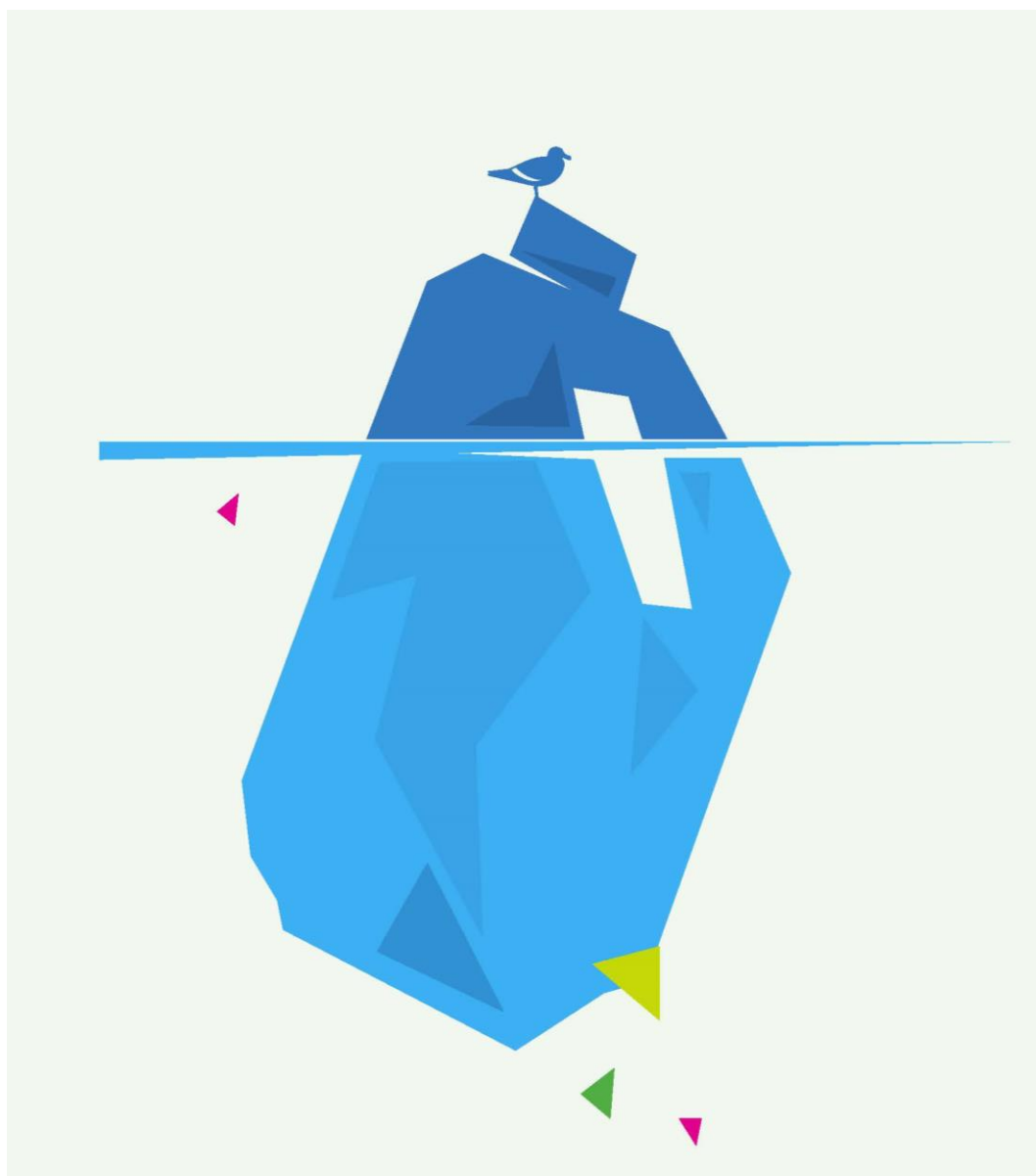


Norske havforskeres forening

# Abstrakt for alle foredrag og postere

Årsmøte Bergen 14-16 november 2016



## Lakselus som begrensning for fortsatt vekst i oppdrettsnæringen

Invitert foredragsholder: Ørjan Karlsen, Havforskningsinstituttet

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Effekten av lakselus på ville laksefisk er valgt som miljøindikator i Stortingsmeldingen «Forutsigbar og miljømessig bærekraftig vekst i norsk lakse- og ørretoppdrett», og hvor det benyttes ett trafikklyssystem for om oppdrettsnæringen skal tillates vekst, reduksjon eller stillstand. Dermed er det en forutsetning for næringen at antall lakselus som slippes ut ikke medfører uakseptable effekter på villfisken. Selv om antall lus i anleggene kan være lavt, og er regulert, medfører det store antallet oppdrettsfisk at vi antar at brorparten av lakselus vi finner på vill laksefisk stammer herfra, selv om det også observeres epidemier av lakselus i områder uten oppdrett. I stortingsmeldingen legges det opp til at status skal evalueres innen produksjonssoner. Disse sonene er avgrenset basert på minst mulig spredning av lakselus mellom disse.

Flere undersøkelser indikerer at mengden lakselus på villfisk samsvarer med smittepresset fra oppdrettsanlegg. Antall lus på villfisk fanget i områder uten eller langt fra nærmeste oppdrettsanlegg er betydelig lavere enn på villfisk fanget i oppdrettsintensive områder, og inne i nasjonale laksefjorder minker antallet lakselus på villfisken når avstanden til oppdrettsanlegg øker. Avstand er viktig da lakselus spres med vannstrømmene.

Antallet lakselus på sjørret i et område brukes til å anslå smittepresset på utvandrende laksesmolt i det samme området. De siste årene er antall lakselus på sjørret i enkelte av de undersøkte områdene er så høyt i perioden for lakseutvandring at det indikerer en uakseptabel påvirkning på utvandrende laksesmolt. Dvs. at en stor andel av laksesmolten får så mye lus at den tar skade og i verste fall dør. På sjørret fanget utover sommeren er antall lakselus i enkelte oppdrettsintensive områder er så høyt at det trolig vil medføre en dødelighet med mindre fisken aktivt unngår dette, for eksempel ved prematur tilbakevandring. Lakselus kan derfor begrense veksten i norsk oppdrettslaks.

## Kjemisk avlusning og krepsdyr – en feltundersøkelse fokusert på restkonsentrasjoner av flubenzuroner i sediment og krepsdyr i nærmiljøet til lakseoppdrett

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Miljøvirkninger fra fiskeoppdrett har vært diskutert i flere tiår, og det er fremdeles usikkerhet omkring effektene på økosystemet, i særdeleshet når det gjelder økende bruk av de kjemiske avlusningsmidlene teflubenzuron og diflubenzuron som hemming av skallskifte hos krepsdyr som reker og sjøkreps. I 2015 ble det gjennomført en feltstudie i Hordaland hvor en først foretok en detaljert bunnkartlegging rundt utvalgte lakse- oppdrettsanlegg. Deretter ble det gjennomført et teinefiske etter krepsdyr og samlet inn sedimentprøver på egnede steder så nært anleggene som mulig. De kjemiske analysene av både krepsdyr (reker, sjøkreps og lignende) og sedimentprøver dokumenterte restkonsentrasjoner av både teflubenzuron og diflubenzuron. De høyeste konsentrasjonene ble funnet i mer skjermete lokaliteter innerst i de undersøkte fjordsystemene.

## Sampling Strategies, Distribution and Concentration of Planktonic Salmon Lice Copepods in the Outer Hardangerfjord and the Altafjord

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Salmon lice are parasitic copepods with three planktonic larvae stages, consisting of two nauplii stages and a copepodite stage. The parasite spread during these stages as plankton, and with the increased number of host represented by salmonid fish in aquaculture it is important to know the concentrations and ecology of the free-living stages.

Finding suitable sampling strategies to collect salmon lice copepods makes it possible to obtain field observed concentrations of salmon lice in their infective stage and in open water. These field data were compared with results from a hydrodynamic salmon lice model, and concluded that the range of concentrations found in the field was within the same range of concentrations simulated by the model. The concentrations obtained were also similar to concentrations found during previous studies in aquaculture impacted regions around Scotland and the Faroe Islands. This study found that areas less influenced by aquaculture had lower concentrations of salmon lice copepods ( $<2 \text{ ind. m}^{-3}$ ). From the vertical distribution of lice, a patchy aggregation in the upper 5 m was found, while the only observed trend in the horizontal distribution was that the concentrations were lower at stations that were  $>10 \text{ km}$  from the nearest salmonid farm.

## Dykkerbasert innsamling av data fra det marine miljø. Erfaringer gjennom nær 50 år

**Æresmedlem Bjørn Gulliksen**

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Skråblikk og erfaringer fra vellykkede og mindre vellykkede prosjekter gjennom en periode på 50 år hvor innsamling av data fra det marine miljø er basert på dykking med komprimert luft. Jeg vil fokusere på dykkerbaserte redskaper og teknikker for innsamling av benthos og isfauna; noe mindre på vitenskapelige resultater fra innsamlingene. Jeg vil bl.a. presentere og diskutere bruk forskjellige typer av sugepumper, avskrapningsteknikker, håndplukk, håver, undervannsfotografering og kvantitativ innsamling ved hjelp av rammer som er plassert på bunnen. Det inkluderes også noen ord om erfaringer fra prosjekter med utgangspunkt i undervannshabitaten «UWL Helgoland» (metningsdykking), samt noen få resultater fra undersøkelser ved norskekysten, Jan Mayen, Bjørnøya og Svalbard (kolonisering og suksessjon av benthos) og isfylte farvann i Antarktis og Arktis (isfauna).

