Abundance and trophic position of gelatinous and half-gelatinous organisms in the Namibian upwelling region

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Table of Contents

I. Abstract

Since the 1970's the abundance of large gelatinous zooplankton increased in the northern Benguela Current System. Very little is known about the background of this increasing abundance. In this study, the distribution and trophic position of gelatinous and half-gelatinous zooplankton in the northern Benguela Current System will be investigated. Samples were taken with a MOCNESS (Multiple Opening and Closing Net and Environmental Sensing System) on board of the *FRS Africana* in December 2009 along a transect off Walvis Bay (Namibia). For stable isotope analyses, samples were taken with different types of gears at stations distributed all over the northern Benguela Upwelling System. An inshore/offshore gradient was found for taxonomical composition, whereas no gradient was found for size and numerical abundance. Within the Medusae, Trachymedusae dominated the offshore system and Leptomedusae the inshore system. Within the Siphonophora, the system was dominated by Diphyniae in offshore waters and by Agalmatidae in inshore waters. Other gelatinous and half-gelatinous organisms were dominated by Salpidae in offshore waters. Inshore, Chaetognatha dominated this group. Stable isotope analyses showed a difference between the taxonomical groups. Salpidae had a lower value of $\delta^{15}N$ than Chaetognatha and Medusae, indicating a lower trophic level of the former group. No difference was found between inshore and offshore samples for Medusae.

II. Zusammenfassung

Seit den 1970er Jahren steigt die Anzahl an gelatinösem Zooplankton im nördlichen Benguela System. Das Wissen über die Hintergründe dieses Anstiegs ist relativ gering. In dieser Studie soll die Verteilung und trophische Stellung von gelatinösen und halb-gelatinösen Organismen untersucht werden. Planktonproben zur taxonomischen Analyse wurden mit einem MOCNESS (Multiple Opening and Closing Net and Environmental Sensing System) während einer Forschungsfahrt mit dem Forschungsschiff *FRS Africana* im Dezember 2009 auf einem Transekt vor Walvis Bay (Namibia) genommen. Proben für die Analyse von stabilen Isotopen wurden im gesamten nördlichen Benguela mittels verschiedener Probennahmegeräten genommen. In der taxonomischen Zusammensetzung konnte ein deutlicher Gradient von der neritischen zur ozeanischen Zone gefunden werden, während die absolute Anzahl und Größe der Tiere keinen deutlicher Trend anzeigte. Innerhalb der Medusae dominierten Trachymedusae das ozeanische und Leptomedusae das neritische System. Innerhalb der Siphonophora wurde das System von Diphyniae im offenen Ozean und von Agalmatidae in küstennahen Gebieten dominiert. Andere gelatinöse und halb-gelatinöse Organismen wurden in der offenen See von Salpidae dominiert, das küstennahe System dominierten Chaetognatha, Inshore wurde das System von Chaetognatha dominiert. Die Analyse der stabilen Isotope ergab, dass sich die taxonomischen Gruppen untereinander unterscheiden. Salpen wiesen einen niedrigeren $\delta^{15}N$ Wert auf als Chaetognatha und Medusen. Innerhalb der Medusen konnten hier keine Unterschiede zwischen den taxonomischen Einheiten gefunden werden die küstennah bzw. küstenfern gesammelt wurden. Die Unterschiede in den stabilen Stickstoffisotopen zwischen Salpidae und Chaetognatha/ Medusae geben einen Hinweis darauf, dass diese Gruppen unterschiedliche trophische Stellungen im Nahrungsnetz einnehmen.

1. Introduction

The Benguela Current System extends along the west coast of South Africa, Namibia and Angola from 17°S to 34°S (Hart and Currie 1960). The system is characterized by episodic upwelling events, which are driven by strong equator ward winds. A region of constant upwelling off Lüderitz at 26°S divided the system into a southern and a northern part. This constant upwelling forms a tongue of turbulent water with little vertical stratification, which acts as a natural barrier between the two parts of the Benguela Current System (Shannon 1985; Agenbag and Shannon 1988). Upwelling in the northern part occurs during the whole year, with a maximum in late southern winter and spring (Shannon 1985); however, seasonality is weak in the environmental conditions. The Benguela Current is bounded by the Angola and Agulhas currents in the north and south, respectively (Fig. 1).

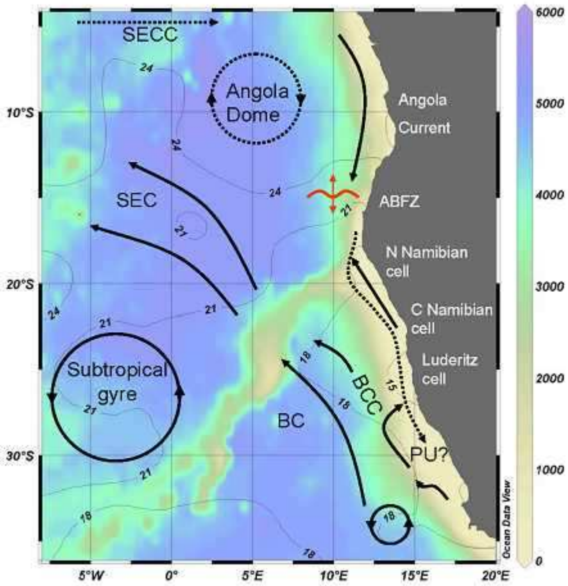

Figure 1: Schematic Diagram of the currents of the Benguela Current System. SECC: South Equatorial Counter Current SEC: South Equatorial Current BC: Benguela Oceanic Current BCC: Benguela Coastal Current ABFZ: Angola-Benguela Front PU: Poleward Undercurrent (modified after GENUS, unpubl.)

The term "gelatinous zooplankton" was defined in many different ways. Some authors only include coelenterates to this term (Haddock 2004); others also include Salpidae, Chaetognatha and some Mollusca like Pteropoda (Harbison 1992; Raskoff 2003). In this study, I will differentiate between gelatinous organisms (Coelenterata) and half-gelatinous organisms containing more structural components (Chaetognatha, Salpidae, Pteropoda and Appendicularia).

There are some indications that the abundance and biomass of gelatinous zooplankton was heavily increased after the collapse of fish stocks in the 1970s in the Benguela Current System (Lynam et al. 2006; Utne-Palm et al. 2010). Large Medusae were not reported during detailed plankton studies in the 1950s and 1960s (Hart and Currie 1960; Stander and De Decker 1969). The first note of large jellyfish in the Benguela Current System was at the beginning of the 1970s (King and O'Toole 1973, Cram and Visser 1973, Schülein 1974). It is still uncertain whether these increases of jellyfish stocks in the region are caused by the overexploitation of fish (Pauly et al. 1998), global climate change (Mills 2001, Purcell 2005) or eutrophication (Arai 2001). But this is not a unique Benguela phenomenon; similar increases in gelatinous zooplankton were observed at a number of locations worldwide: e.g. large Medusa in the Bering Sea, *Pelagia noctiluca* in the Mediterranean (Mills 2001), large Scyphozoa in the Yellow, Bohia and East China Seas (Dong et al. 2010).

Although several papers about the taxonomy (Pagès et al. 1992, Pagès and Gili 1992) and ecology (e.g. Buecher and Gibbons 2003, Buecher et al. 2001, Gibbons and Buecher 2001) of gelatinous zooplankton in the northern Benguela exist, information about the vertical and horizontal distribution of Medusa and their role in food web dynamics are still limited. Only the distributions of large jellyfish like *Chrysaora hysoscella* and *Aequorea aequorea* were examined in several studies (e.g. Sparks et al. 2001, Fearon et al. 1992, Brierley et al. 2001) as well as the effects of advective processes on gelatinous zooplankton (Pagès and Gili 1991). In general, most studies on gelatinous zooplankton are based upon data from the 1980s.

The position of gelatinous zooplankton within the foodweb of several ecosystems was determined by gut content analyses and observations (e.g. Båmstedt and Martinussen 2000; Fancett and Jenkins 1988; Flynn and Gibbons 2007). Since the 1970's, the composition of stable nitrogen (^{15}N) and carbon (^{13}C) isotopes were used to estimate the trophic position of an organism as well as the source of its diet (Fry and Sherr 1984). Minagawa and Wada (1984) and Hobson and Welch

(1992) found a stepwise enrichment of ^{15}N with increasing trophic position of 3-5 ‰ $\delta^{15}N$ per trophic level, whereas the stable carbon isotope ^{13}C only increased by 1-2 ‰ $\delta^{13}C$ per trophic level.

In this study, I will analyse the distribution, composition and the trophic position of the gelatinous and half-gelatinous zooplankton in the northern Benguela Current System to test the following hypothesis: Distinct differences exist between inshore and offshore communities.

(i) Inshore, in the centre of the upwelling region, more and larger organisms with less taxonomical diversity than in the oceanic offshore region are expected.

(ii) Inshore, a more classical short food-chain exists, whereas offshore, a more complex food web exists. These differences are also reflected by the trophic level of the gelatinous and half-gelatinous organisms, with higher trophic levels offshore, especially for the carnivorous Coelenterata and Chaetognatha.

2. Material and methods

2.1. Taxonomical samples

Sampling was conducted at four stations (Fig. 1, Table 1) on an inshore/offshore transect off Walvis Bay in the Benguela Current Region (23°S; 14° -11° 5'E) on cruise 258 of *RV Africana* in December 2009. Samples were taken by oblique hauls (towing speed: 2 knots) with a 1 m^2-Multiple Opening and Closing Net and Environmental Sensing System (MOCNESS; Wiebe et al., 1985) equipped with 9 nets of 333 mm mesh aperture, which can be sequentially opened and closed at defined depths (Table 1). The system was equipped with conductivity (Seabird SBE 4), temperature (Seabird SBE 3S) and depth sensors. Water depths increased from 60 m to 3060 m on the inshore/offshore transect. Veering and heaving speed of the winch was 0.5 m s^{-1}. The heaving speed was reduced to 0.2–0.3 m s^{-1} when the net passed the 200 m depth to increase the water volume sampled in the smaller 50 m and 25 m intervals. The mean filtered volumes per net were ca. 230 m^3. Upon recovery of the MOCNESS, the

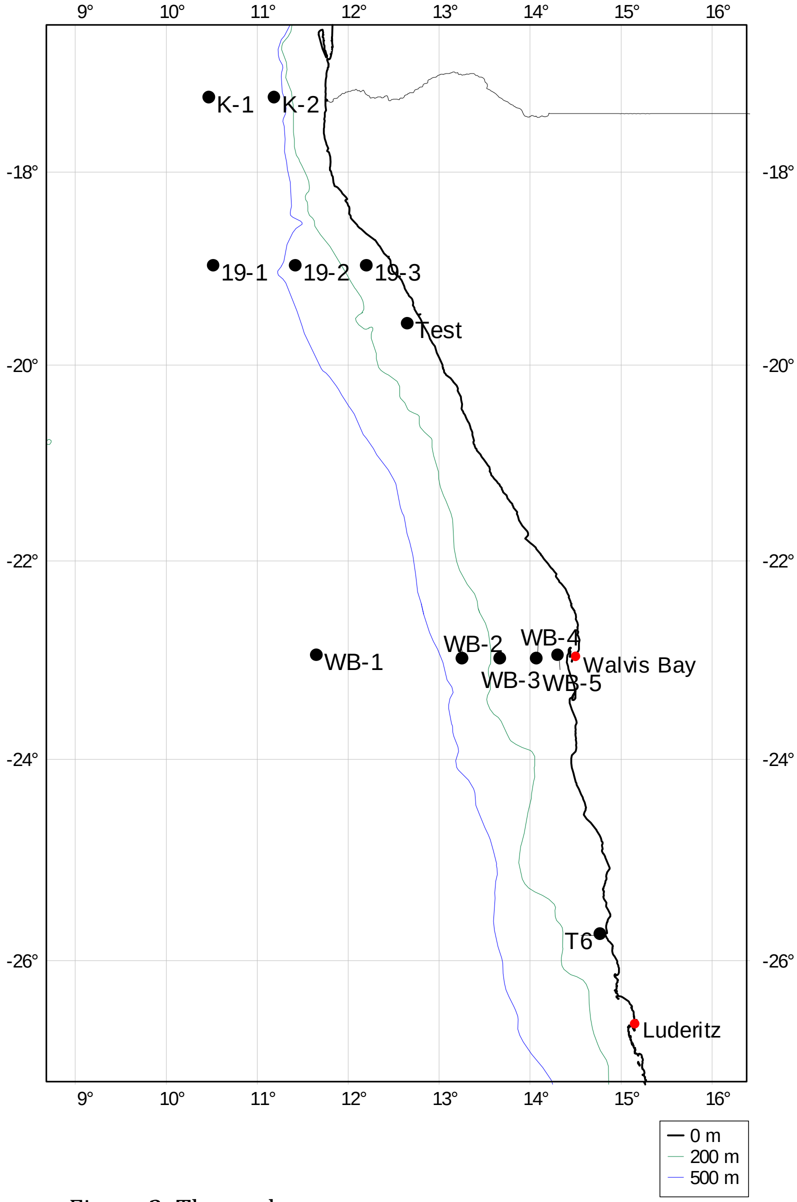

Figure 2: The study area.

nets were rinsed with seawater; plankton was preserved in a 4% formaldehyde–seawater solution buffered with sodium tetraborate (Steedman, 1976) for biomass and taxonomic analyses.

Table 1: Station data and sampled depth intervals of the MOCNESS hauls.

Haul	Station	Date	Sampling time UTC		Lat.	Long.	Sampled depth range and intervals	Remarks
			Start	End				
MOC-1-8	WB-1	12.12.2009	19:35	21:00	22°58'S	11°40'E	0-650-500-400-300-200-100-50-25-22	Net 8 release failed, broken wire
MOC-1-9	WB-2	13.12.2009	12:40	13:35	23°00'S	13°16'E	0-300-200-100-50-25-0	
MOC-1-10	WB-3	13.12.2009	17:35	18:00	23°00'S	13°41'E	0-100-50-25-0	
MOC-1-11	WB-4	13.12.2009	23:10	23:30	23°00'S	14°05'E	0-100-50-25-0	

2.2. Biomass and taxonomic analyses

In the laboratory, the preserved zooplankton samples for biomass determination and taxonomic analyses were sieved into fractions of <0.5, 0.5–1, 1–2, 2–5 and >5 mm. After placing the fractions in 70% ethanol for 30 s and drying them on tissue paper, the material was wet weighed on an analytical balance. This method allowed a subsequent taxonomical analysis instead of a more precise dry weight determination. After weighing, the samples were transferred into a sorting fluid composed of 0.5% propylene-phenoxetol, 5.0% propylene glycol and 94.5% fresh water (Steedman, 1976). Rich zooplankton samples were split according to Kott (1953). The gelatinous zooplankton was removed from the fractionated samples for further analyses. Gelatinous and half-gelatinous zooplankton was sorted into taxonomic groups and cnidarians and ctenophores were identified at species level, if possible. Due to there behaviour to live in colonies, which break into pieces when caught with plankton nets, Siphonophora were not included in the total counts of Cnidaria. The abundance of Siphonophora will be expressed in parts below 1 m². All other groups will be expressed as number of Individuals below 1 m². This is a numerical quantity in the water column below one square meter for the whole water column or parts of the water column. Numerical abundance was related to a volume of 1000 m³.

