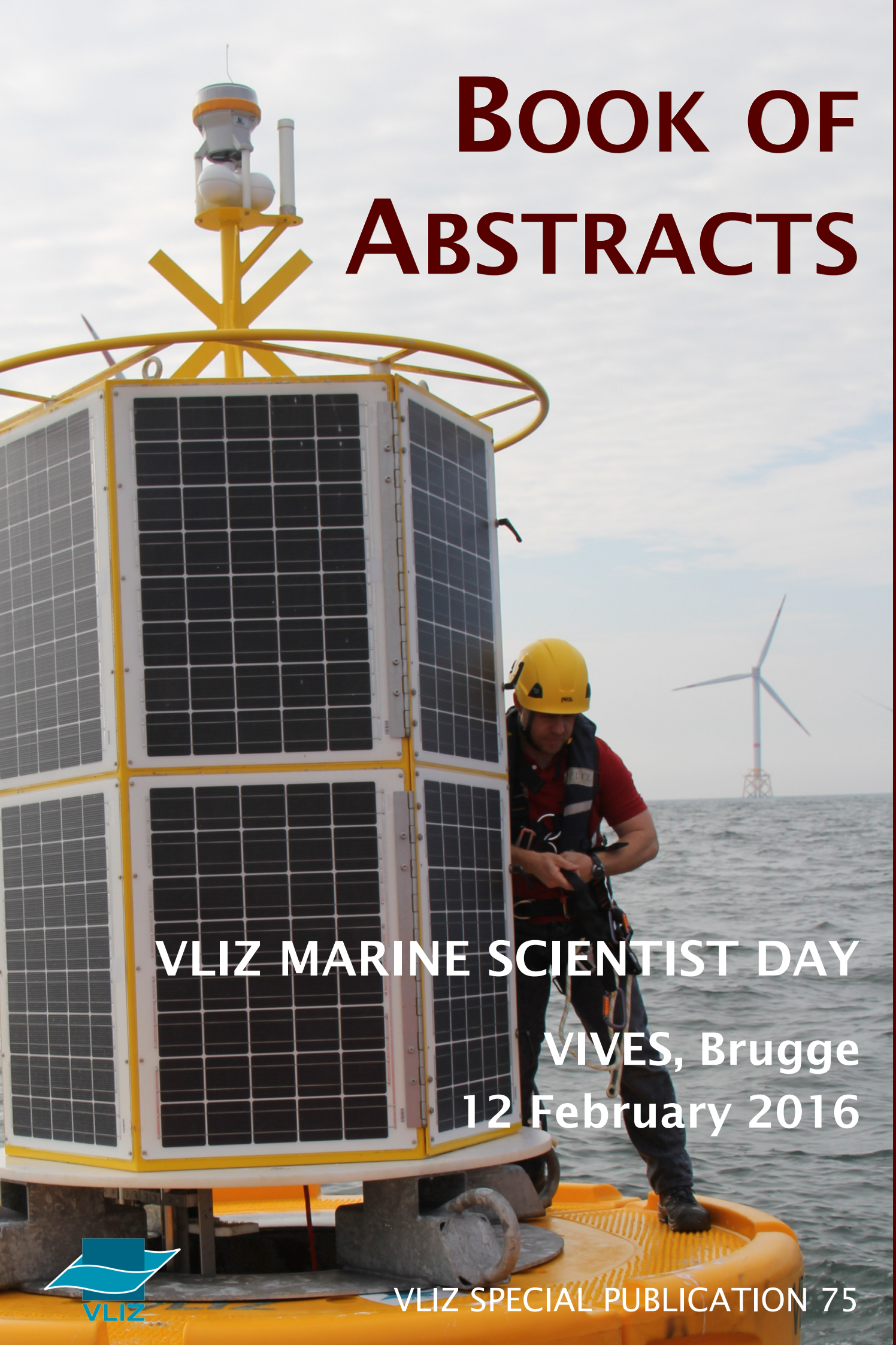
Book of Abstracts



VLIZ MARINE SCIENTIST DAY

VIVES, Brugge

12 February 2016

VLIZ SPECIAL PUBLICATION 75

VLIZ MARINE SCIENTIST DAY 2016

BOOK OF ABSTRACTS

VLIZ MARINE SCIENTIST DAY

VIVES, Brugge
12 February 2016

VLIZ SPECIAL PUBLICATION 75

This publication should be quoted as follows:
Jan Mees and Jan Seys (Eds). 2016. Book of abstracts – VLIZ Marine Scientist Day. Brugge, Belgium, 12 February 2016. VLIZ Special Publication 75. Vlaams Instituut voor de Zee – Flanders Marine Institute (VLIZ): Oostende, Belgium. 165 + xii p.

Vlaams Instituut voor de Zee (VLIZ)
Flanders Marine Institute
VLIZ – InnovOcean site
Wandelaarkaai 7
8400 Oostende, Belgium
Tel. +32-(0)59-34 21 30
Fax +32-(0)59-34 21 31
E-mail: info@vliz.be
http://www.vliz.be

Photo cover:
VLIZ – Leontien De Wulf

This book is based on the information submitted by the respective authors.

ISSN 1377-0950

PREFACE

This is the 'Book of Abstracts' of the 16th edition of the VLIZ Marine Scientist Day, a one day event that was organised on 12 February, 2016 in VIVES, Brugge.

This annual event has become more and more successful over the years. With more than 400 participants and more than 100 scientific contributions, it is fair to say that it is the place to be for Flemish marine researchers and for the end-users of their research. It is an important networking opportunity, where scientists can meet and interact with their peers, learn from each other, build their personal professional network and establish links for collaborative and interdisciplinary research.

Marine scientists from all Flemish universities and scientific institutes – and representing all marine science disciplines – have contributed to this volume. The book thus illustrates the diversity, quality and relevance of the marine sciences in Flanders (and Belgium): it provides a beautiful and comprehensive snapshot of the state-of-the-art of marine scientific research in Flanders in 2016.

Pre-doc and post-doc scientists present their research in an exciting way and communicate their fascinating science – and its importance to society – to the wider public. We thus hope to demonstrate the excellence of Flemish marine science and to increase its national and international visibility.

The volume of research that is presented here holds a great promise for the future. It shows that marine science is a very lively discipline in Flanders, and that a new generation stands ready to address the grand challenges and opportunities that our seas and oceans represent.

I want to congratulate all participants with their contributions, and I invite them all to actively participate in VLIZ-events and activities in the future.

Brugge, 12 February 2016

Prof. Dr Jan Mees
General Director VLIZ

TABLE OF CONTENTS

APPLICANTS VLIZ THESIS AWARDS 2015

APPLICANTS VLIZ NORTH SEA AWARD 2015

ANNUAL VLIZ THESIS AWARDS MARINE SCIENCES 2015

Every year VLIZ awards two marine Master theses. Fundamental as well as applied marine researchers in all disciplines of marine sciences can apply. The prize amounts to 500 EUR and is reserved for young scientists that are graduated at a Flemish university or college for higher education.

The 2015 winners of the Annual VLIZ Thesis Award Marine Sciences are:

GAËTAN DE GRYSE

Ghent University, Faculty of Veterinary Medicine

for the thesis entitled:

DRIEDIMENSIONALE MORFOLOGIE VAN DE ANTENNALE KLIER BIJ DE PENAEUS VANNAMEI EN DE ONTWIKKELING VAN EEN KWANTIFICATIEMETHODE VOOR DE STUDIE VAN HET WHITE SPOT SYNDROME VIRUS

&

THOMAS MESTDAGH

Ghent University, Faculty of Sciences

for the thesis entitled:

EVALUATION AND MODELLING OF THE RESPONSE OF GAS HYDRATE RESERVOIRS TO CHANGING ENVIRONMENTAL CONDITIONS ACROSS A HIGH-LATITUDE CONTINENTAL MARGIN

Driedimensionale morfologie van de antennale klier bij de *Penaeus vannamei* en de ontwikkeling van een kwantificatiemethode voor de studie van het White spot syndrome virus

De Gryse Gaëtan M.

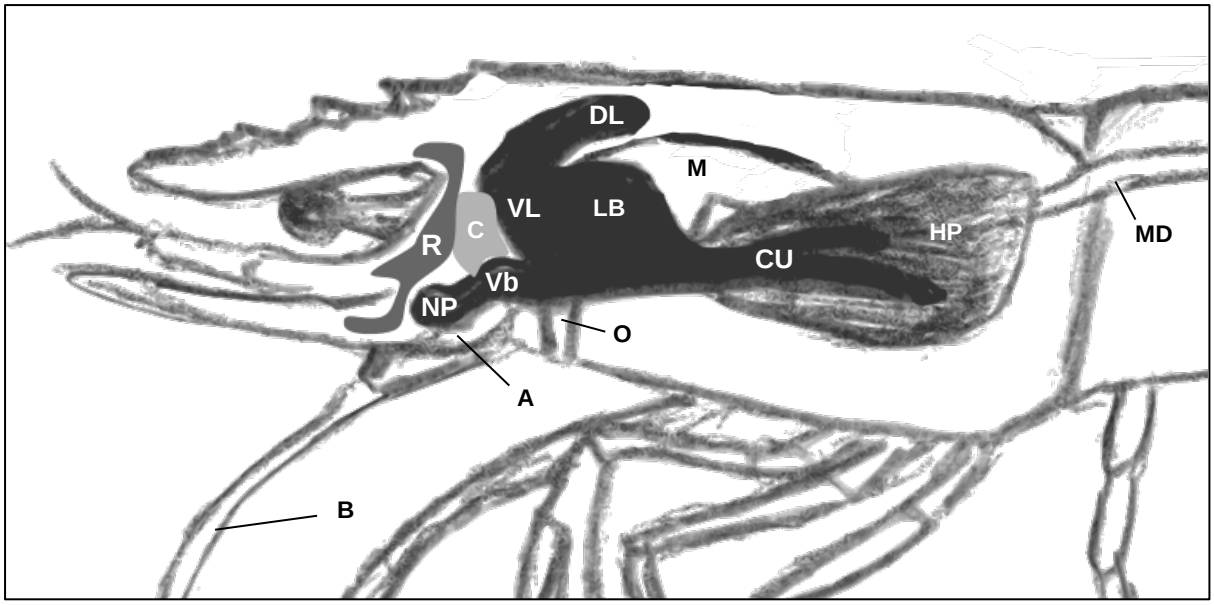
Faculteit Diergeneeskunde, Universiteit Gent, Strandloperstraat 8, 8400 Oostende, Belgium
E-mail: gaetan.degryse@ugent.be

In 2050 zullen naar schatting 9,6 miljard mensen deze wereld bevolken. Om het dreigende voedseltekort op te vangen, wordt onder meer gerekend op de verdere ontwikkeling van de garnalenaquacultuur. De volledige ontplooiing van deze industrie wordt echter sterk gehinderd door virale uitbraken. Het White spot syndrome virus (WSSV) wordt algemeen aanzien als de grootste bedreiging voor de industrie. Al sinds 1992 confronteert het virus de garnalenaquacultuur met massale productieverliezen. Eén van de grote vraagstukken binnen het onderzoek naar WSSV blijft het identificeren van de intredepoort van het virus. Omdat de buitenkant van de garnaal en zijn kieuwen afgeschermd worden door een virus-impermeabele cuticula, gaan veel onderzoekers ervan uit dat WSSV de garnaal binnentreedt via de (midden)darm. Een aantal studies pleiten echter tegen deze visie.

Zo werd er recent in het laboratorium van de promotor bewezen dat WSSV via perorale weg de garnaal moeilijk kan infecteren. Voor een perorale inoculatie zijn er meer dan 106 infectieuze partikels nodig. Het epitheel van het spijsverteringskanaal wordt afgeschermd van zijn lumen door een cuticulaire aflijning of peritrofe membraan. Beiden zijn niet tot zeer moeilijk penetreerbaar door virussen en daarom werd verondersteld dat deze barrière de oorzaak is van de perorale resistentie. Er zijn slechts twee groepen van organen die in direct contact staan met de buitenwereld, waarvan het lumen niet afgelijnd wordt door een cuticula of andere analoge structuur: (i) de tegumentale klieren en (ii) de antennale klieren. Beide organen zijn betrokken in de pathogenese van WSSV, maar enkel deze laatste is effectief een doelwitorgaan waar replicatie plaatsvindt na intramusculaire inoculatie. De antennale klier kreeg tot nog toe slechts beperkte aandacht van de wetenschappelijke gemeenschap. Zelfs een degelijke basis omtrent morfologie en anatomie ontbreekt. Omdat het belangrijk zal zijn om ook dit orgaan te betrekken bij toekomstige pathogenesestudies, werd in deze thesis de structuur van de antennale klier in kaart gebracht.

Vertrekkende vanuit seriële histologische coupes van *Penaeus vannamei*, werd er met behulp van 3D-reconstructiesoftware (AMIRA v5.6) een onverwacht complexe organisatie van de antennale klier bij de *Penaeus vannamei* gevonden (Figuur 1). De cellulaire structuur en opbouw vertonen veel overeenkomsten met het urinaire stelsel van vertebraten. Het orgaan bestaat uit twee bilaterale, compacte glandulaire gedeeltes (Figuur 1, C), gelegen ter hoogte van de overgang van de cephalothorax naar de antennale coxipodiet (eerste segment van het antennale aanhangsel). Dit gedeelte lijkt sterk op de nier van vertebraten. Centraal in het compacte glandulaire gedeelte ligt de coelomosac. Deze is opgebouwd uit één cellaag van podocyten met grote en onregelmatige kernen, en staat in voor de primaire filtratie van de hemolymfe. Het perifere gedeelte wordt ingenomen door het labyrint dat bestaat uit anastomoserende tubuli van unicellulair, afgeplat epitheel. Hier vindt de secundaire modificatie van het filtraat plaats.

Vanuit dit compacte glandulaire gedeelte vertrekken twee structuren die beiden een verderzetting zijn van het labyrint. De anastomoserende tubuli van het labyrint lopen verder naar rostraal, waar ze zich over de gehele lichaamsholte spreiden (Figuur 1, R). Zo gaan ze ondermeer de hersenen volledig omgeven. De tubuli van beide helften versmelten ter hoogte van deze rostrale structuur met elkaar. De cellulaire structuur van dit gedeelte lijkt zeer sterk op die van het labyrint.



Figuur 1. Schematische opbouw en situering van de antennale klier in de *Penaeus vannamei*, A) antennale coxipodiet B) antenne, O) oesofagus, M) maag, MD) middendarm, HP) hepatopancreas, NP) nefroporie, C) compacte glandulaire deel, R) rostrale structuur, Vb) ventrale blaas, LB) laterale blad, CU) caudale uitlopers van het laterale blad, VL) ventrale lobus van de mediane blaas, DL) dorsale lobus van de mediane blaas.

Een tweede verderzetting van het labyrint is de bilaterale ventrale blaas (met glad spierweefsel in de wand), die uitmondt in de nefroporiën (Figuur 1, Vb & NP). Dit zijn de externe openingen van de antennale klier, bilateraal gelegen ter hoogte van de antennale coxipodieten (Figuur 1, A). Scanning-elektronenmicroscopische opnamen werden genomen om de externe conformatie van deze openingen te onthullen. Ze zijn gesitueerd op een komvormige depressie (caudaalwaarts gericht) op een mediale antennale coxipodiet protuberantie. De opening zelf is een halvemaanvormige spleet. Beide helften van de depressie overlappen elkaar en gaan zo de nefroporie elastisch afsluiten. Het is goed denkbaar dat dit gedeelte van het exoskelet minder elastisch is na de ecdysis (vervelling), waardoor de nefroporie minder goed wordt afgesloten. Hierdoor bestaat de mogelijkheid voor omgevingswater om in en uit de antennale klier te sijpelen. Als de antennale klier inderdaad de intredepoort is, kan dit een verklaring zijn waarom garnalen na ecdysis gevoeliger zijn voor WSSV-infectie.

Naast de ventrale blaas en de rostrale structuur is er ook een derde, caudaalwaartse uitstulping van de antennale klier. Deze vertrekt echter niet uit het compacte glandulaire deel, zoals de twee eerder genoemde structuren, maar wel uit een caudaalwaartse uitloper van de ventrale blaas. De caudale uitzetting bestaat uit twee grote (bi)laterale bladen die het spijsverteringskanaal flankeren en uiteindelijk uitlopen tot en met de voorste helft van de hepatopancreas (Figuur 1, LB & CU). Op verschillende plaatsen van deze structuur versmelten beide helften met elkaar, zodat men eigenlijk van één antennale klier of een antennaal complex kan spreken (in plaats van twee aparte bilaterale structuren). De meest opvallende versmelting wordt gevormd door de mediane blaas die de voordarm (maag) rostraal bedekt met een ventrale lobus en dorsaal met een dorsale lobus (Figuur 1, VL & DL). Dit gedeelte van de klier is over de volledige lengte slechts één cellaag dik, met uitzondering van wat glad spierweefsel rond de dorsale lobus en een dunne laag tussen de maag en de mediale zijde van de laterale bladen.

Voor de aanvang van deze thesis werd slechts de compacte glandulaire structuur en de ventrale blaas beschreven. Er bestonden enkel vermoedens rond blaasvormige uitstulpingen in de cephalothorax, vertakkingen tot aan de hersenen en een verbinding tussen beide klierhelften. Deze thesis geeft voor het eerst de gedetailleerde structuur van de gehele antennale klier en toont dat deze klier in beide richtingen veel verder reikt dan algemeen werd aangenomen. De afwezigheid van een cuticula, de cellulaire structuur (één tot twee cellagen dik) en de sterke verspreiding van de antennale klier doorheen de cephalothorax (zoals blijkt uit het 3D-model), versterken de hypothese rond de antennale klier als WSSV-intredepoort. Een enkele cellaag is snel gepenetreerd en door de uitgebreidheid van het orgaan in de cephalothorax, kan het virus snel doorheen de cephalothorax spreiden, zonder daarbij gehinderd te worden door de immuunresponsen gepaard met een hemolymfe-geassocieerde virusspreiding. Dit zou kunnen verklaren hoe WSSV zo snel en efficiënt al zijn doelwitorganen kan bereiken. Het orgaan ligt namelijk naast en tegen de hepatopancreas, spieren, zenuwen, hersenen, subcuticulaire (epi)dermis, lymfoïde organen, kieuwen en het spijsverteringskanaal.
Tijdens de 3D-reconstructie van de klier werd ook speciale aandacht besteed aan eventueel geassocieerde structuren. Dit resulteerde in de ontdekking dat heel wat eerder beschreven spieren van

de cephalothorax sterk geassocieerd zijn met de klier. Omwille van deze reden werden ook de relevante spieren gereconstrueerd in 3D. Dit leidde (samen met de volledige structuur van de klier) tot het uitwerken van enkele opvallende hypothesen zoals een mogelijke rol van de klier in mechanische reiniging van de kieuwkamer en/of het dynamische vervellingsproces van de garnaal, wat niet alleen interessant is vanuit biologisch standpunt, maar ook vanuit een microbiologische hoek. Indien de antennale klier effectief een rol speelt in het reinigen van de kieuwkamer, zou het interessant zijn om de urine van garnalen te onderzoeken op antibacteriële activiteit. Dat de antennale klier in verband wordt gebracht met het vervellingsmechanisme is een potentieel zeer belangrijk gegeven. Het is immers aangetoond dat garnalen significant gevoeliger zijn voor WSSV-infectie tijdens of onmiddellijk na het moment van vervellen. Daarenboven werd eerder al aangehaald (zie boven) dat de nieuwe cuticula een minder goede afsluiting van de nefroporiën zou kunnen verzorgen.

Om de rol van de antennale klier verder uit te klaren, werd ook een poging ondernomen om de *in vivo* dynamiek van de antennale klier te bestuderen tijdens de ecdysis door het orgaan *in vivo* aan te kleuren. Monitoring met een high speed camera zou dan de evolutie van dit orgaan tijdens het vervellingsproces kunnen vastleggen (de *Penaeus vannamei* is, net als vele andere garnalensoorten, transparant). Geen enkele kleurstof bleek echter lang genoeg *in situ* aanwezig te blijven om het experiment te laten doorgaan.

Voor het bestuderen van de WSSV-pathogenese, werd er ook een kwantitatieve polymerase-kettingreactie (qPCR)-methode ontwikkeld. De primers werden ontworpen met behulp van bio-informaticasoftware zoals MEGA, Primer3Plus en OligoAnalyzer. Drie WSSV-genen werden genomineerd als potentiële doelwitsequentie voor de ontwikkeling van een primerpaar, geschikt voor qPCR: (i) het DNA-polymerasegen (ii), het VP28-gen en (iii) het VP19-gen. Enkel voor deze laatste sequentie kon een geschikt primerpaar gevonden worden dat voldoet aan de stringente vereisten, nodig voor een efficiënte qPCR. Met behulp van de ontwikkelde primers werd eerst standaard-DNA aangemaakt uit de WSSV-stock. Vervolgens werden de optimale qPCR-reactiecondities experimenteel bepaald (50 nM forward primer, 200 nM reverse primer en een annealingtemperatuur van 58 °C). Het ontwikkelde qPCR-protocol is theoretisch in staat om met 98 % efficiëntie, één WSSV-kopij per µl te detecteren met een sterke herhaalbaarheid.

Vermits de antennale klier het excretoire orgaan is, moet het qPCR-protocol in staat zijn om WSSV-DNA te detecteren en kwantificeren in urine. Uit ervaring blijkt dat urine van zoogdieren bepaalde componenten bevat die een inhibitorische invloed kunnen uitoefenen op een qPCR-reactie (zoals ureum, magnesium, glucose, …). Een RNA-extractiekit van Qiagen (Viral RNA Mini Kit, Californië, VSA) zou volgens de fabrikant beter geschikt zijn om viraal genomisch materiaal (zowel DNA als RNA) te extraheren uit urine van zoogdieren, bedoeld voor verdere (q)PCR-analyse. Hoewel WSSV een dsDNA-virus is, zou de Viral RNA Mini Kit beter geschikt zijn om deze inhibitorische componenten te neutraliseren tijdens het extractieproces in vergelijking met de Qiamp DNA Mini Kit. Deze thesis weerlegt dit gegeven voor garnalenurine. Er werd aangetoond dat de DNA Mini Kit beter presteert dan de Viral RNA Mini Kit voor qPCR-analyse van DNA, aanwezig in garnalenurine.

Deze thesis legt een belangrijke basis voor toekomstige WSSV-pathogenesestudies. Het ontrafelen van de morfologische en anatomische structuur van de antennale klier, versterkt bovendien de hypothese dat de antennale klier de lang gezochte intredepoort is voor het WSSV. Bovendien werd ook een efficiënte kwantificatiemethode ontwikkeld die toelaat om WSSV-replicatie in het orgaan te bestuderen. Deze bevindingen zullen het onderzoek naar WSSV in een stroomversnelling leiden en finaal bijdragen tot de ontwikkeling van een effectieve WSSV-bestrijding.

Evaluation and modelling of the response of gas hydrate reservoirs to changing environmental conditions across a high-latitude continental margin

Mestdagh Thomas

Universiteit Gent, Faculteit Wetenschappen, Krijgslaan 281 S8, 9000 Gent, Belgium
E-mail: Thomas.Mestdagh@UGent.be

Gashydraten zijn kristallijne vaste stoffen die opgebouwd zijn uit een rooster van watermoleculen waarin een gasmolecule (CO_2, CH_4 of een molecule van een zwaarder gas) gevangen zit. Ze komen voor in de natuur in de poriënruimte van sedimenten bij voldoende hoge druk en lage temperatuur (Sloan and Koh, 2007). Concreet betekent dit dat gashydraten (in de literatuur ook wel clathraten genoemd) veelal teruggevonden worden in mariene sedimenten op en aan de voet van continentale randen, bij oceaanbodemdieptes van 300 m tot 3000 m (Birchwood et al., 2010). Daarnaast komen ze voor in associatie met permafrost, die in poolnabije regio's zowel op het land als onder ondiepe zeeën kan voorkomen (Collett et al., 2011). Tenslotte zijn ook een aantal voorbeelden uit het Baikalmeer en de Zwarte Zee gekend (Khlystov et al., 2013).

Hoewel er wat onenigheid over bestaat, is de omvang van het globale gashydraatreservoir met een geschat volume van enkele honderden tot duizenden gigaton aan koolstof aanzienlijk. Deze waarde is op zijn minst in dezelfde grootteorde als de geschatte reserves aan andere conventionele koolstofbronnen zoals steenkool, aardolie of aardgas (Koh et al., 2012). Het is dan ook niet verwonderlijk dat een aanzienlijk deel van het hydraatonderzoek zich tot op de dag van vandaag toespitst op het potentieel van gashydraten als toekomstige energiebron.

Deze scriptie behandelt echter een andere, maar niet minder onderzochte problematiek. Al snel groeide immers het besef dat gashydraten mogelijk een belangrijke rol kunnen spelen in de koolstofcyclus en bijgevolg in het klimaat van de Aarde (Kvenvolden, 1988). Het basisidee hierachter is dat het gas (hoofdzakelijk methaan), dat initieel gevangen zit in de clathraatstructuur, kan vrijkomen door het smelten of dissociëren van gashydraten. In de natuur kan dit bijvoorbeeld het gevolg zijn van een stijging van de temperatuur aan de zeebodem, door een opwarming van de bovenliggende watermassa's, die vervolgens in de ondergrond propageert naar dieptes waar gashydraten voorkomen, of van een zeespiegeldaling waardoor de druk in de oceaanbodemsedimenten daalt. Wanneer methaan (CH_4) en zijn oxidatieproduct koolstofdioxide (CO_2), beide broeikasgassen, door de sediment- en waterkolom migreren en uiteindelijk als vrij gas in de atmosfeer terecht komen, kunnen deze nog extra bijdragen tot de opwarming, waardoor het smelten van de gashydraten in stand gehouden of versneld wordt. Op deze manier wordt een positief feedback-mechanisme gecreëerd, dat abrupte stijgingen in atmosferische CH_4 of CO_2 concentraties en snelle klimaatschommelingen zou kunnen verklaren.

Dergelijke snelle klimaatschommelingen hebben zich verschillende keren voorgedaan in de geologische geschiedenis, en werden aan het licht gebracht door metingen van koolstof- en zuurstofisotopen. Een bekend voorbeeld, waarvoor dit mechanisme voorgesteld werd, is het *Paleocene - Eocene Thermal Maximum*, afgekort PETM (Dickens et al., 1995). Andere studies opperen dat het afwisselend krimpen en aangroeien van het globale gashydraatreservoir ook een belangrijke rol kan gespeeld hebben in Laat-Pleistocene klimaatschommelingen (Loehle, 1993; Nisbet, 1990). Een bijkomende factor hierbij is dat de faseovergang van gashydraat naar vrij gas en vloeistof gepaard gaat met een volume-expansie, waardoor in weinig permeabele sedimenten de druk in de poriënruimte aanzienlijk kan stijgen. De hieraan gekoppelde daling in de sterkte van het sediment kan uiteindelijk aanleiding geven tot het barsten en afglijden van omvangrijke sedimentpakketten, waardoor grote volumes gashydraten in een korte tijdsspanne zouden kunnen smelten.

Dit vormt de basis voor de *clathrate gun hypothesis*, die Kennett et al. (2003) voorstellen om Laat-Pleistocene klimaatcycliciteiten (glacialen/interglacialen en stadialen/interstadialen) te verklaren. Tenslotte veronderstelt een aantal onderzoekers ook nog dat de hedendaagse klimaatverandering, ten gevolge van menselijke activiteit zoals het massaal verbranden van fossiele brandstoffen, aanleiding kan geven tot het smelten van gashydraten in de komende eeuwen (Hunter et al., 2013; Marín-Moreno et al., 2013), of dat dit zelfs vandaag de dag al aan de gang is op de continentale rand ten westen van Spitsbergen (Westbrook et al., 2009), wat uiteraard een bijkomstig versterkend effect zou kunnen hebben op de opwarming van de Aarde.

Deze scriptie spitst zich toe op de hierboven toegelichte potentiële, maar ook controversiële rol van gashydraten in de koolstofcyclus en het klimaat van de Aarde. De gevoeligheid van gashydraatreservoirs voor veranderende omgevingsparameters is essentiële informatie om de hierboven opgesomde theorieën te kunnen beoordelen. Dit houdt in dat vragen als waar, hoe snel en hoeveel gashydraten kunnen smelten ten gevolge van temperatuur- en/of zeespiegel-schommelingen, dienen te worden beantwoord. Deze studie probeert dit te doen voor methaanhydraatreservoirs langsheen een hypothetische continentale rand op een hoge breedtegraad, omdat klimaat-veranderingen hier over het algemeen het meest uitgesproken zijn (Westbrook et al., 2009). Dit laat bovendien ook toe om vier fundamenteel verschillende omgevingen waarin hydraten kunnen voorkomen (continentale permafrost, permafrost onder ondiepe zeeën, in de zeebodem bovenaan de continentale helling, en in de zeebodem aan de voet van de continentale helling) te beoordelen en te vergelijken. Hiertoe werd een eendimensionaal numeriek model ontwikkeld in MATLAB, waarbij de evolutie van de temperatuur in de ondergrond doorheen de tijd gebaseerd is op de *finite difference method*. Realistische initiële distributies en concentraties van gashydraten in de ondergrond werden verkregen door het implementeren van bestaande vormingsmodellen (het model van Xu and Ruppel (1999) voor mariene gashydraten, en het model van Behseresht and Bryant (2012) voor hydraten geassocieerd met permafrost). Op deze manier kon ook een onderscheid gemaakt worden tussen de gashydraatstabiliteitszone (HSZ), die op basis van druk, temperatuur, en saliniteit van het poriënwater in de ondergrond kan afgebakend worden, en de zone waar gashydraten effectief voorkomen. De omvang van laatstgenoemde zone hangt nog extra af van de beschikbaarheid van methaan in de poriënruimte van de sedimenten, die groot genoeg moet zijn om ervoor te zorgen dat methaanhydraten kunnen vormen en niet oplossen (de methaanconcentratie in het poriënwater moet hiertoe groter zijn dan de oplosbaarheid van methaan in het poriënwater). In veel gevallen beslaat het volume van deze zone (en dus van de gashydraatreservoirs) slechts een fractie van de HSZ. Daarnaast dient men ook rekening te houden met de *sulphate reduction zone* in de bovenste meters van de zeebodem, waarbinnen sulfaatreducerende bacteriën methaan omzetten naar CO_2 en op deze manier de stabiliteit van methaanhydraten belemmeren. Desalniettemin nemen een aantal modelleerstudies het volume van de HSZ (verkeerdelijk) als referentie voor de omvang van gashydraatreservoirs, wat in deze studie dus vermeden werd. Voorts werd ook de consumptie van latente warmte tijdens het smelten van gashydraten in rekening gebracht.

Dit model maakt het mogelijk de respons van methaanhydraatreservoirs op temperatuurstijgingen en zeespiegelschommelingen te simuleren. In eerste instantie werd dit gedaan voor drie scenario's waarin eenzelfde verandering wordt opgelegd in elk van de vier omgevingen, met als doel te achterhalen waar methaanhydraten het meest gevoelig zijn voor wijzigingen in de omgevings-parameters. De resultaten van deze simulaties tonen aan dat methaanhydraatreservoirs in associatie met permafrost onder ondiepe zeeën en in sedimenten bovenaan de continentale helling het snelst dissociëren wanneer de temperatuur aan de zeebodem met 5 °C stijgt. Op deze locaties dissocieert het volledige hydraatreservoir respectievelijk binnen 70000 en 50000 jaar. Deze tijdsspanne wordt in beide gevallen met ongeveer 30000 jaar verlengd wanneer een simultane zeespiegelstijging van 100 m in rekening wordt gebracht, aangezien de hiermee gepaarde stijging van de hydrostatische druk in de poriënruimte een stabiliserend effect heeft op de gashydraten. Verder van belang voor deze hydraatreservoirs is de observatie dat, wanneer de nieuwe, verhoogde temperatuur aan de zeebodem de smelttemperatuur van methaanhydraat bij de druk aan de zeebodem overschrijdt, hydraten vanaf de top van het reservoir kunnen smelten. Dit staat in contrast met diepwaterhydraten, die over het algemeen vanaf de basis smelten, zoals ook aangegeven wordt door deze studie. Wanneer de temperatuur over de continentale rand uniform toeneemt, zal bovengenoemde voorwaarde alleen vervuld zijn wanneer de waterdiepte kleiner is dan een welbepaalde kritische diepte, waarvoor een vergelijking werd afgeleid. Dit is immers belangrijke informatie, omdat methaangas dat vrijkomt aan de top van de hydraatzone op locaties waar bovendien de bovenliggende oceaan vrij ondiep is, een grotere kans heeft om uiteindelijk in de atmosfeer terecht te komen. Ook wanneer louter een zeespiegeldaling gesimuleerd wordt, neemt het effect op de stabiliteit van methaanhydraten toe naarmate de waterdiepte afneemt. Gashydraten in sedimenten aan de voet van de continentale hellingen en in associatie met dikke, continentale permafrost zijn daarentegen duidelijk minder gevoelig voor opwarming of zeespiegelschommelingen, aangezien over een periode van 100000 jaar slechts een kleine fractie of zelfs helemaal geen hydraten dissociëren. Tenslotte geeft de simulatie van de temperatuurstijging ook nog aan dat ijs in permafrost smelt op een tijdschaal van tientallen duizenden jaren. Hierover bestaat echter een grotere mate van onzekerheid dan over de tijdschaal die werd afgeleid voor het dissociëren van gashydraten, aangezien een aantal basisveronderstellingen over permafrostbodems (o.a. omtrent de grootte van de fractie van de poriënruimte die ijs initieel inneemt) nogal moeilijk te bepalen zijn.

In het tweede deel van deze studie werd de respons van methaanhydraatreservoirs op de klimaatveranderingen tijdens de deglaciatie volgend op het *Last Glacial Maximum* (LGM), tijdens het PETM, en tijdens de huidige opwarming van de Aarde expliciet nagebootst, om de theorieën die

hieromtrent geformuleerd zijn te kunnen evalueren. Elk van deze simulaties toont aan dat de tijdschaal voor het destabiliseren van gashydraten ook in deze specifieke gevallen tientallen duizenden jaren bedraagt. Dit komt niet overeen met de responstijd van duizenden jaren, zoals vooropgesteld in de *hydrate dissociation hypothesis* voor het PETM (Dickens et al., 1995), en de *clathrate gun hypothesis* voor Laat-Pleistocene klimaatschommelingen (Kennett et al., 2003). Dit contrast is zelfs nog groter met de voorgestelde tijdsintervallen van enkele eeuwen (Hunter et al., 2013), of zelfs decennia (Westbrook et al., 2009), voor het dissociëren van gashydraten als een gevolg van de hedendaagse klimaatverandering. Deze studie toont aan dat deze snelle tijdschalen enkel van toepassing kunnen zijn op methaanhydraten die zich heel ondiep (i.e. enkele meters tot tientallen meters) in de ondergrond bevinden. Echter, gashydraten op dergelijke kleine dieptes zijn waarschijnlijk eerder uitzondering dan regel. De zogenaamde 'stratigrafische' hydraatreservoirs, die lateraal continu zijn en het overgrote deel van het globaal volume aan gashydraten bevatten, bevinden zich immers doorgaans op tientallen tot honderden meters diepte. Enkel waar een zeer hoge aanvoer van methaangas ervoor zorgt dat de vorming van hydraten de anaerobe oxidatie van methaan door sulfaatreducerende bacteriën en de diffusie van methaan uit de hydraatstabiliteitszone naar de bovenliggende oceaan overschrijdt, kunnen hydraten vlak onder, of zelfs tot op de zeebodem bestaan. Aan deze voorwaarde kan over het algemeen enkel zeer lokaal voldaan worden, bijvoorbeeld ter hoogte van breuken of moddervulkanen, en zijn dus eerder uitzonderlijk (Archer et al., 2009a). Bovendien vormt de oceaan nog een extra buffer tussen de atmosfeer en de hydraatreservoirs in de geosfeer, omdat het eventuele vrijgekomen methaangas ook hier oplost in het oceaanwater en verder geoxideerd kan worden tot CO_2. De volumes volatiel CH_4 die vanuit methaanhydraatreservoirs snel naar de atmosfeer getransfereerd kunnen worden zijn dus waarschijnlijk te klein om significante schommelingen in atmosferische broeikasgasconcentraties en het klimaat teweeg te kunnen brengen.

De algemene conclusie is dat, van de vier fundamenteel verschillende settings langsheen een (Ant)Arctische continentale rand die in deze studie geëvalueerd werden, de stabiliteit van methaanhydraten in associatie met offshore permafrost en in sedimenten bovenaan de continentale helling het gevoeligst is voor veranderingen in temperatuur en druk. Niettemin geeft het model aan dat de tijdschaal voor het dissociëren van gashydraten lang is (tienduizenden jaren), en dat deze voor continentale permafrost of diepwater hydraatreservoirs zelfs nog een grootteorde groter is (honderdduizenden jaren). Het grootste deel van het globale gashydratenreservoir is dus niet gevoelig voor smelten op tijdschalen van tientallen, honderden of duizenden jaren. Hierdoor is het onwaarschijnlijk dat een positief feedback-effect ontstaat dat snel een significante toename van methaan in de atmosfeer en dus een bijkomende opwarming kan veroorzaken. Verder blijkt dat de tijdschalen waarop variaties in atmosferische broeikasgasconcentraties en klimaatschommelingen doorheen de geologische geschiedenis hebben plaatsgevonden, sneller zijn dan de tijdschaal waarop het volume van het globale gashydraatreservoir kan slinken en terug aangroeien. Dit impliceert dat gashydraatreservoirs doorgaans in een onstabiele, vergankelijke toestand moeten zijn, ook vandaag. Voortdurend smelten hydraten of worden er hydraten gevormd, maar dit gebeurt traag, en waarschijnlijk niet (zoals in talrijke studies wordt gepostuleerd) als een directe en dynamische weerspiegeling van veranderingen in het klimaat, die zich doorgaans tien tot honderd keer zo snel manifesteren.

ANNUAL VLIZ NORTH SEA AWARD 2015

Each year the Flanders Marine Institute (VLIZ) awards a scientific prize to foster innovative fundamental or applied research on the structure and functioning of the North Sea ecosystem, with emphasis on coastal and estuarine areas of the Southern Bight and the Channel. The prize is awarded to a researcher (or a research team) working and residing in a country bordering the North Sea. The prize amounts to 1000 EUR and is indivisible. It is granted to reward a recent original scientific contribution, preferably having relevance to the sustainable management of the area concerned. Studies pertaining to the biodiversity of the local ecosystem are equally welcome. The contribution has to be of postgraduate or postdoctoral level.

The Annual VLIZ North Sea Award 2015 is awarded to:

MICROBIAL ELECTRICITY TEAM

consisting of:

Filip Meysman
Team Coordinator

Sairah Malkin, Sebastiaan van de Velde and Eva-Maria Zetsche
Vrije Universiteit Brussel, Department of Analytical, Environmental and Geo-Chemistry

Eric Boschker, Laurine Burdorf, Jeanine Geelhoed, Nicole Geerlings, Silvia Hidalgo Martinez, Dorina Seitaj, Anton Tramper and Diana Vasquez Cardenas
Royal Netherlands Institute of Sea Research (NIOZ), Department of Ecosystem Studies

for the scientific contribution entitled:

DISCOVERY OF LONG-DISTANCE MICROBIAL ELECTRON TRANSPORT
IN THE SEAFLOOR OF THE NORTH SEA

Discovery of long-distance microbial electron transport in the seafloor of the North Sea

Meysman Filip

Vrije Universiteit Brussel, Goudenregenlaan 20, 2950 Kapellen, Belgium
E-mail: filip.meysman@nioz.nl

A living battery in the seafloor
Long filamentous bacteria that are capable of conducting electricity over long distances, and in this way, they create a natural living battery in the ocean floor. It may seem hard to believe, but it is a recent discovery by the Microbial Electricity research team of Prof. Filip Meysman at the Vrije Universiteit Brussel (VUB, Belgium) and the Royal Netherlands Institute of Sea Research (NIOZ, The Netherlands). These "living batteries" perform a whole new form of microbial respiration and were first discovered at various locations in the North Sea, where they have a strong impact on the functioning of the seafloor ecosystem. The electron-conducting capabilities of the bacteria may lead to novel bio-electrical applications.

A surprise in the seafloor
In 2010, Danish microbiologists at Aarhus University made a fabulous discovery. In laboratory experiments they discovered a new type of bacteria, which can generate electricity and are capable of conducting electrons over long distances. Now, a new study, published in the ISME Journal (a high ranking research journal for microbiology), demonstrates that these bacteria are not a laboratory "curiosum", but are widespread in the marine environment, where they turn the seafloor into a living battery system. 'In field studies in the North Sea, we discovered several locations where these electrogenic bacteria are present, and the sediment geochemistry unequivocally shows that electrical currents occur the seafloor' explains team leader Prof. dr. ir. Filip Meysman 'By subsequently analyzing the DNA and comparing it with genetic archives, we know that the same micro-organisms occur in many different habitats, such as mangrove swamps, underneath fish farms and even in hydrothermal vents in the deep ocean.'

An entirely biological battery
The electrochemical battery was invented Alessandro Volta in the year 1800, and is typically regarded as a masterpiece of human engineering talent. The new study however shows that long filamentous bacteria in the seafloor have mastered the trick a few million years ago. By creating a natural battery, these bacteria have a substantial advantage in the competition for energy-rich metabolic resources. 'These bacteria are 100x thinner than a human hair, and form long winding spaghetti-like strings, consisting of 1000's of cells that pass electrons on to each other' explains dr. Sairah Malkin, lead author of the study. 'By generating electricity, these bacteria can harvest their metabolic energy from the seafloor in an ingenuous way. One side of the filament is buried deep into the seafloor, and is "mining" electrons from energy-rich sulphur compounds. These electrons are subsequently passed on from cell to cell upwards along the filament. Cells located at the sediment-water interface are channeling the electrons to oxygen, which is a favorable electron acceptor. As a result of this, an electrical current runs through the seafloor, from deeper sediments horizons towards the surface. It is known for long that microbes can be used to generate electricity, such as in microbial fuel cells, but this process still requires that we supply the electrodes and connecting wires. Here the process is completely microbial, it's a true natural biological battery."

A new form of life
All living cells require energy, and until now, it has been assumed that the energy supply occurs in the same manner, from bacteria to elephants. The general principle is that every cells looks after its own energy supply. The newly discovered bacteria are now challenging this principle as different cells cooperate to ensure the energy supply of the whole organism. "This mechanism, whereby bacteria are generating electricity and are transporting electrons over centimeter-scale distances, amazes microbiologists.' adds Meysman. 'It completely changes the way we think of how cells can cooperate. It's like having two brothers that cooperate in breathing: one brothers exclusively inhales, while the other brother always exhales. It just shows how inventive biological evolution can be."

Bacterial smartphones
The use of organic materials in electronic engineering is an active field of research, for example, in the development of flexible photo-voltaic panels. However, the creation of efficient electrical conduction in organic materials remains notoriously challenging. "Now we have a microbe from the seafloor that has somehow has evolved the enzymatic machinery to master this trick. If we can find out how our

electrogenic bacteria are achieving this, this clearly offers great opportunities for research into novel bio-electrical materials and applications" explains Meysman "Maybe within some years, our smartphones are equipped with minuscule conducting wires of bacterial origin."

More information about the research team can be found on the project website:
www.microbial-electricity.eu

ORAL, POSTER & DEMO PRESENTATIONS

Utilization of the seagrass *Posidonia oceanica* (L.) Delile to evaluate the spatial and temporal dispersion of metal contamination in the marine protected area of Cape Carbonara, Villasimius, Sardinia (Italy)

Alex Diana[1] and Lieven Bervoets[2]

[1] Organisation Systemic PHysiological and Ecotoxicological REsearch, Boulevard Maurice Lemonnier 94/96, 1000 Brussels, Belgium
E-mail: dianaalex@live.it

[2] Organisation Systemic PHysiological and Ecotoxicological REsearch, Groenenborgerlaan 171/U7, 2020 Antwerpen, Belgium

Metal concentrations (Ag, Al, As, Cd, Cr, Ni, Pb, Zn) were measured in leaves, roots and rhizomes of the endemic Mediterranean seagrass *Posidonia Oceanica* (L.) Delile in the protected area of Cape Carbonara, Villasimius, Sardinia (Italy). Seven sites were sampled to study the influence of different potential contaminant sources. The aim of this work is to provide a method and reference data to monitor metal concentrations of this protected area in the future, to correlate the metal concentrations to the contaminant sources, to identify the plant part-metal selectivity for each metal, and to evaluate the evolution of metal concentration over years via lepidochronological analysis of the rhizomes.

The results showed that metal concentrations in this area are rather similar to the ones observed in other sound Mediterranean sites, confirming the low local pollution. Amongst the sampled sites, Fortezza Vecchia appeared logically as the most contaminated and Cape Boi as the most pristine. The leaves of *Posidonia Oceanica* are significantly selective for Cd, Ni, Pb and Zn while the roots are more selective for Ag and Cr. As for the rhizomes, they tend to be rather selective for Ag. Interestingly, Al, a metal scarcely studied in the literature, displayed no concrete selectivity for any plant part studied.

Over the years, metals concentrations remained rather limited in the different sites studied. Arsenic values showed a decrease along the years and Nickel values increased. The results presented in this study demonstrated the usefulness of the *Posidonia Oceanica*.

Keywords: ecotoxicology; *Posidonia Oceanica*; Mediterranean sea; trace metals; lepidochronological analysis

The different response of the macrobenthic community to different anthropogenic activities on a new limnological ecosystem in Wadi Al Rayan Lower Lake, Western desert of Egypt

Alsebai Mohammed[1], Abdel-Naieem Al-Assiuty[2], Ahmed Abada[3] and Mohamed Khalil[2]

[1] Marine Biology Department, Ghent University, Krijgslaan 281-S8, 9000 Gent, Belgium
E-mail: mohammed.alsebai@ugent.be

[2] Zoology Department, Faculty of Science, Tanta University, Tanta, Egypt

[3] Biology Department, Faculty of Education, Kafer Elsheikh University, Elsheikh, Egypt

Wadi Al Rayan area is located in the western desert of Egypt. In the 1970s, two man-made lakes have been formed from the drainage water of farm lands in the EL-Fayoum Province. Since then the biodiversity of this area had changed completely. Benthic communities have been formed gradually in this new limnological ecosystem. By that time, some anthropogenthic activities also started to develop. The establishment of Fish Farms and Land Reclamation are considered as the two main projects using the benefits of lake water.

Benthic invertebrates considered as an ideal tool to monitor the anthropogenic stress because of their short generation time and their life-type that in close association to the sediment. This study aimed to estimate the difference in colonizationby macrofauna in these new environments by investigating the communities monthly for one year from June 2003 to May 2004.

The statistical results showed that the communities were significantly different in both Fish Farms and the Land Reclamation area. The benthic composition of the two communities was also different. At the same time that the two sites reported almost the same species and the same spices richness, but the dominance of the species composition was significantly different. In the Fish Farm area, five species were abundant while the amphipod *Corophium volutator* was reported as th e most dominant among them. But in the Land Reclamation area only two species were dominant with 94% of the benthic population in the Land Reclamation area existing exclusively of just two species; *Hydrobia sp.* and *Corophium volutator*.

Keywords: macrobenthos; anthorpogenic activities; Egypt

Slow but surely might win the race: diverse phytoplankton communities preserve evenness better in a changing environment

Baert Jan[1], Frederik De Laender[2], Koen Sabbe[3] and Colin R. Janssen[1]

[1] Laboratory of Environmental Toxicology and Aquatic Ecology Environmental Toxicology Unit – GhEnToxLab, Ghent University, Jozef Plateaustraat 22, 9000 Gent, Belgium
E-mail: jan.baert@ugent.be

[2] Research Unit of Environmental and Evolutionary Biology, University of Namur, Rue de Bruxelles 61, 5000 Namur, Belgium

[3] Laboratory of Protistology & Aquatic Ecology, Ghent University, Krijgslaan 281-S8, 9000 Gent, Belgium

The ongoing global biodiversity decline might cause severe changes in marine food webs. Biodiversity increases the temporal stability of primary production through a variety of mechanisms that depend on the increased likelihood that some species can compensate for the functional loss of other species. Strong changes in community composition in response to an environmental change, however, may hamper the ability to stabilize community functions against future changes. More even communities (i.e. small differences in species relative abundances) provide the best insurance against environmental changes as they prevent low initial densities of species with favourable traits. Biodiversity increases the temporal stability of community functions mainly by increasing resistance (i.e. reducing the change in primary production), rather than by increasing resilience (i.e. the speed of recovery). Ecological theory suggests that biodiversity can also increase the resistance of the community composition. More diverse communities are more likely to contain more species that are resistant to environmental changes. Hence, fewer changes in community composition should be required to compensate for the loss of function by sensitive species. Despite the tight link between community composition and the ability to stabilize future environmental changes, the effect of diversity on the resistance and resilience of the community composition has not been empirically tested.

Here, we tested if diversity-dependent compositional changes determine the temporal stability of a community function (productivity) against an environmental stressor. We exposed North Sea diatom communities, spanning 5 levels of species richness (1, 2, 4, 6 and 8 species), to 3 concentrations of a herbicide (0,25 and 250 µg L^{-1} atrazine) for 4 weeks, after which they were transferred to atrazine-free growth medium for 3 more weeks. Productivity and community composition was less affected by atrazine in more diverse communities. After stress removal, less diverse communities recovered faster and approach control communities in both function and composition. Biodiversity thus increased the resistance, but decreased the resilience of the community function and composition. More diverse communities were less resilient because community dynamics were slowed down by the increased amount of species interactions. Because species competitive abilities covaried with the environment, slower dynamics reduced competitive replacement, which increased community evenness in a changing environment. Biodiversity thus not only stabilized productivity against the current environmental changes but also promoted the ability to stabilize future environmental changes.

References

Cardinale, B. J. *et al.* Biodiversity loss and its impact on humanity. *Nature* 486, 59-67 (2012).

Cottingham, K. L., Brown, B. L. & Lennon, J. T. Biodiversity may regulate the temporal variability of ecological systems. *Ecol. Lett.* 4, 72-85 (2001).

Doak, D. F. *et al.* The statistical inevitabiity of stabilitdiveristy relationships in community ecology. *Am. Nat.* 151, 264-276 (1998).

Isbell, F. *et al.* Biodiversity increases the resistance of ecosystem productivity to climate extremes. *Nature* 526, 574-577 (2015).

Ives, A. R. & Carpenter, S. R. Stability and diversity of ecosystems. *Science* 317, 58-62 (2007).

Keywords: phytoplankton; biodiversity; stability; stress

Detection of shipwrecks in ocean colour satellite imagery

Baeye Matthias[1], Rory Quinn[2], Samuel Deleu[3] and Michael Fettweis[1]

[1] OD Natural Environment, Royal Belgian Institute of Natural Sciences, Gulledelle 100, 1200 Brussels, Belgium
E-mail: mbaeye@naturalsciences.be

[2] School of Environmental Sciences, Ulster University, Northern Ireland, United Kingdom

[3] Flemish Hydrography, Coastal Division, Agency for Maritime and Coastal Services, Flemish Ministry of mobility and Public Works, Belgium

Waterborne swath acoustic and airborne laser systems are the main methods used to detect and investigate fully submerged shipwreck sites. In the nearshore, waterborne techniques are compromised as search tools as their effective swath is a function of water depth, necessitating very close survey line spacing in shallow water, increasing cost accordingly. Additionally, in turbid coastal waters bathymetric LiDAR is ineffective as it relies on clear non-turbid water. Therefore, the nearshore turbid zone represents a challenging area for archaeologists in the search for fully submerged archaeological sites. In this study, we describe a new methodology to detect the presence of submerged shipwrecks using ocean colour satellite imagery in turbid waters. We demonstrate that wrecks generate Suspended Particulate Matter (SPM) concentration signals that can be detected by high-resolution ocean colour satellite data such as Landsat-8. Surface SPM plumes extend downstream for up to 4 km from wrecks, with measured concentrations ranging between 15 and 95 mg/l. The overall ratio between the plume and background SPM concentrations is about 1.4. During slack tidal phases sediments in suspension settle to create fluffy mud deposits near the seabed. Scour pits developed around wrecks act as sinks where fine-grained suspended material is preferentially deposited at slacks. The scour pits subsequently act as sources for suspended material when the bottom current increases after slacks. SPM plumes develop immediately before maximum ebb or flood current is reached, during maximum current and immediately after. Particulate matter is suspended in sufficient concentrations to be detected in ocean colour data. The ability to detect submerged shipwrecks from satellite remote sensors is of benefit to archaeological scientists and resource managers interesting in locating wrecks and investigating processes driving their evolution.