## Scientific highlights from the Norwegian Young Sea Ice (N-ICE2015) expedition

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The Arctic icescape is rapidly transforming from a thick multi-year ice cover to a thinner and largely seasonal first-year ice cover with significant climate and ecosystem consequences across and beyond the Arctic realm. With this motivation, a multidisciplinary team of scientists set out to study the new ice regime during the Norwegian young sea ICE (N-ICE2015) expedition carried out in the Arctic Ocean north of Svalbard (between 80–83°N) from 11 January to 24 June 2015. Results from the unique time-series collected during the expedition are expected to increase our understanding of the consequences of this shift to a younger and thinner sea ice regime for energy flux across the atmosphere-ice-ocean boundary, ice dynamics and the ice-associated ecosystem in order to improve physical and biogeochemical models towards a more realistic forecast of the future state of the Arctic marine system. In this presentation, we will highlight some of the major findings from N-ICE2015 pertaining to atmospheric and ocean forcing, sea ice mass balance and dynamics, and biogeochemical and ecological processes of the ice-associated ecosystem and the implications for our understanding of the Arctic Ocean in an era of rapid change.



## Arctic warming with less sea ice affect the pan-Arctic distribution of sea ice biota

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The Arctic Ocean is currently undergoing large changes in sea ice extent and thickness because of global warming. The ice situation is dynamic with large seasonal variation, but shows declining sea ice during all seasons of the year. Life cycles of more than 2000 species of Arctic marine biota are connected to sea ice, and rely on this habitat for food and shelter. On the underside of sea ice, a layer of ice algae develops early in the season, before the plankton bloom, and forms high-quality sugars and lipids that represent food and energy for ice-associated food chains. This energy is transformed from grazers via larger ice amphipods and polar cod, to the higher trophic levels of seabirds and seals. The origin and age of sea ice are important for the resulting community composition of sea ice biota, with pronounced differences among biota and living conditions in annual landfast sea ice, offshore annual pack ice, and multiyear pack ice. Data on sea ice biota diversity have been collected as part of scientific expeditions for many years; these have now been summarized in a pan-Arctic context by the *Sea Ice Biota Expert Network*, which is one of several under the *Circumpolar Biodiversity Monitoring Programme* (CBMP/CAFF). The pan-Arctic distributions include the following *Focal Ecosystem Components* (FECs): (1) prokaryotic microbes (2) ice algae and other protists (3) ice meiofauna, and (4) under-ice macrofauna. The status of sea ice biota will be presented in the *State of the Arctic Marine Biodiversity Report* (SAMBR, 2017).

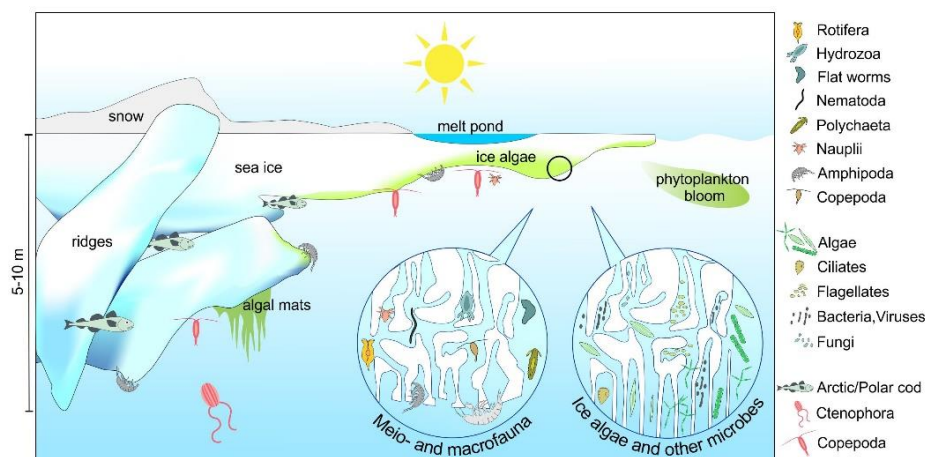


Fig. 1. The focal ecosystem components (circles) in sea-ice. Sea ice provides a wide range of microhabitats for diverse biota including microbes, single-celled eukaryotes (labelled algae), multicellular meiofauna, larger under-ice fauna (represented by an amphipod), as well as polar cod (*Boreogadus saida*). Modified from Bluhm et al. (in press) for the SAMBR-report.

## Life cycle of Arctic fish: The case study of Daubed shanny

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The daubed shanny *Leptoclonus maculatus* is a common and abundant species with a circumglobal Arctic distribution. In the Barents Sea, this species is generally found from the polar front and northwards in sub-zero temperature. Daubed shanny is considered an ecologically significant species in Svalbard waters and is an abundant and energy-rich food source for predatory fishes and sea birds, and has an important role in the transfer of energy from *Calanus* spp. to higher trophic levels. Daubed shanny is an epibenthic fish with a benthic adult stage and a pelagic post larvae stage lasting up to four years. The transition between the pelagic and benthic life mode takes place when postlarvae reach approximately 80 mm in length at 3 to 4 years of age. The pelagic postlarvae has a unique lipid sac in that stores large amounts of dietary lipids. Lipid sac consists of fragile lipid globules, clearly visible by eyes, surrounded by a simple membrane; lipids in lipid sac originating from *Calanus* spp. diet. The existence of lipid sac in larvae body is considered as evolutionary arctic adaptation in development of *L. maculatus* larvae to survive and grow up to benthic adult using mostly lipids store in lipid sac at early stages of life. Here we present our present knowledge of the life cycle strategy and lipid chemistry



## Utvikling av gastrolitter hos Europeisk hummeryngel *Homarus gammarus* gjennom en skallskiftesyklus

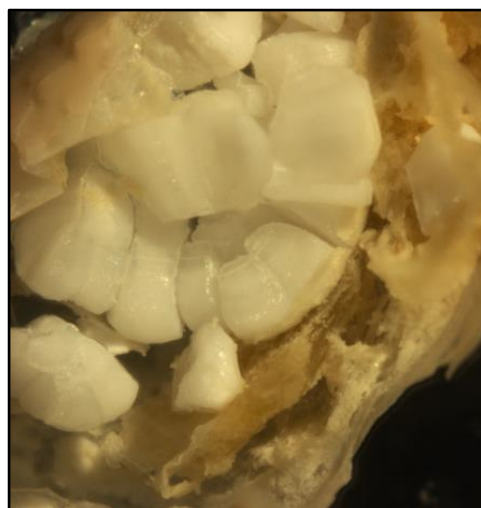
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Gastrolitter er kalsiumlager som finnes i noen arter av kreps, hummer og terrestriske krabber. De ser ut som to avlange, sammentrykte kuler som ligger i hudlommer i mageveggen. Kalsium skilles ut fra det ytre hudlaget og lagres som lettopløselig kalsiumkarbonat. I motsetning til de mer solide kalsiumsteinene man finner i kreps, har hummer gastrolitter som består av mange små, irregulære melkehvite krystaller. Sammensetningen av gastrolittene er den samme som man finner i skallet, men i ulikt mengdeforhold. Gastrolitter hos amerikansk hummer *Homarus americanus* består av magnesium, fosfat, aluminium, jern, silikon, kitin og proteiner, mens ingen analyser er gjort på europeisk hummer *Homarus gammarus*.

Utvikling av gastrolitter hos ferskvannskrepsen *Orconectes virilis* er veldokumentert, mens lite informasjon finnes om hummer. For å få mer kunnskap om utvikling av gastrolitter hos europeisk hummer ble 30 hummeryngel (19-22 mm total lengde) studert gjennom en skallskiftesyklus på 28 dager ved 14°C. På bestemte tidspunkt i skallskiftesyklusen ble yngel lagt på etanol og siden tatt røntgenbilde av. Bildene viste at 12 timer etter skallskiftet hadde gastrolittene løst seg opp og rundt 17 dager inn i den nye syklusen begynte de å bygge seg opp igjen og var fullstendig utviklet ved dag 28. I tillegg ble det gjennomført elementanalyser som viste at gastrolitter hos europeisk hummer består av de samme elementene som de hos amerikansk hummer. Det er fortsatt behov for mer kunnskap om hvilken betydning gastrolittene har for hummeren og hvordan utviklingen av gastrolittene påvirkes av endringer i klimaet som for eksempel havforsuring.



Gastrolitter fra europeisk hummer *Homarus gammarus*. Til venstre: Røntgenbilde av gastrolitter i hummeryngel. I midten: Gastrolittkrystaller i magen på hummeryngel. Til høyre: Nærbilde av krystallene som ligger inne i gastrolitten.

## Jellyfish diversity in Norway and its implications

### **Aino Hosia**

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Carnivorous gelatinous zooplankton or “jellyfish” are a systematically and ecologically diverse group of animals. They belong to two different phyla (Cnidaria and Ctenophora), span a huge size range from <1mm to several meters, have varying diets, and differ widely in terms of life cycles (e.g. holopelagic vs meroplanktonic species). Common to many jellies is that they can under favorable conditions form blooms, with both ecological and socio-economical consequences. The bloom triggering factors, of which we know all too little, are likely species specific. Anthropogenic changes in jellyfish abundances are often sited, but we currently lack sufficient data to accurately describe changes in either abundances or species composition. It is highly unlikely that a group as diverse as “jellyfish” will exhibit a uniform response to environmental changes. Baseline data on diversity, distribution, abundance and species specific ecology of gelatinous zooplankton are thus needed. Contrary to common preconceptions, valuable data on gelatinous zooplankton can also be gained from standard plankton net surveys, despite the notorious fragility of jellies – the scarcity of data on jellies results not from the lack of samples, but rather from processing protocols that neglect the gelatinous component. Interesting results are starting to emerge from the ongoing effort to document and DNA barcode the Norwegian fauna of gelatinous zooplankton. The resulting DNA sequence database may in the future have both faunistic and ecological applications.

