Universität Rostock Traditio et Innovatio

Leibniz Institute for Baltic Sea Research Warnemünde

Master Thesis Marine Biology

Composition and distribution of the

macrozoobenthic communities on the shelf off Angola

2nd April to 20th August 2012

Handover date: 20th August 2012

By

Diana Moritz

Born in Wismar

on 29th October 1987

Registration number: 210208509

University of Rostock

1. Supervisor: Dr. Michael Zettler

Leibniz-Institut für Ostseeforschung Warnemünde
Biologische Meereskunde
Seestrasse 15
D-18119 Rostock
Phone: +49 381 5197 236
Fax: +49 381 5197 440
E-Mail: michael.zettler@io-warnemuende.de

2. Supervisor: Dr. rer. nat. Wolfgang Wranik

Universität Rostock
Institut für Biowissenschaften
Albert-Einstein-Str. 3b
D-18051 Rostock
Phone: +49 381 498 6060
Fax: +49 381 498 6052
E-mail: wolfgang.wranik@uni-rostock.de

Contents

Zusammenfassung

Diese Arbeit beschäftigte sich mit der Zusammensetzung und der Verteilung der makrozoobenthischen Gemeinschaften an 9 Stationen entlang eines latitudinalen Gradienten (8° bis 17°S) in Wassertiefen von 28 m bis 102 m auf dem Schelf vor Angola. Die Temperatur variierte zwischen 14,5°C im Süden und 17,5°C im Norden. Das Sediment zeichnete sich durch unterschiedliche Beschaffenheit aus.

Die Arbeit stellt nun erstmalig eine Zusammenstellung der benthischen Fauna vor Angola an ausgewählten Stationen dar. Es wurden insgesamt 36 Gefäßproben untersucht. Alle Organismen wurden auf dem möglichst niedrigsten taxonomischen Niveau bestimmt. Von den insgesamt 343 ermittelten Taxa weisen die Polychaeten die größte Dominanz mit ca. 40% auf, gefolgt von den Crustaceen (35%), Mollusken (19%), „Andere“ (6%) sowie den Echinodermaten (1%). Die höchste Diversität mit 125 Taxa wurde bei Station Be71 (9°S) ermittelt. Ein weiterer Peak befindet sich bei Station BM5 (13°S) mit 124 Taxa, wobei die geringste Diversität von 42 Taxa bei Station Ku4 gefunden wurde. Die größte Abundanz weist Station Na5 (15°S) mit 38.332 Individuen/m² auf, im Vergleich dazu Station Ku4 (17°S) mit der geringsten Abundanz von 1.188 Individuen/m². Die Biomasse variiert zwischen 10,06 g/m² (Station SU4, 10°S) und 216,85 g/m² (Station Ku4), und wurde im Süden vorrangig von den Mollusken bestimmt. Die Schlüsselarten sind im Süden an der Mündung des Kunene-Flusses *Nuculana bicuspidata*, *Nassarius vinctus* sowie der Polychaet *Cossura coasta*, während in den nördlicheren Regionen die Polychaeten *Diopatra neapolitana*, *Owenia* sp. sowie *Prionospio* sp. sehr abundant auftraten.

Hinsichtlich der Gesamtbetrachtung zeigt sich kein eindeutiger Trend entlang des latitudinalen Gradienten auf dem Schelf vor Angola. Die südlichen Stationen grenzen sich aufgrund des geringen Sauerstoffgehalts von <1 ml/l mit geringer Diversität und Abundanz sowie hoher Biomasse von den übrigen Stationen ab. Jedoch weisen die Werte für die nördlicheren Stationen signifikante Schwankungen auf, die möglicherweise aus der unterschiedlichen Sedimentbeschaffenheit resultieren könnte. Die höchste Diversität wurde bei Stationen mit großer Korngröße ermittelt, wobei steinige Böden eine geringe Diversität aufwiesen. Die größte Abundanz wurde an einer Station bestimmt, die von einer großen Menge an Diatomeen und Schill dominiert wurde, welche als Nahrungsquelle dient sowie Schutz für benthische Organismen bietet.

Summary

This thesis dealt with the composition and distribution of the macrozoobenthic communities at 9 stations in 28 m to 102 m depth along a latitudinal gradient (8° to 17°S) on the shelf off Angola. The temperature varied between 14,5°C in the south and 17,5°C in the north. The sediment revealed different textures.

This study is the first that presents a composition of the benthic fauna at several selected locations off Angola. A total of 36 samples were analysed. All organisms were determined on the lowest taxonomic level, whenever possible. The 343 taxa, that were encountered, exhibit the dominance of the polychaetes with about 40%, followed by the crustaceans (35%), mollusks (19%), other (6%) and echinoderms (1%).

The highest diversity was detected at station Be71 (9°S) with 125 taxa in total. Another peak can be found at station BM5 (13°S) with 124 taxa, whereupon the lowest diversity of 42 taxa was determined at station Ku4 (17°S). The highest abundance could be shown at station Na5 (15°S) with 38.332 individuals/m², contrary to that is station Ku4 with the lowest abundance of 1.188 individuals/m². The biomass varies between 10,06 g/m² at station SU4 (10°S) and 216,85 g/m² at station Ku4, and was mainly influenced by the mollusks in the south. The key species in the south of Angola at the mouth of the Cunene River are *Nuculana bicuspidata* and *Nassarius vinctus*, as well as the polychaete *Cossura coasta*, while the polychaetes *Diopatra neapolitana*, *Owenia* sp. and *Prionospio* sp. occur frequently in the northern regions.

In regard to the overall view, it can be concluded that there is no clear trend along the latitudinal gradient on the shelf off Angola. The southern stations delimit from all other observed stations due to their less oxygen content of <1 ml/l which reasons in a minor diversity, abundance as well as high biomass. However, the values of the northern stations vary significantly that possibly could have resulted from the different sediment textures since the highest diversity was measured at stations of large grain sizes, whereupon rocky bottom exhibited low diversity. The highest abundance was detected at a station that was dominated by diatoms and shell detritus offering protection and serving as nutritional basis for benthic organisms.

1 Introduction

1.1 State of research

Marine sediments form one of the largest habitats on earth by covering more than 80 % of the ocean floor. In spite of high size variations of the benthos, the benthic biomass is dominated by the macrofaunal invertebrates (>0,5 mm), including many species of polychaetes, crustaceans, mollusks and echinoderms (Lenihan & Micheli 2001).

It is a general rule that the species richness of many animals and plants in terrestrial systems declines from the tropics to the poles. It has long been hypothesised that a similar trend is also present in the sea (Ellingsen & Gray 2002).

In fact, this presumption belongs to one of 3 generally accepted gradients of diversity in the sea, that has been summarized by Levinton (1995) as ` The best known diversity gradient is an increase of species diversity from high to low latitudes in continental shelf benthos, in the plankton in continental shelf regions and in the open ocean`.

However, studies on marine fauna revealed different results over the past 2 to 3 decades (Renaud et al. 2009).

Up to now, macrozoobenthic communities on shelves have been already studied worldwide, whereupon research at the Angolan coast has only focused on fisheries, zooplankton and meiozoobenthic communities by i.e. Longhurst (1959), Strømme & Sætersdal (1991), Soltwedel & Thiel 1995 and Soltwedel (1997).

1.2 Shelf off Angola

Angola with its approximately 1.600 km long coastline is located in the southwest of Africa at the Atlantic ocean in the southern hemisphere. The shelf, describing the shallow, nearshore seabed up to 200 meters below the sea level, is influenced by several abiotic factors such as temperature, oxygen, salinity, sediment and ocean currents. An overview of these features is given in the next paragraphs.

1.2.1 Temperature, salinity and oxygen

Angola is characterised by a temperate climate in the south and a tropic climate in the north. During the summer from January to April, there is an increased rainfall and runoff from the Congo River in the northern boundary of Angola. The upper water layer consists of Equatorial Water that is characterised by low salinity and high temperature (Wauthy 1977). The oxygen level is usually above 2 ml/l in a depth of about 100 m, decreasing to slightly over 1 ml/l at the edge of the shelf. Surface temperatures of the northern part (to Benguela) are usually 27 to 28°C, whereupon bottom temperatures of 20°C are reached to about 50 m depth. By contrast, the temperature near the bottom in the southern regions is always lower than 20°C.

During winter, a northward flowing coastal current develops in consequence of the strengthened southeast trade winds, with upwelling occurring all along the coast. This phenomenon appears to be well developed from the North to the centre of the Angolan coast. Surface temperatures of the northern region decreases (20 to 22°C). In the southern region where upwelling is at its peak, surface temperatures near the coast decreases to 15°C. At about 50 m depth, oxygen values <2 ml/l are reached, whereas values below 1 ml/l are found at 100 m depth (Bianchi, 1992).

According to Lass *et al.* (2000), Angola Current water usually has a temperature greater than 24°C and a salinity of more than 36,4 psu in the upper mixed layer. Traveling southwards, the temperature of the water mass gradually declines and becomes less saline. During winter and spring, the Angola Current water with temperatures between 27°C and 30°C retreats to the northwest replaced by slightly cooler waters with temperatures between 20 and 26°C (Meeuwis & Lutjeharms 1990). The isotherms run more or less parallel to the coast (Strømme & Sætersdal 1991) (Figure 1).

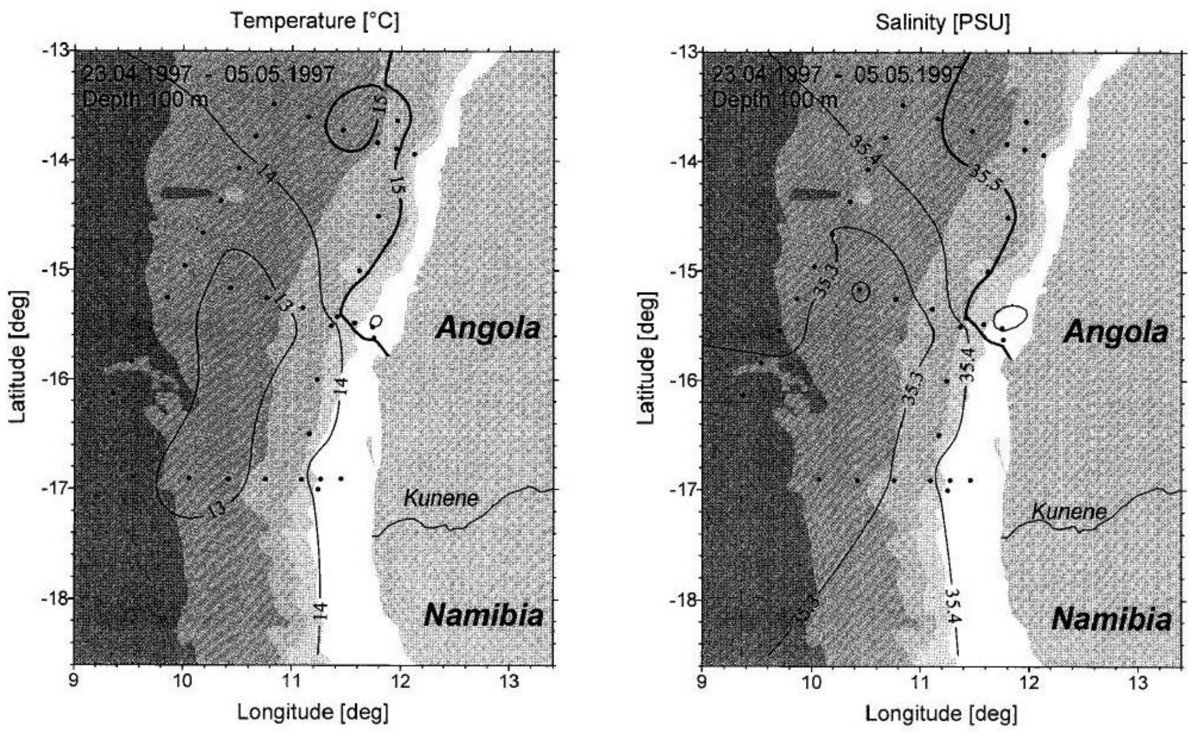

Fig. 1: Horizontal distribution of temperature (left) and salinity (right) in 100 m depth (Lass *et al.* 2000).

1.2.2 Bottom topography and structure

There are different bottom structures (Figure 2) and sediment types (Figure 3) along the coast off Angola. The northern part of the Angolan shelf is characterised by large areas of fine to coarse sand. Outside the Congo River in the north of Luanda, silt appears as the main component of the soil. These areas are interrupted by beds of rocks, stones and corals. The central part of the Angolan shelf is characterised by alternating fields of mud and fine coarse sand, whereupon silt and clay are dominating. Rocky bottoms are mainly found in the centre of the shelf. Travelling southwards to the Cunene River estuary the bottom is level, consisting of clay, silt and also fine to coarse sand in the region north of 15°S. In the south, the bottom deeper than 100 to 200 m is rough and untrawlable (Bianchi 1992)

