

REPORT
ON
MV HALTON EXPEDITION TO WESTERN NORWAY
28th June – 12th July, 2014



Heriot Watt University/Natural History Museum

2015



Front cover shows Reteporellid bryozoan on *Modiolus modiolus* at Trondheim Fjord.

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INDEX

Expedition Personnel	2
Project Aims	8
Study Area	9
Station details	10
Preliminary Results	11
Acknowledgements	17
References	17



The MV *Halton* in Bergen before departure

EXPEDITION PERSONNEL



Dr Bill Sanderson: Expedition Leader

My research is orientated around habitats and species of high biodiversity conservation importance. Throughout the NE Atlantic, Priority Marine Habitats have been identified by OSPAR (Oslo Paris Convention) as important for conservation, especially in Marine Protected Areas. However, many of these habitats have declined throughout this range and there are serious issues concerned with whether protecting them in MPA's will be enough in the context of changing climates and inevitable northward migration as the seas warm. Two PMH's in the NE Atlantic are maerl beds and dense beds formed by the horse mussel *Modiolus modiolus*. Both of these habitat types are extremely rich in terms of the numbers of species they support. But, what will the future hold? How will these habitats and the communities they support change? On the *Halton* 2014 cruise, we have been sampling these important communities to try to better understand how their composition changes latitudinally and, therefore, start to try to predict how these communities might change as the seas warm. My role on MV *Halton* has been largely concerned with supporting the work of my PhD student Rebecca Grieve, whose research addresses the issues described. On the cruise I have also been interested in visiting habitat types such as *Lophelia* coral reefs that we seldom get a chance to see in situ.



Professor Hamish Mair

The aim of the cruise was to enjoy diving in a new area that I had not been to before. As a marine ecologist, I am interested in looking at new and familiar animals in different fjord landscapes and good visibility. My role was to support PhD students on their dives in observing *Modiolus modiolus* in very different biotopes than which I was used to, for example clumps on rocks, clumps in very coarse sand and in coarse 'clinker' of dead calcareous worm tubes.



Rebecca Grieve

I am a PhD student at Heriot Watt University in my first year of study. The title of my PhD is ‘Biogenic habitats and their interaction with marine renewables and climate’. My study habitats are horse mussel beds and maerl beds. I am investigating how a change in hydrodynamics from tidal renewables impacts these ‘biodiversity hotspots’ in a changing climate. I am collecting samples from horse mussel beds and maerl beds to compare biodiversity across a latitudinal gradient. This will hopefully give us an insight into how these habitats and the rich life they support will change in the future as climate change progresses. I joined Heriot Watt Scientific Divers in 2013 while carrying out research on Horse Mussel beds in Orkney. The Natural Environment Research Council and Scottish Natural Heritage fund my research jointly, through the award of an Industrial CASE studentship.



Dr Joanne Porter

I am an Associate Professor at Heriot Watt University Orkney Campus and a Scientific Associate in the Bryozoa section at the Natural History Museum, London. I am a Fellow of the Linnean Society and sit as a member of the Taxonomy and Systematics Committee. I am a keen SCUBA diver (since 1994) recently qualified with IANTD for Trimix diving. My research interests include the taxonomy, biodiversity and chemical ecology of marine Bryozoa. The aim of the expedition was to collect rock samples with bryozoans on them to identify the species pool at different locations, and to compare the results with similar sample data collected in the 1960’s by Professor John Ryland. The idea was to investigate whether there are now more ‘southern’ species present as a response to seawater warming. The presence of non-native Bryozoa species in Norway was investigated, to make comparisons with Scottish survey data. A further aim was to better understand which species of Bryozoa grow in deeper water 35-45m depth and gain a better understanding of different micro-habitats such as deep walls, *Modiolus* associated fauna, *Lophelia* framework, *Lophelia* rubble. The opportunity was taken to make in-situ images of living bryozoan species for development of the Bryozoa Scratchpad website.

<http://britishbryozoans.myspecies.info>

On a personal note, I was interested to get the chance to dive in places I have not dived before, in habitats that have not been well studied, with like-minded people. The expedition provided a great opportunity and to do exactly that.