2.3. Stable Isotope analyses

Samples for stable isotope analyses were taken with different plankton nets (MOCNESS, WP-2 with a closed bucket to minimize the damage of the animals, Multinet, Driftnet, Tucker Trawl and Pelagic Trawl) at 12 stations in the Benguela Current Region (Fig. 2 and Tab. 3). The samples were frozen at -20° C directly after catching,

All samples were defrosted in the laboratory, weighted with an accuracy of 0.001 g with an analytical balance, washed with fresh water and dried. Parts of the samples were dried in a freeze-dryer at -40 °C for at least 24 h, the other samples were dried in a drying oven at 60° C for longer than 48h (see Table 3). Afterwards, the dried samples were pulverized using pestle and mortar. No further treatment was applied to the samples.

Stable isotope analyses and concentration measurements of nitrogen and carbon were performed simultaneously with a THERMO/Finnigan MAT V isotope ratio mass spectrometer, coupled to a THERMO Flash EA 1112 elemental analyzer via a THERMO/Finnigan Conflo III- interface in the stable isotope laboratory of the Museum für Naturkunde, Berlin. Stable isotope ratios were expressed in the conventional delta notation ($\delta^{13}C$ / $\delta^{15}N$) relative to atmospheric nitrogen (Mariotti, 1983) and VPDB (Vienna PeeDee Belemnite standard).

$$\delta^{13}C \ or \ \delta^{15}N[‰] = ((R_{Sample} / R_{S\tan dard}) - 1) * 1000$$

Standard deviation for repeated measurements of lab standard material (peptone) is generally better than 0.15 per mill (‰) for nitrogen and carbon, respectively. Standard deviations of concentration measurements of replicates of lab standards are <3% of the concentration analyzed.

Table 2: Species analysed for stable carbon and nitrogen isotopes. For the location of the station see also Fig. 1 (F: freeze dried; D: oven dried).

Sample Nr.	Species/ Content	Station	Date	UTC Start	Latitude	Longitude	Gear	Depth	drying method
1	*Pelagia noctiluca*	19-3	08.12.2009	18:17	S 18°59	E 12°13	MOCNESS	0-90	F
2	*Pelagia noctiluca*	19-3	08.12.2009	18:17	S 18°60	E 12°14	MOCNESS	0-90	D
3	*Aequorea spp.*	19-3	08.12.2009	18:17	S 18°61	E 12°15	MOCNESS	90-50	D
4	*Aequorea spp.*	19-3	08.12.2009	18:17	S 18°62	E 12°16	MOCNESS	90-50	F
5	*Aequorea spp.*	T6	06.12.2009	03:24	S 25°44	E 14°46	Pelagic Trawl		F
6	*Aequorea spp.*	T6	06.12.2009	03:24	S 25°45	E 14°47	Pelagic Trawl		D
7	*Boroe spp.*	K-2	10.12.2009	01:30	S 17°14	E 11°12	Multinet	300-100	F
8	*Chrysaora hysoscella*	Test	08.12.2009	08:16	S 19°35	E 12°40	MOCNESS	50	F
9	*Chrysaora spp.*	WB-4	13.12.2009	23:10	S 23°00	E 14°05	MOCNESS	0-100	F
10	*Chrysaora spp.*	WB-4	13.12.2009	23:10	S 23°00	E 14°05	MOCNESS	0-100	D
11	*Pelagia noctiluca*	Test	08.12.2009	08:16	S 19°35	E 12°40	MOCNESS	50	F
21	Leptomedusae	19-2	09.12.2009	21:55	S 18°58	E 11°26	MOCNESS	0-330	F
22	*Atolla spp.*	K-1	10.12.2009	19:30	S 17°14	E 10°29	MOCNESS	650-500	F
23	*Abylopsis tetragonata*	19-2	09.12.2009	21:55	S 18°58	E 11°26	MOCNESS	0-330	F
24	Nacromedusae	19-1	11.12.2009	12:30	S 18°59	E 10°32	Tucker Trawl	100-250	F
25	*Haliceras spp.*	19-2	09.12.2009	21:55	S 18°58	E 11°26	MOCNESS	0-330	F
26	*Physophora hydrostatica*	K-2	10.12.2009	02:30	S 17°14	E 11°12	Tucker Trawl	100-200	F
27	Salpidae colony	WB-1	12.12.2009	22:50	S 22°59	E 11°38	Driftnet	0-2	F
28	*Pelagia noctiluca*	WB-3	13.12.2009	16:55	S 23°00	E 13°41	WP-2	0-100	F
29	*Pelagia noctiluca*	WB-5	14.12.2009	01:50	S 22°59	E 14°19	Multinet	0-50	F
30	*Discomedusa lobata*	19-3	08.12.2009	17:45	S 18°62	E 12°16	Tucker Trawl	60-20	F
31	Salpidae	WB-1	12.12.2009	22:50	S 22°59	E 11°38	Driftnet	0-2	F
32	Salpidae	WB-1	12.12.2009	22:50	S 22°59	E 11°38	Driftnet	0-2	D
33	*Chrysaora hysoscella*	Test	08.12.2009	08:16	S 19°35	E 12°40	MOCNESS	50	D
34	*Chrysaora hysoscella*	K-1	10.12.2009	19:30	S 17°14	E 10°29	MOCNESS	100-50	F
35	Siphonophora	WB-1	12.12.2009	22:50	S 22°59	E 11°38	Driftnet	0-2	D
36	Hydrozoa indef.	WB-5	14.12.2009	01:50	S 22°59	E 14°19	Multinet	0-50	D
37	Trachymedusae	19-1	11.12.2009	13:00	S 18°59	E 10°32	MOCNESS	0-700	D
38	Hydrozoa indef.	K-2	10.12.2009	02:30	S 17°14	E 11°12	Tucker Trawl	100-200	D
39	Chaetognatha mixsample	WB-1	12.12.2009	23:55	S 22°59	E 11°38	WP-2	0-600	D
40	Salpidae mixsample	WB-1	12.12.2009	23:55	S 22°59	E 11°38	WP-2	0-600	D
41	Jelly mixsample	WB-1	12.12.2009	23:55	S 22°59	E 11°38	WP-2	0-600	D
42	Siphonophora mixsample	WB-1	12.12.2009	23:55	S 22°59	E 11°38	WP-2	0-600	D
43	Pteropoda	WB-2	13.12.2009	11:48	S 23°00	E 13°41	WP-2	0-300	D
44	Siphonophora mixsample	WB-2	13.12.2009	11:48	S 23°00	E 13°41	WP-2	0-300	D
45	Chaetognatha mixsample	WB-2	13.12.2009	11:48	S 23°00	E 13°41	WP-2	0-300	D
46	Salpidae mixsample	WB-2	13.12.2009	11:48	S 23°00	E 13°41	WP-2	0-300	D
47	Jelly mixsample	WB-2	13.12.2009	11:48	S 23°00	E 13°41	WP-2	0-300	D
48	Jelly mixsample	WB-3	13.12.2009	16:55	S 22°59	E 13°41	WP-2	0-100	D
49	Salpidae mixsample	WB-3	13.12.2009	16:55	S 22°59	E 13°41	WP-2	0-100	D
50	Chaetognatha mixsample	WB-3	13.12.2009	16:55	S 22°59	E 13°41	WP-2	0-100	D
51	Chaetognatha mixsample	WB-4	13.12.2009	21:41	S 23°00	E 14°05	WP-2	0-100	D
52	Jelly mixsample	WB-4	13.12.2009	21:41	S 23°00	E 14°05	WP-2	0-100	D
53	Ctenophora	WB-4	13.12.2009	21:41	S 23°00	E 14°05	WP-2	0-100	D
54	Chaetognatha mixsample	WB-5	14.12.2009	02:28	S 22°59	E 14°19	WP-2	0-50	D
55	Jelly mixsample	WB-5	14.12.2009	02:28	S 22°59	E 14°19	WP-2	0-50	D

The stable nitrogen data were statistically analysed. Due to the fact that the data were not normal distributed the stable nitrogen data of three taxonomical groups (Medusae, Chaetognatha and Salpidae) and for the Medusae of the location (shelf, shelf-break and offshore) and the taxonomical groups (Hydroidomedusae, Scyphozoa and Siphonophora) were analysed by a Kruskal-Wallis-Test and in case of significant differences by a Mann-Whitney-U-Test with a rectified α ($p = 0.0167$) after Bonferroni using the software SPSS (Version 18.0).

3. Results

3.1. Hydrography

Hydrographical data were measured with a Seabird *SBE 911+* CTD with a Rosette water sampler at five stations at the Walvis Bay transect. Strong wind caused upwelling at the onshore stations during sampling. The hydrographical data showed a typical costal upwelling pattern, with cold waters at 15 to 20 nm off the coast. Offshore a thermocline was visible at 50 m depth (Fig. 3). The upwelling also transports waters with reduced salinity to the surface and further offshore. The salinity maximum occurred close below the thermocline at the oceanic edge.

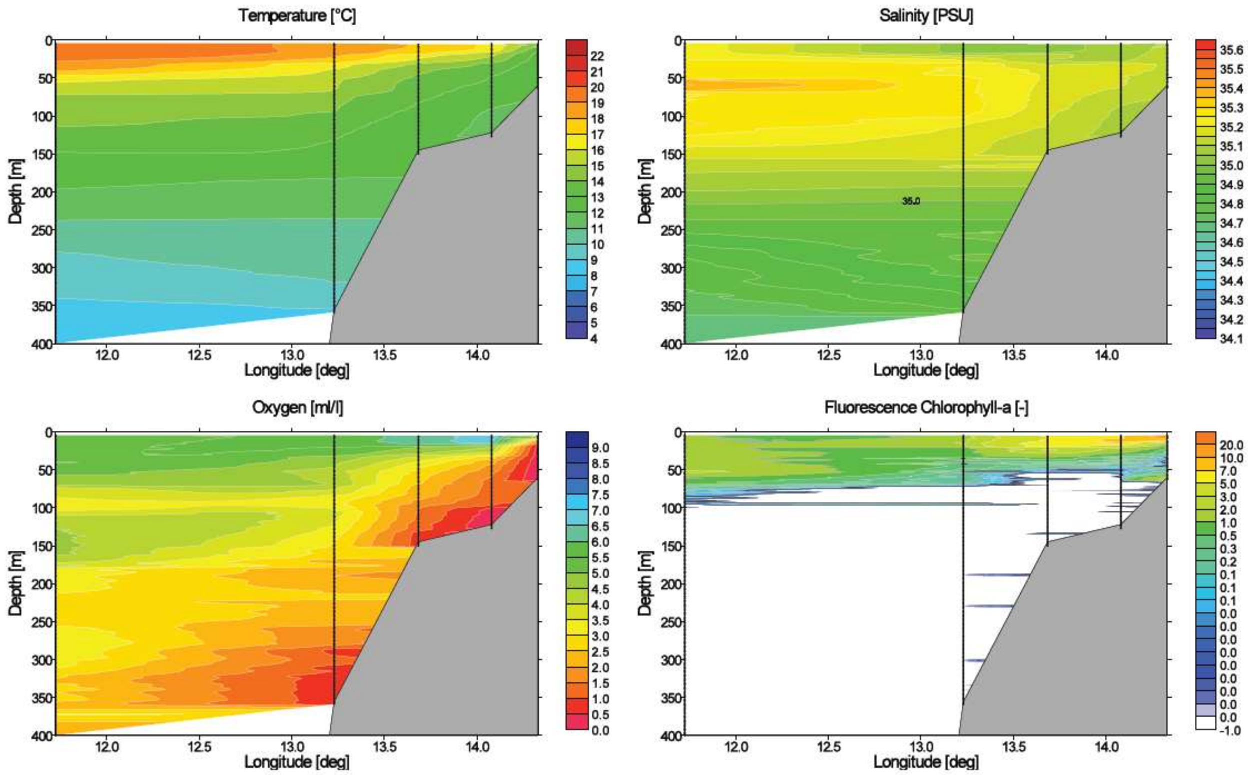

Figure 3: Hydrographic data; distribution of temperature, salinity, oxygen and fluorescence for the upper 400 m at the Walvis Bay transect from 12.12.2009 21:48 to 14.12.2009 01:53 UTC after Mohrholz and Heene (2009)

An oxygen minimum zone (OMZ) was detected on the shelf and on the continental slope between 20 and 400 m depth. At the surface phytoplankton enriched waters increased the oxygen content by photosynthesis at the surface near the coast.

3.2. Zooplankton horizontal distribution

A total of 33 Cnidaria species were found along the transect (20 Medusae, 14 Siphonophora). Additionally one species of Ctenophora (*Beroe ssp.*) was found at the offshore and shelf-break stations. The diversity increased from inshore to offshore (Table 4). Chaetognatha, Salpidae, Pteropoda and Appendicularia were counted but taxonomical not further specified. These groups were found at all stations.

Table 3: Detected species listed in taxonomical order according to Mianzan and Cornelius (1999) for Scyphozoa, Bouillon (1999) for Hydromedusae, and Pugh (1999) for Siphonophora. The table contains all species and taxonomical groups found in all MOCNESS samples (1-8 to 1-11; offshore, shelf-break and shelf) and indicates presence (+) or absence (-) at the specific station.