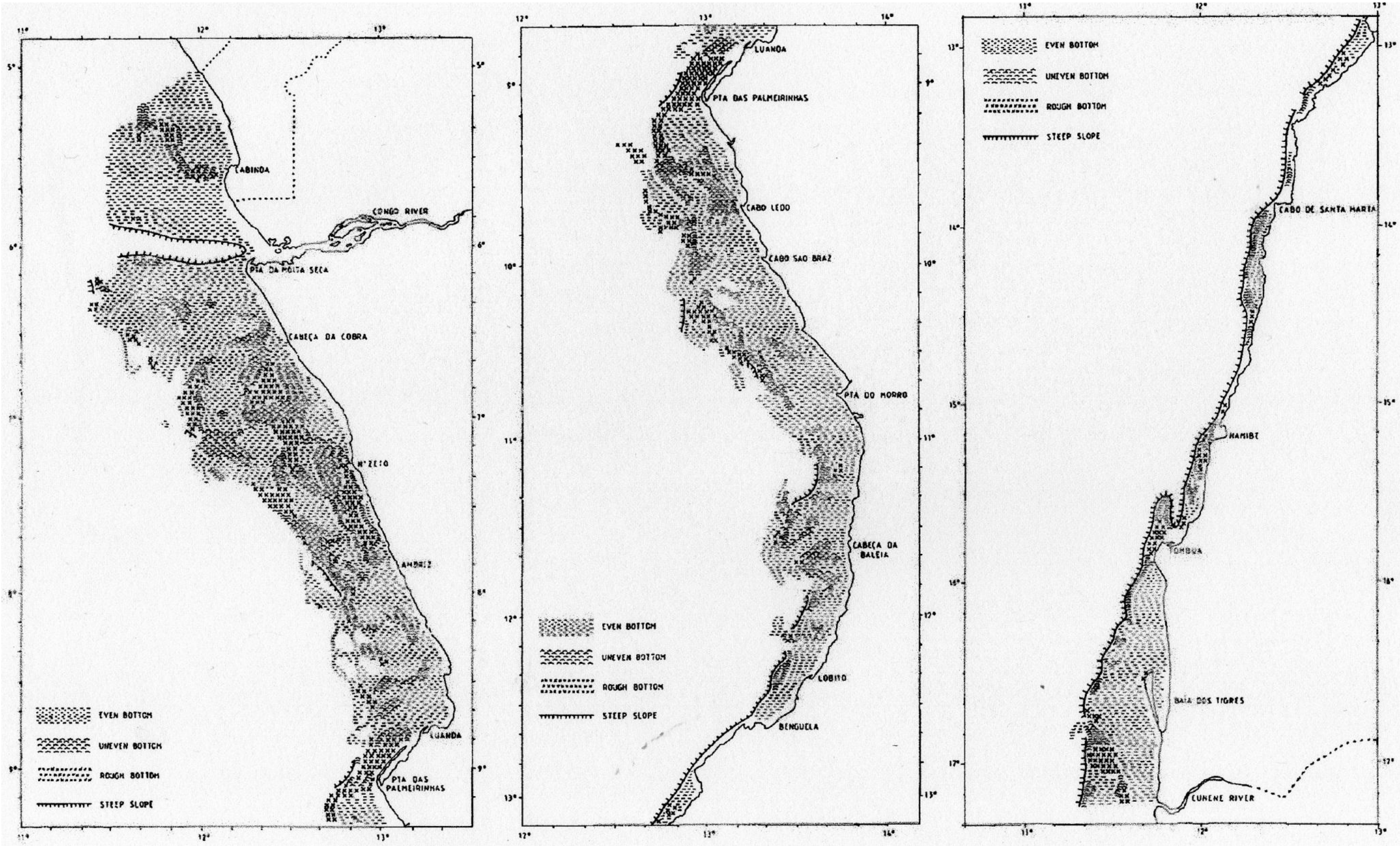

Fig. 2: Shelf bottom structure inferred from echograms along the Angolan coast (Bianchi 1992, redrawn from Strømme & Sætersdal 1991).

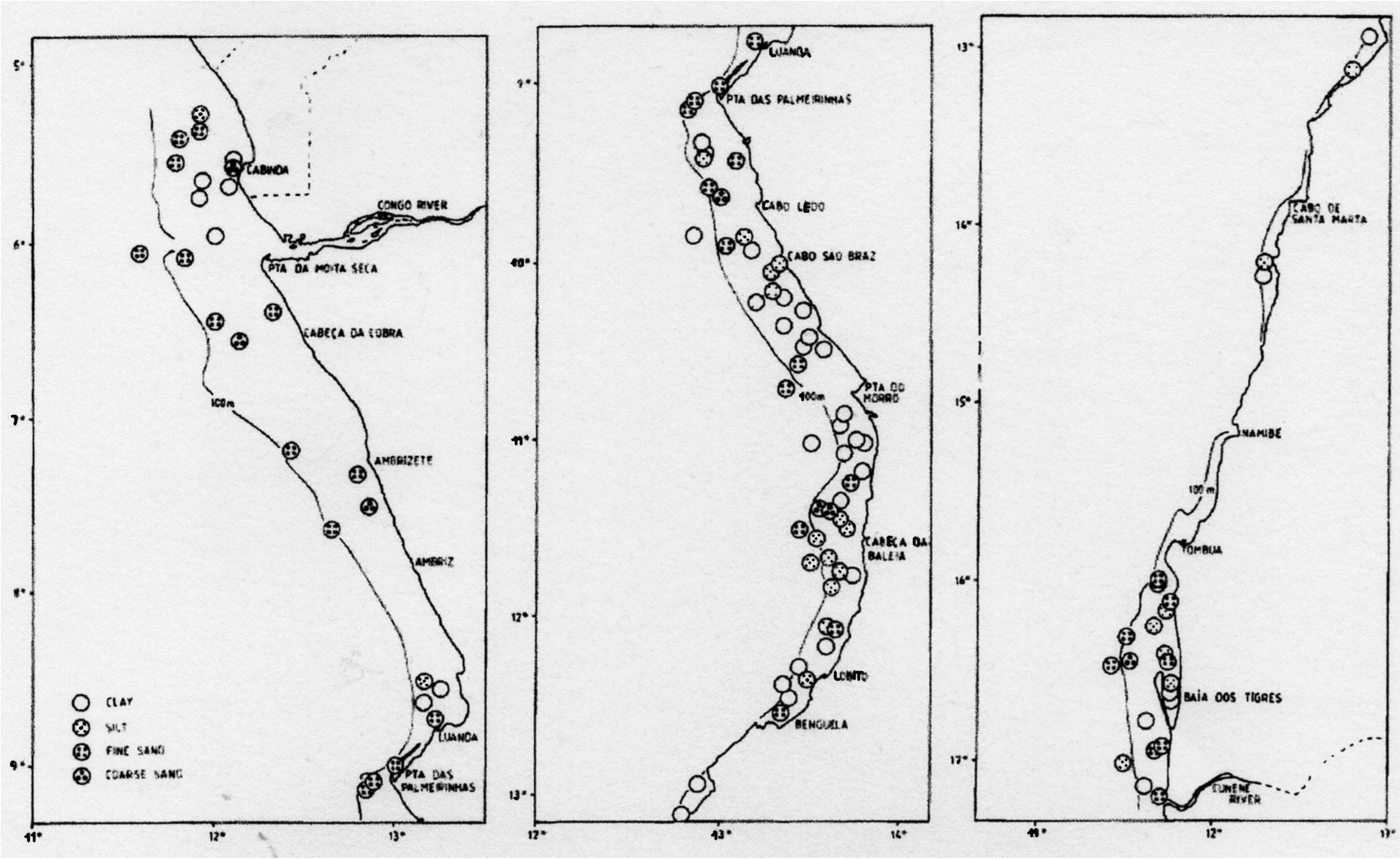

Fig. 3: Stations surveyed by Bianchi (1992) in February and March 1989, indicating the types of sediment along the Angolan coast; empty circle: clay, circle with 3 dots: coarse sand, circle with 4 dots: fine sand, circle with 5 dots: silt.

1.2.3 Current dynamics

The Angolan coast is mainly influenced by the Angola Current representing the eastern part of a cyclonic gyre that is centred around 1°S and 4°E and is driven by the South Equatorial Countercurrent in the Atlantic Ocean (Figure 4).

At about 16°S, the southward-flowing Angola Current converges with the northward- flowing Benguela Current forming the Angola-Benguela Front (ABF) (Hogan 2010) that sharply separates the nutrient-poor warm water of the Angola Current from the nutrient-rich cold water of the Benguela Current and thus, represents a transition zone between the more typical ecosystem in the north and the upwelling-driven ecosystem in the south (Lass *et al.* 2000).

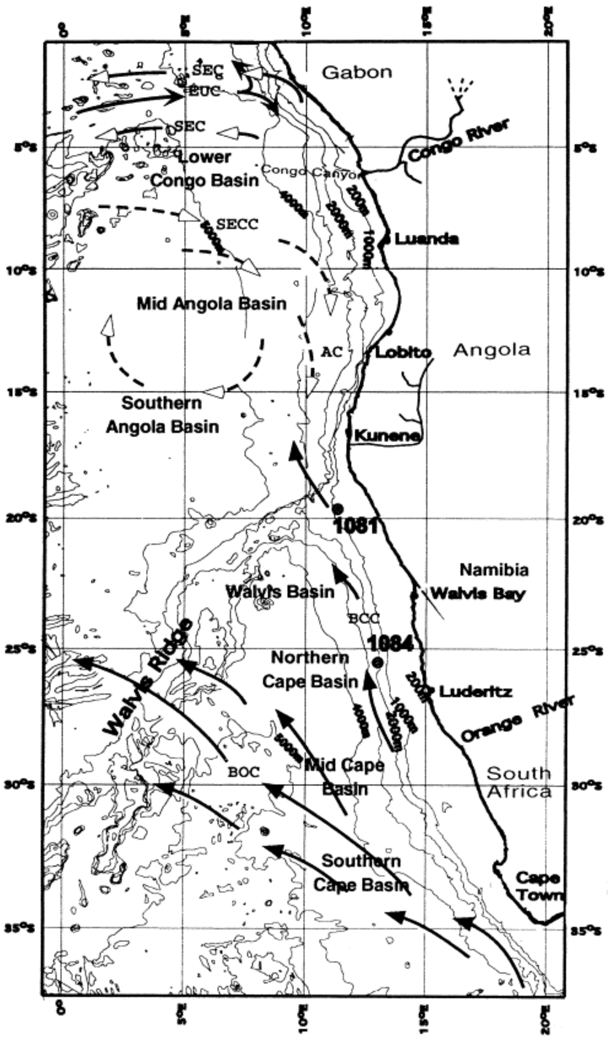

Fig.4: Marine currents in the Southeast Atlantic Ocean at the West African coast; AC: Angola Current, BCC: Benguela Coastal Current, BOC: Benguela Oceanic Current, EUC: Equatorial Undercurrent, SECC: South Equatorial Countercurrent, SEC: South Equatorial Current (Lin & Chen 2002).

The coastal poleward-flowing Angola Current extends from below the surface to 200 m depth in which current speeds of 70 cm/s at the surface and 88 cm/s subsurface were measured during late summer. This poleward undercurrent is distinctive of near bottom water over the shelf and extends westwards of the shelf-break. The subtidal currents over the shelf are dominated by coastal trapped waves. A net poleward flow of 5-8 cm/s or about 5 km/d was noticed. The Angola Current occasionally reaches the surface, resulting in episodes of poleward flow at the surface (Steele *et al.* 2009).

Between the latitudes of 5° and 15°S generally low values of the windstress curl were observed by Lass *et al.* (2000).

1.3 Objective

The aim of this study is the investigation of the composition and distribution of the macrozoobenthic communities along a latitudinal gradient on the shelf off Angola. In the subsequent paragraph, the procedure including materials will be described.

2 Material and methods

2.1 Material

Benthic samples for this study were taken along a transect at the Angolan coast between Namibia and Luanda (Figure 5) on a cruise of the German research vessel Maria S. Merian (MSM 18/4) from July 29th to August 03rd 2011.

Sampling

Triplicate samples (haul 1, 2 and 3) were taken with a 0.1 m² van Veen grab at each of 9 stations from 28 m to 102 m depth. Additional dredge hauls were taken for collection of mobile, larger or rare species. All samples were sieved through a 1 mm² screen and animals were preserved on board in 4% buffered formaldehyde.

A list of all analysed samples including the number of hauls and dredge hauls is given in Table 1. The biotic and abiotic features of the sediment are provided in Table 2.

MSM ID	Station name	Latitude	Longitude	Date of sampling	Depth [m]	H1	H2	H3	D	Total
825	LU5	08°46,980´S	13°10,020´E	03.08.2011	80	1	1	1	3	5
819	Be71	09°26,070´S	12°49,870´E	02.08.2011	102	1	1	1	2	6
813	SU5	10°30,500´S	13°34,600´E	01.08.2011	28	1	-	-	-	1
814	SU4	10°29,380´S	13°25,350´E	01.08.2011	60	1	-	-	1	2
812	LO5	12°20,000´S	13°32,000´E	01.08.2011	60	1	1	1	2	5
807	BM5	13°59,477´S	12°21,690´E	31.07.2011	48	1	1	1	1	4
802	Na5	15°05,750´S	12°06,300´E	30.07.2011	62	4	-	-	-	4
851	Ku4	17°15,840´S	11°36,910´E	15.08.2011	102	1	1	1	2	5
852	Ku5	17°15,700´S	11°43,000´E	15.08.2011	39	1	1	1	1	4

Tab.1: List of all analysed samples including the total number of samples, the location of each station, date of sampling and depth; MSM: Maria S. Merian, H: haul, D: dredge haul.

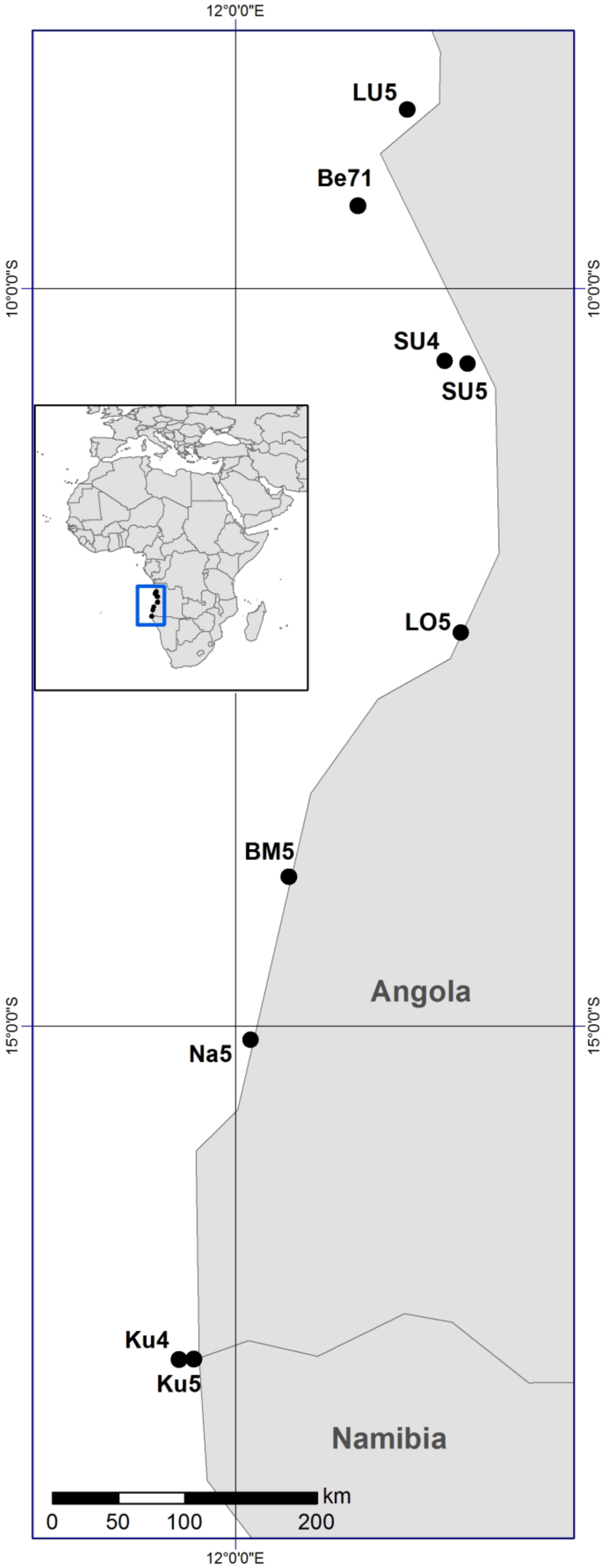

Fig.5: Physical map showing the locations of all sampling stations along the Angolan coast (created with GIS ArcMap, version 10).

