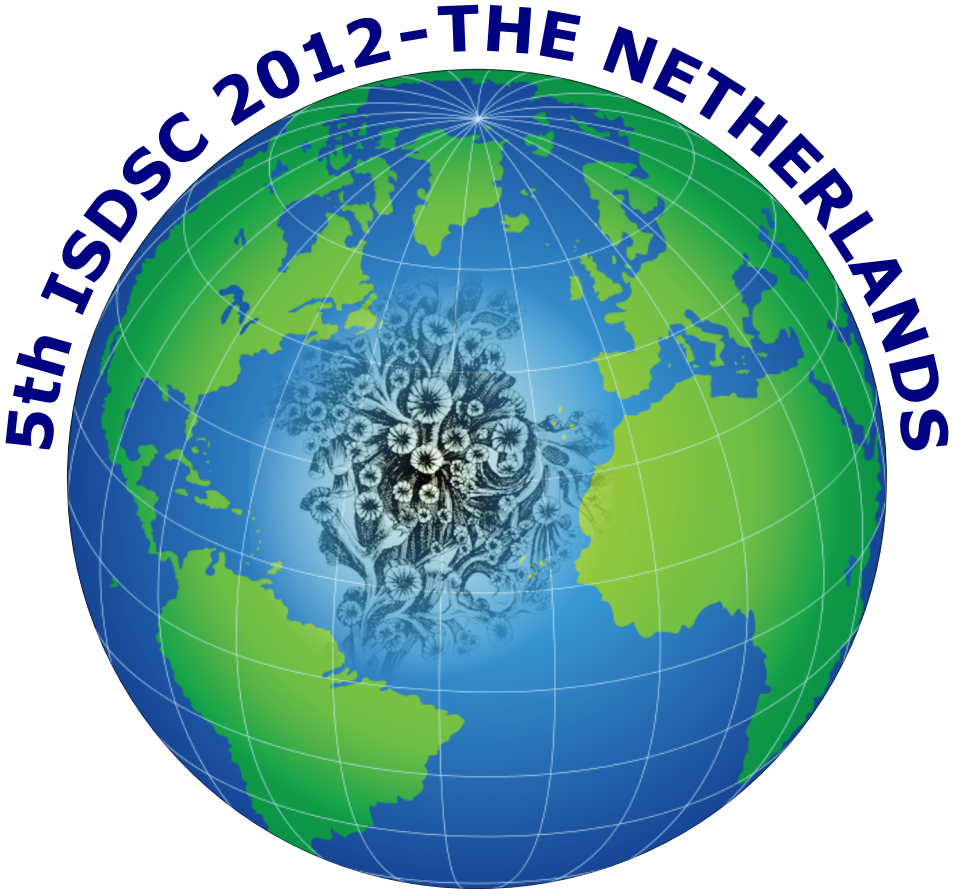
ABSTRACT and PROGRAM BOOK

International Symposium on Deep-Sea Corals
1-6 April 2012
Amsterdam, The Netherlands

BOEM Bureau of Ocean Energy Management · Statoil · NIOZ · PETROBRAS · NOAA · NWO · DECO GEOPHYSICAL · IAS · Ifremer · KNDV · AVAA TECH Analytical X-Ray Technology · KONGSBERG · CoCaRDE · Thermo SCIENTIFIC



SCIENTIFIC PROGRAM

SUNDAY 1 APRIL

8.30 **REGISTRATION workshop**

9.00 - 17.30 **Workshop 'Identification of deep-sea corals from imagery data' focusing on deep-water coral identification from imagery**
convened and organised by Jaime Davies and Inge van den Beld (Ifremer)

16.00 - 17.30 **REGISTRATION at the Artis Conference premises**

Identification of deep-sea corals from imagery data

Workshop 1st April 2012

A workshop 'Identification of deep-sea corals from imagery data' focusing on deep-water coral identification from imagery, convened and organised by Ifremer in association with the French Marine Protected Areas Agency, CoralFISH, NOAA and the University of Plymouth will take place on Sunday 1 April in the Artis conference premises.

Overview

The use of optical imagery as a non-destructive sampling tool is now widely used and essential in deep-sea research. Systems ranging from Remotely Operated Vehicles to towed cameras with varying quality digital imagery acquired pose the advantage of more rapid, less destructive means of understanding deep-sea ecology.

It is not always possible to use traditional taxonomy during analysis of optical imagery and thus a level of expertise/training is necessary. The identification of species from images is difficult and in some cases impossible without physical specimens, it is possible in some instances to identify organisms as distinct morpho-types. To allow consistency in identification it is important to keep a visual species catalogue, an example will be presented during the workshop.

While a previous workshop hosted by MBARI (classification and identification of marine organisms from image and video) in 2009 covered all taxa and regions, this workshop will focus on Atlantic deep-water corals.

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Format

The aim of this workshop is to bring together international coral taxonomy experts and professionals working in the field of image analysis to allow an applied approach to using imagery for coral identification. The workshop will involve presentations from coral experts covering the various coral groups highlighting the main morphological features which can be used to identify coral species from imagery, as well as diagnostic features that may be used to differentiate between similar taxa. Participants are also encouraged to bring example images which either they need help to identify or show useful diagnostic features for the identification of a species.

Registration

Participants must register through the ISDSC website (www.deepseacoral.nl) and costs are €100. The workshop is open to all but spaces are limited to 40 participants, and registration of ISDSC 5 is necessary.
For further information please contact Jaime Davies (Jaime.Davies@ifremer.fr) or Inge van den Beld (Inge.Van.Den.Beld@ifremer.fr).

CONFERENCE PROGRAM - MONDAY 2 APRIL

8.00 REGISTRATION

9.00 Official opening ISDSC 5

Prof. Dr. J. Fokkema (Chair of Council for Earth and Life Sciences of the National Science Foundation NWO)

Prof. Dr. H. Brinkhuis (Director Royal NIOZ)

Prof. Dr. Tjeerd van Weering (Organizing Committee ISDSC 5)

S1 Biodiversity and Biogeography

Session chair: Tjeerd van Weering

9.40 'Biodiversity in cold-water coral ecosystems – The role of ecological succession and habitat complexity' [KEYNOTE]
Pål Buhl-Mortensen

10.10 Deep-sea coral ecosystems off the Southeastern United States and in the Gulf of Mexico: Research progress and future directions
Steve W. Ross and S. Brooke

10.25 COFFEE AND TEA BREAK

S2 Biodiversity and Biogeography

Session chair: Rhian Waller

10.45 The hard, the soft, and the black of azooxanthellate corals: Diversity and distribution in the Colombian Caribbean
Nadiezhda Santodomingo, J. Reyes, P. Florez, L. P. van Ofwegen and B. W. Hoeksema

11.00 Deep-sea soft mushroom corals (Octocorallia: *Alcyonidae*) from the North Atlantic
Tina N. Molodtsova

11.15 Deep cold-water corals as nurseries for fish larvae
Sandrine Baillon, J-F. Hamel, V. E. Wareham and A. Mercier

11.30 Associations and functional links between tusk and cold water coral and sponge habitats examined by experimental long-line fishing
Jan Helge Fosså, T. Kutti, K. Helle and O. A. Bergstad

11.45 The link between cold water corals and fish, examples from across Europe – Observations from a baited photographic lander
Tom Linley, N. Cousins, M. Shields and I. Priede

12.00 Reproduction of deep-sea coral reef builders from the South-Western Atlantic
Débora de Oliveira Pires, J. Cordeiro da Silva and N. Dias Bastos

12.15 **Differences in timing of reproductive cycles in *Lophelia pertusa* from the eastern and western North Atlantic Ocean**
Sandra Brooke, J. Jarnegren and S. Ross

12.30 **LUNCH BREAK**

S3 **Connectivity and genetics**
Session chair: Steve Ross

13.30 **'Seasonal reproduction of Alaskan fjord corals' [KEYNOTE]**
Rhian Waller

14.00 **DNA barcoding reveals high diversity of Hawaiian deep-sea octocorals**
Amy R. Baco, B. LaBelle, D. Figueroa, A. Driskell, S. Cairns and A. Ormos

14.15 **Genetic connectivity among natural *Lophelia pertusa* reefs and shipwrecks in the Gulf of Mexico**
Cheryl Morrison Rauch, R. L. Johnson, M. J. Springmann and D. K. Coykendall

14.30 **Morphometrics in *Desmophyllum dianthus*: a complementary tool for phylogenetic studies**
Anna M Addamo, A. Vertino, M. Taviani and A. Machordom

14.45 **Stylasterid coral (*Errina spp.*) fields in Antarctica and the Sub-Antarctic**
Narissa N Bax, S. Cairns and K. Miller

15.00 **Are there true nearly cosmopolitan cold-water coral species?**
Santiago Herrera, J. A. Sanchez and T. M. Shank

15.15 **COFFEE AND TEA BREAK**

S4 **Connectivity and genetics**
Session chair: Stephen Cairns

15.45 **Octocoral diversity around South Georgia: using genetic techniques to investigate gardens of the deep**
Michelle Taylor, D.J. Agnew and A.D. Rogers

16.00 **Connectivity of the octocorals *Eunicella verrucosa* and *Alcyonium digitatum* and its implications for protection of sessile species in the UK MPA network**
Lyndsey P. Holland and J. R. Stevens

16.15 **Depth-related speciation patterns in the *Ellisellidae* (Anthozoa: *Octocorallia*)**
Jaret P. Bilewitch and S. M. Degnan

16.30 **Assessing connections among populations of the deep sea coral *Desmophyllum dianthus*: a seascape approach**
Karen Miller, P. England and R. Gunasekera

16.45 **When is a bamboo coral not a bamboo coral? A revision of the octocoral family *Isididae***
Les Watling, S. France, S. Rowley and E. Heestand

17.00 **'New insights into the diversity of deep-sea corals' [KEYNOTE]**
Scott France

17.30 ICEBREAKER

CONFERENCE PROGRAM - TUESDAY 3 APRIL

8.00 REGISTRATION

S1 Habitat characterisation, mapping, GIS applications

Session chair: Jason Simms

9.00 'Trans-Atlantic perspectives on the history of *Lophelia* cold-water coral development' [KEYNOTE]
Murray Roberts

9.30 Evaluating levels of accuracy for observer-identified coral data: how good are the data for spatial mapping?
D. M. Tracey and S. J. Parker

9.45 Record of cold-water corals biodiversity in the Sanriku Pacific Coast in northeastern Japan, before the 9.0 Magnitude Earthquake and Tsunami on March 11, 2011.
Asako K. Matsumoto

10.00 Deep-sea corals on Orphan Knoll and Orphan Seamount, Northwest Atlantic: relationships to surficial geology, bathymetry and oceanography.
Shawn Meredyk, E.N. Edinger and D.J.W. Piper

10.15 The distribution of coral reefs in the Bay of Biscay
I.M.J. van den Beld, B. Guillaumont, J.S. Davies, L. Beuck, C. Carré, C. Bayle and S. Arnaud

10.30 COFFEE AND TEA BREAK

S2 Environmental conditions and constraints

Session chair: Di Tracey

11.00 Habitat heterogeneity, distribution and biodiversity of deep-sea corals ecosystems from Campos Basin, Brazil (SW Atlantic)
*Guarani de Hollanda Cavalcanti, M. P. Curbelo Fernandez, R. C. Mikosz Arantes, M. A. da Silva Silveira, L. de Laia Loiola and A. C. dos Santos Bras*il

11.15 Islands in the Stream Revisited: Hydrography, geological setting and fauna of Cape Lookout coral mounds (NC, USA)
Gerard C.A. Duineveld, F. Mienis, M. Lavaleye, A. Davies, S. Ross, S. Brooke, H. de Haas and T. van Weering

11.30 Existence of deep-sea corals in the central Red Sea
Cornelia Roder and C. R Voolstra

11.45 Coral-dominated biotope cataloguing and mapping in the Azores (NE Atlantic)
Fernando Tempera, J. Nuno Pereira, C. Yesson, A. Braga Henriques, F. Porteiro, T. Morato, V. Matos, M. Souto, B. Guillaumont and R. Serrão Santos

12.00 **Back to the Darwin Mounds**
Veerle A.I. Huvenne, D.G. Masson, B.J. Bett, T.P. Le Bas, F. McBreen, S. McPhail, R. Ross

12.15 **Taxonomic characterization of deep-water coral communities: does remote underwater analysis replace laboratory species identification?**
Antonietta Rosso, R. Sanfilippo, A. Vertino, F. Sciuto, L. Beuck and A. Freiwald

12.30 **LUNCH BREAK**

S3 **Biodiversity and Biogeography**
Session chair: Veerle Huvenne

13.30 **The oldest cool-water coral ecosystem on Earth? – Danian coral mounds from Faxe, Denmark**
Bodil Wesenberg Lauridsen, M Bjerager and F. Surlyk

14.00 **Biodiversity in coral ecosystems from the deep Gulf of Mexico: coral-symbiont relationships and genetic connectivity**
Timothy M. Shank, W. Cho, S. Herrera, T. Heyl, C. Munro, E. Cordes, A. Quattrini, P-Y. Hsing, A. Demopolous, and C. Fisher

14.15 **Microbial diversity associated with the cold-water coral *Lophelia pertusa* as revealed by 454 pyrosequencing**
J. P. Galkiewicz, R. Vega Thurber and C.A. Kellogg

14.30 **Chemical ecology of Antarctic soft corals of the genus *Alcyonium*, Linnaeus 1758**
Laura Núñez-Pons, M. Carbone, F. Castelluccio, M. Gavagnin and C.A. Avila

14.45 **Pushing the limits of a facultative relationship: An intimate and complex relationship between the squat lobster *Eumunida picta* and the deepwater coral *Lophelia pertusa***
Martha S. Nizinski, J.P. McClain-Counts and S.W. Ross

15.00 **COFFEE AND TEA BREAK**

S4 **Posters**
Session chair: Marc Lavaleye

15.30 **Poster presentations**
Theme I and II

16.15 **Posters/exhibits**
All posters are on display

17.30 **'Environmental control of deep-sea coral distribution: latest insights and implications' [KEYNOTE]**
Ashley Rowden

CONFERENCE PROGRAM - WEDNESDAY 4 APRIL

8.00 REGISTRATION

S1 Pollution and threats

Session chair: Andrew Davies

9.00 'Deep-sea corals and the oil and gas industry in the Gulf Of Mexico: an adaptive approach to applied studies and management' [KEYNOTE]
Gregory Boland

9.30 Impacts of the Gulf of Mexico oil spill on deepwater coral communities
Erik E Cordes, T. Shank, A. Demopoulos, H. White, A. Quattrini, W. Cho, P.-Y. Hsing and Chuck Fisher

9.45 Methodologies and effect investigations on the scleratininan coral *Lophelia pertusa* in relation to offshore petroleum activities: a laboratory study
Thierry T.B. Baussant, S. Westerlund, M. Nilsen, M. O. Sydnes, E. Larssen, E., Lyng, C. Boccadoro, A. Osland, N. Aarab, E. Ravagnan, R. K. Bechmann, I.C. Taban, A. Bagi, J. Jårnegren and P.B. Mortensen

10.00 What is needed to protect cold-water corals from the potential impacts of oil and gas activities?
Ingeborg Roenning, P.E. Iversen and A.-M. Vik Green

10.15 Enhancing 'bottom fishery impact assessments' to reduce impacts on deep sea corals
A. Williams and F. Althaus

10.30 COFFEE AND TEA BREAK

S2 Conservation strategies and predictive habitat mapping

Session chair: Anthony Grehan

11.00 Review of global and regional initiatives to protect cold-water corals from the impact of deep-sea fishing
Matthew G. Gianni

