Bachelor Thesis

Macroepibenthic communities associated with the hydrocoral *Errina antarctica* from the Chilean fjord region: Does bathymetry influence community structure?

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Statutory declaration

I declare that I have authored this thesis independently, that I have not used other than the declared sources, especially no internet-sources not listed in the list of literature, and that I have explicitly marked all material which has been quoted either literally or by content from the used sources. The submitted printed version is consistent with that on CD-ROM.

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Summary

The cold-water hydrocoral *Errina antarctica* provides habitat for numerous macroepibenthic species and plays an important role for biodiversity in the Chilean fjord region. Gaining knowledge about the assumedly highly diverse benthic communities associated with cold-water corals such as *E. antarctica* is crucial for an efficient management programme for the ecosystems, which are strongly threatened by aquaculture and other human activities.

In this investigation, the epizoobenthic community associated with *E. antarctica* in three bathymetric zones (Zone 1: 10-20 m; Zone 2: 20-30 m; Zone 3: 30-40 m) in the Chilean fjord region is described quantitatively by analysing videos recorded via remotely operated vehicle (ROV). To be able to compare communities from different diving sites, pH, salinity, temperature, depth, oxygen saturation, and oxygen concentration were measured. Videos and abiotic parameters were recorded during dives at four stations. A total of 260 images were extracted from the videos, and abundance of macroepibenthic organisms was calculated. Community composition of different bathymetric zones and stations were investigated by means of multivariate statistical methods (SIMPER, ANOSIM 1) and similarities between samples visualised by Cluster analysis and MDS-plots. Ecological indices (*S*, *H´*, *d*, and *J´*) were calculated. Distribution of differently sized *E. antarctica*-colonies (small [diameter < 10 cm], medium [10 cm < diameter < 20 cm], large [20 cm < diameter]) was investigated.

At the southernmost station (station Is_Solar) oxygen saturation and concentration were lower than at the other stations. Other abiotic parameters measured showed no clear differences between stations. Abundances of *E. antarctica*-colonies of all sizes decreased with depth, the portion of small colonies was highest in Zone 1. Based on abundances, annelids dominated all bathymetric zones, followed by cnidarians, sponges, and chordates. Ecological indices were lowest in Zone 1. SIMPER identified genus spirorbis as dominant in all bathymetric zones and stations. R-values of ANOSIM 1 indicated poor distinctness between bathymetric zones (GR=0.062). Investigating each station separately provided higher distinctness between bathymetric zones 1 and 2 (R-values between 0.234 and 0.568). Neither Cluster-analysis nor MDS-plots showed clear grouping of bathymetric zones. Zone 1 was less heterogeneous than the other zones. Grouping of stations was visible on MDS-plot.

No significant influence of depth on the investigated community was detected. Differences in the characteristics of the four stations overlay bathymetric effects. The observed community composition agrees with results from former investigations, especially the dominance of polychaetes. Differences in diversity between samples from different bathymetric zones are explained by distribution of differently sized *E. antarctica*-colonies. Alternative sampling methods are discussed.

This investigation for the first time provides information on quantitative composition of benthic communities associated with *E. antarctica*, and it is desirable its results will help to provide efficient protection of these threatened systems.

1 Introduction

Benthos comprises the entity of organisms living in and on the sea bed. It includes pelagic (in the water column) and sympagic ("with ice"; Marquardt et al, 2011) organisms (Herrmann, 2006). Further differentiation groups benthic organisms by overall size (macro-, meio-, microbenthos; Levinton, 1995), and habitat (endo-, meso-, epibenthos; Nybakken, 1997). Classic marine biology states, that benthic communities are highly influenced by the factor depth (e.g. Levinton, 1995; Nybakken, 1997). This applies to greater scales, such as the comparison between shelf and deep sea, as well as for smaller scales, such as vertical zonations of the intertidal zone. One reason is the adaption of many species to environmental conditions of a certain depth (Levinton, 1995; Nybakken, 1997). An interesting exception is an effect called deep-water emergence: Some species usually occurring in the deep sea can be found in relatively shallow waters in fjord regions (Häussermann and Försterra, 2009).

1.1 The Chilean fjord region

One of the regions in which deep-water emergence seems to be frequent is the Chilean fjord region (Häussermann and Försterra, 2009). This region extends for approximately 1,600 km from Puerto Montt to Cape Horn at Chile´s western shore (41.47° S – 56° S, 76° W – 66° W), and is one of the world´s largest fjord systems. The region is characterized by hundreds of islands and a complex net of channels and fjords. Its 84,000 km of fragmented coastline provide heterogeneous structures and habitats. Its water masses are highly influenced by subantarctic water as well as continental water deriving from rivers, melting ice and precipitation, which results in a relatively low salinity (Häussermann and Försterra, 2009). Estuarine waters (EW) tend to form a superficial outflow layer, while subantarctic waters flow inwards subsurface (Wichmann et al., 2012). Mixing of the two layers forms subantarctic modified water (SAMW; Häussermann and Försterra, 2009).

A transverse section of a typical fjord is U-shaped, with steep rocky slopes on the one hand, on which both diversity and abundances are highest, and sediment covered bottoms on the other hand, with lower diversity and abundances. The slopes provide habitat to numerous species, including cold-water corals (Häussermann and Försterra, 2009).

1.2 Previous research

In the past, benthic communities were mainly sampled by use of bottom trawls, grabs and dredges. Non-destructive underwater imagery-approaches by SCUBA-diving (see e.g. Dumas et al., 2009; Barrett and Edgar, 2010; van Rein et al., 2011) and remotely operated vehicles (ROV; see e.g. Lirman et al., 2007; Bo et al, 2012; Laudien and Orchard, 2012) have been used increasingly, but have only recently been applied in the Chilean fjord region. They are the most appropriate methods for investigating the highly diverse benthic communities on the slopes of the Chilean fjords. Numerous new species, including cold-water corals, have recently been described while systematically sampling the fjords, and probably many more are still to be discovered. To date, the Western Patagonian coast is one of the least studied areas in marine sciences (Arntz, 1999; Escribano et al., 2003; Häussermann and Försterra, 2009).

1.3 Cold-water corals in the Chilean fjord region

In the past, the coral fauna of the Chilean fjord region was considered rather poor, since sampling was mainly carried out at the soft-bottom grounds of the fjords (Häussermann and Försterra, 2007a). Recent investigations sampling the steep slopes of fjords and channels using alternative methods, e.g. SCUBA- and ROV-diving, showed a greater variety and expansion of cold-water coral communities than expected. As benthic systems on the shelf of the Chilean fjord region had not been studied for a long time, these investigations led to interesting findings including the discovery of reef-like structures of *Errina antarctica* and gorgonians in shallow water (Häussermann and Försterra, 2007a). These observations are evidence for deep-water emergence. During the investigations, 37 species of corals were observed, 4 of which (including *E. antarctica*) are hydrozoans, the others anthozoans (Häussermann and Försterra, 2007a).

1.4 *Errina antarctica* (Gray, 1872)

The cold-water coral *E. antarctica* (family Stylasteridae, class Hydrozoa, phylum Cnidaria; Fig. 1) is distributed in the south western Atlantic (Falkland Islands), south eastern Pacific (Patagonia) and Subantarctic Islands (Burdwood Bank). It mainly occurs in depths of 18-300 m, but has also been recorded from as shallow as 10 m and as deep as 771 m (Häussermann and Försterra, 2009). In the southern Chilean fjord region it is found from 10-119 m

(Häussermann and Försterra, 2007a; 2007b; 2009).

E. antarctica forms calcified colonies of up to 40 cm diameter. The coenosteum is red to orange with white branch tips, inner branch cores and sometimes ampullae. Little is known about the biology of *E. antarctica* (Häussermann and Försterra, 2009). Growth rates of the closely related *E. novaezelandiae* are 1–7 mm/year. Abundances of small *E. novaezelandiae*-colonies are higher than that of large ones (Miller et al., 2004).

Figure 1: *Errina antarctica*, Picture and © Matthias Hüne (Escuela de Biología Marina, Universidad Austral de Chile).

For *E. antarctica* two different growth forms have been described by Häussermann and Försterra (2007b). On vertical walls, the colonies occur as fan-like, uniplanar structures, which are orientated perpendicularly to horizontal currents. This growth form thereby minimizes the surface affected by sediment runoff and maximizes the surface facing the current. Abundances of this growth form vary from a few scattered small colonies to 20 colonies/m².

A second growth form was found on horizontal habitats. Here, the colonies are bushy, with branches orientated and distributed more or less equally in all directions. This form shows higher abundances than the former, with a maximum coverage exceeding 80% (Häussermann and Försterra, 2007b). Häussermann and Försterra (2009) suggest this growth

form to be related to the limestone substrate, which, within the Chilean fjord region, is exclusively found in the Madre de Dios Archipelago.

E. antarctica is considered habitat forming by providing habitat for numerous species, thereby playing an important role for biodiversity in the Chilean fjord region (Häussermann and Försterra, 2009). Häussermann and Försterra (2007b) qualitatively recorded the fauna associated with *E. antarctica*. They stated that both living and dead parts of colonies are of great importance for numerous species. The crinoid *Antedon rosacea*, the ophiurids *Gorgonocephalus chilensis* and *Ophiacantha rosea* use living portions as substrate, while among others the polychaet *Chaetopterus* sp., the crustacean *Pagurus comptus*, the sea urchin *Arbacia dufresnii* were found on dead portions. Furthermore, several sponges and bryozoans not yet identified were surveyed in the surrounding of *E. antarctica* (Häussermann and Försterra, 2007b). Thus, representatives of numerous phyla (Porifera, Annelida, Arthropoda, Ectoprocta, and Echinodermata) and both sessile, sedentary, mobile, and boring species are associated with *E. antarctica* colonies.

1.5 Threats

As the economic interest in the Chilean fjord region is growing rapidly, there are numerous threats to the still relatively unknown cold-water coral systems (Häussermann and Försterra, 2007a). Bottom trawling as practised in cold-water habitats can cause a lot of damage to any cold-water coral (e.g. Fosså et al., 2002; Freiwald et al., 2004, p. 41). Long line fishery can harm cold-water corals, since organisms may get entangled in the lines. To corals in the Chilean fjord region, these are minor threads, which, nonetheless, should be kept in mind.

As many corals have calcified skeletons, the decreasing pH following global warming can cause a lot of damage to organisms and ecosystems containing corals (Bosch et al., 2010; Miller et al., 2011; McCulloch et al., 2012). Thus, anthropogenic climate change is a threat to cold-water corals in the Chilean fjord region (Jantzen et al., 2013). Probably the most important factor threatening any ecosystem in the region is aquaculture (Häussermann and Försterra, 2007a, 2009). Salmon-farming has increased dramatically since the 1980´s. While in 1987 Chile´s contribution to worldwide salmon-production was only 2%, the country is now among the three major salmon-farming countries, together with Scotland and Norway (Katz, 2006). The input of particulate waste, e.g. faeces or dead fish, pharmaceuticals, is likely to have a huge impact on benthic communities (Häussermann and Försterra, 2009).

Another threat affecting *E. antarctica* is the collecting of colonies for local markets. Some of the corals occurring in the Chilean fjord region are sold there as souvenirs (Häussermann and Försterra, 2007b). As mentioned above, *E. antarctica* occurs in shallow water, easily being harvested by divers. Due to the assumedly slow growth rate, this harvesting of corals appears to be quite harmful to both *E. antarctica* and the associated community (Häussermann and Försterra, 2007a).

These threats are heightened by the little protection provided for marine environments in Chile. In the entire fjord region, there are only three marine protected areas, and those allow multiple use. Management plans, administration and control are ineffective, so the great diversity assumed for the region is hardly protected at all (Häussermann and Försterra, 2009).

1.6 Study aims

The ongoing threats and the low number of marine protection areas may lead to severe destruction of the cold-water systems of the Chilean fjord region. Since research activities have been rare in the past, there is a need for investigations in order to learn about the relatively unknown systems and install protection. Häussermann and Försterra (2007a) suggest concentrating the protection on hotspots of diversity. As stated above, *E. antarctica* is of great importance for diversity, and the community associated with it should therefore be investigated.

This study aims to reveal for the first time the quantitative composition of the macroepibenthic faunal community associated with *E. antarctica* in the Chilean fjord region and the influence of depth on the community. Macroepibenthic organisms in the surrounding of *E. antarctica* were identified from images extracted from ROV-recorded videos, and abundances were estimated. Communitiy composition of three bathymetric Zones (Zone 1: 10–20 m; Zone 2: 20–30 m; Zone 3: 30– 40 m) was compared by means of multivariate statistical methods to find out characteristics of and differences between the community compositions of each zone, thereby investigating the influence of bathymetry on the communities. Communities of the three zones were expected to be distinguishable from each other. Furthermore, the distribution of small (diameter < 10 cm), medium-sized (10 cm < diameter < 20 cm) and large (20 cm < diameter) *E. antarctica*-colonies was investigated and set into context with results deriving from the investigation of communities. It was investigated wether or not the distribution pattern of the closely related *E. novaezelandiae*

applies to *E. antarctica*, too. Additionally, abiotic parameters (pH, conductivity, temperature, oxygen saturation and oxygen concentration) were recorded during the dives to provide information on the habitat and explain differences between sampling sites and bathymetric zones, respectively.

2 Materials and methods

2.1 Study area

Study area was the Southern Patagonian Madre de Dios Archipelago (50°–52° S; 74°–75.5° W) in the Chilean fjord region (Fig. 2). Sampling sites were Copihue at a fjord on the west coast of Isla **M**adre **d**e **D**ios (station MDD; 50.34° S; 75.38° W); a channel between **Is**la **Solar** and Isla Hanover on the western side of Isla Hanover (station Is_Solar; 50.96° S; 74.95° W); **Ang**ostura at a channel in the centre of Isla Hanover (station AG; 51.16° S; 74.78° W); and the **s**outhern end of Canal **C**orrientes in the centre of Isla Hanover (station CS; 51.23° S; 74.38° W). No information was available on abiotic parameters, currents or other characteristics of the stations. Substratum at station MDD is limestone, while at the other stations granite is predominant. The limestone is being mined at a nearby site. Miners observed a lot of natural washout of limestone into the sea, especially during rainfall (pers. com. expedition logbook, Carin Jantzen, AWI). For MDD, strong currents were reported, especially around tidal change (pers. com. Laura Fillinger, AWI). The same applies for sation AG, which is located at a fairly narrow channel (pers. com. expedition logbook, Carin Jantzen, AWI).

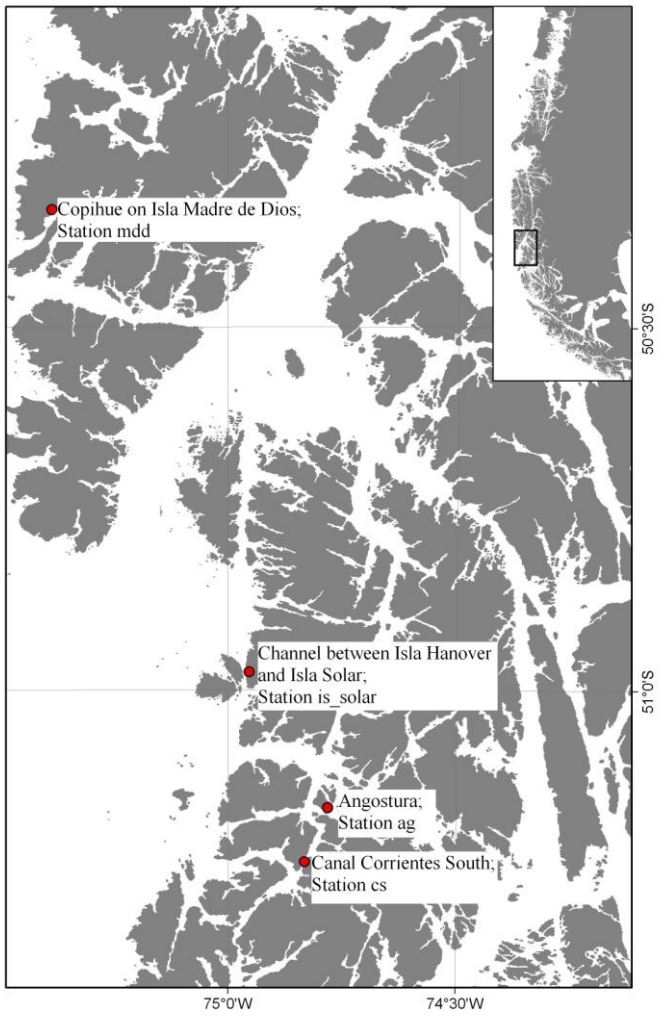

Figure 2: Study site in southwestern Chile. Red dots mark the sampling sites ("stations"): Copihue on Isla Madre de Dios (station MDD); a channel between Isla Hanover and Isla Solar (station Is_Solar); Angostura (station AG); and Canal Corrientes South (station CS).

2.2 Sampling procedure

Macroepibenthic community and abiotic parameters (pH, conductivity, temperature, depth, oxygen saturation and oxygen concentration) were recorded from aboard the tourist-boat *Explorador* in February and March 2012 (Tab. 1), using the AWI-ROV (Fig. 3), which is a modified V8 Sii ROV developed in cooperation with Ocean Modules (Åtvidaberg, Sweden). Three dives were conducted at stations MDD and Is_Solar, respectively (Tab. 1). At stations AG and CS, one dive was conducted, respectively.

Table 1 ROV-dives of this investigation. Linked date, latitude, longitude, maximum depth of images extracted from videos (max. depth), and number of analysed images.

Dive	Date	Latitude	Longitude	max. Depth [m]	Images
MDD1	02/23/2012	50.34° S	75.38° W	32 m	12
MDD2	02/23/2012	50.34° S	75.38° W	30 m	38
MDD3	02/25/2012	50.34° S	75.38° W	37 m	20
Is_Solar1	02/26/2012	50.96° S	74.95° W	37 m	103
Is_Solar2	02/26/2012	50.96° S	74.95° W	50 m	38
Is_Solar3	02/26/2012	50.98° S	74.95° W	73 m	17
AG	03/02/2012	51.16° S	74.78° W	43 m	27
CS	03/02/2012	51.23° S	74.83° W	37 m	5
Total	-	-	-	-	260

Sensors outside the ROV recorded pH (SeaBird SBE 18 [Sea-Bird Electronics, Inc., Bellevue, Washington 98005, USA]), conductivity (as salinity), temperature and depth (CTD; SeaBird SBE19 plus [Sea-Bird Electronics, Inc., Bellevue, Washington 98005, USA]), oxygen saturation and oxygen concentration (SeaBird SBE 43 [Sea-Bird Electronics, Inc., Bellevue, Washington 98005, USA]).

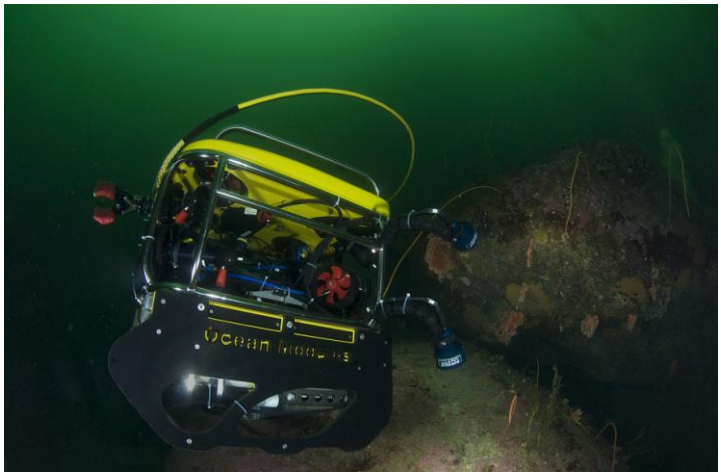

Figure 3: AWI-ROV during sampling. Note *E. antarctica*-colonies on the rocks. Picture and © Matthias Hüne (Escuela de Biología Marina, Universidad Austral de Chile).

Two Kongsberg oe14-502 high definition cameras (Kongsberg Maritime, Kongsberg, Norway) recorded videos during the dives. One camera pointed straight ahead, the second pointed downwards. The cameras´ angle was set to 45° in horizontal and 29° in vertical direction (maximum range). For scaling, a Tritech Micron EchoSounder DST (Tritech

International Ltd., Aberdeen, United Kingdom) altimeter was attached to one of the cameras, measuring the distance between camera lense and recorded surface.

Four Bowtech Aqua Vision LED-2400 (Bowtech Products Ltd., Aberdeen, United Kingdom) provided light for the recordings.Videos were saved on two nanoFlash HD/SD Portable Recorder/Players (Convergent Design, Collorado Springs, CO 80907, USA) on board the vessel.

Time codes linked the video data to the simultaneous measurements of abiotic parameters and altimeter.

2.3 Quantitative analysis

2.3.1 Selection and preparation of images

Videos of the camera respectively furnished with the altimeter (to later be able to scale extracted images) were browsed for *E. antarctica* in VLC Media Player 2.0.3. Frames containing *E. antarctica* and complying with requirements defined below were extracted using the Snapshot-function of the program. These requirements refer to quality and angle of a frame: Only high quality images were extracted, which allow for taxonomic identification of macroepibenthic organisms in the image. Thus, frames showing *E. antarctica* but being too blurry due to a fast movement of the ROV or a distance from recorded surface greater than approximately 2.5 m were not taken into account. Furthermore, only images showing the surface at an angle of approximately 90° were extracted, because only then is the scaling of the entire picture possible.

A total of 260 images from 8 dives at 4 stations were extracted: 70 from 3 dives at station MDD; 158 from 3 dives at station Is_Solar; 27 from 1 dive at station AG; and 5 from 1 dive at station CS (Tab. 1). Via timecodes, each image was matched with the appropriate data on abiotic parameters. Knowing camera-angle, distance between camera and ground, and number and size of pixels in the image, the area displayed in the image was calculated in Microsoft Excel 2010 (for formulas, see Appendix).