Keywords: Landsat-8; suspended sediments; shipwreck detection; bathymetry; scour pits

Photoprotection capacity differs between functional groups of intertidal benthic diatoms: regulation & performance

Blommaert Lander[1], Marie Huysman[2], Alex Barnett[3], Wim Vyverman[1], Johann Lavaud[3] and Koen Sabbe[1]

[1] Universiteit Gent, Krijgslaan 281, 9000 Gent, België
E-mail: lander.blommaert@ugent.be

[2] VIB, Department of Plant Systems Biology, Technologiepark 927, 9052 Gent, België

[3] CNRS/Université de La Rochelle, UMR7266 LIENSs, Institut du Littoral et de l'Environnement, 2 Rue Olympe de Gouges, 17 000 La Rochelle, France

Intertidal marine sediments belong to the most productive ecosystems on earth, despite being characterized by rapidly fluctuating and often extreme light conditions. Its main primary producers are benthic diatoms which possess physiological protection mechanisms against oversaturating light conditions (i.e. 'high light'-HL). Among these mechanisms Non Photochemical Quenching (NPQ) is thought to be the most important one. Its main component (Q_E) is dependent on (1) thylakoid lumen acidification (2) the xanthophyll cycle pigment diatoxanthin, synthetized during thylakoid lumen acidification, and (3) LHCX (Light harvesting complex X) proteins which function as NPQ modulators. Intertidal benthic diatoms consist of two main growth forms. The epipelon comprises larger motile diatoms, which can position themselves along the vertical sediment light gradient, whereas epipsammic diatoms are largely immotile and have to undergo changes in light conditions.

We recently showed that epipelic and epipsammic diatoms show fundamentally different photoprotective responses (Barnett et al. 2015): epipsammic diatoms have higher NPQ and associated xanthophyll cycle capacities compared to epipelic diatoms. In the latter group, the behavioural response (motility) is more important. The regulation and performance of NPQ was studied using model representatives of each functional group during and after exposure to HL (2000 Ymol quanta $m^{-2}s^{-1}$ for 1 h). We observed clear differences in xanthophyll cycle pigment (HPLC) and LHCX protein dynamics (Western blotting) between both representatives. *LHCX* regulation at the transcript level was studied in the epipelic representative *S. robusta* only. All but one *LHCX* genes showed distinct upregulation during HL exposure. Our results indicate that benthic diatoms have an elaborate regulatory network to cope with HL stress, likely due to the harsh light environment of intertidal sediments.

References

Barnett, A. et al., 2015. Growth form defines physiological photoprotective capacity in intertidal benthic diatoms. *The ISME journal*, 9(1), pp.32-45. Available at: http://dx.doi.org/10.1038/ismej.2014.105.

Keywords: diatoms; photoprotection; intertidal sediments

Connectivity and population structure of blacktip reef sharks, *Carcharhinus melanopterus*, in two islands in Terengganu, Malaysia

Borella Lorenzo[1,4], Mark Kochzius[1], Diego Cardenosa[2], Philippe Borsa[3], Mohamed Azmi Ambak[4] and Juanita Joseph[4]

[1] Marine Biology, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium
E-mail: lo.borella@gmail.com

[2] School of Marine and Atmospheric Science & Institute for Ocean Conservation Science, Stony Brook University, Stony Brook, 11794 New York, USA

[3] Institut de Recherche pour le Developpement (IRD), Université Pierre et Marie Curie, Boulevard de Dunkerque 44, CS 90009 13572 Marseille, France

[4] Institute of Oceanography and Environment, Universiti Malaysia Terengganu, Institute of Oceanography and Environment, Universiti Malaysia Terengganu 21030, Kuala Terengganu, Malaysia

In the last decades sharks and their population dynamics are increasingly studied because of their importance for the ecosystems and their high sensitivity to overfishing and anthropological activities, due to their long gestation period, slow reproducing rate, slow growth, and high level of maternal investment (Dulvy et al., 2014).

In this study we investigate the population structure of *Carcharhinus melanopterus* (Quoy & Gaimard, 1824), an ovoviviparous shark of the family Carcharhinidae, which has an important role in the top-down control in coral reef habitats.

The study area is in two islands on the east coast of Peninsular Malaysia: Pulau Redang (Latitude: 5°48'40"N; Longitude: 103°00'20"E), and Pulau Bidong (Latitude: 5°36'40"N; Longitude: 103°03'30"E), that are in a distance of 13.5 km from each other. The objective of the research is two investigate the genetic and haplotype diversity of this species in this area and to understand its worldwide phylogeography. For this purpose, sharks will be caught from the beach using a rod, a tiny tissue sample from the second dorsal fin (<2 cm^2) will be taken and preserved in absolute ethanol, length and weight will be measured using a flexible measuring tape (± 0.1 cm) and a weight scale (± 0.1 kg) and finally, before the shark will be released, a picture of the dorsal fin will be taken on both side of the animal in order to identify each individual.

DNA will be extracted from the tissue samples using a standard phenol-chloroform extraction. According to Keeney et al. (2003), the polymerase chain reaction (PCR) will be performed to amplify a 811 bp long fragment of mtDNA control regions using the two primers Pro-L (proline tRNA; 5'-AGG GRA AGG AGG GTC AAA CT-3') and 282 (12S rRNA; 5'-AAG GCT AGG ACC AAA CCT-3'; J.C. Patton, unpublished data). Both strands will be sequenced and will be read and checked using the programme ABI Sequence Scanner v1.0. The assembly programme CAP3 will be used to edit and align the forward ad reverse sequences.

CLUSTALW as implemented in the software MEGA6 will be used to align the sequences. Haplotype and nucleotide diversity (the indicators used to detect the diversity) will be calculated using ARLEQUIN v.3.5.1 as well as haplotype matrices, haplotype frequency and F_{st} Sequences and F_{st} obtained, will be compared with previous studies made in Red Sea, Australia and French Polynesia (Vignaud et al., 2014) to determine the world-wide phylogeography of the blacktip reef shark.

Carcharhinus melanopterus has been already described as a sedentary species with a high level of site attachment (Mourier and Planes, 2013). Thus, from this research we expect to observe high level of population structure on a global scale, but a low or inexistent genetic structure in the study area due to two reasons: 1) the proximity of the two islands and 2) the low depth in between the two islands (< 30m) that allow movements among the two areas (gene flow).

The importance of this study is to assess the genetic structure of blacktip reef sharks populations, because low gene flow can induce isolation that can enhance the susceptibility of this species to anthropogenic impacts.

References

Dulvy N.K., Fowler S.L., Musick J.A., Cavanagh R.D., Kyne P.M., Harrison L.R., Carlson J.K., Davidson L.N.K., Fordham S.V., Francis M.P., Pollock C.M., Simpfendorfer C.A., Burgess G.H., Carpenter K.E., Compagno L.J.V., Ebert D.A., Gibson C., Heupel M.R., Livingstone S.R., Sanciangco J.C., Stevens J.D., Valenti S. and White W.T. (2014): Extinction risk and conservation of the world's sharks and rays. eLife, 3:e00590.

Mourier J. and Planes S. (2013): Direct genetic evidence for reproductive philopatry and associated fine-scale migations in female balcktip reef shark (*Carcharhinus melanopterus*) in French Polynesia. Molecular Ecology, 22:201-214.

Vignaud T., Mourier J., Maynard J.A., Leblois R., Spaet J.L.Y., Clua E., Neglia V. and Planes S. (2014): Blacktip reef sharks, *Carcharhinus melanopterus*, have high genetic structure and varying demographic histories in their Indo-Pacific range. Molecular Ecology (2014) 23, 5193-5207.

Keywords: population genetics; sharks; Carcharhinus melanopterus; mtDNA; Malaysia; gene flow; phylogeography

A Marine Species Benchmark Dataset for Ecological Modelling

Bosch Samuel[1], Lennert Tyberghein[2] and Olivier De Clerck[1]

[1] Phycology Research Group, Ghent University, Krijgslaan 281-S8, 9000 Ghent, Belgium
E-mail: samuel.bosch@ugent.be

[2] Flanders Marine Institute (VLIZ), Wandelaarkaai 7, 8400 Oostende, Belgium

Species Distribution modelling (SDM) uses machine learning and statistical learning techniques to model ecological niches based on species distribution records and environmental data.. While most algorithms, methods and environmental data used for building SDMs are provided as R packages, ready to use software and data downloads, the species distribution records used in papers featuring new algorithms and methods generally use different datasets. Replication and comparison of SDM experiments are thus made unnecessarily difficult.

The usage of datasets from public repositories like the UCI Machine Learning Repository and the KEEL-dataset repository is a common practice in the machine learning and data mining community. This practice enables researchers to replicate experiments and compare new algorithms and methods with older ones without having to replicate the results of other researchers on their dataset. Usage of datasets from a public repository reduces the amount of tedious “technical work” and greatly eases the comparison of models with published results. So far however, benchmark datasets, are not common practice in ecological and biogeographical studies. For the marine environment a benchmark dataset to evaluate the performance of SDM algorithms is absent all together. The fact that commonly used SDM algorithms and methods were developed using terrestrial case studies only, makes the development of a marine benchmark dataset even more important.

To remedy this problem we compiled a list of marine species suitable for benchmarking SDM algorithms. We selected well studied and well identifiable species from all major taxonomic groups with different range sizes and from different ecoregions. With the above criteria in mind we looked at the availability of public species distribution records from public sources (e.g. OBIS, GBIF, EMODNET, Reef Life Survey) verifying whether sufficient records are available and checking if the distribution of the records didn’t contain significant gaps and errors. Species datasets are linked to environmental data and to biological and ecological properties (traits) enabling refinement of the analytical results by species group, ecology, geography or life history characteristics.

Here we present the first version of Marine SPEcies and Environment Dataset (MarineSPEED v1) containing over 300 species and over three million distribution records. The dataset can serve to evaluate the performance of modelling algorithms aimed at predicting distributions of species under current and future climatic scenarios under a wide array of parameter settings. Here we illustrate the potential of GLASER toward SDM predictor selection and sampling bias correction.

Keywords: sdm; enm; benchmark

Genetic structure of skunk clownfish populations in coral reefs in Madagascar

Bouwens Jan

Marine Biology, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium
E-mail: bouwensjan@hotmail.com

The skunk clownfish, *Amphiprion akallopisos*, is an anemonefish distributed in reef habitats along the shores of the Indian Ocean. They live in groups consisting of a large breeding female, a breeding male and a number of non-breeding, juvenile males associated with an anemone. They are protandrous hermaphrodites. Each pair is monogamous; with the removal of the female, the male changes sex and the largest of the juvenile males develops into a functional male. Eggs sink to the seabed and adhere to the substrate where they are guarded and aerated by the male. Pelagic larvae can disperse dependent on sea current strength and direction, the duration of larval life, swimming behaviour and the mortality rates of the larvae. Widespread, long-range dispersal is difficult to study and therefore there is a general lack of empirical data on larval dispersal in marine environments.

For this study, small pieces of fin tissue from individuals of *A. akallopisos* were collected along the coast of Madagascar. Genetic analysis of the samples was conducted using mitochondrial control region sequences. The genetic information will be used to assess connectivity among populations. These results should improve our knowledge of dispersal patterns between coral reefs and their ecological connectivity. This may contribute to a better planning and management of Marine Protected Area (MPA) networks.

The recovery after disturbance of an population, for example located in a discrete MPA, may depend on larval dispersal from other locations or MPAs. Hence, there is need for studies on larval dispersal and gene flow between populations of coral reef inhabitants.

REVISITED: the soft-bottom benthic habitats of the Belgian Part of the North Sea

Breine Naomi Tafara[1], Annelies De Backer[2], Tom Moens[1], Gert Van Hoey[1] and Kris Hostens[1]

[1] Bio-environmental Research, Aquatic Environment and Quality, Institute for Agricultural and Fisheries Research (ILVO), Ankerstraat 1, 8400 Oostende, Belgium
E-mail: naomi.breine@ilvo.vlaanderen.be

[2] Marine Biology section, Faculty of Science, Biology Department, University of Ghent, Krijgslaan 281 (S8), 9000 Gent, Belgium

The soft-bottom benthic habitat of the Belgian Part of the North Sea (BPNS), has been described by four benthic communities or assemblages in the beginning of the 21st century. So why is a revision needed? Firstly, a proper characterization of the benthic habitat is required to comply with the Marine Strategy Framework Directive (MSFD). This to describe the initial status of the benthic ecosystem, and to assess the future environmental status. Secondly, since these first studies, 10 more years of data is available, and especially the spatial coverage (mainly in the offshore area) has been enlarged. In addition, apart from structural characteristics, functional traits are also taken into account in this study.

For this revisited description, we analyzed a large macrobenthos dataset covering the period 1994 to 2012. Only autumn samples were taken into account to exclude seasonal effects, and all samples sites were located outside known activity areas (e.g. dredge disposal, sand extraction, …) to exclude human disturbance effects (except for fisheries). To investigate the functional characteristics of each habitat, data on functional traits of the benthic species have been collected.

The enlarged data set revealed five benthic assemblages: the *Macoma balthica*, *Abra alba* and *Magelona-Ensis directus* assemblages in the coastal area, and the *Nephtys cirrosa* and *Hesionura elongata* assemblages in the offshore area. Although these assemblages largely correspond to the four assemblages previously described, some interesting new information is noted.

First of all, the coastal *Macoma balthica* and *Abra alba* assemblages remain unchanged. The *Macoma balthica* assemblage is again characterized by the lowest species richness (on average 7 species per 0.1 m^2) and by low densities (on average 580 individuals per m^2). The *Abra alba* assemblage is still the most diverse (on average 26 species per 0.1 m^2). Also the offshore *Nephtys cirrosa* community, in accordance with the earlier studies, is again described by a low species richness (on average 9 species per 0.1 m^{-2}) and very low densities (on average 380 ind. m^{-2}).

On the other hand, two main differences are noted. A new distinct habitat was discerned on the BPNS, described as the *Magelona-Ensis directus* assemblage, which is characterized by a moderate diversity (12 species per 0.1 m^2), and by high densities (on average 2511 ind.m^{-2}). The latter is due to high densities of the alien species *Ensis directus* (American razor clam). Secondly, the offshore *Hesionura* assemblage (corresponding to the former *Ophelia borealis* assemblage) appears to have a much higher species diversity (on average 14 species per 0.1m^2), and also higher densities (on average 780 ind.m^{-3}) than previously registered. This can be explained by the higher sampling effort in the offshore area and the higher identification power of typical interstitial species occurring in the coarse, permeable sands.

In relation to the functional characteristics, the main differences are found between the coastal and offshore assemblages. For example regarding feeding mode, the coastal area is dominated by suspension feeders, while surface deposit feeders dominate the offshore area. Also the mobility types are different, with higher abundance of sessile species in the coastal area as opposed to crawling species in the offshore habitats.

This study reveals that the benthic ecosystem we thought to know quite well, still has some unexpected secrets. First, the habitat typology seems to be more detailed on a fine-scale level than previously described. Secondly, the diversity of some benthic habitats is higher than assumed. And third, although functional characteristics were diverse in all habitats, some clear differences in dominance exist between certain functional traits.

Keywords: macrobenthos; habitats; structural and functional characterization; Belgian Part of the North Sea

Long-distance electron transport by cable bacteria in mangrove sediments

Burdorf Laurine[1], Silvia Hidalgo-Martinez[1], Perran Cook[2] and Filip Meysman[3]

[1] Department of Ecosystem Studies Yerseke, Netherlands Institute for Sea Research, Korringaweg 7, 4401NT Yerseke, Netherlands
E-mail: laurine.burdorf@nioz.nl

[2] Water Studies Centre, School of Chemistry, Monash University, Clayton, VIC 3800, Australia

[3] Department of Analytical, Environmental and Geo-Chemistry, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussel, Belgium

Cable bacteria are long, multicellular, filamentous bacteria that induce long-distance electron transport in sediments. Individual filaments are vertically oriented in the sediment, can be several centimetres long, and can incorporate over 10^4 cells. Cable bacteria have a unique metabolism, referred to as electrogenic sulphur oxidation (e-SOx), which generates an electrical current between distant parts of the bacterial filament. Electrons are harvested from sulphide oxidation in deeper layers of the sediment and are subsequently transported upwards along the longitudinal axis of the filaments. Within the top layer of the sediment, these electrons are finally supplied to a terminal electron acceptor, such as oxygen or nitrate.

The metabolic activity of cable bacteria has a strong imprint on the geochemistry of marine sediments. Concurrent with the development of a cable bacteria community in the sediment, a suboxic zone develops, i.e. a zone devoid of free sulphide and oxygen/nitrate. The spatial segregation of redox half-reactions also leads to a specific pH signature in the pore water of the sediment. This generates a characteristic pH depth profile, consisting of a narrow pH maximum in the top layer of the sediment, and a broad pH minimum deeper in the sediment. By their strong impact on the pore water pH of the sediment, cable bacteria stimulate the cycling of other elements, such as calcium, iron and manganese.

However, cable bacteria have only been recently discovered, and so their geographical distribution and habitat distribution remains largely unknown. Here we report field evidence that cable bacteria are present and active in mangrove sediments. Combining microsensor profiling and fluorescence in situ hybridisation, we recorded high filament densities (77 m cm-2) and the signature of electrogenic sulphur oxidation in sediments of grey mangroves near Melbourne (Australia). Our findings suggest that cable bacteria could be a keystone microbial species in the geochemical cycling of mangroves.

Keywords: mangroves; biogeochemistry; cable bacteria; geomicrobiology

Enhancing the current knowledge on marine biodiversity integration in development cooperation, through a Delphi survey focusing on sub-Saharan Africa

Candido Soraya, Farid Dahdouh-Guebas and Jean Hugé

Vrije Universiteit Brussel, Anemoonstraat 6, 2250 Olen, Belgium
E-mail: soraya.candido@hotmail.com

The rapid and accelerating decline of marine biodiversity leads to a loss of ecosystem functionality and negatively affects the ecosystem services underpinning people's livelihoods all over the world. Ecosystem functions rely on biodiversity to generate processes, such as *e.g.* water quality regulation, that contribute to resilient socio-ecological systems in the face of rapid environmental changes, as highlighted in a range of publications (*e.g.* The Millennium Ecosystem Assessment and The Economics of Ecosystems and Biodiversity).

The links between biodiversity conservation and development are recognized in international policy frameworks, such as the Sustainable Development Goals (SDGs), as well as in the policies of bilateral and multilateral donors who engage in development cooperation with partner countries in the global South. Biodiversity conservation and development cooperation initiatives, which provide the main source of conservation funds in biodiversity-rich areas, would benefit from an effective integration. In the academic literature, there is still a lack of policy-relevant knowledge on the interaction of development cooperation and biodiversity. Recent studies (Miller, 2014; Drutschinin, 2015) emphasize the necessity of global case studies, as well as broader analysis, on development cooperation in relation to biodiversity conservation.

The overall objective of this study is to enhance the current understanding of biodiversity integration in development cooperation by surveying a range of experts (from the donor, NGO and academic communities) through the use of the Delphi technique. The study will focus on the reasons for integrating biodiversity in development cooperation, on the approaches and tools used, on the roles and responsibilities of the various actors and on the expected outcomes and obstacles. The Delphi technique gathers and evaluates expert-based knowledge, in order to identify areas of consensus through a structured, anonymous and iterative survey (consisting of minimum 2 rounds), in which experts are asked to react to a range of questions. The preliminary results of the study are expected in February, 2016 and will be discussed in relation to the literature on biodiversity integration in development cooperation. The overall development objective is to generate policy recommendations. This inter-university research project is embedded in the work of the KLIMOS Research Platform on Climate Change and Development Cooperation.

Keywords: marine biodiversity conservation; development cooperation; sustainable development; delphi

VLIZ Research Infrastructure

Cattrijsse Dre, Karen Rappé, Thanos Gkritzalis, Michiel T'Jampens, Wim Versteeg and Dries Vandewoude

Flanders Marine Institute (VLIZ), Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: andre.cattrijsse@vliz.be

The Research Infrastructure division of the Flanders Marine Institute provides logistical and technical support to marine researchers by ensuring the management, maintenance and operations of the research facilities and equipment. The major infrastructures offered are the research vessel Simon Stevin, the Marine Station Ostend and the unmanned underwater vehicle Genesis.

RV Simon Stevin is deployed for coastal oceanographic research in the Southern Bight of the North Sea and the eastern part of the English Channel. It meets the requirements of the different marine research disciplines in Flanders ranging from physical oceanography, fisheries research, marine biology, microbiology, chemistry, technology and archaeology to earth sciences. The vessel is equipped with standard sampling equipment as well as with high tech instruments. The presence of an ADCP for current measurements and multibeam for bottom characterization and bathymetry, novel biosensors, a dynamic positioning system and a silent diesel-electric drive make the ship one of the most modern of its category. Each year VLIZ invests in the further equipment of the vessel and a vibrocorer has recently been added to the pool of instruments during 2015.

The Marine Station Ostend is housed in former warehouses at the Halve Maan site on the Ostend east bank. In the MSO, multifunctional laboratories , a core repository and workshops are available to marine scientists. It also serves as a depot for research equipment, houses a back-up server for all databases VLIZ maintains as well as a technical workshop for the maintenance of ROV Genesis and other equipment. Seawater holding tanks have been installed in the course of 2015 allowing experimentation with fish or other marine organisms under controlled conditions. MSO can also accommodate large student groups during short term internships performing field exercises or house public activities.

The Remotely Operated Vehicle (ROV) Genesis is deployed worldwide on various foreign research vessels for marine research. The ROV is mainly used for deep-sea research. It provides the opportunity to explore the largely unknown deep-ocean margins and their biodiversity. Genesis is used to film and take samples from deep-sea canyons, cold-water coral reefs, carbonate mounds, mud volcanoes, cold seeps, etc. Recently the RV Simon Stevin has successfully undertaken a first ROV campaign in the Belgian coastal waters. The ROV has received recent refits and technological upgrades to maintain its value as a high tech research tool on an international scale. The operations container and the hydraulic winch system were fully renewed and a full overhaul of the fiber optic data and new cameras and LED-lights will complete the midlife refit of the ROV.

G-tec - Experts in geo-engineering

Coenen Bruno

G-tec, Souverainestraat 58/4, 9800 Deinze, Belgium
E-mail: b.coenen@g-tec.eu

G-tec provides specialized geotechnical engineering services, as well as marine geophysical surveys and marine environmental surveys. In particular, our services are targeted to customers active in dredging, offshore renewable energy, ports & coastal development, infrastructure & civil engineering, pipelines & cables, and mining & quarries.

Up shit creek: new sampling method reveals foraging decisions of a specialised seabird

Courtens Wouter, Eric Stienen, Hilbran Verstraete, Marc Van de walle and Nicolas Vanermen

[1] INBO, Kliniekstraat 25, 1070 Brussels, Belgium
E-mail: wouter.courtens@inbo.be

Sandwich Terns are really picky when it comes to food. In Belgian and Dutch waters, they almost exclusively feed on two fish-groups: Clupeids and Sandeels. But this doesn't mean that by knowing this, their ecology is completely unravelled! If we like to know why for example their chicks are dying or thriving, growing fast or rather slow, we have to conduct long term research. We've been studying their breeding and feeding ecology for the last 15 years and still learn exciting things each year!

The study of the diet of the chicks is relatively straightforward. In a breeding colony, we place a hide and watch the adults feeding their chicks. We write down the species and length of each fish brought to the chicks and do this for several days, at least 8 hours a day... This way, we end up with a pretty good idea of what the chicks have been feeding on.

On the other hand, it's not so easy to study the diet of adult Sandwich Terns (and of most of the other species of seabirds for all that matters). The foraging occurs far out at sea, out of sight except for the most intrepid of observers. As a consequence, not many studies of the adult diet of seabirds are available, especially not in combination with that of their chicks.

Luckily, incubating adult Sandwich Terns have the habit of defecating next to the nest. As a result, after three to four weeks of incubation, a thick crust of faeces has formed around the nest. In there are the remains of all prey eaten in four weeks (mainly otoliths or fish ear bones). This is why we went up shit creek. We collected this faeces crust just before the chicks hatched (end of May) to compare with the chicks diet. Of this, we learned that while the species composition of the chick and adult diets is roughly the same, there is a profound difference between the fish sizes chicks and adults eat. The chicks get the big fishes, while the adults eat the left-overs.

We realised that the scientific problem with combining these two methods is that the samples of chick and adult diets are not taken within the same period of time: the adult sample in May, the samples of the chicks mainly in June. Especially because around the end of May, a shift in the size class of the Clupeids in the North Sea occurs, with bigger fishes becoming more abundant, an innovation to the sampling method was necessary. We had to be able to take long series of consecutive samples of the adult diet during the breeding season. The solution was simple, but took some trial and error. We just had to place clay plates between the nests of incubating adults and empty them every two to three days. Now we had an exact idea of the time-frame of the adults' faeces samples.

We have been using this sampling method for three years now in the Dutch Delta area and learned that after the chicks have hatched, the adults keep on eating small fish and feed the big fish to their chicks. Also, by studying the adult diet in this way, we noticed it gives an indication of prey availability for the chicks and helps us to identify the prey-composition to species level. This way, a small adaptation in sampling method helped to get a better insight in the ecology of this threatened seabird!

Keywords: Sandwich Tern; diet; adult; chick

TROPIMUNDO - Erasmus Mundus Masters Course in Tropical Biodiversity and Ecosystems

Farid Dahdouh-Guebas[1,2], Ludwig Triest[2], Jean-Yves Dubuisson[3], Bernard Riéra[4], Giacomo Santini[5], Julio Ruiz Murrieta[6], François Nguetsop[7], Mohd Lokman Bin Husain[8], Satyanarayana Behara[8] and Ian Tibbetts[9]

[1] Department of Organism Biology, Faculty of Sciences, Université Libre de Bruxelles – ULB, Avenue Franklin D. Roosevelt 50, CPI 264/1, B-1050 Brussels, Belgium
E-mail: fdahdouh@ulb.ac.be

[2] Department of Biology, Faculty of Sciences and Bio-engineering Sciences, Vrije Universiteit Brussel – VUB, Pleinlaan 2, B-1050 Brussels, Belgium

[3] Institut de Systematique, Evolution, Biodiversité, Université Pierre et Marie Curie – UPMC, Place Jussieu 4, Boite 604, 75000 Paris, France

[4] Ecologie et Gestion de la Biodiversité, Muséum National d'Histoire Naturelle – MNHN, Rue Cuvier 57, 75005 Paris, France

[5] Dipartimento di Biologia, Università degli Studi di Firenze – UNIFI, Via Madonna del Piano 6, 50019 Sesto Fiorentino, Italy

[6] Department of Ecology, Universidad Científica del Perú – UCP, Avenida Abelardo Quiñones 2500, 16000 Iquitos, Peru

[7] Department of Plant Biology, Université de Dschang – UDsch, BO Box 96, Dschang, Cameroon

[8] MOE 7th Higher Institution Center of Excellence HICoE in Marine Science, Institut Oceanografi Dan Sekitaran (INOS), Universiti Malaysia Terengganu – UMT, 21030 Kuala Terengganu, Terengganu Darul Iman, Malaysia

[9] Department of Biological Sciences, The University of Queensland – UQ, QLD 4072, St. Lucia (Brisbane), Australia

TROPIMUNDO is an Erasmus Mundus Masters Course in Tropical Biodiversity and Ecosystems funded by the European Commission. It is the first MSc program (2 yrs, 120 ECTS) that integrates the knowledge and skills related to four adjacent interlinked tropical ecosystems under threat (tropical rainforests and woodlands, wetlands, - both terrestrial and coastal such as mangrove forests, seagrass beds and coral reefs). Study of these ecosystems is crucial to understand, protect and manage tropical biodiversity in an era characterised by an international biodiversity crisis with imminent risks of extinction of species due to global warming and anthropogenic impacts such as habitat destruction and changes in land use.

TROPIMUNDO is unique in incorporating a 2nd semester (with theoretical courses and a significant field course) in the tropics in Peru (UCP), Cameroon (UDsch), Malaysia (UMT) or Australia (UQ). Furthermore TROPIMUNDO brings together European expert higher education institutes, with long-standing worldwide expertise in tropical rainforests and woodlands and in coastal ecosystems in Belgium (ULB, VUB), France (UPMC, MNHN) and Italy (UNIFI). They integrate world class scientific education and research expertise on the aforementioned tropical ecosystems and experience in designing and teaching in international MSc programs. The 1st semester primarily aims at teaching basic courses in Europe, whereas the 3rd semester focuses on specialised courses at one of the European partners. The 4th and final semester is dedicated to the thesis, which will be jointly supervised by 3 or 4 partners. Graduates obtain multiple degrees, a joint Europass Diploma Supplement, a Europass Mobility and a Europass Language Passport. TROPIMUNDO's learning outcomes stretch far beyond academic knowledge and insight, but also aim at demonstrating enhanced capabilities in effective analysis and communication, independence, creativity and assertiveness, critical judgement, and ethical and social understanding.

During the two years of the Master program TROPIMUNDO students are able to concentrate on botany, zoology and integrative ecosystem approaches in institutions worldwide. Multiple specialisations are included, such as the evolution of tropical flora and vegetation; faunistic assemblages; informatics tools to treat and manage biodiversity data and databases (biogeographical, genetical, geographical information systems) including the management and conservation of historic collections such as herbarium sheets; the study of diversity, dynamics and evolution of tropical and subtropical ecosystems (with a focus on four related systems, namely tropical rainforests and woodlands, mangrove forests, seagrass beds and coral reefs, including the interactions between flora, fauna, man

and the environment within and between each of these adjacent ecosystems);conservation and restoration ecology of natural habitats and their biodiversity including competences in sustainable management and governance of biodiversity, and finally, in tropical ethnobotany, exploitation and valorisation of the functions, goods and services of natural habitats and their resources, and conservation of traditional ecological knowledge.

TROPIMUNDO maximises the inclusion of European languages by offering a content and language integrated learning program (English or English + French), and it is delivered in a society that is French, English, Dutch, Italian or Spanish-speaking, which is valorised using buddy programs and Tandem Learning. This aims at improving the students' language capabilities for which facilities are provided by all partners.

TROPIMUNDO management is handled by a multi-level and shared responsibility involving 4 decision bodies (Steering, Selection, Internal Evaluation and External Evaluation), and 1 main execution structure (Coordination Office), all operating with equal commitment by the partners. A series of Associated Partners, including scientific institutes, governmental and non-governmental organisations responsible for conservation or management of tropical ecosystems and their biodiversity, and public authorities, agreed to advertise the program, to provide or to communicate existing placements, jobs, internships or thesis perspectives and scholarships, and to assist in evaluating the program. This links TROPIMUNDO to the real and professional world.

References

www.tropimundo.eu

Spatial variation in the concentrations of mercury and persistent organic pollutants in free-ranging bottlenose dolphins from South Florida

Damseaux France[1], Jeremy Kiszka[2], Michael Heithaus[2], George Scholl[3], Gauthier Eppe[3], Jean-Pierre Thomé[4], Jennifer Lewis[5] and Krishna Das[6]

[1] Laboratory of Oceanology, University of Liege (B6c), Allée du 6 Août 11, 4000 Liège, Belgium E-mail: fdamseaux@ulg.ac.be

[2] Marine Sciences Program, Department of biological Sciences, Florida International University, 3000 NE 151st street, North Miami, FL33181, USA

[3] CART, University of Liege (B6c), Allée du 6 Août 11, 4000 Liège, Belgium

[4] Laboratory of Animal Ecology and Ecotoxicology – CART, University of Liege (B6c), Allée du 6 Août 11, 4000 Liège, Belgium

[5] Tropical Dolphin Research Foundation, USA

[6] Laboratory of Oceanology, University of Liege (B6c), Allée du 6 Août 11, 4000 Liège, Belgium

The bottlenose dolphin (*Tursiops truncatus*) is a major apex predator and the most common cetacean species found in nearshore waters of South Florida, including the Lower Florida Keys (LFK) and the Florida Coastal Everglades (FCE). The objective of this study was 1) to assess contamination levels of total mercury (T-Hg) in skin and persistent organic pollutants (PCBs, PBDEs, DDT, HCH, HCB, DLCs and PCDD/Fs) in blubber samples of bottlenose dolphins from the LFK (8 males and 16 females) and from the FCE (13 males and 9 females). Pollutants were analysed by the mean of Direct Mercury analyser (for T-Hg), GC-ECD (POPs) and GC-MS (DLCs and PCDD/Fs). The PCBs were the main compounds found in bottlenose dolphins from the LFK and FCE. The most present congeners where the CB no. 28, 52, 101, 138, 153 and 180 (ΣPCBs LFK males: 13420.5 $ng.g^{-1}$ lipids, ΣPCBs LFK females: 9683.4 $ng.g^{-1}$ lipids, ΣPCBs FCE males: 5637.9 $ng.g^{-1}$ lipids, ΣPCBs FCE females: 1426.9 $ng.g^{-1}$ lipids). PCBs concentrations were significantly higher in individuals from the LFK than those from the FCE but significantly lower than those from other locations in the south-eastern US. Unlike organic pollutants, T-Hg concentrations were significantly higher in FCE male dolphins (LFK: 2936.0 ng.g-1 dw, FCE: 10048.3 ng.g-1 dw). These high concentrations were the highest recorded in the south-eastern US and are most likely due to the presence of mangrove ecosystems. This study highlights the complexity of contaminant dynamics (inorganic vs. organic), even at small spatial scales.
Keywords: Tursiops truncatus; mercury; POPs; Florida

Historical maps of the coastal zone of Flanders

Dauwe Eduard

Ghent University, Bosduivenstraat 4, 8450 Bredene, Belgium
E-mail: eduarddauwe@gmail.com

The Low Countries have a rich history in terms of cartography. Flanders and the Netherlands were leaders in this field after the renaissance in the 15th century, and especially during the 16th and 17th centuries. Van Deventer, Mercator, Ortelius, Blaeu and many others left a heritage of very precise and detailed maps of Flanders and the Netherlands, thanks to their excellent technical and theoretical knowledge.

In this context, a project was developed to digitize and georeference historical maps of the Belgian coastal zone which are part of the collection of the *Cultuurbibliotheek* (Bruges). These maps will be made available for all relevant end users such as (historical) marine researchers who focus on the Flemish coastal region and bordering regions in the Netherlands and France. Maps from the 16th to the 18th century were used.

The goal of this study is plural. The historical maps will be digitally disclosed through *GeoServer*, an open source server for sharing geospatial data. Furthermore, derived products will be created. Multiple maps of the same region, from different times, will be used to create time-lapse movies that demonstrate the (coastal) evolution of that region. Notable regions for this are the nature reserve "Het Zwin", the Scheldt estuary and the region of Ostend. Finally, a web application will be launched where all the aforementioned products will be integrated and disclosed for the public.

Historical maps cannot be used as map layers in GeoServer nor is it possible to create time-lapse movies without first georeferencing them. Georeferencing is the process of positioning a map with respect to a coordinate reference system (CRS), or basically giving it coordinates. The CRS used in this study is WGS84, which is also used by our GPS systems. The historical maps are georeferenced by means of a geographic information system (GIS), namely *QGis*. A background map in the preferred CRS allows to link points on the historical map with the corresponding points in the new CRS. These points can be thought of as pins, at which the historical map is pinned to the background map. They are also called ground control points (GCP's). GCP's are a crucial part of georeferencing. The more GCP's that were used, the more accurate the result.

Next, the georeferenced maps undergo a precision test. This is done in the program *MapAnalyst*. This program generates a distortion grid on the historical map on which the amount of distortion with respect to the background is visualized throughout the map. Furthermore, MapAnalyst generates parameters such as the average standard deviation, the mean positional error, etc. The distortion grid and these parameters will be made available in an information sheet with the relevant metadata.

The maps with a sufficient accuracy are selected for vectorization. In this step, the coastlines of the georeferenced historical maps are carefully redrawn in *QGis*, and saved as vector shapefiles. These files can later be used for further analysis of the coastline.

This project targets different end users ranging from researchers to broad public. The georeferenced maps and corresponding metadata are mainly useful for experts, whereas the scans and time-lapse movies will appeal to a broad audience. Potential users comprise local historians, heritage organizations, museums, provincial visitor centers, coastal municipalities, environmental education, government administrations and scientists in multiple domains.

References

De Maeyer, Ph. (2014). *Cartografie*. Gent: Academia Press.

Jenny, B. and Hurni, L. (2011). Studying cartographic heritage: Analysis and visualization of geometric distortions. *Computers & Graphics*, 35-2, p. 402-411.

Keywords: marine regions; historical maps; GIS; georeferencing; Flanders; coastal zone; GeoServer; cartography; marine research; open source

Long-term trends in the soft bottom benthic fauna of the Belgian part of the North Sea: results of 30 years environmental monitoring

De Backer Annelies, Gert Van Hoey and Kris Hostens

Bio-environmental research group, Aquatic Environment and Quality, Institute for Agricultural and Fisheries Research (ILVO), Ankerstraat 1, 8400 Oostende, Belgium
E-mail: annelies.debacker@ilvo.vlaanderen.be

More than 30 years of environmental monitoring revealed a shift in the coastal macrobenthos community and the offshore demersal fish assemblage of the Belgian part of the North Sea (BPNS) around the year 2004. The shift in the offshore demersal fish assemblage could be related to climate parameters, while the coastal macrobenthic shift was mainly related to physical changes in the benthic habitat.

Since 1984, several locations in the coastal and offshore area of the BPNS have been sampled in autumn on a yearly basis. Three ecosystem components are considered: macrobenthos, epibenthos and demersal fish, the first sampled with a Van Veen grab, the latter two with an 8m- shrimp beam trawl. As the samples are not directly impacted by human activities (except by fisheries), these long-term time series allowed us to study the natural variability over time within the three ecosystem components. For all ecosystem components, a clear differentiation between a coastal and offshore assemblage can be seen. As such, the long-term data allowed us to identify whether the coastal and offshore assemblages changed differently over time per ecosystem component, and whether the three ecosystem components showed similar (or different) trends over time. The observed biological changes were linked to some environmental variables, to investigate whether climate change or physical habitat changes could explain the biological trends over time.

Besides long-term trends at the assemblage level, some trends were apparent at species level as well. Some Lusitanian fish species like lesser weever (*Echiichtys vipera*), solenette (*Buglossidium luteum*), scaldfish (*Arnoglossum laterna*) and sand sole (*Pegusia lascaris*) showed distinct increases since the late 90s, while pouting (*Trisopterus luscus*showed a steep decline over time, which was correlated to the NAO index. The benthic bivalves *Abra alba* and *Kurtiella bidentata*, together with the ophiuroid *Ophiura ophiura* increased significantly since 2004 and this was related to an increase of finer sediments in the coastal area. *Spisula subtruncata*, was the only benthic species that decreased strongly over time in the coastal area.

Keywords: time series; macrobenthos; epibenthos, demersal fish; long-term trends; Belgian part of the North Sea

HPLC-pigment fingerprinting for long-term monitoring of coastal phytoplankton

De Blok Reinhoud[1], Anja Nohe[1], Lennert Tyberghein[2], Klaas Deneudt[2], Jonas Mortelmans[2], Thanos Gkritzalis[2], Koen Sabbe Koen[1] and Wim Vyverman[1]

[1] Laboratory of Protistology & Aquatic Ecology, Department of Biology, Ghent University, Krijgslaan 281-S8, 9000 Ghent, Belgium
E-mail: Reinhoud.deblok@ugent.be

[2] Flanders Marine Institute (VLIZ), Wandelaarkaai 7, 8400 Oostende, Belgium

In many regions worldwide, fluxes of nutrients, organic matter and sediment to coastal seas have been strongly altered as a result of climate and land use change, altering resource availability and growing conditions for coastal plankton. In particular, the increasing frequency of blooms of nuisance or toxic algae has been associated with these profound changes in coastal environments. Long-term data of phytoplankton dynamics in the Belgian Continental Zone (BCZ) are scarcely published and are limited for offshore stations (Breton *et al.* 2006). However, based on available data it appears that the typical phytoplankton succession starts with a spring diatom bloom, which is followed by a bloom of the nuisance prymnesiophyte *Phaeocystis globosa* after depletion of bioavailable silica.

This study aims to obtain a better understanding of the temporal and spatial changes in the annual phytoplankton blooms in the BCZ using HPLC pigment profiling, which provides information on the taxonomic structure of the phytoplankton community. From 2002 until present, nine stations in the BCZ have been sampled on a monthly basis during routine monitoring campaigns by two research vessels, the Zeeleeuw and Simon Stevin. At each station, seawater was filtered over a 0,4 µm glass fiber filter which was kept frozen at -80 ˚C until analysis. Samples were analyzed using a Gilson HPLC system for marker pigments of key phytoplankton groups: fucoxanthin (diatoms), peridinin (dinoflagellates), zeaxanthin (cyanobacteria, chlorophytes) and chlorophyll b (cyanobacteria, chlorophytes and euglenophytes). Using published pigment ratios of the phytoplankton groups, the relative contribution of each group to the total phytoplankton biomass was estimated using the CHEMTAX software.

First analyses showed large interannual fluctuations in peak bloom abundance and distinct differences in bloom timing and magnitude along onshore-offshore and west-east gradients. However, a consistent pattern of a spring diatom bloom was observed, followed by a bloom of *P. globosa*. Furthermore, a significant but relatively small contribution of photosynthetic picoplankton was found, while dinoflagellate blooms occurred only sporadically. Combining this long-term data on phytoplankton composition with information on abiotic factors will improve our understanding of phytoplankton bloom dynamics and the key drivers underlying them. HPLC pigment fingerprinting provides a powerful, time-effective approach to quantify phytoplankton groups in a large number of samples.

References

Breton, E., Rousseau, V., Parent, J.Y., Ozer, J. and Lancelot, C., 2006. Hydroclimatic modulation of diatom/Phaeocystis blooms in nutrient-enriched Belgian coastal waters (North Sea). *Limnology and Oceanography*, *51* (3), pp.1401-1409.

Keywords: HPLC; pigment-fingerprinting; coastal; Belgian Continental Zone; phytoplankton; CHEMTAX

Reproductive barriers in the diatom *Seminavis robusta* species complex and their role in species diversification

De Decker Sam, Koen Van den Berge, Pieter Vanormelingen, Koen Sabbe en Wim Vyverman

Research group of Protistology & Aquatic Ecology (PAE), Department of Biology, Ghent University, Krijgslaan 281/S8, 9000 Gent, Belgium
E-mail: Sam.DeDecker@UGent.be

Despite their enormous diversity and ecological importance, the understanding of diatom speciation is largely uncharted territory. Several studies showed a large cryptic species diversity in microalgae, with a large variety of reproductive systems in some species complexes. Since sexual reproduction is an obligate stage in the life cycle of most diatoms, their evolutionary success may be related to this widespread variation in reproductive systems and rapid evolution of their highly sophisticated signalling systems involved in mating. In this study, we collected a set of *Seminavis robusta* strains from the Veerse Meer and the Grevelingenmeer (the Netherlands) and the spuikom (Belgium).

Phylogenetic analysis based on *rbc*L and LSU rDNA sequences shows that these strains form three distinct cryptic lineages. Sexual reproduction can be induced with high efficiency in intra-group crosses, while inter-group mating successes drop as much as 70%. Interestingly, phylogenetic distance correlates with interbreeding capacity between mating group. This represents an interesting case in which we can dissect the contribution of different possible pre- and post-zygotic reproductive barriers between these recently diverged diatom species. We here focus on the identification of possible pre-zygotic isolating mechanisms, exploiting recent insights into the signalling mechanisms prior to mating in *S. robusta*. These include the production of a conditioning factor by both mating types which induce cell cycle arrest in the opposing mating type and the subsequent production of the pheromone L-diproline by mating type minus cells that attract mating type plus cells. Combinatorial bio-assay experiments were set up with strains of both mating types from the three mating groups.

The receptivity to conditioning factor was monitored by following cell cycle progression, while additionally for mating type minus strains the subsequent production of attraction pheromone L-diproline was measured. The role of these pre-zygotic barriers to interspecies crossing in maintaining species boundaries will be discussed.

Keywords: diatoms; speciation

JPI Oceans pilot action: Ecological aspects of deep-sea mining

De Moor Willem[1], John Hanus[1], Kristin Hamann[2] and Matthias Haeckel[2]

[1] JPI Oceans, Troonstraat 130, 1050 Brussels, Belgium
E-mail: willem.demoor@jpi-oceans.eu

[2] GEOMAR Helmholtz Centre for Ocean Research Kiel, Wischhofstraße 1-3, 24148 Kiel, Germany

The Joint Programming Initiative Healthy and Productive Seas and Oceans (JPI Oceans) is a coordinating and integrating platform for marine and maritime research and innovation, open to all EU Member States and Associated Countries. In 2013 the JPI Oceans Member Country representatives decided to launch a pilot action to study the long-term ecological effects of deep-sea mining. To realise this aim, the German Federal Ministry of Education and Research (BMBF) offered 118 days of on-site research on the recently inaugurated RV Sonne for two cruises in the Pacific. A group of international scientists under the lead of Matthias Haeckel (GEOMAR) and Pedro Martinez (German Centre for Marine Biodiversity Research / Senckenberg institute) subsequently developed a common scientific proposal for these cruises. For Belgium the Marine Biology Research Group of University of Gent and the Royal Belgian Institute of Natural Sciences are part of the research consortium.

The project started in January 2015 and will run for 36 months with an overall budget of approximately €9.5m. Over the course of the first cruise researchers visited various claims of European Countries in the Clarion-Clipperton Zone (CCZ). The second campaign visited the area off the coast of Peru at which German scientists in 1989 conducted the DISturbance and re-Colonization Experiment (DISCOL) to simulate and investigate the environmental impact of nodule mining. Researchers from eleven countries mapped habitats, studied deep sea ecosystems and investigated their functioning in addition to predicting and identifying the environmental implications of nodule and sediment removal, sediment plume dispersion and redeposition caused by mining activities. Following the cruises which were finalised in October 2015, scientists are evaluating the collected data on-shore in the participating institutes.

Preliminary results of the cruise show that the plough marks in the DISCOL area have hardly changed. Very little recolonization, low bioturbation and microbial activity was observed, implying that nodule mining will likely disturb the deepsea ecosystem for many decades. Numerous seamounts were also detected in the deep sea which may make it difficult to mine on large continuous areas. Finally, the cruise has proven that the technology to conduct Environmental Impact Assessments and monitoring is available.

As a next step scientific data analyses will be targeted towards formulating recommendations for deep-sea nodule mining. In addition workshops with policymakers, stakeholders, contractors holding exploration licenses and interested industry planning offshore mining activities will be organised to communicate the project results. Scientific data and results will be stored in public world-wide databases and will also be made available to the Legal and Technical Commission of the International Seabed Authority (ISA) to facilitate implementation into regulations.

Keywords: deep-sea mining; Clarion-Clipperton Zone; Mn-nodules

Connectivity of *Amphiprion akallopisos* (Skunk Clownfish) in the coral reefs of Zanzibar

De Poorter Isabel, Filip Huyghe and Marc Kochzius

Marine Biology, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium
E-mail: depoorterisabel@gmail.com

Coral reefs form an important and diverse environment for many different marine species. Fish, algae and many invertebrates, such as crustaceans and sponges, inhabit these patchy ecosystems. Over the past few decades, environmental and human induced factors, such as pollution and global warming, have severely decreased the global coral reef quality and quantity. Healthy coral reefs are declining, with already 30 % completely deteriorated or even vanished worldwide. The reefs are also heavily overexploited by economic activities like fisheries and tourism. This poses a great threat to the future of these highly diverse ecosystems and all the organisms that inhabit them. Certain protective measures have already been developed, mainly in the form of Marine Protected Areas (MPAs) which attempt to restrict human impact. These no-take zones or other forms of MPAs should help maintaining the biodiversity of the coral reefs by protecting certain reef-species that are vulnerable to fishing or otherwise suffer from human impact. However, in order to construct effective MPA networks, it is important to space these areas correctly. This could be achieved by having a greater understanding of gene flow among populations. In this study, the connectivity between populations of *Amphiprion akallopisos* in six coral reefs at the West coast of Unguja Island (Zanzibar), situated in the Western Indian Ocean, will be investigated with the use of several microsatellite loci as genetic markers. *A. akallopisos* is a poor swimmer and cannot migrate out of its natal reef. Its dispersal therefore depends on a short pelagic larval stage. These larvae cannot usually bridge very large distances. Recently, it was demonstrated that there is highly limited connectivity between the populations of *A. akallopisos* in the Western and Eastern Indian Ocean. On a smaller scale however, like the coral reefs of Zanzibar, it is more likely that connectivity will be higher.

There is only one MPA at the whole west Coast of the Island of Unguja (Chumbe Coral Park). As a baseline, to be able to preserve the full extent of genetic diversity around Unguja Island, this MPA should therefore be connected with other reefs through historic gene flow and genetic breaks should be absent. We use microsatellite markers because these loci of repetitive DNA are often highly polymorphic and abundant in the genome of most organisms. Because of the generally high mutation-rate of these markers, it is possible to estimate the genetic distance between populations or individuals and thus assess gene flow between them even if genetic differentiation is small. From each of the six reefs, 24 small tissue samples of *A. akallopisos* were collected in the form of fin clips while scuba-diving and preserved in 96% ethanol. After incubation of every sample, DNA extraction will be performed using an extraction kit provided by QIAGEN. These DNA-extracts will be amplified using multiplex PCR with four different fluorescent labels, applied to two sets of eight primers each. Length analysis will be performed on these loci and this data will be used in population genetic analysis using Genalex, Arlequin, and Structure.

The aim of our study is to establish whether the reefs along the West coast of Unguja are one panmictic meta-population or if a genetic break is present on such a short geographic scale. This will provide baseline information on the design of MPAs near Unguja that will later be complemented by parentage analysis and self-recruitment estimation to establish the effectiveness of current MPA design on a shorter timescale. Understanding connectivity among these reefs and how the pelagic larvae disperse, will result in a better spacing of MPAs and therefore a better protection and management of these endangered coral reefs

Algal and toxicant dispersal are key factors for maintaining biovolume production in diatom communities affected by a toxic stressor

De Raedt Jonathan[1], Frederik De Laender[2], Jan Baert[1] and Colin R. Janssen[1]

[1] Laboratory of Environmental Toxicology and Aquatic Ecology Environmental Toxicology Unit – GhEnToxLab, Ghent University, J. Plateaustraat 22, 9000 Gent, Belgium
E-mail: jonathan.deraedt@ugent.be

[2] Research Unit in Environmental and Evolutionary Biology, University of Namur, Rue de Bruxelles 61, 5000 Namur, Belgium

According to UNESCO, 50% of the marine wildlife may be on the brink of extinction at the end of this century. Stressors, such as climate change and chemical pollutants, are important drivers of this ongoing diversity loss. However, these stressors may not be the only factor affecting community composition as new species can be introduced from the surrounding communities (which is called biota dispersal). Additionally, environmental conditions can also change as pollutants are diluted in neighboring communities. Here, we examined how biota and stressor (the photosystem II-inhibitor atrazine) dispersal affected community composition when connecting a non-stressed and stressed community. To do so, we performed a microcosm experiment using 6 marine diatoms, initially added at equal densities to both communities. A full-factorial design with 5 biota dispersal levels and 4 stressor dispersal levels was applied. Dispersal was simulated by pipetting the right amount of algae/medium from one community to the other.

Community dynamics were mainly determined by 2 species: the fast growing and stress tolerant species *Asterionellopsis* sp., and the strongest competitor, but less stress tolerant species *Navicula* sp. *Asterionellopsis* sp. was the first to dominate the non-stressed community, thus decreasing diversity. Next, *Navicula* sp. started excluding *Asterionellopsis* sp., leading to an initial increase and a subsequent decrease of diversity. In the stressed community, the stress tolerant *Asterionellopsis* sp. grew fastest, decreasing diversity. Biota dispersal had no effect on diversity in the non-stressed community. In contrast, the effect of stressor dispersal changed over time, being negative first and positive at the end. This effect was caused by the suppression of the competitive dominant *Navicula* sp. Both biota and stressor dispersal had important effects on diversity and productivity in the stressed community. Because of the high input of *Asterionellopsis* sp., this species reached high abundances quickly. Consequently, diversity was lower and total biovolume higher than in the non-dispersed treatments. Moreover, the dilution of the toxicant resulted in faster growth rates of the stress-tolerant species, decreasing diversity and increasing total biovolume even more.

We conclude that

- dynamics in the non-stressed communities were mainly determined by local processes (i.e. competition);
- dynamics in the stressed communities were mainly determined by stressor effects and regional processes (i.e. dispersal);
- biovolume in the stressed community was maintained by the input of a stress tolerant species from the unaffected community, and the dilution of the toxic stressor.

