DIPLOMARBEIT

Titel der Diplomarbeit

Habitat mapping and molluscan zonation of a Red Sea tidal flat at Dahab (Gulf of Aqaba, Egypt)

Verfasserin

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1. Abstract

This study deals with the ecological zonation of a tidal flat in the Gulf of Aqaba (Northern Red Sea, Egypt).

An area of about 0.3 km² was investigated with respect to the distribution of molluscs, drilling predation, sediment composition, density of crustacean burrows and abiotic factors. Special structures such as beach rock, algal mats and accumulations of the oyster *Saccostrea cucullata* were registered with the aid of a GPS device.

The main focus of this study was on the succession of molluscan assemblages along a transect from the high intertidal to the shallow subtidal zone. To this end 18 quantitative sediment samples were taken. The collected material was sieved, molluscs were removed and separated into dead and living individuals. A total of 3566 shells from 97 species were identified, inspected for predatory drill holes and their size, measured with a calliper.

Measurements of abiotic factors (temperature, salinity, pH and oxygen level) showed that changing water levels cause fluctuating environmental conditions, which identify the intertidal area as a stressful habitat for organisms.

The stress decreases from the high intertidal zone to the shallow subtidal zone, which can be seen in the population density of the crab *Dotilla sulcata.* The number of crustacean burrows rose towards the low tide level, which means population density increased.

This is also reflected in analyses of molluscan composition. The number of species per sample increased along the transect line from the high intertidal to the shallow subtidal area. The number of individuals, however, was higher in intertidal samples. This emphasizes the high productivity of the intertidal area, caused by terrestrial nutrient sources and high phytoplankton production.

The tidal flat can be divided into three zones on the basis of the amount of tidal coverage they receive:

The intertidal zone: Only a few well adapted species (11), mainly gastropods, were found in intertidal samples. Most conspicuous was the gastropod *Potamides conicus* (1970 shells), which dominated the intertidal area. Infrequently *Planaxis savignyi, Volema paradisica* and some taxa of the family Cerithiidae occurred in the lower intertidal zone.

The borderland: This area was colonized by the cementing (*Saccostrea cucullata*) and byssally attached (*Brachidontes pharaonis*) bivalves. Distribution of the oyster *Saccostrea cucullata* correlated very well with the low tide level. *Brachidontes pharaonis* was also found along the south-eastern coastline on beach rock formations.

The subtidal zone: In contrast to the intertidal zone, the subtidal zone showed a rich biodiversity with 93 species although, the number of collected shells was much lower. Quantitatively, bivalves dominated the subtidal area (77%). Most abundant was the family Lucinidae. The number of gastropod species (58), however, was higher than that of bivalves (35).

Drilling gastropods (Muricidae and Naticidae) occurred in the subtidal zone and preyed on bivalves and gastropods. This resulted in very high drilling frequencies within subtidal samples. Especially affected were lucinids.

2. Zusammenfassung

Diese Studie beschäftigt sich mit der ökologischen Zonierung einer Gezeitenfläche im Golf von Aqaba (Rotes Meer, Ägypten).

Es wurde eine Fläche von ca. 0,3 km² hinsichtlich Verteilung der Mollusken, Raubdruck, Sedimentzusammensetzung, Dichte von Krabbenbauten und abiotischer Faktoren untersucht. Mit Hilfe eines GPS-Gerätes konnten Beachrock-Formationen, Algenmatten und Akkumulationen der Auster *Saccostrea cucullata* vermessen werden.

Der Schwerpunkt der Untersuchung lag auf der Abfolge von Molluskengesellschaften entlang eines Transektes vom Intertidal ins seichte Subtidal. Es wurden 18 quantitative Sedimentproben mit Hilfe eines Aluminiumrahmens (0,25m²) genommen, welche anschließend geschlemmt wurden. Mollusken wurden aus dem Material aussortiert und in tote und lebende Individuen getrennt. Gesamt konnten 3566 Schalen von 97 verschiedenen Taxa identifiziert, vermessen und auf räuberische Bohrspuren untersucht werden.

Messungen der abiotischen Faktoren (Temperatur, Salinität, pH und Sauerstoffkonzentration) zeigten, dass die Umweltbedingungen im Intertidal aufgrund der wechselnden Wasserstände stark schwanken. Dies bedeutet für die Organismen des Lebensraumes eine erhöhte Stressbelastung.

Extreme Schwankungen der abiotischen Faktoren nehmen vom Land zum Wasser hin ab. Dies macht sich in Faunenzusammensetzung deutlich bemerkbar. Die Populationsdichte der Krabbe *Dotilla sulcata* nimmt beispielsweise Richtung Niedrigwasserlinie deutlich zu.

Ähnliche Ergebnisse lieferte die Analyse der Molluskengesellschaften. Die Zahl der Arten pro Probe stieg entlang des Transektes vom Intertidal ins Subtidal. Die Individuenzahlen der Intertidal-Proben lagen jedoch deutlich höher als jene des Subtidals. Dies weist auf die hohe Produktivität des Intertidals hin, begründet durch terrestrischen Nährstoffeintrag und hohe Primärproduktion.

Die Gezeitenfläche kann anhand der Dauer der Wasserbedeckung in drei Zonen gegliedert werden:

Intertidal: Nur wenige gut angepasste Arten (11) konnten im Intertidal gefunden werden. Mit Abstand das häufigste Weichtier war *Potamides conicus* mit 1970 gezählten Individuen. Diese Art ernährt sich herbivor und ist perfekt an die schwankenden Bedingungen des Intertidals angepasst, wodurch sie in dieser Zone sehr dichte Populationen ausbilden kann. In geringen Abundanzen fanden sich *Planaxis savignyi, Volema paradisica* und *Vertreter* der Familie Cerithiidae in den Proben des unteren Intertidals.

Grenzbereich: Die Zone zwischen Intertidal und Subtidal wurde von *Saccostrea cucullata* und *Brachidontes pharaonis* besiedelt, wobei die Verbreitungszone der Auster *Saccostrea cucullata* erstaunlich gut mit der Niedrigwasserlinie übereinstimmte. Beide Arten leben sessil, *Brachidontes pharaonis* ist mit Byssusfäden befestigt während *Saccostrea cucullata* auf festem Untergrund zementiert ist. Zwischen den Austernaggregaten fanden sich Mikrohabitate für verschiedene Gastropoden. Dichte Populationen von *Brachidontes pharaonis* waren auch auf den Beachrock-Formationen entlang der südöstlichen Küstenlinie zu sehen.

Subtidal: Im Gegensatz zum Intertidal war das Subtidal äußerst artenreich. Die Proben enthielten 93 verschiedene Taxa, obwohl die Individuenzahl deutlich geringer war (1534). Mengenmäßig wurde das Subtidal von Bivalven dominiert (77%), dennoch war die Artenzahl der Gastropoden (58) höher als die Artenzahl der Bivalven (35).

Raubdruck spielt auch in Seichtwasserökosystemen eine bedeutende Rolle. Bohrlöcher liefern direkte Nachweise dieser ökologischen Interaktionen. Es wurden bohrende Schnecken der Familie Muricidae und Naticidae in den Proben des Subtidals gefunden, wodurch sich auch die hohe Bohrintensität im Subtidal erklären lässt.

3. Introduction

Tidal flat deposits are frequently found in the subtropical Lower and Middle Miocene fossil record of the Central Paratethys (Zuschin et al. 2004; Zuschin et al. in review) but actualistic studies in such environments are rare (Fürsich & Flessa 1991). To provide a dataset for comparison with fossil examples from Austria we studied appropriate environments at the northern Red Sea.

Tidal flats are low energy environments, which are submerged at high tide and fall dry at low tide. They develop in sheltered areas such as bays, estuaries and lagoons, where marine sediments and terrigenous material is deposited (Eisma, 1998). While tidal flats of the North Sea (Wadden Sea) are well known (Reineck, 1982), mud flats of the Red Sea are only sparsely explored, because scientists paid more attention to coral reef associated communities.

Although many ecological studies have been published on the molluscan composition of shallow-water environments of the Red Sea (Fishelson, 1971; Mergner, 1979; Taylor and Reid, 1984; Mastaller, 1987; Zuschin and Piller, 1997a, b; Zuschin and Hohenegger, 2000) there is little information available about the ecological zonation of Red Sea tidal flats.

We focused on the succession of molluscan assemblages along a transect from the high intertidal zone to the shallow subtidal zone. Physical conditions such as temperature, salinity and oxygen level fluctuate much more in intertidal than in subtidal zones. This results in a gradient of increasing stress for marine organisms. That gradient is well studied; however investigations concentrated on rocky shores and vertical gradients because sandy shores do not show the obvious pattern of zonation as rocky shores do (Ayal & Safriel, 1981; Somero, 2002; Levinton, 2009; Karleskint et. al., 2010).

The major aim of this study is to illustrate the longitudinal gradient from the intertidal to the shallow subtidal area of a tropical tidal flat on the basis of changes in molluscan assemblages. For this purpose quantitative molluscan samples were taken, abiotic factors such as temperature, salinity, pH and oxygen level were measured, grain size of sediments was studied and openings of crustaceans burrows were counted.

The work was done during an interdisciplinary field trip to Dahab, northern Red Sea in April 2010 arranged by Ao. Prof. Martin Zuschin (Department of Palaeontology, University of Vienna) and Dr. Jürgen Herler (Faculty of Life Sciences, University of Vienna).

4. Study area

The study site is located in the Gulf of Aqaba, a narrow body of warm tropical water between the Sinai Peninsula and the Arabian Peninsula. The gulf is part of the Northern Red Sea, which is the most north-western extension of the Indian Ocean (Head, 1987). The Tidal flat is situated near the small town Dahab (28°29'35''N 34°30'17''E) on the East coast of the Sinai Peninsula, 80 km northeast of Sharm el-Sheikh (Egypt) (Fig. 1).

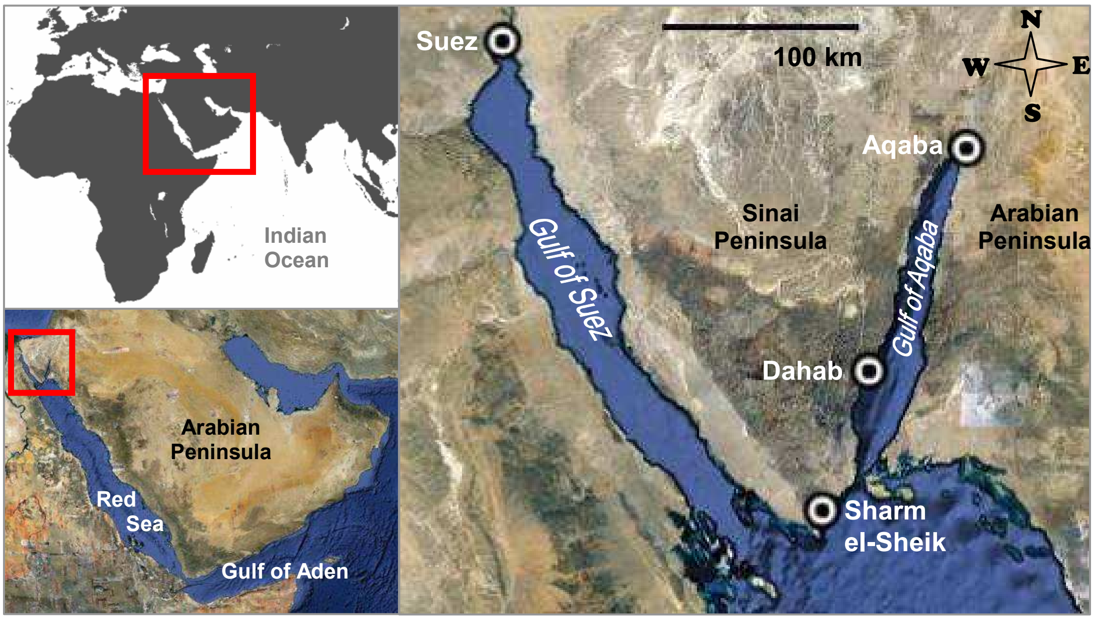

Fig. 1: location map

The Red Sea is surrounded by arid land and desert. As a result of that fresh water supply through rainfall and rivers is very low and evaporation is very high. The consequences are extreme salinities, which increase from the South to the North, reaching 41 ‰ in the Gulf of Aqaba (Head, 1987).

While surface water temperatures range from 16-20 °C in winter and 25-33 °C in summer, the temperature of the deep waters is nearly constant at 20 °C, which is exceptionally warm (Mastaller, 1987).

These environmental factors have a considerable impact on biodiversity and distribution of molluscs in the Red Sea. High salinity is suggested as one of the main reasons for a reduced number of species in the Gulf of Aqaba (637 species) compared to the rest of the Red Sea (850 species). Another peculiarity is the lack of a real deep-sea mollusc fauna, which is caused by the extraordinarily warm deep waters (Mastaller, 1979).

The Red Sea occupies a part of the Great Rift Valley, a system of crustal expansion. This rift valley runs from East Africa trough the Red Sea and the Gulf of Aqaba up to the Dead Sea (Purser & Bosence, 1998).

The Gulf of Aqaba is about 160 km long and 30 km wide and the Straits of Tiran separate the gulf from the rest of the Red Sea. Due to the fact that the sill is only 250-300 metres deep, water mass exchange is reduced (Head, 1987). Moreover high evaporation causes inflow of surface waters from the Red Sea and outflow of high saline deep waters from the gulf (Siddall et al., 2004).

The basin of the gulf is steep-sided with maximum depths of over 1800 m and fronted by a slender shelf (1-2 km wide). Fringing reefs are growing along the coastline, which are interrupted by narrow inlets, called *marsas* on the western and *sharms* on the eastern coast. These channels were probably formed by rivers during the Pleistocene (Head, 1987).

Fig. 2: Google Earth map of Dahab

In the region of Dahab fringing reefs provide very attractive and famous dive sites (e.g. Eel Garden, Lighthouse, The Islands, Napoleon's reef, among others). The study area is located in the East of the Blue Lagoon and is highly frequented by kite surfers. Therefore it is also called "Kite Lagoon" (Fig. 2).

The blue lagoon is a protected area behind the fringing reef with fine biogenic sand substrata, sea grass beds and some smaller patch reefs. In contrast to the Blue lagoon there are no corals and sea grasses in the Kite Lagoon. Due to the flat topography of the environment there is a large intertidal area, where marine and terrestrial sediments are deposited. Such an area is also called tidal flat or mud flat (Fig. 3). Deposits are only a few centimetres thick and lie on the top of a Quaternary fossil reef platform, which can be seen in some places (Jones et al., 1987).

Fig. 3: Google Earth map of the Kite Lagoon (Tidal flat).

The Kite lagoon measures around 500 m in N-S and approximately 600 m in E-W direction. The north-eastern part is very shallow with water depths of less then one meter. In the South there is a pool of a few meters water depth (Fig. 3).

Fig. 4: Tidal flat of the Kite Lagoon at high tide.

5. Material and Methods

The habitat mapping was done with the aid of a GPS device (eTrex Summit, Garmin Ltd.). Initially we recorded the high tide level and the low tide level in order to get the dimensions of the intertidal area. Afterwards we registered special structures such as beachrock, algal mats or accumulations of the oyster *Saccostrea cucullata*. All the data was entered in a Google Earth Map.

Abiotic factors (temperature, salinity, pH and oxygen level) were measured with a multimeter (Multi 350i, WTW GmbH). We did four measurements at high tide and six at low tide. Measuring points were chosen from the high intertidal area to the shallow subtidal area.

To gain knowledge of the substrata we took 6 sediment samples and analysed the grain size distribution. The material was weighed and sieved with 2mm, 1mm, 0.5mm, 0.25 mm, 0.125mm and 0.063 mm mesh size sieves. Each fraction was dried and weighed again. Results were analysed with the program Sedpak (Version 4).

The density of crustacean burrows was investigated by counting holes on the sediment surface. To this end we placed an aluminium square frame (0.25 m²) approximately every 5 m along a 50 m line.

16 lines were taken from the high intertidal zone to the low tide line, each with a distance of about 10 m to the next one.

We classified the holes into two categories, holes with a diameter of about one centimetre or more (large holes) and holes with a diameter less than one centimetre (small holes) (Fig.5).

Fig. 5: Holes of crustacean burrows. The left hole was classified as a small one and the right as a large one.

The main focus of this study was on the changes in molluscan assemblages along a transect from the high intertidal to the shallow subtidal. We took 18 quantitative samples along this gradient.

The sampling was carried out using a 0.25 m² aluminium square frame. The frame was placed on the substrata before the top five centimetres of sediment within the frame were removed with a shovel (Fig. 6). The sample locations were accurately determined using the GPS device. The collected material was sieved with 1 mm mesh size sieve. Molluscs were removed and separated into living and dead individuals. Afterwards the shells were identified, counted and measured with a calliper.

Fig. 6: 0.25 m² square frame and shovel.

The raw data was saved in Microsoft Excel 2003, which was also used to create diagrams to study abundances of the species at different locations. Afterwards percentage abundances were computed and prepared for statistical analyses. This was done by square-root-transformation, in order to minimize the impact of outliers and to emphasize the influence of intermediate abundances (Clarke & Warwick 1994).

Statistical analyses were carried out with the program PAST (Paleontological Statistics, ver. 2.05), a computer software which is available for free (http://folk.uio.no/ohammer/past/).

To show similarities and dissimilarities between the samples Q-mode cluster analyses and a non-metric multidimensional scaling (NMDS) based on the Bray-Curtis similarity index were performed. Rarefaction curves and indices (Shannon, Simpson and Margalef index) were generated to compare diversities.

6. Results

6.1 Habitat mapping

6.1.1 Tidal levels and dimensions of the intertidal area

In the Gulf of Aqaba the maximum range between high tide and low tide is 1.4 m. During our stay in Dahab it was 1 m on the 28th April 2010 (Full moon). Minimum range was 0.4 m on the 6th April 2010 (Last quarter). The average range in the north of the Red Sea is 0.6 m (Edwards, 1987). We did our measurements on 14th April 2010 (New moon) and on 15th April 2010, when tidal range was 0.6 m and 0.7m. Tidal levels are shown in Fig. 7 as blue lines (http://www.wxtide32.com/download.html).

Fig. 7: Map of the Kite lagoon showing tidal marks, the intertidal area and beachrock.

The intertidal zone is the area between the average low tide level and the average high tide level, characterised in Fig. 7 as yellow area.

6.1.2 Beachrock

Beachrock occurs along the south-eastern coastline of the lagoon, which can be seen in Fig. 7 as a narrow dark line. Beachrock is formed by the rapid cementation of beach sediments in intertidal areas of tropical oceans. Adhesive cement is calcium carbonate ($CaCO_3$), in the form of calcite or aragonite.

Prerequisite for formation is supersaturation with $CaCO_3$ through evaporation of seawater (Neumeier, 1998; Hanor, 1978). Beachrock is inclined towards the sea and consists of coarse-grained material (Fig. 8).
The beachrock formation along the Southeast coastline is about 7 m wide.

Fig. 8: Beach rock along the SE-coastline of the Kite lagoon.

6.1.3 Algal mats

The red line in Fig.9 shows the high tide level on the 11th April 2010 and defines a depression in the east of the tidal flat. Tidal waters enter and leave the tidal flat through the very same channel. Therefore water remains longer in that depression than in other places. The channel is coated with algal mats, which consist of thin layers of algae and cyanobacteria (Fig. 9).

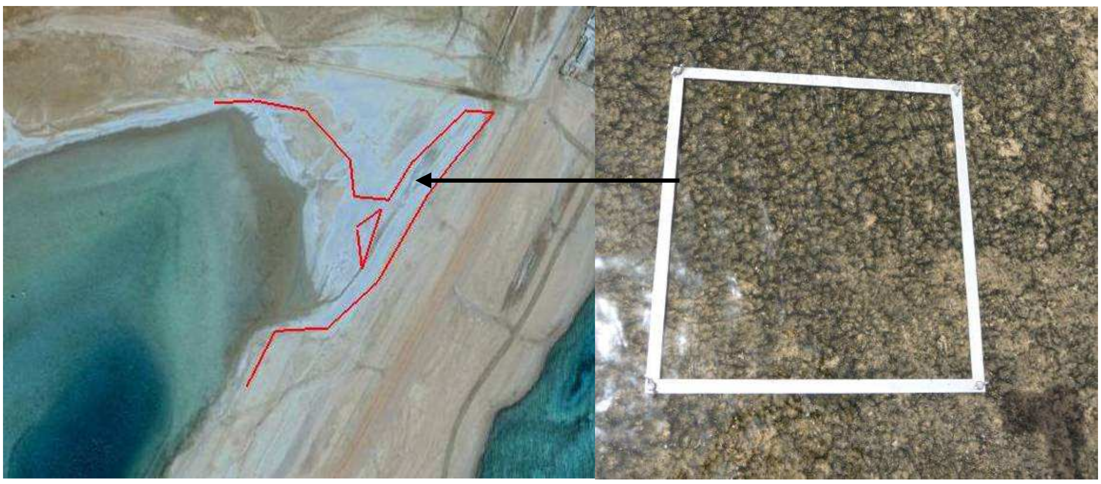

Fig. 9: High tide level on 11th April 2010 and algal mat with 0.25 m² square frame.

6.1.4 Distribution of the oyster *Saccostrea cucullata*

Saccostrea cucullata is a common oyster of the intertidal area. It can be found on rocky shores as well as in mangrove associated habitats (Zuschin & Oliver, 2003). Its distribution is clearly restricted by mean high water neap tides (Morris, 1985). In our study area *Saccostrea cucullata* was mainly located in the low intertidal area on the border to the shallow subtidal zone. The distribution areas, labelled as green fields in Fig. 10, correlate very well with the low tidal level from the 14th April 2010.

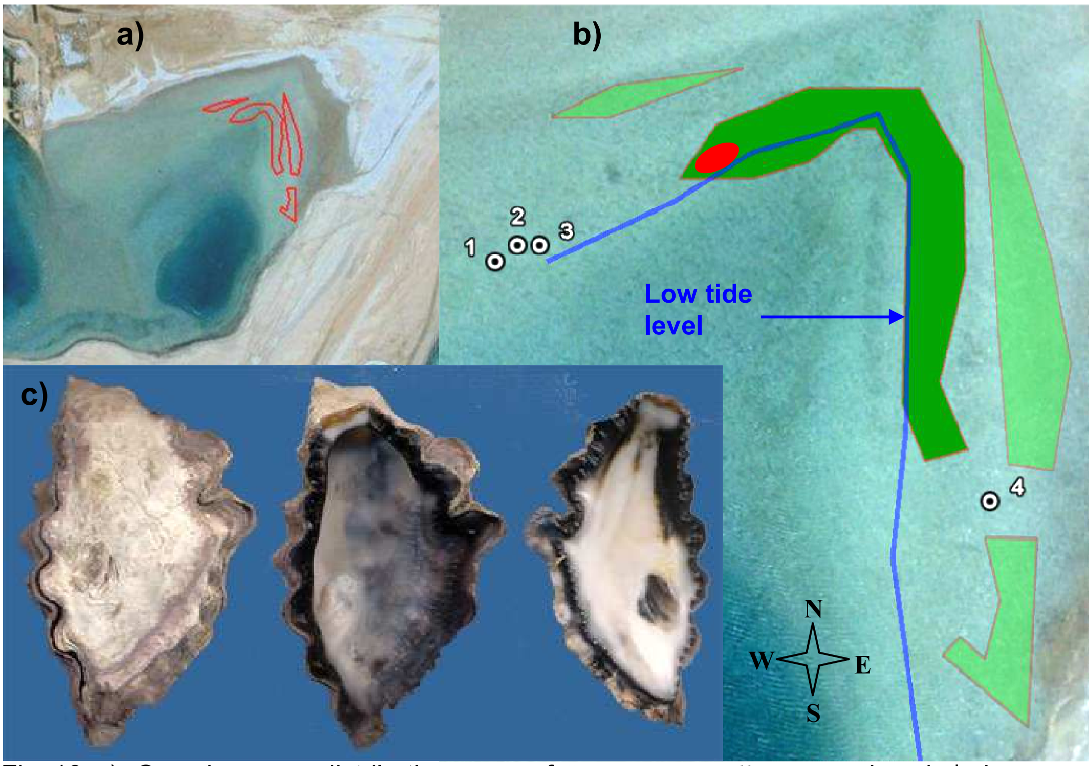

Fig. 10: a) Overview map: distribution areas of *Saccostrea cucullata* are red encircled;
b) Distribution areas of the oyster are labelled as green fields. Dots 1-4 as well as the red ellipse mark separate rather flat accumulations.
c) *Saccostrea cucullata* (http://www.valtat.org/bivalv/saccucull.html)

On the tidal flat oysters were cemented to the hard substrata of the fossil reef platform. The dark green field in Fig. 10b) was densely populated with raised accumulations. The most western patch of the dark green field measured 730 cm x 400 cm with a height of 25 cm (Fig. 11a). Next to this aggregate there were 15-20 smaller patches (35x25x25 cm). Larger accumulations in the northern part of the dark green field reached dimensions of 60x35x28 cm (Fig. 11b).

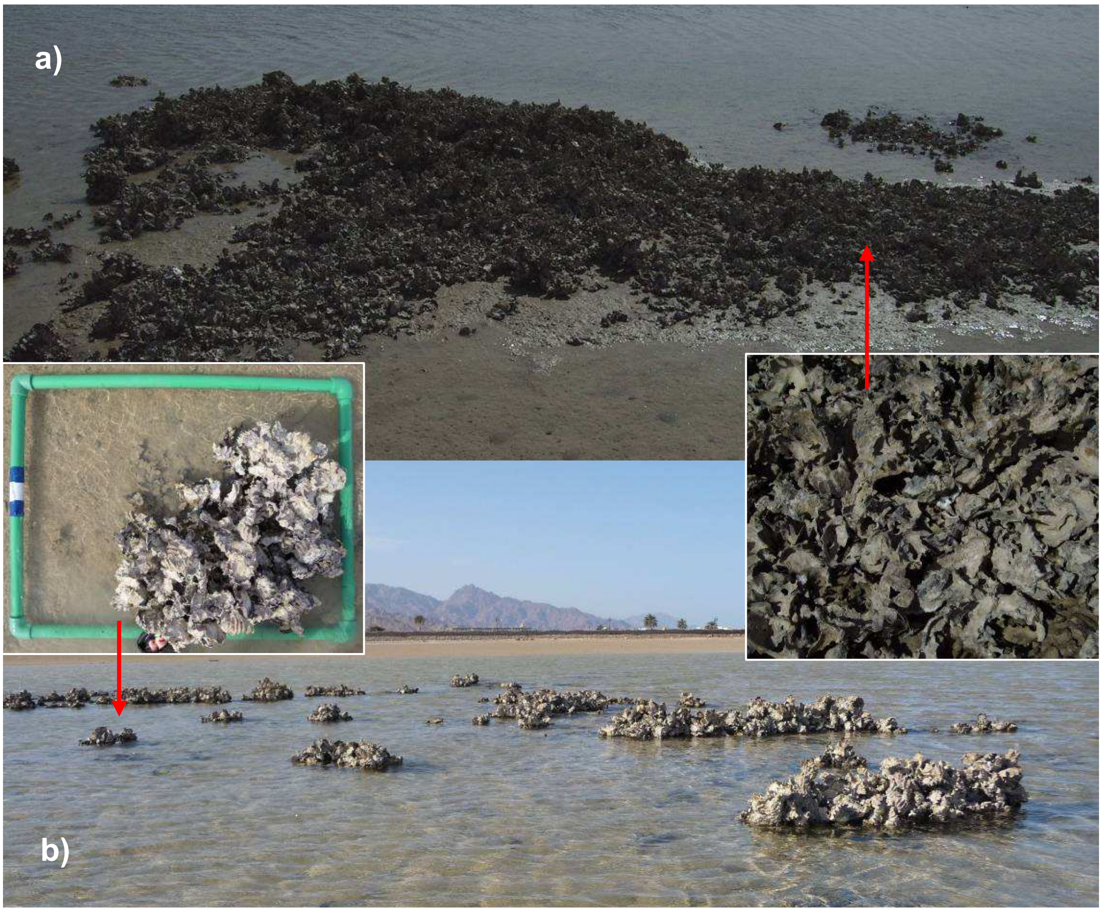

Fig. 11: a) Most western oyster accumulation of the dark green field in Fig. 9b (red ellipse).
b) Oyster aggregates in the northern part of the dark green field.

Light green areas in Fig. 10b) were sparsely colonized with single oysters (Fig. 12).

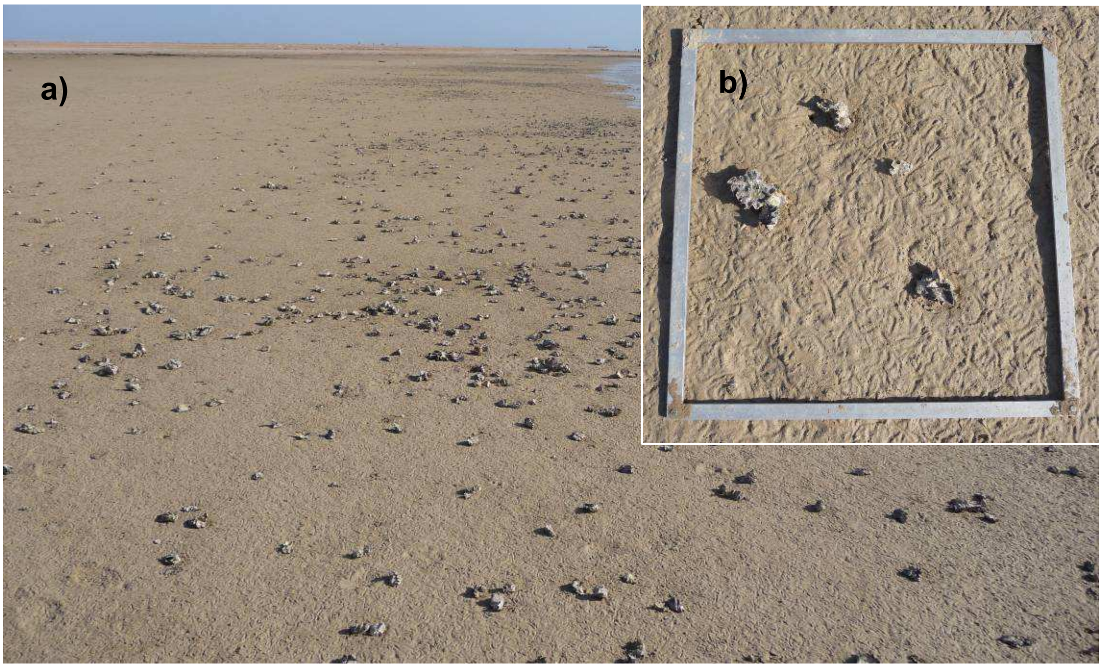

Fig. 12: a) Light green areas of Fig. 9b) are sparsely colonized with *Saccostrea cucullata*.
b) 0.25 m² square frame with four oysters in the sparsely colonized area.

Single dots (1-4) in Fig. 10b mark separate rather flat accumulations. Patch Nr. 1 had approximately a dimension of 120 cm x 120 cm. Accumulation Nr. 2 measured 140 cm x 100 cm and aggregate Nr. 3 reached 200 cm x 100 cm. The south-eastern accumulation Nr. 4 was of smaller size with 50 cm x 30 cm.

Fig. 13: Patch Nr. 1

6.1.5 Abiotic factors

As a result of changing water levels in the intertidal area, environmental parameters fluctuate much more than in the open ocean and organisms have to cope with strong extremes (Jones et al., 1987).

Measurements of temperature, salinity, oxygen level and pH of surface waters were taken on 15th April 2010 between 09:50 and 14:10 (Table 1). On that day high tide occurred at 07:08 and low tide was at 13:30. So our investigations were mainly done during ebb tide.

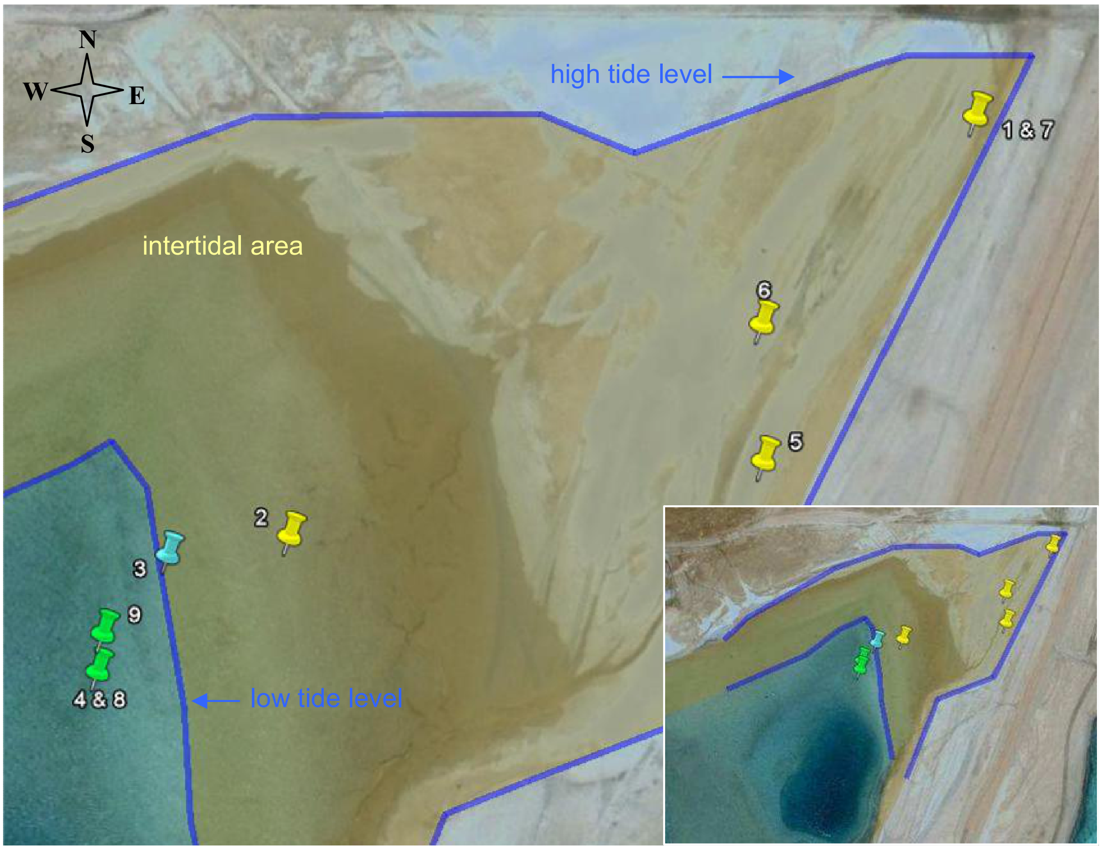

Fig. 14: Map with measuring points for physical parameters (salinity, pH, temperature)

Table 1: Data of environmental parameters (yellow = intertidal area, blue = border zone, green = subtidal zone).

Nr.	Time	Description of the measuring point	Salinity (‰)	Oxygen level (mg/l)	Temp. (°C)	pH
1	09:50	intertidal area, separated tidal channel with algal mats,5 cm water depth;	42	5.2	22.0	8.3
2	09:55	low intertidal zone, 5 cm water depth;	41	5.1	22.8	8.2
3	10:05	border between the intertidal and the subtidal zone, 20 cm water depth;	41	5.3	22.5	8.3
4	10:10	subtidal zone, 35 cm water depth;	41	5.0	22.7	8.3
5	10:28	intertidal area, separated intertidal pool with algal mats, 5 cm water depth;	45	4.3	30.9	8.5
6	12:33	intertidal area, separated intertidal pool with algal mats, water depth 5 cm;	46	4.4	31.1	8.6
7	12:40	intertidal area, separated intertidal pool with algal mats, water depth 5 cm;	44	4.7	31.4	8.6
8	14:05	subtidal area, 5cm water depth;	41	5.3	28.0	8.2
9	14:10	subtidal zone, knee-deep water;	40.7	4.74	28.4	8.2

In the morning, three hours after high tide (measurements 1-4) environmental parameters were nearly the same in the intertidal zone (yellow fields in Tab. 1) and in the subtidal zone (green fields in Tab. 1).

Some hours later (measurements 5-9) clear differences between these two zones were evident. Salinity, temperature and pH increased considerably during ebb tide in the intertidal zone, while values of the subtidal area remained nearly constant compared to the measurements in the morning.

Salinity, however, reached 46 ‰ in separated intertidal pools (measurement 5-7), and levels can go up to 50 ‰ and more (Edwards, 1987). In these pools temperature ascended faster and stronger than in the subtidal zone.

While the oxygen level of the intertidal area decreased remarkably, values of the subtidal zone fluctuated between 4.74 mg/l and 5.3 mg/l without a significant trend. Maybe oxygen levels of the subtidal zone were consistently high due to strong wind and wave motion.

6.1.6 Substrata

Benthic life is strongly influenced by the composition of the substrata. Sediments of sandy shores and tidal flats consist of inorganic particles, organic particles and pore water. In addition grain size distribution gives good information about water energy. Fine sediments occur along shores with little wave action and in sheltered areas such as estuaries and lagoons. Strong currents carry off these fine particles and leave larger grains (Levinton, 2009).

Tidal flat substrates are usually a mixture of sand (0.063-2.0 mm), silt (0.002-0.063mm) and clay (<0.002mm) (Reineck et al. 1982). Results of sediment analyses showed that deposits in the study area can be classified as sand. Percentage of fine and very fine sand increases continuously from the subtidal zone to the intertidal zone (Fig.16).

The bulk of sample 1 is medium sand (light blue bar) with 56%. The fine sand fraction (yellow bar) has only 26 %. In sample 2, however the medium sand fraction has 34% and the fine sand fraction has 48% (Fig. 16).

Fig. 15: Map with sediment sample locations.

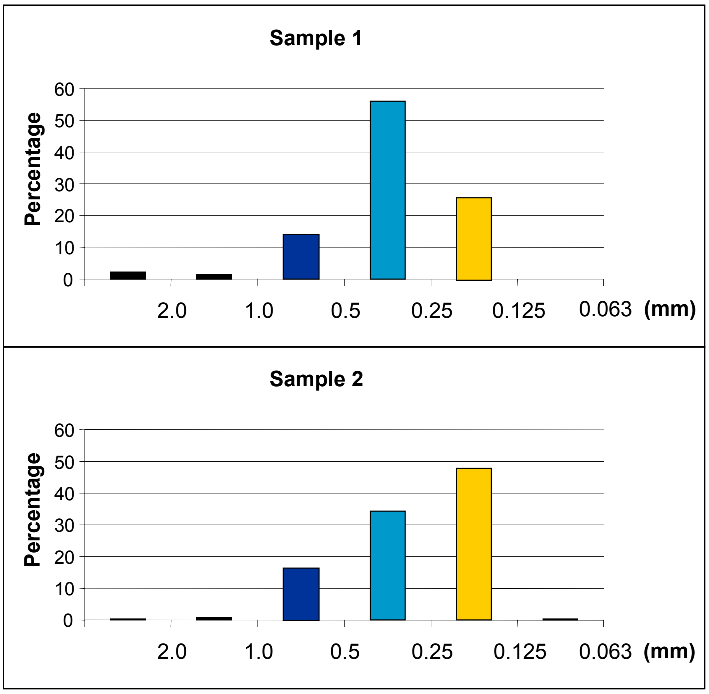

Fig. 16: Grain size distribution of Sample 1 and 2 (subtidal area)

Sample 3 is composed of 40 % fine sand, 34 % medium sand, 10% coarse sand (dark blue bar) and 13 % very coarse sand (black bars).

Sample 4 is similar to sample 3 but additionally there is a very fine sand fraction with 8 % (light yellow bar).

In sample 5 percentage of fine and very fine sand exceeds percentage of medium and coarse sand.

This trend is more obvious in sample 6 where fine sand reaches nearly 60 % (Fig. 17).

