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„Drilled gastropods: temporal and spatial variabilities of predation pressure in the Northern Adriatic Sea“

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Markus Dengg, BSc

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Inhalt

1 Abstract

Drilling predation is known to control species composition and biodiversity in molluscan benthic assemblages. This study focuses on changes in drilling frequency (DF) on a temporal (up to 5000 years) and spatial (from west to east coast) scale in the Northern Adriatic Sea. We used sediment cores do perform deep time and spatial analysis of predation. A total of 44393 gastropods were distinguished, counted and checked for drill holes. The median DF across all samples was 16.93%. The highest values were found in Piran (31.23%) and the lowest at the Po Delta (7.50%). On the family level Turritellidae (up to 58.96%) and Crithiidae (up to 39.27%) showed the highest values in DF. Cerithiidae was the most abundant family with a total of 13208 individuals and occured in nearly every sample, except Panzano. Turritellidae were found to be much lower in abundance with a total of 2652 individuals. No members of the family were found in the core of Venice, whereas they make up to one third of total species abundance in the cores of the Po delta. DF changes over time are diverging between cores. In the cores of Piran and Panzano DF increase towards modern layers. This trend can also be found in the core of Brijuni, but here DF shows a total collapse (from around 40% to 0%) in the most modern layer (0-2 cm depth). The core of Venice shows strong fluctuating DFs all through the core. However, beginning from the middle of the core, DF was found to be lower than in older layers. Cores from the Po-delta show drilling in oldest layers but none at most modern.

Epifaunal living gastropods showed the highest values of DF (28.90%). DF of infaunal living filter-feeders (23.76%) and epibiontic (organisms living attached to others, without any kind of mutualistic interaction) living gastropods (21.30%) were high despite their cryptic lifestyle. It seems to be that more mobile species (e.g., predators and scavengers) were affected by lower predation pressure. This might be the case because molluscivorous predators in the Northern Adriatic Sea consume a wide variety of prey organisms. While naticids prey on infaunal organisms, muricids prey on epifaunal and shallow buried molluscs. The species *Octopus vulgaris* is also known to prey on a wide range of molluscs.

We found that species composition and biodiversity do not correlate with DFs in our cores from the Northern Adriatic Sea. Differences were found for the abundance of prey organisms. It seems to be that more abundant species (e.g., *T. communis* at the cores of the PO) are affected by a higher predation risk. Moreover, it seems to be the case that nutrient and freshwater input, sedimentation rates and anthropogenic impacts shape the gastropod communities at this marine basin. We also found strong varying intensities in these factors between our sampling sites, which might explain some of the trends. While at the stations from the Po-delta, freshwater and sedimentation rates probably had a big influence on DFs, in Venice the benthic assemblages might suffer from the severe human dredging activities. In other cores were anthropogenic impact and abiotic factors are minimized (e.g., Brijuni) DFs do positively correlate with biodiversity.

The predation rates found in this study show values typical for Cenozoic basins, but differ strongly between sites in the Northern Adriatic Sea.
As for trends in DF along cores, we found that abiotic factors like freshwater input (overall low DF along the core) and the strong anthropogenic impact in some regions over recent decades (decrease of DF in uppermost core layers), might have a stronger impact on DFs than pure biotic interaction (stable or even increasing DFs along the core).

2 Zusammenfassung

Prädation durch molluskivore, bohrende Organismen hat großen Einfluss auf die Zusammensetzung einer Gemeinschaft und die Biodiversität von Regionen. In dieser Studie wurden Bohrspuren auf Gastropoden untersucht, um zeitliche und räumliche Muster von Prädation in der Nördlichen Adria zu verstehen. Die Stellen der Probenahme wurden gewählt, um ein möglichst großes Spektum an unterschiedlichen Habitaten abzudecken. Vom westlichen Ende der Noradria (Po-Delta) wo große Mengen an Süßwasser und Sediment sowie der anthropogene Einfluss das Ökosystem bestimmen, bis zum westlichen Ende (Brijuni-Insel) wo vollmarine Bedingungen herrschen und es zu kaum Eintrag von terrestrischen Sedimenten kommt. Zur zeitlichen Auflösung wurden Sedimentkerne einer Länge von ca 1.5m genommen und in Schichten geschnitten. Diese wurden dann auf Mollusken analysiert, die bestimmt, gezählt und danach auf Bohrspuren untersucht wurden.

Im Ganzen wurden 44393 Gastropoden gefunden. Die Prädationsintensitäten (PI) reichen von 7.5% am Po-Delta bis zu 31.23% in den Sedimentkernen von Piran. Der Mittelwert (Median) für die PI aller Kerne beträgt 16.93%.

Auf Familienniveau waren Cerithiidae die am häfigsten gefundenen Gastropoden (13208 Individuen), sie waren in jedem Sedimentkern zu finden außer in jenem von Panzano. Allerdings sind Turritellidae häufiger Opfer von molluskivoren Organismen (PI bis zu 58.96%) während Cerithiide in bis zu 39.27% aller Fälle bebohrt wurden. Es wurden insgesammt 2652 Individuen der species *T. communis* gefunden.

Epifaunal lebende Gastropoden wurden am häufigsten Opfer von Prädation (28,9%). Infaunal lebende Filtrierer (23.76%) und epibiontisch lebende Gastropoden (Gastropoden welche auf anderen Lebewesen leben ohne einander zu beeinflussen) (21.3%) waren jene Gruppen, die am zweithäufigsten Opfer von Räubern wurden. Dies ist insofern von besonderem Interesse, als diese beiden Gruppen durch ihre kryptische Lebensweise eigentlich vermeintlich gut vor Räubern geschützt sein sollten. Dadurch, dass molluskivore Organsimen (vor allem Muricidae und Naticidae Gastropoden und der Gemeine Krake (*Octopus vulgaris*)) in der Nordardia Räuber mit einem sehr breiten Beutesprektum sind, sind diese Ergebnisse aber weniger überraschend. Es scheint jedoch sehr wohl einen Unterschied betreffend der Mobilität von Beuteorgansimen zu geben, da Organismen mit höherer Mobilität (z.B. Räuber und Aasfresser) geringere PI Werte zeigen.

PI korrelieren generell nicht mit Biodiversitätsindices, es scheint aber sehr wohl der Fall zu sein, dass Organismen die höhere Abundanzen haben, eher zu Opfern von Prädation werden. Dies könnte vor allem daran liegen, dass die Nördliche Adria betreffend ihrer einzelnen Habitate sehr unterschiedlich ist. So könnten z.B. im Po-Delta der Süßwassereintrag und hohe Sedimentationsraten ein stärkerer regulierender Faktor für die Biodiversität sein, als es die Prädation ist. Die benthische Lebensgemeinschaft vor der Küste von Venedig dürfte, in jüngster Zeit (100 bis 300 Jahre) stärker durch dredging beeinflusst sein; Prädation dürfte vorallem in älteren Schichten für die Fluktuationen in der PI verantwortlich sein. Für Sedimentkerne wo der anthropogene Einfluss und abiotische Umwelteinflüsse geringer sind (z.B. Brijuni) wurde eine positive Korrelation zwischen Biodiversität und PI festgestellt.

Die PI die in dieser Arbeit gefunden wurden befinden sich auf einem typisch kanäozischem Niveau. Allerdings differieren sie stark zwischen den einzelnen Habitaten.

Prädations Intensitäten entlang einzelner Bohrkerne scheinen stärker von abiotischen Faktoren wie Sedimentation und süßwasser Eintrag (generell niedrige PI), sowie durch Anthropogene Nutzung (abnahme der PI in den oberen Schichten der Kerne) beinflusst zu sein, als durch reine biotische Interaktionen (ansteigende PI bzw. gleichbleibende PI entlang der Kerne).

3 Introduction

The Northern Adriatic Sea is a marine basin, heavily influenced by anthropogenic use and riverine input. Its shallow depth (<50m), intense anthropogenic influence and densely populated shorelines make this ecosystem very sensitive (Lotze et al. 2006). These impacts may be especially severe in the benthic ecosystem, where molluscs play an important role. We focused in this study on the impact of predation on gastropod communities. Predation is known to play an important role in regulating ecosystem processes. Therefore, changes in the predation rates might give insights into environmental changes through time. Predators of gastropods in the Northern Adriatic Sea are mostly gastropods of the families Naticidae and Muricidae. While Naticidae (e.g. *Euspira nitida* (Donovan)) prey mostly on infaunal molluscs (Yochelson et al. 1983), muricid predators (e.g. *Hexaplex trununculs* (Lamark)) favour epifaunal and shallow buried molluscs (Peharda & Morton 2006; Morton et al. 2007; Sawyer et al. 2009). It is also known that especially gastropods are preyed upon by the species *Octopus vulgaris* (Lamark) which is very common in the Northern Adriatic Sea (Nixon 1979). For this study, we were using drill holes as a proxy for predation intensities and therefore changes in the ecosystem. We analysed sediment cores from eight different sites in the Northern Adriatic Sea to account for different levels of anthropogenic and environmental impact and tested the following hypotheses:

1. Higher DF occur in nutrient-rich regions, than in oligotrophic ones.
2. DF is linked to life habits of prey organisms. Metabolically less-active gastropods (filter-feeders) are more likely to be drilled than more active ones (predators). Also, DF might differ between gastropods living infaunal, epifaunal or epibiontic.
3. DF is positively correlated with diversity.
4. DF in the Northern Adriatic is on a pre-Cenozoic level.
5. DFs over time are stronger influenced by changes in abiotic factors than by biotic interactions.

4 Sampling Area

The Northern Adriatic Sea is a semi-enclosed basin. It is located at the northern end of the Adriatic Sea, with a length of >300km and a depth of <50m, between Italy, Slovenia and Croatia. Its southern border is defined as an imaginary line from Ancona (Italy) to the southern tip of Istria (Croatia). This line follows approximately the 50m isobath, dividing the Northern Adriatic and the Central Adriatic Shelf. The shelf area is a low energy environment with low wave height and a small tidal range. Today's basin was flooded due to a sea level rise in the Holocene, therefore it is a young marine basin (McKinney 2007). The seafloor is formed by relict Pleistocene sands, covered by Holocene mud (Pigorini 1968; Goff et al. 2006). Late sands are found in the coastal areas of the Northern Adriatic Sea. The inner shelf is defined by fine sand. The sediment is becoming finer towards the middle shelf, which is formed by silt and clay. The outer shelf is built by relict sands (Zuschin & Stachowitsch 2009) (Fig. 1).

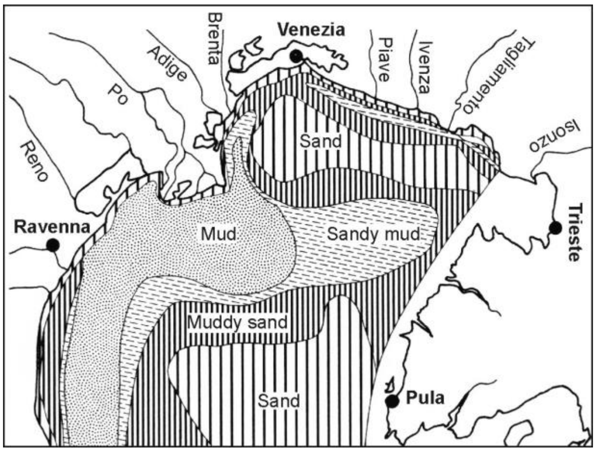

Figure 1: Sediment composition of the Northern Adriatic Sea (from Zuschin & Stachowitsch 2009).

Mean surface temperature is 7°C in winter and 24°C in summer, with a water salinity of 30-35‰ (Cushman-Roisin et al. 2001; Janekovi et al. 2010).

The river Po, at the western coast of the basin, is known to transport large amounts of freshwater and sediments. Once they reach the Northern Adriatic, freshwater circulates southwards and pushes the cyclonic surface circulation of the basin. Sediments and nutrients are spread southwards by the river flow, and by a counter-current towards the north, close to Venice (Fig. 1). Nutrient input from the Po results in a eutrophic to even hypertrophic environment at the Po delta and at the off-shore regions of Venice and the Gulf of Trieste. The western part of the Northern Adriatic Sea, especially the coast of Croatia, is a mesotrophic environment (Barmawidjaja et al. 1995). Due to the high nutrient input from the Po River, the Northern Adriatic Sea has a higher productivity compared to other parts of the Mediterranean (Zavatarelli 1998).

5 Material and Methods

Sediment cores were taken in 2013, using an UWITEC piston corer at seven sites in the Northern Adriatic Sea (Fig. 2). At the seven sites, a total of nine cores were taken. One at Brijuni (M44), two at Piran (M1 and M53), two at Panzano (M28 and M29), one at Venice (M38) and three at the Po delta (M13, M20 and M21).

Figure 2: Sampling area. Positions of stations where samples were taken are marked by a pin.

Of the three cores taken at the Po delta, two were offshore the coast in fishery and shipping areas and one (M20) was taken near an oceanographic buoy (marine protected area). Off the coast of Venice one core was taken. In the Gulf of Trieste four cores were taken in total. Two near the river mouth of Isonzo, at Panzano (M28 & M29). The other two cores were taken off the shore of Piran, with one (M1) close to an oceanographic buoy. To cover the whole geographic area of the Northern Adriatic Sea, one core was taken on the east coast, near the Islands of Brijuni. This station used to be near an oceanographic buoy, but it was removed one year prior to our sampling.

The sediment cores were either 9 or 16 cm in diameter, depending on substrate characteristics, and ranged from 140 to 160 cm in length. Cores were sliced into layers to determine changes in community composition, species abundance and predation over time. The upper 20 cm of each core were sliced into 2cm thick layers, to take recent changes in the environment into account. Below 20cm the core was sliced into 5cm thick layers.

For the analysis of drill holes, only complete specimens were studied. Individuals were distinguished at the species level and counted. Afterwards drill holes, which met the following criteria, were counted: circular in cross section, smooth sides, and oriented perpendicularly to the outer shell surface (Carriker & Yochelson 1968; Rohr 1991; Leighton 2001).

The intensity of drilling predation was characterised using four parameters.

1. Drill frequency (DF) is calculated by using the number of total drills (complete drills, multiple drills and edge drills) and dividing it by the number of total individuals. DF is therefore an index for the total attacks on gastropods. Calculation of DF was done for each species and each layer of every core.
2. Incomplete drill frequency (IDF) gives the ratio of incomplete drill holes, per total individuals present. It is calculated by dividing all incomplete drill holes by the total number of individuals.

IDF can be used as an indicator for failed predatory attacks (Vermeij 1983; Kowalewski 2002; Dietl 2003).

3. Prey effectiveness (PE) is the ability of an individual to withstand an attack. It is calculated by dividing the number of incomplete drill holes by the number of total drills (incomplete drills plus complete drills) (Vermeij 1987; Kowalewski 2002).
4. Multiple drilling frequency (MDF) is calculated for those shells that show more than one drill hole. These drill holes can be either complete or incomplete. For the calculation, the number of individuals showing multiple drill holes was divided by the total number of individuals.

Feeding strategies and ecotypes of species and families were considered, to evaluate for possible predator preferences. The feeding guilds of gastropods analysed were: herbivores, carnivores, filter feeders, grazers, detritus feeders, micro&macro-herbivores, micro-carnivores and scavengers. Ecotypes were distinguished in seven different categories. For non-cryptic ecotypes four different categories were defined: organisms living epifaunal on hard substrate, organisms living epifaunal on soft substrate, organisms living epifaunal on both substrates with no clear preference for either, organisms living epifaunal on vegetation. For organism with a cryptic lifestyle we distinguished between three different ecotypes: epibiontic living organisms (meaning organisms living attached to others without any interaction), semi-infaunal living organisms and infaunal living organisms.

For all sampling stations, the sediments were analysed regarding grain size composition, nutrient- and heavy metal concentrations. Additionally, sediments were dated radiometrically using Pb-210 to calculate sedimentation rates.

Statistical analysis was conducted by using the statistical software R. Graphs were produced in R by using the package “scales”.

7 Results

7.1 Grain size analysis

Concerning grain size, the stations of Panzano and the Po delta show a similar picture (Fig. 3). Panzano is characterised by a split of nearly 50% to 50% in silt and clay fractions, as are the cores of Po M13 and M21. The core from the Po delta station (M20), consist of around 40% clay and 60% silt throughout the core.

The core of Brijuni displays a shift in grain size, from base to top. Att he deepest core layers the sediment consists of around 10% clay, 70% silt and 20% sand. In the core interval of 90 – 130 cm the proportion of clay slightly decreases to around 8% and silt decreases below 15%. In accordance, the proportion of sand increases to 50% and around 30% of the sediment is gravel. In the upper layers, clay and silt levels increase accounting for nearly 70% of the total sediment. The proportion of sand is around 10-20% and around 10% is gravel (Fig. 3).

Both Piran sites show stable amounts of clay throughout the cores (15%). The silt fraction is decreasing in both cores from bottom to top, representing 60% of the total sediment at the bottom and only around 15% in the uppermost layers. Sand increases within both cores. From 15% in bottom layers up to 60% in modern layers. Both cores show a peak in gravel at the upper third of the core. With gravel representing around 20% of the sediment (Fig. 3). The Venice core is characterised by 100% sand throughout the whole core (Fig. 3).

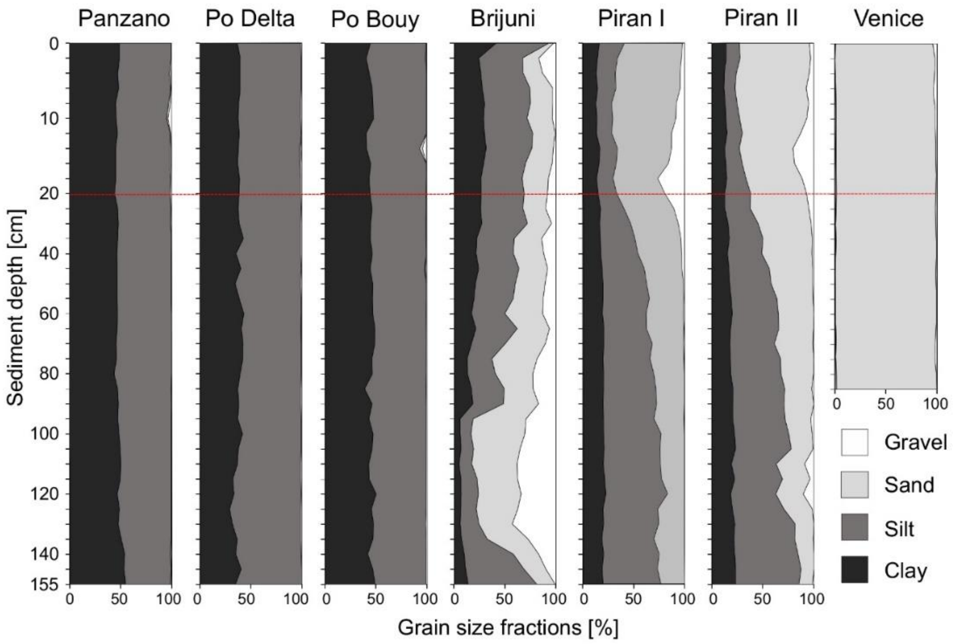

Figure 3: Grain size composition of the cores sampled. The X-axis represents grain size fractions (%). The Y-axis represents the core depth in cm.

7.2 DF, IDF, MDF

Within all cores, a total of 44393 gastropod individuals and 201 species were found. The highest abundance was found in the Piran cores with a total of 29826 individuals. The highest species richness, was found in the Brijuni core with a total 125 species. The lowest abundance and species richness occured at the Po stations with a total of 809 individuals and 33 species within all three cores. Median DF was 16.93% across all cores. Highest DF was found in the Piran M1 core with 31.23%, whereas lowest DF was found in the Po M20 core with 7.5% (Tab. 1).

No incomplete drill holes were discovered at the Po stations. Highest IDF values occured in the Panzano M28 core with 0.46%. Overall IDF is 0.13% (Tab. 1).

MDF is highest at the station of Piran M1 (1.42%) and second highest at Panzano M29 (1.37%). The stations Brijuni (0.26%), Piran M53 (0.39%) and Panzano M28 (0.38%) show values one order of magnitude lower than those at Panzano M29 and Piran M1. No multiple drilling was found at the Po stations and at the Venice station. The overall MDF is 0.43% (Tab. 1).

PE, calculated across all cores is 0.66%, with the highest value at Panzano M28 (1,91%). The other Panzano core has the second highest PE value with 1.2%. The values found for the cores of Piran were found to be half the PE at Panzano. PE at the Piran cores were 0.56% (M1) and 0.23% (M53). Venice (0.82%) and Brijuni (0.9%) show intermediate values.

Core	Total	Species number	Drills	DF (%)	IDF (%)	MDF (%)
Piran M1	10795	109	3371	31,23	0,18	1,42
Po M13	185	16	22	11,89	0,00	0,00
Po M20	360	19	27	7,50	0,00	0,00
Po M21	264	18	22	8,33	0,00	0,00
Panzano M28	1524	41	359	23,56	0,46	0,38
Panzano M29	1850	41	410	22,16	0,27	1,37
Venice M38	1219	81	121	9,93	0,08	0.00
Brijuni M44	9165	125	1325	14,46	0,13	0,26
Piran M53	19031	110	4430	23,28	0,05	0,39
Total	**44393**	**201**	**10087**	**16,93**	**0,13**	**0,43**

Table 1: Median drill frequency (DF), incomplete drill frequency (IDF) and multiple drill frequency (MDF) shown for each core and in total. Total refers to the total number of gastropod individuals found in the core. Drills is the number of complete drill holes in the core.

For comparison between cores *Nassarius pygmaeus (Lamarck, 1822)* was chosen, because it occurred in each core and was also frequently drilled.

7.2.1 Venice

This core has a length of 135 cm and is therefore the shortest of all cores analysed. In total 1239, gastropod individuals of 81 species were found. Total DF, within the core is 9.93% (Table 1).

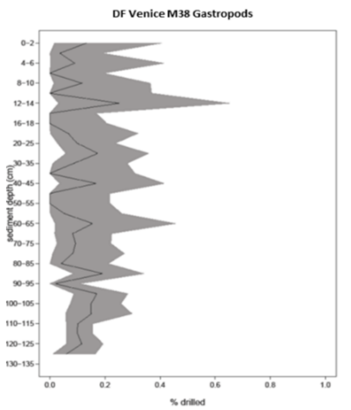

Figure 4: DF at Venice core. Grey shade displays 95% CI. Black line displays DF along the core

Figure 4 (Venice) shows DF along the Venice core. Highest DF value of 25% occures at 12-14 cm. While DF is rather constant in the lower part of the core (95-130 cm core depth) fluctuates in the middle and upper part (0-90 cm core depth) with no drill holes found at three intervals (14-18 cm, 35-40 cm and 50-55 cm).