Keywords: toxicant; diatom communities; dispersal

Allelopathy in algal bloom formation? A (allelo)pathetic story…

De Rijcke Maarten, Jan Baert, Karel De Schamphelaere and Colin R. Janssen

Laboratory of Environmental Toxicology and Aquatic Ecology, Environmental Toxicology Unit (GhEnToxLab), Ghent University, J. Plateaustraat 22, 9000 Ghent, Belgium
E-mail: maarten.derijcke@ugent.be

In its broadest sense, this research aims to assess the present and future risk for harmful algal bloom (HAB) development in Belgian coastal waters. Throughout the last century, these types of events have gradually spread across the globe and have dramatically increased in size, frequency and severity. The hypoxia, physical disturbance, food-web disruption and marine toxins associated with these events can lead to mass mortalities of marine life at all trophic levels. Never before has such an abundance of toxic species and algal toxins caused this much food-web disruption, biodiversity loss and economic costs. Worryingly, these events are predicted to become even more prevalent as climate change starts to take hold. Despite well over 50 years of research into bloom dynamics of harmful algae, the abiotic conditions and biotic interactions leading upto a full scale harmful algal bloom are not fully understood. Understanding these processes is, however, paramount to improve the prediction, mitigation and management of the risks HABs pose to both human health and the coastal environment.

Toxic phytoplankton has been shown to suppress the growth or performance of other benign phytoplankton species. This process is referred to as allelopathy and allelochemicals are a prevalent property of many HAB species. Yet, to date, not a single experimental study has demonstrated the importance of these interactions for the succesful development of a bloom. Here, two toxic species - *Alexandrium minutum* and *Protoceratium reticulatum* - were made to compete with a non-toxic species *Prorocentrum micans* for nutrients and overall community dominance. Algal cultures of all conceivable combinations were made in which each of the three species were added at initial densities of 0, 10 or 100 cells.ml^{-1}. Anthropogenic influences were simulated by varying the N:P ratio (8 and 14) and the inclusion of an IPCC's worst case climate change scenario (20 and 24°C). Each treatment was replicated three times. Algal densities were determined twice a week over an exposure period of 68 days.

Allelopathic interactions were ultimately not needed to fit the outcomes of our experiments. Using a resource-utilization model, differences in resource assimilation rates alone could accurately predict the interspecific competition. The non-toxic dinoflagellate *Prorocentrum micans* was found to be a very strong competitor - often dominating the overall phytoplankton community despite an initial numerical disadvantage. The initial starting densities could, however, inverse the outcome of competition between *A. minutum*, which has a slower nitrogen assimilation rate, and *P. micans*. *Protoceratium reticulatum* was a poor competitor but is known to bloom occasionally. This may indicate that other biotic parameters, such as grazing deterence, may play a more important role in the succesful development of HABs (experiments on-going). Despite its effect on growth rates, an increased temperature was not was not found to determine the outcome of the experiment as identical patterns were found for across all temperature and nutrient conditions.

Keywords: harmful algal blooms; allelopathy; competition

Development of a triad assessment method for brackish sediments in Flanders

De Schamphelaere Kristine[1], Lieven Bervoets[2], Johnny Teuchies[2], Tom Ysebaert[3], Patrick Meire[4] and Ronny Blust[2]

[1] Ecosystem Management - Systemic Physiological and Ecotoxicological, Department of Biology, University of Antwerp, Universiteitsplein 1, 2610 Wilrijk, Belgium
E-mail: kristine.deschamphelaere@uantwerpen.be

[2] Systemic Physiological and Ecotoxicological Research, Department of Biology, University of Antwerp, Groenenborgerlaan 171, 2020 Antwerpen, Belgium

[3] IMARES Wageningen, Institute for Marine Resources and Ecosystem Studies, Korringaweg 5, 4401 NT Yerseke, The Netherlands

[4] Ecosystem Management, Department of Biology, University of Antwerp, Universiteitsplein 1, 2610 Wilrijk, Belgium

In sediment risk assessment, analysis of the pollutant concentrations is essential in determining the degree and nature of sediment contamination. However, chemical analyses provide no evidence of biological effects as, for example, mixture effects are not accounted for. Bioassays provide valuable information on the toxicity effects of sediments, but are carried out under lab conditions and are limited to the testing of a few organisms. An evaluation of the benthic community structure can provide evidence of effects in situ. The sediment quality triad method incorporates measures of various chemical parameters, toxicological effects and benthic community structure in view of conducting an integrated assessment of sediment quality.

In the framework of developing a triad assessment method for the quality evaluation of brackish sediments, 28 sediment samples were taken along the Scheldt estuary (Sea Scheldt (Flanders) and Western Scheldt (the Netherlands)) and other brackish aquatic systems in Flanders. For these samples, chemical parameters (e.g. metals and organic pollutants), toxicological effects and benthic community structure are being assessed.

In this study, two sediment contact bioassays and a pore water bioassay are carried out to test their suitability for uptake in a quality triad method for brackish sediments as indicator of ecotoxicological effects. A 28-day sediment contact bioassay with the polychaete worm *Hediste diversicolor* is performed on a selection of the samples, with growth and mortality being evaluated. A 10-day sediment contact bioassay with the amphipod *Corophium volutator* and a 24h pore water test with the rotifer *Brachionus plicatilis*, evaluating mortality, are carried out on all the samples.

Based on a literature inventory of existing sediment quality standards for brackish waters and on analysis of the ecotoxicological and biological effects of sediment pollutant concentrations, quality guidelines for chemical parameters for Flemish brackish sediments are derived.

For the biological component of the triad method, comprising an evaluation of the benthic invertebrate community, a separate evaluation method is developed for brackish oligohaline more static water systems, and for brackish sediments in the different ecotopes of the Scheldt estuary. For the former a multimetric index is developed based on Stoddart et al.(2008), while the M-ABMI ('Multivariate AMBI') is tested as biological component in a triad method for the evaluation of brackish sediments in Flanders.

Keywords: sediment quality triad method, benthic invertebrate assessment, brackish and estuarine aquatic systems, sediment bioassays

Getting trapped: *Lanice conchilega* structures carbon flows in soft-bottom intertidal areas

De Smet Bart[1], Dick Van Oevelen[2], Magda Vincx[1], Jan Vanaverbeke[3] and Karline Soetaert[2]

[1] Department of Biology, Marine Biology Section, Ghent University, Krijgslaan 281/S8, 9000 Ghent, Belgium
E-mail: badsmet.desmet@ugent.be

[2] Department of Ecosystem Studies, Royal Netherlands Institute of Sea Research (NIOZ), Korringaweg 7, 4400 AC Yerseke, The Netherlands

[3] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment (OD Nature), Gulledelle 100, 1200 Brussels, Belgium

Biogenic reefs constructed by the tube-building ecosystem engineer *Lanice conchilega* (Terrebilidae, Polychaeta) have profound structuring impacts on the benthic environment by altering the biogeochemical and physical properties of the sediment. Their role in food web dynamics of soft-bottom intertidal areas is less well studied and hitherto considered to be rather limited. Besides, whereas previous studies looked at qualitative aspects, another important aspect of food web research comprises the quantification of food web flows, which yields a more realistic approximation of complex food webs. Therefore, this study provides new insights in the functioning of *L. conchilega* reefs in intertidal sediments by quantifying the carbon flows in the food webs in the presence and absence of the tubeworm using linear inverse models (LIMs).

The inverse food web models were based on an empirical dataset from two study sites and two time periods, consisting of biomass and stable isotope data, and general physiological constraints from the literature. The carbon input into reef food webs (191 ± 50 mmol C m^{-2} d^{-1}) is about 40 times higher compared to bare sand areas (5 ± 2 mmol C m^{-2} d^{-1}) and is mainly derived from organic matter (OM) in the water column. Most of the OM input towards these reefs is consumed by suspension feeding macrofauna, particularly *L. conchilega* itself. However, the worm is not an important source of carbon for other macrofaunal organisms and hence provides only a facilitating role. The ratio of OM input to primary production indicates that the OM needs to be produced in an area at least 15 times larger than the reef itself, demonstrating significant OM 'focussing' within the reef food web. In conclusion, the reef structures created by *L. conchilega* act as a trap of OM, resulting in overall high macrofaunal biomass in the presence of the tubeworm, and much more diverse food webs.

Keywords: linear inverse model; biogenic habitat food web; network analysis; stable isotopes; Lanice conchilega; ecosystem engineering

Food for bacteria: a plastic exposure trial at sea

De Tender Caroline[1], Lisa Devriese[1], Sara Maes[1], Kevin Vanhalst[1], Tim De Bock[1], Jürgen Vangeyte[1], André Cattrijsse[2], Johan Robbens[1] and Peter Dawyndt[2]

[1] Insitute of Agriculture and Fisheries Research (ILVO), Burgemeester Van Gansberghelaan 92, 9820 Merelbeke, Belgium
E-mail: caroline.detender@ilvo.vlaanderen.be

[2] Flanders Marine Institute (VLIZ), Wandelaarkaai 7, 8400 Oostende, Belgium

[3] Ghent University, Krijgslaan 281S9, 9000 Ghent, Belgium

Recently we showed that plastic items form a distinct marine habitat for bacteria (De Tender et al., 2015). We observed that the structure of these plastic-related bacterial communities are correlated with environmental factors and the plastic characteristics. Even the stage of colonization could play a role in the colonization process. To understand these processes better, we constructed an exposure experiment at sea. This however, turned out to be a bigger challenge then we thought.

Within the experiment, fifteen constructions were placed at two different locations in the North Sea: the harbour of Ostend and offshore at the Thorton Bank. Once a month one of the constructions is sampled, to observe the evolution in the microbial colonization pattern. Each construction consists of two different types of polyethylene plastic (dolly rope and plastic sheet) to observe differences in bacterial colonization between those two main plastic litter types. The two locations were chosen to look at differences in bacterial communities due to environmental factors.

We expect that after a few months, a stable community on the plastic will be formed, which can maintain on the plastic. This community will be studied by using whole-genome shotgun sequencing (WGS). Using WGS, we are able to look at the taxonomy of all organisms present on the plastic (e.g. bacteria, fungi, eukaryotes,...). Additionally the technique also provides information on the functions of these organisms within the community. Therefore, we hope to detect some bacteria or other micro-organisms, which are able to act in a plastic biodegradation process. And hopefully, those biodegrading micro-organisms could be the solvers of all our plastic litter in sea!

References

De Tender C.A., Devriese, L.I., Haegeman, A., Maes, S., Ruttink, T., Dawyndt, P. (2015) Bacterial community profiling of plastic litter in the Belgian part of the North Sea. Environmental Science and Technology 49, 9629-9638.

Keywords: plastic litter; sequencing; micro-organisms

The LifeWatch infrastructure (demo through poster series)

Dekeyzer Stefanie, Klaas Deneudt, Leen Vandepitte, Annelies Goffin, Simon Claus and Francisco Hernandez

[1] Flanders Marine Institute (VLIZ), Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: stefanie.dekeyzer@vliz.be

LifeWatch was established as part of the European Strategy Forum on Research Infrastructure (ESFRI) and can be seen as a virtual laboratory for biodiversity research primarily, but also for climatological and environmental impact studies, to support the development of ecosystem services, and to provide information for policy makers in Europe. This large European research infrastructure consists of several biodiversity observatories, databases, web services and modelling tools, distributed across Europe, but virtually connected. The LifeWatch e-infrastructure integrates the existing systems, upgrades them were possible and develops new systems where needed.

The LifeWatch Marine Virtual Research Environment (VRE) is a product of LifeWatch that was created based on discussions and developments during a number of LifeWatch meetings in 2014. The LifeWatch Marine VRE portal aims to aggregate some highly relevant marine resources, data systems, web services, online tools, etc. into one environment in the context of LifeWatch. The portal can be considered as a first bottom-up development demonstrating potential and capability emulating the LifeWatch objectives. The integration and interaction between the different components will increase in future versions of the portal. The portal will be updated in the framework of upcoming LifeWatch and H2020 VRE developments. The portal is organized into three interlinked sections: Access, Analyze and Develop.

Belgium contributes to LifeWatch with varied and complementary “in-kind” contributions. These are implemented under the form of long lasting projects by different research centers and universities spread over the country and supported by each respective political authority.

The Flemish LifeWatch partners (Flanders Marine Institute (VLIZ), and Research Institute for Nature and Forest (INBO)) are providing facilitated access to regional and global biodiversity data bases and data systems, through several data services, data publication, data archology activities and the construction of a local marine-freshwater-terrestrial observatory. Furthermore, a central Taxonomic Backbone will bring together taxonomic, biogeographic, trait and genomic data and disseminate this information through web services.

The Walloon LifeWatch partners (Earth and Life Institute of the Université catholique de Louvain, and the Biosystems Engineering Department of the Université; de Liège/Gembloux-ABT) are setting up a Belgian ecotopes database to integrate geographic datasets about European biotic and abiotic factors. Furthermore, ecosystem dynamic descriptors are being monitored. For this purpose a geoportal was launched, where information of ecosystem dynamics (vegetation cycle, snow indices, solar energy and fire indices) can be viewed and downloaded.

The federal authority supports the Royal Belgian Institute of Natural Sciences (RBINS) to develop an Antarctic Biodiversity Information System (AntaBIS) as a LifeWatch virtual laboratory. A second project under the guidance of RBINS and in collaboration with the Royal Museum for Central Africa (RMCA) is the development of a Barcoding facility for Organisms and tissues of Policy Concern (BOPCo). The federal authority also supports the Belgian Biodiversity Platform to set up and animate a LifeWatch scientific node.

During the VLIZ Marine Scientist Day 2016, the (Belgian) LifeWatch infrastructure will be presented through an informative poster series, and through three interactive demo sessions:

- The fish acoustic receiver network (Reubens *et al.*)
- Marine data archeology: a heritage for future science (Goffin *et al.*)
- Building an online and interactive scientific data explorer for Lifewatch observatory data (Deneudt *et al.*)

Where does my jellyfish come from?

Dekker Evelien[1], Valérie Dulière[2] and Geneviève Lacroix[2]

[1] Marine Sciences, Faculty of Geosciences, Utrecht University, Warande 70, 3705 ZE, Zeist, The Netherlands
E-mail: evelien_njn@hotmail.com

[2] Royal Belgian Institute of Natural Sciences, Gulledelle 100, 1200 Brussels, Belgium

The globally observed increase in jellyfish is a major concern due to the negative impacts on commercial activities (such as aquaculture and tourism) and their potential to disturb the trophic balance in marine ecosystems. In order to predict when and where massive jellyfish concentrations could develop, a better understanding of their population dynamics and dispersal is required. In 2013, a mass stranding of jellyfish occurred at the beaches of Belgium and The Netherlands. In order to learn more about the spreading of jellyfish, the OSERIT drift model was expanded to test several types of vertical swimming behaviours. Comparison of the back-calculated trajectories and field observations on polyps will help to further understand the role of swimming behaviour on spreading of jellyfish.

Keywords: jellyfish; spreading modelling; polyps

Towards an understanding of the cytological diversity of green seaweeds (*Ulvophyceae*)

Del Cortona Andrea

Gent University, Krijgslaan 281 S8, 9000 Gent, Belgium
E-mail: andrea.delcortona@ugent.be

In coastal environments green seaweeds (Ulvophyceae) are extremely successful from an evolutionary as well as an ecological perspective. The diversity of morphologies and cytologies they display is remarkable. Morphological types range from unicells and simple filaments to sheet-like and complex corticated thalli. Cytological layouts range from typical small cells containing a single nucleus to giant cells containing millions of nuclei. This cytomorphological differentiation most likely coincided with profound changes in their genomes which reflects in the use of different translation factors, an altered genetic code as well as accelerated evolution of the ribosomal DNA. In order to understand how the evolution of these morphological and cytological types links to genomic changes we combine whole genome sequencing (*Ulva*) with transcriptomics of selected green seaweeds (*Acetabularia*, *Blastophysa*, *Bryopsis*, *Boodlea*, *Caulerpa*) and unicellular Ulvophyceae. Here, as a first step we evaluate the efficiency of *de novo* assembly of transcriptomes. Thereto, we use a reference dataset of *Chlamydomonas*, the closest relative to the Ulvophyceae for which a complete whole genome sequence is available. We analyze the generated data with state-of-the-art methods for comparative genomics and transcriptomics; moreover, we implement the data in the online infrastructure pico-PLAZA (http://bioinformatics.psb.ugent.be/pico-plaza/) that integrates information generated by green algal sequencing initiatives and advanced tools for data mining.

Keywords: Ulvophyceae; morphology; evolution; transcriptomics

Tracing sole juveniles arriving at the Belgian nursery using genomics and otolith shape

Delerue-Ricard Sophie[1,2], Léo Barbut[1,3], Andreas Vanden Bavière[1,2], Ilaria Coscia[1], Johan Robbens[2], Geneviève Lacroix[3] and Filip A.M. Volckaert[1]

[1] Laboratory of Biodiversity and Evolutionary Genomics, Ch. Deberiotstraat 32, 3000 Leuven, Belgium
E-mail: sophie.deleruericard@bio.kuleuven.be

[2] Institute for Agricultural and Fisheries Research, Ankerstraat 1, 8400 Oostende, Belgium

[3] Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environments, Gulledelle 100, 1200 Brussels, Belgium

To monitor fish stocks at an ecologically meaningful scale, fisheries management requires to understand population structure. However it is difficult to measure connectivity between populations especially because early-life stages cannot be tagged due to their small size. Success of larval dispersal is the key to connectivity between spawning grounds and nurseries. *Solea solea* is among the most economically valuable fish species in the North Sea, yet little is known about its population dynamics.

In the present study, we investigate the geographical origin of young-of-the-year sole arriving at the Belgian nursery. Previous studies have shown that powerful tools such as genomic markers and otolith shape can reveal fine scale population structure for other fish species. We have sampled monthly in 2013 and 2014 at 13 stations in the southern North Sea. A total of 150 juveniles of sole were genotyped using the double digest Restriction Site-Associated sequencing (ddRADseq) technique.

Three hundred high quality Single Nucleotide Polymorphic sites were retained and used to define population structuring at a fine geographical (<150 km) and temporal scale. Outlier tests were run in order to identify markers that could be used for traceability and might show signatures of local adaptation. In addition to the genetics approach, otolith shape is used in order to reveal small scale population structure. Combing the two different traceability measure increase our assignment power.

We also compared early-life and adult genetic connectivity patterns at the European scale obtained by previous studies. Results show that southern North Sea populations of sole are highly connected, and that those caught off the Belgian coast are closely related to the Eastern English Channel and the Thames estuary populations.

Keywords: connectivity; traceability; early-life stages; flatfish; North Sea; Solea solea

Building an online and interactive scientific data explorer for LifeWatch observatory data

Deneudt Klaas, Pieter Maes, Bart Vanhoorne and Francisco Hernandez

Flanders Marine Institute (VLIZ), Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: klaas.deneudt@vliz.be

The marine observatory that is being established as a contribution to LifeWatch is becoming operational. The spatial surveys with the RV Simon Stevin that cover the Belgian part of the North Sea are running with a monthly frequency. The sensors networks with biosensors like bird GPS tags, acoustic fish tag receivers, C-pods, acoustic bat recorders are growing and data flow is being organized. In order to provide access to the observatory data and to support scientific validation of the generated data, a scientific data explorer was developed. This online and interactive tool allows users to perform exploratory data analysis and create advanced data visualizations.

In a first step a user defines a selection of data that is loaded from the database into the application. Consequently the app displays a series of visualizations based on the default settings: choropleth point maps, box plots, time series line charts, X-Y plots, etc. A sidebar of the app allows the user to further modify or optimize the settings of the analyses or visualizations. The user can request additional data fields like tides, moon illumination and sun position. The data can be displayed in tabular form and downloaded as tab delimited text files to the local drive for further analysis.

From a technological perspective the tool has been built using the R Shiny framework. R shiny is a web application framework for R suitable for both desktop and mobile devices. The choice for using this R based approach is supported by the fact that R has a lot of well-developed powerful high level functions for data processing and visualization. Since R is broadly accepted as open source programming language for data analysis in biodiversity and ecosystem studies the developed scripts can be made available and re-used by scientists. A dedicated and performant virtual Linux machine has been set up running the Shiny Server. The application is made available through the Lifewatch.be regional portal.

MarineTraining.eu - The one stop shop for marine and maritime education and training

Deprez Tim, Thibaud Mascart, Tim Tkint, Marleen Roelofs, Katherine Brownlie and Ann Vanreusel

Marine Biology research group, Department of Biology, Ghent University, Krijgslaan 281/S8, 9000 Gent, Belgium
E-mail: Tim.Deprez@UGent.be

Are you in search of an internship, MSc or PhD opportunity in the marine sector?

Are you having problems finding the adequate marine or maritime educational and training course?

Are you looking for a particular specialist skill workshop but can't find back any advertisement on it?

Are you tired of losing time searching for a good training initiative?

Don't look further! Here is the answer: The Marine Training Platform is now the reference data source on the marine training and education landscape in Europe.

Some time ago it was rather challenging to find an overview of all the offered marine and maritime education and training offer in Europe. This information was scattered across several websites and tracing the information depended strongly on the advertising and networking skills of the hosting entity. Due to this it was also impossible to give clear views on the actual offer and potential gaps in the training availability.

In response to this, the Belgian node of EMBRC (European Marine Biological Resource Centre - a distributed Research Infrastructure (RI), of which Belgium is an associate partner through Ghent University (UGent), University of Hasselt and the Flanders Marine Institute (VLIZ)) have set up a platform that brings together all available marine trainings at a European scale, and provides a series of services towards training organizers and policy makers. This comprehensive database focusses on higher education institutes (both universities and university colleges) and collects existing marine training initiatives for each country, ranging from master and doctoral programmes, to expert trainings and specialist courses. The platform is expanding gradually by including also non-accredited training initiatives (for instance, research institutes and industries) and via involvement in other European projects and networks. Services in the Marine Training Platform include advertising possibilities, practical services to trainees and training organizers (application and registration) and the support of marine dedicated e-learning initiatives.

For more information: www.marinetraining.eu.

Keywords: higher education; training; EMBRC; one-stop-shop; blue bio-economy

EMBRC.be - The Belgian node of the European Marine Biological Resource Centre

Deprez Tim[1], Peter Bossier[2], André Cattrijsse[3], Koen Chiers[4], Olivier De Clerck[5], Annemie Decostere[6], Klaas Deneudt[3], Marleen De Troch[1], Francisco Hernandez[3], Thibaud Mascart[1], Tom Moens[1] and Tim Tkint[1]

[1] Marine Biology research group, Department of Biology, Ghent University, Krijgslaan 281/S8, 9000 Gent, Belgium
E-mail: Tim.Deprez@UGent.be

[2] Laboratory of Aquaculture & Artemia Reference Center, Department of Animal Production, Ghent University, Coupure Links 653, 9000 Gent, Belgium

[3] Flanders Marine Institute (VLIZ), Wandelaarkaai 7, 8400 Oostende, Belgium

[4] Department of Pathology, bacteriology and poultry diseases, Ghent University, Salisburylaan 133, 9820 Merelbeke, Belgium

[5] Phycology research group, Department of Biology, Ghent University, Krijgslaan 281/S8, 9000 Gent, Belgium

[6] Department of Morphology, Ghent University, Salisburylaan 133, 9820 Merelbeke, Belgium

The European Marine Biological Resource Centre (EMBRC) is a distributed research infrastructure that aims to provide a strategic delivery mechanism for excellent and large-scale marine science in Europe. EMBRC aspires to interconnect the European marine research communities by upgrading and harmonizing their current infrastructures and services. It will support both fundamental and applied research based on marine bio-resources and marine ecosystems and as such encourage the development of blue biotechnologies. EMBRC will provide the suitable research environment for a variety of users from both academia and industry.

Presently, EMBRC has nine European countries and associated countries as full members. The EMBRC national nodes comprise research infrastructures located in leading marine biological stations and laboratories in Europe. The Belgian node is at date represented by Ghent University, University of Hasselt and the Flanders Marine Institute (VLIZ).

EMBRC builds on existing facilities, equipment and human capital in these coastal marine biological stations and laboratories. EMBRC aims for long-term collaboration , development of common strategies, sharing of best practices and the development of common standards related to the use of marine biological resources.Services, foremost tailored to users from academia, industry and governments, will include the provision of access to European marine, coastal ecosystems and biodiversity, marine model organisms, culture collections, technology platforms including imaging, omics and structural biology facilities, e-infrastructure services, as well as culture, laboratory and training facilities.

To achieve these goals, EMBRC strives to establish a legal structure in the form of a European Research Infrastructure Consortium (ERIC) by the end of 2016. The ERIC was invented by the European Commission to provide a suitable framework for the implementation and operation of European Research Infrastructures. EMBRC-ERIC is being built to facilitate marine science in Europe in the long-term and, based on the commitment of European member states, will be operational for a minimum of 25 years.

For more information: www.embrc.eu

Keywords: EMBRC; Europe; research infrastructure; marine bio-resources; interconnect science and industry

Does the dose make the poison? The influence of biotic and abiotic factors on the toxicity of copper in mussels

Deruytter David, Karel De Schamphelaere and Colin R. Janssen

Laboratory of Environmental Toxicology and Aquatic Ecology; Environmental Toxicology Unit – GhEnToxLab, Ghent University, Jozef Plateaustraat 22, 9000 Ghent, Belgium
E-mail: david.deruytter@ugent.be

Paracelsus stated in the 16th century that "*the dose makes the poison*". Modern marine environmental risk assessment (ERA) is still primarily based on this principle through the use of tightly controlled laboratory experiments performed according to international standards. Previous research has indicated that several biotic and abiotic factors may influence the toxicity of pollutants or the sensitivity of various species. Therefore, the relationship between the dose and effect may not be straightforward and current ERA could therefore not accurately reflect the actual risk of chemical contaminants.

To address this issue we evaluated the effect of both biotic and abiotic variables on the toxicity of Cu. The blue mussel was selected as - Cu sensitive - model organism and the influence of the following variables was assessed:

- Local adaptation by using 3 different populations (Adriatic, North and Baltic Sea);
- Life stage variability by performing the experiments on mussel larvae and on settled mussels;
- Environmental variability by changing the salinity and dissolved organic carbon (DOC) concentration of the seawater;
- Presence of other pollutants by changing the Ni or Zn concentration.

Furthermore, these variables were not assessed one by one but in combination. For example: the influence of salinity and DOC was assessed for both larvae and settled mussels and for different populations.

The results indicated that the sensitivity of the different populations to Cu was nearly identical but all other variables had a significant effect on Cu toxicity. Furthermore, interactions between biotic and abiotic variables were frequently observed. As expected, mussel larvae (currently the life stage most commonly used to generate mussel sensitivity data for usage in ERA) were more sensitive to Cu compared to settled mussels when assessed in artificial seawater. However, DOC had a profound protective effect against Cu toxicity in mussel larvae but not in settled mussels. This implies that settled mussels are more sensitive to Cu than larvae in seawater with a high DOC concentration. An increase in the salinity increased the toxicity of Cu in both larvae and adult mussels, although this effect was more prominent in larvae. No interactions between salinity and DOC on Cu toxicity were found. Finally when mussel larvae are exposed simultaneously to Cu and either Ni or Zn this increased the toxicity of Cu, although the magnitude of the effect was higher when Cu was combined with Ni than with Zn. Furthermore, the influence of Ni and Zn on Cu toxicity was more pronounced for the North Sea population compared to the Baltic Sea population. This implies that even if both populations have an equal Cu sensitivity when simultaneously exposed to other metals their response might be different.

To conclude we now know that for mussels:

- The larvae are more sensitive than the settled mussels at low DOC, but vice versa at high DOC;
- Local (geographical) adaptation does not change the inherent sensitivity;
- DOC and salinity have a profound, life stage dependent, effect on the toxicity of Cu;
- Simultaneous exposure to other metals increases the Cu sensitivity, but the magnitude varies with the metal and the population investigated.

Keywords: copper; mussels; ocean; mixture; toxicity; nickel; zinc; salinity

The biological pollutant pump. How a phytoplankton bloom alters the concentrations of organic chemicals in the marine environment

Everaert Gert[1], Frederik De Laender[2], Peter Goethals[3] and Colin R. Janssen[1]

[1] GhEnToxLab, Department of Applied Ecology and Environmental Biology, Ghent University, Jozef Plateaustraat 22, 9000 Gent, Belgium
E-mail: gert.everaert@ugent.be

[2] Research Unit in Environmental and Evolutionary Biology, Université de Namur, Rue de Bruxelles 61, 5000 Namur, Belgium

[3] AECO, Department of Applied Ecology and Environmental Biology, Ghent University, Jozef Plateaustraat 22, 9000 Gent, Belgium

In the present research we performed a large-scale analysis based on three decades of field observations in the North Sea. By using additive models, we inferred spatiotemporal concentration trends of chlorophyll a (n = 440), sediment organic carbon (n = 146) and of concentrations of polychlorinated biphenyls (PCBs) in mussels (n = 3,055) and sediments (n = 1,139). By doing so, we separated the interannual changes of PCB concentrations from the seasonal variability. Using the inferred seasonal variability, we demonstrated a strong positive relation between the chlorophyll a concentrations and the organic carbon content in the sediment ($r = 0.56$; $p < 0.01$) and between the chlorophyll a concentrations and the PCB concentrations in the sediment ($r = 0.57$; $p < 0.01$). Indeed, we found that the timing of phytoplankton blooms in spring and autumn correspond to the annual maxima of the organic carbon content and the PCB concentrations in sediment. However, the PCB concentration in sediment was negatively correlated with the PCB concentration in the blue mussel ($r = -0.33$; $p = 0.01$). The inferred relationships are likely to be driven by the cleansing of the dissolved PCB phase by sinking organic matter during phytoplankton blooms (i.e. biological pump). These results demonstrate the role of seasonal phytoplankton dynamics in the environmental fate of PCBs at large spatiotemporal scales. Hence, the spatiotemporal variability of PCBs (and potentially other organic compounds) should be considered when monitoring the marine environment...a practice which is currently largely neglected.

From this study we concluded that phytoplankton blooms in spring and autumn alter the concentrations of organic chemicals in marine sediments and mussels.

Keywords: additive modelling; environmental fate; marine; organic chemicals; phytoplankton

The impact of disposal of fine grained sediments from maintenance dredging works on SPM concentration and fluid mud in and outside the harbor of Zeebrugge

Fettweis Michael[1], Matthias Baeye[1], Claudio Cardoso[2], Arvid Dujardin[2], Dries Van den Eynde[1], Thomas Van Hoestenberghe[2], Joris Vanlede[3], Luc Van Poucke[2], Carlos Velez[2] and Chantal Martens[4]

[1] Operational Directorate Natural Environment, Royal Belgian Institute of Natural Sciences, Gulledelle 100, 1200 Brussels, Belgium
E-mail: mfettweis@naturalsciences.be

[2] Antea Group, Buchtenstraat 9, 9051 Gent, Belgium

[3] Flanders Hydraulics Research, Department of Mobility and Public Works, Berchemlei 115, 2140 Antwerp, Belgium

[4] Maritime Access Division, Department of Mobility and Public Works, Tavernierkaai 3, 2000 Antwerp, Belgium

The amount of sediments to be dredged and disposed depends to a large part on the Suspended Particulate Matter (SPM) concentration. Tidal, meteorological, climatological and seasonal forcings have an influence on the horizontal and vertical distribution of the SPM in the water column and on the bed, and control the inflow of fine-grained sediments towards harbors and navigation channels. About 3 million tons (dry matter) per year of mainly fine-grained sediments is dredged in the port of Zeebrugge and is disposed on a nearby disposal site. The disposed sediments are quickly resuspended and transported away from the site.

The hypothesis is that a significant part of the disposed sediments recirculates back to the dredging places and that a relocation of the disposal site to another location at equal distance to the dredging area would reduce this recirculation. In order to validate the hypothesis a one year field study was set up in 2013-2014. During one month the dredged material was disposed at a new site. Variations in SPM concentration were related to tides, storms, seasonal changes and human impacts. In the high-turbidity Belgian near shore area the natural forcings are responsible for the major variability in the SPM concentration signal, while disposal has only a smaller influence. The conclusion from the measurements is that the SPM concentration decreases after relocation of the disposal site, but indicate stronger (first half of field experiment) or weaker (second half of field experiment) effects that are, however, supported by the environmental conditions. The results of the field study may have consequences on the management of disposal operations as the effectiveness of the disposal site depends on environmental conditions, which are inherently associated with chaotic behavior.

Keywords: dredging and disposal; human impact; SPM concentration

Flanders Marine Institute (VLIZ) & ICOS: Research Infrastructure network in the Belgian waters... & beyond

Gkritzalis Thanos[1], André Cattrijsse[1], Michiel T'Jampens[1] and Ann-Katrien Lescrauwaet[2]

[1] Research Infrastructure division, Flanders Marine Institute (VLIZ), Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: thanosg@vliz.be

[2] Policy Information division, Flanders Marine Institute (VLIZ), Wandelaarkaai 7, 8400 Oostende, Belgium

Over the past years VLIZ, through its involvement in ICOS, has enhanced its Marine Research Infrastructure capability in the Belgian Part of the North Sea. Within this scope the RV Simon Stevin's underway system is now equipped with a wide spectrum of sensors for measuring biogeochemical parameters (e.g. pCO2, pH, oxygen, chlorophyll, fast repetition rate fluorometer, nutrients). The resulting data are contributing to the construction of a comprehensive biogeochemical map of the Belgian sea surface waters. Additionally a time series station is deployed in the Thorntonbank windfarm, equipped with an array of sensors (e.g. pCO2, pH, O2, temperature, conductivity) that provide a coherent time series record of the biogeochemical system in the local marine environment. The aim from both platforms is to constrain the marine biogeochemical system of the Belgian coast and understand how this dynamic environment evolves.

At an international level VLIZ has collaboration with the University of Valparaiso in Chile in order to set up sensors on ships of opportunity (SOP) for producing continuous underway data in the South Chilean coast. There are also ongoing efforts with the Kenyan Marine and Fisheries Research Institute aiming to equip the RV Mtafiti with equipment capable to collect underway data for biogeochemical and physical parameters. This poster presents the infrastructure details, data and derived products from the aforementioned platforms.

Keywords: marine infrastructure; underway sampling; marine biogeochemistry; marine carbonate system

Using VLIZ online DOI data publication service to publish research data as a citable and traceable dataset

Goffin Annelies, Daphnis De Pooter and Klaas Deneudt

Flanders Marine Institute (VLIZ), Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: data@vliz.be

In science a DOI or Digital Object identifier has been widely used by publishers of peer reviewed journals for over 10 years to uniquely identify a specific article. Associating a DOI to a scientific publication has not only increased the traceability of the cited literature but also simplified the maintenance of citation indexes which serve today to **assign academic credit** to scientists for their work. Nature even describes its Index as 'A global indicator of high-quality research'.

Today, there is growing international support for the idea that **dataset citations** should also lead to **academic credit** for the work done. Scientific journals start to recommend or claim an online available dataset before publishing is granted. Assigning a DOI to your dataset facilitates these processes.

In collaboration with DataCite and the ICSU World Data System, VLIZ offers a data publication service that facilitates the assignment of a DOI upon request and meet the requirements listed below:

- A DOI **identifies your data**. Minimum metadata - including the names of the data author(s) – needs to be associated with the DOI during registration. Having the data authors associated with the DOI will assure that they can receive the **appropriate credit and recognition** for their work. An online input form is provided to allow researchers to describe their dataset.
- A DOI always traces back to its **specific version** and guarantees that the data file is **persistently accessible**. VLIZ commits to keeping the data online and offers the Marine data Archive (MDA) as a certified data repository complying ICSU World Data System and Data Seal of Approval requirements. In case the DOI is requested for the submission of a paper in a peer reviewed journal, the dataset can remain restricted until publiction of the paper.
- With a DOI the data publisher attests that the dataset conforms to certain **quality standards** and contains all necessary metadata to make the dataset usable by other scientists. This will encourage other scientists to use it for their analyses and cite your dataset in their publications. VLIZ checks incoming datasets for compliance with a set of basic **quality standards** and for completeness of required metadata.
-

In one step you can meet the requirements and request a DOI !

Go to http://www.vliz.be/en/publish_data or e-mail to data@vliz.be.

Keywords: data publication; citation; DOI; dataset; credit; data author

Marine data archeology: a heritage for future science

Goffin Annelies, Carolien Knockaert and Elien Dewitte

Flanders Marine Institute (VLIZ), Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: annelies.goffin@vliz.be

The current availability of ecosystem data is in many cases insufficient to create an adequate insight in the underlying processes which influences the functioning of our ecosystems. Data archeology can play an important role to fill in spatial and temporal gaps in the data series, currently available to science. Many sources of historically collected data exist, but are still hidden in dusty closets and filing cabinets, on paper, disks, tapes, cd's, etc. In order to make these data available for scientific research, VLIZ identified a procedure for the execution of data archeology projects.

Data archeology is a process of identification, prioritization and digitization. The first steps are the most challenging and time-consuming but enables us to reconstruct the context in which data were collected such as the used sampling protocols and analysis procedures, the research results, and equally important metadata for a correct interpretation of the dataset. The digitization concerns quality control procedures and the standardization of data.

Data archeology has no use if data are not made available to science. A series of guidelines were defined to facilitate data publication. This includes the description of data, the creation of a citation including DOI registration and storing the data file in a repository such as the Marine Data Archive (MDA). The data files connected to those DOI's are then made publicly available.

Since 2012, VLIZ initiates projects in cooperation with scientific institutes. Some examples are listed below:

- Biological datasets resulting from integrated Belgian-Kenyan research activities.
- Time-series of water temperature and salinity measured during Belgian campaigns in the Southern part of the North Sea and English Channel 1903-1965.
- Historic datasets from the light vessel West-Hinder.
- Water temperature and salinity at the West-Hinder from 1904-1979.
- Zooplankton counts measured at the West-Hinder in 1902.
- Zooplankton studies at a fixed station (West-Hinder) in the North Sea between 1977 and 1979.
- Plankton data for the Belgian Part of the North Sea and adjacent areas. (in cooperation with 4DEMON project).
- Scientific catch data from shrimp fisheries in the Belgian Part of the North Sea: a reconstruction of historic campaigns since 1930.

Visit www.lifewatch.be/data for more information on the procedure and the projects.

Keywords: data archeology; historic; marine; biodiversity; standardization; data publication; archive

Measuring biodiversity with a bottle of water: development and field validation of an eDNA approach with plaice

Grosemans Tara, Jana Asselman, Pieter Boets, Karel De Schamphelaere and Colin R. Janssen

Laboratory of Environmental Toxicology and Aquatic Ecology, Environmental Toxicology Unit - GhEnToxLab, Ghent University, Jozef Plateaustraat 22, 9000 Gent, Belgium
E-mail: Tara.Grosemans@UGent.be

Marine biodiversity is crucial for ecosystem functioning and its resulting services, and is thus essential for human health and the economy. Monitoring of biodiversity is required under the EU Marine Strategy Framework Directive (2008/56/EC). However, conventional monitoring relies on taxonomic expertise and often uses destructive methods. Rapid advances in DNA analysis allow the study of biodiversity from environmental samples (e.g. water) and can significantly improve monitoring methods. With the environmental DNA (eDNA) approach routinely monitored species but also rare and cryptic species can be quickly detected without the use of selective and invasive methods. This approach has already been proven successful in freshwater, but considerably fewer studies have been performed in marine ecosystems.

In this study, a series of 24h experiments were conducted to investigate the eDNA degradation rate and detection limit for plaice (*Pleuronectes platessa*) under controlled conditions. Five aquaria with a volume of 30 L were designated as follows: two contained fish, two that had contained fish and one was a control aquarium. After one week fish were transferred from their aquarium to another aquarium to measure eDNA detection. The aquaria from which the fish were removed was sampled to measure eDNA degradation. From each aquarium 500 mL of water was taken at 0, 8, 16 and 24h. Next, samples were filtered and eDNA was extracted from the filter. Results were obtained by amplifying the eDNA on a qPCR machine with species-specific primers (117 bp) for plaice. These primers were both tested in the laboratory (on water and tissue samples) and in the field (water samples). Field samples were collected monthly for a whole year at 9 LifeWatch sampling stations located in Belgian coastal waters. To obtain positive field water samples for plaice, water was collected before starting a beam trawl at two different locations. To determine the minimal concentration of eDNA in the water for a positive detection, a technical (instrument) and biological (number of fish per volume needed to detect eDNA) limit of detection (LOD) was derived from the qPCR for plaice.

Eight hours after three juvenile fish with a total biomass of 32g were introduced in the aquaria, eDNA of plaice was detectable in the water column with no difference in eDNA quantity between 8, 16 and 24h. In the degradation experiment, there was no difference in eDNA concentration between 8 and 16h, but over the entire 24h timespan of the experiment a clear degradation pattern was observed. The technical LOD was determined at $2*10^{-10}$ ng of DNA amplicons needed to detect a signal. For the biological LOD a final quantity of $2.88E^{-13}$ µg of DNA was needed for a positive signal, which corresponds to a minimal fish density of 1 individual in 468,750 liter of seawater. At both control stations, plaice presence was confirmed with beam trawl sampling and could be detected in the water samples using the eDNA approach.

In conclusion, after 8h presence plaice could be detected via eDNA in the water and eDNA followed a clear degradation pattern once fish were removed from the water. With a minimal fish density of 1 adult per 468,750L, plaice can be detected in the water via eDNA. This is the equivalent to finding five fish in an Olympic swimming pool. Our method has proven to be successful in the field and can be used to monitor plaice in the North Sea. The eDNA approach will now be extended to other vertebrate and invertebrate species.

Keywords: environmental DNA; eDNA; degradation; detection; technical and biological detection limits; monitoring

Microhabitat choice of cryptic species: do closely related nematode species really occur together?

Guden Rodgee Mae[1], Anna-Maria Vafeiadou[1,2], Nele De Meester[1], Annelien Rigaux[1], Sofie Derycke[1,3] and Tom Moens[6]

[1] Ghent University, Marine Biology Section, 1. Krijgslaan 281/S8, 9000 Ghent, Belgium
E-mail: rodgeemae.guden@ugent.be

[2] Aristotle University of Thessaloniki, Biology Department, 54124 Thessaloniki, Greece

[3] Royal Belgian Institute of Natural Sciences (RBINS), OD Taxonomy and Phylogeny, Vautierstraat 29, 1000 Brussels, Belgium

The prevalence of morphologically 'identical' but genetically distinct species, referred as cryptic species, call into question estimates of the existing number of species and may have implications for our understanding of biodiversity-ecosystem functioning relations, but also challenge ecological theory about species interactions. Cryptic species are particularly prominent in marine environments.

Extensive cryptic diversity exists, for instance, in marine free-living nematodes. In *Litoditis marina*, a common bacterivore nematode associated with decomposing macro-algae in the littoral zone of coastal and estuarine environments, at least 10 cryptic lineages have already been demonstrated. At least three of the four most abundant cryptic species were found to co-occur in the field, but the underlying samplings did not allow assessing whether these species truly co-occur or whether they perhaps exhibit differential microhabitat preferences. The lack of easily distinguishable morphological characters prohibits the classical identification approaches. Here, we use qPCR for a rapid detection and quantification of four cryptic species of *L. marina* on macroalgae in the Westerschelde Estuary to investigate whether these four species truly co-occur or show temporal and/or spatial niche differentiation in their natural environment.

Keywords: cryptic diversity; microhabitat preference; coexistence; spatial; temporal

Grey seals *Halichoerus grypus* choking on common sole *Solea solea*

Haelters Jan[1], Willy Dabin[2], Marjan Doom[3], Francis Kerckhof[1], Alexander Steyaert[3] and Thierry Jauniaux[4]

[1] Royal Belgian Institute of Natural Sciences (RBINS), Operational Directorate Natural Environment, 3de en 23ste Linieregimentsplein, 8400 Oostende, Belgium
E-mail: jan.haelters@naturalsciences.be

[2] Observatoire PELAGIS, UMS3462 - Université de La Rochelle - CNRS, Pôle analytique, 5 Allées de l'Océan, 17000 la Rochelle, France

[3] Department of Morphology, Faculty of Veterinary Medicine, Ghent University, Salisburylaan 133, 9820 Merelbeke, Belgium

[4] Department of Pathology, Veterinary College, University of Liège, Sart Tilman Bat B43, 4000 Liège, Belgium

Between 2007 and 2015, we recorded three cases of asphyxiation of grey seals *Halichoerus grypus* caused by a fish lodged in the respiratory tract. In all cases, the fish involved was a common sole *Solea solea*, which had found its way to the trachea of the unfortunate seal, as such completely blocking it.

That this fish species was involved, is not surprising: it has a very agile body, with a spectacular ability to bend longitudinally into a circular shape, as well as laterally into the form of a cigar - the way it was found in the gluttonous grey seals. The common sole currently occurs abundantly in coastal waters of the southern North Sea, and it constitutes an important part of the diet of grey seals in this area.

Asphyxiation due to fish has been described in odontocetes, including in harbour porpoise *Phocoena phocoena*, bottlenose dolphin *Tursiops truncatus*, and very recently in long-finned pilot whale *Globicephala melas*. To our knowledge however, this cause of death has not been described before in grey seals. Furthermore, the significance of this cause of mortality in a single population has not been documented, with in particular aspects of prey abundance, seal behaviour and the limited number of stranded adult grey seals that are being investigated to be considered.

Keywords: grey seal; Halichoerus grypus; common sole; Solea solea; asphyxiation; respiratory tract

Sciaenops ocellatus: Daily and seasonal sound variation during spawning in aquaculture.

Henry Séverine[1], Jean-Claude Falguière[2], Samson Devillers[2] and Eric Parmentier[1]

[1] Laboratoire de Morphologie Fonctionnelle et Evolutive, Département de Biologie, Ecologie et Evolution, Université de Liège, Quartier AGORA - Allée du 6 Août 11, 4000 Liège, Belgique
E-mail: severine.henry@ulg.ac.be

[2] Unité Biodiversité et Environnement, Délégation IFREMER des Antilles, Route de Pointe Fort 79, 97231 Le Robert, Martinique, France

Since the decline of their natural population, red drums (*Sciaenops ocellatus*) were introduced in aquaculture and many studies have been conducted to improve their farming. This sciaenid is known to produce sounds, especially during the reproductive period, but very few studies have investigated this aspect of their biology. Only males have the ability to produce sounds.

This study aims to describe the sound production during a spawning season for fishes in captivity. Specimens of *Sciaenops ocellatus* were recorded during the spawning season at the research and aquaculture station IFREMER in Martinique. Hydrophones were placed in tanks containing either a heterosexual group of fishes or a male isolated with a female. The heterosexual group has been recorded at a rate of 1.5min every 30 minutes during 3 months. Couples have been recorded at the same rate but during 3 weeks. The following acoustic characteristics were measured: number of sounds per time unit, number of pulses in a sound and pulse periods. Sounds were mainly produced at night. In the heterosexual group, the sound production activity, or chorus, began to increase after 21:30 with a peak at 23:00. Call number then decreased and stopped at approximately 1:00. The daily number of sounds and the number of pulses per call are significantly higher during the reproductive period than outside. For the couples the activity began earlier, between 18:00 and 20:00, with a peak around 21:00 and 22:00. Then sounds stopped generally around 23:00. Sounds seem to be an integral part of the reproductive behavior of *Sciaenops ocellatus*.

Acoustics could be used in aquaculture as a monitoring tool which could provide a non invasive way to collect information about the sexual status and maturity of that species.

Keywords: acoustic; red drum

Genetic population structure of *Seriatopora hystrix* in the Indo-Malay Archipelago

Heyndericx Hanneloor, Rosa Van der Ven, Puspita Sutrisno and Marc Kochzius

Marine Biology, Departement Biologie, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium
E-mail: hanneloor.heynderickx@vub.ac.be

Tropical coral reefs are among the most biologically diverse and dynamic ecosystems of the world and are known to provide economically valuable and vital ecosystem services such as fisheries and coastal protection. As reefs provide habitat, spawning and nursery grounds for many important marine species, ongoing degradation and loss of these reefs can result in local extinctions of marine species. In the last couple of years reefs underwent massive declines in both health and abundance due to increasing anthropogenically induced environmental changes. Acidification, climate change, destructive fishing and pollution for example can lower the corals' capacity for adaptation and survival, eventually resulting in the decline of these coral ecosystems. The need for coral reef protection is high and could be aided by the implementation of marine protected areas (MPA's) which may increase coral reef resilience to environmental changes. A profound knowledge on genetic population structure and hence connectivity of these complex coral reef structures would provide necessary evidence to support such implementations.

In 2012 and 2013 *Seriatopora hystrix*, a hermatypic scleractinian coral, was sampled from 13 sample sites in the Indo-Malay Archipelago. Eight sample sites were in the Spermonde Archipelago off the southwest coast of Sulawesi, while the remaining five sites are from Pulau Seribu, off Jakarta in Java. Genetic structure analysis, supplemented with geographic and oceanographic data, will be used to assess population connectivity patterns within and between these two regions. For this, 12 DNA microsatellite markers specifically designed for *S. hystrix* were selected from literature. Genetic population structures will be analysed with computer programs, such as GeneMarker (v. 2.6.0), FSTAT, and STRUCTURE (v. 2.3) by calculating F-statistics and using model based clustering methods.

Previous research by our group found that *Acropora tenuis*, a broadcast spawning coral associated with long dispersal distances, had high connectivity and low level genetic structuring in the Spermonde Archipelago. *Seriatopora hystrix* is a brooding coral mostly associated with short dispersal distances. Hence, for *S. hystrix*, we would expect low connectivity and a high level of population structure.

Due to the presence of a historical geographical barrier in the Java Sea and the fact that *S. hystrix* is a brooding coral we expect allelic compositions to be different between the two sites. In addition, the presence of four different geographical zones in the Spermonde Archipelago also leads to a higher expected level of genetic structuring within these sample sites. In contrast, the sample sites from Pulau Seribu are very closely located to each other, which can provide more detailed information on the dispersal distance. Overall, the results that will be provided by this study will give us a better insight into the connectivity and dispersal patterns of this species.

Keywords: population genetics; Seriatopora hystrix; Indo-Malay Archipelago; microsatellite markers

The ontogeny of shell-boring *Octopus* versus *Nautilus* predator-prey interactions

Hiemstra Auke-Florian and Menno Schilthuizen

Naturalis Biodiversity Center, Postbus 9517, 2300 RA Leiden, The Netherlands
E-mail: aukeflorian.hiemstra@naturalis.nl

To complete our picture of predatory boring by *Octopus*, this study focuses on the rate and pattern of *Octopus* predation in pre-adult stages of *Nautilus*, which encompasses the first 15 years of its life. Dry shells from several natural history museum collections were used for this study. In the 555 examined shells, 334 borings were found. For adult *N. pompilius*136/242 (56.2%) were bored, while for juvenile *N. pompilius* 41/154 (26.6%) were bored. Of the juvenile *Nautilus* 8/52 (15.4%) have multiple borings while 68/179 (38%) of the adult *Nautilus* have multiple borings. One adult *Nautilus* has 6 borings and one juvenile *Nautilus* has 5 borings, both of which set a new record. In adult *Nautilus*, there appears to be no preference to bore on the left or right side of the shell: 129 borings are on the left side (48%) and 140 borings on the right side (52%). In juveniles, though, there is a clear difference in left and right borings. With 47 borings on the left (75,8%) and 15 borings on the right (24,2%) there is a statistical difference. Not just all species of *Nautilus* are attacked by *Octopus*, their predation also has a big impact on all ages.

Keywords: Octopus; Nautilus; predation; shell-boring; Cephalopoda; interaction

South Pacific Information and Data Management to support Integrated Coastal Area Management (SPINCAM) with the support of the Government of Flanders (Belgium)

Iglesias-Campos Alejandro[1], Fernando Félix[2], Julian Barbiere[1] and Julian Reyna[2]

[1] Marine Policy and Regional Coordination Section, Intergovernmental Oceanographic Commission of UNESCO, 7 Place de Fontenoy, 75352 Paris 07 SP, France
E-mail: Msp-ioc@unesco.org

[2] Comisión Permanente del Pacífico Sur CPPS, Av. Carlos J. Arosemena km 3, Guayaquil, Ecuador

SPINCAM was designed to establish a framework of integrated coastal management indicators at the national and regional levels in the countries of the South Pacific region (Chile, Colombia, Ecuador, Panama and Peru) focusing on the state of the coastal and marine environment and socio-economic conditions. The indicators and coastal spatial data aim to support integrated coastal area management (ICAM) and the development of practices for sustainable use in the region. The project is supported by the government of Flanders (Belgium) under the coordination of IOC-UNESCO and the Permanent Commission for the South Pacific, CPPS.

SPINCAM I (2008-2012) focused on developing a harmonized approach to design a core set of national ICAM indicators and five regional indicators following a common. In the process, national and regional information systems were built to support the development and spatial representation of these indicators, and the dissemination of ICAM resources and experiences.