In some cases, light conditions or surface structures only allowed analysis of a certain area of an image. These images were opened in an ArcGIS 10 document to mark the area to be analysed as a polygon. The polygon´s area was calculated and used for further analysis.

2.3.2 Identification and quantification of macroepibenthic organisms

For analysis, each image was opened on a HP Compaq 8200 Elite Convertible Minitower PC (Hewlett-Packard Company, Palo Alto, CA 94304-1185, USA) and a Dell 2007FPb screen (Dell Inc., Round Rock, Texas 78682, USA). *E. antarctica*-colonies were measured in ArcGIS, using the program´s measuring-tool, and grouped into small (diameter < 10 cm), medium (10 cm < diameter < 20 cm in diameter) and large (20 cm < diameter) colonies. Data on *E. antarctica* was not included in the statistical analysis described below, as the focus of the work is on the community associated with this species. The distribution of differently sized colonies at different stations and in different depths was investigated and related to the community compositions observed.

Macroepibenthic organisms were identified to the lowest level possible, mainly based on Häussermann and Försterra (2009) and counted. If organisms occurred in large numbers (e.g. the actinarians *Phellia exlex* and *Metridium senile*), they were counted using the software Inkscape Version 0.48.4.1. Within the program, each individual was marked with a dot. Then, by hitting ctrl+A, the number of objects is shown by the program. As the image itself is counted as an object, the shown number minus one was used as a count for the taxon.

In order to estimate large numbers of individuals of polychaets of genus spirorbis, each image was divided into a grid of 100 numbered rectangles in Microsoft Word 2010. Using Microsoft Excel 2010, ten rectangles were randomly picked (for formulas, see Appendix). In images that could only be analysed in parts, rectangles with more than approximately 75% of their area outside the analysed part of the image were discarded. The spirorbis in the rectangles were counted and the result extrapolated to the analysed area.

The octocorallians *Convexella magellanica* and *Primnoella chilensis* were pooled, because they could not be distinguished visually. The same applies for hydrozoans, most bryozoans and other unidentified orgsnisms. Abundances for each taxon were standardized to 1 m². Following Laudien and Orchard (2012), colonial species (e.g. hydrozoans, bryozoans) were counted as individuals per square meter, since a colony emanates from one individual.

All images, abundances and metadata linked to the images are available at Winkler et al. (2013).

2.3.3 Statistical data analysis

Macroepibenthic community compositions were analysed using PRIMER 6 (Clarke and Gorley, 2006). The samples were grouped into three bathymetric zones: 10–20 m (Zone 1); 20–30 m (Zone 2); and 30–40 m (Zone 3). Compositions of the macroepibenthic community of these zones were compared with each other. Five datasets were generated: The first contained all samples of all zones, allowing an overall comparison of communities in the bathymetric zones. The results of this dataset are effected by differences between bathymetric zones as well as differences between the stations. To erase the effect of differences between stations and to obtain a more specific comparison, one dataset was generated and analysed for each station. The analystic methods described below were thus carried out on five datasets: one for overall comparison, and one for each station.

2.3.3.1 Ecological indices

In order to characterize the investigated community, three ecological indices were calculated for each sample:

Number of taxa (*S*)

The total number of taxa *S* is an important index to characterize a community. All taxa present in one sample are summed up.

Shannon-Wiener diversity index (*H´*, Log e)

$$H' = -\sum_{i=1}^{k} \frac{n_i}{N} ln \frac{n_i}{N} \quad (1)$$

Here n_i is the number of individuals of taxon *i*, while *k* is the number of taxa and *N* the total number of individuals.

Margalef´s index (*d*)

$$d = \frac{(S-1)}{\log N} \quad (2)$$

Again *S* is the number of taxa, *N* the number of individuals. Margalef´s index quantifies the number of taxa at a given number of individuals.

Piellou´s evenness index (*J´*)

$$J' = \frac{H'}{H'_{max}} = \frac{H'}{\log S} \quad (3)$$

Again, *S* is the number of taxa, while H'_{max} is the maximum possible value of the Shannon-Wiener diversity index.

Arithmetic average values were calculated from the results of the samples for each

station and each bathymetric zone.

2.3.3.2 Similarity percentage (SIMPER) analysis

SIMPER identifies the species contributing to the dissimilarities between groups of samples and quantifies each species´ contribution. Species characterizing each group are also identified and the contribution quantified (Clarke and Warwick, 2001).

2.3.3.3 Pre-treatment and resemblance-matrix

Each dataset was fourth-root-transformed. This transformation diminishes the influence of taxa with high abundance values stronger than the more common square-root-transformation and was used here to even the high abundances of spirorbis.

A resemblance-matrix was created based on Bray-Curtis similarity (Bray and Curtis, 1957), providing the distance between two samples by dividing the maximum similarity of two samples *j* and *k* by the actual similarity of *j* and *k*:

$$S_{jk} = 100 * \frac{\sum_{i=1}^{p} 2 \min(y_{ij}, y_{ik})}{\sum_{i=1}^{p} (y_{ij} + y_{ik})} \quad (4)$$

S_{jk} is the similarity between *j* and *k*, while y_{ij} and y_{ik} are the abundance values of taxon *i* in the samples compared; *min* represents the minimum of the two counts. As the Bray-Curtis similarity does not take zero values appearing in both samples as a similarity, it is most suitable for the datasets on hand, which contain numerous zero values (Faith et al., 1987; Clarke and Warwick, 2001).

2.3.3.4 One-way analysis of similarity (ANOSIM 1)

ANOSIM 1 provides an R-value quantifying the possibility to distinguish between two groups of samples. To achieve this, rank-similarities for each group are calculated and compared with one another (original R). Samples are randomly mixed and rank-similarities re-calculated. Based on the results of 999 permutations, a distribution for R-values is created. The probability of the original R fitting this random distribution displays the possibility to distinguish between groups. R = 0 indicate no difference between groups, meaning that similarities between two groups are the same as similarities in one group. If all samples of one group are closer to one another than to any sample of another group, R is = 1. R > 0.75 point towards clear distinctness between groups; R ≈ 0.5 identifies good distinctness despite some accordance; and R < 0.25 shows a rather small possibility to distinguish between groups (Clarke and Warwick, 2001). R-values are calculated for comparison each group with each other as well as for overall comparison (global R; GR). Since the low number of samples

(five) of station CS is not sufficient for receiving valid R-values, this station was not investigated separately by means of ANOSIM.

2.3.3.5 Cluster analysis

A cluster analysis was carried out based on the Bray-Curtis resemblance-matrix. The samples of the dataset were displayed as a dendrogram based on group average linkage, allowing grouping similar samples into clusters (Clarke and Warwick, 2001). As station CS consists of only five samples it was not investigated separately by means of Cluster analysis.

2.3.3.6 MDS analysis

MDS is also based on the Bray-Curtis resemblance-matrix. The dissimilarities between samples are displayed as the distance between dots representing these samples. As the dissimilarities between all samples are taken into account, the graph shows the relation of any sample to any other sample, allowing for verification of grouping of cluster analysis (Kruskal and Wish, 1978; Clarke and Goyle, 2006). The statistical power of the analysis is expressed through a stress-value. Stress-values < 0.1 show good ordination, while values < 0.2 can still be interpreted with a relatively small chance of misinterpretation. Values ≥ 0.2 indicate poor quality, and corresponding graphs are easily misinterpreted (Clarke and Warwick, 2001). As station CS consists of only five samples it was not investigated separately by means of MDS.

3 Results

A total of 260 samples were analysed, the most (158) at station Is_Solar, the least (5) at station CS (Tab. 2). Most samples (178) were collected in Zone 2. Samples of station AG account for 73% of samples of Zone 1, while samples of Is_Solar account for 60% (89%) of samples of Zone 2 (Zone 3).

Table 2 Distribution of samples (percentage to total) within bathymetric zones and stations.

	MDD	Is_Solar	AG	CS	Sum
Zone 1	6 (23%)	1 (4%)	19 (73%)	0 (0%)	26 (100%)
Zone 2	61 (34%)	107 (60%)	8 (4.5%)	2 (1.5%)	178 (100%)
Zone 3	3 (5.5%)	50 (89%)	0 (0%)	3 (5.5%)	56 (100%)
Sum	70 (27%)	158 (61%)	27 (10%)	5 (2%)	260 (100%)

3.1 Abiotic parameters

Ranges of values for temperature, oxygen saturation and concentration were highest at station MDD (Tab. 3). pH was highest at stations AG and CS, while the highest salinity was measured at Is_Solar. Oxygen saturation and concentration were considerably lower at station Is_Solar than at the other stations. Samples were collected in depths between 14.13 m and 39.40 m, the shallowest at AG, the deepest at Is_Solar. For a list of data on abiotic parameters at each sample, see appendix, table A7.

Table 3 Ranges (min-max) of abiotic parameters pH, salinity (Sal.), temperature (Temp.) [°C], depth [m], oxygen saturation (Ox. sat.) [%], and oxygen concentration (Ox. conc.) [µmol/l] linked to samples of stations.

Station	pH	Sal.	Temp. [°C]	Depth [m]	Ox. sat. [%]	Ox. conc. [µmol/l]
MDD	8.19–8.27	31.20–31.60	11.03–11.44	18.01–36.22	74.17–79.47	207.99–223.21
Is_Solar	8.13–8.18	31.71–32.81	10.65–10.80	19.74–39.40	64.92–67.72	183.63–191.79
AG	8.25–8.30	28.72–29.64	10.90–11.00	14.13–29.19	72.19–74.51	206.90–213.57
CS	8.23–8.30	28.91–30.15	10.83–10.97	17.63–36.23	69.72–75.54	199.19–216.89
All stations pooled	8.13–8.30	28.72–32.81	10.65–11.44	14.13–39.4	64.92–79.47	183.63–223.21

3.2 Distribution of differently sized *E. antarctica*-colonies

Abundances of *E. antarctica*-colonies decreased with increasing colony-size (Fig. 4; note that all values are mean values). In overall comparison, most small colonies/m² (11.4 ± 11.8) occured in Zone 1, followed by Zone 3 (7.4 ± 2.0) and Zone 2 (5.5 ± 1.0). Medium sized colonies were most frequent in Zone 3 (1.9 ± 0.6), less in Zone 2 (1.4 ± 0.3), less yet in Zone

1 (0.6 ± 0.3). Large colonies follow the same pattern: 0.4 ± 0.1 in Zone 3, 0.3 ± 0.1 in Zone 2, and 0.2 ± 0.2 in Zone 1.

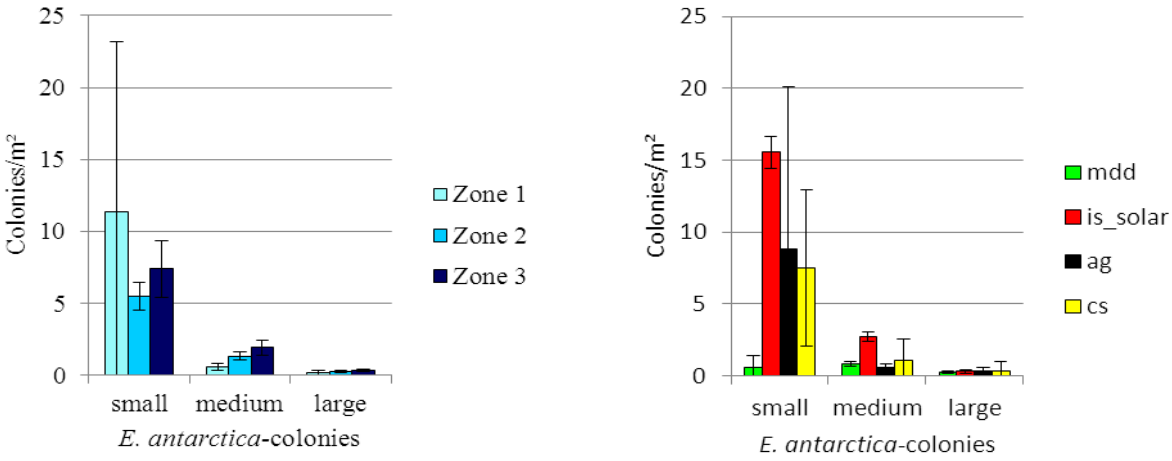

Figure 4: Distribution of small (diameter < 10 cm), medium (10 cm < diameter < 20 cm), and large (20 cm < diameter) *E. antarctica*-colonies [colonies/m²; mean values] in different bathymetric zones (10 m < Zone 1 < 20 m; 20 m < Zone 2 < 30 m; 30m < Zone 3 < 40 m; left) and at each station (left). Bars indicate standard errors.

Most small colonies/m² (15.5 ± 1.1) were found at station Is_Solar, followed by stations AG (8.8 ± 11.3), CS (7.5 ± 5.4), and MDD (0.5 ± 0.8). Medium sized colonies/m² were most frequent at station Is_Solar (2.7 ± 0.3), followed by stations CS (1.0 ± 1.5), MDD (0.8 ± 0.2), and AG (0.5 ± 0.3). There were 0.3 ± 0.2 large colonies/m² at station AG, 0.3 ± 0.7 at station CS, 0.3 ± 0.1 at station Is_Solar, and 0.2 ± 0.1 at station MDD.

3.3 Macroepibenthic community

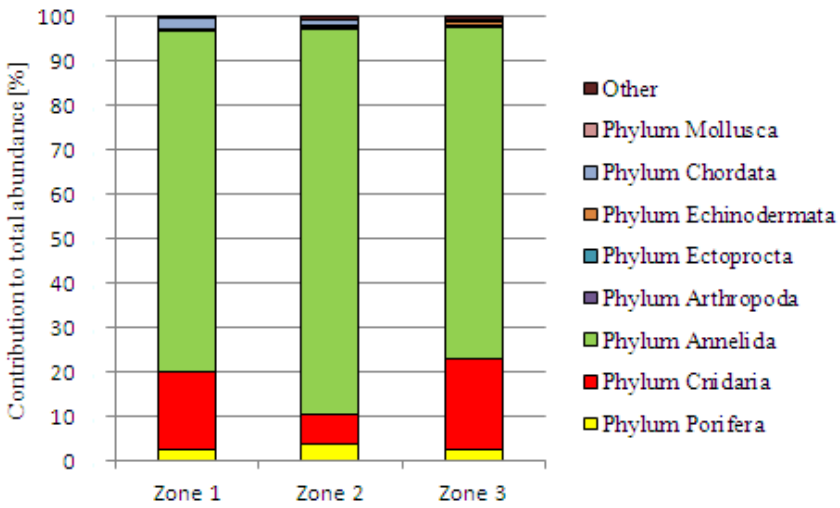

Figure 5: Contribution to total abundance [%] of phyla in different bathymetric zones (10 m < Zone 1 < 20 m; 20 m < Zone 2 < 30 m; 30 m < Zone 3 < 40 m).

A total of 59 taxa (including *E. antarctica*) was found during the investigation, 14 of which are pooled taxa (e.g. “other Porifera indet. sp.”, “Hydrozoa indet. sp.”, “other Cnidaria indet. sp.”). Individuals of 27 species could be identified. Other taxa are unidentified sponges (seven), holothuroideans (two), ascidians (four), cnidarians (two), spirorbis (one) plus the pooled *Convexella magellanica/Primnoella chilensis* (for the complete list of taxa, see table A1). For comparing community compositions, the focus was set on phyla, since most organisms could not be identified to lower taxonomic levels.

In each zone, abundances were highest for annelida (Fig. 5), mainly due to genus spirorbis (class polychaeta). Cnidarians showed second highest values, followed by sponges in Zones 2 and 3 (chordates and sponges in Zone 1). All other phyla constitute less than 1% to total.

3.4 Ecological indices

Overall comparison between different bathymetric zones showed the highest *S*-value (9.07 ± 0.24; Fig. 6) at Zone 2, followed by Zone 3 (8.58 ± 0.40) and Zone 1 (6.42 ± 0.47). *H´*-values were 2.04 ± 0.03 (Zone 2), 2.00 ± 0.05 (Zone 3), and 1.69 ± 0.08 (Zone 1). The highest *d*-value (2.94 ± 0.07) was calculated for Zone 2, followed by Zone 3 (2.84 ± 0.11) and Zone 1 (2.20 ± 0.14). *J´*-values were 0.96 ± 0 (Zone 3), 0.95 ± 0.01 (Zone 2) and 0.94 ± 0 (Zone 1).

The total number of taxa (*S*) ranged between 2.23 ± 0 (Is_Solar, Zone 1) and 9.28 ± 1.00 (CS, Zone 2). It was 9.04 ± 0.27 at station MDD, 8.90 ± 0.28 at station Is_Solar, 7.25 ± 1.65 at station CS, and 6.85 ± 0.89 at station AG. Shannon-Wiener-diversity (*H´*) was 2.05 ± 0.03 at station MDD, 2.01 ± 0.04 at station Is_Solar, 1.82 ± 0.23 at station CS, and 1.75 ± 0.01 at station AG. Margalef´s index (*d*) was highest (2.96 ± 0.08) at station Is_Solar, less at stations MDD (2.82 ± 0.07), AG (2.31 ± 0.50) and CS (2.30 ± 0.34). No relevant differences between the stations (CS: 0.96 ± 0.18; MDD: 0.95 ± 0; Is_Solar: 0.95 ± 0.01; AG: 0.94 ± 0.14) were derived for Piellou´s evenness index (*J´*).

3.5 SIMPER analysis

Taxa characterizing the macroepibenthic community associated with *E. antarctica* in a bathymetric zone or at a station are indicated by the result of SIMPER analysis. In each bathymetric zone genus spirorbis is the taxon contributing the most to total abundance, with up to 42.31% in Zone 1 (Tab. 4). Also the octocorallian *Convexella magelhaenica*/*Primnoella*

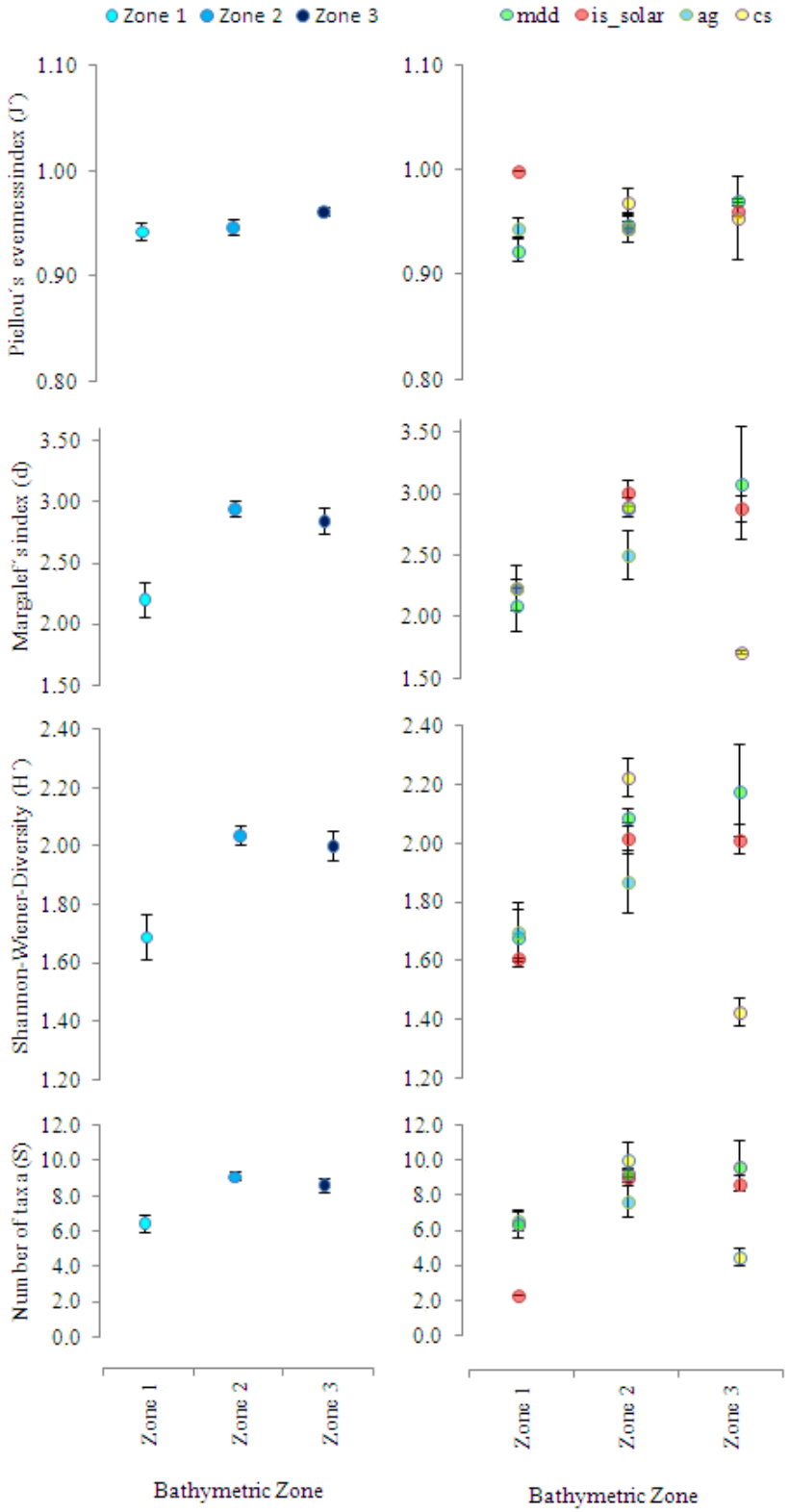

Figure 6: Mean values of *S*, *H´*, *d*, and *J´* in different bathymetric zones (10 m < Zone 1 < 20 m; 20 m < Zone 2 < 30 m; 30 m < Zone 3 < 40 m). Left: overall comparison; right: stations separately. Bars indicate standard errors.

chilensis, two unidentified sponges (Porifera indet. sp. 02 and 04), and hydrozoans are among the most important taxa in each zone.