Taxon	offshore	shelf-break	outer shelf	inner shelf
Phylum **Cnidaria**, Verill (1865)				
Subphylum **Anthozoaria** Petersen (1979)				
Subphylum **Medusozoa** Petersen (1979)				
Superclass **Scyphozoa** Goette (1887)				
Chrysaora hysoscella Linné (1766)	-	-	+	-
Atolla spp. Haeckel (1880)	+	-	-	-
inc. sed. *Tetraplatia volitans* Busch (1851)	+	+	-	-
Superclass **Hydrozoa** Owen (1843)				
Class **Siphonophorae** Eschscholtz (1829)				
Siphonophorae indef.	+		+	+
Order Physonectae Haeckel (1888)				
Family **Agalmatidae** Brandt (1835)	+	+	+	+
Aglama spp. Eschscholtz (1825)	+	-	-	-
Family **Physophoridae** Eschscholtz (1829)				
Physophora hydrostatica Forskål (1775)	+	+	+	-
Family **Forskaliidae** Haeckel (1888)				
Forskalia leuckarti Bedot (1893)	+	+	+	+
Family **Paryidae** Kölliker (1853)	+	+	-	-
Amphicaryon spp. Chun (1888)	+	-	-	-
Family **Hyppopodiidae** Kölliker (1853)				
Vogita spp. Kölliker (1853)	+	-	-	-
Family **Abylidae** Agassiz (1862)	+	+	-	-
Family **Diphyidae** Quoy and Gaimard (1827)				

Table 3: continued

Taxon	offshore	shelf-break	outer shelf	inner shelf
Subfamily **Diphyniae** Moser (1925)	+	+	+	+
Eudoxoides spiralis Bigelow (1911)	+	-	-	-
Eudoxoides mitra Huxley (1859)	+	-	-	-
Lensia spp. Totton (1932)	+	-	-	-
Muggiaea spp. Busch (1851)	+	-	-	-
Class **Hydroidomedusae** Bouillon, Boero, Cicogna, Gili and Hughes (1992)				
Hydroidomedusae indef.	+	+	+	+
Subclass **Anthomedusae** Haeckel (1879)				
Anthomedusae indef.	+	+	-	+
Family **Calycopsidae** Bigelow (1913)				
Bythotiara murrayi Günther (1903)	-	+	-	-
Family **Pandeidae** Haeckel (1879)				
Leukartiara spp. Hartlaub (1913)	-	+	-	+
Subclass **Leptomedusae** Haeckel (1886)				
Leptomedusae indef.	+	-	+	-
Family **Eirenidae** Haeckel (1879)				
Eirenidae indef.	-	-	+	-
Family **Aequoreidae** Eschscholtz (1829)				
Aequorea spp. Péron and Lesueur (1810)	-	-	+	+
Family **Campanulariidae** Jonhston (1836)				
Obelia spp. Péron and Lesueur (1810)	-	-	-	+
Subclass **Limnomedusae** Kramp (1938)				
Family **Proboscidactylidae** Hand and Hendrickson (1950)				
Proboscidactyla menoni Pagès, Bouillon and Gili (1991)	-	-	-	+
Subclass **Nacromedusae** Haeckel (1879)				
Nacromedusae indef.	-	+	-	-
Family **Aeginidae** Gegenbauer (1857) emend. Maas (1904)				
Solmundella bitentaculata Quoy and Gaimard (1833)	+	+	+	-
Subclass **Trachymedusae** Haeckel (1829)				
Trachymedusae indef.	+	+	-	-
Family **Geroniidae** Eschscholtz (1829)				
Liriope tetraphylla Chamisso and Eysenhardt (1821)	+	+	+	-
Family **Halicreatidae** Fewkes (1886)				
Haliceras minima Fewkes (1882)	+	-	-	-
Family **Rhopalonematidae** Russel (1953)				
Aglaura hemistoma Péron and Lesueur (1810)	+	-	+	-
Arctapodema spp. Dall (1907)	-	+	-	-
Phylum **Ctenophora** Eschscholtz (1829)				
Beroe spp. Browne (1756)	+	+	-	-
Total	25	17	13	10

Scyphozoa were only found at a few stations, represented by two species: *Atolla spp.* was found at the offshore station and *Chrysaora hysoscella* was found at one of the shelf station. The inc. sed. *Tetraplatia volitans* was regularly found at the offshore station and the shelf break station.

Siphonophora were present at all stations, however, most of the individuals could only be identified at the family level. The subfamily Diphyniae and the family Agalmatidae as well as *Forskalia leuckarti* were found at all stations. The family Paryidae and *Physophora hydrostatica* were found at the offshore and shelf-break station, some individuals of *Physophora hydrostatica* were also found at the shelf station.

Hydroidomedusae were sometimes in bad conditions and could not be exactly specified (Hydroidomedusae indef.). The subclass Anthomedusae showed no clear horizontal distribution. Individuals of this group were found inshore and offshore at different stations. Within the subclass Leptomedusae not further identified species were found offshore, however, also species from three different families (Eirenidae, Aequoreidae and Campanulariidae) were found at the shelf stations. Only one species of Limnomedusae (*Proboscidactyla menoni*) was found at one shelf station. From the subclass Nacromedusae some not identified species were found at the shelf-break station, and the species *Solmundella bitentaculata* was found at three stations (offshore, shelf-break, shelf). The subclass Trachymedusae was found at the offshore, shelf-break and one of the shelf stations. Only two species were identified, *Liriope tetraphylla* and *Aglaura hemistoma*, the former at all three locations, the latter only at the offshore and shelf stations.

3.2.1. Medusa

The taxonomic composition and numbers of the species differed at the stations (Fig. 4). Highest numbers were found at the outer shelf station with 478 Ind. 1000 m^{-3}. At the shelf-break station 295 Ind. 1000 m^{-3} and at the inner shelf station 223 Ind. 1000 m^{-3} were found. Lowest numbers of species were found with 206 Ind. 1000 m^{-3} at the offshore station. The diversity decreased from offshore to inshore from 12 to 6 taxonomical groups (Fig. 4). At the offshore station the dominant taxonomical group were Trachymedusae (total 68 %) represented by *Liriope tetraphylla* (29 %) and *Aglaura hemistoma* (28 %), this shifted to more not further identified Hydroidomedusae (45 %) at the shelf-break station.

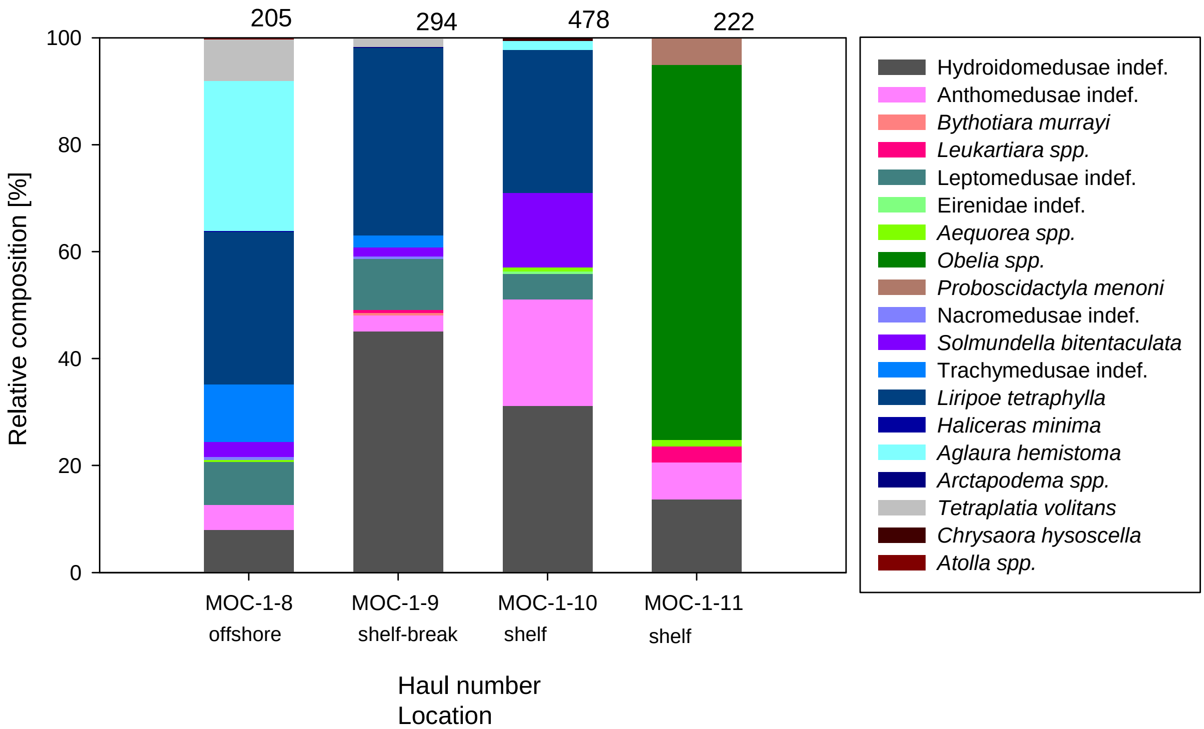

Figure 4: Relative composition of Medusa at the different stations. The numbers above the bars present the absolute number of Medusa per 1000 m³.

Trachymedusae were also found at a high proportion (37 %) at this station. At the outer shelf station (MOC-1-10) more Anthomedusae (20 %) and Nacromedusae (14 %), especially *Solmundella bitentaculata*, were found. The abundance of Trachymedusae decreased to 29 % at this station. The inner shelf station (MOC-1-11) was dominated by the Leptomedusae *Obelia spp.* (70 %). Only at this station Limnomedusae (*Proboscidactyla menoni*; 5 %) were found. Scyphozoa were found at the offshore station (*Atolla spp.*) and the outer shelf station (*Chrysaora hysoscella*), but both were of minor importance.

Hydroidomedusae indef. were found with high shares in the <0.5 mm (44 %) and the >5 mm (43 %) size classes at the offshore station (Fig. 5a). In addition Trachymedusae were abundant at this station. Their abundance increased from 25 % in the smallest size class (<0.5 mm) to 83 % in the 0.5-1 mm size class. The composition of Trachymedusae changed with size classes. In the smallest size class only *Liriope tetraphylla* was found. In the next size class (0.5-1 mm), *Aglaura hemistoma* was additionally found. This species dominated the size class 1-2 mm with 51 % and the abundance of *Liriope tetraphylla* decreased to 23 %. In the size class 2-5 mm Trachymedusae indef. made up the greatest share with 36 %. In the >5 mm size class all groups of Trachymedusae named above were found with a share of 10 %, *Haliceras minima* was found in addition with a share of 2 %. Another important species at this station was *Tetraplatia volitans* which was found in all size fractions except of the largest fraction (>5 mm) with shares between 6 and 11 %. Anthomedusae, Nacromedusae, Leptomedusae and the Scyphozoa *Atolla spp.* were also found at this station but were of minor importance.

The shelf-break station also showed a high abundance of Trachymedusae for most of the size classes. The <0.5 mm size class consisted of Trachymedusae indef. (88 %) and Hydroidomedusae indef. (12 %). In the larger size classes (0.5-1 mm, 1-2 mm, 2-5 mm) the pattern changed to a dominance of Hydroidomedusae indef. with decreasing shares from 82 % to 42 % with increasing size classes. Additionally, many Trachymedusae (mostly *Liriope tetraphylla*) were found (7- 36 %). The size class larger than 5 mm was dominated by this species with 66 %. Again Anthomedusae, Leptomedusae and Nacromedusae were of minor importance at this station.

At the outer shelf station (Fig. 5c) the importance of Anthomedusae and Nacromedusae increased. The smallest two size classes (<0.5 mm and 0.5-1 mm) consisted only of Hydroidomedusae indef. (75 % and 53 %, respectively) and Anthomedusae indef. (25 % and 47 %, respectively). Trachymedusae and Nacromedusae were additionally found in the next two size classes with proportions between 43 % and 6 %. In the >5 mm size class also Leptomedusae (28 %) and *Chrysaora hysoscella* (3 %) were found together with Anthomedusae (14 %), *Solmundella bitentaculata* (16 %) and *Liriope tetraphylla* (38 %).

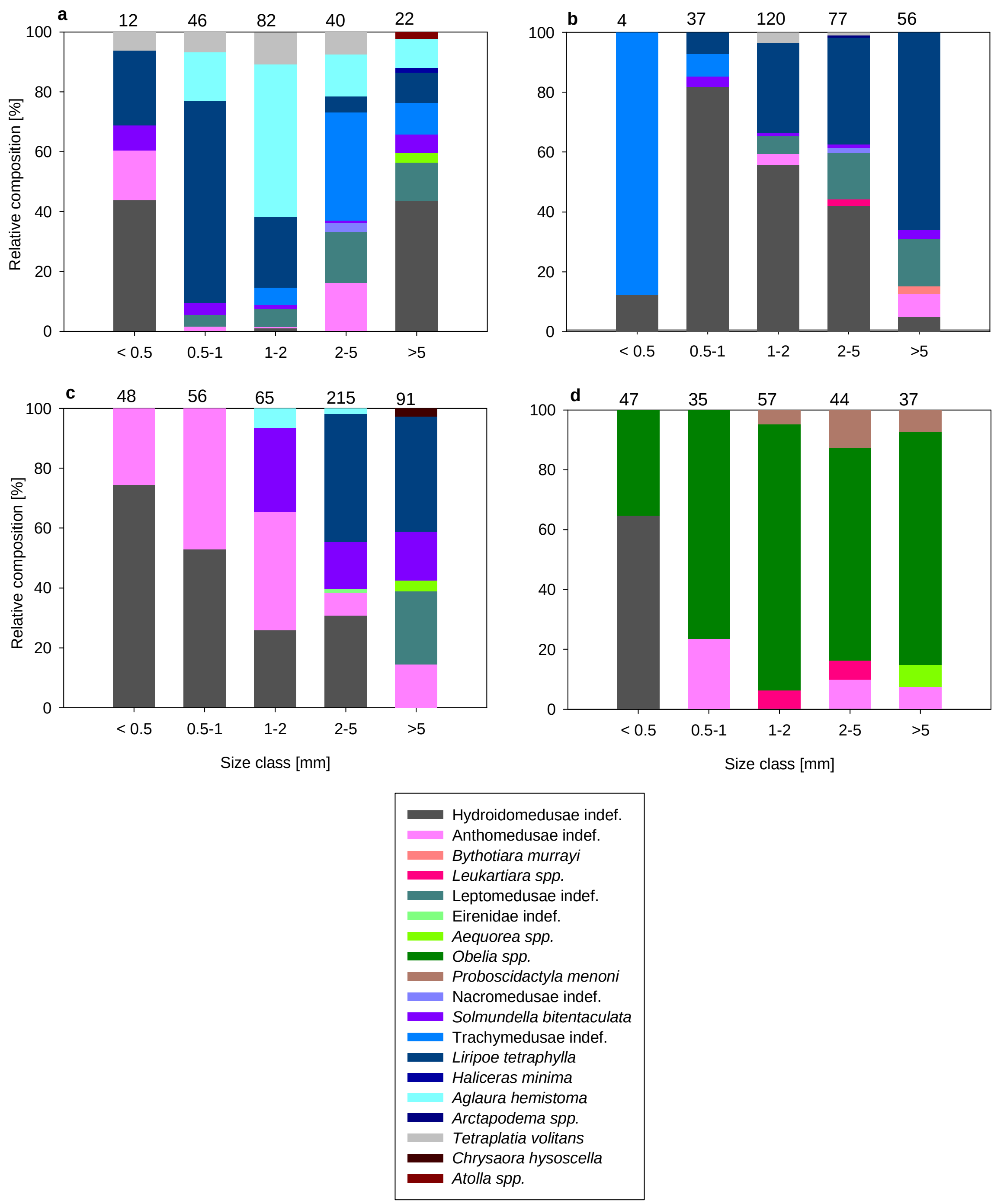

Figure 5(a-d): Relative composition of the taxonomical groups (Ind. below 1 m²) at station MOC-1-8 to MOC-1-11 (a: offshore; b: shelf-break; c: outer shelf; d: inner shelf) for different size classes. The numbers above the bars present the absolute number of Medusa per 1000 m³.

The inner shelf station (Fig. 5d) was dominated by the Leptomedusae *Obelia spp.* (70 and 90 %) in all size classes except for the <0.5 mm size class where Hydroidomedusae indef. made up 65 %. In this size class *Obelia spp.* contributed with 35 % to the Medusae. Anthomedusae were additionally found in the size classes larger than 0.5 mm, especially the species *Leukartiara spp.* A Limnomedusae (*Proboscidactyla menoni*) was found only at this station in the size classes 1-2 mm, 2-5 mm and >5 mm with shares between 5 and 13 %.

3.2.2. Siphonophora

Siphonophora had their highest abundance at the outer shelf station with 6866 parts 1000 m^{-3}. The abundance decreased further offshore to 2804 parts 1000 m^{-3} at the shelf-break station and 1611 parts 1000 m^{-3} at the offshore station. At the inner shelf station only 789 parts 1000 m^{-3} were found.

