 meters. Some euphausiids were found in the upper 25 meters.

Station Label: 100 Number: 588 File: 0588F01.cnv
Date: 28.10.2000 Time: 14:28:34
Latitude:-25°00.95' Longitude: 14°44.55' Depth [m]: 53.46
Surface Temp [°C]: 13.59 Salinity [PSU]: 34.88 Density [kg/m³]: 1026.2
Oxygen [ml/l]: 11.37 Chlorophyll: 13.74 Turbidity: 0.12

Dominant species : as Station 587, but no *Coscinodiscus gigas* (diatom)

Characterization : similar to Station 587.

Large plankton volume in the upper 25 meters, moderate volumes found below 25 m. Very many diatoms in the upper 25 meters, here dominating the sample, and some diatoms below 25 meters. Many copepods and some euphausiids were present at all depths.

Transect 200m Northward, 25°S to 24°S

Station Label: 105 Number: 589 File: 0589_01.cnv
Date: 28.10.2000 Time: 19:40:22
Latitude:-25°09.32' Longitude: 13°57.00' Depth[m]: 201.66
Surface Temp [°C]: 13.7 Salinity [PSU]: 34.92 Density [kg/m³]: 1026.2
Oxygen [ml/l]: 6.25 Chlorophyll: 5.61 Turbidity: 0.11

Station Label: 4 Number: 590 File: 0590F01.cnv
Date: 28.10.2000 Time: 21:22:14
Latitude:-24°59.89' Longitude: 13°52.29' Depth [m]: 202.09
Surface Temp [°C]: 13.07 Salinity [PSU]: 34.9 Density [kg/m³]: 1026.32
Oxygen [ml/l]: 6.04 Chlorophyll: 5.09 Turbidity: 0.11

Station Label: 5 Number: 591 File: 0591F01.cnv
Date: 28.10.2000 Time: 22:51:12
Latitude:-24°49.94' Longitude: 13°54.55' Depth [m]: 202.38
Surface Temp [°C]: 13.41 Salinity [PSU]: 34.91 Density [kg/m³]: 1026.26
Oxygen [ml/l]: 5.47 Chlorophyll: 6.37 Turbidity: 0.11

Station Label: 6 Number: 592 File: 0592_01.cnv
Date: 29.10.2000 Time: 0:24:05
Latitude:-24°39.94' Longitude: 13°56.72' Depth [m]: 209.03
Surface Temp [°C]: 12.85 Salinity [PSU]: 34.92 Density [kg/m³]: 1026.37
Oxygen [ml/l]: 5.69 Chlorophyll: 8.33 Turbidity: 0.11

Station Label: 7 Number: 593 File: 0593F01.cnv
Date: 29.10.2000 Time: 1:54:37
Latitude:-24°29.94' Longitude: 13°57.56' Depth [m]: 203.3
Surface Temp [°C]: 13.18 Salinity [PSU]: 34.94 Density [kg/m³]: 1026.33
Oxygen [ml/l]: 5.64 Chlorophyll: 4.57 Turbidity: 0.11

Station Label: 8 Number: 594 File: 0594F01.cnv

Date: 29.10.2000 Time: 3:25:26
Latitude:-24°19.95' Longitude: 14°00.61' Depth [m]: 200.53
Surface Temp [°C]: 13.55 Salinity [PSU]: 34.96 Density [kg/m³]: 1026.27
Oxygen [ml/l]: 5.35 Chlorophyll: 7.49 Turbidity: 0.11

Station Label: 9 Number: 595 File: 0595_01.cnv
Date: 29.10.2000 Time: 4:52:56
Latitude:-24°10.00' Longitude: 14°01.48' Depth [m]: 200.21
Surface Temp [°C]: 13.71 Salinity [PSU]: 35.01 Density [kg/m³]: 1026.27
Oxygen [ml/l]: 3.45 Chlorophyll: 2.69 Turbidity: 0.1

Transect 24°S Eastward from 20 nm to 5 nm Offshore

Station Label: 10 Number: 596 File: 0596F01.cnv
Date: 29.10.2000 Time: 6:26:14
Latitude:-23°59.97' Longitude: 14°01.60' Depth [m]: 201.35
Surface Temp [°C]: 13.92 Salinity [PSU]: 35.02 Density [kg/m³]: 1026.24
Oxygen [ml/l]: 5.61 Chlorophyll: 5.18 Turbidity: 0.11

Dominant species : thick diatom soup; *Skeletonema costatum*, various *Chaetoceros* spp., *Asterionellopsis glacialis*, *Pseudo-nitzschia* spp., *Thalassiosira* spp., *Stephanopyxis turris*: heterotrophic dinoflagellates.

Characterization : full developed diatom bloom of upwelled water

Station Label: 98 Number: 597 File: 0597F01.cnv
Date: 29.10.2000 Time: 8:04:20
Latitude:-24°00.02' Longitude: 14°10.59' Depth [m]: 52.16
Surface Temp [°C]: 13.59 Salinity [PSU]: 35.03 Density [kg/m³]: 1026.32
Oxygen [ml/l]: 5.27 Chlorophyll: 5.28 Turbidity: 0.11

Dominant species : see Station 596 but less heterotrophic dinoflagellates.

Characterization : see Station 596.