Dr Piotr Kuklinski

I am an Associate Professor at Institute of Oceanology in Sopot, Poland and a Scientific Associate at the Natural History Museum, London. I am a very enthusiastic SCUBA diver (since 1990) enjoying diving in any conditions from tropical to polar waters. My research interests include taxonomy and ecology of bryozoans as well as biomineralogy of their skeletons. I am also involved in many investigations, which focus on general rocky shores ecology including patterns of assemblage development or factors influencing processes of colonization. The aim of the expedition was to collect rock samples with bryozoans from different location along the Norwegian coast. The samples will feed into large scale investigation focusing on size of zooids along different environmental gradients in this case gradient of temperature. Additionally, sampling with the help of others was useful to better understand those amazing temperate habitats.



Mary Spencer Jones

I am a Senior Curator in the Department of Life Sciences at the Natural History Museum, London (NHM) with responsibility for the Recent Bryozoa and Entoprocta collections. These NHM bryozoan collections number over 400,000 specimens collected worldwide over four centuries. Despite the north-east Atlantic Ocean being one of the worlds' most-studied areas, little is known regarding patterns of British bryozoan biodiversity over time. Understanding bryozoan distribution patterns is important since they are vulnerable to anthropogenic disturbances, which include the introduction of non-native species and ocean acidification. The NHM/HW driven project "*Bryozoa of the British Isles*" aims to redress this balance using new and historical collections.

The interaction between the northern Scottish bryozoan faunas and those in fjordic Norway has been previous recorded by previous authors, such as Norman (1890s), Dons (1930s) and Ryland (1960s). Little has been recorded, however, since this period and new Norwegian collections would help to rectify our lack of knowledge between these two areas over the past 50 years.



Sally Rouse

I am a PhD student at Heriot Watt University and the Scottish Association for Marine Science. The title of my PhD project is 'Mapping fine-scale benthic productivity on artificial structures'. It is funded by a Marine Alliance for Science and Technology Scotland (MASTS) Prize Scholarship. I have been diving for eight years, mainly in UK waters. I joined Heriot Watt Scientific Dive Team in 2011 after completing an MSc project on "Diversity and Distribution of bryozoans in Scotland". My role in Norway is to assist the Bryozoan research team in investigating the changes in bryozoan communities in Norwegian waters since the 1960's and monitoring the distribution of non-native bryozoan species.



Dr Richard Shucksmith

I am an award winning photographic ecologist, author & filmmaker. My aim on this expedition was to document and produce engaging public outreach media about the marine life, the science and diving in Norway. I personally wanted to photograph *Lophelia*, seafans and the deepsea jellyfish. Diving the Norwegian fjords went well beyond my expectations and it was an incredible two weeks, which offered many creative opportunities to produce outstanding imagery.

www.diomedia.co.uk

www.ecologicalphotography.co.uk

www.earthinfocus.com



Rachel Shucksmith

My aim on this expedition was to explore the west coast of Norway, to see different habitats that would be inaccessible by divers in the UK, e.g. *Lophelia* reef. I also wanted to collect gelatinous zooplankton samples, and to record their diversity along the coastline of Norway. There is currently no ID key for gelatinous zooplankton and this trip has helped me to gather samples and to photograph a range of species to help develop that resource in the future.



Sue Daly

Wildlife photographer and film-maker (award winning!) based on the island of Sark, Channel Isles. I am also a freelance writer and will be writing a piece on this expedition for Diver magazine. Took up this chance to dive with the great Erling Svenson, see Lophelia (which in turn has meant expanding my diving experience) and enjoying very much the company of like-minded divers. I have been diving since 1988; I am a lapsed PADI instructor and have a HSE Part IV qualification



Pat Spencer

I am a BSAC trained Dive Leader with East Cheshire SAC. I was a member of a club trip organized with MV *Halton* from 21st-28th June to dive the wrecks between Bergen and Florø. A last minute email and phone call from Jo Porter resulted in cancelling a flight home, cashing in an ISA and taking a space for a fortnight's extra diving, an opportunity to sample scenic diving, improve my camera skills (still open for debate) and view the fjords to the north of Florø in glorious weather was the outcome.