11.15 The Government of Canada's National Centre of Expertise in Cold-Water Coral and Sponge Reefs
Jason M. Simms

11.30 Deep-sea corals: science threads in the tapestry of conservation
Thomas F. Hourigan

11.45 A regional high resolution habitat suitability model for *Lophelia pertusa* reefs in Irish waters
Anna Rengstorf, C. Yesson, C. Brown and A. Grehan

12.00 A global habitat suitability model of deep sea *Antipatharia*
Chris Yesson, F. Hendry and M. L Taylor

12.15 ‘Locating vulnerable marine ecosystems in the greatest wilderness on earth’ [KEYNOTE]
Andrew Davies

12.45 LUNCH BREAK

FREE AFTERNOON/EXCURSIONS

CONFERENCE PROGRAM - THURSDAY 5 APRIL

8.00 REGISTRATION

S1 Geochemical proxies in deep-sea corals

Session chair: Andres Rüggeberg

9.00 'Climate change and deep-sea coral communities: predicting impacts in a data poor environment' [KEYNOTE]
Ronald Thresher, J. Guinotte, S. Fallon and R. Matear

9.30 Environmental proxy development in the deep-sea corals *Corallium* sp. and the *Isididae* family corals from the southeast of Tasmania
Stewart J. Fallon, R.E Thresher and K.M. Strzepek

9.45 Geochronological potential and patterns of amino-acid racemisation in cold-water corals and bivalves
Matthias López Correa,D. S. Kaufman, J. Fietzke, A. Freiwald, M. McCulloch, P. Montagna and M. Taviani

10.00 Sclerochronology of *Primnoa pacifica* from British Columbia, Canada, and Washington State, USA: potential paleoproductivity proxies and geographic variation in radial growth rates.
Renita S. Aranha, E. Edinger, G. Layne, G. Piercey and B. De Moura Neves

10.15 Early diagenetic overprint in cold-water coral carbonate mounds: different systems reveal different signatures
Anneleen Foubert, H. Pirlet, M. Thierens, T. Frank, H. Hamaekers, J.P. Henriet and R. Swennen

10.30 COFFEE AND TEA BREAK

S2 Reef and mound structures in time and space

Session chair: Norbert Frank

11.00 Holocene reservoir ages in South Eastern Australia: Chronicles from deep-sea black corals
Aimée F. Komugabe, S. Fallon, S. Eggins, R. Thresher and G. Mortimer

11.15 Gorgonian corals record the ambient seawater neodymium isotopic composition
Paolo Montagna, M. Lopez Correa, S. Goldstein, M.T. McCulloch, A. Freiwald, M. Taviani, J.A. Trotter and J. Raddatz

11.30 Water Mass Distribution in the Northwest Atlantic During MIS 3
Tina van de Flierdt, K. Crocket, L.F. Robinson and J.F. Adkins

11.45 Deep-sea coral records of surface water properties in Gulf of Mexico and the southeastern United States over the last millennium
E. Brendan Roark, N. Prouty, L. Mohon, H. Powers and S. Ross

12.00 **'The growth history of a shallow inshore *Lophelia pertusa* reef: the Mingulay Reef Complex'**
Mélanie Douarin, M. Elliot, J. M. Roberts, S. R. Noble, D. Sinclair, L.-A. Henry, D. Long and S. G. Moreton

12.15 **Benthic foraminifera associated to a cold-water coral reef from Lopphavet, Northern Norway**
Claudio Stalder, S. Spezzaferri, A. Rüggeberg and C. Pirkenseer

12.30 **LUNCH BREAK**

S3 **Coral reef and mound Archives**
Session chair: Jean-Pierre Henriet

13.30 **'Historical perspectives on deep-sea coral ecosystems in the Southern Ocean' [KEYNOTE]**
Laura Robinson

14.00 **Dual control on the distribution of newly discovered large mounds on the slopes of Great and Little Bahama Bank**
Rani Sianipar, G. Eberli, E. Ducassou, T. Mulder and P. Leonide

14.15 **Cold-water coral carbonate mounds as palaeo-archives: the Plio-Pleistocene sediment record from the Challenger Mound (NE Atlantic)**
M. Thierens, H. Pirlet, B. Dorschel, V.A.I. Huvenne, J. Titschack, J.-B. Stuut, C. Colin, E. Brownin, S. Tyrrell, J. R. Lee, M.-F. Loutre, F. Vanhaecke, J.-P. Henriet and A.J. Wheeler

14.30 **Carbonate budget of cold-water coral mounds: First results from the Norwegian and Mediterranean Seas**
Jürgen Titschack, H.G. Fink, M. López Correa, R. De Pol-Holz, N. Joseph, D. Hebbeln and A. Freiwald

14.45 **Solicited talk**
Ronald Keesmaat (Kongsberg)

15.00 **COFFEE AND TEA BREAK**

S4 **Posters**
Session chair: Furu Mienis

15.30 **Poster presentations**
Theme III and IV

16.15 **Posters/exhibits**
All posters are on display

17.30 **'What do cold-water corals tell us about climate change and ocean circulation?' [KEYNOTE]**
Norbert Frank

CONFERENCE PROGRAM - FRIDAY 6 APRIL

8.00 REGISTRATION

S1 Reef and Mound structures in time and space

Session chair: Laura Robinson

9.00 'Carbonate Mounds: from paradox to world heritage' [KEYNOTE]
Jean-Pierre Henriet

9.30 A case of coral-knolls potentially linked to deep seepage: Geological and geochemical approaches of deep-coral build-ups from the Melilla Mound Field (Alboran Sea, Western Mediterranean)
M.C. Comas, F. Martinez-Ruiz, G. J. de Lange, L. Lopez-Alcaide, L. M. Pinheiro, H. de Haas and C. Lo Iacono

9.45 Bedload sediment transport prevents colonization of sand dunes and controls distribution of biogenic cold water coral ridges
T.B.S. Correa, M. Grasmueck, G.P. Eberli and J.K. Reed

10.00 Decoupled Holocene coral growth in the Strait of Sicily (Central Mediterranean)
L. Angeletti, P. Montagna, N. Frank and M. Taviani

10.15 What lies beneath? Compound specific isotope analyses reveals shifting oceanographic regimes in Southeast Australian waters.
K.M Strzepek, R.E Thresher, A. Revill, R. Leeming and S.J. Fallon

10.30 COFFEE AND TEA BREAK

S2 Environmental conditions and constraints

Session chair: Karline Soetaert

11.00 Cold-water coral ecology in the Cap de Creus submarine canyon (northwestern Mediterranean): 7 years of multidisciplinary research
Covadonga Orejas, A.Gori, C.Ferrier-Pagès, C.Lo Iacono, P.Puig, M.S.Naumann, J.Movilla, G.Tsounis, S.Reynaud, A.Olariaga, T.Madurell and JM.Gili

11.15 Cold-water coral communities: Hotspots of carbon processing along continental margins
Dick van Oevelen, C. Cathalot, T. Cox, M. Lavaleye, G. Duineveld, T. Kutti, J.-H. Fosså, K. Soetaert and F. Meysman

11.30 Comparative net prey capture rates of a selection of Scleractinia species under various environmental conditions
Autun Purser, A. Larsson and L. Thomsen

11.45 Trophic structure of deep-sea coral habitats in the Gulf of Mexico
Amanda W.J. Demopoulos, J. McClain-Counts, S. W. Ross, T. McIver and M. Nizinski

12.00 **Uptake of various food sources by the cold water coral *Lophelia pertusa***
Christina E. Mueller, D. van Oevelen and J. J. Middelburg

12.15 **Ecohydrodynamics of Mingulay Reef complex**
Juan Moreno Navas and J M Roberts

12.30 **LUNCH BREAK**

S3 **Acidification**
Session chair: Ron Thresher

13.30 **'Response of cold-water corals to ocean acidification' [KEYNOTE]**
Conny Maier

14.00 **Ocean acidification changes gene expression in the cold-water coral *Lophelia pertusa***
Mikael Dahl, E. Kristiansson, N. Asker and Joakim Larsson

14.15 **Cold water corals grow under future pH conditions in situ**
Carin Jantzen, J. Laudien, V. Häussermann, G. Försterra and C. Richter

14.30 **Ocean acidification effects on the physiology and gene expression profiles of the cold-water coral *Desmophyllum dianthus***
M. Carreiro-Silva, A. Godinho, T. Cerqueira, E. Maître, R. Serrão Santos and R. Bettencourt

14.45 **Carbonate dynamics and calcification of *Lophelia pertusa* in the Northern Gulf of Mexico**
Jay J. Lunden, S. E. Georgian, C. McNicholl, C. Sears, S. El-Ashry and E. E. Cordes

15.00 **Acclimation of the cold water coral *Lophelia pertusa* to predicted rises in atmospheric CO_2 and sea temperatures**
Sebastian J Hennige, L.C. Wicks, N.K. Kamenos and J.M Roberts

15.15 **COFFEE AND TEA BREAK**

S4 **Ecosystem dynamics**
Session chair: Murray Roberts

15.45 **Oxygen-minimum zones: a threat to deep-sea corals and other cnidarians?**
Daphne G. Fautin and W. E. Eash-Loucks

16.00 **Long-term time-lapse observations in situ in a cold-water coral habitat**
Tomas Lundälv, D. Guihen, L. Jonsson and M. White

16.15 Distribution and characterization of deep-sea coral ecosystem habitats off Southeastern United States
John K. Reed, C. Messing, B. K. Walker, S. Farrington, S. Brooke, T. B.S Correa and M. Brouwer

16.30 'Summing up the ISDSC 5 - a personal view' [KEYNOTE]
Martin Hovland

17.00 CLOSING AND FAREWELL DRINK

THEME 1 - POSTERS

New records of *Primnoidae* (Cnidaria: *Octocorallia*) from Brazilian deep waters
Renata C.M. Arantes and L. L. Loiola

Developing sets of genetic markers in Octocorals for higher-level phylogenetic reconstruction and for species-level classifications
Diego F. Figueroa, A. Lemmon and A. R. Baco

Spatial trends in the characteristics of two dominant sea pens in the Northwest Atlantic
Sandrine Baillon, J-F. Hamel and A. Mercier

Shedding light on deep-water oyster environments: Habitat characterisation of live *Neopycnodonte zibrowii* and its Atlantic-Mediterranean distribution
Lydia Beuck, A. Freiwald, M. López Correa, M. Taviani, H. Zibrowius and D. Hebbeln

The impact of cold-water coral structures on fish communities in the NE Atlantic
Matthias Biber, G. Duineveld, M. Lavaleye, M. Bergman, I. van der Beld, L. Kochen and S. van der Wal

Cold-water coral communities in the Condor Seamount (NE Atlantic)
Andreia Braga-Henriques, J. N. Pereira, F. Tempera, F. Porteiro, C. Pham, T. Morato, R. Serrão Santos

New insights on deep-water zoanthids associated with corals in the Azores (NE Atlantic)
Marina Carreiro-Silva, O. Ocaña, A. Braga-Henriques, V. Matos, I. Sampaio, F. Porteiro and S. Stefanni

A comparative analysis of microbial communities associated with *Lophelia pertusa* inhabiting the NE Atlantic Ocean: characterizing bacterial diversity, function, biogeography and affiliations with host genotypes
T.E. Anne Cotton, G.M. Cook and A.M. Osborn

Twilight gardens: first record of *Antipathella subpinnata* (Cnidaria: *Anthozoa*) in the Azore*s*
*Valentina K.F. de Matos, P. Ribeiro, J. Nuno Pereira, F. Tempera, A. Braga-Henriques and F. Porte*iro

Biodiversity and community composition of macrofauna associated with deep-sea coral habitats in the Gulf of Mexico
Amanda W.J. Demopoulos, J. Bourque, J. Frometa and J. McClain-Counts

Insights into the population dynamics of the deep-sea coral genus *Paramuricea*
Cheryl Doughty, A. M. Quattrini and E. E. Cordes

New distributional records of deep-water corals from the Rockall Trough and surrounding areas
Jim Drewery

Annotating optical images from ROVs or drop-frames in Vulnerable Marine Ecosystems studies
Brigitte Guillaumont, C. Carré, I.M.J. van den Beld, L. Beuck and J.S. Davies

Looks can be deceiving: Assessing the monophyly of bamboo corals (*Cnidaria, Octocorallia, Calcaxonia, Isididae*)
Esprit N Heestand, L. Watling and S. France

Models and maps of biodiversity and ecosystem function at the Mingulay Reef Complex, Scotland
Lea-Anne Henry and J. M. Roberts

NOAA initiates deep-sea coral research in the southeastern United States under the Deep Sea Coral Research and Technology Program
A. David, T. Battista, G. Sedberry, A. Shepard, J. Tomczuk and Thomas Hourigan

Cold water corals exhibit $CaCO_3$ precipitation comparable to their tropical congeners – but only in situ
Carin Jantzen, J. Laudien, V. Häussermann, G. Försterra and C. Richter

Effects of a higher CO_2-level on the reproduction of *Lophelia pertusa*
Johanna Järnegren and S. Brooke

Whole genome sequencing of the cold-water coral *Lophelia pertusa* and sea anemones
Steinar D. Johansen, Å. Emblem, B. O. Karlsen, I. Urbarova, J. Evertsen, O. M. Seternes and T. Moum

In situ study of survival and growth of transplanted fragments of cold-water coral *Lophelia pertusa* in Swedish waters
Lisbeth Jonsson, M. Dahl, S. Strömsberg and T. Lundälv

Fish associated with cold water coral and sponge habitats, northern Norwegian continental shelf
Tina Kutti, J. H. Fosså and O. A. Bergstad

Cnidarian and Echinoderm faunas associated with deep rhodolith beds in Campos Basin, Brazil
Livia L. Loiola, R. C. M. Arantes, R. B. de Moura, C. A. M. Barboza and M. P. Curbelo Fernandez

Taxonomy of octocoral family *Plexauridae* in the deep-sea
Vanessa B. Lovenburg and M. Taylor

Coral-dominated assemblages and associated fishes on the Pourtalès Terrace, Florida Keys, USA
Charles G. Messing, A. W David, S. Farrington and J. K Reed

First report of deep-water non-scleractinian corals from Ampère Seamount (North Atlantic)
Tina N. Molodtsova, S. Christiansen, S. Vargas and B. Christiansen

Black corals (Anthozoa: *Antipatharia*) of the Hatton Bank (North Atlantic)
Tina N. Molodtsova, F. Javier Murillo and P. Durán Muñoz

Unrecognised diversity and interesting biogeographic patterns in two octocoral genera
Kirrily Moore

Genetic connectivity among populations of the squat lobster, *Eumunida picta*, associated with *Lophelia pertusa* reefs in the western Atlantic Ocean
Cheryl Morrison Rauch, D. K. Coykendall and M. S. Nizinski

Cold water coral occurrence in the Eastern Ionian Sea based on experimental long line fishery
Chryssi Mytilineou, A. Anastasopoulou, C. Smith, K. Papadopoulou, G. Christidis, K. Dogramatzi, S. Kavadas and A. Siapatis

Is *Isidoides* a bamboo coral? Evidence from DNA phylogenies, mitochondrial gene order and morphology
Eric G. Pante, E. N. Heestand and S. C. France

A global approach to the study of endemism on seamounts: the case of *Chrysogorgia*
Eric G. Pante, S. C. France and S. Samadi

Spatial patterns in the colonization of gold coral (*Gerardia* sp.) across the Hawaiian Archipelago
Frank A. Parrish