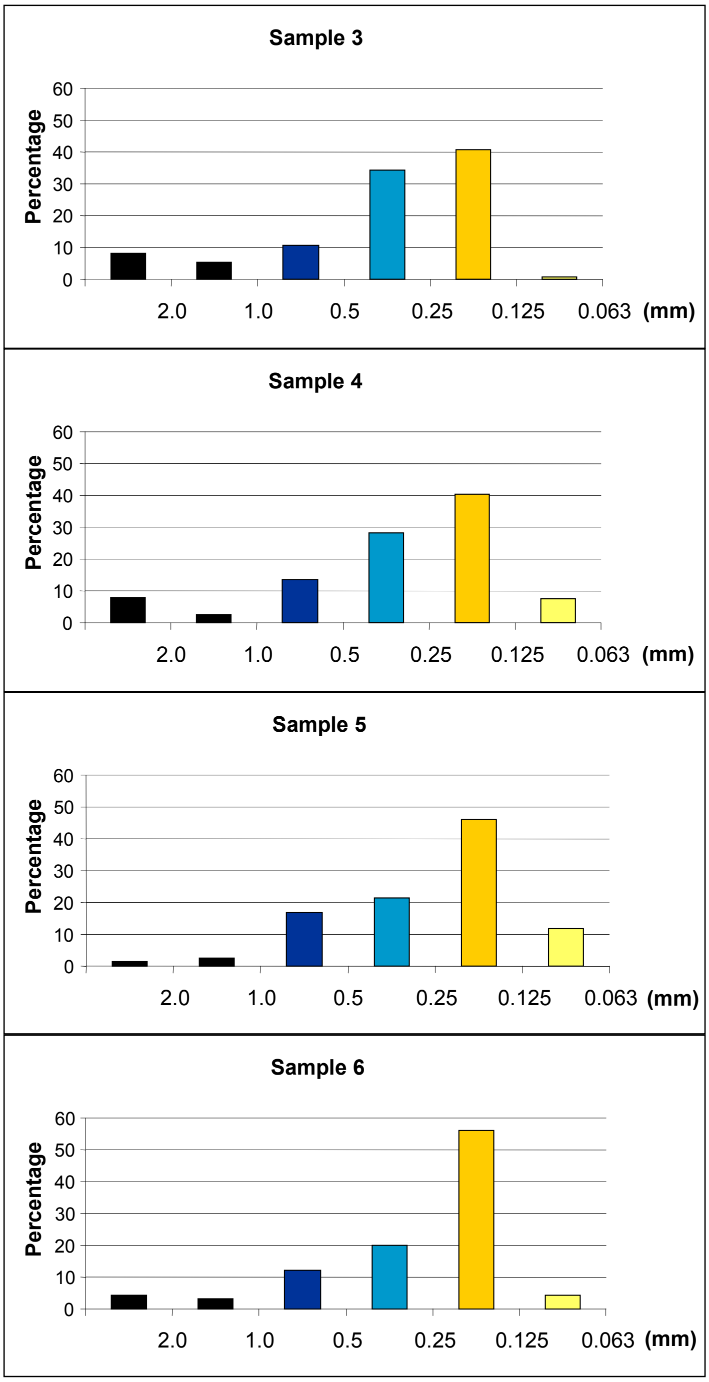

Fig. 17: Grain size distribution of sample 3-6 (intertidal area)

6.2 Crustaceans burrows

The intertidal zone of sandy shores and tidal flats is usually populated by crabs (Brachyura) (Karleskint et al., 2010). We observed an extensive population of *Dotilla sulcata* (Dotillidae) in our study area (Fig. 18 b), a typical crab of the tropics and subtropics. These small crabs, burrow into the sediment and form inflated sand pellets (Fig. 18 a). Their burrowing activity leads to aeration and oxidation of anaerobic sediment layers, which plays an important role in the ecology of the infaunal community (Fishelson, 1971; Bradshaw & Scoffin, 1999, Waafa, 2005).

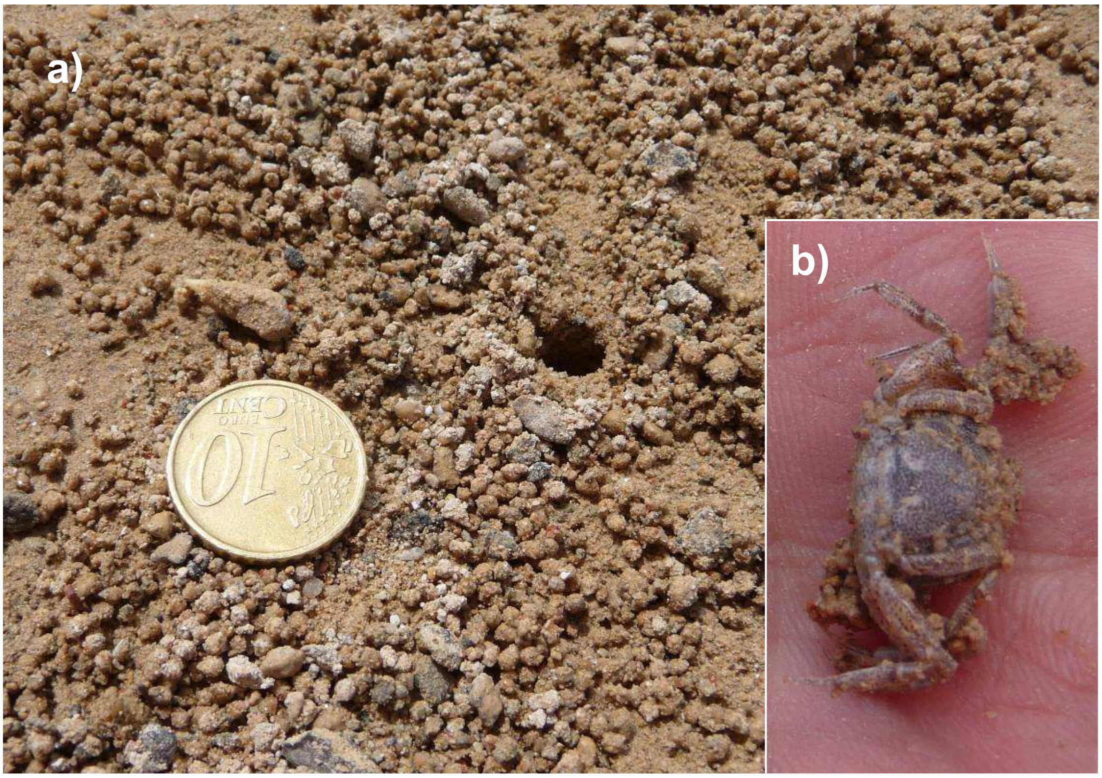

Fig. 18: a) Sand pallets and hole of a crab burrow.
b) *Dotilla sulcata*

On 15th and 16th April 2010 we investigated the population density of *Dotilla sulcata* by counting crab holes on the sediment surface. During our work we also saw a fiddler crab (*Uca*) (Fig. 19), another typical inhabitant of the intertidal area.

Fig. 19: Fiddler crab (*Uca*)

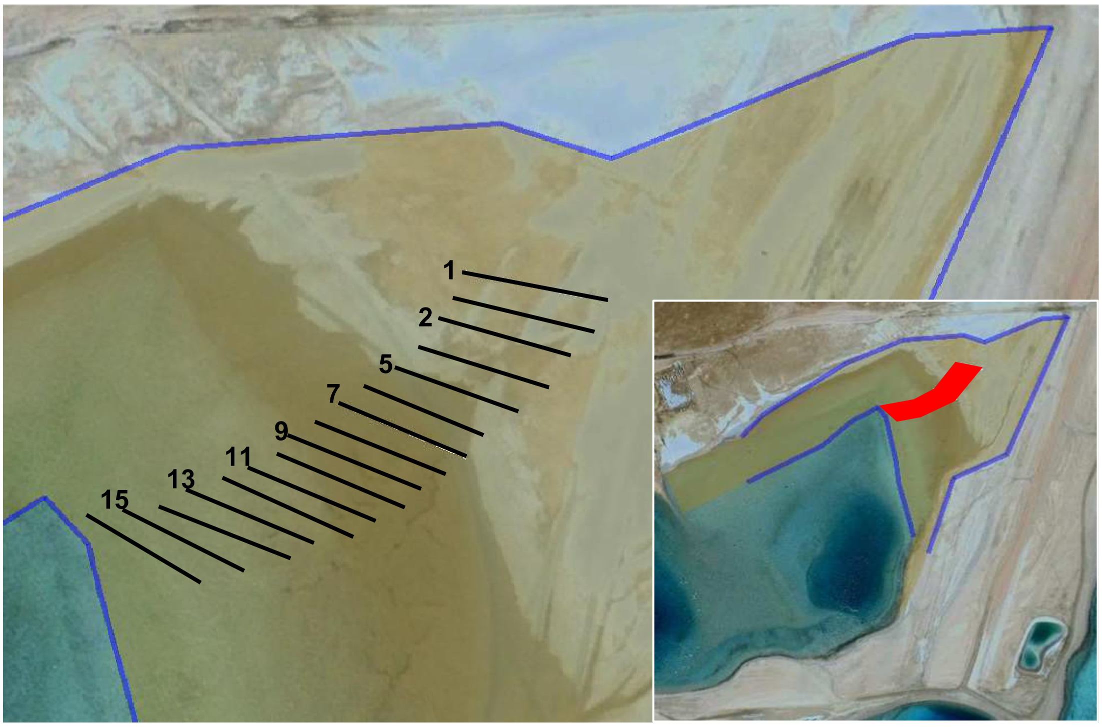

Fig. 20: Map with transect lines (black lines) in the intertidal area. The smaller map in the lower right corner shows the location of these lines (red area) in the lagoon.

The number of smaller holes (diameter < 1cm) within one transect line rose towards the low tide level and reached a peak of 120 holes in transect line number 11. After this the number of burrows decreased. Larger holes (diameter > 1cm) were less abundant and more regularly distributed in the study area (Fig. 21).

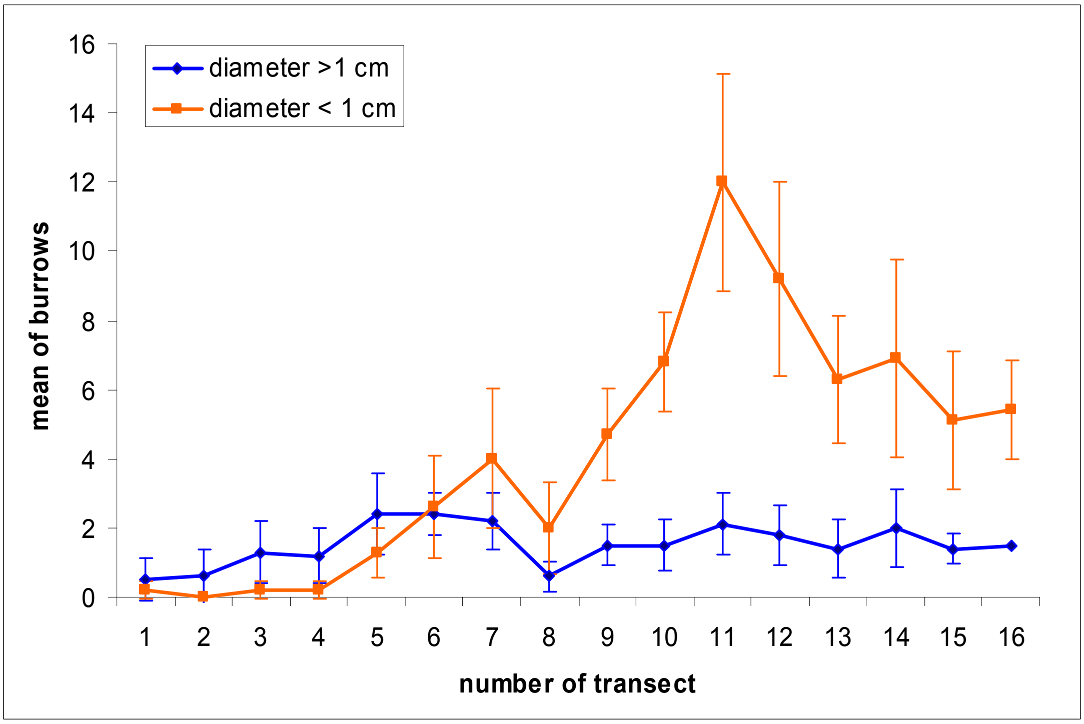

Fig. 21: Number of crustacean burrows in the 16 intertidal transects plus 95 % confidence interval.

6.3 Molluscan composition

6.3.1 Total molluscan fauna

Molluscs are the largest marine phylum with more than 100 000 living species (Levinton, 2009). About 1800 species are reported for the Red Sea (Dekker & Orlin 2009), and most are of Indo-Pacific origin (Mastaller 1987).

A total of 3566 shells from 18 quantitative sediment samples were counted and assigned to 97 species of 44 families. The subtidal collection from the 16th April contained 21 additional species and three new families. So overall we found 109 species and 46 families in the study area, which account for 17 % of the molluscan species richness known from the Gulf of Aqaba (Mastaller 1987).

Gastropods made up 66.41 % of all collected shells, while bivalves only reached 33.54 %. Two scaphopods account for 0.05 % (Fig. 22)

a) Analyses on species level

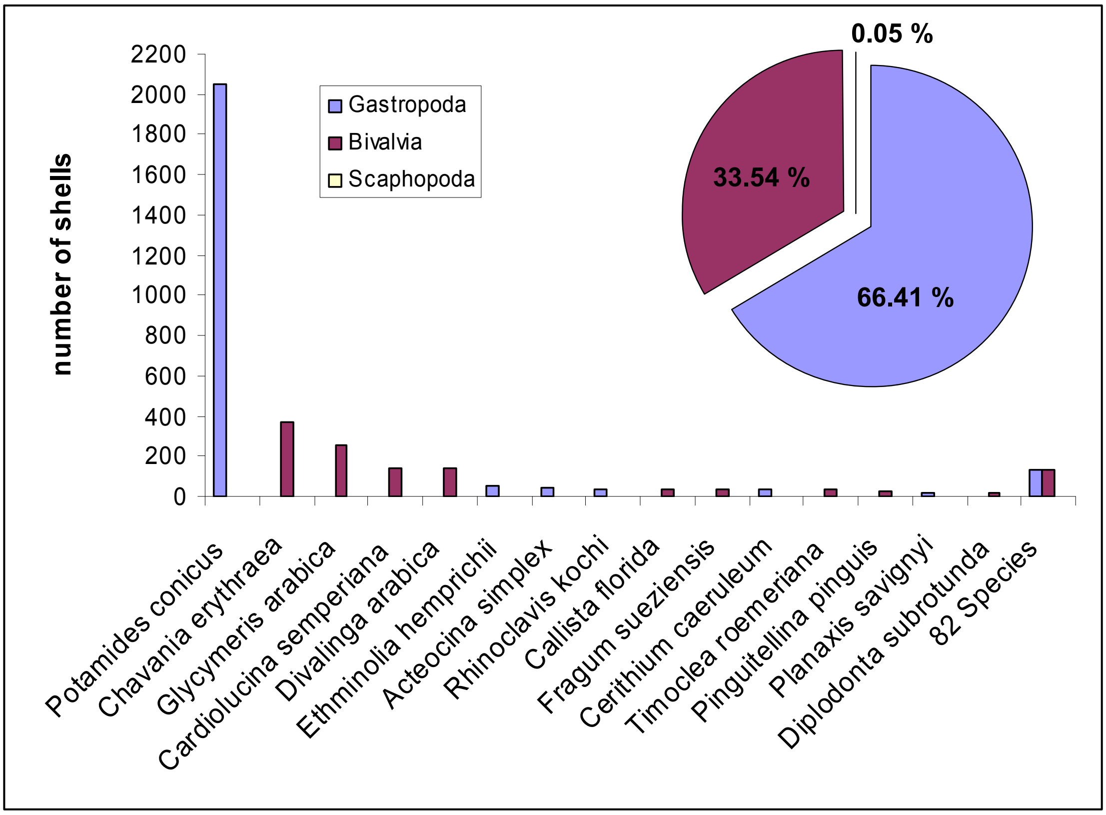

Fig. 22: Most abundant species found in the intertidal and subtidal area.
Pie chart shows percentages of gastropods, bivalves and scaphopods.

By far the most common species was the gastropod *Potamides conicus* with 2056 individuals (57.5 % of all collected shells). The most abundant bivalve was *Chavania erythraea* with 373 shells, followed by *Glycymeris arabica, Cardiolucina semperiana* and *Divalinga arabica* (Fig. 22).

Due to the strong dominance of *Potamides conicus*, I want to depict Fig. 22 once again without that gastropod, to illustrate the remaining molluscan composition in greater detail (Fig. 23).

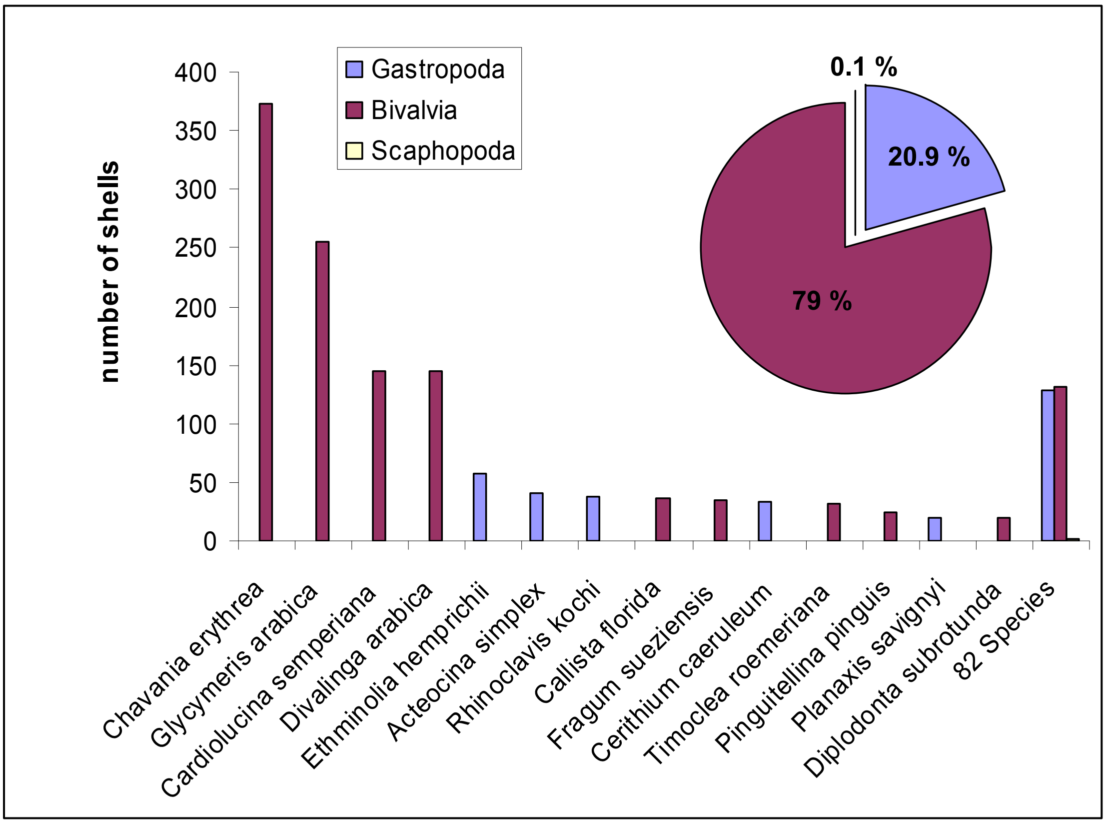

Fig. 23: Most abundant species in the intertidal and subtidal area excluding *P. conicus*. Pie chart shows percentages of gastropods, bivalves and scaphopods excluding *Potamides conicus*.

Two species are underrepresented in this data set: *Saccostrea cucullata* is cemented to and *Brachidontes pharaonis* lives bysally attached to the rocky surface or to other shells. They have a patchy distribution and hardly occurred in our samples.

Accumulations of *Saccostrea cucullata* occured along the low tide level, as described in chapter “6.1.4 Distribution of the oyster *Saccostrea cucullata*”. *Brachidontes pharaonis* showed patchy distribution and appeared between oyster accumulations and on beach rock formations in very high densities (Fig. 24).

Fig. 24: a) *Brachidontes pharaonis* (http://elrinconmarinos-nogasteropodos.iespana.es/Mytilidae.htm) b) patch of *B. pharaonis* in sample 6, c) patch of *B. pharaonis* on beach rock.

b) Analyses on family level

Analyses on family level give approximately equal results as on species level. Most abundant was the gastropod family *Potamididae* (2051 shells). Most important bivalve families were the *Lucinidae* (707 shells) and the *Glycymerididae* (267 shells) (Fig. 25)

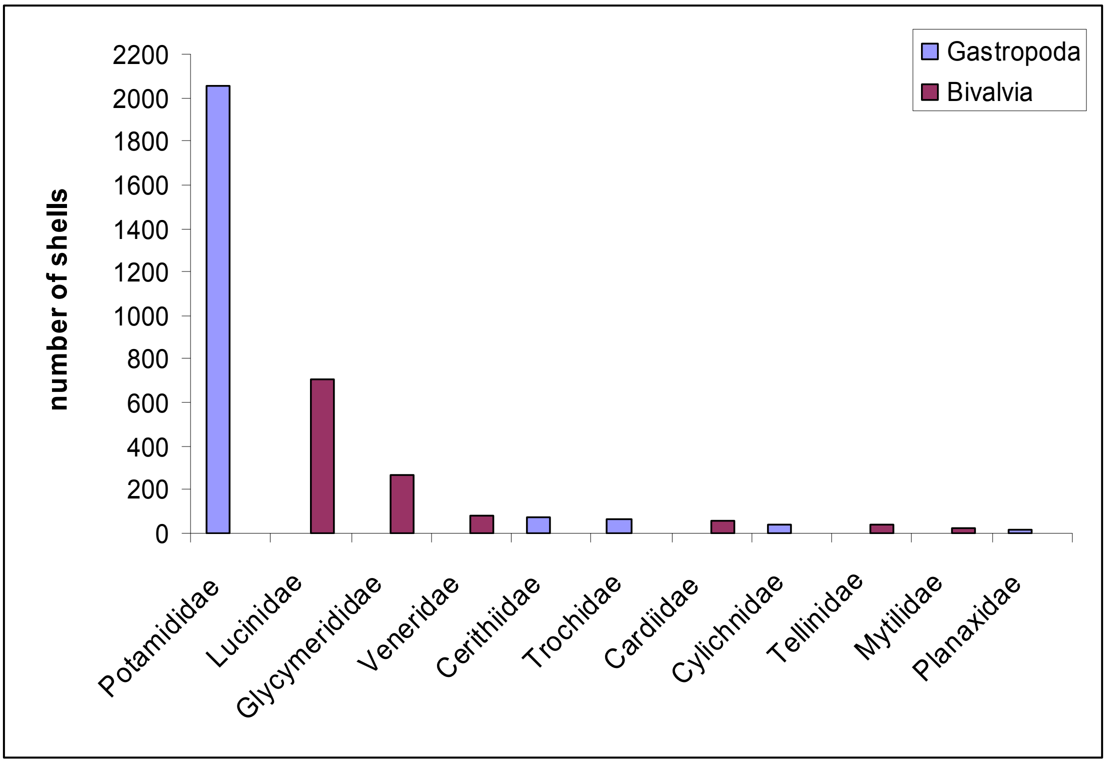

Fig. 25: Most common molluscan families in the intertidal and subtidal area.

6.3.2 Intertidal molluscan fauna

9 samples were taken from the high to the low intertidal zone (Fig. 26), which contained 2032 shells from 11 species. Precisely, these make up 57 % of all collected shells but only 11.3 % of all species known from the study area. That means that the number of individuals was high compared to a low species richness.

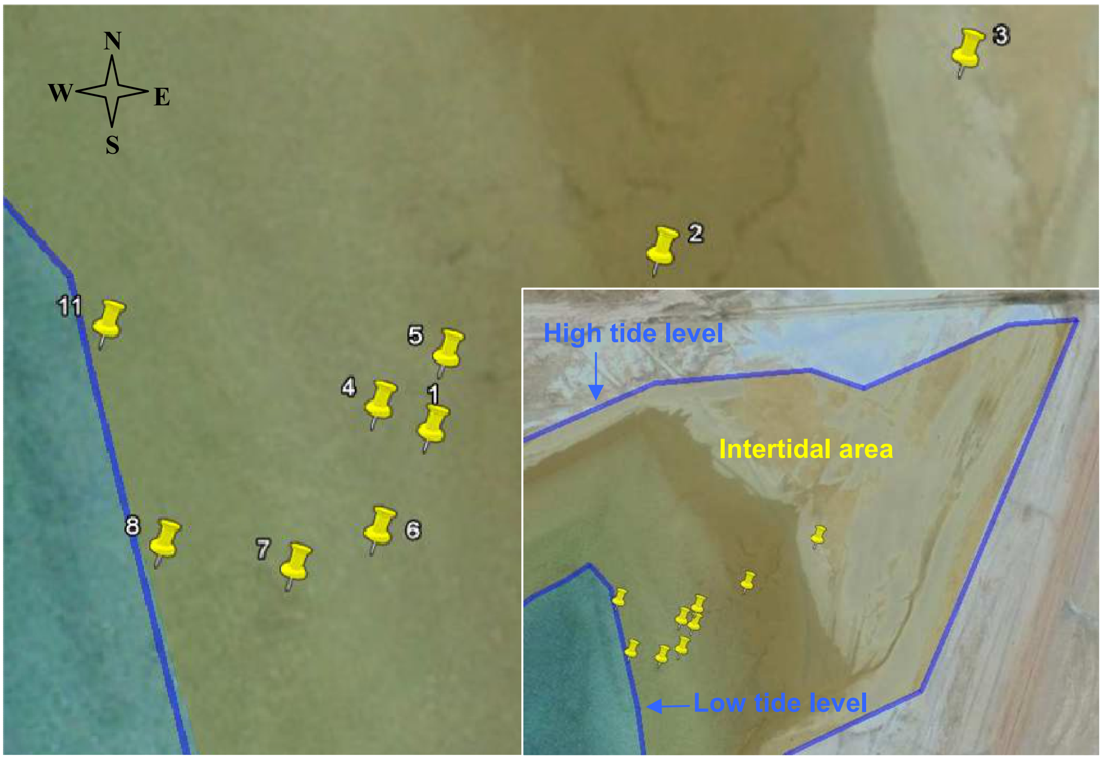

Fig. 26: Map with sample locations in the intertidal area.

a) Analyses on species level

The intertidal area was dominated by the gastropod *Potamides conicus* (1970 shells). It occurred dead and alive in very high densities. In the upper intertidal area (samples 1-5) only potamidids were found.

Another interesting fact is the dominance of gastropods in the intertidal area. There they made up 99.3 % of all collected shells (Fig. 27). Even without including *Potamides conicus* in my computations, gastropods still reach 75.8 %.

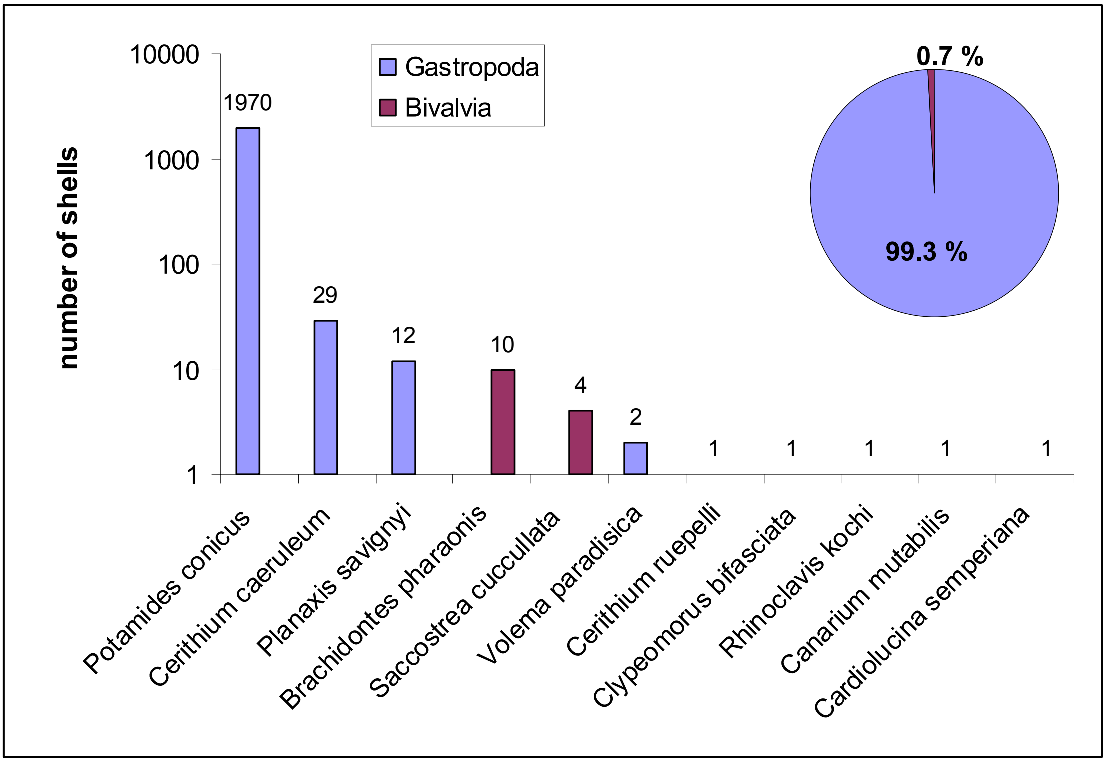

Fig. 27: Most abundant species in the intertidal area on logarithmic scale due to high abundance of potamidids.

b) Analyses on family level

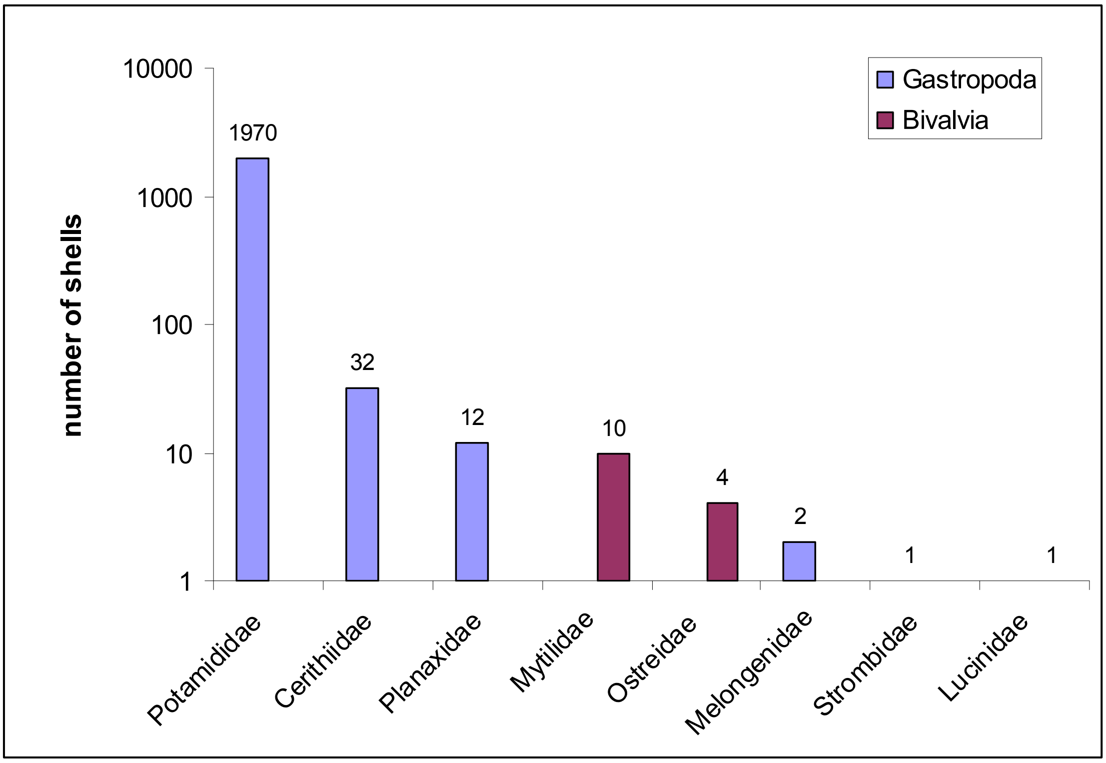

Fig. 28: Most abundant families in the intertidal area on logarithmic scale due to high abundance of potamidids.

Beside the gastropod family Potamididae occurred frequently individuals of the family Cerithiidae and Planaxidae.

6.3.3 Subtidal molluscan fauna

1534 shells from 93 species were found in 9 quantitative samples from the subtidal zone (Fig.29). These make up only 43 % of all collected shells but about 96 % of the species found in this study. So the subtidal had a much higher biodiversity than the intertidal, although the number of individuals was much lower.

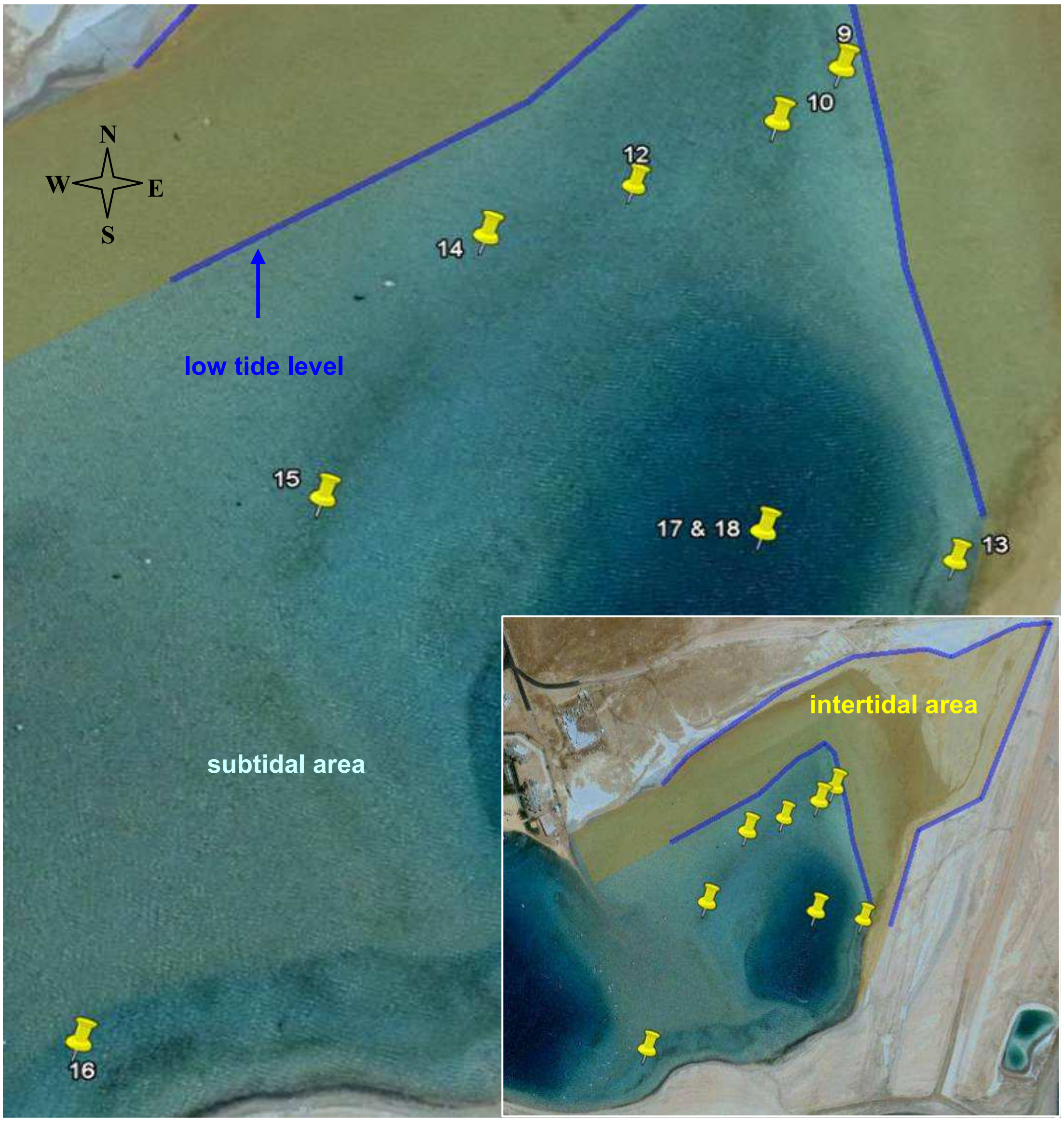

Fig. 29: Map with sample locations in the subtidal area. Inset provides an overview.

a) Analyses on species level

In contrast to the intertidal, in the subtidal bivalves (77 %) were more abundant than gastropods (22,9 %). The most common species was *Chavania erythraea* (373 shells) followed by *Glycymeris arabica* (255 shells), *Divalinga arabica* (145 shells) and *Cardiolucina semperiana* (144 shells) (Fig. 30).

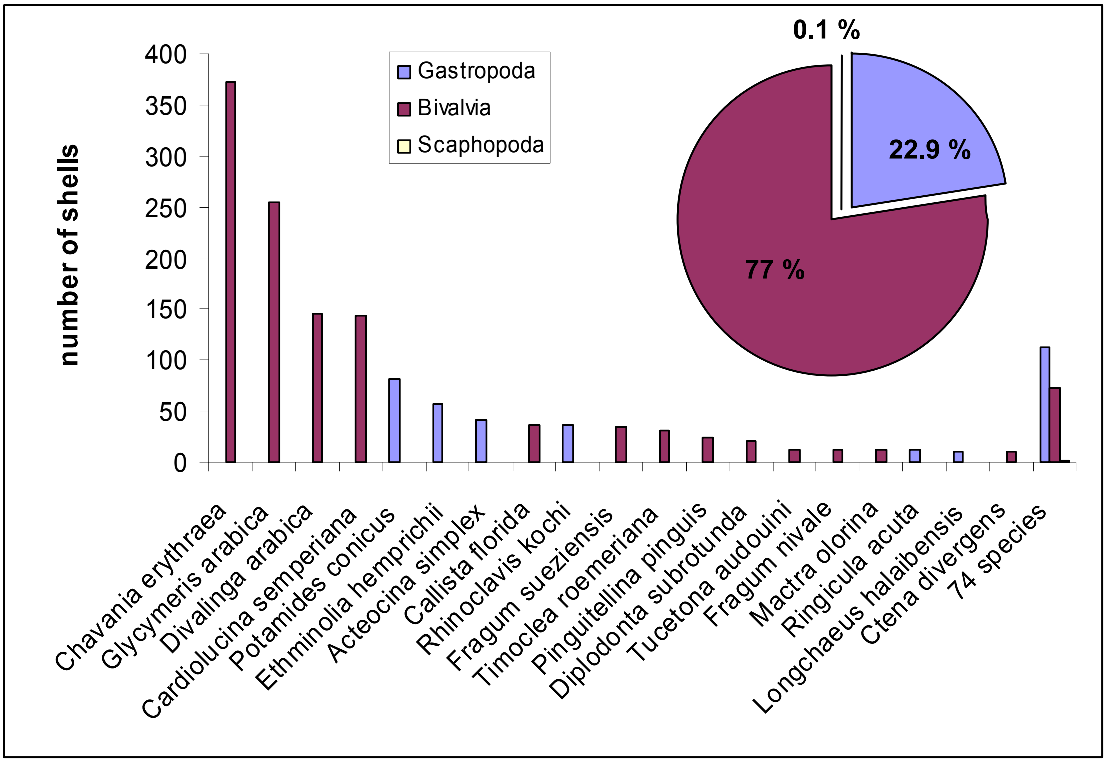

Fig. 30: Most common species in the subtidal area.
Pie chart shows percentages of gastropods, bivalves and scaphopods.

b) Analyses on family level

By far the most common family was the bivalve family Lucinidae with 706 shells. The Glycymerididae were the second most abundant bivalves in the subtidal zone with 267 collected shells (Fig. 31).