SPINCAM II (2012-2016) supports national decision-making processes by establishing baselines and identifying ecological and socio-economic trends in the use of coastal resources. It provides a knowledge base for the implementation of ICAM in the region and the definition of future strategies to deal with global changes. During this period, the national indicators were integrated in the national information systems and products in support of ICAM (e.g. atlases). Since 2015, SPINCAM is implementing pilot case studies* at local scale in collaboration with national and local authorities in each of the countries. The pilot cases contribute to develop the information needs and the tools to support local ICAM initiatives by improving stakeholder participation.

The proposal for a third phase involves a long-term strategy with a programme approach for both ICAM and marine spatial planning in the Southeast Pacific. This strategy takes into account the geographical coverage and complexity of the environmental challenges faced by the region's ocean and coastal zones, while recognizing their importance as drivers in the regional economy. This strategy is in line with the Convention for the Protection of the Marine Environment and Coastal Areas of the Southeast Pacific, commonly known as the Lima Convention.

Throughout the project, SPINCAM is supported by the International Ocean Data and Information Exchange programme (IODE for IOC-UNESCO) activities with respect to the data and information management, the development of coastal and marine atlases (International Coastal Atlas Network ICAN) and capacity building (OceanTeacher Global Academy OTGA and its regional training centers).

From a global perspective, SPINCAM supports the region's contribution to the Global Ocean Science Report (GOSR), the Regular Process for Global Reporting and Assessment of the State of the Marine Environment (United Nations General Assembly) including socio-economic aspects, and the implementation of the Agenda 2030 (Sustainable Development Goal SDG-14).

References

SPINCAM project website: www.spincamnet.org

SPINCAM regional ICAM atlas: www.atlasspincam.net

* Pilot case studies: Algarrobo, El Quisco and El Tabo (Chile), Guapi (Colombia), Churute Ecological Reserve (Ecuador), Las Perlas Archipelago (Panama) and Piura-Bay of Sechura (Peru).

Detecting small marine mammals in the Belgian part of the North Sea using high resolution satellite imagery

Janssen Tom[1], Jan Haelters[2] and Kevin Ruddick[3]

[1] Master of Marine and Lacustrine Science and Management, Faculty of Sciences of VUB, UAntwerpen and UGent, Pleinlaan 2, 1050 Elsene, Belgium
E-mail: jjanssentom@gmail.com

[2] Ecologie en Beheer van de Zee (MARECO), Operational Direction Natural Environment (OD Nature), RBINS, 3 And 23th Linieregimentsplein, 8400 Oostende, Belgium

[3] Remote Sensing and Ecosystem Modelling (REMSEM) team, Operational Direction Natural Environment (OD Nature), RBINS, 100 Gulledelle, 1200 Brussels, Belgium

With the reduction in cost of high resolution satellite optical imagery come new possibilities for remote sensing of larger aquatic animals. Using images retrieved from sensors such as Pleiades, with a 2m multispectral and 50cm panchromatic resolution, megafauna can be detected, traced or tracked on a low-cost basis in comparison to aerial or ship surveys. The objective of this master thesis is to assess the possibilities and limitations of these current high resolution satellite sensors for the detection of aquatic animals.

Practically the feasibility will be tested by processing and analyzing images on the detection of harbour porpoises. Satellite images will be selected covering 100 km^2 of the Belgian part of the North Sea each. With a distribution shift to the southern North Sea, this cetacean is the most abundant marine mammal in Belgian waters. Aerial surveys in April 2008 yielded a number of more than 4000 animals present with a density of 1,2 animals per kilometer. However, detection can be observer biased and surveys can be time-consuming. This implies that for long and/or multiple stretches of line surveys more days of observation need to be taken into account.

Before processing can take place a measuring of optical properties of skin samples is needed to give more insight into the spectral reflectance of these animals. By considering the differences in spectral reflectance between these animals and the ambient waters it may be possible to define an optimal selection of spectral bands or a combination of bands, for reliable and automated detection of the harbour porpoises in satellite imagery. Different factors that can interfere with the performance of detection, such as depth below the surface, turbidity and surface features such as waves and sunglint, will need to be taken into account.

Given that some other authors studied the detection of bigger megafauna, e.g. southern right whales, this is the first study being carried out on one of the smallest cetaceans in a rapidly changing turbid sea as the North Sea. This pushes using the technology to the limit and can give a clear idea whether the current sensors are sufficient in terms of spatial and spectral resolution for surveying small cetacean populations from space.

Keywords: harbour porpoise; marine mammals; satellite imagery; optical remote sensing; North Sea; spectral reflectance

Temporal realised niche analysis of the diatoms community and of *Phaeocystis globosa* on the French Coast of the eastern English Channel

Karasiewicz Stéphane[1], Elsa Breton[2], Alain Lefebvre[3], Tania Hernández Fariñas[3,4] and Sebastien Lefebvre[1,5]

[1] Laboratoire d'Océanologie et Géosciences (UMR 8187 LOG), Université de Lille, 28 Avenue Foch , 62930 Wimereux, France
E-mail: stephane.karasiewicz@univ-lille1.fr

[2] Laboratoire d'Océanologie et Géosciences (UMR 8187 LOG), Université du littoral côte d'Opale, 32 Avenue Foch , 62930 Wimereux, France

[3] Ifremer, laboratoire Environnement et ressources du centre Manche Mer du Nord, 150 Quai Gambetta, BP 699, 62321 Boulogne-sur-Mer, France

[4] Station Biologique de Roscoff, Lab. Adaptation et diversité en milieu marin, Place Georges Teissier, 29680 Roscoff, France

A recent investigation of the effect of environmental controls on the dynamics of spring phytoplankton blooms occurring in the eastern English Channel was done over the last two decades (1993-2014). Concentration of nutrients (Nitrogen and Phosphorus) decreased, at a different rate making N/P ratio increasing while at the same time, the annual mean temperature and PAR decreased. These changes in resources are correlated with a change in diatom community structure (increase in species richness, and decrease in biomass and mean biovolume). Conversely, the magnitude of the following undesirable prymnesiophytes *Phaeocystis globosa's* bloom gradually increased. Contrarily to the diatoms, *P. globosa* has no need for silicate, has a higher N/P ratio and consequently mainly depends on the excess of nitrate left after the diatoms' bloom.

Two non-mutually exclusive hypotheses can be formulated. The first one is that the blooms' magnitude increase of *P. globosa* over time is explained by the preceding decrease of nitrate use efficiency of the diatoms community, which structure and succession changed over time. The second one is that change of climate conditions (light and temperature) favours *P. globosa* over diatoms. To confirm/infirm these hypotheses, the characterisation of the ecological niches is needed. This will provide a more general understanding of the effect of environmental controls on the diatoms community composition and structure in relation with the ecosystem functioning. Ecological niche is defined statistically for each species based on their relative abundance for certain environmental conditions by the OMI analysis. The late winter and early spring diatoms communities are species-rich, displaying large variations in size, shape, coloniality, and therefore in their niche characteristics. For example, we know that small diatoms have a greater competitive advantage when nutrient resources are low but lower resource stoichiometry plasticity than the large ones. A new method was developed, based on the OMI analysis, in order to compare the yearly niche position and breadth of each species within a single fix referential plan.

Here, we present the results on a temporal realised niche analysis performed in an attempt to show the effect of the nutrient reduction and climate change over time on the succession of the diatoms community prior the bloom of *P. globosa*. The apparent decrease of the diatoms community size will be discussed in the context of a reduction and/or expansion of their realised niches of the large and small species, respectively.

Keywords: global change; spring bloom; OMI analysis; succession; niche reduction; niche expansion; referential plan

Towards a better understanding of the adoption of new fishing technology by Belgian fishers

Kinds Arne and Katrien Verlé

Fisheries and Aquatic Production, Animal Sciences Unit, Institute for Agricultural and Fisheries Research, Ankerstraat 1, 8400 Oostende, Belgium
E-mail: arne.kinds@ilvo.vlaanderen.be

In Western Europe, fish stocks are under pressure and as a consequence so are their associated fisheries. In addition, fishing, and particularly practices employing towed bottom contact gears, have a significant impact on benthic ecosystems (Løkkeborg, 2005). This is also a major concern for the mixed demersal fishery in the North Sea. In the Belgian fleet 77% of the landings is accounted for by beam trawlers (Tessens, 2013).

For these reasons, technical and management measures are being developed in an attempt to lower the impact of fishing. The choice of fishing technique can make a large difference in terms of impact on the ecosystem as well as in terms of efficiency (for e.g. fuel consumption). In addition, when considering a particular gear, there exists a broad series of possible measures to improve selectivity and reduce the number of unwanted species and undersized fish. These measures are often developed by the industry itself or in science-industry partnerships. Measures such as escape panels, lighter netting, replacement of the traditional beam with more hydrodynamic structures (e.g., *sumwing*), replacement of the trawl heads with rollers (e.g., *ecoroll beam*) have proven successful in reducing bycatch, fuel consumption or bottom impact (or a combination of these) (e.g., Depestele et al., 2007; Polet et al., 2010; Poos et al., 2013).

However, the diffusion of technical innovations in fisheries has been observed to be a slow process. As is the case in the agricultural sector, it can be assumed that the adoption of new technologies rarely happens on its own and adoption decisions are very likely to be influenced by changes in external factors (Wauters et al., 2005; D'Emden et al., 2006). Therefore, the focus of this study is to identify the factors associated with the decision to adopt and invest in new fishing technology. This study is a first attempt to investigate the drivers and attitudes behind the uptake of new fishing technologies by Belgian fishers.

Fifteen Belgian fishers were selected and invited for a semi-structured open interview in the period January-March 2016. Prior to the interviews, we listed a set of possible themes that may underlie fisher attitude and behaviour. Additional themes that come up frequently during the interviews will be recorded, as well as the perceived link between themes and mentioned associations. These will be described and divergent views will be used to challenge generalisations. The results are expected to indicate that besides profitability, a number of other drivers play a role in adoption behaviour and investment decisions (e.g., social relationships among fishers, external factors such as subsidies and fuel prices, pressure from the producer organisation or policy makers, etc.). Knowing the factors that hamper or facilitate the adoption of innovative techniques can be important for the implementation of management measures aiming for sustainable fisheries.

References

D'Emden, F., Llewellyn, R. and Burton, M. (2006). Adoption of conservation tillage in Australian cropping regions: An application of duration analysis. Technological Forecasting & Social Change 73, pp. 630-647.

Løkkeborg, S. (2005). Impacts of trawling and scallop dredging on benthic habitats and communities. FAO Fisheries Technical Paper. No. 472. Rome, FAO. 58p.

Depestele, J., Polet, H., Stouten, H., Craeynest, K., Van Vanderperren, E. and Verschueren, B. (2007). Is There a Way Out for the Beam Trawler Fleet with Rising Fuel Prices? ICES, CM 2007/M:6.

Polet, H., Depestele, J., Van Craeynest, K., Andersen, B.S., Madsen, N., van Marlen, B., Buisman, E., Piet, G.J., Van Hal, R., Tidd, A.N. and Catchpole, T.L. (2010). Studies and pilot projects for carrying out the Common Fisheries Policy. Topic: LOT 3, Scientific advice concerning the impact of the gears used to catch plaice and sole. Report submitted to the DG for Fisheries and Maritime Affairs, European Commission. Tenders FISH/2007/7. Instituut voor Landbouw- en Visserijonderzoek (ILVO-Visserij): Oostende. 440 pp.

Poos, J.J., Turenhout, M.N.J., van Oostenbrugge, A.E. and Rijnsdorp, H., AD (2013). Adaptive response of beam trawl fishers to rising fuel cost. ICES J. Mar. Sci. 70, 675-684, http://dx.doi.org/10.1093/icesjms/fss196.

Tessens, E., 2014. De Belgische Zeevisserij 2014 - aanvoer en besomming. Dep. Landbouw en Visserij.

Wauters, E., Bielders, C., Poesen, J., Govers, G. and Mathijs, E. (2010). Adoption of soil conservation practices in Belgium: An examination of the theory of planned behaviour in the agri-environmental domain. Land Use Policy 27 (1), pp. 86-94. doi:10.1016/j.landusepol.2009.02.009

Keywords: fishing technology adoption; change management; beam trawl; Belgian fisheries; fisheries management

Building a transnationally harmonised marine geological database

Kint Lars[1], Sytze Van Heteren[2], Ruth Lagring[1] and Vera Van Lancker[1]

[1] OD Nature, Royal Belgian Institute of Natural Sciences, Gulledelle 100, 1200 Brussels, Belgium
E-mail: lkint@naturalsciences.be

[2] TNO, Geological Survey of the Netherlands, PO Box 80015 3508 TA, Utrecht, The Netherlands

Within the framework of marine resource management, a common knowledge base is being developed on the distribution, composition and dynamics of various geological resources. Focus is on data from the Belgian part of the North Sea, being representative of a typical sandbank sedimentary system. To ensure harmonised seabed mapping over large, supraregional areas and to facilitate the exchange of information, special attention was paid to compatibility with marine geodatabases from the adjacent Netherlands territory.

With reference to the seabed and its subsurface, two main databases are being compiled: one comprising all available lithological descriptions and one with all numerical grain-size information. To enable standardisation of the data and make them easily query-able, non-numerical descriptions are being coded to an international standard (EU FP7 Geo-Seas; www.geoseas.eu), of which the Udden-Wentworth scale is the main classifier. Several other parameters were derived, such as percentages mud, sand, gravel, shells and organic material. For the sediment database, cumulative grain-size-distribution curves were compiled, enabling calculations of any desired granulometry parameter, such as percentages of the grain-size fractions (fine, medium, coarse sand) and percentiles that are relevant in seabed-habitat mapping or sediment-transport modelling (D35, D50, D84). For both databases, the completeness and accuracy of the metadata were considered highly important. Information about sampling and coring techniques, analytical methods, horizontal and vertical positioning accuracy, and the exact timing of data acquisition is pivotal in uncertainty analyses, which are an increasingly important element of seabed mapping. The time of seabed mapping is critical to convert measured water depths to a common datum such as TAW in Belgium, facilitating integration of sample data in bathymetry data and thus their incorporation in 4D-modelling studies on morphodynamic change.

For Belgium, the geological databases will be imbedded in the data infrastructure of the Belgian Marine Data Centre (www.bmdc.be), ensuring compatibility with international standards and providing easy access to a wide user community. Following processing to generate data products such as resource-related subsurface models, visualisation is foreseen through Subsurface Viewer (GmbH INSIGHT). Applied maps and models thus disseminated are crucial in decision making, and invaluable for outreach and educational purposes. The newly developed database and its associated data products will contribute to the objectives of the projects TILES (Belspo Brain-be), EMODnet-Geology (EU DG MARE), and ZAGRI (private revenues from the marine-aggregate industry).

Keywords: resources; marine aggregates; data management; seabed mapping; North Sea

Drones record water quality at cm scale

Knaeps Els, Dries Raeymaekers, Liesbeth De Keukelaere, Tom Verstappen and Gert Strackx

VITO, Boeretang 200, 2400 Mol, België
E-mail: els.knaeps@vito.be

Today drones are being used in a variety of civil applications, from windmill inspection to film industry, precision agriculture to the delivery of small packages. We present a new application where drones are used to monitor suspended sediments in the water. Suspended sediment concentrations can already be retrieved from satellite and manned airborne images but drones provide a range of new opportunities. The most important one is their ability to collect data below the clouds. The second one is their extremely high spatial detail, up to cm scale, and the high frequency of image acquisitions (e.g. one every minute). And last but not least: their flexibility. With limited training everyone can acquire and fly a drone equipped with a digital camera. Retrieving sediment concentrations from these unmanned systems is however a challenging task. We have equipped an oktokopter drone with a simple off-the-shelf digital camera. A methodology was developed to convert the the raw digital numbers into physically meaningfull values taking into account the atmospheric absorption and scattering and air/water interface interactions. Two demonstrations have been set-up: one at the harbour of Zeebrugge and one at the Scheldt river close to the harbour of Antwerp. In both cases the oktocopter drone was deployed taking images for several hours. A live data stream was used to view the target in real time and to re-orient the data acquisition if needed. Simulataneous water reflectance measurements were made using a field spectrometer, turbidity was measured in the field and water samples were taken and analysed for their concentration of suspended sediments. These field data allow for an in depth calibration of the processing algorithms and validation of the final output products.

In the end this drone based sediment mapping would allow to monitor sediment plumes generated e.g. during dredging. Mid 2016 a final demonstration is planned where the drone will be deployed from a dredging vessel. The suspended sediment maps allow to monitor the concentrations, the extent and direction of the plume but also provide input for the calibration and validation of near field sediment transport modelling.

Keywords: drone; suspended sediment; dredging

Roots in the sea

Koedam Nico

Biodiversity & Ecosystems, Department of Biology, Faculty of Sciences and Bio-engineering Sciences, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium
E-mail: nikoedam@vub.ac.be

Plants (and angiosperms specifically) are highly successful in having adapted to a wide range of ecological conditions at almost all latitudes. Darwin expressed his awe for the rapid adaptive radiation as 'an abominable mystery' of evolution. However this only holds when considering the terrestrial realm: plants are virtually absent from the marine environment. A notable exception are coastal biotopes which may be dominated by groups of highly specialized plant species, belonging to phylogenetically diverse clades. Species richness however is low, both at local and global scales. The floristic paucity equally applies to mangroves, which 'root in the sea', yet are clearly derived from terrestrial clades with all features that ensue. Mangrove species, which are woody plants almost without exception, occur along tropical and subtropical coasts (between approx. 32° N for the northernmost limit and 38°S for the southernmost limit). They occupy the land-sea interface, bays, estuaries, lagoons, and backwaters. With globally only about 70 species of 17 families of plants, they could be easily neglected if considering the species richness at respective latitudes in neighbouring terrestrial environments. The demanding intertidal environment, with high or changing salinity levels, hypoxia, flooding, tidal dynamics has generated conspicuous adaptations such as the 'breathing roots' and propagules, i.e. the water-borne and often viviparous dispersal units of many species. Many mangroves worldwide are dominated by species of the specialized genus *Rhizophora*, with aerial stilt roots, or of the specialized genus *Avicennia*, with aerial pencil roots. Mangroves are known to have ecological roles in coastal ecosystems, such as shoreline protection and a nursery role to marine and pelagic fauna, which appear to be overproportionate to their limited global area (in comparison to other biotopes). Human coastal communities worldwide often rely on such ecosystem services. The carbon sequestration role of mangroves has recently received much attention: per unit area it has been reported to exceed similar functions by the much better known tropical terrestrial forests.

The Vrije Universiteit Brussel has studied mangrove systems since about two decades, starting almost serendipitously through then informal collaboration with the University of Nairobi (Kenya) and the University of Ruhuna (Sri Lanka). The research has expanded from this modest start to a wide range of research lines, where the unusual aspect of obviously terrestrial clades adapted to 'rooting in the sea' is prevailing. In this contribution I will outline the genesis of this research and the challenges ahead.

Nitrous oxide dynamics in sea ice

Kotovitch Marie[1], François Fripiat[2], Sebastien Moreau[3], Fanny Van der Linden[1], Jean-Louis Tison[5] and Bruno Delille[1]

[1] Unité d'Océanographie Chimique, AGO, Université de Liège, Quartier Agora, Allée du 6 Août, 19 Bâtiment B5A, 4000 Liège, Belgium
E-mail: marie.kotovitch@ulg.ac.be

[2] Analytical and Environmental Chemistry, Vrije Universiteit Brussel, Belgium,

[3] Georges Lemaître Centre for Earth and Climate Research, Catholic University of Louvain, Belgium

[5] Glaciology Unit (DSTE), Université Libre de Bruxelles, Belgium

Fluctuations in greenhouse gases (GHGs) concentration alter the energetic budget of the climate system. There is high confidence that natural systems related to snow, ice and frozen ground (including permafrost) are affected. Nitrous oxide (N_2O) is one of the potent GHG naturally present in the atmosphere, but witch has seen his concentration growing since industrial era. N_2O has a lifetime in the atmosphere of 114 years and a global warming potential (GWP) of 298 to be compared to carbon dioxide that has a GWP of 1. N_2O is also describe as the dominant ozone-depleting substance emitted in the 21st Century. Yet, there are still large uncertainties and gaps in the understanding of the cycle of this compound through the ocean and particularly in sea ice. Sources and sinks of N_2O are therefore still poorly quantified.

The main processes (with the exception of transport processes) involved in the N_2O cycle within the aquatic environment are nitrification and denitrification. To date, only one study by Randall et al. present N_2O measurements in sea ice. Randall et al. pointed out that sea ice formation and melt has the potential to generate sea-air or air-sea fluxes of N_2O, respectively.

Study on ammonium oxidation and anaerobic bacterial cultures shows that N_2O production can potentially occur in sea ice. Denitrification can act as a sink or a source of N_2O. In strictly anaerobic conditions, N_2O is removed by denitrification. However, denitrification can also occur in presence of O_2 at trace level concentrations (>0.2 mg L^{-1}), and in these conditions there is a large N_2O production.

Recent observations of significant nitrification in Antarctic sea ice shed a new light on nitrogen cycle within sea ice. It has been suggested that nitrification supplies up to 70% of nitrate assimilated within Antarctic spring sea ice. Corollary, production of N_2O, a by-product of nitrification, can potentially be significant. This was recently confirmed in Antarctic land fast ice in McMurdo Sound, where N_2O release to the atmosphere was estimated to 4 µmol.m^{-2}.yr^{-1}. This assessment is probably an underestimate since it only accounts for dissolved N_2O while a significant amount of N_2O is likely to occur in the gaseous form like N_2, O_2 and Ar.

Finally, nitrification produces little N_2O in oxygenated waters but the N_2O production yield from nitrification strongly increases as O_2 levels decrease. Hence, it is not possible to distinguish the sources of N_2O solely based on bulk N_2O concentrations or environmental conditions, while deepened knowledge of processes is needed to well understand N_2O emissions.

Keywords: sea ice; biogeochemistry; nitrous oxide

Feeding of Antarctic asteroids - trophic resources, plasticity and diversity

Le Bourg Baptiste, Gilles Lepoint and Loïc Michel

Laboratory of Oceanology, MARE Centre, University of Liège, University of Liège B6C, Allee du 6 Aout 15, 4000 Liege (Sart-Tilman), Belgium
E-mail: baptiste.lebourg@student.ulg.ac.be

Antarctica is currently subjected to strong and contrasted impacts of climate change. While the Western Antarctic Peninsula is one of the most rapidly warming regions of the world, resulting in sea ice cover decreases, sea ice cover is increasing along East Antarctic coasts. Differences of temperature and sea ice cover changes between Antarctic regions is likely impact food web functioning through temperature-related changes in consumer physiology, modifications of benthic community structure (e.g. arrival of exogenous species such as predatory crabs), modifications of benthic-pelagic coupling intensity or disruption of benthic production. Asteroids are an important group of southern bentos. This group has also a great trophic variability and is potentially more resistant than other organisms to temperature changes. This research project proposes to investigate the trophic ecology of Antarctic asteroids using stomach contents and stable isotope analyses.

This research will be structured in two main axes. First, resources supporting asteroid communities will be identified in Western Antarctic Peninsula, where sea ice cover is decreasing, and in Terre Adélie, where sea ice cover is increasing. Second, through trophic niche width and overlap assessment and trophic level estimation, diversity and plasticity of asteroid diet will be studied along Antarctic coasts. Ultimately, this project will help understanding which ecological processes determine how an organism group copes with environmental modifications linked to climate change.

Keywords: sea stars; Antarctic; trophic ecology

EMBRIC - Bringing Europe's Marine Blue Bio-Economy forward

Mascart Thibaud[1], Tim Deprez[1], Karolien Deprez[2], Wim Vyverman[2] and Ann Vanreusel[1]

[1] Marine Biology research group, Department of Biology, Ghent University, Krijgslaan 281/S8, 9000 Gent, Belgium
E-mail: thibaud.mascart@ugent.be

[2] Laboratory of protistology and aquatic ecology, Department of Biology, Ghent University, Krijgslaan 281/S8, 9000 Gent, Belgium

The European Marine Biological Research Infrastructure Cluster (EMBRIC) is designed to accelerate the pace of scientific discovery and innovation from marine Bio-Resources. EMBRIC aims to promote new applications derived from marine organisms in fields such as drug discovery, novel foods and food ingredients, aquaculture selective breeding, bioremediation, cosmetics and bioenergy.

By conducting a comprehensive survey of available resources and techniques, EMBRIC will develop new pipelines and new industry standards.

By interconnecting science, industry and policy, EMBRIC will defragment regional research, development and innovation policies.

By implementing joint academia-industry development activities, EMBRIC will allow industry to directly integrate results and protocols in commercial processes.

By developing best practices and integrated training programs, EMBRIC will accelerate the pace of scientific discovery and innovation.

By connecting 6 existing European Research Infrastructures and 27 partners from Academia, Research institutes, non-for-profit organizations and industry, EMBRIC will facilitate technology transfer, knowledge transfer and transnational access.

The role of the Ghent University within EMBRIC is twofold:

- The marine biology research group, which has a long and outstanding tradition in coordinating training activities will be the EMBRIC work package leader on training and exchange of best practice.
- The laboratory of protistology and aquatic ecology will contribute to breeding and analysing improved microalgae for blue biotechnology applications

Finally, by clustering existing regional research infrastructures, joint academia-industry developments and by facilitating access and technology & knowledge transfer, EMBRIC will interconnect science, industry and policy and furthermore bring Europe's Marine Blue Bio-economy forward.

For more information: www.embric.eu

Keywords: EMBRIC; Europe; blue bio-economy; marine bio-resources; interconnect science and industry

Inter-observer reliability of fish vitality assessments: does the use of categorical or continuous scoring scales affect the Reflex Action Mortality Predictor (RAMP)?

Meeremans Pieter[1,2], Marc Kochzius[2], Noelle Yochum[3] and Sebastian Uhlmann[1]

[1] Institute for Agricultural and Fisheries Research (ILVO), Ankerstraat 1, 8400 Oostende, Belgium
E-mail: Pieter.Meeremans@vub.ac.be

[2] Marine Biology, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium

[3] Oregon State University, 104 Nash Hall, OR 97331 Corvallis, United States of America

To incentivise fishers to fish more selectively, the revised Common Fisheries Policy (CFP) includes an obligation to land all catches of quota-regulated species. From January 1st, 2016, it applies to some demersal fisheries and their target species and by 2019 to catches of all quota-regulated species. To stay viable, those fisheries that struggle to improve selectivity, may seek exemptions from this obligation. One exemption requires scientific evidence to demonstrate "high survival" of discarded fish. Based on international guidelines, methods have been developed in Belgium (Uhlmann et al., in press) to investigate the survival probability of plaice (*Pleuronectes platessa*). This was done using the reflex action mortality predictor (RAMP) approach, which relates status indicators such as vitality and/or injury to mortality probabilities. In other countries, this and similar techniques have been used. However, when several scientific observers with different levels of experience and training become involved in collecting vitality and injury data, there is potential for bias from subjectivity in measurement. To improve credibility of results and maximize accuracy, it is important to assess inter-observer reliability and evaluate whether any variability affects significance (if any) of a vitality-mortality relationship. For the RAMP approach, vitality and injury assessments are completed by scoring impairment in pre-established reflex action behaviour and injury categories. There are multiple ways to calcuate these 'scores', including categorically (i.e., injury/reflex action absent, weak, or present) or continuously (i.e., scale from 0-10). Scoring based on these two metrics may result in different relationships with mortality.

So far, 15 laboratory-held individuals of each plaice and common sole (*Solea solea*) were scored, using both the categorical and continuous metrics, by four different observers. Future trials will involve four days on-board the R/V *Simon Stevin* in February/March 2016, when at least three observers will simultaneously score each of ~400 beam-trawled plaice by using both categorical and continuous scoring scales. All scored plaice will be returned to laboratory holding facilities in Ostend and monitored for any mortality for 14 days. Based on these trials, we will create RAMPs using both categorical and continuous scoring data, and we will evaluate inter-observer variation. Through this analysis, we will be able to determine which RAMP scoring metric is less influenced by observer bias, and whether scores from multiple observers may be used as a proxy for survival (i.e., RAMP) to facilitate implementation of the landing obligation.

References

Uhlmann, S. S., Theunynck, R., Ampe, B., Desender, M., Soetaert, M., and Depestele, J. Injury, reflex impairment, and survival of beam-trawled flatfish. - ICES Journal of Marine Science, doi: 10.1093/icesjms/fsv252.

Sediment deposition affects biodiversity and ecosystem functioning in soft-sediment communities

Mestdagh Sebastiaan[1], Leila Bagaço[1], Ulrike Braeckman[1], Tom Ysebaert[2], Tom Moens[1] and Carl Van Colen[1]

[1] Marine Biology Research Group, Department of Biology, Ghent University, Krijgslaan 281/S8, 9000 Ghent, Belgium
E-mail: sebastiaan.mestdagh@ugent.be

[2] Netherlands Institute for Sea Research (NIOZ-Yerseke), Korringaweg 7, 4401 NT Yerseke, The Netherlands

Estuaries are worldwide affected by human activities such as pollution, fisheries, and the development of coastal infrastructure. A number of human activities, such as dredging or land use change in river basins, alter estuarine sediment transport processes and sediment loads. Changes in such sediment dynamics can have an impact on the biodiversity and functioning of the sediment bed community. For example, benthic macrofaunal organisms influence sediment chemistry and functioning through behavioural activities that affect the fluxes of energy and matter between the sediment and water column, i.e. benthic-pelagic coupling. Changes in macrobenthic community composition related to sediment change can therefore affect ecosystem-wide functioning.

To investigate the effects of sediment deposition on biodiversity and ecosystem functioning in estuarine sediment communities, a laboratory experiment was conducted with sediment samples collected from the Paulina mudflat, Westerschelde estuary (SW Netherlands). Sediment communities were incubated in the laboratory, where a layer of sediment was applied. Four different treatments were used, each of which corresponding to a different thickness of the added layer (0, 1, 2 or 5cm). During incubation at ambient temperature, water samples were taken for measurements of sediment community oxygen consumption, i.e. benthic mineralisation (SCOC). Additionally, bromide was used as a tracer for benthic bioirrigation activities, while luminophores were used to measure benthic bioturbation rates. After incubation, the macrofauna was extracted, identified and counted. Linear regressions were applied to assess the relationships between benthic processes, SCOC, and structural community attributes, e.g. population densities and diversity.

We found a significant decrease in community diversity and population densities of most species with increasing thickness of the deposited sediment. Furthermore, bioturbation and SCOC were negatively affected by the sediment deposition. Linear regression was used to assess relationships between functional parameters and community composition and diversity. Changes in community-wide processes and functioning were correlated with the deposition-induced change in density of some or just one single species. We conclude that sediment deposition can greatly influence the coupled biodiversity and functioning of the estuarine soft-sediment ecosystem.

Keywords: estuaries; bioturbation; bioirrigation; SCOC; macrobenthos; benthic-pelagic coupling

Trophic plasticity of Antarctic echinoids under contrasted environmental conditions

Michel Loïc[1], Bruno David[2], Philippe Dubois[3], Gilles Lepoint[1] and Chantal De Ridder[3]

[1] Laboratory of Oceanology, MARE Centre, University of Liege, Liege, Belgium, B6c, Quartier Agora, Allée du 6 Août 11, 4000 Liège, Belgium
E-mail: loicnmichel@gmail.com

[2] Biogéosciences, UMR CNRS 6282, Université de Bourgogne, Dijon, France,

[3] Laboratoire de Biologie Marine, Université Libre de Bruxelles, Brussels, Belgium

Echinoids are common members of Antarctic zoobenthos, and different groups can show important trophic diversity. As part of the ANT-XXIX/3 cruise of RV Polarstern, trophic plasticity of sea urchins was studied in three neighbouring regions (Drake Passage, Bransfield Strait and Weddell Sea) featuring several depth-related habitats offering different trophic environments to benthic consumers. Three families with contrasting feeding habits (Cidaridae, Echinidae and Schizasteridae) were studied. Gut content examination and stable isotopes ratios of C and N suggest that each of the studied families showed a different response to variation in environmental and food conditions. Schizasteridae trophic plasticity was low, and these sea urchins were bulk sediment feeders relying on sediment-associated organic matter in all regions and/or depth-related habitats. Cidaridae consumed the most animal-derived material. Their diet varied according to the considered area, as sea urchins from Bransfield Strait relied mostly on living and/or dead animal material, while specimens from Weddell Sea fed on a mixture of dead animal material and other detritus. Echinidae also showed important trophic plasticity. They fed on various detrital items in Bransfield Strait, and selectivity of ingested material varied across depth-related habitats. In Weddell Sea, stable isotopes revealed that they mostly relied on highly ^{13}C-enriched food items, presumably microbially-reworked benthic detritus. The differences in adaptive strategies could lead to family-specific responses of Antarctic echinoids to environmental and food-related changes.

Keywords: Antarctic; echinoids; feeding behaviour; stable isotopes; ecological plasticity; diet shift

Is TNT leaking into the North Sea?

Monteyne Els, Frederic Francken, Gijs Coulier and Koen Parmentier

Royal Belgian Institute for Natural Sciences, Operational Directorate Natural Environment, 3de en 23ste Linieregimentsplein, 8400 Oostende, Belgium
E-mail: emonteyne@naturalsciences.be

After World War I, an estimated 35,000 tons of ammunition was dumped in the North Sea offshore Knokke-Heist, on a shallow sandbank called 'Paardenmarkt'. It is estimated that apart from conventional artillery shells , roughly 12,000 tons consisted of chemical warfare. These shells contain toxic chemical agents such as CLARK (I and II) and Yperite (mustard gas). But not only the chemical warfare itself is toxic. One should also take into account the explosive compounds (mainly TNT), which can be equally toxic. While it is estimated that 1,200 tons of chemical compounds are dumped, the total amount of explosives on the Paardenmarkt is estimated to be at least 2,500 tons.

The Paardenmarkt ammunition dumpsite extends over 3 km^2 and is indicated on hydrographic maps with a pentagon, where neither fishing nor anchoring is allowed. Extension of the Zeebrugge harbor, increased beach nourishment works and nearby dumping sites for dredging activities in the Zeebrugge harbor and access channels to these harbor have led to increased siltation of the area, covering the ammunition with fine-grained sediments, rendering them anoxic. At present, there are no indications for acute danger and the best option therefore seems to leave the dumpsite untouched - under the precondition of regular monitoring. Since the mid nineties, seabed monitoring is done on a regular basis to map the erosion/accumulation processes, whereas chemical monitoring is done to screen for specific ammunition related compounds.

Additional research is required to assess the risk of possible leakage. A diffusion model of the toxicants leaking from the shells has been made in previous studies (Francken & Hafez, 2009). In order to validate and refine these models, actual measurements of TNT have to be performed. TNT has been suggested to bind strongly to sediments (Shen *et al.*,1998]. Passive sampling is a method to assess the labile fraction of TNT in sediments. For this purpose new methods have to be developed, using for example ceramic passive samplers or polydimethylsiloxane passive samplers. The analytical methods require to be very specific and with a high sensitivity to measure trace levels of TNT.

References

Francken, F., and A.M. Hafez, 2009. A Case Study in Modeling Dispersion of Yperite and CLARK I and II from Munitions at Paardenmarkt, Belgium. Marine Technology Society Journal, 43: 52-61. doi:10.4031/MTSJ.43.4.3

Shen, C.F., S.R. Guiot, S. Thiboutot, G. Ampleman and J. Hawari, 1998. Fate of explosives and their metabolites in bioslurrytreatment processes. Biodegradation, 8(5): 339-347.

Keywords: TNT; passive sampling; ammunition dumping site

Functional diversity of endosymbiotic bacterial communities in marine green algae

Morrissey Kathryn

University of Gent, Krijgslaan 281, 9000 Gent, Belgium
E-mail: kathryn.lee.mo@gmail.com

Siphonous green seaweeds are among the morphologically most complex algae and also among the most notorious invasive species in many parts of the world. Their ecological success has repeatedly been linked to their association with endo- as well as epiphytic bacteria. Indeed, recent studies based on 16S rDNA barcoding revealed rich associated bacterial communities. However, little is known about their functional diversity as well as the principles underlying their assembly. To address how bacteria contribute to the ecological success of siphonous green algae and whether the competitive potential of invasive species may be at least partly shaped by associated microbes, we will apply a metagenomic approach to analyse the functional diversity of epi- and endophytic bacterial communities associated with native and invasive species of Caulerpa.

In this study, natural populations of two Caulerpa species (C. cylindracea and C. prolifera) found along the Turkish coastline of the Izmir region were sampled. Addtionally, in situ experiments combined with lab experiments aimed at altering the abiotic conditions of the Caulerpa were conducted to assess the role of environmental factors in bacterial recruitment and microbiome stability. Characterization of bacterial communities involves Illumina-based 16S rDNA finger printing, combined with microbiome metagenome and transcriptome sequencing. In addition we will develop and apply DNA-stable isotope probing to label bacteria and hence provide detailed phylogenetic and functional information about the microorganisms responsible for the metabolism of a particular substrate.

Keywords: Caulerpa; bacteria; metagenomics; functional diversity; abiotic stresses

Extremely low genetic diversity in *Uca annulipes* (H. Milne-Edwards, 1937) in deforested mangroves

Nehemia Alex[1,2] and Marc Kochzius[1]

[1] Marine Biology, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium
E-mail: alexander_nehemiah@yahoo.co.uk

[2] Department of Biological Sciences, Sokoine University of Agriculture, P.O. Box 3038, Morogoro, Tanzania

The fiddler crabs *Uca annulipes* are common dominant species in mangrove forest. They are well known for their engineering activities of burrowing in sediments, which enhance soil aeration and makes unavailable food to be available for other marine organisms. Salt farming is a threat to mangrove ecosystem in some countries of Africa and Asia. It involves clearing of mangroves to pave the way for construction of solar pans. This study took place along the Tanzania coast, where about 75 % of the salt is produced in solar pans, which are located in mangrove areas. Mitochondrial Cytochrome Oxidase subunit I (COI) sequences from 138 and 126 individuals inhabiting mangrove sites around the salt ponds and sites with no salt ponds were used to investigate whether there is shift in genetic diversity due to salt farming activities. Extremely low genetic diversity was obtained from populations residing in deforested mangrove sites around salt ponds. The differences in genetic diversity between populations from mangrove sites around salt ponds and sites without salt ponds were significant ($p < 0.05$). The cause of this extremely low genetic diversity may be due to inbreeding within the populations that resulted from isolations of these populations due to fragmentation of the habitat. These results have implication on conservation of coastal resources and sampling strategy in the field.

Keywords: mangal forest; salt works; molecular markers; anthropogenic activities

Light and life beneath sea ice in the Canadian Arctic

Neukermans Griet, Guislain Bécu, Eric Rehm and Marcel Babin

ULaval, Pavillon Alexandre-Vachon, 1045 Avenue de la Médecine, Université Laval, Québec (Québec) G1V 0A6, Canada
E-mail: griet.neukermans@takuvik.ulaval.ca

In the last three decades, unprecedented changes have been observed in the Arctic. The region is warming two to three times faster than the global average, resulting in a rapid decline of extent and thickness of sea ice. This strongly influences light penetration and phytoplankton growth in the Arctic Ocean.

In the frame of the GreenEdge project, we monitored the development of a spring bloom of microalgae (sea ice algae, as well as phytoplankton) from an ice camp in April-July 2015 in Baffin Bay, Canadian Arctic. We observed strong variations in space and time of the spectral light intensity in the ice-covered water column and of the microalgae concentration and composition beneath sea ice. Early in the season, spatiotemporal changes in snow depth appeared to be the major driver of changes in light and life beneath the ice cover. For example, the contrast in snow depth between two sites, spaced 40 meters apart, resulted in an order of magnitude difference in the amount of light transmitted to the ocean beneath. Strong spectral differences in transmission were also observed owing to light absorption by ice algae, which bloomed in the low snow site but were absent from the high snow site. Complex irradiance profiles with sub-surface maxima were found in the high snow site caused by spatial heterogeneity in the overlying snow cover. The high spatiotemporal variability of light and life beneath sea ice poses great challenges for monitoring algal blooms in the Arctic's ice-covered waters.

More information of the GreenEdge project: http://www.greenedgeproject.info/

Blog of monitoring campaign in 2015: https://greenedgeproject.wordpress.com/

GreenEdge project educational site: http://www.aoa.education/

GreenEdge project documentary teaser, Parafilms Production: https://vimeo.com/141660727

Keywords: Arctic Ocean; phytoplankton; light; sea ice algae

A spatial data infrastructure (SDI) for integrated coastal zone management

Ngisiange Noah, Erick Okuku, Jelvas Mwaura, Joseph Kamau, Melchizedec Osore and Harison Onganda

Oceanography and Hydrography Department, Kenya Marine And Fisheries Research Institute, 81651, 80100, Mombasa, Kenya
E-mail: ngisiange@gmail.com

The coastal zone is a difficult geographical area to manage due to temporal issues (tides and seasons) and the overlapping of physical geography and hydrography (offshore, near shore, shoreline, inshore), of jurisdictions, legal mandates and remits of government agencies and the often competing needs of stakeholders. Typically, many different local, national and regional government agencies are responsible for different aspects of the same physical areas and uses of the coastal zone, e.g. fisheries, environment, transport (inland and marine) and urban planning. Given such diversity of interest groups, stakeholders, managerial authorities and administrative structures that converge at the shore, conflicts are almost inevitable between and among coastal users, managers, developers and the wider public, as well as between human society and the natural environment (Bartlett 2000).

Because of such complex physical and institutional relationships, a coastal SDI is developed that gives comprehensive information for generation of quick informed decisions towards effective and sustainable management. The main elements that the SDI promotes include mapping of key marine ecosystems surveys, species distribution, mapping of monitoring and restoration sites, mapping of community livelihoods through social economics surveys, mapping of distribution of community development, mapping of fishing grounds and key landing sites. All the surveys that have been undertaken have included the mapping aspect by use of a GPS to collect geographic information and embedded to the data. A spatial database is designed and developed ready for mapping using ArcGIS 10 and QGIS software. Maps have been developed based on different thematic area. The locations of interest include all the six counties along the coast region. The results indicate rich biodiversity distribution along the Kenyan coast and also the key areas that need management interventions. Also from this infrastructure we could depict which communities interact with which ecosystems and the projects that are running in support of livelihood for sustainability. This infrastructure inputs to the national spatial data infrastructure spearheaded by Survey of Kenya department.

Keywords: spatial data infrastructure; geographic information system; database; coastal; restoration; fisheries

The poly-B-hydroxybutyrate (PHB) regulate response of mussel larvae challenged with *Vibrio coralliilyticus*

Nguyen Van Hung, Nancy Nevejan, Peter De Schryver, Viet Dung Nguyen and Peter Bossier

Laboratory of Aquaculture and Artemia Reference Center, Department of Animal production, University of Ghent, Rozier 44, 9000 Gent, Belgium
E-mail: VanHung.Nguyen@Ugent.be

Marine invertebrates, including blue mussel (*Mytilus edulis*) lack an acquired, memory type immunity based on T-lymphocytes subsets and clonally derived immunoglobulins. Blue mussels rely solely on the innate immune mechanisms that include both humoral and cellular responses. Antimicrobial peptides are an important component of the humoral defense system in marine invertebrates, providing an immediate and rapid response to invading microorganisms. Poly-B-hydroxybutyrate (PHB) is a natural polymer that can be depolymerized into water-soluble short chain fatty acid monomers. Short chain fatty acids have been described as being bacteriostatic and capable of downregulating the expression of virulence factors of bacterial pathogens. To date, knowledge of the immune reactions in bivalve larvae and of the mechanisms of gene expression regulation by PHB is still limited.

In this study, we investigated the immune response of mussel larvae "in vivo", challenged with the pathogen *Vibrio coralliilyticus* (10^5 CFU mL^{-1}), in the presence or not of 1 mg L^{-1} amorphous PHB. The expression of three genes that code for the antimicrobial peptides (AMPs) *mytimycin, mytilinB, defensin* and one gene that code for the hydrolytic enzyme *lysozyme* was followed-up in time. RNA were isolated from mussel larvae tissue at 3, 6, 12, 24, 48 hours post-exposure to the pathogen and AMPs were quantified by q-PCR using 18SrRNA gene as a housekeeping gene.

Our data demonstrated that AMPs genes had a tendency to be upregulated in infected mussel larvae, and the strongest expression was observed from 24h post-infection onwards. The *lysozyme* gene, on the other hand, was expressed evenly during the whole exposure time to the pathogen. Compared to the expression of the *lysozyme* gene, *mytimycin* was expressed 530 times stronger and *mytilinB* 6 times more. The expression of *defensin* gene was found to be expressed 350 times stronger than lysozyme 48h post-infection. Additionally, our results confirmed that both *mytilinB* and *defensin* genes were expressed in 2days-old blue mussel D-larvae in contrast to earlier findings. We further found that PHB positively governs the expression of AMPs genes in infected mussel larvae 6h post-infection but did not have a significant impact on the expression of the *lysozyme* gene under the same stressor conditions.

Keywords: mussel larvae; PHB; gene expression; antimicrobial peptides; lysozyme; phenoloxidase activity; mytimycin; mytilinB; defensin

Influence of geometry, initial bathymetry and sediment availability on the morphodynamic evolution of the Scheldt mouth area, based on numerical modelling

Nnafie Abdel, Tomas Van Oyen and Bart De Maerschalk

Flanders Hydraulics Research, Berchemlei 115, 2140 Antwerpen, Belgium
E-mail: abdel.nnafie@mow.vlaanderen.be

We investigate effects of different geometries, initial bathymetries and sediment availability on the morphodynamic evolution of the Scheldt mouth area. Specifically, our investigation started from a simple model, excluding as many processes as possible (such as waves and winds), and schematizing tidal forcing and bathymetry. A comparison of observed characteristics of the flow field throughout the estuary with modeling results illustrates that this approach is sufficient to describe the main dynamics of the flow field.

When considering a real geometry, resemblance between modeled and measured bathymetry is obtained, but also significant differences. The simulated ebb-tidal delta (elongated channels on both the south and north sides of the mouth area, and the shoal area in between these channels) is comparable to present bathymetry. However, the shallow area in between these main channels is characterized by many small-scaled secondary channels, which do not occur in field observations.

Moreover, along the southern bank in the estuary (near Breskens), model results show the formation of an additional channel, which does not occur in observed bathymetry. Results in case of using an idealized funnel-shaped geometry reveal that an ebb-tidal delta develops in the mouth area only in case of a narrow transition between this area and estuary. This result suggests that the present narrow transition between estuary and its mouth area plays a profound role on the present-day bathymetry.

Results regarding different initial bathymetries demonstrate that increasing the initial depth of the mouth area weakens the channelization of the ebb-tidal delta that forms in this area. Moreover, the resulting ebb-tidal delta in this area expands less seaward than those that develop in case of a shallower initial depth. These results highlight the significant influence of depth changes on morphodynamics of the mouth area, thereby pointing out possible importance of sea level rise on the present-day morphology.

When accounting for spatial variations of thickness of erodible sediment layers, results show that simulated channels are less pronounced compared with the case when layer thickness is constant. Moreover, small-scale secondary channels seem to be reduced in the shoal area.

Keywords: morphodynamics; Scheldt estuary; ebb-tidal delta; elongated tidal bars

Long-term phytoplankton monitoring data (1970-2015) from the Belgian North Sea reveal shifts in community composition and seasonal dynamics

Nohe Anja[1], Ruth Lagring[2], Karien De Cauwer[2], Annelies Goffin[3], Lennert Tyberghein[3], Klaas Deneudt[3], Wim Vyverman[1] and Koen Sabbe[1]

[1] Protistology and Aquatic Ecology, Department of Biology, Ghent University, Krijgslaan 281/S8, 9000 Gent, Belgium
E-mail: Anja.Nohe@UGent.be

[2] Belgian Marine Data Centre (BMDC), Operational Directorate Natural Environment, Royal Belgian Institute of Natural Sciences, Gulledelle 100, 1200 Brussels, Belgium

[3] Flanders Marine Insitute (VLIZ), Wandelaarkaai 7, 8400 Oostende, Belgium

Long-term monitoring programs are essential for detecting trends and changes in marine ecosystem species composition and biomass in view of climate change and other anthropogenic impacts (such as eutrophication and modified nutrient cycles). Long-term monitoring programs however are time-consuming and costly and are therefore generally rare, not really 'long-term' or miss a sufficient temporal resolution (Wiltshire et al. 2010). While in our neighbouring countries (the Netherlands, Germany and France) phytoplankton monitoring programs have existed for several decades, Belgium lacks a coordinated program. In the framework of the 4DEMON (www.4demon.be) BRAIN-be project, we have compiled and intercalibrated all available datasets on phytoplankton species composition and biomass from the Belgian part of the North Sea from the 1970s onwards. Because there is a lack of data from the 1980s and 1990s, we compared phytoplankton species composition and biomass data between the 1970s and 2000s. We uniquely focused on diatoms and dinoflagellates, which are two important components of the phytoplankton in the BPNS. First analyses have shown that diatom and dinoflagellate abundances have increased during the last decades. The dinoflagellate to diatom abundance ratio has increased in favour of dinoflagellate species. The seasonal distribution patterns also reveal remarkable shifts. While diatoms exhibited in the 1970s two defined blooms, a large spring peak and a smaller peak in late summer, the diatom winter abundances have increased significantly in later years and can reach abundances similar to the spring and late summer blooms. Also dinoflagellates showed two peaks in the 1970s, a small peak in late spring and a second bigger peak in late summer/early autumn. In the 2000s, dinoflagellates revealed variable seasonal cycles with years with only one single bloom. Furthermore, our data shows an upward trend of several phytoplankton genera (e.g. *Pseudo-nitzschia*, *Guinardia*, *Thalassionema*, *Prorocentrum*, *Protoperidinium* etc.).

References

Wiltshire KH, Kraberg A, Bartsch I, Boersma M, Franke HD, Freund J, Gebuhr C, Gerdts G, Stockmann K, Wichels A. 2010. Helgoland Roads, North Sea: 45 Years of Change. Estuaries and Coasts 33:295-310.

Keywords: Belgian North Sea; biodiversity; diatoms; dinoflagellates; time-series analysis

Assessment of Biodiversity, Socio-Economic Status and Conservation Options at the Kisite- Mpunguti Marine Park in South Coast, Kenya

Horace Owiti Onyango, Jacob Ochiewo, Faith Kimanga and Richard Angwenyi

Kenya Marine and Fisheries Research Institute, Mkomani, Silos Road, Po Box 81651-80100, Mombasa, Kenya
E-mail: owitihorace@yahoo.com

In order to address the challenges faced by the existing conventional MPAs and the less conventional community managed conservation areas that are increasingly coming up, it is important generate scientific data from both the biophysical and socioeconomic spheres to guide decision-making while at the same time taking cognizance of emerging socioeconomic issues such as oil and gas exploration that were not there when the first conventional MPAs were established. An assessment was conducted on the socio-ecological and economic issues that relate to the interaction and effectiveness of conservation and sustainable use of biodiversity resources at Kisite- Mpunguti Marine Park in the Kenya South Coast. A combination of questionnaire, key informant interview and observation techniques were used to establish resource users' perceptions towards the status of local biodiversity. Results indicate that: overdependence on biodiversity resources for consumption; inequity in ownership and access to natural resources including benefits from use and conservation of biodiversity; inadequate knowledge and inefficient use of information; and legal and institutional systems that promote unsustainable exploitation, are the major conservation challenges faced by the respondents. 81% of interviewees said that there were heavily degraded local sites, and among these 93% were optimistic that these sites could still be rehabilitated while also suggesting possible methods of doing so. It is recommended that the social, cultural and economic context for conservation and sustainable use measures should involve community participation and use of local knowledge; and the curbing of destructive or unsustainable uses by those who are uninterested or uncaring. There is need to provide support for on-going community conservation initiatives (*tengefu*) and development of joint-management programs which "do not seek to replace traditional forest practices and fishing activities but augment them. Successful joint management requires a significant transfer of responsibility from state agencies to villagers.