Station	Organic part [%]	GS [µm] 50%	O_2 [ml/l]	Salinity	Description of the substrate
LU5	15,04	7	1,08	35,7	grey/brown soft organic silt
Be71	5,51	59	1,3	35,7	hard clay-containing silt, some shell detritus
SU5	2,18	58	2,3	35,7	muddy and fine sand with shell detritus and diatoms
SU4	n.m.	n.m.	n.m.	35,6	lithoidal, coarse sand
LO5	11,96	14	1,04	35,7	brown/grey soft mud
BM5	2,37	87	1,36	35,7	dark grey muddy fine sand
Na5	8,1	14	1,28	35,6	muddy mixed sand with diatoms; first 3 cm oxidized; below: grey/black colour
Ku4	8,83	18	0,66	35,5	soft dark brown/black silt, intense H_2S smell
Ku5	9,88	23	0,82	35,5	soft black silt, 2 mm brown coating, intense H_2S smell

Tab.2: Values of the abiotic and biotic features of each sampling station and sediment characteristics; GS: grain size, n.m.: not measured.

2.2 Methods

2.2.1 Sample processing

In laboratory, 36 samples, fixed in 4 % formalaldehyde sea water, were washed over a 0,5 mm mesh and conducted with a stereomicroscope with 10-40x magnification. The organisms were determined with different literature, also using the internet (e.g. http://marinespecies.org/). All specimens were identified to the lowest taxonomic level whenever possible. For preservation, the organisms were fixed in 95% ethanol and glycerol. The biomass was determined by a special accuracy weighing machine (Analytical balance Cubis® MSA225S-000-DA, Sartorius GmbH). Furthermore, the key species were photographed (AxioVision: version 4.8.2.0).

2.2.2 Statistical analysis

Multivariate community analysis was done using Primer (version 6) with the whole abundance. To detect possible differences in assemblage composition between habitats, this analysis was carried out on square-root transformed and abundance data. Bray-Curtis index and group average linkage were performed for cluster analysis and non-metric multidimensional scaling (MDS) ordination.

3 Results

This paragraph is divided in different categories including diversity, community analysis, biomass and abundance as well as key species.

The stations in all diagrams are sorted in the order of the south-north-gradient.

It has to be taken in account that the effort of sampling at the stations was different, so that only one haul was respectively analysed from Na5, SU4 and SU5, while from station SU4 a dredge haul was also present. That is why the standard deviations are missing in the diagrams. From the other stations (Ku4, Ku5, BM5, LO5, Be71, LU5) 3 hauls and at least one dredge haul were analysed.

3.1 Diversity

A total of 343 taxa were encountered that were sorted in the main groups Polychaeta, Crustacea, Echinodermata, Mollusca and Other (see appendix). The number of taxa within the main groups is provided in Table 3.

Main group	Taxa
Polychaeta	135
Crustacea	120
Mollusca	65
Echinodermata	3
Other	20

Tab.3: Overview of the number of taxa within each main group.

The macrobenthic population on the shelf off Angola is dominated by the polychaetes. They contributed 39%, followed by crustaceans (35%), molluscs (19%) and Other (6%). The minority is represented by the echinoderms with 1% (Figure 6). Figure 7 graphically illustrates the variation in the number of taxa along the stations.

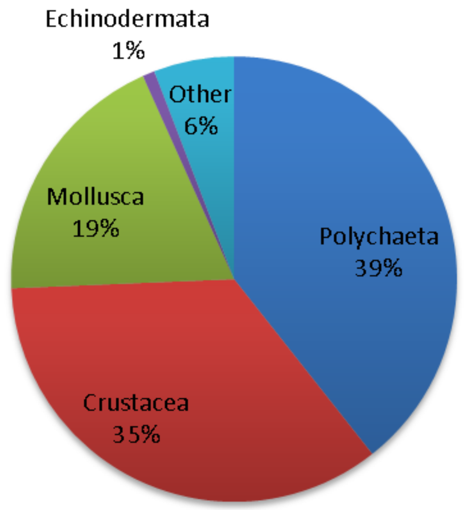

Fig.6: Composition [%] of the investigated area.

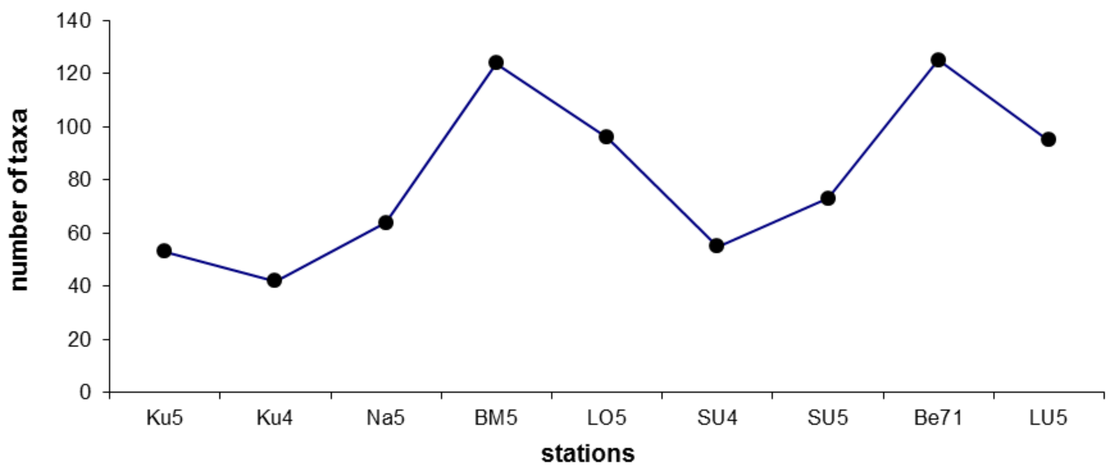

Fig.7: The total number of taxa at each sampling station.

The percentage share of the main groups is illustrated graphically in Figure 8. The exact values are provided in Table 4, including the total number of taxa at each station as well as the number of taxa within each main group.

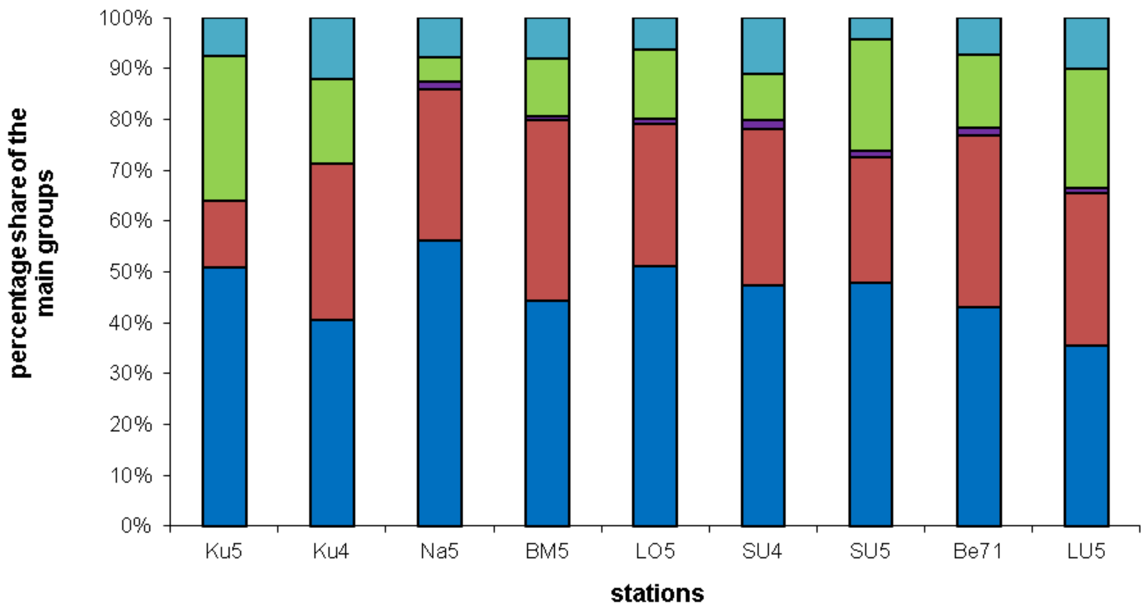

Fig.8: Percentage share of the main groups at each station; blue: Polychaeta, red: Crustacea, purple: Echinodermata, green: Mollusca, turquoise: Other.

	Ku5	Ku4	Na5	BM5	LO5	SU4	SU5	Be71	LU5
Polychaeta	27	17	36	55	49	27	35	54	32
Crustacea	7	13	19	44	27	16	18	42	27
Echinodermata	0	0	1	1	1	1	1	2	1
Mollusca	15	7	3	14	13	5	16	18	21
Other	4	5	5	10	6	6	3	9	9
Total number	53	42	64	124	96	55	73	125	90

Tab.4: Number of taxa within the main groups of each sampling station as well as the total number.

The values of each main group vary significantly along the stations (Table 4). An alternating trend is remarkable (Figure 7). The most abundant group in all stations is represented by the polychaetes (17 to 54 taxa), whereupon the echinoderms exhibit the lowest values of 0 to 2 taxa. The trend of each main group can be seen in Figure 9.

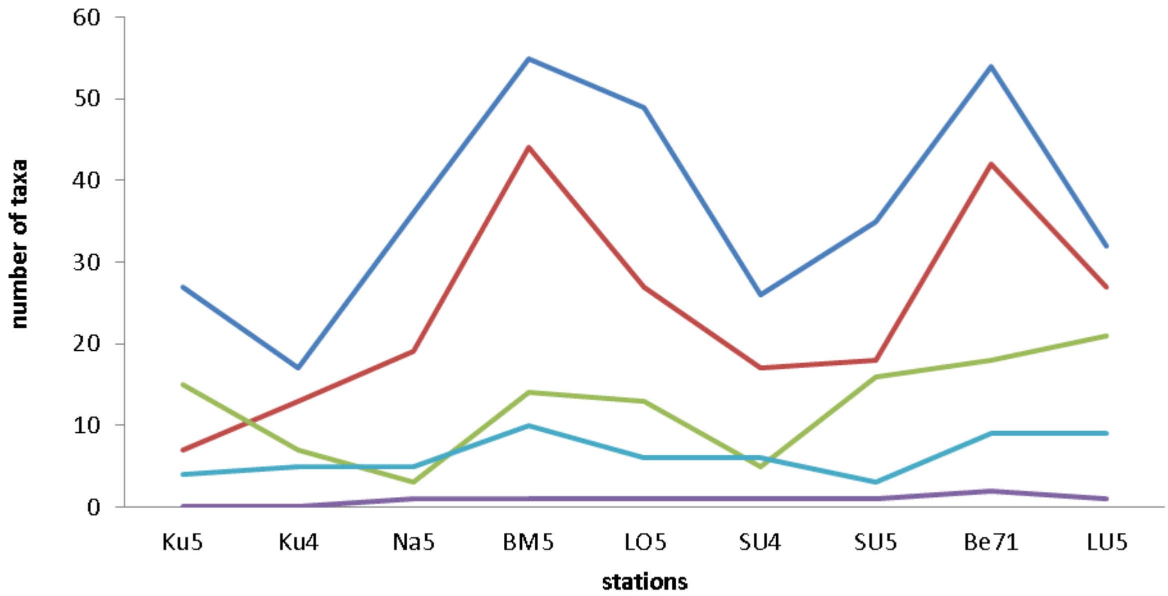

Fig.9: Diversity trends of all groups; blue: Polychaeta, red: Crustacea, purple: Echinodermata, green: Mollusca, turquoise: Other.

It can be noticed that all curves fluctuate, except that one of the echinoderms. The curve shapes of Polychaeta, Crustacea and Mollusca appear to be similar, whereat the diversities of the polychaetes and mollusks reveal the greatest fluctuations.

Biodiversity indices

There is a variety of indices for measuring biodiversity that have been described by Kahn (2006). In this study, the Shannon- and the Margalef index were used. They are shortly summarised in the next paragraphs followed by the results for each station (Figure 5). The results of the dredge samples were not incorporated in the calculation.

a) Shannon index

The Shannon index reflects the complexity of biological interactions in a community and is the very widely used index for comparing diversity between various habitats (Clarke & Warwick 2001). The so-called Shannon-Weaver equation (H´) describing this model was derived from Shannon´s information theory (Oliver *et al.* 2011).

For each station, the Shannon index was calculated using the following formula:

$$H' = - \sum p_i \cdot \log_2$$

with $p_i = n_i / N$.

N indicates the total number of species, n_i the species and p_i the proportion of individuals belonging to the i-th species in the dataset of interest - the higher the value, the greater the diversity.

b) Margalef index

This index is also a measure of species diversity that has a very good discriminating ability and is sensitive to sample size (Kahn 2006). Furthermore, it can be interpreted as the ratio between the maximum number of interspecific interactions and the maximum number of intraspecific interactions (Giavelli *et al.* 1986). It is calculated from the total number of present species and abundance or total number of individuals:

$$d = (s-1)/\log N,$$

where s describes the number of species and N indicates the total number of individuals in the sample (Margalef 1958).

Station	Shannon index	Margalef index
LU5	4,10	28,83
Be71	5,44	36,86
SU5	4,23	18,53
SU4	3,96	16,60
LO5	4,93	29,50
BM5	2,35	31,43
Na5	3,38	13,74
Ku4	3,07	13,33
Ku5	2,75	13,14

Tab.5: The calculated values of the Shannon index and Margalef index for each station.

The calculated values of the Shannon index vary between 2,31 (station BM5) and 5,44 (station Be71). The values of the Margalef index range from 13,33 (station Ku4) to 36,86 (station Be71).