In Zone 1, > 90% of the average similarity between the samples is made up by the five taxa named above plus an unidentified ascidian (ascidia indet. sp. 01). In this zone the average similarity between the samples is 48.06%.

Additional to the five taxa named above there are seven more contributing to > 90% of similarity in Zone 2. These are the actinarian *Phellia exlex*; the sea urchin *Arbacia dufresnii*; an unidentified taxon (other indet. sp. 04); an unidentified ascidian (Ascidia indet. sp. 01); two more unidentified sponges (Porifera indet. sp. 05 and the pooled group of other Porifera indet. sp.); and the pooled group of unidentified starfishes (Asteroidae indet. sp.). In Zone 2 the average similarity between the samples is 36.24%.

In Zone 3, the average similarity between the samples is 35.68%. The five taxa named above plus five more make up > 90% of this similarity: *A. dufresnii*, an unidentified faunal organism, possibly a sponge (other indet. sp. 04); *P. exlex*; the pooled group of unidentified sponges (other Porifera indet. sp.); and the polychaet *Chaetopterus variopedatus*.

At all stations spirorbis is among the taxa contributing most to total abundace, with a contribution of up to 42.15% at station AG (Tab. 5). An unidentified ascidian (Ascidia indet. sp. 01) is characteristic for MDD, AG, and CS, contributing up to 22.83% to total similarity at station AG. Also an unidentified sponge (Porifera indet. sp. 02) is characteristic for three stations (MDD, Is_Solar, AG), as well as *C. magelhaenica*/*P. chilensis* (Is_Solar, AG, CS). Hydrozoans (Hydrozoa indet. sp.) characterize stations Is_Solar (16.00%), AG (4.66%) and CS (38.56%), being the most contributing taxa at the latter.

The average similarity between samples of station MDD is 57.75%, 90.95% of which is made up by seven taxa. Of these taxa three are unidentified sponges (Porifera indet. sp. 02, 04, and 05). 24.05% is contributed by Spirorbis. An unidentified ascidian (Ascidia indet. sp. 01) and the actinarians *P. exlex* and *Metridium senile* are the other characterizing taxa of station MDD.

At station Is_Solar, 90% of the average similarity between samples (36.70%) is due to 11 taxa: Four unidentified sponges (Porifera indet. sp. 02, 03, 04, and the pooled group of other Porifera indet. sp.) the cnidarians *C. magelhaenica*/*P. chilensis* and *P. exlex*, hydrozoans, *A. dufresnii*, *C. variopedatus* and an unidentified faunal organism, possibly a sponge (other indet. sp. 04), characterize the station, together with the most contributing spirorbis (19.59%).

Table 4 Results of SIMPER-analysis for similarities in bathymetric zones. Average similarity between samples within one zone of depth (10 m < Zone 1 < 20 m; 20 m < Zone 2 < 30 m; 30m < Zone 3 < 40 m), taxa cumulatively contributing > 90% (> 10%; > 5%) and their average abundance (Av.Abund), average similarity between stations (Av.Sim), standard deviation of similarity (Sim/SD), contribution to similarity [%] (Contrib%) and cumulated contribution to similarity (Cum.%).

Zone 1					
Average similarity: 48.06					
Taxon	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spirorbis indet. sp.	3.30	20.33	1.68	42.31	42.31
Ascidia indet. sp. 01	1.47	11.04	2.16	22.97	65.27
Convexella magelhaenica (Studer, 1878) or *Primnoella chilensis* (Philippi, 1894)	1.03	5.77	0.88	12.00	77.27
Porifera indet. sp. 02	0.80	2.77	0.61	5.76	83.03
Porifera indet. sp. 04	0.67	1.78	0.50	3.71	86.74
Hydrozoa indet. sp.	0.61	1.68	0.44	3.50	90.24
Zone 2					
Average similarity: 36.24					
Taxon	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spirorbis indet. sp.	3.03	9.14	0.84	25.22	25.22
Porifera indet. sp. 02	1.34	4.57	0.91	12.61	37.82
Hydrozoa indet. sp.	0.99	3.86	0.76	10.64	48.47
Phellia exlex (McMurrich, 1904)	1.22	3.07	0.60	8.47	56.94
other indet. sp. 04	0.83	2.55	0.63	7.05	63.98
Porifera indet. sp. 04	0.92	2.30	0.63	6.34	70.32
C. magelhaenica/P. chilensis	0.70	2.23	0.53	6.15	76.47
Ascidia indet. sp. 01	0.79	2.05	0.55	5.67	82.14
Arbacia dufresnii (Blainville, 1825)	0.45	1.01	0.37	2.79	84.92
other Porifera indet. sp.	0.45	0.84	0.38	2.32	87.24
Porifera indet. sp. 05	0.48	0.75	0.34	2.06	89.30
Asteroidae indet. sp.	0.36	0.60	0.32	1.65	90.95
Zone 3					
Average similarity: 35.68					
Taxon	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spirorbis indet. sp.	2.92	9.74	0.88	27.29	27.29
C. magelhaenica/P. chilensis	1.03	4.35	0.85	12.18	39.48
A. dufresnii	0.83	3.74	0.74	10.49	49.97
Hydrozoa indet. sp.	0.83	2.86	0.65	8.02	57.99
other indet. sp. 04	0.89	2.80	0.66	7.86	65.84
Porifera indet. sp. 02	0.94	2.57	0.62	7.20	73.04
P. exlex	1.36	2.34	0.47	6.55	79.59
Porifera indet. sp. 04	0.67	1.43	0.48	4.00	83.59
other Porifera indet. sp.	0.55	1.36	0.42	3.82	87.41
Chaetopterus variopedatus (Renier, 1804)	0.45	1.02	0.35	2.87	90.28

Table 5 Results of SIMPER-analysis for similarities at stations. Average similarity between samples within one station, taxa cumulatively contributing > 90% (> 10%; > 5%) and their average abundance (Av.Abund), average similarity between stations (Av.Sim), standard deviation of similarity (Sim/SD), contribution to similarity [%] (Contrib%) and cumulated contribution to similarity (Cum.%).

Station MDD					
Average similarity: 57.75					
Taxon	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spirorbis indet. sp.	3.82	13.89	1.43	24.05	24.05
Porifera indet. sp. 02	2.16	10.82	3.73	18.73	42.79
Porifera indet. sp. 04	1.62	7.08	1.98	12.25	55.04
Ascidia indet. sp. 01	1.42	6.53	1.63	11.31	66.35
Phellia exlex (McMurrich, 1904)	1.8	5.67	0.94	9.81	76.16
Metridium senile (Linnaeus, 1761)	1.58	5.42	0.84	9.39	85.55
Porifera indet. sp. 05	1.00	3.12	0.87	5.40	90.95
Station Is_Solar					
Average similarity: 36.70					
Taxon	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spirorbis indet. sp.	2.55	7.19	0.68	19.59	19.59
Hydrozoa indet. sp.	1.20	5.87	1.07	16.00	35.59
Convexella magelhaenica (Studer, 1878)/ *Primnoella chilensis* (Philippi, 1894)	1.03	4.68	0.90	12.75	48.34
other indet. sp. 04	1.06	4.26	0.88	11.60	59.94
Arbacia dufresnii (Blainville, 1825)	0.74	2.96	0.66	8.07	68.01
Porifera indet. sp. 02	0.86	2.35	0.59	6.39	74.40
P. exlex	1.05	2.11	0.47	5.76	80.16
Chaetopterus variopedatus (Renier, 1804)	0.51	1.24	0.38	3.39	83.55
other Porifera indet. sp.	0.50	1.08	0.39	2.93	86.49
Porifera indet. sp. 03	0.53	1.05	0.41	2.87	89.35
Porifera indet. sp. 04	0.55	0.96	0.39	2.62	91.98
Station AG					
Average similarity: 52.22					
Taxon	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spirorbis indet. sp.	3.69	22.01	1.96	42.15	42.15
Ascidia indet. sp. 01	1.61	11.92	2.09	22.83	64.98
C. magelhaenica/P. chilensis	1.16	7.11	1.11	13.61	78.58
Hydrozoa indet. sp.	0.74	2.43	0.58	4.66	83.24
Porifera indet. sp. 02	0.73	2.10	0.52	4.02	87.26
Porifera indet. sp. 03	0.70	1.99	0.51	3.82	91.08
Station CS					
Average similarity: 29.15					
Taxon	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Hydrozoa indet. sp.	1.79	11.24	2.42	38.56	38.56
Spirorbis indet. sp.	3.87	9.98	0.87	34.23	72.78
Ascidia indet. sp. 01	1.43	4.37	0.87	15.00	87.78
C. magelhaenica/P. chilensis	1.00	1.44	0.41	4.93	92.71

Six taxa contribute 91.08% of the 52.22% average similarity of the samples at station AG. These are two unidentified sponges (Porifera indet. sp. 02 and 03), an unidentified ascidian (Ascidia indet. sp. 01), hydrozoans, *C. magelhaenica*/*P. chilensis* and spirorbis, the latter being the most contributing taxon (42.15%).

The average similarity between the five samples of station CS is 29.15%. > 90% of it is made up by four taxa: Hydrozoans, spirorbis, an unidentified ascidian (Ascidia indet. sp. 01) and *C. magelhaenica*/*P. chilensis*.

For further results containing information about the taxa responsible for the dissimilarities between bathymetric zones, stations, and similarities between bathymetric zones at each station, see appendix, tables A2, A3, and A4.

3.6 ANOSIM 1

GR is 0.062 for overall comparison between bathymetric zones, indicating poor distinctness between the zones (Tab. 6). All other R-values for overall comparison of bathymetric zones indicate the same. The highest R-value is 0.196, comparing Zones 1 and 3.

At stations MDD and Is_Solar, R-values for distinctness between Zone 1 and the other zones indicate good distinctness despite some accordance. Poor distinctness is indicated for the comparison of Zones 2 and 3 as well as at station AG, where Zones 1 and 2 were compared.

For more results containing information about the distinctness between stations see appendix, Table A5.

Table 6 R-values of ANOSIM 1 for bathymetric zones (10 m < Zone 1 < 20 m; 20 m < Zone 2 < 30 m; 30 m < Zone 3 < 40 m). Clear (R > 0.75), good (0.25 < R < 0.75) and poor distinctness (R < 0.25); GR=Global R.

GR: 0.062	Zone 1	Zone 2
Zone 2	0.055	-
Zone 3	0.196	0.047

Table 7 R-values of ANOSIM 1 for bathymetric zones (10 m < Zone 1 < 20 m; 20 m < Zone 2 < 30 m; 30 m < Zone 3 < 40 m) at stations. Clear distinctness (R > 0.75), good distinctness (0.25 < R < 0.75) and poor distinctness (R < 0.25).

MDD	Zone 1	Zone 2
Zone 2	0.341	
Zone 3	0.568	0.095
Is_Solar	Zone 1	Zone 2
Zone 2	0.537	
Zone 3	0.451	0.044
AG	Zone 1	
Zone 2	0.234	

3.7 Cluster and MDS analysis

Due to the huge amount of samples, dendrograms of the Cluster-analysis of overall comparison (available at Winkler et al., 2013) and that of station Is_Solar (see appendix, Fig. A2) are very unclear and therefore nearly impossible to interpret. At stations MDD and AG (see appendix, Fig. A1 and A3) no grouping among bathymetric zones was detected either.

MDS-plot of bathymetric zones shows no clear distinctness between zones (Fig. 7). All but one sample of Zone 1 have a similarity of > 30%. Samples of the other bathymetric zones are widely spread in the plot. The stress-value of 0.23 points towards easy misinterpretation (Clarke and Warwick, 2001), thus the analysis of the plot should be treated with care.

Stations are distinguishable, as the samples of each station are being grouped together (Fig. 8). Samples of station CS are an exception. Again, the stress-value is 0.23.

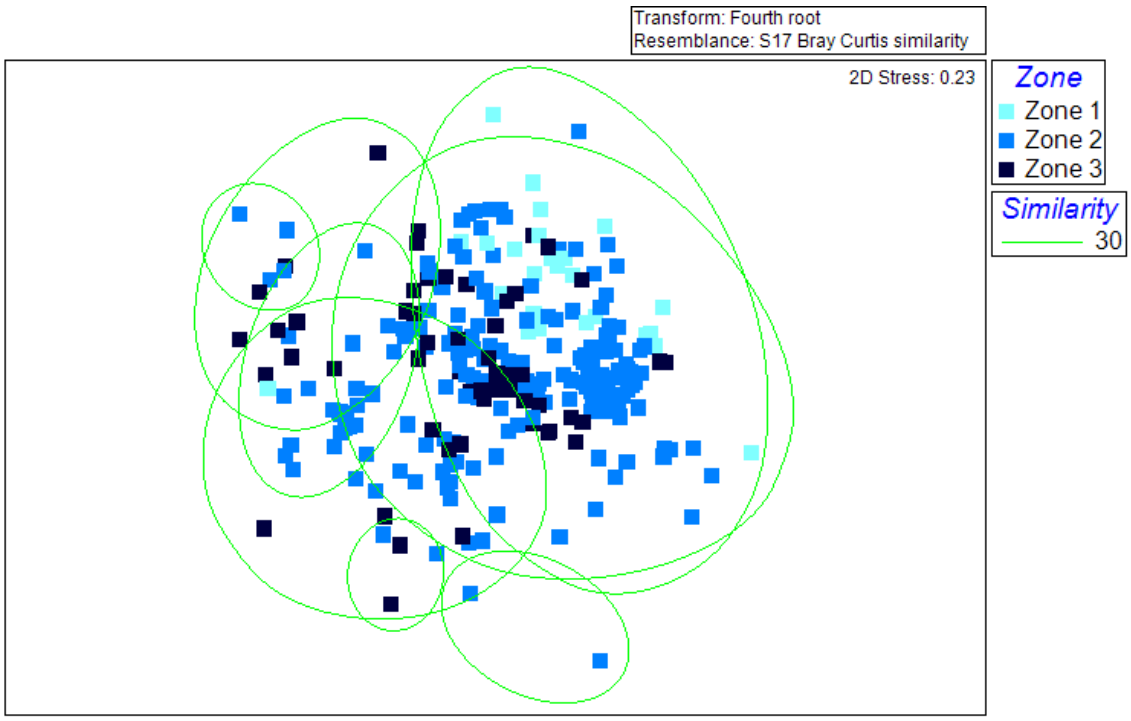

Figure 7: MDS-plot visualizing distinctness between samples of bathymetric zones (10 m < Zone 1 < 20 m; 20 m < Zone 2 < 30 m; 30m < Zone 3 < 40 m). The green line indicates a similarity of 30%.

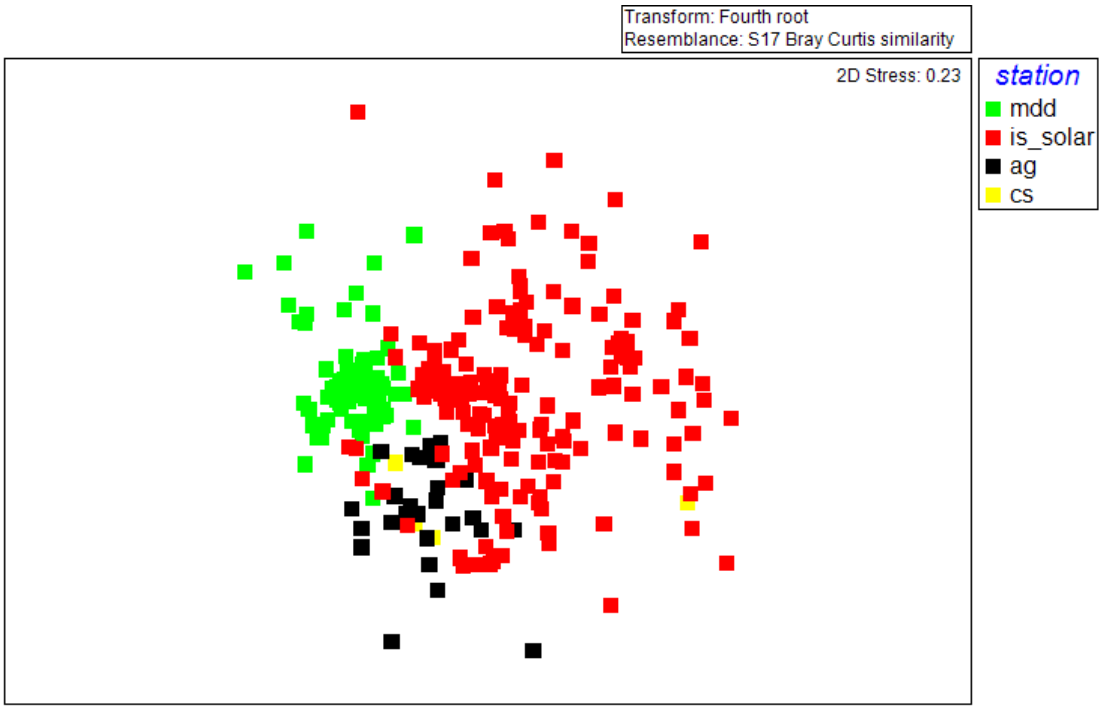

Figure 8: MDS-plot visualizing distinctness between samples of the stations MDD, Is_Solar, a, and CS.

4 Discussion

4.1 Methods

Extracting images from ROV-recorded videos seems to be a good method for providing a great amount of samples in relatively good quality. Nonetheless, certain aspects of the methods used in this investigation are to be discussed.

Grouping of samples into zones bordering each other is problematic, as two samples of one zone can bathymetrically be further apart (in this study, up to 10 m) than two samples of different zones, which can be taken from almost the same depth. This may result in low distinctness between groups of samples. It is possibly a major reason for the results of this study. Collecting samples along transects of defined depths as described by Laudien and Orchard (2012) avoids this effect. The greater distinctness between Zones 1 and 3 (compared to that between Zones 1 and 2, 2 and 3, respectively) possibly illustrates this effect and indicates that zones not bordering each other are more suitable for investigating differences between zones.

Possibly the biggest source of errors was the problematic taxonomic identification of macroepibenthic organisms from ROV-videos. Even though exclusively images of good quality were used, it was not always possible to identify every organism in the images, and sometimes structures could not even be doubtlessly identified as faunal organisms. For this reason, there are many unidentified species, especially in the taxa of porifera and ascidians. On the other hand, some larger organisms, e.g. echinodermata, could often be identified to species level.

Another problem of the underwater imagery approach is that of the varying distance between ground and camera. Usually, the closer the camera gets, the more detailed the image appears, providing a bigger chance to notice and identify small faunal organisms. The method of extracting images from ROV-videos is applicable only for organisms larger than 0.5 cm (Laudien and Orchard, 2012). It is very likely that many small organisms were not noticed during the analysis of the images. The low impact of molluscs and bryozoans to the overall distribution of phyla in the macroepibenthic community (Fig. 5) can probably be explained by the fact that small organisms could hardly be noticed in the samples. It was tried to define a maximum distance between camera and ground applicable for a sufficient chance of identification of macroepbenthic organisms. Distance is not the only factor influencing the quality of an image. The factor of blurriness due to ROV-movement or underwater sight

contributes to the problem of not being able to identify macroepibenthic organisms. Thus, a picture taken from a relatively great distance can still provide better possibility for identification of the organisms in it than a blurry picture taken from a relatively small distance. For this reason, it was not possible to define a maximum distance. Instead, the usability of an image was decided about by sight. It turned out that images taken from a distance greater than approximately 2.5 m were not suited for further use, but this value does not apply for all dive sites. In total two images taken from a distance greater than 2.5 m were used, one from station AG (distance=2.54 m), and one from station MDD (distance=2.56 m).

The difficulties with identification of macroepibenthic organisms from ROV-videos suggest the use of other methods, which might provide a better possibility for identification of macroepibenthic organisms. During some of the dives the ROV was accompanied by a SCUBA-diver, who was taking pictures of *E. antarctica* (one of these pictures is displayed in Figure 1). These high quality pictures show numerous species, e.g. the barnacle *Ornatoscalpellum gibberum* (for a list of species identified on these pictures, see appendix, Table A6), that were not identified on images extracted from the ROV-videos. It is very likely that these species occur on some of the ROV-images as well, but could not be identified or even noticed there. Thus, the macroepibenthic community could not be comprised completely with the methods used in this investigation.

Identification of small macroepibenthic organisms might be ensured either by taking high quality images during SCUBA-dive, or by collecting of organisms and their identification aboard, which is a destructive method. Organisms of down to 0.3 cm can be identified using SCUBA-based underwater photography (Beuchel and Gulliksen, 2008). SCUBA-diving is only applicable for a maximum depth of 40 m (Häussermann and Försterra, 2007a). In the german guideline for scientific diving (Deutsche Gesetzliche Unfallversicherung, 2001), 50 m is the maximum admissible depth, but costly safety equipments and devices are required to dive deeper than approximately 30 m.On the one hand, this might not seem sufficient for investigations on communities associated with *E. antarctica*, a species abundant as deep as 771 m (Häussermann and Försterra, 2007b) and in a fjord region with a maximum depth of approximately 1,200 m (Häussermann and Försterra, 2009). On the other hand, the samples used in this investigation were not taken deeper than 39.40 m, being just within reach of SCUBA-diving. Thus, for a study in a comparable range of depth, SCUBA-diving is an appropriate alternative to the ROV. Economic considerations

might draw a different picture, of course: Conducting the investigation with SCUBA-divers would hardly have provided a comparable amount of samples without enormous financial and safety-related efforts, especially in an area as remote as the Chilean fjord region.