Erling Svenson

Erling Svenson has almost 40 years' diving experience. He is hugely knowledgeable on all aspects of marine life and ecology around Norway and beyond. His book "*Marine Fish & Invertebrates of Northern Europe*" is now in its sixth edition and the English edition, published in 2003, is a much-used volume on the shelf of many divers. Erling's images are spectacular and his local knowledge about the diving sites around the coast of Norway proved invaluable to the success of the expedition.

https://www.facebook.com/gorgonocephalus?fref=pb&hc_location=profile_browser



Bob Anderson

I am skipper/owner of the dive boat *Halton* that operates in Scapa Flow and beyond, traveling as far afield as Northern Ireland and Norway. I am also a technical diver that believes in investing effort into improving the underwater world we are privileged to visit.

www.mvhalton.co.uk



Theresa Murphy

Halton crew member Theresa is team gas mixer, camera collector and was responsible for dumping buckets of cold water onto overheating divers! She is also an experienced technical diver and PADI Divemaster.



Elisabeth Carrera

Elisabeth was part of the *Halton* crew for summer 2014 as the cook. Elisabeth is a CMAS 3*, IANTD and Audi qualified diver, and has been diving since 1999. She is also a free-diving instructor. Elisabeth was interested to get a glimpse into the world of scientific diving and sample collection! She got to dive new and exciting dive sites and will forever remember Heriot Watt Scientific Divers whenever she sees Horse Mussels.

PROJECT AIMS

The overall purpose of the cruise is to investigate the impacts of climate change on diversity of marine invertebrates in Norwegian coastal waters.

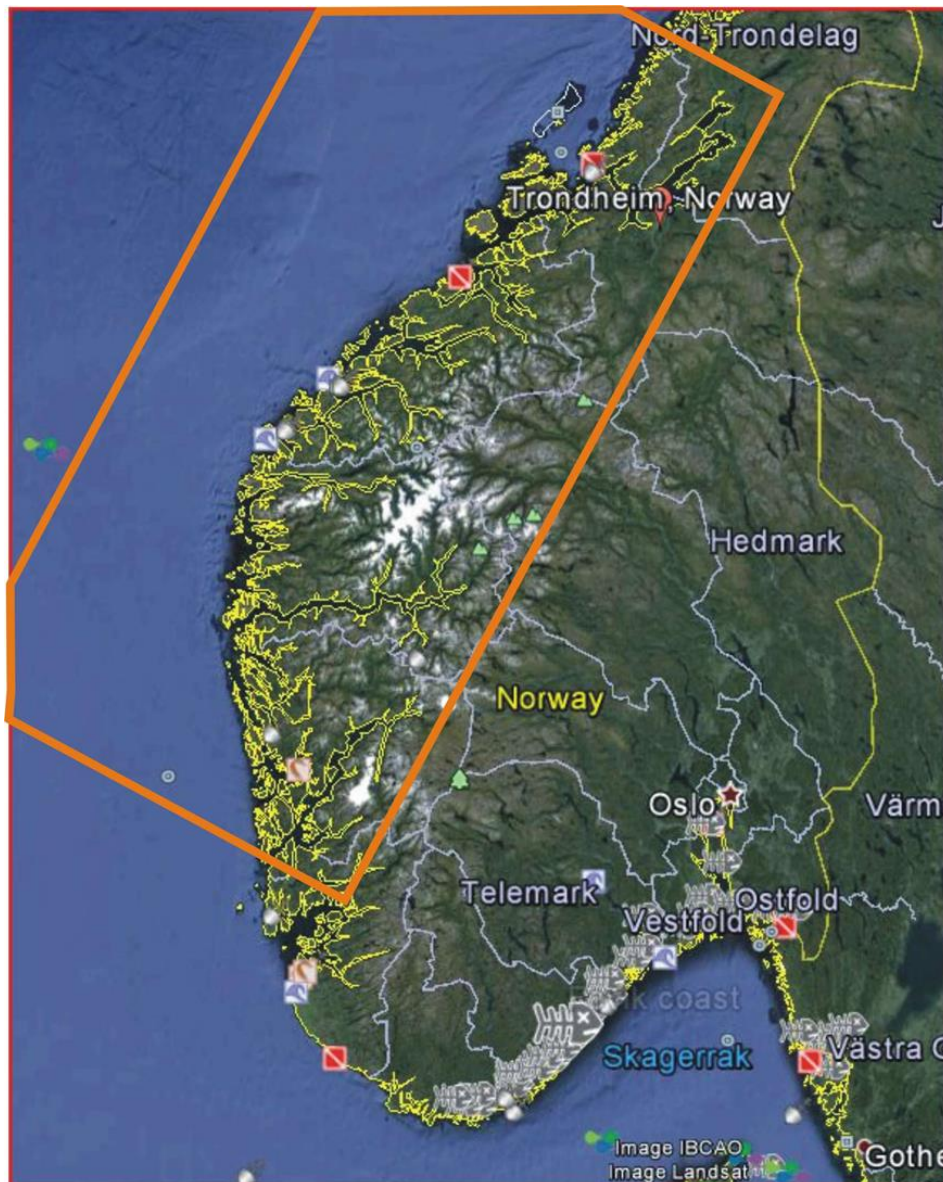
There were five objectives to the cruise:

