BOOK OF ABSTRACTS

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THE EFFECT OF GOLD MINING ON THE DISTRIBUTION OF METALS IN THE AQUATIC ECOSYSTEM OF THE THIGITHE RIVER IN TANZANIA

BY GORDIAN MATABA

PROMOTOR : LIEVEN BERVOETS (UANTWERPEN)
MENTOR : VERA VERHAERT (UANTWERPEN)

Mining activities often are associated with metal contamination of the nearby terrestrial and aquatic environments. Hence, the present study was performed in a section of the river Thigithe flowing beside North Mara Gold Mine (NMGM) (Nyamongo Area) in Tarime district, Tanzania. The aim was to assess the effect of gold mining activities on the metals distribution in the aquatic ecosystem of river Thigithe. Surface water, sediment and tissues (muscles, gills, livers) of the most common and abundant fish (*Labeo victorianus*) were sampled during the dry season (August 2013). In these samples, the following trace elements were analysed: Cd, Pb, Cr, Co, Ni, Cu, Zn, As and Hg.

Results show that concentrations of all metals analysed in the surface water were below or near the detection limit. Regarding the sediments, the average concentrations of metals were higher in sites upstream of the mine compared to more downstream sampling sites. Very high concentrations of arsenic were recovered, ranging from 17.14 - 31.59 µg/g dw. However, for the other elements, concentrations of all metals fell below or slightly above the crustal background concentrations. In addition, when compared to sediment quality guidelines, sediments were not toxic for aquatic benthic fauna. These findings show that the mineralogy of the area is the potential source of metals for the sediments.

In general, concentrations of metals in fish gills and liver tissues were relatively higher than in muscle samples. Metal concentrations in fish tissues were comparable to slightly higher compared to metal levels in tissues of fishes from unpolluted environment in other regions. The health risk by consuming contaminated fish was assessed. Compared to FAO/WHO (1995) and European community (2006) maximum levels of contaminants in foods, the measured metal burdens in fish muscles do not pose health risks to humans upon fish consumption. Based on the Minimum Risk levels (MRLs) of a contaminant that an average 70kg person can take per day through oral route without suffering health risks, As had the lowest edible amount of fish muscle and Ni the highest.

Keywords
Tanzania, river Thigithe, gold mining, metal, fish, health risk

CHANGES IN NEMATODE COMMUNITY AFTER ICE-SHELF DISINTEGRATION IN LARSEN B, ANTARCTIC PENINSULA: COMPARISON 2007-2011

BY LAURA BALLESTEROS REDONDO

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The aim of this study was to provide insights on how nematode communities are responding to large-scale ice-shelf collapse in the Antarctic Peninsula region by comparing published data from 2007 with new material from 2011. Changes in the nematode community of two stations in the Larsen B area were investigated, where large part of the original ice shelf disintegrated in 2002. Both stations, B.South and B.West, were selected because they showed most divergent communities in 2007. In 2007 and in 2011 the genus *Microlaimus* was dominant in the outer station B.South, and *Halomonhystera* in the inner station B.West. Population densities increased drastically in B.West between 2007 and 2011 due to an increase in the genus *Halomonhystera*. Results may suggest that changes in nematode densities might be due to enhanced food supply because of longer ice-free periods but taking into consideration that there are other factors taking place.

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TAXONOMY AND ECOLOGY OF THE FOSSIL FRESHWATER MOLLUSCS FROM A LATE MIOCENE PALAEO-LAKE IN THE ALBERTINE BASIN (UGANDA)

BY SARAH MUSALIZI

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From Late Miocene (Toronian, 8 - 9Ma) till Late Pliocene (Piacenzian, 2.5 Ma) times, a gigantic lake, Palaeolake Obweruka, extended in the Albertine Basin. This palaeolake was geomorphologically identical to Modern L. Tanganyika and in addition shares the occurrence of thallasoid (marine-like) molluscan faunas. Former research on this palaeolake revealed that evolution gave rise to 3 different thalassoid malacofauna's, each preceded by an extinction. Over the last years fossil bearing deposits were discovered north of L. Albert, dating from the earliest lake stage (8-9 Ma), from which evidence had been missing. In the present study, the fossil molluscan assemblages from these deposits were treated. They yielded a diverse mollusk community (15 species) dominated by viviparids (*Neothauma*) and unionids (*Coelatura*), that lived in a vast but relatively shallow lake. About half of the species are new to science. Assemblages from the subsequent deeper lake stage (7 – 4.5Ma) contain species that were also found during earlier investigations in other parts of the basin. The major scientific importance of the earliest assemblages is that they consist for a large part of thalassoid endemics, new to science, representing evidence for a first thalassoid evolutionary escalation at the very onset of the lake. It is clear that the four thalassoid molluscan faunas of L. Obweruka represent rapid escalatory punctuations, each preceded by a major environmental shift and an extinction.

Keywords: punctuated equilibrium evolution, thalassoidism, prey-predation arms race, long-lived lake, recurrent extinction and radiation events, *Neothauma, Kaya, Lanistes, Pila, Melanoides, Cleopatra, Pseudocleopatra, Potadomoides, Coelatura, Nitia, Nkondonaia, Pleiodon, Chambardia, Etheria*.

FISHERIES EXCLUSION IN OFFSHORE WIND FARMS: EFFECTS ON MACROBENTHIC COMMUNITIES

BY SEBASTIAAN MESTDAGH

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Offshore wind farms are being established in the Belgian part of the North Sea as part of the national effort to meet European emission reduction targets. Within the Belgian offshore wind farms, all commercial fisheries activities are banned. Bottom trawling is the most used fishing method in Belgian waters. As trawling is very destructive to the sea bottom, its ban might influence the macrobenthos in the wind farm concession zones. We investigated the effects of the fisheries ban in the Belwind offshore wind farm on the macrobenthic communities. Van Veen grab samples were analysed for several biotic (macrobenthic densities, biomass, species richness, Shannon-Wiener diversity and BP_C) and abiotic variables (median grain size, total organic matter and mud content of the sediment). Newly analysed data were added to existing data to create a time series spanning the period from 2010 to 2013, and divided over a control area and a fisheries exclusion area. Only for BP_C there were no data available before 2013, so no time series could be established for this variable. The results were compared to the results from previous research. PERMANOVA tests revealed for the first time a significant interaction effect between year and area for total densities, but this was not the case for any other variable. A number of small changes within the macrobenthic community could be observed compared to previous research. The significant interaction effect found for the densities of *Gastrosaccus spinifer* in the previous research was not found again, but significant area effects were still observable. No difference in BP_C values, and therefore ecosystem functioning, was found between the two areas in 2013. We conclude that the cessation of fisheries in de wind farm concessions could potentially have significant effects on the macrobenthic communities, but up to now only relatively small initial changes can be observed. However, a higher sample density might have revealed more detailed patterns and possibly bigger changes that have been overlooked up to now. Longer monitoring might be required to assess the full extent of recovery of the macrobenthos.