## Makroalger i klimaforandringens tid

Invitert foredragsholder Inga Kjersti Sjøtun

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Sjøtemperaturen i overflatelaga er den viktigste faktoren som bestemmer utbreiinga av ulike makroalgar langs kysten. Sjøtemperaturen set grenser for overleving eller reproduksjon. Mange artar i kaldtempererte område har ein optimumstemperatur for vekst som ligg rundt 10-15 °C, noko som fell saman med sommartemperaturen i overflata langs store deler av kysten vår under normale år. Dei siste 15-20 åra har imidlertid sjøtemperaturen i overflata på Vestlandet nådd opp i sommartemperaturar på godt over 20 °C ved fleire høve, og vintertemperaturar som ligg 2-3 grader over normaltemperaturen er heller ikkje noko særst. Høgare sommar- og vintertemperaturar har innverknad på makroalgesamfunna langs kysten. Den øvre fysiologiske temperaturtollegrensa for mange tare-artar ligg ein stad mellom 20 og 23 °C, og etter somrar med spesielt høge sjøtemperaturen i overflata har lokal nedgang i sukkertaredekket blitt observert. I eit konkurranseforsøk der vekst og overleving til sagtang, sukkertare og japansk drivtang vart undersøkt to påfølgjande somrar med svært ulik sjøtemperatur (2014 og 2015), viste sukkertare redusert vekst og auka erosjon gjennom sommaren 2014, der overflatetemperaturen var over 19 °C gjennom 17 dagar av forsøket. Også meir generelle effektar av høgare sommar- eller vintertemperaturar i overflata har vist seg. Auka frekvens av sørlege makroalgar (artar som har si nordlege grense ein stad på kysten av Noreg) har blitt observert, og i tillegg har fleire nye artar for Norge blitt registrerte, der alle er relativt vanlege eit stykke sør for Norge. Har desse artane som er blitt registrerte i Noreg spreidd seg sørfrå ganske nyleg, eller har det funnest små populasjonar her som har overlevd under kaldare periodar i spesielle biotopar? Langs kysten finst spesielle stader der det kan sjå ut som sjeldne, sørlege makroalgar kan overleva lenge. I Tjongspollen, ein relativt stor og upåverka varmtvasspoll i Hordaland, er det funne fleire svært sjeldne makroalgar med varmtemperert opphav, og ein sannsynlegvis endemisk raudalge som nyleg er blitt beskriven. Spørsmålet er om innelukka varmtvasspollar huser mange varmekjære makroalgar frå tidlegare varmeperiodar, og om desse no kan spreia seg langs kysten.

## Phytoplankton productivity quantified from chlorophyll fluorescence

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Phytoplankton are the main food source for marine life, and accurate quantification of its productivity is essential for understanding how marine food webs function. As a novel non-invasive technology, chlorophyll fluorescence can be used to assess in situ primary production in phytoplankton - overcoming the limited spatial and temporal resolution of traditional bottle techniques. Here we present data on gross and net primary production from Pulse Amplitude Modulated (PAM) fluorescence, <sup>14</sup>C fixation and O<sub>2</sub> production of a natural phytoplankton community in the arctic Godthåbsfjorden, in West Greenland. Using a novel combination of PAM fluorescence and bio-optical measurements we derived the electron requirement for carbon (C) fixation and oxygen (O<sub>2</sub>) production in absolute units. Both short- (2h) and long-term (24h) experiments demonstrated a strong coupling between the three techniques, especially during light-limited conditions, resulting in predicable parameters for conversion of PAM fluorescence to gross and net primary production. We documented an electron requirement for gross <sup>14</sup>C fixation of  $7.7 \pm 0.8$  (mean  $\pm$  S.E, with units of mol e<sup>-</sup> (mol C)<sup>-1</sup>). Future applications using PAM fluorescence on moorings and Autonomous Underwater Vehicles (AUVs) for improved spatial and temporal resolution of primary production will be discussed.

## A morphological study of the parasitic barnacle, *Anelasma squalicola* (Lovén, 1844)

**Helge Olsen Theil Bergum**

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The pedunculate barnacle, *Anelasma squalicola*, is found parasitizing various squaloid sharks of the family Etmopteridae. Its peduncle has been modified to bury in the flesh of its host, and has replaced its cirri as a feeding device. It is however still in possession of its cirri and digestive tract, both seemingly of a vestigial nature. Due to the curious appearance of *Anelasma* it has been of great interest to scientists since its first description in the 18<sup>th</sup> century, but despite this it has rarely been studied, and many details of its morphology remain unclear.

By employing new methodologies including SEM, histology, micro-CT scanning and 3D-reconstruction, this study aims to clarify *Anelasma*'s morphology and its adaptations to a parasitic lifestyle.

Through micro-CT scanning and 3D-reconstruction the root system of *Anelasma* has been revealed, showing an extensively branching system. Histology reveals that the exocuticle of the peduncle and the roots has been entirely reduced. The cement glands are numerous, and can be seen throughout the lower part of the mantle and in the waist, they have been seen emptying into the lacunae and I hypothesize that their function in *Anelasma* is to aid in the nutrient uptake from its host. The nutrient transporting lacunar system has also been seen in great detail, originating from the great central lacunae running axially through the peduncle and branching out to envelop the ovarian tubes and out into the tips of the roots. All in all, *Anelasma* seems beautifully adapted to a life as a parasite.

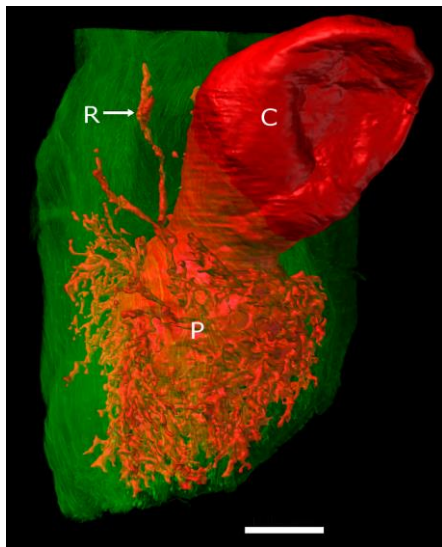


Figure 1: Volume rendering of *Anelasma squalicola*. The tissue of its host, *Etmopterus spinax*, can be seen in green, while the body and roots of the parasite is seen in red. P, peduncular region; C, capitular region; r, root. Scale bar: 2 mm.

## Exploration of the benthic macrofauna and ecosystems associated with hydrothermal vents on the Arctic Mid-Ocean Ridge (AMOR)

**Hans Tore Rapp**<sup>1,2</sup> on behalf of the CGB team

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Over the last years CGB researchers have explored the deep-water fauna in the Arctic and the NE Atlantic oceans with special emphasis on hydrothermal vents and seamounts along the AMOR. Among the main objectives have been to investigate local adaptations and speciation processes, as well as addressing potential ecological and evolutionary/genetic connectivity between different chemosynthetic habitats in the area, including hydrothermal vents, cold seeps and sunken wood. We have shown that chemosynthetic habitats in the Norwegian and Greenland seas host an endemic and highly specialized fauna, particularly at the deep parts of the Knipovich Ridge and Loki's Castle. We have shown that there are obvious similarities between the fauna found at hot vents along AMOR, at cold seeps along the Norwegian margin, and from wood-falls in the abyssal Norwegian Sea. A shared group of keystone species directly or indirectly dependent on chemosynthetically derived energy has been identified. At a first glance the gastropods *Rissoa griegi* and *Skenea profunda* as well as the amphipod *Exitomelita sigynae* seem to dominate the fauna completely. Upon closer examination, however, polychaetes are highly abundant and their diversity is high. Polychaetes also represent the faunal group with the highest number of new taxa discovered and so far, about a dozen new species of polychaetes are being formally described from the Loki Castle alone. Molecular tools are now being used to provide more information about the evolutionary history of this special fauna, and to explore the possible connections between the Atlantic and Pacific reduced habitat faunas through time. Our explorations have revealed large mineral resources on these deep-sea ridge systems and there is a growing interest in utilization of these resources. The consequences of deep-sea mining are not well known and we are aiming at getting an understanding of the ecosystem resilience, function and potential recovery after mineral extraction in our vent systems. The novelty and high degree of endemism of the vent fauna in the Norwegian- and Greenland Seas call for much more in depth studies and use of the precautionary approach in future management of these unique deepsea habitats.

## Forårsaker miljøgifter DNA-skade hos blåskjell, sandflyndre, torsk, sjøfugl og isbjørn?

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Det er avgjørende for alt liv at genmaterialet beholdes intakt og uforandret fra celledeling til celledeling. Det indre av celler er veldig dynamisk med tusenvis av kjemiske reaksjoner hvert minutt, og det dannes kontinuerlig reaktive molekyler som fører til skade på cellekomponenter. Alle celler har derfor både et forsvar mot slike reaktive molekyler og effektiv reparasjon. Grunnen til at man er så opptatt av slik skade er at det kan føre til endringer i celler som kan føre til kreft og celledød, samt påvirke funksjonen til celler, for eksempel i immunsystemet. Eksponering for toksiske stoffer kan føre til økt DNA-skade. Målet med denne presentasjonen er å gi en oversikt over tildels overraskende resultater fra studier med ulike marine organismer.

Hemocytter fra virvelløse dyr som blåskjell, sjøstjerne og strandkrabbe er svært følsomme for oksidativ stress og får lettere DNA-skade enn lymfocytter fra torsk. For torsk i indre Oslofjord ser det ut som miljøgift-eksponering fører til mer skade hos immunceller i blodet, men også større evne til å motstå slik skade sammenlignet med torsk fra rene områder. Resultater for isbjørn er mindre åpenbare – for denne arten ser det ut som om individer med høy miljøgiftbelastning har mindre DNA-trådbrudd i lymfocytter enn i individer med mindre miljøgifter i kroppen. Dette kan forklares ved egenskaper til lymfocyttene, noe vi undersøker videre. Resultater for DNA-skader i lymfocytter hos ulike arter av arktisk sjøfugl i relasjon til miljøgiftbelastning var også overraskende og lignet på de vi har funnet for isbjørn.

## dCOD 1.0: Decoding the systems toxicology of Atlantic cod (*Gadus morhua*)

**Anders Goksøyr** (UiB), Guttorm Alendal (UiB), Augustine Arukwe (NTNU), Malin Celander (GU, Sweden), Morten Brun (UiB), Nancy Denslow (UFL, USA), Marta Eide (UiB), Jed Goldstone (WHOI, USA), Bjørn Einar Grøsvik (IMR), Ketil Hylland (UiO), Inge Jonassen (UiB), Odd André Karlsen (UiB), Jan Ludvig Lyche (NMBU), Ian Mayer (NMBU), Daniela Pampanin (IRIS), Cinta Porte (CSIC, Spain), Hans J. Skaug (UiB), John Stegeman (WHOI, USA).