Collecting organisms would probably be the best method in terms of identification of macroepibenthic organisms, since each individual can be identified with great care and accuracy. However, it is a rather destructive method, and the damage caused should be taken into concern, especially in an environment like the cold-water coral systems of Patagonia, which is highly threatened by human activities (see chapter 1.5).

4.2 The influence of bathymetry on community composition

4.2.1 Discussion of statistical results

The results suggest that bathymetry does not significantly influence the macroepibenthic community associated with *E. antarctica* within the investigated depth of 10–40 m. Neither distribution of phyla, nor ecological indices or R-values of ANOSIM 1 indicated significant differences between the underlying bathymetric zones of 10–20 m, 20–30 m, and 30–40 m.
However, in overall comparison the R-value showing distinctness between Zones 1 and 3 is the highest (0.196; Tab. 6). The same applies to station MDD. This might point toward a slight influence of depth on the community, but the result is far from being significant.

In contrast to the results of ANOSIM 1 for overall comparison, R-values point towards better distinction when looking at stations separately (Tab. 7). This might found in dissimilarities of stations. It is possible that e.g. samples of Zone 2 at station Is_Solar are similar to such of Zone 1 at station MDD. Pooling these samples would result in a low R-value for the distinctness between Zones 1 and 2. As each station has its own characteristics (see chapter 4.3), such effects are likely to occur.

Disregarding its high stress-value (0.23), also the MDS-plot (Fig. 7) points to no great distinctness between the bathymetric zones. However, samples of Zone 1 seem to be distributed less heterogeneously than those of Zones 2 and 3. Only one sample of Zone 1 is not within 30% similarity. This is the only sample of station Is_Solar contributing to Zone 1, so the difference to the other samples of Zone 1 is explicable by differences between stations. Samples of the other zones are spread out over the whole graph. Results of SIMPER (highest similarity in Zone 1; Tab. 4) and a Cluster-analysis containing the three bathymetric zones which was carried out to check the trend found in the MDS-plot (Zones 2 and 3 part at 83.5%

similarity, while Zone 1 parts at of 66% similarity; Fig. A4) strengthen the interpretation of the MDS-plot. The homogeneity of samples of Zone 1 matches the zones relatively low diversity.

4.2.2 Distribution of phyla

Distribution of phyla is similar in the zones (Fig. 5). All three are dominated by annelids; apart from cnidarians, sponges, and chordates, no phylum contributed more than 1% to the characterization of any zone. The greatest differences to be seen between the zones are the relatively low contribution of cnidarians in Zone 2, and the relatively high contribution of chordates in Zone 1. However, these do not influence the overall impression. The contribution of polychaetes increases with depth in a range between 30 and 200 m in Spitsbergen (Laudien and Orchard, 2012), and Montiel et al. (2011) found diversity of polychaetes higher in depths above 120 m than in deeper waters in the Magellan Strait. A connection of number or diversity of polychaetes with depth was not observed during the present study, but cannot be negated due to the low maximum sampling-depth of 39.40 m. Since in Montiel et al. (2011) only diversity between shallow water (down to 120 m) and deep water (beneath 120 m) were compared, no conclusions can be drawn concerning changes on a smaller scale. Diversity of polychaetes was not investigated in the present study, and the methods used did not allow for identification down to species level for genus spirorbis. In Laudien and Orchard (2012) the trend of contribution to total abundance increasing with depth is cognizable between 30 and 50 m already. These depths are comparable with Zone 3 of the present study, in which contribution of annelids is the lowest (76.5 % in Zone 1; 87.0 % in Zone 2; 74.8 % in Zone 3). These results do not provide any trend concerning the contribution of annelids to total distribution of phyla.

4.2.3 Ecological indices and distribution of *E. antarctica*

The impression of macroepibenthic community strucutre not being influenced by bathymetry is strengthened by the results for Piellou's evenness index (*J'*), which is nearly the same for all three zones (Fig. 6). In contrast, *S*-, *H´*- and *d*-values differ between zones: They are lower in Zone 1 than in Zones 2 and 3. This applies to each station separately (apart from station CS, which contains no samples for Zone 1) as well as to overall comparison (Fig. 6). Bringing these results into relation is difficult, because bathymetric effects on macroepibenthic communities in shallow waters of Patagonia have not been investigated so far. From other

studies, diversity decreasing with depth (Laudien and Orchard, 2012) has been reported as well as diversity not being influenced by depth (McClain et al., 2010; Tecchio et al., 2011) or increasing with depth (Jones et al., 2007; Tecchio et al., 2011). None of these studies refer to the area or range of depth investigated in the present one, though. Hermann (2006) investigated macrozoobenthic infauna of shallow waters (5–30 m) at Kongsfjorden (Svalbard, Spitsbergen). In his study, diversity was highest in depths of 10-15 m (Zone 1, respectively), decreasing with depth. These results are in contrast to the findings of the present study. The contradiction can be explained by Intermediate Disturbance Hypothesis (IDH). In Kongsfjorden grounded icebergs frequently disturb shallow-water communities, which results in a lower diversity. The influence of grounded icebergs decreases with depth, and in depths of 10–15 m (Zone 1, respectively) the intermediate disturbance frequency allows greater diversity. In deeper water there are still less disturbances, and in line with the IDH diversity is lower here (Herrmann, 2006). The Chilean fjord region is strongly influenced by icefields (Pantoja et al., 2011), but to the best of our knowledge its benthic communities are not affected by grounded icebergs. This is due to the geography of the region, which is characterized by the steep slopes of the fjords providing the main habitat for benthic communities (see chapter 1.1), rather than by shallow, gently sloped areas, on which grounded icebergs can affect benthic communities.

The samples of Zone 1 are made up for 73% by samples of station AG (Tab. 2). At this station *S*-, *H´*- and *d*-values are lower than at the other stations (apart from *d* at CS, which is 0.01 lower than at AG; Fig. 6). The high influence of samples from station AG in Zone 1 strengthens the trend of the result in overall comparison (see chapter 4.3). Nonetheless, also six samples of station MDD and one sample of station Is_Solar contributing to Zone 1 show lower *S*-, *H´*- and *d*-values here than in the other zones. Furthermore, the findings are strengthened by the results of SIMPER (Tab. 4): There are the least taxa contributing to 90% of similarity within Zone 1 (6 in Zone 1, 12 in Zone 2, 10 in Zone 3). This also suggests a low diversity for this Zone.

Although the standard error of small colonies in Zone 1 (SE = 11.77) is rather high, distribution of *E. antarctica*-colonies helps to explain the results. As *E. antarctica* is considered habitat forming (Häussermann and Försterra, 2009) and providing substrate for numerous species (Häussermann and Försterra, 2007b), it can be assumed that *S*-, *H´*- and *d*-values increase with abundance of *E. antarctica*. Relative portions of medium-sized and

(minimally) large *E. antarctica*-colonies increase with depth (Fig. 4). Possibly the impact of small colonies on diversity of the associated fauna is smaller than that of medium-sized and large ones. This would explain why *S*-, *H´*- and *d*-values are smaller in Zone 1, which is characterized by high abundances of small *E. antarctica*-colonies, than they are in Zone 2 and 3, which contain less small but more medium-sized and large colonies.

The appearance of *E. antarctica* between 14.13 m and 39.40 m fits in well with what has been reported from the Chilean fjord region (Häussermann and Försterra [2007b]: 10–40 m; Häussermann and Försterra [2007a]: below 10 m). In the region it can be found in depths of down to 119 m (Häussermann and Försterra, 2009). Distribution of *E. antarctica*-colonies in the bathymetric zones (Fig. 4) leads to the question why there are more small colonies but less medium-sized and large ones in Zone 1. Collecting of bigger colonies by divers as described by Häussermann and Försterra (2007a) might be an explanation. Shallow waters are well accessible for divers, so in Zone 1 colonies big enough to be sold as souvenirs can easily be harvested. Miller et al. (2004) found damage to colonies of *Errina novaezelandiae* in New Zealand´s fjords up to eight times higher in dived than in not-dived areas, large colonies being more affected. They also found the distribution pattern examined for *E. antarctica* in the present study, with small colonies being the most abundant (Miller et al., 2004). If it is true that medium-sized and big colonies have a greater impact on diversity, the harvesting of large colonies would directly lead to a decrease of diversity in Zone 1.

Another hint of the damaging effects of divers and their collecting of *E. antarctica*-colonies is provided by an interesting observation recorded during some of the ROV-dives.

Figure 9: Rubble of *E. antarctica* and empty shells of bivalvia (probably *Aulacomya atra*) at horizontal, perturbed spots at station MDD.

As stated above, Häussermann and Försterra (2007b) found reef-like structures with up to 80% coverage of *E. antarctica* in Madre de Dios archipelago near station MDD. No comparable structures were found during this investigation. Instead, at horizontal spots with perturbed water a great amount of *E. antarctica*-rubble was

observed, which in great portions consisted of parts of colonies recently damaged (identified by the still redish colour; Fig. 9). It possible that this damage was caused by divers collecting colonies and breaking some of them while doing so.

4.3 Characterisation of stations by abiotic parameters

In the MDS-plot visualizing the distinctness between samples of the four stations investigated (Fig. 8) a clear grouping of samples can be observed. Only the samples of station CS are not being grouped together. The distinctness between the stations, resulting from differences in the surveyed benthic community, can probably be explained by the abiotic parameters, which were measured during the dives and characterize the respective station.

One main difference between station MDD and the other stations is substratum. At MDD it is limestone, at the other stations Patagonian Batholith (Sepúlveda et al., 2010), which is granite (Bartole et al., 2008). Interestingly, pH is highest at AG and CS, but not at MDD. The difference (max. at MDD: 8.27; max. at CS and AG: 8.30) is minimal. At station Is_Solar the values of pH are in a similar range (8.13–8.18). It is a curious result that abundance of small *E. antarctica*-colonies is approximately 30 times lower at station MDD than it is at station Is_Solar (Fig. 4). Abundances of medium-sized and large colonies are in similar ranges at MDD and the other stations. As described in chapter 2.1, during rain there is a lot of limestone being washed into the sea. For *E. antarctica* and other calcareous organisms this condition should be beneficial on the one hand. On the other hand, large amounts of sediment can be a threat to cold-water corals (Freiwald et al., 2004). This might apply to small colonies especially, because they can easily be smotherd by sediments, explaining the relatively low abundance of small *E. antarctica*-colonies at station MDD.

No clear relation between pH and depth is evident. At stations AG and CS pH seems to decrease with depth, while at MDD the opposite is cognizable. At Is_Solar no relation with depth was detected. Instead, pH increases with time during each dive at this station, which might either indicate inaccurate measurement, or be caused by continuous changes in the water body due to currents, tides or changing ROV-position.

Häussermann and Försterra (2009) provide a general grouping of water masses based on salinity values. Following this classification, salinity of stations MDD and Is_Solar can be allocated with SAMW ($31 < \text{salinity} < 33$), which is the result of mixing between EW from the surface and subantarctic water flowing inwards subsurface (see chapter 1.1). Stations AG

and CS are identified as salty-EW (21 < salinity < 31). This applies well for AG and Is_Solar, since the samples of AG are from relatively shallow, those of Is_Solar from relatively deep water (see Tab. A7). EW forms the upper layer, SAMW a lower layer (Wichmann et al., 2012). Samples of CS are from relatively deep water, contradicting this model. It should be kept in mind that only five samples were taken at CS, which might result in little resilience of results taken from this station. In accordance with numerous ivestigations from the Chilean fjord region (Galea et al., 2007; Pantoja et al., 2011; Häussermann et al., 2012), salinity increases with depth at all four stations.

No trend can be derived from temperatures measured. They seem to decrease with depth at stations Is_Solar and CS, whereas at station AG no relation is cognizable. The same applies for MDD, although a slight increase with depth can be suspected here. In accordance with Häussermann and Försterra (2009) temperatures at the station closest to the equator, which is station MDD, are higher than at the other stations.

Oxygen saturation and concentration follow the same pattern. At stations MDD and CS a decrease with depth is cognizable, while no trend is observed at station AG. At station Is_Solar values increase with time, which might indicate inaccurate measurement. Here, the values are considerably lower than at other stations. For oxygen concentration this is contradictory, since mean temperatures are lowest at this station.

It should be kept in mind that the dives were conducted over a period of eight days (Table 1) and in different weather conditions. These factors might affect the results, since stronger winds lead to vertical mixing, air temperature affects that of surface water and so forth. Nonetheless, it is rather likely that the differences between abiotic parameters measured during the dives map the characteristics of the four stations.

These characteristics are important for the results of comparison between bathymetric zones, because portions of stations contributing to each bathymetric zone differ strongly (Tab. 2). Characteristics of a station contributing more samples than another station to one bathymetric zone have a stronger impact on that zone than the latter station. Vice versa, one may conclude that characterics of a bathymetric zone, and with it the benthic community thriving in it, are highly dependent on what station contributed most samples to that zone. Consequently, the influence of the characteristics of a station can be stronger than influence of depth on the macroepibenthic community, especially if the bathymetric zone is almost exclusively made up by samples of that station. This may complicate the evaluation of

bathymetry´s influence on macroepibenthic communities. The MDS-plots illustrate, that characteristics of the bathymetric zones investigated differ less than those of the four stations: no grouping is observed when samples are allocated to bathymetric zones (Fig.7). In contrast, there is a clear clustering of samples when allocated to stations (Fig. 8). Thus, in the present study the macroepibenthic community was influenced by sampling site rather than by sampling depth.

4.4 Macroepibenthic community

Community composition of all zones was dominated by annelids (Fig. 5), mainly of genus spirorbis (class polychaeta). This agrees with numerous studies describing polychaetes contributing essentially to macrobenthic communities in the Chilean fjord region (e.g. Thiel and Ullrich, 2002; Montiel et al., 2005; Quiroga et al., 2012). Laudien and Orchard (2012) found shallow (30 and 50 m depths, respectively) hard-bottom communities of Kongsfjorden (Svalbard, Spitsbergen) dominated by rhodophyta (flora was not included in the present study). Other important taxa in Laudien and Orchard (2012) were sponges, anthozoans (cnidarians) and, again, polychaetes. All these groups play major roles in the present study, too. The benthic community described in an investigation from the fjord-like Bathurst Channel in Tasmania (Barrett and Edgar, 2010) also shows similarities to that found during the present study: *Primnoella* spp. and *Clavularia* sp. are taxa observed in both investigations, as are sponges and bryozoans. Algae were dominant in low waters in Barrett and Edgar (2010), but were, as stated above, not included in the present study. The great amounts of mussels (*Mytilus* sp.) surveyed in Bathurst Channel are in contrast to the present study, during which only five individuals of bivalvia were observed. This might be due to the greater depth investigated here. Müller (2012) found *M. chilensis* occurring exclusively in the intertidal in Comau fjord in the Chilean fjord region. *Alaucomya atra*-abundances were highest in a depth of 5 m and decreased drastically with depth. It is therefore likely that also in the present study mussels occur in shallower waters in the investigated area, but are not associated with *E. antarctica*, which occurs in greater depths. At station MDD lots of empty mussel-shells, probably *Aulacomya atra*, were observed in perturbed spots were gravel and rubble accumulated (Fig. 9). This finding also points towards the presence of bivalvia in the investigated area.

Other studies (Roux et al., 1995; Newcombe and Cárdenas, 2011) using underwater photography found hard bottom substrate in San-Jose Gulf (Argentina) and the Magellan Strait, respectively, characterized by ascidians and bryozoans (plus sponges, respectively). In the present study, all these taxa were present, and ascidians (chordates; only in Zone 1) and sponges added noticeably to the overall composition of phyla (Fig. 5). Neither Roux et al. (1995) nor Newcombe and Cárdenas (2011) observed the dominance of polychaetes (12% of total abundance in Roux et al., 1995; none in Newcombe and Cárdenas, 2011) surveyed during the present study. Differences in the substrate investigated (gravel and sand in Roux et al., 1995) and in the methods used (neglect of organisms < 2 cm in Newcombe and Cárdenas (2011) explain these differing results.

Most of the species reported to live on *E. antarctica* by Häussermann and Försterra (2007b) were encountered in the present study. These are the ophiurid *Gorgonocephalus chilensis*, the sea anemone *Metridium senile*, the polychaet *Chaetopterus* sp., the decapod *Pagurus comptus*, the starfish *Lophaster stellans* and the sea urchin *Arbacia dufresnii*. Furthermore, "*various not yet identified sponges and bryozoans*" (Häussermann and Försterra, 2007b) are mentioned to occur near *E. antarctica*, and it is likely that these match some of the unidentified sponges and bryozoans surveyed during the dives of the expedition on hand. The ophiurid *Ophiacantha rosea*, which was also found to live on *E. antarctica* (Häussermann and Försterra, 2007b), has not been identified during the present study, but could be the ophiurid present on some of the pictures taken by a SCUBA-diver joining the ROV during some of the dives (see Fig. 1; Tab. A6).

The high influence of *C. maghelaenica/P. chilensis*, as found in Zones 1 and 3 (Tab. 4), is reported for the Chilean fjord region, the latter even being considered habitat-forming (Häussermann and Försterra, 2007a; 2009).

4.5 Conclusions and outlook

In the investigated bathymetric range of 10–40 m, no evidence of depth significantly influencing the structure of macroepibenthic communities associated with *E. antarctica* was found. Differences between the three zones were rather small in overall comparison; similarities between samples seem to be higher in Zone 1 than in the other zones. It seems that bathymetric effects on the communities are overlain by the differences between the diving-

stations. On a smaller scale, when looking at the four stations separately, distinctness between bathymetric zones is more evident.

Two strategies are suggested for future studies to avoid the effect of locational factors overlaying bathymetrical ones: Investigations could

a) focus on a more specific environment, e.g. on communities occurring exclusively on limestone, diminishing differences between characterisitcs of the sampling sites, or

b) cover a wider range of sampling sites to gain knowledge about the situation in the whole fjord region. For this strategy it is advisable to collect an equal number of samples from each site and bathymetric zone. The influence of each site on the results would then be equally strong.

For both strategies it is recommended to compare samples collected in defined depths (e.g. 15 m, 25 m, 35 m) rather than in bathymetric zones bordering each other (e.g. (10 m < Zone 1 < 20 m; 20 m < Zone 2 < 30 m; 30 m < Zone 3 < 40 m), since in the latter case samples of two different zones can be taken from almost exactly the same depth, while samples within one zone can be taken from the whole range of depth of that zone.

The distribution pattern described by Miller et al. (2004) for *E. novaezelandiae* seems to apply to *E. antarctica* as well: Abundance of small colonies is clearly higher than that of medium-sized and large colonies in Zone 1. It decreases drastically with depth, possibly due to divers harvesting large colonies in shallow water. Diversity of macroepibenthic community increases with relative abundance of medium-sized and large colonies, leading to the conclusion, that harvesting of large colonies is likely to be extremely harmfull to communities associated with *E. antarctica.*

The investigation at hand describes the macroepibenthic community associated with *E. antarctica* quantitatively for the first time. It is desirable that it may help to better understand one aspect of the diverse ecosystem of the Chilean fjord region and to promote the struggle for protection of the area. Considering the threats described in chapter 1.5 and the destruction of *E. antarctica*, which was also evident during this investigation (see Fig. 9), it seems crucial to provide efficient protection for the benthic communities of the Chilean fjord region. To achieve this goal, knowledge about the endangered ecosystems should be gathered rather quickly. Otherwise many of the species and secrets assumed to occur in the region might remain unrevealed to science.

Literature

Arntz, W.E. (1999): *Magellan-Antarctic: ecosystems that drifted apart. Summary review*. In: Arntz W.E. and Ríos C (eds.): *Magellan-Antarctic: ecosystems that drifted apart*. Institut de Ciències del Mar, C.S.I.C.: 503–511.

Barrett, N.S. and Edgar, G.J. (2010): *Distribution of benthic communities in the fjord-like Bathurst Channel ecosystem, south-western Tasmania, a globally anomalous estuarine protected area*. Aquatic Conservation: Marine and Freshwater Ecosystems, 20: 397–406.

Bartole, R., de Muro, S., Morelli, D. and Tosoratti, F. (2008): *Glacigenic features and tertiary stratigraphy of the Magellan Strait (Southern Chile)*. Geologica Acta, 6: 85–100.

Beuchel, F. and Gulliksen, B. (2008): *Temporal patterns of benthic community development in an Arctic fjord (Kongsfjorden, Svalbard): results of a 24-year manipulation study*. Polar Biology, 31: 913–924.

Bo, M., Bertolino, M., Bavestrello, G., Canese, S., Giusti, M., Angiolillo, M., Pansini, M. and Taviani, M. (2012): *Role of deep sponge grounds in the Mediterranean Sea: a case study in southern Italy.* Hydrobiologia, 687: 163–177.

Bosch, T., Colijn, F., Ebinghaus, R., Körtzinger, A., Latif, M., Matthiessen, B., Melzner, F., Oschlies, A., Petersen, S., Proelß, A., Quaas, M., Requate, T., Reusch, T., Rosenstiel, P., Schrottke, K., Sichelschmidt, H., Siebert, U., Soltwedel, R., Sommer, U., Stattegger, K., Sterr, H., Sturm, R., Treude, T., Vafeidis, A., van Bernem, C., van Beusekom, J., Visbeck, M., Wahl, M., Wallmann, K. and Weinberger, F. (2010): *Wie der Klimawandel die Chemie der Meere verändert*. In: *World Ocean Review* (Bosch, T., Colijn, F., Ebinghaus, R., Körtzinger, A., Latif, M., Matthiessen, B., Melzner, F., Oschlies, A., Petersen, S., Proelß, A., Quaas, M., Requate, T., Reusch, T., Rosenstiel, P., Schrottke, K., Sichelschmidt, H., Siebert, U., Soltwedel, R., Sommer, U., Stattegger, K., Sterr, H., Sturm, R., Treude, T., Vafeidis, A., van Bernem, C., van Beusekom, J., Visbeck, M., Wahl, M., Wallmann, K. and Weinberger, F., edts.). maribus GmbH, Hamburg: 234 pp.