STUDY ON WAVE SYSTEMS AND THEIR IMPACT ON THE SEABED AND WATER COLUMN TURBIDITY IN THE BELGIAN COASTAL ZONE.

BY SILVY THANT

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Suspended particulate matter (SPM) concentration is one of the key parameters to describe the environmental status, and to evaluate and understand the impact of human activities on the water column and seabed in both nearshore and offshore areas. In order to do so, long-term measurements are needed in order to resolve all natural variations in SPM concentration. Processes affecting SPM concentration are turbulence caused by tides under both neap and spring tide cycles, and by meteorological events. Other, more long-term fluctuations are related to seasons. SPM concentration has been measured since 2005 at the MOW1 site and the Blankenberge site, situated west of Zeebrugge in the high-turbidity zone off the Belgian-Dutch coast. The measurements have been carried out using a benthic tripod that allowed measuring during all meteorological conditions, including storms.

The impact of extreme weather conditions (e.g. storms) on sediment re-suspension and SPM concentration has been investigated using meteorological and wave data from IVA MDK (afdeling Kust - Meetnet Vlaamse Banken). SPM concentration data from MOW1 and Blankenberge were estimated using the backscatter data from a 3MHz acoustic Doppler profiling current meter.
A semi-automatic detection algorithm for identifying extreme events in SPM was developed to handle the large amount (~4 years) of SPM concentration data. These events were caused by following specific extreme weather conditions: 1) NW storms with high swell activity, 2) SW storms and 3) strong NE winds. In total 41 events of extreme SPM concentration were detected of which 19 were caused by a NW storm, 14 by SW storm conditions and 6 by strong eastern winds. Two events could not be classified.
NW storms accompanied by swell waves (i.e. waves with longer-than-average period) generate bottom shear stresses up to 30 Pa, causing strong resuspension and erosion of fluffy bed material and of the bed itself. This occasionally leads to the formation of high concentration mud suspensions (HCMS). Upward mixing of SPM in the higher water column is hindered due to the high SPM concentrations causing a decrease in turbulent energy. In contrast, SW storms are characterized by a lower erosion capacity and a better upward vertical mixing of SPM. In general, only NW storms can induce resuspension and erosion in the navigation channels. NE winds cause increases in SPM concentration by the advection of sediment out of the Westerschelde mouth. Additionally, the interaction of different wave systems, together with water depth and sediment type will play an important role in understanding the variation in impact of different extreme weather conditions.

Keywords
Suspended particulate matter, storm impact, Southern North Sea, mixing, high concentrated mud suspensions

CHARACTERIZATION OF NITRATE SOURCES AND TROPHIC STRUCTURE OF THE GILGEL GIBE I RESERVOIR USING STABLE ISOTOPES

BY AINA MARTINEZ USEROS

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The Gilgel Gibe Reservoir is at risk of eutrophication by the inefficient use of fertilizers, the important animal waste disposal, together with the high soil erosion, and the discharge of liquid and solid waste from the populations upstream the reservoir. Our study aimed to (1) understand the aquatic food web structure of the dam and create an ecosystem state baseline in case of future deterioration and (2) to evaluate the impact of nitrate pollution by Jimma city on the Gilgel Gibe River waters, which feed the Gilgel Gibe Reservoir. Reservoir Food Web Study Fish, plankton, sediments, benthic macroinvertebrates, macrophytes, periphyton and terrestrial leaves were analyzed for stable isotopes of nitrogen ($\delta^{15}N$) and carbon ($\delta^{13}C$) to study the food web structure at Gilgel Gibe Reservoir and to understand the main food sources of the two fish species present at the dam, *Labeobarbus intermedius* and *Oreochromis niloticus.* Our isotope data revealed that *L.. intermedius* most likely feeds on macrophytes, scraper macroinvertebrates and zooplankton. *O. niloticus* ^{15}N and $\delta^{13}C$ values revealed a missing component in our food web analyses. We hypothesized a cannibalism behavior between early life stages, which will constitute the missing component at our food web. Nitrate Fate and Sources Study.
A dual isotope approach ($\delta^{1}8O\text{-}NO_3^-$ and $\delta^{15}N\text{-}NO_3^-$) was used to trace the source and fate of the nitrates present at the surface waters of the city of Jimma, Boye Wetland and the Gilgel Gibe River. Overall, our study did not reveal an important contribution of urban and wetland nitrate towards the Gilgel Gibe River waters. We assume that the natural treatment function of the wetland removes all nitrate coming from the city. However, considering the increasing industrial activities and population densities in the area and the lack of a waste water treatment system in the city, a most likely future scenario includes a saturation of the natural wetland treatment capacity and a subsequent contamination of the Gilgel Gibe waters by nutrients coming from the city. Management priorities should focus on improving the sewer collection system, incorporating some treatment for this water and a periodical monitoring of the wetland N-species concentrations in order to identify saturation of the Boye Wetland natural treatment functions.

Key words: Ethiopia · Gilgel Gibe · Stable Isotopes · Nitrate · Urban · Sources · Surface Water ·

SEDIMENTOLOGICAL AND GEOCHEMICAL CHARACTERIZATION OF A SMALL SCALE TURBIDITE CYCLE IN THE EL ARRAICHE MUD VOLCANO PROVINCE (GULF OF CÁDIZ)

BY ANA CRAÇA CUNHA

PROMOTOR: DAVID VAN ROOIJ (UGENT)

The El Arraiche Mud Volcano province was first discovered in 1999 during the TTR-9 cruise on board of the R/V Professor Logachev. Since then, intensive research as been performed in this region, focusing mostly on the mud volcanoes and in cold water coral mounds, and associated processes. The study of the hydrodynamic conditions and sedimentary processes started receiving attention about 5 years ago. So far, no studies concerning mass wasting events were performed in this region.