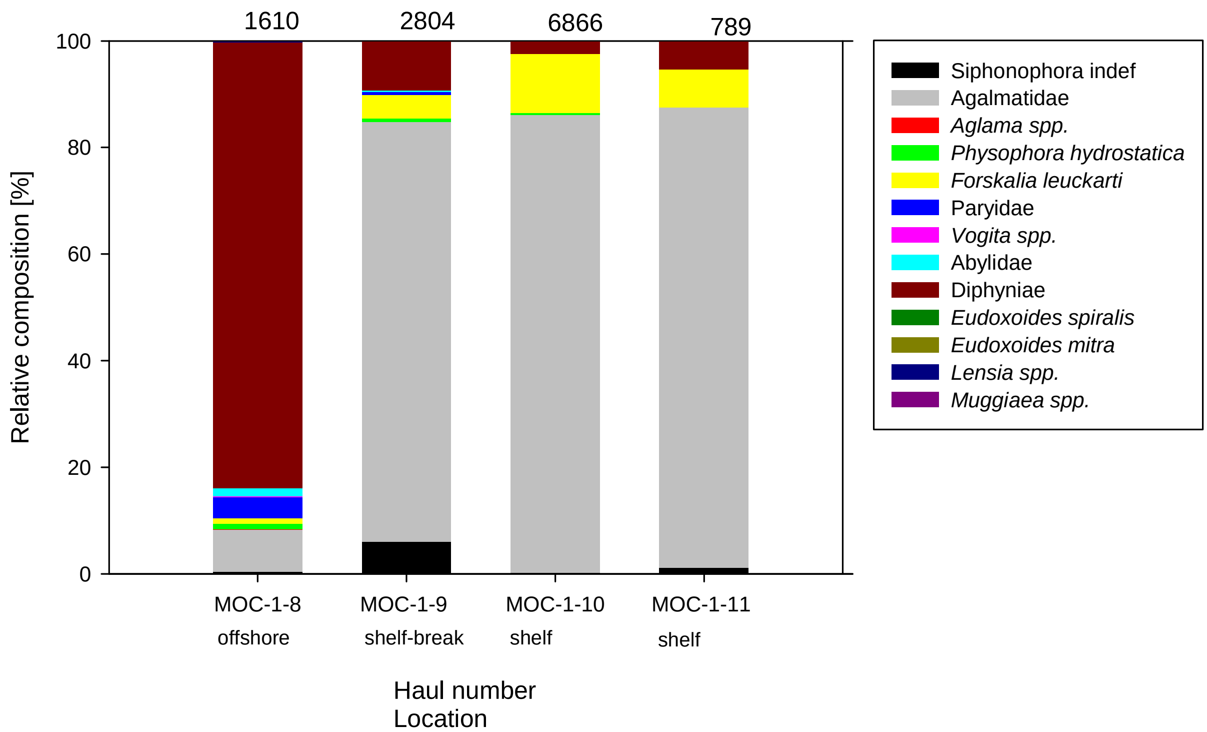

Figure 6: Composition of Siphonophora along the Walvis Bay transect. The numbers above the bars present the absolute number of parts of Siphonophora found per 1000 m³.

The offshore station was dominated by the subfamily Diphyniae (84 %). The families Agalmatidae and Paryidae contributed with 8 % and 4 %, respectively, to the standing stock. *Physophora hydrostatica*, *Forskalia leuckarti* and the family Abylidae contributed with 1 %, each, and Siphonophora indef., *Aglama spp.*, *Vogita spp.*, *Eudoxoides mitra, Lensia spp.* and *Muggiaea spp.* were found in lower amounts (<1 %). At the shelf-break station, the pattern has changed and the family Agalmatidae had the greatest share with 79 %. Diphyniae contributed with 9 %, Siphonophora indef. with 6 % and *Forskalia leuckarti* with 4 %. *Physophora hydrostatica* and the family Paryidae both contributed with 1 %. The family Abylidae was seldom found (<1 %). At both shelf stations Agalmatidae (86 %) were the most abundant taxonomical group. All other groups were of minor importance.

The relative importance of Diphyniae decreased from 97 % in the <0.5 mm size fraction to 72 % in the >5 mm size fraction (Fig. 7a) at the offshore station. All other groups were of minor importance; however, the diversity increased with increasing size fraction. Agalmatidae dominated all size groups at the shelf-break and at both shelf stations (Fig. 7b-d), but their importance decreased with increasing size from 91 % to 57 % at the shelf-break station. In the larger fractions also Siphonophora indef., Diphyniae, *Forskalia leuckarti*, Paryidae and Abylidae were found, but neither group contributed more than 20 % to the standing stock. On the shelf (Fig. 7 c,d), all other groups were numerically not important, except for the 2-5 mm size fraction at the outer shelf station where *Forskalia leuckarti* contributed with 12 %.

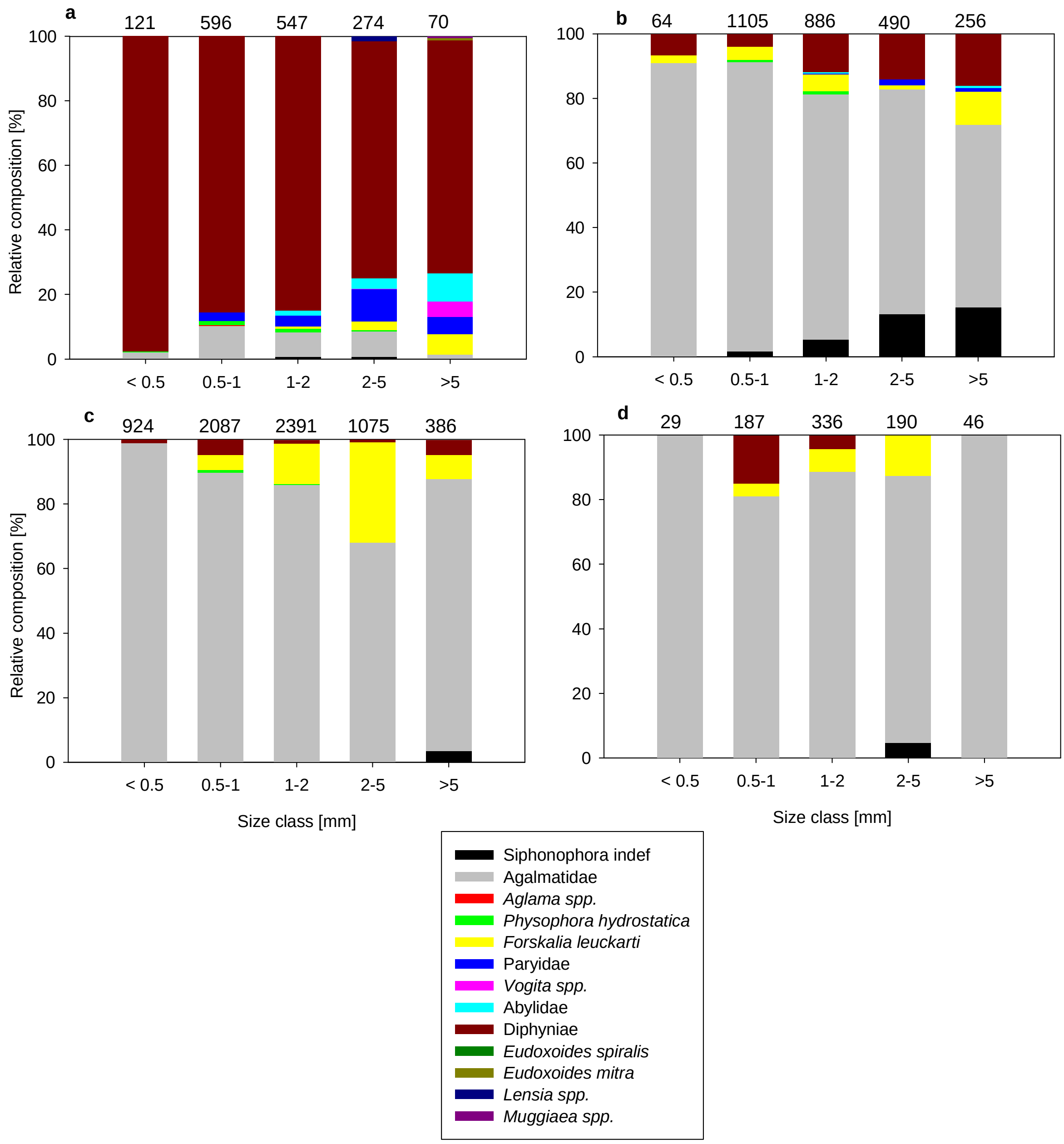

Figure 7(a-d): Composition of Siphonophora (parts below 1 m²) at stations MOC-1-8 to MOC-1-11 (a: offshore; b: shelf-break; c: outer shelf; d: inner shelf) for different size classes. The numbers above the bars present the absolute number of parts of Siphonophora per 1000 m³.

3.2.3. Other gelatinous and half-gelatinous zooplankton

This artificial group is composed of Ctenophora (only *Beroe spp.*), Chaetognatha, Salpidae, Tunicata, Pteropoda and Appendicularia. The number of species was lowest at the offshore station with 5185 Ind. per 1000 m³. Highest numbers were detected at the shelf-break station with 48447 Ind. per 1000 m³. The number of species decreased from the shelf-break station towards the coast to 14888 Ind. per 1000 m³ at the inner shelf station.

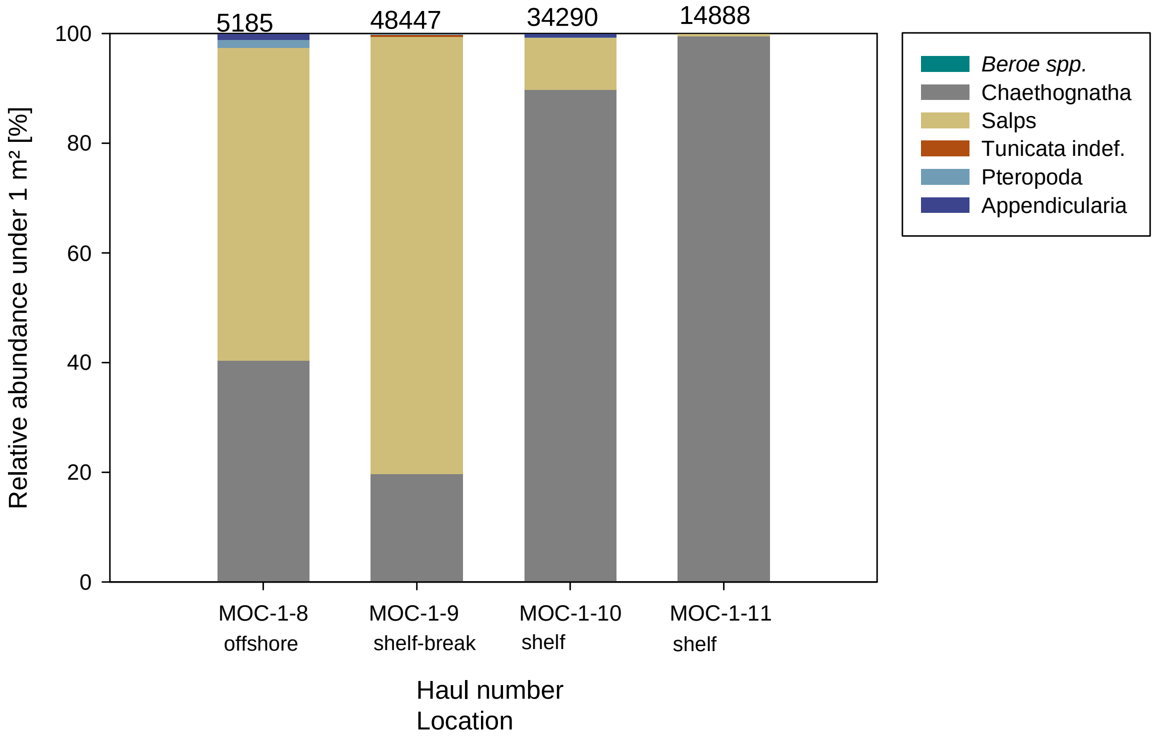

Figure 8: Relative composition of the different gelatinous and half-gelatinous taxa in the different stations. The numbers above the bars present the absolute number of Individuals per 1000 m³.

The offshore and shelf-break stations were dominated by Salpidae (56 % and 80 %). At the offshore stations the importance of Salpidae decreased from the smallest size class (<0.5 mm) to the biggest size class (>5 mm) from 99 % to 14 %. Therefore the importance of Chaetognatha increased from 1 % to 85 %. At the shelf-break station the importance of Salpidae increased with size class from 8 % to 86 % at the size class 2-5 mm, at the size class >5 mm their importance decreased slightly to

74 %. Again Chaetognatha showed an opposite behaviour. Their importance decreased from 86 % to 13 %. Both shelf stations were dominated by Chaetognatha (90 % and 99 %), whereas at the outer shelf station Salpidae and Appendicularia (in the <0.5 mm size class) were also found in higher amounts, at the inner shelf station almost only Chaetognatha were found.

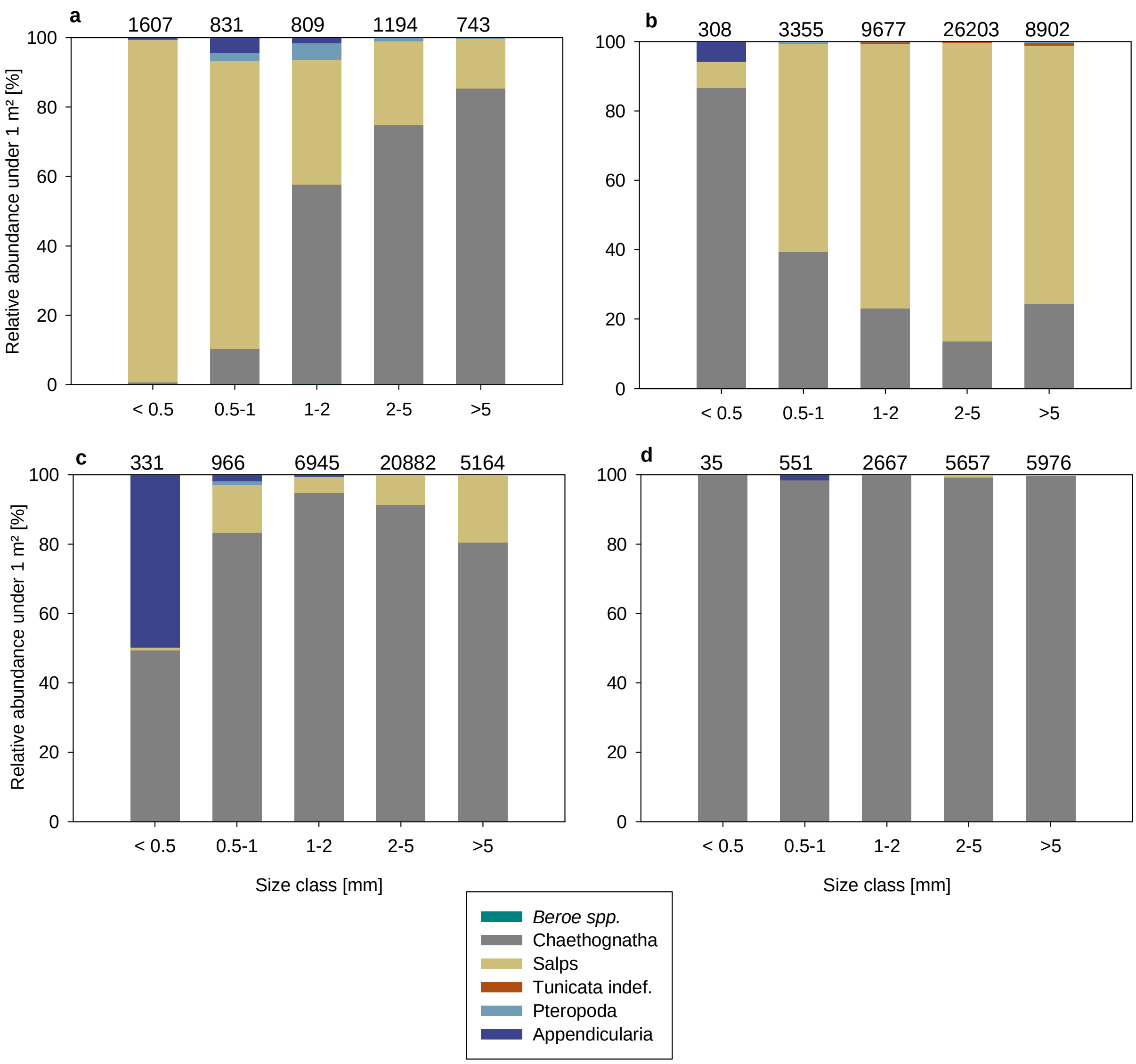

Figure 9(a-d): Relative composition of the different gelatinous and half-gelatinous taxa (Ind. below 1 m^2) at station MOC-1-8 to MOC-1-11 (a: offshore; b: shelf-break; c: outer shelf; d: inner shelf) for different size classes. The numbers above the bars present the absolute number of individuals per 1000 m^3.