- 1) To conduct in situ surveys and clump sampling of Horse Mussel (*Modiolus modiolus*) bed habitats to assess their associated biodiversity and build a model of how this community changes with latitude. To collect live samples of Horse Mussels to perform biochemical tests to assess the levels of stress in Horse Mussels from Norwegian waters. To collect samples of Horse Mussel tissue for subsequent DNA analysis, to be integrated into a wider scale study already underway to quantify genetic connectivity and dispersal of Horse Mussels throughout their known range.
- 2) To photograph and collect samples of marine Bryozoa to assess changes in the species composition of the Norwegian fauna in comparison with historical surveys that were undertaken by Nordgaard (1800's) and Ryland (1963). This is to test the hypothesis: are there more Lusitanian species in the Norwegian fauna compared to Arctic/Boreal species now than there were recorded in previous surveys, in response to the increase in sea water temperature over the last 50 years. This work will also include a focus on the documentation of non-native and invasive bryozoan species given that this is a gap in the recent Alien Species report (Gederaas et al. 2012) by the Norwegian Biodiversity Information Centre.
- 3) To conduct in situ surveys and sampling of maerl beds using cores to develop a high resolution environmental envelope model.
- 4) To collect amphipod shrimps in small non-destructive traps placed by divers amongst complex habitats, such as *Lophelia pertusa*, horse mussel beds and maerl and compare this to catch rates in other less complex habitats.
- 5) To conduct zooplankton sampling, to complete the following objectives: a) to describe and quantify the spatial variability and diversity of the gelatinous zooplankton between Bergen and Trondheim, b) to allow a comparison to be made between UK and Norwegian fauna through specimen collection c) to support the development of an identification guide for the north-east Atlantic through specimen collection and d) to provide data on pelagic communities, complementing benthic species collection.

STUDY AREA

Geographical area in which the MV *Halton* operated (with reference to latitude and longitude). Coordinates (corners) of area marked on the map

A (south –west corner):	61° 12' 56.92'' N	08° 42' 32.83'' E
B (south - east corner):	59° 19' 24.59'' N	06° 14' 10.42'' E
C (north –west corner):	65° 16' 12.79'' N	07° 18' 38.05'' E
D (north –east corner):	63° 54' 48.13'' N	12° 30' 26.34'' E



STATION DETAILS

Bryozoan samples were taken by SCUBA diving at the following locations:

Station	Locality	Latitude N	Longitude E	Depth (m)	Date
1	Vatlestraumen	60 20.330	05 11.369	10-13	29/06/2014
2	Herdlefjorden-shark wall	60 30.379	05 12.049	26	29/06/2014
3	Krakhellesundet	61 09.311	05 01.092	22	30/06/2014
4	Tansøy	61 29.327	04 58.196	9.7	30/06/2014
5	Florø marina	61 36.081	05 02.115	on pontoons	30/06/2014
6	Stingane, Vågsfjorden	61 54.895	05 03.654	32	01/07/2014
7	Stadt	62 10.080	05 04.718	29	01/07/2014
8	Ålesund marina	62 28.404	06 09.162	on pontoons	01/07/2014
9	Dryna, Harøyfjorden	62 38.852	06 31.587	12-14	02/07/2014
10	Føllingel	63 04.801	07 13.298	35	02/07/2014
11	Kristiansund marina	63 06.811	07 43.977	on pontoons	02/07/2014
12	Gjemmesundet	62 58.348	07 47.084	35	03/07/2014
13	Jomoeya	63 13.164	08 14.555	33	03/07/2014
14	Skrubboeya, Moldtun	63 33.981	09 26.321	32	04/07/2014
15	Munkholmen, Trondheim	63 27.852	10 23.422	15-32	04/07/2014
16	Tautraryggen, Trondheim Fjord	63 36.031	10 30.461	43	06/07/2014
17	Oerdalsmeset, Trondheim Fjord	63 51.514	11 04.269	30	08/07/2014
18	Bridge stanchions on East side of Skarnsundet Bridge	63 50.650	11 04.825	14-28	10/07/2014
19	Black stick reef, Skarnsundet	63 52.398	11 03.011	30	10/07/2014
20	Kalddalen, Trondheim Fjord	63 43.464	10 52.704	35-43	11/07/2014

PRELIMINARY RESULTS

Latitudinal comparison of biodiversity associated with the biogenic structures Maerl beds and Horse Mussel reefs.

Dr William Sanderson, Professor Hamish Mair, Rebecca Grieve

Biogenic habitat formers are species that congregate to form a habitat discrete from the seabed and can enable a rich flora and fauna often resulting in a biodiversity hotspot. The horse mussel (*Modiolus modiolus*, Linnaeus, 1784) can occur in large numbers on the seabed to create a continuous expansive reef; the shells of the mussels provide a hard substrate for epifauna and algae to grow, the 3D structure of the reef provides interstitial spaces for invertebrates and the deposition of faeces and pseudo faeces provides a rich sedimentary habitat.

Maerl, a calcareous, disjointed, free-living red algae, occurs in aggregations to create an isolated habitat that is high in biodiversity and biomass. Similarly, the interlocking 3D lattice structure of the maerl provides extensive interstitial spaces for some rare polychaetes and amphipods, and the outer surface of the rhodoliths provide a hard substrate for algae, some which are endemic to this habitat.



At the horse mussel bed in Skarnsundet, Trondheim fjord mussels grow together in the common clumping formation, but unusually they are attached to bedrock rather than a sediment substrate. The rich life is evident with organisms growing on the shells and large sea cucumbers and urchins grazing.

Horse mussels are a boreal species, with beds reaching their most southerly limit in the Irish Sea, within the NE Atlantic. Maerl-forming species are extremely slow growing, with the average growth in Scotland being less than 1mm per year.

These habitats are at risk from changing climate and ocean acidification so understanding the life they support and how valuable will help to ensure their future maintenance and protection. Additionally understanding how the biodiversity associated with them across a range of latitudes may help inform how the value of these habitats will change with impending changing environmental conditions.

The team had a biodiversity data for a range of latitudes from 53°N up to 60°N in Shetland. This Norway expedition allowed us to gain three more latitudinal points for Maerl and horse mussel beds up to 63°N. Visiting and sampling these latitudes in Norway gives us the most wide ranging latitudinal data for horse mussel beds in the NE Atlantic. There is relatively little knowledge of the extent and distribution of these habitats in Norway; our team found an extensive bed around the Skarnsundet Bridge in northern Trondheim fjord. Much of the reef occurred on bedrock – something that is very scarcely documented in the literature and is not known to occur within UK waters. This unexpected finding changes our understanding of ‘suitable habitat’ for horse mussel bed formation.