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Digital Life is a strategic research initiative by the Research Council of Norway to foster convergence and cross-disciplinarity between life sciences, computation, modelling and engineering. Six large research projects and a Center for Digital Life Norway were funded in the first round of this initiative with a total of 250 MNOK. dCod 1.0 is one of the research projects funded. The goal of the dCod-project is to combine competencies in environmental toxicology, biology, bioinformatics and mathematics across the traditional department boundaries, to create a deeper understanding of the Atlantic cod's adaptations and reactions to stressors in the environment. Building on thorough studies and mapping of the cod genome and long research traditions on the physiology, toxicology and reproduction biology of cod, the dCod project will expand our knowledge with genomics based methods, where studies of how the cod genome responds under different environmental conditions will be investigated.

The project aims to generate large amounts of experimental data to be the basis of mathematical models that can describe these responses based on different scenarios.

Overall, the goal is to create a tool for environmental monitoring and risk assessment that can be used in assessing the impacts of for example the oil industry, sewage discharge into harbours and industrial discharge into Norwegian fjords. Climate change and ocean acidification, in addition to cocktail effects of several stressors, will also be studied. Initial results will be presented.



## Kan IPBES sine vitenskapelige utredninger bidra til å stanse den sjette masseutryddelsen av liv på jorda?

### **Invitert foredragsholder Ivar Baste**

Miljødirektoratet og byråmedlem i Naturpanelet (IPBES)

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Klodens mangfold av liv i form av mikroorganismer, planter og dyr og økosystemene de danner bidrar til menneskelig velferd på mange ulike måter. Omfanget av menneskelig aktivitet gjør at vi står overfor en mulig sjette masseutryddelse av liv i klodens historie. Det er internasjonal enighet om en rekke mål - de såkalte Aichi målene - for å stanse tapet av biologisk mangfold. Spørsmålet om i hvilken grad fremdriften i arbeidet med å nå disse målene avhenger av tilgangen på legitim, faglig troverdig og forvaltningsrelevant kunnskap om samspillet mellom økosystem og samfunn har blitt viet internasjonal oppmerksomhet. Dette er grunnlaget for at Naturpanelet (IPBES) i 2012 ble opprettet som en parallell til Klimapanelet (IPCC).

IPBES har så langt involvert omlag 1200 frivillige eksperter fra hele verden i å utrede spørsmål som er godkjent av medlemslandene. Arbeidet skjer i henhold til trinnvise og fagfelle vurderte prosesser som omfatter en kritisk analyse, syntese og vurdering av tilgjengelig vitenskapelig litteratur og annen relevant informasjon. Det legges særlig vekt på å trekke frem forvaltningsrelevante funn og å angi grad av vitenskapelig sikkerhet i konklusjonene som presenteres i sammendraget for beslutningstakere for godkjenning av medlemslandene. Norge har ansvar for å lede og støtte arbeidet med å bygge kapasitet i tråd med behov som er prioritert av medlemslandene.

IPBES ferdigstilte i 2016 en tematisk utredning om pollinering og matproduksjon og en metodologisk utredning om scenarier og modeller. Fire regionale utredninger om biologisk mangfold og økosystemtjenester (Afrika; Amerika; Asia og Stillehavet; og Europa og Sentral-Asia) og en utredning om landegradering er planlagt ferdigstilt i 2018. En global utredning om biologisk mangfold og økosystemtjenester er planlagt ferdigstilt i 2019. Både den globale og de regionale utredningene favner marine spørsmål. IPBES relevans i forhold til den sjette masseutryddelsen avhenger av i hvilken grad panelet lykkes med å fremme samspillet mellom vitenskap og forvaltning og med å bidra til å skille mellom myter og fakta i avveiningen mellom ulike samfunnshensyn.

## Valuation of marine ecosystem services

### **Margrete Aanesen**

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The marine environment provides several ecosystem services from which human beings benefit. Due to limited possibilities to observe many marine resources, they are vulnerable to exploitation, overuse and degradation. The increased focus on ecosystem services in general, and marine ecosystem services in particular may contribute to increased attention. Working with ecosystem services, for some disciplines like economics, it is of interest to analyze how they contribute to human welfare, or in other words; what we are willing to pay for their conservation. Results from valuation surveys of (marine) ecosystem services may also be used to inform decision makers when making trade-offs between exploitation and conservation of marine species. Researchers from Norwegian College of Fisheries Science/UiT-The Arctic University of Norway have for some years worked with marine ecosystem services and how they can be valued from an economic perspective. We have implemented five surveys on willingness-to-pay to protect cold-water coral nationally and internationally, a survey on the trade-off between protecting the coastal zone and economic development in the coastal zone, and we are now working on a survey on willingness-to-pay for reducing marine waste (plastics) in the Arctic. This last survey is implemented as part of the MARP-project (Marine Plastic Pollution in the Arctic: origin, status, costs and incentives for prevention). In this presentation we will say a few words about the use of valuation surveys on marine ecosystem services, and then go in more detail into the survey on marine plastics in the Arctic.

## Plastic in Atlantic cod (*Gadus morhua*) from the Norwegian coast

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### Introduction

Microplastics contaminate oceans and affect marine organisms in several ways. This study documents the occurrence of microplastic (<5 mm), mesoplastics (5-20 mm) and macroplastic (20+ mm) in the stomachs of cod (*Gadus morhua*), one of the most common and economically important marine fish in Norway. Fish stomachs (n=302) were examined from six different locations along the coast of Norway (fig 1.). Nine individual stomachs contained items identified as synthetic polymers, eight of these were from a single location (Bergen). All objects found in the stomachs analyzed by Fourier Transform Infrared Spectroscopy (FTIR) scanned and subsequently compared with FTIR libraries to confirm the identity of the items.



### Results

This study provides the first record of plastic polymers identified in the stomachs of cod in Norwegian cod. Nine individual stomachs had items identified as synthetic polymers; eight of these were from one location (Bergen). 27% of the stomachs investigated from Bergen contained plastic where polyester was the predominant polymer.

We found polypropylene (PP), styrene and polystyrene (PS), polyvinyl chloride (PVC), PMMA or Plexiglas, polyethylene terephthalate (PET or PETE), polytetrafluoreten (Teflon) and nylon 66.

It is worth noting that 88% of the plastic items found in this study were located in full stomachs. Only one empty stomach contained plastic. Our study reflects the possible capacity the cod has to effectively rid itself of ingested plastics, and important ability associated with the fitness of the fish.

Based on our study it appears that Atlantic cod from the coast of Norway tend to contain low levels of micro-, macro and mesoplastic. However, our analyses are conservative and most likely an underestimate.

## Ingestion and effects from microplastic (polyethylene) derived from toothpaste and blue mussel (*Mytilus galloprovincialis*)

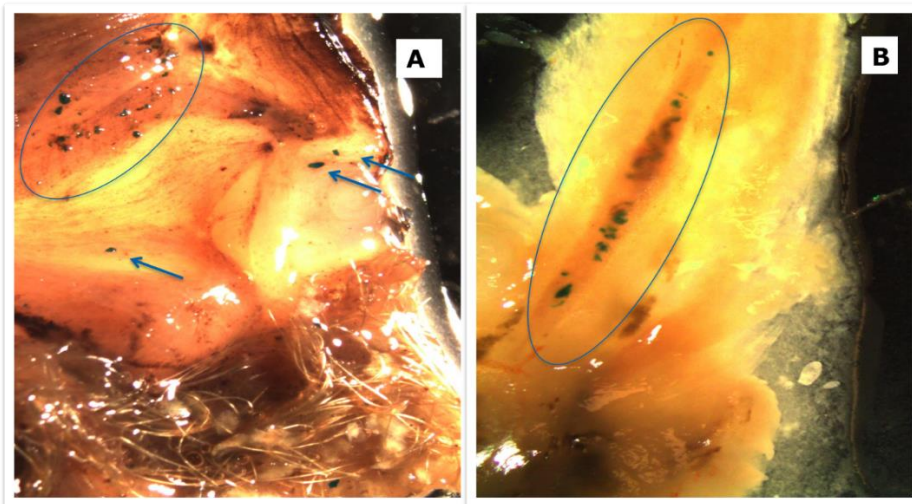
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Polyethylene (PE) microplastic particles (<5 mm) found in consumer products, such as toothpaste find their way into the marine environment via effluents from wastewater treatment works. There is major concern that these particles may harm marine organisms, particularly filter feeders. In order to evaluate the effects of such particles on bivalves, blue mussels (*Mytilus galloprovincialis*) were exposed over 21 days to PE particles (10mg/L; 50-570 µm) isolated from toothpaste. Both virgin and weathered PE particles (deployed in the Outer Oslofjord for 3 weeks) were used in order to best mimic 'real world' exposure scenarios in the marine environment. The mussels ingested both raw and weathered particles, however they ingested 26% more of the weathered particles. Particles <383 µm were ingested. To our knowledge this is the first study identifying ingestion of such large microplastic particles in bivalves. PE particle ingestion resulted in alteration of the gills and digestive gland and also necrosis in other tissues such as the mantle. Bivalve tissue is eaten whole and is therefore of special concern regarding seafood safety with our study showing that they are able to ingest primary PE microplastic particles derived from consumer products, such as toothpaste.