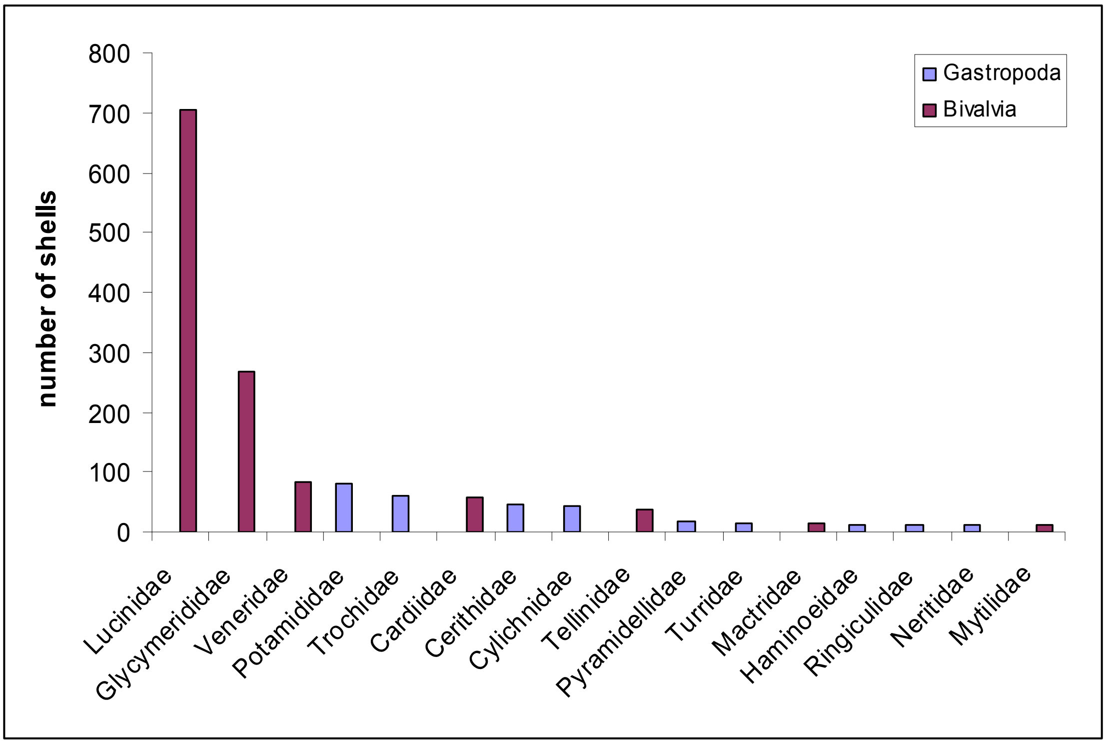

Fig. 31: Most abundant families in the subtidal area.

6.3.4 Live and dead assemblages

About 30 % of all collected shells were alive whereas 70 % were dead (Fig. 32). Beside *Potamides conicus* the most abundant living molluscs were *Cerithium caeruleum* (22 individuals) and *Glycymeris arabica* (19 shells) (Fig. 33). Many empty shells of *Cerithium caeruleum* were inhabited by hermit crabs. In the dead assemblage the most abundant molluscs after *Potamides conicus* were *Chavania erythraea* (366 shells) and *Glycymeris arabica* (236 shells). Fig. 33 demonstrates that the bulk of living individuals were among the potamidids.

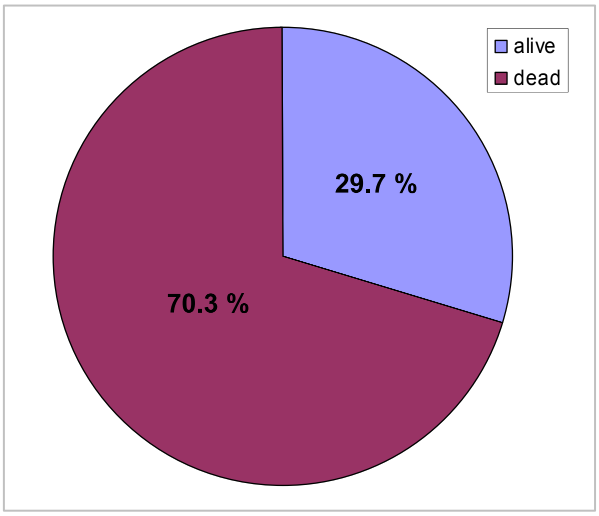

Fig. 32: Pie chart shows percentages of living and dead molluscs.

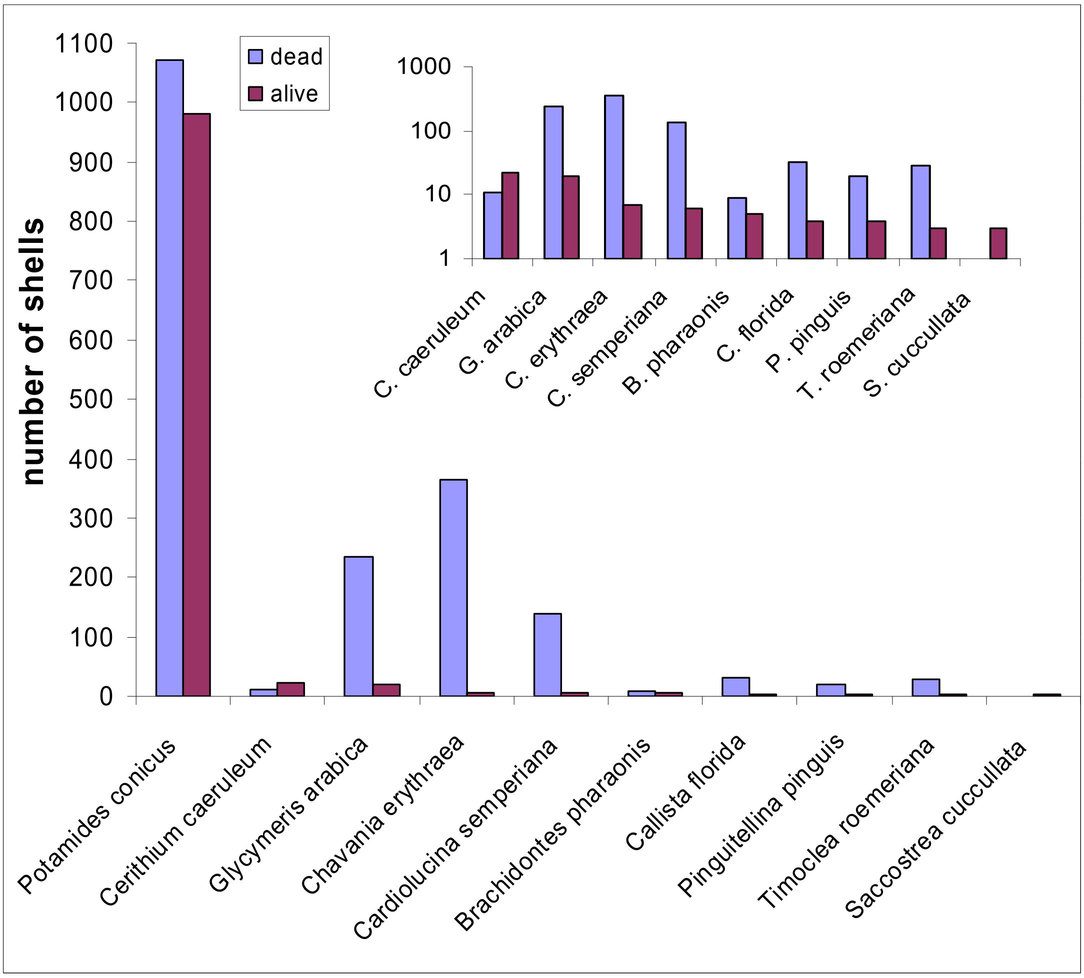

Fig. 33:Live and dead assemblages of molluscs ordered by the most common living species. Inset shows the same figure again excluding *Potamides conicus* on logarithmic scale.

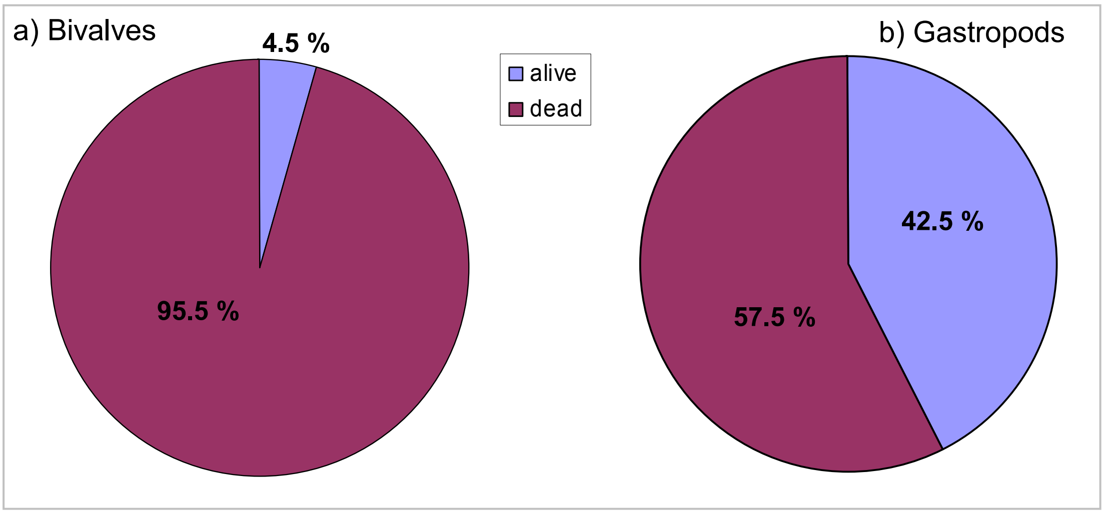

Fig. 34 Pie charts shows percentages of living and dead molluscs.
a) Bivalves, b) Gastropods;

Percentage of living gastropods is much higher than percentages of living bivalves (Fig. 34). There were also differences in live and dead assemblages between the intertidal and the subtidal zone. The percentage of living individuals in the intertidal zone (49.3%) was much higher than in the subtidal zone (3.8%) (Fig. 35).

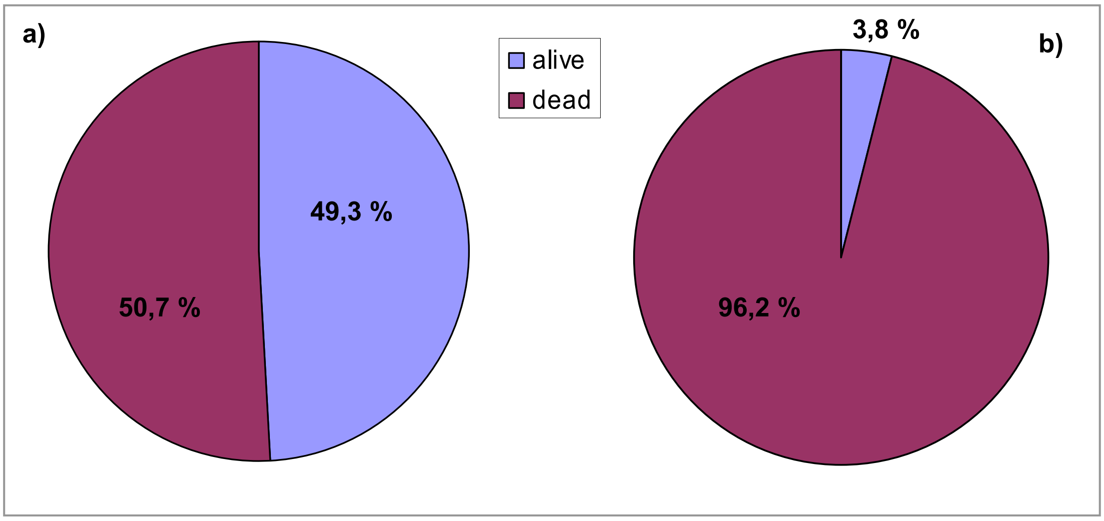

Fig. 35: Pie charts show percentages of live and dead molluscs.
a) intertidal area, b) subtidal area;

Fig. 36 also shows that percentages of living individuals are much higher in the intertidal (samples 3, 2, 1, 4, 5, 6, 7, 8 and 11) than in the subtidal zone (samples 9, 10 ,12, 14, 15, 13, 16 and 18) . Sample 17 was removed from this diagram because it contained only 8 shells. In sample 7 there was only one living gastropod although sample 6 and 8 contained a high number of living molluscs. These results point to a patchy distribution of living individuals in the lower intertidal zone.

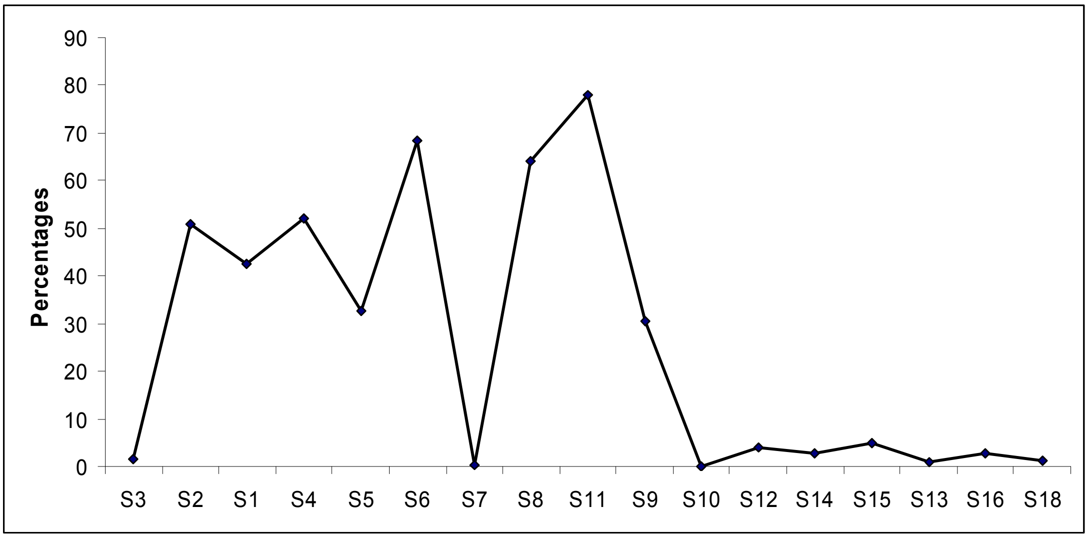

Fig 36: Percentages of living individuals in each sample.

6.4 Statistical Comparison

6.4.1 Q-mode clustering

To show the similarity between different samples I used the Q-mode cluster analysis (Bray-Curtis similarity index), which produces dendrograms with groups of similar data sets.

a) Total molluscan fauna

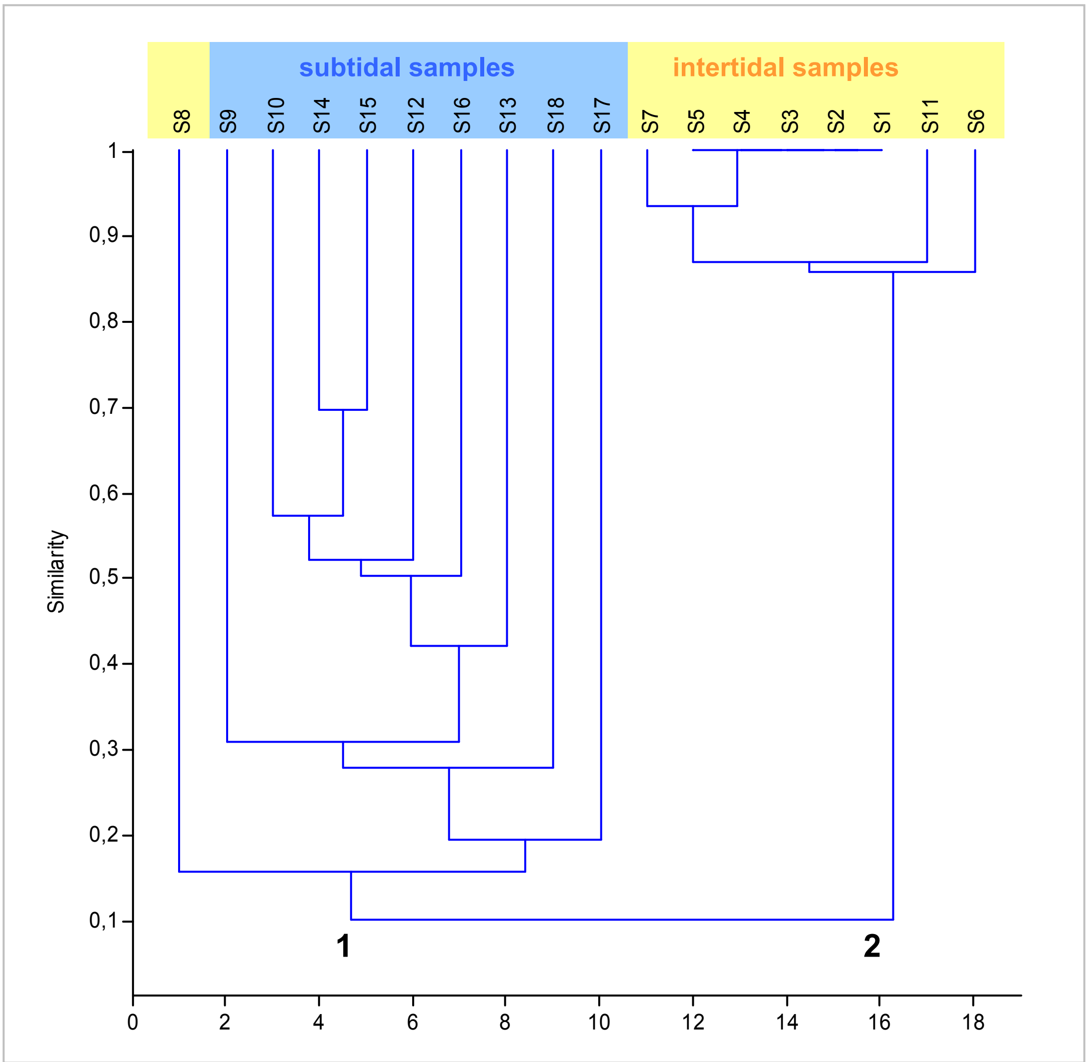

Fig. 37: Q-mode cluster dendrogram of the total molluscan fauna.

The dendrogram splits into two clusters (1 and 2) at a similarity level of 0.1.: Cluster 1 is basically composed of subtidal samples. An exception is sample 8, which was taken in the border zone between the intertidal and the shallow subtidal area. Cluster 2 contains only samples of the intertidal zone. Samples 1-5 built a cluster with a similarity of 1.0 because they contained only *Potamides conicus* (Fig. 37).

b) Dead molluscan assemblage

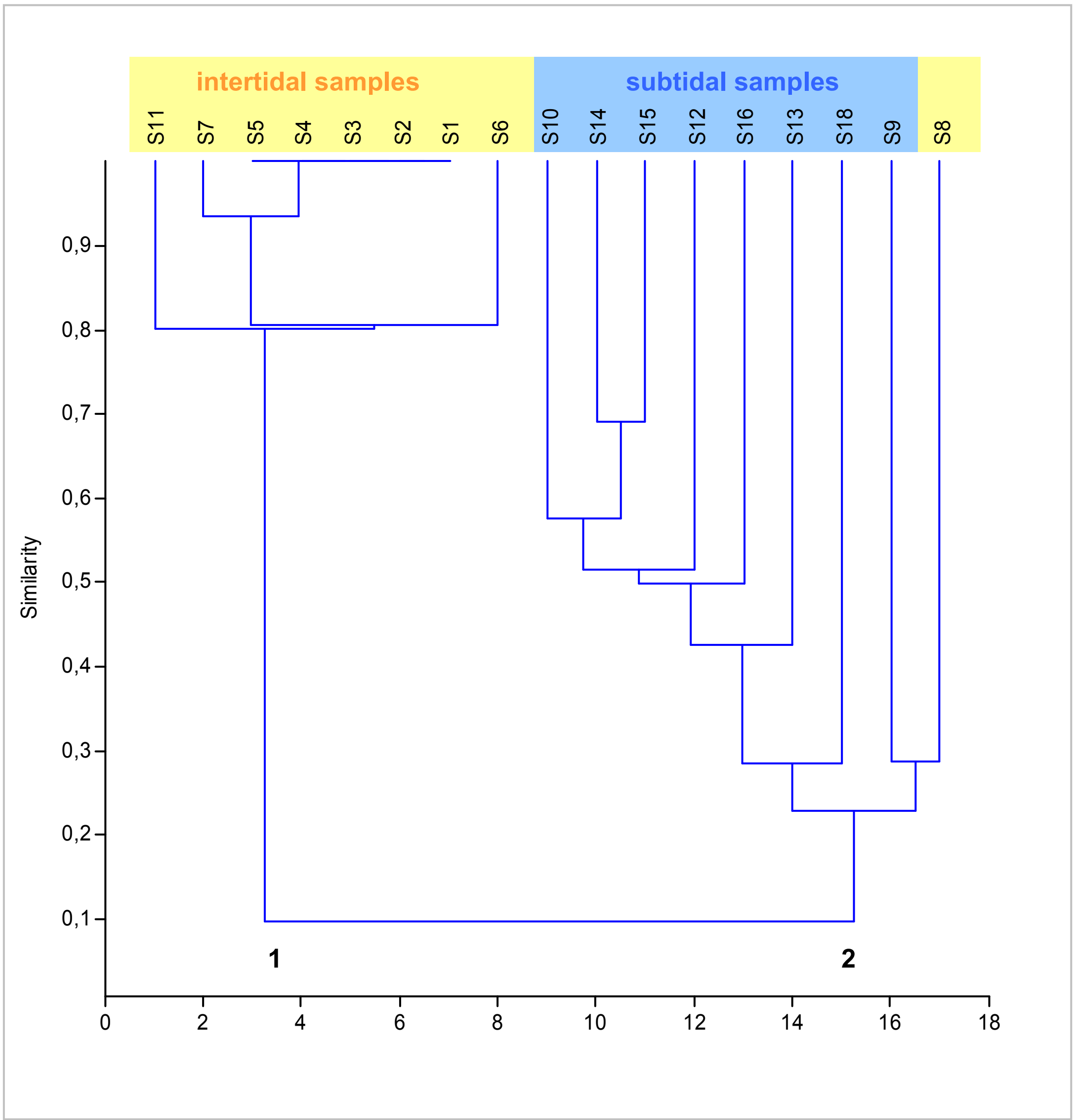

Fig. 38: Q-mode cluster dendrogram of the dead molluscan assemblage.

The dendrogram is similar to that of the total molluscan fauna. One difference is that sample 8 clusters with sample 9 instead of being an isolated outlier. Sample 17 was removed because it contained only 4 empty shells. As in the dendrogram before intertidal samples show a very high similarity compared to the subtidal samples (Fig. 38)

c) Living molluscan assemblage

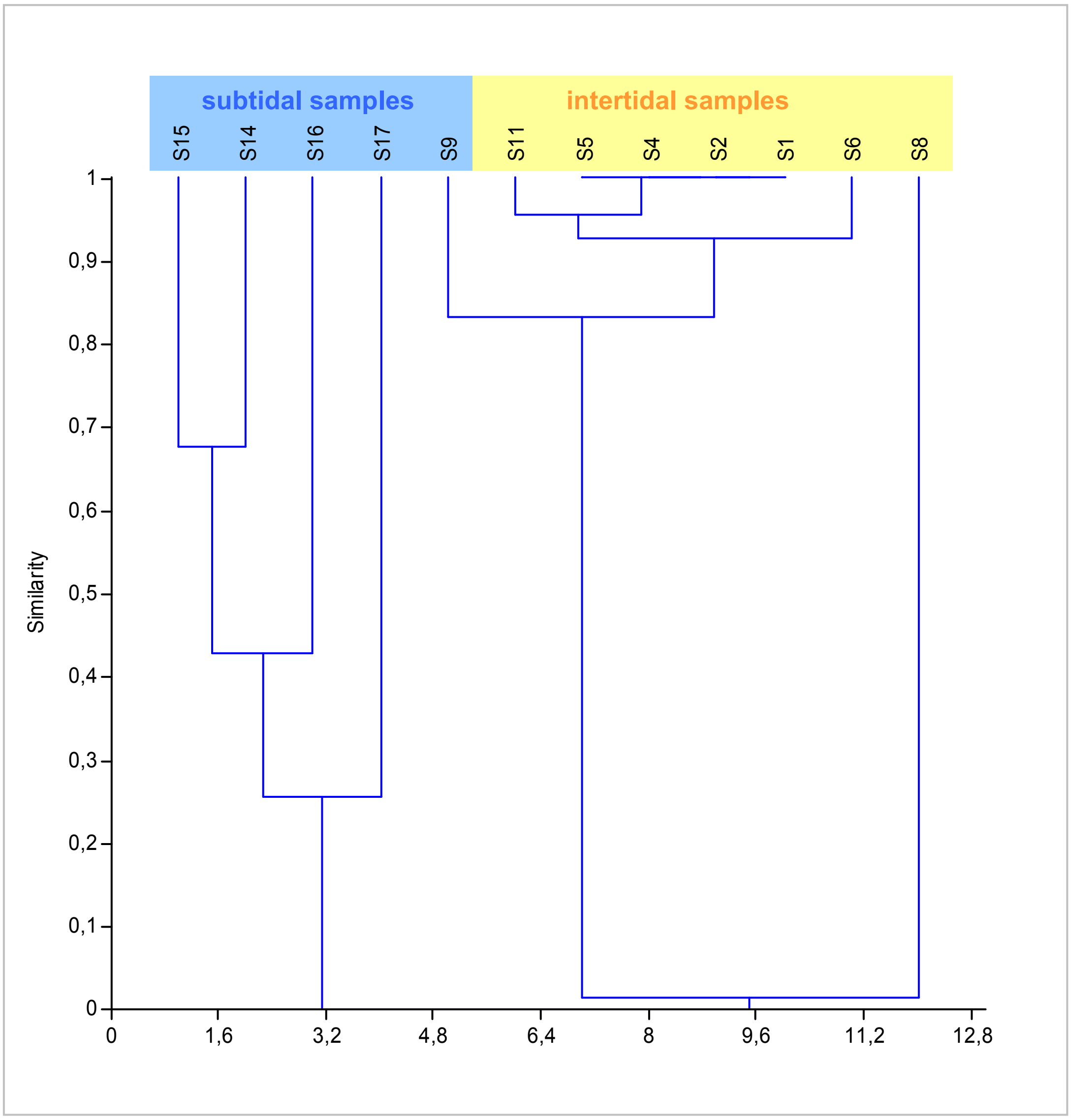

Fig.39: Q-mode cluster dendrogram of the living molluscan assemblage.

Samples 3, 7,10,12,13 and 18 were removed for statistical analyses because they contained only a few living molluscs. As in previous dendrograms sample 8 is separated from other intertidal samples. In contrast to the dead assemblage sample 9 clusters with intertidal instead of subtidal samples. This is not surprising because it was taken in the very shallow subtidal zone (Fig. 39).

6.4.2 Non-metric Multidimensional Scaling

This statistical method is also used to show similarities or differences between samples. Points representing samples with similar molluscan composition lie close together on the plot, while points of dissimilar samples are farther away from another (Krebs, 1999).

a) Total molluscan fauna

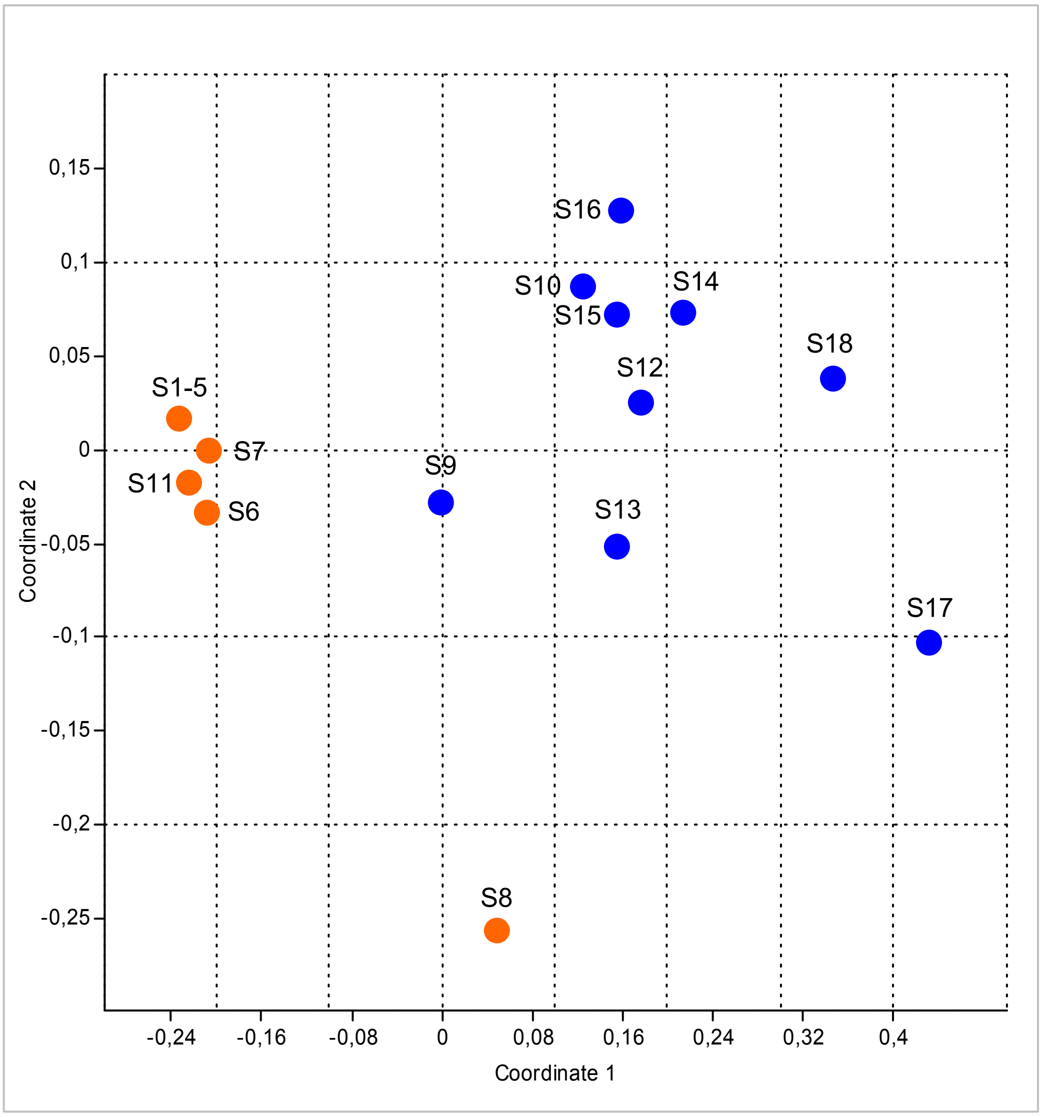

Fig. 40: non-metric MDS (Bray-Curtis similarity measure) of the total molluscan fauna.
orange = intertidal samples, blue = subtidal samples;

Ordination of all samples on the MDS identifies two clearly separated groups: Orange points mark intertidal samples which build one group plus one outlier (S8), while blue dots represent subtidal samples and constitute the second group.

Coordinate 1 separates intertidal from subtidal samples and is therefore interpretable as ecological factor, which differs between these two zones. Probably this factor is the influence of the tides (desiccation and fluctuating temperature, oxygen level, salinity), which is stronger in the intertidal than in the subtidal area.

The intertidal group (1-7 and 11) shows a very high similarity because sample points lie very close together on the scaling. Coordinate 2 accounts for the exceptional position of sample 8. This sample contains only a few potamidids but a relatively high number of Cerithiidae.

Subtidal points are plotted further away from each other, which means that there are more differences between subtidal samples than between intertidal samples. Point 17 lies slightly aside because of the small number of individuals in the sample (Fig. 40).

b) Dead molluscan assemblage

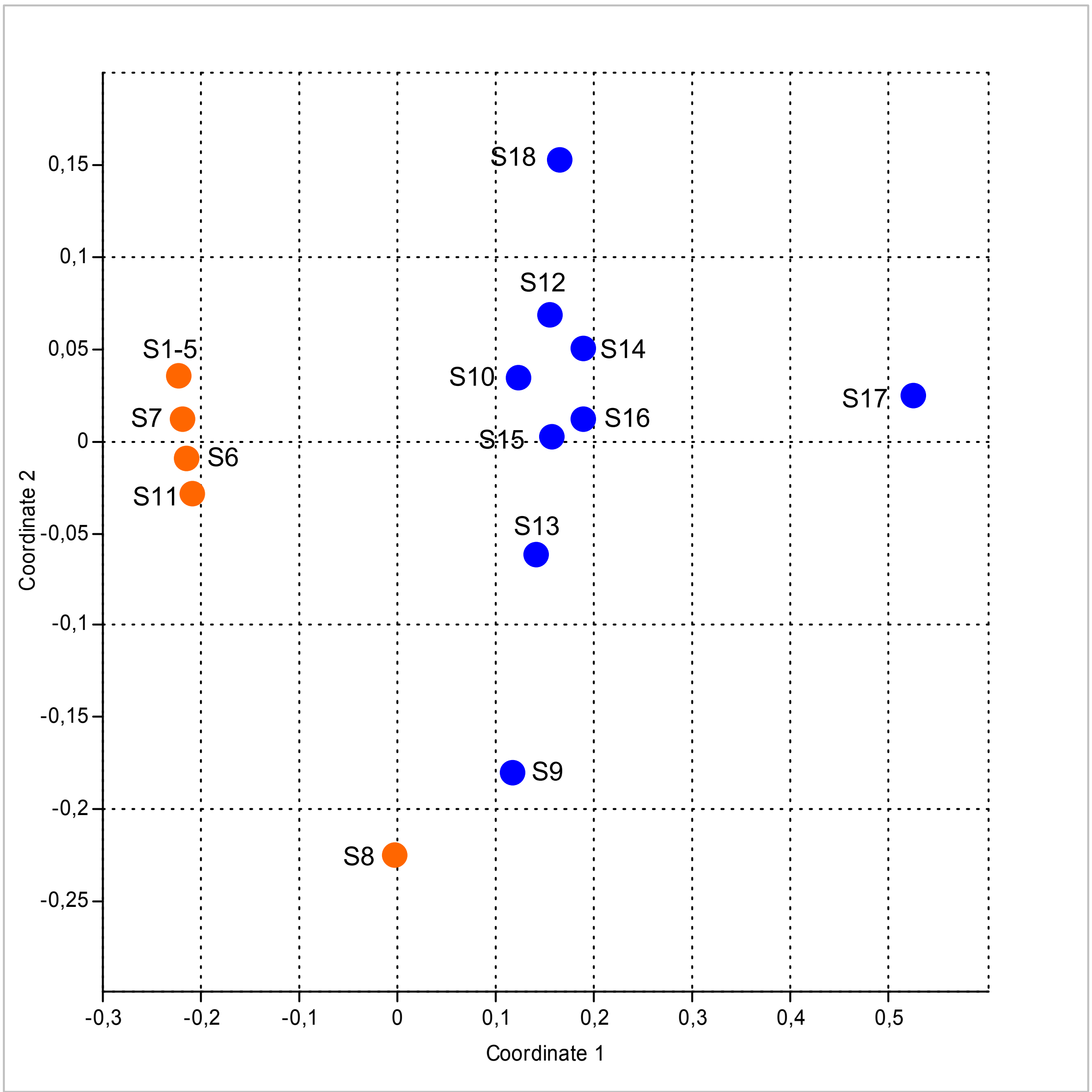

Fig.41: non-metric MDS (Bray-Curtis similarity measure) of the dead molluscan assemblage. orange = intertidal samples, blue = subtidal samples;

The ordination of the dead molluscan assemblage is similar related to that of the total molluscan fauna. A difference is that samples 9 and 18 plot farther away from the subtidal group than in Fig. 40. That correlates with the results of the Q-mode cluster analysis of the dead molluscan assemblage (Fig. 38), in which sample 9 clusters with sample 8.

c) Living molluscan assemblage

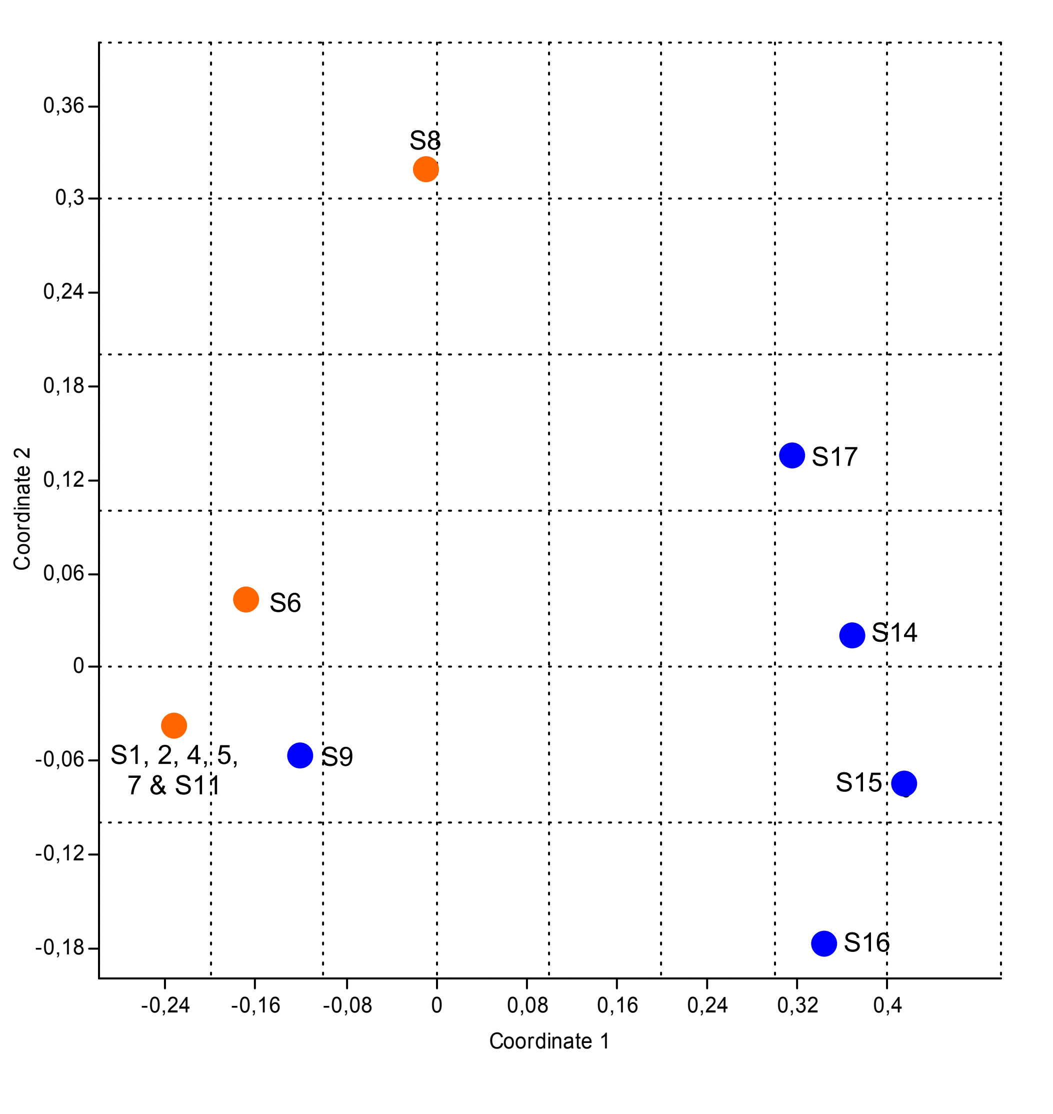

Fig. 42: non-metric MDS (Bray-Curtis similarity measure) of the living molluscan assemblage. orange = intertidal samples, blue = subtidal samples;

Samples 3, 7,10,12,13 and 18 were removed because they contained only a few living molluscs. Samples 1-5, 7 and 11 plot all together in one point, because of the dominance of living potamidids. Due to the importance of cerithiids sample 8 is again further away from all other intertidal points. Subtidal samples show similar relations as in Fig. 39. Samples 14, 15, 16 and 17 build a group and sample 9 clusters with intertidal samples (Fig. 42).