During the MD169 MiCROSYSTEMS campaign (2008), a 3.5m sediment core containing a well preserved turbidite cycle was collected in a small sub-basin east of the Renard Ridge, an area considered to be fairly quite. In this work, sedimentological, geophysical and geochemical techniques are use to characterize and the sedimentary sequence. A time frame for the emplacement of the turbidites is inferred by correlating with cores for which relative chronostratigraphic ages have been previously defined. A relation between the frequency and magnitude of turbidites and climate and sea level changes is observed. A sediment source rich in biogenic elements (Ca, Sr or Si), and poor in detrital and organic material is deduced from the XRF analysis. Three likely source areas (all at the surrounding the ridges) are inferred from the study of the regional bathymetry.

Keywords: Gulf of Cádiz, El Arraiche MV field, fine grained turbidites, climatic events, sea level change.

SPATIO – TEMPORAL ANALYSIS OF MACROBENTHOS COMMUNITIES AS A TOOL TO ASSIST IN CONSERVATION PRACTICES IN THE ZWIN COASTAL LAGOON.

BY ANTHONY DUBOURG

PROMOTOR: CARL VAN COLEN (UGENT)

Designated as a Special Area of Conservation (SAC) under the EU Habitats Directive, the Zwin nature reserve is considered as ecologically highly important. The coastal lagoon functions as a feeding habitat for fish, crustaceans and birds. Since macrobenthos is essential for intertidal ecosystem functioning as a food resource, it is essential that we gain insight in the distribution patterns of macrobenthic assemblages. Furthermore, since restoration measurements have been conducted in the Zwin nature reserve to restore a natural hydrodynamic regime and to prevent siltation processes from occurring, an understanding of the impact of management actions on macrobenthic communities is crucial. Univariate and multivariate analysis revealed that spatial distribution patterns are clearly related to environmental variables such as median grain size, mud content and organic matter, which can be considered as indicative for the hydrodynamic regime. Spatial and temporal variation analysis by means of univariate statistics, revealed a shift in species composition in highly impacted zones due to restoration measurements. A multivariate approach showed a significant relation of macrobenthic assemblages with environmental variables. However, a significant scatter and overlap in species distribution is less indicative for disturbance due to management actions. Then again, given a high enough amount of sample replicates to reduce within zone and within year variation, impact of monitoring actions could be better unravelled. Thus, spatial and temporal analysis could serve as an important tool for monitoring effects of restoration measurements.

ADAPTIVE RESPONSES TO HIGH ENVIRONMENTAL AMMONIA IN EUROPEAN SEABASS (DICENTRARCHUS LABRAX) ACCLIMATED TO DIFFERENT SALINITIES.

BY ANTONY FRANKLIN DASAN

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The European Sea Bass (*Dicentrarchus labrax*), a euryhaline marine teleost, is increasingly the most important marine species in European aquaculture, owing to increased farming of the marine fish, especially in the Mediterranean region. Farmers in the Mediterranean region are rearing the fish in sea cages and land-based systems, which greatly augment ammonia buildup. Upon this background, this experimental study set out to establish the adaptability of the fish to High Environmental Ammonia (HEA), at different ambient salinities.
European sea bass acclimated to different salinity treatments (32ppt, 20ppt, 10ppt and 2.5ppt), and fed at up to 2% of body weight, were subjected to High Environmental ammonia (20 mgL-1)in different experimental tanks. The effects of this exposure and adaptability of the fish to the conditions of the experiment were observed and recorded at 0 h (control) 12h, 48h, 84h and 180h intervals. Measures of the effects of exposure of fish to HEA at different salinities included ammonia excretion rate, plasma ammonia accumulation, liver and muscle glycogen, liver and muscle lipid and protein content respectively, plasma Na+, K+ and Cl- levels, as well as changes in gill NA+/K+-ATPase and H+-ATPase activities respectively. Blood was drawn and fish were dissected to obtain liver, white muscle, and gill tissues after every interval to be used in serological and chemical analysis. High salinity environments have been shown to augment ammonia toxicity because it facilitates increased concentration of the NH3 moiety, which is solely responsible for ammonia toxicity, in aqueous ammonia. As such, these changes, and even loss of function, were expected to be more severe in fish exposed to higher salinities and in chronic exposure to HEA.

As was expected, chronic exposure of fish to HEA significantly affected the plasma osmolality, eliciting changes in Na+, K+ and Cl- concentrations. Additionally, the rate of ammonia excretion markedly increased with prolonged exposure, although there was a sudden increase following acute exposure to HEA, regardless of salinity. The depletion of energy reserves in form of glycogen, lipids and proteins also increased with chronic exposure of *D. labrax* to HEA, salinity notwithstanding. There was a decreasing trend in both muscle and liver glycogen, lipid and protein levels. However, the depletion in muscles occurred more acutely than was observed in the liver with significant reductions being observed as early as 12 h after exposure. In general, lower energy stores were recorded at chronic exposures to HEA regardless of salinity. For instance, muscle glycogen ranged between 24.46 mg/g wet weight; 32 ppt; 180 h, and 63.53 mg/g wet weight; 10 ppt; control. The liver glycogen levels were markedly higher but exhibited a significant decreasing trend ranging between 110.48 mg/g wet weight; 2.5 ppt; 180 h, and 355.54 mg/g wet weight; 10 ppt; control. The same trend was observed with both liver (2.07mg/g wet weight; 10ppt, 84hrs - 5.09 mg/g wet weight; 32ppt, control) and muscle (0.311 mg/g wet weight; 2.5 ppt, 84 h - 1.22 mg/g wet weight; 20 ppt, control) lipid content, and liver (269.14 mg/g wet weight; 20 ppt, 180 h - 576.05 mg/g wet weight; 32 ppt, control) and muscle (229.86 mg/g wet weight; 10 ppt, 180h - 668.57 mg/g wet weight; 2.5 ppt, control) protein levels.