Keywords: biodiversity; marine protected areas; conservation and management

Socio-Economic Assessment of Artisanal Shrimp Fishery of the Malindi Ungwana Bay

Horace Owiti Onyango

Kenya Marine and Fisheries Research Institute, Mkomani, Silos Road, Po Box 81651-80100, Mombasa, Kenya
E-mail: owitihorace@yahoo.com

The importance of Malindi Ungwana Bay prawn fishery is indisputable, given that it hosts Kenya's only prawn trawling industry and supports livelihoods of thousands of artisanal fishers and their dependants. While the contribution of the prawn trawl fishery has generated data for management, the artisanal shrimp fishery which is conducted along the near-shore areas that are also the feeding and nursery grounds of critical larval and juvenile stages of these shallow water penaeid shrimps has not been fully understood thus resulting in difficulties in coming up with effective management regimes. This study focused on the socio-economic conditions of the artisanal prawn fishermen and their perception towards bottom trawl in order to understand the effectiveness of the Prawn Fishery Management Plan 2010 in minimizing resource-use conflicts and to guide in revision of the existing management plan. A combination of questionnaire survey, participant observation, and key informant interviews were used to collect data. Results reveal that the prawn fishers are involved in professional, seasonal or subsistence fishing. Prawn catches from the bay have declined significantly because of climate change (54%), use of destructive fishing gears (25%), and overfishing (21%), thereby threatening the health of the bay's ecosystem as well as the future of small-scale fishery. We evaluate various social, economic and ecological challenges faced by the prawn fishers and propose a conceptual framework that recognizes linkages among social, economic and ecological aspects in devising a sustainable prawn fishery management system. We recommend effective enforcement of policies and regulations, strong institutional collaboration and active fisher community participation in management to ensure sustainable use of the resource base.

Keywords: prawn fishery; management plan

MarineRegions.org: a standard list of marine georeferenced place names and areas

Oset Garcia Paula, Simon Claus, Nathalie De Hauwere, Bart Vanhoorne, Francisco Souza Dias, Francisco Hernandez and Jan Mees

Flanders Marine Institute (VLIZ), Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: info@marineregions.org

One of the data systems that are being developed and managed within the LifeWatch taxonomic backbone framework is Marine Regions. This system serves as the geographic backbone for large-scale integrated marine biogeographic databases. The system is an integration of the VLIMAR Gazetteer (Claus et al, 2010) and the VLIZ Maritime Boundaries Geodatabase (Claus et al, 2014).

The identity of each marine geo-object within the database is given by the Marine Regions Geographic IDentifier (MRGID), which is unique and persistent. Each different geo-object is defined by a place type (administrative or physical) and its vector coordinates (either point, line or polygon), but can have multiple synonyms. The structure of the database is an open hierarchy where each geographic unit points to one or more other units applying different relation types. Such hierarchical structure is essential to integrate quantitative and qualitative natural history and distributional data (Reusser and Lee, 2011).

Marine Regions is connected to different data and information systems, such as the World Register of Marine Species (WoRMS) and its Global Species Databases, the MarBEF Data System, the SCAR-Marine Biodiversity Information Network or the Integrated Marine Information System (IMIS). By linking Marine Region's MRGIDs with species unique AphiaIDs (Vandepitte et al, 2015) the geographical distribution of species can be obtained and visualised. Moreover, the Marine Regions gazetteer is one of the main geographical web services that are offered within the LifeWatch virtual e-Lab. Using these web services allows the user to retrieve a list of marine species per geographical area, a distribution list of geographical areas per species, or to perform quality control of biodiversity datasets.

With regards to content, Marine Regions provides regional and global checklists, integrates several thematic gazetteers and provides geographic data on different administrative or managerial areas and boundaries. The amount of data has nearly tripled since 2005, from 14,332 geo-objects to the current 47,449 marine geographic places with more than 60,945 place names (as of January 2016). The number of unique visitors to the Marine Regions portal has increased in the last two years from 50294 to 86793. The number of downloads per year has constantly increased from 859 in 2008 (when statistics begin) to 8784 in 2015.

References

Claus, S.; De Hauwere, N.; Vanhoorne, B.; Deckers, P.; Souza Dias, F.; Hernandez, F.; Mees, J. (2014). Marine Regions: Towards a global standard for georeferenced marine names and boundaries. Mar. Geod. 37(2): 99-125

Claus, S.; De Hauwere, N.; Vanhoorne, B.; Hernandez, F. (2010). The VLIMAR Gazetteer: a standard for marine geographic features, in: Fichaut, M. et al. (Ed.) (2010). International Marine Data and Information Systems Conference IMDIS 2010, 29-31 March 2010, Paris, France: Book of abstracts. pp. 185

Reusser, D. A., and H. Lee, 2011. Evolution of natural history information in the 21st century – developing an integrated framework for biological and geographical data. Journal of Biogeography 38:1225–1239

Vandepitte, L.; Vanhoorne, B.; Decock, W.; Dekeyzer, S.; Trias Verbeeck, A.; Bovit, L.; Hernandez, F.; Mees, J. (2015). How Aphia - the platform behind several online and taxonomically oriented databases - can serve both the taxonomic community and the field of biodiversity informatics. J. Mar. Sci. Eng. 3(4): 1448-1473

Coastal Land Use and Land Cover: the missing link to the Large Marine Ecosystem Assessment Framework

Ouellette William and Wondifraw Getinet

IOC-UNESCO, 7, Place de Fontenoy, 75352 PARIS 07 SP, France
E-mail: william.ouellette@gmail.com

The intergovernmental Oceanographic Commission (IOC) of UNESCO is leading the assessment of Large Marine Ecosystems (LMEs). These LMEs provide a diverse range of ecosystem services that are of immense socio-economic value to the countries bordering them. A central theme to the LMEs assessment is the impact of natural and anthropogenic stressors on marine ecosystems and the sustainability of ecosystem services. Through a conceptual framework that illustrates the interaction between natural and human systems, the consequences of these impacts on humans can be assessed. Currently, the LMEs assessment is based on six themes: productivity, fisheries, habitats, pollution, socio-economics and governance. For each theme, a number of indicators of current status and future projections are available allowing for a global comparative assessment of all 66 LMEs and the Pacific Warm Pool and to identify the ones most at risk and where human dependency is greatest.

The LMEs assessment is not currently taking into account land use and land cover changes in their coastal vicinity. Through processes like Integrated Coastal Area Management (ICAM), it has been recognized that terrestrial sectors like agriculture, forestry and industries hold a high stake in coastal development. Therefore, excluding the monitoring of land cover and land use (LULC) changes occurring in coastal areas does not give the full picture of the state of LMEs worldwide. In this research, the additional theme of coastal LULC is suggested as the missing link of the LMEs assessment program. Drivers of LULC often relate to socio-economic indicators, which are already well documented. However, socio-economic factors do not always impact marine and coastal ecosystems in a direct manner, but first through LULC, which in turn interacts with the sea. For instance, water quality is the most obvious example of impacts of LULC (e.g rapid urbanization, deforestation for agricultural land) on marine and coastal areas. Accelerated coastal erosion due to coastal wetlands and mangrove loss is also an important stressor on coastal and marine ecosystems and its ability to provide ecosystem services to communities who depend on them.

In order to achieve these objectives, a variety of satellite-derived open-source global and regional land cover products from the period 2000 and 2014 have been used to assess the change in forest, agriculture and urban cover, the land cover classes most accurately estimated at reasonably high spatial resolution on a global scale, and the ones impacting coastal and marine ecosystems the most. The analysis is performed at the buffer distances of 10 km, 20 km, 50 km and 100 km inland from the shoreline, and the LULC change data is made available on a per-LME basis through a Web Feature Service (WFS). The derived LULC data is then compared with data from other LMEs assessment themes (i.e. socio-economic and demographics) to look for correlations in the datasets. The main goal of this research is to fulfil the data gap in the LMEs assessment undertaken by IOC and GEF under the Transboundary Water Assessment Program (TWAP), thus recognizing the importance of the land component in assessing LMEs and of the ICAM approach in the sustainable management of our marine and coastal areas.

Keywords: large marine ecosystems; LMEs; coastal areas; global land use; global land cover changes; LULC; socio-economic activities; integrated coastal area management; GIS; remote sensing

The blue economy in Belgium

Overmeire Ann

Flanders' Maritime Cluster, Slijkensesteenweg 2, 8400 Oostende, Belgium
E-mail: ann.overmeire@flanders-maritime-cluster.be

Flanders' Maritime Cluster (FMC) is the cluster organisation for the marine and maritime industry in Flanders, located in Ostend. The themes covered by FMC are coastal defence, offshore energy and marine aquaculture. The activities of the cluster organisation comprise networking events, facilitating collaborative innovation projects, development of test and demonstration locations at sea, and (international) promotion of the blue sector. Together with partners like VLIZ, we strive that the Flemish government would recognize the blue economy as a spearhead cluster.

Meet the company: International Marine & Dredging Consultants (IMDC)

Pandelaers Cleo and Mark Bollen

IMDC, Van Immerseelstraat 66, 2018 Antwerpen, Belgium
E-mail: cleo.pandelaers@imdc.be

For over 30 years IMDC provides specialized, water-related engineering and consultancy services for governmental departments, contractors, the European Community, the World Bank, port authorities and industrial agencies. From the very start IMDC has been systematically expanding its knowledge through research and development activities which are implemented in close collaboration with a broad range of European universities and research entities. IMDC has been active in over 50 countries worldwide, thus establishing a strong international reputation.

Our staff
The background of the IMDC staff ranges from research scientists and experienced engineers to qualified technicians. Besides hydraulic and civil engineers, IMDC staff also includes oceanographers, bio-engineers, chemists, ecologists, geologists and geographers.

Our projects
The IMDC products consist of studies (feasibility, master plans, pre-designs), designs, tender documents, environmental impact assessments, plans for infrastructure projects, surveys, procurement assistance and supervision during construction for offshore wind farm projects, ports and coastal infrastructure in Belgium and abroad.

The fields of expertise of IMDC are:

- Marine & estuarine systems: Our capacity to analyse complex hydrodynamic and morphological systems is based on thorough knowledge of the physical processes combined with detailed in-situ survey campaigns. This enables us to provide solutions for harbour siltation and salt intrusion problems, thermal spreading and turbidity plumes.
- Dredging: IMDC can cover just about any stage of a dredging project, ranging from an initial site visit to detailed designing efforts, drawing up contract documents and budget estimates, to supervision and expert missions.
- Coastal engineering: Due to the global sea level rise, coastal protection is becoming a hot issue. IMDC provides an extensive range of services based on the combination of profound theoretical know-how in hydraulics, morphology and risk analysis as well as broad experience in technical solutions. Our preference goes to natural and sustainable options wherever feasible.
- Port & offshore engineering: IMDC focuses on the hydraulic design in Master Planning, port layouts, erosion protection structures and breakwaters. In the offshore field we provide wave analysis and morphological studies, scour protection design, optimisation of cable and pipeline routes.
- Blue energy: Thanks to its extensive hydraulic know-how, IMDC is able to contribute to not only finding the best options for offshore wind farms but also to participating in studies which identify possibilities for wave and tidal energy solutions.
- River basin management: The management of river basins requires an integrated and sustainable approach based on an exhaustive knowledge of hydrology and hydrodynamics. IMDC can provide a wide range of services such as detailed river modelling, real time flood forecasting and flood mapping, inundation risk analysis and flood risk management plans.
- Waterways & inland navigation: Based on thorough knowledge of both natural and man-made waterways we can provide solutions for waterborne transport needs including the definition of required river training works, the reduction of maintenance needs and the conservation of ecological values in vulnerable stretches.
- Hydraulic design: An erroneous design of water intakes or outlets often leads to suboptimal solutions with excessive abrasion and/or recirculation problems. IMDC can provide an in-depth analysis of hydraulic systems (water intakes, outlets, pipeline systems and sea outfalls). The proper definition of requirements will lead to an economical design with low maintenance costs during the exploitation of the system.
- Environmental studies: Our primary environmental concern goes to water-related problems, with special attention given to reducing the ecological impact of hydraulic works and dredging projects. We encourage the beneficial reuse of dredged material and a permanent monitoring effort to understand and minimise the on-site impact of marine activities.

- Measurements : IMDC organises project specific measurement campaigns to acquire the necessary data for any complex hydrodynamic or sediment related problem. We work with the most up-to-date equipment, a great deal of which is developed in-house.

ENGIE-Tractebel Engineering
IMDC is also able to offer the facilities of its parent company, the Tractebel Engineering group, an ENGIE Company, for any large project as well as for the consultation of any expertise within their wide range of engineering tasks.

Catalogue 'Marine Research Infrastructure' - Compendium for Coast and Sea

Pirlet Hans, Thomas Verleye, Ann-Katrien Lescrauwaet and Jan Mees

Flanders Marine Institute (VLIZ), Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: hans.pirlet@vliz.be

In November 2015, the second version of the Compendium for Coast and Sea was launched. The Compendium is an integrated knowledge document about the socio-economic, environmental and institutional aspects of the coast and sea in Flanders and Belgium. The document aggregates disperse information and data from Flemish and Belgian marine and maritime research in order to increase the communication within the network of marine experts and to enhance the visibility and accessibility of marine research. This initiative is the result of intense cooperation with a network of experts and is coordinated by the Flanders Marine Institute (VLIZ).

The backbone of the Compendium for Coast and Sea is constituted by an extensive background document, which can be digitally consulted in both Dutch and English on the website www.compendiumkustenzee.be. Chapter 1 of the background document describes the Belgian marine scientific landscape, whereas Chapter 2 provides a summary of the knowledge on the different user functions of the coast and sea.

In the context of the Compendium for Coast and Sea, a number of derived communication products were developed such as the Catalogue 'Marine Research Infrastructure'. This publication discloses the research infrastructure (RI) which is available in the Belgian marine research groups (MRGs), affiliated to universities, graduate schools and scientific institutes. The goal of this catalogue is to provide an overview of the (technical) expertise of the MRGs, stimulate collaboration and optimise the use of the available RI. Furthermore, this publication can be used as an input for international, European and national marine science policy and mapping initiatives. To this purpose, a framework was developed with two levels of hierarchy in order to report the available RI in a standardised way. The catalogue is interactively accessible on www.compendiumkustenzee.be.

References

Pirlet, H.; Verleye, T.J.; Lescrauwaet, A.-K.; Mees, J. (Ed.) (2015). Catalogue 'Marine Research Infrastructure. Flanders Marine Institute (VLIZ): Oostende. ISBN 978-94-920431-5-3. 129 pp.

Keywords: Compendium for Coast and Sea; research infrastructure

The secret life of a Mediterranean seagrass litter macrofauna community : a history of oxygen.

Remy François[1], Loïc Michel[1], Nicolas Sturaro[1], Thibaud Mascart[2] and Gilles Lepoint[1]

[1] Laboratory of Oceanology; Department of Ecology, Biology and Evolution, Université of Liège, Allée de la Chimie, 3, Building B6C, 4000, Liège, Belgium
E-mail: francois.remy@ulg.ac.be

[2] Marine Biology research group, Department of Biology, Ghent University, Krijgslaan 281/S8, 9000 Gent, Belgium

Most of the foliar primary production of *Posidonia oceanica*, a major Mediterranean seagrass, sheds in autumn and is exported from the meadow to adjacent areas to form "Exported Macrophytodetritus Accumulations", EMAs. These EMAs are a habitat, shelter and feeding place for an abundant and diverse community of macrofauna. Being very dynamic places and potentially playing a role of transition compartment between water column and sediment, EMAs present high variability in term of physicochemical conditions and more specifically in term of oxygen concentration. Mild to severe hypoxic periods (2 - 0.01 mL O_2.L^{-1}) can be observed *in situ* at different moments of the year, and this variability thus potentially play a structuring role on the macrofauna community. During this study, our main specific questions were (1) Does oxygen stratification occur inside EMAs? (2) If present, how long does it take to observe this stratification? (3) Is the macrofauna impacted and do the dominant species occupy defined positions inside the different micro-habitats?

To assess the importance of this impact, an experimental study was conducted in October 2014 near the STARESO oceanographic station (Calvi, Corsica) using an original "layer-sampling" design. The experimental construction was put underwater inside an EMA for 48 hours at a depth of 8m. Samples were collected (N=8) in a 20cm thick EMA using "sealed" boxes to sample every 5cm, from the sediment, to the water column. Oxygen, nutrients and of course the litter itself (containing the macrofauna) were sampled carefully to make sure no exchange occurred between the 4 different layers.

After data analysis, the assessment was clear: oxygen stratification occurred in less than 48h and oxygen level inside the layer close to the sediment experienced a fast decrease below the hypoxia threshold (2 mL O_2.L^{-1}). Diversity was highly impacted, showing a clear positive link with oxygen concentration. Macrofauna also appeared to follow this oxygen stratification but this response was very species specific. Some species didn't follow oxygen and are present in every layer and most of them were strongly positively linked to oxygen concentration.

But a few (*Nebalia strausi* and *Athanas nitescens*) were strongly negatively linked to oxygen concentration and were present only in the more hypoxic layers.

This experimentation thus confirmed our *in situ* observations. Oxygen stratification occurred quickly (< 48h) when EMAs were experiencing calm weather. This stratification observed from the water column to the sediment was very marked. Diversity and abundance of most abundant macrofauna species were drastically influenced by this stratification, showing the importance of these micro-habitats in structuring of this macrofauna community.

Keywords: macrofauna; hypoxia; oxygen; seagrasses; Posidonia oceanica; invertebrates

Lifewatch acoustic receiver network: setup of a PostgreSQL database, web interface and collaborative environment to cope with big data

Reubens Jan[1], Pieterjan Verhelst[2], Klaas Deneudt[1] and Francisco Hernandez[1]

[1] Flanders Marine Institute (VLIZ), Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: Jan.Reubens@UGent.be

[2] Marine Biology Department, Ghent University, Krijgslaan 281/S8, 9000 Gent, Belgium

Technology does not stand still and it helps researchers to perform high-quality scientific research. Improving technology allows us to gather continuous information on ocean processes, animal behaviour and environmental variables using automated devices. The acoustic receiver network for instance, allows flexible and cost-efficient spatio-temporal tracking of migratory fish species. This network uses acoustic telemetry to gather the data. In the framework of LifeWatch (http://www.lifewatch.be), which was established as part of the European Strategy Forum on Research Infrastructures, the Flanders Marine Institute (VLIZ) and the Research Institute for Nature and Forest (INBO) created this receiver network to support biodiversity research and environmental impact studies. The network currently consists of 88 receivers, covering both the Belgian part of the North Sea, the Western Scheldt Estuary and the river Scheldt. Detailed observations of animal movements and behaviour in relation to the aquatic environment can significantly improve our understanding of ecosystem functioning and dynamics (e.g. migration routes, spatio-temporal habitat use and migratory behaviour). In addition, it provides the scientific basis for fisheries management, species protection, marine spatial planning and environmental impact assessments.

But having a network of devices, each able to capture up to 1.6 million detections, leads to big data. Big data easily goes beyond the limits of normal spreadsheets, requires a lot of RAM memory and requires (too) much calculating power from your personal computer when performing the analyses. Thus, we have to look for alternative solutions to work with this kind of data.

VLIZ hosts a PostgreSQL database able to store all the information. The database is linked to a collaborative environment (R-server) where all analyses of the data can be performed and results can be visualized using the R-shiny application. To facilitate the data-entry for researchers, a web interface was developed in PHP using symphony framework. There are several entry forms to manage metadata on receivers, tags and animals and upload the detections into the database in an automated way.

This database is a first step towards an European animal tracking network. Such a network will: 1) improve the capacity to monitor large scale movements of marine animals, 2) foster cooperation between scientists across borders and 3) foster efficient use of resources and compete for large scale European funding opportunities.

Do you want to know more? Visit us at the LifeWatch Demo boot!

Keywords: sensors; acoustic receivers; big data; collaborative environment; database

Does pulse trawling force plaice onto a different diet?

Ribeiro Maria[1], Charlotte Desmet[1], Jozefien Derweduwen[2], Lorna Teal[3], Bart Vanelslander[3] and Jochen Depestele[2]

[1] Ghent University, Marine Biology, Krijgslaan 281-S8, 9000 Gent, Belgium
E-mail: maria.i.c.m.r@gmail.com

[2] Institute of Agricultural and Fisheries Research (ILVO), Ankerstraat 1, 8400 Oostende, Belgium

[3] Institute for Marine Resources and Ecosystem Studies, Wageningen IMARES, PO Box 68, 1970 AB, Ijmuiden, The Netherlands

Introduction
Beam trawl fisheries are one of the more important fisheries in the North Sea. Beam trawling has a significant impact on the physical properties of the sea floor, and on the benthic fauna inhabiting the substrate. The benthic animals may be killed directly by the passage of a beam trawl, they may be caught by the gear and subsequently discarded dead or alive or they may escape the passing gear. Scavenging organisms may profit from dead, stressed or injured organisms following a beam trawl's passage. Several beam trawlers have replaced their tickler chains by electrodes to catch Dover sole (*Solea solea*) and European plaice (*Pleuronectes platessa*). This reduces the intensity of physical contact with the seabed and may hence alter the mortality of benthic organisms in the wake of the gear passage. Our study investigated the contribution of moribund or dead benthic organisms from beam trawling to the diet of European plaice and compared differences in diet between areas impacted by tickler chains and areas where electric pulses were used.

Material & methods
Two experimental sites of 1 km by 150 m were delineated in the Dutch part of the southern North Sea (Frisian Front). Fishing disturbance took place along the longitudinal direction of the experimental site by either a 12 m tickler chain beam trawler or a 12 m pulse trawler. The gears were hauled after the first passage across the experimental site (i.e. without prior fishing disturbance) and plaice stomachs were collected. Fishing continued in the experimental sites for up to 13 passages across the site. Stomach samples were collected again after the trawls had passed multiple times across the experimental sites. Trawling took place during summer and in daylight hours. In total 280 plaice stomachs were analysed for individuals ranging between 15 and 37 cm, of which 80 stomachs were collected prior to fishing.

Results and discussion
The diet of plaice in the Frisian front was numerically dominated by annelids (*Scalibregma inflatum*, *Lumbrineris* sp.). The weight of the stomach content was, however, primarily determined by larger organisms such as sea potatoes (e.g. *Echinocardium cordatum*) and bivalves (e.g. *Nucula nitidosa*). Annelids particularly dominated the diet of smaller individuals, whereas larger individuals also predated on other prey species like the masked crab *C. cassivelaunus*. Preliminary analyses indicated that the diet of plaice changed significantly after fishing disturbance as indicated by an increased stomach fullness and species number in the stomachs. The consumption of small annelids and especially the deep burrowing species *S. inflatum*, increased significantly, although its gravimetrical contribution remained low. Changes in diet composition were particularly apparent after trawling with tickler chain beam trawls. The preliminary analyses indicate that plaice increases its foraging efforts after trawling by predating on smaller annelids. The replacement of tickler chains by electrodes reduces the change in the diet of plaice but does not seem to eliminate it.

Acknowledgments
The study was financed by the EU FP 7 project BENTHIS (grant no. 312088; www.benthis.eu).

Genetic diversity of the tiger prawn *Penaeus monodon* in relation to metal pollution at the Tanzanian coast

Rumisha Cyrus[1,2], Martine Leermakers[3], Marc Elskens[3], Robinson H. Mdegela[4], Paul Gwakisa[5] and Marc Kochzius[1]

[1] Marine Biology, Department of Biology, Vrije Universiteit Brussel (VUB), Pleinlaan 2, 1050 Brussels, Belgium
E-mail: ckrumisha@yahoo.com

[2] Department of Biological Sciences, Sokoine University of Agriculture, 3038 Morogoro, Tanzania

[3] Analytical, Environmental and Geo- Chemistry, Department of Chemistry, Vrije Universiteit Brussel (VUB), Pleinlaan 2, 1050 Brussels, Belgium

[4] Department of Veterinary Medicine & Public Health, Sokoine University of Agriculture, 3021 Morogoro, Tanzania

[5] Department of Veterinary Microbiology and Parasitology, Sokoine University of Agriculture, 3021 Morogoro, Tanzania

Pollution of coastal ecosystems is currently a world wide problem. This environmental problem is inevitable in developing countries such as Tanzania that largely depend on extractive industries from natural resources for economic development. Previous studies reported the inefficiency of waste treatment facilities in the country to contain harmful trace metals (Kihampa, 2013), and hence the growing industrial sector and coastal urban population is likely to aggravate the contaminantion of the coastal areas. Accumulation of metals in coastal waters can disrupt migration patterns and induce genotypic selection of torelant and elimination of intorelant genotypes (Mussali-Galante et al., 2014). High levels of metals in coastal waters can also significantly reduce the population size, leading to inbreeding and genetic drift. This affects the genetic variability of the population, which is the basis for adaptation. Metal pollution which has been reported in various sites in the country (Kruitwagen et al., 2008; Rumisha et al., 2012), may affect prawn fisheries. This study was conducted to assess the genetic variability of tiger prawns in relation to metal pollution along the Tanzanian coast. Approximately 159 individual tiger prawns and 120 sediment samples were collected from eight sites along the coast for analysis of trace metals and genetic diversity. Our results show insignificant correlation (Spearman's rank correlation coefficient (r) = -0.28) between gene diversity by loci of tiger prawns at the Tanzanian coast and the degree of contamination at different sites which ranged from low to moderate. Comparisons were also made for individual metals, because the index for degree of contamination is a measure of total metal content at a site. Results showed that the average gene diversity was insignificantly correlated with the measured elements. However the effective number of alleles (Ne) was significantly negatively correlated with Co, Cr and V enrichment (r between Ne and Co, Cr, and V, was -0.76, -0.81, and -0.71, respectively). The number of alleles was also negatively correlated with the concentration of Cu in tissues of tiger prawns (r = -0.85). The moderate degree of genetic differentiation measured between sites (mean Fst= 0.069), could account for the lack of association between the average gene diversity and the level of metals in the environment and tissues. Five out of the 13 microsatellite loci analysed, showed an average migration rate of at least 2, suggesting that, there is moderate gene flow across the coastline. Migration between low and moderately contaminated sites masks the effects of pollutants on gene diversity, because migrants contrubute alleles to the receiving population. A much clear pattern is anticipated when more loci will be analysed. Neverthless, the present results provide preliminary information on the patterns of genetic diversity in relation to metal pollution on the Tanzania coast.

References

Kihampa, C., 2013. Heavy metal contamination in water and sediment downstream of municipal wastewater treatment plants, Dar es Salaam , Tanzania. Int. J. Environ. Sci. 3, 1407-1415. doi:10.6088/ijes.2013030500011

Kruitwagen, G., Pratap, H.B., Covaci, A., Wendelaar Bonga, S.E., 2008. Status of pollution in mangrove ecosystems along the coast of Tanzania. Mar. Pollut. Bull. 56, 1022-1042. doi:10.1016/j.marpolbul.2008.02.018

Mussali-Galante, P., Tovar-sánchez, E., Valverde, M., Rojas, E., 2014. Genetic Structure and Diversity of Animal Populations Exposed to Metal Pollution. Rev. Environ. Contam. Toxicol., Reviews of Environmental Contamination and Toxicology 227, 79-106. doi:10.1007/978-3-319-01327-5

Rumisha, C., Elskens, M., Leermakers, M., Kochzius, M., 2012. Trace metal pollution and its influence on the community structure of soft bottom molluscs in intertidal areas of the Dar es salaam coast, Tanzania. Mar. Pollut. Bull. 64, 521-531

Keywords: giant tiger shrimp; heavy metal pollution; simple sequence repeats (SSR); genetic population structure; Tanganyika

Optical remote sensing of Lake Victoria

Runya Robert[1], Kevin Ruddick[2] and Quinten Vanhellemont[2]

[1] Vrije Universiteit Brussels (O&L), Pleinlaan 2, 1050 Brussels, Belgium
E-mail: rrunya89@gmail.com

[2] Royal Belgian Institute of Natural Sciences (RBINS), Gulledelle 100, 1200 Brussels, Belgium

Lake Victoria is the second largest freshwater lake in the world by surface area. The transboundary lake is of great economic and ecological importance supporting fishing activities of local populations and also serves as a biodiversity hotspot. Despite joint actions by the lake basin countries to enhance management and monitoring, the lake still remains under severe human pressure. The introduction of Nile perch (*Lates niloticus*) in the 1980s and increasing eutrophication from land-based nutrients with consequent anoxia and reduced water transparency are among the impacts that may lead to massive growth of invasive water hyacinths. Studies indicate that light penetration in the lake plays a significant role in primary production and also in determining the hunting and survival success of visual predators and their prey. Underwater visibility also affects feeding and mating choices of fish.

This study aims to demonstrate the suitability of using remotely sensed satellite data to enhance management of Lake Victoria and for providing an inexpensive way to gather, on a large spatial scale, optical properties of the lake. Use of remote sensing products has a wide application in both marine and freshwater bodies, and can aid natural resources managers to make optimal decisions to ensure sustainability of fisheries, biodiversity and ecosystem resources. We will explore the use of the Landsat-8 satellite, that provides imagery free of charge, every 16 days, with 30m spatial resolution. Landsat-5 provides an additional temporal dimension with imagery back to 1984.

Other data sources that are considered are the similar Sentinel-2/MSI satellite, currently in ramp-up phase, and the geostationary SEVIRI series (images every 15minutes during daylight since 2003, with 3 km resolution at the sub-satellite point, and free of charge for research use.

None of these missions provide standard water quality products, moreover atmospheric correction algorithms have to be adapted for inland waters. Standard atmospheric correction algorithms assume sea level altitude for calculation of molecular scattering in the atmosphere, which will cause an overestimation for Lake Victoria that is at 1134 m elevation. RBINS has designed algorithms and processing software for Landsat, Sentinel-2 and SEVIRI that supports the processing of data for inland waters.

The objective of this thesis is to provide thematic products, retrievable from satellite imagery such as floating vegetation, suspended particulate matter and water transparency. These products - if available with proper time frequency - will be useful in identifying conditions for the occurrence of turbid waters, floating vegetation, which can potentially be linked to declining species richness. The imagery could be used to develop an up-to-date decision support system for long-term monitoring and management of the lake. A review of the scientific literature on the environmental status of Lake Victoria with a focus on fisheries, phytoplankton, floating vegetation, benthic vegetation, suspended sediments and water transparency will be conducted. Water color maps of floating vegetation, suspended sediments and water transparency will be generated. The literature review together with ground-truthed data will be used to validate and make a critical discussion on the quality of the satellite imagery.

Keywords: Lake Victoria; satellite; remote sensing; optics; ocean color

Satellite vs Drone: Mapping of Mangroves in Setiu Wetland, Malaysia

Ruwaimana Monika[1], Farid Dahdouh-Guebas[1], Nico Koedam[1], Mohd Muslim Aidy[2], Satyanarayana Behara[2] and Dries Raeymaekers[3]

[1] Laboratory of Plant Biology and Nature Management, Department of Biology, Vrije Universiteit Brussel - VUB, Pleinlaan 2, 1050 Brussels, Belgium
E-mail: monruw@gmail.com

[2] Remote Sensing and Coastal Zone Management, Department of Oceanography and Environment, University Malaysia Terengganu, UMT-INOS, 21030 Kuala Terengganu, Malaysia

[3] USENSE, Private Company, Smetstraat 50, 3501 Hasselt, Belgium

Mangrove ecosystem is hard to penetrate: tangling hibiscus and high roots that get in the way, plus muddy substrate trapping the feet. However, the importance of this ecosystem is undeniable. Therefore, an easier and faster technique is needed to assess the mangrove. Satellite-based remote sensing becomes a choice, but as the mangrove located on tropical areas, cloud coverage is posing a trouble. Aerial photograph using the drone could be a promising ways to do the mangrove survey. This research will mapped mangrove in Setiu Wetland, Malaysia, using 3 different layers: manual ground 5x5m^2 plot inventory, aerial photograph using drone from 100m elevation, and SPOT satellite image. The result will be compared and combined to generate a detailed and comprehensive mangrove vegetation map.

Keywords: mangroves; drone; remote sensing

Tidal marsh vegetation die-off: spatial developments and feedback mechanisms

Schepers Lennert[1], Matthew Kirwan[2], Glenn Guntenspergen[3] and Stijn Temmerman[1]

[1] Ecosystem Management Research Group (ECOBE), University of Antwerp, Universiteitsplein 1, 2610 Wilrijk, Belgium
E-mail: lennert.schepers@uantwerpen.be

[2] College of William and Mary, Virginia Institute of Marine Science, Greate Rd 1375, 23062 Gloucester Point, VA, USA

[3] Patuxent Wildlife Research Center, U.S. Geological Survey, Center Road 308, 20705 Beltsville, MD, USA

The Blackwater marshes (Maryland, USA) have experienced large-scale vegetation die-off over the last century, resulting in a spatial gradient of increasing vegetation die-off with distance to the mouth of the Blackwater river. Marsh vegetation has several feedback mechanisms for keeping its elevation relative to sea level, compensating sea level rise: (i) marsh vegetation reduces flow velocities and attenuates waves, thereby promoting sedimentation. (ii) The plants produce above and below ground biomass, contributing in this way also to marsh accretion. When this vegetation disappears, however, these feedbacks are reversed: higher current velocities and waves keep sediment in suspension, and organic material is no longer accumulated. Moreover, higher current velocities and waves can erode the (degraded) soil.

However, we hypothesize that these feedback mechanisms all depend on the spatial patterns of vegetation die-off as these patterns determine the hydrodynamic forces: the size of the pools and how these pools are positioned relative to the tidal channel system will influence the currents and wave action. As an example, small pools surrounded by vegetation will experience low hydrodynamic forces compared to large pools that are directly connected to the tidal creek network. These hydrodynamic regimes will determine sedimentation and erosion processes and will affect in the long term the elevation of the marshes.

We studied the spatial patterns of vegetation die-off by remote sensing analysis, and the long-term effects of these patterns on sedimentation and erosion processes were investigated by field topography measurements.

Keywords: marshes; pool; sea level rise; bio-geomorphic feedback

Self-organised shoreline protection: mutual feedbacks between plant traits and hydrodynamics

Schoutens Ken, Alexandra Silinski and Stijn Temmerman

Ecosystem Management Research Group, Deperatement of Biology, University of Antwerp, University of Antwerp, Campus Drie Eiken, Universiteitsplein 1, B-2610 Wilrijk (Antwerp), Belgium
E-mail: ken.schoutens@uantwerpen.be

Nature-based shoreline protection strategies such as the use of tidal marshes are a necessity in order to protect coastal societies against today's challenges such as sea level rise and the increase in severity of storm surges. Local hydrodynamic conditions seem to create spatial variation in morphological plant traits on different scales in tidal marshes (individual, population and community level). The notion that morphological plant traits form an important determinant for the capacity of a tidal marsh to dissipate hydrodynamic energy is more and more emphasized in recent literature. Nevertheless, the mutual feedbacks between morphological plant traits and hydrodynamics which ultimately control the shoreline protection function of tidal marshes are poorly understood.

Field measurements among different locations in the brackish part of the Elbe Estuary (Germany) will be conducted during a one year time period (2016). Hydrodynamics (e.g. wave heights and current velocities), sediment dynamics (i.e. bed elevation change) as well as plant morphological traits (e.g. aboveground and belowground morphology) of different pioneer species (*Bolboschoenus maritimus* and *Schoenoplectus tabernaemontani*) will be measured monthly. We expect that local incoming hydrodynamics determine morphological plant traits of different species and that this affects the local hydrodynamics. We hypothesize that this will enable us to determine how the shoreline protection capacity of tidal marshes varies spatially due to the mutual feedbacks between local hydrodynamics and morphological plant traits.

Keywords: tidal marshes; plant traits; hydrodynamics; shoreline protection

Bio-geomorphic controls on seaward marsh expansion and accretion

Silinski Alexandra[1], Erik Fransen[2], Tjeerd J. Bouma[3], Patrick Meire[1] and Stijn Temmerman[1]

[1] ECOBE, Department of Biology, Universiteit Antwerpen, Universiteitsplein 1C, 2610 Wilrijk, Belgium
E-mail: alexandra.silinski@uantwerpen.be

[2] StatUA Center for Statistics, Universiteit Antwerpen, Prinsstraat 13, 2000 Antwerp, Belgium

[3] Royal Netherlands Institute for Sea Research, Korringaweg 7, 4400 AC Yerseke, The Netherlands

Little is known on the mechanisms controlling horizontal seaward expansion of marshes and on the vertical sediment accretion rates that are associated with it. Key questions to resolve are: i) whether simple geomorphological conditions such as elevation are a major predictor of clonal marsh expansion rates; ii) whether there are seasonal vegetation-induced effects in sedimentation and erosion rates; and iii) how steep the spatial gradient in sedimentation and erosion rates is from the bare tidal flat into the vegetated marsh? These questions have been addressed with a two-scale study approach performed on two contrastingly wave-exposed marshes in the Scheldt Estuary (SW Netherlands and N Belgium) where *Scirpus maritimus* is the dominant pioneer species. On the one hand (i), we investigated the relations between large-scale, geomorphological parameters (elevation, slope) and clonal marsh expansion rates at both sites. On the other hand (ii), we performed a small-scale monthly field monitoring during two years at the same two marshes where we investigated the relations between spatio-temporal variations in vertical elevation change and spatio-temporal variations in vegetation properties along cross-shore transects. We found that at the sheltered site, clonal expansion rates were almost twice as high as at the exposed site. Furthermore, expansion rates at the sheltered site related well to elevation. At the exposed site, this relation was less strong as wave exposure might cause a dominant disturbance here. Moreover, we found clear seasonal sedimentation and erosion patterns that followed well the seasonal vegetation cycle, with prevailing sedimentation in summer when aboveground biomass was maximal and erosion in winter when plant shoots had largely decayed. Especially at the exposed site, the presence of vegetation had a positive effect on sedimentation within the marsh. Finally, our results show that clonal marsh expansion succeeded at elevations for which previous studies at the same locations showed that transplants of individual shoots could not establish, emphasising the importance of clonal integration for both survival and lateral expansion in disturbance-driven ecosystems.

Keywords: clonal marsh expansion; Scirpus maritimus; waves

Raising healthy chicks: diet effects on chick development of Lesser Black-backed Gulls

Sotillo Alejandro, Catia Santos and Luc Lens

Terrestrial Ecology Unit, Department of Biology, Ghent University, K. L. Ledeganckstraat 35, 9000 Ghent, Belgium
E-mail: alejandro.sotillogonzales@ugent.be

The Lesser Black-backed Gull *Larus fuscus* is a large gull species (135-150 cm wingspan) found in coastal regions of the North Atlantic, including the Belgian Coast, where it arrives in summer to breed. These gulls exploit different food sources: discarded fish from demersal trawlers, human (urban and industrial) food waste, and soil dwellers such as earthworms, insects and small mammals mainly at agricultural fields and urban parks. Each of these food sources is exploited with different frequencies by each individual bird and in each period of the breeding season. We are studying what drivers lead a breeding gull to forage on a particular food source, and whether certain foraging strategies are more advantageous than others. From the chick's point of view, an ideal diet has to meet all energetic and nutritional requirements for development from hatching until fledging. Depending on the origin of the food provided, a chick's diet will have different energy densities and nutrient content, but certain food sources are also more abundant and/or easier to obtain, so that a chick might be fed a lower quality diet in larger quantities, or vice versa.

GPS tracking data gathered in the framework of the LifeWatch Belgium Project show that a majority of tracked Lesser Black-backed gulls forage inland, looking for soil invertebrates and human refuse. However, fishery discards are a key component of the diet provided by most gull parents to their chicks. Some food types, such as industrial food waste, are used as a secondary, or replacement, food source. We have tested the effects of the amount and type of food provided to a chick on its development in captivity rearing experiments performed at the Ostend Bird Rescue Centre (VOC Oostende). These results bring light on the consequences of each foraging strategy for the offspring, which we then compare to the costs of foraging at different habitat types.

Keywords: seabirds; lesser black-backed gull; foraging distribution; chick rearing; artificial diet; chick development

Do marshes attenuate storm surges? A numerical study on the effects of marsh geometry and marsh size on storm surge reduction rates

Stark Jeroen[1], Yves Plancke[2], Stefaan Ides[3], Patrick Meire[1] and Stijn Temmerman[1]

[1] University of Antwerp, Universiteitsplein 1, 2610 Wilrijk, Belgium
E-mail: jeroen.stark@uantwerpen.be

[2] Flanders Hydraulics

[3] Port of Antwerp

As ecosystem-based adaptation to global change is gaining ground, conservation and restoration of tidal wetlands and marshes is starting to be implemented in addition to conventional coastal defence structures to protect coastal and estuarine areas from increasing flood hazards (*Temmerman et al., 2013*). In this study, the capacity of tidal wetlands to locally attenuate peak water levels during storm tides is analysed using a two-dimensional hydrodynamic model (TELEMAC2D) for '*Het Verdronken Land van Saeftinghe*', a 3000 ha intertidal marsh in the Netherlands. The effect of marsh vegetation on tidal flow is implemented in the model by increased bottom friction. The model reproduces observed water level variations by *Stark et al. (2015)* reasonably well along a 4 km marsh channel transect. Scenario analyses are performed to study the effect of marsh geometry (i.e., platform and channel elevation) and marsh size (i.e., the position of the levees surrounding the marsh).

The model results indicate that peak water level reduction largely varies between individual flooding events and between different locations in the marsh. Scenarios with varying marsh channel depths show that attenuation rates on the marsh scale increase by up to 4 cm/km if the channel elevation is raised by 0.7 m on average. For scenarios in which the channels are lowered by 0.9 m on average, marsh scale attenuation rates decrease by up to 2 cm/km. The elevation of the marsh platform has little effect on the maximum attenuation, but it determines which tides are attenuated. In particular, only overmarsh tides that inundate the platform are attenuated, while undermarsh tides that only flood the marsh channels are not attenuated or even amplified. Furthermore, model scenarios with variable dike positions show that attenuation rates can be minimized by blockage and set up of water levels against dikes or other structures confining the marsh size. This blockage only affects peak water level attenuation across wetlands if the duration of the flood wave is long compared to the marsh size. A minimum marsh width of 6 to 10 km is required to completely avoid blockage effects for the storm tidal cases assessed in this study.

Finally, a relation is found between flood wave attenuation rates, local marsh geometry and the flood wave height. If blockage does not affect flood wave propagation, variations in attenuation rates between different locations in the marsh and between tides with varying high water levels can be explained with a single relationship (Eq. 1) based on the ratio between the water volume on the marsh platform and the total water volume on the platform and in the channels:

(1) $dHWL/dx = -36.2 * a_v + 8.0$

in which $dHWL/dx$ is the flood wave attenuation rate in cm/km and a_v the ratio between the water volume above the vegetated platform and the total water volume in the marsh. Attenuation starts to occur when this ratio exceeds 0.2-0.4 and increases from there on up to a maximum of 29 cm/km for a ratio of about 0.85. The relationship holds for marshes covered with typical wetland grasses (i.e. *Spartina*, *Elymus* and *Scirpus* species) and only for higher storm tides that induce large-scale sheet flow over the marsh surface. These findings may assist coastal communities and managers in the optimization of the coastal protection function of tidal wetlands in combination with dikes.

References

Stark, J., Van Oyen, T., Meire, P., Temmerman, S. 2015. Observations of tidal and storm surge attenuation in a large tidal marsh. Limnology and Oceanography, 60: 1371-1381. doi: 10.1002/lno.10104

Temmerman S., P. Meire, T. J. Bouma, P. M. J. Herman, T. Ysebaert, and H. J. De Vriend. 2013. Ecosystem-based coastal defence in the face of global change. Nature 504: 79-83. doi:10.1038/nature12859

Keywords: salt marsh; storm surge; coastal defense; hydrodynamic modelling

Meet the company: About DEME

Sterckx Tomas

Dredging International, Scheldedijk 30, 2070 Zwijndrecht, Belgium
E-mail: bnl-secretariaat@deme-group.com

The Belgian dredging, environmental and marine engineering group DEME is an international market leader for complex marine engineering works.

Driven by several worldwide challenges (rising sea level - the scarcity of raw materials - the growing need for energy - reducing CO2 emissions - the contamination of our waterways and soils), DEME has transformed from solely a dredging and land reclamation company to a worldwide operating multidisciplinary and innovative marine engineering and environmental group.

Building on 170 years of experience and know-how, DEME has organically moved into several related activities, such as the financing of marine engineering and environmental projects, executing EPC related complex marine engineering projects including civil engineering works, the development and construction of renewable energy projects, providing services for the oil, gas and energy sector, the decontaminating and recycling of polluted soils and sludge, the mining of marine resources (granulates and minerals), etc.

Thanks to an integrated company structure, DEME strongly emerges as a global solutions provider, which offers its clients overall solutions. DEME has the most modern, high-tech and versatile fleet.

DEME was named 'Belgian Enterprise of the Year 2015' and has 4,600 employees worldwide. In 2014, the Group achieved a turnover of 2.6 billion euros.

www.deme-group.com

Gathering ideas for Sea Change

Sterken Mieke, Laure Van Medegael, Evy Copejans and Jan Seys

Flanders Marine Institute (VLIZ), Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: mieke.sterken@vliz.be

Sea Change (www.seachangeproject.eu) is a Horizon 2020 project aiming at increasing public awareness about the importance of the ocean in our daily lives, and about the influence of our lifestyles on the ocean's state. Sea change is now looking for innovative ideas for events or actions to increase our understanding of the mutual influences between the ocean and society. In this framework, VLIZ is developing an 'idea challenge', encouraging people to submit their ideas, presented in a short video, on how to increase people's awareness and appreciation of the ocean. The ideas gathered from this competition will be evaluated during brainstorm sessions organized in seven European countries, in each of which one concept for an event or action will be developed and realized.

By organizing this video competition, Sea Change involves the public directly in the search for good outreach ideas, aiming at encouraging people to think about their relationship with the ocean and hence increasing their ocean literacy.

Keywords: Sea Change; ocean literacy; public outreach

Hello from the other side - Interkingdom Crosstalk between bacteria and diatoms

Stock Frederike[1], Wim Vyverman[1], Sven Mangelinckx[2], Anne Willems[3] and Lynn Vanhaecke[4]

[1] Laboratory of Protistology and Aquatic Ecology, Biology Department, Ghent University, Krijgslaan 281-S8, 9000 Gent, Belgium
E-mail: frederike.stock@ugent.be

[2] SynBioC, Department of Sustainable Organic Chemistry and Technology, Ghent University, Coupure Links 653, 9000 Ghent, Belgium

[3] Laboratory of Microbiology (LM-UGent), Department of Biochemistry and Microbiology, Ghent University, K.L. Ledeganckstraat 35, 9000 Ghent, Belgium

[4] Department of Veterinary Public Health and Food Safety, Ghent University, Salisburylaan 133 D1, 9820 Merelbeke, Belgium

Unsuspicious and yet indispensable - diatoms are an important group of microalgae in our oceans which produce up to 20% of global photosynthesis. They live in close association with heterotrophic bacteria, a partnership which evolved over millions of years and led to many different interactions between these microorganisms. However, many details about their complex interaction still remain to be elucidated and this study aims provide further insights.

Diatoms as well as bacteria use small molecules to communicate among themselves. Diatoms produce pheromones to attract mating partners. Likewise bacteria release structurally similar signal molecules to start expression of certain genes, for instance genes causing virulence. Given the structural similarity between the molecules released by diatoms and bacteria this research investigates whether diatoms are able to "listen" to bacterial communication and respond accordingly.

Interkingdom crosstalk has already been discovered between bacteria and plants. Researchers discovered that *M. truncatula* (clover) is able to respond to bacterial signals by releasing mimics of the bacterial molecule and thereby interfering with bacterial communication. Moreover gene expression changed as soon as the plant was exposed to the bacterial signal.

However, so far it is unknown whether such interactions also exist between diatoms and bacteria. In this study diatoms are exposed to synthetic bacterial molecules and their physiological and morphological response is being monitored. First results suggest that diatoms are indeed able to respond differently to a range of bacterial signals.

Keywords: diatoms; bacteria; interkingdom crosstalk; cell signalling

Diatom-bacteria interactions: Symbiosis on the move

Stock Willem[1], Karen Grace Bondoc[2], Wim Vyverman[1], Georg Pohnert[2], Anne Willems[3] and Sven Mangelinckx[4]

[1] Laboratory of Protistology and Aquatic Ecology, Biology Department, Ghent University, Krijgslaan 281 – S8, 9000 Ghent, Belgium
E-mail: Willem.Stock@ugent.be

[2] Institute for Inorganic and Analytical Chemistry, Friedrich Schiller University, Lessingstrasse 8, 07743 Jena, Germany

[3] Laboratory of Microbiology (LM-UGent), Department of Biochemistry and Microbiology, Ghent University, K.L. Ledeganckstraat 35, 9000 Ghent, Belgium

[4] SynBioC, Department of Sustainable Organic Chemistry and Technology, Ghent University, Coupure Links 653, 9000 Ghent, Belgium

Intertidal mudflats are highly productive ecosystems, which play a vital role in nutrient recycling and coastal protection. Primary production in these systems can be very high, and is mainly due to the presence of dense biofilms of benthic microalgae (mostly diatoms and euglenoids) embedded in a complex matrix of extracellular polymeric substances. These mats are also inhabited by a diverse bacterial community. Some of these (namely the Proteobacteria and the Bacteroidetes) are consistently found in association with the diatoms. This specificity suggests that, even in the complex and highly dynamic biofilm environment, these bacteria find their way to the diatoms and/or vice versa. In order to unravel the recognition mechanisms between host and bacteria, we are currently performing tracking assays to compare how one symbiosis partner reacts to the presence of the other. Video analyses allows us to identify who is actually attracted by whom and will allow us to identify the infochemicals involved. These videos illustrate the dynamic nature of these interactions in which both partners are motile and allow a microscopic glimpse into one of the most productive systems on Earth.

Keywords: diatom; bacteria; motility assay; chemotaxis; biofilm

Analysis of overtopped wave loads on storm walls at the Belgian coast - A process based approach by means of hydraulic modelling

Streicher Maximilian and Andreas Kortenhaus

Department of Civil Engineering, Ghent University, Technologiepark 904, 9052 Zwijnaarde (Ghent), Belgium
E-mail: Maximilian.Streicher@UGent.be

Introduction and objectives
In several cases along the coasts of low-lying countries storm surges cause wave overtopping over the primary sea defences. Additionally, wave induced impacts at the secondary coastal defense structure or building may occur. Typically the set-up for the Belgium coastline is comprised of a dike (primary sea defence) and a storm wall (secondary sea defence) or buildings in cross-shore direction. The flow formation after overtopping, spatial variation over the crest and final interaction of the overtopping flow with the storm wall are not sufficiently investigated and design guidance is limited. Site specific cases can be found in literature (Kortenhaus et al., 2008) and various underlying physical processes are not completely understood (Allsop et al., 2004). Hence, the design of storm walls is solely based on the reduction in overtopping not taking into account the hydrodynamic loading due to overtopped waves (Verwaest et al., 2011). The main objective of this study is to gain more insight in the different processes leading to wave induced loads on storm walls, located on top of sloping structures. These processes are identified, key parameters systematically varied and linked to the loads on the storm wall.

Experimental set-up
Physical experiments were conducted in the 30 m long, 1.2 m high and 1 wide wave flume at Ghent University in March 2015 (model scale 1:25). Several configurations were tested for a long foreshore (slope of 1:35) together with a dike (slope of 1:2) and promenade widths of 10 m and 30 m in prototype. The crest elevation and water level were varied, resulting in freeboards between 1 m - 3 m. A standard offshore wave spectrum with 1000 waves was used for each test with different spectral wave heights $H_{m-1,0}$ in between 2 m and 4.75 m offshore. According peak wave periods ranged between Tp = 8.5 s and 13.15 s. The resulting spectral wave heights at the dike toe ranged between 0.526 m and 2 m. Due to wave breaking on the shallow foreshore long waves were found at the dike toe location. Measurements were taken from wave conditions at the dike toe, the mean and individual overtopping, layer thickness and velocity on the crest and the wave-induced pressures and forces on the storm wall.

Results and discussion
Good agreement for both, load and overtopping measurement, with the findings from literature was shown. The overtopped flow layer thickness and speed have been studied in more detail and were related to the measured forces on the storm wall. The overtopped flow can be described as a bore wave travelling over the promenade until impacting the storm wall. An average speed was determined by the signal of two wave gauges placed after each other in flow direction on the promenade. The layer thickness was retrieved from the same wave gauge signals. It was found that the data set can be split into dynamic and quasi-static loading cases, as described in extended PROVERBS parameter map for vertical breakwaters (Kortenhaus and Oumeraci, 1998). The research of bore characteristics (layer thickness and speed) and their relation to the loads on the storm wall will support an improved design guidance for storm walls and buildings on top of dike structures.

References

Allsop, N.W.H. et al., 2004. Safety under wave overtopping - how overtopping processes and hazards are viewed by the pyblic. 29th International conference on coastal engineering (ASCE), Lisbon, Portugal, pp. 1-12.

Kortenhaus, A., Buss, T., Sulz, O., Marengwa, J. and Lehmann, H.-A., 2008. Storm surge protection walls in Germany. Die Küste. Archiv für Forschung und Technik an der Nord- und Ostsee, 74, pp. 200-211.

Kortenhaus, A. and Oumeraci, H., 1998. Classification of wave loading on monolithic coastal structures. International conference on coastal engineering, , Copenhagen, Denmark

Verwaest, T. et al., 2011. Hydrodynamic loading of wave return walls on top of seaside promenades. 6th International conference on coastal structures, Yokohama, Japan, pp. 568-576.