3.2 Community analysis

Multilinkage cluster analysis by group average linkage was applied for grouping the species into various clusters at different similarity levels adopting Bray Curtis similarity index. The results are shown graphically as a dendrogram and in a MDS-plot. All determined organisms, from both, hauls and dredge samples, the quantity and the stations were incorporated in the calculation.

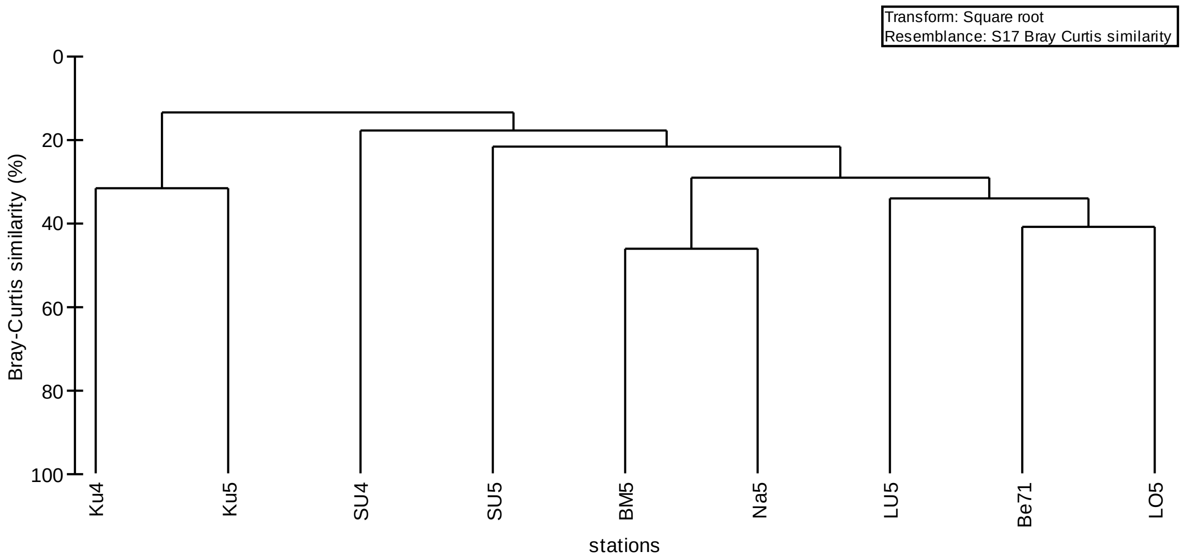

Fig.10: Hierarchical, agglomerative clustering of square root-transformed macrobenthos data of the abundance of all stations using group-average linking on Bray-Curtis similarities (%).

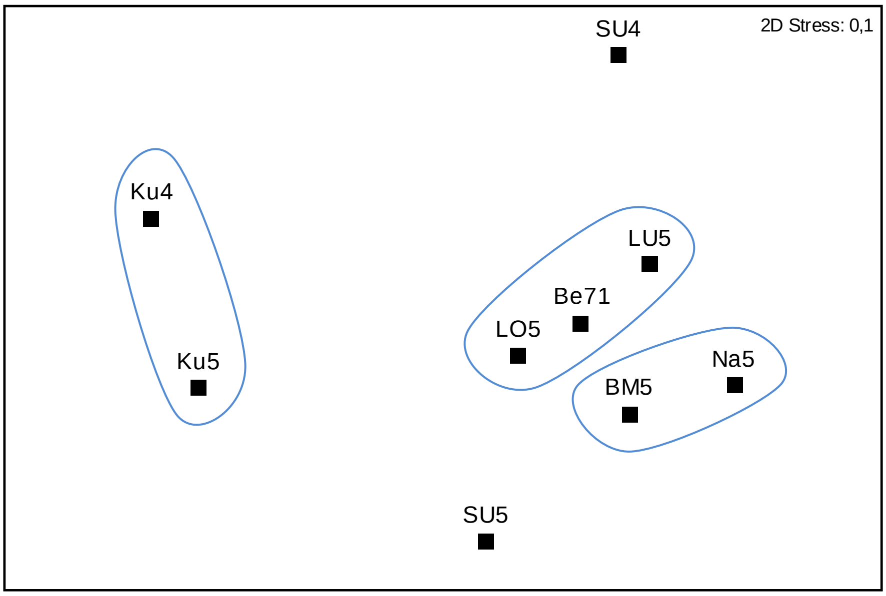

Fig.11: Multidimensional scaling ordination for square root-transformed macrobenthos data of the abundance based on Bray-Curtis similarities (stress=0.1).

Clusters (Figure 10) occur over a relatively small range of similarities (~10 – 35%). At about 10% the sites are divided into two clusters, and at 20% or rather 30% into two main groups. One group comprises a cluster of the two stations in the south (Ku4 and Ku5), the other group implies the stations located to the north of the first group containing the clusters of the single stations SU4 and SU5 as well as a site of the stations LU5, Be71 and LO5.

The sites in stations BM5 and Na5 show highest similarity to each other (~45%), whereas the site in station SU4 is most dissimilar. The MDS ordination (Figure 11) illustrates the same result as a 2D-diagram.

3.3 Abundance and Biomass

The abundance and biomass are both shown graphically (Figures 12, 14) containing the total values of each sampling station. The exact values of each group are provided in Table 6 (abundance) and Table 7 (biomass). The variations of each group along the coast are additionally illustrated graphically in Figure 13 (abundance) and Figure 15 (biomass).

Abundance

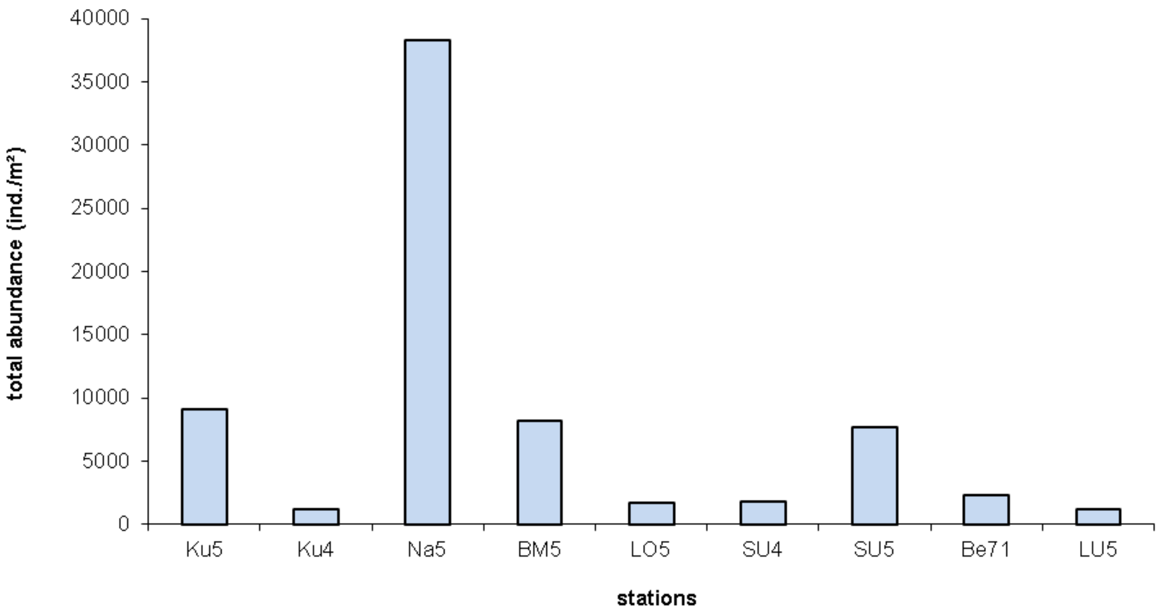

Fig.12: Total abundance [individuals/m²] of each sampling station.

	Ku5	Ku4	Na5	BM5	LO5	SU4	SU5	Be71	LU5
Polychaeta	4.501	277	35.662	5.885	931	499	2.258	1.678	858
Crustacea	50	122	1.922	1.443	442	668	4.328	307	99
Echinodermata	0	0	21	95	4	525	221	81	4
Mollusca	1.939	766	42	218	114	24	735	69	111
Other	2.605	23	685	551	173	77	148	179	151
Total	9.095	1.188	38.332	8.192	1.664	1.793	7.690	2.314	1.223

Tab.6: Abundance [individuals/m²] of each main group at each station, including single and total values.

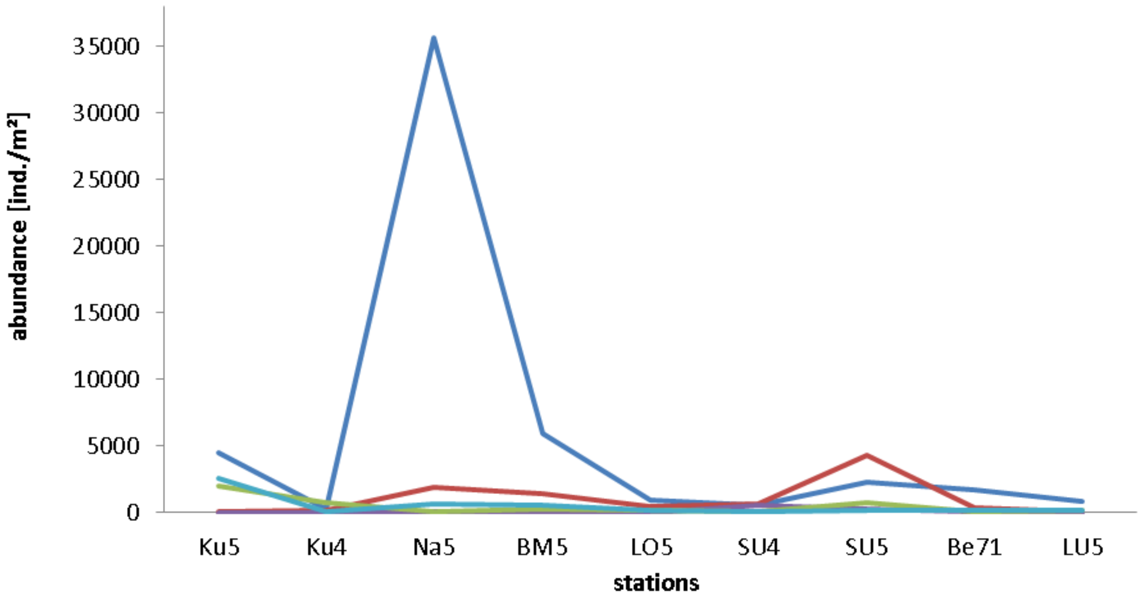

Fig. 13: Abundance of each main group; blue: Polychaeta, red: Crustacea, purple: Echinodermata, green: Mollusca, turquoise: Other.

The values of the total abundance vary between 1.188 ind./m² (Ku4) and 38.332 ind./m² (Na5). The polychaetes reveal the highest abundance of 35.662 ind./m² at station Na5. This is also illustrated with the highest peak of all curves in Figure 13, whereupon the other curves are considerably flatter. The lowest abundances of 4 ind./m² were determined for the echinoderms at stations LO5 and LU5. At the southern stations Ku4 and Ku5, they were not found.

Biomass

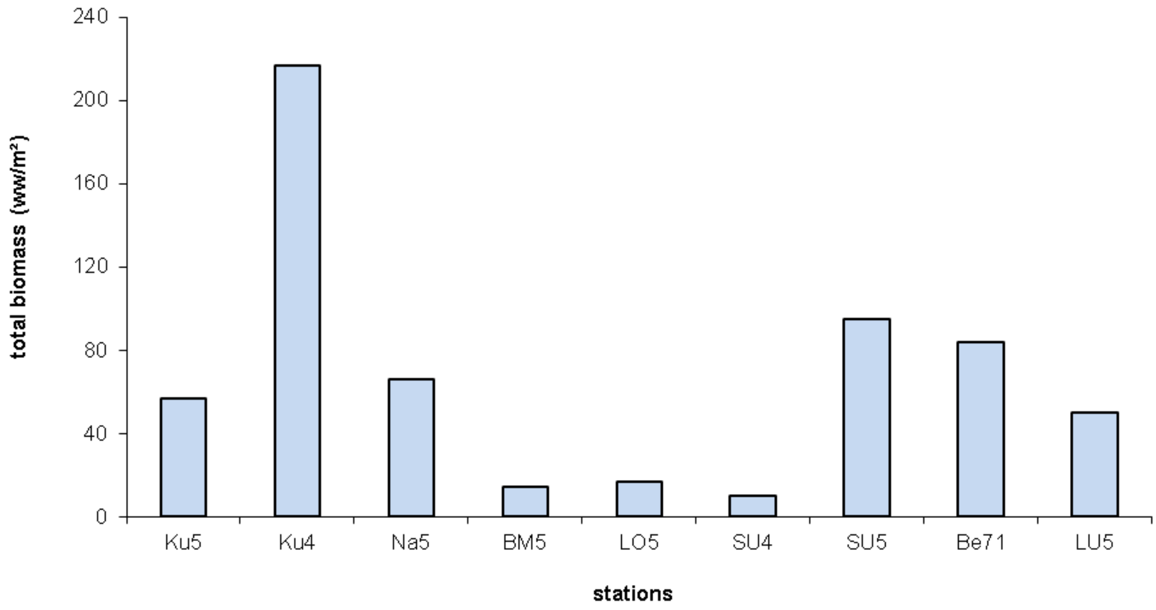

Fig.14: The total averaged biomass [wet weight in g/m²] at each sampling station.

	Ku5	Ku4	Na5	BM5	LO5	SU4	SU5	Be71	LU5
Polychaeta	8,59	1,68	30,71	10,30	5,07	0,40	22,26	10,21	46,49
Crustacea	0,05	0,07	1,71	1,66	9,73	2,45	14,09	10,16	0,90
Echinodermata	0	0	0,001	0,04	0,29	6,55	0,003	5,13	0,08
Mollusca	46,72	213,54	33,41	1,99	1,54	0,57	58,25	54,30	1,34
Other	1,34	1,55	0,19	0,45	0,18	0,1	0,60	3,82	1,41
Total	56,71	216,85	66,01	14,43	16,81	10,06	95,20	83,63	50,22

Tab.7: The averaged biomass [wet weight in g/m²] of each main group at each station, including single and total values.