These findings indicate that it was chronic exposure to HEA and not necessarily salinity that had adverse effects on the physiology of the fish. However, salinity significantly ($p<0.05$ or $p<0.01$) affected osmolality of *D. labrax* since more acute changes in osmolality were observed in European Seabass acclimatized to brackish and estuarine water (10 and 20 ppt) salinities. At 20 ppt, a significant effect on osmolality of *D. labrax* was observed among the control group. At 10

ppt, there was a significant ($p<0.05$) alteration in osmolality in fish exposed for 48 h, as compared to all other salinity treatments and exposure periods. These shows that brackish water salinities

significantly affected the osmolality of *D. labrax.* The effect of HEA on osmolality was only observed in more chronic exposure periods (i.e. 48h, 84h, and 180h). The same trend was observed with Na+, K+, and Cl- levels in plasma whereby chronic (i.e. 48h, 84h, and 180h) exposure of fish to HEA triggered a significant decreasing trend in these parameters.

Keywords: High environmental ammonia (HEA), salinity, European sea bass (*Dicentrarchus labrax*), gills permeability, osmolality, ammonia dynamics, urea dynamics, energy budget.

DISPERSION AND DEPOSITION OF SEDIMENT PLUMES, RESULTING FROM INTENSIVE MARINE AGGREGATE EXTRACTION.

BY DIMITRIOS EVANGELINOS

PROMOTOR: VERA VAN LANCKER (MUMM)

To cope with increasing demands on marine aggregates, new extraction practices have been implemented in the Belgian Part of the North Sea. Since 2012, intensive extractions take place, using both small (2.500 m^3) and large (>10.000 m^3) trailer suction hopper dredgers. Investigations were needed on the near and far field impact; the latter with respect to deposition of fines from sediment plumes. This could impact on a nearby Habitat Directive Area hosting ecologically valuable gravel beds, adapted to a clear water regime. Near the dredge tracks, sediments were more heterogeneous and some fining trend was observed in the top surface of the seabed. Acoustic data, in combination with water samples, showed distinct sediment plumes constrained in space and time. Under disturbed conditions, multimodal particle-size distributions tended to show higher class-weight percentages of the 6-10 µm fractions. In the far field, seabed samples were enriched with mud, evidenced by an extra particle-size mode around 10 µm. Mud percentages were up to 22 %, unusual for an area rich in gravel and coarse sediments. Plume modelling, considering both dredging activities and ruling hydro-meteorological conditions did not show significant deposition in the Habitat Directive Area, though simulations were restricted to winter conditions. Future simulations should consider calm weather conditions and simultaneous activities, in combination with trapping of fines in permeable beds. Within the context of the Marine Strategy Framework Directive consequences of habitat changes are discussed and recommendations are given on minimizing environmental impacts.

Keywords: marine aggregate extraction; environmental monitoring; suspended particulate matter; plume modelling; European Marine Strategy Framework Directive

ROLE OF FOLIVORY IN MANGROVE ECOSYSTEM FUNCTIONING - IDENTIFYING THE KEY FUNCTIONAL GROUP

BY DUNG THI THANH THANH NGUYEN

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Herbivory in general and folivory in particular is normally underestimated in mangroves. The aim of this study is to assess the role of folivory in mangrove ecosystem functioning by estimating level of folivory and identifying the key functional feeding guild. Leaf samples of fourteenmangrove species were taken from three study sites in two mangrove bio-geographical regions (USA and South Africa as the subtropical regions and Sri Lanka as the tropical area). Level of folivory is expressed as the percentage of damaged leaves and percentage of leaf area loss, which were estimated by visual observation and using ImageJ software. Six feeding guilds were identified by comparing with references. A number of statistical tests such as Kruskal-Wallis, Wilcox, t-test, Wald's test were applied to the percentage of leaves damaged and leaf area loss data in order to see whether there is a significant difference in folivory rate between sites, feeding guilds and mangrove species. The results show that there is approximately 50% of leaves were attacked by folivores and roughly 2.8% leaf area was lost due to folivory in all study areas. Leaf chewers are detected as a dominant feeding guild with the presence in a majority of damage (about 70%). Among all mangrove species, *Laguncularia racemosa* suffers the highest destruction with 91.3% of the attacked leaves and an average 11.3% leaf area loss while *Excoecaria agallocha*, in contrast, suffers the least from folivory with an average of 20% damaged leaves and 0.3% area loss. Since the amount of leaf fall can affect the quantity as well as the quality of material that is transferred to marine environment, the fact that 50% of leaves were attacked demonstrated that folivory plays a crucial role in the ecosystem functioning of mangroves by utilizing above-ground production. Studies in a longer period of time are recommended to assess long term effect of folivory.

BENTHOS AND HABITAT CHARACTERIZATION UNDER DIFFERENT FISHING PRESSURES OFF PORTUGAL (WESTERN IBERIAN MARGIN)

BY ELIANA ALFARO CORDOVA

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The seabed of the Western Iberian Margin (WIM) off Portugal has been exposed to bottom trawl fishery for decades. Fishing vessels are permanently operating in the Southeast area above 6 nm from the coast, between 200 and 500 m depth. Impacts of bottom trawling on benthic environments implies alteration on seabed morphology, sediment resuspension, changes in biogeochemical cycles, as well as destruction of megafauna. However, fishing impact studies have been mainly focused on shallow- water ecosystems, leaving a gap of information about the effect of trawling on deep-sea environments.
This study characterized benthic habitats and its associated epifauna and endofauna in an area off the WIM subjected to different levels of fishing pressure. Two transects, between 200 and 400 m depth, were surveyed based on video footage using a Remotely Operated Vehicle (ROV). Habitats along both bathymetric transects were classified according to seabed morphology, while trawl marks were counted and abundances of groups at high taxon level of epifauna analysed. Sediment samples for metazoan meiofauna and environmental analyses, were taken at three stations under different fishing pressures. Groups of meiofauna, as well as pigment composition and sediment granulometry, were analysed. Fishing activity in the area was monitored through online marine traffic system during 30 days and correlated with integrated traffic density maps. Eight habitats were characterized along the transects. Epifauna was composed by 15 groups dominated by polychaetes and anemones, showing abundance and diversity variations among the habitats. Meiofauna was composed by 19 groups dominated by Nematoda, Copepoda and nauplii. There were no significant differences in meiofauna densities between stations. Meiofauna densities were highly concentrated in the first 2 cm of the sediment, and this was apparentlys rather related to food availability than to sediment granulometry, despite the low phytopigment concentrations found at the stations. Trawling marks showed a patchy distribution with higher concentrations west of the transects. Additionally, density maps of navigation and online vessel monitoring showed similarities with the trawl marks observed at the video footage, except for the eastern portion (habitat 8) of transect II. Variability of specific epifauna groups could be also related to trawling activity while analysis on meiofauna suggested no effect from fishery. However, further studies should be made in order to clarify the observations.