Figure 5 (Venice) shows DFs of *Bittium latreillii (Payraudeau, 1826)* and *N. pygmaeus*. *B. latreillii* were the most abundant and most-drilled species of this core. Its DF was high in the lower part of the core, with up to 50% at 100 cm core depth. In the middle and upper part DF strongly fluctuates between 0% and 50%. *N. pygmaeus* was only drilled in the bottom layers of the core with a maximum of nearly 20% at 120cm core depth. No drilling on *N. pygmaeus* occured in the middle and upper part of the core.

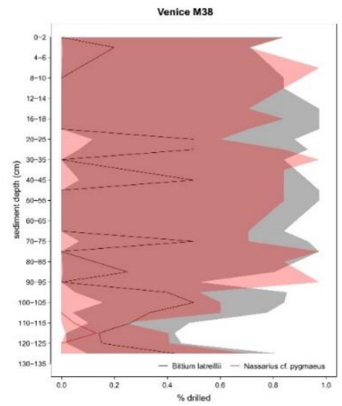

Figure 5: DF of B. latreillii (red) and N. pygmaeus (grey) along the core. Shading shows 95% CI. Lines display DF along the core.

Total IDF was 0.08% with only one incompletely drilled individual at 115-120cm core depth (Fig. 6).

No multiple drilled individuals were found in this core.

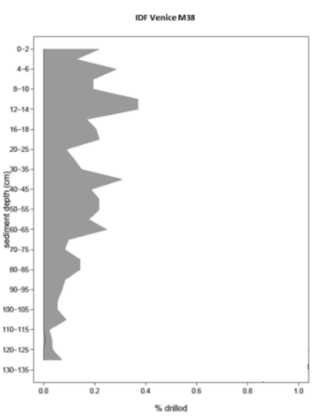

Figure 6: IDF along the Venice core. Grey shade displays 95% CI. Black line displays IDF along the core.

7.2.2 Panzano

7.2.2.1 M28

This core is one of two taken at Panzano station. It has a core length of 150cm. In total 1524 Individuals of 41 species were found. Total DF was 23.56% (Tab. 1).

As shown in Fig. 7 (Panzano M28), overall DF decreases towards the top of the core. The highest values can be found at the bottom, with a maximum peak of 60% in DF at the 120-125 cm interval. The lowest values of DF were found at 70-85 cm core depth, where drilling only occured in 15% of all individuals. In the middle part of the core (18-70 cm) DF is stable, fluctuating around 25%. A strong decrease can be observed in the top layers. From nearly 40% at 18 cm core depth to 0% DF in the top layer.

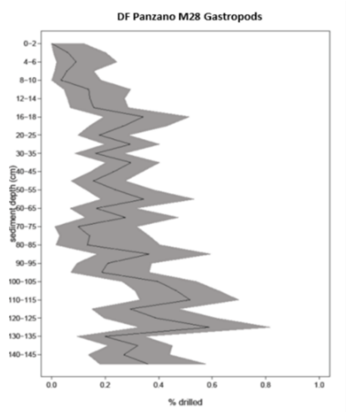

Figure 7: DF along Panzano M28 core. Grey shade displays 95% CI. Black line displays DF along the core.

The DF patterns of *Turritella communis (Risso, 1826)* and *N. pygmaeus* are very like the overall DF. Highest DF is observed in the 120-125cm layer, while lowest values were found around 70-80cm core depth. The strong decrease in modern layers can be more clearly seen in DF of *N. pygmaeus*. No individuals of *T. communis* were found in the top layer of the core (Fig. 8).

Total IDF is 0.46% (Tab. 1) and three peaks with around 5% were found at 65-70cm, 105-110cm and 140-145cm core depth (Fig. 9).

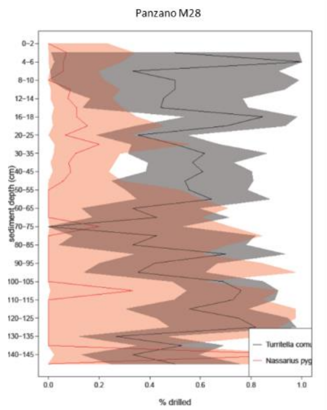

Figure 10: DF of T. communis (grey) and N. pygmaeus (red) at Panzano M28. Shading shows 95% CI. Lines display DF along the core.

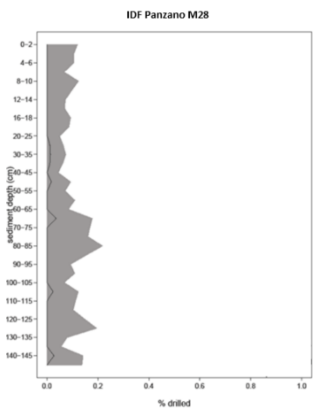

Figure 9: IDF along Panzano M28 core. Grey shade displays 95% CI. Black line displays IDF along the core.

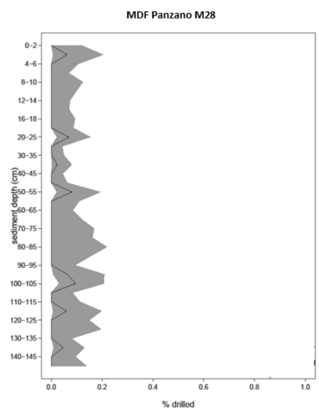

Figure 8: MDF along Panzano M28 core. Grey shade displays 95% CI. Black line displays MDF along the core.

Total MDF is 0.38% (Tab. 1) and reaches a maximum of 10% at the layer of 95- 105cm. Over large parts of the core no multiple drill holes were observed (Fig. 10).

7.2.2.2 M29

In Panzano M29 core, 1850 individuals in 41 species were found. Total DF was 22.16% (Table 1). Total core length was 150 cm.

DF shows a similar pattern, as found in the other Panzano core. The highest values are at lower core depth and overall DF decreases towards the top. The middle part of the core (18-65 cm) has a quite stable DF, whereas in the lower parts of the core, strong fluctuations can be observed. Highest DF, with over 60% of all individuals drilled, was found at the 115-125cm depth layers. Lowest values were found at 80-85cm interval with around 10% of individuals drilled. Within this interval, the lowest abundance of individuals was found. Again, the overall lowest abundance of individulas was found in the top layers, where DF is strongly decreases starting at 18cm core depth (Fig. 11).

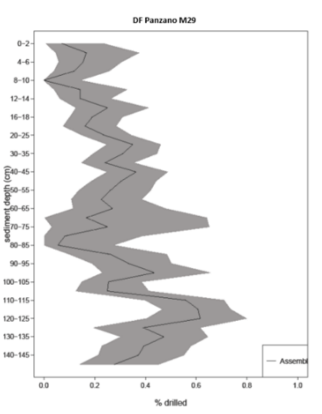

Figure 11: DF along the Panzano M29 core. Grey shade displays 95% CI. Black line displays DF along the core.

Figure 12 (Panzano M29) shows the DF of *T. communis* and *N. pygmaeus*, which were the most frequently drilled species within this core. *T. communis* shows overall higher drilling intensity compared to *N. pygmaeus*. Highest drilling frequency in *T. communis* was observed at 60-65cm core depth, with nearly 100% of all individuals drilled. The species shows a high fluctuation in DF in the upper layers of the core. Within these layers, species abundance was also very low. Highest values of DF paired with high species abundance can be found at layers of 110-125 cm core depth. There DF reached over 80% and a total of 89 individuals of *T. communis* were found. In the top layers where DF is strongly fluctuates, only 31 specimens within the first 16cm were found. No individuals of *T. communis* were found at the 10-12cm layer. No individuals of *N. pygmaeus* were found below 65cm core depth. Above 65cm core depth DF has a maximum of 20% and an overall median of 10.5%.

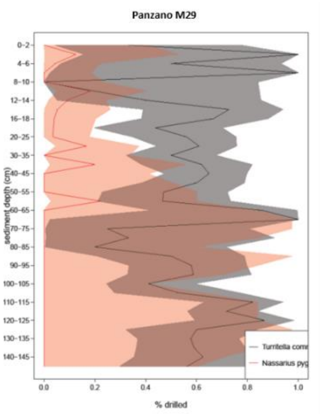

Figure 12: DF of T.communis (grey) and N. pygmaeus (red) at Panzano M29. Shading shows 95% CI. Lines display DF along the core.

Total IDF is 0.27% (Tab. 1). As shown in Figure 13 (Panzano M29), highest IDF was found at the 65-80cm interval, where IDF reaches nearly 15%. Three small peaks of incomplete drilling with around 5% were found at 20-25cm, 135-140 cm and 145-150cm core depth.

MDF is ranked second highest among all cores (1.37%) (Tab. 1). As in other cores, Figure 14 (Panzano M29) shows that in most parts of the core, no multiple drilling occured. Three small peaks of around 5% multiple drilled individuals were found at the layers of 145-152 cm, 135-140 cm and 20-25 cm core depth. The layer with the highest value of drilled individuals is 70-75 cm, where more than 12% of all individuals are multiply drilled. This high value, however, comes from only 2 multiple drilled individuals out of a total of 15 individuals within this layer.

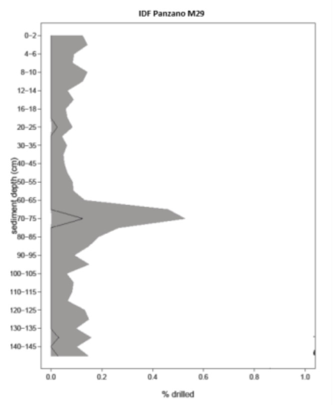

Figure 13: IDF along the Panzano M29 core. Grey shade displays 95% CI. Black line displays IDF along the core.

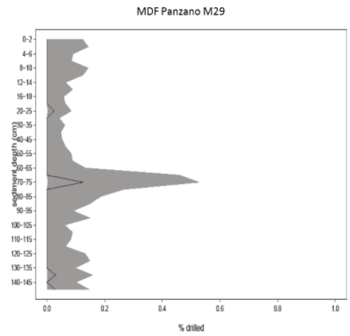

Figure 14: MDF along the Panzano M29 core. Grey shade displays 95% CI. Black line displays MDF along the core.

7.2.3 Po

Sampling stations at Po are influenced by high sedimentation rates (up to 2cm per year) and high freshwater input.

7.2.3.1 Po M13

In total, 185 individuals in 16 species were found within this core. Therefore, this core has the lowest values of species abundance as well as of species richness. The total core length is 152 cm. Overall DF was highest of all Po cores with 11.89% (Tab. 1).

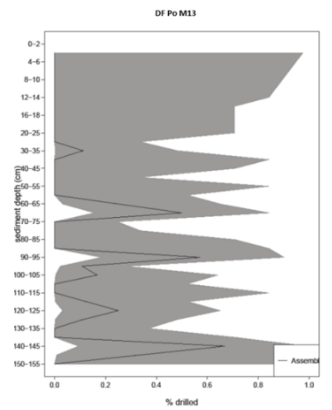

Figure 15: DF along the Po M13 core. Grey shade displays 95% CI. Black line displays DF along the core.

Concerning DF along the core, it is interesting that no drilling occurred in the uppermost 25 cm of the core (grey shading indicates 95% CI of DF). Within this core segment also only 25 gastropod individuals were found. Highest drilling frequencies occur in the lowest layers of the core, reaching a maximum of over 60% at 145-150cm. In total, DF strongly fluctuates along the core. The layers where DF has the lowest values (130 cm, 110cm, 70-85 cm and 35-60 cm) are always after a layer with a high DF value (140-145 cm, 115-120 cm, 85-90 cm and 65-70 cm) (Fig. 15).

Figure 16 (Po M13) shows that no drilling occured in *N. pygmaeus* and mostly all drilling happened *on T. communis*. *N. pygmaeus* did was only found in the middle part of the core not at the top and bottom layers. DF in *T. communis* varies strongly through the core. As observed in the overall core DF, a layer of high DF is always followed by a complete lack in drilling. In general DF of the core assemblage follows DF of *T. communis*.

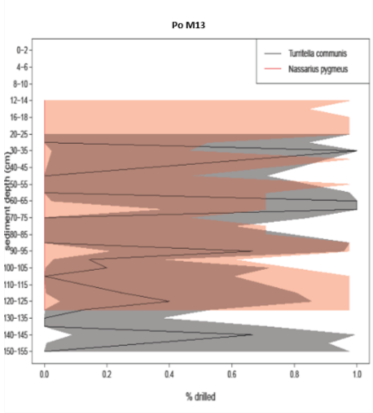

Figure 16: DF for T.communis (grey) and N. pygmaeus (red) at Po M13. Shading shows 95% CI. Lines display DF along the core.

No incomplete drilling or multiple drilling was found in core M13.

7.2.3.2 Po M20

In this core, a total of 360 individuals in 19 species were found. Overall DF was 7.50%, which is the lowest value measured within all cores (Tab. 1). Total core length was 150 cm.

DF is highest in the lowest parts of the core, and is decreasing up-core. 66% drilled individuals at the bottom layer is derived from a total of only 3 individuals of *T. communis*. Up-core, DF declines. No drill holes were found in the most modern layers (Fig. 17)

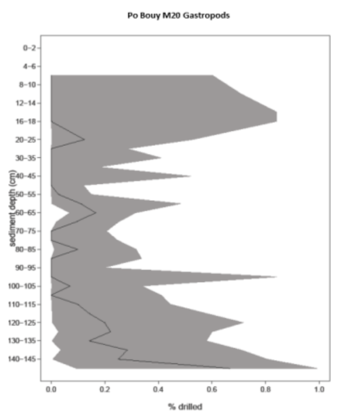

Figure 17: DF along Po M20 core. Grey shade displays 95% CI. Black line displays DF along the core.

Fig. 18 (Po M20) shows two peaks in drilling for *T. communis,* which are both in layers with low individual numbers. As mentioned before at the 145-150 cm layer only 3 individuals occured with 2 of them drilled. At the 60-65 cm layer 7 individuals were found, of which 6 are drilled. Drilling in *N. pygmaeus* is overall very low, with the only drill holes found in the layers of 50-55 cm and 60-65 cm core depth. Overall occurrence of *N. pygmaeus* is also restricted to the middle part of the core (115 cm to 18 cm core depth).

No incomplete drill holes or multiple drill holes were found in this core.

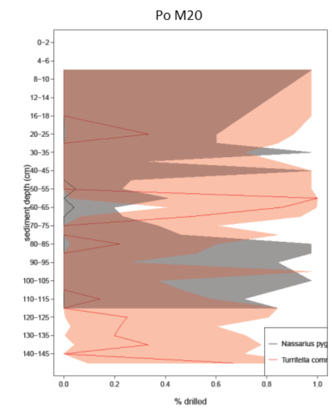

Figure 18: DF of N.pygmaeus (grey) and T.communis (red) at Po M20 core. Shading shows 95% CI. Lines display DF along the core.

7.2.3.3 Po M21

264 individuals and 18 gastropods species were found at Po M21. Total DF was 8.33% (Tab. 1). The core had a length of 155cm.

Fig. 19 (Po M21) shows the overall DF along the core. No drilled specimens were found in the lowest layer of the core, but in general DF was highest at the bottom layers of the core, showing a similar picture as the other cores from Po. DF decreases towards the top layers. However, in contrast to the other two cores from Po, drill holes occur in the top layers (6-8cm) of this core. This sharp peak comes from 3 individuals of *T. communis* of which 1 is drilled. Highest DF, with 60%, can be found at the 140-145 cm layer, with a second peak of around 50% DF at 125-130 cm core depth.

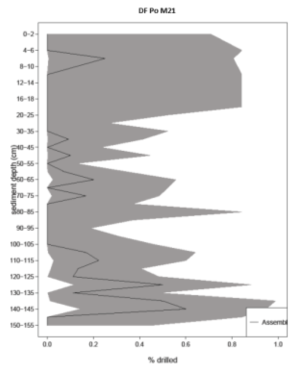

Figure 19: DF along Po M21 core. Grey shade displays 95% CI. Black line displays DF along the core.

As shown in Fig. 20 (Po M21) no drill holes occured in *N. pygmaeus*, but in contrast to other cores of this station, the species is not limited to the middle part of the core. As *T. communis* was by far the most frequently drilled species, it shows the same pattern as the overall drilling for this core.

Within this core no incomplete or multiple drill holes were found.

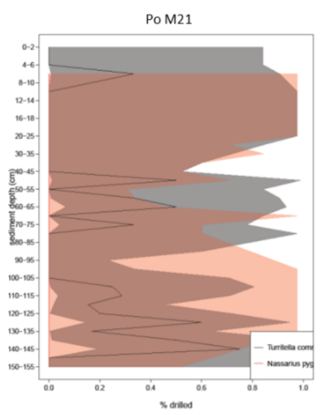

Figure 20: DF of T. communis (grey) and N. pygmaeus (red) along Po M21 core. Shading shows 95% CI. Lines display DF along the core.

7.2.4 Brijuni

With 125 species, the Brijuni core has the highest species number among all cores sampled. Total species abundance was 9165, and therefore third highest of all cores. Total DF was 14.46% (Tab. 1). This core was dated to 8000 years at the bottom layer, and is therefore covers the longest period of all sampled cores. With a total core length of 160 cm this core was also the longest one sampled.

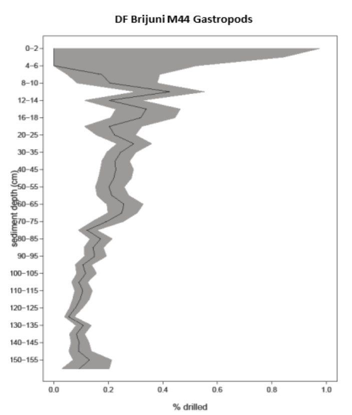

Figure 21: DF along Brijuni M44 core. Grey shade displays 95% CI. Black line displays DF along the core.

As shown in Fig. 21 (Brijuni), DF increases up-core, with a total collapse in the most modern layers. Between 155 cm and 80 cm core depth, DF is stable around 15%. Up-core of 80 cm, DF increases to nearly 30% at the 25-30 cm layer. Afterwards DF starts to fluctuate, with under 18% at the 12-14 cm layer and more than 40% at the 10-12 cm layer. At the top layers (0-6cm core depth) no drill holes were observed. Highest species abundance was found in the bottom and middle layers of the core, with a maximum of 749 Gastropod individuals in the 125-130 cm layer. Towards the top, species abundance is decreasing, reaching its minimum in the most modern layers. From 0-6 cm core depth, only 8 gastropod individuals were found. The highest species number (89) was found at the 95-100 cm layer. Species number also decreases towards the top of the core, with only one species and individual in the most modern layer (*Calyptraea chinensis Linnaeus, 1758*).

Fig. 22 (Brijuni) shows the DF of *Alvania geryonia* (*Nardo, 1847)* and *N. pygmaeus* along the core. *A. geryonia* is represented by a total of 1230 individuals, and was therefore the most abundant species in this core. In lower layers, DF in *A. geryonia* fluctuates around 15%. In the middle part, two peaks in DF can be observed at 70-75 cm and 35-40 cm core depth, both with over 35% drilled individuals. The high peak of 100% drilled individuals at the 14-16 cm layer comes from a single individual. The overall decrease in abundance is also clearly visible in *A. geryonia*, with a maximum of 132 individuals at the 120-125 cm layer. The species only rarely occurs in the top most layers and is completely missing at 0-4 cm, 6-10 cm, 12-14cm and 18-20 cm core depths. A similar trend can be found for *N. pygmaeus* in abundance as well as in DF. Although in *N. pygmaeus* no drill holes were discovered in the lowest layers of the core, DF is highest in the middle part, with a maximum of 37% at 55-60cm core depth. DF of *N. pygmaeus*, however, strongly fluctuates throughout the core, with a total breakdown found after peaks. Total abundance is 283 individuals with a maximum of 29 per layer, at 135-140 cm and 140-145 cm. No individuals were found at 0-6 cm, 10-12 cm and 16-20 cm core depth.

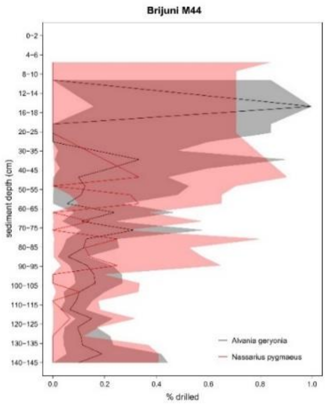

Figure 22: DF of Alvania geryonia (grey) and N. pygmaeus (red) at the Brijuni core. Shading shows 95% CI. Lines display DF along the core.

Total IDF is 0.13% (Tab. 1) with nearly no incomplete drilling in the lowest parts of the core, and only some small peaks at 110-150 cm, 90-95 cm, 75-80 cm and 55-60 cm core depths. The strongest peak with 5% incompletely drilled individuals was found at 14-16cm core depth (Fig. 23).

MDF was highest in the upper layers of the core. It reached a maximum in the 10-12cm layer, with nearly 15% multiple drilled shells. Another quite strong peak was found at the 40-45 cm layer (nearly 10%). In the lower parts of the core no multiple drill holes were found. A small peak at the middle part of the core (90-95cm core depth) shows an MDF of 4% (Fig. 24).

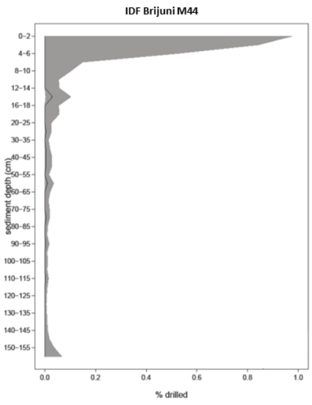

Figure 23: IDF at Brijuni M44 core. Grey shade displays 95% CI. Black line displays IDF along the core.

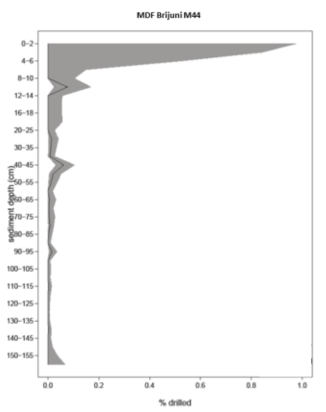

Figure 24: MDF at Brijuni M44 core. Grey shade displays 95% CI. Black line displays MDF along the core.

7.2.5 Piran

The cores from Piran were highest in species abundance among all cores. Also the highest values of DF were found in these two cores (Tab. 1).

7.2.5.1 Piran M1

Within this core, a total abundance of 10795 individuals in 109 species was found. DF is highest among all cores, reaching 31.23% (Tab. 1). Total core length was 142 cm.