Samples are currently being sorted and will be sent away for identification of benthic organisms. The faunal data from the benthic samples will be integrated in to predictive model along with similar data from the UK. The predictive model will be projected under different climate scenarios and will hopefully show how the Maerl and horse mussel populations may be threatened in the future. Furthermore, a suite of statistical models will be applied to the data to compare the habitats and biota they support from 53°N to 62°N. Another expected output will be the clarification of the environmental requirements for these priority habitats. Understanding the optimum environmental niche of these habitats will inform the most suitable areas for the restoration or creation of new maerl and horse mussel habitats. The data will help towards the completion of Rebecca Grieves PhD thesis and additionally it is hoped that data from the Norway expedition will be published over the next year two years.

Population genetics and stress markers of *Modiolus modiolus*

Dr Joanne Porter, Dr William Sanderson, Clara Mackenzie

Management of species of conservation importance, such as *Modiolus modiolus*, requires detailed knowledge about their genetic structure and status. Understanding population connectivity has become a major factor in determining and defining threats to marine biodiversity and is crucial to the marine conservation and management process (Coscia *et al.*, 2013; Schunter *et al.*, 2011; Weersing & Toonen, 2009). Likewise, such information may be of use in informing the successful maintenance of these populations through breeding programmes (Jiale *et al.*, 2009) and /or restoration of habitats (Roberts *et al.*, 2011).

M. modiolus samples collected during the Norway research expedition will contribute to a wider scale study already underway at Heriot-Watt University, which aims to quantify genetic connectivity and dispersal of *M. modiolus* throughout its known range. Specifically, samples collected in Norway will contribute to the following research objectives:

- Investigate genetic connectivity and diversity of *M. modiolus* populations across the UK and Atlantic range of the species via microsatellite screening;
- Investigate phylogeography of *M. modiolus* populations across the UK and Atlantic ranges of the species via analyses of intraspecific genetic patterns of *M. modiolus* using partial mitochondrial gene cytochrome oxidase subunit 1 (CO1).

M. modiolus samples were collected on 07/07/2014 from a population situated at 20m seawater depth at the Skarnsundet Bru (English: Skarnsund Bridge) (Latitude 63.839, Longitude 11.067) site near Inderoy, Norway. Animals (n=50) were dissected within 24 hours of collection and adductor muscle tissues were preserved in ethanol and placed on ice for transport back to Heriot-Watt University for subsequent genetic processing and analyses. To date, DNA has been successfully extracted from all samples and phylogeographic analyses are currently underway. Results will enhance current understanding of *M. modiolus* evolution and dispersal (see Halaynch *et al.* 2013) by providing information on finer scale population structure of UK and North Atlantic populations.



Processing of horse mussel tissue samples at Skarnsundet marina.

Microsatellite analyses of samples are also proceeding and will contribute to knowledge of population connectivity of UK and Norwegian *M. modiolus* populations. Microsatellite analyses will also provide an indication of population genetic diversity, and thus contribute to understanding of the adaptive capabilities of *M. modiolus* under future climate change conditions. Collectively, results will inform marine spatial planning efforts across UK and OSPAR management regions for the species (OSPAR, 2008) and will prove a valuable contribution towards meeting the EU Marine Strategy Framework Directive (MSFD) objective for “good environmental status” for priority habitats (e.g. *M. modiolus* habitats) by 2020 (MSFD, 2008).

Tissue samples from the same organisms were preserved in buffers for the subsequent analysis of Heat shock protein and other markers of stress in populations from the northern part of the range for the species.

Bryozoan biodiversity and non-natives species surveys

Dr Joanne Porter, Dr Piotr Kuklinski, Mary Spencer Jones and Sally Rouse

Twenty sites were sampled during the course of the expedition. Initial species identifications were made where possible and specimens were photographed in situ, dried and curated for further examination by Scanning Electron Microscope back at the NHM London, to confirm correct diagnosis.