Interactions of deep sea benthic fish and cold-water corals from bathyal habitats in the Azores (NE Atlantic)
Filipe M. Porteiro, J. N. Pereira, C. Pham, F. Tempera, G. Menezes, A. Henriques, T. Morato and R. S. Santos

Are cold-water corals important habitat for fish? A further analysis of the Irish case
Giulia Prato, A. Rengstorf and A. Grehan

Community phylogenetics of octocorals in the deep Gulf of Mexico, with notes on the evolutionary relationships of their ophiuroid associates
Andrea M. Quattrini, W. Cho, T. M. Shank, C. Doughty, R. Falco and E. Cordes

A preliminary reconstruction of phylogenetic relationships among deep-sea octocorals from the Azores (NE Atlantic) based on mtDNA sequence data
Pedro A. Ribeiro, A. Raposo, A. Braga-Henriques, V. de Matos, I. Sampaio, F. Porteiro and R. Serrão Santos

An unusually shallow and productive deep-water coral community discovered off the southeastern United States coast
Steve W. Ross, S. Brooke and A. Quattrini

Catalogue and identification guide of deep-sea Alcyonacea of the Azores archipelago (NE Atlantic)
Íris, I. S., Sampaio, J. R. Xavier, O. Ocaña and F. M. Porteiro

***Serpula/Madrepora* (serpulid/coral) bioconstructions in deep-water settings from the Adriatic Sea (Mediterranean)**
Rossana Sanfilippo, A. Rosso, A. Vertino, L. Beuck and A. Freiwald

Evidence of bioerosion by echinoids in deep-sea coral habitats of the Northeast Atlantic
Angela Stevenson and C. Rocha

Molecular systematics of precious corals (*Coralliidae*: *Octocorallia*)
Tzu Hsuan Tu, C. F. Dai and M.-S. Jeng

Community recruitment and coral transplantation in the Santa Maria di Leuca cold-water coral province (Mediterranean): a pilot study
Agostina V. Vertino, A. Rosso, R. Sanfilippo, L. Beuck, E. Le Guilloux and D. Basso

Exploration of mesophotic coral reef ecosystems in the Northwestern Hawaiian Islands
Daniel Wagner, R. K. Kosaki, K. A. Gleason, C. Kane, G. B. McFall, R. C. Boland, Y. P. Papastamatiou and R. L. Pyle

Southern Ocean Corals: Surprising diversity and abundance.
Rhian G. Waller, L. F. Robinson, K. Scanlon and the NBP11-03 Science Party

Recent progress in our understanding of the distribution of Black Corals (*Anthipatharia: Anthozoa: Cnidaria*) throughout the North Atlantic
Vonda E. Wareham, T.N. Molodtsova and D. Opresko

The carbon budget of *Lophelia pertusa*: the importance of determining multiple parameters in stressor studies
Laura. C. Wicks, S. Hennige and J. M. Roberts

Microsatellite genetic characterization of *Lophelia pertusa* populations from Campos and Santos Basins, Rio de Janeiro, Brazil
Carla Zilberberg, P. O. Marques, L. Peluso, J. A. Marques and V. Tascheri

THEME 2 - POSTERS

First insights into physiological responses of the cold-water coral *Lophelia pertusa* towards isolated and combined effects of ocean acidification and rising temperature
Janina Büscher, A. Form and U. Riebesell

Coral gardens in the Bay of Biscay (NE Atlantic)
Jaime Davies, B. Guillaumont, I. van den Beld, C. Bayle and S. Arnaud

Mapping coral and sponge habitats in a shelf-depth coral-rich environment, Learmonth Bank, Northern British Columbia, Canada, using multibeam sonar and ROV video observations
Barbara De Moura Neves, C. Du Preez, E. Edinger and S. Robinson

Low pH and the role of endolythic algae in CWC
Günter, GF Försterra, V. Huessermann, C. Mayr and C. Jantzen

Uptake rates of dissolved organic matter by four cold-water coral species from the Cap de Creus canyon (northwestern Mediterranean)
Andrea Gori, C. Orejas and C. Ferrier-Pagès

A preliminary description of the Arc Mounds, a province of mid-sized carbonate mounds on the south-west Porcupine Bank.
Anthony J. Grehan, J.F. Bourillet, B. Loubrieu, A. Rengstorf, G. Duffy and F. Stapleton

Overview of CWC mounds in the Eastern Alboran Sea (Western Mediterranean)
Claudio Lo Iacono, E. Gràcia, M. Comas, R. Bartolomé, R. G. Booth and J. Dañobeitia

Set up of in situ mark and recapture technique to assess cold water coral growth process
Franck Lartaud and N. Le Bris

"Squires' Coppice" revisited
*K. Mackay , H. Bostock and Ashley Rowde*n

Acoustic and visual seabed classification of a deep-water *Oculina varicosa* coral reef offshore southeast Florida, USA
Amanda Maness, N. Grindlay and A. Shepard

Response of four species of Mediterranean cold-water corals exposed to a future low-pH scenario
Juancho Movilla, A. Gori, C. Orejas, Á. López-Sanz, J. Grinyó, C. Domínguez, E. Calvo and C. Pelejero

Acclimatisation of key physiological processes in the cold-water corals *Lophelia pertusa* and *Madrepora oculata* over their ambient temperature range
M. S. Naumann, C. Orejas and C. Ferrier-Pagès

Post glacial hummocky biogenic (coralline algae) formations in South Cyclades, Greece
Fani Papakosta, T. Hasiotis and A. Paleokrassas

Habitat characterisation of deep-water coral on the Aviles Canyon's system (Cantabrian Sea)
Francisco Sanchez, F .Sánchez, M. Gomez-Ballesteros, C. González-Pola, J. Cristobo, A. García-Alegre, A. Muñoz-Recio, S. Parra, M. Druet, P. Ríos and A. Serrano

Multi-scale spatial distribution and characterization of CWC habitats in the northern Ionian sea
Alessandra Savini, A. Vertino, F. Marchese, L. Beuck, B. Loubrieu, C. Corselli, A. Freiwald, K. Olu, J. Sarrazin and M. Taviani

Benthic Habitat Mapping and Characterization of *Lophelia pertusa* Bioherms and Associated Sessile Invertebrates
April E. Zilg, S. W Ross and S. D. Brooke

THEME 3 - POSTERS

Taphonomy of *Desmophyllum dianthus* in a coral graveyard, Orphan Knoll, NW Atlantic Ocean
Aurelien Blenet, A. Poirier, E.Edinger, B. Ghaleb and C. Hillaire-Marcel

Geochemistry and age distributions of Stylasterid corals from the Southern Ocean
Madeleine R. Bryant, L. F. Robinson and B. Rosenheim

The εNd of ocean circulation as we know it? Changes in the deglacial NW Atlantic from deep sea corals
Kirsty C. Crocket, T. van de Flierdt, L. F. Robinson and J. F. Adkins

Under the skin: the internal structure of coldwater coral reefs; Pen Duick Escarpment compared to Rockall Trough
Henk de Haas, F. Mienis, T. C. E. van Weering, H. de Stigter, C. van der Land, M. Tokarev, M. Ivanov and A. Gorban

'Accumulation rates and characteristics of shallow inshore *Lophelia pertusa* cores from the Mingulay Reef Complex'
Mélanie Douarin, M. Elliot, J. M. Roberts, S. R. Noble, D. Sinclair, L.-A. Henry, D. Long and S. G. Moreton

Small-scale sediment accumulation dynamics within a cold-water coral mound – a case study from the Mauritanian margin
Markus Eisele, J. Titschack, F. Mienis, C. Wienberg, N. Frank, D. Hebbeln and A. Freiwald

Depth-Age Distribution of Solenosmilia corals from South/Southeast Tasmania
Stewart J Fallon, R.E Thresher and J. Adkins

High productivity during the Late Pleistocene and Early Holocene triggered intense cold-water coral growth in the Alboran Sea (western Mediterranean Sea)
Hiske G. Fink, C. Wienberg, R. De Pol-Holz, P. Wintersteller and D. Hebbeln

Norwegian Sea acidification and ventilation during the past four decades recorded in cold-water coral *Madrepora oculata*
Cecile Gonzalez-Roubaud, N.Tisnerat, L. Bordier, P. Louvat, J. Gaillardet, D. Blamart, J. Hall-Sencer; N. Frank, A. Juilliet-Leclerc and E. Douville

Comparative geochemical study of two cold-water coral systems in the Bay of Biscay: Pajès Escarpment (off-shore Gijón, Spain) versus St. Nazaire Canyon (off-shore La Rochelle, France).
Helen Hamaekers, A. Foubert, A. De Cleyn, E. Vassilieva, A. Rüggeberg, S. Flögel and R. Swennen

Trace element records from deep-sea black corals
Aimée F. Komugabe, S. Fallon, S. Eggins, R. Thresher and C. Alibert

Major and trace elements in recent cold-water corals from the Azores archipelago
Soraya. Marali, M. Wisshak, M. López Correa, P. Montagna, M. McCulloch and A. Freiwald

Gulf Stream variability at Cape Lookout, North Carolina
Anja Pedersen, F. Mienis, M.-S. Seidenkrantz, A. Fischel, N.Frank and D. Hebbeln

Deep sea coral record of Rhenium variability over the last millennia
Nancy G. Prouty, E. B. Roark, A. Koenig and D. Selby

Intermediate water Δ14C off Brazil between 3-40 ka BP
Mario Ruckelshausen, R. Kowsmann, G.M. Santos and A. Mangini

COCARDE: new view on old mounds – an international network of carbonate mound research
Andres Rueggeberg, A. Foubert, A. Vertino, D. Van Rooij, S. Spezzaferri, J.-P. Henriet, and the COCARDE Science Community (http://www.cocarde.eu/participants)

Drilling carbonate mounds in shallow and deep time: Puebla de Lillo Carbonate Mound Drilling (LIMO-DRILL)
Elias Samankassou, A. Foubert, J. Bahamonde, A. Rüggeberg, P. Lapointe, C. Dullo and J.P. Henriet

Origins of coral diversity in Southeast Asia
Nadiezhda Santodomingo, Kenneth Johnson, Willem Renema and the Throughflow Project

Recent benthic foraminifera from cold-water coral substrates of Rockall and Porcupine Bank, NE Atlantic Ocean
Gino G.B. Smeulders, H. de Stigter, K. Koho, F. Mienis, H. de Haas and T. van Weering

Reappearance of deep-sea corals around the Faroe Island in association with oceanographic changes during the Medieval Warm Anomaly
*Francisca Staines-Urias, M.-A. Sicre, A. Kuijpers and C. Morig*i

Keeping up appearances: The effect of preservation technique on the geochemical signature of bamboo corals.
Kelly M. Strzepek, R.E Thresher, A. Revill, C. Smith, R. Leeming and S.J. Fallon

Mediterranean Scleractinian corals: from Miocene to present
Agostina Vertino and Jarosław Stolarski

The Great Wall of(f) Mauritania: Cold-water corals in an upwelling region
Claudia Wienberg, L. Beuck, A. Freiwald, M. Taviani, J. Titschack, N. Frank and D. Hebbeln

THEME 4 - POSTERS

Are there any deep sea corals living in the Croatian part of the Adriatic Sea?
Tatjana Bakran-Petricioli, D. Petricioli, M. Taviani and Z. Vukić

Examining interactions between fisheries and coral areas in Icelandic waters using high resolution effort estimated from electronic logbook and VMS data.
Julian Burgos and S.Á. Ragnarsson

Assessment of sediment resuspension on deep-sea coral communities due to submarine pipeline installations off Brazilian coast (SW Atlantic)
Guarani de Hollanda Cavalcanti, M.P. Curbelo Fernandez, V. Pires Ribeiro Ferreira, D. Leite Moreira and R.C. Mikosz Arantes

Biomarker identification and monitoring of oil exposed cold-water *Lophelia pertusa* Coral
D. Katharine Coykendall, C. Morrison Rauch, S.W. Ross and S. Brooke

Policy driven fundamental coral research can lead to useful applied outcomes: the example of the EU FP7 CoralFISH project
Anthony Grehan

NOAA's Deep-sea coral and sponge research program on the West Coast of the United States
M. E. Clarke, M. Yoklavich and T.F. Hourigan

Working amongst DWCRs off mid Norway
Martin Hovland and L.P. Myhre

New evidence underpinning the North-West Rockall Bank candidate Special Area of Conservation (cSAC)
Fionnuala McBreen, N. Golding, V.A.I. Huvenne, B.J. Bett, D. Jones, K. Robert and S. McPhail

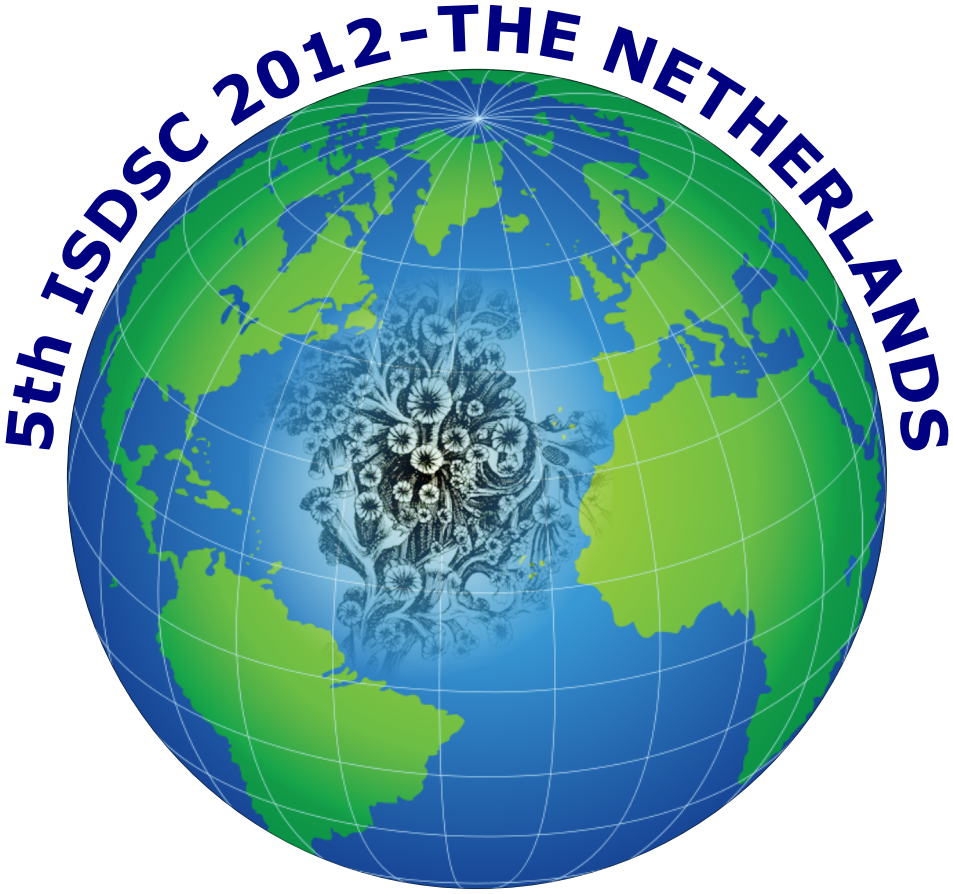
Age and growth of habitat-forming *Solenosmilia variabilis* – an assessment of recovery potential
H. Neil, Di Tracey, M. Clark and P. Marriot

Expanding oil and gas exploration into areas with unique cold-water coral ecosystems
Marianne M.N. Nilsen, T. Baussant and B. F. Godala

The impact of bottom longline on cold-water coral communities
Christopher K. Pham, T., Morato; T. Bento; A. Braga-Henriques; V. Matos; J.N. Pereira; F. Porteiro; I. Sampaio; R.S. Santos and F. Tempera

The Government of Canada's Coral and Sponge Web Application
Jason M. Simms and M. Gullage

Cold-water coral reef habitat restoration within the Koster Sea National Park, Sweden.
Susanna M. Strömberg and L.G. Jonsson



ABSTRACTS
MONDAY 2 APRIL

9.40-10.10 [KEYNOTE]

Biodiversity in cold-water coral ecosystems – The role of ecological succession and habitat complexity

Pål Buhl-Mortensen[1] (paalbu@imr.no)

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Most cold-water corals occur on hard or mixed substrates in areas with relatively strong currents. They create habitats with complex architecture reaching decimeters to meters above the seabed. Such habitats can be defined at different spatial scales both within and between colonies. Within the colonies, microhabitats are characterized by different water flow, food supply and substrates. Sheltered cavities within a colony often contain organic-rich sediments, while the outer or upper parts have a high water flow with little sedimentation. By continuous skeletal growth, corals also offer substrates of different age. Gorgonian corals may occur in stands termed coral gardens. *Primnoa resedaeformis* and *Paragorgia arborea* are the most abundant and widely distributed large gorgonians in the North Atlantic, but many more species contribute to coral gardens. Scleractinian colonies growing at one site for hundreds of years transform the bottom to a cover of skeleton fragments via alternating growth, death and fragmentation. Such areas are termed coral reefs. In the Atlantic the most common reef forming species is *Lophelia pertusa*. Cold-water corals offer at least five different microhabitats within the colonies: (i) surface of live tissue, (ii) inside of live tissue, (iii) surface of exposed skeleton, (iv) cavities inside skeleton, and (v) free space between branches. Except for the live tissue, many similar microhabitats can be found on bottoms without corals. Cold-water coral reefs commonly display vertical zones, with living coral at the top and skeletal fragments at increasing stages of decay towards the bottom of the reef.