3.3. *Stable Isotopes*

Stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotopes of gelatinous and half-gelatinous zooplankton were analysed (Fig. 10). The stable carbon isotope values ranged from -21 ‰ in Salpidae to -13.7 ‰ in Leptomedusae. Stable nitrogen isotope values ranged from 2 ‰ in Pteropoda to 14.5 ‰ in Leptomedusae. $\delta^{15}N$ mean value of Chaetognatha were highest (12.3 ‰ ±0.8 ‰) on the shelf. Only one offshore and one shelf-break samples were available; these values were lower in $\delta^{15}N$ than the shelf samples (10.8 ‰ and 11.0 ‰, respectively). The mean value of Medusae decreased from 11 ‰ (±1.4 ‰) at the shelf stations to 8.6 ‰ (±0.7 ‰) at the shelf-break station. Salpidae had their highest mean value at the shelf-break station with 7.4 ‰. The lowest value of Salpidae was measured at the offshore station with 5.9 ‰ (±1.2 ‰). A Kruskal-Wallis-Test showed a significant difference between these three groups (χ^2=18.720; df= 2; $p < 0.001$). An a-posteriori Mann-Whitney-U-Test showed that these differences were significant between Chaetognatha and Salpidae (U=0.0; $p < 0.005$) as well as between Medusae and Salpidae (U=0.0; $p < 0.001$). No significant differences were detected between Medusae and Chaetognatha (Tab.4). Overall, the $\delta^{15}N$ values decreased from Chaetognatha to Medusae to Salpidae to Pteropoda. Significant differences exist between the three locations (shelf, shelf-break and offshore) for Medusae (Kruskal-Wallis-Test; χ^2=13.564; df= 2; $p < 0.05$). A Mann-Whitney-U-Test showed a significant difference between the shelf and the shelf-break samples (U=13.0; $p < 0.001$). No significant differences were found for the other two combinations (shelf – offshore and shelf break – offshore). Sample size was not sufficient to make statistical analyses for Salpidae, Chaetognatha and Pteropoda.

The C:N ratio was calculated from the carbon and nitrogen concentration. The highest C:N ratio was found for Pteropoda (8.6), Salpidae ranked next (8.3 ±0.4), followed by Chaetognatha (6.1 ±0.1) and Medusae (5.3 ±0.2). All values were close to the Redfield ratio of 6.6.

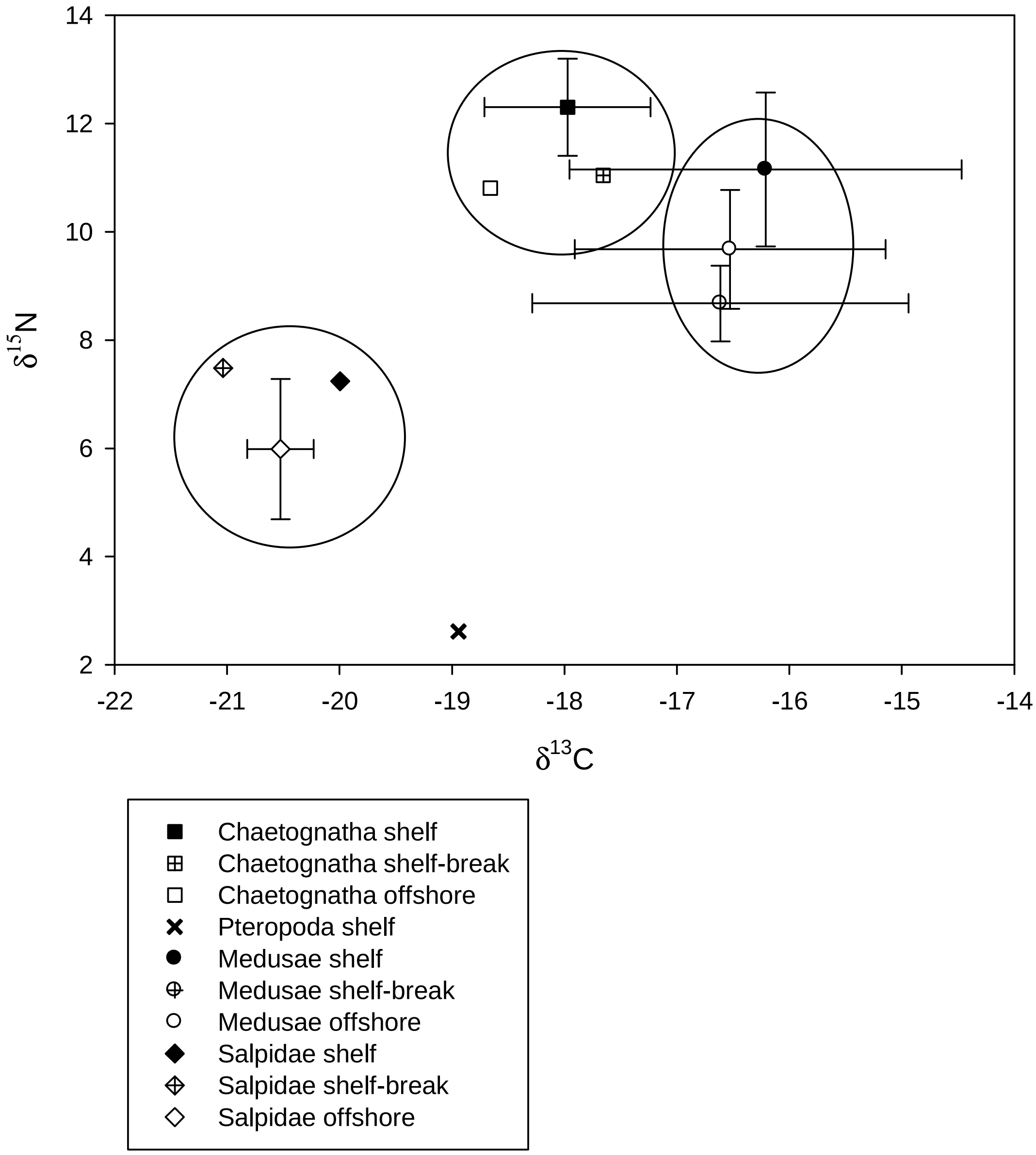

Figure 10: Relationship between stable nitrogen ($\delta^{15}N$) and stable carbon ($\delta^{13}C$) isotopic signatures of different taxonomical groups (circled) in the northern Benguela upwelling system. If only one individual was measured, single symbols are used. Standard deviations are shown by the lines, single symbols reflect single measurements.

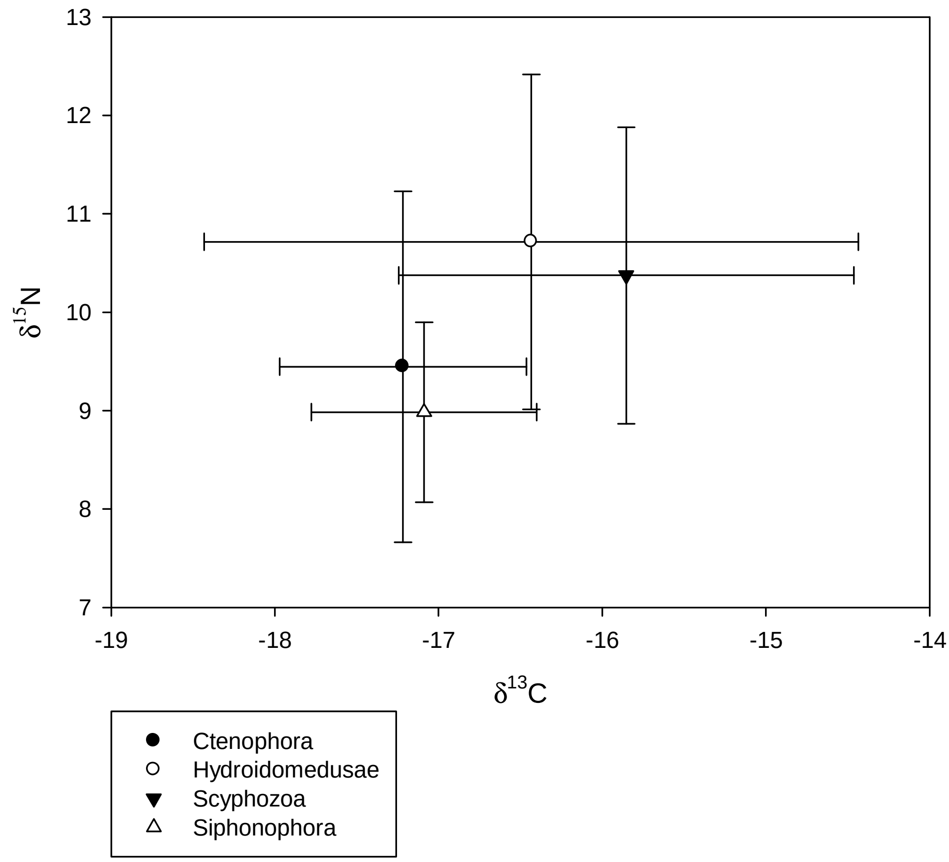

Figure 11: Relationship between stable nitrogen ($\delta^{15}N$) and stable carbon ($\delta^{13}C$) isotopic signatures of different taxonomical groups of Medusae. Mean value and standard deviation are shown.

All stations were pooled and different taxonomical groups of Coelenterata (Ctenophora, Hydroidomedusae, Scyphozoa and Siphonophora) are presented (Fig. 11). The different taxonomical groups within the Medusae also showed high deviation in their stable isotope signature. The highest mean $\delta^{15}N$ value was measured for the Hydroidomedusae with 10.7 ‰ (±1.7); the lowest $\delta^{15}N$ value was measured in Siphonophora with 8.9 ‰ (±0.9). No significant differences (Kruskal-Wallis-Test) in the stable nitrogen isotope signature between these taxonomical groups were detected (Tab. 4).

Table 4: Statistical results for stable nitrogen isotopes. Results from Kruskal-Wallis-Tests were given as χ^2 values, results from Mann-Whitney-U-Tests as U values. Not significant results were marked as n.s.

Category	Significance
Taxonomical groups	χ^2=18.720; df= 2; p <0.001
Chaetognatha - Medusae	n.s.
Chaetognatha - Salpidae	U=0.0; p <0.005
Medusae - Salpidae	U=0.0; p <0.001
Medusae location	χ^2=13.564; df= 2; p <0.05
Shelf - shelf break	U=13.0; p <0.001
Shelf - offshore	n.s.
Shelf break - offshore	n.s.
Medusae taxonomical	n.s.

4. Discussion

Abundance of gelatinous and half gelatinous organisms increased during the last decades in the northern Benguela Current System. The aim of this study was to investigate the distribution and trophic position of these gelatinous and half-gelatinous Organisms. Analysing gelatinous zooplankton with net samples is difficult due to the loss of material through meshes or large gelatinous organisms, mainly Cnidarians, may clog the nets during the sampling period. But the biggest problem is that most of the taxonomical characteristics were destroyed by rinsing and sieving the samples which hampers the identification to species level. Nevertheless, the analyses of gelatinous organisms with net samples will provide very interesting results. Such analyses were also successfully done by other authors (e.g. Pagès and Gili 1991, Pagès 1992, Buecher and Gibbons 2003 and Gibbons and Buecher 2001).

Pagès (1992) found a distribution similar to this study of Medusae in the Benguela Current System during a cruise in December 1981 using a Bongo net 57 cm in mouth diameter fitted with 500- 300 µm mesh size. Contrary to this study, the author presented abundances over the whole area and only differentiated between the favourable habitats of the species. Like in this study, Trachymedusae were mainly found offshore. *Liriope tetraphylla* and *Aglaura hemistoma* were most abundant in both studies. Pagès (1992) defined the Limnomedusae *Proboscidactyla menoni* as shelf species and different Leptomedusae and Anthomedusae as shelf-break and shelf species. Within these groups *Clytia spp.* was the most abundant Leptomedusae on the shelf and *Mitrocomella grandis* was the most abundant shelf-break species (Pagès, 1992). In this study, the most abundant Leptomedusae species was *Obelia spp.* and the Scyphozoa *Chrysaora hysoscella* was of minor importance (Tab. 5). Pagès (1992) found a very high abundance of the latter species but included data of the Sea Fisheries Research Institute in Cape Town to the abundance data of this species as well as for the Leptomedusae *Aequorea aequorea*. The samples were collected using large trawl nets, which catch high amounts of large jellyfish.

Table 5: Mean abundance (Ind. $1000m^{-3}$) for Medusae and Siphonophora collected during December 1981 (Pagès 1992), March 2008 (Jung 2010) and December 2009 (this study) in the northern Benguela Current Region (0-100m).