FEEDING ECOLOGY STUDY OF THE FATE OF POLY-B-HYDROXYBUTYRATE (PHB) AS POTENTIAL BIOLOGICAL ANTIBIOTIC FOR MARINE CRUSTACEANS

BY FARHANA AHMED

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The natural polymer, poly-β-hydroxybutyrate (PHB) has antimicrobial and growth promoting activities. It can be degraded through biological and enzymatic activities into a water soluble short chain fatty acid monomer and is thought to be a potential biological control for diseases in aquaculture. In the present study, the marine crustacean, *Artemia franciscana* was used as aquaculture model organism to study how PHB works in the animal body. To trace the PHB in the body, ^{13}C prelabeled PHB bacteria were supplied to the animals and ^{13}C stable isotope tracer analysis was done. By means of ^{13}C prelabelled PHB, it was observed that PHB is significantly assimilated in the tissue of *Artemia franciscana* nauplii. Assimilation of ^{13}C of prelabeled PHB was measured from 2h after supplying with prelabeled PHB onwards and the assimilation of ^{13}C increased over time. Differences in assimilation in terms of isotopic abundance, assimilation efficiency and uptake per unit biomass carbon were observed for different food types (only labeled PHB, *Aeromonas hydrophila* (LVS3) + labeled PHB, *Dunaliella tertiolecta* + labeled PHB, and *Tetraselmis suecica* + labeled PHB), though the differences were not significant ($p>0.05$). Transgenerational transfer of carbon originating from PHB was observed in the F_1 generation offspring from the F_0 generation parents of PHB treatment. This suggests an influence of PHB on the gonadal development and reproduction activities in the F_0 generation parents of PHB treatment. However, the assimilated PHB did not provide significant protection to the F_1 generation offspring against *Vibrio harveyi* and *Vibrio campbellii* infection. No significant differences of *Hsp70* gene expression and *Hsp70* quantity was observed in the F_0 generation parents of PHB treatment but the *Hsp70* gene expression in the F_1 generation offspring of PHB treatment was reduced significantly as compared to the F_1 generation offspring of non-PHB treatment. Overall, the present study indicates that PHB is being assimilated in animal tissue and showed for the first time that PHB is used as a carbon and energy source in marine crustaceans.

Key words: Poly-β-hydroxybutyrate, marine Crustacea, biological control, assimilation, assimilation efficiency, isotope tracer analysis, transgenerational immune transfer.

THE EFFECT OF OCEAN ACIDIFICATION ON THE FUNCTIONING OF COASTAL MARINE BENTHOS

BY JASPER ELSEN

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The marine environment experiences, at this very moment, the negative effects of two abiotic, anthropogenic processes: ocean acidification and O2 limitation. Yet, even though ample research has been performed on the individual effects of these stressors, research investigating the combined effects of both stressors is largely absent in literature. Additionally, previous research usually covers only lethal effects whilst sub-lethal effects are often left aside, even though they can have as large of an impact on marine ecosystems as lethal effects do. Consequently, our current understanding concerning the impacts we have on the oceans may be biased. As a response, this thesis sets out to investigate the combined sub-lethal effects of ocean acidification and O2 limitation. Specimens of *Abra alba, Macoma balthica, Nephtys hombergii, Ophiura ophiura, Siaglion mathildae, Tellina fabula* and different nematode genera have been kept in mesocosm experiments, in which they were to be subjected to an acidification of 0.3 pH units; and the full range of O2 availability (100% O2 saturation – hypoxia). The gathered results show that, even though both stressors have impacted the respiration rates of both macro- and meiofauna, no combined effect of ocean acidification and O2 limitation was found. Simultaneously, as a result of the acidification, significant shifts occurred in the nematode assemblage composition, and a lowered sedimentary pH was observed in the top 0.25 cm sediment layer.

A HUMAN RISK ASSESSMENT FOR METAL CONTAMINATION IN LAKE TANGANYIKA (TANZANIA).

BY JULIETHA BAZIL MOSILLE

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The last decades, water pollution has become a big problem due to the increase of industrial, agricultural and urban activities. All forms of contaminants might end up into lakes by direct discharge, run-off or via rivers entering into lakes. This study was conducted to determine the status of metal contamination in Lake Tanganyika. Samples of sediment, water and fish tissue from northern and southern sites of the Tanzanian part of Lake Tanganyika were analyzed. In this study, twelve different metals were analyzed: Cr, Mn, Co, Cu, Ni, Zn, As, Cd, Pb, and Hg.
The results show that metal concentrations in the water for most metals such as Cr, Co, Zn, Ni and As were either close to or below the detection limit. The metal concentrations in the sediment samples were higher compared to metal levels in the surface water for most metals, with concentrations being higher in the northern part than the southern part of the lake. The concentrations in fish tissues varied between stations. Generally, the concentrations of metals were higher in the gills and livers than in the muscles.
Human risk assessment was performed to determine whether the fish are safe for human consumption, based on the average per capita fish consumption of the Tanzanian population of 17g a day according to (FAO, 2005). In comparison with the agency for toxic substances and disease registry (ATSDR, 2013) minimum risk levels, it was found that the fish from Lake Tanganyika are still safe for human consumption.

Keywords: lake Tanganyika, metal contamination, human health risk.