Bray, J.R. and Curtis, J.T. (1957): *An ordination of the upland forest of the Southern Wisconsin.* Ecological Monographs, 27: 325–349.

Clarke, K.R. and Gorley, R. (2006): *PRIMER v6: User Manual/Tutorial.* PRIMER-E, Plymouth: 192 pp.

Clarke, K.R. and Warwick, R.M. (2001): *Change in marine communities: an approach to statistical analysis and interpretation, 2nd edition.* PRIMER-E, Plymouth: 174 pp.

Deutsche Gesetzliche Unfallversicherung (2001): *Einsatz von Forschungstauchern BGR/GUV-R 2112.* 72 pp.
URL: http://publikationen.dguv.de/dguv/pdf/10002/r-2112.pdf (04/17/2013)

Dumas, P., Bertaud, A., Peignon, C., Leopold, M. and Pelletier, D. (2009): *A "quick and clean" photographic method for the description of coral reef habitats.* Journal of Experimental Marine Biology and Ecology, 368: 161–168.

Escribano, R., Fernández, M. and Aranis, A. (2003): *Physical–chemical processes and patterns of diversity of the Chilean eastern boundary pelagic and benthic marine ecosystems: an overview*. Gayana Zoología, 67: 190–205.

Faith, D.P., Minchin P.R. and Belbin L. (1987): *Compositional dissimilarity as a robust measure of ecological distance.* Vegetatio, 69: 57–68.

Fosså, J.H., Mortensen, P.B. and Furevik, D.M. (2002): *The deep-water coral* Lophelia pertusa *in Norwegian waters: distribution and fishery impacts.* Hydrobiology, 471: 1–12.

Freiwald, A., Fosså, J.H., Grehan, A., Koslow, T. and Roberts, J.M. (2004): *Cold-water coral reefs.* UNEP-WCMC, Cambridge: 85 pp.

Galea, H.R., Häussermann, V. and Försterra, G. (2007): *List of species.* Check-List 2007, 3(2): 159–167.

Häussermann, V. and Försterra, G. (2007a): *Large assemblages of cold-water corals in Chile: a summary of recent findings and potential impacts.* Bulletin of Marine Science, 81: 195–207.

Häussermann, V. and Försterra, G. (2007b): *Extraordinary abundance of hydrocorals (Cnidaria, Hydrozoa, Stylasteridae) in shallow water of the Patagonian fjord region.* Polar Biology, 30: 487–492.

Häussermann, V. and Försterra, G. (eds.) (2009): *Marine benthic fauna of Chilean Patagonia*. Nature in Focus, Santiago: 1000 pp.

Häussermann, V., Försterra, G. and Plotnek, E. (2012): *Sightings of marine mammals and birds in the Comau Fjord, Northern Patagonia, between 2003 and mid 2012*. Spixiana, 35: 247–262.

Herrmann, M. (2006): *Macrozoobenthos communities of Arctic softbottom: Structure and importance as a food basis for demersal fishes.* Reports on Polar and Marine Research, 528: 82 pp.

Jantzen, C., Laudien, J., Sokol, S., Försterra, G., Häussermann, V., Kupprat, F. and Richter, C. (2013): In situ *short-term growth rates of a cold-water coral*. Marine and Freshwater Research, in press.

Jones, D.O.B., Bett, B.J. and Tyler, P.A. (2007): *Depth-related changes in the arctic epibenthic megafaunal assemblages of Kangerdlugssuaq, East Greenland.* Marine Biology Research, 3: 191–204.

Katz, J. (2006): *Salmon farming in Chile*. In: *Technology, adaptation, and exports: How some developing countries got it right* (Chandra, V., ed.). The international bank for reconstruction and development/The world bank, Washington: 193–224.

Kruskal, J.B., Wish, M. (1978): *Multidimensional scaling*. Sage University Paper Series on Quantitative Applications in the social Sciences, 11: 93 pp., Sage Publications, Newbury Park, CA.

Laudien, J. and Orchard, J.-B. (2012): *The significance of depth and substratum incline for the structure of a hard bottom sublittoral community in glacial Kongsfjorden (Svalbard, Arctic)—an underwater imagery approach.* Polar Biology, 35: 1057–1072.

Levinton, J.S. (1995): *Marine biology – function, biodiversity, ecology.* Oxford University Press, New York, Oxford, 420 pp.

Lirman, D., Gracias, N.R., Gintert, B.E., Gleason, A.C.R., Reid, R.P., Negahdaripour, S. and Kramer, P. (2007): *Development and application of a video-mosaic survey technology to document the status of coral reef communities.* Environmental Monitoring and Assessment, 125: 59–73.

Marquardt, M., Kramer, M., Carnat, G., Werner, I. (2011): *Vertical distribution of sympagic meiofauna in sea ice in the Canadian Beaufort Sea.* Polar Biology, 34: 1887–1900.

McClain, C.R., Lundsten, L., Barry, J. and DeVogelaere, A. (2010): *Assemblage structure, but not diversity or density, change with depth on a northeast Pacific seamount.* Marine Ecology – an Evolutionary Perspective, 31: 14–25.

McCulloch, M., Trotter, J., Montagna, P., Falter, J., Dunbar, R., Freiwald, A., Försterra, G., Correa, M.L., Maier, C., Rüggeberg, A. and Taviani, M. (2012): *Resilience of cold-water scleractinian corals to ocean acidification: Boron isotopic systematics of pH and saturation state up-regulation.* Geochimica et Cosmochimica Acta, 87: 21–34.

Miller, K., Mundy, C.N. and Chadderton, W. L. (2004): *Ecological and genetic evidence of the vulnerability of shallow-water populations of the stylasterid hydrocoral* Errina novaezelandiae *in New Zealand's fiords.* Aquatic Conservation: Marine and Freshwater Ecosystems, 14: 75–94.

Miller, K.J., Rowden, A.A., Williams, A. and Häussermann, V. (2011): *Out of their depth? Isolated deep populations of the cosmopolitan coral* Desmophyllum dianthus *may be highly vulnerable to environmental change*. PLoS ONE 6(5): e19004. doi:10.1371/journal.pone.0019004

Montiel, A., Gerdes, D., Hilbig, B. and Arntz, W.E. (2005): *Polychaete assemblages on the Magellan and Weddell Sea shelves: comparative ecological evaluation.* Marine Ecology Progress Series, 297: 188–202.

Montiel, A., Quiroga, E. and Gerdes, D. (2011): *Diversity and spatial distribution patterns of polychaete assemblages in the Paso Ancho, Straits of Magellan, Chile.* Continental Shelf Research, 31: 304–314.

Müller, J. (2012): *The two mytilids* Aulacomya atra *and* Mytilus chilensis *from the Chilean fjord region: Aspects of population dynamics, production and metabolism.* Master Thesis, Christian Albrechts University and Geomar, Kiel, Germany: 47 pp.

Newcombe, E.M. and Cárdenas, C.A. (2001): *Rocky reef benthic assemblages in the Magellan Strait and the South Shetland Islands (Antarctica).* Revista de Biología Marina y Oceanografía, 46: 177–188.

Nybakken, J.W. (1997): *Marine biology: an ecological approach (4th edition).* Addison Wesley Longman, Inc., Menlo Park, California, 481 pp.

Pantoja, S., Iriarte, J.L. and Daneri, G. (2011): *Oceanography of the Chilean Patagonia*. Continental Shelf Research, 31: 149–153.

Quiroga, E., Ortiz, P., Gerdes, D., Reid, B., Villagran, S. and Quiñones R. (2012): *Organic enrichment and structure of macrobenthic communities in the glacial Baker Fjord, Northern Patagonia, Chile.* Journal of the Marine Biological Association of the United Kingdom, 92: 73–83.

Roux, A.M., Fernandez, M. and Bremec, C. (1995): *Preliminary survey of the benthic communities of the Patagonian shrimp fishing grounds in San-Jorge Gulf (Argentina).* Ciencas Marinas, 21: 295–310.

Sepúlveda, F.A., Palma-Heldt, S., Hervé, F. and Fanning, C.M. (2010): *Permian depositional age of metaturbidites of the Duque de York Complex, southern Chile: U-Pb SHRIMP data and palynology.* Andean Geology, 37:375–397.

Tecchio, S., Ramirez-llodra, E., Sarda, F., Company, J.B., Palomera, I., Mecho, A., Pedrosa-Pamies, R. and Sanchez-Vidal, A. (2011): *Drivers of deep Mediterranean megabenthos communities along longitudinal and bathymetric gradients.* Marine Ecology Progress Series, 439: 181–U219.

Thiel, M. and Ullrich, N. (2002): *Hard rock versus soft bottom: the fauna associated with intertidal mussel beds on hard bottoms along the coast of Chile, and considerations on the functional role of mussel beds.* Helgoland Marine Research, 56: 21–30.

van Rein, H., Schoeman, D.S., Brown, C.J., Quinn, R. and Breen, J. (2011): *Development of benthic monitoring methods using photoquadrats and scuba on heterogeneous hard-substrata: a boulder-slope community case study.* Aquatic Conservation: Marine and Freshwater Ecosystems, 21: 676–689.

Wessel, P. and Smith, W.H.F. (1996): *A global self-consistent, hierarchical, high-resolution shoreline database.* Journal of Geophysicl Research, 101: 8741–8743.

Wichmann, C.-S., Hinojosa, I.A. and Thiel, M. (2012): *Floating kelps in Patagonian fjords: an important vehicle for rafting invertebrates and its relevance for biogeography.* Marine Biology, 159: 2035–2049.

Winkler, M., Fillinger, L., Funke, T., Richter, C., Laudien, J. (2013): *Physical oceanography and sea-bed photographs (benthos) along ROV profile Errina2012_AG*. doi:10.1594/PANGAEA.805605
URL: http://www.pangaea.de/search?q=ref38759 (04/17/2013)

List of selected abbreviations

AG	Angostura; diving station at a channel in the centre of Isla Hanover
ANOSIM 1	One-way analysis of similarity
AWI	Alfred-Wegener-Institut Helmholtz-Zentrum für Polar und Meeresforschung
CS	Canal Corrientes south; diving station at a channel in the centre of Isla Hanover
ID	Identification
IDH	Intermediate Disturbance Hypothesis
EW	Estuarine water
GR	Global R (result of ANOSIM 1)
Is_Solar	Isla Solar; diving sation at a channel between Isla Solar and Isla Hanover
MDD	Madre de Dios; diving station at Copihue on Isla Madre de Dios
MDS	Non-metric Multidimensional Scaling
ROV	Remotely Operated Vehicle
SAMW	Subantarctic modified water
SIMPER	Similarity Percentage

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A Appendix

A.1 Formulas used in Microsoft Excel 2010

Formulas used in Microsoft Excel 2010 to estimate area displayed in each image (by Milian Noack):

Horizontal length of one pixel [m]: =2*(TAN(RADIANS(45/2))*O2)/1920

45 = camera angle (horizontal) [°]

O2 = distance (camera-ground [m]

1920 = number of horizontal pixels in image

Vertical length of one pixel [m]: =-2*(TAN(RADIANS(29/2))*O2)/1080

29 = camera angle (vertical) [°]

O2 = distance (camera-ground [m]

1080 = number of horizontal pixels in image

Horizontal length of image [m]: =P2*1920

P2 = Horizontal length of one pixel [m]

1920 = number of horizontal pixels in image

Vertical length of image [m]: =-Q2*1080

Q2 = Vertical length of one pixel [m]

1080 = number of horizontal pixels in image

Area displayed in image [m^2]: =R2*S2

R2 = Horizontal length of image [m]

S2 = Vertical length of image [m]

Formula used in Microsoft Excel 2010 to randomly pick 1 out of 100 rectangles for the estimation of abundance of spirorbids: =RUNDEN(ZUFALLSZAHL()*100;0)

A.2 Additional results

Table A 1 List of taxa found during investigation

Phylum Porifera
Porifera indet. sp. 01 (Tedania sp.?) [individuals/m²]
Porifera indet. sp. 02 (yellow) [individuals/m²]
Porifera indet. sp. 03 (ocre, encrusting) [individuals/m²]
Porifera indet. sp. 04 (brownish, mainly encrusting) [individuals/m²]

Porifera indet. sp. 05 (redish, encrusting) [individuals/m²]
Porifera indet. sp. 06 (pinkish, encrusting) [individuals/m²]
Porifera indet. sp. 07 (Cliona sp.?) [individuals/m²]
other Porifera indet. sp.[individuals/m²]
Phyllum Cnidaria
Convexella magelhaenica (Studer, 1878) or Primonella chilensis (Philippi, 1894) [colonies/m²]
Actinostola chilensis (McMurrich, 1904) [individuals/m²]
Thouarella sp. [colonies/m²]
Hormathia pectinata (Hertwig, 1882) [individuals/m²]
Dactylanthus antarcticus (Clubb, 1908) [individuals/m²]
Phellia exlex (McMurrich, 1904) [individuals/m²]
Metridium senile (Linnaeus, 1761) [individuals/m²]
Boloceropsis sp. [individuals/m²]
Gorgonia indet. sp.[colonies/m²]
Hydrozoa indet. sp. [colonies/m²]
other Cnidaria indet. sp. [individuals or colonies/m²]
Phyllum Mollusca
Opistobranchia indet. sp. [individuals/m²]
other Gastropoda indet. sp. [individuals/m²]
Bivalvia indet. sp.[individuals/m²]
Phyllum Arthropoda
Chaetopterus variopedatus (Renier, 1804) [individuals/m²]
Spirorbis indet. sp. [individuals/m²]
other Polychaeta indet. sp. [individuals/m²]
Pygnogonida indet. sp. [individuals/m²]
Pagurus comptus (White, 1847) [individuals/m²]
Propagurus gaudichaudi (H. Milne Edwards, 1836) [individuals/m²]
other Decapoda indet. sp.[individuals/m²]
Phyllum Ectoprocta
Microporella hyadesi (Jullien, 1888) [colonies/m²]
Adeonella sp. [colonies/m²]
Reteporella magellensis (Busk, 1884)[colonies/m²]
other Bryozoa indet. sp. [colonies/m²]
Phyllum Echinodermata
Henricia sp. [individuals/m²]
Arbacia dufresnii (Blainville, 1825) [individuals/m²]
Ophiomyxa vivipara (Studer, 1876) [individuals/m²]
Cosmasterias lurida (Philippi, 1858) [individuals/m²]
Solaster regularius (Sladen, 1889) [individuals/m²]
Odontaster penicillatus (Phillippi, 1870) [individuals/m²]
Porania antarctica (Smith, 1876) [individuals/m²]
Lophaster stellans (Sladen, 1889) [individuals/m²]
Pseudechinus magellanicus (Philippi, 1857) [individuals/m²]
Ganeria falklandica (Gray, 1847) [individuals/m²]
Labidiaster radiosus (Lütken, 1871) [individuals/m²]
Anasterias antarctica (Lütken, 1857) [individuals/m²]
Gorgonocephalus chilensis (Philippi, 1858) [individuals/m²]
Asteroidae indet. sp. [individuals/m²]
Holothuria indet. sp. 01 (Cladodactyla sp.?) [individuals/m²]
Holothuria indet. sp. 02 (Heterocucumis sp.?) [individuals/m²]
other Holothuria indet. sp. [individuals/m²]
Phyllum Chordata

Sycozoa sp. [individuals/m²]
Sebastes oculatus (Cuvier, 1833) [individuals/m²]
other indet. sp. 01 (white ascidian) [colonies/m²]
other indet. sp. 02 (grey ascidian) [colonies/m²]
other indet. sp. 03 (purple ascidian) [colonies/m²]
other Chordata indet. sp. [individuals/m²]
Other
other indet. sp. 01 [individuals or colonies/m²]
other indet. sp. 02 (yellowish structure) [individuals or colonies/m²]

Table A 2 Results of SIMPER-analysis for dissimilarities in bathymetric zones. Average dissimilarity taxa cumulatively contributing > 90% (> 10%; > 5%) and their average abundance (Av.Abund). average dissimilarity between stations (Av.Sim). standard deviation of dissimilarity (Sim/SD). contribution to dissimilarity [%] (Contrib%) and cumulated contribution to dissimilarity (Cum.%).

Zones 1 & 2 Average dissimilarity = 65.68	Zone 2	Zone 1				
Taxon	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Spirorbis indet. sp.	3.03	3.30	9.58	1.22	14.59	14.59
P. exlex	1.22	0.00	4.37	0.88	6.65	21.24
M. senile	0.44	0.88	4.19	0.70	6.38	27.61
Porifera indet. sp. 02	1.34	0.80	4.14	1.26	6.30	33.91
Ascidiaindet. sp. 01	0.79	1.47	4.01	1.19	6.11	40.02
Hydrozoa indet. sp.	0.99	0.61	3.57	1.09	5.44	45.45
Porifera indet. sp. 04	0.92	0.67	3.37	1.14	5.14	50.59
C. magelhaenica/P. chilensis	0.70	1.03	3.37	1.16	5.13	55.72
other indet. sp. 04	0.83	0.04	3.16	0.97	4.81	60.53
Porifera indet. sp. 03	0.37	0.47	2.32	0.85	3.53	64.06
Asteroidae indet. sp.	0.36	0.43	2.08	0.89	3.17	67.23
other Porifera indet. sp.	0.45	0.23	1.97	0.78	3.00	70.23
A. dufresnii	0.45	0.05	1.89	0.71	2.87	73.10
Porifera indet. sp. 05	0.48	0.09	1.79	0.72	2.73	75.83
Ascidia indet. sp. 02	0.33	0.31	1.79	0.74	2.72	78.56
C. variopedatus	0.36	0.09	1.68	0.61	2.56	81.11
Holothuria indet. sp. 02 (Heterocucumis sp.?)	0.12	0.22	1.06	0.52	1.62	82.73
other Gastropoda indet. sp.	0.24	0.10	1.05	0.54	1.60	84.34
C. lurida	0.17	0.12	1.03	0.53	1.57	85.91
other Chordata indet. sp.	0.07	0.22	1.01	0.52	1.54	87.45
O. vivipara	0.20	0.00	0.86	0.39	1.31	88.76
Porifera indet. sp. 07 (Cliona sp.?)	0.13	0.11	0.80	0.44	1.22	89.98
other Bryozoa indet. sp.	0.16	0.05	0.67	0.41	1.02	91.00

Zones 2 & 3 Average dissimilarity = 65.72	Zone 2	Zone 3				
Taxon	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Spirorbis indet. sp.	3.03	2.92	9.34	1.20	14.22	14.22
P. exlex	1.22	1.36	5.35	1.11	8.14	22.36
Porifera indet. sp. 02	1.34	0.94	3.87	1.17	5.89	28.25
other indet. sp. 04	0.83	0.89	3.17	1.06	4.82	33.07

Hydrozoa indet. sp.	0.99	0.83	3.11	1.09	4.73	37.80
Porifera indet. sp. 04	0.92	0.67	3.09	1.13	4.70	42.49
C. magelhaenica/P. chilensis	0.70	1.03	3.08	1.15	4.68	47.18
Ascidiaindet. sp. 01	0.79	0.26	2.72	0.97	4.14	51.32
A. dufresnii	0.45	0.83	2.71	1.08	4.13	55.44
other Porifera indet. sp.	0.45	0.55	2.30	0.93	3.50	58.94
C. variopedatus	0.36	0.45	2.20	0.82	3.35	62.29
Porifera indet. sp. 03	0.37	0.47	2.04	0.83	3.11	65.40
M. senile	0.44	0.22	1.98	0.56	3.01	68.41
Porifera indet. sp. 05	0.48	0.23	1.82	0.77	2.76	71.18
O. vivipara	0.20	0.32	1.59	0.66	2.42	73.59
other Gastropoda indet. sp.	0.24	0.32	1.50	0.69	2.29	75.88
Asteroidae indet. sp.	0.36	0.15	1.40	0.73	2.13	78.01
Ascidiaindet. sp. 02	0.33	0.19	1.39	0.66	2.12	80.13
other Cnidaria indet. sp.	0.14	0.28	1.12	0.58	1.71	81.84
Sycozoa sp.	0.15	0.19	1.00	0.52	1.52	83.36
Thouarella sp.	0.04	0.22	1.00	0.47	1.52	84.88
C. lurida	0.17	0.08	0.81	0.49	1.23	86.11
Adeonella sp.	0.16	0.10	0.77	0.42	1.17	87.28
Microporella hyadesi (Jullien. 1888)	0.12	0.12	0.73	0.43	1.11	88.40
Holothuria indet. sp. 02 (Heterocucumis sp.?)	0.12	0.09	0.69	0.41	1.06	89.45
other Bryozoa indet. sp.	0.16	0.08	0.69	0.43	1.04	90.49

Groups 10–20 & 30.1–40

Average dissimilarity = 68.64 Zone 1 Zone 3

Taxon	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Spirorbis indet. sp.	3.30	2.92	9.20	1.15	13.40	13.40
Ascidiaindet. sp. 01	1.47	0.26	5.26	1.55	7.67	21.07
P. exlex	0.00	1.36	4.49	0.81	6.55	27.62
M. senile	0.88	0.22	3.87	0.59	5.64	33.26
Porifera indet. sp. 02	0.80	0.94	3.65	1.13	5.32	38.58
A. dufresnii	0.05	0.83	3.46	1.14	5.04	43.62
other indet. sp. 04	0.04	0.89	3.40	0.97	4.95	48.57
C. magelhaenica/P. chilensis	1.03	1.03	3.36	1.12	4.90	53.47
Hydrozoa indet. sp.	0.61	0.83	3.31	1.07	4.82	58.29
Porifera indet. sp. 04	0.67	0.67	3.05	1.06	4.45	62.74
Porifera indet. sp. 03	0.47	0.47	2.55	0.89	3.72	66.45
other Porifera indet. sp.	0.23	0.55	2.46	0.84	3.58	70.04
C. variopedatus	0.09	0.45	2.02	0.71	2.94	72.98
Asteroidae indet. sp.	0.43	0.15	1.88	0.76	2.73	75.72
Ascidiaindet. sp. 02	0.31	0.19	1.51	0.65	2.20	77.92
other Gastropoda indet. sp.	0.10	0.32	1.39	0.59	2.03	79.95
O. vivipara	0.00	0.32	1.31	0.55	1.91	81.86
Thouarella sp.	0.00	0.22	1.08	0.45	1.57	83.43
Holothuria indet. sp. 02 (Heterocucumis sp.?)	0.22	0.09	1.05	0.48	1.54	84.97
Porifera indet. sp. 05	0.09	0.23	0.99	0.49	1.44	86.40
other Cnidaria indet. sp.	0.04	0.28	0.98	0.51	1.43	87.84
other Chordata indet. sp.	0.22	0.00	0.89	0.46	1.29	89.13
C. lurida	0.12	0.08	0.80	0.43	1.16	90.29

Table A 3 Results of SIMPER-analysis for dissimilarities between stations. Average dissimilarity between samples of different stations, taxa cumulatively contributing > 90% (> 10%; > 5%) and their average abundance (Av.Abund), average dissimilarity between stations (Av.Sim), standard deviation of dissimilarity (Sim/SD), contribution to dissimilarity [%] (Contrib%) and cumulated contribution to dissimilarity (Cum.%).