Overall DF, as shown in Fig. 25 (Piran M1), increases towards the top of the core. In the bottom layers (100-142 cm) DF fluctuates around 20%. A sharp peak in DF can be observed at 95-100 cm core depth, with drilling intensities of over 35%. Above, DF decreases again to the 20% level and afterwards slowly increases again to more than 40% in the 18-20cm layer. In the upper layers, DF is stable around 37%. Upper layers have higher species abundance than older layers. A maximum of 2182 individuals occurs in the 20-25 cm layer and the second highest value in 10-14 cm core depth with 2093 individuals. The abundance minimum was found in the 120-125 cm layer with only 43 individuals.

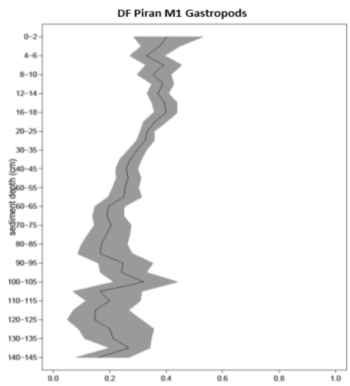

Figure 25: DF along Piran M1 core. Grey shade displays 95% CI. Black line displays DF along the core.

The trend of an increase in DF towards upper layers can also be observed when looking at the most abundant species of the core (Fig. 26). In total 2037 individuals of *Bittium latreillii (Payraudeau, 1826)* were found, with a maximum of 255 individuals in 20-25 cm core depth. Drilling intensity strongly fluctuates in the bottom layers of the core, where abundance is low. 100% DF comes from one single individual at 120-125 cm core depth. As abundance increases towards the top, stablizes. Nonetheless a clear trend of increase in DF from bottom to top is evident. This is also true for *N. pygmaeus*, which is less drilled in lower layers of the core, compared to upper layers. The increase in DF starts for both species at the 70-75 cm layer. *N. pygmaeus* shows a peak in DF (nearly 60%) at 16-18 cm. Abundance of *N. pygmaeus* is quite stable throughout the core with a maximum of 154 individuals in the 30-35 cm layer.

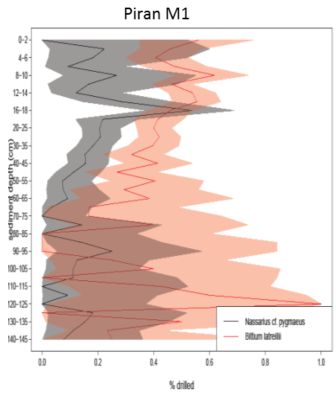

Figure 26: DF for N. pygmaeus (grey) and B. latreillii (red) at the Piran M1 core. Shading shows 95% CI. Lines display DF along the core.

Incomplete DF in this core is 0.17% (Tab. 1). Figure 27 (Piran M1) illustrates that highest numbers in incomplete drills were found in the lower layers of the core. Most incomplete drill holes occured in the 95-110 cm interval.

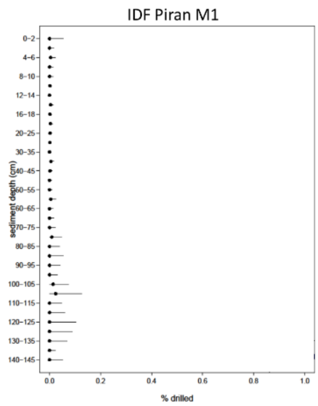

Figure 27: IDF along the Piran M1 core. Grey bars display 95% CI. Black dots display IDF along the core.

Multiple drilling frequency shows a weak trend of increase towards the top of the core. In bottom layers MDF reaches a maximum of 5%. Starting from 25 cm up-core, MDF shows an increase, until it reaches its total maximum of 10% in the uppermost layer (Fig. 28).

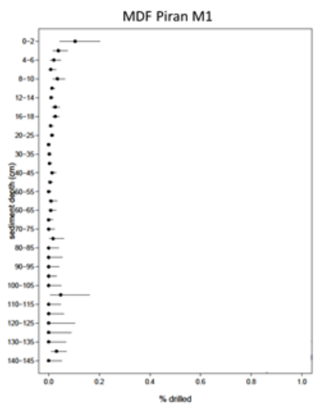

Figure 28: MDF at the Piran M1 core. Grey bars display 95% CI. Black dots display MDF along the core.

7.2.5.2 Piran M53

19031 Individuals were found in this core. This is the highest value of all cores. Total species number (110) was second highest of all cores. DF is relatively high with 23.28%, incomplete DF (0.05%) is lowest (Tab. 1). Total core length was 152 cm.

As shown in Figure 29 (Piran M53), DF increases up-core. Highest values of DF were found in the top most layers. In the interval of 8-14 cm DF reached 35%. The lowest value in DF was found at the 110-115 cm layer, were DF reached 10%. In the lowest layer (145-152 cm), DF is above 20%. This layer also shows lowest species abundance, with 45 individuals found in total. At the interval of 70-145 cm DF fluctuates around 15% with a peak at 70-75 cm, where DF reaches 20%. Up-core from 65cm core depth, DF increases slightly, reaching its maximum in the uppermost layers of the core. By far the highest abundance per layer was found in the 8-10 cm interval with 1082 individuals and the 6-8 cm layer with 890 individuals.

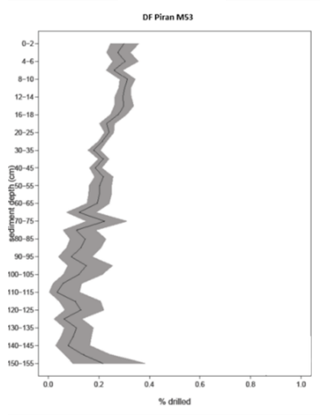

Figure 29: DF at Piran M53 core. Grey shade displays 95% CI. Black line displays DF along the core.

DF of *B. latreilllii* shows a quite strong fluctuation along the core. In the lowest parts (130-152 cm) DF fluctuates between 20% and 60%. At 70-130 cm core depth DF reaches a maximum of 30%, with some layers were no drill holes occured at all (95-100 cm, 110-115 cm and 120-130 cm). Up-core of the 70 cm layer, DF fluctuates around 30%, with a depression at 30-35 cm, where less than 20% of the individuals were drilled. A peak at the 10-12 cm layer was found, with more than 40% drilled individuals. DF in *B. latreillii* decreases again in the topmost layers of the core, from over 40% at the 10-12 cm interval to slightly under 30%. In *N. pygmaeus* nearly no drill holes were found in the lowest layers of the core. Only 2 peaks can be found at the 120-125 cm and 90-85 cm layer, none of them reaching more than 20% DF. Starting up-core from 70 cm core depth, DF increases and fluctuates around 10%. The highest DF found for *N. pygmaeus* is 25% in the 16-18 cm layer (Fig. 30).

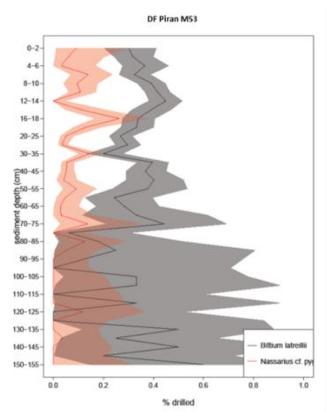

Figure 30: DF for B. latreillii (grey) and N. pygmaeus (red) at Piran M53. Shading shows 95% CI. Lines display DF along the core.

Total IDF is 0.28%, with only one peak at the 135-140 cm layer of the core (Fig. 31).

Total MDF is 0.39%. Along the core, only 3 small peaks in MDF were found, none of them reaching more than 5% (130-135 cm, 50-60 cm and 8-12 cm) (Fig. 32).

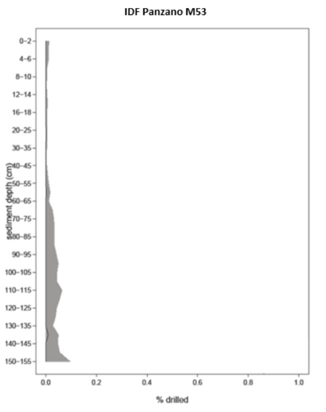

Figure 32: IDF at Piran M53. Grey shade displays 95% CI. Black line displays IDF along the core.

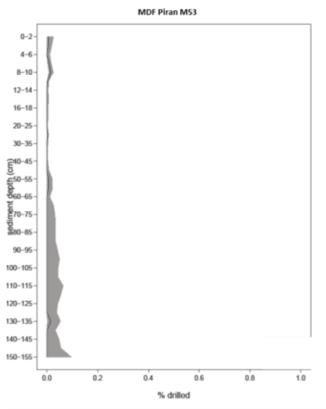

Figure 31: MDF at Piran M53. Grey shade displays 95% CI. Black line displays MDF along the core.

7.3 PE

Table 2 shows prey effectiveness values for all stations, for which PE was calculated. PE was not calculated for the stations of Po, as no incomplete drill holes were found. Highest PE was found for the cores from Panzano, where PE was above 1% (1.9% M28 and 1.2% M29). Venice and Brijuni show similar values in PE, 0.9% in Brijuni and 0.82% for Venice. Piran stations show the lowest values in PE, with 0.53% at Piran M1 and 0.23% at Piran M53.

Core	Ntot	Ndrill	PE (%)
Piran M1	10795	3390	0.56
Panzano M28	1524	366	1.91
Panzano M29	1850	415	1.20
Venice M38	1219	122	0.82
Brijuni M44	9165	1337	0.90
Piran M53	19031	4440	0.23
Po stations	809	71	0.00
Total	**43584**	**10070**	**0,66**

Table 2: Total PE values for all stations.

7.3.1 Venice

PE at the Venice station was 0.82% (Tab. 2). Figure 33 shows that the only layer where prey effectively resistes predation was at 120-125 cm, where around 5% of all drilled shells withstood drilling attacks.

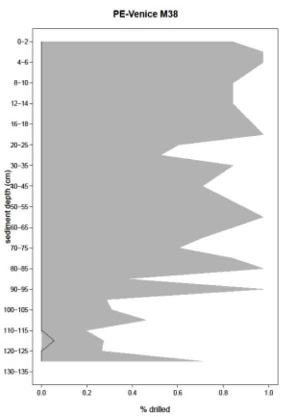

Figure 33: PE at the Venice station. Grey shade displays 95% CI. Black line displays PE along the core.

7.3.2 Panzano

7.3.2.1 Panzano M28

PE at this station was the highest among all samples (1.91%) (Tab. 2). PE was higher in upper layers. The highest value was found in the 65-70 cm layer, where around 15% of prey organisms withstood drilling attacks. At 30-35 cm, 45-50 cm and 140-145 cm core depth PE was around 10% and at the 105-110 cm layer 5% of all gastropods withstood attacks.

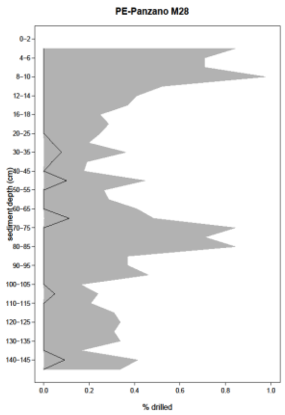

Figure 34: PE at the Panzano M28 station. Grey shade displays 95% CI. Black line displays PE along the core.

7.3.2.2 Panzano M29

PE at the Panzano M29 station was second highest among all samples (1.20%) (Tab. 2). This high value comes mainly from the 70-75 cm layer, where nearly 40% of all gastropods withstood attacks. Other layers of PE are at the bottom of the core (135-140 cm and 145-150 cm) and at the top (20-25 cm). Within these layers, around 10% of gastropods resited predatory attacks.

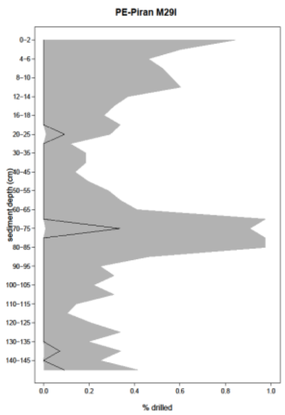

Figure 35: PE at the Panzano M29 station. Grey shade displays 95% CI. Black line displays PE along the core.

7.3.3 Brijuni

Total PE of this core was 0.9% (Tab. 2). In general PE is zero the in most modern (0-14) and in the oldest (115-160 cm) layers. Between this range several peaks of PE can be found; the strongest reaches around 10% at the 14-16 cm layer. All other peaks in PE display values of under 5%.

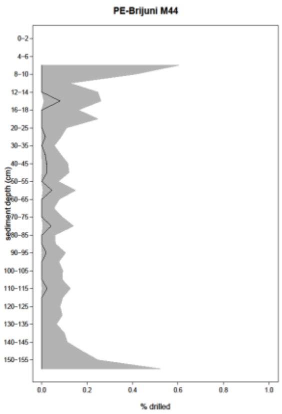

Figure 36: PE at the Brijuni station. Grey shade displays 95% CI. Black line displays PE along the core.

7.3.4 Piran

7.3.4.1 Piran M1

As shown in Table 2, Piran M1 has a PE of 0.56%. Except for two intervals in the middle (65-75 cm and 85-100 cm) and at the base of the core (115-145 cm), PE was detected in every layer. However, in all except 2 layers (75-80 cm and 105-110 cm) PE was never higher than 2%. At the 75-80 cm interval PE reaches 5% and the highest values of PE were found at the 105-110 cm layer (17%) (Fig. 37).

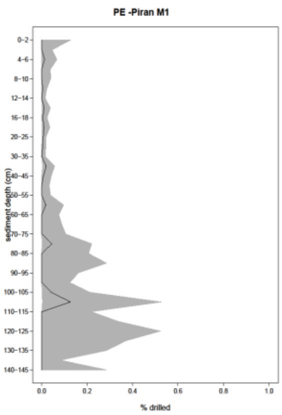

Figure 37: PE at Piran M1 station. Grey shade displays 95% CI. Black line displays PE along the core.

7.3.4.2 Piran M53

PE was 0.23% at this station (Tab. 2). Along the core, incomplete drill holes occurred only in three layers. At 25-30 and 55-60 cm, PE did not reach more than 2%. In contrast, a sharp peak in the 135-140 cm layer was found. Here around 10% of predatory attacks were not successful.

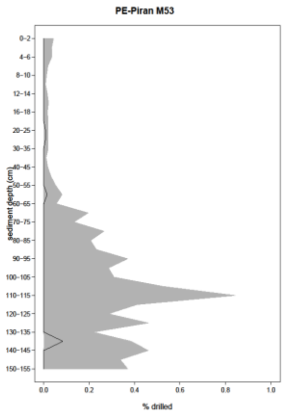

Figure 38: PE at Piran M53 station. Grey shade displays 95% CI. Black line displays PE along the core.

7.4 DF per taxonomic Level

Samples were analysed for drilling at family and species level. Tables given here show the ten most abundant families and species per core. A complete family and species list for each core can be found in the appendix. Highest species richness was found at the cores of Brijuni (125) and Piran with 108 (M1) and 112 (M53) species, respectively. The cores from Po (16 species in M13, 20 sp. in M20, 19 sp. in M21) showed the lowest values of species richness of all cores sampled. The core of Venice also shows a high species richness (81) while the two cores of Piran show rather low species richness (43 sp. in M28 and 44 sp. in M29).

7.4.1 Venice

The most abundant families in the Venice core were Certhiidae (260 ind.) and Rissoidae (259 ind.). Except for Mangeliidae (158 ind.) all other families show abundances of <100 individuals. Highest DF values were found for Phasianellidae (22.73%) and Cerithiopsidae (22.22%). Both families were rather low in abundance, with 44 and 18 individuals, respectively. DF in the most abundant families was 18.08% for Certhiidae, 11.58% for Rissoidae and 3.8% for Mangeliidae. Nassariidae (96 ind.) and Trochidae (89 ind.) show similar abundances and DF (3.13% Nassariidae, 4.49% Trochidae). Among the Naticidae only 1 out of 37 individuals was drilled (2.7%). No drill holes were found for Muricidae (Tab. 3).

Family	Ntot	Ndrill	DF (%)
Certhiidae	260	47	18,08
Cerithiopsidae	18	4	22,22
Mangeliidae	158	6	3,8
Muricidae	28	0	0
Nassariidae	96	3	3,13
Naticidae	37	1	2,7
Phasianellidae	44	10	22,73
Pyramidellidae	65	7	10,77
Rissoidae	259	30	11,58
Trochidae	89	4	4,49

Table 3: 10 most abundant families, Venice M38

The most abundant species in this core were *B. latreillii* (124 ind.) and *Mangelia costulata* (Risso 1926) (114 ind.). All other species show abundances of <100 individuals. *B. latreillii* was the most frequently drilled species (25.81%), followed by *Tricolia pullus* (Linnaeus 1758) (22.73%). However, *T. pullus* has only 44 individuals of which 10 were drilled. *Pusillina inconspicua* (Adler 1844) (15.09% DF) and

Turbonilla rufa (Philippi, 1836) (14.63% DF) were similar in abundance (53 and 41 ind., respectively) and DF. Bittium reticulatum (da Costa, 1778) has 84 individuals within this core, of which 9 were drilled (10.71%). For all other species, DF was <8%. *M. costulata* was drilled only very rarely (2.63%) compared to its total abundance (Tab. 4).

Species	Ntot	Ndrill	DF (%)
Bittium latreillii	124	32	25,81
Bittium reticulatum	84	9	10,71
Gibbula ardens	38	1	2,63
Mangelia costulata	114	3	2,63
Nassarius pygmaeus	96	3	3,13
Pusillina lineolata	64	5	7,81
Pusillina radiata	49	2	4,08
Pusillina inconspicua	53	8	15,09
Tricolia pullus	44	10	22,73
Turbonilla rufa	41	6	14,63

Table 4: 10 most abundant species, Venice M38

7.4.2 Panzano

7.4.2.1 Panzano M28

Turritellidae is the most abundant family in the Panzano M28 core (555 ind.). They also show the highest value in DF (52.97%). Nassariidae were second highest in abundance, with 384 individuals, of which 30 were drilled (7.81%). Of the 151 Calyptraeidae only 1 individual was drilled (0.66%). For Aporrhaidae 117 individuals were found, of which 5 were drilled (4.27%). All other families show abundances of <80 individuals. However, Eulimidae (51 ind.) and Rissoidae (30 ind.), both show high values in DF (21.57% and 20%, respectively) (Tab.5)

Family	Ntot	Ndrill	DF (%)
Akeridae	37	0	0.00
Aporrhaidae	117	5	4.27
Calyptraeidae	151	1	0.66
Eulimidae	51	11	21.57
Haminoeidae	24	0	0.00
Nassariidae	384	30	7.81

Naticidae	76	0	0.00
Philinidae	24	0	0.00
Rissoidae	30	6	20.00
Turritellidae	555	294	52.97

Table 5: 10 most abundant families, Panzano M28

Looking at Panzano M28, one can see that *T. communis* is by far the most abundant species (555 ind.). It is also the only turritellid species in this core. Therefore, DF for this species is the same as for the family as shown in Table 5 (52.97%). *C. chinensis* was the second most abundant species in this core, with a DF of only 0.67%, as only 1 out of 150 individuals was drilled. *A. pespelecani* is the only species found from the family Aporrhaide, therefore it shows the same values as in Table 5 (DF 4.27%; 117 ind.). The same holds true for *N. pygmaeus,* which was the only species found in the family of Nassariidae*. Melanella frielei (Jordan, 1894)* is low in abundance, but has a high DF. Out of the 28 individuals found, 10 were drilled, leading to a DF of 35.71%. For *Melanela spp.* no distinction on species level was possible. This group has 15 individuals, with 1 drilled (6.67%). No drill holes were found for *Akera bullata (O.F. Müller, 1776), Euspira macilenta (Phillipi, 1844) Euspira pulchella (Risso, 1826) and Philine quadripartita (Ascanius, 1722)* (Tab.6).

Species	Ntot	Ndrill	DF (%)
Akera bullata	37	0	0
Aporrhais pespelecani	117	5	4,27
Calyptraea chinensis	150	1	0,67
Euspira macilenta	59	0	0
Euspira pulchella	17	0	0
Melanella frielei	28	10	35,71
Melanella spp	15	1	6,67
Nassarius pygmaeus	384	30	7,81
Philine quadripartita	22	0	0
Turritella comunis	555	294	52,97

Table 6: 10 most abundant species, Panzano M28

7.4.2.2 Panzano M29

The most abundant and frequently drilled family at Panzano M29 was Turritellidae with 580 individuals, of which 342 were drilled (58.96%). Second in abundance was Epitoniidae*,* but no drilling was found within this family. Also for Hydrobiidae (150 ind.) no drilling was found, despite their high abundance. Calyptraeidae were drilled in 0.82%, which is equal to 1 drilled individual out of a total 117. Of the 398 individuals within the family Nassariidae, 22 were drilled (5.53%). Mangeliidae (26 ind., 23.08%), Rissoidae (33 ind., 15.15%) and Eulimidae (42 ind., 16.67%) all show low abundance, but rather high drilling frequencies. DF (2.63%) and abundance was found to be low for Pyramidellidae. No drilling was found for Acteonidae (22 ind.) (Tab. 7).

Family	Ntot	Ndrill	DF (%)
Acteonidae	22	0	0,00
Calyptraeidae	117	1	0,85
Epitoniidae	556	0	0,00
Eulimidae	42	7	16,67
Hydrobiidae	150	0	0,00
Mangeliidae	26	6	23,08
Nassariidae	398	22	5,53
Pyramidellidae	76	2	2,63
Rissoidae	33	5	15,15
Turritellidae	580	342	58,96

Table 7: 10 most abundant families, Panzano M29

DF on species level at Panzano M29 reflects the trends of the family level. Most frequently drilled, was *T. communis* (58.96%). In contrast, the second most abundant species, *Epitonium cantrainei (Weinkauff, 1866)* (555 ind.) was not drilled at all. *N. pygmaeus* was also abundant (384 ind.), but infrequently drilled (5.47%). *Ecrobia ventrosa (Montagui, 1803)* and *C. chinensis,* also show high abundances, but low drilling intensities. While no drilling was found for *E. ventrosa* (150 ind.), only 1 specimen out of 117 was drilled in *C. chinensis* (0.85%). Highest frequencies were found in *A. pespelecani* with 17 out of 17 drilled individuals (100%). No drilling was found for *Acteon tornatilis (Linnaeus, 1758), Bittium submamillatum (de Rayneval & Ponzi, 1854*)*, Ebala nitidissima (Montagu, 1803)* and *Melanella alba (da Costa, 1778)* (Tab. 8.).