BENTHIC COMPOSITION AS AN ENVIRONMENTAL FACTOR STRUCTURING ASSEMBLAGES OF CORAL REEF-ASSOCIATED FISH

BY KENNEDY OSUKA EDEYE

PROMOTOR: MARC KOCHZIUS (VUB)
CO-PROMOTOR: ANN VANREUSEL (UGENT)

Benthic habitat composition is a key ecological factor that structures assemblages of coral reef fishes. However, natural and anthropogenic induced disturbances impact the relationship that may exist between benthic components and fish assemblages. This study applied hierarchical cluster analysis to identify and characterise reefs, based on benthic cover of coral, algae and rubble from 32 sites in the east coast of Africa. Twelve coral associated fish functional groups were linked to the identified habitats and their relative abundance and biomass in each habitat compared. Analysis revealed five habitat types showing a dominance of hard corals (51.9 ± 11.3 sd %), diversified hard corals (42.5 ± 8.5 sd %), diversified soft corals (33.3 ± 15.3 sd %), fleshy algae (37.5 ± 13.5 sd %) and turf algae (42.0 ± 18.9 sd %). Coastal sites from central Tanzania and northern Mozambique were associated with a dominance of hard corals, fleshy and turf algae. Northern Madagascar reefs showed a dominance of multiple habitats including hard corals, fleshy algae and diversified hard and soft corals. Hard corals, diversified hard coral and turf algae habitats dominated reefs in Comoros. Corallivores, invertivores, detritivores and grazers showed a high preference to diversified coral dominated habitats while planktivores and small excavators showed an antagonistic preference to same habitats. The preference by nearly 60 % of fish functional groups to diversified coral habitats conformed to intermediate disturbance hypothesis. Algal dominated habitats were associated with a higher biomass of browsers and omnivores than coral dominated habitats. Integrated coastal zone management specifically reduction of land based nutrient input and establishment of marine protected areas is recommended especially in disturbed habitats dominated by fleshy and turf algae. These measures will in time shift the disturbance from high to intermediate leading to phase shift reversal and recovery of fish functional diversity.

Keywords: Benthic structure, diversified habitats, fish functional groups, intermediate disturbance.

CHARACTERIZATION OF BRUSSELS CSO EVENTS AND THEIR EFFECTS ON THE OXYGEN LEVEL IN THE ZENNE RIVER.

BY KENNETH BINE NJUME

PROMOTOR: NATACHA BRION (VUB)

This research was aim at characterize the CSO events in Brussels and their effects on the Oxygen level in the Zenne River with the use of online data gotten from some monitoring agencies like AQUIRIS and FlowBru. Brussels is a dense populated urban area with a population of about 1.6 million surrounded by many industries. The Zenne River cuts across the Brussels Regions and most of the domestic wastes, industrial wastes and surface runoffs end up in the river in the form of CSO. The characterization of the CSO events was base on the seasonal variation, CSO frequency and contribution of the CSO to the river and the duration of the CSOs. These CSOs contain pollutant such as COD and BOD which affects the Oxygen Saturation level in the river especially during wet weather conditions when the volume of the pollutant loads increases. The Oxygen Saturation level was calculated base on the concentration of the pollutants at the outlet of the

WWTP---North (Eppegem). Temperature was another variable that played a vital role in the depletion level of O2 because during high temperature, high depletion rate of O2 was witnessed.

SEAGRASS DETRITUS IN THE MEDITERRANEAN: A PREFERRED HABITAT FOR HARPACTICOID COPEPODS. IS THERE AN ACTIVE MIGRATION TOWARDS SEAGRASS DETRITUS?

BY LAURA AGUSTO

PROMOTOR: MARLEEN DE TROCH (UGENT) & GILLES LEPOINT (ULG)
SUPERVISOR: THIBAUD MASCART (UGENT)

An *in-situ* experiment was conducted within a seagrass macrophytodetritus field in the Bay of Calvi, Corsica. The species-specific migration of harpacticoid species towards macrophytodetritus was studied. Defauntated macrophytodetritus was used to attract harpacticoids migrating either through the water column or from the sediment in separate experimental cores. The colonization process was allowed for a period of 24 hours and for a period of 96h. These two time experiments were done independent from each other.
In the Mediterranean Sea, harpacticoid copepods occur in high numbers in the endemic seagrass *Posidonia oceanica* L. Delille meadows (Danovaro *et al.* 2002) and detritus accumulations (Mascart *et al.* 2013). Detritus accumulations form new ephemeral habitats which can remain present from days to months and occur at relative large distances from live seagrass. The morphology of copepods gives an indication of the habitat in which they occur. Four different copepod morphological types, or morphotypes, can be distinguished in a seagrass habitat: 1) mesopsammic types which are found mainly in the sediment. They have slender vermiform bodies with non-protruding appendages. 2) Phytal types live attached to the seagrass leaves and have developed clinging appendages like prehensile legs. 3) Phytal-swimmers are well capable of swimming but live inside the phytal habitat. 4) pelagic types possess long antennae and large swmming legs. Colonization capacities are suggested to be related to species-specific swimming abilities. Harpacticoids are well known emergers and colonize new habitats fast. Their presence in detritus accumulations preludes the fact that they that they are capable of colonizing new habitats at large distances. However knowledge on how colonization of novel structures occurs by harpacticoids is lacking. Migration toward new habitats can occur through active mechanisms, swimming or crawling, or passive patterns governed by hydrodynamics. Colonization of detritus can occur by active migration through the water column of from the sediment by an upwards migration. Results showed an influence of the experimental core on the species composition for the 96h colonization experiment. The study found a higher amount of species to migrate from the sediment upwards. Active migration was dominated by phytal-type species. A reclassification of phytal-types migrating through the water column is proposed as they show a good swimming ability. Three species, *Amphiascus minutus, Sarsamphiascus tenuiremis* and *Ectinosoma cf. dentatum* were identified as migrating both through the water column as from the sediment.

USE OF SKIN AND BLUBBER BIOPSIES TO ASSESS THE ECOTOXICOLOGICAL STATUS OF CETACEANS IN THE MEDITERRANEAN SEA.