Groups MDD & CS						
Average dissimilarity = 69.51	Group MDD	Group CS				
Taxon	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Spirorbis indet. sp.	3.82	3.87	9.15	1.23	13.17	13.17
P.exlex	1.80	0.00	5.59	1.27	8.04	21.20
M. senile	1.58	0.00	5.45	1.05	7.84	29.04
Porifera indet. sp. 04	1.62	0.74	5.04	1.99	7.26	36.30
Porifera indet. sp. 02	2.16	0.95	5.00	1.25	7.19	43.49
Hydrozoa indet. sp.	0.30	1.79	4.81	2.18	6.92	50.41
Porifera indet. sp. 05	1.00	0.54	3.25	1.30	4.68	55.09
C. magelhaenica/P. chilensis	0.15	1.00	3.06	1.02	4.40	59.49
Ascidia indet. sp. 01	1.42	1.43	2.92	1.03	4.20	63.69
Asteroidae indet. sp.	0.75	0.00	2.44	1.18	3.51	67.20
other Chordata indet. sp.	0.00	0.99	2.39	0.97	3.44	70.64
Ascidia indet. sp. 02	0.29	0.68	2.03	0.82	2.92	73.56
other indet. sp. 04	0.39	0.54	1.92	0.85	2.76	76.33
other Porifera indet. sp.	0.36	0.38	1.90	0.82	2.73	79.06
other Gastropoda indet. sp.	0.07	0.34	1.60	0.59	2.29	81.36
C. variopedatus	0.07	0.41	1.43	0.60	2.05	83.41
Propagurus gaudichaudi (H. Milne Edwards. 1836)	0.00	0.45	1.39	0.57	2.00	85.41
Pygnogonida indet. sp.	0.00	0.38	1.39	0.57	2.00	87.41
Sycozoa sp.	0.17	0.34	1.34	0.67	1.92	89.33
other Polychaeta indet. sp.	0.00	0.28	1.28	0.56	1.84	91.17

Groups MDD & AG						
Average dissimilarity = 62.10	Group MDD	Group AG				
Taxon	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Spirorbis indet. sp.	3.82	3.69	7.74	1.16	12.46	12.46
P.exlex	1.80	0.00	5.95	1.35	9.58	22.05
M. senile	1.58	0.00	5.82	1.11	9.37	31.42
Porifera indet. sp. 02	2.16	0.73	5.35	1.57	8.61	40.03
Porifera indet. sp. 04	1.62	0.54	4.36	1.52	7.02	47.05
C. magelhaenica/P. chilensis	0.15	1.16	3.82	1.51	6.15	53.20
Porifera indet. sp. 05	1.00	0.19	3.18	1.27	5.12	58.32
Asteroidae indet. sp.	0.75	0.16	2.60	1.25	4.18	62.50
Hydrozoa indet. sp.	0.30	0.74	2.51	1.07	4.04	66.54
Porifera indet. sp. 03	0.00	0.70	2.28	0.90	3.68	70.22
Ascidia indet. sp. 01	1.42	1.61	2.11	1.11	3.40	73.62
Ascidia indet. sp. 02	0.29	0.51	1.99	0.88	3.20	76.82
other Porifera indet. sp.	0.36	0.39	1.84	0.85	2.96	79.78
Holothuria indet. sp. 02 (Heterocucumis sp.?)	0.02	0.42	1.37	0.63	2.21	81.99
other indet. sp. 04	0.39	0.05	1.33	0.64	2.14	84.14
other Chordata indet. sp.	0.00	0.37	1.19	0.63	1.91	86.05
Porifera indet. sp. 01 (Tedania sp.?)	0.31	0.00	1.02	0.52	1.64	87.69

C. variopedatus	0.07	0.16	0.79	0.41	1.27	88.96
Porifera indet. sp. 07 (Cliona sp.?)	0.13	0.10	0.73	0.42	1.17	90.14

Groups CS & AG

Average dissimilarity = 59.52 Taxon	Group CS Av.Abund	Group AG Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Spirorbis indet. sp.	3.87	3.69	10.29	1.18	17.29	17.29
Hydrozoa indet. sp.	1.79	0.74	4.42	1.22	7.43	24.71
C. magelhaenica/P. chilensis	1.00	1.16	3.90	1.33	6.55	31.27
Ascidia indet. sp. 01	1.43	1.61	3.64	0.87	6.12	37.38
Porifera indet. sp. 02	0.95	0.73	3.45	1.13	5.80	43.18
other Chordata indet. sp.	0.99	0.37	3.09	1.11	5.19	48.37
Porifera indet. sp. 04	0.74	0.54	2.99	0.98	5.02	53.39
Ascidia indet. sp. 02	0.68	0.51	2.88	0.95	4.84	58.23
Porifera indet. sp. 03	0.00	0.70	2.58	0.85	4.34	62.57
other Porifera indet. sp.	0.38	0.39	2.39	0.75	4.02	66.58
other Gastropoda indet. sp.	0.34	0.15	2.18	0.60	3.66	70.24
other Polychaeta indet. sp.	0.28	0.14	1.90	0.62	3.19	73.43
C. variopedatus	0.41	0.16	1.83	0.65	3.07	76.50
Porifera indet. sp. 05	0.54	0.19	1.81	0.69	3.04	79.54
Pygnogonida indet. sp.	0.38	0.00	1.72	0.56	2.89	82.42
P. gaudichaudi	0.45	0.00	1.65	0.56	2.78	85.20
Holothuria indet. sp. 02 (Heterocucumis sp.?)	0.00	0.42	1.48	0.60	2.49	87.69
other Cnidaria indet. sp.	0.34	0.08	1.40	0.62	2.36	90.04

Groups MDD & Is_Solar

Average dissimilarity = 70.67 Taxon	Group MDD Av.Abund	Group Is_Solar Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Spirorbis indet. sp.	3.82	2.55	9.40	1.29	13.30	13.30
M. senile	1.58	0.02	5.46	1.10	7.73	21.02
P.exlex	1.80	1.05	5.33	1.27	7.54	28.56
Porifera indet. sp. 02	2.16	0.86	4.82	1.41	6.83	35.39
Porifera indet. sp. 04	1.62	0.55	4.17	1.52	5.90	41.29
Ascidia indet. sp. 01	1.42	0.28	4.16	1.58	5.89	47.18
Hydrozoa indet. sp.	0.30	1.20	3.50	1.36	4.96	52.13
C. magelhaenica/P. chilensis	0.15	1.03	3.18	1.32	4.50	56.63
other indet. sp. 04	0.39	1.06	3.10	1.20	4.38	61.02
Porifera indet. sp. 05	1.00	0.15	3.07	1.26	4.35	65.37
A. dufresnii	0.12	0.74	2.44	1.08	3.46	68.83
Asteroidae indet. sp.	0.75	0.17	2.35	1.19	3.33	72.16
other Porifera indet. sp.	0.36	0.50	1.89	0.93	2.67	74.83
C. variopedatus	0.07	0.51	1.80	0.75	2.55	77.38
Porifera indet. sp. 03	0.00	0.53	1.58	0.75	2.23	79.61
Ascidia indet. sp. 02	0.29	0.25	1.36	0.71	1.93	81.53
Ophiomyxa vivipara (Studer. 1876)	0.02	0.33	1.15	0.56	1.63	83.17
other Gastropoda indet. sp.	0.07	0.33	1.08	0.62	1.53	84.70
Porifera indet. sp. 01 (Tedania sp.?)	0.31	0.01	1.00	0.53	1.41	86.11
Cosmasterias lurida (Philippi. 1858)	0.16	0.16	0.93	0.57	1.32	87.42
Sycozoa sp.	0.17	0.16	0.86	0.51	1.22	88.64
other Cnidaria indet. sp.	0.12	0.19	0.82	0.48	1.16	89.81
Adeonella sp.	0.02	0.21	0.68	0.41	0.96	90.76

Groups CS & Is_Solar

Average dissimilarity = 69.85	Group CS	Group Is_Solar				
Taxon	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Spirorbis indet. sp.	3.87	2.55	10.80	1.25	15.46	15.46
Ascidia indet. sp. 01	1.43	0.28	4.20	1.48	6.02	21.48
other indet. sp. 04	0.54	1.06	3.89	1.17	5.57	27.05
C. magelhaenica/P. chilensis	1.00	1.03	3.67	1.21	5.25	32.30
P.exlex	0.00	1.05	3.49	0.70	4.99	37.29
Porifera indet. sp. 02	0.95	0.86	3.37	1.10	4.83	42.12
Porifera indet. sp. 04	0.74	0.55	2.83	0.96	4.05	46.16
A. dufresnii	0.00	0.74	2.82	0.98	4.04	50.20
Hydrozoa indet. sp.	1.79	1.20	2.72	0.97	3.89	54.10
other Chordata indet. sp.	0.99	0.03	2.64	0.98	3.78	57.87
C. variopedatus	0.41	0.51	2.51	0.84	3.59	61.46
other Porifera indet. sp.	0.38	0.50	2.41	0.83	3.45	64.91
other Gastropoda indet. sp.	0.34	0.33	2.23	0.69	3.19	68.10
Ascidia indet. sp. 02	0.68	0.25	2.08	0.75	2.97	71.07
Porifera indet. sp. 03	0.00	0.53	1.75	0.72	2.51	73.58
Pygnogonida indet. sp.	0.38	0.02	1.63	0.57	2.34	75.92
P. gaudichaudi	0.45	0.03	1.63	0.58	2.33	78.25
other Polychaeta indet. sp.	0.28	0.00	1.55	0.54	2.23	80.48
other Cnidaria indet. sp.	0.34	0.19	1.52	0.67	2.18	82.66
Porifera indet. sp. 05	0.54	0.15	1.50	0.67	2.15	84.81
Sycozoa sp.	0.34	0.16	1.48	0.65	2.12	86.92
O. vivipara	0.00	0.33	1.28	0.52	1.84	88.76
Porifera indet. sp. 07 (Cliona sp.?)	0.46	0.11	1.27	0.67	1.81	90.58

Groups AG & Is_Solar

Average dissimilarity = 67.84	Group AG	Group Is_Solar				
Taxon	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Spirorbis indet. sp.	3.69	2.55	10.60	1.28	15.62	15.62
Ascidia indet. sp. 01	1.61	0.28	5.75	1.60	8.47	24.09
other indet. sp. 04	0.05	1.06	4.03	1.20	5.94	30.03
P.exlex	0.00	1.05	3.72	0.73	5.48	35.51
Hydrozoa indet. sp.	0.74	1.20	3.70	1.11	5.46	40.97
Porifera indet. sp. 02	0.73	0.86	3.40	1.11	5.02	45.99
C. magelhaenica/P. chilensis	1.16	1.03	3.11	1.05	4.58	50.57
A. dufresnii	0.04	0.74	3.00	1.03	4.42	54.99
Porifera indet. sp. 03	0.70	0.53	2.97	1.03	4.39	59.37
Porifera indet. sp. 04	0.54	0.55	2.63	0.98	3.88	63.25
other Porifera indet. sp.	0.39	0.50	2.40	0.86	3.54	66.79
C. variopedatus	0.16	0.51	2.29	0.77	3.37	70.16
Ascidia indet. sp. 02	0.51	0.25	2.20	0.82	3.24	73.40
Holothuria indet. sp. 02 (Heterocucumis sp.?)	0.42	0.12	1.71	0.69	2.52	75.92
other Gastropoda indet. sp.	0.15	0.33	1.46	0.66	2.15	78.07
other Chordata indet. sp.	0.37	0.03	1.39	0.63	2.05	80.12
O. vivipara	0.00	0.33	1.37	0.54	2.02	82.14
Porifera indet. sp. 05	0.19	0.15	1.11	0.51	1.64	83.79
Asteroidae indet. sp.	0.16	0.17	1.07	0.53	1.58	85.37

other Cnidaria indet. sp.	0.08	0.19	0.85	0.48	1.25	86.62
other Bryozoa indet. sp.	0.04	0.21	0.81	0.46	1.19	87.81
C. lurida	0.04	0.16	0.78	0.43	1.15	88.97
Porifera indet. sp. 07 (Cliona sp.?)	0.10	0.11	0.76	0.42	1.12	90.09

Table A 4 Results of SIMPER-analysis for samples of different bathymetric zones at stations. Average dissimilarity, taxa cumulatively contributing > 90% (> 10%; > 5%) and their average abundance (Av.Abund), average dissimilarity between stations (Av.Sim), standard deviation of dissimilarity (Sim/SD), contribution to dissimilarity [%] (Contrib%), and cumulated contribution to dissimilarity (Cum.%).

MDD

Zone 2
Average similarity: 58.75

Taxon	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spirorbis indet. sp.	3.96	13.96	1.41	23.76	23.76
Porifera indet. sp. 02	2.21	10.96	3.69	18.66	42.42
Porifera indet. sp. 04	1.68	7.37	2.26	12.54	54.96
P. exlex	2.05	7.29	1.21	12.41	67.37
Ascidiacea indet. sp. 01	1.43	6.32	1.5	10.76	78.13
M. senile	1.28	4.16	0.8	7.08	85.21
Porifera indet. sp. 05	1.07	3.54	0.99	6.03	91.24

Zone 1
Average similarity: 76.72

Taxon	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
M. senile	3.83	28.3	6.14	36.89	36.89
Spirorbis indet. sp.	3.12	16.07	1.35	20.95	57.84
Porifera indet. sp. 02	1.52	10.46	6.36	13.64	71.48
Ascidiacea indet. sp. 01	1.29	9.19	5.8	11.98	83.45
Asteroidae indet. sp.	1.18	8.55	8.99	11.14	94.59

Zone 3
Average similarity: 69.71

Taxon	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
M. senile	3.04	16.9	19.47	24.25	24.25
Spirorbis indet. sp.	2.31	12.43	18.48	17.84	42.08
Porifera indet. sp. 02	2.3	11.5	15.85	16.5	58.58
Porifera indet. sp. 05	1.55	9.08	11.21	13.02	71.6
Ascidiacea indet. sp. 01	1.36	7.86	15.86	11.27	82.87
Porifera indet. sp. 04	1.48	7.67	5.42	11	93.87

Zones 1 & 2

Average dissimilarity = 48.59	Zone 2	Zone 1				
Taxon	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
M. senile	1.28	3.83	8.45	2.22	17.38	17.38
Spirorbis indet. sp.	3.96	3.12	7.49	1.14	15.41	32.8
P.exlex	2.05	0	6.54	1.67	13.46	46.26
Porifera indet. sp. 05	1.07	0	3.42	1.46	7.04	53.31
Porifera indet. sp. 04	1.68	1.06	3.25	1.2	6.7	60
Porifera indet. sp. 02	2.21	1.52	2.6	1.67	5.35	65.36

Asteroidae indet. sp.	0.71	1.18	2.01	1.11	4.13	69.48
Ascidiacea indet. sp. 01	1.43	1.29	1.94	1.37	3.99	73.47
other indet. sp. 04	0.4	0.18	1.47	0.75	3.03	76.5
C. lurida	0.15	0.34	1.34	0.78	2.75	79.25
other Porifera indet. sp.	0.37	0	1.21	0.7	2.49	81.74
Porifera indet. sp. 01 (Tedania sp.?)	0.36	0	1.14	0.58	2.34	84.07
Hydrozoa indet. sp.	0.33	0	1.05	0.6	2.15	86.22
Ascidiacea indet. sp. 02	0.32	0	1.02	0.58	2.1	88.32
C. magelhaenica/P.chilensis	0.15	0.18	0.94	0.59	1.93	90.25

Zones 2 & 3

Average dissimilarity = 41.97	Zone 2	Zone 3				
Taxon	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Spirorbis indet. sp.	3.96	2.31	6.92	1.75	16.48	16.48
M. senile	1.28	3.04	5.3	1.71	12.63	29.11
P.exlex	2.05	0.42	5.17	1.59	12.31	41.42
Porifera indet. sp. 05	1.07	1.55	2.08	1.09	4.96	46.38
other indet. sp. 04	0.4	0.59	2.07	0.92	4.94	51.32
Porifera indet. sp. 02	2.21	2.3	1.95	1.24	4.64	55.97
other Porifera indet. sp.	0.37	0.75	1.92	1.18	4.56	60.53
Asteroidae indet. sp.	0.71	0.74	1.78	1.11	4.23	64.77
Porifera indet. sp. 04	1.68	1.48	1.7	1.18	4.04	68.81
Ascidiacea indet. sp. 01	1.43	1.36	1.59	1.33	3.78	72.59
Ascidiacea indet. sp. 02	0.32	0.36	1.46	0.87	3.48	76.07
Porifera indet. sp. 07 (Cliona sp.?)	0.12	0.43	1.43	0.75	3.4	79.46
Hydrozoa indet. sp.	0.33	0.32	1.37	0.88	3.26	82.72
O. vivipara	0	0.36	1.09	0.69	2.59	85.31
other indet. sp.	0.11	0.32	1.04	0.76	2.48	87.79
Porifera indet. sp. 01 (Tedania sp.?)	0.36	0	1.01	0.58	2.42	90.21

Zones 1 & 3

Average dissimilarity = 35.75	Zone 1	Zone 3				
Taxon	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Spirorbis indet. sp.	3.12	2.31	5.44	1.87	15.23	15.23
Porifera indet. sp. 05	0	1.55	5.4	6.18	15.11	30.34
Porifera indet. sp. 02	1.52	2.3	2.87	1.14	8.04	38.38
Porifera indet. sp. 04	1.06	1.48	2.81	1.13	7.86	46.24
M. senile	3.83	3.04	2.73	1.61	7.64	53.88
other Porifera indet. sp.	0	0.75	2.51	1.35	7.03	60.91
other indet. sp. 04	0.18	0.59	2.11	0.79	5.9	66.81
Asteroidae indet. sp.	1.18	0.74	1.64	0.92	4.6	71.41
Porifera indet. sp. 07 (Cliona sp.?)	0	0.43	1.5	0.68	4.21	75.62
P.exlex	0	0.42	1.38	0.68	3.87	79.48
other indet. sp.	0.18	0.32	1.29	0.79	3.6	83.08
O. vivipara	0	0.36	1.27	0.68	3.54	86.62
Ascidiacea indet. sp. 02	0	0.36	1.27	0.68	3.54	90.16

Is_Solar

Zone 2

Average similarity: 37.50					
Taxon	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Hydrozoa indet. sp.	1.39	7.87	1.47	21	21

Spirorbis indet. sp.	2.37	6.22	0.61	16.6	37.6
other indet. sp. 04	1.13	4.87	0.99	12.98	50.58
C. magelhaenica/P.chilensis	0.99	4.51	0.85	12.03	62.61
Porifera indet. sp. 02	0.85	2.32	0.59	6.2	68.8
A. dufresnii	0.65	2.24	0.58	5.98	74.79
P.exlex	0.86	1.95	0.46	5.2	79.99
C. variopedatus	0.51	1.17	0.37	3.11	83.1
Porifera indet. sp. 03	0.55	1.16	0.43	3.08	86.18
other Porifera indet. sp.	0.49	1.01	0.4	2.68	88.87
Porifera indet. sp. 04	0.51	0.82	0.36	2.19	91.05

Zone 3
Average similarity: 37.47

Taxon	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spirorbis indet. sp.	2.98	9.77	0.87	26.07	26.07
C. magelhaenica/P.chilensis	1.1	4.84	0.98	12.93	39
A. dufresnii	0.91	4.54	0.87	12.11	51.11
other indet. sp. 04	0.95	3.18	0.72	8.49	59.6
Hydrozoa indet. sp.	0.83	2.74	0.65	7.31	66.91
P.exlex	1.48	2.69	0.51	7.19	74.1
Porifera indet. sp. 02	0.9	2.44	0.61	6.52	80.62
Porifera indet. sp. 04	0.65	1.31	0.46	3.48	84.1
other Porifera indet. sp.	0.53	1.24	0.4	3.32	87.42
C. variopedatus	0.49	1.24	0.39	3.31	90.73