	This study Dec. 2009 0-100 m			
Taxon	offshore	shelf-break	outer shelf	inner shelf
Siphonophorae indef.	51,52	416,58	8,83	11,70
Agalmatidae	2238,49	3321,95	6705,87	849,74
Physophora hydrostatica	232,32	31,33	15,45	0,00
Forskalia leuckarti	68,03	142,37	952,26	74,30
Paryidae	110,79	0,00	0,00	0,00
Abylidae	920,20	10,75	0,00	0,00
Diphyidae	8961,78	120,88	158,83	34,17
Muggiaea spp.	1,70	0,00	0,00	0,00
Hydroidomedusae indef.	13,61	110,95	150,26	34,86
Anthomedusae indef.	9,09	35,56	84,96	13,34
Leukartiara spp.	0,00	0,00	0,00	6,77
Leptomedusae indef.	72,78	29,57	16,72	0,00
Eirenidae indef.	0,00	0,00	3,47	0,00
Aequorea spp.	0,00	0,00	2,21	1,87
Obelia spp.	0,00	0,00	0,00	195,43
Proboscidactyla menoni	0,00	0,00	0,00	7,49
Nacromedusae indef.	0,00	2,69	0,00	0,00
Solmundella bitentaculata	32,00	5,38	67,27	0,00
Trachymedusae indef.	0,00	25,28	0,00	0,00
Liriope tetraphylla	727,27	132,21	127,92	0,00
Aglaura hemistoma	480,43	0,00	11,30	0,00
Tetraplatia volitans	174,80	0,00	0,00	0,00
Chrysaora hysoscella	0,00	0,00	3,47	0,00

	Pagès 1992 Dec. 1981 0-100 m				Jung 2010 March 2008 0-100 m				
Taxon	Oceanic	Costal-shelf	Shelf	Costal	offshore	shelf-break	outer shelf	inner shelf	coastal
Siphonophorae indef.	-	-	-	-	2350,60	1471,36	1679,49	11,61	23701,32
Agalmatidae	0,48	-	-	-	-	-	-	-	-
Physophora hydrostatica	0	-	-	-	-	-	-	-	-
Forskalia leuckarti	0,36	-	-	-	-	-	-	-	-
Paryidae	0,36	-	-	-	-	-	-	-	-
Abylidae	2,4	-	-	-	-	-	-	-	-
Diphyidae	2,13	-	-	-	-	-	-	-	-
Muggiaea spp.	-	-	-	877	-	-	-	-	-
Hydroidomedusae indef.	-	-	-	-	-	-	-	-	-
Anthomedusae indef.	-	-	-	-	81,48	0,00	897,44	7,14	0,00
Leukartiara spp.	-	-	2,07	-	-	-	-	-	-
Leptomedusae indef.	-	-	-	-	20,06	0,00	251,78	80,25	844,83
Eirenidae indef.	-	-	-	-	-	-	-	-	-
Aequorea spp.	-	-	4,06	-	-	-	-	-	-
Obelia spp.	-	-	-	0	-	-	-	-	-
Proboscidactyla menoni	-	-	-	43,64	0,00	0,00	0,00	0,00	154,26
Nacromedusae indef.	-	-	-	-	0,00	5,19	0,00	0,00	0,00
Solmundella bitentaculata	0	-	-	-	-	-	-	-	-
Trachymedusae indef.	-	-	-	-	2703,41	40,29	0,00	3,57	0,00
Liriope tetraphylla	8,68	-	-	-	-	-	-	-	-
Aglaura hemistoma	0,56	-	-	-	-	-	-	-	-
Tetraplatia volitans	0	-	-	-	-	-	-	-	-
Chrysaora hysoscella	-	59,43	-	-	7,41	0,00	0,00	0,00	28,74

The distribution of Siphonophora presented by Pagès (1992) was also different to the distribution found in this study. The author stated that the Diphyniae *Muggegia atlantica* was the most abundant species with 877 Individuals per 1000 m³ in the upper 100 m. All other species presented by Pagès

(1992) were at lower values between 2.38 to 0.02 Individuals per 1000 m³. In this study, three of four stations were dominated by Agalmatidae and only the offshore station was dominated by Diphyniae. In an undergraduate study Jung (2010) found a clearer inshore/offshore gradient in the number of Medusae species with lower abundances in offshore waters in March 2008, but the taxonomical composition was similar.. The distribution and taxonomical composition of Siphonophora, however, was different to this study. Jung (2010) found a higher abundance of Diphyniae and a lower abundance of Agalmatidae (Tab. 5).

A Salpidae bloom could be detected in the investigated area. It mainly occurred at the offshore and shelf-break station, whereas the size spectrum changed from smaller individuals at the offshore station to larger individuals at the shelf-break station. Salpidae are efficient filterers of phytoplankton (Deibel 1982) thus holding the standing stock of phytoplankton and hence other zooplankton down by maintaining a high primary production (Berner 1957, 1967 as quoted by Silver and Bruland 1981). Such blooms often cause a huge amount of large faecal pallets which are important in the vertical transfer of particulate matter (e.g. Wiebe et al. 1987, Iseki 1981, Silver and Bruland 1981, Madin 1982). Chaetognatha had their highest absolute abundance at the outer shelf station. This is hardly surprising considering the neritic nature of the most abundant species (*Sagitta fredrici*) in the Benguela Current System (Pierrot-Bults and Nair 1991, Gibbons 1994).

As stated in the hypothesis, I expected to find more and larger Cnidarians with less taxonomical diversity inshore, in the centre of the upwelling region, than in the oceanic offshore region. The taxonomical diversity was increasing from inshore to offshore but the number of species per 1000 m³ was not constantly decreasing from inshore to offshore. The highest concentration of Siphonophora and Medusae was detected at the outer shelf station. The abundance decreased from this station to the offshore station. The highest abundance of all other gelatinous and half- gelatinous organisms was detected at the shelf-break station. These differences may show patterns from the ecosystem related to upwelling filaments. However, to do these analyses more data on the structure of such filaments as well as the taxonomical composition of zooplankton within the filament are necessary. The size of the Medusae revealed no difference between the offshore and inshore stations. But visual observation during the cruise showed that many large *Chrysaora hysoscella* live in inshore waters. However, these large organisms were not quantitatively sampled by the MOCNESS. Therefore, the hypothesis can not be verified nor it can be denied due to a lack of data. More research must be done to verify the first results presented in this study.

The hypothesis that a more complex food web exists offshore than inshore could also not be accepted based on the analysis of stable nitrogen isotopes. More research on this topic should be done since it was not possible to analyse sufficient samples of Chaetognatha and Salpidae for a statistical analysis. The trophic position of the different taxonomical groups could be determined using enrichment factor of 3-5 ‰ per trophic level for $\delta^{15}N$ (Minagawa and Wada, 1984; Hobson and Welch, 1992). Unfortunately, the stable nitrogen isotope data for phytoplankton were not analysed yet, so there is no baseline available. However, the guts of the analysed Pteropoda were not removed. These guts contained a huge amount of phytoplankton and hence the value of 2 ‰ $\delta^{15}N$ can be used as a baseline. Salpidae belonged to the next trophic level with a mean value of 6 ‰, Medusae made the next trophic level with 10 ‰. Chaetognatha occupy the highest trophic level with a mean value of 11 ‰. These results can be confirmed by other studies which result in similar trophic levels of the analysed groups (Teuber 2009).The statistical analyses showed that no significant difference between Chaetognatha and Medusae exist; so they maybe belong to the same trophic position. Gut content analyses also showed that both groups manly feed on Copepoda (Purcell 2003, Sabatès et al. 2010, Raskoff 2002, Oresland 2000, Gibbons et al. 1992). Teuber (2009) found a slightly lower $\delta^{15}N$ value for Chaetognatha (8-9 ‰) but a similar value for the Medusae *Aequorea aequorea* (11- 14 ‰) in samples from March 2008. The author also concluded that Chaetognatha may mainly feed on *Calanoides carinatus* due to their stable nitrogen signature and the feeding behaviour of Chaetognatha.

Conclusion

There is no clear inshore- offshore gradient in the horizontal distribution of gelatinous zooplankton in the Benguela Current System depending on absolute numbers. But in the species distribution an inshore-offshore gradient was found. A change was found from a Trachymedusae dominated offshore system to a Leptomedusae dominated inshore system for Medusae and from a Diphyniae dominated offshore system to an Agalmatidae dominated inshore system for Siphonophora. Salpidae dominated the offshore fauna whereas Chaetognatha were more abundant inshore within the other gelatinous and half-gelatinous zooplankton.

The analyses of stable nitrogen isotopes allow an estimation of trophic positions of the different taxonomical groups. Salpidae had a lower trophic position than Chaetognatha and Medusae.

Future prospects

The results of this study could only be seen as preliminary investigations. More work especially on seasonality and stable isotopes should be undertaken, especially for Salpidae and Chaetognatha and for the different taxonomical groups within the Medusae. A better understanding of the gelatinous and half-gelatinous zooplankton in the Benguela Current System is essential for a better understanding of the ecosystem itself and for the regime shift that took place within the last decades.

5. Literature

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6. Appendix

Appendix 1: Abundance of detected species (Individuals per 1000 m³)

	MOC-1-8 N1 650-500 m					MOC-1-8 N2 500-400 m				
Volume	446	446	446	446	446	413	413	413	413	413
Depth intervall	150	150	150	150	150	100	100	100	100	100
Size class	< 0.5	0.5-1	1-2	2-5	>5	< 0.5	0.5-1	1-2	2-5	>5
Scyphozoa indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Chrysaora hysoscella	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Atolla spp.	0,0	0,0	0,0	0,0	2,2	0,0	0,0	0,0	0,0	0,0
Siphonophorae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Agalmatidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Aglama spp.	0,0	4,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Physophora hydrostatica	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Forskalia leuckarti	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Paryidae	0,0	0,0	0,0	0,0	0,0	0,0	41,2	12,1	0,0	0,0
Vogita spp.	0,0	0,0	0,0	0,0	9,0	0,0	0,0	0,0	4,8	7,3
Abylidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,4	0,0	0,0
Diphyidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Diphyniae	0,0	29,1	11,2	0,0	0,0	16,9	210,7	174,3	87,2	0,0
Eudoxoides spiralis	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Eudoxoides mitra	0,0	0,0	0,0	0,0	2,2	0,0	0,0	0,0	0,0	0,0
Lensia spp.	0,0	0,0	0,0	17,9	0,0	0,0	0,0	0,0	0,0	0,0
Muggiaea spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Hydroidomedusae indef.	6,7	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Anthomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Anthomedusae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	38,7	0,0
Bythotiara murrayi	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Leukartiara spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Leptomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Leptomedusae indef.	0,0	0,0	0,0	13,5	4,5	0,0	0,0	7,3	7,3	7,3
Eirenidae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Aequorea spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Obelia spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Limnomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactylidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactyla spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactyla menoni	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Nacromedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Nacromedusae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Solmundella bitentaculata	0,0	0,0	0,0	0,0	4,5	0,0	0,0	0,0	0,0	0,0
Trachymedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Trachymedusae indef.	0,0	0,0	0,0	58,3	6,7	0,0	0,0	0,0	0,0	4,8
Liripoe tetraphylla	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Haliceras minima	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Aglaura hemistoma	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Arctapodema spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Tetraplatia volitans	0,0	0,0	4,5	6,7	0,0	0,0	0,0	0,0	0,0	0,0
Ctenophora *Beroe spp.*	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,4	0,0	0,0
Chaethognatha	0,0	9,0	13,5	186,1	237,7	0,0	14,5	63,0	247,0	203,4
Salps	0,0	0,0	2,2	31,4	38,1	0,0	16,9	94,4	690,1	140,4
Tunicata indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Pteropoda	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Appendicularia	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

	MOC-1-8 N3 400-300 m					MOC-1-8 N4 300-200 m				
Volume	400	400	400	400	400	451	451	451	451	451
Depth intervall	100	100	100	100	100	100	100	100	100	100
Size class	< 0.5	0.5-1	1-2	2-5	>5	< 0.5	0.5-1	1-2	2-5	>5
Scyphozoa indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Chrysaora hysoscella	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Atolla spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Siphonophorae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,2	0,0
Agalmatidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Aglama spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Physophora hydrostatica	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,2	0,0	0,0
Forskalia leuckarti	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Paryidae	0,0	40,0	37,5	55,0	15,0	0,0	0,0	31,0	71,0	0,0
Vogita spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Abylidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,2	0,0
Diphyidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Diphyniae	47,5	945,0	672,5	312,5	85,0	0,0	337,0	654,1	345,9	115,3
Eudoxoides spiralis	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Eudoxoides mitra	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Lensia spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Muggiaea spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Hydroidomedusae indef.	25,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Anthomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Anthomedusae indef.	0,0	0,0	0,0	0,0	0,0	13,3	2,2	0,0	0,0	0,0
Bythotiara murrayi	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Leukartiara spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Leptomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Leptomedusae indef.	0,0	0,0	7,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Eirenidae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Aequorea spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,4
Obelia spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Limnomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactylidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactyla spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactyla menoni	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Nacromedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Nacromedusae indef.	0,0	0,0	0,0	7,5	0,0	0,0	0,0	0,0	0,0	0,0
Solmundella bitentaculata	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,2
Trachymedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Trachymedusae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	31,0	4,4	0,0
Liripoe tetraphylla	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Haliceras minima	0,0	0,0	0,0	0,0	2,5	0,0	0,0	0,0	0,0	0,0
Aglaura hemistoma	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Arctapodema spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Tetraplatia volitans	5,0	7,5	0,0	0,0	0,0	0,0	2,2	0,0	2,2	0,0
Ctenophora *Beroe spp.*	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Chaethognatha	7,5	82,5	550,0	1195,0	945,0	15,5	153,0	1259,4	2308,2	1631,9
Salps	2,5	62,5	270,0	315,0	217,5	0,0	0,0	15,5	71,0	48,8
Tunicata indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Pteropoda	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,2
Appendicularia	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

	MOC-1-8 N5 200-100 m					MOC-1-8 N6 100-50 m				
Volume	450	450	450	450	450	196	196	196	196	196
Depth intervall	100	100	100	100	100	50	50	50	50	50
Size class	< 0.5	0.5-1	1-2	2-5	>5	< 0.5	0.5-1	1-2	2-5	>5
Scyphozoa indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Chrysaora hysoscella	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Atolla spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Siphonophorae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Agalmatidae	0,0	8,9	0,0	2,2	0,0	30,6	107,1	158,2	234,7	0,0
Aglama spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Physophora hydrostatica	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Forskalia leuckarti	0,0	0,0	0,0	0,0	0,0	0,0	5,1	51,0	91,8	56,1
Paryidae	0,0	15,6	17,8	26,7	2,2	0,0	0,0	0,0	0,0	5,1
Vogita spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Abylidae	0,0	0,0	4,4	2,2	0,0	0,0	0,0	0,0	0,0	0,0
Diphyidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Diphyniae	73,3	217,8	506,7	213,3	33,3	66,3	290,8	158,2	382,7	51,0
Eudoxoides spiralis	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Eudoxoides mitra	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Lensia spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Muggiaea spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	5,1
Hydroidomedusae indef.	0,0	0,0	0,0	0,0	46,7	0,0	0,0	10,2	0,0	30,6
Anthomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Anthomedusae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Bythotiara murrayi	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Leukartiara spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Leptomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Leptomedusae indef.	0,0	0,0	0,0	4,4	0,0	0,0	5,1	10,2	0,0	0,0
Eirenidae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Aequorea spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Obelia spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Limnomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactylidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactyla spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactyla menoni	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Nacromedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Nacromedusae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Solmundella bitentaculata	0,0	0,0	0,0	2,2	0,0	0,0	5,1	0,0	0,0	0,0
Trachymedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Trachymedusae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Liripoe tetraphylla	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Haliceras minima	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Aglaura hemistoma	0,0	0,0	17,8	6,7	0,0	0,0	0,0	51,0	30,6	5,1
Arctapodema spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Tetraplatia volitans	0,0	2,2	15,6	2,2	0,0	0,0	0,0	15,3	0,0	0,0
Ctenophora *Beroe spp.*	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	5,1	0,0
Chaethognatha	44,4	82,2	422,2	946,7	388,9	10,2	20,4	61,2	403,1	362,2
Salps	11,1	4,4	11,1	57,8	37,8	71,4	10,2	10,2	132,7	45,9
Tunicata indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Pteropoda	2,2	24,4	137,8	31,1	4,4	0,0	15,3	96,9	30,6	15,3
Appendicularia	0,0	0,0	0,0	0,0	0,0	0,0	0,0	10,2	0,0	0,0