BY MARIANNA PINZONE

PROMOTOR: KRISHNA DAS (ULG) & MARLEEN DE TROCH (UGENT)

δ13C, δ15N values and blubber lipids concentrations of 31 PCBs, 15 organgochlorine compounds, 9 PBDEs and 17 PCDD/Fs were measured in Northwestern Mediterannean Sea long-finned pilot whales (*Globicephala melas*), sperm whales (*Physeter macrocephalus*) and fin whales (*Balaenoptera physalus*). The isotopic analysis was performed using an EA-IRMS coupled in continuous flow to an elemental analyzer; while pollutans levels were measured by gas chromatography with electron-capture detection. To assess the toxic potency of the dioxin-like compounds the TEQ approach recommended by the World Health Organization for human and wildlife health was applied. In total 75 fin whales, 61 sperm whales and 49 long-finned pilot whales were collected between 2006 and 2013. A clear distinction in δ15N values was observed among the three species, with sperm whales at the higher trophic level, followed by long-finned pilot whales and fin whales; in accordance with their dietary regimes. δ13C values resulted significantly different between the toothed-whales and the baleen whale. Long-finned pilot whales displayed the highest concentrations of ΣPCBs, ΣDDTs and ΣPBDEs, followed by sperm whales and fin whales. In general, pollutant concentrations found in our species were significantly higher than both their Southern Hemisphere and North Atlantic counterparts. Sex differences were observed only in sperm whales and fin whales with males presenting higher contaminant burden than females. The congeners profiles did not differ among species; however the congeners concentrations were substantial in their differentiation. Finally, in the two odontocetes dioxin-like PCBs accounted for over 80% of the total TEQ. This study demonstrated the serious threat that the release of pollutants in the Mediterranean Sea is excercising on the local cetacean populations, especially on toothed-whales, of which most of the analysed individuals showed pollutants concentrations higher than the estimated threshold toxicity value of 17000 ng.g−1 for blubber in marine mammals. It also showed limitations and potential problems of experimental procedures such as the use of biopsies for blubber sampling in species such as the sperm whale, and the use of δ15N as only surrogate for trophic position.

Keywords: chemical tracer, biopsy, blubber, trophic level, toxicity, Northwestern Mediterranean Sea

A FUNCTIONAL CHARACTERIZATION OF PHYTOPLANKTON DISTRIBUTION IN THE GILGEL GIBE RESERVOIR AND THE EFFECT OF THE ENVIRONMENT

BY RAPHAËLLE LE CLERCQ

PROMOTOR: LUDWIG TRIEST (VUB)

Tropical reservoirs have been reported to experience ecological disturbances such as eutrophication, siltation, industrial contamination or toxic Cyanobacteria blooms. Building knowledge about these artificial ecosystems becomes increasingly important, especially in countries that are expected to develop more of these large water---related infrastructures. The present case study focuses on the young Gilgel Gibe Reservoir (south---western Ethiopian highlands), on its limnology and on its spatial heterogeneity hypothetically reflected in the phytoplankton distribution patterns captured by Reynolds' functional classification.

The Gilgel Gibe Reservoir is a very inorganic---turbid and nutrient---enriched environment due to soil degradation processes and unregulated urban and rural discharges. It falls under the hypereutrophic state for its Total Phosphorus content and meso--- to eutrophic for its Chlorophyll a values, depending on the season and the chosen Trophic State Index.

A longitudinal zonation was detected along the axis from the main inlet up to the dam outlet with, accordingly, a typical lotic zone followed by a transition zone before the lentic conditions close to the dam. However, if the limnological variables were consistent with this theory and other tropical case studies, phytoplankton response differed in some aspects. The most riverine site showed the highest productivity thanks to the high abundance of species adapted to turbid environments and to the absence of zooplankton. Productivity decreases towards the Centre with a shift in species composition (lower contribution of species sensitive to zooplankton activity). At the outlet, phytoplankton biovolume increases – as compared to the Centre--- with a higher contribution of Cyanobacteria, mainly colony---forming *Microcystis spp.* that are favoured in enriched and stagnant environment.

Distinctive influences from the two other inlets were also detected in limnological variables and phytoplankton response. The Nedi River showed a longitudinal gradient, different and much shorter than the main one, from its riverine zone until the outlet. The Nadaguda River presents a third pattern, intermediate between riverine and enriched pond conditions.

Keywords: tropical reservoir, phytoplankton, functional classification, Gilgel Gibe, Ethiopia

RELATIONSHIP BETWEEN PESTICIDE ACCUMULATION IN ZEBRA MUSSEL AND COMMUNITY STRUCTURE OF AQUATIC MACROINVERTEBRATES

BY TAYEBEH BASHNIN

PROMOTOR: LIEVEN BERVOETS (UANTWERPEN)
SUPERVISOR: MAARTEN DE JONGE (UANTWERPEN)

In this study it has been examined to which level bioaccumulated pesticides in transplanted zebra mussels can give an indication of trends in environmental pesticide pollution. In addition, it was investigated if pesticide body residues could be related to ecological responses (alternation in macroinvertebrate community composition). The study was conducted by measuring pesticide accumulation in translocated zebra mussels as well as assessing macroinvertebrate community structure by calculating biological water quality indices (BBI, MMIF, BMWP, total macroinvertebrate taxa and EPT). The results indicated that high body burdens of dimethoate, terbutylazine, chlorpyrifos and hexachlorobenzene were related to low biological water quality. Therefore for above mentioned pesticide threshold values of accumulated levels could be derived, above which ecological quality, as expressed by macroinvertebrate communities, were always low. The results suggest that zebra mussel body burdens can be used to predict the ecological impacts of pesticide contamination on the macroinvertebarte communities and to measure pesticides bioavilability. However, it should mentioned that the quantile regression analysis did not show negative significant relationship between calculated pesticides and the calculated biological water quality indices with the exception of hexachlorobenzene, indicating that other factors than the accumulated pesticides affect the community structure as well.