Keywords: storm wall; loads; layer thickness; velocity; hydraulic experiments; design guidance

Wind-blown sand in beach-foredune and beach-dike environments at the Belgian Coast

Strypsteen Glenn and Pieter Rauwoens

Department of Civil Engineering, Technology Cluster Construction, Faculty of Engineering Technology, KU Leuven, Ostend, Belgium, Zeedijk 101, 8400 Ostend, Belgium
E-mail: glenn.strypsteen@kuleuven.be

At many places, coastal dunes operate as a natural safety barrier against the destructive forces of the sea, protecting the hinterland from flooding. Shifting of sand dunes is essential to let the growth of the dunes keep pace with sea-level rise, and at the same time create an attractive and dynamic dune landscape. Opposed to sea dikes, wind-blown sand allows dunes to grow naturally and vertically with the rising sea-level, and therefore ensuring a long-term coastal safety.

Although, a lot of research has been done in the area of Aeolian transport, it is only during the recent years Aeolian transport in coastal areas becomes significantly more important. In these areas, the physical processes are more complex, due to a large number of supply limiting parameters. In this research, a model will be developed which relates the wind-driven sand transport at the Belgian coast with physical parameters such as the wind speed, humidity and grain size of the sand, and the slope of beach and dune surface. For the first time, the physics of wind-blown sand and coastal dunes is studied at the Belgian coast. The 67km long Belgian coastline is highly urbanized and therefore subjected to coastal protection and safety. The coast mostly consists of sandy beaches and dikes. Although, still 33km of dunes exist, whose dynamics are far less understood. The overall research approach consists of three pathways: (i) field measurements, (ii) physical model tests, and (iii) numerical simulations. First and most importantly, several field campaigns will provide accurate data of meteo-marine conditions, morphology, and sand transport events, on a wide beach at the Belgian Coastline. The experimental set-up consists of a monitoring station, which will provide time series of vegetation cover, shoreline position, fetch distances, surficial moisture content, wind speed and direction and transport processes. The horizontal and vertical variability of the event scale Aeolian sand transport are analyzed with 12 MWAC sand traps. Two saltiphones register the intensity and variations of grain impacts over time. Two meteo-masts, each with four anemometers and one wind vane, provide quantitative measurements of the wind flow at different locations on the beach. Surficial moisture is measured with a moisture sensor. The topography measurements are typically done with laser techniques. To start, two sites are selected for measurement campaigns: one consists of the typical beach - dike system, a second site involves the coastal foredunes. Next to the field measurements, physical model tests are used to provide data that is difficult to measure in the field. They will be used to determine the shear velocity and critical shear velocity, in which sand particles initiate motion, in function of the transport flux. The effect of surficial moisture, vegetation and morphologic landforms will also be investigated in the model tests. Numerical simulations will gain a better insight in the physical processes of the Aeolian events and will be validated with the experimental results from the field campaigns and the physical model tests.

The ultimate objective of the research is to obtain a sand transport model for the Belgian Coast, which can be used to assess the stability of nourishments in a quantitative matter. But at the same time, it also will gain a better insight in the beach-dune and beach-dike interactions with the changing climate.

We acknowledge the support of VLIZ for the purchase of research infrastructure for measuring and monitoring of Aeolian transport in beach-foredune and beach-dike systems at the Belgian coast.

Keywords: Coastal Aeolian geomorphology; field measurements; physical model tests; numerical simulations; Belgian Coast

Climate change from another perspective: effects of temperature fluctuations on population dynamics and species interactions

Vafeiadou Anna-Maria[1,2], Chariton Chintiroglou[2] and Tom Moens[1]

[1] Ghent University, Marine Biology Section, Krijgslaan 281/S8, 9000 Ghent, Belgium
E-mail: AnnaMaria.Vafeiadou@Ugent.be

[2] Aristotle University of Thessaloniki, Biology Department, 54124 Thessaloniki, Greece

Although the rise of temperature is one of the main consequences of global climate change, organisms may develop plasticity towards thermal stress. However, extreme temperature maxima and the increased frequency and different amplitude of fluctuations, which occur worldwide the last decades, can eventually alter population dynamics. While the effects of average temperature increase on population dynamics and species interactions have been widely studied, the effects of changed-amplitude fluctuations of temperature have not been much investigated. The present study focuses on the effects of diurnal temperature fluctuations on the fitness of free-living marine nematodes, which due to their high abundance and short life span are an excellent model group for testing such stress conditions. We examine whether daily temperature fluctuations affect a) fitness and population dynamics and b) interspecific interactions of two congeneric species: *Diplolaimelloides meyli* and *D. oschei*, which co-occur in nature. Microcosm experiments were performed using mono-species and two-species combinations incubated under constant and daily fluctuating temperature. Results showed effects of temperature regime on the fitness for the monospecific populations, with higher numbers of adults and shorter minimum development time under fluctuating temperature compared to the stable temperature control. Furthermore, interspecific competition negatively affected the involved species' fitness under both stable and fluctuating temperature conditions, an effect which was more pronounced under fluctuating temperature. The strength of the interaction's effect on species fitness is though dependent on thermal regimes. We conclude that changes in daily temperature fluctuations may be very important determinants of the effects of temperature change on species interactions.

Keywords: plasticity; extreme events; resilience; population fitness; competition

Right place, wrong time: mixture toxicity effects of pathogens and HABs on bivalve recruitment.

Van Acker Emmanuel, Maarten De Rijcke, Karel De Schamphelaere and Colin R. Janssen

Laboratory of Environmental Toxicology and Aquatic Ecology: Environmental Toxicology Unit - GhEnToxLab, Ghent University, J. Plateaustraat 22, 9000 Ghent, Belgium
E-mail: Emmanuel.VanAcker@UGent.be

Anthropogenic activities such as global shipping and aquaculture have spread many pathogens and harmful algae to such an extent that they are considered cosmopolitan species. Combined with coastal eutrophication and overfishing, this has led to a dramatic increase in the size, frequency and severity of harmful algal blooms (HABs) across the globe. The resulting food-web disruption, biodiversity loss and socio-economic costs are unprecedented. Through hypoxia, physical agitation, starvation and the production of potent marine toxins, HABs may lead to mass mortalities of marine life at all trophic levels. Yet, despite many years of research, the nutrient fluxes and phytoplankton dynamics that cause a harmful algal bloom - as well as the full extent of their environmental impact - is not fully understood. If we are to safeguard our marine ecosystems and all of its ecosystem services, this knowledge needs to become available for the successful management of HABs.

Nearly all wild and cultured bivalve populations experience periodical episodes of mass mortality. Rather than a single stressor, these dramatic events are often caused by an interplay of abiotic and biotic pressures. These episodes could become more frequent as pathogens and harmful algal blooms (HABs) - both long known to contribute considerably to these events - are expected to benefit from climate change. Moreover, it was recently discovered that pathogens like *Vibrio* spp. benefit from the copious amounts of organic carbon released by HAB species. Regardless of their co-occurrence, to date science has failed to address the potential for mixture toxicity/adverse effects between both stressors. Specifically, nothing is known on these potential effects on the earliest, most sensitive life stages of bivalves. In this study we addressed the question whether this negligence leads to a substantial underestimation of the effect of harmful algae on bivalve recruitment. More specifically, we studied whether potentially harmful dinoflagellates and *Vibrio* spp. may synergistically affect the development, viability and immunological resilience of blue mussel (*Mytilus edulis*) larvae.

Fertilized eggs of *M. edulis* were exposed to environmentally relevant concentrations of six dinoflagellates (*Alexandrium minutum, A. ostenfeldii, Karenia mikimotoi, Protoceratium reticulatum, Prorocentrum cordatum, P. lima* and *P. micans*) or a known pathogen (*Vibrio coralliilyticus* or *V. splendidus*) or both. After 5 days of exposure, the larval development, larval viability and phenoloxidase innate immune response of the exposed mussel larvae were measured. Significant adverse effects were found for all algae (except *P. cordatum*) and *V. splendidus*. The phenoloxidase immune response was also found to react in a species-dependent manner to the presence of both the algae and a pathogen. Yet, regardless of their individual effects, no mixture toxicity/adverse effect was observed. This can be attributed to a difference in timing of each stressors impact: dinoflagellates were found to produce their adverse effect sooner rather than later - often completing their effect within the first 48 hours of the test. The pathogen *V. splendidus*, on the other hand, only became toxic when the larvae started to feed at the end of the five 5 days exposure period. Understanding the effects of algae, might be sufficient to successfully manage the effects of HABs on bivalve recruitment.

To safeguard bivalve stocks, however, similar studies should still be undertaken on adult bivalves which filter both the toxic phytoplankton and bacteria alike.

Tidal wetlands as Ecosystem-based adaptation to coastal flood risks

Van Coppenolle Rebecca, Christian Schwarz and Stijn Temmerman

Ecosystem Management Group - ECOBE, Department of Biology, University of Antwerp,
Universiteitsplein 1C - C032, 2610, Wilrijk, Belgium
E-mail: rebecca.vancoppenolle@uantwerpen.be

Coastal hazards are realities to coastal communities around the world; coastlines and their human settlements face increasing threats due to climate change, such as increasing cyclone intensity or rising sea-level. Traditional coastlines protection structures are mainly engineering structures in need of costly maintenance and adaptations and whose ability to endure will be challenged by climate change induced events. Over the past years and in some regions, the use of preserved or restored coastal habitats as tidal wetlands have been developed, often in complement to more hard engineering structures, to protect populations and economic assets from coastal hazards. This approach, defined as Ecosystem-based management, relies on the ability of vegetation to alleviate coastal hazards and to adapt by sedimentation to the sea-level rise in addition to other valuable ecosystem services.

Our study investigates a specific aspect of the Ecosystem-based management approach, namely the ability of salt marshes and mangroves to reduce storm surges, by comparing the consequences of its presence in the world's most populated deltas. We investigate these consequences using a GIS model that assesses the potential reduction in surge height due to presence or absence of coastal vegetation. The Ganges-Brahmaputra delta in India and Bangladesh is used as a case study to present initial insights on the implications of Ecosystem-based management on a large spatial scale.

Keywords: ecosystem-based management; tidal wetlands; storm surge reduction; GIS

Bottom trawling keeps the geochemistry of the seafloor permanently out of steady state

Van de Velde Sebastiaan[1], Yue Gao[1] and Filip Meysman[1,2]

[1] Department of Analytical, Environmental and Geochemistry, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussel, Belgium
E-mail: sevdevel@vub.ac.be

[2] Department of Ecosystem Studies, Royal Netherlands Institute for Sea Research, Korringaweg 7, 4401 Yerseke, The Netherlands

Bottom trawling is a non-selective fishing technique during which heavy chains and gear are dragged across the seafloor. The direct environmental impact of bottom trawling on the physical sediment structure has received much attention, as well as the impact on the fish populations, benthic ecosystems and sediment resuspension (Jones, 1998; Puig et al., 2012). Yet bottom trawling also strongly alters the seafloor biogeochemistry, but the impact on the biogeochemical cycling and microbial communities has not received a lot of attention (Puig et al., 2012). At the moment, bottom trawling is intensively applied in the Belgian and Dutch part of the North Sea. Hence, it is important to document its effect on the sediment biogeochemistry.

A single bottom trawling impact in June 2014 was recorded during a monthly field study in the Belgian Coastal Zone (Station 130). After the event, we followed up the transient evolution of the biogeochemistry in the upper 20 cm the sediment through time. To this end intact sediment cores were collected before and after the event (May - September 2014). Porewater was extracted and analysed for major cations (Ca^{2+}, dissolved Fe, dissolved Mn), nutrients (NH_4^+, PO_4^{3-}), dissolved inorganic carbon (DIC), SO_4^{2-} and trace metals (As, Co) at a resolution of 0.5-1 cm.

Our results show that reduced minerals (FeS, $MnCO_3$) in the upper 10-20 cm of the sediment are initially regenerated to an oxidized form (FeOOH, MnO_2), after which the system returns to its original steady-state over a period of months. During this recovery phase, organic matter mineralization pathways progress through the classical sequence of redox pathways (manganese, iron, and sulfate reduction).

Overall, this field study shows that the pore water returns to the initial steady-state condition within approx. four months. This time period can be compared to the frequency of bottom trawling (1-3 per year for the Belgian coastal zone; Depestele et al., 2012) If the seafloor is bottom only trawled three times a year, the upper 20 cm of the sediment column will stay in a permanent transient state, favouring suboxic over anoxic mineralization pathways, and potentially preventing the burial of organic matter and reduced minerals. This high-frequency disturbance will strongly affect the natural ecosystem functioning, inducing a clear anthropogenic imprint on the biogeochemical cycling in coastal and shelf environments with intensive bottom trawling.

References

Depestele J. et al. 2012. An integrated impact assessment of trammel net and beam trawl fisheries "WAKO II" - Final Report. *Brussels: Belgian Science Policy Office 2012*. 233p

Puig P. et al. 2012. Ploughing the deep sea floor. *Nature.* 489 :286-290

Jones F.B. 1992. Environmental impact of trawling on the seabed : A review. *New Zealand Journal of marine and Freshwater Research*. 26 :59-67

Keywords: bottom trawling; coastal sediment; geochemistry

Management goals for the Seine estuary: the importance of silica dynamics in tidal marshes

Van de Walle Samuel and Stefan Van Damme

University of Antwerp, Institute of Environment & Sustainable Development (IMDO), Campus Drie Eiken - Building P, Fort VI-straat 276, 2610 Wilrijk, Belgium
E-mail: Samuel.vandewalle@outlook.com

Incorporating current uses and ecosystem perspectives, rather than an attempt at restoration of pristine conditions, is of vital importance in an estuary management plan. The Sigma plan for the Scheldt estuary includes such considerations. In the case of the Seine however, restoration efforts lack a holistic framework based on ecological functioning. Based on an inter-estuarine comparison, it is the aim to extrapolate methods and ecological objectives from the Scheldt estuary to the well documented Seine estuary.

Although Scheldt and the Seine share similar human pressures, their ecological functioning reveals major differences. An extremely turbid zone near the Seine mouth prevents primary production, while the short residence time of the water in the Seine estuary hampers the build-up of phytoplankton biomass. Nutrients are flushed out into coastal Seine Bay where large scale algal blooms are observed. Notably, these are also characterized by shifts of diatom to non-diatom communities as dissolved silica is often depleted. Losses of pelagic diatom production resulting from silica limitation have not only been blamed for toxic algal blooms, but for the reduction in ability of coastal food webs to support higher trophic levels (Jacobs et al 2008).

The N:Si ratio (Redfield-Brzezinski) observed in diatoms is 16:15, and Si limitation is known to occur at N:Si ratio larger then 4:1(Gilpin et al 2004). As Si input has remained steady while N input has climbed (Billen et al 2001), diatoms are put at a competitive disadvantage. Tidal marshes have been reported to be a net sink for biogenic silica, storing it in phytoliths of silicified plants (e.g. reed; *Phragmites australis*), and releasing it gradually as dissolved silica. Especially during summer and spring, when diatom growth reduces DSi availability, this internal recycling mechanism is of crucial importance for preventing Si limitation(Struyf et al 2005).

Balancing the demand and supply of DSi will be approached by calculating the area of marshes required to enhance internal recycling of Si to the point where harmful algal blooms are inhibited via competition with diatoms. The calculated marsh area will feature as one element within the systemic restoration framework of the Seine. Moreover, the comparison between Seine and Scheldt of the demands and supplies will indicate a ranking of estuarine system resilience and vigor.

References

Billen G, Garnier J, Ficht A, Cun C. 2001. Modeling the response of water quality in the Seine river estuary to human activity in its watershed over the last 50 years. *Estuaries* 24: 977-93

Gilpin LC, Davidson K, Roberts EC. 2004. The influence of changes in nitrogen: silicon ratios on diatom growth dynamics. *Journal of Sea Research* 51: 21-35

Jacobs S, Struyf E, Maris T, Meire P. 2008. Spatiotemporal aspects of silica buffering in restored tidal marshes. *Estuarine Coastal and Shelf Science* 80: 42-52

Struyf E, Van Damme S, Gribsholt B, Meire P. 2005. Freshwater marshes as dissolved silica recyclers in an estuarine environment (Schelde estuary, Belgium). *Hydrobiologia* 540: 69-77

Keywords: tidal marshes; Si; Seine; estuary management

Changes in bottom shear stress, due to aggregate extraction, in the area of the Hinder Banks (Belgian Continental Shelf)

Van den Eynde Dries, Matthias Baeye, Michael Fettweis, Frederic Francken and Vera Van Lancker

Operational Directorate Natural Environment, Royal Belgian Institute of Natural Sciences, Gulledelle 100, 1200 Brussels, Belgium
E-mail: dvandeneynde@naturalsciences.be

The bottom shear stress determines sediment resuspension and erosion, deposition and bottom morphology. Bottom shear stress is influenced by a number of factors, including surface sediment structure and benthic organisms that all influence the bottom roughness. Therefore bottom shear stress is used as an indicator in the European Marine Strategy Framework Directive (MSFD), to evaluate changes linked to human activities. In the MSFD report, published by the Belgian State (2012), it is stated that human impact asks consideration when the bottom shear stress, calculated by a validated mathematical model over a spring-neap tidal cycle, increases by more than 10 %. The validation of the mathematical model however is not straightforward as measuring of bottom shear stresses is difficult and the lack of quantitative bottom stress measurements hampers a sound validation of model results.

In the framework of monitoring physical impacts of aggregate extraction on the offshore Hinder Banks, bottom mounted Acoustic Doppler Current Profilers (ADCP) were deployed to measure the current profiles currents (Van Lancker *et al.*, 2015). The near-bed current profiles have been used to calculate bottom shear stress and bottom roughness, and their associated error ranges. Data from five deployments at two stations, along the eastern and southern part of the Oosthinder, were available.

The modelling of bottom shear stress was done in an efficient way based on the different models of Soulsby (1995), Soulsby and Clarke (2005) and Malarkey and Davies (2012) so that they could be included in larger scale sediment transport models. Currents were modelled using a three-dimensional hydrodynamic model, based on the COHERENS software (Luyten, 2014), waves were calculated using an implementation of the WAM model.

Results of the validation showed, for a mean bottom shear stress of around 0.7 Pa, a bias less than -0.09 Pa, a root-mean-square error less than 0.25 Pa and a correlation coefficient higher than 0.77 for the first two deployments along the eastern part of the Oosthinder sandbank. The results on the southern part, where the ADCP was deployed in the trough of steep dunes were less good, mainly due to strong tide-topography interactions. Overall, the results are acceptable, giving the high uncertainty associated with measurements of bottom shear stresses.

To assess the impact of aggregate extraction (about 35 million m^3 in 10 year time), three different scenarios of extraction were simulated. Results show that in the relatively deep waters of the Hinder Banks, the impact on the bottom shear stress remains restricted to the areas of the extraction, while the impact outside the impact areas (as defined by the Belgian State, 2012) remained limited to less than 2 %.

References

Belgian State, 2012. Omschrijving van de Goede Milieutoestand & vaststelling van Milieudoelen, Kaderrichtlijn Marien Strategie - Art 9 & 10, 33 pp.

Luyten P. (Editor), 2014. COHERENS - A Coupled Hydrodynamical-Ecological Model for Regional ans Shelf Seas: User Documentation. Version 2.6. RBINS Report, Operational Directorate Natural Environment, Royal Belgian Institute of Natural Sciences, Brussels, Belgium, 1554 pp.

Malarkey J. and A.G. Davies, 2012. A simple procedure for calculating the mean and maximum bed stress under wave and current conditions for rough turbulent flow based on Soulsby and Clarke's (2005) method. Computers & Geosciences, 43: 101-107.

Soulsby, 1995. Bed shear-stresses due to combined waves and currents. In: Advances in Coastal Morphodynamics. M.J.F. Stive, H.J. de Vriend, J. Fredsøe, L. Hamm, R.L. Soulsby, C. Teisson and J.C. Winterwerp (eds.), 4-20 to 4-23. Delft Hydraulics, The Netherlands.

Soulsby R.L. and S. Clarke, 2005. Bed shear-stresses under combined waves and currents on smooth and rough beds. Report TR 137. HR Wallingford, Wallingford, United Kingdom, 42 pp.

Van Lancker, V., M. Baeye, D. Evangelinos and D. Van den Eynde, 2015. Monitoring of the impact of the extraction of marine aggregates, in casu sand, in the zone of the Hinder Banks. Period 1/1 -

31/12 2014. Brussels, RBINS-OD Nature. Report MOZ4-ZAGRI/I/VVL/201502/EN/SR01, 74 pp. (+ 5 Annexes).

Keywords: bottom shear stress; MSFD; aggregate extraction

Annual dynamics of CO_2 partial pressure within bulk sea ice and related CO_2fluxes at Cape Evans (Antarctica)

Van der Linden Fanny[1], Willy Champenois[1], Bernard Heinesch[2], Sébastien Moreau[3], Marie Kotovitch[1], Gauthier Carnat[4], Jiayun Zhou[4], François Fripiat[5], Tim Haskell[6], Jean-Louis Tison[4] and Bruno Delille[1]

[1] Unité d'Océanographie Chimique, Université de Liège, Allée du 6 août 19 - Bât B5A, 4000 Liège, Belgium
E-mail: fvanderlinden@ulg.ac.be

[2] Unit of Biosystems Physics, Université de Liège, Avenue de la Faculté d'Agronomie 8, 5030 Gembloux, Belgium

[3] Georges Lemaître Centre for Earth and Climate Research, Université catholique de Louvain, Chemin du Cyclotron, 2, 1348 Louvain-la-Neuve, Belgium

[4] Laboratoire de Glaciologie, Université libre de Bruxelles, Avenue Franklin Roosevelt 50, 1050 Bruxelles, Belgium

[5] Analytical and Environmental Chemistry, Vrei Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium

[6] Callaghan Innovation, New Zealand

Sea ice is a biome actively participating in the regional cycling of CO_2 as both a source and a sink at different times of the year.

In the frame of the YROSIAE project (Year-Round Ocean-Sea-Ice-Atmosphere Exchanges), annual dynamics of sea ice pCO_2 was compared with CO_2 fluxes measured by automated accumulation chambers at Cape Evans (Ross Island, Antarctica). Results confirmed a general trend of brine pCO_2 supersaturation with respect to the atmosphere during the late winter (concentration of dissolved inorganic carbon - DIC - in brine and brine expulsion in the brine skim) leading to CO_2 degassing, and undersaturation during the spring (carbon-uptake by autotrophs and brine dilution) leading to atmospheric CO_2 uptake. Despite high primary production at the bottom of the ice in spring, DIC profiles suggest that sea ice as a whole appears to be net heterotrophic. Still, sea ice absorbs CO_2 from the atmosphere, as a result of physical processes.

Some variability in the CO_2 fluxes (both in magnitude and sign) could not be explained by variability in sea ice pCO_2 but rather seemed driven by variability in atmospheric conditions and sea ice surface properties. For instance, in late spring, CO_2 fluxes showed a diurnal variability (from CO_2 degassing to uptake) related to atmospheric temperature variations. Large and episodic CO_2 fluxes were systematically positively correlated with strong wind events, and large CO_2 degassing was observed over thin, wet and salty snow cover.

Keywords: sea ice; pCO2; CO2 fluxes

Battle for the reefs: Monitoring the development of biodiversity on four artificial oyster reefs

Van der Pool Jesse and Niek Visschedijk

Building with Nature, Delta Academy, HZ University of Applied Sciences, 5 Edisonweg, 4382 NW Vlissingen, The Netherlands
E-mail: pool0001@hz.nl

Four artificial oyster reefs were placed at the Oesterdam sand nourishment in the Eastern Scheldt of the Netherlands in 2010 to reduce the erosion of the sand nourishment. The reefs consist of a metal cage filled with dead oyster shells and are intended to eventually turn into living oyster reefs and form a food source for birds. Through the construction of the artificial reefs, a heterogeneous, hard substrate was introduced onto the soft substrate which introduced a new habitat type which will likely support a different community composition. The biodiversity on the artificial reefs has been monitored for two years to investigate how the biodiversity is developing. What species have colonized the reefs? Do the reefs differ from each other, or from a natural reef in biodiversity? By placing the artificial reefs in an area with naturally soft substrate, have we created a haven for hard substrate exotic species to exist? Will the reefs turn into living and adapting reefs?

Keywords: oyster reefs; biodiversity; exotic species

Community structure of the macrozoobenthos and demersal fish in the Belgian North Sea

Van Gyseghem Margo and Marc Kochzius

Marine Biology, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium
E-mail: Margo_vg@hotmail.com

Since the ocean is of major importance for human activities, research specifically focussing on marine ecosystems is needed. In the area of the North Sea a lot of coastal and oceanographic research has already been conducted on the impact of fisheries, eutrophication, sediment extractions, as well as pollution by trace metals and polychlorbiphenyls. The aim of this study is to investigate the community structure of the macrozoobenthos and demersal fish on the one hand, and to identify relationships between environment factors or anthropgenic impacts on the other hand. This is of importance, because the macrozoobenthos and demersal fish communities of the North Sea are a very important bioindicators (Callaway et al. 2002).

Samples of macrozoobenthos and demersal fish were taken with the RV Simon Stevin at three different stations (230, ZG03, and 120) in the Belgian North Sea using a beam trawl. All three stations were similar concerning the salinity (station 120: 33.4 p.s.u; station 230: 32.3 p.s.u; station ZG03: 32.6 p.s.u.) and granulomtry (125-250 Mm; Danis et al. 2004). Station 120 and 230 (+/- 11.5 m) had the same depth, while station ZG03 was deeper (18.6 m). Sampling have been done in 2011 (230 (2 replictaes), 120 and ZG03), 2012 (230 (2 replicates), 120 and ZG03), 2014 (230 (2 replicates), 120 and ZG03) and in 2015 (230 (3 replicates), ZG03, and Ostend (2 replicates). After the beam trawling was finished the samples were examined on board of the ship. The organisms were identified and the number and weight of individuals was recorded.

The Shannon diversity index (H) is low, which might indicate habitat degradation or environmental pollution. The Pielou index is below 0.5, which means that the different species are not equally abundant and that some species dominate the community.

A multivariate analysis has been conducted using the Bray-Curtis similarity between the different samples and a cluster analysis. Stations 120 and ZG03 are usually clustered together in the dendrogramme. The metal and polychlorbiphenyl concentrations are the highest in station 120 (Danis et al. 2004), which is the closest to the coast. Station ZG03 is located close to areas of sand extraction, which could have a big influence on the benthic community.

References

Callaway R., J. Alsvåg, I. de Boois, J. Cotter, A. Ford, H. Hinz, S. Jennings, I. Kröncke, J. Lancaster, G. Piet, P. Prince, and S. Ehrich (2002) Diversity and community structure of epibentic invertebrates and fish in the North Sea. ICES Journal of Marine Science, 59: 1199- 2114

Danis B., P. Wantier, S. Dutrieux, R. Flammang, Ph. Dubois, M. Warnau (2004) Contaminant levels in sediments and asteroids (*Asterias rubens* L., Echinodermata) from the Belgian coast and Scheldt estuary: polychlorinated biphenyls and heavy metals. Science of the Total Environment, 333: 149-165

Piet, G. J. and Rijnsdorp, A. D. (1998) Changes in the demersal fish assemblage in the south- eastern North Sea following the establishment of a protected area (''plaice box''). ICES Journal of Marine Science, 55: 420-429

Piet, G. J., van Hal, R., and Greenstreet, S. P. R. (2009) Modelling the direct impact of bottom trawling on the North Sea fish community to derive estimates of fishing mortality for non- target fish species. ICES Journal of Marine Science, 66: 1985-1998

Reiss, H., Degraer, S., Duineveld, G. C. A., Kröncke, I., Aldridge, J., Craeymeersch, J., Eggleton, J. D., Hillewaert, H., Lavaleye, M. S. S., Moll, A., Pohlmann, T., Rachor, E., Robertson, M., vanden Berghe, E., van Hoey, G., and Rees, H. L. (2010) Spatial patterns of infauna, epifauna, and demersal fish communities in the North Sea. ICES Journal of Marine Science, 67: 278-293

Keywords: macrozoobenthos: demersal fish, Belgian North Sea

Choose your biodiversity index wisely when doing an ecosystem impact assessment!

Van Hoey Gert, Annelies De Backer and Kris Hostens

Bio-Environmental research, Aquatic Environment and Quality, Institute for Agricultural and Fisheries Research, Ankerstraat 1, 8400 Oostende, Belgium
E-mail: gert.vanhoey@ilvo.vlaanderen.be

Biodiversity indices are widely used by scientists to measure and monitor ecosystem biodiversity, and to communicate information about the status of an ecosystem or the impact of human activities in a simple way. Ecosystem assessments are a high-level objective for marine policy, related for example to the Marine Strategy Framework Directive or the UN Convention on Biological Biodiversity. However, diversity is not always considered in the ecosystem assessment algorithms and diversity is calculated in various forms or indices, which hampers the comparison between different assessments. In this contribution, we illustrate the pros and cons of using different biodiversity indices to assess the benthic ecosystem, based on running EU benthic indicator work (E.g. ICES Benthos Ecology working group, benthic indicator intercalibration).

A large set of indicators has been defined to assess different structural and functional aspects of benthic ecosystems (compiled in the Devotool and the MARMONI and WISER databases). Forty-six benthic indicators are listed, of which 48 % are related to biodiversity, at least to a certain degree. These benthic indicators consist of different algorithms, be it direct measurements or based on single, multi-metric or multivariate analyses. Benthic biodiversity is usually assessed as the 'number of species' or the 'Shannon Wiener' diversity index. The literature on benthic diversity indicators showed that the relationship between benthic diversity and human pressure is not always straightforward. For example, for the Belgian part of the North Sea it was shown that the diversity responses to sand extraction, dredge disposal and offshore wind energy exploitation were not univocal. In some coastal areas in the Mediterranean region no biodiversity response to the existing pressures could be illustrated at all. On the other hand, the pressure-response relation between a chemical pollutant gradient and benthic indicators in the North Atlantic was quite clear.

All these studies show that biodiversity responses are case specific, depending on the study area, data type, and type of impact. Therefore, biodiversity indices have often been excluded from ecosystem impact assessments. However, the intercallibration work within the EU also showed that the strength of the biodiversity response also depend on the diversity index that has been used. Diversity indices based on 'number of species' showed a more direct and rapid response to different pressures than other indices (e.g. Simpson index). So, if diversity indices are included, an adequate definition of the assessment settings (e.g. data, pressure window, index boundaries) needs to be given to ensure a reliable and comparable impact assessment. Moreover, the appropriate benthic biodiversity index should be selected for each ecosystem impact assessment, taking into account the strengths and weaknesses of each index.

Keywords: biodiversity; indices; ecosystem impact assessment

Biodiversity conservation in social-ecological systems: "mapping the local discourses on biodiversity conservation in Singaporean mangroves."

Van Mossevelde Els[1], Katherine Vande Velde[1], Jean Hugé[1], Nico Koedam[2] and Farid Dahdouh-Guebas[1]

[1] Systems Ecology and Resource Management lab, Biology, ULB, Belgium
E-mail: els.v.mossevelde@gmail.com

[2] Biodiversity & Ecosystems, Department of Biology, Faculty of Sciences and Bio-engineering Sciences, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium

Mangroves provide several ecosystem services that are beneficial to mankind and are of high ecological and social importance. The impact of ongoing coastal development in Singapore has resulted in massive degradation and loss of mangroves and their valuable biodiversity. At present, there is no binding legislation on mangrove biodiversity conservation. Current ambiguous and inadequate policy further increase the risk of degradation and loss. The lack of agreement on local conservation aims and management priorities lead to ineffective biodiversity conservation. These conservation aims and management priorities range from a strict protected areas approach to more development-prone conservation (i.e. the New Conservation Debate). Inclusive conservation acknowledges the need to consider the plurality of discourses with regard to biodiversity conservation and their value as sources of knowledge to move past the unproductive debate on best practices to ultimately increase effectiveness of biodiversity conservation. Within the inclusive framework we will map out and analyse the local discourses on biodiversity conservation by making use of the Q methodology. This method allows us to uncover people's subjectivity (opinions, viewpoint, beliefs etc.) concerning biodiversity conservation without using prearranged categories. In doing so we aim to elucidate potential areas of consensus or clear dis-consensus, allowing the consideration of possible win-win and/or allowing more considerate (i.e. less biased) decisions on compromise between mangrove biodiversity and development in Singapore. Moreover, this study contributes to the research for a broadly applicable method to locally increase effectiveness of biodiversity conservation, within aquatic and terrestrial social-ecological systems.

Keywords: mangroves; biodiversity conservation; Q-methodology; inclusive framework; effective management

Connectivity of *Amphiprion akallopisos* (skunk anemonefish) in the Western Indian Ocean using microsatellite markers

Van Nieuwenhove Annelore, Filip Huyghe and Marc Kochzius

Marine Biology, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium
E-mail: annelore18.vn@gmail.com

Like many coral reef fishes, *Amphiprion akallopisos* (skunk anemonefish) is very popular in the pet and aquarium hobbyist trade. A rapid increase in demand for aquarium species has resulted in an overexploitation of wild populations and consequent destruction of coral reefs. To protect this species and manage the vulnerable marine ecosystems they are associated with, networks of marine protected areas (MPAs) are necessary. An important factor which should be taken into account when designing MPA networks is connectivity among populations through larval dispersal. Connectivity can be determined using genetic markers such as mitochondrial DNA and microsatellites. Microsatellites - also known as short tandem repeats (STRs) or simple sequence repeats (SSRs) - are very well suited for population genetic studies, because they are often hypervariable in length due to high mutation rates, and ubiquitous in the non-coding DNA of most organisms. Because they are so fast evolving, they are better suited to reveal recent barriers to gene flow among populations than many other genetic markers. In this study, the population genetic structure of the skunk anemonefish in the Western Indian Ocean (WIO) will be determined in order to investigate connectivity among populations, by using microsatellites as genetic markers. Samples from three different populations from the east and west coast of Madagascar will be analysed and compared with each other and with samples from Kenya, Tanzania and Mozambique at the African mainland. Small pieces of fin tissue of 124 individuals of *A. akallopisos* were collected at 6 different sites in the WIO and were preserved in 96 % ethanol right after diving. In the coming months, a genetic analysis of all 124 samples will be conducted, using multiplex PCR with four different fluorescent labels applied to two sets of eight microsatellite markers. Parallel with this study, the same samples will be analysed using mitochondrial Control Region sequences. The aim is to provide an answer to the following questions: is a genetic break present between the populations of Madagascar and the African mainland? Is there gene flow between the east and west coast of Madagascar? Are the results comparable when using mitochondrial DNA, a generally slower evolving genetic marker? The results of this study will contribute to the conservation and management of coral reefs and its inhabitants.

RBINS - OD Nature demonstration of the new Marine Mammal data base www.marinemammals.be

Vandenberghe Thomas[1], Jan Haelters[2], Thierry Jauniaux[3], Serge Scory[1], Francis Kerckhof[2], Steven Degraer[1], Bob Rumes[1], Sigrid Maebe[1] and Elise Toussaint[1]

[1] RBINS, OD Nature, Gulledelle 100, 1200 Brussel, Belgium
E-mail: tvandenberghe@naturalsciences.be

[2] RBINS, OD Nature, 3de en 23ste Linieregimentsplein, 8400 Oostende, Belgium

[3] Université de Liège, Faculté Médecine Vétérinaire, Boulevard de Colonster 20 (B43), 4000 Liège

Marinemammals.be: A resource for marine mammal observations
Did you know that the southern North Sea is home to a number of marine mammals, such as harbour porpoises, white-beaked dolphins, and common and grey seals? Did you know that species occurring in the nearby Atlantic Ocean and the northern North Sea may frequent our waters, or wander into them? Did you know that since historical times, strandings and observations of 19 cetacean and 5 pinniped species occurred at the Belgian coast?

If you did not know, now is your chance to find out all about observations and strandings of marine mammals in the Belgian North Sea. Marinemammals.be is a new website from the Royal Belgian Institute of Natural Sciences, OD Nature, where you can explore all Belgian marine mammal data: information on sightings and strandings and the results of scientific research on dolphins, whales and seals from Belgian waters. Also some data from neighbouring countries (Northern France, the Netherlands) are taken up in the database.

The Marinamammals.be website was set up as a joint venture between the Royal Belgian Institute of Natural Sciences (RBINS), Operational Directorate Natural Environment (OD Nature), and the Department of Morphology and Pathology of the University of Liège. RBINS is the competent authority in the national legislation that protects marine mammals. The University of Liège executes autopsies of stranded animals.

Collecting data on strandings and sightings of marine mammals is important as such data can provide us with a lot of information about marine mammals, their population trends, problems they face, and ultimately on the condition of the marine environment in general. Until some decades ago, only few data was collected from stranded animals. Nowadays, full necropsies are performed and tissue samples are collected for research purposes. Registered users of the new website can request tissue samples for scientific research purposes.

The site has an open access part of observations and strandings of marine mammals in Belgium. Queries can be made of species, year, circumstances, etc. Pictures and video images are available in some cases. You can also find out what to do when you find a stranded animal on the beach. And if you are interested in the autopsy of the stranded animals, you will find lots of information techniques used.

Belgian Marine Mammal Tissue Bank
The new website also houses the Belgian Marine Mammal Tissue Bank (BMMTB). It was set up in 1990 and originally contained tissue samples from marine mammals washed ashore and bycaught in Belgium. Through collaboration with stranding networks in neighbouring countries, tissue samples from animals that washed ashore in northern France and in The Netherlands were added since 1995. Similar collections exist in the United Kingdom, Ireland and Germany.

The goal of the BMMTB is to provide high quality tissue samples of marine mammals for dedicated research purposes. This initiative, and similar initiatives in other countries, can allow for more efficient studies of regional and temporal variations in life history, ecology, toxicology and pathology of marine mammals.

The tissues in the BMMTB were collected, fixed and stored according to protocols established by the European Cetacean Society (ECS). They are stored at RBINS in Brussels and Ostend and at the University of Liège, Department of Morphology and Pathology.

You can explore the BMMTB on the same new website and get access to more than 25.000 (mostly) tissue samples taken from marine mammals. Queries can be performed for species, type of tissue,

method of storage, etc., and tissues can be requested. In order to access this page, you need to be a registered user.

The demonstration will show the website marinemammals.be and the Belgian Marine Mammal Tissue Bank. We will bring some skeleton parts of marine mammals that we use for educational purposes.

Keywords: marine mammals; OD Nature; RBINS; database; website; tissue bank

Mapping and Monitoring the Belgian Coast using Kite Aerial Photogrammetry

Vandenbulcke Annelies[1], Cornelis Stal[2] and Alain De Wulf[3]

Ghent University, Krijgslaan 281 (S8) 9000 Gent, Belgium
E-mail: annelies.vandenbulcke@ugent.be

Mapping and monitoring coastal areas is an important aspect of the documentation of marine dynamics and the assessment of flooding risks. Airborne laser scanning is frequently used for this purpose, but next to this classic mapping technique, Kite Aerial Photogrammetry (KAP) is a promising alternative. In this research contribution, it is demonstrated that KAP can be used to create digital surface models in a fast and accurate manner to map and monitor sand dunes and particular areas of interest situated directly along the coastline. A case study was performed at the beach of Raversijde in Ostend, Belgium. The resulting models can be used after a storm surge, to assess the need of beach nourishment, to evaluate coastal erosion or when new constructions need to be placed along the coastline. The principle of KAP is similar to that of conventional airborne campaigns. An important factor are the weather conditions. The kite system can be used in conditions from 2 (light breeze) to 5 (fresh breeze) on the Beaufort scale. This in contrast to the use of UAVs, which need to be operated in windless conditions. The procedure involves the kite operator walking around on the beach, on which ground control points (GCPs) have been placed as black-and-white targets. To achieve the best positional accuracy, GCPs are surveyed with a total station. The kite has a working altitude of 10 to 20 meters above ground level. The kite carries a shock- and waterproof, non-metric camera of 12.1 megapixel. This camera makes it possible to acquire images with a ground resolution of less than 5 cm. Agisoft Photoscan is used to combine the photographs into a mosaic. The aerial triangulation with camera calibration and subsequent model generation is mostly an automated process. The photomosaic is georeferenced and orthorectified using the GCPs. In one day, an area of up to 10 ha can be surveyed and processed to produce digital height maps and orthorectified images. Kite systems can be used as an addition to classic topographic surveys and aircraft-based surveys, with considerable gains in the cost of the data acquisition.

Keywords: mapping; monitoring; coast

Cold-Water Corals in the southern Gulf of Cadiz

Vandorpe Thomas[1], Dierk Hebbeln[2], Claudia Wienberg[2], Michèle Van den Berghe[1] and David Van Rooij[1]

[1] Renard Centre of Marine Geology, Ghent University, Krijgslaan 281 S8, 9000 Gent, Belgium
E-mail: vandorpethomas@hotmail.com

[2] MARUM, Bremen University, Leobener Strasse, Bremen, Germany

The Atlantic Moroccan Coral Province (AMCP) is situated in the southern Gulf of Cadiz roughly between 34° 50'N to 35°35'N and 6°30'W to 7°15'W. This area is characterized by the presence of several tectonic features (e.g. ridges and transverse faults), contourite drifts (Pen Duick, Renard South, Renard North, ...), mud volcanoes (Gemini, Mercator, Al Idrissi, ...) and many small surfacing cold-water coral mounds. Besides these surfacing mounds, hundreds to thousands of mounds were discovered in the subsurface through 2D seismic parasound and sparker seismic profiles. Over 90% of the mounds are situated at water depths between 600 and 1000 meters and most of them occur in clusters. Growth of cold-water corals in this area is known to be prominent during glacial periods (Wienberg et al., 2010) and thus rises the questions how many growth periods have there been in the past and when did they occur?

The cold-water coral mounds are rather small in this region compared to the 100 m high mounds in the Belgica Province in the Porcupine basin (Huvenne et al., 2003). Their width varies between 20 and 200 m with a modus around 60 m, while their height varies between 2 and 40 m with a modus around 10 m. Moreover, many (>10) horizons at which mound growth initiated can be distinguished, compared to the single mound growth event observed in the Porcupine Basin (Huvenne et al., 2003). These initiation phases can be very closely together (several meters apart), indicating several start-up periods during one glacial cycle. This points towards rapidly changing environmental conditions in the AMCP which were sometimes favourable for initiation and growth of cold-water coral mounds. These favourable periods rapidly switched into periods when corals were not able to settle and the mounds could get buried. Some coral mounds are large enough to penetrate several start-up horizons.

Mound growth initiates mostly at elevated places, e.g. tectonic ridges, outcropping bedrock or even previous cold-water coral mounds. When mounds were able to reach a certain height at which they did not get buried by sediments during subsequent non-favourable periods, they were usually recolonized, leading to complex mound shapes. All of these factors indicate that the AMCP is a very promising region to further unravel the conditions (both geographically and environmental) favourable for mound initiation.

References

Huvenne, V.A.I., De Mol, B., Henriet, J.P., 2003. A 3D seismic study of the morphology and spatial distribution of buried coral banks in the Porcupine Basin, SW of Ireland. Marine Geology 198, 5-25.

Wienberg, C., Frank, N., Mertens, K.N., Stuut, J.-B., Marchant, M., Fietzke, J., Mienis, F., Hebbeln, D., 2010. Glacial cold-water coral growth in the Gulf of Cádiz: Implications of increased paleo-productivity. Earth and Planetary Science Letters 298, 405-416.

Keywords: cold-water corals; contourites; Gulf of Cadiz

Kenyan RV Mtafiti, at your service!

Vanhaecke Delphine[1], Nina Wambiji[2], Enock Wakwabi[2], Edward Kimani[2], Charles Magori[2] and Jan Mees[1]

[1] Flanders Marine Institute (VLIZ), Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: delphine.vanhaecke@vliz.be

[2] Kenya Marine and Fisheries Research Institute, Mombasa, Kenya

In 2013, the Government of Flanders donated its oceanographic research vessel (RV) Zeeleeuw (renamed RV Mtafiti, Swahili for 'Researcher'), to the Government of Kenya to advance marine scientific research in the West Indian Ocean (WIO) region. The Kenya Marine and Fisheries Research Institute (KMFRI), as a centre of excellence in marine sciences in the WIO region, was mandated to manage and operate RV Mtafiti. Flanders Marine Institute (VLIZ), within the frame of the VLIZ-KMFRI collaboration, coordinated and facilitated the preparations involved with the translocation of the ship from the harbor of Ostend (Belgium) to Mombasa (Kenya), installed navigation tools and sampling equipment on board and provided training for the navy crew and scientists from KMFRI.

RV Mtafiti is the first permanent maritime research platform available on the East African coast, in the vast area between Somalia and Mozambique. The presence of this research vessel opens a wide range of opportunities for the collection of much needed marine data and information in order to establish scientifically underpinned marine resource management and development plans for the WIO region.

In December 2015, RV Mtafiti conducted her Maiden Voyage, a two-week scientific cruise in the Kenya Exclusive Economic Zone (EEZ). KMFRI staff collected samples from Shimoni to Kilifi. Further activities planned for RV Mtafiti involve undertaking national as well as regional oceanographic surveys. Annually, RV Mtafiti will run four fisheries and oceanographic surveys in the Kenya EEZ. The State Department of Fisheries is also planning to use the vessel for monitoring, surveillance and control surveys. In addition, the involvement of RV Mtafiti in the Second International Indian Ocean Expedition (IIOE2) running from 2015 - 2020, is being explored. The IIOE2 comes with a science plan addressing major questions about the Indian Ocean and Earth System, such as the impacts of climate change, pollution, and increased fish harvesting on the Indian Ocean as well as the influence of the Indian Ocean on other components of the Earth System (http://www.scor-int.org/IIOE-2/IIOE2.htm). RV Mtafiti could contribute by conducting scientific cruises at the East African coast.

In April 2016, VLIZ and KMFRI are organizing an international workshop (sponsored by VLIR-UOS), onboard RV Mtafiti. VLIZ-trainers will make scientific campaign leaders of the participants, transferring their skills and expertise gained over the years in operating and managing a research vessel and undertaking scientific cruises. Participants will come from the WIO-region creating a network of academics that will promote the deployment of RV Mtafiti for collaborative research projects and the involvement in the IIOE2.

Finally, we call out to you and the entire (Flemish) marine scientific community to take part in this venture! RV Mtafiti is operational and at your service! Ship time with RV Mtafiti can be requested to undertake research in the underexplored WIO Region. Help jumpstart the deployment of RV Mtafiti and the advancement of marine sciences in the WIO region! by collecting new marine data needed for the sustainable management of the coastal and marine resources of the West Indian Ocean.

References

Hood, R.R., H.W. Bange, L. Beal, L.E. Beckley, P. Burkill, G.L. Cowie, N. D'Adamo, G. Ganssen, H. Hendon, J. Hermes, M. Honda, M. McPhaden, M. Roberts, S. Singh, E. Urban, and W. Yu. 2015. Science Plan of the Second International Indian Ocean Expedition (IIOE-2): A Basin-Wide Research Program. Scientific Committee on Oceanic Research, Newark, Delaware, USA.

Keywords: oceanographic research vessel; RV Mtafiti; Kenya; WIO-region; sampling

VLIZ-philanthropy: the sea as a good cause

Vanhaecke Delphine, Tina Mertens, Jan Seys, Leen Vandepitte and Jan Mees

Flanders Marine Institute, Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: delphine.vanhaecke@vliz.be

The Flanders Marine Institute (VLIZ), recognized as a charitable organization, uses donations, bequests and other financial contributions in a targeted manner to support philanthropic projects that increase scientific knowledge about the sea and promote social awareness of the major importance of the seas and ocean. A project can be put forward by anyone but needs to be supported by at least one VLIZ staff member, who will act as mentor of the project. Each project proposal is then presented to the VLIZ Scientific Committee, which includes representatives from all Flemish universities and research institutions performing marine research, for approval. The Scientific Committee in turn presents the project for approval to the VLIZ Board of Directors.

In 2015, the first two projects were launched, with more lined up for 2016!

In June, VLIZ launched the Beach Observation Network, SeaWatch-B (VLIZ mentor: Jan Seys). This project aims to generate reliable long-term data on our North Sea and beaches using volunteering citizen-scientists (SeaWatchers). The generated data are crucial to study the environmental changes of our sea and beaches, such as pollution, climate change and overexploitation of ocean resources. To this purpose, an achievable and scientifically sound measuring program was developed. Sampling equipment for the SeaWatchers is purchased with membership fees and donations that VLIZ receives annually. Currently, 10 SeaWatchers are active at our coast. The dream is to reach a network of 67 volunteers, that is one SeaWatcher for each kilometer of Belgian coast. More information on this project can be found at www.seawatch-b.be . The project can be supported at www.vliz.be/support-our-seawatchers.

In December, another project was approved, namely 'Support the WoRMS Editors' (VLIZ mentor: Leen Vandepitte). The World Register of Marine Species (WoRMS, http://marinespecies.org/) is an authoritative reference list of all life in the ocean. It aims to capture the names of all species described since the pioneering work of Carl Linnaeus and is continuously updated and improved by a group of taxonomic experts ("the editors"). Currently, more than 200 editors across the world, each with their expertise in a certain taxonomic group, are working on this Register voluntarily. Each year up to 2,000 newly described species are added to the Register. Completing and correcting WoRMS requires an enormous continuing effort and is entirely dependent on the expertise and time of the editors. On top of that, it is a race against time as species are at risk of disappearing due to changing maritime conditions (such as warming, pollution and acidification), before they are discovered. For this project, VLIZ provides an online platform at www.vliz.be/support-the-worms-editors enabling users of WoRMS (and the public at large) to make (tax-deductible) donations to support the work of the many WoRMS editors.

In the near future, VLIZ-philanthropy also aims to launch calls for proposals for grants to support the marine scientific community. Calls for travel grants, marine research grants and grants for ocean observations and expeditions will be the main focus. Nonetheless, major donors will be free to make a suggestion to formulate a call around their specific interest.

Also you can help! Make a gift to VLIZ-philanthropy at www.vliz.be/make-gift and support our philanthropic projects! Good to know: gifts to VLIZ are tax-deductible as from EUR40 per year. Or suggest a project that is aimed at helping our seas and ocean and could benefit from our support! More information regarding the conditions and requirements can be found at www.vliz.be/projects-philanthropy or feel free to contact filantropie@vliz.be.

Keywords: VLIZ philanthropy; donations; projects; SeaWatch-B; WoRMS

Mapping of chlorophyll a concentration at 20 m resolution using Sentinel-2 imagery

Vanhellemont Quinten and Kevin Ruddick

Royal Belgian Institute of Natural Sciences, Gulledelle 100, 1200 Brussels, Belgium
E-mail: quinten.vanhellemont@naturalsciences.be

In the last couple of years new applications of high spatial resolution (15-30m pixel sizes) satellite data from the Landsat series of satellites have emerged, such as the monitoring of dredging operations and the environmental impact assessment of offshore constructions (e.g. wind farms). There are several reasons for this increased use of Landsat imagery: (1) access to data archive was made free and open to the public in 2008, (2) the much improved Operational Land Imager (OLI) was launched on board Landsat-8 (L8) in 2013, (3) member states of the European Union are required to monitor the first nautical mile under the Water Framework Directive, and (4) the environmental impact assessment of offshore constructions are mandatory by law. Fulfilling these monitoring requirements is impossible using traditional ocean colour satellites data due to their limited spatial resolution (250 - 1000 m pixel sizes), and impractical and expensive using in situ monitoring techniques.

However, applications of L8/OLI data remain limited due to its spectral band set. In turbid coastal waters, L8/OLI can mainly be for the mapping of parameters related to suspended sediments and turbidity. The MultiSpectral Imager (MSI) on the Sentinel-2 series of satellites has a similar spatial resolution (10-60 m), but an increased spectral coverage. Especially of interest to the marine and inland water community are the additional red-edge bands at 20 m spatial resolution, which will allow for the detection of the chlorophyll a absorption peak at around 665 nm. The first Sentinel-2 satellite (S2A) was launched 23rd of June 2015, and is currently in the ramp-up phase of its operations. The second unit (S2B) is planned for launch in mid-2016, and will increase temporal coverage. Here we present a first look at the imagery of this new sensor. We demonstrate the mapping of chlorophyll a concentration in turbid coastal waters that is now for the first time possible at 20 m resolution. S2A has become operational right on time for the 2016 growing season in Europe, and will provide unprecedented spatial and temporal coverage of our waters.