6.4.3 Rarefaction

Rarefaction curves can be used to demonstrate species richness from samples of different size. Usually the number of species rises with the sample size. So the number of species alone is not that significant for biological diversity. Rarefaction curves illustrate how many species would have been detected in samples of smaller size (Krebs, 1999)

Rarefaction curves normally have a steep slope on the left and flatten to the right, which means the bulk of species has been found. Curves without that flattening indicate high number of undiscovered species (Krebs, 1999)

a) Total molluscan fauna

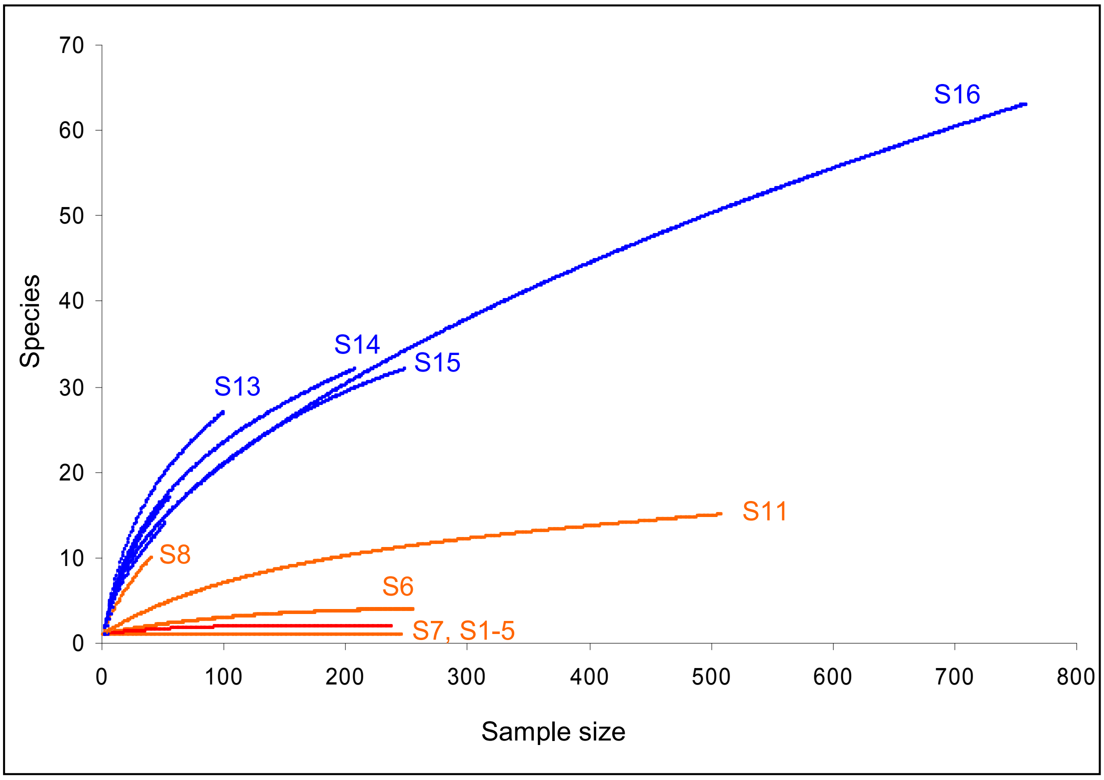

Fig.43: Individual Rarefaction curves of intertidal and subtidal samples
Blue = subtidal samples, orange = intertidal samples (total molluscan fauna)

Fig. 43 illustrates that species richness in subtidal samples is higher than in intertidal samples. Shapes of subtidal curves indicate a large number of species remained undiscovered. The curve of sample 8 is more similar to subtidal than to intertidal curves, which is due to the position in the border zone between intertidal and subtidal area.

Curves of the subtidal zone lie very close together and overlap. Therefore, intertidal and subtidal curves are portrayed separately (Fig. 44).

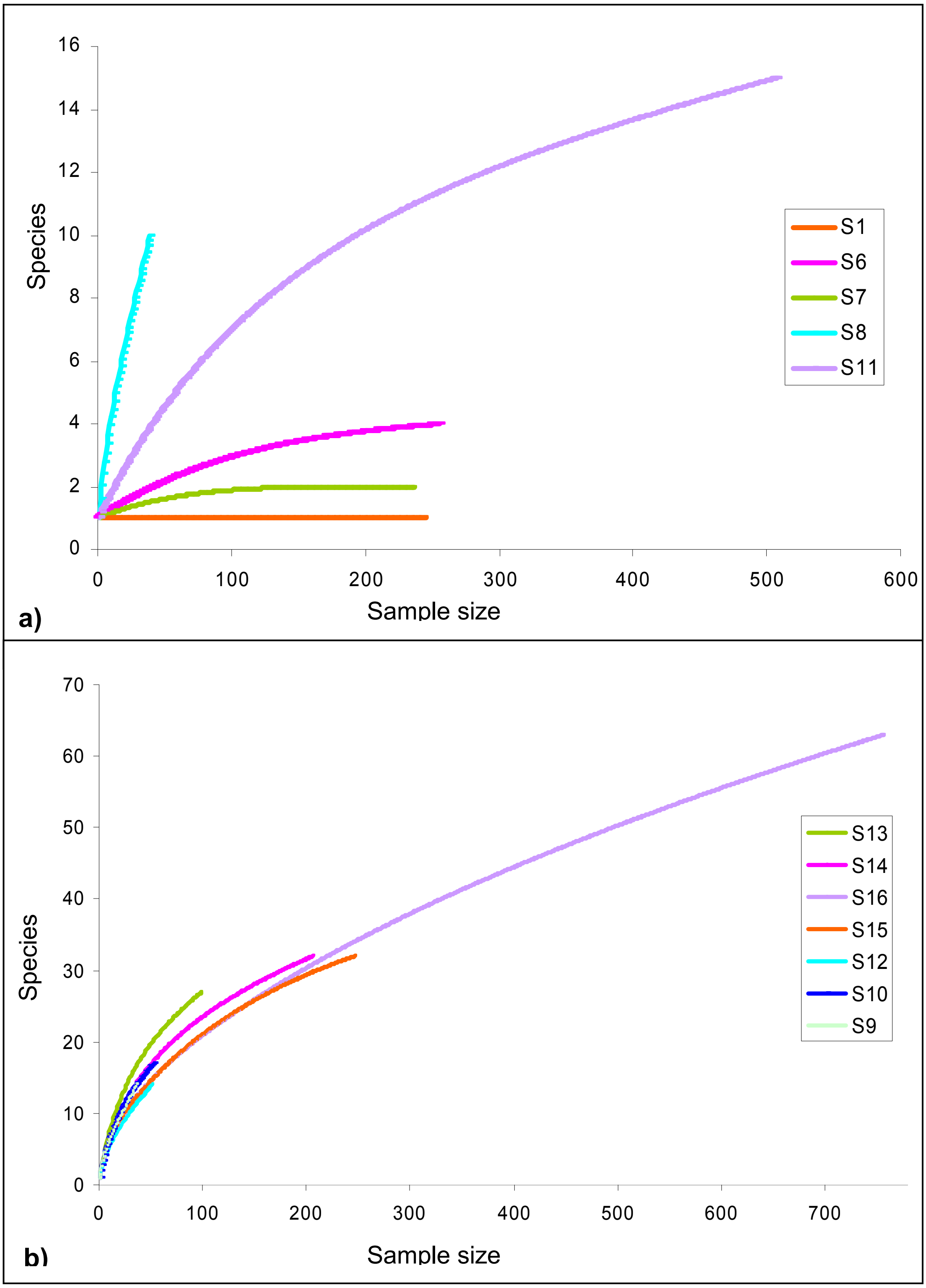

Fig. 44: Rarefaction curves of the total molluscan fauna. a) intertidal area, b) subtidal area;

Curve S1 in Fig. 44 a) represents samples 1-5 and is horizontal, which means that these samples only contain one species. Curves S11 and S8 demonstrate highest diversities within intertidal samples. Curves of subtidal samples in Fig. 44 b) all have a similar shape which means species diversity is similar in all the samples.

b) Dead molluscan assemblage

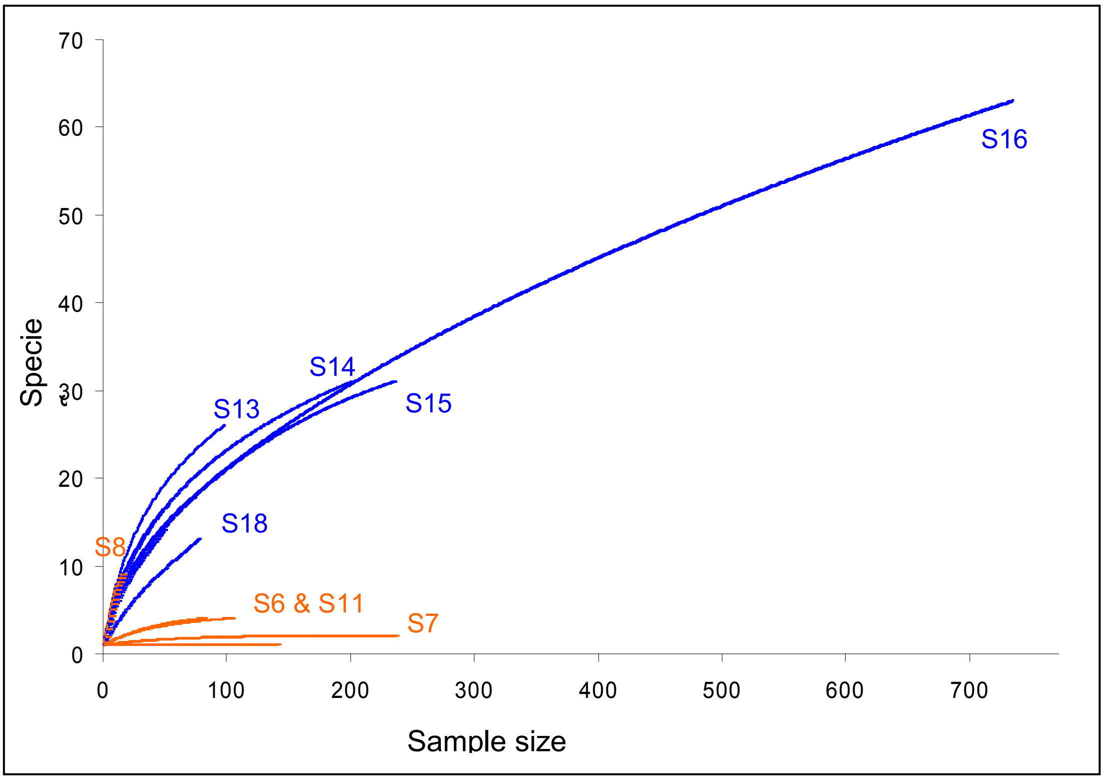

Fig. 45: Individual Rarefaction curves of intertidal and subtidal samples
Blue = subtidal samples, orange = intertidal samples (dead molluscan fauna)

Fig. 45 looks similar to Fig. 43, a small difference being the change in position of curves S7 and S11 and the slope of curve S8 being steeper. Fig. 46 provides a detailed view of intertidal curves.

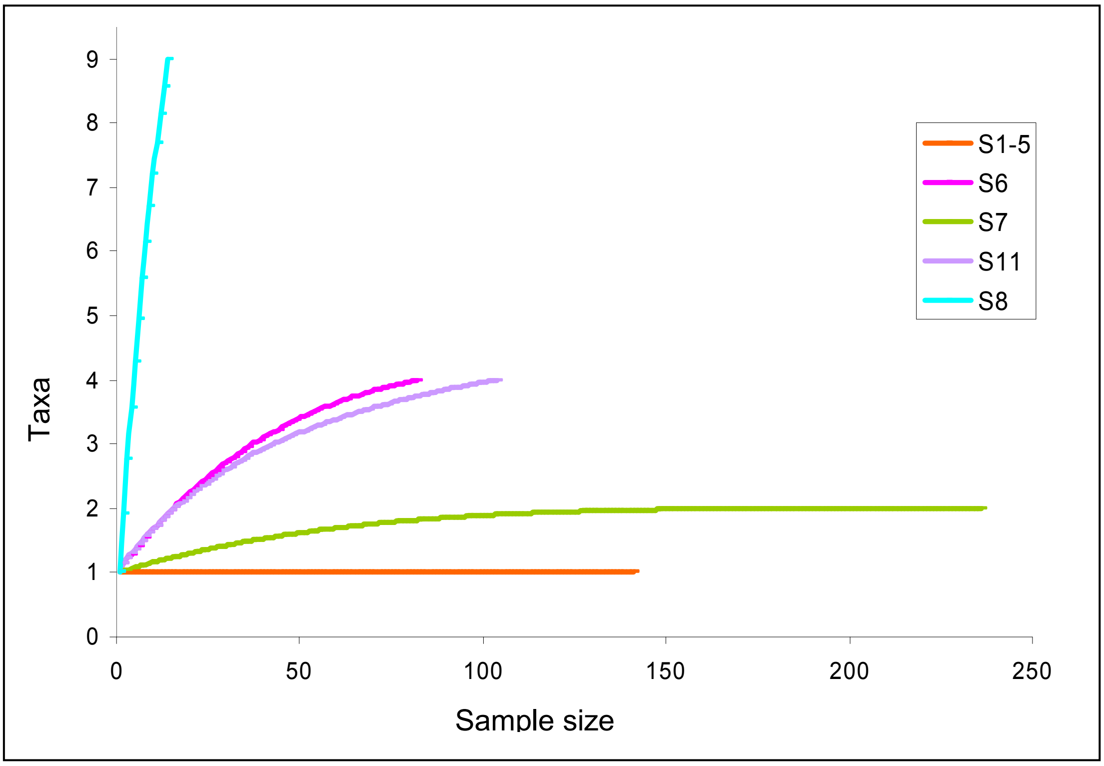

Fig. 46: Rarefaction curves of intertidal samples (dead molluscan assemblage).

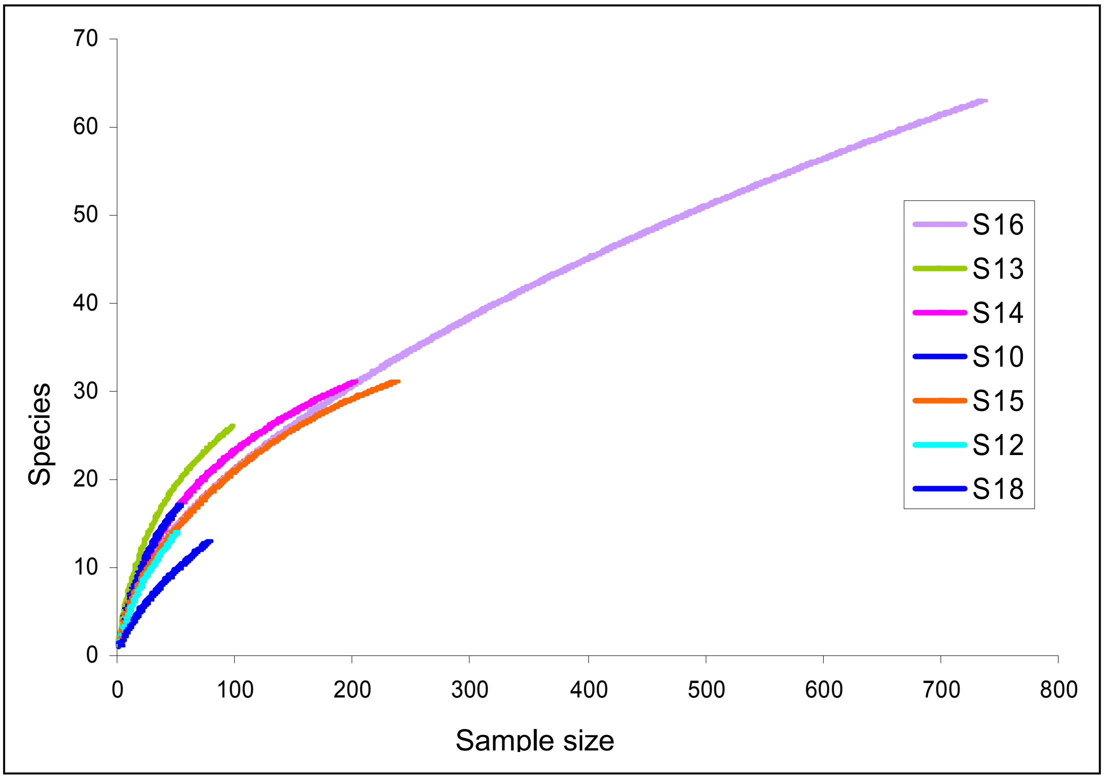

Fig. 47: Rarefaction curves of subtidal samples (dead molluscan assemblage).

Fig. 47 shows rarefaction curves of subtidal samples in greater detail. Curves 10, 12, 14, 15 and 16 are overlapping while curve S18 and S13 have marginal position.

c) Living molluscan assemblage

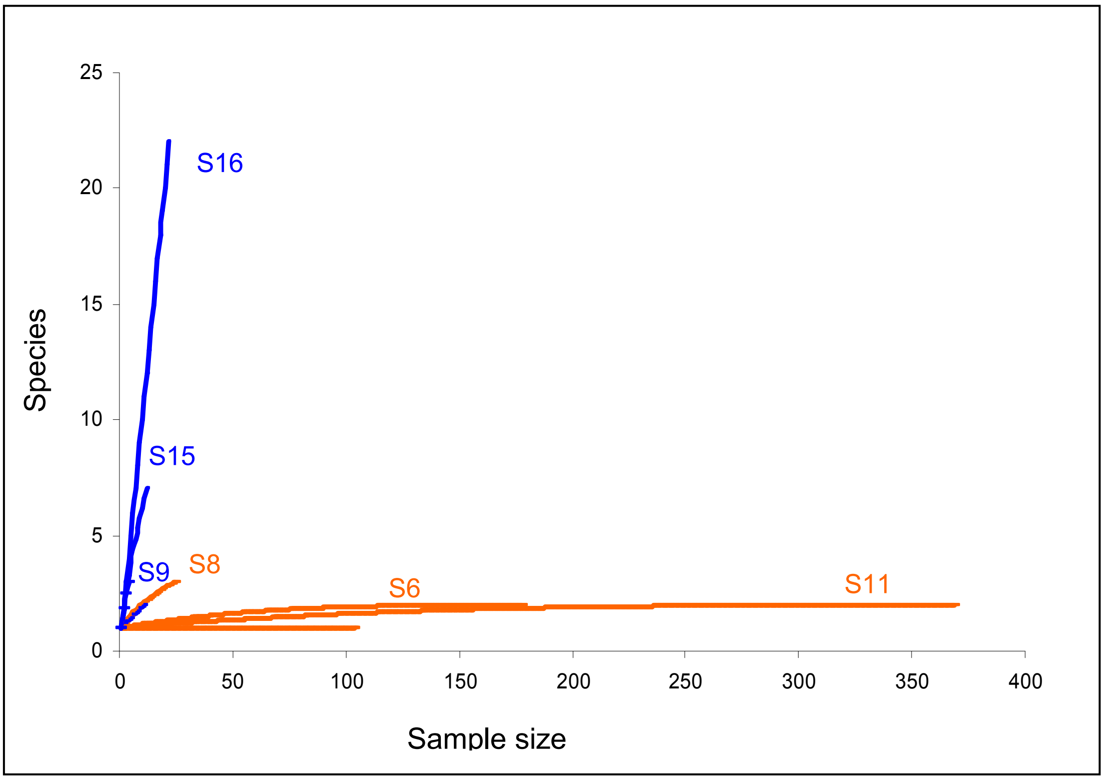

Fig. 48: Individual Rarefaction curves of intertidal and subtidal samples
Blue = subtidal samples, orange = intertidal samples (living molluscan fauna)

In contrast to intertidal curves, subtidal slopes are very steep because of a small number of living individuals in subtidal samples (Fig. 48). Fig. 49 presents rarefaction curves of the living molluscan fauna in more detail.

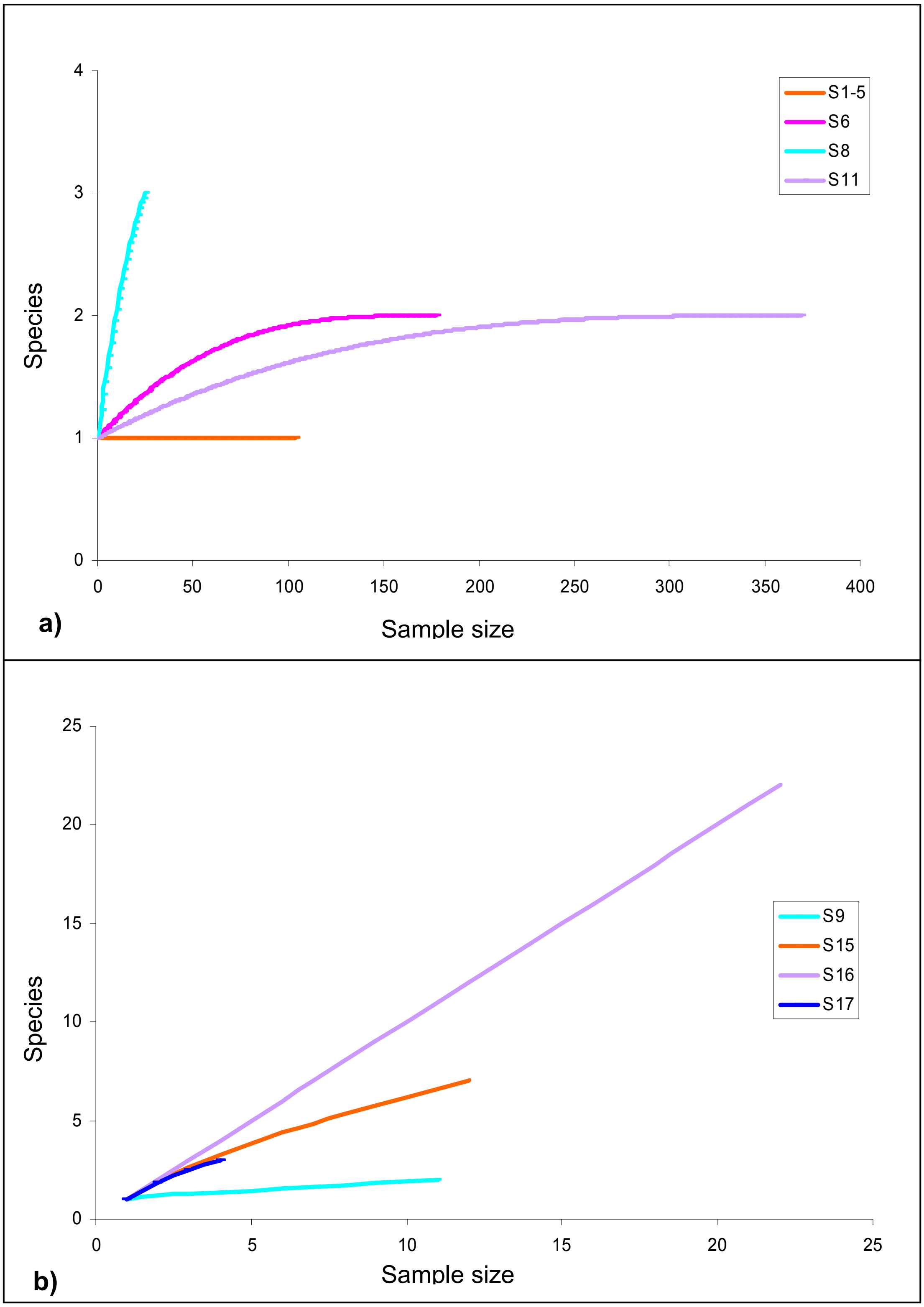

Fig. 49: Rarefaction curves of the living molluscan fauna. a) intertidal area, b) subtidal area;

6.4.4 Number of Species

a) Total molluscan fauna

A total of 118 species occurred in our study. The mean number of species per samples varies greatly between the intertidal (2.88 species) and the subtidal zone (24.33 species) (Fig. 50).

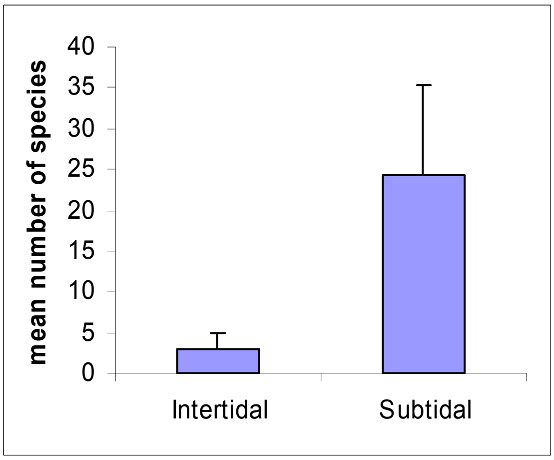

Fig. 50: Mean number of species for the intertidal and subtidal area plus 95% confidence interval.

Species numbers of samples increase from the high intertidal to the shallow subtidal zone. Sample 16 shows the highest species number. In sample 17 and 18 from the somewhat deeper basin in the south of the lagoon a relatively small number of species was found compared to shallow subtidal samples (Fig. 51).

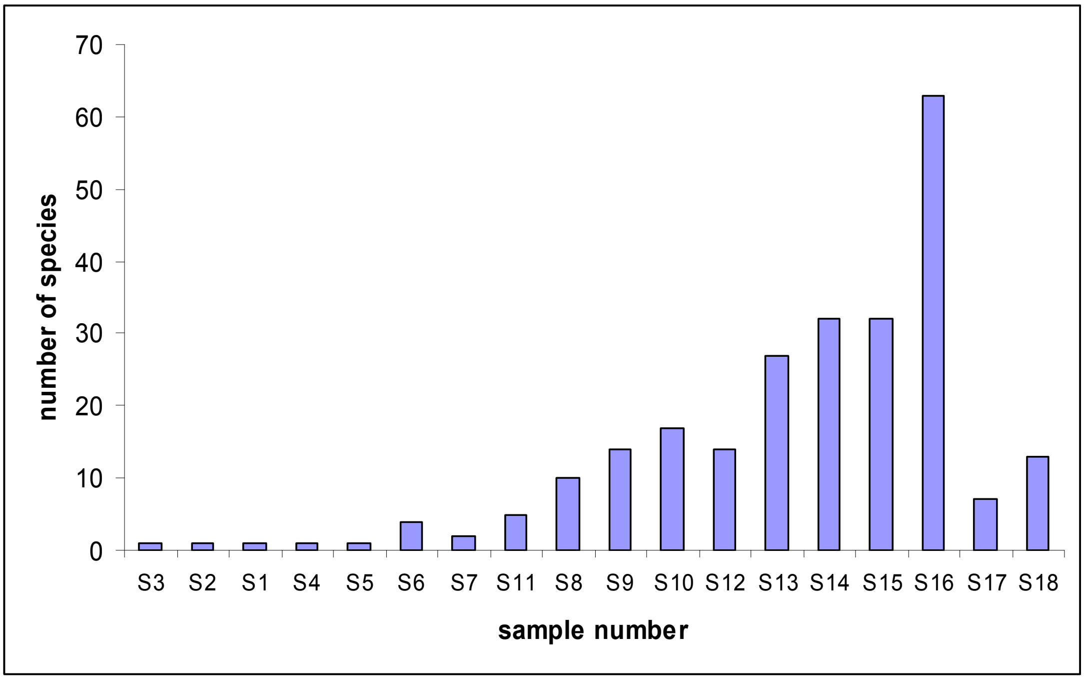

Fig. 51: Species numbers of quantitative samples (total molluscan fauna)

b) Dead molluscan fauna

The mean number of species in the intertidal area is rather low with 2.5 while in the subtidal area it is relatively high with 21.5 (Fig. 52).

The species numbers per sample for the dead molluscan assemblages are nearly the same as for the total molluscan fauna (Fig. 53)

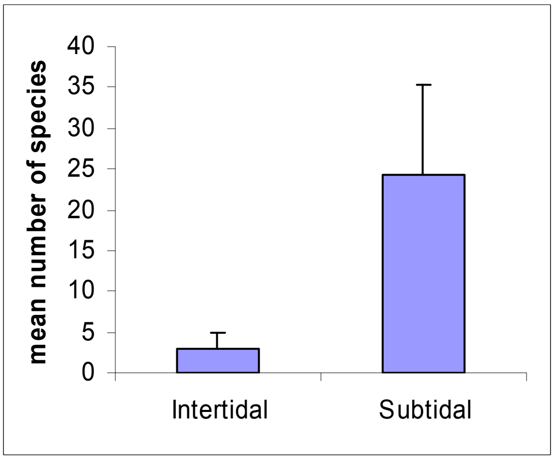

Fig. 52: Mean number of species for the intertidal and subtidal area plus 95% confidence interval.

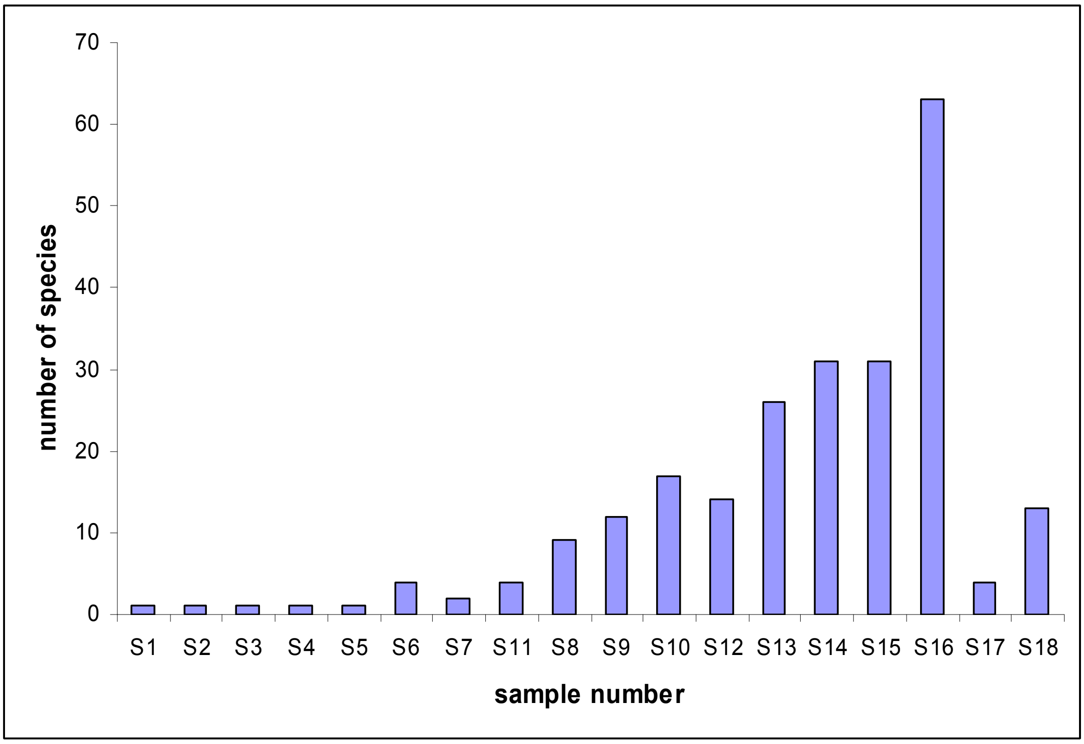

Fig. 53: Species numbers of quantitative samples (dead molluscan fauna)

c) Living molluscan fauna

Differences in the mean number of species per sample between intertidal and subtidal zone are less pronounced. This is because the mean number of species of the subtidal zone is considerably lower (3.37 species) than for dead molluscs (Fig. 54)

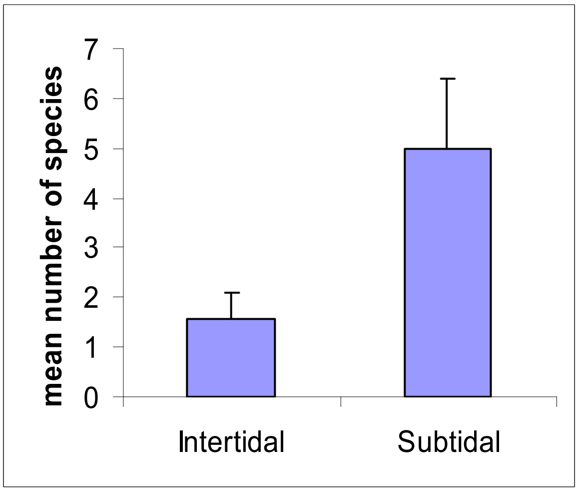

Fig. 54: Mean number of species for the intertidal and subtidal area plus 95% confidence interval.

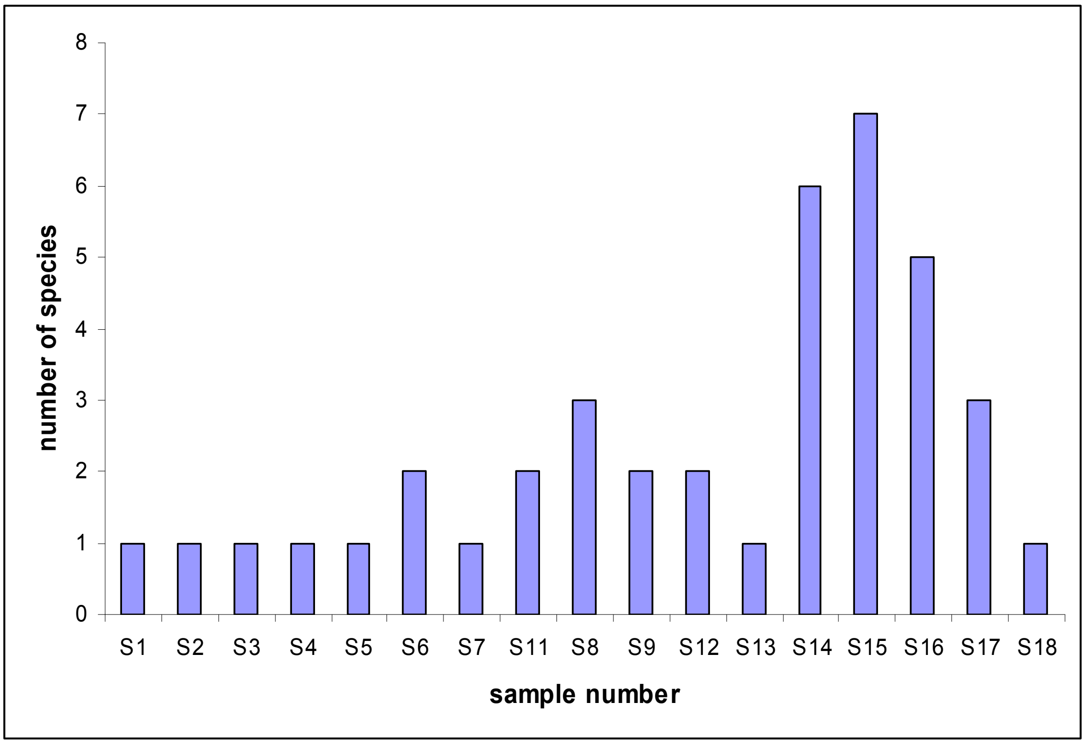

Fig.: 55: Species numbers of quantitative samples (living molluscan fauna)

The number of species per sample rose from the intertidal to the subtidal zone, similar to Fig. 53. However the increase was not that strong as it was in the dead molluscan assemblage. Sample 10 did not contain any living molluscs (Fig. 55).

6.4.5 Diversity Indices

Diversity indices are calculated to gain information of biodiversity in samples or in ecosystems (Magurran 2004). Calculations include richness as well as abundances of species. Several indices exist with different ways of calculation. I used the statistical program PAST to compute the Shannon, the Simpson and the Margalef index.

The Shannon index, which is basically influenced by species in the middle of the rank sequence, considers the number of species and the species evenness (how equally abundant the species are). The Shannon index is calculated with the following equation (Magurran 2004).

$$H = -\sum_{i} p_i \cdot \ln p_i$$

Values range between 1,5 (low evenness) and 3,5 (high evenness).

The Simpson index demonstrates the probability that two randomly picked individuals belong to different species. This index is strongly affected by the 2-3 most abundant species. It is usually expressed as 1-D (D = dominance).

$$D = \sum_{i=1}^{S} \frac{n_i(n_i - 1)}{n(n-1)}$$

Values can range from zero to one. Values near one indicate low while values near zero indicate high dominance (Krebs, 1999).

The Margalef index is a simple index, which uses a combination of S (the number of species recorded) and N (the total number of individuals). It compensates for sampling effects by dividing richness (S) by the total individuals in the sample (Magurran 2004).

$$D_{Mg} = (S-1)/\ln N$$

a) Total molluscan fauna

All three diversity indices show significantly higher values for the subtidal than for the intertidal zone, which means species richness and evenness is high in the subtidal zone while dominance is high in the intertidal zone.

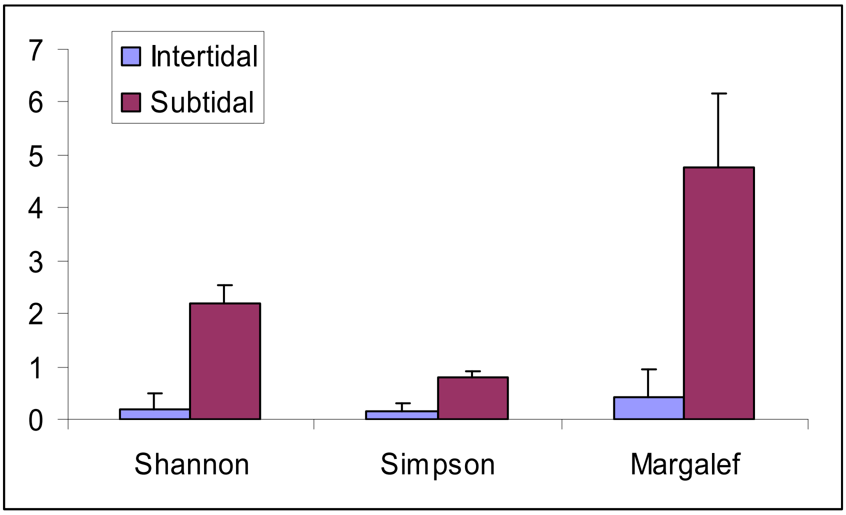

Fig. 56: Mean value of diversity indices plus 95% confidence interval. (total molluscan fauna)

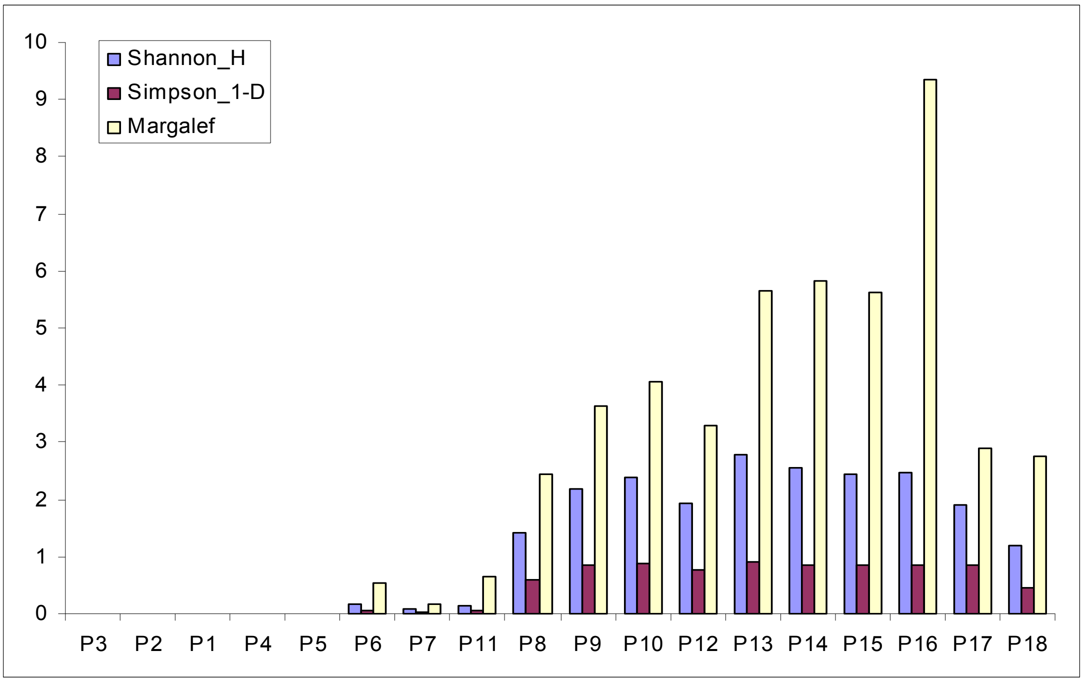

Fig. 57: Diversity indices of the total molluscan fauna.