The majority of coral-associated species are commensals not directly depending on the living corals. The diversity of species associated with cold-water corals is lower for gorgonians than for scleractinians. However, most of the few specialised and obligate symbionts associated with gorgonians and othe octocorals. These are connected to the live parts of the corals. Among these are endo and ecto parasitic copepods, presumed to feed on coral coenenchyme.

The gorgonian-associated fauna is dominated by crustaceans (particularly amphipods), and ophiuroids. Bryozoans and polychaetes are the most diverse groups on the reefs. The abundance and diversity of the associated fauna are significantly correlated with host morphology (i.e. number of branches) and area of exposed skeleton. In the reefs the highest diversity is found with dead coral skeleton. The live tissue seems to prevent attachment of sessile epibiotic species. Even among the few mobile species found intimately associated with living coral polyps, there are few, if any, examples of obligate relationships. However, many of these species are seldom found in other habitats. The composition of associated species is clearly different in the micro-habitats of cold-water corals. More studies on the fine-scale distribution of species within coral habitats are needed to better understand the environmental requirements of the species and the structure and functioning of the coral community. The occurrence of age gradients in coral habitats may allow us to separate the effects of succession from the environmental differences related to microhabitats.

10.10-10.25

Deep-Sea Coral Ecosystems Off the Southeastern United States and in the Gulf of Mexico: Research Progress and Future Directions

Steve W. Ross*[1] *(rosss@uncw.edu) *and Sandra D. Brooke*[2]

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Research on deep-sea corals (DSC) has expanded greatly in US waters, especially off the southeastern US (SEUS) and in the Gulf of Mexico (GOM) driven largely by several targeted federal programs. As of 2000, knowledge of these habitats was represented by a few geological papers and very limited information on coral locations. Since then, it has become apparent that the continental slope from off North Carolina through the Straits of Florida (370-1000 m) contains thousands of coral (dominated by *Lophelia pertusa*) mounds/ridges, ranging from a few meters to over 150 m tall. In addition to mound building, many species of deep corals also colonize emergent rocky substrata. Where conditions allow, a few deep-coral sites exist in shallower waters (180-220 m) off the SEUS. These coral species also occur in the GOM (300-1000+ m) from the north-central region to off West Florida; however, coral banks are more scattered and seem to cover less area in the GOM. Recent evidence suggests that coral habitats on the West Florida slope may be the most extensive in the GOM. DSC support high biodiversity of associated fauna, including many undescribed and newly described species, and some fauna (especially fishes) appear to have an obligate association with these deep reefs. GOM *L. pertusa* are somewhat genetically separated from those off the SEUS, which in turn are somewhat isolated from those of the northeastern Atlantic. In recognition of their ecological value and vulnerability, four huge protected areas were created off the SEUS (July 2010). We will review recent DSC research progress, information gaps, management activities, and future studies.

10.45-11.00

The hard, the soft, and the black of azooxanthellate corals: Diversity and distribution in the Colombian Caribbean

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During the last decade, the knowledge of azooxanthellate corals in the Colombian Caribbean has been increased through the exploration campaigns by INVEMAR. The distribution of 140 species of corals, including hard corals (Scleractinia 62 species), black corals (Antipatharia 18 species), and soft corals (Octocorallia 60 species) was statistically analyzed to determine its relation to a geographic gradient (132 stations) and a bathymetric range (20-520 m depth). Five principal patterns were observed: 1. Northeastern (54 species) 2. Southwestern (24 species), 3. Insular (3 species) 4. Widespread (59 species), and 5. Exclusive to deep-sea coral communities (26 species). Two main oceanographic factors were identified to play a role in the separation of the fauna (northeastern vs. southwestern): La Guajira upwelling system and the Magdalena River influx. These patterns are depth-related, since mainly the shallow water fauna exhibit the separation northeastern/southwestern, whereas most of the deep-water (below 200 m depth) species are widely distributed along the Colombian Caribbean. These data were also analyzed from a conservation perspective in order to propose new strategies to protect the coral fauna. Ongoing research will contribute to fill gaps of information in remote insular areas and deeper habitats (below 500 m).

11.00-11.15

Deep-sea soft mushroom corals (Octocorallia: *Alcyonidae*) from the North Atlantic

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Members of the genus *Anthomastus* generally known as "deep-sea soft mushroom corals" are easily distinguished by striking and very characteristic appearance, recognized even on underwater images. Photographs of red colonies with huge expanded autozooids can be found in modern colorful books about the deep-sea. Species of *Anthomastus* were reported from different localities in the bathyal zone of the world Ocean. Up to date, 27 nominal species have been described or ever considered in the genus *Anthomastus*. At the same time, most of deep-sea soft mushroom corals reported from the North Atlantic were assigned to only one species, *Anthomastus grandiflorus* Verrill 1878. The aim of the present work was to revise the North-Atlantic group of species of *Anthomastus* and to examine collection of deep-sea soft mushroom corals from the northern Mid-Atlantic Ridge and adjacent areas. Study of the type material of *Anthomastus grandiflorus* Verrill, *A. agaricus* Studer, *A. canariensis* Write & Studer, *A. purpureus* (Koren&Danielssen) and *A. agassizi* Verrill proved that each of these species has to be considered as valid. The type material of *Pseudoanthomastus inusitatus* Tixier-Durivault&d'Hondt and *Heteropolypus insolitus* Tixier-Durivault gave an opportunity to re-evaluate the scope and diagnoses of the genera *Heteropolypus* and *Pseudoanthomastus*. In the material collected from the northern Mid-Atlantic Ridge, four species of deep-sea mushroom corals belonging to the genera *Anthomastus*, *Heteropolypus* and *Pseudoanthomastus* were found, including two species new for science. Patterns of vertical and geographical distribution of the North Atlantic deep-sea soft mushroom corals were analyzed. Functional morphology of di- and three-morphic alcyonarians and cases of development of dimorphic colonies in different taxa of deep-sea corals are discussed.

11.15-11.30

Deep cold-water corals as nurseries for fish larvae

***Sandrine Baillon[1] (sbaillon@mun.ca)**, J-F. Hamel[2], V. E. Wareham[3] and A. Mercier[1]*

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It is well known that deep cold-water corals (CWC) are biodiversity hotspots and vulnerable to anthropogenic disturbances, and that many fish populations have undergone drastic declines. While linkages between CWC and fishes are suspected from correlative evidence, whether CWC represent an essential fish habitat (EFH) supporting commercial fisheries remains uncertain because proof of a functional connection is missing. Here we provide unprecedented evidence of the utilisation of deep CWC by fish larvae. Hundreds of fish larvae were found in soft coral colonies collected around Newfoundland between 2005 and 2010. Most larvae were at an early stage of development (<8 mm, with and without yolk sack) and tucked deeply within the corals. From a detailed study of pennatulacean corals, prevalence and/or yields of fish larvae was determined to vary with host species, depth, location and size of the colony. Evidence of the role of CWC in the early life history of fishes provides one of the strongest arguments yet for the preservation of CWC as EFH.

11.30-11.45

Associations and functional links between tusk and cold water coral and sponge habitats examined by experimental long-line fishing

***Jan Helge Fosså[1] (jan.helge.fossaa@imr.no)**, Tina Kutti[1], Kristin Helle[1] and Odd Aksel Bergstad[1]*

[1] Institute of Marine Research, Norway

The role of cold water coral as habitat for fish was examined by conducting experimental long-line fishing in the Traena coral field, northern Norwegian shelf break. In the 20*30 km large study area 1400 tailed *Lophelia* reefs are present and large areas are occupied by sponge-beds. Depth ranges from 250 to 400 m. The observational study was carefully planned and included fishing in multiple pairs of coral, sponge-bed and control plots what were dispersed in space and sampled with the same intensity at two periods in times. The objective was to quantify the proportion of the commercially exploited demersal fish populations that utilize cold water corals as habitats and to collect information on the functional role of these habitats for fish. Mainly tusk was caught in the study area, composing on average 80 and 70% of the total catch in 2009 and 2010 respectively. The catches of tusk were twice as high in March 2010 as compared to June 2009. In both years the CPUE (catch per unit of effort) of tusk was highest in the most complex habitat (high density of cold water corals and sponges) and lowest in the unstructured plain sea-bed habitat. The variability in the CPUE in replicate lines and plots was, however, high and no statistical significant differences in tusk abundance in different habitats were found. The overall abundance of tusk in Traena was similar to that observed in coral areas off the shelf break in south-western Norway (i.e. 50 ind. 1000 hooks-1) but 25% higher than that estimated from log book data for the ICES statistical rectangle IIa where the study area is located. The associations with complex habitats did not seem to increase the fitness of the fish as evidenced by the weight and length data. Stomach content analysis showed that the dominant prey item of tusk was the squat lobster *Munida sarsii* in all habitats examined, however, tusk had been feeding on a wider range of prey and the proportion of empty stomachs was lower in structurally complex habitats as compared to the plain sea-bed habitat. This study confirmed that tusk on the Norwegian shelf shows a slight preference for inhabiting structurally complex habitats such as cold water coral environments. Tusk is a top predator and is mainly energetically linked to the coral reefs where it will experience enhanced feeding possibilities due to a higher abundance of its main prey item (*M. sarsii*) and a higher diversity of prey.

11.45-12.00

The link between cold water corals and fish, examples from across Europe – Observations from a baited photographic lander

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[1] University of Aberdeen, Scotland

It is well recognised that there is need for information on the interaction between fish and cold water coral habitats in order to develop ecosystem based management in the deep waters of Europe and beyond. Oceanlab's BRIL (Biogenic Reef Ichthyofauna Lander) was designed specifically to study how deep reef forming corals can influence fish assemblages. By deploying BRIL in reef and non-reef areas; comparisons can be made between fish species assemblages, localised abundance and fish size. BRIL is an autonomous lander consisting of a downward facing camera suspended above a baited reference cross. High quality images of the organisms attracted to the bait are taken every minute for approximately 24 hours. Additional environmental data such as water current, temperature, pressure and conductivity are also collected. BRIL has generated a unique dataset after deployments in four distinct European sites: Eastern Norwegian Sea, Northern Norway; Porcupine Seabight/Rockall Trough, Atlantic Ocean; The Bay of Biscay, Atlantic Ocean and Ionian Sea, Mediterranean. These sites, intended as representative of the variation seen in European cold water reefs, may allow comparison not only between reef and none-reef habitats but also between Europe's reefs. This presentation will outline the findings of these lander deployments at the site level and discuss overall trends in the corals impact on fish assemblages. This research forms part of the EU FP7 CoralFISH project.

12.00-12.15

Reproduction of deep-sea coral reef builders from the South-Western Atlantic

Débora de Oliveira Pires*[1] *(debora.pires@coralvivo.org.br), *Joana Cordeiro da Silva*[1] *and Nathalia Dias Bastos*[1]

[1] Museu Nacional/Universidade Federal do Rio de Janeiro, Brazil

The deep-sea logistics imposes restrictions to studies that require repetitive long-term collection. Thus, studies on reproduction of deep-water corals have commonly been made without appropriate temporal series. This may lead to erroneous interpretations due to an inadequate number of samplings. This fact can especially compromise approaches on the timing of the reproductive cycles. This study included *Madrepora oculata*, *Solenosmilia variabilis*, *Lophelia pertusa*, and *Enallopsammia rostrata*, which are among the main deep-sea coral habitat builders off Brazil. Samples were collected in Campos Basin, off Rio de Janeiro State (22°S, 040°W), in thirteen consecutive months, in the scope of the "Deep Sea Coral Assessment Project", conducted by the R&D Center of the Brazilian Energy Company (Petrobras), through ROV, at approximately 600 m depth. Different colony fragments of the studied species were investigated through histology. Colonies of both sexes were seen, indicating that all four species are gonochoric. So, for now, this appears to be the predominant reproductive pattern observed in corals in the area, as well as in deep-sea corals in general, where 80% of coral species are gonochoric. However, our samples showed some exceptions in *M. oculata* and *L. pertusa*, which presented a few colonies with different hermaphroditism patterns. Such findings indicate this condition could be more common in nature than expected. *E. rostrata* and *M. oculata* presented continuous reproduction. Although fertile year-round, *Solenosmilia variabilis* seems to present a reproductive peak between April and September (Autumn to Spring). On the other hand, *Lophelia pertusa* had a seasonal reproduction, confirming previous observations on this species of periodic reproduction in the North-East Atlantic. The possible spawning season of *L. pertusa* from Campos Basin concentrates between May and July (evidenced by high frequency of mature male and female gametes), while in the North-East Atlantic apparently is on February. Determination of seasonal phytodetritus fluxes would be important to infer the association or not of this phenomenon with the reproductive peak of species in the Campos Basin. Our results suggest that all studied species are broadcast spawners, since no embryos or larvae were observed in any examined sample. Gonochorism and external fertilization were also previously suggested to occur in other sympatric species, the octocoral *Anthoptilum murrayi*. All species have large oocytes suggesting the production of lecitotrophic larvae.