### Acknowledgements

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## MARine Plastic Pollution in the Arctic: origin, status, costs and incentives for Prevention (MARP<sup>3</sup>)

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MARP<sup>3</sup> is an interdisciplinary research project, bringing together specialists from law, economics and ecology, in producing research needed to prevent marine plastic pollution in the Arctic, with a focus on Svalbard and the Barents Sea. The project will analyse the relationship between the different actors in the region in terms of potential polluters and institutions, regulations and facilities that can promote more sustainable resource and environmental management in the Arctic. MARP<sup>3</sup> will evaluate the state and sources of marine waste, investigate if the political and legal framework in the region is adequate, estimate the costs of marine plastics on ecosystem services that humans benefit from and evaluate regulatory mechanisms. We are working with relevant industry and local experts to identify where the waste found originates from. Since there is a large fishery in the region, the fishing industry is one of the stakeholders represented in our project through the Norwegian Fisherman's Association. Our preliminary findings from a "waste workshop" with experts at Svalbard, including Norwegian, Russian and Icelandic fishers, concludes that we can identify some fishing gear that has been damaged and thereby potentially lost at sea, while other fishing gear have been cut/ punctured and should therefore remain onboard the vessel and treated accordingly. We also found waste for which there is "no excuse" that it should end up in the ocean. We are continuing our cooperation with the industry to understand the mechanisms behind why waste ends up in the ocean.

## Microplastic research on the Kontiki 2 expedition. Results from the first leg (Peru-Easter Island)

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Two rafts of the Kon Tiki 2 Expedition sailed from Lima in November equipped for full-scale ocean and climate research. The rafts of the Kontiki 2 expedition were expected to sail through an accumulation zone of garbage, the so called South Pacific gyre<sup>1</sup>. Only limited information about the composition of the litter, its seize distribution, and its interaction with the organic pollutants regulated by UNEPs Stockholm convention is known<sup>2</sup>.

Marine litter was sampled during the transect with a Manta trawl with a mesh to collect plastics larger than 300µm. In addition a newly developed stationary 3 Stage Pump sampler within the EU project Clean Sea ([www.cleanease-project.eu](http://www.cleanease-project.eu)) was used to study the size distribution of the litter. Identification of the plastics or polymer materials from the manta trawl was performed on board using a micro NIR. Preliminary results from the micro NIR microplastics analysis show mainly nylon fibers as illustrated in figure 1.

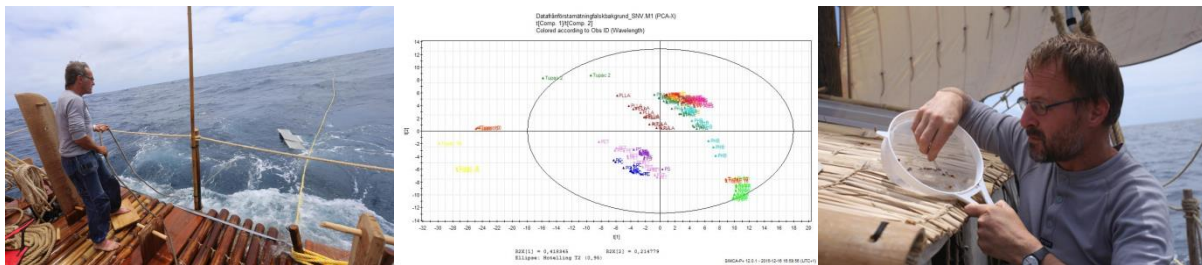


Figure 1. The operation of the Manta trawl during the first leg of the Kontiki 2 expedition, a principal component (PCA) plot of the micro NIR analysis on board of one of the rafts and the collection of the Manta trawl sample

<sup>1</sup> Eriksen, M., N.A. Maximenko, M. Thiel, A. Cummins, G. Lattin, S. Wilson, J. Hafner, A. Zellers, and S. Rifman, 2013: Plastic pollution in the South Pacific subtropical gyre. *Marine Pollution Bulletin*, 68 (1-2), 71-76.

<sup>2</sup> Andrés Cózara, Fidel Echevarría, J. Ignacio González-Gordillo, Xabier Irigoien, c, Bárbara Úbedaa, Santiago Hernández-León, d, Álvaro T. Palmae, Sandra Navarrof, Juan García-de-Lomasa, Andrea Ruizg, María L. Fernández-de-Puellesh, and Carlos M. Duarte. Plastic debris in the open ocean *PNAS*, 2014, vol. 111 10239–10244

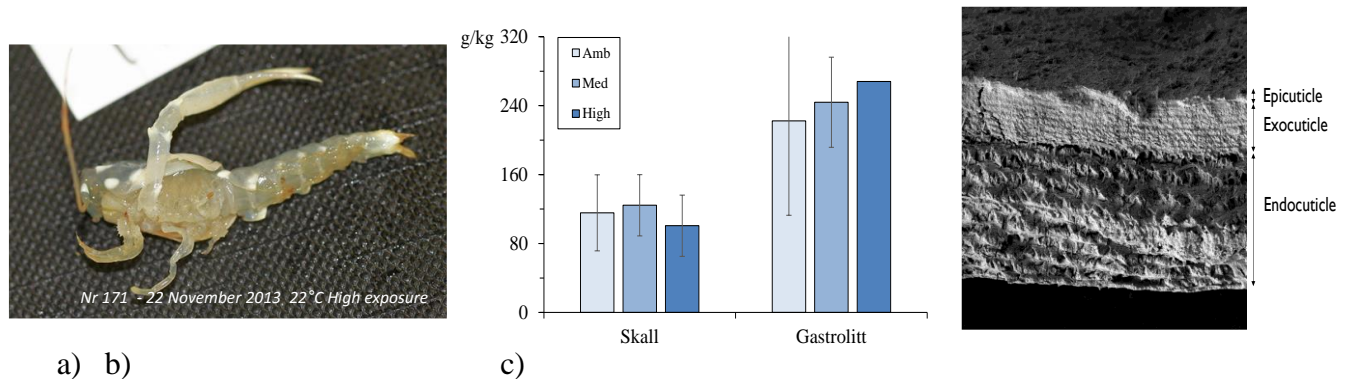
Foredrag

## Havforsurning forårsaker misdannelser i skallet hos Europeisk hummeryngel, men hva er det egentlig som skjer?

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Det er tidligere vist at Europeisk hummerlarver (*Homarus gammarus*) som eksponeres for økte nivåer av  $p\text{CO}_2$  utvikler misdannelser både som larver og seinere som yngel (Agnalt et al. 2014). Deformitetene utviklet seg særlig i ryggskjoldet og klørne. I et oppfølgende eksperiment ble det satt fokus på hva som skjer i skallet og med kalsiumlageret (gastrolitter) når 4 måneder gamle yngel ble eksponert for 1000 og 1400  $\mu\text{atm}$   $p\text{CO}_2$  ved 14, 18 og 22°C. Yngelen ble fulgt i 12 uker. All overlevende yngel ble undersøkt med røntgen for gastrolitter. Skallet ble analysert for Ca, Mg, Fe, Al, Si, samt undersøkt via skanning elektronmikroskop (SEM) for struktur og oppbygging. Dødeligheten økte med økende temperatur, og det var en tendens til økt dødelighet med eksponering. Ved avslutning hadde 33% av yngelen i 14°C og høy  $p\text{CO}_2$  eksponering utviklet misdannelser. Ved 18 °C og 20 °C hadde tilsvarende 67% og 44% av yngelen misdannelser. Elementanalysene viste at det var dobbelt så mye kalsium i gastrolittene sammenlignet med skallet. I skallet er det kalsium som dominerer, 7-8.5 ganger høyere verdier enn magnesium. I gastrolittene var det en tendens til økt mengde kalsium med  $p\text{CO}_2$  eksponering, men variasjonen var stor. Aluminium finnes bare i skallet og vanligvis helt i det ytterste laget (epicuticle). For å forstå hvordan misdannelser utvikles i tilknytning havforsurning er det viktig med inngående forståelse av prosesser tilknyttet skallskifte, sett i sammenheng med gastrolittene som fungerer som kalsiumlager.



Figur 1. a) deformert hummeryngel som har vært eksponert for høy  $p\text{CO}_2$ ; b) mengde kalsium (g/kg) i skall og gastrolitter i hummeryngel eksponert for ambient, middels og høy  $p\text{CO}_2$ ; tverrsnitt (SEM) av skallet til en hummeryngel som har vært i ambient, med 3 definerte lag/strukturer.



## En kombinasjon av eksisterende teknologier til et nytt verktøy kan gi deg mulighet til å måle og karakterisere partikler – i sanntid

**Odd Ketil Andersen, Hans Rosendahl & Kirsten J. Redmond**

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I mange sammenhenger er det behov for å kunne måle og karakterisere partikler, for eksempel: å måle spredning av utslipp, identifisere lekkasjer, identifisering av influensområde av oljeutslipp ved havari, identifisere naturlige prosesser, identifisere potensielt skadelige alger. Dagens løsninger for å kunne måle og karakterisere av partikler *in situ* måler på en volum av vann, og nærmere informasjon om konsentrasjon av de forskjellige partikler må fås ved å analysere prøver i laboratorium. Det å kunne identifisere enkeltpartikler vil være vesentlig nytt og gi en bedre oppløsning og informasjonsinnhold.

Vi utvikler en teknologi som kombinerer laser doppler hastighets målinger (partikkeltelling og størrelsesmåling) med fluorosens og scatter-signal til å kunne identifisere enkelt partikler *in situ* og i sann tid. Metodene har blitt testet på tre alger og på råolje dråper.

De første resultatene har vist at vi klarer å måle fluorescens i enkeltpartikler, og at de forskjellige partikler kan bli identifisert ved bruk av multivariat analyse på spektralinformasjon (Fig. 1).

Vi vil presentere resultatene fra videretesting av metodene, og diskutere deres betydning innenfor marinforskning, blant annet – hva andre partikler kan vi fange opp med bruk av disse metoder? Vi vil også presentere andre mulige anvendelsesområder innenfor industri og forskning.