Diversity indices are zero or very low in the intertidal area, because the dominance of one species (*P. conicus*) is very high. Sample 8 (located at the border to the subtidal), however marks the turnover to relatively high values of all three indices. The Margalef index reaches a maximum value of 9.35 in sample 16 while the Shannon and the Simpson index are relatively constant within subtidal samples (Fig. 57).

b) Dead molluscan fauna

Fig. 58 and 59 show nearly the same pattern as Fig. 56 and 57, high diversity indices for the subtidal zone and low values for the intertidal zone.

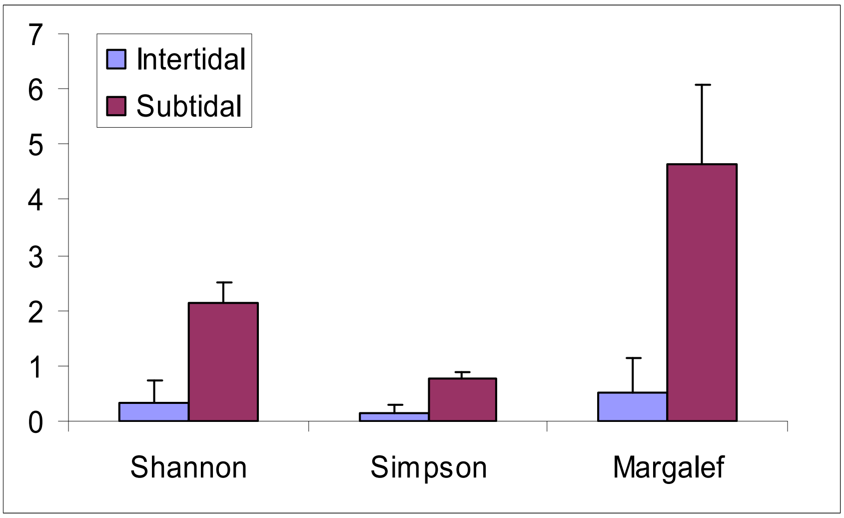

Fig. 58: Mean value of diversity indices plus 95% confidence interval. (dead molluscan fauna)

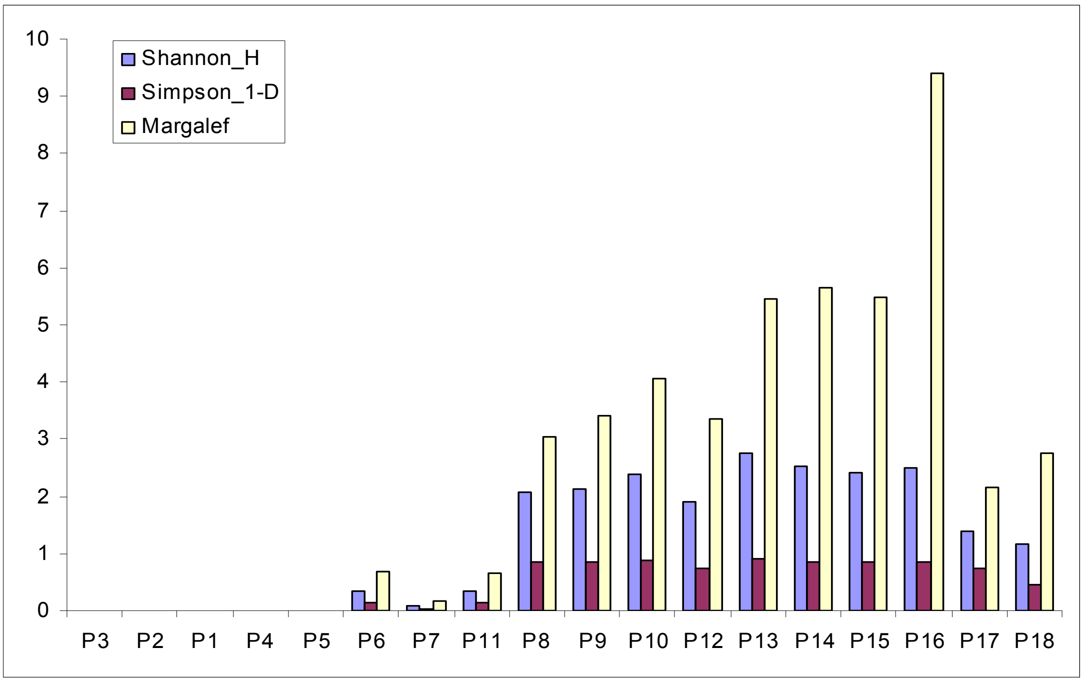

Fig. 59: Diversity indices of the dead molluscan fauna.

c) Living molluscan fauna

Similar to Fig. 58 diversity indices of the intertidal zone are very low. Although, subtidal diversity indices of the living molluscan community are lower than those of the dead assemblage, the basic trend is similar to that of the dead assemblage (Fig. 60).

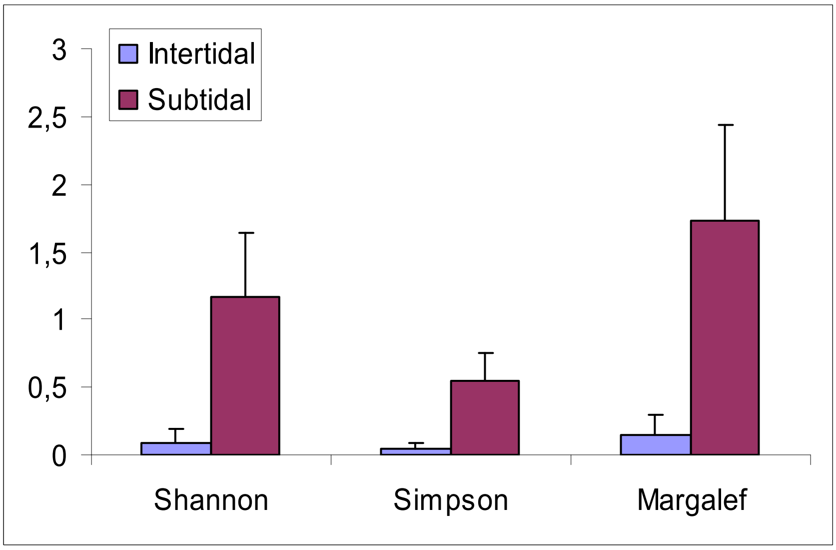

Fig. 60: Mean value of diversity indices plus 95% confidence interval. (living molluscan fauna)

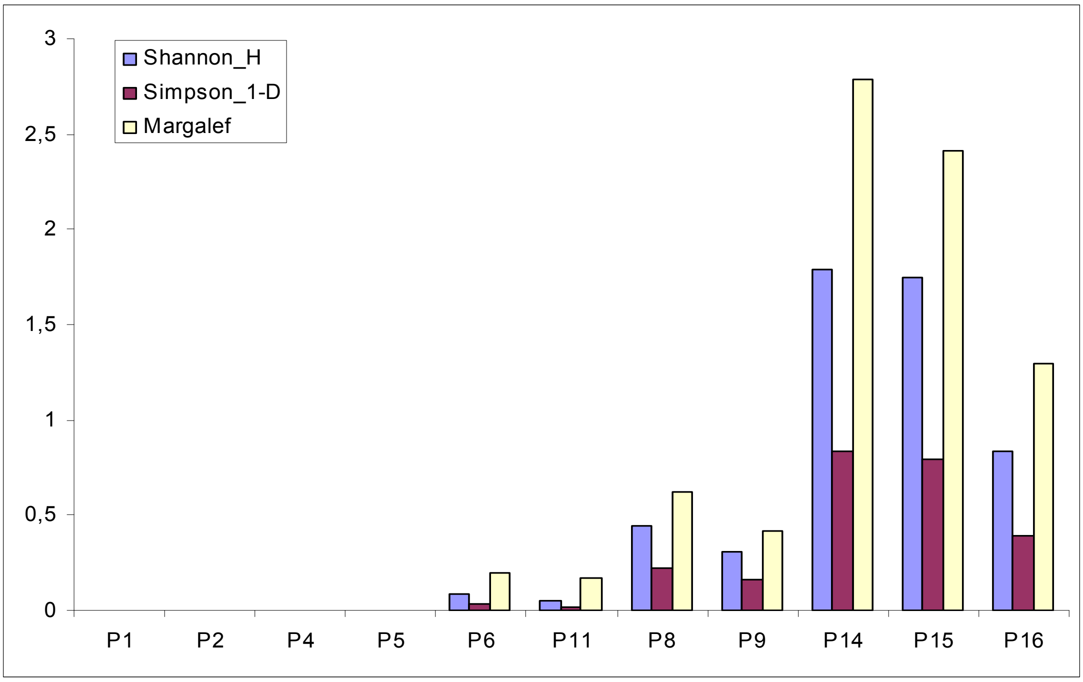

Fig. 61: Diversity indices of the living molluscan fauna.

Samples 3, 7,10,12,13 and 18 were removed when calculating indices for the living assemblage, because of the low number of living individuals. The trend is very similar to that on of the dead fauna. Diversity indices are low in the intertidal (indicating high dominance) and high in the subtidal area, especially in samples 14-16 (indicating high evenness) (Fig. 61).

6. 5 Dominant taxa

Results of chapter “6.3 Molluscan composition” showed a strong dominance of *Potamides conicus* in the intertidal area. Dominance is lower in the subtidal zone but one species, *Chavania erythraea* was found more often than others. Dominance relations are more obvious, when data are analysed on family level. The gastropod family Potamididae dominates the intertidal and the bivalve family Lucinidae the subtidal area (Fig. 62). This chapter discusses sampled data of these two families in more detail.

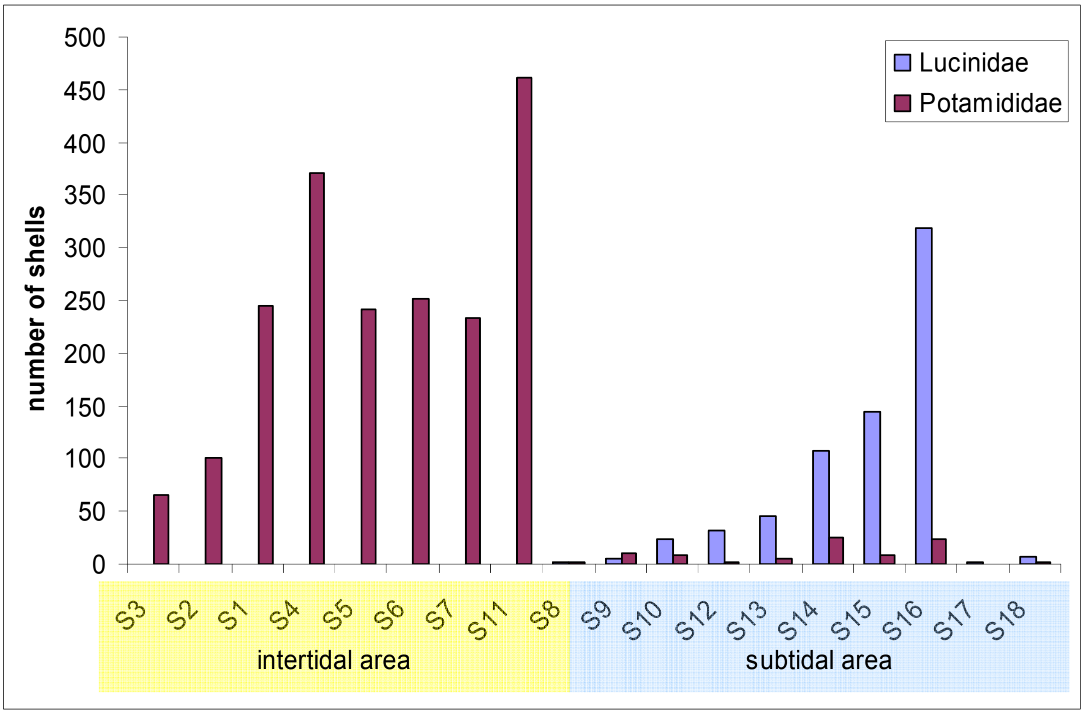

Fig. 62: Abundances of Potamidids and Lucinids.

Potamidids also appear in subtidal samples, but only empty shells could be found. Lucinids only colonize the subtidal zone. Sample 16 contained many very small lucinids. This sample was taken on the sandbar, which separates the Kite lagoon from the Blue lagoon (Fig. 62).

6.5.1 Potamididae

These snails are popularly called "horn shells" or "mudcreepers" and belong to the superfamily Cerithioidea. They colonize mud flats of the tropical region, where they feed on microscopic algae. In this family the columella is strongly twisted and the short siphonal canal gutter-like. Sometimes the outer lip is surrounding this feature like a curved blade. The brown operculum is multispiral, horny and rather thin. They can cope with hypersaline conditions of lagoons as well as with brackish water of estuaries (Bosch et al., 1995).

Fig. 63: *Potamides conicus* (http://www.gastropods.com)

We discovered only one species of the family Potamididae: *Potamides conicus* which is elongated, conical, strong and heavy in size with small nodules. Spiral bands of different colours, varying from brown, ochre, yellow to beige and white, adorn these shells. Size ranges between 4-15 mm (Rusmore-Villaume, 2008). We measured size of 2056 individuals with a calliper and found the following size distribution. Living individuals show a peak at 11.0-11.9 mm height and empty shells at 10.0-10.9 mm (Fig. 64).

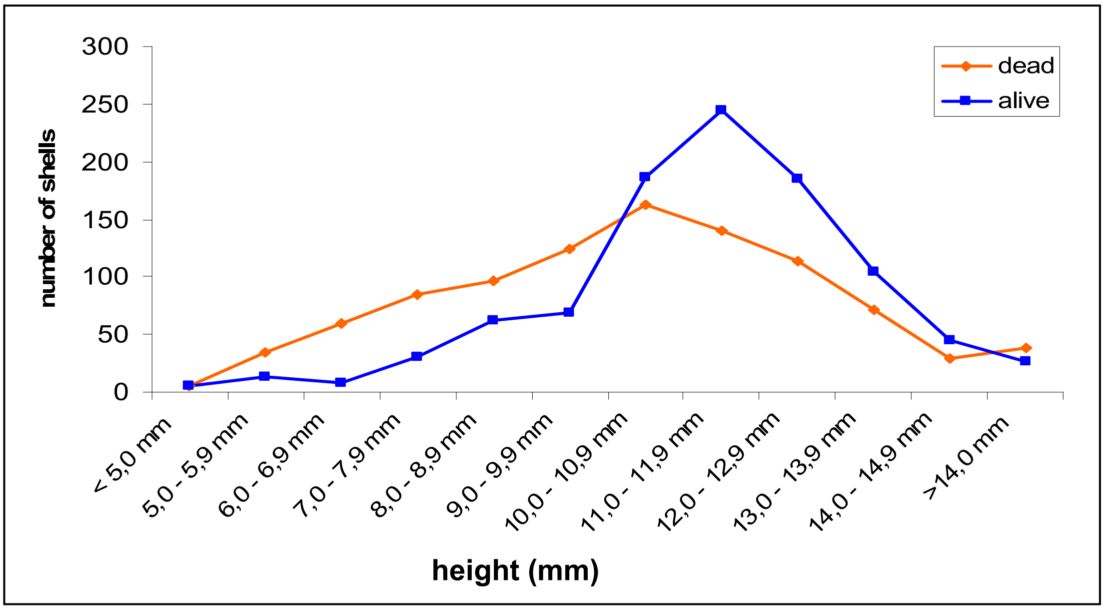

Fig. 64: Size distribution of *Potamides conicus*.

6.4.2 Lucinidae

Shells of this diverse family are typically lenticular with an anterior and posterior sulcus. Red Sea lucinids often show an interestingly distinguishing sculpture (e.g. *Divalinga arabica*) and are usually white in colour. The hinge has two cardinal teeth and anterior and posterior laterals. The ligament is often deeply sunken and in most cases external (Bosh et al., 1995).

Fig. 65: Divalinga arabica (www.nmr-pics.nl)

Lucinids live infaunal and in symbiosis with sulphide-oxidizing bacteria. They can be found in intertidal areas, coral reefs, sea grass beds as well as on the continental margin (Amler et al., 2000).

We identified 8 different species of this genus in our samples: *Cardiolucina semperiana, Cavilucina fieldingi, Chavania erythraea, Ctena divergens, Divalinga arabica, Lamellolucina dentifera, Pillucina vietnamica,* and *Anodontia sp.* Most abundant were *Chavania erythraea, Cardiolucina semperiana* and *Divalinga arabica*. A very interesting fact is the high number of predatory drill holes in this family. Nearly every second shell of *Chavania erythraea* was drilled (see below). As with *Potamides conicus* we also measured size of *Chavania erythraea.* Due to the fact that only 7 living individuals (5x <5mm, 2x 7.0-7.9 mm) were found Fig. 66 shows only the size distribution of empty shells.

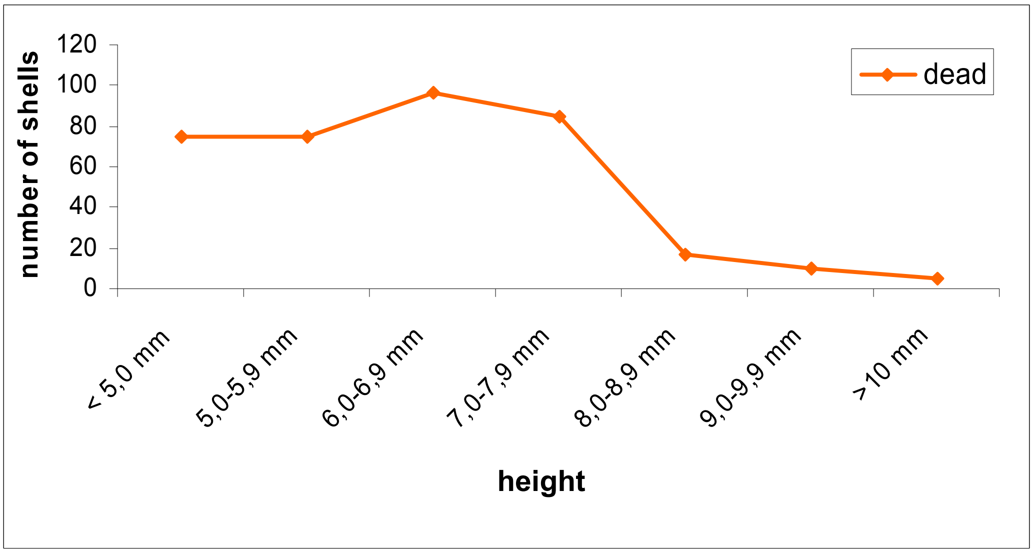

Fig. 66: Size distribution of *Chavania erythraea*.

6.6 Drilling predation

Although, the amount of tidal coverage regulates intertidal zonation, biological factors such as competition and predation also play a considerable role (Karleskint et al., 2010). Important predators in the food web of intertidal areas are drilling snails (Muricidae or Naticidae). Influence of drilling predation can be analysed by counting shells with predatory drill holes.

Fig. 67: Molluscs with drill holes.
Row 1: 5x *Chavania erythraea*
Row 2: 3x *Divalinga arabica*
Row 3: 1x *Callista florida,* 1x *Fragum nivale,* 4x *Acteocina simplex;*

Prey animals are often bivalves with a skeleton consisting of two valves, which tend to disarticulate after death. So the probability of finding one of the valves of the prey is two times higher than finding specifically the one of the two that was drilled. Therefore, a correction factor of 2 is necessary. So drilling frequency for bivalves can be calculated by dividing the number of drilled valves (d) by half of the total number of valves (0.5 n). (Kowalewski, 2002).

$$\text{Equation for bivalves: } f_d = d/0.5n$$

$$\text{Equation for gastropods: } f_d = d/n$$

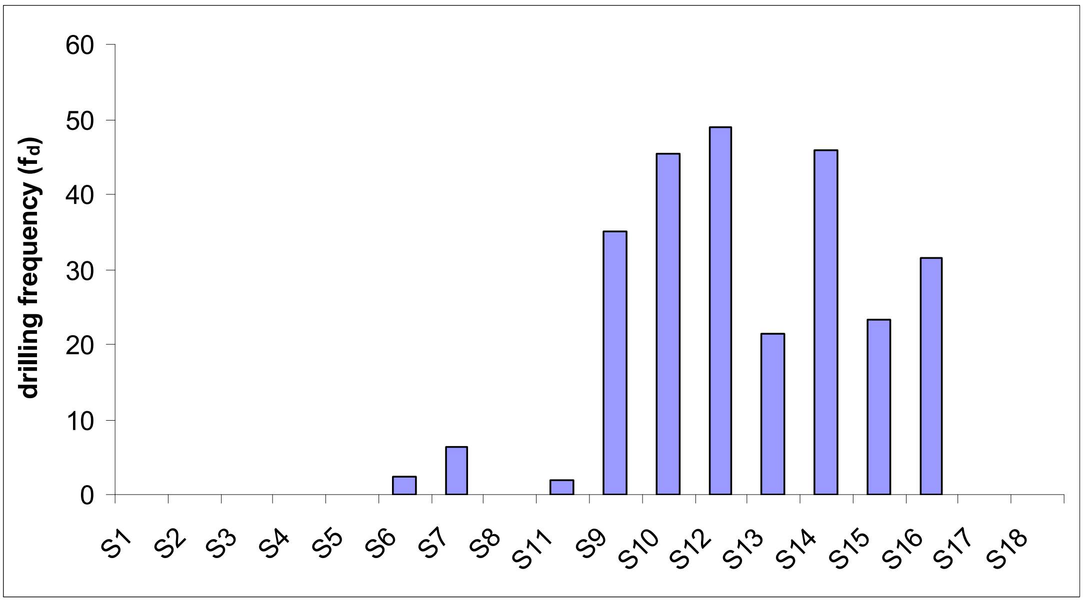

Fig. 68: Drilling frequencies of all quantitative samples.

There is no drilling predation in the higher intertidal area. We found some potamidids with drill hole in samples 6, 7 and 11. Very high drilling frequencies occurred in subtidal samples (Fig. 68).

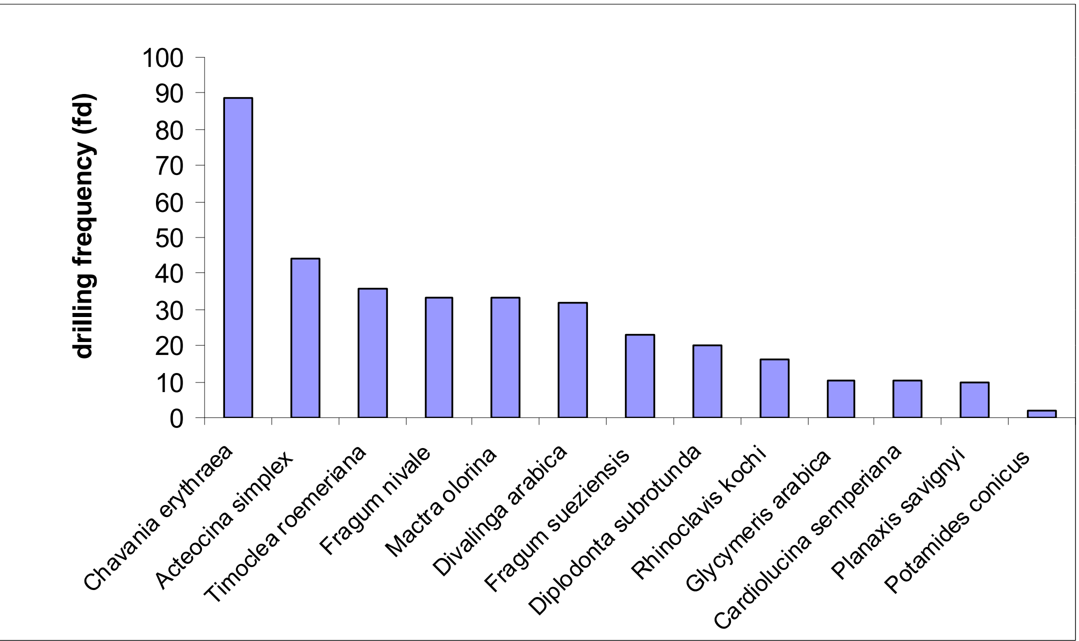

Fig. 69: Taxa showing high drilling frequencies.

Chavania erythraea was most affected by drilling predation in our study. The gastropod *Acteocina simplex* and the bivalves *Timoclea roemeriana, Fragum nivale, Mactra olorina and Divalingaa arabica* were also strongly drilled (Fig. 69)

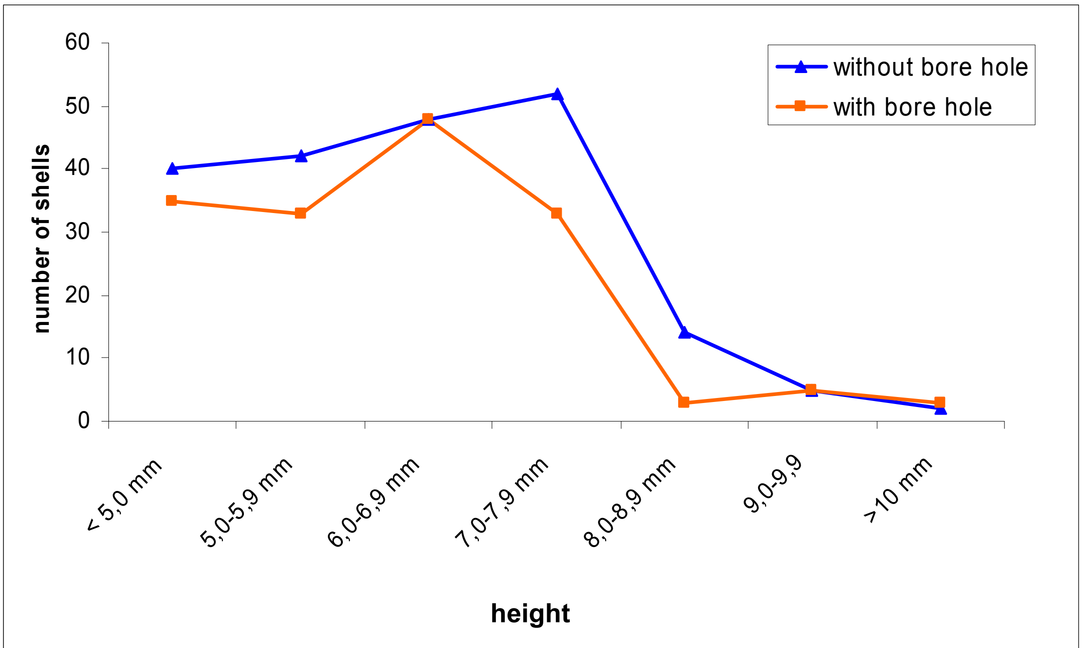

Fig. 70: Size distribution of *Chavania erythraea*.

Data of size measurements showed a remarkable difference between drilled and undrilled shells of *Chavania erythraea*. Shells without drill hole had their peak at 7.0-7.9 mm and shells with drill hole at 6.0-6.9 mm lengths (Fig. 70).

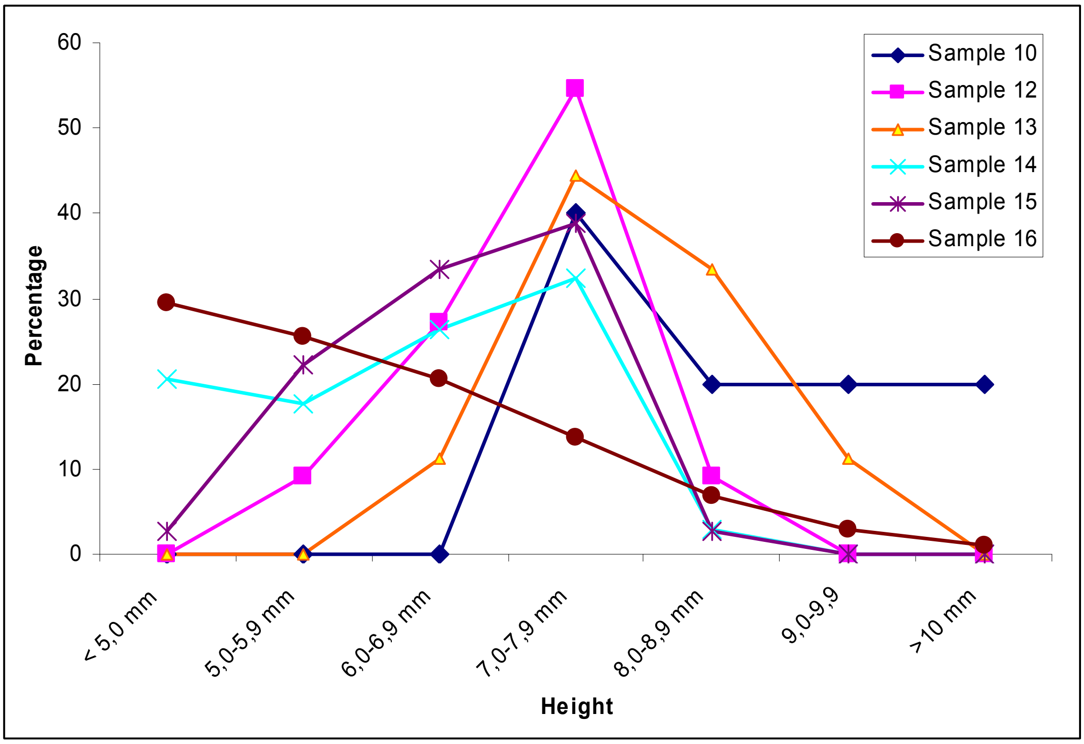

Fig. 71: Size distribution of *Chavania erythraea* (without drill holes) in individual samples.

Comparing undrilled shells, all samples except sample 16 have their peak in size category 7.0-7.9mm (Fig. 71). Among drilled shells, however, samples 10, 12 and 14 have their peaks at 6.0-6.9mm and samples 13 and 15 at 7.0-7.9 mm (Fig. 72). Sample 16 has its peak in the category <5mm in both diagrams.

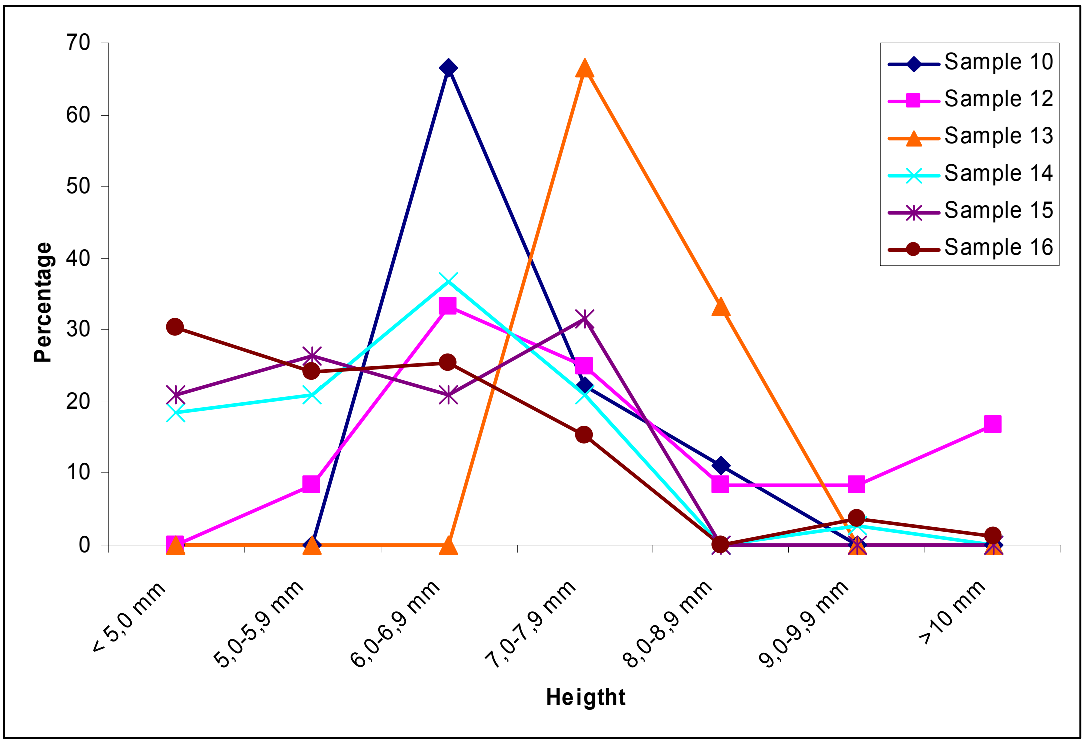

Fig. 72: Size distribution of *Chavania erythraea* (with drill holes) in individual samples.

6.7 Subtidal collection

We crossed the subtidal area on the 16th April 2010 and picked up larger eye-catching shells. So this is a qualitative collection making no claim to be complete or comprehensive.

6.7.1 Bivalves

Table 2: Bivalves of the subtidal collection.

Species	Family	single valved	double valved	alive
Anadara sp.	Arcidae	7	0	2
Brachidontes variabilis	Mytilidae	0	0	1
Glycymeris arabica	Glycymeridae	2	0	0
Glycymeris pectunculus	Glycymeridae	3	0	1
Chama sp.	Chamidae	6	0	0
Divalinga arabica	Lucinidae	1	0	0
Codakia paytenorum	Lucinidae	2	0	0
Anodontia sp.	Lucinidae	3	0	1
Fragum nivale	Cardiidae	2	0	0
Fulvia fragilis	Cardiidae	17	0	0
Lunulicardia auricula	Cardiidae	1	0	0
Tridacnia maxima	Cardiidae	1	0	0
Mactra olorina	Mactridae	76	3	1
Leptomya subrostrata	Semelidae	1	0	0
Asaphis violascens	Psammobiidae	6	0	0
Callista florida	Veneridae	12	3	0
Circe crocea	Veneridae	4	0	0
Circe scripta	Veneridae	4	0	0
Circe rugifera	Veneridae	3	0	0
Circenita callipyga	Veneridae	4	0	2
Dosinia erythraea	Veneridae	10	8	0
Dosinia histrio	Veneridae	1	0	1
Pitar hebrea	Veneridae	0	1	0
Tapes deshayesii	Veneridae	3	0	0
Lioconcha ornata juvenil	Veneridae	0	0	1

The subtidal collection contained 25 bivalve species of 10 families. Eight of these species did not occur in the 18 quantitative samples (marked blue in Table 4).

6.7.2 Gastropods

Table 4: Gastropods of the subtidal collection.

Species	Family	dead	alive	hermit crab
Trochus sp.	Trochidae	1	0	0
Nerita sanguinolenta	Neritidae	6	1	0
Casmaria ponderosa	Cassidae	1	0	0
Cerithium adansonii	Cerithidae	0	2	4
Cerithium caeruleum	Cerithidae	0	0	3
Clypeomorus bifasciata	Cerithiidae	1	0	0
Rhinoclavis kochi	Cerithidae	5	1	10
Turritella sp.	Turritellidae	0	1	0
Archimediella maculata	Turritellidae	4	0	0
Potamides conicus	Potamididae	2	0	0
Canarium erythrinum	Strombidae	1	0	0
Canarium mutabilis	Strombidae	2	0	3
Gibberulus gibberulus	Strombidae	1	0	0
Tricornis tricornis	Strombidae	2	0	0
Murex forskoehlii	Muricidae	0	3	0
Thais savignyi	Muricidae	0	1	0
Notocochlis gualteriana	Naticidae	3	0	0
Polinicesn mamilla	Naticidae	1	0	0
Mamilla melanostoma	Naticidae	2	0	0
Volema pyrum	Melongenidae	18	8	4
Fusinus verucosus	Fasciolariidae	0	3	1
Turrilatirus turritus	Fasciolariidae	0	0	1
Conus parvatus	Conidae	1	0	0
Conus tessulatus	Conidae	10	2	0
Conus arenatus	Conidae	7	10	0
Bulla ampulla	Acteonidae	2	0	0

In the subtidal collection we discovered 26 gastropod species of 13 families. 13 species and two families did not occur in the 18 quantitative samples (marked blue in Table 4). Altogether the subtidal collection provided 21 new species and three new families. So this collection emphasizes the high diversity of the subtidal area.

7. Discussion

As measurements of abiotic factors showed that changing water levels cause fluctuating environmental factors. The interaction of tides, waves, wind and sunlight create a stressful environment. Inhabitants have to cope with desiccation, hypersaline conditions and heat (Karleskint et al. 2010).

Soft sediments retain water in the pores between the sediment particles. So burrowing into the sediment is a chance to escape desiccation and to reduce temperature stress. Therefore many tidal flat invertebrates live infaunal and dig burrows up to 100 cm depth (Karleskint et al. 2010)

The gradient from a fully terrestrial to a fully marine habitat can be described as a stress gradient, which decreases from the upper intertidal zone to the shallow subtidal zone. The stress level correlates with the time of being exposed to air and causes a typical longitudinal zonation (Karleskint et al. 2010).

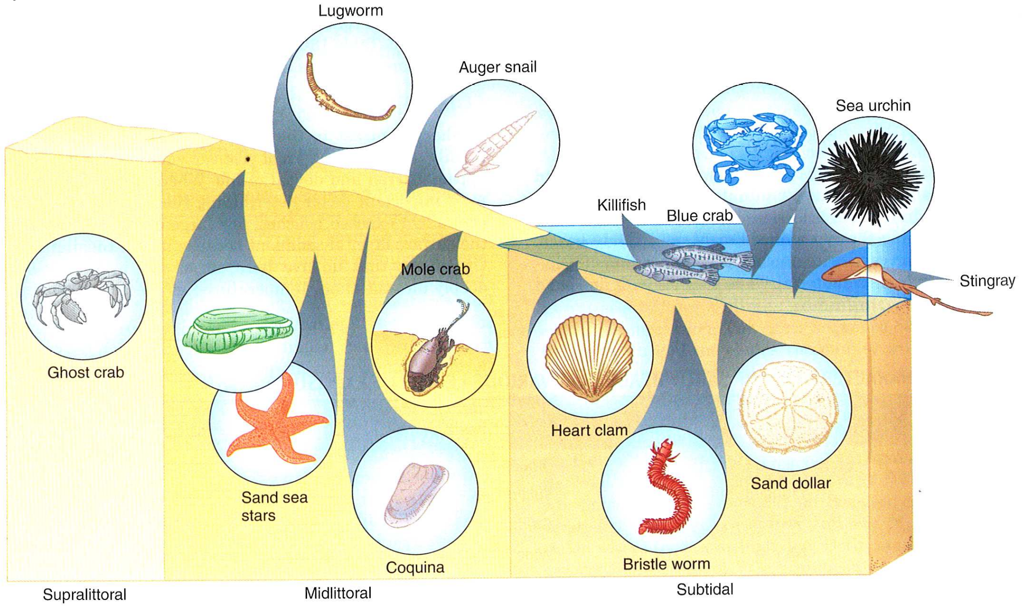

Fig. 73: Longitudial zonation of sandy shores (Karleskint et al., 2010)

Tidal flats are very productive marine environments, due to terrestrial nutrient sources and high phytoplankton production. The rich nutrient supply of the intertidal area leads to great abundances of organisms and strong interspecific competition (Levinton 2009).

Tidal channels in the study area were covered by algal mats. Algae and cyanobacteria provide a rich food source for the gastropod *Potamides conicus,* a grazer which is perfectly adapted to the fluctuating environment of the intertidal area. It was by far the most common species of the intertidal area in this study with 1970 collected shells. The upper intertidal area (samples 1-5) was completely dominated by this gastropod. In the lower intertidal area 10 other species occurred with very low abundances.

Therefore statistical analyses demonstrated a high similarity between intertidal samples (Q-mode cluster analysis, MDS) (Fig. 37 & 40). Diversity indices (Shannon, Simpson and Margalef) showed high dominance and low eveness for that area (Fig. 56).

The border zone between intertidal and subtidal zone was colonized by *Saccostrea cucullata*, a typical oyster of the intertidal area. Between oyster patches there were dense populations of *Brachidontes pharaonis, which also* appeared on beach rock formations along the south-eastern coastline.