Numerical modelling of wave energy converters

Verbrugghe Tim, Brecht Devolder, Peter Troch and Andreas Kortenhaus

Coastal Engineering, Bridges and Roads; Civil Engineering Department; Ghent University, Technologiepark 904, 9052 Zwijnaarde, Belgium
E-mail: timl.verbrugghe@ugent.be

Introduction
In the last century, research into renewable energy resources became more and more important. Where wind and solar energy are already commercially viable, wave energy is a rather new, but promising development. The power within ocean waves is dense, can efficiently travel long distances and is sufficient to contribute significantly to the energy market. Wave energy from ocean waves is absorbed by using Wave Energy Converters (WECs). WEC development is characterised by a large variety of device types; differentiation is made based on the location, device geometry, mooring type and operating method. In this research, focus is put on wave activated bodies. These are floating devices, located nearshore or offshore, producing energy directly from their own kinetic and potential energy, in response to the incoming waves. In order to extract a considerable amount of wave power at a location in a cost-effective way, large numbers of WECs are arranged in farms using a particular geometrical configuration. Interactions between the individual WECs (near field effects) affect the overall power production of the farm. In response to an incoming wave, a floating body starts moving in six degrees of freedom. As a consequence, the device itself starts creating waves, called radiated waves. Additionally, because of the presence of a structure in the wave field, the incoming waves are partially reflected and diffracted. The total wave field around a WEC is thus a combination of incoming, radiated, reflected and diffracted waves. This results into zones with higher wave elevations and zones with lower wave elevations compared to the incident wave field. One should thus avoid that one WEC is positioned in the wake region of another WEC. By arranging the WEC park layout with the individual WECs positioned in zones with amplified wave elevations, the total power production can be significantly higher. In combination with these near field effects, the installation of a WEC park also influences the wave climate further away (far field effects). The wave height reduction behind an entire WEC farm affects other users in the sea, the environment or even the coastline. When installed close enough to the shoreline, a WEC farm can be used as a first-line coastal defence mechanism.

Numerical modelling
In order to answer these fundamental underlying questions on WEC farm design, we aim to develop a methodology and a numerical tool, by using coupled numerical models, supported by experimental validation data. Applying these models could lead to finding the optimal and cost-effective configurations of WEC farms for power production, and quantifying the related environmental impact. The novelty of this approach is that a numerical model, suited for near field effects will be developed and validated. Several modelling types are considered. Firstly, CFD modelling with OpenFOAM is applied, which takes turbulence, viscosity and non-linearity into account, but has a high computational cost. Alternatively, a linear/non-linear potential flow solver (BEM Method) can be used, which neglects turbulence and viscosity, but runs fast and efficient. Furthermore, it will be combined with a numerical wave propagation model suited for predicting far field effects for two purposes: to reduce the computational cost of the near field model and to get more accurate results of the far field effect of WECs. Several models can be applied for propagating the waves in the far field: the mild-slope model MILDwave, the non-hydrostatic model SWASH, or the fully non-linear potential flow model OceanWave3D. The resulting coupled numerical tool will allow us to draw reliable conclusions regarding optimal and cost-effective design of farms of wave energy converters.

Keywords: waves; wave energy; numerical modelling; coupled models

Role of *Vibrio tapetis* in the development of skin ulceration in common dab (*Limanda limanda*)

Vercauteren Maaike[1], Annelies Declercq[1], Evelien De Swaef[2], Lisa Devriese[3], Hans Polet[4], Annemie Decostere[1] and Koen Chiers[1]

[1] Departement of Pathology, Bacteriology and Poultry Diseases, Faculty of Veterinary Medicine, Ghent University, Salisburylaan 133, 9820 Merelbeke, Belgium
E-mail: maaike.vercauteren@ugent.be

[2] Departement of Morphology, Faculty of Veterinary Medicine, Ghent University, Salisburylaan 133, 9820 Merelbeke, Belgium

[3] Animal Sciences Unit - Aquatic Environment and Quality, Institute for Agricultural and Fisheries Research (ILVO), Ankerstraat 1, 8400 Oostende, Belgium

[4] Fishery and Aquatic Production, Institute for Agricultural and Fisheries Research (ILVO), Ankerstraat 1, 8400 Oostende, Belgium

The increasing prevalence of skin ulcers in commercially important flatfish nowadays is an important threat to the fishing industry. Until now, a clear understanding on the possible causes of this disease is still missing. Environmental factors such as temperature rise, fluctuations in salinity, the impact of electric fishing, as well as skin trauma and infections with pathogenic bacteria, such as infection *Vibrio tapetis*, are suspected to play a role in the development of these skin ulcers. To investigate the impact of these parameters, an infection model whereby skin ulcers can be induced, is developed.

In the current study, individually tagged wild-caught common dab (*Limanda limanda*) as representatives for marine flatfish were used. Sixty fish were divided in five groups of 12 animals each. To evaluate whether mechanical damage might play a role in ulcer development, from each fish three different areas both on the pigmented and non-pigmented side were treated as follows: removal of mucus, descaling, no damage. The order of the three treatments was randomized for all individuals. Following mechanical treatment, the animals of three groups were challenged by immersion in a suspension of *V. tapetis* (3×10^5 colony forming units/ml), recovered in pure culture from a skin ulcer of a wild-caught dab. Two non-treated control groups were immersed in a tank with water without *V. tapetis*. The fish were clinically monitored for three weeks post-challenge, and morbidity and mortality data recorded. In case humane endpoints were reached, the fish were sacrificed and a full necropsy performed.

Mortality during the experimental period was higher in the challenged group compared to the control group. The fish that died after inoculation displayed dark red ulcerated skin wounds with subcutaneous bleeding at the areas from which the mucus and scales had been removed prior to immersion. Of the animals surviving the experiment, six challenged individuals showed severe ulcerative lesions three weeks post inoculation. In all other surviving animals (challenged and control), variable healing was observed.

Skin (ulcer) samples and samples of internal organs are currently processed for bacteriological, histological and immunohistochemical examination to elucidate the role of *Vibrio tapetis* in the development of lesions and/or mortality and to decipher the interaction of the pathogen with its host.
To conclude, the hitherto obtained results point towards *Vibrio tapetis* possibly having an etiological role in the development of skin ulcerations in dab subsequent to prior skin damage. However, this research hypothesis needs to be rectified by means of the results of the on-going analyses.

Keywords: skin ulcer; Vibrio tapetis; infection model

Longer shelf life of the brown shrimp (*Crangon crangon*) by chlorine dioxide treatment of the cooling water on board of fishing vessels

Verhaeghe Thomas, Ruben Braeckman and Geertrui Vlaemynck

Technology and Food Science Unit, Institute for Agricultural and Fisheries Research (ILVO), Brusselsesteenweg 370, 9090 Melle, Belgium
E-mail: thomas.verhaeghe@ilvo.vlaanderen.be

The brown shrimp, one of the flagships of the Flemish coastal fisheries, is known for its excellent taste but also regrettably characterized by a short shelf life (ca. 4 days). As a result, a major part of the shrimp is treated after landing with high amounts of benzoic acid (up to 6‰) to prolong shelf life. Only a minor part of the catch can be sold as a fresh, additive-free, high-end product. Today shrimp are still cooked and cooled by means of (untreated) seawater. By cooking shrimp, the number of spoilage bacteria is strongly reduced by heat. However, by cooling with seawater, cooked shrimp get recontaminated, leading to a strong shelf life reduction. This study examined different techniques to disinfect the cooling water in order to improve the product shelf life and quality. Different physical and chemical disinfection methods were compared, based on investment, feasibility, efficiency and production of harmful components. Based on this preliminary study, chlorine dioxide (ClO_2) was selected as the most promising method to implement. Chlorine dioxide was added to sea water samples (CFU > 10^3) in a 1, 3 and 5 ppm concentration and the total plate count of treated and untreated water was determined on plate count agar (PCA) and marine agar (MA). All treated samples showed reduced plate counts compared to untreated samples. Samples treated with 5 ppm showed no detectable counts on PCA. Shrimp were also cooked and subsequently cooled with treated seawater (1-5 ppm), this resulted in a shelf life of 15 days for shrimp cooled with 3 and 5 ppm ClO_2. As ClO_2 is known as a strong oxidizing agent, it has the potential to cause taste deviations. Therefore, shrimp cooled with treated water (3 ppm) were tested by a sensory panel directly after treatment and after a 4 days at 4°C under modified atmosphere. No off-flavors and/or odors were reported by the sensory panel. Based on these results, ClO_2-treatment of cooling water can be a promising technique to prolong the shelf life of the cooked brown shrimp without diminishing its quality. Further studies on board of the vessel should provide more information on the feasibility of this technique.

Keywords: brown shrimp; Crangon crangon; shelf life; cooling water; treatment; chlorine dioxide

Marine migration routes of North-western European silver eel (Anguilla anguilla L.)

Verhelst Pieterjan

Marine Biology department, Ghent University, Krijgslaan 281, 9000 Ghent, Belgium
E-mail: Pieterjan.Verhelst@UGent.be

The marine spawning migration of the European eel (Anguilla anguilla L.) is one of the most challenging biological questions to date. Despite extensive research on the complex life cycle of this critically endangered species, many questions still remain. One of these knowledge gaps is the eel migration route from the European coastline to their spawning ground in the Sargasso Sea. Experts generally agree on the British Isles hypothesis: eels from North-Western Europe are assumed to use the residual current and migrate north in the North Sea and pass north of the British Isles to reach the Atlantic Ocean, where they take a southwest-to-westward course to their spawning grounds. This hypothesis is based on findings of a few eels from the German Bight and the Baltic Sea. The aim of this study was to validate the British Isles hypothesis by acoustic tracking of European silver eel from North-Western Europe. We found striking evidence that eel from some parts of north-western Europe migrate in a counter-current direction through the English Channel to reach the spawning grounds. These results not only will provide more insight into the general migration behaviour of North-Western European eel, but can also contribute to more efficient global conservation of the species.

Keywords: migration; European eel; telemetry

Bright Club: finding the comedy in your research

Verkest Sofie and Ilja Van Braeckel

Science Communication Centre, VUB Campus Etterbeek | M401, Belgium
E-mail: sverkest@vub.ac.be

You are funny. Yes, you. Science Comedy like Bright Club, The PhD Comics and the Big Bang theory shows that researchers and their research can be seriously funny and that laughter is an excellent way to talk about science to the general public.

Bright Club is an international format where researchers are trained to go on stage and talk about science as a stand-up comedian. Belgian Bright Club Organisers Sofie Verkest and Ilja Van Braeckel walk you through the science of comedy and tell you all about this innovative and popular form of science communication and how it will improve your skills as a researcher.

Sofie Verkest is head of the Science Communication Centre of the VUB. She has a background in journalism, is founder of the popular science blog Wtnschp.be and gives communication training to researchers.

Ilja Van Braeckel is science communicator in the Science Communication Centre of the VUB, cartoonist, editor in chief of the science blog Wtnschp.be and Bright Club trainer and comedian.

Tail myonecrosis in brown shrimp (*Crangon crangon* L.) caught in the North Sea

Vermeersch Xavier[1], Koen Chiers[2], Annemie Decostere[2] and Geertrui Vlaemynck[1]

[1] Technology and Food Science Research Unit, Institute for Agricultural and Fisheries Research (ILVO), Brusselsesteenweg 370, 9090 Melle, Belgium
E-mail: Xavier.Vermeersch@ilvo.vlaanderen.be

[2] Veterinary Pathology, Faculty of Veterinary Medicine, UGent, Salisburylaan 133, 9820 Merelbeke, Belgium

Myonecrosis of the tail has been observed in cultured Pacific white shrimp (*Litopenaeus vannamei*) and is caused by Infectious Myonecrosis Virus (IMNV). A similar condition (White Tail Disease) has been reported in freshwater prawns (*Macrobrachium rosenbergii*) caused by *M. rosenbergii* nodavirus and Extra Small Virus like particle. Additionally, *Vibrio harvyei* infections in *L. vannamei* induced similar lesions. Here we demonstrate myonecrosis of the tail in wild caught European brown shrimp.

During the period 2014 - 2015, several batches of brown shrimp were caught by commercial fishing vessels at two month intervals within the 12 mile zone of the Belgium North Sea coast. Shrimp were transferred to the experimental facility within 2 hours after landing and stocked in well aerated seawater tanks. Within 3 weeks, a minority of shrimp developed a circumferential black delineation at the tail with a whitish discoloration of the muscle tissue in the distal end of the carapace and demonstrated a progressive reduction in movement leading to a localised paralysis of the affected region. Samples were taken for histological and virological examination by means of RT-PCR for IMNV.

Upon histological examination, all shrimp presented a distinct coagulative muscle necrosis. A secondary bacterial invasion of the necrotic muscle was additionally observed in the shrimp who often remained alive up to several weeks after the appearance of the first symptoms.

In the hepatopancreas, inclusions of intranuclear bacilliform virus were consistently encountered albeit in low numbers. RT-PCR for IMNV was negative in all samples.

This is the first report of tail necrosis in brown shrimp caught in the North Sea, resembling infectious myonecrosis. However, the etiology still needs to be elucidated.

Keywords: crangon; brown shrimp; myonecrosis; white tail; paralysis

Exploring population structure of Mnemiopsis leidyi in north-western European waters

Verwimp Christophe[1], Lies Vansteenbrugge[1], Kris Hostens[1], Hilde Muylle[2], Olivier Honnay[3], Isabel Roldan-Ruiz[2], Johan Robbens[1] and Tom Ruttink[2]

[1] Aquatic Environment and Quality, Animal Sciences Unit, Institute for Agricultural and Fisheries Research (ILVO), Ankerstraat 1, 8400 Oostende, Belgium
E-mail: christophe.verwimp@ilvo.vlaanderen.be

[2] Growth and Development, Plant Sciences Unit, Institute for Agricultural and Fisheries Research (ILVO), Caritasstraat 39, 9090 Melle, Belgium

[3] Ecology, Evolution and Biodiversity Conservation Section, Department of Biology, Katholieke Universiteit Leuven, Kasteelpark Arenberg 31 - box 2435, 3001 Leuven, Belgium

The American ctenophore, Mnemiopsis leidyi, is a non-native species originating from the Atlantic coasts of America, introduced in European seas via ballast water discharges. Its invasive capacity is attributed to its tolerance to a wide spectrum of abiotic variation and high fecundity. This species is capable of endangering commercially important fishing grounds through competition and predation, and contributed to the collapse in zooplanktivorous fish stocks in the Black Sea in the 1980s. Since 2006, this ctenophore is present in the North Sea and the Baltic Sea. Phylogeographic studies agree upon multiple invasions of M. leidyi in Europe, with parallel routes (Gulf of Mexico to Black and Mediterranean Sea; Atlantic coasts of North America to north-western Europe). Adequate understanding of the invasion history and colonization dynamics is vital to mitigate the effects of non-native species. Furthermore, human mediated invasions provide the opportunity to investigate the evolutionary processes underlying range expansion in real-time.

Until now the population structure of M. leidyi has only been determined on a 'worldwide' scale, using a limited number of genetic markers and limited sampling locations within north-western Europe. In this study, we investigate the genetic diversity and population structure of north-western European populations, to reconstruct invasion routes and to understand whether (and how) M. leidyi adapts to its new environment. The first step in our study was the optimization of a Genotyping-by-Sequencing (GBS) procedure to characterize M. leidyi individuals and populations on a genome-wide scale. General patterns of genetic diversity across the different geographical regions were investigated by cluster analysis based on neutral markers. Candidate loci under natural selection were identified using Fst outlier analysis, and allele frequencies of loci displaying significant signs of selection were investigated for different geographical regions covering north-western Europe and one North American location.

We genotyped 200 specimens captured across the coastal North Sea area (English Channel to German Bight), the Scheldt Estuary and the Baltic Sea, and six samples from North America. Our results suggest a differentiation between the North American and the north-western European populations. Approximately 1% of the 21k screened SNP loci are identified as Fst outliers, which indicates that positive selection is involved in the differentiation process. Surprisingly, no signs of neutral genetic differentiation within the entire north-western European region were detected. The lack of population structure within this region could be explained by extensive gene flow and/or a large effective population size which limits genetic drift. On the other hand, we found a clear neutral genetic differentiation between one 'winter-surviving' population from the Spuikom (a semi-enclosed basin in the harbour of Ostend), sampled in early spring 2015 vs. samples taken at the same location in 2014. This is possibly due to a genetic bottleneck.

To conclude, marker discovery and validation using GBS combined with population genomic analyses is a promising approach to uncover population structure and to detect adaptation in recently established populations. Further work on the collection and genotyping of additional samples will be carried out to increase the geographical and genotypic resolution of the analyses. This will allow us to gather additional evidence for the different processes that shape M. leidyi populations.

Keywords: population genomics; invasion biology; adaptation

The risk of aquarium trade toward introductions of seaweed in European waters

Vranken Sofie[1], Samuel Bosch[1], Viviana Peña[2], Frederik Leliaert[3], Frederic Mineur[4] and Olivier De Clerck[1]

[1] Phycology Research Group, Department Biology, Ghent University, Krijgslaan 281 S8, 9000 Ghent, Belgium
E-mail: sofie.vranken@ugent.be

[2] BioCost, Faculty of Science, University of A Coruña, Campus de la Zapateira, 15071, A Coruña, Spain

[3] Marine Biology Research Group, Department Biology, Ghent University, Krijgslaan 281 S8, 9000 Ghent, Belgium

[4] School of Biological Sciences, Queen's University Belfast, Lisburn Road 97, BT9 7BL Belfast, United Kingdom

Seaweeds globally represent one of the largest groups of marine aliens, constituting between 20 and 29% of all marine introduced species in Europe (Schaffelke et al. 2006). Large-scale substitution of dominant native seaweeds with alien species may alter coastal productivity and food web structure, and therefore impact ecosystem services. Only a few impact studies on invasive seaweeds have been carried out worldwide, and these have detected a range of negative ecological effects, with reduction in abundance of native biota being most frequently reported (Williams & Smith 2007).

Database compilations (e.g. Wallentinus 2002) usually rate maritime traffic and aquaculture, in particular oyster cultivation, as main vectors for primary introductions of alien seaweeds to Europe (Wallentinus 2002). The northwestern Pacific origin, as well as time and location of first records, for the large majority of alien species found on Atlantic shores of Europe and Mediterranean lagoons demonstrate the role of oyster imports from East Asia as a vector of introductions (Mineur et al. 2014), which is confirmed experimentally (Mineur et al. 2007). The threat posed by other vectors however has in many cases not been assessed accurately, especially for invasive species from other geographical origins (e.g. Indo-Pacific species found in the Western Mediterranean Sea). Apart from the notorious case of *Caulerpa taxifolia* (Wiedenmann et al. 2001), the role of aquarium trade, that potentially involves a wide range of seaweed species (both as ornamental plants or as hitchhikers), has been largely overlooked for species belonging to other genera.

The main objective of our research is to characterize the risk posed by the European aquarium trade market regarding introduction of potentially invasive species and their possible impact on the European biodiversity. First, we characterized the diversity and magnitude of the European aquarium trade circuit. Second, we sampled the algae diversity encountered in aquaria ranging from private aquarists over shops and wholesalers to public aquaria. Using DNA-barcoding approaches we identified no less than 137 species, of which 15 % are flagged as introduced species. We then estimated the realized temperature niche, using species occurrence data available from OBIS and GBIF and predicted the potential range of these species in Europe by mapping this realized temperature niche on present and future climate conditions. These data are used to identify regions particularly vulnerable toward introductions of aquarium-associated seaweeds.

References

Mineur, F., Belsher, T., Johnson, M. P., Maggs, C. A., & Verlaque, M. (2007). Experimental assessment of oyster transfers as a vector for macroalgal introductions. Biological Conservation,137(2), 237-247.

Schaffelke, B., Smith, J. E., & Hewitt, C. L. (2006). Introduced macroalgae – a growing concern. Journal of Applied Phycology, 529-541.

Wallentinus (2002). Invasive Aquatic Species of Europe. In Invasive Aquatic Species of Europe. Distribution, Impacts and Management (pp. 27-52). Kluwer Academic Publ., The Netherlands

Wiedenmann, J., Baumstark, A., Pillen, T. L., Meinesz, A., & Vogel, W. (2001). DNA fingerprints of *Caulerpa taxifolia* provide evidence for the introduction of an aquarium strain into the Mediterranean Sea and its close relationship to an Australian population. Marine Biology, 138(2), 229-234.

Williams, S. L., & Smith, J. E. (2007). A global review of the distribution, taxonomy, and impacts of introduced seaweeds. Annual Review of Ecology, Evolution, and Systematics, 327-359.

Keywords: invasive species; seaweed; aquarium; risk assessment

APPLICANTS
VLIZ Thesis Awards
Marine Sciences 2015

Coral reef quality off the west coast of Unguja Island, Zanzibar

Bravo Henrique

Vrije Universiteit Brussel, Master in Biology, EMMC in Tropical Biodiversity and Ecosystems, Pleinlaan 2, 1050 Brussels, Belgium
E-mail: h.bravo.go@gmail.com

Coral reef quality can be measured using a suite of different methods. In this particular study, the quality of six coral reef sites located on the west coast of Unguja Island (Zanzibar, Tanzania) was analysed and compared with previous studies conducted in the same area using three distinct methods. The measurements of 1) benthic cover, 2) sea urchin density, and 3) levels of trace metals were collected in order to test hypotheses stating that reefs closer to the capital of the island, Stone Town, were more deteriorated than reefs located further away due to potential anthropogenic impacts.

Four replicates were taken at each site for the measurements of sea urchin density and benthic composition of the reef. A methodical process that included the use of transects was used in order to obtain a representative analysis of the reefs. For the measurement of trace metals, which are indicative of the levels of pollution, 12 samples (six from sediments and six from a species of sponge, Haliclona fascigera) were obtained from every site, with the exception of Chapwani. These samples were then processed in the laboratory.

The data were then analysed and some results indicated a gradient of reef quality whilst others remained inconclusive. The first two measurements of reef benthos and sea urchin density depicted higher rates of coral reef degradation in sites closer to Stone Town than those located further away. Conversely, analysis on the levels of trace metals, when compared to other studies, did not reveal any unusual values. Enrichment Factor and Biota-Sediment Bioaccumulation Factor were also calculated using the concentrations of the trace metals. Those results showed some sites where enrichment had an anthropogenic source and some trace metals that were being bioaccumulated by a species of sponge, H. fascigera. It is therefore possible to conclude that this species is a suitable bioindicator for further studies.

Keywords: biomonitor; benthos; line transects; MPA; pollution; Tanzania

Genetic diversity and connectivity of the reef-building coral *Seriatopora hystrix* along the East coast of Africa

Buitrago Carol, Rosa Van Der Ven and Marc Kochzius

Laboratory for Marine Biology, Department of Biology, Vrije Universiteit Brussel (VUB), Pleinlaan 2, 1050 Brussel, Belgium
E-mail: Carol.Buitrago@vub.ac.be

Following the global trend, coral reefs in East Africa are declining rapidly due to the effect of direct and indirect anthropogenic stressors, such as pollution, destructive fishing practices, ocean acidification, and climate change. These ecosystems are of critical importance for the more than 39 million people living at the coasts of Kenya, Tanzania, and Mozambique. Coral reefs are the most biodiverse marine ecosystems worldwide providing several goods and services to human populations that include coastal stability, food, tourism and recreation, and cultural heritage. Therefore, conservation action that effectively protects these ecosystems is urgently needed.

This study aims to provide insightful information about the genetic diversity and population structure of the reef-building coral *Seriatopora hystrix* along the East African coast in relation with its particular life history traits. Herein, we utilise nine polymorphic microsatellite loci to assess the genetic variation in ten populations of *S. hystrix* (Fig. 1A). Analyses of genetic diversity distribution support the relation between biogeographical patterns of coral species distribution and genetic diversity of *S. hystrix.* Moreover, populations of *S. hystrix* were well structured (FST = 0.23; RST = 0.41) and strong differentiations were found over shorter distances, with no isolation-by-distance.

Inbreeding associated with sexual reproduction rather than selfing seemed to explain better the deficits of heterozygotes found in some populations. Two genetic breaks were identified around latitude 4˚ S and 14˚ S, which corresponded with the most extreme populations and also coincide with dispersal barriers imposed by the oceanic currents (Fig. 1B). This study did not detect traces of recent bottleneck events, or admixture. Additionally, estimates of contemporary migration support that long distance gene flow can occur, yet still the long life span of scleractinian corals might blur the differences between contemporary and ancestral events. In conclusion, this study found that *S. hystrix* in East Africa exhibits characteristics of a metapopulation where migration takes place mostly from south to north throughout the East African Coastal Current (EACC, Fig. 1C). Therefore, combined efforts for environmental conservation and building capacity of locals should be reinforced in the Northern Mozambique Channel, which might act as seeding source for northern reefs enhancing the resilience of coral reefs after catastrophic events.

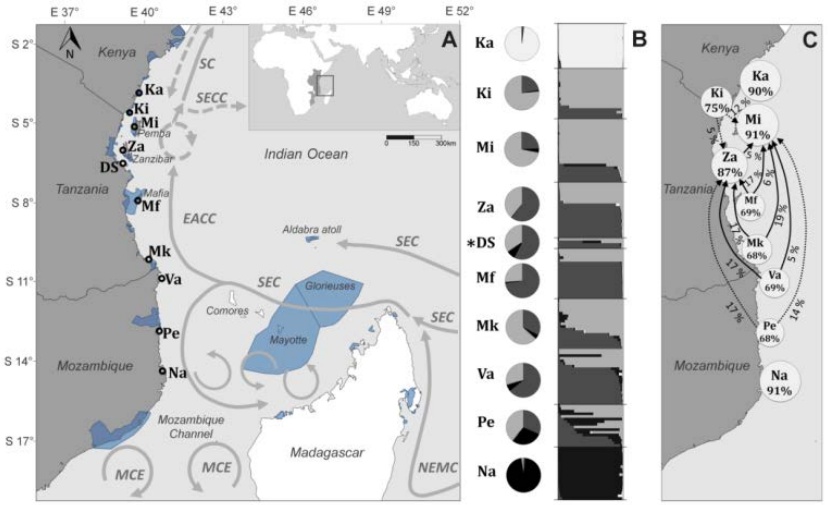


Fig. 1. A. Map of the East African coast with sample sites of *Seriatopora hystrix*. The principal ocean currents in this area are depicted with grey arrows: Northeast Madagascar Current (NEMC), South Equatorial Current (SEC), East African Coastal Current (EACC), Somali Current (SC), South Equatorial Countercurrent (SECC), and Mozambique Channel Eddies (MCE); dotted arrows represent seasonal currents during the Northeast monsoon (Esenkov & Olson, 2002; Schouten et al., 2003; and Mahongo & Shanghude, 2014). Blue shaded areas represent marine protected areas (http://www.mpatlas.org/).

Fig. 1. B. Pie charts show the distribution of the four genetic clusters (K = 4) at each sampled site as suggested in the Bayesian clustering implemented in the software STRUCTURE. The histogramme displays the individual's estimated membership fraction in each of the clusters (each bar represents an individual). * Given the small sample size, DS was only used in the STRUCTURE analysis.

Fig. 1. C. Migration rates estimated with BAYESASS. Black arrows represent the direction of the contemporary migration event. The non-migration rates are indicated inside the circles and migration rates besides the directional black arrow. Inconsistent migration rates are indicated with dotted arrows.

References

Esenkov O.E. and D.B. Olson. 2002. A numerical study of the Somali coastal undercurrents. Deep Sea Research Part II: Topical Studies in Oceanography 49:1253-1277.

Mahongo S.B. and Y.W. Shaghude. 2014. Modelling the dynamics of the Tanzanian coastal waters. Journal of Oceanography 5:1-7.

Marine Conservation Institute. 2015. MPAtlas. Seattle, WA. www.mpatlas.org [Accessed 01/04/2015].

Schouten M.W., W.P. de Ruijter, P.J. van Leeuwen and H. Ridderinkhof. 2003. Eddies and variability in the Mozambique Channel. Deep Sea Research Part II: Topical Studies in Oceanography 50 :1987-2003.

Keywords: coral reefs; population genetics; microsatellites; gene flow; population structure; migration; inbreeding; NMC; WIO; conservation

Seagrass ecosystem in decline: Application of low-cost techniques for monitoring *Posidonia oceanica* meadow health

Emil De Borger

Oceans & Lakes, Marine and Lacustrine Science and Management, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium
E-mail: emil.deborger@hotmail.com

Inleiding
In dit eindwerk ben ik, Emil De Borger, samen met de Griekse NGO Archipelagos Institute of Marine Conservation op zoek gegaan naar gemakkelijke en goedkope manieren om lokaal zeegrasvelden (van de soort Posidonia oceanica) in kaart te brengen. Het onderzoek werd gedaan rond het Griekse eiland Samos waar Archipelagos gevestigd is, en waar het zeegras in verschillende ecologische toestanden voorkomt, wat toelaat methoden in verschillende omstandigheden te testen. De geteste methoden zijn als volgt: (i) het gebruik van een akoestisch sonarapparaat gemaakt voor sportvissers, waarmee bodemstructuren zoals zeegrasvelden waargenomen kunnen worden en mogelijks in kaart gebracht; (ii) een quadcopter "drone" met een GoPro camera aan gevestigd gebruiken om snel luchtfoto's maken met een hoge resolutie in ondiep water. Beide methoden werden gesterkt door 'ground-truthing' data verkregen uit onderwatertransecten, zodat een validatie van de resultaten mogelijk werd. Het sonarapparaat toonde een discriminatiesucces van 82% tussen Posidonia oceanica velden en ander zeebodemsubstraat. De gegenereerde luchtfoto's haalden een resolutie tussen 0.01 en 0.11 m2 × pixel-1, wat toeliet degenererende structuren en kleine groeivormen te discrimineren vanuit de lucht. Uit dit onderzoek zijn ook gebreken en mogelijke verbeteringen duidelijk geworden, die toegepast kunnen worden in toekomstig onderzoek van Archipelagos. Belangrijk is om de experimentele aard van deze thesis te benadrukken, de methoden stellen een eerste test voor, waarbij praktisch nog beperkingen en werkpunten ondervonden werden.

Waarom dit onderzoek?
Posidonia oceanica is een endemische zeegrassoort voor de Middellandse Zee, waar ze naar schatting tussen 31.000 en 43.000 km^2 van alle kustwateren (ongeveer 25%) bedekt. In gezonde toestand vormt de soort monospecifieke velden (Eng.: meadows) tot een diepte van 50 meter. *P. oceanica* is van vitaal belang voor het Middellandse zee-ecosysteem doordat ze voorziet in een resem ecosysteemdiensten, zowel voor de mens als voor andere soorten. De soort kent een hoge primaire productie (en secundaire productie door epibiota), voorziet in zuurstof en voedsel voor organismen in de waterkolom, biedt een schuilplaats en broedplek voor verschillende vissoorten, en is zelfs de exclusieve habitat voor diverse organismen. Dode rhizomen en wortels vangen substraat en dood organisch materiaal op, waardoor een structuur ontstaat die de "*matte*" (term van Franse origine) gevormd wordt die tot 4 meter hoog kan worden, en waarop *P. oceanica* blijft groeien. Deze structuur voorziet een multidimensionaal habitat voor invertebraten, blijkt een belangrijke 'sink' te zijn voor koolstof, vangt sediment op, en vermindert erosie en golfinslag aan lustgebieden. Binnen de Middellandse zee is geen andere soort die deze functies in dezelfde mate vervult en combineert.

De antropogene impact op deze soort is echter groot, sinds 1960 is naar schatting 13-38% van de zeegrasvelden verdwenen, en dit is vooral te wijten aan vervuiling, toenemende turbiditeit, en directe schade van ankers en trawlernetten. *Posidonia oceanica* staat ook onder druk door invasieve soorten (e.g. *Caulerpa sp.* als invasieve alg), en klimaatverwarming aangezien de soort zich in sommige streken op de rand van haar temperatuurtolerantie bevindt. Hierdoor is de soort beschermd vanuit Europese richtlijnen.

Dit onderzoek richt zich op de bescherming van de soort met het doel dit zo goedkoop mogelijk te doen. Fondsen voor zeegrasmonitoring zijn niet altijd voorhanden, en veel werk wordt gedaan door NGO's die steeds op hun budget moeten letten. Het is vooral gericht op het in beeld brengen van zeegrasvelden, en de mogelijkheid om na te gaan of een veld positief of negatief evolueert in de tijd (dus herhaalbaarheid), en of de technieken gemakkelijk en goedkoop zijn zodat ze gebruikt kunnen worden door vrijwilligers zonder grote achtergrondkennis.

Methoden
Vier sites op het eiland Samos gekozen, waarbij gemikt werd om variatie te verkrijgen in de ecologische omstandigheden waarin *Posidonia oceanica* voorkwam (zie figuur 2 p. 17 en tabel 2 p. 18). Op elke site werd eerst data verzameld die een beeld gaf van de toestand van het zeegras (ook nuttige informatie voor Archipelagos zelf), en waarmee de twee experimentele methoden getoetst konden worden.

Dit werd gedaan volgens een surveyprotocool dat vaak in zeegrasonderzoek gebruikt wordt (bv. Seagrasswatch). Vier transecten van 50 m, 25 m parallel van elkaar en loodrecht op de kustlijn werden elke 5 m gesampled door freedivers. Binnen een rooster (0.5 m × 0.5 m) werd het percentage gezond zeegras genoteerd, alsook het percentage invasieve alg, dode '*matte*', en het type substraat. Van elk transect werden ook de begin- en eindcoördinaten genoteerd als referentie. Niet alleen heeft deze informatie gediend om de twee experimentele methoden te toetsen, vervolgens zijn er ook ecologische indices mee berekend die de staat van het zeegras in de site beschrijven, om in de toekomst naar te kunnen refereren.

De eerste techniek die getest werd was het gebruik van een quadcopter met een GoPro camera aangehecht om snel luchtfoto's te maken van een bepaald gebied. Dit gebeurde in samenwerking met een lokale quadcopter-enthousiast en ingenieur Pavlos Ioannidis. De camera zit via een gimbal mount gemonteerd op de quadcopter om de invloed van schokken en vibraties tijdens de vlucht te verminderen. Het vluchtpatroon was als volgt: loodrecht opstijgen, parallel langs de kustlijn vliegen over een bepaalde lengte, achterwaarts verwijderen van de kustlijn, parallel langs de kustlijn in de tegengestelde richting als voorheen, tot een bepaald gebied was bestreken (meestal ook levensduur batterij ±11 minuten als bepalende factor). De camera, ingesteld op filmen met 30 fps., was steeds loodrecht naar beneden gericht, en met de kustlijn op een constante positie als referentie. De filmpjes werden daarna gesplitst in frames, 1 op 200 frames werd uit de video gehaald en optisch gecorrigeerd (GoPro lens heeft een sterk fisheye effect). Daarna werden deze frames samen geplakt tot een grotere panoramafoto (al deze stappen m.b.v. Adobe Photoshop). Deze afbeelding werd vervolgens via een GIS-programma nog gecorrigeerd met behulp van GPS-coördinaten vanuit GoogleEarth. Uiteindelijk werd deze panoramafoto nog vergeleken met GoogleEarth beelden (2014). Hierbij werd dezelfde oppervlakte binnen een polygoon vergeleken op het vlak van zeegras-inhoud, pixelgrootte en welke structuren er zichtbaar waren.

De tweede techniek die getest werd was een sonarapparaat (Lowrance Fishfinder) gemonteerd op een kayak. De transducer van het apparaat stuurt een geluidsgolf van (een) bepaalde frequentie(s) ('ping') naar de zeebodem. Structuren op de zeebodem reflecteren en vervormen deze geluidsgolf volgens bepaalde eigenschappen (hardheid, vorm, dichtheid), waardoor de transducer de echo terug oppikt en een beeld kan vormen van de zeebodem. Omdat *Posidonia oceanica* luchtholten bevat en sterk afwijkt van het zeebodemsubstraat is het zichtbaar op de sonogrammen (beelden gevormd door het apparaat). Daarna werd gezocht hoe het detectieproces geautomatiseerd kon worden. Dit werd gedaan volgens een Matlab applicatie (SAVEWS Jr.). Hierin werden parameters zoals bv.: minimale hoogte vegetatie, ruis van de waterkolom, en de standaardafwijking van één ping tot de volgende bepaald, waarmee het programma de echo's per uitgezonden geluidsgolf kan onderverdelen in 'vegetatie', 'geen vegetatie', of 'onbruikbaar' (bv. te veel ruis). Deze classificatie gebeurt daarna in clusters van telkens 30 pings, om foute observaties te relativeren en in zekere mate outliers te vermijden. Hierna werden de resultaten van deze classificatie manueel nagekeken, en geplot op een GIS raster over een satellietbeeld voor visualisatiedoeleinden.

Resultaten en discussie
Afbeeldingen en tabellen zijn in het manuscript te vinden, ik verwijs hiernaar met figuurnummer en paginanummer.

De onderwater transecten zijn zeer nuttig gebleken en hebben een grotere zekerheid toegevoegd aan de verdere resultaten. De ecologische indices voor de vier sites zijn samengevat in figuur 4 p.31. In alle sites buiten Ireon zijn waarden te zien die een positieve toestand aangeven. De Conservation Index (CI, max. 1) geeft het relatief percentage dode '*matte*' aan, dit laatste werd echter alleen in grote mate gevonden in Ireon. De Substitution Index (SI, optimaal 0) geeft weer hoeveel invasieve soorten voorkomen. Ook hier weer werd slechts in Ireon het grootste deel aan invasieve soorten vervangen; *Halophila stipulacea*. Van de invasieve algen *Caulerpa* sp. werden slechts kleine percentages waargenomen. De Phase Shift Index (PSI, optimaal 0) combineert de twee voorgaande, en week enkel voor Ireon af van optimale waarden. Voor deze techniek stelden we ook vast dat een zeer nauwkeurige GPS gebruikt moet worden, of verankerde transecten om deze in de toekomst te herhalen (zie figuur 5 p.30 voor voorbeelden van onnauwkeurige GPS data).

Met de videobeelden van de quadcopter zijn panoramafoto's gemaakt met een hoge resolutie (zie figuur 7 p.35 voor voorbeelden, en tabel 7 p.36 voor vergelijkingswaarden). De afbeeldingen halen een resolutie tussen 0.01 en 0.11 $m^2 \times pixel^{-1}$, gemiddeld 63.3% fijner dan het GoogleEarth vergelijkingsmateriaal. Het verschil in oppervlakte van waargenomen *Posidonia oceanica* varieert gemiddeld 8.6%. Het was gemakkelijker structuren te onderscheiden op de quadcopter panoramafoto's, zoals zeegrasvelden, rotsstructuren, dode '*matte*' en ankersporen, dit kwam ook doordat de zelfgemaakte afbeeldingen een grotere kleurenrijkdom bezitten (zie figuur 7, p.35, figuur

9, p.38). Uit deze tests worden ook enkele mogelijke verbeteringen duidelijk. Allereerst kan er voor een betere camera gekozen worden, een hogere resolutie is steeds een pluspunt. Ter vervanging van de camera kan mogelijks ook een lichtgewicht spectroscoop gebruikt worden. GPS kan ook aan de quadcopter toegevoegd worden, zo zijn videobeelden meteen van een plaats voorzien, wat het corrigeren van de foto's gemakkelijker maakt.

De classificatiealgoritme was over alle opnames 84% juist in het automatisch classificeren van de sonogrammen. Op figuur 10 en 11 p.40 zijn voorbeelden van de sonogrammen te vinden. De kleuren op deze figuren kunnen gekozen worden omdat met verschillende kleurenschema's andere vormen duidelijker of onduidelijker worden. Met deze techniek zijn zeegrasvelden zichtbaar, en pings zijn ook van een GPS locatie voorzien, goed voor mapping-doeleinden. Door de lichtgewicht kajak zijn wel golfbewegingen zichtbaar op de sonogrammen, en is deze beperkt tot goede weersomstandigheden. In deze tests bleek het algoritme ook problemen te ondervinden bij het onderscheiden van zeegrasvelden, en rotsen op de zeebodem. Ook dode *'matte'* onder de bovenlaag van het sediment was niet zichtbaar. Voor onderzoek naar de ecologische toestand van *Posidonia oceanica* is dit wel belangrijke en nodige informatie.

Genetische structuur van *Rhizophora mucronata* in relatie tot oceaanstromen en geografische afstand

Lorent Sophie

Oceans & Lakes, Marine and Lacustrine Science and Management, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium
E-mail: sophie.lorent@gmail.com

Lange afstandsverspreiding is van groot belang bij het in stand houden van het evolutionair potentieel van soorten. Het maakt immers de genetische uitwisseling tussen populaties mogelijk, en heeft zodoende het potentieel om de genetische verscheidenheid binnen die populaties en hun rekbaarheid tegenover mogelijke toekomstige omgevingsveranderingen te verhogen. In de context van toenemende antropogene activiteit en de effecten daarvan op de omgeving, behoren mangroven tot een van de meest bedreigde en gefragmenteerde ecosystemen in de tropen.

In deze studie hebben we met behulp van vijf microsatellietmarkers het genetisch patroon van de mangrovesoort *Rhizophora mucronata* Lam. bestudeerd voor 13 populaties in Zuid-Oost Afrika, gaande van Kenia tot het zuiden van Mozambique, en met populaties op Madagascar en de Seychellen. Doordat de hydrochorepropagulen (i.e., verspreidingseenheden) meerdere dagen en zelfs maanden kunnen drijven en leefbaar blijven, heeft *R. Mucronata* een reëel potentieel om over grote afstanden te verspreiden.

Het doel van dit onderzoek is om inzicht te krijgen in grootschalige connectiviteitspatronen, afgeleid van genetische informatie, en deze te bestuderen in relatie tot geografische afstand en oceaanstromen.Onze resultaten tonen aan dat de populaties uit het onderzochte gebied geen panmictische eenheid vormen, en dat isolatie door afstand en oceaanstromen belangrijke verklarende factoren zijn voor de geobserveerde genetische patronen.

Oceaanstromen kunnen enerzijds connectiviteit tussen ver van elkaar gelegen populaties onderhouden, maar anderzijds kunnen oceanografische fenomenen zoals wervelstromen en convergetiezones ook belangrijke barrières vertegenwoordigen. Zo zorgt de Zuid-Equatoriale stroom bijvoorbeeld voor connectiviteit tussen Oost-Afrikaanse populaties en die op de eilanden in het oosten. Anderzijds voorkomt deze stroming een barrière tussen noordelijke en zuidelijke populaties langsheen de Oost-Afrikaanse kust.

We konden ook aantonen dat centraal gelegen populaties, wat betreft oceaanstromingen en geografische afstanden tot anderen populaties, méér divers waren dan populaties die eerder in de periferie zijn gesitueerd. Met dit onderzoek brengen we inzicht in de connectiviteit van de mangrovesoort *R. Mucronata* in Oost-Afrika, een gebied waarover vooralsnog geen genetisch populatie onderzoeken voor mangrove soorten werd gedaan.

Daarboven tonen onze resultaten dat bij het onderzoeken van connectiviteit tussen populaties niet enkel isolatie door afstand in rekening dient gebracht te worden, maar dat ook kennis inzake oceaanstromen en oceanografische fenomenen in acht dienen te worden genomen. Dergelijke studies, waarin genetische en oceanografische gegevens en kennis worden gecombineerd, vormen een veelbelovende basis om globale verspreidings- en connectiviteitspatronen, en zodoende ook mogelijke veranderingen in het biogeografisch verspreidingsgebied.

Mitigating the impact of the tropical tuna purse seine fisheries on silky sharks (*Carcharhinus falciformis*): small scale behavioral analyses and future improvements in the protocol for videodata acquisition in the purse seine net

Maksimovic Ana

Faculteit Wetenschappen en bio-ingenieurswetenschappen, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussel, Belgium
E-mail: maksimovic.n.ana@gmail.com

Sharks are top predators in marine ecosystems. Due to their low fecundity and late maturity, they are considered among the most vulnerable species to human exploitation. Silky sharks (*Carcharhinus falciformis*) figure among the most frequent shark species that are accidentally caught in the purse seine tropical tuna fisheries worldwide. Juveniles are commonly attracted by floating objects together with tropical tuna aggregations. Possible mitigation measures that reduce the bycatch of silky sharks have been considered, among which the possibility to attract them out of the purse seine net. This research has been the first step towards assessing the key stimuli that may be employed in such conservation measures, by studying the behavior of silky sharks in the purse seine net at a fine scale. We analysed the videos filmed in the net during three scientific cruises conducted in the Pacific Ocean in the period 2012-2014. We found indications of different behavioral patterns of silky sharks in the net that may guide future developments of mitigation measures.

Swimming speed and distance between individuals in a group were found constant throughout all the cruises. Also, the results showed a bimodal distribution of group sizes that suggests that social interactions may play an important role in the spatial distribution of silky sharks. Other analysed categories, like the attraction to the net, have shown a certain disparity among years, possibly caused by the difference in sample sizes or bias while filming. What is certain is that there was a need for an established protocol for video data collection which the scientists would follow in the years to come. To this purpose, we developed a protocol as a set of step-by-step advice that could be applied in the future cruises in order to standardize the data collection procedure.

Keywords: purse seine fisheries; silky sharks; bycatch mitigation; shark behavior

Extension of (a) numerical tool(s) for the investigation of coastal safety measures: a 2D and 3D hydrodynamical model for the IJzermonding and harbour of Nieuwpoort

Christophe Noël and Sara Porchetta

KU Leuven, Faculteit Ingenieurswetenschappen, Kasteelpark Arenberg 1 bus 2200, 3001 Heverlee, Belgium
E-mail: noel_christophe@hotmail.com

The goal of this master's thesis was to provide a basis for future studies to study the influence of a storm surge barrier at Nieuwpoort and the effects of climate change on the tidal flats of the IJzermonding. For this purpose a three-dimensional model of the IJzermonding was set up, which is based on a two-dimensional model from a previous study. This three-dimensional model should make it possible to get a better approximation and a better understanding of the physically related processes
occurring in the IJzermonding. Furthermore, the three-dimensional model enables to take into account flow directions which might be in opposite directions. These flow directions should not be neglected as they have an important contribution to sediment transport processes. In estuaries and coastal areas, sediment transport processes are strongly present and are thus important to understand.

To implement and interpret the three-dimensional model in a thorough way, multiple new theories were studied. A new bottom roughness law was studied, which enables to describe the bottom roughness on the tidal flats better than the classically used constant bottom roughness law. For a three-dimensional model the constant viscosity turbulence closure model is not sufficient and a more complex model, the
k - ε turbulence closure model or the low-Reynolds mixing-length and k - ε turbulence closure model, should be used. Although in the end only one model is implemented, both were studied. Similarly more advanced theories were studied for the morphodynamics. The formulas of mixed sediments and these of a new erosion and deposition criterion were analysed.

The modelling of the hydrodynamics and morphodynamics is performed with the OpenTELEMAC-MASCARET software. The hydrodynamic modelling is obtained by TELEMAC-3D and the morphodynamic modelling by SISYPHE. This software is open source and made it possible to implement the above mentioned theories. As mentioned above, the low-Reynolds mixing-length and k - ε turbulence closure model is not implemented, since research is still ongoing.

Validation of these theories has proven to be impossible in the scope of this master's thesis due to inexplicable vertical eddy viscosity profiles. Further research on these profiles is recommended, since the eddy viscosity is of major importance for both the hydrodynamics and the morphodynamics.

Study of Piezophilic Bacteria in Biodegradation of Triacontane ($C_{30}H_{62}$)

Rifai Ridwan Muhamad

LabMET, Faculteit Bio-ingenieurswetenschappen, Universiteit Gent, Coupure Links 653, 9000 Gent, Belgium
E-mail: ridwanrifai@windowslive.com

Piezophiles are bacteria that need high hydrostatic pressure for growth. They inhabit the deep sea, an oligothropic environment where nutrient and carbon sources are limited. These conditions imposed over piezophiles a critical stress which allows them to make proficient use of some unique nutrient and carbon sources, as for instance aliphatic hydrocarbon. Some studies had been conducted to assess the response of piezophile on the contamination of aliphatic hydrocarbons.

Unfortunately, these studies did not reach hydrocarbons with a length of 30 atoms. Thus, here we examined the biochemical and microbial response of piezophilic bacteria in case of contamination by triacontane ($C_{30}H_{62}$) and identified bacteria able to degrade $C_{30}H_{62}$ and $C_{20}H_{42}$. Deep sea sediments from the West Iberian trench (1km, about 100bars or 10MPa) was enriched using three different pressure conditions (1, 100, and 200bars) and two oxygen conditions (aerobic and anaerobic) using $C_{30}H_{62}$ as the unique carbon source. The enrichment was conducted for nine consecutive incubation periods, each with duration of 10 days. Biochemical parameters (dissolved O2, pH, and anions concentration) and microbial responses (cells number by flow cytometry and hydrophobicity response) were periodically measured during the enrichment. At the end of the enrichment step, the microbial community was analysed by using DGGE and Illumina gene sequencing.

Isolation procedures were conducted on microbial communities with a stable structure using culture dependent methods (i.e.plating w/o osmolites and high pressure reactors). Axenic isolates were identified by 16S rRNA sequencing and characterised using bioinformatics protocols. Bacterial growth was observed in each culture condition, carrying high respiration rates, showing acidification of the medium, and uptake of PO43- and SO42-. DGGE analysis showed a microbial community shift following contamination with triacontane and Illumina gene sequencing later refined these results, showing a dominancy of Acidobacteria, Gammaproteobacteria, and Alphaproteobacteria in the environmental sample. These dominant microbial groups were observed shifted towards Gammaproteobacteria and Epsilonproteobacteria; Gammaproteobacteria and Alphaproteobacteria; Deltaproteobacteria, Alphaproteobacteria, and Epsilonproteobacteria; and Deltaproteobacteria and Alphaproteobacteria in reactor 1AER, 1ANA, 100, and 200, respectively. As many as 37 single colonies were isolated and underwent Sanger sequencing, eventually resulting in 9 single strain sequences. RDP and EzTaxon gene database were used as references and generated
7 identified species names, i.e. Pseudoalteromonas issachenkonii, Pseudoalteromonas undina, Photobacterium aplysiae, Vibrio kanaloae, Thalassospira povalilytica, Halomonas alkaliphila, and Halomonas titanicae.

Meta-proteomics and biomass features analysis are underway to further understand the mechanisms and microbial cell properties featuring deep-sea solid hydrocarbons degraders.

Keywords: Piezophiles; microbial enrichment; microbial community shift; triacontane; hydrocarbons Biodegradation

Interaction of marine pathogens and Harmful Algae (HAB): effect on bivalve recruitment

Emmanuel Van Acker

Universiteit Gent, Laboratory of Environmental Toxicology and Aquatic Ecology, GhEnToxLab, J. Plateaustraat 22, 9000 Gent, Belgium
E-mail: Emmanuel.vanacker@ugent.be

Over the last decades, toxin producing Harmful algal blooms (HABs) have become a frequent phenomenon on a global scale. This is a major concern, since shellfish get regularly poisoned with phycotoxins and pose serious threats to human health. In addition, it has been shown for a limited number of toxic algal species that HABs can affect the reproductive stages of bivalves. As embryogenesis and larval development are probably the most sensitive life stages, it is crucial to nderstand these processes. Despite of this, no studies have investigated whether harmful algae and marine pathogens, which have long been known to cause significant losses in bivalves (e.g. summer mortalities), may have interactive effects on bivalves.

In this study, embryonic development experiments were performed on larvae of the model organism Mytilus edulis. The potential interactions between HABs and pathogens were investigated by simultaneously exposing mussel larvae to different concentrations of harmful dinoflagellates and pathogenic bacteria of the genus Vibrio during five days. Through this method, the adverse effects of five dinoflagellates and one pathogenic bacteria, Vibrio splendidus, were confirmed. Dinoflagellates were found to have a major impact within the first days of the embryogenesis, while the pathogenic effects were concentrated in the last days. Minor, but significant, interaction effects were found for V. splendidus and three dinoflagellate species. V. coralliilyticus, who didn't had a significant independent effect, still showed minor interaction effects with two dinoflagellates.

Although the contribution of the interaction is limited in comparison to the individual effects, our experimental results suggest that interaction effects do exist and that they are species dependent with regards to the algae. Moreover, it was experimentally demonstrated that HABs can induce pathogenic stress by providing extra organic matter available for bacterial growth. As such, HABs and marine pathogens may contribute to the observed yearly variation in availability of wild bivalve larvae.

Keywords: harmful algal blooms; HABs; dinoflagellates; marine pathogens; Vibrio splendidus; Vibrio Coralliilyticus; interaction effects; Mytilus edulis

APPLICANTS
VLIZ North Sea Award 2015

The importance of *Lanice conchilega* reefs in trophic linkages in intertidal areas

De Smet Bart

Mariene Biologie, Universiteit Gent, Krijgslaan 281 S8, 9000 Gent, Belgium
E-mail: badsmet.desmet@ugent.be

Living organisms can have important impacts on physical and chemical processes occurring in their environment, as already stated by Charles Darwin in 1881 after having observed burrowing earthworms. However, the role of species in modifying habitats was only systematically defined in the late 20th century when Jones and co-authors introduced the concept of "ecosystem engineers": organisms that directly or indirectly alter the availability of resources to other species, by modifying the physical environment. In the marine environment, ecosystem engineers show a high variety and have representatives in all kinds of habitats, ranging from coastal areas (e.g. burrowing mangrove crabs) up to the open waters of oceans and extreme environments such as the deep sea (e.g. zooplankton producing faecal pellets). Since ecosystem engineers tend to prevail in stressful environments (characterised by strong abiotic forces such as wave action or drought), coastal sediments harbour particularly large amounts of ecosystem engineering species such as sea grasses, burrowing invertebrates or feeding sting rays.