12.15-12.30

Differences in timing of reproductive cycles in *Lophelia pertusa* from the eastern and western North Atlantic Ocean

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Between 2002 and 2010, samples of *Lophelia pertusa* were collected from the Trondheim Fjord in Norway (eastern North Atlantic) and in the western North Atlantic off the southeastern US coast (SEUS) and in the Gulf of Mexico (GOM). Reproductive cycles of *L. pertusa* from these areas were examined using standard histological techniques. Analysis of oocyte diameter indicated a difference of several months in the timing of gametogenesis between samples from the eastern and western North Atlantic. Populations of *L. pertusa* from Norway initiated oogenesis in January and completed the spawning cycle in February the following year. Populations in the SEUS and GOM contained small oocytes in November and spawned in October. Environmental data (physical and biotic) will be compared between the two regions and correlations made with the timing of reproduction in each region. Con-specific populations from different locations that show such marked differences in reproductive cycles provide a rare opportunity to investigate the factors that influence the timing of reproduction in deep sea species. Considering this reproduction timing offset between regions, examination of *L. pertusa* from other areas is important to determine the degree of reproductive variability, which may have a significant impact on recruitment and population structure.

13.30-14.00 [KEYNOTE]

A Deepwater emerged species in the Alaskan Fjords: Reproduction and development of Red Tree Corals.

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The Southeastern Alaskan fjords are one of the great fjord regions of the world, formed through large-scale oceanographic processes and complex geological formations, they provide a diverse array of marine habitats. The slenderness of the continental shelf and the deep passageways threading through the area may also make connections between offshore and inshore waters more likely. Indeed a number of species usually found deep in the Gulf of Alaska are found shallower than their normal distribution, including a recently discovered population of Red Tree Corals, *Primnoa pacifica*. The term 'Deepwater Emergence' has been used to describe this phenomenon, though the environmental factors that allow species to survive much shallower than their usual distribution (often by thousands of meters) are not yet fully understood.

In Alaska in particular, cold-water coral areas are considered Essential Fish Habitat (EFH) and five deep-water areas of Red Tree corals off southeast Alaska have already been identified as 'Habitat Areas of Particular Concern' (HAPC). These corals form habitat for commercially important rockfish (*Sebastes aleutianus*, *S. borealis* and *S. ruberrimus*) as well as juvenile crabs, and can form massive stands, 2-3m in height. They are also exceptionally slow growing, living for over 100 years, leading to slow recovery from extensive fisheries damage in the Gulf of Alaska. The relatively recent discovery of dense thickets (over 100 colonies) of *P. pacifica* at shallow depths (~20-100 ft) within Southeast Alaskan fjords presented a unique opportunity to examine the reproductive biology of this species on a seasonal basis, a study unachievable within their more common 150-900 m depth range, yet would provide information vital to the management of this species.

Thirty-eight colonies of Red Tree corals were tagged in September 2010 and sampled approximately every 3 months until January 2012 for reproductive histology and ultramicroscopy. In addition a Star Oddi temperature/salinity probe and Sontek-Argonaut current meter were deployed at the sample site, and CTD's taken every sampling season. Results of this study show prolonged continuous reproduction, low fecundities and novel protected development – life history strategies more concurrent with K-strategists. Yet paradoxically, the environment they inhabit, a fjord with two tidewater glaciers, is highly unstable over relatively short time scales (tens of years in this area), potentially making these thickets ephemeral populations. The life history traits observed also make this species particularly susceptible to mechanical damage from fishing gear, which might crop colonies and result in even lower fecundities, affecting natural population turnover.

14.00-14.15

DNA barcoding reveals high diversity of Hawaiian deep-sea octocorals

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Globally, studies of deep-sea octocoral distribution and diversity have been hampered by a lack of keys and a plethora of unidentified specimens. Even in areas where intensive morphological work has been done, as many as half of the specimens remain unidentified to species or even genus. Recently, a suite of genetic markers have been identified as barcoding proxies for octocorals. Here, we make one of the first attempts at broad-scale application of 3 of these markers, to recent and museum collections of octocorals of approximately 1000 specimens from the Hawaiian Archipelago, to gain a better understanding of the diversity and distribution of deep-sea octocorals there. Sequence results for all 3 markers show a greater number of haplotypes than morphological species. Each of these markers as taken alone has been shown to underestimate species richness. Extrapolating from this we show that morphological work to date on these specimens underestimates species richness by 30-40%, suggesting the diversity of octocorals in the Hawaiian Archipelago is substantially greater than previously thought. The large percentage of haplotypes represented by single individuals suggests that the full diversity of deep-sea octocorals in Hawaii remains drastically undersampled. This work also shows that species ranges based on current species designations are overestimated, with multiple smaller-range haplotypes for given morphological operational taxonomic units. We evaluate these results to assess the usefulness of application of these markers to understanding deep-sea coral distributions in the broader Pacific and beyond.

14.15-15.00

Genetic connectivity among natural *Lophelia pertusa* reefs and shipwrecks in the Gulf of Mexico

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In the Gulf of Mexico (GOM), the cold-water coral *Lophelia pertusa* forms extensive reefs at relict cold seep sites where authigenic carbonates serve as a substrate for larval settlement. Given the ties between hydrocarbon seeps and oil reserves, *L. pertusa* reefs are especially vulnerable to oil industry activities in the GOM. Knowledge of the degree to which populations are connected through larval dispersal is imperative to effective management and mitigation efforts. An initial study identified genetic structuring at a broad geographic scale (the North Atlantic Ocean), with GOM populations distinct from western and eastern North Atlantic and New England Seamount populations. In the present study, improved sampling of GOM *L. pertusa* populations allows for a more thorough examination of connectivity patterns. Using twelve microsatellite DNA markers and over 400 samples, we assessed the spatial scale and pattern of genetic connectivity across six natural *L. pertusa* reef localities that span 900 km in the GOM, as well as colonies inhabiting three anthropogenic structures, the shipwrecks Gulfpenn, Gulf Oil and Ewing. Population genetic analyses indicate weak structuring and moderate gene flow among sampled *L. pertusa* populations in the GOM. It follows that the natural *L. pertusa* communities sampled are important larval sources and may replenish impacted areas with new recruits. Fine-scale genetic structuring was examined at Viosca Knoll, the most extensive and well characterized *L. pertusa* community in the GOM. The extent of asexual reproduction via fragmentation, or degree of clonality, will be contrasted between the Viosca Knoll in the GOM and sites in the eastern North Atlantic Ocean examined previously. Results will be discussed in terms of oceanographic conditions that may influence connectivity and resilience of these unique and fragile ecosystems.

14.30-14.45

Morphometrics in *Desmophyllum dianthus*: a complementary tool for phylogenetic studies

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In the last decade the order Scleractinia has been subjected to a systematics "renovation", due to incongruence between molecular and morphological results. A new multidisciplinary approach, that includes morphological, molecular and distributional data, has proven to be useful to explore and better define taxonomic boundaries within this order. However, the effort has not been uniform, especially for the azooxanthellate cold-water corals, causing a biased view of global biogeographical and evolutionary history of the Scleractinia. When the morphological features are not enough to disentangle the evolutionary history of certain taxa, molecular phylogenies could provide an evidence of the evolutionary events involved, comparing the intra and intergenetic variability to identify patterns of biological diversity. On the other hand, genetically-based studies may not allow us to discriminate morphological variations (phenotypes) in relation to different environmental conditions which can be of extreme importance for paleoecological studies.

Desmophyllum dianthus (Esper, 1794) is an azooxanthellate and solitary deep-water coral. Morphologically it is one of the simplest in skeleton construction but presents several morphotypes which, in the past, have been considered as different species. In this study we combine morphometric and molecular analyses of *Desmophyllum* specimens from different and widely separated geographic areas, focusing on macro- and micromorphological skeletal features. Our goal is to test if the combination of morphometrics and molecular data provides a better understanding of population connectivity and evolutionary patterns within the species *Desmophyllum dianthus*.

14.45-15.00

Stylasterid coral (*Errina spp*.) fields in Antarctica and the Sub-Antarctic.

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The recent discovery of field-like aggregations of the stylasterid coral *Errina spp.* on the Antartic Continental Shelf has highlighted the importance of deep sea coral populations in the Southern Ocean. Subsequently, areas of dense *Errina spp*. populations in the Dumont d'Urville Sea are currently listed as a Vulnerable Marine Ecosystem (VME), with *Errina spp*. listed as VME indicator taxa through The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). This classification recognises that the conservation of these reefs is crucial to maintaining regional biodiversity, and insures that if *Errina spp*. is identified in abundance a VME is established, whereby a 1 nm-radius area is closed to fishers.

Little is known about the diversity and abundance of *Errina spp*. in Antarctica. This paper aims to document our current knowledge on field-like aggregations, by investigating regional morphological and geographical differences among populations. Antarctic samples were collected by beam trawl, or benthic dredge from multiple voyages (CEAMARC, TA0402, TAN0802, NBP 11-04, NBP 11-05, V2, LAMPOS, ANTXIII). DNA sequence data from the ITS-2 was used to determine the degree of genetic differentiation among coral populations to infer connectivity or isolation across two spatial scales 1) between the Ross Sea and the Dumont d'Urville Sea and 2) within the Ross Sea. Morphological investigations where conducted with reference to the Smithsonian Natural History stylasterid collection.

Results of this study suggest both large scale (> 2000km) ocean expanses (Fst = 0.137, P = 0.002) and local scale (10- 73km) seas (Fst = 0.376, P = < 0.001) act as effective barriers to gene flow for *E. fissurata* populations. Genetic and morphological diversity is high in Antarctic and Southern Ocean *Errina spp*. Phylogenetic analysis of *Errina spp*. revealed a possible cryptic species in the Dumont d'Urville Sea. *E. laterorifa* was only present in the Ross Sea and was identified as genetically separate from *E. fissurata*. To increase morphological accuracy we designate a neotype for *E. fissurata* and *E. laterorifa*, as a reference for these species which are morphologically very similar and often occur in sympatry. A photographic key to the genera is compiled for the Antarctica/Sub-Antarctic region to assist researchers, fisheries observers, invertebrate museum curators and aid in future studies on this ecologically important Antarctic genera.

15.00-15.15

Are There True Nearly Cosmopolitan Cold-Water Coral Species?

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Several marine species, particularly from cold-water environments, have apparent widespread and discontinuous distributions. Processes that have been invoked to explain their existence include present day connectivity among populations, small divergence after recent emergence of dispersal barriers, and selective pressures for similar morphologies after speciation. In the case of deep-sea benthic invertebrates a handful of genetic studies have suggested that although long-distance dispersal is possible, hydrographic barriers and distance between suitable habitats often limit the connectivity of populations and generate differences in their genetic composition. Depth has also been identified as an important factor driving population structuring in some taxa. Other variables that have been invoked to explain observed patterns of differentiation among populations of widespread deep-sea organisms include habitat type, larval dispersal mode, species-specific associations and the nature of the genetic marker employed. The presence of cryptic-species complexes has also been detected in various presumed widespread morphospecies. However, the distinction among species sensu stricto, incipient species and structured populations in many deep-sea marine invertebrates remains contentious due to the difficulties in defining the species boundaries for certain groups and to the paucity of the genetic, ecological and taxonomic data available to date. The characterization of geographical and spatial distribution patterns of genetic types is thus a fundamental first-hand approach to identify and understand the processes that shape the ranges of occurrence of marine taxa and that ultimately drive the biodiversity in the deep-sea. A number of cold-water coral morphospecies, including scleractinians, gorgonaceans and antipatharians, are thought to be nearly cosmopolitan, e.g. *Lophelia pertusa*, *Solenosmilia variabilis*, *Madrepora oculata*, *Paragorgia arborea* and *Primnoa resedaeformis*, and many others have apparent trans-oceanic distributions. Previous studies have examined the genetic diversity of some of these taxa in a regional context, suggesting that genetic differentiation does not occur at scales of discrete features such as seamounts or canyons, but at larger scales (e.g. ocean basins). However, to date no studies have evaluated such diversity throughout the entire known distribution of a cold-water coral species. *Paragorgia arborea* (Gorgonaceae: Paragorgiidae) is one of the most prominent coral morphospecies in cold-water sublitoral and bathyal hard-substrate habitats. *P. arborea* has been reported from polar, sub-polar and subtropical regions of all of the world's oceans. This conspicuous and locally abundant coral can grow massive colonies, playing an important ecological role generating habitats for numerous species of associated organisms. We utilized mitochondrial and nuclear genetic variants in a phylogeographic context to examine the compatibility of the *Paragoriga arborea* morphospecies with the genealogical-phylospecies concept by examining specimens collected over its nearly entire known distribution. Global genetic variation revealed basin scale differences, but no significant correlation with depth. These differences are comparable to the intraspecifc levels of genetic variability found in other coral taxa. To explore further these patterns of variation, next-generation sequencing approaches are underway.

15.45-16.00

Octocoral diversity around South Georgia: using genetic techniques to investigate gardens of the deep

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Investigations of by-catch from the Patagonian toothfish longline fishery around South Georgia found octocorals to be the most abundant and diverse animals captured. Unfortunately octocorals are notoriously difficult to identify morphologically by non-specialists. Given the needs of management to understand patterns of diversity in order to protect hotspots, an alternative method of identification was formulated using molecular techniques and verified morphologically.

By-catch octocorals were placed into a wider Octocorallia (excluding Helioporacea) phylogeny to investigate their species richness using a COI+igr1+msh1 gene combination (alongside analyses with igr1 removed). Phylogenetic trees of Octocorallia comprised at least 108 genera and 142-156 species across 28 families.

Analyses consistently resolved three clades within Octocorallia: Clade 1 – Scleraxonia/ Alcyoniina/Holaxonia; Clade 2 – Pennatulacea/Calcaxonia; Clade 3 – majority Calcaxonia. Previous analyses, with a different spread of species, resolved three different clades. The inclusion of igr1 in Bayesian inference analysis placed Pennatulacea towards the base of Octocorallia phylogeny, otherwise the three clades were in a polytomy. Few octocoral families were resolved as monophyletic; this confirms that taxonomic re-evaluations are required across this subclass.

Primnoidae were the family most frequently caught as by-catch around South Georgia and with 11 of the 37 described Primnoidae genera represented (not including 2 new genera), this is the largest genetic study of this family so far. Considering just by-catch, 34 species in 21 genera of octocorals were identified and morphologically verified.

With industry forays into deep-waters expanding in scope, scale and geographically utilising non-empirically collected data, such as fisheries by-catch, and improving identifications and diversity estimates using genetic techniques are methods that can and should be implemented more widely.

16.00-16.15

Connectivity of the octocorals *Eunicella verrucosa* and *Alcyonium digitatum* and its implications for protection of sessile species in the UK MPA network

Lyndsey P. Holland*[1] *(lph204@exeter.ac.uk) *and Jamie R. Stevens*[1]

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Elucidating patterns of connectivity for species of conservation concern is crucial in the design of networks of ecologically coherent marine protected areas (MPAs), such as that recently proposed to the UK Government for implementation in 2012. However, data concerning connectivity are deficient for most sessile invertebrate taxa and proposed MPA networks may not afford adequate protection for such species, especially for temperate or deeper species. Such is the case for two key octocoral species from Britain and northwest Europe: *Eunicella verrucosa* and *Alcyonium digitatum*. Both species are subject to damage via commercial fishing activity, and *E. verrucosa* (deemed 'vulnerable' on the IUCN red list) is one of seven cnidarians highlighted within the UK MPA network design guidelines. *Eunicella verrucosa* is thought to produce lecithotrophic larvae with limited pelagic duration, traits conducive to philopatric settlement and strong population structure. While evidence indicates *E. verrucosa* broadcast spawns in summer, winter broadcasting by *A. digitatum* suggests farther dispersal potential and hence increased gene flow if larvae are subjected to increased hibernal wind driven currents. *Eunicella verrucosa* has an unusually extensive distribution from Angola to western Ireland and a depth within this range spanning epi-mesobenthic zones (4-500m), of which the UK constitutes the most northerly and shallow portion of its range (unlike *A. digitatum*).Therefore we can also explore connectivity of this species within the context of marginal populations at their latitudinal limits, the implications of which are particularly relevant given evidence for a recent northerly range expansion of *E. verrucosa*. We developed novel DNA microsatellite panels for *E. verrucosa* and *A. digitatum* and used their variation to examine genetic connectivity across the range of each species in the NE Atlantic. The microsatellites were developed using an enrichment approach and 82 potential loci for *E. verrucosa* and 54 for *A. digitatum* were screened, from which informative, polymorphic loci were selected for subsequent genotyping. Prior to this research, no genetic assessment of population structure within either species has been conducted. Contrary to our expectations, both species exhibit considerable gene flow regionally and locally, although certain sites exhibit genetic signatures indicative of inbreeding. These data imply that presumed life history traits are unreliable indicators of connectivity, and that genetic data should be incorporated into MPA design and conservation management planning. Moreover, source and sink dynamics may surpass national boundaries and for certain species, UK conservation policy should incorporate foreign populations and legislation.