There is a quite similar trend for biomass (Figure 14). The highest value of about 216,85 g can be found at station Ku4. The lowest value of 10,06 g is provided at station SU4 (Table 7). In the south, the biomass was particularly influenced by the mollusks that were very frequent at station Ku5 (Figure 15, Table 6) and indicates the highest biomass value of 213,54 g/m². In the same region, the echinoderms were not present. They also contributed the lowest biomass of 0,001 g/m² (station Na5). Furthermore, the values of the crustaceans are very low in the same area compared to the values of the northern stations, except for LU5.

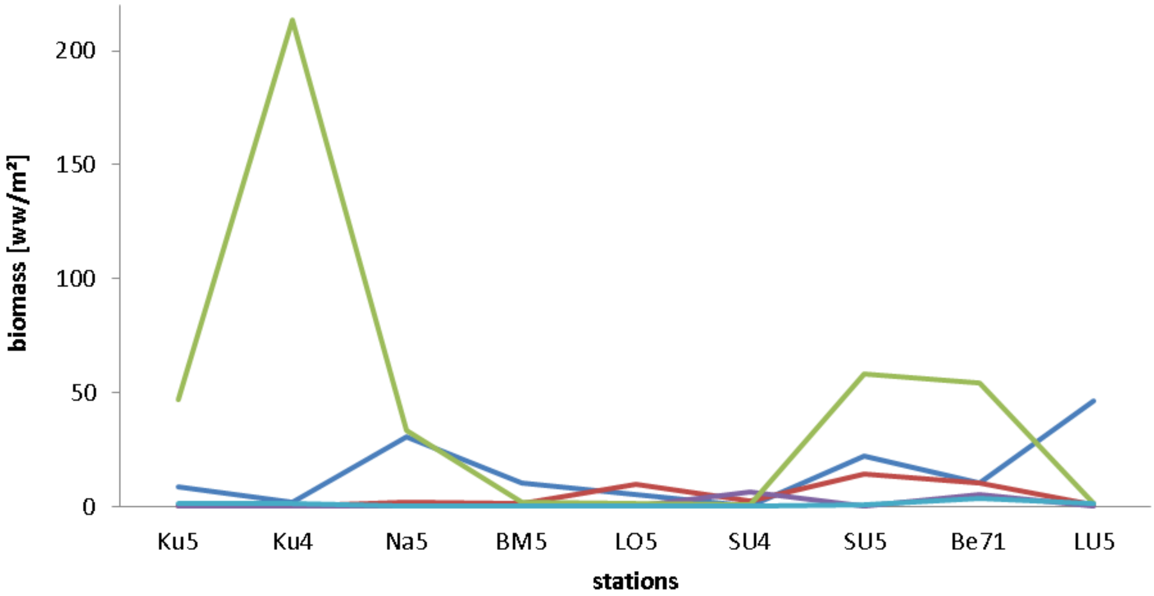

Fig.15: Average biomass of all main groups; blue: Polychaeta, red: Crustacea, purple: Echinodermata, green: Mollusca, turquoise: Other.

3.4 Profiles of the key species

Key or keystone species can be defined as species that are dominant in ecosystems and which have large effects on them and their communities (Bengtsson 1997). On the following pages, the key species (Table 8) are presented in a summarised profile, describing their distribution, morphology, nutrition, reproduction and habitat preferences.

The profiles are arranged according to their taxonomic order and within alphabetical order.

Key species	Class	Station	Abundance [ind./m²]
Nuculana bicuspidata	Bivalvia	Ku5/Ku4	382/217
Nassarius vinctus	Gastropoda	Ku5/Ku4	798/529
Cossura coasta	Polychaeta	Ku5	3389
Diopatra neapolitana	Polychaeta	LU5	294
Owenia sp.	Polychaeta	BM5/Na5	2682/9790
Prionospio sp.	Polychaeta	Na5	10200

Tab.8: List of all key species arranged according to their class including their locations and their abundance [individuals/m²].

3.4.1 Bivalvia

Nuculana bicuspidata **(Gould, 1845)**

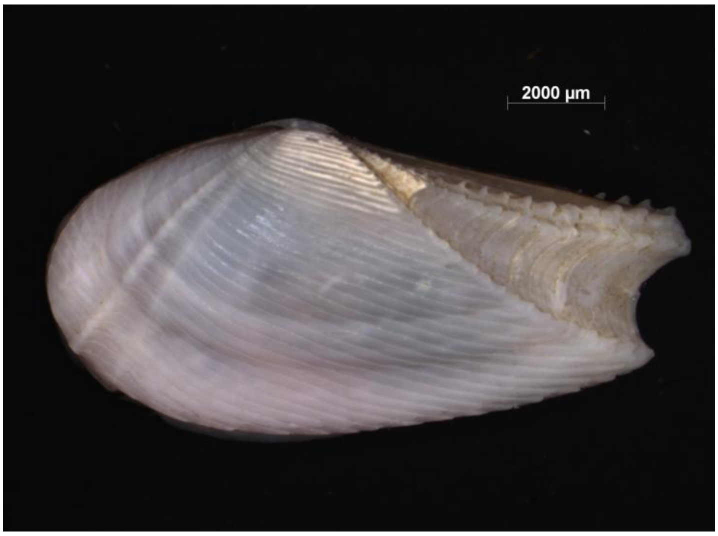

Fig.16: *Nuculana bicuspidata* from station Ku4.

Distribution:	This bivalve lives from Mauritania to Angola, but was also found near Velddrif (Namibia) and Cape Cross (South Africa) (Kensley 1985).
Morphology:	The shiny white shell is elongated, equivalve, asymmetrical, thick-walled, short but rostral elongated posteriorly and rounded anteriorly. The posterior surface is strongly ribbed. The ribs are concentrical at the front end, where they are interrupted by a strong incision. The width of the shell ranges from 3 mm to 2 cm (Mangalo 2004).
Nutrition:	*N. bicuspidata* is a typical suspension feeder and filters detritus (Michel *et al.* 2011).
Reproduction:	This information is not published.
Habitat:	The shell is a typical sand-dweller (Kensley 1985) that lives close to the sediment-water interface in organic-rich, fine-grained material (Michel *et al.* 2011).

3.4.2 Gastropoda

***Nassarius vinctus* (Marrat, 1877)**

Fig.17: *Nassarius vinctus* from station Ku4.

Distribution: This gastropod occurs from East London to Namibia, particularly on continental shelves in 35 to 150 m depth (Kilburn & Rippey 1982).

Morphology: The dark cream-coloured or whitish shell is ovate, rather thick-walled and relatively wound with deep sutures and an inner lip forming a very thin callus. A thin outer lip and a wide siphonal are also present. The body size ranges from 1 mm to 3 cm.

Nutrition: *N. vinctus* is an active scavenger (Herbert & Comptom 2007).

Reproduction: There is an annual episodic breeding season from March to August. The fertilisation of the genus *Nassarius* is external. About 6.000 egg capsules, each one containing about 200 eggs, are attached to stones and rocks. The larvae develop in the water column (Marine Ecological Surveys Limited 2008).

Habitat: This species typically lives on the sediment surface of soft bottoms (Kilburn & Rippey 1982), especially on muddy gravels (Herbert & Comptom 2007), but also on rocks and boulders (Marine Ecological Surveys Limited 2008).

3.4.3 Polychaeta

***Cossura coasta* (Kitamori, 1960)**

Fig.18: *Cossura coasta* (Kitamori 1960) without the posterior part from station Ku5.

Distribution: *C. coasta* occurs worldwide from 1 m to 2400 m depth (Rouse & Pleijel 2001).

Morphology: The body consisting of a distinct muscular thoracic region and a more fragile `abdomen´ is small (less than 10 mm) and can possess about 100 segments. Living animals are translucent with pale tan or brown tinting (Rouse & Pleijel 2001). The dorsal branchia is a typical characteristic arising from setiger 3 (Day 1963).

Nutrition: *Cossura* is a deposit-feeder and uses its unique nuccal tentacles by opening the buccal cavity widely and placing them on the sediment surface (Rouse & Pleijel 2001).

Reproduction: This polychaete appears to be gonochoric. Little is known about the reproduction, e.g. whether they copulate or brood larvae in any way (Rouse & Pleijel 2001).

Habitat: *C. coasta* is non-tubiculous and burrows in shallow marine sediments, but is more common in mixed sand and mud sediments in the deep sea (Rouse & Pleijel 2001).

***Diopatra neapolitana* Delle Chiaje, 1841**

Fig.19: *Diopatra neapolitana* Delle Chiaje, 1841 from station LU5.

A: anterior body with head, dorsal-lateral view
B: dorsally head with antennae and palps

Distribution: *D. neapolitana* is a cosmopolitan species that has been recorded in the Mediterranean, the Red Sea, the Eastern Atlantic Ocean and Indian Ocean (Rouse & Pleijel 2001).

Morphology: The body size varies from a few mm to several metres, but around a few cm is common. The majority is tubiculous. Living animals are iridescent and show characteristical red or brown pigmentation patterns, often as transverse segmental bands. The oval prostomium bears a pair of rounded or elongated frontal lips anteriorly as well as a pair of antero-lateral palps and 3 more posterior antennae. Sexual dimorphism is present (Rouse & Pleijel 2001).

Nutrition: This polychaete feeds as carnivore, herbivore and scavenger (Rouse & Pleijel 2001).

Reproduction: *D. neapolitana* is gonochoric and releases its gametes in the water column where the larvae develop (Rouse & Pleijel 2001).

Habitat: This species inhabits intertidal mudflats and shallow subtidal transitional waters and is capable of constructing tubes produced by a secreted layer that is adhered by sand particles, fragments of solid parts from other animals, e.g. shells, and algae (Pires *et al.* 2012).

***Owenia* sp.**

Fig.20: The anterior part of *Owenia* sp. with head from station BM5.

Distribution: *Owenia* sp. occurs worldwide to around 200 m depth, but also lives in some abbysal regions (Rouse & Pleijel 2001).

Morphology: The body is elongate and cylindrical with between 20 and 30 segments. The length ranges from less than 10 mm to more than 100 mm. The head comprises the prostomium and peristomium, apparently with no associated segments. The prostomium bears a multilobed `crown´ (Rouse & Pleijel 2001).

Nutrition: This polychaete is a surface deposit and suspension feeder (De Santa-Isabel *et al.* 1998).

Reproduction: *Owenia* is gonochoric. The females shed an average of 70.000 eggs in the water column (external fertilisation) from May to June each year. The larvae develop in the pelagic (Rouse & Pleijel 2001).

Habitat: The polychaete lives in intertidal sediments, constructing distinctive tightly fitting sedimentary tubes that often include sand particles, shell fragments and Foraminifera tests and from which *Owenia* is extremely difficult to extract (Rouse & Pleijel 2001).

***Prionospio* sp.**

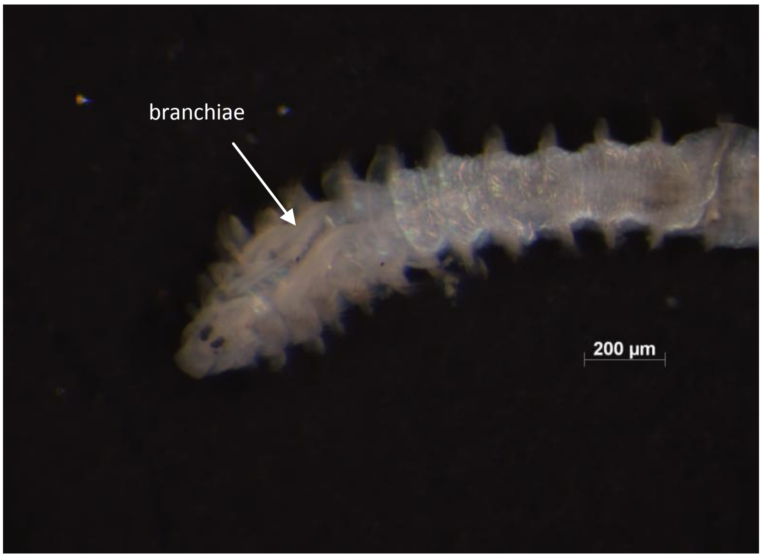

Fig.21: The anterior part of *Prionospio* sp. with head from station Na5.

Distribution: This polychaete is distributed worldwide from intertidal to abyssal depths (Rouse & Pleijel 2001).

Morphology: *Prionospio* ranges in length from a few mm to several cm, shows a variety of colours and pigmentation patterns, and can easily be recognized by the pair of elongate grooved palps extending from the dorsally head, but is not always present (Figure 21). The branchiae can be pinnate and are limited to the anterior region terminating by about segment 15. The prostomium is usually a narrow, ellipsoidal lobe resting on the top of the peristomium. The tip is often rounded (Rouse & Pleijel 2001).

Nutrition: The genus is a typically deposit feeder (Rouse & Pleijel 2001).

Reproduction: This gonochoric polychaete spawns its gametes in the water column where are brooded - particularly in spring and summer (Rouse & Pleijel 2001).

Habitat: *Prionospio* lives in burrows or tubes in sandy and muddy sediments (Rouse & Pleijel 2001).

4 Discussion

This paragraph is divided in a) latitudinal gradient describing the results of this study comparing with prior studies at shelves from different areas with regard to diversity, biomass and abundance, b) key species and c) challenge indicating the difficulties determining the organisms.

4.1 Latitudinal gradient

In this study, Figure 7 generally shows an alternating trend for the Angolan shelf. There are two peaks, at station BM5 and Be71, whereupon the stations Ku4, Ku5 and SU4 exhibit the lowest diversities. The result of the cluster analysis (Figure 10) and the MDS-Plot (Figure 11) additionally do not show any evidence of a latitudinal gradient, since stations LU5, Be71 and LO5 form a cluster, not including SU4 and SU5.

Some studies also do not reveal a latitudinal cline for marine fauna in shallow waters (Kendall & Aschan 1993, Boucher & Lambshead 1995, Joydas & Damodaran 2008). Hillebrand (2004), who analysed more than 100 studies from around the world, suggested that the gradient is likely weak if detectable at all (Gray 1994).

Kendall & Aschan (1993), e.g., investigated areas of different climates including the coast of Svalbard in the arctic part of Norway, off the temperate coast of the British Islands and the tropical island Java. They figured out that there was no variation in sample species richness.

Clarke (1992), Poore & Wilson (1993) and Crame (2000) pointed out that there could be a difference within the hemispheres, since the evidence of latitudinal gradient of decreasing richness from the tropics to Antarctica in the southern hemisphere is less convincing than in the northern hemisphere. Consequently, the latitudinal cline across all taxa in the sea may not to be similar as seen on land (Clarke 1992, Clarke & Crame 1997).