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METABOLIC AND PHYSIOLOGICAL RESPONSES OF EUROPEAN SEABASS (DICENTRARCHUS LABRAX) ON THE INTERACTIVE EFFECTS OF AMMONIA, NUTRITIONAL STATUS AND SALINITY

BY RINDRA RASOLONIRIANA

PROMOTOR: GUDRUN DE BOECK (UANTWERPEN)
CO-PROMOTOR: AMIT KUMAR SINHA (UANTWERPEN)

Salinity is a limiting factor for many marine organisms, especially as it varies downward. Owing to the global warming, glaciers and ice caps have been rapidly disappearing with more frequent intense rainfall events. Consequently, the salinity gradient of some marine ecosystems such as enclosed bays, estuaries and the inshore water has gradually reduced over the last few decades. Besides, euryhaline teleosts including diadromous and non-diadromous fish often encounter osmotic challenges at different stages of their life cycle. Furthermore, the effects of salinity challenge do not act in isolation; due to increasing human pressure and eutrophication, ammonia pollution occurs simultaneous with salinity stress. It is also expected that during certain periods (e.g. winter), food deprivation may occur simultaneously in natural water bodies which can modulate the performance of fish during salinity and ammonia threat. Therefore, the objective of the present study was to investigate the interactive effect of salinity challenge, ammonia toxicity and starvation on the metabolic, physiological and ion-osmoregulatory responses of European sea bass (*Dicentrarchus labrax*), a euryhaline species of ecological and commercial importance.

Therefore, we designed an experiment to determine the responses of sea bass in function of the nutrient status and a salinity challenge (32 ppt, 20 ppt, 10 ppt and 2.5 ppt) when they are exposed to 20 mg.L-1 ammonia (corresponding to 50% of the 96h-LC50). The fish were acclimated to the experimental salinities for at least two weeks prior to the experimentation. Following the acclimation to the different salinity regimes, fish were kept unfed for seven days prior to the ammonia exposure. Effects were checked at 12 hours, 48 hours, 84 hours and 180 hours of exposure time.
Results show that when the salinity decreases, particularly in its lowest level, ammonia excretion was inhibited; and as a consequence, the ammonia accumulation is more prominent in these fish. Besides, this accumulation is aggravated by the inability of sea bass to completely detoxify ammonia; sea bass can transform ammonia into urea but is unable to excrete it. Overall, the situation of unfed fish is worse compared to that of fed ones.

The osmolality in the plasma points towards an inefficient osmoregulation capacity at low salinities under HEA exposure. Even though the ion concentration in the plasma reflects this disturbance, it was detected that sea bass rely mostly on the sodium-potassium-chloride cotransporter pump at normal salinity. When the salinity decreased below 10 ppt, sea bass would increase the use of the sodium-potassium antiporter pump more and more which requires energy. This was confirmed by the activity of the sodium potassium ATPase. At the lowest salinity, fish activate the proton pump and increased activities of the proton ATPase were needed to maintain sodium homeostasis. The same response was observed in fasted and fed fish but the activation in fed fish was more prominent.

The analysis on the energy stores in the liver and the muscle corroborates the extra energy requirement at the lowest salinity and particularly the drastic decline of glycogen at the same salinity level explains the incompetency of pumps to maintain homeostasis at hypo-osmotic environment. Overall, the result indicates that osmotic stress is unlikely to occur within the salinity regime of 32 to 20 ppt. However, at lower salinities (10 ppt and 2.5 ppt) feed deprivation tends to reduce 8 physiological, metabolic, biochemical and ion regulatory mechanism and thus

make the fish more difficult to adapt to hypo-osmotic environment and make them susceptible to the ammonia toxicity.

Key words: High environmental ammonia (HEA), starvation, salinity, European sea bass, ammonia dynamics, urea dynamics, metabolic status, ion regulation, proton ATPase.

SPATIAL AND TEMPORAL VARIABILITY OF SEDIMENTARY PROCESSES ASSOCIATED TO THE GUILVINEC CANYON, BAY OF BISCAY

BY ZOË PAUWAERT

PROMOTOR: DAVID VAN ROOIJ (UGENT)

Submarine canyons make for a unique habitat for reef building organisms such as deep water oysters *Neopycnodonte zibrowii* (Van Rooij et al., 2010)) and cold-water corals *Lophelia pertusa* (De Mol et al., 2011). They use the hard substrate and concealed space to build their banks, and get their food out of passing currents. However, sedimentary processes and changing hydrographical conditions can endanger the successful survival of these reefs. A case study, researching these sedimentary processes and the hydrographical environment in the Guilvinec canyon, on the Armorican margin, Bay of Biscay, is presented in this dissertation. The environmental and sedimentological conditions were investigated using two CTD casts, high resolution multibeam echosounding data and a seismic site survey.
Interpretation of the data and comparison between the different data sets is done in order to determine the general morphology and evolution of the Guilvinec canyon. Hereby, the important stratigraphical units and sedimentary processes shaping the canyon are identified. The different water masses in the canyon are identified and any possible interaction with the canyon system and the canyon flanks is described. This knowledge is used to determine whether this system could be a favourable environment for cold-water corals.
Two water masses could be identified: MOW and ENAW. The canyon has an asymmetric cross section, with a steeper western flank and less steep eastern flank. Tributary gullies form incisions with different depths and frequencies, both parameters having higher values for the western flank. Several events of mass wasting could be recognized on the multibeam data and the seismic profiles. Three stratigraphical units are identified: U1, having a transparent acoustic character with some discontinuous low amplitude reflectors, possible Miocene in age; U2 has a less transparent acoustic character, with low amplitude, constant frequency, laminated reflectors and an irregular structure with the same acoustic character, dated as Miocene; U3 is dominated by high amplitude, continuous, laminated reflectors with an increasing frequency, reaching the surface. This latter unit is subdivided into U3a and U3b, both deposited during Plio-Pleistocene times. U3a has the previously described acoustic character. Cutting the surface, some channel-like erosional surfaces can be recognized. The infill has a high amplitude acoustic character with none to a few discontinuous reflectors, identified as U3b.
The hydrographical setting of this canyon is ideal to sustain the life of cold-water corals. However, initial settling is more likely on the western flank due to higher turbulence near the bottom causing erosion of loose suspended sediment, favouring stern attachment of the coral specimen to the hard substrate and preventing burial of the reef.

KEYWORDS
Guilvinec canyon, sedimentary processes, stratigraphy, MOW, ENAW, cold-water corals