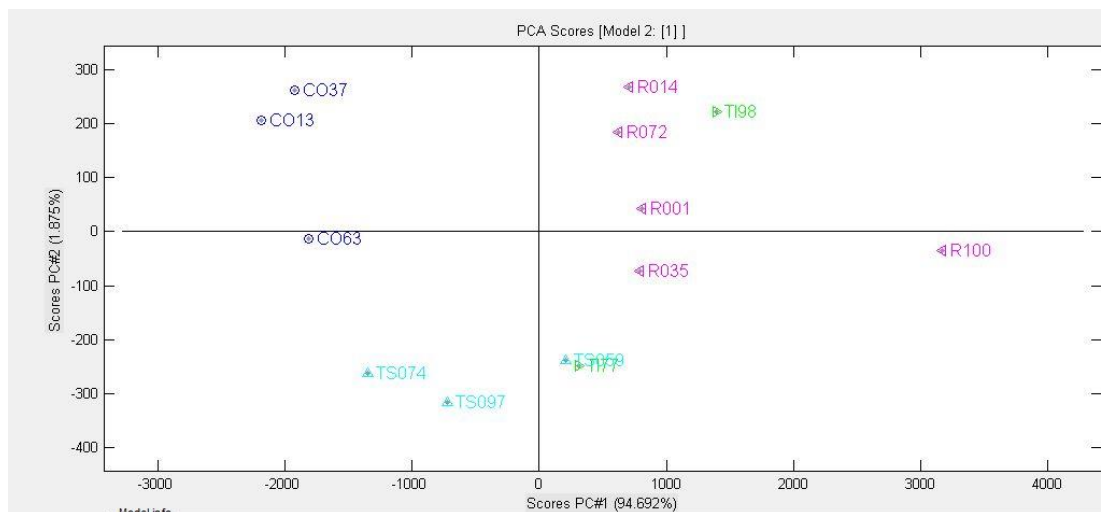


Fig. 1: Score plot fra en prinsipalkomponentanalyse på spektra fra de forskjellige partikler. CO er partikler identifisert som råolje, mens de øvrige partikler stammer fra alger: R = *Rhodomonas* sp., TS = *Tetraselmis* sp. og TI = *Isochrysis galbana* (T. Iso).

## Trophic ecology of the macrofauna community at the Loki's Castle vent field

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Food webs at deep-sea hydrothermal vents do not solely depend on photosynthetic primary production. Rather than utilizing sunlight as a source for energy, the primary producers at deep-sea hydrothermal vents practice chemosynthesis using available reduced chemical compounds. Thus, chemosynthetic microorganisms make up the base of the food web. Stable isotopes were used to study structure, function and trophic interactions in the macrofaunal community in the Loki's Castle vent field, aiming to interpret the importance of chemosynthetic energy versus the input of particulate organic matter (POM) from the surface waters. The Loki's Castle hydrothermal vents, a high-temperature (310-320°C) black smoker vent field, is located at the junction between the Knipovich- and Mohn's Ridges (73°N 008°E) at ~2400m depth. The fauna samples were collected in a sedimentary area with diffuse venting and barite chimneys (~20°C) near the high temperature vent, and stable isotopes ( $\delta^{13}\text{C}$ ,  $\delta^{15}\text{N}$ ) were analyzed from 23 taxa. Preliminary results indicate that the macrofaunal community is adapted to a life in a chemosynthetic habitat since most have  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values lighter than suspended POM ( $\delta^{13}\text{C} -21.8 \pm 0.8\%$ ,  $\delta^{15}\text{N} 6.1 \pm 1.6\%$ ). However, most of the invertebrate fauna in our data are likely consumers and not hosting true endo- or ectosymbionts. Furthermore, species and genera level taxonomical resolution made it possible to distinguish that some organisms are indirectly linked to chemosynthesis, while others are possibly more opportunistic. Finally, the very low  $\delta^{15}\text{N}$  values indicate that the community derives nutrition from chemosynthetic production and that local microbial nitrogen fixation is the most important source of energy for the benthic community in this vent system.

## Taxonomic Revision of the Family Heteropiidae (*Porifera*, *Calcarea*) in Norwegian Waters

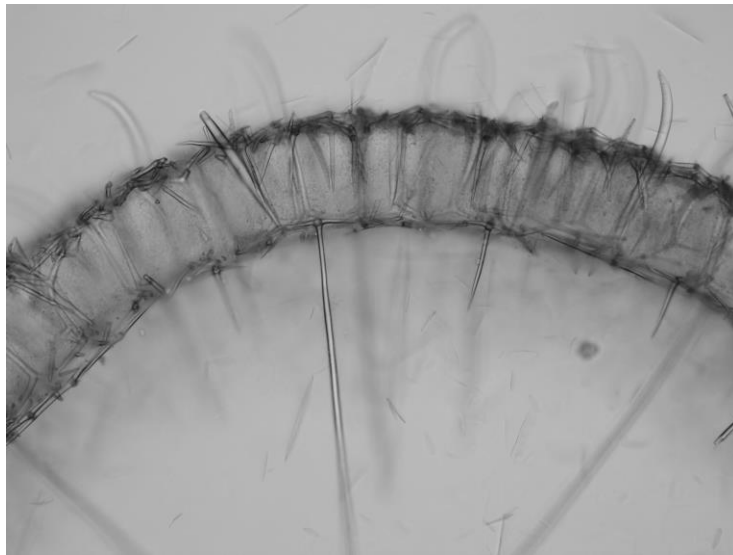
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In the last decade, several studies in the Norwegian Sea have shown that calcareous sponges represent a diverse and abundant group, with a wide distribution from the lower littoral to the abyssal zone. Ecosystems with documented presence of calcareous sponges include kelp forests, deep water coral reefs, hydrothermal vents and cold seeps. However, the number of calcareous species is thought to be underestimated, because they are small, inconspicuous, and therefore easily ignored. Also, the complicated taxonomy and the limited information available for some of the families, such as Heteropiidae, support the need for a revision at several scales. Heteropiidae is one of the more diverse families in the subclass Calcaronea, and five species are so far reported from Norwegian waters (*Sycettusa glacialis* (Haeckel, 1870), *Sycettusa kuekenthali* (Breitfuss, 1896), *Sycettusa nitida* (Arnesen, 1900), *Sycettusa murmanensis* (Breitfuss, 1898) and *Sycettusa lanceolata* (Breitfuss, 1898)).

Through an integrated approach, using morphological characters combined with molecular data, this work aims to revise the Heteropiidae sponge fauna in Norwegian waters, to map the distribution of species and to provide a key for their identification.



**Fig.** *Sycettusa thompsoni*, cross section of the wall.

## Phylogeny of Ampharetidae

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The ecology of the polychaete family Ampharetidae has received a lot of interest due to its almost ubiquitous presence in chemosynthetic habitats (hydrothermal vents, cold seeps and organic falls), and a number of new species have recently been described. The taxonomy of the family, however, is complex with a high number of genera, of which many are monospecific. Interpretations of morphological characters are challenging, and there is a need to clarify which characters are phylogenetically informative. With this study we aim to use a multi-gene molecular approach (using COI, 16S, 18S and 28S) to generate a phylogeny of Ampharetidae with high taxonomic sampling within the family. Preliminary results of this work will be presented, and implications for the taxonomy of Ampharetidae will be discussed.

# The parasitic barnacle, *Anelasma squalicola*; prevalence, infection behaviour and effects on its host, *Etmopterus spinax*, in Lusterfjord, Norway

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*Anelasma squalicola* is a recently evolved parasitic pedunculated barnacle. Very little is known of its biology due to its low prevalence in deep sea lantern sharks (family: Etmopteridae), in which it is found embedded in the skin. It is the only parasitic barnacle to use its peduncle as a trophic organ as well as having a vertebrate host.

A population of more heavily infected sharks (*Etmopterus spinax*) in Lusterfjord, Norway, has finally allowed for targeted sampling of the parasite.

The study shows that *E. spinax* has a heterogeneous population structure and potentially narrow home range, which may affect prevalence and dispersal of *A. squalicola*.

*A. squalicola* appears capable of infecting hosts regardless of size. It has high site specificity, which may be due to areas of the shark where the skin is easier to penetrate. It is most commonly found in pairs, which suggests strongly the need for a reproductive partner.

The results further suggest that *A. squalicola* is highly capable of coordinating settlement on the host shark in order to ensure a paired configuration. Instances of additional individuals (more than two) may be preventing parasite reproduction.

Infection did not affect liver mass or condition of hosts, but appears to prevent maturation in males.

This study provides the most extensive host-parasite description of *A. squalicola* to date, and reveals both a complex host population structure as well as a highly distinctive infection behaviour, which combined shape this parasite-host interaction.



## Microplastic occurrence and distribution from discharge points to deep basins in an urban model fjord

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Increased use of plastics has led to large volumes of plastic reaching the oceans. Microplastic particles (<5 mm), are globally present, and the ocean floor is a likely sink. Exposed benthic fauna potentially ingests microplastics, providing a re-entry route of microplastics and associated chemicals into the ecosystem. However, the magnitude and effects are largely unknown. Uni Research Environment has carried out marine environmental monitoring since the 70's, giving in-depth knowledge about the fjord system, which is an ideal area for investigating microplastic distribution and effects. Plastic fragments and fibers have been detected at most sites after qualitative manual sorting. An ongoing project extracts microplastics quantitatively from sediment by density separation by Microplastic Sediment Separator (MPSS). Microplastics in Polychaeta at discharge sites and the deep hollows in the Byfjorden in Bergen have been investigated after tissue digestion, filtration, visual inspection and analysis by FT-IR and Raman spectroscopy. Results so far show that there is microplastic at all the investigated sites and that Polychaeta at outlet points and in the deep fjord basins contain mainly colored fibers, and few fragments. Blue fibers were confirmed by Raman (532nm) to be polystyrene. Occurrence of ingested fibers depends on body size, feeding habits and mobility of the Polychaeta. Analytical methods and preliminary results from the ongoing investigation will be presented. Data will be used to map microplastic dispersal from point sources by 3D-hydrodynamic modelling. Knowledge of marine dispersal is needed for cost-efficient monitoring of marine microplastics, and realistic assessment of environmental effects.

**Acknowledgements:** Funding from Bergen Municipality, RFFVest (RFFV 258890), Uni Research Environment (SIS). Thanks to present and previous co-workers at Uni Research SAM-Marin. Scott Gallager at Woods Hole Oceanographic Institution (USA) for Raman Spectroscopy, Egil Nodland, Dep. of Chemistry (UoB) for FT-IR-analyses.