Roy *et al.* (2000) suggested that particularly bivalve species show strong latitudinal diversity gradients. However, Figure 9 reveals also an alternating trend with peaks at stations Ku5, BM5, LO5, SU5, Be71 and LU5. There is only a difference of 6 taxa between the southern station Ku5 and the northern station LU5.

The most southern stations Ku4 and Ku5 in this study are located in the mouth of the

Cunene River representing the northern fringe of an oxygen minimum zone (OMZ; O_2<0,5 ml/l) that generally ranges from 80 m to 120 m depth off northern Namibia. In fact, not all organisms are able to cope with hypoxia that influences both the structure and function of benthic communities (Levin *et al.* 2009). Indeed, echinoderms were not found there, but a high abundance of the mollusks *Nuculana bicuspidata* and *Nassarius vinctus*, as well as, the polychaete *Owenia* sp. and specimens of the subclass Oligochaeta could be detected.
`It is well known that coastal areas with high physical variability such as estuaries contain low diversities´ (Gray *et al.* 1997).
The natural and human-induced hypoxia experienced by benthos in such areas is graphically described in the following illustration.

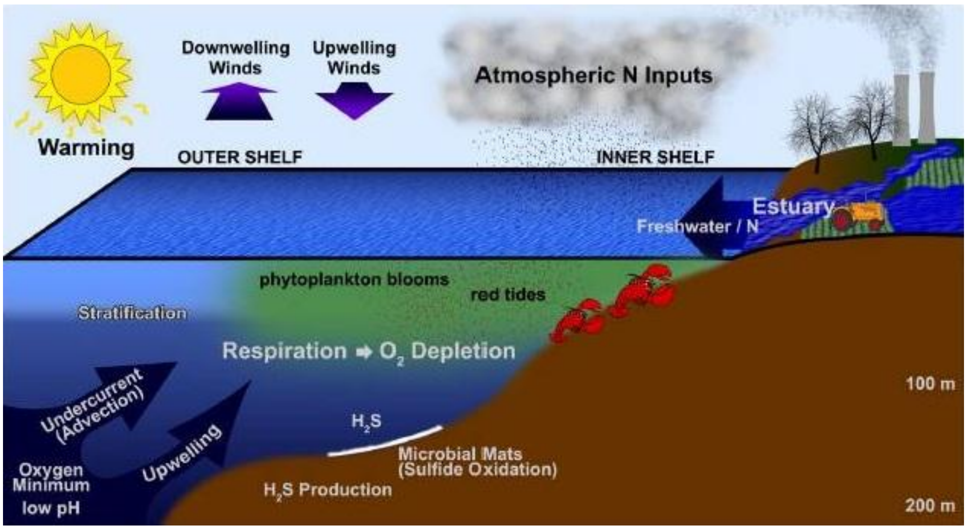

Fig.22: Mechanisms of the formation of hypoxia experienced by zoobenthos along continental shelves (Levin *et al.* 2009).

However, the northern stations do not show this condition. The oxygen content maintains >1 ml/l (Table 2). Thus, a possibly cause for the alternate trend could be the variability in structure and topography of the sediments along the coast.
In fact, Etter & Grassle (1992) found relationships between species and sediment heterogeneity. They suggested that sediment particle size influences the composition of benthic communities and thus, has an important role in determining the number of species within a community. Levin *et al.* (2000) emphasized that depth also has an effect. But surveys, conducted by Gray *et al.* (1997), in both the deepsea and coastal habitats, are

shown to traverse a variety of microhabitats. They hypothesized that sediment heterogeneity may not be an explanation for high species richness in coastal environments. Together with Gray (1994) and Coleman *et al.* (1997), they certainly found high diversity especially in soft sediments in tropical regions. Sanders (1968) also figured out that the number of species in soft-bottoms was higher in the tropics than in the boreal regions.

The soft-sediment benthic macrofauna on the European continental shelf surveyed by Renaud *et al.* (2009) exhibited little evidence of a latitudinal trend that was statistically very small. Nevertheless, a lack of decline in diversity on continental-shelf soft substrates along a latitudinal gradient has also been documented by others (Kendall & Aschan 1993, Ellingsen & Gray 2002).

Contrary to that, Thorson (1952, 1957) showed in different publications that the increases in numbers of species towards the equator is very pronounced in the epifaunas of hard-bottoms, whereupon the number of infaunal species of soft-bottoms did not change in arctic, temperate and tropical seas. These observations agree with the results of Renaud *et al.* (2009).

The results of the survey conducted by Golikov and Scarlato (1973) indicated that, within similar habitats, the distribution of biomass among species is similar at all latitudes. On the shelf off Angola, the biomass varies a lot, both total biomass (Figure 12) and that of each group (Figure 13). The high values in the southern region were primarily caused by the high abundance of the molluscs, particularly of the bivalve *Nuculana bicuspidata*.

So far, many studies have revealed that invertebrate distribution correlates with grain size.

However, Snelgrove & Butman (1994) commented that animal-sediment relationships are more variable and that many species are not always associated with a single sediment type.

Nichols (1970), Gray (1974) and Etter & Grassle (1992) tried to explain the relationship between sorting and species richness. Well-sorted sediments offer a smaller range of grain sizes and interstitial spaces that may provide fewer niches in contrast to poorly sorted sediments that consequently contain a less diversity.

Comparing the diversity with the grain size in this study, a relationship can be inferred. The measured average grain sizes of 87 µm at station BM5 and 59 µm at station Be71 were the largest in the whole area, whereupon e.g. the oxygen levels were not the highest. Although the bottoms of some other sampling stations were also soft, the grain sizes were significantly smaller. Thus, these stations showed low diversities compared to the stations BM5 and Be71. Station SU5, with an average grain size of 58 µm, additionally contained a high benthic diversity. However, the low number of species at station SU4 may result from the lithoidal structure of the bottom that is a preferred habitat of epifauna and infauna of rocks, e.g. brittle stars and polychaetes of the family Serpulidae, that were found in this study.

Furthermore, the value of the Shannon index at station Be71 is 5,44 (Table 5). Generally, the values vary between 1,5 and 3,5, and rarely surpasses 4,5. It has been reported that under log normal distribution an amount of 10^5 species are required to reach a value >5 (Kahn 2006). All in all, 5 stations exhibit values >3,5.

At the stations off the big cities Luanda and Lobito, i.e. LU5 and LO5, the diversities of 90 and 96 taxa could be reasoned by anthropogenic influence, e.g. pollution and tourism. Especially, the abundances of 1.223 individuals/m² (LU5) and 1.664 individuals/m² (LO5) are significantly low (Table 6).

An evidence for latitudinal gradient may exist for decapods, especially for brachyuran crabs and penaeids (Natantia). Large diversities were only found at stations from the tropical regions off Angola – 9 taxa of brachyuran crabs at station LU5 (8°S) and 13 taxa of penaids at station Be71 (9°S). Only a few species were present in the south, except at station Ku4 and Ku5, where low oxygen levels were measured. These decapods usually occur frequently in tropical areas (Bertini *et al.* 2010, Dall 1990, Steele 1988). Bertini *et al.* (2010) figured out that the highest diversity of decapods on the shelf off Brazil was on soft bottoms consisting of very fine sand. The results of this study are agreeable, since the richness of decapods at station SU4, but also SU5, is very low. According to the diversity of brachyuran crabs and penaids, there may be an evidence for a cline with decreasing distance to the equator, particularly on soft bottoms.

Snelgrove and Butman (1994) also suggested that depth and sediment grain size may act as secondary forces, while it is more likely that the amounts of hydrodynamic energy and the availability of organic matter have more influence on the composition of benthic communities. The energy profile of water above the sediment surface determines the particle size, which in turn has an effect on burrowing organisms. The greater the energy, the higher the velocity, consequently, the more sediment particles will be carried away.

Hence, depth determines the energy of the waves on the bottom. Thus, the effect is the greatest in shallow waters and decreases with increasing distance to the coast (Bergen *et al.* 2001).

In the current study, there is no correlation between depth and diversity. For example, at stations SU4 and LO5 the samples were taken from 60 m depth (Table 1), whereat the number of species ranges from 55 to 96. For stations Ku4 and Be71, both at 102 m depth, there is a difference of 83 species.

The highest abundance of all areas was found at station Na5 (15°S). Many animals such as polychaetes are detritus feeders and use shell detritus and diatoms as food resources. Furthermore, it offers protection. A lot of organisms accumulate there, especially polychaetes like *Prionospio* sp., *Owenia* sp., *Diopatra* sp. and species of the family Cirratulidae.

Most investigations on shelves revealed the predomination of polychaetes (e.g. Joydas & Damodaran 2008) - that is consistent with the result of this study. The hierarchical order of the main groups slightly varies. On the shelf off Angola the main group with the lowest diversity is represented by the echinoderms, just as in other areas (Ellingsen & Gray 2002, Joydas & Damodaran 2008).

For all analyses and comparisons, it must be taken in account that the effort of sampling differed within the stations (Table 1). Consequently, investigating more samples, i.e. more hauls of the stations (e.g. SU4, SU5 or Na5), could significantly change the result of diversity, biomass and abundance.

4.2 Key species

The bivalve *Nuculana bicuspidata* (Gould 1945) and the snail *Nassarius vinctus* (Marrat 1877) were most abundant in the south of the sampling area at the mouth of the Cunene River at stations Ku4 and Ku5. This conclusion is consistent with the result of an investigation from 2009 by Zettler *et al.* In addition, a high number of the polychaete *Cossura coasta* was also found at station Ku5. These two mollusks and the polychaete seem to be well adapted to the nearly anoxic and hypoxic conditions in this region, whereupon *C. coasta* also appeared less frequently northwards. This indicates that *C. coasta* may prefer areas with relatively low oxygen content (<1 ml/l).

The polychaetes *Diopatra neapolitana*, *Owenia* sp. and *Prionospio* sp. showed high frequencies in the northern regions, particularly at stations LU5, BM5 and Na5. All of them burrow in sand and are capable of constructing tubes in which they hide from predators. Therefor, they use sand particles, fragments of other animals, e.g. shells and also Foraminifera tests that adhere to the secreted layer produced by these polychaetes. Especially at station Na5, the sediment contained a lot of diatoms and shell detritus that favour the construction of tubes and also serve as nutritional basis. At station BM5 and LU5, the bottom was very soft consisting of mud with particles of small grain sizes facilitating the process of burrowing. All in all, the appearance with regard to distribution and habitat preferences of these polychaetes agrees with the references of the literature.

4.3 Challenge

The most difficult challenge was the identification of the organisms on species level. The majority lacked of segments or characteristical appendices that are required for identification, especially in case of immaturity or physical damages that were e.g. caused while sieving or sampling with the van Veen grab. Another fact is the smallness, since the body lengths of several individuals, predominantly polychaetes, did not exceed a few millimetres.

At last, the identification was rather based on family level than on genus or species level. Consequently, the diversity of each station is expected to be higher than examined so far since the shelf of Angola is an area that is not well-investigated. Thus, the species are not well-known. That makes it more difficult to determine the examined organisms on species level that have been still identified on family level. The time factor played also an important role. Since the identification was often time consuming, the organisms were given so-called working names.

5 References

Bengtsson, J. (1997) Which species? What kind of diversity? Which ecosystem function? Some problems in studies of relations between biodiversity and ecosystem. Applied Soil Ecology 10 (1998) 191-199.

Bergen, M., Weisberg, S.B., Smith, R.W., Cadien, D.B., Dalkey, A., Montagne, D.E., Stull, J.K., Velarde, R.G., Ranasinghe, J.A. (2001) Relationships between depth, sediment, latitude, and the structure of benthic infaunal assemblages on the mainland shelf of southern California. Marine Biology (138) 637-647.

Bertini, G., **Fransozo, A.** (2004) Bathymetric distribution of brachyuran crab (Crustacea, Decapoda) communities on coastal soft bottoms off southeastern Brazil. Marine Ecology Progress Series (279) 193-200.

Bianchi, G. (1992) Demersal assemblages of the continental shelf and upper slope of Angola. Marine Ecology Progress Series (81) 101-120.

Clarke, A. (1992) Is there a latitudinal diversity cline in the sea? Trends in Ecology and Evolution (7) 286-287.

Clarke, A., Crame, J.A. (1997) Diversity, latitude and time: patterns in the shallow sea. Marine Biodiversity. Patterns and Processes (eds R.F.G. Ormond, J.D. Gage & M.V. Angel), Cambridge University Press, Cambridge, UK.

Clarke, K.R., Warwick, R.M. (2001) Changes in marine communities: an approach to statistical analysis and interpretation, 2nd edition, PRIMER-E, Plymouth.

Coleman, N., Gason, A.S.H., Poore, G.C.B. (1997) High species richness in the shallow marine waters of south-east Australia. Marine Ecology Progress Series (154) 17-26.

Crame, J.A. (2000) Evolution of taxonomic diversity gradients in the marine realm: evidence from the composition of recent bivalve faunas. Paleobiology (26) 188-241.

Dall, W. (1990) The Biology of the Penaeidae. Academic Press, London, UK.

Day, J.H. (1963) The polychaete fauna of South Africa: Part 8. New species and records from grab samples and dredgings. Bulletin of the British Museum (Natural History). Zoology (10) 381-445.

De Santa-Isabel, L.M., Campos Peso-Aguiar, M., Silva de Jesus, A.C., Kelmo, F., Ximenes Cabral Dutra, L. (1998) Biodiversity and spatial distribution of Polychaeta (Annelida) communities in coral-algal buildup sediment, Bahia, Brazil. Revista de Biologia Tropical 46 (5) 111-120.

Ellingsen, K.E., Gray, J.S. (2002) Spatial patterns of benthic diversity: is there a latitudinal gradient along the Norwegian continental shelf? Journal of Animal Ecology (71) 373-389.

Etter, R.J., Grassle, J.F. (1992) Patterns of species diversity in the deep-sea as a function of sediment particle size diversity. Nature (360) 576-578.

Giavelli, G., Rossi, O., Sartore, F. (1986) Comparative evaluation of four species diversity indices related to two specific ecological situations. Field Studies (6) 429-438.

Golikov, A.N., Scarlato, O.A. (1973) Comparative characteristics of some ecosystems of the upper regions of the shelf in tropical, temperate and Arctic waters. Helgoländer wissenschaftliche Meeresuntersuchungen (24) 219-234.

Gray, J.S. (1974) Animal-sediment relationships. Oceanography and Marine Biology. An Annual Review (12) 223-261.