Species	Ntot	Ndrill	DF (%)
Acteon tornatilis	22	0	0
Aporrhais pespelecani	17	17	100
Bittium submamillatum	17	0	0
Calyptraea chinensis	117	1	0,85
Ebala nitidissima	37	0	0
Ecrobia ventrosa	150	0	0
Epitonium cantrainei	555	0	0

Melanella alba	28	0	0
Nassarius pygmaeus	384	21	5,47
Turritella communis	580	342	58,96

Table 8: DF of the 10 most abundant species, Panzano M29

7.4.3 Po

7.4.3.1 Po M13

Overall, DF is very low at the Po stations. Of the 10 most abundant families, only 2 were drilled. DF in Turritellidae was 23.08%, with 21 out of 91 drilled individuals. For Naticide DF was 25%, where 1 out of a total of 4 specimens was drilled. For all other families (Aporrhaide, Calyptaeidae, Certhiidae, Cylichniidae, Iravadiidae, Mangeliidae, Nassariidae and Philinidae) no drill holes were found (Tab 9.).

Family	Ntot	Ndrill	DF (%)
Aporrhaidae	3	0	0,00
Calyptraeidae	2	0	0,00
Cerithiidae	2	0	0,00
Cylichnidae	10	0	0,00
Iravadiidae	8	0	0,00
Mangeliidae	2	0	0,00
Nassariidae	58	0	0,00
Naticidae	4	1	25,00
Philinidae	2	0	0.00
Turritellidae	91	21	23,08

Table 9: DF of the 10 most abundant families, Po M13

Due to the low overall abundance at Po M13 the total species list of this core is given here. The most abundant and most frequently drilled species was *T. communis,* where 21 out of 91 individuals were drilled (23%). The only other drilled species was *E. nitida,* with 1 out of 3 individuals drilled (33%). For all other species of this core, no drill holes were found (Tab 10.).

Species	Ntot	Ndrill	DF (%)
Acteon tornatilis	1	0	0,00
Aporrhais pespelecani	3	0	0,00
Bittium submamillatum	2	0	0,00
Calyptraea chinensis	2	0	0,00
Cylichnina laevisculpta	10	0	0,00

Euspira macilenta	1	0	0,00
Euspira nitida	3	1	33,00
Hyala vitrea	8	0	0,00
Mangelia attenuata	1	0	0,00
Mangelia costulata	1	0	0,00
Nassarius pygmeus	58	0	0,00
Odostomia spp,	1	0	0,00
Philine quadripartita	1	0	0,00
Philine scabra	1	0	0,00
Triphoridae indet,	1	0	0,00
Turritella communis	91	21	23,00

Table 10: DF of the most abundant species, Po M13

7.4.3.2 Po M20

Nassariidae (130 ind.) was the most abundant family in the Po M20 core. DF however, was rather low, as only 2 individuals were drilled (1.54%). Second highest in abundance were Turritellidae (116 ind.), which show the highest value in DF (18.01%). Mangeliidae and Calyptraeidae show the same abundance (6) and DF (16.67%) with each family having only 1 drilled individual. Of the 2 individuals of Fasciolarriidae found, both were drilled. Therefore, DF is 100%. No drill holes were found in all other families (Aporrhaide, Certhiidae, Cylichnidae, Eulimidae, Iravadiidae, Naticidae, Philinidae and Pyramidellidae) of this core (Tab.11).

Family	**Ntot**	**Ndrill**	**DF**
Aporrhaidae	15	0	0,00
Calyptraeidae	6	1	16,67
Cerithiidae	36	0	0,00
Cylichnidae	10	0	0,00
Eulimidae	2	0	0,00
Fasciolariidae	2	2	100,00
Iravadiidae	23	0	0,00
Mangeliidae	6	1	16,67
Nassariidae	130	2	1,54
Naticidae	2	0	0,00
Philinidae	7	0	0,00
Pyramidellidae	2	0	0,00

Turritellidae	116	21	18,10

Table 11: DF of the most abundant families of Po M20

Table 12 lists the 11 most abundant species of the Po M20 core. *N. pygmaeus* was most abundant (126 ind.) but low in DF (1.59%). *T. communis,* on the other hand, was abundant (116 ind.) and had high DF (18.10%). *B. submamillatum* (36 ind.), *Hyala vitrea (Montagu, 1803)* (23 ind.) and *A. pespelecani* (15 ind.) show intermediate abundances, with none of them being drilled. For those species with lower abundance, drill holes were only found in *C. chinensis* and *M. costulata,* both having 1 out of 6 individuals drilled (16.67%). For the other species (*C. cylindracea, Nassarus lima (Dyllwin, 1817), Philine aperta (Lionnaeus 1767)* and *Philine scabra (O.F. Müller 1784))* no drill holes were found.

Species	Ntot	Ndrill	DF (%)
Aporrhais pespelecani	15	0	0,00
Calyptraea chinensis	6	1	16,67
Bittium submamillatum	36	0	0,00
Cylichna cylindracea	10	0	0,00
Hyala vitrea	23	0	0,00
Mangelia smithii	6	1	16,67
Nassarius lima	3	0	0,00
Nassarius pygmaeus	126	2	1,59
Philine aperta	3	0	0,00
Philine scabra	4	0	0,00
Turritella communis	116	21	18,10

Table 12: DF of the 11 most abundant species, Po M20

7.4.3.3 Po M21

Overall abundance and drilling intensity was low in this core. The most abundant family was Turritellidae with 119 individuals. They were also the most frequently drilled family, with a DF of 17.65%. The only other family found to be drilled were Cerithiidae, with 7.69% and a total abundance of 13 individuals. Nassariidae were abundant (66 ind.) but did not show any drill holes; this is also the case in all other families (Aporrhaidae, Calyptraeidae, Cylichnidae, Eulimidae, Iravadiidae, Mangeliidae, Nassariidae, Philinidae and Pyramidellidae) found in this core (Tab. 13).

Family	Ntot	Ndrill	DF (%)
Aporrhaidae	13	0	0,00
Calyptraeidae	8	0	0,00
Cerithiidae	13	1	7,69

Cylichnidae	10	0	0,00
Eulimidae	4	0	0,00
Iravadiidae	19	0	0,00
Mangeliidae	2	0	0,00
Nassariidae	66	0	0,00
Philinidae	2	0	0,00
Pyramidellidae	4	0	0,00
Turritellidae	119	21	17,65

Table 13: DF of the 11 most abundant families, Po M21

The species list of the Po M21 core totally reflects the family list, with the only species found to be drilled *T. communis* (17.65%) and *B. submamillatum* (7.69%). They were the only species found for their families, therefore abundance is the same as at the family level (Tab. 13). For all other species found in this core *(A. pespelecani, C. chinensis, C. cylindracea, E. glabra, H. vitrea, N. pygmaeus, N. reticulatus, O. spp)*, no drill holes were detected (Tab. 14).

Species	Ntot	Ndrill	DF (%)
Aporrhais pespelecani	13	0	0
Bittium submamillatum	13	1	7,69
Calyptraea chinensis	8	0	0
Cylichna cylindracea	10	0	0
Eulima glabra	4	0	0
Hyala vitrea	19	0	0
Nassarius pygmaeus	64	0	0
Nassarius reticulatus	2	0	0
Odostomia spp	3	0	0
Turritella communis	119	21	17,65

Table 14: DF of the 10 most abundant species, Po M21

7.4.4 Brijuni

The Brijuni core is characterised by a high abundance of Rissoidae (3150 ind.), Cerithiidae (1597 ind.) and Trochide (1466 ind.). These families are around one order of magnitude higher in abundance, than all other families in the core. Lottidae show the highest DF (41.19%), with 70 out of 170 individuals drilled, followed by Cerithiidae (25.36%) and Triphoridae (23.15%). Rissoidae show a DF of 12.35%, with a total of 389 drilled individuals. Nassariidae and Paramidellidae show similar values in abundance (290 and 214 individuals, respectively) and in DF (7.93% for Nassariidae and 8.41% for Pyramidellidae).

Trochidae show a low DF (6.96%) despite their high abundance. DF for Scissurellidae was 5.03%, which is a total of 8 drilled individuals out of 159. Lowest DFs were found for Epitoniidae (3.08%) and Muricidae (3.27%), with both species showing similar values in abundance (130 for Epitoniidae and 153 for Muricidae) (Tab. 15).

Family	Ntot	Ndrill	DF (%)
Cerithiidae	1597	405	25,36
Epitoniidae	130	4	3,08
Lottidae	170	70	41,18
Muricidae	153	5	3,27
Nassariidae	290	23	7,93
Pyramidellidae	214	18	8,41
Rissoidae	3150	389	12,35
Scissurellidae	159	8	5,03
Triphoridae	622	144	23,15
Trochidae	1466	102	6,96

Table 15: DF of the 10 most abundant families, Brijuni M44

Table 16 lists the 10 most abundant species of the Brijuni M44 core. *A. geryonia* was most abundant (1230 ind.), and had intermediate DF (11.95%). *B. submamillatum* displays the second highest value in abundance (931 ind.) and in DF (26.10%). The most frequently drilled species found, was *B. latreillii* with a total of 101 drilled individuals out of 373 (27.08%). *Jujubinus montagui (Wood, 1828)* was abundant (878 ind.) but infrequently drilled (6.49%). In contrast, *Alvania beanii (Hanley in Thorpe, 1844)* was abundant (604 ind.) and frequently drilled (22.52%). No distinction at the species level was possible for *Triphoridae.* Therefore they are listed as *Triphoridae indet.,* displaying a total abundance of 386 individuals and a DF of 18.65%. A similar value for DF (18.87%) but a lower value in abundance (265 ind.) can be found for the species *B. reticulatum.* The species *Jujubinus exasperatus (Pennant, 1777), P. inconspicua* and *N. pygmaeus* show similar values concerning abundance and DF. *J. exasperatus* has a total abundance of 345 and a DF of 7.54%. For *P. inconspicua* a total of 315 individuals was found, of which 23 were drilled (7.3%). A total of 283 individuals with 21 of them drilled (7.42%) was found for *N. pygmaeus.*

Species	Ntot	Ndrill	DF (%)
Alvania beanii	604	136	22,52
Alvania geryonia	1230	147	11,95
Bittium latreilli	373	101	27,08

Bittium reticulatum	265	50	18,87
Bittium submamillatum	931	243	26,10
Jujubinus exasperatus	345	26	7,54
Jujubinus montagui	878	57	6,49
Nassarius pygmaeus	283	21	7,42
Pusillina inconspicua	315	23	7,30
Triphoridae indet	386	72	18,65

Table 16: DF of the 10 most abundant species, Brijuni M44

7.4.5 Piran

The Piran cores are characterized by a very high number of Cerithiidae. Across both cores 11.300 individuals of this family were found. The second most abundant family were Rissoidae, with a total of 5868 individuals, followed by Nassariidae with 4578 individuals. For all other families less than 1300 individuals were present in each core.

7.4.5.1 Piran M1

Table 17 lists the 10 most abundant families of the Piran M1 core. Highest abundance was found for Cerithiidae (4217 ind.), which were also among the most frequently drilled families (39.27%). Rissoidae were second most abundant (2533 ind.) and were also drilled in high numbers (26.67%). Nassariidae, however, were less frequently drilled (16.78%), compared to their high abundance in this core (1317 Ind.). Highest values for DF were found for Turritellidae, were 145 individuals out of a total of 325 were drilled (44.62%). Triphoridae (39.48%) and Mangeliidae (35.53%) show similar values. However, their abundance strongly diverge, with a total of 501 individuals found for Mangeliidae and 271 for Triphoridae. Muricidae were also among the most frequently drilled families (20.38%); here 32 out of 157 speciemens were drilled. DF for Aporrhaide (121 ind.) was 9.09%. Naticidae, with a total abundance of 341 individuals, were drilled in 7.92%.

Family	Ntot	Ndrill	DF (%)
Aporrhaidae	121	11	9,09
Cerithiidae	4217	1656	39,27
Mangeliidae	501	178	35,53
Muricidae	157	32	20,38
Nassariidae	1317	221	16,78
Naticidae	341	27	7,92
Pyramidellidae	300	80	26,67

Rissoidae	2533	837	33,04
Triphoridae	271	107	39,48
Turritellidae	325	145	44,62

Table 17: DF of the 10 most abundant families, Piran M1

As shown in Table 18, the most abundant species in the Piran M1 core was *B. latreillii,* with a total of 2037 individuals found. It is also ranked among the most frequently drilled species of this core, with a DF of 43.45%. Only *A. geryonia* shows a higher value in DF (44.24%) but is much less abundant (269 ind.). Also, the only other species displaying a DF of over 40%, *T. communis* (42.9%)*,* is less abundant (303 ind.). *B. submalliatum* is the second most abundant species, with a total of 1807 individuals. It is also drilled very frequently (35.1%). *N. pygmaeus* has the third highest abundance in the core (1317 ind.), but a far lower DF, when compared with other highly abundant species (16.78%). *Cerithium vulgatum (Bruguière, 1792)* (34.38%)*, Pusillina lineolate (Michaud, 1830)* (32.32%)*, Pusillina radiata (Philippi, 1836)* (31.62%) and *Mangelia unifasciata (Deshayes, 1835)* (34.25%)*,* all show similar DF. Yet, *P. lineolate* (913 ind.) and *P.radiata* (854 ind.) are four times more abundant than *M. unifasciata* (219 ind.) and *C. vulgatum* (192 ind.). Among the top 10 most abundant species, *E. pulchella* (283 ind.) showed the lowest DF (8.13%).

Species	Ntot	Ndrill	DF (%)
Alvania geryonia	269	119	44,24
Bittium latreillii	2037	885	43,45
Bittium submamillatum	1807	634	35,10
Cerithium vulgatum	192	66	34,38
Euspira pulchella	283	23	8,13
Mangelia unifasciata	219	75	34,25
Nassarius pygmaeus	1317	221	16,78
Pusillina lineolata	913	295	32,31
Pusillina radiata	854	270	31,62
Turritella communis	303	130	42,90

Table 18: DF of the 10 most abundant species, Piran M1

7.4.5.2 Piran M53

Cerithiidae were the most abundant (7083) and most frequently drilled (33.63%) family in the Piran M53 core. Second highest in abundance were Rissoidae with 3335 individuals and a total of 923 drilled shells (27.68%). Nassariidae (3261 ind.) were as abundant as Rissoidae, but their DF was much lower. Only 288 individuals were drilled, leading to a total DF of 6.99%. Among the less abundant families, Turritellidae (30.14%), Pyramidellidae (30.15%) and Triphoridae (30.75%) were most frequently drilled.

However, Turitellidae were nearly more than twice as abundant (763 ind.) as Triphoridae (426 ind.) and Pyramidellidae (461 ind.). Mangeliidae showed high values of abundance as well as in drilling frequency; in total 204 out of 873 individuals were drilled (23.37%). Of the 329 individuals within the family Aporrhaidae 47 were drilled (14.29%). Despite their high abundance (710 ind.) only 7.04% of all Naticidae were drilled. For Muricidae, a total of 280 individuals, of which 17 were drilled was found (6.07%) (Tab. 19).

Family	Ntot	Ndrill	DF (%)
Aporrhaidae	329	47	14,29
Cerithiidae	7083	2382	33,63
Mangeliidae	873	204	23,37
Muricidae	280	17	6,07
Nassariidae	3261	228	6,99
Naticidae	710	50	7,04
Pyramidellidae	461	139	30,15
Rissoidae	3335	923	27,68
Triphoridae	426	131	30,75
Turritellidae	763	230	30,14

Table 19: DF of the 10 most abundant families, Piran M53

B. latreillii (3749 ind.) was the most abundant species in the Piran M53 core. *N. pygmaeus* was the second-most abundant (3252 individuals). For *B. submamillatum* a total of 2607 individuals were found. The only other species with >1000 individuals was *P. radiata* (1309 ind.) Highest DF was found in *B. reticulatum* (38.78%), yet this species is only moderately abundant (392 ind.). *B. latreillii* (34.52%) and *B. submamillatum* (33.1%) were drilled equally often. The other species showing high DF values, are one order of magnitude lower in abundance. *A. geryonia* is drilled in 33.76%, with a total of 622 individuals. *P. lineolata* shows a DF of 32.79%, with a total of 677 individuals found. DF in *P. radiata* was found to be 23.76% and for *M. unifaciata* a DF of 26.04% was calculated. Yet, it must be taken into account, that *M. unifasciata* (384 ind.) is represented by around 1000 individuals less than *P. radiata* (1309 ind.). Despite its high abundance, DF is low in *N. pygmaeus*, with only 228 individuals out of 3252 drilled (7.01%). *E. pulchella* is represented by 566 individuals of which 40 were drilled (7.07%) (Tab. 20).

Species	Ntot	Ndrill	DF (%)
Alvania geryonia	622	210	33,76
Bittium latreillii	3749	1294	34,52

Bittium reticulatum	392	152	38,78
Bittium submamillatum	2607	863	33,10
Euspira pulchella	566	40	7,07
Mangelia unifasciata	384	100	26,04
Nassarius pygmaeus	3252	228	7,01
Pusillina radiata	1309	311	23,76
Pusillina lineolata	677	222	32,79
Turritella communis	763	230	30,14

Table 20: DF of the 10 most abundant species, Piran M53

7.5 Life Habits

7.5.1 Ecotypes

In total we distinguished seven ecotypes in our samples: Epibiontic, Epifaunal on soft, hard and soft&hard substrate, infaunal in soft substrate, semi-infaunal in soft substrate. We also found three individuals of freshwater snails and one planktonic (Tab. 21). Each ecotype was analysed for DF.

Ecotype	**Ntot**	**Ndrill**	**DF (%)**
Epibiontic	3489	743	21,30
Epifauna hard	1871	308	16,46
Epifauna soft	9724	932	9,58
Epifauna soft&hard	6893	1926	27,94
Epifauna vegetation	18132	5238	28,90
Infauna soft	3602	856	23,76
Semi-infaunal soft	661	84	12,71
Planctonic	1	0	0,00
Freshwater	3	0	0,00
	44393	**10087**	**16,93**

Table 21: Pooled results for DF in ecotypes of all cores.

Highest DF of all ecotypes was found in organisms living epifaunal on vegetation (28.9%). This is also the category most of the found organisms belong to (18132). The most-abundant species within this group is *B. latreillii.* Organisms living epifaunal on both, soft and hard substrate are second highest in DF (27.94%). This group is represented by a total of 6893 individuals and the most abundant species within this group is *B. submamillatum*. For species living infaunal in soft sediment, DF is 23.76%. This group is represented by 3602 individuals, which belong mostly to the family Nassariidae. Epibiontic organisms show a DF of 21.3% and are therefore among the most frequently drilled ecotypes. In total

3489 epibiontic individuals were found, which mostly belong to the family Pyramidellidae. 16.46% of all individuals living epifaunal on hard substrate were drilled. In total 1871 individuals belong to this group, with Muricidae as the most abundant and drilled family. Of the 661 individuals of semi-infaunal organisms, 12.71% were drilled. All individuals of this group belong to the species *Aporrhais pespelecani (Linnaeus, 1758).* 9.58% of organisms living epifaunal on soft sediment were drilled. A total of 9724 individuals were found in this group. The most-abundant family in this group were Nassariidae. The one single individual of a planktonic gastropod species (*Creseis acicula (Rang, 1828)*) and the three individuals of a freshwater species (*Oxychilus sp. (Fitzinger, 1833)*) found within the cores, do not show any drill holes (Tab. 21).

7.5.1.1 Venice

The most abundant ecotype in the Venice core was epifauna on vegetation (589 individuals), this category also had the highest DF (14.6%). Epibiontic organisms (115 individuals) were drilled with 13.91%. Organisms living epifaunal on soft and hard sediment were represented by 312 individuals, which were drilled in 6.49%. For all other ecotypes, DF was less than 4%. No drill holes were found in planktonic (1 individual) and semi-infaunal (7 individuals) organisms (Tab. 22).

Ecotype	Ntot	Ndrill	DF (%)
Epibiontic	115	16	13,91
Epifauna hard	73	1	1,37
Epifauna soft	312	12	3,85
Epifauna soft&hard	77	5	6,49
Epifauna vegetation	589	86	14,60
Infauna soft	45	1	2,22
Planctonic	1	0	0,00
Semi-infaunal soft	7	0	0,00
	1219	121	9,93

Table 22: DF per ecotype at Venice M38.

7.5.1.2 Panzano stations

The most abundant ecotype in the Panzano M28 core, with a total of 636 individuals, were organisms living infaunal in soft sediment. At 46.23% DF in this group is much higher than that of all other ecotypes. The second most drilled ecotype (epibiontic) shows less than half of the drilling frequency (17.95%). Organisms living epifaunal on vegetation (10.13%) and epifaunal on soft sediment (8.08%) display a DF that is nearly five times lower than the one found for infaunal soft sediment organisms.

DF for semi-infaunal living gastropods was 4.27%. Organisms living epifaunal on soft- and hard sediment were only drilled at 0.66%. No drill holes were found for the one specimen living epifaunal on hard sediment and for the three individuals of freshwater snails (Tab. 23).

Ecotype	Ntot	Ndrill	DF (%)
Epibiontic	78	14	17,95
Epifauna hard	1	0	0,00
Epifauna soft	458	37	8,08
Epifauna soft&hard	152	1	0,66
Epifauna vegetation	79	8	10,13
Infauna soft	636	294	46,23
Semi-infaunal soft	117	5	4,27
Freshwater	3	0	0,00
	1524	359	23,56

Table 23: DF per ecotype at Panzano M28.

Drilling per ecotype at the Panzano M29 station is different from Panzano M28. Here the most frequently drilled group are semi-infaunal living gastropods, where every individual of the core (17) was drilled, and DF is therefore 100%. The second-highest group in DF are organisms living epifaunal on vegetation. Of the total 542 individuals belonging to this group, 64.02% were drilled. In contrast to the other core from this station, where infaunal gastropods were drilled most often, only 28.57% of them were drilled in this core. For the other groups within this core, DF was below 10%. Epibiontic living gastropods show a DF of 9.29%, epifauna on soft sediment 2.8%. As in the other Panzano core, lowest values in DF were found for epifauna on soft & hard sediment (0.85%) and epifauna on hard sediment (0%) (Tab. 24).

Ecotype	Ntot	Ndrill	DF (%)
Epibiontic	140	13	9,29
Epifauna hard	3	0	0,00
Epifauna soft	999	28	2,80
Epifauna soft&hard	118	1	0,85
Epifauna vegetation	542	347	64,02
Infauna soft	14	4	28,57
Semi-infaunal soft	17	17	100,00
	1833	410	22,16

Table 24: DF per ecotype at Panzano M29

7.5.1.3 Po stations

At the Po M13 station, drilling only happened on gastropods living infaunal in soft sediment, which show a DF of 20.95%. Twenty-one out of 22 drill holes were found on *T. communis.* The only other drilled species in this core was *Euspira nitida (Donovan, 1804)* (Tab. 25).