## Hexactinellid sponge grounds in the Emerald Basin – distribution, associated fauna and fisheries impacts

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Deep-sea, dense aggregations of sponges, referred to as “sponge grounds”, have received increased scientific attention in recent years. The ecological importance of sponges in benthopelagic coupling, in structuring adjacent substrate, and not least, in the provision of habitat for associated fauna, warrants conservation measures that may have been neglected in the past. The slow growth and low recovery potential of some deep-sea sponges, combined with fragile morphologies, contributes to the vulnerability of sponges to fishing gear, in particular to bottom trawling. Sponges of the class Hexactinellida, more commonly known as “glass sponges”, form sponge grounds worldwide, and damage from fishing gear has been found in several grounds. A unique population of *Vazella pourtalesi*, also known as the “Russian Hat” was recently found off the Scotian shelf between 75-275 m depth. The sponge ground extends over 8.000 km<sup>2</sup> and represents the largest monospecific aggregation described to date for this species. In this study, we describe and compare the epibenthic megafauna in areas with and without *Vazella pourtalesi*, as well as the megafauna associated with different states (live, damaged or dead) of *Vazella*. In addition, we develop a general linear model using environmental and trawling data to the abundance of *Vazella pourtalesi* in the Emerald Basin. Very little is currently known about this species, the sponge grounds it forms and why it is ubiquitous in the Emerald Basin. This study will shed some light on the drivers of megafaunal composition in this sponge ground and assess the impact that trawling may be exerting over it; contributing to the baseline knowledge required for the conservation of this ecosystem.



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## Systematics and biogeography of carnivorous sponges

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The carnivorous sponges (family Cladorhizidae) are unique within phylum Porifera as they lack a functional aquiferous system used for filter feeding, instead using adhesive filaments or other structures to catch and envelop prey items such as small crustaceans. Although certain species of carnivorous sponges have been reported as shallow as <20 m, the carnivorous feeding mode is generally considered to be an evolutionary adaptation to oligotrophic conditions in the deep sea, and carnivorous sponges constitute a large part of the total sponge fauna at abyssal and hadal depths.

Here, we provide an overview of the carnivorous sponge fauna of the Norwegian EEZ including species from the Norwegian Shelf, Svalbard and the Arctic Mid-Ocean Ridge. We also present a brief summary of a recently finished PhD project including a systematic revision, taxonomic descriptions, and a biogeographic overview of Atlantic cladorhizids, as well as an investigation of the microbiome of several carnivorous sponges including a methanotrophic species from the Barbados Accretionary Prism.



## Marin biodiversitetsforskning ved Universitetsmuséet i Bergen

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Universitetsmuséet i Bergen forvalter viktige, vitenskapelige samlinger med opprinnelse helt tilbake til pionertiden i norsk havforskning ved det gamle Bergen Museum. Etter etableringen av Universitetet ble forvaltningen av marine prøver tillagt Zoologisk Museum, der forskningen etter hvert fokuserte særlig på ferskvann og terrestre miljø.

Siden år 2000 har Universitetsmuséet (UM) gradvis økt sitt marine engasjement, blant annet gjennom samarbeid med Havforskningsinstituttet (HI) og internasjonale partnere i studier av ulike grupper evertebrater og (arktiske) fisk. UMs partnerskap med HI i MAR-ECO-prosjektet (fra 2004) ble også en tydelig markering av den nye marine perioden ved museet. UM er for tiden involvert i mange prosjekter med vidt geografisk spenn, men med hovedvekt på norske farvann.

I samarbeidet med HI i MAREANO-prosjektet, er UMs fremste interesse å sikre dokumentasjons- og forskningsmateriale til taksonomisk og systematisk forskning. Utbyttet av dette samarbeidet er allerede i ferd med å få internasjonale dimensjoner, ettersom et økende antall taksonomiske spesialister får anledning til å studere materialet. Artsdatabanken finansierer ulike faunakartleggingsprosjekt ved UM. Mange av disse har også en komponent av DNA-strekkoding. Museet har, gjennom det såkalte NorBOL-konsortiet, et spesielt ansvar for å koordinere arbeid med marine organismer som sikter mot oppbyggingen av et DNA-bibliotek for det norske artsmangfoldet.

UM samarbeider også med HI i inventering og taksonomiske studier av vestafrikanske bunndyr innsamlet gjennom økosystemtokt med *R/V Dr. Fridjof Nansen*. Muséets forskere er også involvert i biodiversitetsundersøkelser i Det Indiske Hav og i Karibben. Det primære fokus i muséets egen forskning på marine dyr er taksonomi, systematikk, evolusjonshistorie og biogeografi.

# The influence of hydrothermal fluids on pelagic eukaryotic microorganism diversity and subsequent prey selection in a pelagic amphipod in the Nordic Seas

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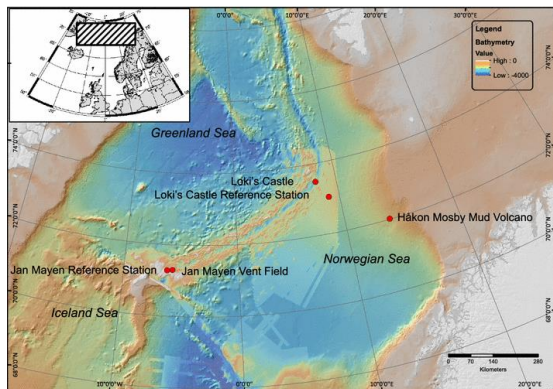
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Deep-sea hydrothermal vents and cold seeps are considered biological hotspots, and although efforts have been made to understand the diversity and function of the bacterial composition of these systems, pelagic single cell heterotrophic organisms remain un-described in hydrothermal vents and seeps of the Nordic Seas. Here, we used molecular methods to investigate the eukaryotic microorganisms surrounding two vents systems, the Jan Mayen Vent Field (JMVF) and Loki's Castle (LC) as well as the Håkon Mosby Mud Volcano (HMMV). Hierarchical clustering and non-metric multidimensional scaling, with class as taxonomic entry, suggested that water mass, followed by depth, were the most important factors shaping the pelagic microbial community. The communities at JMVF and the reference station were very similar, supporting that prevailing water mass is indeed the most important factor. However, the community composition at LC was different compared to the reference station, suggesting that we cannot exclude that some heterotrophic microorganisms derive nutrition from chemosynthesis. Heterotrophic microorganisms represent an important link between bacterial production and higher trophic levels. Therefore we also investigated the gut content of one pelagic amphipod predator, *Themisto abyssorum*, from the same three localities using PCR based methods. These studies revealed that *T. abyssorum* may be omnivorous instead of having an exclusively carnivorous feeding mode. There were differences in gut content between the three localities and further investigations are needed in order to find out whether the differences are primarily linked to water mass as suggested for the microorganism composition, or are due to differences in the available prey field at variable depth and hydrothermal conditions.



The *map* is an overview of the Nordic Seas and the localities from these studies.

## **SponGES - Deep-sea Sponge Grounds Ecosystems of the North Atlantic: an integrated approach towards their preservation and sustainable exploitation**

**Hans Tore Rapp<sup>1,2,3</sup> & Joana Xavier<sup>1,2</sup>** on behalf of the SponGES consortium

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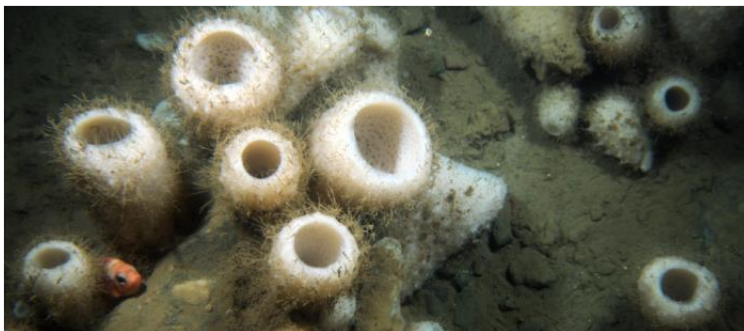
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Sponge-dominated communities of the deep-sea have been increasingly recognized as important ecosystems providing numerous goods and services to our planet and ultimately to us humans. Yet, sponge grounds have been thus far the most overlooked ecosystem of the deep-sea and major knowledge gaps still exist about basic aspects of their biology and ecology.

Here we will present SponGES, a research and innovation project funded in the framework of the European Commission's Horizon 2020 Blue Growth Programme. The SponGES consortium, which pools together the complementary expertise and state-of-the-art facilities of 19 European, Canadian and American partner institutions, will through a four-year period focus on one of the most diverse, ecologically and biologically important and vulnerable marine ecosystems of the deep-sea, the sponge grounds – that to date have received very little research and conservation attention. Our approach will address the scope and challenges of EC's Blue Growth Call by strengthening the knowledge base, improving innovation, predicting changes, and providing decision support tools for management and sustainable use of marine resources. SponGES will develop an integrated ecosystem-based approach towards the preservation and sustainable exploitation of North Atlantic sponge grounds by pursuing four main goals:

→ Strengthen the knowledge-base on North Atlantic sponge ground ecosystems by investigating their distribution, diversity, biogeography, function and dynamics. → Improve innovation and industrial application by unlocking the biotechnological potential of these ecosystems namely towards drug discovery and tissue engineering. → Improve the capacity to model, understand and predict threats and impacts and future anthropogenic and climate-driven changes to sponge grounds. → Advance the science-policy interface and develop tools for improved resource management and good governance of these ecosystems from regional to international levels across the North Atlantic.



SponGES has received funding from EU's H2020 programme under Grant agreement no 679849

## Bruk av laser avstandsmåling (triangulering) for målinger av åpne/lukke atferd og vekst hos muslinger: effekt av råolje eksponering

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Eksisterende metoder for å måle åpne/lukke atferd hos muslinger er avhengig av å lime instrumenter direkte på utsiden av skallene. Vi benytter laser triangulering til å måle bevegelsene av blåskjell før og under eksponering for råolje. Bruk av laserteknologi gir mulighet til å måle uten å forstyrre dyret. Det er en fordel at triangulering metoden gir avstand (oppløsning 0.02  $\mu\text{m}$ ) uten behov for kalibrering.