	MOC-1-8 N7 50-25 m					MOC-1-8 N8 25-22 m				
Volume	110	110	110	110	110	15	15	15	15	15
Depth intervall	25	25	25	25	25	3	3	3	3	3
Size class	< 0.5	0.5-1	1-2	2-5	>5	< 0.5	0.5-1	1-2	2-5	>5
Scyphozoa indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Chrysaora hysoscella	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Atolla spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Siphonophorae indef.	0,0	0,0	109,1	45,5	0,0	0,0	0,0	0,0	0,0	0,0
Agalmatidae	0,0	900,0	581,8	36,4	0,0	0,0	3266,7	1066,7	133,3	200,0
Aglama spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Physophora hydrostatica	9,1	163,6	154,5	36,4	0,0	0,0	333,3	0,0	0,0	0,0
Forskalia leuckarti	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Paryidae	0,0	0,0	63,6	63,6	0,0	0,0	0,0	0,0	66,7	133,3
Vogita spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Abylidae	0,0	0,0	118,2	72,7	36,4	0,0	0,0	466,7	1066,7	1000,0
Diphyidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Diphyniae	1927,3	4336,4	2863,6	363,6	45,5	3066,7	7400,0	3466,7	866,7	1600,0
Eudoxoides spiralis	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Eudoxoides mitra	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Lensia spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Muggiaea spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Hydroidomedusae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Anthomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Anthomedusae indef.	0,0	9,1	9,1	9,1	0,0	0,0	0,0	0,0	0,0	0,0
Bythotiara murrayi	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Leukartiara spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Leptomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Leptomedusae indef.	0,0	36,4	45,5	45,5	9,1	0,0	0,0	0,0	0,0	66,7
Eirenidae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Aequorea spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Obelia spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Limnomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactylidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactyla spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactyla menoni	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Nacromedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Nacromedusae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Solmundella bitentaculata	27,3	36,4	27,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Trachymedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Trachymedusae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Liripoe tetraphylla	63,6	772,7	481,8	54,5	9,1	133,3	200,0	66,7	0,0	400,0
Haliceras minima	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Aglaura hemistoma	0,0	190,9	872,7	54,5	36,4	0,0	0,0	133,3	0,0	66,7
Arctapodema spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Tetraplatia volitans	0,0	9,1	81,8	18,2	0,0	0,0	200,0	200,0	0,0	0,0
Ctenophora *Beroe spp.*	0,0	0,0	36,4	9,1	0,0	0,0	0,0	0,0	0,0	0,0
Chaethognatha	0,0	545,5	1790,9	1372,7	536,4	0,0	1466,7	4266,7	2666,7	4800,0
Salps	39090,9	16727,3	5481,8	2190,9	436,4	4533,3	2133,3	1933,3	600,0	1066,7
Tunicata indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Pteropoda	9,1	327,3	236,4	90,9	0,0	0,0	66,7	0,0	133,3	66,7
Appendicularia	236,4	872,7	290,9	27,3	0,0	0,0	533,3	0,0	0,0	0,0

	MOC-1-9 N1 300-200 m					MOC-1-9 N2 200-100 m				
Volume	406	406	406	406	406	665	665	665	665	665
Depth intervall	100	100	100	100	100	100	100	100	100	100
Size class	< 0.5	0.5-1	1-2	2-5	>5	< 0.5	0.5-1	1-2	2-5	>5
Scyphozoa indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Chrysaora hysoscella	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Atolla spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Siphonophorae indef.	0,0	0,0	0,0	17,2	0,0	0,0	0,0	22,6	39,1	52,6
Agalmatidae	0,0	64,0	108,4	4,9	4,9	18,0	894,7	1097,7	401,5	210,5
Aglama spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Physophora hydrostatica	0,0	0,0	0,0	0,0	0,0	0,0	0,0	6,0	0,0	0,0
Forskalia leuckarti	0,0	0,0	59,1	17,2	0,0	4,5	12,0	0,0	0,0	79,7
Paryidae	0,0	0,0	0,0	27,1	0,0	0,0	0,0	7,5	0,0	7,5
Vogita spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Abylidae	0,0	0,0	0,0	0,0	2,5	0,0	0,0	0,0	0,0	0,0
Diphyidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Diphyniae	9,9	27,1	22,2	7,4	0,0	3,0	63,2	276,7	171,4	99,2
Eudoxoides spiralis	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Eudoxoides mitra	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Lensia spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Muggiaea spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Hydroidomedusae indef.	0,0	56,7	192,1	36,9	0,0	1,5	0,0	4,5	19,5	0,0
Anthomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Anthomedusae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Bythotiara murrayi	0,0	0,0	0,0	0,0	2,5	0,0	0,0	0,0	0,0	1,5
Leukartiara spp.	0,0	0,0	0,0	4,9	0,0	0,0	0,0	0,0	0,0	0,0
Leptomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Leptomedusae indef.	0,0	0,0	0,0	19,7	9,9	0,0	0,0	1,5	0,0	9,0
Eirenidae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Aequorea spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Obelia spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Limnomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactylidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactyla spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactyla menoni	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Nacromedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Nacromedusae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Solmundella bitentaculata	0,0	0,0	0,0	2,5	4,9	0,0	0,0	0,0	0,0	0,0
Trachymedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Trachymedusae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Liripoe tetraphylla	0,0	0,0	0,0	0,0	0,0	0,0	1,5	18,0	46,6	99,2
Haliceras minima	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Aglaura hemistoma	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Arctapodema spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,5	0,0
Tetraplatia volitans	0,0	0,0	12,3	2,5	0,0	0,0	0,0	0,0	0,0	0,0
Ctenophora *Beroe spp.*	0,0	0,0	2,5	4,9	4,9	0,0	0,0	0,0	0,0	1,5
Chaethognatha	29,6	170,0	2226,6	2133,0	352,2	72,2	392,5	742,9	822,6	1705,3
Salps	0,0	12,3	66,5	93,6	4,9	0,0	4,5	162,4	258,6	192,5
Tunicata indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Pteropoda	0,0	0,0	0,0	0,0	0,0	0,0	3,0	15,0	15,0	10,5
Appendicularia	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,5

	MOC-1-9 N3 100-50 m					MOC-1-9 N4 50-25 m				
Volume	124	124	124	124	124	61	61	61	61	61
Depth intervall	50	50	50	50	50	25	25	25	25	25
Size class	< 0.5	0.5-1	1-2	2-5	>5	< 0.5	0.5-1	1-2	2-5	>5
Scyphozoa indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Chrysaora hysoscella	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Atolla spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Siphonophorae indef.	0,0	0,0	88,7	96,8	80,6	0,0	229,5	295,1	360,7	98,4
Agalmatidae	225,8	3032,3	1233,9	483,9	346,8	98,4	1655,7	737,7	229,5	82,0
Aglama spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Physophora hydrostatica	0,0	40,3	40,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Forskalia leuckarti	0,0	225,8	161,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Paryidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Vogita spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Abylidae	0,0	0,0	24,2	0,0	8,1	0,0	0,0	0,0	0,0	0,0
Diphyidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Diphyniae	0,0	24,2	16,1	8,1	24,2	0,0	49,2	0,0	98,4	49,2
Eudoxoides spiralis	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Eudoxoides mitra	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Lensia spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Muggiaea spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Hydroidomedusae indef.	0,0	8,1	8,1	0,0	0,0	0,0	0,0	0,0	163,9	32,8
Anthomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Anthomedusae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Bythotiara murrayi	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Leukartiara spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Leptomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Leptomedusae indef.	0,0	0,0	40,3	32,3	16,1	0,0	0,0	0,0	0,0	0,0
Eirenidae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Aequorea spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Obelia spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Limnomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactylidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactyla spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactyla menoni	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Nacromedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Nacromedusae indef.	0,0	0,0	0,0	8,1	0,0	0,0	0,0	0,0	0,0	0,0
Solmundella bitentaculata	0,0	8,1	8,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Trachymedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Trachymedusae indef.	0,0	0,0	0,0	0,0	0,0	16,4	32,8	0,0	0,0	0,0
Liripoe tetraphylla	0,0	0,0	88,7	72,6	24,2	0,0	0,0	131,1	0,0	0,0
Haliceras minima	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Aglaura hemistoma	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Arctapodema spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Tetraplatia volitans	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Ctenophora *Beroe spp.*	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Chaethognatha	88,7	879,0	1629,0	1290,3	1508,1	983,6	5721,3	8836,1	14918,0	8442,6
Salps	8,1	2258,1	6548,4	3096,8	1927,4	65,6	2163,9	24590,2	26983,6	6491,8
Tunicata indef.	0,0	0,0	0,0	0,0	16,1	0,0	0,0	245,9	196,7	196,7
Pteropoda	0,0	48,4	64,5	32,3	72,6	0,0	49,2	49,2	163,9	196,7
Appendicularia	8,1	0,0	8,1	0,0	0,0	65,6	49,2	0,0	0,0	0,0

	MOC-1-9 N5 25-0 m				
Volume	75	75	75	75	75
Depth intervall	25	25	25	25	25
Size class	< 0.5	0.5-1	1-2	2-5	>5
Scyphozoa indef.	0,0	0,0	0,0	0,0	0,0
Chrysaora hysoscella	0,0	0,0	0,0	0,0	0,0
Atolla spp.	0,0	0,0	0,0	0,0	0,0
Siphonophorae indef.	0,0	0,0	0,0	0,0	0,0
Agalmatidae	80,0	320,0	53,3	1280,0	106,7
Aglama spp.	0,0	0,0	0,0	0,0	0,0
Physophora hydrostatica	0,0	13,3	0,0	0,0	0,0
Forskalia leuckarti	0,0	40,0	0,0	0,0	0,0
Paryidae	0,0	0,0	0,0	0,0	0,0
Vogita spp.	0,0	0,0	0,0	0,0	0,0
Abylidae	0,0	0,0	0,0	0,0	0,0
Diphyidae	0,0	0,0	0,0	0,0	0,0
Diphyniae	0,0	66,7	26,7	0,0	0,0
Eudoxoides spiralis	0,0	0,0	0,0	0,0	0,0
Eudoxoides mitra	0,0	0,0	0,0	0,0	0,0
Lensia spp.	0,0	0,0	0,0	0,0	0,0
Muggiaea spp.	0,0	0,0	0,0	0,0	0,0
Hydroidomedusae indef.	0,0	120,0	0,0	0,0	0,0
Anthomedusae	0,0	0,0	0,0	0,0	0,0
Anthomedusae indef.	0,0	0,0	53,3	0,0	53,3
Bythotiara murrayi	0,0	0,0	0,0	0,0	0,0
Leukartiara spp.	0,0	0,0	0,0	0,0	0,0
Leptomedusae	0,0	0,0	0,0	0,0	0,0
Leptomedusae indef.	0,0	0,0	0,0	0,0	0,0
Eirenidae indef.	0,0	0,0	0,0	0,0	0,0
Aequorea spp.	0,0	0,0	0,0	0,0	0,0
Obelia spp.	0,0	0,0	0,0	0,0	0,0
Limnomedusae	0,0	0,0	0,0	0,0	0,0
Proboscidactylidae	0,0	0,0	0,0	0,0	0,0
Proboscidactyla spp.	0,0	0,0	0,0	0,0	0,0
Proboscidactyla menoni	0,0	0,0	0,0	0,0	0,0
Nacromedusae	0,0	0,0	0,0	0,0	0,0
Nacromedusae indef.	0,0	0,0	0,0	0,0	0,0
Solmundella bitentaculata	0,0	0,0	0,0	0,0	0,0
Trachymedusae	0,0	0,0	0,0	0,0	0,0
Trachymedusae indef.	26,7	0,0	0,0	0,0	0,0
Liripoe tetraphylla	0,0	26,7	53,3	0,0	0,0
Haliceras minima	0,0	0,0	0,0	0,0	0,0
Aglaura hemistoma	0,0	0,0	0,0	0,0	0,0
Arctapodema spp.	0,0	0,0	0,0	0,0	0,0
Tetraplatia volitans	0,0	0,0	0,0	0,0	0,0
Ctenophora *Beroe spp.*	0,0	0,0	53,3	0,0	0,0
Chaethognatha	1640,0	6106,7	2666,7	13440,0	6240,0
Salps	200,0	17453,3	49920,0	235946,7	68373,3
Tunicata indef.	0,0	26,7	400,0	640,0	640,0
Pteropoda	0,0	0,0	0,0	0,0	106,7
Appendicularia	133,3	0,0	0,0	0,0	0,0

	MOC-1-10 N1 100-50 m					MOC-1-10 N2 50-25 m				
Volume	151	151	151	151	151	59	59	59	59	59
Depth intervall	50	50	50	50	50	25	25	25	25	25
Size class	< 0.5	0.5-1	1-2	2-5	>5	< 0.5	0.5-1	1-2	2-5	>5
Scyphozoa indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Chrysaora hysoscella	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Atolla spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Siphonophorae indef.	0,0	0,0	0,0	0,0	26,5	0,0	0,0	0,0	0,0	0,0
Agalmatidae	410,6	1099,3	1337,7	483,4	152,3	2406,8	3423,7	4491,5	1813,6	915,3
Aglama spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Physophora hydrostatica	0,0	33,1	13,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Forskalia leuckarti	0,0	39,7	99,3	33,1	6,6	0,0	305,1	1000,0	1271,2	101,7
Paryidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Vogita spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Abylidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Diphyidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Diphyniae	13,2	99,3	53,0	19,9	19,9	16,9	203,4	16,9	0,0	33,9
Eudoxoides spiralis	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Eudoxoides mitra	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Lensia spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Muggiaea spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Hydroidomedusae indef.	72,8	0,0	0,0	72,8	0,0	0,0	118,6	67,8	118,6	0,0
Anthomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Anthomedusae indef.	19,9	53,0	26,5	0,0	26,5	0,0	0,0	50,8	67,8	0,0
Bythotiara murrayi	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Leukartiara spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Leptomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Leptomedusae indef.	0,0	0,0	0,0	0,0	39,7	0,0	0,0	0,0	0,0	0,0
Eirenidae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Aequorea spp.	0,0	0,0	0,0	0,0	6,6	0,0	0,0	0,0	0,0	0,0
Obelia spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Limnomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactylidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactyla spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactyla menoni	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Nacromedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Nacromedusae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Solmundella bitentaculata	0,0	0,0	19,9	33,1	13,2	0,0	0,0	33,9	67,8	33,9
Trachymedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Trachymedusae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Liripoe tetraphylla	0,0	0,0	0,0	79,5	46,4	0,0	0,0	0,0	84,7	16,9
Haliceras minima	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Aglaura hemistoma	0,0	0,0	0,0	0,0	0,0	0,0	0,0	16,9	16,9	0,0
Arctapodema spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Tetraplatia volitans	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Ctenophora *Beroe spp.*	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Chaethognatha	165,6	741,7	2172,2	6556,3	3470,2	84,7	644,1	15254,2	52983,1	7203,4
Salps	0,0	13,2	6,6	39,7	26,5	0,0	67,8	135,6	627,1	186,4
Tunicata indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Pteropoda	0,0	0,0	0,0	26,5	0,0	0,0	33,9	50,8	16,9	0,0
Appendicularia	258,3	0,0	39,7	0,0	6,6	50,8	67,8	50,8	33,9	0,0