Ecotype	Ntot	Ndrill	DF (%)
Epibiontic	10	0	0,00
Epifauna soft	61	0	0,00
Epifauna soft&hard	4	0	0,00
Epifauna vegetation	2	0	0,00
Infauna soft	105	22	20,95
Semi-infaunal soft	3	0	0,00
	185	22	11,89

Table 25: Ecotype DF at Po M13

Table 26 shows the drilling per ecotype at the Po M20 station. DF was highest for gastropods living epifaunal on hard sediment. Here we found only 2 shells, which were both drilled. DF in gastropods living infaunal in soft sediment was 16.41%, with *T. communis* as the most drilled species. In total 7 individuals living epifaunal on soft and hard sediment, with 1 drilled, were found, leading to a DF of 14.29%. From 136 individuals found living epifaunal on soft sediment, 3 were drilled (DF 2.21%). No drill holes were found for the categories epibiontic, epifaunal on vegetation and semi-infaunal.

Ecotype	Ntot	Ndrill	DF (%)
Epibiontic	27	0	0,00
Epifauna hard	2	2	100,00
Epifauna soft	136	3	2,21
Epifauna soft&hard	7	1	14,29
Epifauna vegetation	45	0	0,00
Infauna soft	128	21	16,41
Semi-infaunal soft	15	0	0,00
	360	27	7,5

Table 26: DF per ecotype at Po M20

At the Po M21 station most of the drilling (15.22%) happened on gastropods living infaunal in soft sediment. Second highest DF was calculated for organisms living epifaunal on vegetation (6.67%). For all other ecotypes (epibiontic, epifaunal on soft sediment, semi-infaunal) no drill holes were found (Tab. 27).

Ecotype	Ntot	Ndrill	DF (%)
Epibiontic	27	0	0,00
Epifauna soft	71	0	0,00
Epifauna vegetation	15	1	6,67
Infauna soft	138	21	15,22
Semi-infaunal soft	13	0	0,00
	264	22	8,33

Table 27: DF per ecotype at Po M21

7.5.1.4 Brijuni

At the Brijuni station every ecotype was drilled. Highest DF was found in gastropods living epifaunal on soft and hard sediment (20.54%). Second highest DF was found in organisms living epifaunal on hard sediment (18.45%). Epibiontic and Infaunal gastropods show similar values in DF (16.85% and 16.96%, respectively). However, in total, more epibiontic gastropods were found (1252) compared to infaunal (230). Highest individual number was found for gastropods living epifaunal on vegetation (3306). Although occurring in such high numbers, DF for this ecotype is intermediate (13.04%) compared to the rest of the core. Of the 39 individuals living semi-infaunal, found in this core, 10.26% were drilled. Lowest DF was found for gastropods living epifaunal on soft sediment (6.88%), despite their high total abundance (1614) (Tab. 28).

Ecotype	Ntot	Ndrill	DF (%)
Epibiontic	1252	211	16,85
Epifauna hard	1458	269	18,45
Epifauna soft	1614	111	6,88
Epifauna soft&hard	1266	260	20,54
Epifauna vegetation	3306	431	13,04
Infauna soft	230	39	16,96
Semi-infaunal soft	39	4	10,26
	9165	1325	14,46

Table 28: DF per ecotype at the Brijuni

7.5.1.5 Piran stations

DF at the Piran M1 station (Tab. 29), is overall high compared to other stations. Highest values were found for gastropods living epifaunal on vegetation (36.36%) and epifaunal on soft and hard sediment (33.44%). These two ecotypes were also highest in abundance, with epifauna on vegetation being more than twice (5192) as abundant as epifauna on soft and hard sediment (2126). Epibiontic living gastropods show a DF of 27.82% (719 ind.). Infaunal living gastropods were drilled in 24.27% (717 ind.). Epifaunal living gastropods were drilled in 23.6% from a total abundance of 89 individuals. Although gastropods living epifaunal on soft sediment, show high abundance (1831 individuals), they were drilled only at an intermediate level (19.99%). Significantly lowest drilling was found in gastropods living semi-infaunal. Here 121 individuals show a DF of 9.09%.

Ecotype	Ntot	Ndrill	DF (%)
Epibiontic	719	200	27,82
Epifauna	89	21	23,60
Epifauna soft	1831	366	19,99
Epifauna soft&hard	2126	711	33,44
Epifauna vegetation	5192	1888	36,36
Infauna soft	717	174	24,27
Semi-infaunal soft	121	11	9,09
	10795	3371	31,23

Table 29: DF per ecotype at Piran M1

As in the Piran M1 core (Tab. 29), highest DF at the Piran M53 core (Tab. 30) was found for gastropods living epifaunal on soft and hard sediment (30.13%) and on vegetation (29.62%). Epifauna on vegetation is also the group with highest abundance (8362 individuals), whereas epifaunal living gastropods are less than half as abundant (3143 individuals). The third highest value in DF was found for epibiontic gastropods (25.78%), which showed an intermediate abundance of 1121 individuals. Infaunal (17.62%) and semi-infaunal (14.29%) gastropods show very similar DF. However, infaunal living gastropods show a much higher abundance (1589 individuals) than semi-infauna (329 individuals). Lowest values in DF were found for gastropods living epifaunal either on soft (8.84%) or hard (6.12%) substrate, with epifauna on soft sediment showing the second-highest value in abundance (4242 individuals) for all groups.

Ecotype	Ntot	Ndrill	DF (%)
Epibiontic	1121	289	25,78
Epifauna hard	245	15	6,12
Epifauna soft	4242	375	8,84
Epifauna soft&hard	3143	947	30,13
Epifauna vegetation	8362	2477	29,62
Infauna soft	1589	280	17,62

Semi-infaunal soft	329	47	14,29
	19031	4430	23,28

Table 30: DF per ecotype at Piran M53

7.5.2 Feeding Guilds

For feeding guilds we distinguished between ten different guilds: detritus feeders, filter-feeders, grazers, herbivoures, macro-herbivores, micro-herbivores, microcarnivores, parasites, predators and scavengers. Pooled results for this guilds are listed in Table 31.

Feeding Guild	Ntot	Ndrill	DF (%)
Detritus	1065	97	9,11
Filter-feeder	3087	1111	35,99
Grazer	15366	4662	30,34
Herbivorous	9295	2218	23,86
Macro-herbivorous	40	0	0,00
Micro-herbivorous	514	11	2,14
Microcarnivorous	226	2	0,88
Parasite	2566	525	20,46
Predator	5900	932	15,80
Scavenger	5929	529	8,92
	43988	10087	14,75

Table 31: Pooled values of DF for feedin-guilds across all cores.

Highest DF was found for filter-feeding gastropods (35.99%) with a total of 3087 individuals. The most common species within this guild is T. communis (2304 Ind.). Grazers (15366 Ind.) also show a high DF (30.34%), with the genus Bittium (10235 Ind.) as the most important member, concerning abundance and DF. Herbivorous (23.86%) and parasitic (20.46%) gastropods were found to have similar values of DF. While herbivorous show more than four times higher abundances (9295 Ind.), with Alvania sp. as the most important (concerning abundance and DF) species in this guild. For parasites (2566 Ind.) the family Eulimidae was found to be most important concerning abundances and DF. For predatory gastropods (5900 Ind.) a DF of 15.80% was found, with Naticidae as the most important family. Detritus feeders (1065 Ind.) and scavengers (5929 Ind.) show similar values of DF (9.11% and 8.92% respectively). Only low values of DF were found for Micro herbivorous (2.14%) and micro carnivorous (0.88%) gastropods. No drilling was found in Macro-herbivorous organisms.

7.5.2.1 Venice

At the Venice M38 core the most abundant feeding guild were grazers with 480 individuals, and this was also the group with the highest DF (15.63%). Second highest in DF were parasitic gastropods (14.06%) from only 64 individuals. DF in herbivores was 9.19%, with 185 individuals found. Even though their abundance was high (353) only 4.82% of predatory gastropods were drilled. Only scavengers (96 individuals) were less frequently drilled (3.13%). No drill holes were found in detritus-fedders and filter-feeders, as well as in micro-herbivores and micro-carnivores (Tab. 32).

Feeding guild	Ntot	Ndrill	DF (%)
Detritus	10	0	0,00
Filter-feeder	16	0	0,00
Grazer	480	75	15,63
Herbivorous	185	17	9,19
Micro-herbivorous	7	0	0,00
Micro-carnivorous	8	0	0,00
Parasite	64	9	14,06
Predator	353	17	4,82
Scavenger	96	3	3,13
	1219	121	9,93

Table 32: DF per feeding guild, Venice M38

7.5.2.2 Panzano stations

At the Panzano M28 station, filter-feeders were found to be the most abundant guild (706 ind.), which also shows high DF (41.78%); only grazers have a higher DF (50%). However, for grazers, only 4 individuals were found, of which 2 were drilled. Parasites (20.75%) and herbivores (19.35%) were found to be drilled less than half as frequently as filter-feeders. Also, abundance in these two groups was low (herbivores 31 ind. and parasites 53 ind.). Scavengers were second highest in abundance (384 ind.), but only 7.81% of them were drilled. Predators (154 ind.) and detritus feeders (123 ind.) show similar values in abundance and drilling frequency (6.49% and 4.07%, respectively). No drill holes were found in the groups of micro-herbivores and micro-carnivores and for macro-herbivores (Tab. 33).

Feeding guild	Ntot	Ndrill	DF (%)
Detritus	123	5	4,07
Filter-feeder	706	295	41,78
Grazer	4	2	50,00
Herbivorous	31	6	19,35

Macro-herbivores	37	0	0,00
Micro-herbivore	24	0	0,00
Micro-carnivores	8	0	0,00
Parasites	53	11	20,75
Predators	154	10	6,49
Scavengers	384	30	7,81
	1524	359	23,56

Table 33: DF per feeding guild at Panzano M28

As shown in Table 34 (Panzano M29), filter-feeders occured in high abundance (676 ind.) and were drilled in 50.74% of all cases in the Panzano M29 core. Drilling frequency was much lower in all other guilds. Of the 30 individuals found to be parasitic, eight were drilled (26.67%). DF in herbivores was 25.00% where 5 out of 20 individuals were drilled. Detritus-feeders (157 ind.) were found to be drilled in 12.74%. Predators (65 ind.) were drilled in 7.27%. Scavengers (327 ind.) showed a rather low DF with 6.73%. No drill holes were found for micro–carnivores (3 ind.) and micro-herbivores (6 ind.) and grazers (4 ind.).

Feeding guild	Ntot	Ndrill	DF (%)
Detritus	157	20	12,74
Filter-feeder	676	343	50,74
Grazer	4	0	0,00
Herbivorous	20	5	25,00
Micro-herbivorous	61	0	0,00
Micro-carnivorous	5	0	0,00
Parasite	30	8	26,67
Predator	165	12	7,27
Scavenger	327	22	6,73
	1833	410	22,16

Table 34: DF per feeding guild at Panzano M29

7.5.2.3 Po stations

At the Po M13 station, drill holes were only found in two guilds. Filter-feeders were the most abundant and most frequently drilled group (93 ind., 22.58%). DF for predators was found to be 10%, but only 10 from individuals. No drill holes were found on scavengers, even though they were high in abundance (58 ind.) and on the rare detritus-feeders, grazers, parasites and micro-carnivores (Tab. 35).

Feeding guild	Ntot	Ndrill	DF (%)
Detritus	11	0	0,00
Filter-feeder	93	21	22,58
Grazer	2	0	0,00
Micro-carnivorous	10	0	0,00
Parasite	1	0	0,00
Predator	10	1	10,00
Scavenger	58	0	0,00
	185	22	11,89

Table 35: DF per feeding guild at Po M13

Drilling at the Po M20 station happened in 3 guilds. Most frequently drilled were filter-feeders (18.03%), which are also abundant (122 ind.). Second highest DF was found for predators (15%), where three out of 20 individuals were drilled. For the most abundant guild, scavengers (130 ind.), DF was found to be rather low (1.54%). No drill holes were found for detritus-feeders, grazers, herbivores, micro-carnivores and parasites. These groups also showed rather low abundances with <40 individuals (Tab. 36).

Feeding guild	Ntot	Ndrill	DF (%)
Detritus	39	0	0,00
Filter-feeder	122	22	18,03
Grazer	36	0	0,00
Herbivorous	1	0	0,00
Micro-carnivorous	10	0	0,00
Parasite	2	0	0,00
Predator	20	3	15,00
Scavenger	130	2	1,54
	360	27	7,5

Table 36: DF per feeding guild for Po M20

As in the other cores from Po, most of the drilling happened in filter-feeders at Po M21. They were found to be highest in abundance (119 ind.) and DF was 17.65%. The only other drilled guild were grazers, with 13 individuals found, of which 1 was drilled, leading to a DF of 7.69%. No drill holes were found for scavengers, even though they were abundant (66 ind.) and for all other guilds (detritus-feeder, macro-herbivores, micro-carnivores, parasites), which also show low abundance (<33 ind.) (Tab. 37).

Feeding guild	Ntot	Ndrill	DF (%)
Detritus	32	0	0,00
Filter-feeder	119	21	17,65
Grazer	13	1	7,69
Macro-herbivorous	1	0	0,00
Micro-carnivorous	19	0	0,00
Parasite	5	0	0,00
Predator	9	0	0,00
Scavenger	66	0	0,00
	264	22	8,33

Table 37: DF per feeding guild for Po M21

7.5.2.4 Brijuni

The station of Brijuni shows overall high values in DF. The most frequently drilled guild were filter-feeders with 20.53%. However, compared to other guilds from this core, they were quite low in abundance, with only 151 individuals. Those groups showing highest abundance, grazers (3223 ind.) and herbivores (3161 ind.), are also drilled by nearly the same amount (15.98% for grazers, 14.24% for herbivores). Parasites, third highest in abundance (1167 ind.), show a DF of 16.88%. Drilling intensity was found to be 10.53% for predators, where 95 of the 902 individuals found were drilled. Scavengers (290 ind.) and detritus-feeders (203 ind.) show similar values in DF (7.93% for scavengers, 6.4% for detritus-feeders). Micro-herbivores have low abundance (55 ind.) and a DF of only 1.82%. No drill holes were found in macro-herbivores and micro-carnivores, which were also low in abundance (<12 ind.) (Tab. 38).

Feeding guild	Ntot	Ndrill	DF (%)
Detritus	203	13	6,40
Filter-feeder	151	31	20,53
Grazer	3223	515	15,98
Herbivorous	3161	450	14,24
Macro-herbivorous	2	0	0,00
Micro-herbivorous	55	1	1,82
Micro-carnivorous	11	0	0,00
Parasite	1167	197	16,88
Predator	902	95	10,53
Scavenger	290	23	7,93

	9165	1325	9,93

Table 38: DF per feeding guild at Brijuni

7.5.2.5 Piran stations

Table 39 (Piran M1) shows the results for Piran M1 station. Grazers were the most abundant (4307 ind.) guild with a high DF of 38.89%. The only guild showing a higher DF were filter-feeders (39.47%), however, they were much less abundant (375 ind.). Herbivores were both abundant (2561 ind.) and frequently drilled (31.94%). DF for predators, third highest in abundance (1465 ind.) was 23.89%. Scavengers, showing a similar abundance (1317 ind.), were drilled in 16.78%. Of the 488 parasitic living gastropods found, 135 were drilled, leading to a DF of 27.66%. DF for micro-herbivores was found to be 10.42% with a total of 96 individuals found. Detritus-feeders (135 ind.) were drilled in 8.89%. Lowest DF was found for micro-carnivores, were only 2 out of 51 individuals were drilled (3.92%).

Feeding guild	Ntot	Ndrill	DF(%)
Detritus	135	12	8,89
Filter-feeder	375	148	39,47
Grazer	4307	1675	38,89
Herbivorous	2561	818	31,94
Micro-herbivorous	96	10	10,42
Micro-carnivorous	51	2	3,92
Parasite	488	135	27,66
Predator	1465	350	23,89
Scavenger	1317	221	16,78
	10795	3371	31,23

Table 39: DF per Feeding Guild Piran M1

As in the other core of Piran, grazers were the most abundant feeding guild at Piran M53. They show a significantly higher abundance (7297 ind.) than all other goups, and were also the most frequently drilled guild (32.81%). Herbivores (3336 ind.) and scavengers (3261 ind.) also occured in high numbers. However, they diverge significantly in DF, with herbivores drilled in 27.64% and scavengers only in 6.99%. Predators also show high abundance (2822 ind.) within this core, and were drilled in 15.73%. Parasites (756 ind.) and filter-feeders (829 ind.) show similar abundances, as well as DF. For parasites, a DF of 21.83% was found and filter-feeders were drilled in 27.74%. The only other drilled guild were detritus-feeders. Here 47 out of 355 individuals were drilled (13.24%). No drill holes were found for micro-herbivores (271 ind.) and micro-carnivores (104 ind.) (Tab. 40).

Feeding guild	Ntot	Ndrill	DF (%)
Detritus	355	47	13,24
Filter-feeder	829	230	27,74
Grazer	7297	2394	32,81
Herbivorous	3336	922	27,64
Micro-herbivorous	271	0	0,00
Micro- carnivorous	104	0	0,00
Parasite	756	165	21,83
Predator	2822	444	15,73
Scavenger	3261	228	6,99
	19031	4430	23,28

Table 40: DF per feeding guild at Piran M53

8 Discussion

8.1 Higher DF in nutrient-rich areas

The Northern Adriatic Sea is, in general, low in nutrients and depends on nutrient input from rivers. Therefore higher nutrient values are to be found near deltas, especially near deltas of the rivers Po and Isonzo (Spillman et al. 2007; Campanelli et al. 2011; Ingrosso et al. 2016). Our cores were taken at different habitats, concerning nutrient content. While cores from Brijuni and Venice were taken in low nutrient areas, cores from Panzano and Po-delta were taken at high nutrient areas. Piran cores were thought to be taken at an intermediate nutrient area, however recent research (Tamse et al. 2015) suggests that this area might be of high production during springtime and fall due to river plumes.

Panzano and Piran cores follow our hypothesis that high nutrient input begets high values of DF. At Panzano high DFs of 23.56% and 22.16% were found. Highest DFs were found at the cores of Piran (31.23% and 23.28%), which we thought of as an area with low nutrient input, characterised also by a sandy-mud sediment. Recent research by Tamse et al. (2015) shows that riverine input might be of importance, especially in spring. The sampling conducted by this group was done in 2007 near the same maritime bouy where our sampling was conducted in 2013. It shows that, at least for surface primary production, riverine input of three small rivers and the Isonzo lead to a phytoplankton bloom in spring and autumn. These two events might support the region with enough nutrients to enble higher predation rates in molluscs than expected. At Po stations, rather low DFs of 11.89%, 7.5% and 8.33% were found. This seems contradict the high-nutrient input rates from the river. However, high sedimentation rates of up to 2cm y^{-1} and freshwater input might act as stronger influences on benthic organisms than nutrient input. Organisms living in this habitat might need to invest more energy in escaping sedimentation and can therefore not completetly use the higher amounts of nutrients supplied. Additionally, it is not clear, which impact the high intensity of shipping and fishing in this area has on the benthic system. This holds true for the whole Northern Adriatic Sea as shipping numbers have been increasing since the 18th century and are expected to rise (Umwelt Bundesamt 2016).
As for low nutrient areas, Venice and Brijuni, DFs were also found to be low (9.93% at Venice and 14.4% at Brijuni). The Venice area is also characterised by oligotrophic relict sands and nutrients reach this area only by currents bringing watermasses from the Po river to the north and from the Isonzo river to the west (Artegiani et al. 1997). Concerning Brijuni, no nutrient input from rivers is possible and nutrient input might be mostly due to land run-off from Brijuni islands.

8.2 DF is linked to life habits

Concerning DF, it is thought that more mobile organisms (eg. predators) are less frequently preyed upon, while less-mobile organisms (eg. filter-feeders) suffer from a higher predation intensity (Vermeij

1977; Vermeij 1983; Chattopadhyay et al. 2015). Concerning our data this seems to be true for nearly all samples. At Po cores, DFs were higher in non-, or less mobile (eg. infaunal) than in highly mobile (eg. predatory and scavenger) organisms. At the Panzano cores less mobile organisms show DFs of up to 50%, while drilling frequency on mobile species is low (6-7%). In the two cores from Piran mobile gastropod species show quite high drilling intensities (up to 26%) but they are still only half as frequently drilled as less mobile species within this core. To our surprise, epibiontic living gastropods were, despite their cryptic lifestyle, found to be frequently drilled in all our samples. A possible explantion for this might be that they are hidden as long as their host is living, but as soon as the host dies they become easy prey due to their thinner shells (Sawyer & Zuschin 2010). Following the hypothesis of higher DFs in less mobile species, filter-feeders should suffer under a higher predation pressure than other gastropod lifestyles. For Po stations, drill-holes were mostly found on filter-feeding gastropods. Predators were only drilled at a much-lower frequeny and most drilling occured in juveniles. The only predatory gastropods found in the Po cores were from the family Naticide, which mostly prey on infaunal organisms. All gastropods found to be filter-feeders belong to the infaunal species *T. communis*. It seems that these gastropods can cope better with the highly stressful environment at the Po Delta than others. Therefore, this combination of prey and predator might be so unique at these cores. For the core from Venice no drill holes were found in filter-feeders, which might be due to their low abundance of only 16 individuals along the core. The high DF values for herbivorous gastropods might be due to a high abundance of muricid snails in the same layers. Again predators (4.82%) and scavangers (3.13%) show low DFs while drilling on less mobile organisms was rather high (14.06%). The cores of Piran and Brijuni further support this hypothesis, as DFs found in non-mobile species were twice as high as for mobile species. However, in these cores, high values for DFs in mobile species might be since they are one order of magnitude more abundant than non-mobile organisms. Mobile gastropods might simply be more accessible prey and therefore show higher DF values.
In general, our data support the theory that drilling predation on less mobile species is higher than in more mobile species. However, more research needs to be done to fully understand the ongoing processes and predator-prey interactions, especially in more stressful habitats.