Målinger på blåskjellene var tatt i løpet av en uke. De tre første dager var i rent sjøvann (kontroll) før de var eksponert for en av tre råolje konsentrasjoner (0.015, 0.06 og 0.25  $\text{mg L}^{-1}$ ). Skallbevegelsene var målt med bruk av en SICK OD Precision lasersensor (SICK Sensor Intelligence, Tyskland) i 2 sek intervaller gjennom forsøket.

Resultatene viser at åpne/lukke atferd hos blåskjell er sensitive til råolje. Blåskjellene viste klar respons til 0.25  $\text{mg L}^{-1}$ , med å øke tid med skallene lukket, og en redusert gjennomsnittlig åpning. I motsetning til tidligere studier, fant vi at blåskjell kan være sensitive til konsentrasjoner under 0.06  $\text{mg L}^{-1}$ , men at det er stor variasjoner i respons mellom individene ved lave konsentrasjoner. Allikevel indikerer resultatene at økt skallbevegelse kan være en sensitiv parameter å overvåke ved lave konsentrasjoner.

Vi har i tillegg testet å benytte målingene fra skjellene til å kalkulere vekst. Sanntids målinger av vekst kan være nyttig for å forstå hvordan muslinger fordeler energiopptaket sitt under eksponering til forurensing, og kan representere en sensitive parameter for miljøovervåkning. Videre vil resultatenes betydning for miljøovervåkning nevnes.

## Ny unik prøvetakingsmetode for sjøbunnsprøver

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#### Innledning

NUI har siden 1976 levert undervannstjenester og kompetanse til bl.a. olje- og gassindustrien. Vårt analyselaboratorium utfører prøvetaking og analyse av uorganiske gasser og flyktige organiske forbindelser (VOC) i normal og hyperbar atmosfære.

#### Bakgrunn

Myndighetene setter krav til prøvetaking og analyse av mulig forurensing i sedimenter i forkant av en dykkeoperasjon. Det manglet standard krav til metode for prøvetaking, håndtering, analyser og grenseverdier, og industrien var spesielt usikre på om det var tap av VOC og andre gasser i prøvene. Dette er også en aktuell problemstilling for miljøprøver.

#### Metoder

NUI har utviklet en unik gasstett sedimentprøvetaker med tilhørende prosedyrer for prøvetaking og analyser. Tilsvarende utstyr og metode er ikke kjent utviklet av andre. Sedimentprøven forsegles på havbunnen, og åpnes ikke før analyser av VOC og andre gasser er utført ved lab. Dynamisk forsegling gir mulighet for volumekspansjon av prøvetaker for trykkutligning, og sikrer system uten overtrykk ved transport.

#### Resultater

Prøvetakeren er operasjonell ved alle dyp, og har hittil vært benyttet til analyse av VOC, H<sub>2</sub>S, Hg og THC. Andre mulige analyser er f.eks. PAH, PCB, metaller, mikroplast og marine organismer.

#### Videreutvikling - Miljøprøver

Med støtte fra Innovasjon Norge videreutvikler NUI metodikken for miljøprøvetaking f.eks. ved oppdrettsanlegg, havner, industriområder og skipsvrak. Utfordringen er å sikre at brukerne av analyseresultatet får de data de trenger, og informasjon og kontakt med samarbeidspartnere/forskningsmiljøer er viktig for utviklingen. Metoden vil gi et mer nøyaktig bilde av hva som befinner seg i sedimentene på sjøbunnen enn det som tidligere har vært tilgjengelig.



## Plastforurensning fra sprengsteinmasser til marine miljø

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Sprengstein fra samferdselsprosjekter benyttes ofte i forbindelse med utfyllinger i sjø. I 2016 fikk Moss Havn tillatelse til å benytte sprengstein til tildekking av forurenset sjøbunn. Sprengstein ble levert fra Jernbaneverkets anlegg på Follobanen og Oslo kommunes anlegg ved Bekkelaget. Totalt er 38 lekterlass deponert ved bruk av splittlekter, hvert lass med et estimert volum på 842 m<sup>3</sup>. Etter deponering av masser ble det observert plast (skyteledning og armeringsfiber, se Figur 1) flytende i vannet. Plast har blitt observert også i tidligere tiltak der sprengstein er deponert i sjø. På oppdrag for Moss Havn satte Rambøll derfor i gang en kartlegging av spredning av skyteledning og armeringsfiber i området, med den hensikt å beskrive fordeling av plast mellom sjøbunn og strandsoner. For å dokumentere spredning ble de to typene plastforurensning visuelt kartlagt og kvantifisert på sjøbunn ved bruk av dykkere og dropkamera, og i strandsonen ved befaring. Resultatene viser at under vann var tettheten av plast på sjøbunnen høyest i et område utenfor utfyllingsområdet. Spredningen var i henhold til dominerende strømreretning, og det ble kun observert armeringsfibre på sjøbunn. Observasjonene viste også at det var høyere tetthet av armeringsfibre i områder som lå dypere enn 15 meter, sammenlignet med områder som lå grunnere enn 15 meter. Det ble derfor antatt at spredningen vil være avhengig av hvor dypt massene deponeres. Fibrene ble antatt å ha negativ oppdrift når de deponeres dypere enn 15 meter, og positiv oppdrift grunnet en 15 m. I strandsonen ble det observert skyteledning, men også her dominerte armeringsfibre i antall, og spredningen var i henhold til dominerende strømreretning. Høyeste observerte tetthet av armeringsfibre var 60 fibre/m<sup>2</sup> på sjøbunnen, mens høyeste tetthet i strandsonen var 80 fibre/m<sup>2</sup>. Det ble også vist at skyteledning flyter i vannet og derfor kan disse samles opp med lenser som er egnet for formålet.



Figur 1. Bildene er tatt av skyteledning (venstre) og to typer armeringsfibre (høyre) funnet i området i Moss Havn hvor det er brukt sprengsteinmasse for tildekking av forurenset sjøbunn.

## Investigating how toxicants affect population-relevant endpoints in Atlantic cod (*Gadus morhua*) within the dCod project

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Atlantic cod (*Gadus morhua*) is an important fish species in the North Atlantic, both for fishery and ecosystem functioning. There is increasing concern that environmental toxicants contribute to an observed decline in coastal cod populations. Atlantic cod is commonly used as an indicator species in marine environmental monitoring programs, including the water column monitoring of offshore petroleum activities in Norwegian waters.

The dCod project aims to generate a deeper understanding of the responses of cod to environmental contamination pressures, by integrating exposure data with responses ranging from subcellular to whole organisms, using systems biology models. This poster will present the part of the project focussing on phenotypic anchoring, i.e. effects expressed in the whole organism such as behaviour, reproduction and immunocompetence. Cod will be collected from the field and subjected to laboratory exposure experiments to link exposure to toxicants, metabolomic and toxicogenomic expression profiles with phenotypic responses, to identify the most important events in the mode of action of selected toxicants and to quantify key processes that may ultimately affect that individual and its population.

## Investigating the demosponge community composition in an Arctic seamount through a reverse taxonomic approach

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The Schultz massif is a large seamount, located at the Arctic Mid Ocean Ridge, which rises from 3500 to approximately 550 m depth. Its benthic communities have been investigated in recent years and samples were collected by sledge, trawl and ROV. In addition, high-definition video showed several sponge-dominated communities differing in density and species composition. These communities have been partly studied from a morphological point of view, however a large number of collected specimens remains to be identified and morphologically-cryptic species are expected to be found. The aim of this project is to test the use of a reverse taxonomic approach in the assessment of the demosponge community composition of different sections of the Schultz massif. We will produce molecular barcodes for as yet unidentified collected demosponges and assign them to molecular operational taxonomic units (MOTUs). Sequences publicly available in the Sponge Barcoding Project database, GenBank and the Sponge Gene Tree Server will be used as a phylogenetic backbone for assignment of our sequences to genotypic clusters, and previously identified specimens will be sequenced and used as "regional anchors" for our samples.



Funding: This study is part of the SponGES project funded by the European Union's Horizon 2020 research and innovation programme (grant agreement 679849).



## Sponge assemblages of the Schultz seamount – Arctic Mid-Ocean Ridge

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Several multidisciplinary surveys made by the Centre for Geobiology to the Arctic Mid-Ocean Ridge (AMOR) have revealed deep-sea ecosystems of conservation importance such as hydrothermal vents, cold seeps and seamounts in this area. The Schultz massif, a large seamount rising from 3500 to approximately 550 m depth, has been investigated by means of biological sampling (sledge, trawl), and high-definition video imagery capture (ROV), revealing seemingly rich and undisturbed benthic communities mostly dominated by sponges, anthozoans and ascidians. Here we report our findings regarding the composition and distribution of sponge-dominated communities along a depth gradient (summit, slope and base) of this seamount. The summit and shallower areas (550-700 m) are inhabited mainly by dense aggregations of glass sponges (*Schaudinnia rosea*, *Trichasterina borealis*, *Scyphidium septentrionale* and *Asconema foliata*) along with tetractinellids (*Geodia parva*, *G. hentscheli*, *G. phlegraei* and *Stelletta raphidiophora*). The slope is characterized by *G. hentscheli* and the hexactinellid *Amphidiscella monai* while the deeper areas (>2000 m depth) are dominated by the demosponges *Radiella sarsi*, *Tentorium semisuberites*, *Thenea abyssorum* and *Lissodendoryx* spp. alongside with the glass sponges *A. monai*, *Caulophacus arcticus* and *Asconema megatrialia*, revealing a shift in the community composition with depth. Areas with otherwise barren grounds are characterized by highly abundant calcareous sponges of the genera *Brattegardia* and *Clathrina* as well as the demosponges *Forcepia* spp. Several unidentified species detected in the video footage indicate an even richer sponge fauna, and among the examined specimens several species considered to be new to science have been found. Overall the sponge assemblages found on the Schultz seamount exhibit little to no endemism with most species having a typical boreo-Arctic deep-sea distribution.