Gray, J.S. (1994) Is deep-sea species diversity really so high? Species diversity of the Norwegian continental shelf. Marine Ecology Progress Series (112) 205-209.

Gray, J.S., Poore, G.C.B., Ugland, K.I., Wilson, R.S., Olsgard, F., Johannessen, Ø. (1997) Coastal and deep-sea benthic diversities compared. Marine Ecology Progress Series (159) 97-103.

Herbert, C.T., Comptom, J.S. (2007) Geochronology of Holocene sediments on the western margin of South Africa. South African Journal of Geology (110) 327-338.

Hillebrand, H. (2004) Strength, slope and variability of marine latitudinal gradients. Marine Ecology Progress Series (273) 251-267.

Hogan, C.M., Baum, S., Saundry, P. (2011) Angola Current. In: Encyclopedia of Earth. Eds. Cutler J. Cleveland (Washington, D.C.: Environmental Information Coalition, National Council for Science and the Evironment).

Joydas, T.V., Damodaran, R. (2008) Infaunal macrobenthos along the shelf waters of the west coast of India, Arabian Sea. Indian Journal of Marine Sciences (38) 191-204.

Kahn, S.A. (2006) Methodology for Assessing Biodiversity. Centre of Advanced Study in Marine Biology, Annamalai Universität, Annamalai Nagar, Indien.

Kendall, M.A., Aschan, M. (1993) Latitudinal gradients in the structure of macrobenthic communities: a comparison od Arctic, temperate and tropical sites. Journal of Experimental Marine Biology and Ecology (172) 157-169.

Kensley, B. (1985) The faunal deposits of a late pleistocene raised beach at milnerton, Cape Province, South Africa. The annals of the South African museum, Rustica Press, Cape Town.

Kilburn, R., Rippey, E. (1982) Sea shells of Southern Africa. Macmillan South Africa, Johannesburg.

Lass, H.U., Schmidt, M., Mohrholz, V., Nausch, G. (2000) Hydrographic and current measurements in the area of the Angola-Benguela front. Journal of physical oceanography (30) 2589-2609.

Lenihan, H.S., Micheli, F. (2001) Soft sediment communities. *In* M. Bertness, M.E. Hay, and S.D. Gaines (editors), *Marine Community Ecology*. Sinauer Associates, Inc., Sunderland.

Levin, L.A., Cage, J.D., Martin, C., Lamont, P.A. (2000) Macrobenthic community structure within and beneath the oxygen minimum zone, NW Arabian Sea. Deep-Sea Research II (47) 189-226.

Levin, L.A., Ekau, W., Gooday, A.J., Jorissen, F., Middelburg, J.J., Naqvi, S.W.A., Neira, C., Rabalais, N.N., Zhang, J. (2009) Effects of natural and human-induced hypoxia on coastal benthos. Biogeosciences (6) 2063-2098.

Levinton, J.S. (1995) Marine biology. Function, biodiversity, ecology. Oxford University Press, New York.

Lin, H.-L., Chen, C.-J. (2002) A late Pliocene diatom Ge/Si record from the Southeast Atlantic. Marine Geology (180) 151-161.

Longhurst, A.R. (1959) Benthos densities off tropical West Africa. ICES Journal of Marine Science 25 (1) 21-28.

Mangalo, M. (2004) Diplomarbeit: Actuopaläontologische Untersuchungen an Mollusken aus dem Auftriebsgebiet vor Namibia. Ludwig-Maximilians Universität, München.

Margalef, R. (1958) Information theory in ecology. General Systems (3) 36-71.

Marine Ecological Surveys Limited (2008) Marine Macrofauna Genus Trait Handbook. Marine Ecological Surveys Limited, Bath.

Meeuwis, J.M., Lutjeharms, J. R. E. (1990) Surface thermal characteristics of the Angola-Benguela front. South African Journal of Marine Science (9) 261-279.

Michel, J., Westphal, H., Von Cosel, R. (2011) The mollusk fauna of soft sediments from the tropical, upwelling-influenced shelf of Mauritania (Northwestern Africa). Palaios (26) 447-460.

Oliver, J., Hammerstrom, K., McPhee-Shaw, E., Slattery, P., Oakden, J., Kim, S., Hartwell, S.I. (2011) High species density patterns in macrofaunal invertebrate communities in the marine benthos. Marine Ecology (32) 278-288.

Pires, A., Gentil, F., Quintino, V., Rodrigues, A.M. (2012) Reproductive biology of Diopatra neapolitana (Annelida, Onuphidae), an exploited natural resource in Ria de Aveiro (Northwestern Portugal). Marine Ecology (33) 56-65.

Poore, G.C.B, Wilson, G.D.F. (1993) Marine species richness. Nature (361) 597-598.

Renaud, P.E., Webb, T.J., Bjørgesæter, A., Karakassis, I., Kedra, M., Kendall, M.A., Labrune, C., Lampadariou, N., Somerfield, P.J., Wlodarska-Kowalczuk, M., Vanden Bergh, E., Claus, S., Aleffi, I.F., Amouroux, J.M., Bryne, K.H., Cochrane, S.J., Dahle, S., Degraer, S., Denisenko, S.G., Deprez, T., Dounas, C., Fleischer, D., Gil, J., Grémare, A., Janas, U., Mackie, A.S.Y., Palerud, R., Rumohr, H., Sardá, R., Speybroeck, J., Taboada, S., Van Hoey, G., Weslawski, J.M., Whomersley, P., Zettler, M.L. (2009) Continental-scale patterns in benthic invertebrate diversity: insights from the MacroBen database. Marine Ecology Progress Series (382) 239-252.

Rouse, G.W., Pleijel, F. (2001) Polychaetes. Oxford University Press Inc., New York.

Roy, K., Jablonski, D., Valentine, J.W. (2000) Dissecting latitudinal diversity gradients : functional groups and clades of marine bivalves. Proceedings of the Royal Society B (267) 293-299.

Schmidt, M. (2011) Short Cruise Report RV Maria S. Merian Cruise MSM 18/4, Leibniz Institute for Baltic Sea Research, Warnemünde.

Snelgrove, P.R.V., Butman, C.A. (1994) Animal-sediment relationships revisited: cause versus effect. Oceanography and Marine Biology: An Annual Review (32) 111-177.

Soltwedel, T. (1997) Meiobenthos distribution pattern in the tropical East Atlantic: indication for fractionated sedimentation of organic matter to the sea floor? Marine Biology (129) 747-756.

Soltwedel, T., Thiel, H. (1995) Biogenic sediment compounds in relation to marine meiofaunal abundances. International Review of Hydrobiology (80) 297-311.

Steele, D.H. (1988) Latitudinal Variations in Body Size and Species Diversity in Marine Decapod Crustaceans of the Continental Shelf. Internationale Revue der gesamten Hydrobiologie und Hydrographie (78) 235-246.

Steele, J.H., Thorpe, S.A., Turekian, K.K. 2009. Ocean Currents: A derivative of the encyclopedia of ocean sciences, 2nd Edition, Academic Press, London.

Strømme, T., Sætersdal, G. (1991) Surveys of the fish resources of Angola, 1985-86 and 1989. Reports on surveys with RV `Dr. F. Nansen´ Institute of Marine Research, Bergen, Norway.

Thorson, G. (1952) Zur jetzigen Lage der marinen Bodentier-Ökologie. Zoologischer Anzeiger (16) 276-327.

Thorson, G. (1957) Bottom communities (sublittoral or shallow shelf). In: Hedgepeth JW (ed) Treatise on marine ecology and paleoecology. Geological Society of America, New York.

Wauthy, B. (1977) Révision de la classification des eaux de surface du golfe de Guinée (Berrit 1961). Cahiers ORSTROM, Série Océanographie (15) 279-295.

Zettler, M.L., Bochert, R., Pollehne, F. (2009) Macrozoobenthos diversity in an oxygen minimum zone off northern Namibia. Marine Biology (156) 1949-1961.

6 Appendix

6.1 Materials

In the following all used materials, chemicals and appliances are listed.

Appliances:

Hand sieve: IOW
∅ 180 mm
weight: 0,2 kg
mesh size: 1 mm

Kautex bottles: Omnilab
1 litre

Screw neck vials : clear glass, 40 ml
VWR International GmbH

Microscope: M3Z Discussion Stereomicroscope
Stand: Wild Typ 439168
Crossbar: Wild Typ 479887
Lens: Wild M3Z
Eyepiece Base: Leica
Eyepiece: Wild 10x/21B 445111
ZEISS Microscope Axio Lab.A1
ZEISS SteREO Discovery.V8

Light source: ZEISS CL 1500 ECO
Schott KL 2500 LCD

Camera: AxioCam ICc3
Resolution: 2028 x 1540 pixels

Scales: Analytical balance Cubis® MSA225S-000-DA

Sartorius GmbH

Readability: 0.01 mg

Weighing range: 220 g

Calibration: International, isoCAL

Forcep set

Photographic trays

Pan of sort

Software: AxioVision: version 4.8.2.0

Primer: version 6

GIS, ArcMap: version 10

Chemicals: Formol 35% aquaeous solution:

VWR International GmbH

902409010

Methylene blue:

Merck KGaA

159270

Ethanol 95% (v/v) denaturated TECHNICAL:

VWR International GmbH

20827.412

Glycerol 87% technical grade:

AppliChem GmbH

6.2 Data sets

All determined taxa are listed in alphabetical order according to their main group, also indicating their locations. Furthermore, they are arranged according to their order, class, family or phylum.

6.2.1 Crustacea

Order	Taxa	Stations
Amphipoda	*Ampelisca* sp.	Ku4,Na5,BM5,LO5,SU4,SU5,Be71,LU5
	Amphilochus sp.	SU5
	Amphipoda (red eyes)	Na5,BM5,SU5,Be71,LU5
	Amphipoda B	BM5
	Amphipoda C	BM5
	Apherusa sp.	SU5
	Byopedos sp.	SU5,Be71
	Caprellidae	Na5,BM5,SU4
	cf. *Ceradocus*	Na5
	Ericthonius sp.	Be71
	Eriopisa sp.	LO5,Be71
	Eriopisa B	LO5
	Eriopisella?	Ku4
	Eriopisella sp.	LO5
	Eupariambus fallax K.H. Barnard, 1957	Ku4,BM5
	Eusiridae	Be71
	Gammaropsis sp.	Ku5,Na5,BM5,Be71
	Grandidierella sp.	SU4,SU5
	Harpinia sp.	Be71
	Hyperia sp.	SU4
	Isaeidae	Na5,BM5,SU4,Be71
	Isaeidae?	LU5
	Lepidepecreum sp.	BM5
	Leucothoe procera Bate, 1857	Ku5
	Leucothoe sp.	LO5,SU4,Be71
	Leucothoe?	BM5
	Lysianassidae	Ku4,Na5,BM5
	Lysianassidae?	BM5
	Maera?	BM5,LO5,SU4
	Melita sp.	SU5
	Melitidae	Ku4
	Melitidae?	LO5
	cf. *Metopa*	Na5
	Oeditoceridae	Ku4,Na5,BM5,SU4,Be71,LU5
	Oeditoceridae B	Na5
	Orchomene sp.	BM5,SU4
	Perioculodes sp.	Ku4,Na5,BM5
	Photis sp.	BM5,SU5

Amphipoda	Phoxocephalidae	BM5,LO5,SU4,Be71
	Phoxocephalidae?	BM5
	Phthisica sp.	SU5
	Sthenotoidae?	Na5
	Synchelidium sp.	SU5
	cf. *Thaumatoplax*	Ku5
	Tiron sp.	SU4
Cumacea	*Bodotriia* sp.	SU5
	Bodotriia?	BM5
	Cumacea	Ku5
	Cumacea with melanophores	BM5
	Cyclaspis sp.	BM5
	Diastylis sp.	Ku4,Na5,BM5,LO5,SU5,Be71,LU5
	Eocuma cadenati Fage, 1950	BM5
	Eocuma cadenati?	BM5
	Eocuma calmani Fage, 1928	Be71
	Eocuma cochlear Le Loeuff & Intes, 1972	SU5
	Eocuma lanatum Le Loeuff & Intes, 1972	Na5,BM5
	Eocuma sp.	Ku5
	Iphinoe sp.	BM5,SU5
Decapoda	Brachyura A	LU5
	Brachyura A2	LO5,LU5
	Brachyura A3	LO5
	Brachyura B	LO5,Be71,LU5
	Brachyura C	SU4,Be71
	Brachyura E	LU5
	Brachyura F („Schamkrabbe“)	LU5
	Brachyura K	LO5
	Brachyura L (cf. *Parthenope*)	LU5
	Brachyura M	BM5,Be71,LU5
	Brachyura G (cf. *Rochinia*)	LU5
	Brachyura H (Majidae)	BM5,LU5
	Brachyura K (Ebalinae)	Be71
	Brachyura N	LO5
	Brachyura O	LO5
	Brachyura P	LO5,Be71
	Brachyura Q	Be71
	Callianassa sp.	Ku4,BM5,LO5, SU5,Be71
	Callianassa juv.	BM5
	Crangon sp.	Be71
	Euphausiacea	BM5
	Euphausiacea juv.	BM5,LU5
	cf. *Pachygrapsus*	Ku4
	Galathea sp.	BM5,LO5,Be71,LU5
	Galathea-like	BM5
	Galathea juv.	Na5
	Lobster larva? 2	BM5
	Macropodia sp.	Be71
	Megamphopus sp.	SU5
	Munidopsis sp.	SU4
	Natantia A	Be71

Decapoda	Natantia B	LO5,Be71,LU5
	Natantia C	SU4
	Natantia D	LU5
	Natantia E	Be71
	Natantia G	Be71, LU5
	Natantia H	BM5, LO5, Be71, LU5
	Natantia I	LO5, Be71, LU5
	Natantia juv.	LO5
	Natantia K	LU5
	Natantia L	Be71, LU5
	Natantia M	LO5, Be71, LU5
	Natantia N	BM5, LO5, Be71
	Natantia O	BM5, Be71
	Natantia P	LO5
	Natantia Q	Be71
	Natantia S	Be71
	Natantia U	Be71
	Pagurus sp.	Ku5, Ku4, BM5, LO5, SU4, SU5, Be71, LU5
	Stomatopoda	SU5, Be71
Isopoda	Arcturidae	Na5, BM5, SU5
	Cyathura sp.	Na5, BM5, Be71
	Gnathia sp.	LU5
	Isopoda	Ku4, BM5
Mysidacea	Mysidacea	Ku4, SU4, LU5
	Mysidacea juv.	LO5
Sessilia	*Balanus* sp.	Ku5
	Pollicipes sp.	LU5
Tanaidacea	*Apseudes grossimanus* Norman & Stebbing, 1886	Be71
	Calozodion?	SU4
	Hemikalliapseudes sp.	Na5, BM5, LO5
	Tanaidacea	Be71

Tab. 9: Determined crustaceans arranged according to the order, and their locations.