	MOC-1-10 N3 25-0 m				
Volume	96	96	96	96	96
Depth intervall	25	25	25	25	25
Size class	< 0.5	0.5-1	1-2	2-5	>5
Scyphozoa indef.	0,0	0,0	0,0	0,0	0,0
Chrysaora hysoscella	0,0	0,0	0,0	0,0	10,4
Atolla spp.	0,0	0,0	0,0	0,0	0,0
Siphonophorae indef.	0,0	0,0	0,0	0,0	0,0
Agalmatidae	427,1	1875,0	1052,1	145,8	83,3
Aglama spp.	0,0	0,0	0,0	0,0	0,0
Physophora hydrostatica	0,0	0,0	0,0	0,0	0,0
Forskalia leuckarti	0,0	0,0	0,0	0,0	0,0
Paryidae	0,0	0,0	0,0	0,0	0,0
Vogita spp.	0,0	0,0	0,0	0,0	0,0
Abylidae	0,0	0,0	0,0	0,0	0,0
Diphyidae	0,0	0,0	0,0	0,0	0,0
Diphyniae	0,0	0,0	0,0	0,0	0,0
Eudoxoides spiralis	0,0	0,0	0,0	0,0	0,0
Eudoxoides mitra	0,0	0,0	0,0	0,0	0,0
Lensia spp.	0,0	0,0	0,0	0,0	0,0
Muggiaea spp.	0,0	0,0	0,0	0,0	0,0
Hydroidomedusae indef.	0,0	0,0	0,0	0,0	0,0
Anthomedusae	0,0	0,0	0,0	0,0	0,0
Anthomedusae indef.	10,4	0,0	0,0	0,0	0,0
Bythotiara murrayi	0,0	0,0	0,0	0,0	0,0
Leukartiara spp.	0,0	0,0	0,0	0,0	0,0
Leptomedusae	0,0	0,0	0,0	0,0	0,0
Leptomedusae indef.	0,0	0,0	0,0	0,0	10,4
Eirenidae indef.	0,0	0,0	0,0	10,4	0,0
Aequorea spp.	0,0	0,0	0,0	0,0	0,0
Obelia spp.	0,0	0,0	0,0	0,0	0,0
Limnomedusae	0,0	0,0	0,0	0,0	0,0
Proboscidactylidae	0,0	0,0	0,0	0,0	0,0
Proboscidactyla spp.	0,0	0,0	0,0	0,0	0,0
Proboscidactyla menoni	0,0	0,0	0,0	0,0	0,0
Nacromedusae	0,0	0,0	0,0	0,0	0,0
Nacromedusae indef.	0,0	0,0	0,0	0,0	0,0
Solmundella bitentaculata	0,0	0,0	0,0	0,0	0,0
Trachymedusae	0,0	0,0	0,0	0,0	0,0
Trachymedusae indef.	0,0	0,0	0,0	0,0	0,0
Liripoe tetraphylla	0,0	0,0	0,0	125,0	31,3
Haliceras minima	0,0	0,0	0,0	0,0	0,0
Aglaura hemistoma	0,0	0,0	0,0	0,0	0,0
Arctapodema spp.	0,0	0,0	0,0	0,0	0,0
Tetraplatia volitans	0,0	0,0	0,0	0,0	0,0
Ctenophora *Beroe spp.*	0,0	0,0	0,0	0,0	0,0
Chaethognatha	239,6	1093,8	6718,8	10135,4	2458,3
Salps	10,4	437,5	1125,0	6479,2	3802,1
Tunicata indef.	0,0	0,0	0,0	0,0	0,0
Pteropoda	0,0	0,0	0,0	0,0	0,0
Appendicularia	93,8	10,4	10,4	10,4	0,0

	MOC-1-11 N1 100-50 m					MOC-1-11 N2 50-25 m				
Volume	178	178	178	178	178	57	57	57	57	57
Depth intervall	50	50	50	50	50	25	25	25	25	25
Size class	< 0.5	0.5-1	1-2	2-5	>5	< 0.5	0.5-1	1-2	2-5	>5
Scyphozoa indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Chrysaora hysoscella	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Atolla spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Siphonophorae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	35,1	0,0
Agalmatidae	16,9	84,3	33,7	11,2	33,7	70,2	438,6	1035,1	561,4	87,7
Aglama spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Physophora hydrostatica	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Forskalia leuckarti	0,0	0,0	0,0	0,0	0,0	0,0	0,0	52,6	52,6	0,0
Paryidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Vogita spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Abylidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Diphyidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Diphyniae	0,0	56,2	11,2	0,0	0,0	0,0	0,0	35,1	0,0	0,0
Eudoxoides spiralis	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Eudoxoides mitra	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Lensia spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Muggiaea spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Hydroidomedusae indef.	16,9	0,0	0,0	0,0	0,0	87,7	0,0	0,0	0,0	0,0
Anthomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Anthomedusae indef.	0,0	16,9	0,0	0,0	5,6	0,0	0,0	0,0	17,5	0,0
Bythotiara murrayi	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Leukartiara spp.	0,0	0,0	0,0	5,6	0,0	0,0	0,0	0,0	0,0	0,0
Leptomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Leptomedusae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Eirenidae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Aequorea spp.	0,0	0,0	0,0	0,0	5,6	0,0	0,0	0,0	0,0	0,0
Obelia spp.	11,2	16,9	0,0	11,2	0,0	0,0	17,5	0,0	0,0	0,0
Limnomedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactylidae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactyla spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Proboscidactyla menoni	0,0	0,0	5,6	11,2	5,6	0,0	0,0	0,0	0,0	0,0
Nacromedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Nacromedusae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Solmundella bitentaculata	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Trachymedusae	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Trachymedusae indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Liripoe tetraphylla	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Haliceras minima	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Aglaura hemistoma	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Arctapodema spp.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Tetraplatia volitans	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Ctenophora *Beroe spp.*	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Chaethognatha	16,9	191,0	943,8	1297,8	606,7	35,1	333,3	2263,2	9035,1	877,2
Salps	0,0	0,0	0,0	56,2	11,2	0,0	0,0	17,5	17,5	0,0
Tunicata indef.	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Pteropoda	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Appendicularia	0,0	0,0	0,0	0,0	0,0	0,0	35,1	0,0	17,5	0,0

	MOC-1-11 N3 25-0 m				
Volume	68	68	68	68	68
Depth intervall	25	25	25	25	25
Size class	< 0.5	0.5-1	1-2	2-5	>5
Scyphozoa indef.	0,0	0,0	0,0	0,0	0,0
Chrysaora hysoscella	0,0	0,0	0,0	0,0	0,0
Atolla spp.	0,0	0,0	0,0	0,0	0,0
Siphonophorae indef.	0,0	0,0	0,0	0,0	0,0
Agalmatidae	14,7	0,0	88,2	44,1	29,4
Aglama spp.	0,0	0,0	0,0	0,0	0,0
Physophora hydrostatica	0,0	0,0	0,0	0,0	0,0
Forskalia leuckarti	0,0	29,4	44,1	44,1	0,0
Paryidae	0,0	0,0	0,0	0,0	0,0
Vogita spp.	0,0	0,0	0,0	0,0	0,0
Abylidae	0,0	0,0	0,0	0,0	0,0
Diphyidae	0,0	0,0	0,0	0,0	0,0
Diphyniae	0,0	0,0	0,0	0,0	0,0
Eudoxoides spiralis	0,0	0,0	0,0	0,0	0,0
Eudoxoides mitra	0,0	0,0	0,0	0,0	0,0
Lensia spp.	0,0	0,0	0,0	0,0	0,0
Muggiaea spp.	0,0	0,0	0,0	0,0	0,0
Hydroidomedusae indef.	0,0	0,0	0,0	0,0	0,0
Anthomedusae	0,0	0,0	0,0	0,0	0,0
Anthomedusae indef.	0,0	0,0	0,0	0,0	0,0
Bythotiara murrayi	0,0	0,0	0,0	0,0	0,0
Leukartiara spp.	0,0	0,0	14,7	0,0	0,0
Leptomedusae	0,0	0,0	0,0	0,0	0,0
Leptomedusae indef.	0,0	0,0	0,0	0,0	0,0
Eirenidae indef.	0,0	0,0	0,0	0,0	0,0
Aequorea spp.	0,0	0,0	0,0	0,0	0,0
Obelia spp.	44,1	58,8	205,9	102,9	117,6
Limnomedusae	0,0	0,0	0,0	0,0	0,0
Proboscidactylidae	0,0	0,0	0,0	0,0	0,0
Proboscidactyla spp.	0,0	0,0	0,0	0,0	0,0
Proboscidactyla menoni	0,0	0,0	0,0	0,0	0,0
Nacromedusae	0,0	0,0	0,0	0,0	0,0
Nacromedusae indef.	0,0	0,0	0,0	0,0	0,0
Solmundella bitentaculata	0,0	0,0	0,0	0,0	0,0
Trachymedusae	0,0	0,0	0,0	0,0	0,0
Trachymedusae indef.	0,0	0,0	0,0	0,0	0,0
Liripoe tetraphylla	0,0	0,0	0,0	0,0	0,0
Haliceras minima	0,0	0,0	0,0	0,0	0,0
Aglaura hemistoma	0,0	0,0	0,0	0,0	0,0
Arctapodema spp.	0,0	0,0	0,0	0,0	0,0
Tetraplatia volitans	0,0	0,0	0,0	0,0	0,0
Ctenophora *Beroe spp.*	0,0	0,0	0,0	0,0	0,0
Chaethognatha	73,5	1455,9	6500,0	10823,5	21735,3
Salps	0,0	0,0	0,0	29,4	44,1
Tunicata indef.	0,0	0,0	0,0	0,0	0,0
Pteropoda	0,0	0,0	0,0	0,0	14,7
Appendicularia	0,0	0,0	0,0	0,0	0,0

Appendix 2: Stable isotope data

Sample Nr.	Species/ Content	d 15N/14N	d 13C/12C	mgN/sample	mgC/sample	C:N Ratio
1	*Pelagia noctiluca*	8,666	-14,536	0,043	0,159	3,711266545
2	*Pelagia noctiluca*	9,581	-14,858	0,050	0,186	3,733536593
3	*Aequorea spp.*	14,565	-14,504	0,021	0,073	3,477860836
4	*Aequorea spp.*	11,429	-14,156	0,020	0,068	3,43240598
5	*Aequorea spp.*	9,491	-13,779	0,109	0,404	3,704721155
6	*Aequorea spp.*	10,357	-16,646	0,091	0,456	5,03076688
7	*Boroe spp.*	8,185	-16,684	0,085	0,421	4,950746274
8	*Chrysaora hysoscella*	10,681	-15,597	0,049	0,181	3,676480208
9	*Chrysaora spp.*	11,944	-14,161	0,039	0,152	3,895517134
10	*Chrysaora spp.*	12,936	-14,934	0,045	0,196	4,315896973
11	*Pelagia noctiluca*	9,657	-17,097	0,018	0,081	4,574483779
21	Leptomedusae	9,031	-15,002	0,035	0,117	3,316582896
22	*Atolla spp*	8,057	-16,27	0,100	0,409	4,08821209
23	*Abylopsis tetragona*	8,004	-17,232	0,083	0,341	4,131815714
24	Nacromedusae	9,954	-15,309	0,088	0,348	3,942828723
25	*Haliceras spp.*	10,171	-14,072	0,037	0,114	3,117131632
26	*Physophora hydrostatica*	8,349	-17,31	0,080	0,375	4,694870729
27	Salps colonie	6,446	-20,696	0,048	0,302	6,325758257
28	*Pelagia noctiluca*	10,55	-18,433	0,038	0,168	4,385561614
29	*Pelagia noctiluca*	11,223	-18,176	0,055	0,238	4,322352509
30	*Discomedusa lobata*	10,915	-15,569	0,051	0,209	4,111469756
31	Salp	6,491	-20,632	0,040	0,264	6,607337957
32	Salp	4,069	-20,083	0,040	0,237	5,895470303
33	*Chrysaora hysoscella*	11,756	-15,704	0,095	0,379	3,987320756
34	*Chrysaora hysoscella*	8,518	-14,905	0,085	0,344	4,026492398
35	Siphonophora	9,497	-16,062	0,046	0,179	3,903952924
36	Hydrozoa indef.	11,449	-18,8	0,076	0,497	6,554442588
37	Trachymedusae	11,278	-16,428	0,199	0,920	4,62769599
38	Hydrozoa indef.	8,708	-16,053	0,092	0,454	4,908211475
39	Chaetognatha mixsample	10,808	-18,659	0,102	0,518	5,076981204
40	Salpen mixsample	6,927	-20,688	0,066	0,488	7,365887691
41	Jelly mixsample	10,151	-18,771	0,080	0,394	4,935065888
42	Siphonophora mixsample	10,277	-17,943	0,102	0,440	4,297485983
43	Pteropoda	2,614	-18,941	0,056	0,412	7,386778019
44	Siphonophora mixsample	8,79	-16,893	0,091	0,394	4,336164636
45	Chaetognatha mixsample	11,043	-17,655	0,134	0,692	5,179059217
46	Salps mixsample	7,481	-21,035	0,043	0,341	7,901175692
47	Jelly mixsample	8,168	-19,657	0,038	0,389	10,18459042
48	Jelly mixsample	12,643	-17,908	0,082	0,511	6,20188861
49	Salps mixsample	7,237	-19,995	0,080	0,678	8,45054302
50	Chaetognatha mixsample	11,418	-18,745	0,098	0,561	5,731301933
51	Chaetognatha mixsample	13,212	-17,276	0,104	0,554	5,343908003
52	Jelly mixsample	12,811	-16,293	0,073	0,376	5,170686716
53	Ctenophora	10,707	-17,75	0,083	0,523	6,282476254
54	Chaetognatha mixsample	12,276	-17,896	0,086	0,425	4,956978364
55	Jelly mixsample	10,503	-19,12	0,035	0,173	4,916274991

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6.2. *Eidesstattliche Erklärung*

Hiermit bestätige ich, dass die vorliegende Arbeit von mir selbständig verfasst wurde und ich keine anderen als die angegebenen Hilfsmittel – insbesondere keine im Quellenverzeichnis nicht benannten Internet–Quellen – benutzt habe und die Arbeit von mir vorher nicht einem anderen Prüfungsverfahren eingereicht wurde. Die eingereichte schriftliche Fassung entspricht der auf dem elektronischen Speichermedium. Ich bin damit einverstanden, dass die Masterarbeit veröffentlicht wird.

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Sarina Jung