Zone 1
Less than 2 samples in group

Zones 2 & 3

Average dissimilarity = 63.91	Zone 2	Zone 3				
Taxon	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Spirorbis indet. sp.	2.37	2.98	9.72	1.2	15.21	15.21
P.exlex	0.86	1.48	5.33	1.02	8.34	23.55
Hydrozoa indet. sp.	1.39	0.83	3.45	1.11	5.4	28.95
other indet. sp. 04	1.13	0.95	3.38	1.07	5.29	34.25
Porifera indet. sp. 02	0.85	0.9	3.32	1.11	5.19	39.44
C. magelhaenica/P.chilensis	0.99	1.1	3.02	1.07	4.73	44.17
A. dufresnii	0.65	0.91	2.74	1.05	4.29	48.46
Porifera indet. sp. 04	0.51	0.65	2.58	1	4.04	52.5
C. variopedatus	0.51	0.49	2.57	0.91	4.02	56.52
Porifera indet. sp. 03	0.55	0.52	2.45	0.96	3.83	60.36
other Porifera indet. sp.	0.49	0.53	2.44	0.92	3.81	64.17
O. vivipara	0.34	0.33	1.97	0.74	3.08	67.25
other Gastropoda indet. sp.	0.34	0.33	1.73	0.77	2.7	69.95
Ascidiacea indet. sp. 01	0.33	0.18	1.46	0.68	2.28	72.23
Ascidiacea indet. sp. 02	0.28	0.18	1.31	0.62	2.06	74.29
other Cnidaria indet. sp.	0.14	0.3	1.22	0.6	1.91	76.2
Thouarella sp.	0.02	0.24	1.12	0.48	1.75	77.95
Adeonella sp.	0.26	0.11	1.11	0.51	1.74	79.69
Sycozoa sp.	0.13	0.2	1.05	0.52	1.65	81.34
other Bryozoa indet. sp.	0.27	0.08	1.01	0.54	1.59	82.92
Asteroidae indet. sp.	0.18	0.12	0.93	0.53	1.46	84.38

Microporella hyadesi (Jullien. 1888)	0.17	0.13	0.92	0.49	1.44	85.82
C. lurida	0.19	0.08	0.91	0.51	1.42	87.25
Porifera indet. sp. 05	0.14	0.16	0.8	0.47	1.25	88.5
Holothuria indet. sp. 02 (Heterocucumis sp.?)	0.13	0.1	0.76	0.44	1.19	89.69
Porifera indet. sp. 07 (Cliona sp.?)	0.13	0.07	0.63	0.43	0.99	90.67

Zones 1 & 2

Average dissimilarity = 77.34	Zone 2	Zone 1				
Taxon	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Spirorbis indet. sp.	2.37	0	10.71	0.93	13.84	13.84
Hydrozoa indet. sp.	1.39	0	7.28	1.8	9.41	23.26
other indet. sp. 04	1.13	0	5.58	1.35	7.22	30.48
Asteroidae indet. sp.	0.18	1.16	5.43	1.89	7.02	37.5
C. lurida	0.19	1.16	5.39	1.87	6.97	44.47
C. variopedatus	0.51	1.16	4.66	1.51	6.02	50.49
A. dufresnii	0.65	1.38	4.34	1.11	5.61	56.1
P.exlex	0.86	0	4.19	0.66	5.41	61.51
Porifera indet. sp. 02	0.85	0	3.79	0.99	4.9	66.41
C. magelhaenica/P.chilensis	0.99	1.16	3.21	1.08	4.15	70.56
Porifera indet. sp. 03	0.55	0	2.43	0.79	3.15	73.71
other Porifera indet. sp.	0.49	0	2.2	0.73	2.84	76.55
Porifera indet. sp. 04	0.51	0	2.11	0.7	2.73	79.28
O. vivipara	0.34	0	1.83	0.54	2.36	81.64
Ascidiacea indet. sp. 01	0.33	0	1.51	0.58	1.95	83.59
other Gastropoda indet. sp.	0.34	0	1.49	0.59	1.92	85.52
Adeonella sp.	0.26	0	1.24	0.44	1.61	87.13
Ascidiacea indet. sp. 02	0.28	0	1.24	0.5	1.61	88.73
other Bryozoa indet. sp.	0.27	0	1.1	0.49	1.42	90.15

Zones 1 & 3

Average dissimilarity = 75.38	Zone 3	Zone 1				
Taxon	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Spirorbis indet. sp.	2.98	0	12.69	1.34	16.84	16.84
P.exlex	1.48	0	5.88	0.87	7.8	24.64
C. lurida	0.08	1.16	5.64	2.3	7.48	32.12
Asteroidae indet. sp.	0.12	1.16	5.6	2.17	7.43	39.55
other indet. sp. 04	0.95	0	4.55	0.99	6.04	45.59
C. variopedatus	0.49	1.16	4.15	1.32	5.5	51.09
Hydrozoa indet. sp.	0.83	0	4.01	1.04	5.32	56.41
Porifera indet. sp. 02	0.9	0	3.88	1	5.15	61.56
C. magelhaenica/P.chilensis	1.1	1.16	3.1	1.09	4.11	65.67
Porifera indet. sp. 04	0.65	0	2.69	0.82	3.57	69.24
other Porifera indet. sp.	0.53	0	2.69	0.73	3.57	72.8
A. dufresnii	0.91	1.38	2.63	0.91	3.49	76.3
Porifera indet. sp. 03	0.52	0	2.18	0.69	2.89	79.19
O. vivipara	0.33	0	1.72	0.56	2.29	81.48
Thouarella sp.	0.24	0	1.56	0.48	2.07	83.55
other Gastropoda indet. sp.	0.33	0	1.4	0.54	1.86	85.41
other Cnidaria indet. sp.	0.3	0	1.19	0.5	1.58	86.99
Sycozoa sp.	0.2	0	1.04	0.42	1.38	88.38
Ascidiacea indet. sp. 01	0.18	0	0.83	0.39	1.1	89.47
Ascidiacea indet. sp. 02	0.18	0	0.79	0.39	1.05	90.52

AG

Zone 1

Average similarity: 56.15

Taxon	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spirorbis indet. sp.	3.52	23.8	2.31	42.39	42.39
Ascidiacea indet. sp. 01	1.61	13.06	2.75	23.26	65.65
C. magelhaenica/P.chilensis	1.3	8.88	1.39	15.81	81.46
Hydrozoa indet. sp.	0.84	3.2	0.67	5.7	87.17
Porifera indet. sp. 03	0.65	1.96	0.49	3.49	90.65

Zone 2

Average similarity: 44.04

Taxon	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spirorbis indet. sp.	4.08	19.17	1.43	43.52	43.52
Ascidiacea indet. sp. 01	1.63	9.16	1.47	20.8	64.32
Porifera indet. sp. 02	1.01	3.44	0.72	7.82	72.13
C. magelhaenica/P.chilensis	0.82	3.38	0.69	7.67	79.8
Ascidiacea indet. sp. 02	0.72	1.87	0.49	4.24	84.04
Holothuria indet. sp. 02 (Heterocucumis sp.?)	0.72	1.85	0.5	4.19	88.24
Porifera indet. sp. 03	0.84	1.83	0.51	4.16	92.4

Zone 1& 2

Average dissimilarity = 50.69	Zone 1	Zone 2				
Taxon	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Spirorbis indet. sp.	3.52	4.08	9.01	1.2	17.78	17.78
Porifera indet. sp. 02	0.62	1.01	3.64	1.16	7.18	24.97
Porifera indet. sp. 03	0.65	0.84	3.43	1.12	6.77	31.74
C. magelhaenica/P.chilensis	1.3	0.82	3.17	1.16	6.25	37.99
Hydrozoa indet. sp.	0.84	0.51	3.15	1.09	6.21	44.2
Ascidiacea indet. sp. 02	0.42	0.72	3.03	0.96	5.98	50.18
Holothuria indet. sp. 02 (Heterocucumis sp.?)	0.3	0.72	2.89	0.97	5.7	55.88
Porifera indet. sp. 04	0.58	0.42	2.62	0.96	5.17	61.05
other Porifera indet. sp.	0.32	0.56	2.47	0.86	4.87	65.92
Ascidiacea indet. sp. 01	1.61	1.63	2.42	1.19	4.77	70.69
other Chordata indet. sp.	0.3	0.52	2.24	0.9	4.42	75.11
Porifera indet. sp. 05	0.13	0.33	1.81	0.61	3.57	78.68
C. variopedatus	0.06	0.4	1.7	0.61	3.35	82.03
Asteroidae indet. sp.	0.15	0.17	1.04	0.5	2.06	84.09
other Gastropoda indet. sp.	0.13	0.17	1.03	0.49	2.02	86.11
other Polychaeta indet. sp.	0.13	0.16	1	0.49	1.98	88.09
Ascidiacea indet. sp. 03	0	0.16	0.99	0.36	1.96	90.05

Table A 5 R-values of ANOSIM 1 for stations. Clear distinctness (R > 0.75), good distinctness (0.25 < R < 0.75) and poor distinctness (R < 0.25).

GR: 0.301	MDD	Is_Solar	AG
Is_Solar	0.345	-	-
AG	0.692	0.165	-
CS	0.785	0.246	0.412

Table A 6 List of species identified on pictures taken by SCUBA-diver Matthias Hüne (Escuela de Biología Marina, Universidad Austral de Chile) during ROV-dives.

Pseudechinus magellanicus	*Adeonella sp. 2*
Pareuthria plumbea	*Pareuthria powelii*
Eurypodius latreillei (?)	*Pagurus comptus*
Didemnum studeri (?)	*Arbacia dufresnii*
Campylonotus vagans	*Calliostoma sp.*
Gorgonocephalus chilensis	*Pareuthria powelii*
Patagonotothen tessellata	*Gonactinia prolifera*
Hypsicomus phaeotenia (?)	*Corella eumyota*
Primonella chilensis/ Convexella magelhaenica	*Ornatoscalpellum gibberum*
Clavularia magelhanica (?)	*Ophiacantha rosea* (?)

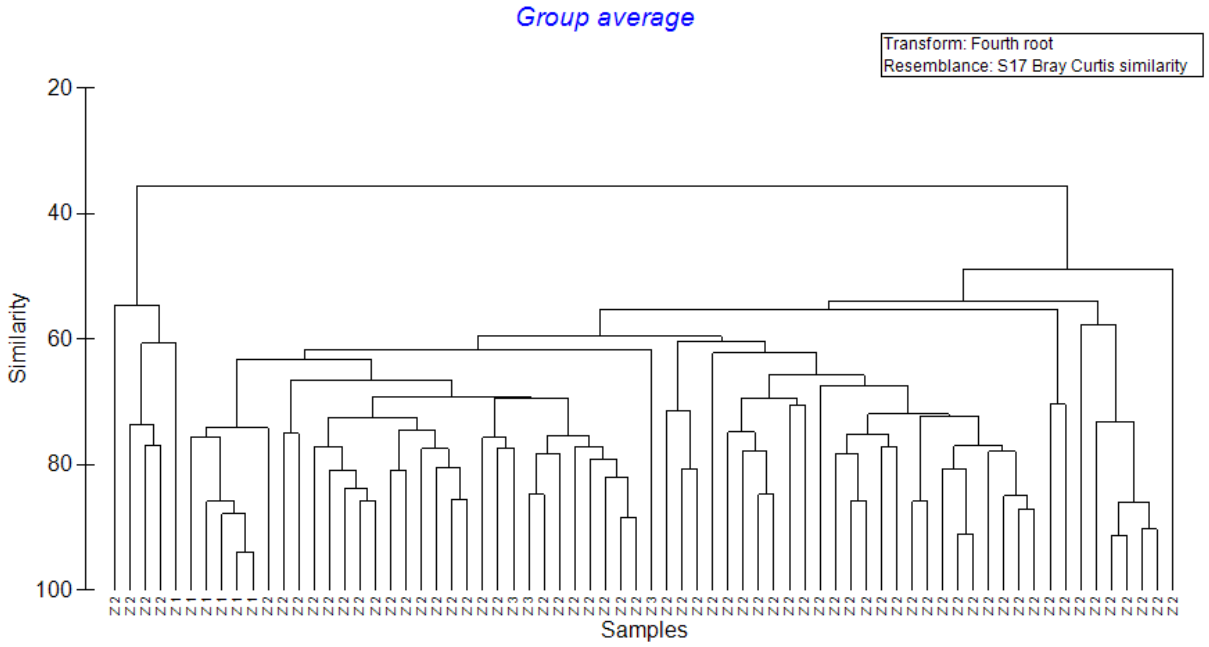

Figure A 1: Dendrogram of Cluster-analysis of station MDD. Samples are named after bathymetric zones; vertical axis shows % of similarity.

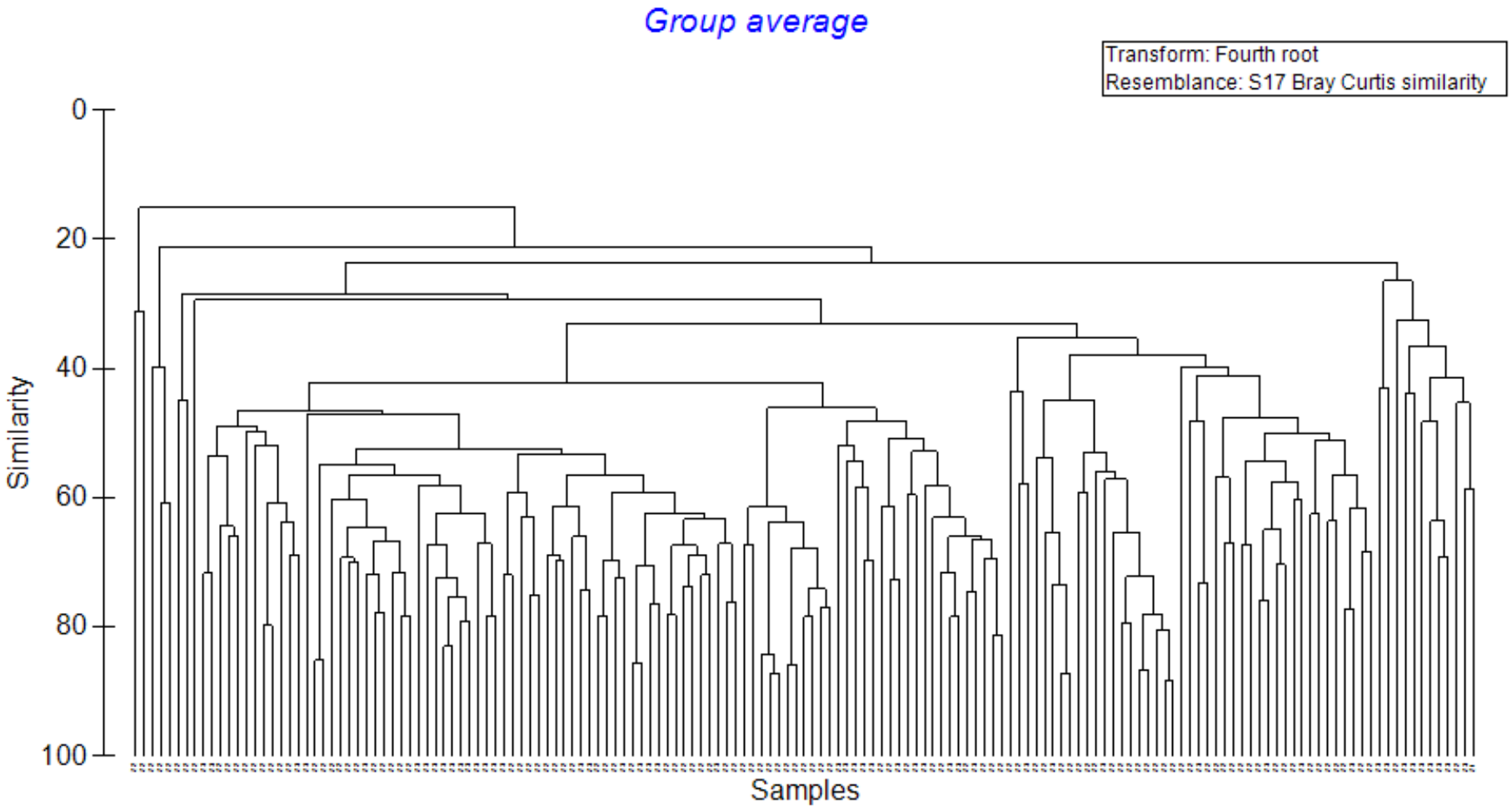

Figure A 2: Dendrogram of Cluster-analysis of station Is_Solar. Samples are named after bathymetric zones; vertical axis shows % of similarity.

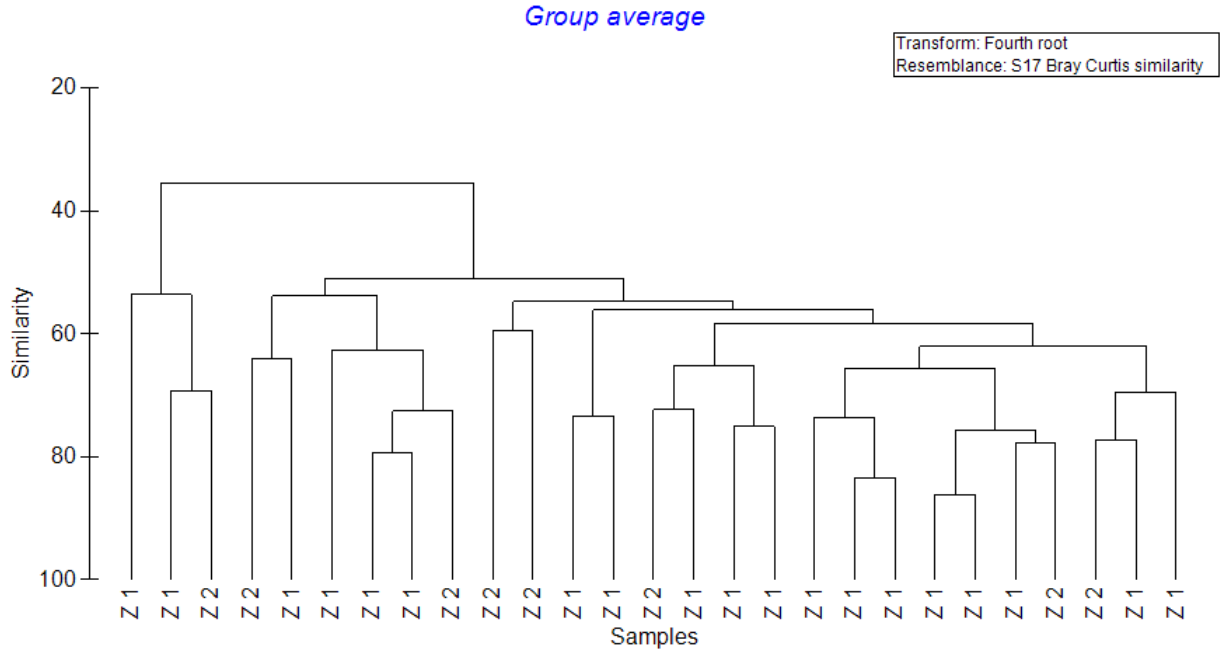

Figure A 3: Dendrogram of Cluster-analysis of station AG. Samples are named after bathymetric zones; vertical axis shows % of similarity.

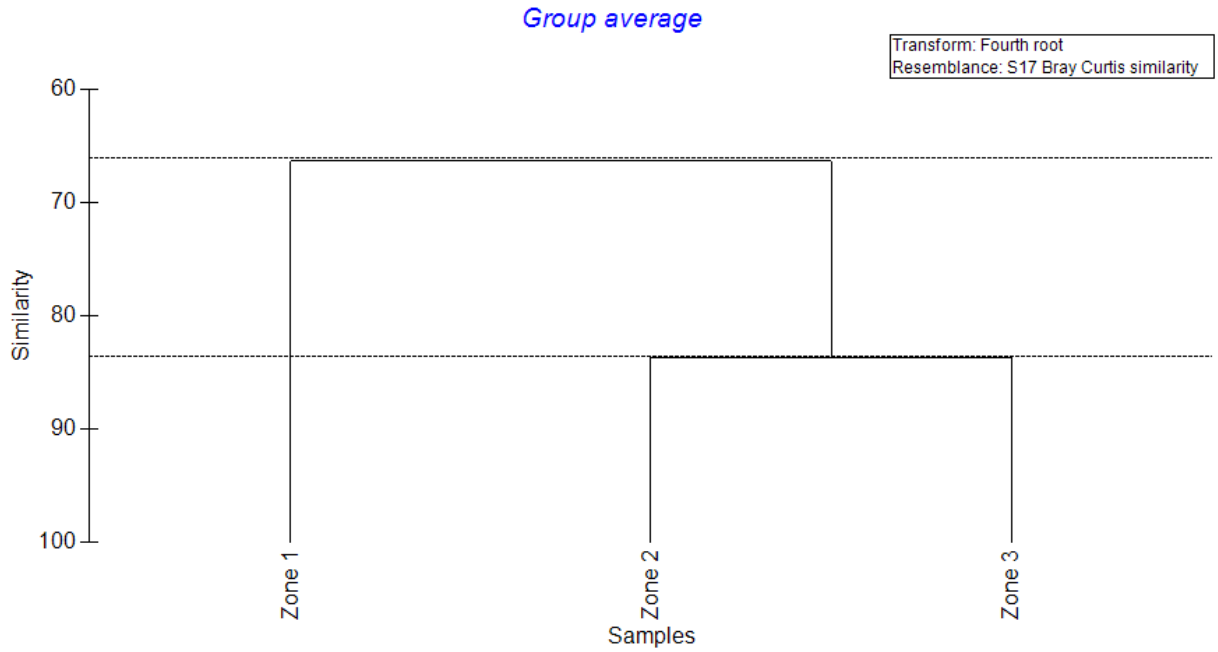

Figure A 4: Dendrogram of Cluster-analysis of bathymetric zones.