When we distinguish between DFs found for gastropods living infaunal, epifaunal and epibiontic, we need to be aware of the different predators that are preying on these organisms. While naticid gastropods preferentially prey on organisms living infaunal, muricid snails prey mostly on organisms living epifaunal or only shallow burrowed (Chattopadhyay et al. 2014; Yochelson et al. 1983; Dietl 2003). Therefore, simply by the presence or absence of these predators, patterns of drilling intensities on communities can be predicted. As for prey organisms, *T. communis* has a special status, as it is only burrowed shallow within the sediment and can therefore be preyed on by both predator groups found in the Northern Adriatic Sea. For our data, no clear pattern was found, distinguishing between life habits. Infaunal gastropods were drilled in 23.76%, epifaunal in 22.94% and epibiontic in 21.3%. No difference in abundance was found for infaunal (3602 Ind.) and epibiontic (3489 Ind.) living gastropods. However, epibiontic living gastropod were found to be one order of magnitude higher in abundance (36620 Ind.) than the other types. Concerning predatory gatstropods, naticids were nearly twice as abundant as muricids across all cores. Presence and absence of predators within cores is also linked to the abundance of prey organisms. In Panzano cores, where the highest abundance of epifaunal organisms was found, the abundance of muricids is also high. The same holds true for Piran cores. In Brijuni no naticid gastropods were found, while the abundance of muricids is high and therefore also drilling on epifaunal gastropods is higher. In general, high DFs of epifaunal organisms could be linked to their high abundances. While DFs of infaunal gastropods might possibly be linked to the presence or absence of naticid predators (Chattopadhyay et al. 2015). As for epibiontic organisms, DFs should be low as they have a cryptic livestyle. However, as already discussed before, high DFs might come from the loss of their host and being easy prey afterwards.

Our data do not show any direct differences between the different ecotypes. Morevover it seems that high abundances of certain ecotypes favour high drilling frequencies. Also habitat characteristics (eg., sedimentation) might have a strong influence on the DFs found for different ecotypes.

8.3 High diversity increases DF´s

Studies on fossil mollusc assemblages show a link between biodiversity and predation. In the Maastrichian (Harries & Schopf 2007) and in the Eocene (Hansen & Kelley 1995) traces for a link of high diversity, leading to higher DFs were found. However, studies from recent ecosystems also show that there does not need to be a correlation of DFs and diversity (Kelley & Hansen 2009). In general it is supposed, by ecological measures, that an intermediate predation intensity leads to a higher diversification of prey organisms (Huston 1998). This also seems to be true for gastropods (Covich 2010). Concerning DFs of different taxa, it is important to take their abundance into account. Species that are higher in abundance are more likely to get preyed upon. Encounter rates of prey organisms and their abundances seem to play an important role in the control of DFs (Leighton 2002).

This also seems to be true for our study. While high DFs were found in the cores of Piran, which also show also high species abundance, low predation intensities were found for the Po cores, which show low species abundance. For a link between species richness and DFs no clear trend was found. In fact, for Brijuni, which has the highest species richness of all cores, only an intermediate DF was observed. This might be because abiotic factors and human impact are reduced at this station. Therefore, the predator-prey interactions might be more distinct than in other cores. For Venice, high species richness does not correlate with the rather low predation intensities. At this station, anthropogenic preassure has been very high for several centuries and is still increasing. Today´s bottom trawling is a strong negative influence on the benthinc ecosystem (personal observation). In contrast, the cores of Panzano, having rather low species richness, show high DF. A possible explanation for this might be high seasonal nutrient input and therefore temporarily higher predation rates. This hypothesis would need further testing as time-averaging is too strong to accomplish for this question.

When taking a closer consider the species assamblages, it seems that not only high abundances control the predation risk of a certain species. While *N. pygmaeus* showed high abundances in most of the cores, its DFs are rather low. In contrast, members of the genus *Bittium* seem to be high in abundance and display high DFs in most cores. As both species are epifaunal, it might be that species of the genus *Bittium* are easier prey since they are grazers, while *N. pygmaeus* is a scavenger. In cores with muddy sediments (Po, Panzano) the species *T. communis* seems to play an important role as prey organism. For this species, abundance as well as DFs were high. This might be linked to a less heterogenious habitat and therefore less divergence in predator and prey interactions (Miyashita et al. 2016).

8.4 DF in the Northern Adriatic is at a pre-Cenozoic level

Research done by Kelly (2006) and McKinney (2007) suggest that predation rates in the Northern Adriatic are on a pre-Cenozoic level. Both surveys were done on bulk samples taken near Venice. Both show that DF are below 10%, this would be a typical value of drilling predation for the Cretaceous (Kelley 2006; McKinney 2007). In contrast, research by Zuschin and Stachowitsch (2009) suggested that predation intensities at the Northern Adriatic are like predation intensities in other parts of the Mediterranean and therefore at typical modern levels

In this study we found an overall DF of 16.93% across all cores, which suggests that drilling predation in the Northern Adriatic happens on a typicall Cenozoic level. However, DFs did show a strong variation between our cores. Low values were found at Venice (9.93%). As discussed before the area offshore Venice might possibly have lower DFs due to a reduced nutrient input, but this station is not exemplary for the whole Northern Adriatic. At the stations of Piran (31.23% and 22.28%), Panzano (23.56% and 22.16%) and Brijuni (14.46%), DFs were on a typical Cenozoic level.

PE found in this study is very low when compared to other Cenozoic basins. This might be due to the very pronounced habitat differences between our sampling stations. Abiotic factors (freshwater, nutrients, sedimentation) might have stronger influences on predation in the Northern Adriatic Sea compared to other basins.

In general, this study does not support the theory of predation rates on pre-Cenozoic level at the Northern Adriatic Sea. Rather it seems to be the case that, due to the high habitat heterogeneity, different predation rates can be found.

8.5 DFs over time are influenced stronger by changes in abiotic factors than by biotic interactions.

Concerning DF trends along cores it seems to be that the presence or absence of certain predators has a big influence in overall drilling. While drilling in some cores (e.g., Po) were mostly caused by naticid predators, others (e.g, Brijuni) are influenced by muricid and naticid predators.

In general, the cores of Brijuni and Piran show an up-core increase of DFs. The cores of Panzano and the Po-delta show higher values of DF in lower layers and are decreasing up-core. With a total lack of drilling in some of the upper layers at the cores from Po. DF found for the core of Venice is stable until the middle of the core. In up-core regions strong variations between single layers were found.

Intermediate DF along the core in Brijuni might be explained by medium abundances of prey organsims for both predatory families. As general prey abundance increases towards the upper layers of the core, DF might also increase. For the total breakdown at the uppermost layer (0-2 cm) a possible explanation might be that the samples were taken at an oceanographic bouy, which was taken away one year prior to our sampling. Maybe, due to human activity, one layer of sediment got on top of the others and no specimens have yet settled. However, this is only a theory and would need further research over the next years. At the cores from Po, infaunal gastropods were only found in deeper layers and general species abundance was decreasing up-core. This might be an explanation for the strong decrease of DF in upper regions of the cores. As discussed before this decrease might mostly be due to increasing freshwater input and sedimentation loads as well as human activity in the area over the last decades. The DFs at the cores from Piran and Panzano are strongly influenced by the DFs of the most abundant families of predator and prey organisms. Here in layers with high abundances of epifaunal living gastropods, higher abundances of muricids were found and vice versa for infaunal gastropods and naticids. However, while the increase in DF at the upper layers of the cores of Piran might be explained by higher prey abundances, the decrease in upper layers of the Panzano cores can not be simply explained simply by biotic interaction. Here it seems that freshwater input and stronger human activity over the last decades are influencing DFs. The core of Venice shows higher stability in DF at down-core layers. Again, the interaction of predatory and prey organisms is balanced. While in upper layers of the core, where DFs start to vary, predator and prey organisms show strong variance in abundance. Here the intense human impact (dredging and fishing) for several centuries might shape the patterns of DF. Changes along cores might not solely be explained by biotic interactions. Expecially in regions with high anthropogenic activity and strong abiotic factors (rivers), trends found in DF might be shaped stronger by these factors. For regions where these stressors are reduced (e.g., Brijuni) DFs seem to be mainly influenced by biotic interaction.

9 Conclusion

The Northern Adriatic is a marine basin, strongly influenced by riverine inputs. Nutrient, sediment and freshwater input shape and characterise molluscan assamblages. Therefore, high variabilities within our samples concerning diversity and DF were found. Strongest differences in drill frequency (DF) were found in nutrient-rich (e.g., Panzano) to nutrient-poor (e.g., Venice). Multiple drill frequency (MDF) and incomplete drill frequency (IDF) are of minor relevance for gastropods.

The hypothesis that infaunal lifestyle protects organisms from predation can not be supported by this study. Moreover, it seems that these organisms often suffer especially severe predation pressure. In general, it seems that predators in the Northern Adriatic are more generalised concerning prey (high DF in infaunal, epifaunal and epibiontic lifestyles).

Biodiversity measures correlated only in some of our samples (eg. Brijuni) with DFs. We suppose that other factors, such as freshwater input or anthropogenic preassures (eg. fishing and bottom trawling) have strong effects on the biodiversity in this marine area.

The hypothesis of drill frequencies (DFs) on a pre-Cenozoic level within the Northern Adriatic is rejected by this study. Although it needs to be mentioned that we found great spatial differences in DFs across our samples.

Concerning trends in drill frequency (DF) along cores, we conclude that drilling is influenced more by environmental factors and antropogenic activities than solely by biotic interactions.

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12 Appendix

12.1.1.1 DF per taxonomic level

12.1.1.1.1 Venice

Family	Ntot	Ndrill	DF (%)	lCI	uCI	pval
Aclididae	1	0	0,00	0	0,975	1,000
Acteonidae	10	0	0,00	0	0,308	0,002
Aporrhaidaeÿ	7	0	0,00	0	0,410	0,016
Caecidae	7	1	14,29	0,003	0,579	0,125
Calliostomatidae	17	0	0,00	0	0,195	1,000
Calyptraeidae	15	0	0,00	0	0,218	1,000
Cerithiidae	260	47	18,08	0,135	0,233	0,000
Cerithiopsidae	18	4	22,22	0,064	0,476	0,031
Clathurellidae	8	0	0,00	0	0,369	0,008
Columbelidae	9	2	22,22	0,028	0,600	0,180
Costellariidae	2	0	0,00	0	0,842	0,500
Creseidae	1	0	0,00	0	0,975	1,000
Cylichnidae	1	0	0,00	0	0,975	1,000
Cystiscidae	3	0	0,00	0	0,708	0,250
Epitoniidae	16	0	0,00	0	0,206	1,000
Eulimidae	8	1	12,50	0,003	0,527	0,070
Fasciolariidae	3	0	0,00	0	0,708	0,250
Fissurellidae	3	0	0,00	0	0,708	0,250
Haminoeidae	7	0	0,00	0	0,410	0,016
Iravadiidae	2	0	0,00	0	0,842	0,500
Mangeliidae	158	6	3,80	0,014	0,081	0,000
Muricidae	28	0	0,00	0	0,123	1,000
Nassariidae	96	3	3,13	0,006	0,089	0,000
Naticidae	37	1	2,70	0,000	0,142	1,000
neritidae	4	0	0,00	0	0,602	0,125
Phasianellidae	44	10	22,73	0,114	0,378	0,000
Philinidae	4	0	0,00	0	0,602	0,125

Pyramidellidae	65	7	10,77	0,044	0,209	1,000
Raphitomidae	9	1	11,11	0,002	0,482	0,039
Retusidae	6	0	0,00	0	0,459	0,031
Ringiculidae	1	0	0,00	0	0,975	1,000
Rissoidae	259	30	11,58	0,079	0,161	0,000
Scissurellidae	1	0	0,00	0	0,975	1,000
Tornidae	2	0	0,00	0	0,842	0,500
Triphoridae	14	4	28,57	0,083	0,581	0,180
Trochidae	89	4	4,49	0,012	0,111	0,000
Tylodinidae	4	0	0,00	0	0,602	0,125

Table 41: DF on family level at Venice station

Species	Ntot	Ndrill	DF (%)	lCI	uCI	pval
Aclis minor	1	0	0,00	0	0,975	1,000
Acteon tornatilis	10	0	0,00	0	0,308	0,002
Alvania cancellata	2	0	0,00	0	0,842	0,500
Alvania cimex	3	1	33,33	0,008	0,906	1,000
Alvania geryonia	3	1	33,33	0,008	0,906	1,000
Alvania punctura	2	0	0,00	0	0,842	0,500
Aporrhais pespelecani	7	0	0,00	0	0,410	0,016
Bela brachystoma	2	0	0,00	0	0,842	0,500
Bela nebula	23	0	0,00	0	0,148	1,000
Bittium latreillii	124	32	25,81	0,183	0,344	1,000
Bittium reticulatum	84	9	10,71	0,050	0,194	0,431
Caecum trachea	7	1	14,29	0,003	0,579	0,125
Calliostoma conulus	4	0	0,00	0	0,602	0,125
Calliostoma laugieri	13	0	0,00	0	0,247	0,000
Calyptraea chinensis	14	0	0,00	0	0,232	0,000
Ceratia proxima	2	0	0,00	0	0,842	0,500
Cerithidium submamillatum	33	4	12,12	0,034	0,282	1,000
Cerithiopsidae indet,	10	3	30,00	0,067	0,652	0,344
Cerithiopsis tubercularis	8	1	12,50	0,003	0,527	0,070
Cerithium protractum	19	2	10,53	0,013	0,331	0,001
Circulus tricarinatus	2	0	0,00	0	0,842	0,500
Clathrella clathrata	1	0	0,00	0	0,975	1,000

Comarmondia gracilis	8	0	0,00	0	0,369	0,008
Crepidula moulinsii	1	0	0,00	0	0,975	1,000
Creseis acicula	1	0	0,00	0	0,975	1,000
Cylichna cylindracea	1	0	0,00	0	0,975	1,000
Cylichnina laevisculpta	5	0	0,00	0	0,522	0,063
Diodora gibberula	2	0	0,00	0	0,842	0,500
Diodora graeca	1	0	0,00	0	0,975	1,000
Epitonium algerianum	1	0	0,00	0	0,975	1,000
Epitonium clathrus	14	0	0,00	0	0,232	0,000
Epitonium turtonis	1	0	0,00	0	0,975	1,000
Eulima glabra	2	0	0,00	0	0,842	0,500
Eulimella acicula	1	0	0,00	0	0,975	1,000
Eulimidae indet,	3	0	0,00	0	0,708	0,250
Euspira macilenta	5	0	0,00	0	0,522	0,063
Euspira pulchella	32	1	3,13	0,001	0,162	1,000
Fusinus rostratus	3	0	0,00	0	0,708	0,250
Gibberula spp,	3	0	0,00	0	0,708	0,250
Gibbula ardens	38	1	2,63	0,001	0,138	1,000
Gibbula guttadauri	5	0	0,00	0	0,522	0,063
Gibbula leucophaea	1	0	0,00	0	0,975	1,000
Gibbula fanulum	1	0	0,00	0	0,975	1,000
Hexaplex trunculus	3	0	0,00	0	0,708	0,250
Jujubinus striatus	14	0	0,00	0	0,232	0,000
Jujubinus exasperatus	29	3	10,34	0,021	0,274	1,000
Mangelia attenuata	15	2	13,33	0,016	0,405	0,007
Mangelia costulata	114	3	2,63	0,005	0,075	0,000
Mangelia unifasciata	4	1	25,00	0,006	0,806	0,625
Marshallora adversa	5	1	20,00	0,005	0,716	0,375
Melanella frielei	2	0	0,00	0	0,842	0,500
Mitrella minor	9	2	22,22	0,028	0,600	0,180
Monophorus perversus	5	3	60,00	0,146	0,947	1,000
Mures brandaris	2	0	0,00	0	0,842	0,500
Muricidae juvenil	23	0	0,00	0	0,148	1,000
Nassarius pygmaeus	96	3	3,13	0,006	0,089	0,000

Odostomia eulimoides	4	0	0,00	0	0,602	0,125
Odostomia turriculata	2	1	50,00	0,012	0,987	1,000
Odostomia spp,	9	0	0,00	0	0,336	0,004
Philine quadripartita	3	0	0,00	0	0,708	0,250
Philine scabra	1	0	0,00	0	0,975	1,000
Phorcus/Gibbula sp,1	1	0	0,00	0	0,975	1,000
Pusillina lineolata	64	5	7,81	0,025	0,173	90,000
Pusillina radiata	49	2	4,08	0,005	0,140	43,600
Pusillina inconspicua	53	8	15,09	0,067	0,276	1,000
Pusillina philippi	5	0	0,00	0	0,522	0,063
Raphitoma atropurpurea	2	0	0,00	0	0,842	0,500
Raphitoma echinata	7	1	14,29	0,003	0,579	0,125
Retusa truncatula	1	0	0,00	0	0,975	1,000
Ringicula conformis	1	0	0,00	0	0,975	1,000
Rissoa membranacea	14	7	50,00	0,230	0,770	1,000
Rissoa monodonta	35	5	14,29	0,048	0,303	1,000
Rissoa spp,	25	1	4,00	0,001	0,204	1,000
Rissoa violacea	4	0	0,00	0	0,602	0,125
Scissurella costata	1	0	0,00	0	0,975	1,000
Smaragdia viridis	4	0	0,00	0	0,602	0,125
Tricolia pullus	44	10	22,73	0,114	0,378	0,000
Triphoridae indet,	4	0	0,00	0	0,602	0,125
Turbonilla acutissima	7	0	0,00	0	0,410	0,016
Turbonilla rufa	41	6	14,63	0,055	0,292	1,000
Tylodina sp 1	4	0	0,00	0	0,602	0,125
Vexillum tricolor	2	0	0,00	0	0,842	0,500
Vitreolina curva	1	1	100,00	0,025	1,000	1,000
Weinkauffia turgidula	7	0	0,00	0	0,410	0,016

Table 42: DF per species at Venice

12.1.1.1.2 Panzano M28

Family	Ntot	Ndrill	DF (%)	lCI	uCI	pval
Acteonidae	3	0	0	0	0,708	0,250

Akeridae	37	0	0	0	0,095	1,000
AporrhaidaeÂ	117	5	4,27	0,014	0,097	0,000
Calyptraeidae	151	1	0,66	0,001	0,036	0,000
Cerithiidae	3	2	66,66	0,094	0,992	1,000
Cylichnidae	4	0	0	0	0,602	0,125
Epitoniidae	2	0	0	0	0,842	0,500
Eulimidae	51	11	21,56	0,112	0,353	1,000
Haminoeidae	24	0	0	0	0,142	1,000
Hydrobiidae	1	0	0	0	0,975	1,000
Iravadiidae	6	0	0	0	0,459	0,031
Mangeliidae	22	7	31,81	0,138	0,549	0,134
Muricidae	8	0	0	0	0,369	0,008
Nassariidae	384	30	7,81	0,053	0,110	0,000
Naticidae	76	0	0	0	0,047	0,000
Phasianellidae	1	0	0	0	0,975	1,000
Philinidae	24	0	0	0	0,142	1,000
Pyramidellidae	21	3	14,28	0,030	0,363	0,001
Retusidae	1	0	0	0	0,975	1,000
Rissoidae	30	6	20	0,077	0,386	0,001
Turritellidae	555	294	52,97	0,487	0,572	0,174
Zonitidae	3	0	0	0	0,708	0,250
	1524	359	10,00			

Table 43: DF at family level, Panzano M28

Species	Ntot	Ndrill	DF (%)	lCI	uCI	pval
Acteon tornatilis	3	0	0,00	0	0,708	0,250
Akera bullata	37	0	0,00	0	0,095	1,000
Aporrhais pespelecani	117	5	4,27	0,014	0,097	0,000
Atys jeffreysi	8	0	0,00	0	0,369	0,008
Bela brachystoma	13	7	53,85	0,251	0,808	1,000
Calyptraea chinensis	150	1	0,67	<0,000	0,037	0,000
Ceratia proxima	5	0	0,00	0	0,522	0,063
Cerithidium submamillatum	3	2	66,67	0,094	0,992	1,000
Crepidula moulinsii	1	0	0,00	0	0,975	1,000
Cylichna cylindracea	3	0	0,00	0	0,708	0,250

Cylichnina laevisculpta	1	0	0,00	0	0,975	1,000
Epitonium cantrainei	1	0	0,00	0	0,975	1,000
Epitonium clathratulum	1	0	0,00	0	0,975	1,000
Eulima glabra	6	0	0,00	0	0,459	0,031
Eulimella acicula	1	0	0,00	0	0,975	1,000
Euspira macilenta	59	0	0,00	0	0,061	0,000
Euspira pulchella	17	0	0,00	0	0,195	1,000
Hadriania craticulata	3	0	0,00	0	0,708	0,250
Haminoea hydatis	3	0	0,00	0	0,708	0,250
Hyala vitrea	1	0	0,00	0	0,975	1,000
Hydrobia sp,1	1	0	0,00	0	0,975	1,000
Mangelia attenuata	3	0	0,00	0	0,708	0,250
Mangelia costulata	2	0	0,00	0	0,842	0,500
Mangelia unifasciata	4	0	0,00	0	0,602	0,125
Melanella alba	1	0	0,00	0	0,975	1,000
Melanella frielei	28	10	35,71	0,186	0,559	0,185
Melanella spp,	15	1	6,67	0,001	0,319	0,001
Murex brandaris	3	0	0,00	0	0,708	0,250
Muricidae indet,	2	0	0,00	0	0,842	0,500
Nassarius pygmaeus	384	30	7,81	0,053	0,110	0,000
Odostomia eulimoides	9	1	11,11	0,002	0,482	0,039
Odostomia spp,	11	2	18,18	0,022	0,518	0,065
Oxychilus sp,	3	0	0,00	0	0,708	0,250
Philine quadripartita	22	0	0,00	0	0,154	1,000
Philine scabra	2	0	0,00	0	0,842	0,500
Pusillina inconspicua	3	0	0,00	0	0,708	0,250
Pusillina lineolata	12	2	16,67	0,020	0,484	0,039
Pusillina radiata	9	2	22,22	0,028	0,600	0,180
Pusillina sp 1	6	2	33,33	0,043	0,777	0,688
Retusa minutissima	1	0	0,00	0	0,975	1,000
Tricolia pullus	1	0	0,00	0	0,975	1,000
Turritella comunis	555	294	52,97	0,487	0,572	0,174
Vitreolina incurva	1	0	0,00	0	0,975	1,000
Weinkauffia turgidula	13	0	0,00	0	0,247	0,000

	1524	359	7,34			

Table 44: DF per species at Panzano M28

12.1.1.1.3 Panzano M29

Family	Ntot	Ndrill	DF (%)	lCI	uCI	pval
Aclididae	15	0	0	0	0,218	1,000
Acteonidae	22	0	0	0	0,154	1,000
Akeridae	3	0	0	0	0,708	0,250
Aporrhaidaeÿ	17	17	100	0,804	1,000	1,000
Calyptraeidae	117	1	0,85	<0,000	0,047	0,000
Cerithiidae	17	0	0	0	0,195	1,000
Cylichnidae	3	0	0	0	0,708	0,250
Epitoniidae	556	0	0	0	0,007	0,000
Eulimidae	42	7	16,66	0,069	0,314	1,000
Fasciolariidae	3	0	0	0	0,708	0,250
Fissurellidae	2	1	50	0,012	0,987	1,000
Haminoeidae	3	0	0	0	0,708	0,250
Hydrobiidae	150	0	0	0	0,024	0,000
Iravadiidae	5	3	60	0,146	0,947	1,000
Mangeliidae	26	6	23,07	0,089	0,436	0,009
Muricidae	6	0	0	0	0,459	0,031
Nassariidae	398	22	5,52	0,035	0,082	0,000
Naticidae	9	4	44,44	0,137	0,788	1,000
Philinidae	1	0	0	0	0,975	1,000
Pyramidellidae	76	2	2,63	0,003	0,092	0,000
Rissoidae	33	5	15,15	0,051	0,319	1,000
Triphoridae	2	0	0	0	0,842	0,500
Turritellidae	580	342	58,96	0,979	0,999	0,000
	1850	410	18,16			