16.15-16.30

Depth-related speciation patterns in the Ellisellidae (Anthozoa: Octocorallia)

Jaret P. Bilewitch*[1] *(jaret.bilewitch@uqconnect.edu.au) *and Sandie M. Degnan*[1]

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The gorgonian corals of the Ellisellidae (Anthozoa: Octocorallia) are globally distributed and belong to one of the few monophyletic octocoral families, based on congruent morphological and molecular synapomorphies. Within this family, however, the division of taxa into genera (and subgenera) has changed repeatedly throughout its >250-year taxonomic history. The family is currently thought to comprise approximately 100 species in 11 genera, making the taxon a manageable-sized unit for a complete revision. We used DNA sequences of two domains of the mtMutS mitochondrial gene, obtained from specimens in international museum collections, to determine the phylogenetic and systematic relationships of all ellisellid genera and species. This represents the first molecular phylogeny of a complete, monophyletic octocoral family, allowing for further taxonomic revision of the Ellisellidae in its entirety. Ellisellids are of particular biogeographic interest since they occupy a broad bathymetric distribution from sub-tidal zones to near-abyssal depths, with certain species exceeding a 50m-depth range. Within the family, numerous shallow and deep water clades exist in polyphyletic associations with each other, suggesting several ecological expansions from one depth to another over evolutionary timescales. The broad horizontal (geographic) and vertical (depth) distribution of the Ellisellidae allows the examination of depth-related patterns of species diversification across broad spatial and evolutionary scales. Thus, our comprehensive phylogenetic study of this family affords a rare opportunity to bridge an evolutionary and ecological gap between shallow- and deep-sea taxa, whose distributions do not overlap within most other octocoral families. Our molecular reconstruction of the ellisellid phylogeny provides insights into the origins of modern trans-bathymetric patterns through inferences of the depth zone occupied by the most recent common ancestor of the family and lineages within it. We examined the correlation between ancestral depth expansions and lineage-specific genetic diversifications by coding the depths at which extant sampled taxa are found as a continuous variable and subsequently used character state reconstruction methods to predict ancestral bathymetric distributions. The frequency of trans-bathymetric diversifications (shallow to deep water and vice versa) was used to examine the hypothesis that specific bathymetric zones act as refugia of evolutionary diversity. Certain zones could thus foster species capable of recolonizing other depths subjected to biodiversity loss or extirpation events. For instance, the deep-seas may have sheltered relict fauna that contained or produced lineages capable of re-colonizing shallower environs following geologic periods of climatic stress.

16.30-16.45

Assessing connections among populations of the deep sea coral *Desmophyllum dianthus*: a seascape approach

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The deep sea represents one of the last frontiers in marine science. Recent discovery voyages in SE Australia and the Antarctic have revealed an incredible diversity of marine invertebrates at ocean depths, with many seamount communities dominated by deep sea corals. Many of these areas are now designated within Marine Protected Areas (MPAs), recognising the diversity and vulnerability of these deep sea coral communities. The success of MPAs lies in their functioning to maintain networks among protected areas, as well as in their value as sources of recruits to unprotected areas through spillover. However little is known about the nature of connectivity, particularly in the deep sea, nor the potential for larval dispersal out of MPAs into unprotected areas. In this study, we have combined molecular data with dispersal modelling approaches to explore the nature of connectivity among seamount populations of the ubiquitous coral *Desmophyllum dianthus* within and among MPAs in SE Australia and other areas in the Southern Ocean. We found significant genetic subdivision ($FST=0.07$, $p<0.05$) based on microsatellite DNA data among 19 populations of *D. dianthus* from the Tasmanian Seamounts, Cascade Plateau and Macquarie Ridge. While the three geographic areas were genetically distinct, we also found significant genetic differentiation among sites even on the same seamount suggesting deep sea corals, like their shallow counterparts, may well have limited larval dispersal and localised recruitment. Depth was an important driver of differentiation, with coral populations at different depths within the same geographic region significantly subdivided ($FST=0.08$, $p<0.05$). Three dimensional particle dispersal modelling showed that current strength and direction differs considerably between shallow and deep waters around the Tasmanian Seamounts and this may well affect the transport of coral larvae both within and between seamounts and marine protected areas. The identification of genetic structure within a global species such as *D. dianthus* provides insight as to how diversity is being maintained in the deep sea, how it may be affected into the future, and will be an important consideration in management activities including the development of MPAs in the High Seas.

16.45-17.00

When is a bamboo coral not a bamboo coral? A revision of the octocoral family Isididae

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The octocoral genus *Isis* was one of the first octocorals to be described and named. One of its major features was the axial skeleton which consisted of calcareous internodes periodically interrupted by purely organic nodes. This feature was then seen in many subsequent octocorals which were placed in the Suborder Calcaxonia, Family Isididae. There were, however, some other differences between many of these other 'bamboo' corals and the genus *Isis*, especially in the contractility of the polyps, the thickness of the tissue along the branches, and the design and ornamentation of the sclerites. Ultimately the family was divided into four subfamilies based primarily on the morphology and arrangement of the sclerites. Recent genetic work, however, suggests that the various observed morphological disparities are more severe than originally thought, and that the node-internode design of the skeletal axis is a convergent feature. In particular, the genus *Isis*, and probably all members of the current subfamily Isidinae, is not closely related to the other bamboo coral subfamilies or even to other families in the Calcaxonia, but instead belongs in the octocoral Suborder Holaxonia. In addition, the bamboo coral subfamily Keratoisidinae has a mitochondrial genome arrangement and sclerite composition that differs from the remaining subfamilies, so we also propose to elevate each of the subfamilies to family level.

17.00-17.30 [KEYNOTE]

New insights into the diversity of deep-sea corals

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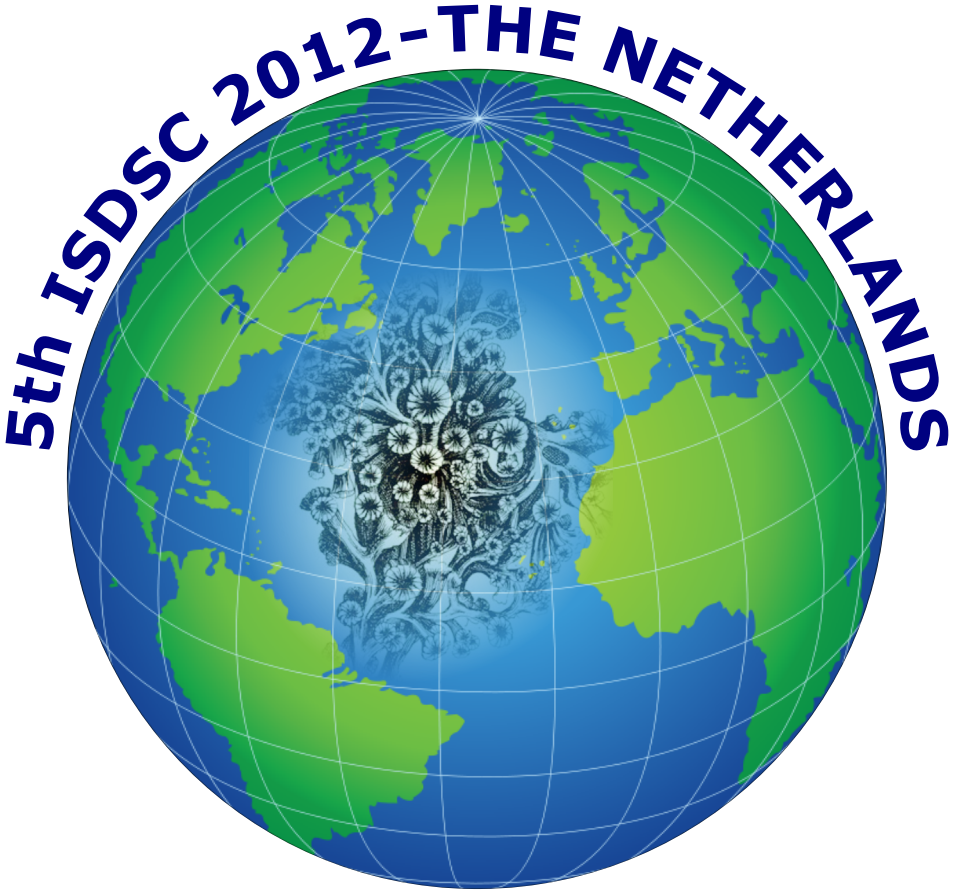
The continuing surge of interest in deep-sea habitats and communities and the development of new technologies to explore them are leading to a better understanding of the diversity of deep-sea corals. I will review some of the latest developments in alpha taxonomy and systematic relationships, and highlight how these are important to our broader understanding of deep-sea coral biology. For example, much of the taxonomy of deep-sea octocorals comes from the late 19th- and early 20th centuries and an inherent problem is that many species are known only from their type material, which in most cases consists of just a few specimens (and these often fragmented due to method of sampling), and thus many genera are in need of revision. Many of these genera are widely distributed in the North Atlantic and the Pacific Oceans, but the patterns are incomplete because relatively few specimens have been collected in the South Atlantic, Indian, eastern Pacific, and Southern Oceans. However, research and exploratory activities, and in particular targeted-sampling using ROVs, from locations around the world are adding well-preserved coral specimens to available collections, as well as in situ imagery showing the corals in the context of their habitat. Such collections provide material for complete morphological analyses, e.g. SEM, histology, and, from the same colonies, appropriately-preserved tissues for genetic analyses, along with an insight into their ecology.

DNA sequences generated from available tissues lead to molecular phylogenies that enable us to then make phylogenetically-relevant comparisons for other aspects of deep-sea coral biology. For example, as documented by Watling et al. and Heestand et al., morphological and genetic analyses of the family Isididae – the bamboo corals – has revealed at least 3 independent evolutionary lineages (3 or 4 families?) and fundamental differences in the skeleton of *Isis* – a shallow-water bamboo coral that now appears only distantly related to the cosmopolitan deep-sea Keratoisidinae; these results suggest there are alternate pathways to generate a nodal skeleton that have independent evolutionary origins.

As new techniques, e.g. next-generation sequencing, and conceptual approaches, e.g. community phylogenetics, continue to be developed and applied to deep-sea corals, we will gain an improved understanding of the taxonomic diversity and biogeography needed for conservation of these long-lived organisms.



ABSTRACTS
TUESDAY 3 APRIL

9.00-9.30 [KEYNOTE]

Trans-Atlantic perspectives on the history of *Lophelia* cold-water coral development

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The last decade has seen exponential growth in the number of scientific studies examining cold-water corals (CWC), the habitats they form and the palaeoceanographic archives they provide. Over this exciting period of CWC research important patterns have emerged. For example, phases of CWC growth and hiatus in the Atlantic Ocean mirror glacial-interglacial cycles and coral occurrence is often closely tied to particular water masses. But our wider understanding of how CWCs metapopulations are structured has typically been limited to local and, occasionally, regional scales. This not only reduces our ability to draw conclusions about ecological connectivity between populations but also impedes our ability to use novel palaeoceanographic proxies of water mass age and provenance to their full potential. This talk will set out the case for expanding our vision as a CWC research community to embrace international ocean basin-scale research, not only for its scientific value but also to make best use of scarce and costly deep-ocean research infrastructure.

9.30-9.45

Evaluating levels of accuracy for observer-identified coral data: how good are the data for spatial mapping?

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Deep-sea corals in the New Zealand region are diverse and, because of their vulnerability and distribution, at risk from effects of anthropogenic activities such as fishing. New Zealand protected coral species in the orders Antipatharia, Alcyonacea (specifically the gorgonian sea fan corals), Scleractinia, and family Stylasteridae are known to be encountered incidentally during commercial fisheries in New Zealand, particularly by deepwater trawls targeting orange roughy (*Hoplostethus atlanticus*) or oreo species (Family *Oreosomatidae*). While it is important to understand the risk to protected corals, and ensure commercial fishing impacts are minimised, it is also important to know the accuracy of those data used to assess impacts. Samples of corals identified at-sea by Government observers using classification guides were returned to the laboratory between 2007 and 2010. The samples provided both an opportunity to map the observed coral distribution at a fine taxonomic level and to assess the accuracy of the identifications made by observers. Of the 545 records that could be compared, analyses showed that 293 (54%) were incorrectly identified by the observers. The percentage error was particularly high (about 90% incorrect) for the stony branching corals, which are difficult to distinguish to species. Although identification to the lowest possible taxonomic level was generally poor, accuracy was much improved at the higher taxonomic identification level (e.g., to family) with only certain gorgonian corals seen as commonly mis-classified. The evaluation study provided us with an assessment of confidence in the identification and mapped data and showed how improvements to the guides and the refining of data collection methods can help at-sea. While a higher taxonomic level of identification provides an understanding of the distribution of protected coral groups, identifying coral specimens to the lowest taxonomic level is paramount to understanding impacts on the region's biodiversity. To ensure effective monitoring in our Southern Ocean a similar evaluation of identifications was carried out of selected taxa including corals that had initially been identified by scientific observers from New Zealand vessels in the Ross Sea toothfish longline fishery in 2009-10. Over a thousand samples were retained for subsequent classification by experts. Of the 4555 records compared, the observer identifications were reasonably accurate (88% correct). However, there were some problems in distinguishing stylasterid hydrocorals from gorgonian corals (e.g., the precious coral *Corallium spp*.) and what were assumed to be branching scleractinian corals forms. An identification guide, along with specific training for observers, benefitted the accuracy of data collection compared with previous years.

9.45-10.00

Record of cold-water corals biodiversity in the Sanriku Pacific Coast in northeastern Japan, before the 9.0 Magnitude Earthquake and Tsunami on March 11, 2011.