The shallow subtidal area was characterised by a high number of species which increased with water depth (Fig. 74). Ninety-three species were found in subtidal samples. High values of diversity indices (Shannon, Simpson and Margalef index) reflect these results. In contrast to the intertidal zone that area was dominated by bivalves, such as lucinids, venerids and glycymeridids.

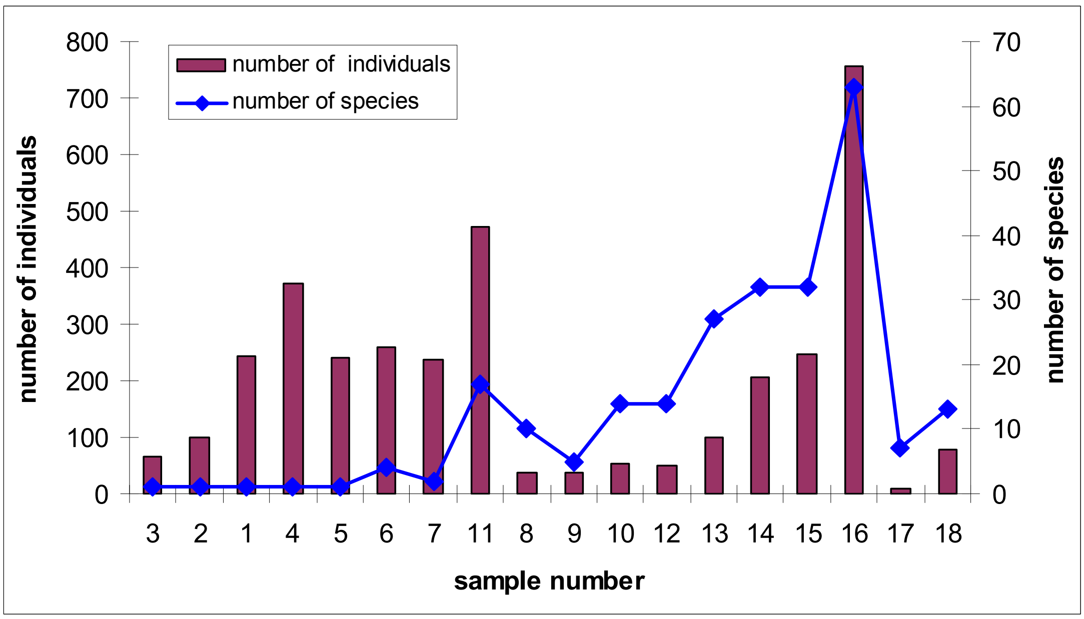

Fig. 74: Number of individuals and number of species of quantitative samples.

The number of species increased with water depth along the transect from the high intertidal to the shallow subtidal zone. Especially high numbers of individuals as well as high numbers of species were found in sample 16 (Fig. 74).

This sample was taken from the sandbar, which separates the Kite lagoon from the blue lagoon (Fig. 29). Maybe this border zone is especially biodiverse because it can be colonized by typical tidal flat organisms as well as by organisms of the blue lagoon, a structured habitat with sea grass beds and some smaller patch reefs.

Samples 17 and 18 were taken from the deeper tidal pool (Fig. 29) and contained fewer individuals and species than the other samples. One reason could be high salinity in that pool. Maybe hypersaline waters built on the tidal flat during ebb tide flow into that pool and sink to the bottom because density of water increases with salinity. We did not take measurements from the bottom of this pool and therefore this remains speculative.

The number of living molluscs in the subtidal area was very low (Fig. 36). Not a single living individual of *Potamides conicus* was found in subtidal samples (Fig. 75).

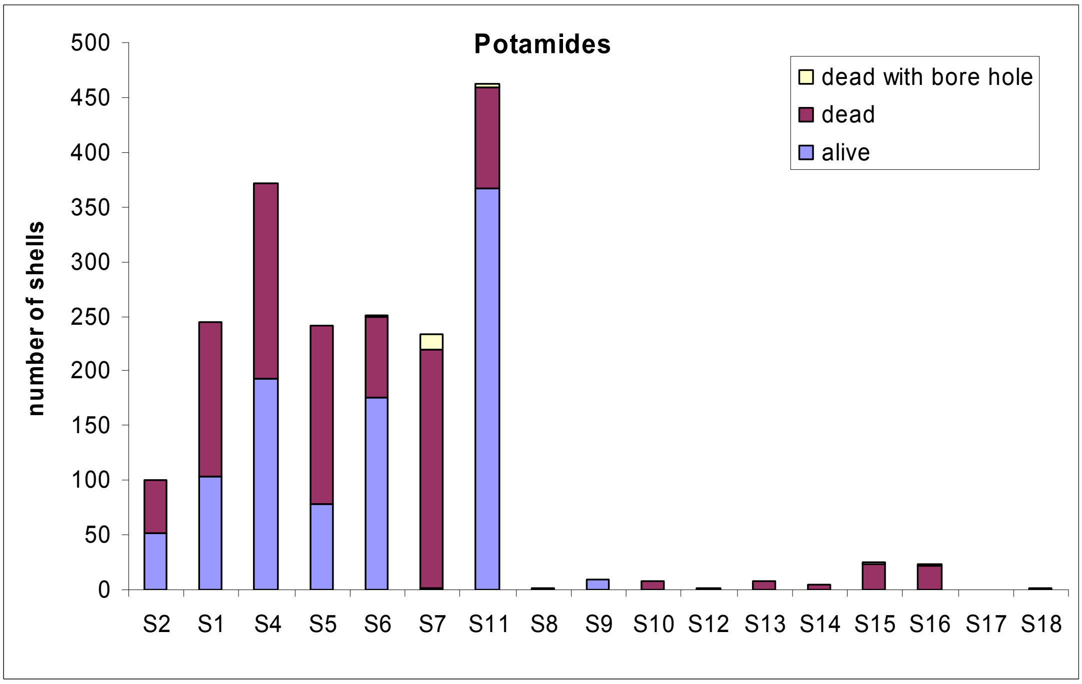

Fig. 75: Abundances of *Potamides conicus*.

Live-dead comparisons of molluscan assemblages on shelves showed that dead assemblages are on average 25 % richer in species diversity than living communities. However, taxonomic similarity is high and species relative abundances are positively correlated. (Kidewell, 2008).

Similar results were noted in this study. The mean number of species for the dead assemblage of the subtidal area was 25, while it was only 5 for the living community of the subtidal area (Fig. 52 and Fig. 54). Nonetheless, results of Q-mode clustering and non-metric MDS showed similar patterns for dead and living assemblages (Fig. 38 & 39 and Fig. 41 & 42). Thus dead molluscan assemblages are good models of living community diversity and composition.

Predation also plays an important role in tidal flat ecosystems. As Fig. 68 shows there is no drilling predation in the upper intertidal zone. The simple reason is that there were only potamidids and no predators. Drilling frequency increased in the lower intertidal zone and reached a peak in the subtidal zone.

Especially affected by predation were lucinids and cylichnids. Families which come into consideration as predators are the Muricidae and the Naticidae. We found two species of the family Muricidae: *Murex forskoehlii* and *Thais savignyi,* as well as two species of the family Naticidae: *Notocochlis gualteriana* and *Naticarius onca. Thais savignyi* prefers to feed on oysters.

8. Conclusion

The tidal flat can be divided into three different habitats with completely different molluscan compositions:

1. The Intertidal area: This zone is most affected by tides and water level changes. Therefore, only specialists can survive in this stressful habitat. The mudcreeper *Potamides conicus* is perfectly adapted and dominates this area. Furthermore *Planaxis savignyi, Volema paradisica* and some species of the family Cerithidae can be found.

2. The borderland: The border zone between intertidal area and subtidal area is structured by *Saccostrea cucullata* and *Brachidontes pharaonis*. The mud between oyster patches is populated by gastropods. The composition is similar to that of the intertidal area.

3. The subtidal zone: This area shows a rich biodiversity with 93 different species. Quantitatively, the area is dominated by bivalves, most importantly Glycymerididae, Lucinidae, Cardiidae, Veneridae and Tellinidae.

9. Acknowledgements

First of all I would like to thank my supervisor Martin Zuschin, for his great guidance, support and patience during the last year. He helped me with sampling and identifying species as well as with analysing data and writing.

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Special thanks to Susanne Pramendorfer for the grammatical correction and linguistic suggestions. I am very grateful to Peter C. Dworschak (Natural History Museum of Vienna, NHMV) for the determination of the crab *Dotilla sulcata.*

Big thanks to my friends Beate and Nicole for their encouraging words and helpful discussions. The pleasant atmosphere in our apartment allowed me to work concentrated and efficient.

I would like to extend special thanks to my family for believing in me and their financial support during my studies. Thank you for attracting my interest in nature during my childhood and for encouraging me to study Biology.

Harald, last but not least I want to thank you for your endless patience over the past 5 years. Your constantly optimistic outlook helped me to overcome all the obstacles during my studies.

10. Appendix

10.1 Measuring data of quantitative samples

Table 6: Sample 1: *Potamides conicus* (dead)
Measurements in mm.

height	width	height	width	height	width	height	width	height	width	height	width
15,0	5,0	11,0	4,0	10,0	4,0	9,0	3,0	7,0	3,0	6,0	2,0
15,0	5,0	11,0	3,0	10,0	3,0	9,0	3,0	7,0	4,0	6,0	2,0
14,0	5,0	11,0	3,0	10,0	4,0	8,0	3,0	7,0	3,0	6,0	2,0
13,0	5,0	11,0	4,0	10,0	4,0	8,0	3,0	7,0	3,0	6,0	2,0
13,0	5,0	11,0	4,0	10,0	4,0	8,0	3,0	7,0	3,0	6,0	3,0
13,0	5,0	10,0	4,0	10,0	4,0	8,0	4,0	7,0	3,0	6,0	2,0
13,0	3,0	10,0	3,0	10,0	3,0	8,0	3,0	7,0	4,0	6,0	2,0
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13,0	5,0	10,0	3,0	10,0	3,0	8,0	4,0	7,0	3,0	6,0	2,0
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12,0	4,0	10,0	3,0	9,0	3,0	8,0	3,0	6,0	3,0		
11,0	4,0	10,0	3,0	9,0	3,0	8,0	3,0	6,0	3,0		

Table 7: Sample 1: *Potamides conicus* (alive)
Measurements in mm.

height	width	height	width	height	width	height	width	height	width	height	width
17,0	6,0	14,0	4,5	10,5	4,0	11,0	4,0	10,0	4,0	9,0	3,0
12,5	5,0	11,0	4,5	11,5	4,0	10,5	4,0	12,0	4,0	7,0	3,0
12,5	5,0	13,0	4,5	11,0	4,0	11,5	4,0	11,0	4,0	10,0	3,0
12,0	5,0	13,0	4,5	10,5	4,0	13,0	4,0	10,0	4,0	10,0	3,0
13,5	5,0	11,5	4,5	12,0	4,0	11,0	4,0	9,0	4,0	9,0	3,0
13,0	5,0	11,0	4,5	12,5	4,0	11,0	4,0	11,5	3,5	7,0	3,0
14,0	5,0	12,0	4,5	10,0	4,0	11,0	4,0	11,0	3,5	7,5	3,0
12,0	5,0	13,0	4,5	12,0	4,0	10,0	4,0	9,5	3,5	7,0	3,0
13,0	5,0	10,0	4,5	14,0	4,0	10,0	4,0	9,0	3,5	8,0	3,0
16,0	5,0	10,5	4,0	9,0	4,0	11,5	4,0	12,0	3,5	6,0	2,5
15,5	5,0	12,0	4,0	12,0	4,0	11,0	4,0	7,0	3,5	4,0	2,0
13,0	4,5	12,0	4,0	11,0	4,0	9,0	4,0	9,0	3,5	5,0	2,0
12,5	4,5	10,5	4,0	11,0	4,0	11,0	4,0	9,0	3,5	5,0	2,0
12,0	4,5	13,0	4,0	10,0	4,0	11,0	4,0	8,5	3,5	4,0	1,5
13,0	4,5	11,0	4,0	12,0	4,0	12,0	4,0	10,0	3,5		
12,0	4,5	13,0	4,0	11,0	4,0	9,0	4,0	10,0	3,0		
13,0	4,5	12,5	4,0	12,0	4,0	12,0	4,0	12,0	3,0		
13,5	4,5	10,0	4,0	12,0	4,0	10,0	4,0	8,0	3,0		

Table 8: Sample 2: *Potamides conicus* (dead)
Measurements in mm.

height	width	height	width	height	width	height	width	height	width	height	width
15,0	5,0	12,0	4,0	11,0	3,0	10,0	4,0	9,0	3,0	8,0	3,0
15,0	5,0	12,0	4,0	11,0	4,0	10,0	3,0	8,0	4,0	7,0	3,0
14,0	5,0	12,0	4,0	11,0	4,0	10,0	3,0	8,0	3,0	5,0	3,0
14,0	5,0	12,0	4,0	11,0	3,0	10,0	4,0	8,0	3,0	4,0	2,0
13,0	4,0	12,0	4,0	11,0	4,0	10,0	3,0	8,0	3,0		
13,0	4,0	12,0	5,0	11,0	4,0	10,0	3,0	8,0	3,0		
13,0	4,0	12,0	4,0	11,0	5,0	9,0	4,0	8,0	3,0		
13,0	4,0	12,0	4,0	11,0	4,0	9,0	3,0	8,0	3,0		
13,0	4,0	11,0	4,0	11,0	4,0	9,0	4,0	8,0	4,0		

Table 9: Sample 2: *Potamides conicus* (alive)
Measurements in mm.

height	width	height	width	height	width	height	width	height	width	height	width
16,0	5,0	12,0	5,0	15,0	5,0	14,0	4,0	11,0	3,0	7,0	3,0
14,0	5,0	13,0	5,0	14,0	5,0	13,0	4,0	13,0	4,0	5,0	2,0
13,0	4,0	12,0	4,0	16,0	4,0	13,0	4,0	13,0	4,0	8,0	3,0
14,0	5,0	15,0	4,0	14,0	4,0	13,0	4,0	14,0	5,0	12,0	4,0
14,0	6,0	14,0	5,0	12,0	4,0	13,0	4,0	9,0	3,0	7,0	3,0
13,0	5,0	13,0	5,0	15,0	5,0	14,0	5,0	11,0	4,0	4,0	3,0
16,0	5,0	10,0	4,0	10,0	4,0	13,0	5,0	8,0	3,0		
13,0	4,0	7,0	3,0	13,0	4,0	13,0	4,0	7,0	3,0		
14,0	5,0	13,0	5,0	15,0	5,0	13,0	4,0	7,0	3,0		

Table 10: Sample 3: *Potamides conicus* (dead)
Measurements in mm.

height	width	height	width	height	width	height	width	height	width	height	width
19,0	4,0	12,0	4,0	10,0	4,0	9,0	4,0	7,0	3,0	6,0	3,0
19,0	4,0	12,0	5,0	10,0	4,0	9,0	4,0	7,0	4,0	6,0	3,0
16,0	5,0	12,0	4,0	10,0	4,0	9,0	4,0	7,0	3,0	6,0	3,0
16,0	5,0	12,0	5,0	10,0	4,0	9,0	3,0	7,0	4,0	6,0	3,0
15,0	5,0	12,0	4,0	10,0	4,0	9,0	3,0	7,0	3,0	5,0	3,0
14,0	5,0	12,0	4,0	10,0	4,0	8,0	3,0	7,0	3,0	5,0	3,0
13,0	5,0	11,0	4,0	10,0	3,0	8,0	3,0	7,0	3,0	5,0	2,0
13,0	5,0	11,0	4,0	10,0	4,0	8,0	3,0	7,0	3,0	5,0	2,0
13,0	5,0	11,0	5,0	10,0	5,0	8,0	3,0	6,0	3,0	4,0	2,0
13,0	5,0	11,0	4,0	10,0	3,0	7,0	3,0	6,0	3,0	4,0	2,0
13,0	5,0	10,0	3,0	9,0	4,0	7,0	3,0	6,0	3,0		

Table 11: Sample 3: *Potamides conicus* (alive)
Measurements in mm.

height	width
12,0	4,0

Table 12: Sample 4: *Potamides conicus* (dead)
Measurements in mm.

height	width	height	width	height	width	height	width	height	width	height	width
17,4	5,9	12,1	4,5	11,1	4,1	10,0	3,9	9,2	3,7	8,0	4,0
16,2	5,4	12,1	4,5	11,0	4,5	9,9	4,0	9,2	3,8	7,9	3,7
16,2	5,3	12,0	4,3	11,0	4,3	9,9	3,9	9,1	3,6	7,6	3,3
16,0	5,6	12,0	4,9	11,0	4,2	9,9	4,0	9,1	3,7	7,6	3,7
15,7	5,1	12,0	4,8	11,0	4,2	9,9	4,4	8,9	3,6	7,6	3,5
15,4	5,8	12,0	4,9	11,0	4,1	9,9	4,3	8,9	3,6	7,5	3,7
14,9	5,0	11,9	4,7	10,9	4,1	9,8	4,2	8,8	3,8	7,5	3,5
14,5	5,4	11,9	4,2	10,9	3,9	9,8	4,2	8,8	3,8	7,4	2,9
14,4	4,9	11,8	4,4	10,8	4,1	9,8	4,0	8,7	3,5	7,1	3,1
14,2	5,3	11,8	4,4	10,8	4,7	9,8	4,1	8,6	4,0	7,1	3,2
14,0	5,7	11,8	4,8	10,8	4,5	9,6	4,0	8,6	3,6	7,1	2,9
13,6	5,1	11,8	4,3	10,8	4,5	9,6	4,2	8,6	3,9	7,0	3,2
13,1	4,7	11,8	4,6	10,8	4,2	9,5	4,3	8,5	3,6	6,9	3,2
13,1	4,9	11,7	4,2	10,8	3,9	9,5	4,0	8,5	3,3	6,6	3,3
13,0	4,9	11,7	4,4	10,7	4,5	9,5	3,7	8,4	3,9	6,6	3,1
12,9	4,7	11,6	4,3	10,7	4,2	9,5	3,9	8,4	3,8	6,4	2,7
12,6	4,3	11,5	4,8	10,6	4,6	9,5	4,3	8,3	3,4	6,2	2,9
12,4	4,5	11,5	4,9	10,6	3,9	9,5	4,4	8,3	3,7	5,9	3,1
12,3	5,4	11,5	4,3	10,5	4,5	9,4	3,9	8,2	3,7	5,7	2,8
12,3	4,6	11,3	4,2	10,5	3,8	9,4	4,0	8,2	3,5	5,5	2,8
12,2	4,7	11,3	5,2	10,5	4,3	9,4	4,2	8,2	3,4	5,4	2,0
12,2	4,3	11,2	4,4	10,5	3,9	9,4	2,9	8,1	3,5	5,3	2,4
12,2	4,5	11,2	4,6	10,3	4,3	9,4	3,8	8,1	3,7	31 fragments	
12,2	5,0	11,2	4,8	10,2	4,7	9,3	4,0	8,0	3,5		
12,2	4,4	11,1	4,4	10,2	3,5	9,2	4,2	8,0	3,7		

Table 13: Sample 4: *Potamides conicus* (alive)
Measurements in mm.

height	width	height	width	height	width	height	width	height	width	height	width
16,0	5,5	12,5	4,0	11,9	4,4	11,0	4,3	10,5	5,0	9,0	3,3
16,0	5,5	12,5	4,0	11,9	4,0	11,0	4,2	10,5	4,0	9,0	3,5
15,5	5,0	12,5	4,0	11,9	4,5	11,0	4,0	10,5	4,3	9,0	4,0
15,0	5,1	12,5	4,7	11,8	4,8	11,0	4,0	10,5	4,0	8,8	3,0
14,7	4,5	12,5	5,0	11,8	5,0	11,0	4,5	10,5	4,1	8,8	3,2
14,4	5,3	12,5	4,5	11,8	4,2	11,0	4,0	10,5	4,0	8,7	3,5
14,2	5,0	12,5	4,5	11,7	4,3	11,0	4,0	10,5	3,8	8,5	3,7
14,2	5,0	12,4	4,4	11,6	4,8	11,0	4,5	10,5	4,5	8,5	3,2
14,1	5,0	12,2	4,5	11,5	4,5	11,0	4,5	10,3	4,1	8,5	4,0
14,0	5,0	12,2	4,8	11,5	4,0	11,0	4,0	10,3	4,0	8,0	3,0
14,0	5,0	12,2	4,6	11,5	4,0	11,0	4,5	10,2	4,2	8,0	3,7
14,0	5,0	12,1	4,7	11,5	4,0	11,0	3,8	10,2	4,2	7,7	3,1
13,9	4,8	12,1	4,1	11,5	4,0	11,0	4,4	10,2	4,0	7,5	3,0
13,8	5,2	12,1	4,4	11,5	4,0	11,0	4,3	10,0	4,0	7,5	3,2
13,7	5,0	12,0	4,0	11,5	4,5	11,0	4,3	10,0	3,7	7,0	3,0
13,5	4,3	12,0	4,5	11,5	4,0	11,0	4,2	10,0	3,8	7,0	3,0
13,5	5,0	12,0	4,0	11,4	3,9	11,0	4,0	10,0	4,0	7,0	3,0
13,3	4,6	12,0	4,0	11,3	3,6	11,0	4,0	10,0	3,6	6,5	3,0
13,3	4,9	12,0	4,2	11,2	4,0	11,0	3,5	10,0	4,0	6,0	2,0
13,0	4,5	12,0	4,7	11,2	4,0	10,8	4,0	10,0	3,5	5,7	2,3
13,0	4,8	12,0	4,5	11,2	4,0	10,8	4,0	10,0	3,5	5,5	2,5
13,0	5,0	12,0	4,7	11,2	4,0	10,7	4,0	10,0	4,0	5,5	2,5

13,0	4,0	12,0	4,5	11,2	4,0	10,7	4,0	10,0	4,1	5,2	2,3
13,0	4,5	12,0	4,5	11,2	4,0	10,7	4,2	9,9	3,8	5,0	2,5
13,0	4,2	12,0	4,5	11,2	4,5	10,7	3,5	9,8	4,0	5,0	2,3
13,0	5,0	12,0	4,0	11,2	4,0	10,6	3,9	9,8	3,8	5,0	2,3
13,0	4,5	12,0	4,5	11,2	4,5	10,6	4,5	9,8	4,0	5,0	2,3
13,0	4,5	12,0	4,1	11,2	4,4	10,6	4,4	9,7	4,1	4,0	2,0
13,0	5,0	12,0	5,0	11,2	4,0	10,6	4,2	9,7	3,8		
12,8	4,3	12,0	4,5	11,2	4,5	10,6	4,2	9,5	4,1		
12,8	4,5	12,0	4,5	11,1	4,0	10,5	4,0	9,4	3,9		
12,7	4,8	12,0	4,5	11,0	4,5	10,5	4,2	9,4	3,8		
12,6	4,5	12,0	4,2	11,0	4,3	10,5	4,0	9,1	3,8		

Table 14: Sample 5: *Potamides conicus* (dead)
Measurements in mm.

height	width	height	width	height	width	height	width	height	width	height	width
16,5	5,8	12,8	4,3	11,2	4,0	10,1	3,9	9,1	3,6	7,1	3,4
16,0	5,5	12,6	5,2	11,2	4,7	10,1	4,2	8,9	4,3	7,0	3,5
15,8	6,3	12,6	4,7	11,2	4,3	10,1	4,5	8,9	3,7	6,8	3,1
15,5	5,5	12,6	5,1	11,2	4,1	10,0	4,0	8,7	3,5	6,8	3,1
14,0	5,5	12,5	4,6	11,2	4,2	10,0	4,3	8,7	3,7	6,7	3,3
14,0	5,3	12,5	4,5	11,0	4,2	10,0	4,2	8,7	3,9	6,6	2,9
14,0	5,2	12,3	4,8	11,0	4,2	9,9	3,8	8,7	3,7	6,5	2,7
13,8	4,9	12,3	4,6	10,8	4,3	9,8	4,3	8,7	3,8	6,3	3,0
13,8	4,9	12,2	4,9	10,7	4,3	9,8	3,8	8,7	3,8	6,3	2,9
13,7	4,8	12,1	4,4	10,6	4,2	9,8	4,3	8,7	4,1	6,2	2,0
13,7	5,0	12,1	4,6	10,5	4,3	9,8	4,0	8,6	3,6	6,2	2,5
13,5	5,3	11,9	4,2	10,5	4,5	9,7	3,9	8,6	3,9	6,2	2,7
13,5	4,5	11,7	4,7	10,5	3,8	9,7	3,8	8,6	3,6	6,1	2,7
13,4	4,8	11,7	4,3	10,5	4,2	9,6	4,2	8,6	3,9	6,1	2,8
13,3	4,7	11,7	4,6	10,5	3,8	9,5	4,4	8,4	3,5	5,9	2,9
13,2	4,9	11,6	4,4	10,4	4,1	9,5	4,1	8,0	3,6	5,9	3,1
13,2	4,5	11,6	4,2	10,4	3,8	9,5	3,6	8,0	3,5	5,7	2,6
13,0	4,7	11,6	4,6	10,3	4,3	9,4	3,7	7,9	2,9	5,7	2,6
13,0	5,0	11,5	5,5	10,3	4,3	9,4	3,7	7,8	3,5	5,5	2,5
12,9	4,5	11,5	4,4	10,2	4,3	9,3	4,4	7,7	3,5	5,4	2,6
12,8	4,6	11,5	3,9	10,2	4,7	9,3	4,1	7,6	3,3	5,2	2,4
12,8	4,0	11,4	4,4	10,2	4,1	9,2	3,5	7,6	3,2	5,2	2,4
12,8	5,5	11,3	4,3	10,1	3,8	9,1	4,2	7,2	3,0	25 fragments	

Table 15: Sample 5: *Potamides conicus* (alive)
Measurements in mm.

height	width	height	width	height	width	height	width	height	width	height	width
18,0	5,0	14,0	5,0	13,0	4,5	12,2	4,2	11,5	4,0	10,5	4,0
16,0	5,2	14,0	5,0	13,0	4,0	12,0	4,5	11,5	4,5	10,1	4,0
15,5	5,0	14,0	4,5	13,0	5,0	12,0	4,0	11,5	4,0	10,0	4,3
15,2	5,0	14,0	5,0	13,0	5,0	12,0	4,2	11,5	4,0	10,0	3,5
15,2	5,0	13,9	5,0	13,0	4,8	12,0	4,0	11,5	4,0	10,0	4,0
15,0	4,2	13,7	5,0	13,0	4,5	12,0	4,0	11,2	4,0	10,0	4,3
15,0	5,0	13,5	4,5	13,0	4,0	12,0	4,0	11,0	4,0	9,0	3,8
15,0	5,0	13,5	4,5	12,8	4,2	12,0	4,5	11,0	4,0	8,5	3,5
14,5	4,5	13,5	4,0	12,8	4,7	12,0	4,0	11,0	4,0	8,5	3,2
14,2	5,2	13,5	5,0	12,5	4,7	12,0	4,0	11,0	4,0	8,5	3,2
14,0	4,5	13,5	4,1	12,5	4,5	11,8	4,5	11,0	4,5	8,0	3,5
14,0	5,0	13,4	4,5	12,5	4,5	11,5	5,0	11,0	4,0	8,0	3,0
14,0	5,0	13,0	4,5	12,5	4,0	11,5	4,0	10,8	4,5	7,0	2,5
14,0	5,0										

Table 16: Sample 6: *Potamides conicus* (dead)
Measurements in mm.

height	width	height	width	height	width	height	width	height	width	height	width
16,0	6,0	12,0	4,0	11,0	4,0	10,0	4,0	9,5	3,5	8,0	3,0
14,0	5,0	12,0	4,0	11,0	4,0	10,0	4,0	9,5	4,0	7,5	3,0
13,0	5,0	12,0	4,5	11,0	5,0	10,0	4,0	9,5	3,5	7,0	3,0
13,0	4,5	12,0	3,5	11,0	4,0	10,0	4,0	9,5	3,0	7,0	3,5
13,0	4,5	12,0	5,0	11,0	4,0	10,0	4,0	9,0	3,5	7,0	3,0
13,0	4,0	11,5	3,5	11,0	4,0	10,0	4,0	9,0	4,0	7,0	2,5
12,5	4,0	11,5	4,0	11,0	4,0	10,0	3,5	9,0	3,0	6,5	3,0
12,5	4,0	11,5	4,0	11,0	3,5	10,0	3,5	8,5	3,0	6,0	2,5
12,5	5,0	11,5	4,5	11,0	4,0	10,0	4,0	8,5	3,0	5,5	2,5
12,0	4,0	11,5	4,5	10,5	3,5	10,0	4,0	8,5	3,0	5,0	2,0
12,0	4,0	11,0	4,0	10,5	4,0	10,0	4,0	8,5	4,0	5,0	2,0
12,0	4,5	11,0	4,0	10,5	4,0	9,5	3,5	8,0	3,0		
12,0	4,0	11,0	4,0	10,0	4,0	9,5	3,5	8,0	3,5		

Table 17: Sample 6: *Potamides conicus* (alive)
Measurements in mm.

height	width	height	width	height	width	height	width	height	width	height	width
14,5	4,5	12,0	4,0	11,0	4,0	10,5	4,0	10,0	3,5	8,5	3,0
14,0	5,0	12,0	4,0	11,0	4,0	10,5	3,5	10,0	4,0	8,5	3,0
14,0	4,5	12,0	3,5	11,0	4,0	10,5	3,5	10,0	3,0	8,5	3,5
14,0	4,5	12,0	4,0	11,0	3,5	10,5	4,0	10,0	3,0	8,5	3,5
14,0	5,0	12,0	4,0	11,0	4,0	10,0	4,0	10,0	3,5	8,5	3,0
13,5	4,0	12,0	4,0	11,0	4,0	10,0	4,0	10,0	4,0	8,5	3,0
13,0	4,0	12,0	4,0	11,0	3,5	10,0	4,0	10,0	4,0	8,5	3,5
13,0	4,5	12,0	4,0	11,0	3,5	10,0	3,0	10,0	3,5	8,5	3,0
13,0	4,0	12,0	4,0	11,0	4,0	10,0	4,0	10,0	3,5	8,5	3,5
13,0	4,0	11,5	4,0	11,0	3,5	10,0	4,0	10,0	3,5	8,5	3,5
13,0	4,5	11,5	4,0	11,0	4,0	10,0	3,0	10,0	4,0	8,5	3,0
13,0	4,0	11,5	4,0	11,0	4,0	10,0	3,5	10,0	4,0	8,5	3,0
12,5	4,5	11,5	4,0	11,0	4,0	10,0	4,0	9,5	4,0	8,0	3,0
12,5	4,0	11,5	4,0	11,0	4,0	10,0	4,0	9,5	4,0	8,0	3,0
12,0	4,0	11,0	4,0	11,0	4,0	10,0	4,0	9,5	3,5	8,0	3,0
12,0	4,0	11,0	4,0	11,0	3,5	10,0	4,0	9,5	3,5	8,0	3,0

12,0	4,0	11,0	4,0	11,0	3,5	10,0	3,5	9,5	3,5	8,0	3,0
12,0	4,0	11,0	4,0	11,0	3,0	10,0	4,0	9,5	3,5	8,0	3,0
12,0	4,0	11,0	4,0	11,0	4,0	10,0	3,5	9,5	3,5	7,0	3,0
12,0	4,0	11,0	4,0	11,0	4,0	10,0	4,0	9,5	3,0	7,0	3,0
12,0	4,0	11,0	4,0	11,0	4,0	10,0	4,0	9,5	3,5	7,0	2,5
12,0	4,0	11,0	4,0	11,0	4,0	10,0	3,5	9,5	3,5	7,0	3,0
12,0	4,0	11,0	4,0	11,0	4,0	10,0	4,0	9,0	3,0	6,0	2,5
12,0	4,0	11,0	4,0	11,0	4,0	10,0	3,5	9,0	3,0	6,0	3,0
12,0	4,5	11,0	4,0	11,0	4,0	10,0	4,0	9,0	3,5	4,5	2,0
12,0	4,5	11,0	4,0	10,5	4,5	10,0	4,0	9,0	3,5		
12,0	4,0	11,0	4,0	10,5	4,0	10,0	3,5	9,0	3,0		
12,0	5,0	11,0	4,0	10,5	4,0	10,0	4,0	9,0	4,0		
12,0	4,0	11,0	4,0	10,5	3,5	10,0	3,5	9,0	3,5		
12,0	4,0	11,0	4,0	10,5	4,0	10,0	4,0	9,0	3,0		

Table 18: Sample 6, Measurements in mm.

Gastropods dead	height	width
Planaxis savignyi	8,0	5,0
	7,0	4,0
	8,0	5,0
Clypeomorus bifasciata	12,1	6,4

Bivalves dead	length	height
Brachidontes pharaonis	10,5	17,0
	9,0	16,0
Bivalves alive	length	height
Brachidontes pharaonis	6,0	13,0
	5,5	10,0
	7,5	10,5

Table 19: Sample 7, *Potamides conicus* (dead)
Measurements in mm.

height	width	height	width	height	width	height	width	height	width	height	width
17,1	5,3	13,3	4,4	12,0	4,9	11,1	3,9	10,3	4,0	8,3	3,2
16,9	5,3	13,3	5,4	11,9	4,5	11,1	4,7	10,2	4,1	8,2	3,4
15,8	5,3	13,2	5,1	11,9	4,1	11,1	4,5	10,2	3,8	8,1	3,6
15,6	5,0	13,1	4,8	11,9	4,5	11,0	3,9	10,2	4,1	8,0	3,5
15,6	5,3	13,0	4,7	11,9	4,8	11,0	3,6	10,1	3,8	7,9	3,5
15,5	4,8	13,0	4,8	11,9	5,1	11,0	4,5	10,1	3,7	7,8	3,3
15,5	5,3	12,9	4,8	11,8	4,9	11,0	4,1	10,0	3,8	7,8	3,5
15,4	5,4	12,8	4,7	11,8	4,5	11,0	3,8	10,0	3,5	7,7	3,2
15,1	5,0	12,8	4,8	11,8	4,9	10,9	4,0	10,0	4,4	7,6	3,5
15,0	5,5	12,7	4,7	11,8	4,5	10,9	4,2	9,9	4,6	7,6	3,5
14,9	4,7	12,7	4,6	11,8	4,3	10,9	4,4	9,9	4,3	7,6	3,2
14,9	5,7	12,7	5,0	11,8	4,3	10,9	4,2	9,9	3,9	7,5	3,5
14,6	5,7	12,6	4,9	11,7	4,5	10,9	4,0	9,8	4,2	7,5	3,5
14,6	5,6	12,6	4,2	11,7	4,1	10,8	4,3	9,8	4,4	7,4	3,1
14,5	5,4	12,6	4,7	11,7	4,4	10,7	4,1	9,8	4,0	7,4	3,2
14,3	5,3	12,6	4,0	11,7	4,7	10,7	3,9	9,8	4,2	7,4	3,1
14,3	4,8	12,5	4,7	11,6	3,9	10,7	4,3	9,7	3,9	7,3	3,3
14,2	4,9	12,5	4,3	11,6	4,0	10,7	4,3	9,7	3,9	7,2	3,4
14,1	4,8	12,5	4,7	11,6	4,0	10,7	3,9	9,7	3,9	7,2	3,3
14,1	5,3	12,5	4,8	11,5	4,7	10,5	4,2	9,7	4,1	7,1	3,2
13,8	4,7	12,4	4,6	11,5	4,6	10,5	4,8	9,6	3,8	7,0	3,2
13,8	5,0	12,4	4,6	11,5	5,0	10,4	3,7	9,5	3,5	7,0	2,9
13,8	4,4	12,4	4,8	11,5	4,1	10,4	4,1	9,4	3,4	6,9	3,0
13,7	4,3	12,4	4,5	11,4	4,3	10,4	4,1	9,4	3,9	6,8	3,1
13,7	4,9	12,4	4,4	11,4	4,3	10,4	3,6	9,2	4,0	6,8	3,2
13,6	5,1	12,4	5,0	11,4	3,9	10,4	4,2	9,2	3,2	6,5	2,4
13,6	5,6	12,3	4,9	11,4	4,1	10,4	4,2	9,0	3,5	6,4	3,1

13,5	4,7	12,2	4,6	11,3	4,7	10,4	4,2	8,8	3,5	6,1	2,5
13,5	5,2	12,2	4,7	11,3	4,4	10,4	4,2	8,8	3,5	6,0	3,0
13,4	5,1	12,2	4,0	11,3	4,5	10,4	3,8	8,7	3,6	5,8	2,6
13,4	5,0	12,2	4,6	11,3	4,3	10,3	4,4	8,7	3,5	5,7	2,4
13,3	4,6	12,1	4,4	11,3	3,6	10,3	4,2	8,7	3,7	5,4	2,7
13,3	5,0	12,0	4,7	11,2	4,1	10,3	4,2	8,5	3,5	16,30	5,40
13,3	4,6	12,0	4,3	11,2	4,0	10,3	3,7	8,4	3,4	14,60	5,20
13,3	4,7	12,0	4,9	11,2	4,1	10,3	4,3	8,4	3,4	14,30	5,60
14,10	4,90	13,20	5,10	12,40	4,40	11,10	4,60	10,50	4,50	14,10	4,90
14,00	4,70	12,60	4,50	11,30	4,60	11,10	4,60	10,30	4,20	11 fragments	

Table 20: Sample 7, Measurements in mm.

Gastropods dead	height	width
Planaxis savignyi	8,5	5,5
	9,0	5,5
	7,0	4,5
	6,0	3,5

Gastropods alive	height	width
Potamides conicus	9,0	3,5

Table 21: Sample 8, Measurements in mm.

Gastropods dead	height	width
Potamides conicus	12,0	4,5
Planaxis savignyi	9,9	5,9
	8,8	5,7
	6,8	3,7
Rhinoclavis kochi	18,0	6,0
Cerithium ruepelli	20,0	7,0
Volema paradisica	9,5	6,1
Cerithium caeruleum	18,0	11,0
	31,0	14,0
Gastropods alive	height	width
Cerithium caeruleum	22,0	10,0
	20,0	9,0
	17,5	8,0
	17,5	9,5
	17,0	7,5
	17,0	9,0
	17,0	9,5
	16,5	8,0
	16,0	7,0
	16,0	7,0
	16,0	8,5
	15,5	9,0
	15,5	8,5
	15,0	8,0
	15,0	8,0
	14,5	7,0
	14,0	6,5
	14,0	8,0
	14,0	6,0
	14,0	8,0
	13,0	6,5
	13,0	7,0
Canarium mutabilis	30,0	15,0

Bivalves dead	length	height
Saccostrea cucullata	46,0	43,0
Brachidontes pharaonis	10,0	21,0
	8,5	17,0
	7,5	12,0
Cardiolucina semperiana	11,0	7,0
Bivalves alive	length	height
Brachidontes pharaonis	8,5	17,0
	7,0	14,0

Table 22: Sample 9, Measurements in mm.

Gastropods dead	height	width
Clypeomoris bifasciata	16,0	11,0
Rhinoclavis kochi	25,0	18,0
	19,0	16,0
	12,0	4,5
	10,0	4,0
Cerithium caeruleum	20,0	9,0
Planaxis savignyi	13,0	7,0
Longchaeus halaibensis	12,0	3,5
	10,0	3,0
	10,0	3,0
	10,0	3,0
	9,0	3,0
	7,0	2,5
	7,0	2,5
Acteocina simplex	8,0	3,0
Gastropods alive	height	width
Potamides conicus	15,5	5,5
	14,0	4,5
	15,5	6,0
	12,0	5,5
	12,5	4,5
	12,5	5,0
	11,5	5,0
	10,0	4,0
	8,0	2,0
	10,0	4,0
Fusinus verrucosus	6,8	2,1

Bivalves dead	height	width
Brachidontes pharaonis	8,0	12,0
Chavania erythrea	7,5	7,6
	7,3	6,9
	7,1	6,6
	7,1	6,4
	5,5	5,0
Fulvia fragilis	23,5	24,0
Mactra olorina	27,0	21,0
Circe juvenil	9,0	7,0
Dosinia erythrea	33,0	32,0

Table 23: Sample 10, Measurements in mm.