Table 45: DF at family level, Panzano M29

Species	Ntot	Ndrill	DF (%)	lCI	uCI	pval
Aclis minor	15	0	0,00	0	0,218	1,000
Acteon tornatilis	22	0	0,00	0	0,154	1,000
Akera bullata	3	0	0,00	0	0,708	0,250

Aporrhais pespelecani	17	17	100,00	0,804	1,000	1,000
Bela brachystoma	7	4	18,41	0,901	1,000	1,000
Bittium submamillatum	17	0	0,00	0	0,195	1,000
Calyptraea chinensis	117	1	0,85	<0,000	0,047	0,000
Ceratia proxima	4	3	75,00	0,194	0,994	0,625
Chrysallida terebellum	8	0	0,00	0	0,369	0,008
Cylichna cylindracea	3	0	0,00	0	0,708	0,250
Diodora graeca	2	1	50,00	0,012	0,987	1,000
Ebala nitidissima	37	0	0,00	0	0,095	1,000
Ecri¢bio ventrose	150	0	0,00	0	0,024	0,000
Epitonium cantrainei	555	0	0,00	0	0,007	0,000
Epitonium clathrus	1	0	0,00	0	0,975	1,000
Eulima glabra	1	0	0,00	0	0,975	1,000
Euspira macilenta	7	3	42,86	0,099	0,816	1,000
Euspira pulchella	2	1	50,00	0,012	0,987	1,000
Fusinus rostratus	3	0	0,00	0	0,708	0,250
Haminoea hydatis	2	0	0,00	0	0,842	0,500
Hexaplex trunculus	2	0	0,00	0	0,842	0,500
Hyala vitrea	1	0	0,00	0	0,975	1,000
Mangelia attenuata	3	1	33,33	0,008	0,906	1,000
Mangelia costulata	5	1	20,00	0,005	0,716	0,375
Mangelia unifasciata	11	0	0,00	0	0,285	0,001
Megastomia conoidea	3	0	0,00	0	0,708	0,250
Megastomia sp,1	3	0	0,00	0	0,708	0,250
Melanella alba	28	0	0,00	0	0,123	1,000
Melanella frielei	12	7	58,33	0,276	0,848	0,774
Melanella spp,	1	0	0,00	0	0,975	1,000
Murex brandaris	3	0	0,00	0	0,708	0,250
Muricidae indet,	1	0	0,00	0	0,975	1,000
Nassarius lima	14	1	7,14	0,002	0,339	0,002
Nassarius pygmaeus	384	21	5,47	0,034	0,082	0,000
Odostomia eulimoides	1	0	0,00	0	0,975	1,000
Odostomia spp,	10	1	10,00	0,002	0,445	0,021

Philine quadripartita	1	0	0,00	0	0,975	1,000
Pusillina inconspicua	4	1	25,00	0,006	0,806	0,625
Pusillina lineolata	14	4	28,57	0,083	0,581	0,180
Pusillina radiata	9	0	0,00	0	0,336	0,004
Rissoa sp,1	6	0	0,00	0	0,459	0,031
Triphoridae indet,	2	0	0,00	0	0,842	0,500
Turbonilla acutissima	14	1	7,14	0,002	0,339	0,002
Turritella communis	580	342	58,96	0,979	0,999	0,000
Weinkauffia turgidula	1	0	0,00	0	0,975	1,000
	1850	410	14,03			

Table 46: DF per species at Panzano M29

12.1.1.1.4 Po M13

Family	Ntot	Ndrill	DF (%)	lCI	uCI	pval
Acteonidae	1	0	0,00	0	0,975	1,000
AporrhaidaeÂ	3	0	0,00	0	0,708	0,250
Calyptraeidae	2	0	0,00	0	0,842	0,500
Cerithiidae	2	0	0,00	0	0,842	0,500
Cylichnidae	10	0	0,00	0	0,308	0,002
Iravadiidae	8	0	0,00	0	0,369	0,008
Mangeliidae	2	0	0,00	0	0,842	0,500
Nassariidae	58	0	0,00	0	0,062	0,000
Naticidae	4	1	25,00	0,006	0,806	0,625
Philinidae	2	0	0,00	0	0,842	0,500
Pyramidellidae	1	0	0,00	0	0,975	1,000
Triphoridae	1	0	0,00	0	0,975	1,000
Turritellidae	91	21	23,08	0,148	0,331	0,000
	185	22	3,70			

Table 47: DF on family level, Po M13

Species	Ntot	Ndrill	Freq	lCI	uCI	pval
Acteon tornatilis	1	0	0,00	0	0,975	1,000
Aporrhais pespelecani	3	0	0,00	0	0,708	0,250
Bittium submamillatum	2	0	0,00	0	0,842	0,500

Calyptraea chinensis	2	0	0,00	0	0,842	0,500
Cylichnina laevisculpta	10	0	0,00	0	0,308	0,002
Euspira macilenta	1	0	0,00	0	0,975	1,000
Euspira nitida	3	1	33,00	0,008	0,906	1,000
Hyala vitrea	8	0	0,00	0	0,369	0,008
Mangelia attenuata	1	0	0,00	0	0,975	1,000
Mangelia costulata	1	0	0,00	0	0,975	1,000
Nassarius pygmeus	58	0	0,00	0	0,062	0,000
Odostomia spp,	1	0	0,00	0	0,975	1,000
Philine quadripartita	1	0	0,00	0	0,975	1,000
Philine scabra	1	0	0,00	0	0,975	1,000
Triphoridae indet,	1	0	0,00	0	0,975	1,000
Turritella communis	91	21	23,00	0,148	0,331	0,000
	185	22	3,50			

Table 48: DF per species, Po M13

12.1.1.1.5 Po M20

Family	Ntot	Ndrill	DF (%)	lCI	uCI	pval
Aporrhaidae	15	0	0,00	0	0,218	0,000
Calyptraeidae	6	1	16,67	0,004	0,641	0,219
Cerithiidae	36	0	0,00	0	0,097	0,000
Cylichnidae	10	0	0,00	0	0,308	0,002
Eulimidae	2	0	0,00	0	0,842	0,500
Fasciolariidae	2	2	100,00	0,158	1,000	0,500
Hydrobiidae	1	0	0,00	0	0,975	1,000
Iravadiidae	23	0	0,00	0	0,148	0,000
Mangeliidae	6	1	16,67	0,004	0,641	0,219
Muricidae	1	0	0,00	0	0,975	1,000
Nassariidae	130	2	1,54	0,002	0,054	0,000
Naticidae	2	0	0,00	0	0,842	0,500
Philinidae	7	0	0,00	0	0,410	0,016
Pyramidellidae	2	0	0,00	0	0,842	0,500
Rissoidae	1	0	0,00	0	0,975	1,000
Turritellidae	116	21	18,10	0,115	0,263	0,000

	360	27	9,56			

Table 49: DF per family, Po M20

Species	Ntot	Ndrill	DF (%)	lCI	uCI	pval
Aporrhais pespelecani	15	0	0	0	0,218	0,000
Calyptraea chinensis	6	1	16,66	0,004	0,641	0,219
Cerithidium submamillatum	36	0	0	0	0,097	0,000
Cylichna cylindracea	10	0	0	0	0,308	0,002
Eulima glabra	2	0	0	0	0,842	0,500
Euspira macilenta	1	0	0	0	0,975	1,000
Euspira nitida	1	0	0	0	0,975	1,000
Fusinus rostratus	2	2	100	0,158	1,000	0,500
Hyala vitrea	23	0	0	0	0,148	0,000
Hydrobia sp 1	1	0	0	0	0,975	1,000
Mangelia smithii	6	1	16,66	0,004	0,641	0,219
Muricidae juv,	1	0	0	0	0,975	1,000
Nassarius lima	3	0	0	0	0,708	0,250
Nassarius pygmaeus	126	2	1,58	0,001	0,056	0,000
Nassarius reticulatus	1	0	0	0	0,975	1,000
Odostomia eulimoides	2	0	0	0	0,842	0,500
Philine aperta	3	0	0	0	0,708	0,250
Philine scabra	4	0	0	0	0,602	0,125
Setia sp,	1	0	0	0	0,975	1,000
Turritella communis	116	21	18,10	0,115	0,263	0,000
	360	27	7,65			

Table 50: DF per species, Po M20

12.1.1.1.6 Po M21

Family	Ntot	Ndrill	DF (%)	lCI	uCI	pval
Acteonidae	1	0	0,00	0	0,975	1,000
Akeridae	1	0	0,00	0	0,975	1,000
AporrhaidaeÂ	13	0	0,00	0	0,247	0,000
Calyptraeidae	8	0	0,00	0	0,369	0,008
Cerithiidae	13	1	7,69	0,001	0,360	0,003

Cylichnidae	10	0	0,00	0	0,308	0,002
Epitoniidae	1	0	0,00	0	0,975	1,000
Eulimidae	4	0	0,00	0	0,602	0,125
Iravadiidae	19	0	0,00	0	0,176	1,000
Mangeliidae	2	0	0,00	0	0,842	0,500
Nassariidae	66	0	0,00	0	0,054	0,000
Philinidae	2	0	0,00	0	0,842	0,500
Pyramidellidae	4	0	0,00	0	0,602	0,125
Ringiculidae	1	0	0,00	0	0,975	1,000
Turritellidae	119	21	17,65	0,112	0,257	1,000
	264	22	1,69			

Table 51: DF per family, Po 21

Species	Ntot	Ndrill	DF (%)	lCI	uCI	pval
Acteon tornatilis	1	0	0,00	0	0,975	1,000
Akera bullata	1	0	0,00	0	0,975	1,000
Aporrhais pespelecani	13	0	0,00	0	0,247	0,000
Bittium submamillatum	13	1	7,69	0,002	0,360	0,003
Calyptraea chinensis	8	0	0,00	0	0,369	0,008
Cylichna cylindracea	10	0	0,00	0	0,308	0,002
Epitonium cantreinei	1	0	0,00	0	0,975	1,000
Eulima glabra	4	0	0,00	0	0,602	0,125
Hyala vitrea	19	0	0,00	0	0,176	0,000
Mangelia attenuata	1	0	0,00	0	0,975	1,000
Mangelia costulata	1	0	0,00	0	0,975	1,000
Nassarius pygmaeus	64	0	0,00	0	0,056	0,000
Nassarius reticulatus	2	0	0,00	0	0,842	0,500
Odostomia eulimoides	1	0	0,00	0	0,975	1,000
Odostomia spp	3	0	0,00	0	0,708	0,250
Philine quadripartita	1	0	0,00	0	0,975	1,000
Philine scabra	1	0	0,00	0	0,975	1,000
Ringicula conformis	1	0	0,00	0	0,975	1,000
Turritella communis	119	21	17,65	0,112	0,257	0,000
	264	22	1,33			

Table 52: DF per species, Po M21

12.1.1.1.7 Brijuni

Family	Ntot	Ndrill	DF (%)	lCI	uCI	pval
Aclididae	74	2	2,70	0,003	0,094	0,000
Acteonidae	6	0	0,00	0	0,459	0,031
AporrhaidaeÂ	39	4	10,26	0,028	0,242	1,000
Caecidae	7	0	0,00	0	0,410	0,016
Calliostomatidae	59	6	10,17	0,038	0,208	17,500
Calyptraeidae	40	3	7,50	0,015	0,204	1,000
Capulidae	3	0	0,00	0	0,708	0,250
Cerithiidae	1597	405	25,36	0,232	0,276	0,000
Cerithiopsidae	128	40	31,25	0,233	0,400	1,000
Clathurellidae	20	3	15,00	0,032	0,379	0,003
Columbellidae	36	5	13,89	0,046	0,295	1,000
Costellariidae	1	0	0,00	0	0,975	1,000
Cytiscidae	23	0	0,00	0	0,148	1,000
Epitoniidae	130	4	3,08	0,008	0,077	0,000
Eulimidae	102	5	4,90	0,016	0,111	0,000
Fascicolariidae	73	19	26,03	0,164	0,376	1,000
Fissurellidae	110	2	1,82	0,002	0,064	0,000
Haminoeidae	17	0	0,00	0	0,195	1,000
Hydrobiidae	5	0	0,00	0	0,522	0,063
Iravadiidae	1	0	0,00	0	0,975	1,000
Lottidae	170	70	41,18	0,336	0,490	0,026
Mangeliidae	94	21	22,34	0,143	0,321	1,000
Mitromorphidae	10	0	0,00	0	0,308	0,002
Muricidae	153	5	3,27	0,010	0,075	0,000
Nassariidae	290	23	7,93	0,050	0,117	0,000
Naticidae	116	11	9,48	0,048	0,163	0,000
Neritidae	2	0	0,00	0	0,842	0,500
Phasianellidae	1	0	0,00	0	0,975	1,000
Philinidae	16	0	0,00	0	0,206	1,000
Pyramidellidae	214	18	8,41	0,050	0,130	0,000
Rapitomidae	81	7	8,64	0,035	0,170	0,032

Retusidae	10	0	0,00	0	0,308	0,002
Ringiculidae	1	0	0,00	0	0,975	1,000
Rissoidae	3150	389	12,35	0,112	0,135	0,000
Scissurellidae	159	8	5,03	0,021	0,097	0,000
Tornidae	4	0	0,00	0	0,602	0,125
Triphoridae	622	144	23,15	0,198	0,267	0,000
Trochidae	1466	102	6,96	0,057	0,084	0,000
Turbinidae	27	0	0,00	0	0,128	1,000
Turritellidae	103	28	27,18	0,188	0,368	1,000
Vanikoridae	4	1	25,00	0,006	0,806	0,625
Velutinidae	1	0	0,00	0	0,975	1,000
	9165	1325	8,40			

Table 53: DF per family, Brijuni M44

Species	Ntot	Ndrill	DF (%)	lCI	uCI	pval
Aclis minor	74	2	2,70	0,003	0,094	0,000
Acteon tornatilis	6	0	0	0	0,459	0,031
Alvania beanii	604	136	22,51	0,192	0,261	0,000
Alvania cancellata	164	10	6,10	0,029	0,109	0,000
Alvania carinata	1	0	0	0	0,975	1,000
Alvania lineata	83	16	19,27	0,114	0,294	1,000
Alvania cimex	179	13	7,26	0,039	0,121	0,000
Alvania geryonia	1230	147	11,95	0,101	0,139	0,000
Alvania punctura	79	9	11,39	0,053	0,205	77,800
Aporrhais pespelecani	39	4	10,25	0,028	0,242	1,000
Bela brachystoma	14	4	28,57	0,083	0,581	0,180
Bela menkhorsti	9	1	11,11	0,002	0,482	0,039
Bela nebula	2	1	50	0,012	0,987	1,000
Bittium latreilli	373	101	27,07	0,226	0,319	0,000
Bittium reticulatum	265	50	18,86	0,143	0,241	0,000
Bittium submamillatum	931	243	26,10	0,233	0,290	0,000
Bolinus brandaris	1	0	0	0	0,975	1,000
Bolma rugosa	27	0	0	0	0,128	1,000
Caecum trachea	7	0	0	0	0,410	0,016
Calliostoma conulus	2	0	0	0	0,842	0,500

Calliostoma zizyphinum	51	4	7,84	0,021	0,189	1,000
Calliostoma sp1	6	2	33,33	0,043	0,777	0,688
Calyptraea chinensis	25	1	4	0,001	0,204	1,000
Capulus ungaricus	3	0	0	0	0,708	0,250
Cerithiopsis barleei	24	10	41,66	0,221	0,634	0,541
Cerithiopsis diadema	5	3	60	0,146	0,947	1,000
Cerithiopsis nana	8	3	37,5	0,085	0,755	0,727
Cerithiopsis spp,	50	12	24	0,130	0,382	0,000
Cerithiopsis tubercularis	29	7	24,13	0,102	0,435	0,008
Cerithium vulgatum	28	11	39,28	0,215	0,594	0,345
Chrysallida indistincta	1	0	0	0	0,975	1,000
Chrysallida interstincta	10	1	10	0,002	0,445	0,021
Chrysallida sp,1	1	0	0	0	0,975	1,000
Chrysallida sp,2	3	0	0	0	0,708	0,250
Chrysallida sp,3	7	0	0	0	0,410	0,016
Chrysallida sp,4	1	0	0	0	0,975	1,000
Circulus striatus	4	0	0	0	0,602	0,125
Clelandella miliaris	1	0	0	0	0,975	1,000
Comarmondia gracilis	20	3	15	0,032	0,379	0,003
Crepidula moulinsii	15	2	13,33	0,016	0,405	0,007
Crisilla semistriata	18	2	11,11	0,013	0,347	0,001
Curveulima devians	7	0	0	0	0,410	0,016
Diodora graeca	69	0	0	0	0,052	0,000
Dizoniopsis abylensis	1	1	100	0,025	1,000	1,000
Emarginula huzardii	1	0	0	0	0,975	1,000
Emarginula rosea	40	2	5	0,006	0,169	1,000
Epitonium algerianum	3	0	0	0	0,708	0,250
Epitonium cantrainei	17	0	0	0	0,195	1,000
Epitonium clathrus	110	4	3,63	0,009	0,090	0,000
Eulima bilineata	22	3	13,63	0,029	0,349	0,001
Eulima glabra	21	2	9,52	0,011	0,304	0,000
Eulimella acicula	3	0	0	0	0,708	0,250
Euparthenia bulinea	20	2	10	0,012	0,317	0,000
Euspira nitida	95	11	11,57	0,059	0,198	0,045

Folinella excavata	2	0	0	0	0,842	0,500
Fusinus rostratus	73	19	26,02	0,164	0,376	1,000
Gibberula spp,	23	0	0	0	0,148	1,000
Gibbula ardens	238	19	7,98	0,048	0,122	0,000
Gibbula fanulum	4	0	0	0	0,602	0,125
Haminoea hydatis	2	0	0	0	0,842	0,500
Hexaplex trunculus	118	3	2,54	0,005	0,073	0,000
Hyala vitrea	1	0	0	0	0,975	1,000
Hydrobia acuta	5	0	0	0	0,522	0,063
Jujubinus exasperatus	345	26	7,53	0,049	0,108	0,000
Jujubinus montagui	878	57	6,49	0,049	0,083	0,000
Lamellaria perspicua	1	0	0	0	0,975	1,000
Mangelia attenuata	2	0	0	0	0,842	0,500
Mangelia costata	(=coarctata)	5	100	0,2	0,005	0,716
Mangelia costulata	5	1	20	0,005	0,716	0,375
Mangelia sp,1	1	0	0	0	0,975	1,000
Mangelia unifasciata	56	13	23,21	0,129	0,364	1,000
Manzonia crassa	38	1	2,63	0,001	0,138	1,000
Marshallora adversa	213	65	30,51	0,244	0,372	1,000
Megalomphalus azoneus	4	1	25	0,006	0,806	0,625
Megastomia conoidea	45	3	6,66	0,013	0,183	1,000
Megastomia conspicua	4	0	0	0	0,602	0,125
Melanella alba	3	0	0	0	0,708	0,250
Melanella polita	10	0	0	0	0,308	0,002
Melanella frielei	5	0	0	0	0,522	0,063
Melanella spp,	3	0	0	0	0,708	0,250
Metaxia metaxa	13	1	7,69	0,002	0,360	0,003
Mitrella minor	36	5	13,88	0,046	0,295	1,000
Mitromorpha mediterranea	10	0	0	0	0,308	0,002
Monophorus perversus	10	6	60	0,262	0,878	0,754
Monophorus thiriotae	11	4	36,36	0,109	0,692	0,549
Muricidae indet,	8	0	0	0	0,369	0,008
Nassarius lima	7	2	28,57	0,036	0,710	0,453
Nassarius pygmaeus	283	21	7,42	0,046	0,111	0,000

Natica stercusmuscarum	14	0	0	0	0,232	0,000
Naticidae indet	7	0	0	0	0,410	0,016
Ocenebra erinaceus	17	2	11,76	0,014	0,364	0,002
Ocinebrina helleri	3	0	0	0	0,708	0,250
Odostomia eulimoides	50	3	6	0,012	0,165	1,000
Odostomia spp,	8	0	0	0	0,369	0,008
Ondina vitrea	2	0	0	0	0,842	0,500
Philine catena	8	0	0	0	0,369	0,008
Philine scabra	8	0	0	0	0,369	0,008
Pusillina inconspicua	315	23	7,30	0,046	0,108	0,000
Pusillina lineolata	140	11	7,85	0,039	0,136	0,000
Pusillina philippi	83	6	7,22	0,026	0,151	0,008
Pusillina radiata	95	7	7,36	0,030	0,146	0,000
Raphitoma aequalis	5	0	0	0	0,522	0,063
Raphitoma atropurpurea	17	4	23,52	0,068	0,499	0,049
Raphitoma echinata	19	1	5,26	0,001	0,260	1,000
Raphitoma hispida	1	0	0	0	0,975	1,000
Raphitoma horrida	1	0	0	0	0,975	1,000
Raphitoma leufroyi	12	1	8,33	0,002	0,385	0,006
Raphitoma linearis	13	0	0	0	0,247	0,000
Raphitoma pseudohystrix	12	1	8,33	0,002	0,385	0,006
Raphitoma spp,	1	0	0	0	0,975	1,000
Retusa truncatula	2	0	0	0	0,842	0,500
Retusa umbilicata	8	0	0	0	0,369	0,008
Ringicula conformis	1	0	0	0	0,975	1,000
Rissoa guerinii	3	1	33,33	0,008	0,906	1,000
Rissoa decorata	9	3	33,33	0,074	0,701	0,508
Rissoa splendida	74	2	2,70	0,003	0,094	0,000
Rissoa spp,	9	0	0	0	0,336	0,004
Rissoa violacea	14	2	14,28	0,017	0,428	0,013
Rissoina bruguieri	12	0	0	0	0,265	0,000
Scissurella costata	159	8	5,03	0,021	0,097	0,000
Smaragdia sp,	2	0	0	0	0,842	0,500
Tectura virginea	170	70	41,17	0,336	0,490	0,026