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Otsuchi Bay (141°56'E, 39°20'N and 142°1'E, 39°22'N) is located at the Pacific Coast in northeastern Japan. In March 11, 2011, the area was strucked by 9.0 Magnitude Earthquake and 15m high Tsunami waves. It is a very important biogeographical region to investigate cold-water octocoral fauna in the northwest pacific. However, no observation or descriptions have been reported for the area further north than Sagami-bay. The studied area is located in the cold-temperate zone and has been thought that the fauna should be characterized as sub-arctic fauna. In 1998, one Primnoid coral has collected during the dredge survey. It took time to get next coral sample in 2002. Since then, it has been recorded at least 13 species of octocorals and 4 species of solitary hexacorals. Most of corals distribute on the hard substrate at the depth of ca.67-100m with water temperature about ca.16 degree C in summer. Average annual water temperature at 1m depth was between 7.0 to 20 degree C in 2005-2009. The most famous north-flowing ocean current in Northwest Pacific is Kuroshio. Kuroshio has its roots from North Equatorial Current. It begins off Taiwan then flows toward the north-east along Japan with transporting warm tropical waters to Japanese marine fauna and turn its direction off Tokyo. Otsuchi is located far north from this current. The notable point of this study is that the family Melithaeidae was observed commonly at the Otsuchi bay. Family Melithaeidae is a Pacific endemic family and has high species diversity. Their habitats range from shallow water to depths of over several hundred meters and from tropical to temperate zone. In Japan, they distribute along with the flow of the warm ocean current. In this paper, I suggest that the influence of the warm Kuroshio current and tropical fauna is still partly active in the northeast of Japan. All these environment were destroyed in March 11, 2011. And because of full of rubble still remain at the bottom, it is not clear how long does it take for the environment to recover. This area has met Tsunami attack several times and they have been recovered after those previous Tsunami damage. The March 2011 quake is the largest one. This is a valuable record of ecological systems before the extraordinary natural disaster.

10.00-10.15

Deep-sea corals on Orphan Knoll and Orphan Seamount, Northwest Atlantic: relationships to surficial geology, bathymetry and oceanography.

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Orphan Knoll is a 1700-m-deep foundered continental fragment off the continental margin of Newfoundland. Orphan Seamount is a 1850-m-deep volcanic seamount just southeast of Orphan Knoll. Orphan Knoll hosts ~250 enigmatic mounds typically 20-50 m high, mostly formed from block-faulted bedrock and topped by pelagic limestone and manganese oxide crusts. Deep-sea megafaunal ecosystems on Orphan Knoll and Seamount are largely unexplored and remain unaltered through direct anthropogenic affects. An ROV cruise in 2010 provided the first combined geological and biological surveys of these areas. We describe surficial geology, megafaunal abundance and distribution, and apply descriptive and predictive species distribution models of benthic deep-sea megafaunal ecosystems. ROV-based video transects were used to describe surficial geology and coral and sponge species occurrence. The ROV also collected near-bottom multibeam data and surficial geological samples. Although the Orphan Knoll mounds exposed block-faulted Miocene bedrock, most of the seabed around the mounds is composed of sand, gravel, cobbles and boulders, including hemipelagic sediment and ice-rafted debris. The most common types of coral on the Orphan Knoll mounds were the solitary scleractinians *Flabellum sp*. and *Vaughnella margarita*, Isidid gorgonian corals, *Chrysogorgia sp*., Bathypathes and Stauropathes antipatharian corals, pennatulaceans, and an unconfirmed gorgonian. Most hard-substrate dependent corals observed were growing on cobbles, boulders, and ice-rafted debris, rather than the bedrock itself. A *Desmophyllum dianthus* coral graveyard occurred at the base of a bedrock cliff on Orphan Knoll. Soft-bottom, low-slope habitats on Orphan Knoll near the mounds included small gorgonians, soft corals, and the solitary scleractinians *Caryophyllia ambrosia* and *Flabellum sp*.. Abundance of non-coral or sponge megafauna was higher on the mud-bottom areas of Orphan Knoll than on the mounds, and was dominated by ophiuroids and crinoids (both stalked and unstalked). Common corals of the Orphan Seamount were large *Chrysogorgia sp*. and Isidid gorgonians and antipatharians *Bathypathes sp*., Nephtheid and *Anthomastus* soft corals, which were most prevalent and abundant, near the summit of the seamount. Scleractinian corals *Vaughanella margaritata* and *Flabellum sp*. occurred on non-bedrock areas of the seamount above 2200 m depth. Common sponges on the Orphan Knoll mounds and the Orphan Seamount included *Geodia*, *Polymastia*, *Euplectella*, and other varieties of unconfirmed hexactinellids and demosponges. The heterogeneous nature of deep-sea corals, and their habitat characteristics imply widely differing results of distribution models among coral morphologic and taxonomic groups. Bathymetric variables depth, slope, aspect, and water density were the most important predictors of megafaunal presence identified by gradient Forest and confirmed through MaxEnt species distribution models. The same variables dominated for coral species as a group; although substrate type had a significant influence on coral distributions, it was not a dominant predictor, because different types of corals have quite different substrate requirements. Predictive modeling of coral, sponge, and megafaunal abundance and distribution for the Orphan Knoll and Orphan Seamount area was most useful when applied to suites of co-occurring coral species that share depth ranges, substrate requirements, and other habitat characteristics.

10.15-10.30

The distribution of coral reefs in the Bay of Biscay

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The Bay of Biscay (NE Atlantic) consists of more than 130 submarine canyons, of which 85% are in the French EEZ. Canyons are complex topographical features and have been documented as areas of high species richness. Antipatharians, gorgonians, scleractinians and sponges are considered as Vulnerable Marine Ecosystem (VME) species and are able to form important structural habitats, including reefs and sponge grounds, for other species. It is suggested that fish use *Lophelia*/*Madrepora* reefs as feeding, refuge and nursery areas. Cold-water coral reefs have been documented in the Bay of Biscay since the 20th century. Non-destructive optical techniques are ideal for studying VMEs. However, due to historical, environmental, technical or financial constraints, various techniques, e.g. tethered cameras and Remotely Operated Vehicles (ROVs), are used. Variation in data acquisition methods can lead to problems with spatial or temporal comparisons. Within the European FP7-funded project CoralFISH, methodology and the software COVER (Ifremer, France) have been developed to facilitate comparison between different image data and areas. In this presentation an example of the application of this methodology and software will be given. Various tools (historical cruises, foreign cruises, tethered camera, ROVs) have been used to study the heterogeneous environment in the Bay of Biscay. The focus will be on coral reefs.

11.00-11.15

Habitat heterogeneity, distribution and biodiversity of deep-sea coral ecosystems from Campos Basin, Brazil (SW Atlantic)

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Deep-sea coral ecosystems from Campos Basin (SE-Brazil) have been investigated since 2004 within the Campos Basin Deep-sea Corals Assessment Project and other initiatives conducted by the Research and Development Center of the Brazilian Energy Company - PETROBRAS with the partnership of some national universities. Since then, several cruises with ROV were conducted between 350 and 1700 m depth in areas where geophysical information (side-scan sonar, multibeam and seismic profiles) indicated the presence of reflective targets, or in areas where the occurrence of deep-sea coral had been proven by geological sampling (sediment cores). Among them, seven cruises were carried out for mapping deep-sea coral ecosystems (ground-truthing) and habitat characterization, considering their physical (geomorphological and oceanographic) and biological aspects. In addition, 13 monthly sampling were performed to collect four of the main deep-sea scleractinian reef-building species (*S. variabilis*, *Lophelia pertusa*, *Enalopsammia rostrata* and *Madrepora oculata*) for reproductive and molecular biology studies. This paper presents the results of the Brazilian deep-sea coral research project after a seven-year study and consolidates all the information available on these ecosystems for Campos Basin. Besides the great contribution to the scientific knowledge on deep-sea corals of the Brazilian coast, still scarce considering its huge extension (7367 km), the results can be considered an important tool for environmental management actions, including conservation and management of deep-sea coral habitats in SE-Brazil.

11.15-11.30

Islands in the Stream Revisited: Hydrography, Geological Setting and Fauna of Cape Lookout Coral Mounds (NC, USA)

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Extensive exploration of coral habitats on the continental slope off the southeastern United States in the period 2000-2007 documented the presence of mound and ridge structures off North Carolina (Cape Lookout, Cape Fear). The mounds were partly covered with live *Lophelia pertusa* and partly with sediment and/or dead coral framework. The fauna on the mounds included several invertebrate and fish species new for the area or to science, while the fish fauna appeared different from those inhabiting shallower and deeper surroundings. The characteristics of the NC coral mounds were attributed to local environmental conditions and/or habitat characteristics, but interpretation was hampered by paucity of physical data. The NC coral mounds lie at ~400 m depth underneath the Gulf Stream which is discernible as a relatively warm and strong unidirectional current flowing northward along the SEUS margin up to Cape Hatteras. Surface currents of the Gulf Stream system have been well studied, especially the meanders and eddies, but deeper observations are scarce. In 2009 two benthic landers were deployed near the NC coral mounds for a period of 6 months in order to measure environmental parameters (T, S, turbidity, bottom currents) and particle fluxes. Mid 2010 when both landers were retrieved, supplementary samples, seismic and video records were collected from the mounds and immediate surroundings. Baited lander experiments were conducted to study the scavenger community. The lander data revealed a strong periodic influence of the nearby Gulf Stream on the temperature and current regime on the coral mounds with potential consequences for the turbidity and particle flux. Individual mounds differed in coral coverage with consequences for species richness of associated fauna and sediment metabolic activity. Baited cameras showed high activity of single species pointing to frequent deposition of food falls. On the basis of our findings on the NC coral mounds, parallels will be drawn with observations in coral habitats in the north eastern Atlantic Ocean.

11.30-11.45

Existence of deep-sea corals in the central Red Sea

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The Red Sea is one of the most saline and warmest oceans on Earth with year-round salinities of more than 38 ‰ and temperatures higher than 20°C down to the seafloor. Furthermore, the Red Sea is known for it's oligotrophic waters, which is low in nutrients and suspended material. Even though the existence of deep-sea corals to date has only been observed in waters colder than 13°C and rich in food, we here introduce benthic deep-sea coral communities found in depths between 750 m to 250 m in the central Red Sea. We provide phylogenetic information on four different species and review our findings in the frame of known morphological features for deep-sea corals. Their distribution is discussed in relation to physico-chemical environmental properties and we report on metabolic demands and calcification potentials of various species found. Our results demonstrate that the existence of deep-sea corals is not restricted to low-temperature waters, and that other habitat characteristics such as food availability or alkalinity might play a significant role for their distribution.

11.45-12.00

Coral-dominated biotope cataloguing and mapping in the Azores (NE Atlantic)

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With a regional checklist totalling more than 160 coral species and vast areas with substrate and oceanographic characteristics considered suitable for the development of these organisms, the rugged seafloor region surrounding the Azores archipelago is considered a NE Atlantic deep-sea coral hotspot. An inventory of 40 megafaunal facies has recently been compiled based on the examination of video and photo archives corresponding to more than 40 years of deep-sea research around the Azores. Twenty distinct coral-dominated facies are presented which occur between 50 and 3,500m depth that for the most part represent biotopes of conservation importance such as coral gardens and scleractinian reefs. The work to go beyond the known point occurrences and develop spatially-explicit coral habitat suitability models is also illustrated. At a regional scale, the COLETA database (currently containing over 1600 historical and modern occurrences belonging to 34 families) is used to provide the coral distribution records for the Azores. Predictive mapping is then conducted using statistical models where covariates consist of selected oceanographical, biological, geomorphological, physical and chemical parameters upscaled to a 300-m resolution from publicly available databases and climatological atlases. Work at a local scale (pixel size: 50m x 50m) is also presented where habitat-building coral occurrence data from new ROV and drop-down camera surveys are used. The potential of using solely terrain-based covariates such as depth, slope, aspect, bathymetric position index and curvature is investigated on the Condor seamount and southern flank of the Faial-Pico Passage. Geomorphological parameters derived from multibeam bathymetry are frequently the only available environmental covariates in cases where oceanographic data is insufficient to characterize the fine-scale near-seabed conditions experienced by benthic organisms. This work contributes towards the mapping of some of the most important deep-sea biotopes of conservation importance in a 1.6 million km^2 region, as well as providing input for the development of the deep-sea section of the EUNIS habitat classification system.

12.00-12.15

Back to the Darwin Mounds

Veerle A.I. Huvenne*[1] *(vaih@noc.ac.uk), *D.G. Masson*[1], *B.J. Bett*[1], *T.P. Le Bas*[1], *F. McBreen*[2], *S. McPhail*[1] *and R. Ross*[3]

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The Darwin Mounds are small (5 m high, 75 m across) cold-water coral mounds discovered in 1998 on regional-scale TOBI sidescan sonar data from the N Rockall Trough. The initial discovery was followed by high-resolution sidescan sonar, video and sampling surveys in 1999-2000, revealing more information about the coral species (*Madrepora oculata* and *Lophelia pertusa*) and associated fauna, about mound shape and size and about the sedimentary framework of the area. The mounds are seated within a thin, well-sorted sandy contourite, possibly of post-glacial age, and are at least partly made up of the contourite sands baffled between the coral framework (Huvenne et al., 2009). The build-ups have been partly shaped by the prevailing bottom currents (Wheeler et al., 2008), although Masson et al. (2003) suggested the initial coral settling grounds may have consisted of sand volcanoes formed by localised fluid expulsion (pore waters). The 2000 data, however, also illustrated that many mounds were affected by deep-sea bottom trawling, an observation that eventually lead to their protection in August 2003. Since 1999-2000, however, no further scientific work has been carried out in the area, and a revisit, also to monitor the current status of the mounds, was more than due. Hence, in May-June 2011, we carried out a detailed habitat mapping survey in the area, using the Autosub6000 AUV equipped with high-resolution multibeam, dual frequency sidescan sonar, chirp profiler and monochrome camera. In addition video data and stills were collected with an inspection-class ROV, while the dataset was extended with well-positioned piston cores. This contribution will present some of the first results of this expedition, illustrating the effect of 8 years of cold-water coral protection. In addition, the newly recovered piston cores and very detailed sidescan sonar data will cast new light on the mound formation history.

Huvenne, V.A.I., Masson, D.G. & Wheeler, A.J. (2009). Sediment dynamics of a sandy contourite: the sedimentary context of the Darwin cold-water coral mounds, Northern Rockall Trough. International Journal of Earth Sciences. 98(4), 865-884. doi: 10.1007/s00531-008-0312-5
Masson, D.G., Bett, B.J., Billett, D.S.M., Jacobs, C.L., Wheeler, A.J. & Wynn, R.B. (2003). A fluid escape origin for deep-water coral-topped mounds in the northern Rockall Trough. Marine Geology 194, 159-180.
Wheeler, A.J., Kozachenko, M., Masson, D.G. & Huvenne, V.A.I. (2008). The influence of benthic sediment transport on cold-water coral bank morphology and growth: the example of the Darwin Mounds, NE Atlantic. Sedimentology, 55, 1875-1887. doi: 10.1111/j.1365-3091.2008.00970.x

12.15-12.30

Taxonomic characterization of deep-water coral communities: does remote underwater analysis replace laboratory species identification?

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Modern technologies continuously increase our ability to analyze underwater seascape, even at great depths, through the improvement of video recording by remotely operated vehicles.

Video and image recording (VIR) actually help the identification of communities, their location, distribution and health. VIR can be used to identify large-sized epibenthic species, both individual and colonial, which exhibit particularly diagnostic morphologies or growth habits. This is the case for the two main Mediterranean framework-building deep-sea corals, i.e. *Madrepora oculata* and *Lophelia pertusa*, even if in some cases their detection through VIR needs to be ground-truthed with sample-based analysis.

Definetely more difficult, if not impossible, is the identification by video analysis of the epibionts/skeletobionts (e/s) associated with corals, with exception for some particularly obvious and/or large species such as *Delectopecten vitreus* and *Spondylus gussoni*, and the serpulid worm *Serpula vermicularis*. Furthermore, the great majority of skeletonized epibiont/skeletobiont taxa is characterized by small specimens and colonies exhibiting a cryptic habit, among which several serpulids, the majority of bryozoans and foraminifers. To these species also infaunal elements colonizing local sediment veneers and pockets add, such as burrowing mollusks and ostracods. All these species are completely overlooked through VIR. Consequently, in studies finalized to: 1. assess total biodiversity; 2. fully characterize community composition and structure; 3. evaluate the presence of facies within the community; the collection of samples is absolutely necessary.