The boreal-arctic bryozoan species *Palmiskenea skenei* (Ellis & Solander, 1786) in Trondheim fjord

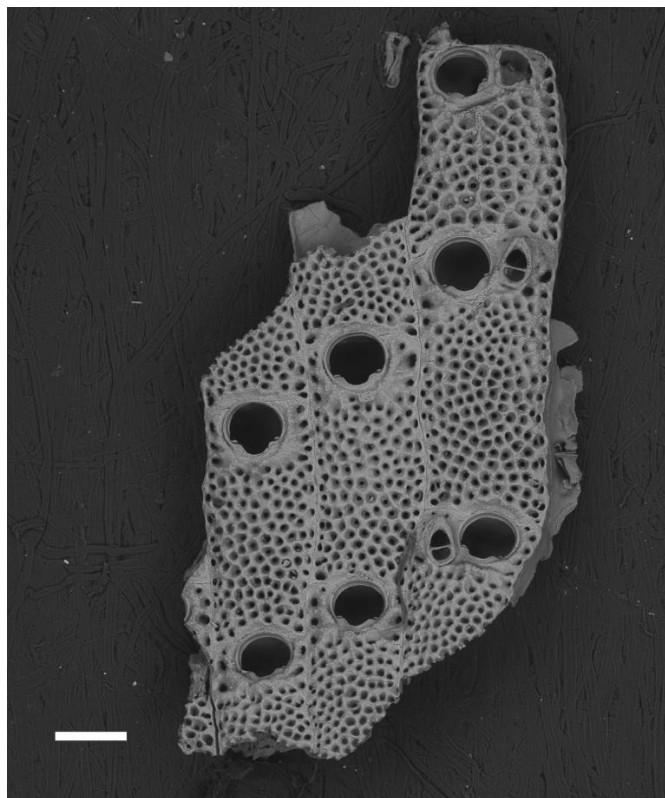
SCUBA divers also collected rock samples from three locations. The rocks were rinsed in freshwater and then dried out and curated into buckets. Samples were offloaded at Trondheim and then transported to Poland, for expert bryozoan identification and data collation using microscope facilities.



Curated rocks with bryozoan epifauna drying out ready for transport and further analysis.

Marina surveys were conducted to investigate the presence of non-native species. The cruise started in Bergen (60° 23.963' N, 05° 18.740' E) and over the two-week period surveys were conducted at intervals along the coastline, heading northwards, and including the major ports of Ålesund (62° 28.404' N, 06° 09.162' E) Kristiansund (63° 06.811' N, 07° 43.977'E) and Trondheim (63° 26.318' N, 010° 23.976'E). When the vessel moored up in each harbour, surveys of the local pontoons were conducted, to identify fouling species and to ascertain whether any non-native Bryozoa were present. Seven species of fouling Bryozoa were identified. Two of these were the non-native species *Tricellaria inopinata* d'Hondt and Occhipinti Ambrogi, 1985, and *Schizoporella japonica* (Ortmann, 1890). These non-native species have previously been recorded from UK waters and *Tricellaria inopinata* is also well known from the Venice lagoon in Italy and more recently the Belgian coast. Until now there have been no confirmed records of any of these species from Norwegian coastal waters. It is likely given the locations of occurrence, that small boat traffic is a vector for the introduction of these species. Recommendations are given for the amendment and addition of species to the Norwegian Black List (Gederaas, et al. 2012).

A scientific paper has been accepted for publication in the journal, *BioInvasions Records*, entitled 'First records of marine invasive non-native Bryozoa in Norwegian coastal waters from Bergen to Trondheim'.



A Scanning Electron Microscope image of the invasive non-native bryozoan species, *Schizoporella japonica*, collected at Ålesund marina. Scale Bar = 200 microns.

Zooplankton sampling

Rachel Shucksmith

The timeframe for the itinerary of the cruise was challenging and so a comparatively small number of plankton tows were completed. Some observations, however, of plankton were made via *in situ* diver surveys that provide to be more successful. Some representative samples of key species were collected and preserved for further analysis. *In situ* photography was also conducted. Some of this material and imagery will be used in the future towards the completion of objective 5c as outlined in the introduction and objectives section.



Periphylla periphylla jelly



Aglantha digitale jelly

ACKNOWLEDGEMENTS

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