6.2.2 Echinodermata

Class	Taxa	Stations
Ophiuroidea	*Amphiura* sp.	Ku5, SU5, Be71
	Ophiura sp.	BM5, LO5, SU4, LU5
-	Echinodermata	Be71

Tab.10: Determined echinoderms arranged according to the class, also undetermined echinoderm, and their locations.

6.2.3 Mollusca

Class	Taxa	Stations
Bivalvia	*Abra* sp.	Ku5, Na5, LO5, Be71, LU5
	Bivalvia D	SU5
	Bivalvia: small, white	Ku5
	cf. *Lucinoma capensis*	Be71, LU5
	cf. Ostreidae	LU5
	Congetica congoensis (Thiele & Jaeckel, 1931)	SU5
	Corbula sp.	LO5
	Costellipitar peliferus (Cosel, 1995)	Ku5
	Cuspidaria sp.	LO5, Be71
	Dosinia sp.	BM5
	Lucinoma capensis (Thiele & Jaeckel, 1931)	Be71
	Macoma sp.	SU5
	Mytilidae	Ku5, SU5, LU5
	Nucula sp.	LU5
	Nuculana bicuspidata (Gould, 1845)	Ku5, Ku4
	Nuculana cf. commutata (Philippi, 1844)	LU5
	Nuculana-like	BM5
	Phaxas sp.	LO5, SU4, LU5
	Pitar sp.	Ku5, BM5, LO5, SU5, Be71
	Solemya cf. *togata* (Poli, 1791)	BM5
	Tellina sp.	BM5
	Thyasira sp.	Ku5
Cephalopoda	Octopoda	LU5
Gastropoda	*Acteon* sp.	SU5
	Bufonaria marginata (Gmelin, 1791)	Ku4, Na5
	Bullia skoogi (Odhner, 1923)	Ku5, Ku4
	Cancilla scrobiculata crosnieri Cernohorsky, 1970	Be71
	Clavatula sp.	LU5
	Cylichna sp.	Ku5, BM5, Be71, LU5
	Eulima sp.	Ku5
	Euspira fusca (Blainville, 1825)	LU5
	Euspira grossularia (Marche-Marchad, 1957)	LU5
	Euspira notabilis (Jeffreys, 1885)	LU5
	Fusinus sp.	Na5, BM5
	Gastropoda	Be71
	Gastropoda	Be71
	Gastropoda B	LO5
	Gastropoda B	LU5
	Gastropoda C	SU5
	Gastropoda C (twisted)	Be71
	Gastropoda D	Be71
	Gibberula sp.	BM5
	Jolya letourneauxi Bourguignat, 1877	SU5
	cf. *Lippistes cornu* (Gmelin, 1791)	LU5
	Nassarius sp.	Ku5, LO5, SU5, Be71
	Nassarius vinctus (Marrat, 1877)	Ku5, Ku4

Gastropoda	*Natica acinonyx* Marche-Marchad, 1957	LU5
	Natica bouvieri Jousseaume, 1883 (=*N. canariensis* Odhner, 1931)	BM5
	Natica marchadi Pin, 1992	Ku5
	Natica multipunctata (Blainville, 1825)	LU5
	Nudibranchia	SU5, Be71
	Philine aperta (Linnaeus, 1767)	Ku5, BM5, LU5
	Philine sp.	BM5, LO5, SU4, LU5
	Rissoidae	SU5, LU5
	Strombina descendens (von Martens, 1904)	Be71
	Tectonatica rizzae (Phillipi, 1844)	LU5
	Tectonatica sagraiana (d'Orbigny, 1842)	Ku5, Ku4, LO5, SU5, Be71
	Turridae	Be71
	Turridae?	Ku4, BM5
	Turritella sp.	Ku4, LO5, SU4
	Ungulunidae	SU5
Polyplacophora	Polyplacophora	SU4
Scaphopoda	Scaphopoda	BM5, LO5, Be71, LU5
Solenogastres	Solenogastres	LO5, LU5

Tab.11: Determined mollusks arranged according to the class, and their locations.

6.2.4 Other

Phylum	Taxa	Stations
Annelida	Oligochaeta	Ku5, Na5, BM5, LO5, LU5
Arthropoda	Pycnogonida	Na5, BM5
Brachiopoda	Brachiopoda	LU5, Be71
	Brachiopoda B	Be71
	Discinisca sp.	BM5
Bryozoa	Bryozoa	Ku4, Na5, BM5, LU5
Chordata	*Molgula* sp.	Ku4,
Cnidaria	Anthozoa	SU4, Ku4, Na5, BM5, LO5, LU5, Be71
	Anthozoa?	LU5
	Coral	BM5, LU5
	Edwardsia?	Ku5, BM5
	Hydrozoa	Ku4, Na5, BM5
	Octocorallia soft	Ku4
	Plumose anemone	LU5
	Virgularia sp.	SU4, SU5
Nemertea	*Lineus* sp.	LO5, Be71, LU5
	Nemertini	Ku5, BM5, LO5, SU4, Be71
	Tubulanus sp.	Ku5, Na5, BM5, LO5, SU5, Be71, LU5
Phoronida	*Phoronis* sp.	SU5
	Phoronopsis sp.	LO5

Tab.12: Determined organisms of the main group Other arranged according to the phylum, and their locations.

6.2.5 Polychaeta

Family	Taxa	Stations
Ampharetidae	Ampharetidae	Ku5, Na5, BM5, LO5, SU4, SU5, Be71, LU5
	Ampharete-like	Ku5
	cf. *Ampharete* sp.	BM5, LO5, SU5, Be71
	Phyllamphicteis?	Ku5, Ku4
	Phyllamphicteis sp.	Na5, LO5, SU4, Be71, LU5
	Phyllocomus sp.	LO5
Amphinomidae	*Chloeia* sp.	LU5
	Chloeia-like	Be71
	Chloeia inermis Quatrefages, 1866	Be71
	Paramphinome sp.	Be71
Aphroditidae	Aphroditidae	Na5, SU4, LU5
Capitellidae	Capitellidae	Na5, BM5, SU4, Be71
	Capitellidae?	LO5
	Heteromastus sp.	Ku4, Be71
	Heteromastus?	Ku5
Chaetopteridae	*Chaetopterus* sp.	Ku5, LO5, SU5, Be71, LU5
	Spiochaetopterus costarum (Claparède, 1869)	LO5, LU5
Cirratulidae	*Caulleriella* sp.	BM5
	Chaetozone B	SU5
	Chaetozone sp.	Ku5, BM5, SU5, Be71
	Cirratulidae	Ku5,Ku4,Na5,BM5,LO5,SU4,SU5,Be71,LU5
	Cirratulidae (2 small eyes)	Ku5
	Cirratulidae B	Ku5, BM5
	Cirratulidae (orange)	Ku5
	Cirratulidae?	LO5
	Cirratulidae D	Be71
Cossuridae	*Cossura coasta* Kitamori, 1960	Ku5, Ku4, Na5, BM5, LO5, SU5, Be71, LU5
Eunicidae	*Eunice* sp.	Be71
	Marphysa sp.	Be71
Euphrosinidae	*Euphrosine* sp.	SU4
Fabriciidae	*Fabricia* sp.	BM5, SU4, SU5, LU5
Flabelligeridae	Flabelligeridae	Na5, LO5
	Pherusa sp.	Ku5, Ku4, SU5
Goniadidae	*Goniada congoensis* Grube, 1877	Na5
	Goniada sp.	Ku5, Ku4, SU5, Be71
	Goniadidae	Na5
Glyceridae	*Glycera* sp.	Na5
	Glyceridae	BM5, LO5, SU5, Be71, LU5
Hesionidae	Hesionidae	Ku5
	Hesionidae?	Na5
	Ophiodromus sp.	Na5, BM5, LO5, Be71, LU5
	Ophiodromus?	BM5
Heterospionidae	*Heterospio* cf. *longissima* Ehlers, 1874	SU5

Heterospionidae	*Heterospio* sp.	Be71, LU5
Lumbrineridae	Lumbrinereidae Lumbrineridae B	Ku5, Na5, BM5, LO5, SU4, SU5, Be71, LU5 BM5
Magelonidae	*Magelona* sp. Magelonidae	SU4, SU5 BM5, Be71
Maldanidae	*Euclymene* sp. Maldanidae cf. *Petaloproctus* *Rhodine* sp.	BM5 Na5, BM5, LO5, SU4, Be71, LU5 LU5 Ku5, BM5, LO5, SU5, Be71
Nephtyidae	Nephtyidae Nephtyidae?	Ku5,Ku4, Na5,BM5,LO5,SU4,SU5,Be71,LU5 BM5
Nereididae	Nereidae *Nereis* sp. *Pseudonereis* B *Pseudonereis variegata* (Grube, 1857)	Ku5, LU5 Be71 LU5 LO5
Onuphidae	*Diopatra* juv. *Diopatra neapolitana* Delle Chiaje, 1841 *Diopatra* sp. cf. *Diopatra* cf. *Onuphis*	Ku4 Ku5, Ku4, BM5, LO5, LU5 Na5, BM5, LO5, SU5, Be71 BM5 BM5
Opheliidae	*Ophelia* sp.	BM5, SU4
Orbiniidae	*Orbinia* sp. Orbiniidae Orbinidae? Questidae cf. *Questidae*? *Scoloplos* sp.	BM5 Be71 BM5 SU5 BM5 Na5, BM5, LO5, SU5, Be71
Oweniidae	*Myriochele sp.* *Owenia*	Ku5, SU5 Ku4, Na5, BM5, LO5, SU4, SU5, Be71
Paraonidae	*Aricidea* sp. *Aricidea* B *Aricidea*-ähnlich *Cirrophorus* sp. *Cirrophorus* B Paraonidae	Na5, BM5, LO5, Be71, LU5 LO5 SU5 Na5, BM5, LO5, Be71 BM5 BM5, SU5, Be71
Pectinariidae	*Amphictene* sp. *Pectinaria* sp.	Ku5, SU5, Be71 SU4, Na5, BM5, LO5, LU5, Be71
Phyllodocidae	*Eteone* sp. *Eumida* sp. Phyllodocidae	Na5, BM5, SU4, Be71 Ku4, Na5 Na5, LO5, Be71, LU5
Pilargidae	*Loandalia* sp. *Sigambra* cf. *robusta* (Ehlers, 1908) *Sigambra* sp. *Sigambra*?	LO5 Ku5, Ku4 Ku5, Na5, BM5, LO5, SU5, Be71, LU5 LO5
Poecilochaetidae	*Poecilochaetus* sp. Poecilochaetidae	LO5, Be71 BM5
Polynoidae	*Harmothoe* sp.	Ku4, Ku5, BM5, LO5, SU5

Polynoidae	*Harmothoe* B	LO5
	Harmothoe C	BM5
Sabellariidae	*Sabellaria eupomatoides* Augener, 1918	Ku4
Sabellidae	*Chone* sp.	BM5
	Laonome sp.	LO5, SU5
	Sabellidae	Na5
Serpulidae	Serpulidae	BM5, SU4, Be71, LU5
Sigalonidae	*Sthenelais* cf. *incisa* Grube, 1877	LO5
	Sthenelais sp.	BM5, LO5, SU4, SU5, Be71, LU5
Sipunculidae	Sipunculidae	Na5
Spionidae	*Laonice* B	SU4
	Malacoceros sp.	SU4
	Minuspio?	LO5
	Paraprionospio pinnata (Ehlers, 1901)	Ku5, Ku4, BM5, LO5, SU5, Be71, LU5
	Polydora sp.	Na5, BM5, SU4, SU5, Be71, LU5
	Prionospio B	Ku5, LO5, Be71
	Prionospio sexoculata Augener, 1918	LO5, SU4
	Prionospio sp.	SU4, Ku5, Ku4, Na5, BM5, LU5, Be71
	Scolelepis sp.	SU5
	Spio-ähnlich	LO5
	Spio B	Be71
	Spiophanes afer Meissner, 2005	Be71
	Spiophanes black side	Na5, LO5, Be71
	Spio black side	BM5, LO5
	Spio sp.	Ku5, Ku4, Na5, BM5, LO5, Be71, LU5
	Spiophanes sp.	BM5, SU5, Be71
Sternaspidae	*Sternaspis scutata* Ranzani, 1817	LO5, Be71, LU5
	Sternaspida	Be71
Syllidae	*Autolytus* sp.	Be71
	Exogone sp.	SU4
	Syllidae	Ku5, Na5, BM5, SU4
	Typosyllis sp.	SU4
Terebellidae	*Lanice* sp.	SU5
	cf. Terebellidae	SU4
	Terebellidae	Na5, BM5, LO5, Be71, LU5
	Terebellides stroemii Sars, 1835	LO5
Trochochaetidae	*Trochochaeta* sp.	Na5, LO5, LU5
-	Pointed polychaete	LO5
	Polychaete small	Na5
	Polychaete (brown head)	BM5
	Polychaete small A	BM5
	Polychaete small B	BM5
	Polychaete small C	BM5
	Polychaete small D	BM5
	Scale worm	Be71

Tab.13: Determined polychaetes arranged according to the family, also undetermined polychaetes, and their locations.

Acknowledgement

First of all, I like to thank Dr. Michael Zettler for giving me the opportunity to write this master´s thesis and for his helpful advice to be successful in writing, as well as Prof. Dr. Wolfgang Wranik, who kindly accepted to be my second supervisor at short notice.

In addition, I am grateful for the help of Dr. Ralf Bochert, who often took the time to agree with the working names I gave to the organisms or to correct them.

Furthermore, I like to thank Ines Glockzin and her daughter Marie, Nadine Keiser and especially Franziska Glück for supporting me to proceed with the examination of the samples and, of course, for determining the organisms.

A thank also goes to Kerstin Schiele for helping me with the software GIS.

At last, I want to thank Prof. Dr. Michael Hollmann from the Ruhr-University of Bochum, who determined several gastropods of this study belonging to the family Naticidae.

Declaration of academic honesty

I hereby confirm to have written this master´s thesis on my own. No other literature sources were used than the listed ones.

Diana Moritz Rostock, 20th August 2012