Station Label: 117 Number: 598 File: 0598F01.cnv
Date: 29.10.2000 Time: 9:13:00
Latitude:-24°00.02' Longitude: 14°16.24' Depth [m]: 111.23
Surface Temp [°C]: 13.25 Salinity [PSU]: 35 Density [kg/m³]: 1026.36
Oxygen [ml/l]: 5.09 Chlorophyll: 4.98 Turbidity: 0.11

Dominant species : see Station 597 but less *Skeletonema costatum*, more *Asterionellopsis glacialis* and cf. *Fragilaria*.

Characterization : similar to Station 596 and 597 changed diatom species composition; other water body with other history or mixing of two water bodies ?

Station Label: 118 Number: 599 File: 0599F01.cnv
Date: 29.10.2000 Time: 10:20:16
Latitude:-23°59.97' Longitude: 14°21.72' Depth [m]: 81.68
Surface Temp [°C]: 12.83 Salinity [PSU]: 34.99 Density [kg/m³]: 1026.44
Oxygen [ml/l]: 4.25 Chlorophyll: 3.39 Turbidity: 0.12

Dominant species : Thick brown diatom soup, *Skeletonema costatum*, more cf *Fragilaria* sp. and *Stephanopyxis turris*, *Pseudo-nitzschia* spp.; very many resting spores of *Chaetoceros* cf. *diadema*.

Characterization : late stage of diatom bloom as massive resting spore formation of *Chaetoceros cf. diadema* and presence of heterotrophic dinoflagellates.

Transect 200m Northward, 24°S to 23°S

Station Label: 10 Number: 600 File: 0600F01.cnv
Date: 29.10.2000 Time: 12:50:22
Latitude:-23°59.91' Longitude: 14°01.70' Depth [m]: 201.61
Surface Temp [°C]: 14.2 Salinity [PSU]: 35.02 Density [kg/m³]: 1026.18
Oxygen [ml/l]: 6.07 Chlorophyll: 2.61 Turbidity: 0.1

Station Label: 11 Number: 601 File: 0601_01.cnv
Date: 29.10.2000 Time: 15:10:21
Latitude:-23°50.01' Longitude: 13°55.28' Depth [m]: 202.18
Surface Temp [°C]: 14.12 Salinity [PSU]: 35.02 Density [kg/m³]: 1026.2
Oxygen [ml/l]: 6.13 Chlorophyll: 7.16 Turbidity: 0.11

Station Label: 12 Number: 602 File: 0602F01.cnv
Date: 29.10.2000 Time: 17:21:58
Latitude:-23°40.05' Longitude: 13°44.25' Depth[m]: 199.1
Surface Temp [°C]: 14.05 Salinity [PSU]: 35.01 Density [kg/m³]: 1026.2
Oxygen [ml/l]: 5.65 Chlorophyll: 1.18 Turbidity: 0.1

Station Label: 13 Number: 603 File: 0603_01.cnv
Date: 29.10.2000 Time: 19:23:57
Latitude:-23°30.02' Longitude: 13°35.42' Depth [m]: 202.98
Surface Temp [°C]: 14.16 Salinity [PSU]: 35 Density [kg/m³]: 1026.18
Oxygen [ml/l]: 5.61 Chlorophyll: 1.43 Turbidity: 0.1

Station Label: 14 Number: 604 File: 0604F01.cnv
Date: 29.10.2000 Time: 20:59:14
Latitude:-23°20.02' Longitude: 13°32.52' Depth [m]: 200.7
Surface Temp [°C]: 14.13 Salinity [PSU]: 35.01 Density [kg/m³]: 1026.19
Oxygen [ml/l]: 5.66 Chlorophyll: 2.41 Turbidity: 0.11

Station Label: 15 Number: 605 File: 0605_01.cnv
Date: 29.10.2000 Time: 22:25:27
Latitude:-23°09.95' Longitude: 13°32.38' Depth [m]: 202.11
Surface Temp [°C]: 14.2 Salinity [PSU]: 35.03 Density [kg/m³]: 1026.2
Oxygen [ml/l]: 5.55 Chlorophyll: 2.99 Turbidity: 0.11

Station Label: 89 Number: 606 File: 0606F01.cnv
Date: 30.10.2000 Time: 0:07:42
Latitude:-22°59.94' Longitude: 13°32.07' Depth [m]: 199.78
Surface Temp [°C]: 14.34 Salinity [PSU]: 35.04 Density [kg/m³]: 1026.16
Oxygen [ml/l]: 5.53 Chlorophyll: 2.51 Turbidity: 0.11

Min. Surface Temp [°C]: 11.85 Station 570
Max. Surface Temp [°C]: 16.81 Station 509
Min. Surface Salinity [PSU]: 34.88 Station 588
Max. Surface Salinity [PSU]: 35.49 Station 509
Min. Surface Density [kg/m³]: 1025.88 Station 572
Max. Surface Density [kg/m³]: 1026.55 Station 570
Min. Surface Oxygen [ml/l]: 2.67 Station 567
Max. Surface Oxygen [ml/l]: 11.37 Station 588
Min. Surface Chlorophyll: 0.68 Station 578
Max. Surface Chlorophyll: 33.29 Station 553
Min. Surface Turbidity: 0.08 Station 491
Max. Surface Turbidity: 0.14 Station 541