Some ecosystem engineers are capable of constructing biogenic reefs: solid structures created by an accumulation of organisms and forming a community or habitat which is very different from its surroundings. A prime example is the reefs constructed by the tube-building polychaete *Lanice conchilega* (Terebellidae), a well-known and widely distributed ecosystem engineer in soft-bottom environments. These *L. conchilega* reefs have profound structuring impacts on the benthic environment by altering the biogeochemical and physical properties of the sediment, which consequently affects the community composition, abundance and species richness of its environment.

Several studies have focussed on ecosystem engineers, biogenic reefs and on the polychaete *L. conchilega*, and they mainly contributed to our understanding of the role of these organisms in structuring their environment and the subsequent changes in the interactions between biotic and abiotic components (e.g. bioturbation). Nevertheless, significant knowledge gaps remain, especially dealing with the link between ecosystem engineers and food webs. Therefore, this PhD thesis aims at improving our understanding of the structural and functional role of reefs constructed by the ecosystem engineer *L. conchilega* in temperate soft-substrate coastal ecosystems. The study focusses on the French side of the English Channel, where substantial reefs of *L. conchilega* occur. An overview of the remaining knowledge gaps is outlined in Chapter 1, along with an elaborate description of the focal organism *L. conchilega* and a description of the two study sites in this PhD: the Bay of the Mont Saint-Michel (BMSM) and Boulogne-sur-Mer (Boulogne).

Biogenic reefs composed of *L. conchilega* are important from a conservation point of view, because they noticeably increase the biodiversity in otherwise species-poor environments. Most research however focusses on the effect of *L. conchilega* on a single ecosystem component at a time and this link is investigated at the local scale. In order to understand the general ecological function of the reefs beyond the local scale, the integrated effect of intertidal *L. conchilega* reefs on the major bentho-pelagic components of a soft-bottom intertidal ecosystem was studied in Chapter 2. The different components of the benthos community (i.e. macro-, hyper-, and epibenthos) were compared between an area dominated by *L. conchilega* and an area without any bioengineering species. Additionally, the effect of different local environmental characteristics on the structuring role of the reef habitat was investigated by including the two study sites. All three investigated benthic assemblages were positively affected by the presence of the *L. conchilega* reef structures. The magnitude of the effect depended on the link between the benthic assemblage and the sediment and was largest for the macrobenthos and least strong for the hyperbenthos (small animals living in the water column close to the seabed). The macro- and epibenthic community composition (benthic organisms living in and on the surface of the sediment respectively) was mainly structured by tubeworm density and macrobenthic food availability respectively, while the hyperbenthic community was rather structured by biotic environmental variables (such as total organic matter, chlorophyll a and suspended particulate matter). For the macro- and epibenthos, the reef effect was more pronounced in Boulogne than for in BMSM and was shown to be mainly driven by the higher tubeworm density in the intertidal area of Boulogne.

The high abundance, diversity and biomass of the macrofauna associated with *L. conchilega* render the reef areas exceptionally important feeding grounds for waders in otherwise uniform habitats, as shown in Chapter 3. Because of the high food availability, waders were attracted to the reef areas of the Bay of the Mont Saint-Michel and their densities in the reef exceeded densities in bare sand areas about 47 times. Based on faecal analysis, *L. conchilega* was the only identifiable polychaete species present in all bird species, however waders in the reef area tended to feed on the associated fauna, and especially crustaceans, rather than specifically on the tubeworm itself. The findings of this and the previous chapter reinforce the central role that *L. conchilega* reefs play in linking benthic, pelagic and air-borne compartments in soft-bottom intertidal areas.

While the importance of *L. conchilega* reefs for higher trophic levels was clearly demonstrated, there is no knowledge on the possible existence of reverse interactions; i.e. whether and to which extent predators affect the activity of *L. conchilega* within the reef habitat. A mesocosm experiment was set up to investigate the activity of the tubeworm in the absence and restricted and unrestricted presence of the predatory shrimp *Crangon crangon* (Chapter 4). The bioirrigation activity was quantified by the decrease of an artificially introduced bromide (Br-) tracer, while the feeding activity was measured from the incorporation of 13C via stable isotope analysis. The bioirrigation activity of the *L. conchilega* reef equalled about 30 L m-2 d-1 and was shown to remain unaffected in the presence of the predatory shrimp *C. crangon*. The food uptake of the tubeworm was however about three times lower in the unrestricted presence of *C. crangon*, presumably due to the retraction of the worm's body and tentacles in its tube, induced by physical contact with the predator. Hence, *C. crangon* exerts a trophic pressure on the tubeworm which affects its feeding activity, but not its bioirrigation activity, enabling the tubeworm to maintain its functional role in soft-bottom intertidal areas, even under high predatory pressure.

Notwithstanding the investigated bottom-up and top-down effects within bio-engineered *L. conchilega* reefs, the significance of the common and often influential process of ecosystem engineering on the food web structure and dynamics remains largely unknown. Moreover, most studies dealing with this issue have a theoretical nature and empirical evidence is largely lacking. Chapter 5 combined a classical and a more integrative stable isotope approach to explore the potential effect of *L. conchilega* reefs on the structure of the macroscopic soft-bottom intertidal food web of the two study locations. Despite the structural impacts of the ecosystem engineer on the associated macrofaunal community as reported in Chapter 2, the presence of *L. conchilega* reefs only has a minor effect on the structure of the food web. The isotopic niche width of the consumer communities of reef and control areas are highly similar, implying that consumer taxa do not shift their diet when feeding in a *L. conchilega* reef. Besides, species packing and hence trophic redundancy were not affected, pointing to an unaltered stability of the food web in the presence of *L. conchilega*. The ecosystem engineer's influence on the water column is probably too limited to substantially stir the global structure of the soft-bottom intertidal food web, which is mainly driven by water column-derived primary production.

Whereas the study in Chapter 5 looked at qualitative aspects, another important aspect of food web research consists in the quantification of food web flows, which yields a more thorough approximation of complex food webs. Therefore, Chapter 6 makes use of linear inverse models (LIMs) to present a comprehensive analysis of carbon cycling and dynamics of the food web of a soft-bottom intertidal area in the presence and absence of *L. conchilega* reefs; focussing on the macrofaunal part of the food web. The food web models were based on an empirical dataset from two study sites and two time periods, consisting of biomass and stable isotope data, and general physiological constraints from the literature. The carbon input into reef food webs was about 40 times higher compared to bare sand areas and was mainly derived from organic matter in the water column. The tubeworm focussed the organic matter which is produced in an area at least 15 times larger than the reef itself. Although most of the organic matter input towards these reefs was consumed by suspension feeding macrofauna, particularly *L. conchilega* itself, the worm was not an important source of carbon for other macrofaunal organisms. Rather, the tubeworm reinforces the bentho-pelagic coupling by establishing reef structures which act as a trap of organic matter, resulting in an overall high macrofaunal biomass in the presence of the tubeworm, and much more diverse and well-organised food webs.

The gained knowledge on the structural and functional role of the ecosystem engineer *L. conchilega* in natural soft-substrate coastal ecosystems is summarised and integrated in Chapter 7. This chapter is revolved around a conceptual diagram and discusses the potential of *L. conchilega* in linking community composition, feedback effects, food web structure and carbon cycling at the ecosystem level and beyond the local scale. The combined knowledge emphasises the added value of *L. conchilega* reefs in otherwise uniform intertidal areas. Additionally, the engineering effects of *L. conchilega* on the physical, biological and socio-economic aspects of the ecosystem are compared to the engineering effects of a variety of other ecosystem engineers. Whereas this PhD thesis

provides one of the first attempts to link food web structure/stability and ecosystem engineering in soft-bottom intertidal areas, the discussion thoroughly elaborates on the incorporation of these two research areas.

In conclusion, the ecosystem engineer *Lanice conchilega* facilitates the bentho-pelagic coupling in soft-bottom intertidal areas and it was proven to strongly affect the faunal community composition, diversity, abundance and biomass, even under high predatory pressure. Notwithstanding this strong structural and functional role provided by the *L. conchilega* reefs, no direct effects on the overall structure or stability of the intertidal food web were detected. The magnitude of the links between different food web compartments however is modified by the increased carbon input in the presence of the reefs.

Potential risk of organic micro pollutants on marine phytoplankton in the greater North Sea: integration of modelling and experimental approaches

Everaert Gert

Laboratory of Environmental Toxicology and Aquatic Ecology, Ghent University, Jozef Plateaustraat 22, 9000 Gent, Belgium
E-mail: Gert.Everaert@UGent.be

A complex chemical cocktail, with unknown composition and concentrations, is present in marine waters. Although the awareness of the vulnerability of marine ecosystems to pollution-induced changes increased, the ecotoxicological effects of chemical pollutants on marine ecosystems are poorly understood. Even in intensively monitored regions such as the North Sea, current knowledge of the ecotoxicological effects of chemicals is limited to few (priority) substances and few (model) species. To partly address this knowledge gap, in the present work it was assessed how marine ecosystems respond to the presence of organic chemicals. By analysing existing data and performing laboratory experiments, ecotoxicological effects of organic chemicals to marine organisms and ecosystem functions were quantified. Specific aims of this work were: (1) to infer spatiotemporal trends of concentrations of organic chemicals; (2) to investigate the impact of primary and secondary emissions on the spatiotemporal trends of organic chemicals; (3) to examine the partitioning of organic chemicals in different environmental compartments; (4) to assess the potential ecotoxicological effect of realistic mixtures of organic chemicals on marine phytoplankton species; and (5) to quantify the relative contribution of organic chemicals to the phytoplankton growth dynamics.

Spatiotemporal trends of polychlorinated biphenyl (PCB) concentrations were inferred based on an extensive set of concentrations monitored between 1991 and 2010 in sediments of the Belgian Coastal Zone (BCZ) and the Western Scheldt. The time trends unravelled two to three-fold decreases of the PCB concentrations in the BCZ during the last 20 years. In the Western Scheldt estuary, time trends were spatially heterogeneous and not significantly decreasing. These results demonstrated that international efforts to cut down emissions of PCBs have been effective to reduce concentrations in open water ecosystems like the BCZ but had little effect in the urbanized and industrialized area of the Scheldt estuary. Most likely, estuaries were subject to secondary emissions from historical pollution.

The spatiotemporal trends of PCB concentrations in the Belgian marine waters were confirmed at larger spatiotemporal scales. To do so, multidecadal field observations (1979–2012) in the North Sea and Celtic Sea were analyzed to characterize the spatiotemporal concentrations of PCBs in mussels (*Mytilus edulis*) and in sediments. Decreasing interannual PCB concentrations were found in North Sea sediments and mussels. In addition, interannual changes of PCB concentrations were separated from seasonal variability. By doing so, superimposed to the generally decreasing interannual trends, seasonally variable PCB concentrations were observed. These seasonal variations were tightly coupled with seasonally variable chlorophyll a concentrations and organic carbon concentrations. Indeed, the timing of phytoplankton blooms in spring and autumn corresponded to the annual maxima of the organic carbon content and the PCB concentrations in sediments. These results demonstrated the role of seasonal phytoplankton dynamics (biological pump) in the environmental fate of PCBs at large spatiotemporal scales. The latter was a novel result since the working of the biological pump was never assessed before based on field data collected at the scale of a regional sea and in multiple decades.

Despite the generally decreasing spatiotemporal trends of PCBs, it was not clear whether current concentrations (still) pose a risk to marine ecosystems. Therefore, the spatiotemporal trends were used to assess the ecological risk of PCBs to marine life in the North Sea and Celtic Sea. To do so, PCB concentrations were compared with environmental assessment criteria (EAC). It was found that the potential ecotoxicological risk of PCBs changed considerably over time and in space. Risk quotients (RQs) of PCBs in marine sediments primarily depended on the location of the monitoring site, i.e. the closer to the coast, the higher the RQ. Especially in summer, when PCB concentrations in sediments are high, PCBs present in marine coastal sediments may have posed an environmental risk. By contrast, RQs in mussel depended first on the interannual changes of PCB concentrations. At present, in the Celtic Sea, RQs in mussels are below the value of 1, suggesting no potential environmental risk. In the North Sea, however, PCBs in mussels may still exceed the prescribed

environmental quality criteria. Overall, it was demonstrated that the spatiotemporal variability in PCB concentrations should be considered in future environmental risk assessments.

Comparing concentrations of chemicals with quality thresholds (e.g. EAC) only suggests a potential ecological risk. Therefore, if risk quotients exceed the value of 1, additional assessments are recommended. Hence, additional experimental studies were performed in which a marine diatom was exposed to a realistic mixture of organic contaminants. To do so, passive samplers were used to achieve exposure to realistic mixtures of organic chemicals close to ambient concentrations. The main conclusion was that organic chemicals present in Belgian marine waters did not affect the intrinsic growth rate of *Phaeodactylum tricornutum*. The relative contribution of several environmental factors to the growth of *P. tricornutum* was examined and it was found that natural drivers such as nutrients regime, light intensity and temperature explained about 85% of the observed variability in the experimental data. The main effect of organic chemicals to the growth of *P. tricornutum* was limited to about 1%. In this context, caution is needed prior to extrapolating these results to field conditions. In the present research, results were obtained under laboratory controlled conditions with one single species and thus neglecting possible species interactions. Therefore, it is suggested to assess the validity of the results in a mesocosm experiment (including multiple species and different trophic levels) or under field conditions.

It was not realistic to use only one algal species to represent the ecotoxicological effects of organic chemicals on the entire phytoplankton community. Therefore, an ecosystem model was used to assess the potential adverse effects of organic contaminants on the total primary production. To do so, we modelled phytoplankton dynamics using four classical drivers (light and nutrient availability, temperature and zooplankton grazing) and tested whether extending this model with a chemical-induced growth limitation term improved the model fit. As the inclusion of monitored concentrations of PCBs and pesticides did not lead to a better model fit, it was suggested that the chemical-related growth limitation of marine phytoplankton in the North Sea and the Kattegat was small compared to the limitations caused by the classical drivers. The inferred contribution of organic chemicals to phytoplankton growth limitation was about 1% in Belgian coastal waters, but in the Kattegat the organic chemicals explained about 10% of the phytoplankton growth limitation. These results suggested that there are regional differences in the contribution of organic chemicals to the phytoplankton growth limitation.

This dissertation evaluated the potential risk of organic micropollutants in the marine environment. By integration of existing monitoring data, experimental data and advanced statistical analyses, it is shown that the spatiotemporal variability of PCB concentrations should be considered in future environmental risk assessments and that ambient concentrations of the organic chemicals present are not major drivers of phytoplankton growth. Concentrations of PCBs and pesticides have generally decreased over time in open waters. In coastal waters and in estuaries, however, concentrations remained relatively unchanged. These results demonstrate that international efforts to decrease emissions of PCBs have been effective to reduce concentrations in open water ecosystems, but had little effect in urbanized and industrialized estuaries. The latter is reflected in the relatively high risk quotients (>1) close to the coast. Based on the outcome of the traditional risk assessment, two extra analyses, one model-based approach and one laboratory-based experiment, were performed. Despite the fact that the risk assessment identified a potential ecotoxicological effect of organic chemicals, neither the lab-based study, nor the model-based study indicated that organic chemicals have a major ecotoxicological effect on marine phytoplankton. By contrast, it was demonstrated that phytoplankton, by means of the biological pump, is an important driver in the fate of organic chemicals. The latter is a novel result since the effectiveness of the biological pump was never assessed before based on field data collected at the scale of a regional sea in multiple decades. Overall, natural factors such as nutrients, temperature, light availability and zooplankton grazing are much more important drivers of the marine phytoplankton growth than organic chemicals. In future research, the validity of these conclusions should be further assessed for other substances, other species and higher trophic levels.

Towards a better understanding of the mechanisms of coral bleaching

Roberty Stephane

Lab of Ecophysiology and Animal Physiology, Université Liège, Chemin de la Vallée 4, 4000 Liège, Belgium
E-mail: sroberty@ulg.ac.be

Coral reefs are among the richest and the most diverse biological ecosystems on Earth. The persistence, the resilience and the ecological success of reef-building corals in tropical oligotrophic waters relies on the symbiosis between cnidarians and photosynthetic dinoflagellates of the genus *Symbiodinium*. This association allows the transfer of highly energetic compounds and an efficient recycling of growth-limiting nutrients (CO2, nitrogen and phosphorus) in the oligotrophic environment that are tropical seas (Yellowlees et al. 2008). During last decades coral reefs had to face several large-scale bleaching events compromising their survival (Oliver et al. 2009). This phenomenon linked to anthropogenic climate change and El-Niño events is triggered by warming ocean temperatures in combination with high levels of solar irradiance (UV and/or visible radiations; Lesser (2011)). In these conditions, the mutualistic relationship between host cells and their intracellular symbiotic *Symbiodinium* sp. becomes unstable and results in the loss of the algae by the host organism (Weis 2008).

The causes of coral bleaching

It has been shown at the end of the 80's that elevated solar radiation and temperature impair the photosynthetic activity and induce an oxidative stress in symbiotic cnidarians and in cultured *Symbiodinium* (Lesser et al. 1990). Since then a great deal of evidence has been collected, progressively lifting the veil on the cellular mechanisms leading to the disruption of the symbiosis. It has generally been found that the initial step of bleaching is very likely linked to photosynthesis in Symbiodinium. Indeed, thermal and light stress were reported to cause photoinhibition and damages to the chloroplast and the photosynthetic apparatus in at least three ways. (1) The photosystem II (PSII) and the associated D1 protein are damaged at a rate exceeding the normal repair mechanism (e.g., Hill et al. (2011)) or the repair mechanisms itself is inhibited by heat stress (Takahashi et al. 2009). (2) The Calvin-Benson cycle is compromised under these conditions, through the inactivation of ribulose-1,5-bisphosphate carboxylase/oxygenase (rubisco), the enzyme responsible for CO2 fixation (Jones et al. 1998; Lilley et al. 2010). (3) The thylakoid membrane integrity of chloroplasts can be directly compromised by heat and high light. All of these ways are inter-related, may act in concert and result in the build-up of excess energy, ultimately leading to the generation of reactive oxygen species (ROS) (Suggett et al. 2008; Krueger et al. 2014). Overall this led to the establishment of the hypothesis that ROS and oxidative stress play a significant role in the bleaching phenomenon. Indeed, ROS produced in excess could cause major cellular damages in *Symbiodinium* and host cells. These include membrane oxidation (Tchernov et al. 2004), protein denaturation (Downs et al. 2000), damage to nucleic acids (see Lesser (2006) for review) and can trigger a cellular signaling cascade leading to cell death (Dunn et al. 2004; Richier et al. 2006; Bouchard and Yamasaki 2009) and/or the expulsion of the symbiotic algae by the host (Gates et al. 1992; Weis 2008).

Getting a better insight into the photosynthetic mechanisms in *Symbiodinium*

Phylogenetic studies conducted these last two decades have revealed that the genus *Symbiodinium* is delineated into nine lineages or clades (A-I), each comprising multiple strains or species (Pochon and Gates 2010). Different *Symbiodinium* phylotypes can exhibit a wide range of physiological responses to environmental variations and stress (e.g. Krueger et al. (2014)), thus allowing their coral hosts to occupy a wide range of environmental niches and also significantly contributing to their persistence under change (Howells et al. 2012). Therefore, the host specificities along with the external environmental conditions act as the driving forces responsible for particular pairings between both partners. Light is likely the most important of these environmental factors and recent studies showed that the vertical distribution of certain coral species could be explained by their association with symbionts adapted to the particular light regime experienced by the host. These adaptations may originate, among other, from a less sensitive PSII repair mechanism (Takahashi et al. 2009) and peculiar regulation mechanisms of the photosynthetic activity (e.g. Reynolds et al. (2008)). In the natural environment the coral holobiont has to cope with significant daily variations in light intensities that sometimes exceed *Symbiodinium* photosynthetic capacity (such as during thermal stress). This implies the existence of regulatory mechanisms that mitigate the excitation pressure when the light absorbed is in excess of that required for CO2 assimilation. This can be

done by dissipating the energy in excess and/or diverting electrons in excess in the photosynthetic apparatus. In addition to the linear electron flow (LEF) operating during oxygenic photosynthesis, alternative electrons flows (AEF) have been widely described in higher plants and microalgae. They include cyclic electron flow around Photosystem I (PSI-CEF) and oxygen reduction by photosynthetic electrons through various processes: the Mehler reaction, chlororespiration, photorespiration, and mitochondrion-dependent reoxidation of reducing equivalents (see Cardol et al. (2011) for review).
In the current context of climate changes and their impacts on symbiotic cnidarians a better understanding of the AEF present and their roles in *Symbiodinium* is needed. Indeed, despite that the existence of Mehler reaction, chlororespiration, or PSI-CEF has been strongly suggested in many reports to date, the nature and the relative amplitude of these mechanisms is still a matter of debate in *Symbiodinium*. Therefore, the purpose of the study presented in the first publication of the "scientific contribution" was to investigate the amplitude of photosynthetic alternative electron flows to oxygen (chlororespiration, Mehler reaction, mitochondrial respiration), its light dependence and the occurrence of PSI cyclic electron flow in *Symbiodinium* strains belonging to different Clades (A1, B1 and F1). Joint measurements of oxygen evolution, PSI and PSII activities allowed us to demonstrate that PSI-CEF and chlororespiratory activities are low compared to the extent of the Mehler reaction which can account for up to 50% of maximum photosynthetic electron transfer rate in all strains. This mechanism in *Symbiodinium* plays a photoprotective role. It takes place under high light intensities when the LEF to CO2 fixation saturates, thus acting as an efficient electron sink. By alleviating the excitation pressure over PSII and PSI, it might thus prevent photoinhibition and photodamages. By acting as an efficient electron flow, it also generates an extra proton gradient across the thylakoid membranes, without net synthesis of NADPH. Thus, it might promote the synthesis of extra ATP probably required for CO2 fixation or other cellular reactions (Cardol et al. 2011).

The dark side of the Mehler reaction
Discovered in 1951, the Mehler reaction involves the direct reduction of O2 by PSI and leads to the production of superoxide ion ($O_2^{\cdot-}$) (Mehler 1951). The generated ROS are rapidly converted into water thanks to the activities of the two chloroplast-associated enzymes, superoxide dismutase (SOD) and ascorbate peroxidase (APX) (together grouped into the Mehler Ascorbate Peroxidase or MAP pathway). The flow of electrons extracted from water at the PSII level to water produced by APX, is called the water-water cycle (WWC) (Asada, 1999). The Mehler reaction is at the basis of the sink-limitation model of coral bleaching proposed by Wooldridge (2009). Indeed, the O2 reduction by PSI and the WWC possess only a finite capacity for protection beyond which the electron transport chain becomes over-reduced, significant damage to PSII occurs and the rate of ROS production may exceeds the capacity of the cellular antioxidant network.
Although several studies have pointed out the water-water cycle as being one of the primary mediators of the ROS-mediated process leading to coral bleaching (Suggett et al. 2008; Weis 2008), the impacts of environmental stress on the O2 reduction by PSI and the associated ROS-detoxifying enzymes remained to be determined. Based on the results of the first study presented here (Roberty et al. 2014), I analyzed the impacts of an acute thermal and light stress (conditions known to induce bleaching) on the WWC in the model *Symbiodinium* strain A1 (2nd publication). We observed that high light treatment at 26°C resulted in the up-regulation of SOD, APX and GR activities and an increased production of ROS with no significant change in the amplitude of the Mehler reaction. Under high light and at 33°C, the Mehler reaction significantly increased relative to total electron transport (75% vs 50% at 26°C). This increase was concomitant with a two-fold increase in ROS generation compared to the treatment at 26°C, while enzymes involved in the WWC were largely inactivated. These data show for the first time that combined heat and light stress inactivate antioxidant capacities of the WWC, and suggests that its photoprotective functions are overwhelmed under these conditions.
This study also indicates that cnidarians may be more prone to bleach if they harbor *Symbiodinium* cells having a highly active Mehler-type electron transport, unless they are able to quickly up-regulate their antioxidant capacities (Roberty et al. 2015). Indeed ROS accumulating in the chloroplasts, and more especially H2O2, will diffuse into the host tissue where damages occur and where they trigger a cellular signaling cascade that will ultimately lead to cell death (Bouchard and Yamasaki 2009) and to the phenomenon of coral bleaching (Weis 2008). The resulting loss of symbionts by the coral host will have dramatic ecological consequences on the colony and over the entire reef ecosystem (Hoegh-Guldberg 1999).

References
Bouchard JN, Yamasaki H (2009) Implication of nitric oxide in the heat-stress-induced cell death of the symbiotic alga Symbiodinium microadriaticum. Marine Biology 156:2209-2220

Cardol P, Forti G, Finazzi G (2011) Regulation of electron transport in microalgae. Biochimica et Biophysica Acta (BBA) - Bioenergetics 1807:912-918

Downs CA, Mueller E, Phillips S, Fauth JE, Woodley CM (2000) A molecular biomarker system for assessing the health of coral (Montastraea faveolata) during heat stress. Marine Biotechnology 2:533-544

Dunn SR, Thomason JC, Le Tissier MDA, Bythell JC (2004) Heat stress induces different forms of cell death in sea anemones and their endosymbiotic algae depending on temperature and duration. Cell Death and Differentiation 11:1213-1222

Gates RD, Baghdasarian G, Muscatine L (1992) Temperature stress causes host-cell detachment in symbiotic cnidarians - implications for coral bleaching. Biological Bulletin 182:324-332

Hill R, Brown CM, DeZeeuw K, Campbell DA, Ralph PJ (2011) Increased rate of D1 repair in coral symbionts during bleaching is insufficient to counter accelerated photo -inactivation. Li and Oceanography 56:139-146

Hoegh-Guldberg O (1999) Climate change, coral bleaching and the future of the world's coral reefs. Marine and Freshwater Research 50:839-866

Howells EJ, Beltran VH, Larsen NW, Bay LK, Willis BL, van Oppen MJH (2012) Coral thermal tolerance shaped by local adaptation of photosymbionts. Nature Clim Change 2:116-120

Jones RJ, Hoegh-Guldberg O, Larkum AWD, Schreiber U (1998) Temperature-induced bleaching of corals begins with impairment of the CO2 fixation mechanism in zooxanthellae. Plant Cell and Environment 21:1219-1230

Krueger T, Becker S, Pontasch S, Dove S, Hoegh-Guldberg O, Leggat W, Fisher PL, Davy SK (2014) Antioxidant plasticity and thermal sensitivity in four types of Symbiodinium sp. Journal of Phycology 50:1035-1047

Lesser MP (2006) Oxidative stress in marine environments: Biochemistry and physiological ecology. Annual Review of Physiology 68:253-278

Lesser MP (2011) Coral bleaching: causes and mechanisms Coral reefs: an ecosystem in transition. Springer, pp405-419

Lesser MP, Stochaj WR, Tapley DW, Shick JM (1990) Bleaching in coral reef anthozoans: effects of irradiance, ultraviolet radiation, and temperature on the activities of protective enzymes against active oxygen. Coral Reefs 8:225-232

Lilley RM, Ralph PJ, Larkum AWD (2010) The Determination of Activity of the Enzyme Rubisco in Cell Extracts of the Dinoflagellate Alga *Symbiodinium sp.* by Manganese Chemiluminescence and its Response to Short-term Thermal Stress of the Alga. Plant, Cell & Environment 9999

Mehler AH (1951) Studies on reactions of illuminated chloroplasts: I. Mechanism of the reduction of oxygen and other hill reagents. Archives of Biochemistry and Biophysics 33:65-77

Oliver JK, Berkelmans R, Eakin CM (2009) Coral bleaching in space and time. In: van Oppen MJH, Lough JM (eds) Coral Bleaching: Patterns, Processes, Causes and Consequences. Springer, Berlin Heidelberg, pp21-39

Pochon X, Gates RD (2010) A new Symbiodinium clade (Dinophyceae) from soritid foraminifera in Hawai'i. Molecular Phylogenetics and Evolution 56:492-497

Reynolds JM, Bruns BU, Fitt WK, Schmidt GW (2008) Enhanced photoprotection pathways in symbiotic dinoflagellates of shallow-water corals and other cnidarians. Proceedings of the National Academy of Sciences of the United States of America 105:13674-13678

Richier S, Sabourault C, Courtiade J, Zucchini N, Allemand D, Furla P (2006) Oxidative stress and apoptotic events during thermal stress in the symbiotic sea anemone, Anemonia viridis. Febs Journal 273:4186-4198

Roberty S, Bailleul B, Berne N, Franck F, Cardol P (2014) PSI Mehler reaction is the main alternative photosynthetic electron pathway in Symbiodinium sp., symbiotic dinoflagellates of cnidarians. New Phytologist 204:81-91

Roberty S, Fransolet D, Cardol P, Plumier JC, Franck F (2015) Imbalance between oxygen photoreduction and antioxidant capacities in Symbiodinium cells exposed to combined heat and high light stress. Coral Reefs 34:1063-1073

Suggett DJ, Warner ME, Smith DJ, Davey P, Hennige S, Baker NR (2008) Photosynthesis and production of hydrogen peroxide by Symbiodinium (Pyrrhophyta) phylotypes with different thermal tolerances. Journal of Phycology 44:948-956

Takahashi S, Whitney SM, Badger MR (2009) Different thermal sensitivity of the repair of photodamaged photosynthetic machinery in cultured Symbiodinium species. Proceedings of the National Academy of Sciences of the United States of America 106:3237-3242

Tchernov D, Gorbunov MY, de Vargas C, Yadav SN, Milligan AJ, Haggblom M, Falkowski PG (2004) Membrane lipids of symbiotic algae are diagnostic of sensitivity to thermal bleaching in corals. Proceedings of the National Academy of Sciences of the United States of America 101:13531-13535

Weis VM (2008) Cellular mechanisms of Cnidarian bleaching: stress causes the collapse of symbiosis. Journal of Experimental Biology 211:3059-3066

Wooldridge SA (2009) A new conceptual model for the warm-water breakdown of the coral–algae endosymbiosis. Marine and Freshwater Research 60:483-496

Yellowlees D, Rees TAV, Leggat W (2008) Metabolic interactions between algal symbionts and invertebrate hosts. Plant Cell and Environment 31:679-694.

Electrofishing: exploring the safety range of electrical pulses for marine species and its potential for further innovation

Soetaert Maarten

Universiteit Gent, Gasmeterlaan 126, 9000 Gent, Belgium
E-mail: maarten_soetaert@hotmail.com

In traditional beam trawl fisheries, a gear comprising tickler chains, chain matrices or bobbin ropes is dragged over the seafloor to startle and catch flatfish or shrimp. These heavy fishing have well-known disadvantages such as seabed disturbance, fuel consumption and high by-catches. Pulse trawling is the most promising alternative for conventional beam trawling at this moment. In these electrotrawls, the mechanical stimulation by tickler chains, chain matrices or bobbins is (partly) replaced by electric stimulation, resulting in a less intensive drag and subsequently decreased seabed disturbance and fuel consumption. Additionally, the electric pulses generated by electrodes affect the target species more selectively, thus reducing by-catch. The nearly 100 vessels that have adopted this technique at this moment can be divided into two pulse types as a function of the target species. The first type constituting the vast majority of pulse vessels targets flatfish, particularly Dover sole (*Solea solea* L.), by using a bipolar pulse of 60-80 Hz. This stimulus induced a cramp response in the sole's muscle, which makes it bend in a U-form and prevents it from escaping, resulting in increased catch efficiency. A minority of vessels target brown shrimp (*Crangon crangon* L.) by outfitting their boat with electrotrawls that produce a unipolar startle pulse of 5 Hz. These pulses force shrimp to flip their tail 5 times a second, which makes them jump out of the sediment in the water column. This allows the fishermen to catch them more selectively with less by-catch, also in clear water conditions. However, despite the promising opportunities, several concerns about negative effects of electric pulses on survival, behaviour and reproduction of target and non-target species need to be addressed (ICES recommendations, 2009), which led to the general aim of this thesis. **Chapter 1** elaborates on the history and development of the use of electric pulses in trawls, as well on possible side-effects, emphasizing the areas meriting further investigation. The consequential specific aims of the thesis may be found in **Chapter 2**, and include the investigation of possible side-effects of electric pulses on adult invertebrates (**Chapter 3 & 4**), flatfish (**Chapter 5**) and roundfish (**Chapter 5, 6 & 7**) as well as testing new applications of pulse stimulation improving the selectivity (**Chapter 8**).

The first major gap in knowledge was the effect of electric pulses on marine benthic invertebrates. This was addressed in **Chapter 3**, presenting the results of experiments performed with brown shrimp (*Crangon crangon* L.) and ragworm (*Alita virens* S.) as model species for crustaceans and polychaetes, respectively. These animals were exposed to a homogenously distributed electric field with varying values of frequency, electric field strength, pulse polarity, pulse shape, pulse duration and exposure time to determine the range of safe pulse parameter settings and evaluate the effect of the pulses already being used on commercial electrotrawls. Behaviour during and shortly after exposure, 14 day (14-d) mortality rates, gross and histological examination were used to evaluate possible effects. No significant increase in mortality or injuries was encountered for either species within the range of pulse parameters tested. In contrast, examination of the hepatopancreas of shrimp exposed to the highest field strength revealed a significantly higher severity of an intranuclear bacilliform virus (IBV) infection. The obtained results hence were promising, but indirect effects, in particular on shrimp, as well as an increased impact of repetitive exposure under commercial conditions were still a major concern.

Therefore, brown shrimp were exposed 20 times in 4 days using commercial electrodes and pulse settings to catch shrimp (shrimp startle pulse) or sole (sole cramp pulse) and monitored for 14 days post first exposure (**Chapter 4**). Additionally to the previous experiment, also the size, egg loss, moulting and the degree of IBV infection were evaluated and compared between non-stressed non-exposed shrimp (control group 1) and shrimp exposed to electrodes without electric stimulus (control group 2) and as well as shrimp exposed to mechanical stimuli. In this study, no effect of electric stimulation on the degree of IBV infection was found. The survival of shrimp repetitively exposed to electric pulses did not significantly differ from those that were repetitively mechanically stimulated. However, the lowest survival was observed for the sole cramp pulse, and was significantly lower than second control group displaying the highest survival. On the other hand, the mechanic stimulated shrimp demonstrated the lowest percentage of moults compared to all other treatments, significantly lower than the second control group in which the highest percentage of moults was noted. Additionally, the mechanically stimulated shrimp that died during the experiment had a significantly larger size compared to the surviving individuals. Although negative

impact of repetitive electric exposures on shrimp could not be ruled out, these results demonstrate that any impairing effects should be balanced against the harmful impact of the conventional trawls.

Despite being the major target species of beam trawls, no research investigating the effect of electric pulses on flatfish was reported so far. Dover sole (*Solea solea* L.), was therefore used as model species and exposed to over 40 different homogenously distributed electric fields with varying pulse parameters (**Chapter 5**). Fish behaviour during and shortly after exposure, 14-d post exposure mortality rates, as well as gross and histological examination was used to evaluate possible effects. Sole showed an escape response below a frequency of 20 Hz and a cramp reaction above 40 Hz, immediately followed by post-exposure escape behaviour. No mortality was observed and histological examination did not reveal any abnormalities, indicating the absence of irreversible lesions as a direct consequence of exposure to electric pulses in sole.

Atlantic cod (*Gadus morhua* L.) exposed in the same homogenous experimental set-up (**Chapter 5**), showed similar reactions during exposure. However, immediately after exposure to high electric loads, this gadoid round fish showed tonic-clonic epileptiform reactions. Moreover, one cod developed a spinal injury, which confirmed observations of cod with paravertebral bleedings in published laboratory and field research. Further research (**Chapter 6**) revealed that these epileptiform seizures were not observed when cod was exposed near electrotrawls' wire-shaped electrodes (heterogenous electric field) generating commercial cramp pulses, and may thus be promoted by the homogenous set-up with plate-shaped electrodes. The heterogenous set-up with cod aimed to investigate the variability in occurrence of electric-induced injuries in cod, by exposing wild cod and cultured cod from two different farms to the pulse used by electrotrawls targeting sole. Gross and radiographic examination revealed spinal injuries in 0-5% of fish when exposed near the electrodes. This contrasts with other studies showing incidences varying between 0 and 70% under the same experimental settings, demonstrating a fish-effect rather than a pulse (setting) effect. Analysis of the size, somatic weight, muscularity, number of vertebral bodies and vertebral mineral contents of cod of different origin did not reveal any (co-)decisive physiological nor morphological parameter for exhibiting vulnerability to electric pulses. However, some clues such as the impact of breeding-conditions definitely warrant further research.

Subsequently, we aimed to assess the vulnerability of another roundfish, sea bass (*Dicentrachus labrax* L.), and compare its susceptibility for spinal injuries with that of gadoid roundfish such as cod and whiting (*Merlangius merlangus* L.) (**Chapter 7**). Therefore, sea bass were divided in 2 groups based on the size of the animals and exposed near commercial electrodes the same way as cod (Chapter 6). The behaviour during and after exposure was comparable to that of cod, but no epileptic seizures were induced in this heterogenous set-up. Further gross, radiographic and histologic examination did not demonstrate lesions, suggesting that bass is a less sensitive gadoid roundfish species. As a consequence, sea bass is not to be used as an alternative model species for all roundfish, and it is recommended to include other parameters besides anatomy of the musculature when examining the effect of electric pulses in future research.

The last study (**Chapter 8**) focussed on a possible new application of electric pulses, aiming in (further) improving the selectivity of beam and pulse trawl gears. Firstly, the conventional benthos release panels (BRP) were improved. These BRPs are known to release large amounts of benthos and debris which facilitate the sorting process as well as to reduce the catch of undersized fish. However, unacceptable losses of commercial sole and damage to the BRP as a consequence of slack between the round net and square panel hampers a successful introduction in commercial beam trawl fisheries. To eliminate these drawbacks, the BRPs were inserted in square nets and the selectivity for BRPs square mesh size of 150 mm, 200 mm and 240 mm was assessed. Secondly, an electric cramp stimulus was implemented on the BRP to eliminate the loss of commercial sole. The first modification successfully eliminated the bag formation and subsequent damage while benthos and undersized fish were released in significant quantities. The results of the second innovation suggest that larger than 25 cm was retained, without negatively affecting the release of benthos and most undersized commercial fish. Although further research using smaller mesh sizes or optimized electric stimuli to achieve retention of all commercial sole is warranted, this study clearly demonstrates the promising potential of electric stimuli for further innovation.

Finally, an overall discussion of the scientific results and future research perspectives are provided in **Chapter 9**. The laboratory findings and implications for the field are reviewed, subsequently focusing on the estimated total impact of electrotrawls and elaborating on further innovations that may be created.

The non-indigenous ctenophore *Mnemiopsis leidyi* in the southern North Sea: Ecological and socio-economic effects related to its trophic position and the current distribution of gelatinous zooplankton

Vansteenbrugge Lies

ILVO, Ankerstraat 1, 8400 Oostende, Belgium
E-mail: lies.vansteenbrugge@ilvo.vlaanderen.be

In recent years, abundances of gelatinous zooplankton are thought to have increased all over the world, resulting in jellyfish-dominated ecosystems and food webs. This trend, also referred to as 'jellification', is mainly based on a few local case studies and media-driven public perception, because long-term jellyfish datasets are scarce. Sudden increases in jellyfish densities (blooms) are a common life cycle characteristic, mainly driven by natural fluctuations in the climate. However, certain anthropogenic pressures, such as overfishing, eutrophication, non-deliberate transport of non-indigenous species can be correlated with varying jellyfish abundances. Moreover, gelatinous zooplankton blooms can directly interfere with anthropogenic activities, for example by clogging and rupturing of commercial fishing nets, by stinging beach tourists or by killing fish in sea farms. To be able to manage and reduce the potential problems and economic costs related to jellyfish outbreaks, understanding the mechanisms driving these outbreaks is imperative.

In the 1980s, the ctenophore *Mnemiopsis leidyi* A. Agassiz 1865, indigenous to the Atlantic coast of North and South America, was introduced in the Black Sea through ballast water of ships. The densities of this invasive species rapidly increased in the Black Sea, and in addition to overfishing and eutrophication led to a collapse of the major fisheries, causing vast ecological and socio-economic losses. Consequently, the first observations of *M. leidyi* in northern European marine waters in 2005, and the subsequent sightings of this non-indigenous ctenophore in Belgian marine waters in 2007 caused the appropriate concern. This PhD thesis, as part of the Interreg Iva 2 Seas MEMO project, aimed to assess the structural and functional role of the non-indigenous ctenophore *Mnemiopsis leidyi* in the southern North Sea. More specifically, we focussed on (1) the current distribution of *M. leidyi* in Belgian marine waters, the adjacent ports and the Westerschelde estuary, related to other gelatinous zooplankton, (2) the trophic ecology and interactions of *M. leidyi* in the planktonic food web, (3) the potential ecological and socio-economic effects of the presence of *M. leidyi* and other gelatinous zooplankton in these waters, and (4) the overall threat of *M. leidyi* and the implications for non-indigenous species' management.

After a general introduction (**Chapter 1**) on jellyfish and gelatinous zooplankton, the potential introductory pathways of invasive species and the life cycle characteristics of *M. leidyi*, the data and results are presented in seven chapters. Different approaches were used to tackle the research questions and objectives, including field studies, experimental and laboratory work, database analyses and public questionnaires. In this PhD study, the term 'gelatinous zooplankton' was narrowed down to the planktonic medusa phase (jellyfish) of the phylum Cnidaria (classes Hydrozoa and Scypohozoa) and the phylum Ctenophora.

In the southern North Sea, long-term data on gelatinous zooplankton are scarce, which is partly driven by the difficulties to sample and preserve these often 'fragile' organisms, *M. leidyi* in particular. Therefore, in **Chapter 2**, methodological issues concerning sampling and preservation were investigated. We focused on two different types of plankton nets: a WP2 net (mesh size 200 µm) and ring trawl net (mesh size 1000 µm). Based on their different mesh size and way of deployment (vertical versus undulating trawl), we evaluated whether they can be compared in terms of *M. leidyi* density and size distribution. *Mnemiopsis leidyi* densities from 245 sampling events were analysed according to net type and revealed that WP2 nets do not provide a good estimate of its presence compared to ring trawl nets. Moreover, when *M. leidyi* was present in both nets, much larger density estimates were found by the WP2 net (45.2 ± 114.0 ind.m^{-3} for WP2 net versus 12.8 ± 28.5 ind.m^{-3} for ring trawl net). The ring trawl net gave a good overview of adult population structure, but may underestimate some of the small ctenophores. Consequently, both the filtered volume and the mesh size largely determine the catch. We also tested different preservation solutions and methods with respect to morphological and genetic identification of *M. leidyi* and in function of stable isotope analyses. From our experiments it became clear that unpreserved samples are preferred for any type of analysis. However, in many situations, direct identification in the field is not possible and preserving the sample is inevitable. Then, short-term preservation in

Lugol's solution or RCL2® may provide a good alternative, but shrinkage was observed in both preservatives. For stable isotope analyses, different preservation methods resulted in significant differences in both $\delta^{13}C$ and $\delta^{15}N$, which should be considered when comparing different isotopic compositions. The findings and recommendations formulated in this study should be considered in future *M. leidyi* monitoring. Zooplankton samples collected during this PhD were analysed on board and *M. leidyi* was morphologically identified and measured alive (except for Tentaculata larvae which were genetically identified).

The discovery of *M. leidyi* in Belgian waters in 2007 created a unique opportunity to enhance our knowledge on the distribution of gelatinous zooplankton in the southern North Sea (**Chapter 3**). Monthly and seasonal CalCOFI ring trawl plankton net samples (mesh size 1000 µm, undulating trawl) from the Belgian part of the North Sea and the adjacent Westerschelde estuary were gathered between March 2011 and February 2012. The gelatinous zooplankton in these samples consisted of three Scyphozoa, three Ctenophora and 27 Hydrozoa taxa, including three non-indigenous species: *M. leidyi*, *Nemopsis bachei* and *Lovenella assimilis*. In an addendum (Addendum II), we also described the re-discovery of larval mantis shrimp (*Rissoides desmaresti*), which has not been observed in the Belgian part of the North Sea since 1913. Average gelatinous zooplankton densities reached up to 18 ind.m^{-3} near the coast, gradually declining towards the open sea, while in the brackish Westerschelde, average densities remained below 3 ind.m^{-3}. Gelatinous zooplankton densities were highest in summer and autumn, and the ctenophore *Pleurobrachia pileus* and the hydromedusa *Clytia* sp. were present year-round and at every location. Gelatinous zooplankton densities never outnumbered the non-gelatinous zooplankton densities from the CalCOFI net. Due to the larger mesh size (1000 µm) of this net, only the larger fraction of the zooplankton is captured. The spatial and temporal distribution patterns seemed to be mainly driven by temperature (season) and salinity (location). In terms of population dynamics, the predatory ctenophore *Beroe* sp. followed the three reproductive cycles of its prey *P. pileus*, but may profit from the high abundances of *M. leidyi* in summer and autumn by reaching higher densities. This study provides a firm baseline to evaluate potential gelatinous zooplankton increases in the Belgian part of the North Sea and the Westerschelde estuary.

The analysis of the spatio-temporal distribution and population dynamics of *M. leidyi* in the southern North Sea and its main coastal ports (**Chapter 4**) revealed that *M. leidyi* occurred from August to December, but was never found more than 30 km offshore. Densities were generally low (average 0.8 ± 2.8 ind.m^{-3}) compared to other invaded ecosystems in Europe (densities up to 867 ind.m^{-3}). Highest densities of *M. leidyi* were found in the semi-enclosed basin in the port of Oostende (18.4 ind.m^{-3}) and the Westerschelde estuary (1.9 ind.m^{-3}). The presence of larvae and the sudden appearance of high numbers across the size distribution in August indicated that ports and estuaries may act as sources, populating the adjacent coastal (sink) areas. By means of a zero-inflated negative binomial regression model, the observed variation in *M. leidyi* densities was related to temperature (highest densities when temperature starts to decrease), wave height (higher densities in low energetic systems) and dissolved oxygen concentrations (higher densities at low oxygen concentrations). Although *M. leidyi* densities remained relatively low since its first appearance in Belgian waters in 2007, a permanent *M. leidyi* population has established in the southern North Sea. As outbreaks may happen with only small changes in environmental parameters, further monitoring of this notorious non-indigenous species is recommended.

Knowledge on the diet of *M. leidyi* and its interactions with other components of the pelagic food web will largely contribute to assess the impact of this non-indigenous species on the ecosystem. Using both stable isotope (SI; $\delta^{13}C$ and $\delta^{15}N$) and fatty acid (FA) analyses, we revealed spatial and temporal variation in the trophic ecology of *M. leidyi* in different ecosystems in the southern North Sea (**Chapter 5**). Based on the isotopic composition, we found that spatial differences were largely driven by variation at the base of the food web rather than diet changes of *M. leidyi* in the different ecosystems. Temporal variation in *M. leidyi* SI composition was also influenced by shifting baseline values and driven by seasonal changes in the associated plankton communities. In this chapter, we provide the first data on the FA composition of *M. leidyi* as compared to FA concentrations of two other (indigenous) ctenophores. The total FA concentration of *M. leidyi* was three to four times lower compared to *Pleurobrachia pileus* and *Beroe* sp., categorising this non-indigenous ctenophore as a lipid-poor organism. Trophic interactions between *M. leidyi* and the two co-occurring ctenophores (*P. pileus* and *Beroe* sp.) showed considerable resource differentiation, which could be the result of competition or both ctenophores could have different diets. A mixture of zooplankton was identified as potential food source for *M. leidyi*. FA markers supported the carnivorous diet of *Beroe* sp., but its SI composition did not confirm it as a predator of *M. leidyi*.

The feeding ecology of *M. leidyi* was further investigated as its invasive success is partly related to a broad and flexible planktivorous diet. In **Chapter 6**, we investigated the feeding rates and carbon assimilation of *M. leidyi* by means of grazing experiments with a pelagic diatom species

Phaeodactylum tricornutum and three potential mesozooplankton prey species: nauplii from brine shrimp *Artemia salina*, a copepod *Acartia tonsa,* and eggs and larvae of European sea bass *Dicentrarchus labrax*. Clearance rates were on average 0.2 ± 0.1 $L.mL_{M.leidyi}^{-1}.h^{-1}$, with no significant differences in clearance rates between prey type or prey size. The assimilation of carbon by *M. leidyi* for these different prey types was determined using ^{13}C tracer experiments. Highest carbon assimilation was observed for *Acartia* and sea bass larvae (most efficiently assimilated), and lowest for the pelagic diatom *P. tricornutum*. To further elucidate the prey-dependent variation in carbon uptake, we investigated the effect of each prey type in terms of fatty acids as a proxy for food quality. The consumption of sea bass larvae, characterised by higher levels of DHA (an essential fatty acid), resulted in significantly higher FA concentrations in *M. leidyi*. As *M. leidyi* does not convert excess food into storage lipids, survival, growth and reproduction are likely enhanced by the higher food quality, which might contribute to its invasive success. As global warming may result in an earlier appearance of *M. leidyi* and thus temporal overlap with high quality prey such as fish larvae, a substantial impact on the ichthyoplankton community in the southern North Sea might be expected.

The third aim of this PhD study was to determine the potential ecological and socio-economic effects of the presence of *M. leidyi* in Belgian waters. For the latter, we needed to broaden our scope by focusing on the impact of all prevailing jellyfish on beach tourism in Belgium, as *M. leidyi* is too small and fragile, and thus rarely noticed by tourists (except for divers). In **Chapter 7**, we examined to what extent the main jellyfish messages in the Flemish media corresponded with the knowledge and perception in the tourism sector along the Belgian coast. We searched Flemish newspapers for jellyfish-related articles issued between January 2000 and September 2012 and executed questionnaires at the Belgian coast in the summer of 2012. The number of Flemish newspaper articles increased from less than 5 in 2000 to 27 articles in 2010. Almost 75 % of these articles reported on the causes and economic consequences of jellyfish blooms, and many articles mentioned the dramatic consequences of stinging, poisonous and invasive species. The analysis of the questionnaires showed that the perception of beach tourists on jellyfish is only partly driven by the general media (mainly related to the causes of jellyfish blooms), while personal experience (e.g. stinging, slimy organisms) was at least an equally important driver. As public perception is a key driver for certain policy decisions, integrated coastal zone managers should consider the provision of simple and good information concerning jellyfish (e.g. billboards or aquaria) at the beach. The results of this socio-economic study might serve as a baseline for future citizen science programs.

Finally, the main results of this PhD study were discussed in a broader perspective to manage the introduction and presence of non-indigenous or invasive species (**Chapter 8**). We performed a risk assessment for *M. leidyi* in the southern North Sea by means of the online Harmonia+ tool, which generates exposure (introduction, establishment and spread) and impact (on the environment and human activities) scores. An overall risk of 0.286 was calculated for the non-indigenous ctenophore *M. leidyi* in the southern North Sea, which is considered to be low. Up to 2012, *M. leidyi* showed a clear seasonal outbreak between summer and autumn. Relatively high densities (up to 18 $ind.m^{-3}$) were only observed in the ports, which are considered to be of lower ecological value compared to the 'richer' coastal zone or Westerschelde estuary, where *M. leidyi* densities mostly remained below 1 $ind.m^{-3}$. The combination of periods with unfavourable environmental conditions, the diverse gelatinous zooplankton community (potential competition) and the presence of predators such as *Beroe* sp., probably has limited the success of *M. leidyi* in the southern North Sea. However, this PhD study (including the more recent observations in 2014) showed that the population of *M. leidyi* is fully established in the different southern North Sea ecosystems. Therefore, *M. leidyi* should remain under close observation by means of regular monitoring surveys, and management actions should not be postponed in order to safeguard the current ecosystem services. As such, trying to keep the population under control is most probably the only way forward for a proper management of this non-indigenous species. Ratification of the Ballast Water Convention by all countries around the world is another key issue to at least prevent the introduction of new species and to avoid potential re-introduction of *M. leidyi* in our waters. In light of the Marine Strategy Framework Directive, the early detection (and subsequent eradication) of non-indigenous species (many of them appearing in the water column as some sort of zooplankton stage), for example by means of automated sampling tools, needs to be promoted. This PhD study is a baseline for future (gelatinous) zooplankton monitoring in the Belgian part of the North Sea and Westerschelde estuary (and by extension the southern North Sea).