Tricolia sp,	1	0	0	0	0,975	1,000
Triphoridae indet,	386	72	18,65	0,148	0,229	0,000
Trophonopsis sp 1	4	0	0	0	0,000	0,602
Turbolilla acutissima	45	6	13,33	0,050	0,268	1,000
Turbonilla jeffreysii	7	1	14,28	0,003	0,579	0,125
Turbonilla rufa	1	1	100	0,025	1,000	1,000
Turbonilla sp,1	3	1	33,33	0,008	0,906	1,000
Turbonilla spp,	1	0	0	0	0,975	1,000
Turritella communis	103	28	27,18	0,188	0,368	1,000
Typhinellus labiatus	2	0	0	0	0,842	0,500
Vexillum ebenus	1	0	0	0	0,975	1,000
Vitreolina curva	31	0	0	0	0,112	1,000
Weinkauffia turgidula	15	0	0	0	0,218	1,000
	9160	1329	11,62			

Table 54: DF per species, Brijuni M44

12.1.1.1.8 Piran M1

Family	Ntot	Ndrill	DF (%)	lCI	uCI	pval
Aclididae	6	4	66,66	0,222	0,957	0,688
Acteonidae	31	3	9,67	0,020	0,258	0,000
AporrhaidaeÂ	121	11	9,09	0,046	0,157	0,000
Caecidae	5	0	0	0	0,522	0,063
Calliostomatidae	12	4	33,33	0,099	0,651	0,388
Calyptraeidae	49	3	6,12	0,012	0,169	0,000
Capulidae	1	0	0	0	0,975	1,000
Cerithiidae	4217	1656	39,26	0,377	0,408	0,000
Cerithiopsidae	14	5	35,71	0,127	0,649	0,424
Clathurellidae	5	1	20	0,005	0,716	0,375
Cylichnidae	1	0	0	0	0,975	1,000
Cystiscidae	10	2	20	0,025	0,556	0,109
Epitoniidae	56	15	26,78	0,158	0,403	0,001
Eulimidae	42	4	9,52	0,026	0,226	0,000
Fasciolariidae	12	6	50	0,210	0,789	1,000
Fissurellidae	86	0	0	0	0,042	0,000
Haliotidae	1	0	0	0	0,975	1,000

Haminoeidae	68	0	0	0	0,053	0,000
Hydrobiidae	74	0	0	0	0,049	0,000
Lottiidae	1	0	0	0	0,975	1,000
Mangeliidae	501	178	35,52	0,313	0,399	0,000
Marginellidae	13	0	0	0	0,247	0,000
Muricidae	157	32	20,38	0,143	0,275	0,000
Nassariidae	1317	221	16,78	0,148	0,189	0,000
Naticidae	341	27	7,91	0,052	0,113	0,000
Philinidae	14	0	0	0	0,232	0,000
Pyramidellidae	300	80	26,66	0,217	0,321	0,000
Raphitomidae	82	17	20,73	0,125	0,311	0,000
Retusidae	50	2	4	0,004	0,137	0,000
Rissoidae	2533	837	33,04	0,312	0,349	0,000
Scissurellidae	13	1	7,69	0,001	0,360	0,003
Tornidae	5	1	20	0,005	0,716	0,375
Triphoridae	271	107	39,48	0,336	0,456	0,001
Trochidae	58	9	15,51	0,073	0,274	0,000
Turbinidae	3	0	0	0	0,708	0,250
Turritellidae	325	145	44,61	0,391	0,502	0,059
	10795	3371	17,18			

Table 55: DF on family level at Piran M1

Species	Ntot	Ndrill	DF (%)	lCI	uCI	pval
Aclis minor	6	4	66,66	0,222	0,957	0,688
Acteon tornatilis	31	3	9,677	0,020	0,258	0,000
Alvania cancellata	2	1	50	0,012	0,987	1,000
Alvania carinata	1	1	100	0,025	1,000	1,000
Alvania cimex	158	56	35,44	0,280	0,434	0,000
Alvania lineata	15	6	40	0,163	0,677	0,607
Alvania geryonia	269	119	44,23	0,382	0,504	0,067
Alvania hispidula	2	1	50	0,012	0,987	1,000
Aporrhais pespelecani	121	11	9,09	0,046	0,157	0,000
Atys jeffreysi	9	0	0	0	0,336	0,004
Bela brachystoma	131	48	36,64	0,283	0,455	0,003
Bela menkhorsti	2	1	50	0,012	0,987	1,000

Bela	*nebula*	7	3	42,85	0,098	0,816	1,000
Bittium	*latreillii*	2037	885	43,44	0,412	0,456	0,000
Bittium	*reticulatum*	181	71	39,22	0,320	0,467	0,005
Bolma	*rugosa*	3	0	0	0	0,708	0,250
Caecum	*trachea*	5	0	0	0	0,522	0,063
Calliostoma	*laugieri*	1	0	0	0	0,975	1,000
Calliostoma	*zizyphinum*	11	4	36,36	0,109	0,692	0,549
Calyptraea	*chinensis*	47	3	6,382	0,013	0,175	0,000
Capulus	*ungaricus*	1	0	0	0	0,975	1,000
Cerithidium	*submamillatum*	1807	634	35,08	0,328	0,373	0,000
Cerithiopsis	*jeffreysi*	3	0	0	0	0,708	0,250
Cerithiopsis	*spp,*	4	1	25	0,006	0,806	0,625
Cerithiopsis	*tubercularis*	7	4	57,14	0,184	0,901	1,000
Cerithium	*vulgatum*	192	66	34,38	0,276	0,416	0,000
Chrysallida	*clathrata*	1	0	0	0	0,975	1,000
Chrysallida	*indistincta*	0	0	0	NA	NA	NA
Chrysallida	*interstincta*	23	5	21,73	0,074	0,437	0,011
Chrysallida	*excavata*	2	0	0	0	0,842	0,500
Chrysallida	*sp,4*	3	3	100	0,292	1,000	0,250
Circulus	*tricarinatus*	5	1	20	0,005	0,716	0,375
Comarmondia	*gracilis*	5	1	20	0,005	0,716	0,375
Crepidula	*moulinsii*	2	0	0	0	0,842	0,500
Cylichna	*cylindracea*	1	0	0	0	0,975	1,000
Cylichnina	*laevisculpta*	26	0	0	0	0,132	0,000
Diodora	*graeca*	86	0	0	0	0,042	0,000
Ebala	*nitidissima*	2	0	0	0	0,842	0,500
Ecrobia	*sp,1*	10	0	0	0	0,308	0,002
Epitonium	*cantrainei*	36	8	22,22	0,101	0,392	0,001
Epitonium	*clathrus*	20	7	35	0,153	0,592	0,263
Eulima	*glabra*	35	3	8,57	0,018	0,231	0,000
Eulimella	*acicula*	3	1	33,33	0,008	0,906	1,000
Euspira	*macilenta*	58	4	6,89	0,019	0,167	0,000
Euspira	*pulchella*	283	23	8,12	0,052	0,119	0,000
Fusinus	*rostratus*	12	6	50	0,210	0,789	1,000

Gibberula	*spp,*	10	2	20	0,025	0,556	0,109
Gibbula	*ardens*	3	0	0	0	0,708	0,250
Gibbula	*guttadauri*	4	0	0	0	0,602	0,125
Granulina	*marginata*	13	0	0	0	0,247	0,000
Haliotis	*lamellosa*	1	0	0	0	0,975	1,000
Haminoea	*hydatis*	11	0	0	0	0,285	0,001
Hexaplex	*trunculus*	114	18	15,78	0,096	0,238	0,000
Hydrobia	*sp,1*	64	0	0	0	0,056	0,000
Jujubinus	*striatus*	1	0	0	0	0,975	1,000
Jujubinus	*exasperatus*	33	8	24,24	0,110	0,423	0,005
Jujubinus	*montagui*	17	1	5,88	0,001	0,287	0,000
Laona	*pruinosa*	1	0	0	0	0,975	1,000
Mangelia	*attenuata*	41	13	31,70	0,180	0,481	0,028
Mangelia	*stosiciana*	10	4	40	0,121	0,738	0,754
Mangelia	*costulata*	91	34	37,36	0,274	0,481	0,021
Mangelia	*unifasciata*	219	75	34,24	0,279	0,409	0,000
Manzonia	*crassa*	28	10	35,71	0,186	0,559	0,185
Marshallora	*adversa*	101	49	48,51	0,384	0,587	0,842
Megastomia	*conspicua*	18	4	22,22	0,064	0,476	0,031
Megastomia	*conoidea*	116	9	7,76	0,036	0,142	0,000
Melanella	*alba*	2	0	0	0	0,842	0,500
Melanella	*frielei*	2	0	0	0	0,842	0,500
Melanella	*polita*	3	1	33,33	0,008	0,906	1,000
Monophorus	*perversus*	9	3	33,33	0,074	0,701	0,508
Mures	*brandaris*	39	13	33,33	0,190	0,502	0,053
Nassarius	*pygmaeus*	1317	221	16,78	0,148	0,189	0,000
Ocenebra	*erinaceus*	4	1	25	0,006	0,806	0,625
Odostomia	*eulimoides*	33	12	36,36	0,204	0,549	0,163
Odostomia	*spp,*	5	1	20	0,005	0,716	0,375
Ondina	*diaphana*	4	0	0	0	0,602	0,125
Ondina	*vitrea*	6	0	0	0	0,459	0,031
Philine	*catena*	2	0	0	0	0,842	0,500
Philine	*quadripartita*	11	0	0	0	0,285	0,001
Pusillina	*lineolata*	913	295	32,31	0,292	0,355	0,000

Pusillina	*radiata*	854	270	31,61	0,285	0,349	0,000
Pusillina	*sarsi*	5	0	0	0	0,522	0,063
Pusillina	*inconspicua*	143	36	25,17	0,182	0,331	0,000
Pusillina	*philippi*	93	32	34,40	0,248	0,450	0,003
Pusillina	*sp*	30	1	3,33	0,001	0,172	0,000
Raphitoma	*atropurpurea*	14	5	35,71	0,127	0,649	0,424
Raphitoma	*hispida*	9	1	11,11	0,002	0,482	0,039
Raphitoma	*horrida*	3	0	0	0	0,708	0,250
Raphitoma	*linearis*	1	1	100	0,025	1,000	1,000
Raphitoma	*pumila*	14	3	21,42	0,046	0,508	0,057
Raphitoma	*echinata*	38	6	15,78	0,060	0,313	0,000
Raphitoma	*leufroyi*	3	1	33,33	0,008	0,906	1,000
Retusa	*sp 1*	2	0	0	0	0,842	0,500
Retusa	*sp 2*	2	0	0	0	0,842	0,500
Retusa	*minutissima*	11	0	0	0	0,285	0,001
Retusa	*truncatula*	9	2	22,22	0,028	0,600	0,180
Rissoa	*membranacea*	1	0	0	0	0,975	1,000
Rissoa	*monodonta*	1	1	100	0,025	1,000	1,000
Rissoa	*sp,1*	3	1	33,33	0,008	0,906	1,000
Rissoa	*sp,2*	1	1	100	0,025	1,000	1,000
Rissoa	*violacea*	13	6	46,15	0,192	0,749	1,000
Scissurella	*costata*	13	1	7,69	0,001	0,360	0,003
Setia	*sp,1*	1	0	0	0	0,975	1,000
Tectura	*virginea*	1	0	0	0	0,975	1,000
Triphoridae	*indet,*	161	55	34,16	0,268	0,420	0,000
Turbonilla	*acutissima*	74	41	55,40	0,433	0,670	0,416
Turbonilla	*gradata*	4	1	25	0,006	0,806	0,625
Turbonilla	*pusilla*	4	2	50	0,067	0,932	1,000
Turbonilla	*rufa*	2	1	50	0,012	0,987	1,000
Turritella	*communis*	303	130	42,90	0,372	0,487	0,016
Turritella	*turbona*	22	15	68,18	0,451	0,861	0,134
Weinkauffia	*turgidula*	48	0	0	0	0,074	0,000
		10795	3371	23,55			

Table 56: DF per species, Piran M1

12.1.1.1.9 Piran M53

Family	Ntot	Ndrill	DF (%)	lCI	uCI	pval
Aclididae	11	0	0,00	0	0,285	0,001
Acteonidae	90	11	12,22	0,062	0,208	7,770
Akeridae	12	0	0,00	0	0,265	0,000
AporrhaidaeÂ	329	47	14,29	0,106	0,185	0,000
Calliostomatidae	17	1	5,88	0,001	0,287	0,000
Calyptraeidae	66	0	0,00	0	0,054	0,000
Cerithiidae	7083	2382	33,63	0,325	0,347	0,000
Cerithiopsidae	34	16	47,06	0,297	0,649	0,864
Clathurellidae	8	0	0,00	0	0,369	0,008
Cylichnidae	1	0	0,00	0	0,975	1,000
Cystiscidae	10	0	0,00	0	0,308	0,002
Epitoniidae	96	15	15,63	0,090	0,245	1,000
Eulimidae	70	3	4,29	0,008	0,120	0,010
Fasciolariidae	54	7	12,96	0,053	0,249	1,000
Fissurellidae	119	0	0,00	0	0,031	0,000
Haminoeidae	233	0	0,00	0	0,016	0,000
Hydrobiidae	45	0	0,00	0	0,079	0,568
Lottiidae	1	0	0,00	0	0,975	1,000
Mangeliidae	873	204	23,37	0,205	0,263	0,000
Marginellidae	35	0	0,00	0	0,100	1,000
Muricidae	280	17	6,07	0,035	0,095	0,000
Nassariidae	3261	228	6,99	0,061	0,079	0,000
Naticidae	710	50	7,04	0,052	0,092	0,000
Phasianellidae	15	1	6,67	0,002	0,319	0,001
Philinidae	67	0	0,00	0	0,054	0,000
Pyramidellidae	461	139	30,15	0,259	0,346	0,001
Raphitomidae	217	15	6,91	0,039	0,111	0,000
Retusidae	102	0	0,00	0	0,036	0,000
Rhizoridae	1	0	0,00	0	0,975	1,000
Rissoidae	3335	923	27,68	0,261	0,292	0,000
Scissurellidae	26	0	0,00	0	0,132	1,000
Tornidae	8	0	0,00	0	0,369	0,008

Triphoridae	426	131	30,75	0,263	0,354	0,127
Trochidae	142	10	7,04	0,034	0,126	0,000
Turbinidae	30	0	0,00	0	0,116	1,000
Turritellidae	763	230	30,14	0,269	0,335	0,000
	19031	4430	9,13			

Table 57: DF per family, Piran M53

Species	Ntot	Ndrill	DF (%)	lCI	uCI	pval
Aclis minor	11	0	0,00	0	0,285	0,001
Acteon tornatilis	90	11	12,22	0,062	0,208	1,000
Akera bullata	12	0	0,00	0	0,265	0,000
Alvania beanii	12	2	16,67	0,021	0,484	0,039
Alvania cancellata	17	4	23,53	0,068	0,499	0,049
Alvania cimex	197	69	35,03	0,283	0,421	1,000
Alvania geryonia	622	210	33,76	0,300	0,376	0,043
Alvania lineata	2	0	0,00	0	0,842	0,500
Alvania punctura	5	0	0,00	0	0,522	0,063
Aporrhais pespelecani	329	47	14,29	0,106	0,185	0,000
Atys jeffreysi	34	0	0,00	0	0,103	1,000
Bela brachystoma	200	52	26,00	0,201	0,327	1,000
Bela menkhorsti	6	0	0,00	0	0,459	0,031
Bela nebula	5	4	80,00	0,283	0,995	0,375
Bittium latreillii	3749	1294	34,52	0,329	0,361	0,000
Bittium reticulatum	392	152	38,78	0,339	0,438	1,000
Bittium submamillatum	2607	863	33,10	0,312	0,349	0,000
Bolinus brandaris	11	2	18,18	0,022	0,518	0,065
Bolma rugosa	30	0	0,00	0	0,116	1,000
Calliostoma laughieri	1	0	0,00	0	0,975	1,000
Calliostoma ziziphinum	16	1	6,25	0,001	0,302	0,001
Calyptraea chinensis	66	0	0,00	0	0,054	0,000
Cerithiopsis barleei	1	0	0,00	0	0,975	1,000
Cerithiopsis nofronii	4	4	100,00	0,397	1,000	0,125
Cerithiopsis spp,	10	0	0,00	0	0,308	0,002
Cerithiopsis tubercularis	19	12	63,16	0,383	0,837	0,359

Cerithium sp,1	164	37	22,56	0,164	0,297	1,000
Cerithium vulgatum	171	36	21,05	0,152	0,279	1,120
Chrysallida interstincta	35	5	14,29	0,048	0,303	1,000
Circulus striatus	8	0	0,00	0	0,369	0,008
Clanculus cruciatus	5	0	0,00	0	0,522	0,063
Comarmondia gracilis	8	0	0,00	0	0,369	0,008
Crisilla semistriata	5	5	100,00	0,478	1,000	0,063
Cylichna cylindracea	1	0	0,00	0	0,975	1,000
Cylichnina umbilicata	27	0	0,00	0	0,128	1,000
Diodora graeca	115	0	0,00	0	0,032	0,000
Diodora italica	4	0	0,00	0	0,602	0,125
Epitonium clathrus	26	0	0,00	0	0,132	1,000
Epitonium muricatum	49	14	28,57	0,165	0,433	0,004
Epitonium turtonis	21	1	4,76	0,001	0,238	1,000
Eulima glabra	53	1	1,89	0	0,101	1,200
Eulima spp,	2	0	0,00	0	0,842	0,500
Eulimella acicula	4	0	0,00	0	0,602	0,125
Euparthenia bulinea	1	0	0,00	0	0,975	1,000
Euspira macilenta	144	10	6,94	0,033	0,124	0,000
Euspira pulchella	566	40	7,07	0,050	0,095	0,000
Folinella excavata	1	0	0,00	0	0,975	1,000
Fusinus rostratus	54	7	12,96	0,053	0,249	1,000
Gibberula philippii	9	0	0,00	0	0,336	0,004
Gibberula turgidula	1	0	0,00	0	0,975	1,000
Gibbula Ardens	18	0	0,00	0	0,185	1,000
Gibbula fanulum	4	0	0,00	0	0,602	0,125
Gibbula guttadauri	4	0	0,00	0	0,602	0,125
Granulina marginata	35	0	0,00	0	0,100	1,000
Haminoea hydatis	26	0	0,00	0	0,132	1,000
Hexaplex trunculus	267	15	5,62	0,031	0,091	0,000
Hydrobia acuta	33	0	0,00	0	0,106	1,000
Hydrobiidae indet,	12	0	0,00	0	0,265	0,000
Johania retifera	6	0	0,00	0	0,459	0,031
Jujubinus striatus	22	2	9,09	0,011	0,292	0,000

Jujubinus exasperatus	44	7	15,91	0,066	0,301	1,000
Jujubinus montagui	43	1	2,33	0,001	0,123	1,000
Jujubinus spp,	1	0	0,00	0	0,975	1,000
Mangelia attenuata	70	17	24,29	0,148	0,360	1,000
Mangelia costata	2	0	0,00	0	0,842	0,500
Mangelia costulata	196	29	14,80	0,101	0,206	0,000
Mangelia stosiciana	10	2	20,00	0,025	0,556	0,109
Mangelia unifasciata	384	100	26,04	0,217	0,307	0,000
Manzonia crassa	38	0	0,00	0	0,093	1,000
Marshallora adversa	169	68	40,24	0,327	0,480	0,014
Megastomia conoidea	136	15	11,03	0,063	0,175	0,000
Megastomia conspicua	7	1	14,29	0,003	0,579	0,125
Melanella frilei	2	0	0,00	0	0,842	0,500
Melanella polita	12	2	16,67	0,020	0,484	0,039
Metaxia metaxa	1	0	0,00	0	0,975	1,000
Muricidae indet	1	0	0,00	0	0,975	1,000
Nassarius pygmaeus	3252	228	7,01	0,061	0,079	0,000
Nassarius nitidus	7	0	0,00	0	0,410	0,016
Nassarius reticulatus	2	0	0,00	0	0,842	0,500
Ocenebra erinaceus	1	0	0,00	0	0,975	1,000
Odostomia acuta	12	0	0,00	0	0,265	0,000
Odostomia eulimoides	91	26	28,57	0,195	0,390	1,000
Odostomia spp,	2	0	0,00	0	0,842	0,500
Ondina vitrea	6	0	0,00	0	0,459	0,031
Parthenina suturalis	4	0	0,00	0	0,602	0,125
Philine quadripartita	55	0	0,00	0	0,065	0,006
Philine scabra	6	0	0,00	0	0,459	0,031
Phorcus richardi	1	0	0,00	0	0,975	1,000
Pusillina inconspicua	248	58	23,39	0,182	0,292	0,001
Pusillina radiata	1309	311	23,76	0,214	0,262	0,000
Pusillina sarsii	13	0	0,00	0	0,247	0,000
Pusillina lineolata	677	222	32,79	0,292	0,365	0,000
Pusillina philippi	128	40	31,25	0,233	0,400	1,000
Pusillina sp 1	43	1	2,33	0,001	0,123	1,000

Raphitoma atropurpurea	23	0	0,00	0	0,148	1,000
Raphitoma densa	27	1	3,70	0,001	0,190	1,000
Raphitoma echinata	138	9	6,52	0,030	0,120	0,000
Raphitoma hispida	11	4	36,36	0,109	0,692	0,549
Raphitoma horrida	9	0	0,00	0	0,336	0,004
Raphitoma leufroy	7	1	14,29	0,003	0,579	0,125
Raphitoma linearis	2	0	0,00	0	0,842	0,500
Retusa laevisculpta	40	0	0,00	0	0,088	182,000
Retusa minutissima	8	0	0,00	0	0,369	0,008
Retusa truncatula	27	0	0,00	0	0,128	1,000
Rissoa spp,	5	0	0,00	0	0,522	0,063
Rissoa violacea	14	1	7,14	0,001	0,339	0,002
Scissurella costata	26	0	0,00	0	0,132	1,000
Similiphora similior	20	5	25,00	0,086	0,491	0,041
Tectura virginea	1	0	0,00	0	0,975	1,000
Tricolia pullus	15	1	6,67	0,001	0,319	0,001
Triphoridae spp,	236	58	24,58	0,192	0,306	0,229
Turbonilla acutissima	152	87	57,24	0,489	0,652	0,088
Turbonilla pusilla	2	0	0,00	0	0,842	0,500
Turbonilla rufa	8	5	62,50	0,244	0,915	0,727
Turritella communis	763	230	30,14	0,269	0,335	0,000
Vitreolina curva	1	0	0,00	0	0,975	1,000
Volvulella acuminata	1	0	0,00	0	0,975	1,000
Weinkauffia turgidula	173	0	0,00	0	0,021	0,000
	19031	4430	11,69			

Table 58: DF per species, Piran M53