Gastropods dead	height	width
Plesiothyreus pararabica	1x < 5	
Rhinoclavis aspera	42,0	10,5
Rhinoclavis kochii	12,5	4,5
Potamides conicus	18,0	6,0
	15,0	5,0
	13,0	5,0
	12,5	4,0
	12,0	6,0
	10,0	4,0
	10,0	5,0
	9,0	4,0
Atys cylindricus	8,5	4,5
	8,0	4,0
Otopleura sp.	1,7	0,5

Bivalves dead	height	width
Glycymeris arabica	7,1	7,3
Chavania erythraea	10,4	10,6
	9,1	9,4
	8,5	8,3
	8,3	8,8
	7,9	8,6
	7,7	8,0
	7,2	7,7
	7,1	7,6
	7,0	7,6
	6,9	7,2
	6,8	7,4
	6,7	7,2
	6,5	7,2
	6,2	6,5
Cardiolucina semperiana	7,6	7,3
	7,5	7,4
	7,5	7,3
	7,2	7,1
	7,2	7,1
	7,0	7,5
Divalinga arabica	13,4	14,5
	10,4	10,7
Adontia sp.	9,6	10,5
	9,7	10,5
Diplodonta subrotunda	11,5	12,2
	8,7	9,2
	8,0	9,0
	7,7	7,3
	7,6	8,0
Fragum nivale	10,6	8,2
Fragum sueziensis	6,3	6,0
Fulvia fragilis	6,4	7,6
	1 fragment	
Pinguitellina pinguis	9,3	11,5
	7,6	9,4
	7,0	8,9
Circe juvenil	9,8	11,4

Table 24: Sample 11: *Potamides conicus* (dead)
Measurements in mm.

height	width	height	width	height	width	height	width	height	width	height	width
14,5	5	11,3	4,4	10,5	4,5	9,5	3,5	9	3,6	6,7	2,7
13,6	4,8	11,3	4	10,5	4,3	9,5	3,6	8,6	3,5	6,7	3,2
13,5	4,5	11,1	4,7	10,5	4,2	9,5	3,7	8,5	3,2	6,4	2,9
13	5	11	4,5	10,5	3,5	9,5	3,6	8,3	3,7	6,4	3,1
13	5	11	4	10,5	3,9	9,4	4	8,1	3,3	6,3	2,8
12,8	4,6	11	4,2	10,5	3,9	9,4	3,9	8	4	6,3	2,9
12,5	4,5	11	4,4	10,5	4,3	9,3	3,6	7,6	3,4	6,3	3
12,4	4,3	11	4	10,4	3,6	9,3	3,4	7,4	3	6,2	2,9
12,2	5	10,9	4	10,2	4,2	9,2	3,6	7,4	3,4	6	2,9
12,2	4,5	10,9	4,4	10,2	3,8	9,2	3,5	7,4	3,8	6	2,7
12	4,8	10,9	4	10,1	4,2	9,2	3,6	7,4	3,5	5,5	2,5
11,8	4,5	10,9	4,1	10,1	4,1	9,1	3,5	7,3	3	5,2	2,1
11,7	4,6	10,8	4,7	10	3,5	9,1	3,9	7	3,5	5	2,5
11,5	4,4	10,7	4,5	9,8	4,2	9,1	3,9	6,8	3	3 fragments	
11,4	4,3	10,7	4	9,6	3,7	9	3,5	6,8	3		
11,4	4	10,6	4,2	9,5	4	9	3,6	6,7	3		

Table 25: Sample 11: *Potamides conicus* (alive)
Measurements in mm.

height	width	height	width	height	width	height	width	height	width	height	width
15,5	5,0	12,5	4,0	11,5	4,0	11,0	4,0	10,5	4,0	9,5	3,0
15,0	5,0	12,5	4,0	11,5	4,0	11,0	4,0	10,5	4,0	9,5	3,5
15,0	5,0	12,0	4,5	11,5	3,5	11,0	4,0	10,0	4,0	9,5	3,5
14,5	5,0	12,0	4,0	11,5	4,0	11,0	4,0	10,0	4,0	9,5	4,0
14,5	5,0	12,0	4,0	11,5	4,0	11,0	4,0	10,0	3,5	9,5	3,5
14,5	5,0	12,0	4,0	11,5	4,0	11,0	4,0	10,0	3,5	9,0	3,5
14,0	4,5	12,0	4,5	11,5	4,0	11,0	3,5	10,0	4,0	9,0	4,0
14,0	4,5	12,0	4,0	11,5	4,0	11,0	3,5	10,0	4,0	9,0	4,0
14,0	4,5	12,0	4,5	11,5	4,0	11,0	4,0	10,0	4,0	9,0	4,0
14,0	5,0	12,0	4,0	11,5	3,5	11,0	3,5	10,0	4,0	9,0	4,0
14,0	4,5	12,0	4,0	11,5	4,5	11,0	4,0	10,0	3,5	9,0	4,0
14,0	4,0	12,0	4,0	11,5	4,0	11,0	4,0	10,0	4,0	9,0	3,5
13,5	4,5	12,0	4,0	11,5	4,0	11,0	4,0	10,0	3,5	9,0	3,0
13,5	4,5	12,0	4,0	11,5	4,0	11,0	4,0	10,0	4,0	9,0	3,5
13,5	4,5	12,0	4,0	11,5	4,0	11,0	4,0	10,0	4,0	9,0	3,0
13,5	4,5	12,0	4,5	11,5	4,0	11,0	4,0	10,0	4,0	9,0	3,5
13,5	4,5	12,0	4,0	11,5	4,0	11,0	4,0	10,0	3,0	9,0	4,0
13,0	5,0	12,0	4,5	11,5	4,0	11,0	4,0	10,0	4,0	9,0	4,0
13,0	4,0	12,0	4,5	11,5	4,0	11,0	3,5	10,0	3,5	9,0	3,0
13,0	4,5	12,0	4,0	11,5	4,0	11,0	4,0	10,0	3,5	9,0	3,5
13,0	5,0	12,0	4,0	11,5	4,5	11,0	4,0	10,0	3,5	9,0	3,5
13,0	4,5	12,0	4,5	11,5	4,5	11,0	4,0	10,0	4,0	8,5	3,5
13,0	4,5	12,0	4,5	11,5	4,0	11,0	4,0	10,0	4,0	8,5	3,5
13,0	4,0	12,0	4,0	11,5	4,5	11,0	4,0	10,0	4,0	8,5	3,5
13,0	4,5	12,0	4,5	11,5	4,0	11,0	3,5	10,0	4,0	8,5	3,0
13,0	4,5	12,0	4,0	11,5	4,0	11,0	3,5	10,0	4,0	8,5	3,0
13,0	5,0	12,0	4,0	11,5	4,0	11,0	4,0	10,0	3,5	8,5	3,0
13,0	4,5	12,0	4,0	11,5	4,0	11,0	3,5	10,0	4,0	8,5	3,0
13,0	4,5	12,0	4,0	11,5	4,0	11,0	4,0	10,0	4,0	8,5	3,5
13,0	4,0	12,0	4,0	11,0	3,5	11,0	4,0	10,0	3,5	8,5	3,5
13,0	5,0	12,0	4,0	11,0	4,0	11,0	4,0	10,0	4,0	8,5	3,0

13,0	5,0	12,0	4,0	11,0	4,0	11,0	4,0	10,0	4,0	8,5	3,5
13,0	5,0	12,0	4,5	11,0	4,0	11,0	4,0	10,0	4,0	8,0	3,5
13,0	4,5	12,0	4,0	11,0	4,0	11,0	4,0	10,0	4,0	8,0	3,0
13,0	4,5	12,0	4,0	11,0	4,0	11,0	4,0	10,0	4,0	8,0	3,0
13,0	4,5	12,0	4,0	11,0	4,0	11,0	4,0	10,0	4,0	8,0	3,5
13,0	4,0	12,0	4,0	11,0	4,0	11,0	4,0	10,0	4,0	8,0	3,5
13,0	4,0	12,0	4,0	11,0	4,0	11,0	4,0	10,0	3,5	8,0	3,0
13,0	4,0	12,0	4,5	11,0	4,0	11,0	4,0	10,0	3,5	8,0	3,0
13,0	5,0	12,0	4,0	11,0	4,0	11,0	4,0	10,0	3,5	8,0	3,0
13,0	4,0	12,0	4,0	11,0	4,0	11,0	4,0	10,0	4,0	8,0	3,0
13,0	5,0	12,0	4,0	11,0	3,5	11,0	4,0	10,0	3,5	8,0	3,0
13,0	5,0	12,0	4,0	11,0	4,0	10,5	4,0	10,0	4,0	8,0	3,0
13,0	4,0	12,0	4,0	11,0	4,0	10,5	4,0	10,0	4,0	8,0	3,0
13,0	5,0	12,0	4,0	11,0	4,0	10,5	4,0	10,0	4,0	8,0	3,0
13,0	4,5	12,0	4,0	11,0	4,0	10,5	4,0	10,0	4,0	8,0	3,0
12,5	4,5	12,0	4,0	11,0	4,0	10,5	3,5	10,0	3,0	7,0	3,0
12,5	4,0	12,0	4,0	11,0	4,0	10,5	4,0	10,0	4,0	7,0	3,0
12,5	4,5	12,0	5,0	11,0	4,0	10,5	4,0	10,0	4,0	7,0	3,0
12,5	4,0	12,0	4,0	11,0	4,0	10,5	3,5	10,0	3,5	7,0	3,0
12,5	4,0	12,0	4,0	11,0	4,0	10,5	3,0	10,0	3,5	7,0	3,0
12,5	4,0	12,0	4,0	11,0	4,0	10,5	3,5	10,0	3,0	7,0	3,0
12,5	4,0	12,0	4,5	11,0	4,0	10,5	4,0	10,0	4,0	7,0	3,0
12,5	4,5	12,0	4,0	11,0	4,0	10,5	3,5	10,0	3,5	7,0	3,0
12,5	4,5	12,0	4,0	11,0	4,0	10,5	4,0	10,0	4,0	7,0	3,0
12,5	4,0	12,0	4,0	11,0	4,0	10,5	4,0	10,0	4,5	7,0	3,0
12,5	4,0	12,0	4,0	11,0	4,0	10,5	4,0	10,0	4,0	6,5	3,0
12,5	4,0	12,0	4,0	11,0	4,0	10,5	4,0	9,5	3,0	6,0	3,0
12,5	4,5	12,0	4,0	11,0	4,0	10,5	4,0	9,5	3,5	6,0	3,0
12,5	4,0	11,5	4,5	11,0	4,0	10,5	4,0	9,5	4,0	5,0	2,5
12,5	4,0	11,5	4,0	11,0	4,0	10,5	4,0	9,5	4,0	5,0	2,0

Table 26: Sample 11, Measurements in mm.

Gastropods dead	height	width
Cerithium caeruleum	17,0	8,5
	17,0	8,0
	18,0	9,5
	18,0	9,5
	14,5	7,0
Planaxis savignyi	10,0	5,5
	7,0	4,0
Volema paradisica	9,0	6,0

Bivalves alive	height	width
Saccostrea cucullata	63,0	42,0
	41,0	25,0
	48,0	36,0

Table 27: Sample 12, Measurements in mm.

Gastropods dead	height	width
Diodora rupelli	6,5	11,7
Euplica varians	8,9	3,8
Planaxis savignyi	11,0	7,0
Potamides conicus	1 fragment	
Bivalves alive	height	width
Cardiolucina semperiana	6,0	6,5
Callista florida	21,0	28,5

Bivalves dead	height	width
Glycymeris arabica	15,7	15,0
	15,6	15,1
	9,5	8,7
	8,2	7,2
Chavania erythraea	11,6	10,8
	10,4	10,0
	10,1	9,7
	8,8	8,3
	8,5	8,3
	8,0	7,3
	7,9	7,7
	7,9	7,5
	7,8	7,5
	7,6	7,9
	7,5	7,3
	7,5	7,1
	7,4	7,1
	7,3	7,1
	7,0	6,8
	6,9	6,4
	6,8	6,5
	6,7	6,2
	6,7	6,4
	6,6	6,2
	6,3	5,9
	6,3	6,0
	6,1	5,9
Cardiolucina semperiana	7,9	7,9
	7,1	7,1
	7,1	6,7
	6,7	6,7
	6,5	6,5
Divalinga arabica	14,1	13,8
	14,4	13,7
	9,6	8,8
Diplodonta subrotunda	10,8	9,8
Pinguitellina pinguis	10,2	8,0
Fulvia fragilis	7,0	7,5
Callista florida	36,5	27,5
	13,0	9,7
	13,1	9,5
	11,2	8,2
	11,2	8,3
Timoclea roemeriana	9,8	7,2
Lioconcha ornata	10,2	8,0

Table 28: Sample 13, Measurements in mm.

Gastropods dead	height	width
Nerita sanguinolenta	10,3	18,0
	9,3	15,9
	9,0	15,9
	8,6	16,1
	8,3	14,4
Cerithium caeruleum	19,3	9,9
	18,4	10,3
	1 fragment	
Rhinoclavis kochii	13,9	5,1
Planaxis savignyi	13,7	8,8
	10,6	7,1
	10,4	6,1
	8,0	5,0
Potamides conicus	17,8	6,5
	17,7	6,0
	13,4	5,4
	12,2	4,6
	12,0	5,6
	10,2	4,6
	9,4	4,5
	7,9	4,0
Euplica varians	7,9	3,6
Nassarius erythraeus	8,0	3,5
	6,0	3,5
Ancilla linolata	6,7	2,8
Vexillum amabile	8,2	4,0
	5,5	3,3
Conus sp. juvenil	12,0	7,8
Turridae indet. 1	8,0	3,0
Longchaeus halaibensis	12,7	4,0
	10,4	3,3
	7,3	2,8
	6,5	2,6

Gastropods alive	height	width
Archimediella maculata	65,0	14,0

Bivalves dead	height	width
Brachidontes pharaonis	1 fragment	
Modiolus auriculatus	15,3	26,4
	15,2	26,5
	8,0	12,6
Glycymeris arabica	8,2	8,1
	7,2	7,0
	5,8	5,5
Chavania erythraea	8,3	8,5
	8,3	8,4
	8,1	8,3
	7,6	7,5
	7,6	7,1
	7,5	7,4
	7,2	6,6

Bivalves dead	height	width
Chavania erythraea	10,5	9,0
	9,2	8,5
	8,3	7,8
	7,5	7,2
	7,3	7,0
Cardiolucina semperiana	8,0	7,9
	7,7	7,5
	7,2	6,8
Ctena divergens	18,3	17,7
	14,2	13,8
	12,9	11,8
	12,5	11,9
	11,8	10,4
	7,4	6,8
	1 fragment	
Divalinga arabica	12,6	12,1
	12,2	11,5
	11,3	10,5
	11,3	10,5
	11,3	10,4
	11,1	10,2
	11,0	10,8
	10,9	10,3
	10,5	10,2
	10,5	9,9
	10,4	9,9
	10,2	9,6
	10,0	9,3
	10,0	9,3
	9,9	9,4
	9,8	9,2
	9,8	9,1
	9,4	8,7
	9,2	8,3
	9,0	8,2
	8,8	8,2
	8,0	7,4
Lamellolucina dentifera	15,0	13,4
Diplodonta subrotunda	15,8	14,0
	15,5	14,5
	13,6	12,3
	9,7	8,8
	9,0	8,2
	8,9	8,3
	7,8	7,7
Fulvia fragilis	11,6	12,1
	11,9	11,0
Pinguitellina pinguis	7,3	5,9
Callista florida	11,1	8,1
Irus macrophylla	14,2	13,6
Lioconcha ornata	11,2	9,3

Table 29: Sample 14, Measurements in mm.

Gastropods dead	height	width
Pagodatrochus variabilis	2x <5mm	
Rhinoclavis kochii	13,5	5,0
	11,1	4,2
	8,5	3,1
	7,1	2,7
	6,4	2,6
	5,6	2,2
	5,1	2,1
	8x <5mm	
Columbellidae indet 1	1x <5mm	
Turridae indet 2	7,0	2,8
	6,1	2,1
Turridae indet 3	1x <5mm	
Turbonilla sp.	1x <5mm	
Pupa solidula	8,6	4,3
Acteocina simplex	7,2	2,9
	6,9	2,7
	5,5	2,2
Atys ehrenbergi	1x <5mm	
Atys cylindricus	10,0	4,8
Liloa curta	2x <5mm	
Ringicula acuta	8x <5mm	
Scaphopoda indet 1	1x	
Gastropods alive	height	width
Notocochlis gualtieriana	13	15

Bivalves alive	height	width
Glycymeris arabica	1x <5mm	
Cardiolucina semperiana	0,7	0,7
Chavania erythraea	1x < 5mm	
Pinguitellina pinguis	3,8	5,0
Callista florida	3,75	5

Bivalves dead	height	width
Glycymeris arabica	9,0	9,7
	7,0	7,2
	6,9	7,9
	6,8	7,3
	6,7	7,4
	6,3	6,9
	6,0	6,1
	5,8	6,5
	5,7	6,5
	5,6	6,1
	4,7	5,3
	4,3	4,5
	4,3	4,5
	4,2	4,5
Glycymeris pectunculus	6,5	6,9
	5,0	5,1
Septifer forskali	5,9	2,8
Diplodonta subrotunda	16,5	18,6
	15,0	16,7
	14,4	16,8
	11,1	11,4
Fulvia fragilis	7,6	8,0
	5,7	6,5
Fragum nivale	8,6	7,1
	7,9	6,8
	5,6	4,6
	4,7	4,0
	3,8	3,1
Fragum suziensis	6,9	6,8
	5,6	5,6
	2x <5mm	
Mactra olorina	28,8	39,2
	27,2	/
	10,5	14,5
	10,4	14,6
	6,2	8,0
Pinguitellina pinguis	6,7	8,0
	5,3	6,5
	5,3	6,8
	5,3	6,6
	5,0	6,3
	4,8	6,0
Semele fragillima	4,5	5,6
Exotica triradiata	4,2	7,7
Circe juvenil	7,2	8,6
Callista florida	6,4	8,8
	4,3	6,0
	4,5	6,1
Timoclea roemeriana	1x <5mm	

Table 30: Sample 14, Measurements in mm.

Bivalves dead	height	width	height	width	height	width
Cardiolucina semperina	7,4	7,7	6,3	6,2	6,1	6,0
	7,4	7,6	6,5	6,9	5,8	6,0
	7,3	7,7	6,5	6,5	5,6	5,9
	6,8	6,6	6,4	6,8		
	6,8	6,6	6,4	6,9		
	6,6	7,0	6,4	6,4		
Divalinga arabica	12,6	13,1	10,6	11,2	8,4	9,5
	12,4	13,0	10,5	10,9	7,8	8,5
	11,9	12,6	10,2	10,8	6,8	7,4
	11,4	12,2	10,2	10,7	6,8	7,3
	11,0	11,4	9,6	10,1	6,6	7,1
	11,0	11,5	9,6	10,0	6,3	6,8
	10,8	11,6	9,5	9,9	5,7	6,2
Chavania erythraea	9,1	9,9	6,6	7,0	5,5	5,9
	8,4	8,6	6,6	6,8	5,4	5,7
	7,9	8,4	6,6	7,3	5,4	6,2
	7,7	8,1	6,5	6,8	5,4	5,4
	7,6	8,3	6,5	6,8	5,3	5,4
	7,6	8,0	6,5	6,6	5,2	5,8
	7,5	7,6	6,5	6,5	5,2	5,4
	7,3	7,7	6,4	6,8	5,1	5,5
	7,3	7,6	6,4	6,7	5,0	5,4
	7,3	7,6	6,3	6,2	5,0	5,2
	7,2	7,6	6,3	6,8	4,9	5,1
	7,2	7,6	6,3	6,3	4,9	5,2
	7,1	7,1	6,2	6,5	4,9	5,2
	7,1	7,4	6,2	6,4	4,8	5,0
	7,1	7,5	6,2	6,3	4,6	5,0
	7,1	7,2	6,1	6,5	4,5	4,7
	7,1	7,5	6,1	6,4	4,3	4,5
	7,0	7,1	6,1	6,6	4,2	4,6
	7,0	7,5	5,9	6,2	4,2	4,6
	7,0	7,3	5,9	6,2	3,9	4,2
	6,8	7,3	5,9	6,3	3,8	3,9
	6,8	7,5	5,9	6,2	3,2	3,2
	6,8	7,2	5,8	5,8		
	6,7	7,1	5,7	5,9		

Table 31: Sample 15, Measurements in mm.

Gastropods dead	height	width
Rhinoclavis aspera	34,5	9,5
Rhinoclavis kochii	20,5	6,7
	11,7	4,4
	10,1	3,8
	8,9	2,6
	7,0	2,6
	6,9	2,6
	6,4	2,5
	5,7	2,4
	5,2	2,3
Potamides conicus	16,7	5,5
	16,6	6,0
	15,7	5,6
	15,7	5,5
	15,6	5,9
	14,6	4,7
	14,0	5,0
	14,0	5,5
	14,0	6,0
	13,9	5,3
	13,8	5,5
	13,6	5,4
	13,5	5,5
	13,5	5,3
	13,0	5,5
	12,5	5,2
	12,4	5,3
	12,4	5,8
	11,9	5,7
	11,1	4,8
	9,8	4,4
	9,4	4,2
	9,0	4,4
	7,8	3,6
	7,7	3,8
Plesiotrochus unicinctus	1x <5mm	
Cerithiopsidae indet 1	1x <5mm	
Columbellidae indet 1	7,5	3,2
Nassarius erythraeus	6,2	3,2
Ancilla lineolata	10,0	4,6
Turridae indet 2	5,4	2,4
	5,5	2,1
	5,0	2,0
Acteocina simplex	8,0	3,0
	1x <5mm	
Atys cylindricus	8,0	4,2
	5,8	2,5
Ringicula acuta	2x <5mm	

Bivalves dead	height	width
Glcymeris pectunculus	9,6	9,7
Brachidontes pharaonis	27,0	11,8
	8,3	4,3
Septifer forskali	5,2	3,2
Anodontia sp.	11,9	13,4
	8,5	9,6
	8,9	9,9
Cavilucina fieldingi	11,6	11,5
Ctena divergens	9,6	10,6
	13,1	14,5
Diplodonta subrotunda	12,6	13,5
	11,5	12,5
Fragum nivale	10,6	9,0
	7,1	5,9
	6,9	5,9
	4,8	4,1
Fragum sueziensis	7,1	7,2
	5,2	5,6
	4,7	4,7
Mactra olorina	13,4	17,3
	36,9	49,8
Exotica triradiata	5,7	10,4
	3,7	7,1
Pinguitellina pinguis	5,8	7,0
	5,8	7,0
	4,6	5,8
	4,4	5,7
Loxoglypta secunda	8,7	14,8
Circe juvenil	11,3	13,1
Timoclea roemeriana	8,5	10,7
	4,8	6,1
	5,0	6,5

Bivalves alive	height	width
Glycymeris arabica	1x <5mm	
Chavania erythraea	0,75	0,75
	0,7	0,7
	2x <5mm	
Cardiolucina semperiana	0,7	0,7
	0,7	0,7
	0,5	0,5
Divalinga arabica	0,7	0,75
Pinguitellina pinguis	0,6	0,8
Callista florida	1,4	1,85
Timoclea roemeriana	0,6	0,7

Table 32: Sample 15, Measurements in mm.

Bivalves dead	height	width	height	width	height	width
Glycymeris arabica	11,7	12,7	8,5	9,1	6,1	6,7
	10,7	11,4	7,9	8,6	6,0	5,4
	10,6	11,7	7,6	8,1	5,9	6,2
	10,3	10,8	6,9	7,5	5,4	6,0
	9,8	10,7	6,9	7,4	5,4	5,5
	9,0	9,8	6,6	6,7	5,4	5,8
	9,0	9,8	6,4	6,9	3,2	3,5
	8,6	9,4	6,3	6,6		
Cardiolucina semperiana	7,9	7,4	6,9	6,6	6,6	6,7
	7,7	7,9	6,8	6,8	6,5	6,4
	7,4	7,3	6,7	6,1	6,1	6,6
	7,3	7,6	6,7	6,8	5,1	5,4
	7,3	7,2	6,6	6,9	3 fragments	
	7,2	7,4	6,6	6,9		
Chavania erythraea	8,9	8,9	7,0	7,3	6,0	6,2
	8,0	8,4	7,0	7,2	5,9	6,5
	7,9	8,4	6,9	7,1	5,9	6,2
	7,8	7,8	6,9	7,1	5,8	6,1
	7,6	8,7	6,8	7,2	5,8	6,4
	7,6	7,6	6,8	6,9	5,8	6,2
	7,5	8,1	6,8	7,2	5,7	6,2
	7,4	7,9	6,7	7,4	5,5	6,0
	7,3	7,3	6,7	7,4	5,5	5,7
	7,3	7,9	6,6	7,2	5,4	5,9
	7,3	7,6	6,6	6,9	5,4	5,9
	7,3	7,9	6,6	7,1	5,4	5,7
	7,2	7,8	6,6	6,6	5,2	5,7
	7,1	7,8	6,6	7,1	4,9	5,1
	7,1	7,5	6,6	6,9	4,8	5,0
	7,1	7,1	6,6	6,9	4,7	5,0
	7,0	7,4	6,2	6,5	4,6	5,0
	7,0	7,1	6,0	6,2	3,4	3,9
Divalinga arabica	14,1	14,3	10,6	11,1	8,9	9,5
	13,0	13,4	10,5	10,9	8,9	9,6
	12,9	13,8	10,5	11,4	8,9	9,5
	12,7	13,6	10,5	11,3	8,8	9,1
	12,5	13,1	10,4	10,9	8,5	8,8
	12,4	13,1	10,3	11,1	8,5	9,2
	12,0	12,6	10,3	10,8	8,5	9,2
	11,9	12,5	10,3	10,8	8,0	8,6
	11,9	13,0	10,2	10,6	8,0	8,5
	11,8	12,3	10,0	10,7	7,9	8,4
	11,7	12,3	9,5	9,9	7,7	8,2
	11,7	12,4	9,4	9,9	7,5	8,2
	11,6	12,3	9,4	10,1	7,5	8,2
	11,5	11,9	9,3	9,7	6,1	6,6
	11,5	12,4	9,1	9,8	5,3	5,7
	11,2	11,9	9,1	9,8	4,3	4,9
	11,1	11,7	9,1	9,6	10,2	/
	11,1	11,5	9,0	9,6	1 fragment	
	10,8	11,4	9,0	9,6		
	10,7	11,3	9,0	9,5		

Table 33: Sample 16, Measurements in mm.

Gastropods dead	height	width
Stomatia duplicata	1x <5mm	
Pagodatrochus variabilis	1x <5mm	
Trochidae indet 1	1x <5mm	
Bothropoma cf. Bellula	1x <5mm	
Nerita sanguinolenta	1x <5mm	
Smaragdia souverbiana	5x <5mm	
Cerithiidae indet 1	1x <5mm	
Cerithium sp. 1	1x <5mm	
Rhinoclavis kochi	3x <5mm	
Diala semistriata	1x <5mm	
Planaxis savignyi	5,7	3,8
	1x <5mm	
Potamides conicus	11 fragments	
	13x < 5mm	
Plesiotrochus unicinctus	1x <5mm	
Notocochlis gualteriana	5,5	5,9
Naticarius onca	4,6	5,9
Triphoridae indet 1	1x <5mm	
Triphoridae indet 2	1x <5mm	
Triphoridae indet 3	5,3	1,2
Opalia crassilabrum	7,9	1,9
Columbellidae indet 1	9,6	4,0
	2x <5mm	
Columbellidae indet 2	1x <5mm	
Columbellidae indet 3	1x <5mm	
Fusinus verrucosus	17,4	7,2
Ancilla lineolata	6,3	2,9
	1x <5mm	
Gibberula savignyi	7x <5mm	
Conus sp. juvenil	1x <5mm	
Turridae indet 2	7,8	3,4
Turridae indet 4	5,4	2,2
Turridae indet 5	2x <5mm	
Turridae indet 6	7,8	2,7
	1x <5mm	
Otopleura sp.	18,2	5,8
	1x <5mm	
Syrnola sp.	1x <5mm	
Pyramidellidae indet 1	5,3	1,1
Acteocina simplex	7,2	2,6
	5,9	2,4
	5,6	2,2
	5,7	2,3
	31x <5mm	
Acteon sp.	1x <5mm	
Liloa curta	1x <5mm	
Diniaty dentifer	2x <5mm	

Bivalves dead	height	width
Huxleyia diabolica	1x <5mm	
Glycymeris pectunculus	9x <5mm	
Septifer forskali	5,3	3,0
	1x <5mm	
Cavilucina fieldingi	10,2	11,4
Ctena divergens	1x <5mm	
Pillucina vietnamica	7,8	8,1
	5,8	6,4
	7,1	7,1
	6,2	6,5
	2x <5mm	
Diplodonta subrotunda	1x <5mm	
Fragum nivale	7,8	6,5
	1x <5mm	
Fragum sueziensis	5,0	5,1
	6,0	5,6
	6,0	5,6
	5,3	5,4
	5,0	5,0
	5,8	/
	21x <5mm	
Lunulicardia auricula	/	6,3
Mactra olorina	15,0	19,1
	13,5	17,2
	/	20,8
	1x <5mm	
Mactra lilacea	18,1	24,1
Semelangulus mesodesmoides	4x <5mm	
Pinguitellina pinguis	5,1	5,3
	1x <5mm	
Loxoglypta secunda	6,3	11,1
Ervilia scaliola	3,2	5,0
Circe juvenil	6,1	6,9
Dosinia erythraea	23,3	/
	9,0	9,2
	7,1	7,1
	6,1	6,3
	1x <5mm	
Lioconcha ornata	8,1	10,0
	7,3	8,6
Bivalves alive	height	width
Glycymeris arabica	1,0	1,1
	16x <5mm	
Lioconcha ornata	1x <5mm	
Callista florida	1x <5mm	
Timoclea roemeriana	1x <5mm	
Chavania erythraea	1x <5mm	

Table 34: Sample 16, Measurements in mm.

Bivalves dead	height	width	height	width	height	width	height	width
Glycymeris arabica	14,5	16,2	8,8	9,6	7,0	8,0	5,7	6,2
	13,3	13,4	8,8	9,9	7,0	7,5	5,6	6,0
	12,8	13,8	8,7	9,8	7,0	7,7	5,6	6,0
	12,7	13,1	8,6	9,4	6,9	7,3	5,3	5,8
	12,7	13,3	8,6	9,2	6,9	7,8	5,2	5,2
	11,9	12,9	8,5	9,3	6,9	7,4	5,1	5,8
	11,8	13,3	8,4	9,4	6,9	7,5	5,1	5,5
	11,6	12,7	8,4	8,8	6,8	7,4	5,0	5,4
	11,4	12,4	8,4	9,1	6,8	7,5	5,0	5,3
	11,4	12,2	8,4	9,4	6,7	7,1	5,0	5,3
	10,9	11,8	8,3	8,9	6,7	7,2	4,9	5,0
	10,8	11,6	8,3	8,9	6,7	7,2	4,9	5,3
	10,7	12,0	8,3	8,4	6,6	7,0	4,8	5,2
	10,3	11,7	8,2	9,0	6,6	7,4	4,8	5,4
	10,1	11,0	8,1	8,6	6,6	7,3	4,7	4,9
	10,1	10,6	8,1	9,1	6,6	7,3	4,7	5,0
	10,0	11,1	8,1	9,0	6,5	7,2	4,6	4,9
	10,0	10,1	8,0	9,2	6,3	6,8	4,5	4,8
	10,0	10,9	7,9	8,4	6,3	6,9	4,5	4,6
	9,9	11,2	7,8	8,5	6,2	6,6	4,3	4,7
	9,8	10,7	7,8	8,5	6,0	6,7	/	5,8
	9,7	10,9	7,7	7,9	6,0	6,7	8,1	/
	9,5	10,5	7,6	8,3	6,0	6,6	/	6,5
	9,4	10,0	7,6	8,6	5,9	6,2	7,1	/
	9,4	10,1	7,5	8,1	5,8	6,3	5,6	/
	9,3	9,9	7,4	7,7	5,8	6,0	74x <5mm	
	9,2	10,2	7,3	7,5	5,8	6,4	3 fragments	
	9,0	9,6	7,2	8,3	5,8	6,4		
	8,9	9,6	7,2	8,2	5,7	5,7		
Cardiolucina semperiana	7,9	8,1	6,6	6,8	6,1	6,4	5,1	5,3
	7,8	7,8	6,6	6,6	6,1	6,3	5,0	5,5
	7,6	7,5	6,6	6,8	6,1	6,3	5,0	5,1
	7,5	7,1	6,6	6,9	6,1	6,3	4,9	5,8
	7,4	7,2	6,5	6,6	6,0	6,3	4,9	5,2
	7,4	7,4	6,5	7,1	6,0	6,5	4,7	4,9
	7,3	7,5	6,5	6,6	6,0	6,5	4,7	5,2
	7,2	7,5	6,4	6,7	5,9	5,8	4,7	4,8
	7,1	7,4	6,4	6,5	5,9	6,2	4,7	4,7
	7,1	7,5	6,3	6,2	5,8	6,1	4,4	4,9
	7,0	7,7	6,3	6,4	5,7	5,7	4,3	4,6
	7,0	7,3	6,3	6,6	5,7	6,1	4,2	4,6
	6,8	7,2	6,3	7,1	5,6	6,0	6,5	/
	6,8	6,8	6,3	6,7	5,6	6,3	6,2	/
	6,8	7,0	6,3	6,1	5,6	5,4	5,7	/
	6,8	6,8	6,2	6,3	5,6	6,2	6,8	/
	6,7	7,0	6,2	6,2	5,6	5,9	11x <5mm	
	6,7	7,0	6,2	6,5	5,5	5,8	2 fragments	
	6,7	6,7	6,2	6,2	5,4	5,9		
	6,7	6,9	6,1	5,8	5,2	5,3		
Chavania erythraea	10,1	10,4	7,1	6,9	6,1	6,8	5,5	6,1
	11,2	11,8	7,1	7,1	6,1	6,4	5,4	5,9
	9,9	9,8	7,1	7,3	6,1	6,6	5,4	5,8

	9,6	9,5	7,0	7,7	6,1	6,4	5,4	5,9
	9,5	9,8	6,9	7,4	6,0	6,2	5,2	5,7
	9,4	9,7	6,9	6,9	6,0	6,5	5,2	5,5
	9,3	9,1	6,9	7,6	6,0	6,5	5,2	5,4
	9,3	9,5	6,9	7,5	6,0	6,4	5,2	5,9
	8,5	8,8	6,9	7,2	5,9	6,3	5,1	5,4
	8,3	8,2	6,8	7,2	5,9	6,0	5,1	5,2
	8,3	8,1	6,8	7,2	5,9	6,2	5,1	5,2
	8,2	8,5	6,8	7,1	5,9	6,2	5,1	5,5
	8,1	8,0	6,8	7,5	5,9	6,1	5,1	5,2
	8,1	8,2	6,8	6,9	5,9	6,0	5,0	5,2
	8,1	8,8	6,8	7,3	5,9	6,0	5,0	5,4
	7,8	7,4	6,7	7,0	5,9	6,3	5,0	5,3
	7,8	8,0	6,7	7,2	5,9	6,5	4,9	5,2
	7,8	8,1	6,7	7,0	5,9	6,3	4,9	5,6
	7,8	8,2	6,7	6,6	5,8	5,9	4,9	5,2
	7,8	8,0	6,7	6,7	5,8	6,3	4,8	5,3
	7,8	7,8	6,7	6,7	5,8	6,3	4,7	5,0
	7,7	7,8	6,6	6,7	5,8	6,1	4,7	5,1
	7,6	7,3	6,6	6,7	5,8	6,1	4,7	5,1
	7,6	7,7	6,5	6,8	5,8	5,8	4,7	4,9
	7,5	7,8	6,5	6,3	5,7	6,3	4,6	4,9
	7,5	7,6	6,5	6,7	5,7	6,2	4,6	5,1
	7,5	7,7	6,5	6,6	5,7	6,3	4,6	4,9
	7,3	7,3	6,4	6,9	5,7	5,9	4,5	4,8
	7,3	7,4	6,4	6,7	5,7	5,7	4,5	4,9
	7,2	7,5	6,4	6,9	5,7	6,0	4,5	4,8
	7,2	7,3	6,3	6,7	5,6	6,0	4,4	4,8
	7,2	7,9	6,2	6,4	5,6	6,0	4,3	4,7
	7,2	7,8	6,2	6,6	5,6	6,0	4,3	4,6
	7,1	6,9	6,2	6,3	5,6	5,6	4,3	4,8
	7,1	6,6	6,1	6,4	5,6	5,9	4,2	4,4
	7,1	6,8	6,1	6,3	5,5	5,6	2 fragments	
	7,1	7,3	6,1	6,7	5,5	5,7	35x <5mm	
Divalinga arabica	16,2	16,7	12,3	12,8	10,6	11,2	9,3	10,1
	14,6	15,0	12,0	12,8	10,6	11,4	9,3	9,8
	13,6	14,4	12,0	13,1	10,5	/	9,3	10,0
	13,5	14,1	11,9	13,2	10,4	11,3	9,2	9,7
	13,3	14,3	11,8	12,2	10,4	11,1	9,0	9,9
	13,0	13,8	11,8	12,5	10,4	11,2	5,8	5,9
	12,6	13,4	11,7	12,6	10,4	11,0	4,9	5,3
	12,5	13,1	10,9	11,7	10,2	11,0	3x <5mm	
	12,4	13,4	10,8	11,9	9,9	10,5	1 fragment	
Callista florida	16,3	21,7	8,2	10,9	6,2	8,5	5,1	7,1
	14,4	18,1	6,9	9,2	5,6	7,7	4,8	6,6
	12,2	16,2	6,3	8,7	5,4	7,7	11x <5mm	
Timoclea roemeriana	6,1	8,3	6,2	7,8	5,2	6,6	18x <5mm	
	4,1	5,1	6,0	7,5				

Table 35: Sample 17, Measurements in mm.

Gastropods dead	height	width
Gibberula savignyi	1x <5mm	
Ringicula acuta	1x <5mm	

Bivalves dead	length	height
Glycymeris arabica	1x <5mm	
Petricola lapicida	8,02	10,99
Bivalves alive	length	height
Cardiolucina semperiana	1x <5mm	
Nucula inconspicua	1x <5mm	
Pinguitellina pinguis	4,85	6,19
	4,66	5,65

Table 36: Sample 18, Measurements in mm.