Table A 7 Abiotic parameters pH, salinity (Sal.), temperature (Temp.) [°C], depth [m], oxygen saturation (Ox. sat.) [%] and oxygen concentration (Ox. conc.) [µmol/l] of all samples.

Sample	pH	Sal.	Temp. [°C]	Depth [m]	Ox. sat. [%]	Ox. conc. [µmol/l]
MDD3_1	8.22	31.60	11.42	25.20	78.72	220.02
MDD3_2	8.22	31.60	11.43	25.63	78.81	220.27
MDD3_3	8.22	31.58	11.44	25.55	78.83	220.31
MDD3_4	8.23	31.58	11.43	25.53	79.01	220.81
MDD3_5	8.23	31.59	11.44	25.69	79.23	221.43
MDD3_6	8.22	31.51	11.32	27.69	78.89	221.10
MDD3_7	8.22	31.51	11.32	26.23	78.84	220.99
MDD3_8	8.22	31.52	11.33	24.78	78.69	220.52
MDD3_9	8.22	31.52	11.33	24.32	78.70	220.54
MDD3_10	8.22	31.52	11.35	24.20	78.73	220.54
MDD3_11	8.22	31.57	11.42	27.70	78.81	220.36
MDD3_12	8.23	31.56	11.40	27.74	79.47	222.30
MDD4_2	8.19	31.21	11.18	18.53	76.51	215.51
MDD4_3	8.20	31.21	11.16	18.01	76.66	216.04
MDD4_4	8.20	31.21	11.17	19.38	76.73	216.17
MDD4_6	8.20	31.23	11.21	21.39	77.54	218.23
MDD4_7	8.21	31.21	11.23	18.84	78.04	219.61
MDD4_8	8.21	31.20	11.21	18.87	78.06	219.74
MDD4_9	8.21	31.20	11.21	18.87	77.76	218.88
MDD4_10	8.19	31.22	11.03	22.74	74.42	210.28
MDD4_11	8.22	31.26	11.13	23.45	76.66	216.10
MDD4_13	8.24	31.34	11.29	29.96	79.39	222.91
MDD4_14	8.22	31.28	11.15	25.77	77.87	219.35
MDD4_15	8.22	31.31	11.19	25.78	78.35	220.48
MDD4_16	8.22	31.27	11.17	25.75	78.13	220.04
MDD4_17	8.22	31.27	11.17	25.77	78.13	220.06
MDD4_18	8.22	31.29	11.16	25.79	78.20	220.22
MDD4_19	8.22	31.28	11.16	25.80	78.13	220.07
MDD4_20	8.22	31.29	11.17	25.79	78.22	220.23
MDD4_21	8.22	31.29	11.16	25.78	78.19	220.19
MDD4_22	8.22	31.26	11.15	24.98	78.07	219.96
MDD4_23	8.22	31.26	11.14	24.43	77.90	219.55
MDD4_24	8.22	31.26	11.13	24.57	77.93	219.64
MDD4_26	8.22	31.26	11.14	24.60	78.23	220.49
MDD4_27	8.22	31.26	11.13	24.60	78.22	220.49
MDD4_28	8.22	31.26	11.13	24.58	78.19	220.39
MDD4_31	8.21	31.26	11.09	24.58	77.70	219.19
MDD4_32	8.22	31.27	11.14	24.59	77.95	219.64
MDD4_33	8.22	31.28	11.18	24.59	78.23	220.23
MDD4_34	8.22	31.29	11.20	24.58	78.70	221.47
MDD4_35	8.23	31.30	11.22	24.59	79.20	222.75

Sample	pH	Sal.	Temp. [°C]	Depth [m]	Ox. sat. [%]	Ox. conc. [µmol/l]
MDD4_36	8.23	31.29	11.24	24.58	79.58	223.74
MDD4_37	8.22	31.25	11.15	24.58	79.02	222.65
MDD4_38	8.23	31.31	11.23	24.58	78.86	221.74
MDD4_39	8.22	31.24	11.08	24.57	78.81	222.42
MDD4_40	8.20	31.24	11.04	24.58	77.54	219.02
MDD4_41	8.22	31.34	11.27	24.58	78.69	221.06
MDD4_42	8.23	31.30	11.24	24.57	78.86	221.71
MDD4_43	8.23	31.30	11.24	24.58	79.43	223.31
MDD4_44	8.21	31.26	11.13	27.10	78.36	220.89
MDD7_2	8.27	31.55	11.33	22.32	76.99	215.67
MDD7_4	8.25	31.55	11.36	24.24	75.45	211.25
MDD7_5	8.26	31.56	11.32	25.15	76.20	213.51
MDD7_6	8.26	31.54	11.34	25.20	76.11	213.20
MDD7_7	8.25	31.55	11.32	25.36	75.59	211.84
MDD7_8	8.25	31.55	11.32	25.39	75.33	211.12
MDD7_9	8.26	31.55	11.30	25.40	75.41	211.40
MDD7_11	8.24	31.53	11.34	25.67	74.78	209.48
MDD7_12	8.24	31.55	11.30	26.20	75.05	210.42
MDD7_13	8.24	31.56	11.29	25.33	74.88	209.95
MDD7_16	8.25	31.56	11.30	22.21	74.98	210.17
MDD7_17	8.25	31.56	11.30	22.18	74.95	210.10
MDD7_18	8.25	31.56	11.30	22.20	74.99	210.22
MDD7_19	8.25	31.56	11.30	22.20	74.92	210.03
MDD7_21	8.24	31.58	11.28	27.09	74.21	208.09
MDD7_24	8.24	31.58	11.28	27.96	74.22	208.12
MDD7_25	8.24	31.58	11.28	28.48	74.17	207.99
MDD7_27	8.24	31.58	11.29	36.22	75.32	211.18
MDD7_28	8.24	31.58	11.28	35.92	74.92	210.09
MDD7_29	8.26	31.60	11.39	34.38	77.19	215.92
Is_Solar1_1	8.13	31.89	10.74	21.60	65.02	184.08
Is_Solar1_2	8.13	31.90	10.74	21.54	65.08	184.22
Is_Solar1_4	8.13	31.97	10.75	24.08	65.17	184.35
Is_Solar1_5	8.13	31.96	10.76	25.07	64.92	183.63
Is_Solar1_6	8.13	31.97	10.76	24.69	65.05	183.99
Is_Solar1_8	8.13	32.02	10.77	24.59	65.17	184.23
Is_Solar1_9	8.13	31.94	10.76	24.57	65.13	184.26
Is_Solar1_10	8.13	31.94	10.75	24.56	65.24	184.62
Is_Solar1_11	8.13	32.02	10.76	24.55	65.25	184.51
Is_Solar1_12	8.14	31.95	10.75	24.49	65.35	184.87
Is_Solar1_13	8.13	31.92	10.75	23.86	65.34	184.88
Is_Solar1_14	8.13	31.94	10.76	23.67	65.39	184.99
Is_Solar1_15	8.14	31.95	10.76	23.21	65.40	185.01
Is_Solar1_16	8.13	31.97	10.76	23.05	65.40	184.96

Sample	pH	Sal.	Temp. [°C]	Depth [m]	Ox. sat. [%]	Ox. conc. [µmol/l]
Is_Solar1_17	8.14	31.92	10.76	23.08	65.40	185.02
Is_Solar1_18	8.14	31.95	10.76	23.00	65.36	184.89
Is_Solar1_19	8.14	31.96	10.76	22.95	65.41	185.01
Is_Solar1_20	8.14	31.94	10.76	22.95	65.32	184.78
Is_Solar1_21	8.14	31.97	10.76	22.93	65.44	185.09
Is_Solar1_22	8.13	31.95	10.76	22.95	65.36	184.87
Is_Solar1_23	8.13	31.97	10.77	22.90	65.38	184.90
Is_Solar1_24	8.13	31.97	10.76	22.97	65.37	184.90
Is_Solar1_25	8.13	31.98	10.76	23.12	65.41	185.00
Is_Solar1_26	8.14	31.91	10.75	22.43	65.40	185.09
Is_Solar1_27	8.14	31.92	10.76	22.13	65.47	185.23
Is_Solar1_28	8.14	32.08	10.78	29.00	65.34	184.63
Is_Solar1_29	8.14	32.11	10.77	29.01	65.49	185.02
Is_Solar1_30	8.14	32.13	10.77	29.00	65.45	184.89
Is_Solar1_31	8.14	32.16	10.77	29.02	65.45	184.82
Is_Solar1_32	8.14	32.23	10.78	29.04	65.60	185.17
Is_Solar1_33	8.14	32.22	10.78	29.02	65.60	185.20
Is_Solar1_34	8.14	32.35	10.78	28.98	65.63	185.10
Is_Solar1_35	8.14	32.39	10.78	29.09	65.77	185.44
Is_Solar1_36	8.14	31.96	10.76	27.85	65.67	185.76
Is_Solar1_37	8.14	32.01	10.76	27.89	65.69	185.73
Is_Solar1_39	8.14	32.33	10.78	28.39	65.80	185.61
Is_Solar1_40	8.14	32.24	10.77	29.10	65.81	185.77
Is_Solar1_41	8.14	32.33	10.78	29.10	65.84	185.73
Is_Solar1_42	8.14	32.20	10.77	29.10	65.92	186.13
Is_Solar1_43	8.14	32.29	10.78	29.10	66.01	186.26
Is_Solar1_44	8.14	32.27	10.77	29.10	65.98	186.21
Is_Solar1_45	8.14	32.08	10.77	29.11	65.99	186.49
Is_Solar1_46	8.14	32.07	10.77	29.09	65.99	186.52
Is_Solar1_47	8.14	32.43	10.77	29.65	66.09	186.33
Is_Solar1_48	8.14	32.42	10.77	29.81	66.11	186.40
Is_Solar1_49	8.15	32.36	10.78	29.89	66.26	186.89
Is_Solar1_50	8.15	32.31	10.77	29.91	66.32	187.11
Is_Solar1_51	8.15	32.32	10.77	29.96	66.33	187.14
Is_Solar1_52	8.15	32.35	10.78	30.10	66.33	187.09
Is_Solar1_53	8.15	32.17	10.77	28.87	66.37	187.46
Is_Solar1_54	8.15	32.16	10.77	27.57	66.31	187.31
Is_Solar1_55	8.15	31.88	10.76	23.65	66.38	187.90
Is_Solar1_56	8.15	31.88	10.76	23.64	66.33	187.74
Is_Solar1_57	8.15	31.69	10.75	23.60	66.21	187.65
Is_Solar1_58	8.15	31.71	10.75	23.87	66.26	187.75
Is_Solar1_60	8.15	32.06	10.77	28.13	66.27	187.29
Is_Solar1_61	8.15	32.18	10.77	28.13	66.19	186.91

Sample	pH	Sal.	Temp. [°C]	Depth [m]	Ox. sat. [%]	Ox. conc. [µmol/l]
Is_Solar1_62	8.15	32.51	10.77	33.99	66.32	186.90
Is_Solar1_65	8.15	32.88	10.68	38.19	66.53	187.38
Is_Solar1_66	8.15	32.87	10.68	36.96	66.58	187.55
Is_Solar1_67	8.15	32.89	10.68	36.70	66.56	187.52
Is_Solar1_68	8.15	32.88	10.68	36.71	66.51	187.36
Is_Solar1_69	8.15	32.88	10.68	36.72	66.58	187.54
Is_Solar1_70	8.15	32.88	10.69	36.54	66.58	187.51
Is_Solar1_71	8.15	32.88	10.69	36.51	66.64	187.71
Is_Solar1_72	8.15	32.88	10.68	36.32	66.58	187.54
Is_Solar1_73	8.15	32.88	10.68	36.30	66.62	187.64
Is_Solar1_74	8.15	32.88	10.69	36.32	66.58	187.52
Is_Solar1_75	8.15	32.88	10.69	36.32	66.62	187.63
Is_Solar1_76	8.15	32.88	10.68	36.33	66.60	187.60
Is_Solar1_77	8.15	32.88	10.68	36.34	66.62	187.67
Is_Solar1_78	8.15	32.88	10.68	36.34	66.51	187.38
Is_Solar1_79	8.15	32.85	10.72	36.32	66.76	187.94
Is_Solar1_80	8.15	32.88	10.67	37.60	66.64	187.76
Is_Solar1_81	8.15	32.88	10.68	37.84	66.57	187.53
Is_Solar1_82	8.15	32.89	10.67	37.03	66.41	187.12
Is_Solar1_83	8.15	32.86	10.65	36.67	66.50	187.49
Is_Solar1_84	8.15	32.78	10.69	35.54	66.45	187.27
Is_Solar1_85	8.15	32.82	10.67	35.56	66.49	187.43
Is_Solar1_86	8.15	32.64	10.73	32.08	66.53	187.48
Is_Solar1_87	8.16	32.61	10.74	30.70	66.61	187.71
Is_Solar1_88	8.15	32.45	10.77	30.63	66.66	187.90
Is_Solar1_89	8.15	32.49	10.77	30.63	66.62	187.79
Is_Solar1_90	8.16	32.03	10.79	28.03	66.65	188.32
Is_Solar1_91	8.15	32.07	10.79	28.01	66.62	188.17
Is_Solar1_92	8.16	32.29	10.80	29.16	66.73	188.19
Is_Solar1_93	8.16	32.40	10.80	29.40	66.62	187.78
Is_Solar1_94	8.16	32.45	10.79	29.90	66.66	187.85
Is_Solar1_95	8.16	32.52	10.78	30.10	66.76	188.07
Is_Solar1_96	8.16	32.51	10.78	30.09	66.78	188.14
Is_Solar1_97	8.16	32.51	10.79	30.11	66.76	188.07
Is_Solar1_98	8.16	32.47	10.79	30.10	66.71	187.95
Is_Solar1_99	8.16	32.52	10.78	30.53	66.86	188.39
Is_Solar1_100	8.16	32.56	10.76	30.53	66.83	188.31
Is_Solar1_101	8.16	32.56	10.76	30.47	66.72	187.99
Is_Solar1_102	8.16	32.55	10.77	29.86	66.73	188.02
Is_Solar1_103	8.16	32.46	10.78	28.77	66.76	188.13
Is_Solar1_104	8.16	32.48	10.78	28.76	66.74	188.06
Is_Solar1_105	8.16	32.49	10.78	28.60	66.71	187.98
Is_Solar1_106	8.16	32.47	10.78	28.48	66.67	187.90

Sample	pH	Sal.	Temp. [°C]	Depth [m]	Ox. sat. [%]	Ox. conc. [µmol/l]
Is_Solar1_107	8.16	32.44	10.79	28.48	66.73	188.07
Is_Solar1_108	8.16	32.22	10.78	25.16	66.61	188.01
Is_Solar1_109	8.16	32.09	10.78	24.65	66.64	188.26
Is_Solar2_1	8.18	32.22	10.79	27.70	66.51	187.71
Is_Solar2_2	8.18	32.54	10.79	27.71	66.53	187.40
Is_Solar2_3	8.18	32.51	10.79	27.41	66.51	187.37
Is_Solar2_4	8.17	32.47	10.79	27.95	66.55	187.53
Is_Solar2_5	8.18	32.25	10.78	26.76	66.53	187.76
Is_Solar2_6	8.17	32.15	10.78	26.68	66.56	187.96
Is_Solar2_7	8.18	32.21	10.79	26.56	66.52	187.74
Is_Solar2_8	8.18	32.25	10.79	26.55	66.48	187.59
Is_Solar2_9	8.17	32.18	10.78	26.55	66.50	187.76
Is_Solar2_10	8.17	32.27	10.79	26.55	66.52	187.68
Is_Solar2_11	8.18	32.27	10.79	26.55	66.46	187.51
Is_Solar2_12	8.18	32.37	10.79	26.16	66.42	187.28
Is_Solar2_13	8.18	32.37	10.79	26.16	66.53	187.58
Is_Solar2_14	8.18	32.02	10.77	26.17	66.46	187.89
Is_Solar2_15	8.18	32.49	10.78	29.10	66.57	187.56
Is_Solar2_16	8.18	32.54	10.78	29.20	66.79	188.17
Is_Solar2_17	8.18	32.36	10.78	27.91	66.76	188.28
Is_Solar2_18	8.18	32.55	10.78	29.84	66.85	188.30
Is_Solar2_19	8.18	32.49	10.78	29.82	66.88	188.45
Is_Solar2_20	8.18	32.54	10.78	29.84	66.91	188.51
Is_Solar2_21	8.18	32.54	10.78	29.85	66.86	188.36
Is_Solar2_22	8.18	32.56	10.77	30.00	66.87	188.39
Is_Solar2_23	8.18	32.58	10.77	30.58	66.96	188.61
Is_Solar2_24	8.18	32.57	10.77	31.17	66.87	188.38
Is_Solar2_25	8.18	32.58	10.77	30.95	66.86	188.34
Is_Solar2_26	8.18	32.54	10.78	31.64	66.96	188.64
Is_Solar2_27	8.18	32.59	10.77	31.63	66.81	188.18
Is_Solar2_28	8.18	32.62	10.77	31.35	66.89	188.41
Is_Solar2_29	8.18	32.68	10.76	36.52	66.94	188.49
Is_Solar2_30	8.18	32.80	10.72	37.87	67.03	188.77
Is_Solar2_31	8.18	32.77	10.72	37.85	67.13	189.07
Is_Solar2_32	8.18	32.80	10.71	38.16	67.08	188.92
Is_Solar2_33	8.18	32.80	10.71	38.20	66.98	188.64
Is_Solar2_34	8.18	32.81	10.71	38.39	67.00	188.70
Is_Solar2_35	8.18	32.81	10.71	38.72	66.98	188.66
Is_Solar2_36	8.18	32.76	10.73	38.57	67.03	188.78
Is_Solar2_37	8.18	32.81	10.70	39.10	66.97	188.64
Is_Solar2_38	8.18	32.68	10.75	39.40	66.73	187.96
Is_Solar3_1	8.17	32.29	10.74	25.04	66.83	188.70
Is_Solar3_2	8.17	32.29	10.75	25.06	66.71	188.35

Sample	pH	Sal.	Temp. [°C]	Depth [m]	Ox. sat. [%]	Ox. conc. [µmol/l]
Is_Solar3_3	8.18	32.05	10.71	22.84	67.70	191.60
Is_Solar3_4	8.18	32.00	10.71	22.16	67.70	191.64
Is_Solar3_5	8.18	32.01	10.71	22.09	67.68	191.59
Is_Solar3_6	8.18	32.02	10.71	22.01	67.68	191.56
Is_Solar3_7	8.18	31.99	10.71	22.11	67.66	191.56
Is_Solar3_8	8.18	31.99	10.71	22.13	67.69	191.63
Is_Solar3_9	8.18	32.09	10.72	23.05	67.64	191.36
Is_Solar3_10	8.18	32.11	10.72	23.06	67.61	191.24
Is_Solar3_11	8.18	32.12	10.72	23.07	67.64	191.30
Is_Solar3_12	8.18	32.08	10.72	23.05	67.58	191.19
Is_Solar3_13	8.18	32.12	10.72	23.29	67.65	191.32
Is_Solar3_14	8.18	31.95	10.71	20.56	67.72	191.79
Is_Solar3_15	8.18	31.94	10.71	20.50	67.68	191.66
Is_Solar3_16	8.18	31.93	10.71	20.45	67.70	191.73
Is_Solar3_17	8.18	31.95	10.71	20.43	67.64	191.54
Is_Solar3_18	8.18	31.93	10.71	19.74	67.60	191.45
AG_1	8.29	28.80	10.95	18.90	72.23	207.60
AG_2	8.29	28.81	10.94	18.91	72.28	207.80
AG_3	8.29	28.80	10.94	18.90	72.24	207.69
AG_4	8.29	28.81	10.94	18.89	72.19	207.54
AG_5	8.29	28.77	10.93	18.90	72.25	207.79
AG_6	8.29	28.81	10.94	18.91	72.30	207.82
AG_7	8.29	28.78	10.93	18.89	72.29	207.88
AG_8	8.28	29.00	10.94	21.13	72.06	206.90
AG_9	8.25	29.64	10.98	29.19	73.20	209.15
AG_10	8.29	28.85	10.91	19.49	74.03	212.88
AG_11	8.29	28.85	10.90	19.50	73.80	212.28
AG_12	8.29	28.82	10.92	19.50	73.73	212.05
AG_13	8.29	28.84	10.90	19.49	73.75	212.14
AG_14	8.30	28.79	10.92	19.33	73.94	212.67
AG_15	8.29	28.82	10.91	18.82	73.64	211.79
AG_16	8.30	28.80	10.92	17.60	73.75	212.14
AG_17	8.30	28.73	10.96	16.48	73.86	212.37
AG_18	8.30	28.72	10.97	14.13	74.21	213.29
AG_19	8.30	28.74	10.95	14.15	74.09	213.02
AG_20	8.30	28.77	10.93	15.74	74.08	213.04
AG_21	8.30	28.79	10.92	16.88	74.00	212.83
AG_22	8.29	28.88	10.90	21.02	73.59	211.62
AG_23	8.28	29.21	10.99	24.21	73.87	211.58
AG_24	8.27	29.37	10.99	24.20	74.06	211.90
AG_25	8.27	29.37	10.99	24.20	74.03	211.83
AG_26	8.29	29.14	10.98	23.98	74.51	213.57
AG_27	8.28	29.25	11.00	23.99	74.48	213.20

Sample	pH	Sal.	Temp. [°C]	Depth [m]	Ox. sat. [%]	Ox. conc. [µmol/l]
CS_1	8.29	28.91	10.97	17.63	75.54	216.89
CS_2	8.23	30.15	10.83	36.23	69.72	199.19
CS_4	8.25	29.78	10.90	35.65	70.78	202.42
CS_6	8.28	29.36	10.94	34.42	72.49	207.65
CS_7	8.30	29.11	10.97	32.62	73.06	209.48