Gastropods dead	height	width
Ethminolia hemprichii	57x <5mm	
Rhinoclavis kochii	3x <5mm	
Turbonilla sp.	1x <5mm	
Retusa truncatula	1x <5mm	
Diniatys dentifer	1x <5mm	
Ringicula acuta	1x <5mm	
Scaphopoda indet 1	23,35	1,75

Bivalves dead	length	height
Glycymeris arabica	1x <5mm	
Cardiolucina semperiana	1x <5mm	
Chavania erythrea	7,0	7,3
	6,6	6,8
	6,0	6,4
	5,0	5,1
	1x <5mm	
Fulvia fragilis	7,0	7,8
Pinguitellina pinguis	3x <5mm	
Callista florida	1x<5mm	
Bivalves alive	length	height
Chavania erythrea	1x<5mm	

Total assemblage
Bivalves

Family	Species	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18
Nuculidae	*Nucula inconspicua*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Nucinellidae	*Huxleyia diabolica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Glycymerididae	*Glycymeris arabica*	0	0	0	0	0	0	0	0	0	1	0	4	3	15	24	206	1	1
	Glycymeris pectunculus	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	9	0	0
Mytilidae	*Brachidontes pharaonis*	0	0	0	0	0	5	0	5	1	0	0	0	1	0	2	0	0	0
	Septifer forskali	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	0
	Modiolus auriculatus	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
Ostreidae	*Saccostrea cucullata*	0	0	0	0	0	0	0	1	0	0	3	0	0	0	0	0	0	0
Lucinidae	*Anodontia sp.*	0	0	0	0	0	0	0	0	0	2	0	0	0	0	3	0	0	0
	Cardiolucina semperiana	0	0	0	0	0	0	0	1	0	6	0	6	3	16	22	89	1	1
	Cavilucina fieldingi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
	Chavania erythraea	0	0	0	0	0	0	0	0	5	14	0	23	12	71	58	184	0	6
	Ctena divergens	0	0	0	0	0	0	0	0	0	0	0	0	7	0	2	1	0	0
	Divalinga arabica	0	0	0	0	0	0	0	0	0	2	0	3	22	21	59	38	0	0
	Lamellolucina dentifera	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Pillucina vietnamica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0
Ungulinidae	*Diplodonta subrotunda*	0	0	0	0	0	0	0	0	0	5	0	1	7	4	2	1	0	0
Cardiidae	*Fragum nivale*	0	0	0	0	0	0	0	0	0	1	0	0	0	5	4	2	0	0
	Fragum sueziensis	0	0	0	0	0	0	0	0	0	1	0	0	0	4	3	27	0	0
	Fulvia fragilis	0	0	0	0	0	0	0	0	1	2	0	1	2	2	0	0	0	1
	Lunulicardia auricula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Mactridae	*Mactra olorina*	0	0	0	0	0	0	0	0	1	0	0	0	0	5	2	4	0	0
	Mactra lilacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Tellinidae	*Exotica triradiata*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	5	0	0
	Semelangulus mesodesmoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0
	Pinguitellina pinguis	0	0	0	0	0	0	0	0	0	3	0	1	1	7	5	2	2	3
	Loxoglypta secunda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
Semelidae	*Semele fragillima*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	Ervilia scaliola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Veneridae	*Callista florida*	0	0	0	0	0	0	0	0	0	0	0	6	1	4	1	23	0	1
	Circe sp. (juvenil)	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	1	0	0
	Dosinia erythrea	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	5	0	0
	Irus macrophylla	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Lioconcha ornata	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	3	0	0
	Timoclea roemeriana	0	0	0	0	0	0	0	0	0	0	0	1	0	1	4	25	0	0
Petricolidae	*Petricola lapicida*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

Total assemblage
Gastropods

Family	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Fissurellidae	*Diodora rupelli*	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Trochidae	*Ethminolia hemprichii*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	57
	Stomatia duplicata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Pagodatrochus variabilis	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0
	Trochidae indet. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Colloniidae	*Bothropoma cf. bellula*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Neritidae	*Nerita sanguinolenta*	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	1	0	0
	Smaragdia souverbiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0
Phenacolepadidae	*Plesiothyreus pararabica*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Cerithidae	*Cerithium caeruleum*	0	0	0	0	0	0	0	24	1	0	5	0	3	0	0	0	0	0
	Cerithiidae indet 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Cerithium sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Cerithium ruepelli	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Clypeomorus bifasciata	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
	Rhinoclavis kochi	0	0	0	0	0	0	0	1	4	1	0	0	1	15	9	3	0	3
	Rhinoclavis aspera	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Dialidae	*Diala semistriata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Turritellidae	*Archimediella maculata*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Planaxidae	*Planaxis savignyi*	0	0	0	0	0	3	4	3	1	0	2	1	4	0	0	2	0	0
Potamididae	*Potamides conicus*	245	100	66	371	241	251	233	1	10	8	462	1	8	5	25	24	0	0
Plesiotrochidae	*Plesiotrochus unicinctus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
Strombidae	*Canarium mutabilis*	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Naticidae	*Notocochlis gualteriana*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0
	Naticarius onca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Cerithiopsidae	*Cerithiopsidae indet. 1*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Triphoridae	*Triphoridae indet 1*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Triphoridae indet 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Triphoridae indet 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Epitoniidae	*Opalia crassilabrum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Columbellidae	*Euplica varians*	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
	Columbellidae indet. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3	0	0
	Columbellidae indet. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Columbellidae indet 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0

Family	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Nassariidae	*Nassarius erythraeus*	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0
Melongenidae	*Volema paradisica*	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Fasciolariidae	*Fusinus verrucosus*	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
Olividae	*Ancilla linolata*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	0	0
Cystiscidae	*Gibberula savignyi*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	1	0
Costellariidae	*Vexillum amabile*	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Conidae	*Conus sp. juvenil*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
Turridae	*Turridae indet. 1*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Turridae indet. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	1	0	0
	Turridae indet. 3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	Turridae indet. 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Turridae indet. 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
	Turridae indet. 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Pyramidellidae	*Longchaeus halaibensis*	0	0	0	0	0	0	0	0	7	0	0	0	4	0	0	0	0	0
	Otopleura sp.	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0
	Syrnola sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Turbonilla sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
	Pyramidellidae indet. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Retusidae	*Retusa truncatula*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Acteonidae	*Pupa solidula*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Cylichnidae	*Acteocina simplex*	0	0	0	0	0	0	0	0	1	0	0	0	0	3	2	35	0	0
	Acteon sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Haminoeidae	*Atys cylindricus*	0	0	0	0	0	0	0	0	0	2	0	0	0	1	2	0	0	0
	Atys ehrenbergi	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	Liloa curta	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0
	Diniatys dentifer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1
Ringiculidae	*Ringicula acuta*	0	0	0	0	0	0	0	0	0	0	0	0	0	8	2	0	1	1
Scaphopoda	*Scaphopoda indet 1*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1

Living assemblage

Bivalves

Family	Species	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18
Nuculidae	*Nucula inconspicua*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Glycymerididae	*Glycymeris arabica*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	17	0	0
Mytilidae	*Brachidontes pharaonis*	0	0	0	0	0	3	0	2	0	0	0	0	0	0	0	0	0	0
Ostreidae	*Saccostrea cucullata*	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
	Cardiolucina semperiana	0	0	0	0	0	0	0	0	0	0	0	1	0	1	3	0	1	0
	Chavania erythraea	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	1	0	1
	Divalinga arabica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
	Pinguitellina pinguis	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2	0
Veneridae	*Callista florida*	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	0
	Lioconcha ornata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Timoclea roemeriana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0

Gastropods

Family	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Cerithidae	*Cerithium caeruleum*	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	0
Turritellidae	*Archimediella maculata*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Potamididae	*Potamides conicus*	104	51	1	193	79	175	1	0	10	0	366	0	0	0	0	0	0	0
Strombidae	*Canarium mutabilis*	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Naticidae	*Notocochlis gualteriana*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Fasciolariidae	*Fusinus verrucosus*	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0

Dead assemblage
Bivalves

Family	Species	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18
Nuculidae	*Nucula inconspicua*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nucinellidae	*Huxleyia diabolica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Glycymerididae	*Glycymeris arabica*	0	0	0	0	0	0	0	0	0	1	0	4	3	14	23	189	1	1
	Tucetona audouini	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	9	0	0
Mytilidae	*Brachidontes pharaonis*	0	0	0	0	0	2	0	3	1	0	0	0	1	0	2	0	0	0
	Septifer forskali	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	0
	Modiolus auriculatus	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
Ostreidae	*Saccostrea cucullata*	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Lucinidae	*Anodontia sp.*	0	0	0	0	0	0	0	0	0	2	0	0	0	0	3	0	0	0
	Cardiolucina semperiana	0	0	0	0	0	0	0	1	0	6	0	5	3	15	19	89	0	1
	Cavilucina fieldingi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
	Chavania erythraea	0	0	0	0	0	0	0	0	5	14	0	23	12	70	54	183	0	5
	Ctena divergens	0	0	0	0	0	0	0	0	0	0	0	0	7	0	2	1	0	0
	Divalinga arabica	0	0	0	0	0	0	0	0	0	2	0	3	22	21	58	38	0	0
	Lamellolucina dentifera	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Pillucina vietnamica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0
	Diplodonta subrotunda	0	0	0	0	0	0	0	0	0	5	0	1	7	4	2	1	0	0
Cardiidae	*Fragum nivale*	0	0	0	0	0	0	0	0	0	1	0	0	0	5	4	2	0	0
	Fragum suezienis	0	0	0	0	0	0	0	0	0	1	0	0	0	4	3	27	0	0
	Fulvia fragilis	0	0	0	0	0	0	0	0	1	2	0	1	2	2	0	0	0	1
	Lunulicardia auricula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Mactridae	*Mactra olorina*	0	0	0	0	0	0	0	0	1	0	0	0	0	5	2	4	0	0
	Mactra lilacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Tellinidae	*Exotica triradiata*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	5	0	0
	Semelangulus mesodesmoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0
	Pinguitellina pinguis	0	0	0	0	0	0	0	0	0	3	0	1	1	6	4	2	0	3
	Loxoglypta secunda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
Semelidae	*Semele fragillima*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	Ervilia scaliola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Veneridae	*Callista florida*	0	0	0	0	0	0	0	0	0	0	0	5	1	3	0	22	0	1
	Circe sp. (juvenil)	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	1	0	0
	Dosinia erythrea	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	5	0	0
	Irus magrophylla	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Lioconcha ornata	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0
	Timoclea roemeriana	0	0	0	0	0	0	0	0	0	0	0	1	0	1	3	23	0	0
Petricolidae	*Petricola lapicida*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

Dead assemblage
Gastropods

Family	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Fissurellidae	*Diodora rupelli*	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Trochidae	*Ethminolia hemprichii*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	57
	Stomatia duplicata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Pagodatrochus variabilis	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0
	Trochidae indet. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Colloniidae	*Bothropoma cf. bellula*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Neritidae	*Nerita sanguinolenta*	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	1	0	0
	Smaragdia souverbiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0
Phenacolepadidae	*Plesiothyreus pararabica*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Cerithidae	*Cerithium caeruleum*	0	0	0	0	0	0	0	2	1	0	5	0	3	0	0	0	0	0
	Cerithiidae indet 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Cerithium sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Cerithium ruepelli	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Clypeomorus bifasciata	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
	Rhinoclavis kochi	0	0	0	0	0	0	0	1	4	1	0	0	1	15	9	3	0	3
	Rhinoclavis aspera	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Dialidae	*Diala semistriata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Turritellidae	*Archimediella maculata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Planaxidae	*Planaxis savignyi*	0	0	0	0	0	3	4	3	1	0	2	1	4	0	0	2	0	0
Potamididae	*Potamides conicus*	141	49	65	178	162	76	232	1	0	8	96	1	8	5	25	24	0	0
Plesiotrochidae	*Plesiotrochus unicinctus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
Strombidae	*Canarium mutabilis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Naticidae	*Notocochlis gualteriana*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Naticarius onca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Cerithiopsidae	*Cerithiopsidae indet. 1*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Triphoridae	*Triphoridae indet 1*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Triphoridae indet 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Triphoridae indet 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Epitoniidae	*Opalia crassilabrum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Columbellidae	*Euplica varians*	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
	Columbellidae indet. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3	0	0
	Columbellidae indet. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0

Family	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Nassariidae	*Nassarius erythraeus*	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0
Melongenidae	*Volema pyrum*	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Fasciolariidae	*Fusinus verrucosus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Olividae	*Ancilla linolata*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	0	0
Cystiscidae	*Gibberula savignyi*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	1	0
Costellariidae	*Vexillum amabile*	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Conidae	*Conus sp. juvenil*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
Turridae	*Turridae indet. 1*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Turridae indet. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	1	0	0
	Turridae indet. 3 (5)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	Turridae indet 4 (3)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Turridae indet 5 (4)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
	Turridae indet. 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Pyramidellidae	*Longchaeus halaibensis*	0	0	0	0	0	0	0	0	7	0	0	0	4	0	0	0	0	0
	Otopleura sp.	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0
	Syrnola sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Turbonilla sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
	Pyramidellidae indet 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Retusidae	*Retusa truncatula*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Acteonidae	*Pupa solidula*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Cylichnidae	*Acteocina simplex*	0	0	0	0	0	0	0	0	1	0	0	0	0	3	2	35	0	0
	Acteon sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Haminoeidae	*Atys cylindricus*	0	0	0	0	0	0	0	0	0	2	0	0	0	1	2	0	0	0
	Atys ehrenbergi	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	Liloa curta	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0
	Diniatys dentifer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1
Ringiculidae	*Ringicula acuta*	0	0	0	0	0	0	0	0	0	0	0	0	0	8	2	0	1	1
Scaphopoda	*Scaphopoda indet 1*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1

10.2 Pictures of Bivalves

Plate 1

1) *Saccostrea cucullata*
2) *a+b) Brachidontes pharaonis*

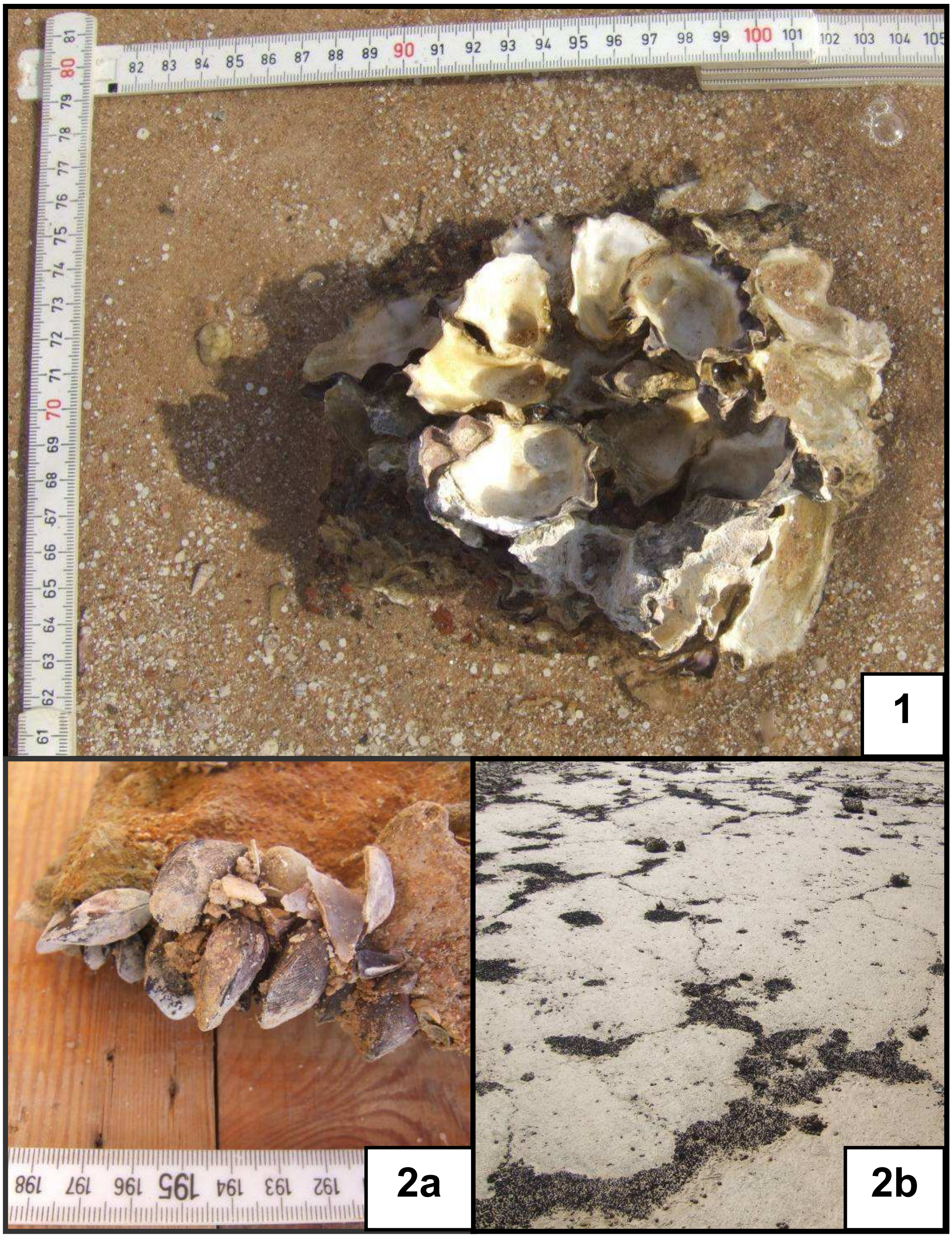


Plate 2

1) *Anadara uropigimelana*
2) *Glycymeris pectunculus*
3) *Chama sp.*
4) *Cardiolucina semperiana*

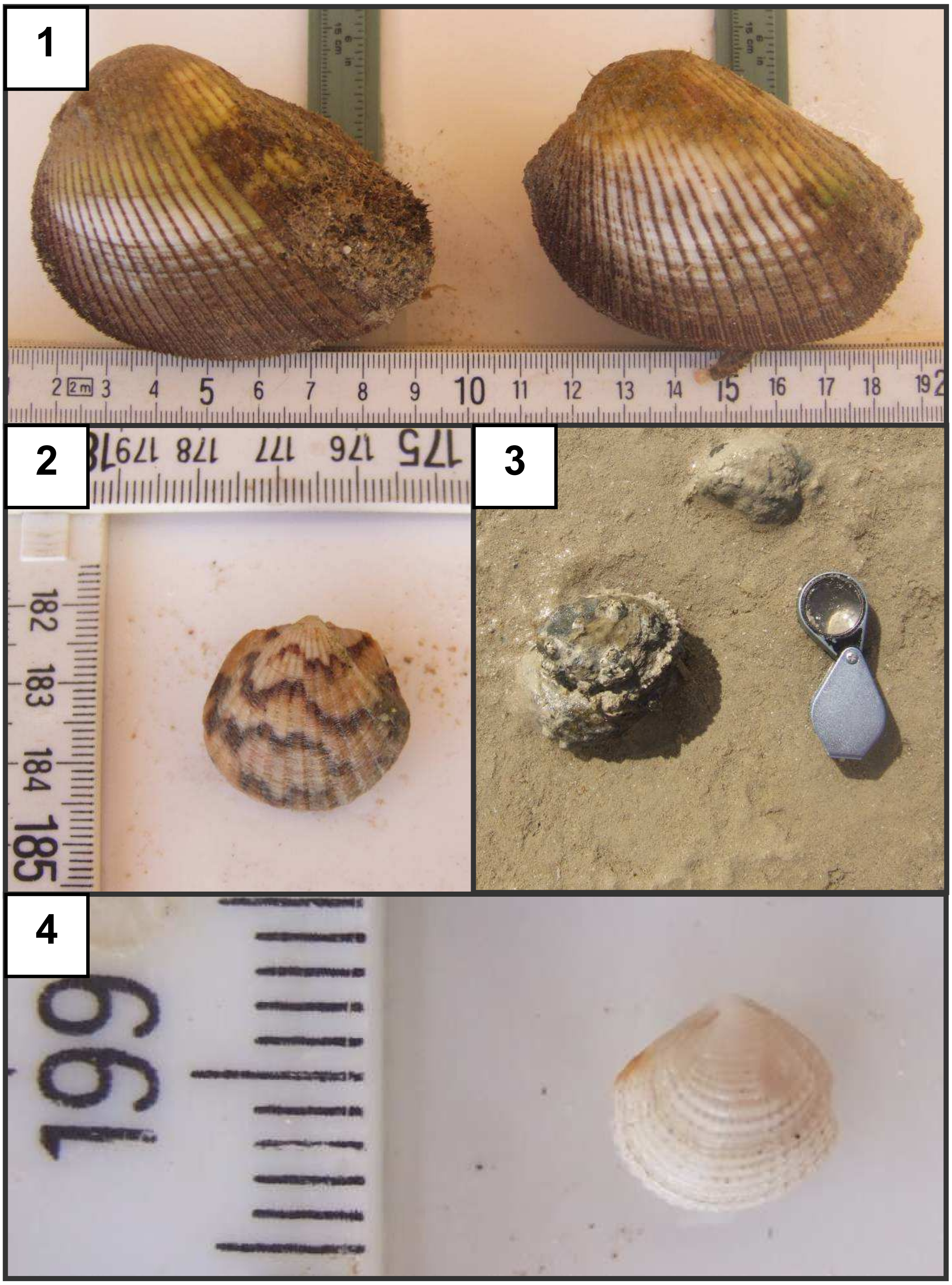
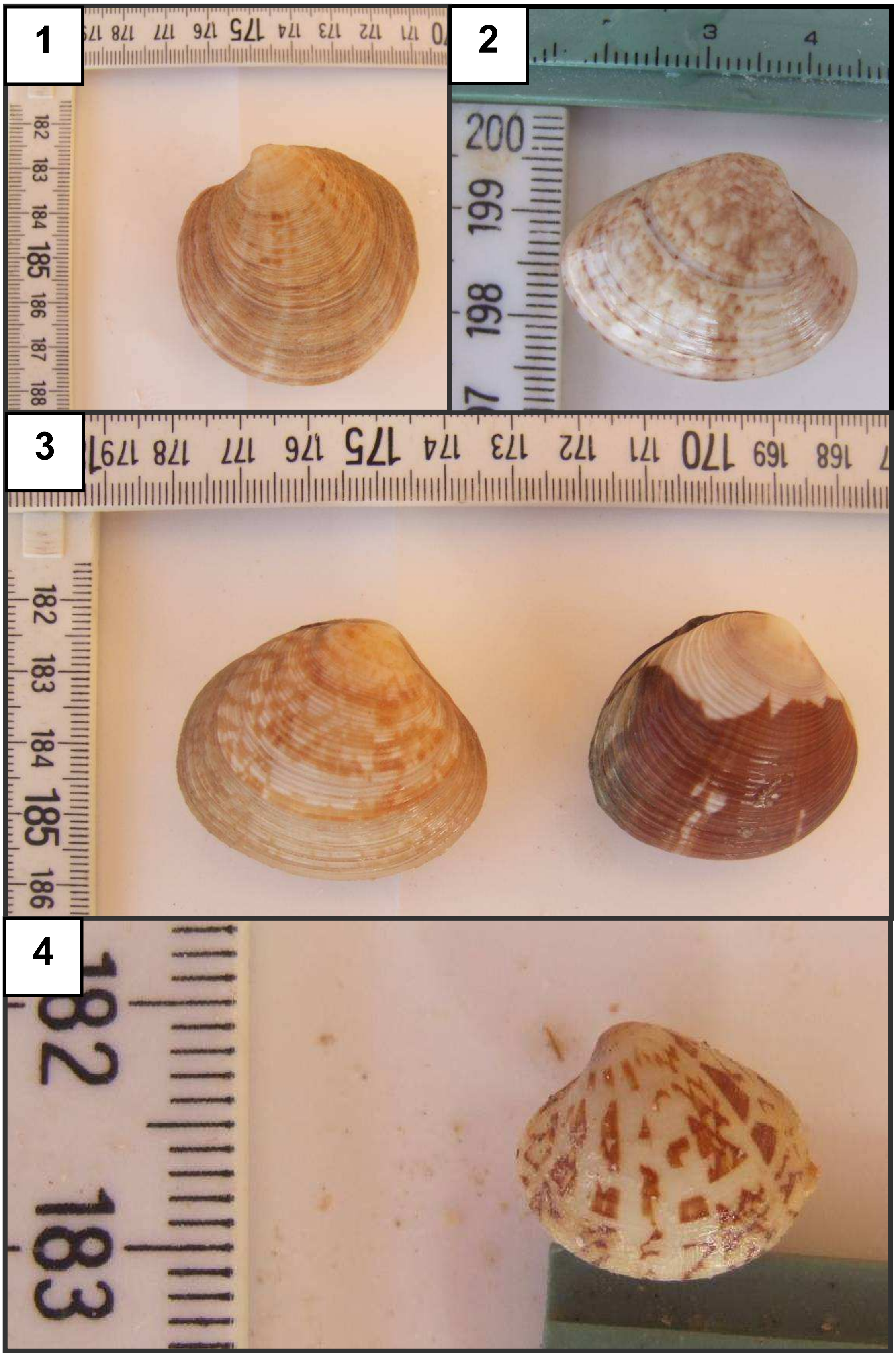


Plate 3

1) *Dosinia erythraea*
2) *Callista florida*
3) *Circenita callipyga*
4) *Pitar hebraea*



10.3 Pictures of Gastropods

Plate 1

1) *Conus arenatus*
2) *Conus tessulatus*
3) *Fusinus verrucosus*

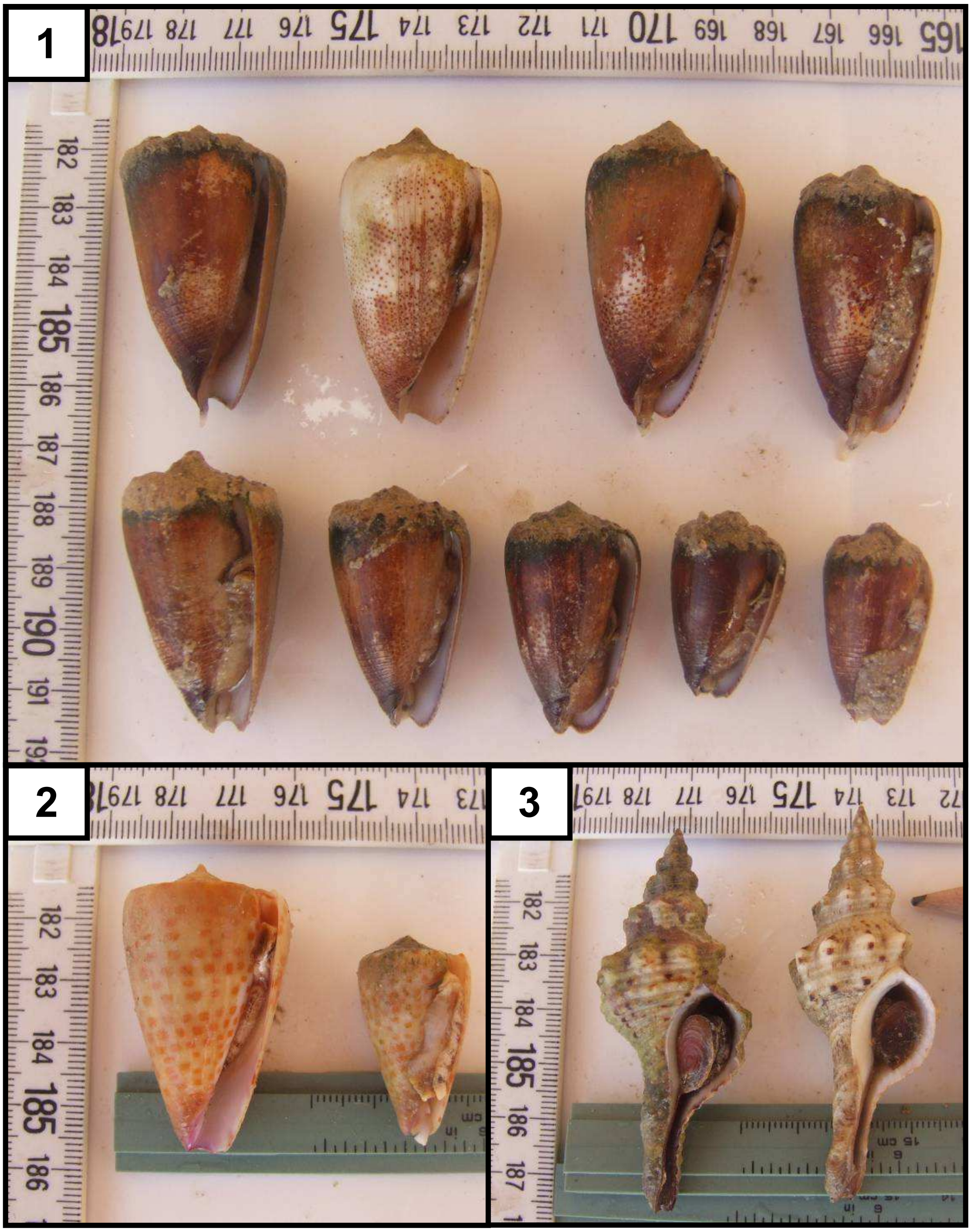


Plate 2

1) *a+b) Nerita sanguinolenta*
2) *Cerithium caeruleum*
3) *Clypeomorus bifasciata*
4) *Cerithium adansonii*
5) *Rhinoclavis fasciata*

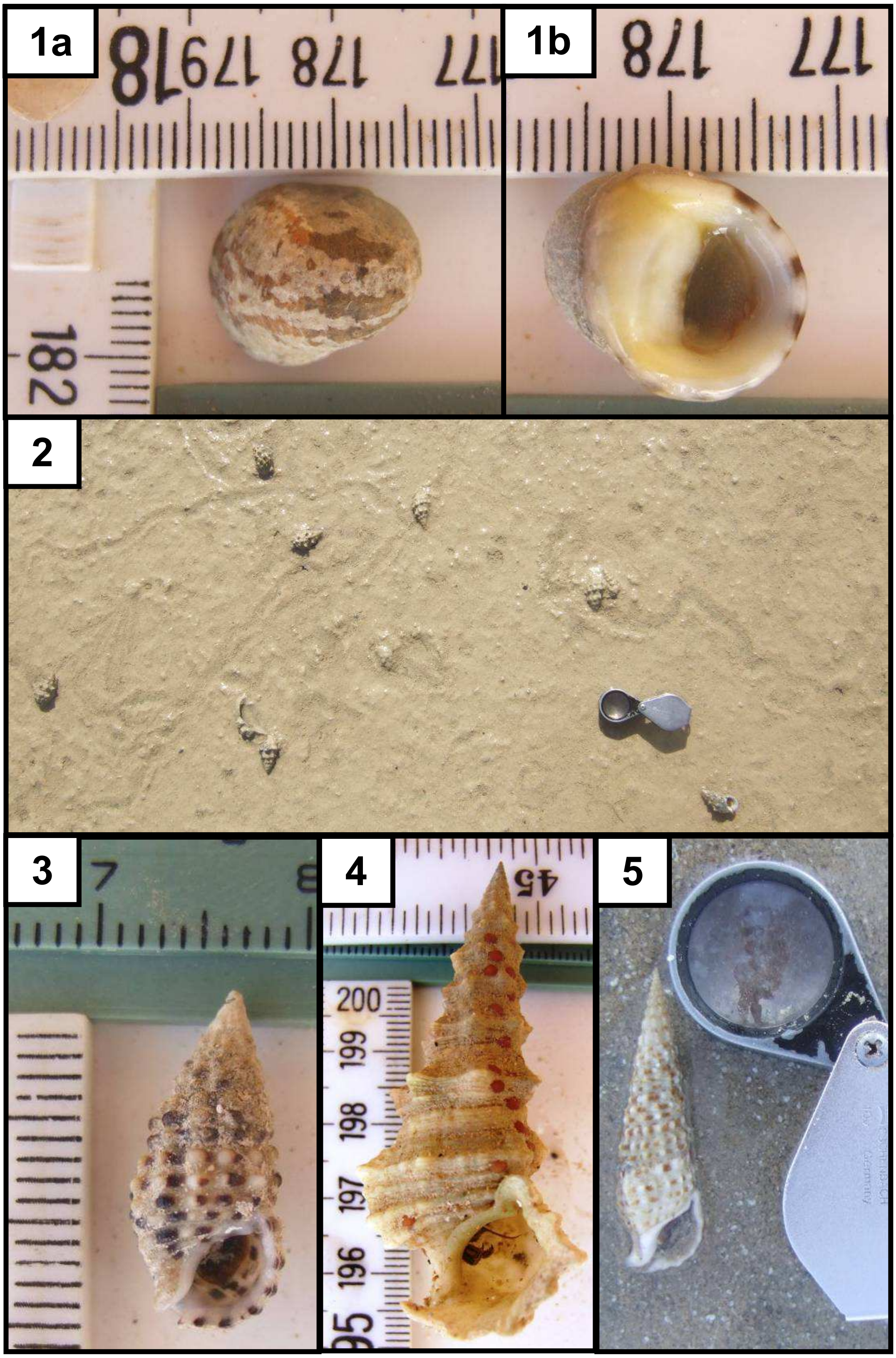


Plate 3

1) *Archimediella maculata*
2) *Canarium mutabilis*
3) *Planaxis savignyi*
4) *Mammilla melanostoma*
5) *a+b) Notocochlis gualteriana*

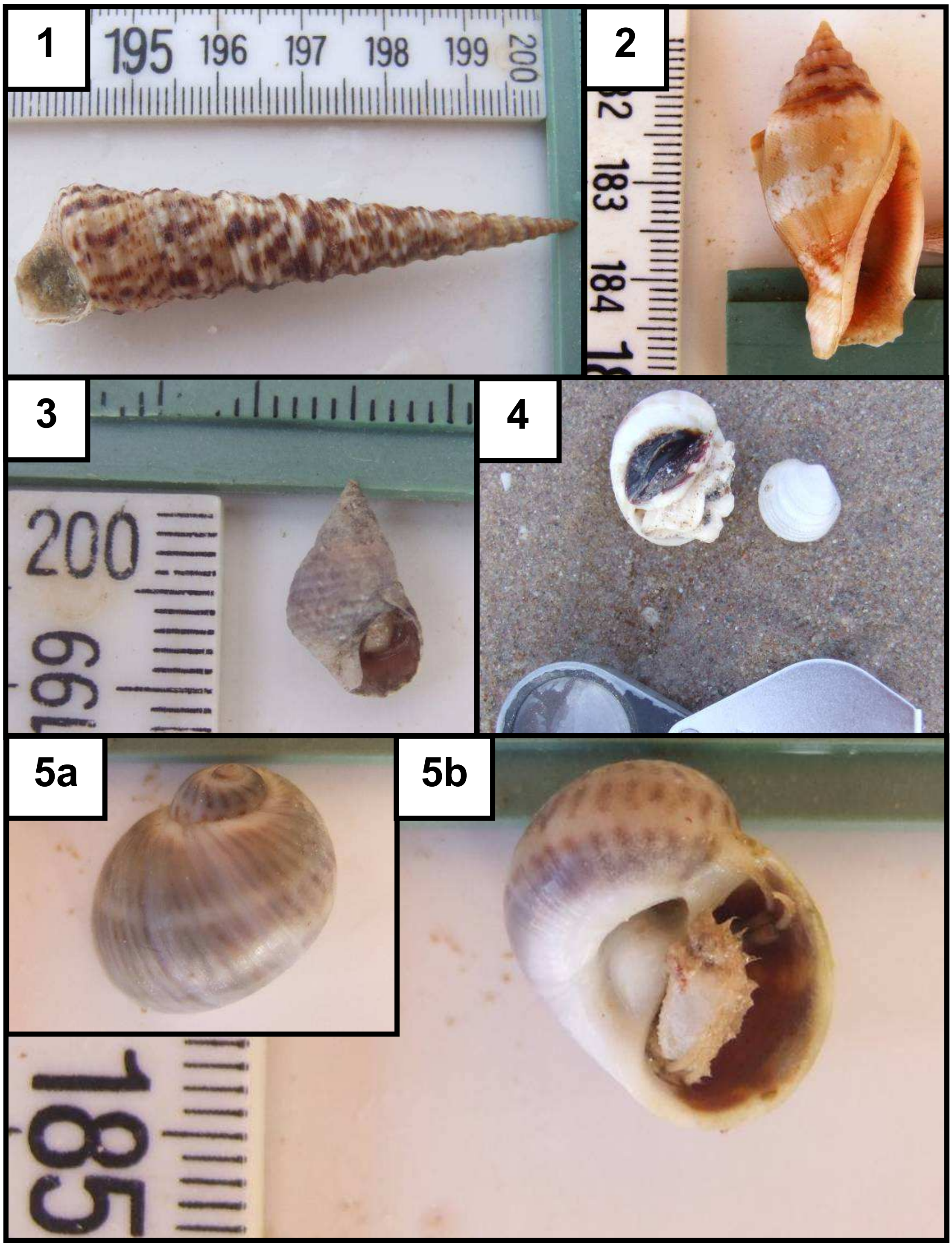
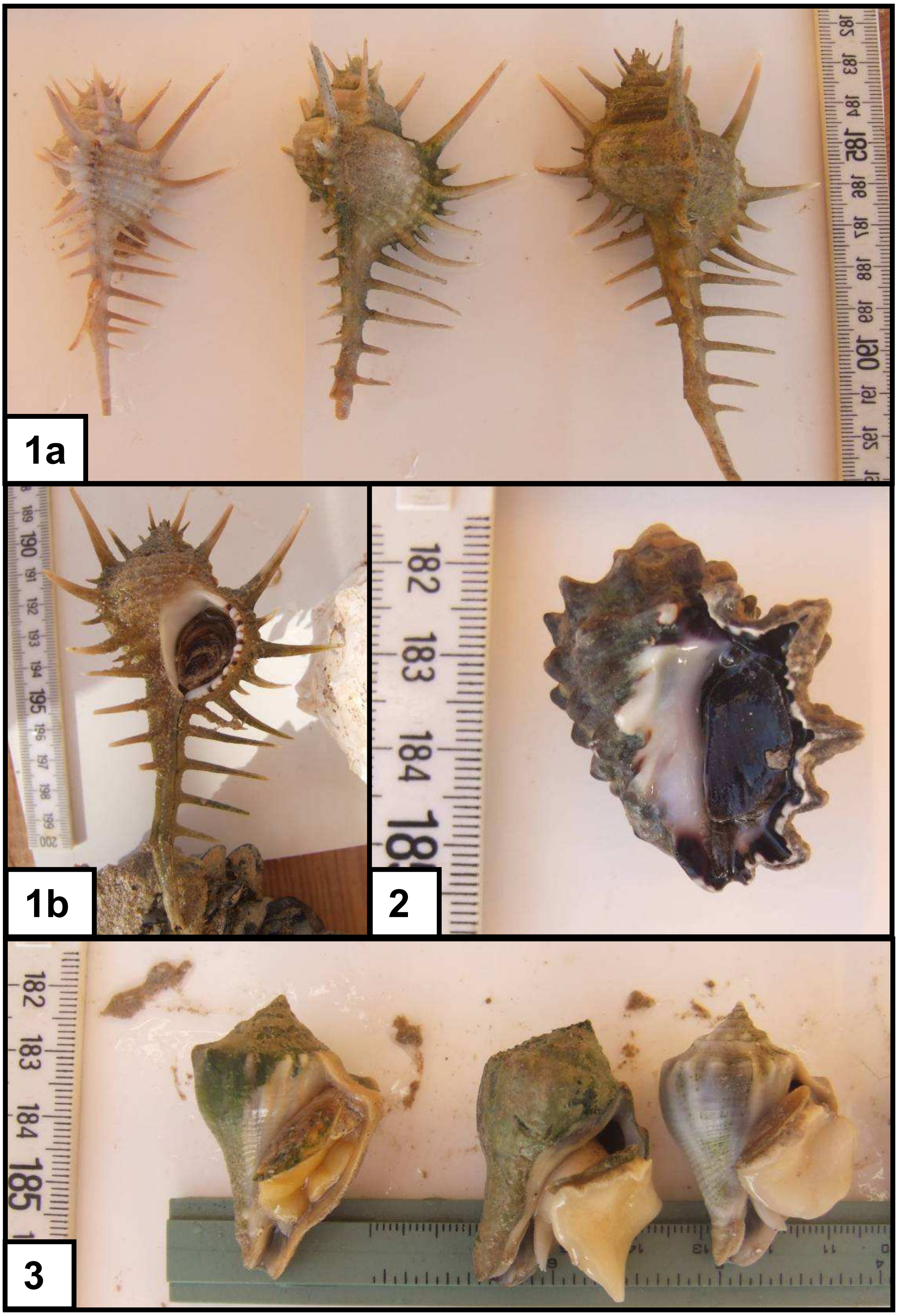


Plate 4

1) *a+b) Murex forskoehlii*
2) *Thais savignyi*
3) *Volema paradisica*



11. References

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Curriculum vitae

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PERSONAL DETAILS

Date of birth	17 January 1986
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EDUCATION

04/2010 – 02/2011	Diploma thesis at the Department of Palaeontology, University of Vienna, Thesis title: Habitat mapping and molluscan zonation of a Red Sea tidal flat at Dahab (Gulf of Aqaba, Egypt)
10/2005 – 02/2011	Studies in biology and chemistry (Teacher Training Programme) at the University of Vienna
09/2000 – 06/2005	Commercial Academy in Ybbs/Donau (Handelsakademie)
09/1996 – 06/2000	Sports Secondary School in Scheibbs (Sporthauptschule)
09/1992 – 06/1996	Elementary School in Scheibbs (Volksschule)

FIELD COURSES

2008	Field methods in aquatic Palae-Ecosystems (fossil oyster-biostrome) at Stetten, Austria
2010	Field work in aquatic sediments at Dahab, Egypt
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