In this study we present some examples of taxonomic identification through video analysis of skeletonised organisms from Mediterranean cold-water coral areas. Most images have been ground truthed with benthic samples collected by ROV arm or by grabbing/coring in neighboring areas.

13.30-14.00 [KEYNOTE]

The oldest cool-water coral ecosystem on Earth? – Danian coral mounds from Faxe, Denmark

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Fossil cool-water coral mounds are relatively rare in contrast to their modern counterparts. The main reason is that cool-water coral mounds are a geologically young phenomenon in both shallow and deep water. In mid-Danien time, shortly after the mass extinction at the Cretaceous–Tertiary boundary and during a rise in sea level, the azooxanthellate scleractinian genus *Dendrophyllia*, which is known from rare finds in the upper Maastrichtian, started to form coral mound complexes in the epicontinental sea covering the Danish Basin in NW Europe. The large Faxe quarry exposes an extremely well preserved Danian cool-water coral mound complex with numerous individual mounds 50−100 m in diameter. The coral mounds are intercalated with bryozoan mounds. The mounds are situated over the north-easternmost part of the Ringkøbing-Fyn High, limiting the Danish Basin to the south. A local seafloor high formed the nucleus for extensive colonisation of scleractinian corals, possibly due to higher velocity of nutrient-rich bottom currents. *Dendrophyllia candelabrum* is the dominant framebuilding coral species but patchy occurrences of the scleractinian genera *Oculina* and *Faksephyllia* also occur. Large octocoral species of *Moltkia* and *Isis* are common at certain levels. A rich fauna of stylasterine corals is found in pockets of loose coral limestone. A range of sedimentary mound core and flank facies are recognised. The degree of preservation of the fossils in the coral limestone varies markedly. A type of unconsolidated coral limestone contains an extremely well preserved originally aragonitic flank fauna where the aragonite skeletons have been recrystallized to calcite. Thus fauna provides a rare and unique taphonomic window to the diversity and abundance of the aragonite faunas in a fossil cool-water coral mounds, which otherwise commonly are lost in the geological record. The diversity of the total fauna of the mound complex is very high and an estimation of 500 species has been suggested. Among the species described are many from different families which have never been described as fossils before. Small aragonitic gastropods are very common and are represented by more than 120 species. The coral mound complex is probably the oldest and largest of its kind and the palaeoecological reconstruction shows that the composition and distribution of the fauna is similar to modern cold-water coral reefs.

14.00-14.15

Biodiversity in coral ecosystems from the deep Gulf of Mexico: coral- symbiont relationships and genetic connectivity

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Deep-sea corals provide habitat structure for an array of species that have developed diverse symbiotic relationships with varying degrees of specificity to their host corals. Increasing intensities of fishing and mineral and oil extraction on seamounts and hydrocarbon-rich continental margins place a premium on understanding the processes that control the diversity of coral-rich ecosystems. The co-evolution of host-associate relationships may constrain the genetic connectivity of populations. We examined more than fifteen long-term coral community observation stations in the deep Gulf of Mexico and additional sites, ranging between 16 and 300+ kilometers from the Deepwater Horizon (DWH) wellhead. We documented patterns of associative relationships between particular invertebrates and their host corals via imaging, morphological and molecular systematic/phylogenetic approaches. Associate specimens were collected to assess levels of connectivity across hosts and locations, both inside and outside the Gulf. More than 720 coral-associated invertebrates (including shrimp, amphipods, anemones, barnacles, and crabs) were imaged and sampled. More than 120 representatives of these sampled taxa were morphologically and genetically identified. We have found more than 80 coral-community associated morphospecies from 6 Phyla living on >18 coral hosts, including octocorals, antipatharians, and scleractinians in the deep Gulf of Mexico. Of these ~80 morphospecies, coral symbionts are predominantly crustaceans (>27 species) and echinoderms (>15 species). Coral-associated species hosted only by dead or exposed coral skeleton (e.g., barnacles and polychaetes) are also observed. Genetic identifications have revealed cases of high fidelity in some groups (e.g., specific ophiuroid brittle star species only inhabiting specific species of octocoral), suggesting that these symbionts may be obligate to particular species of corals. Differences in coral associate composition varied markedly with depth and biogeographic location within the Gulf, yet showed notable similarities with coral-associate composition and relationships in deep-water coral ecosystems around the world. This presentation will describe the patterns and diversity of coral symbiotic relationships in the deep Gulf, the potential spill impacts on coral-associate relationships, and the genetic connectivity among associates. These results will be discussed in the context of ecosystem vulnerability and resilience.

14.15-14.30

Microbial diversity associated with the cold-water coral *Lophelia pertusa* as revealed by 454 pyrosequencing

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The cold-water coral *Lophelia pertusa* creates reef structures in the deep sea, forming complex relief that acts as shelter for diverse fishes and invertebrates. Each coral colony is also habitat for thousands of microorganisms. The microbial community associated with *L. pertusa*, hypothesized to support the growth and health of the coral, has been previously studied using culture- and PCR-based assays. These methods have known limitations in the number and diversity of recovered environmental DNA sequences. A metagenomic approach was employed to broadly sequence the microbial-sized community associated with *L. pertusa* and identify both dominant and rare microbial-community members.

Lophelia pertusa samples were collected from the Gulf of Mexico and western Atlantic Ocean via submersible and ROV and fixed in RNALater®. DNA from the microbial- sized portion of the *L. pertusa* holobiont was extracted, amplified using multiple displacement amplification (Genomiphi™), and sequenced on a 454 Pyrosequence Titanium machine using FLX chemistry. Results from the two libraries (Atlantic sample, 385,000 sequences; Gulf sample, 221,000 sequences) were uploaded to MG-RAST, QIIME, and DeconSeq for quality control and analysis.

These data represent the first deep sequencing of microbes associated with a deep-sea coral. Although clone libraries have been used in the past to decipher community composition, they are limited by the cost and time needed to sequence clones as well as by potential primer bias. Gene fragments from the pyrosequencing libraries revealed a much more diverse microbial community than has been found using other methods. Pyrosequencing of shallow-water corals thus far has shown them to be dominated by *Proteobacteria*, whereas the *L. pertusa* libraries are principally composed of *Firmicutes*. Other bacterial phyla were also present in smaller proportions, including *Actinobacteria*, *Bacteroidetes*, *Chloroflexi*, and *Planctomycetes*. Further, these libraries revealed the first archaeal and viral sequences associated with *Lophelia*.

14.30-14.45

Chemical ecology of Antarctic soft corals of the genus *Alcyonium* Linnaeus 1758

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Soft corals belong to the order Alcyonacea (octocorals), and they are characterized for the absence of hard massif calcium carbonate skeletons. Instead, they contain sclerites, spiny skeletal tiny elements that provide some degree of support and texture (sometimes suggested to deter predators too). Sclerites are also useful for species identification. In particular, the genus *Alcyonium* is quite extended in the oceans, with 59 species described around the world. In the Southern Ocean, this genus is represented by 8 reported species, some of them very abundant within benthic communities. Antarctic ecosystems are described to be greatly structured by biotic factors such as competition and predation, mainly driven by macroinvertebrate consumers and omnivorous mesograzers, which exert remarkable ecological pressures on sessile soft-bodied organisms. This scenario illustrates the typical favoring conditions for the evolution of chemical defenses. In fact the cnidarians are well known for their potential in producing bioactive compounds. In this study we aimed to study the chemical ecology of Antarctic soft corals of the genus *Alcyonium*. Hence, samples from five different species were investigated for the presence of defensive agents through the performance of feeding bioassays with the sea star *Odontaster validus* and the amphipod *Cheirimedon femoratus* as putative sympatric predators. Striking repellent activities were observed towards both types of consumers in the diethyl ether extracts from all the species assessed. This suggests that chemical defense, presumably of lipophilic nature, is a first-line protection strategy against predation in *Alcyonium* soft corals from Antarctic waters. Moreover, chemical analysis of the crude lipophilic fractions led to the purification of characteristic sesquiterpenoid metabolites in two of the samples, including two newly isolated products. We also analyzed the fatty acid composition for all the samples. Sesquiterpenoid and fatty acid fractions were furthermore examined for their ecological role in avoiding predator consumption. Finally the lipidic and secondary metabolite patterns of the five species of the research were investigated and contrasted from a chemotaxonomical point of view by comparison with the literature data available for the genus *Alcyonium*, as well as considering other octocorals from Antarctica.

14.45-15.00

Pushing the limits of a facultative relationship: An intimate and complex relationship between the squat lobster *Eumunida picta* and the deepwater coral *Lophelia pertusa*

Martha S. Nizinski*[1] *(nizinski@si.edu), *J.P. McClain-Counts*[2] *and S.W. Ross*[3]

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The squat lobster *Eumunida picta* is the numerically dominant megainvertebrate associated with well developed deep-sea coral habitats in the western North Atlantic. Ten cruises (Summer-Fall; Cape Lookout, NC - Cape Canaveral, FL) conducted from 2000-2005, and 2009 provided an opportunity to investigate abundance and distribution of *E. picta* based largely on in situ observations of 5,774 animals. *Eumunida picta* is closely tied to structure, particularly that structure formed by live and dead colonies of *Lophelia pertusa*. *Eumunida picta* were most frequently observed as solitary individuals on the coral matrix, and noted only infrequently on coral rubble and rarely found on sand substrata. Whether coral was dead or live did not significantly affect the location of these squat lobsters in relation to the coral mound. Although *E. picta* occur in and on coral substrata and adjacent rubble habitats, individuals were observed most frequently on outer surfaces of coral branches at or near the tops of coral mounds. Unlike most other species of squat lobsters, *E. picta* is an active predator utilizing a variety of feeding modes. *Eumunida picta* were most often observed with claws extended into the water column, perpendicular to the coral substratum, a hunting stance positioning the squat lobster for capturing prey such as midwater fishes from the water column. Other feeding modes observed included grazing, deposit feeding and scavenging. By utilizing this variety of feeding modes, this species maximizes opportunities for feeding on prey located over, on, and within the coral substrata. The relationship between *E. picta* and coral substrata is complex and intimate since aspects of occurrence, abundance, feeding and geographic and bathymetric distributions of this crustacean are strongly influenced by the availability and abundance of *L. pertusa* habitat. Centers of distribution and abundance as well as the feeding ecology for this species are directly tied to abundance and distribution of *L. pertusa*. Placement of *E. picta* on the coral mound and its hunting posture demonstrate adaptations of this squat lobster to living in association with deep-sea coral habitats. Clearly population success of this species is dependent on coral habitat. Thus, the close association between *E. picta* and the coral pushes the limits of what traditionally has been considered a facultative relationship. Based on the complexity of this organism-substratum relationship, loss of coral habitat would have significant impacts on populations of *E. picta*.

17.30-18.00 [KEYNOTE]

Environmental control of deep-sea coral distribution: latest insights and implications

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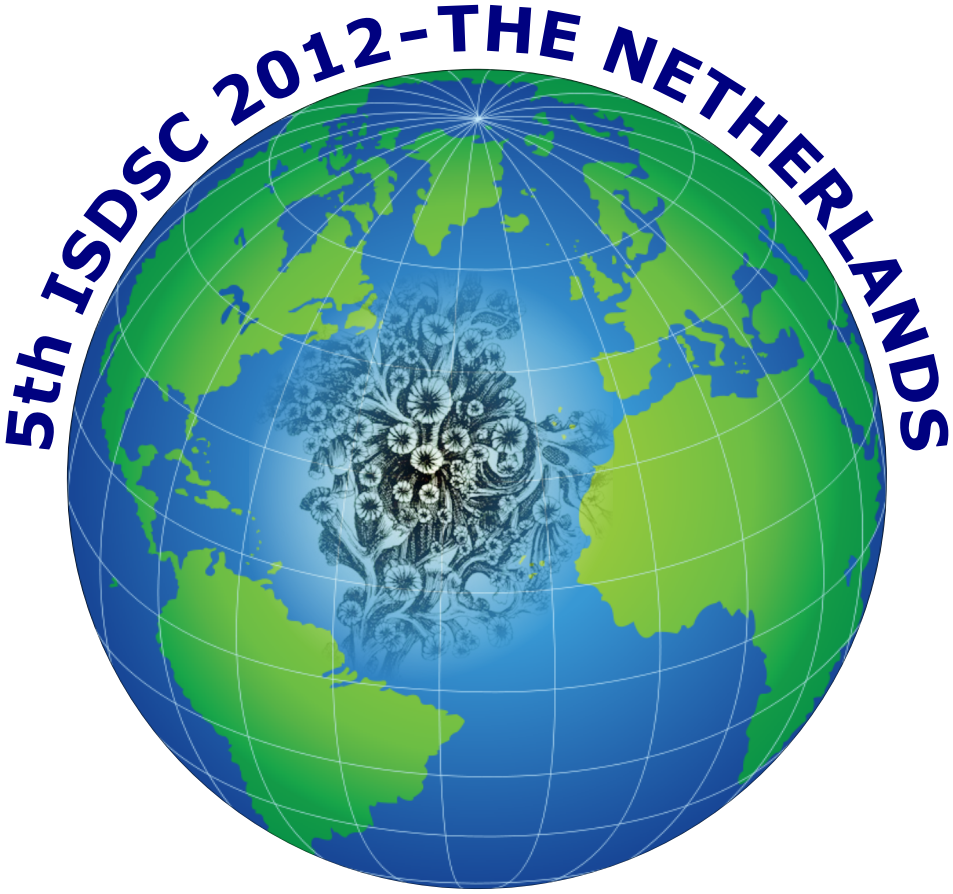
[1] NIWA, New Zealand

Research of the environmental conditions that control the distribution of deep-sea coral has made significant advances in recent years. Many of the controls that operate to determine the large-scale (1000s km) distribution of deep-sea corals are now broadly known, as well as those that operate at meso-scales (10-100 km). Some of this understanding has resulted from the recently improved availability of environmental data layers and the accessibility of habitat-suitability modelling techniques, as well as the widespread use of GIS for managing and presenting information. Global and regional habitat-suitability models for deep-sea corals have served to elucidate the importance of particular variables and identify places where corals could exist, but remain to be explored. In addition, model outputs have served to identify areas where corals are or could be vulnerable to disturbance by human activities such as fishing or mining, and the implications of climate change for deep-sea coral distribution patterns. Mapping techniques using bathymetric and backscatter data from multibeam echosounders, and images from AUVs/ROVs, have allowed for significant gains in the appreciation of the factors that govern the small-scale (10-100s m) distribution of deep-sea corals. For example, to identify the substratum configuration and position that promotes the growth of corals at particular habitats such as canyons and seamounts. These findings also have practical applications for environmental management. This invited presentation will provide a critical review and outlook of the contributions presented during the theme session "Environmental Conditions and Constraints". With the aim of drawing on examples that provide new practical means to gain understanding, as well as new ecological insights into the environmental control of deep-sea coral distribution. The latest methods and findings will be also be set in the context of the current management and conservation imperatives for deep-sea corals.



ABSTRACTS
WEDNESDAY 4 APRIL

9.00-9.30 [KEYNOTE]

Deep-Sea Corals and the Oil and Gas Industry in the Gulf Of Mexico: an Adaptive Approach to Applied Studies and Management

Gregory S. Boland[1] (gregory.boland@boem.gov)

[1] Bureau of Ocean Energy Management, USA

The development of oil and gas resources has been identified as a potential threat to deep-sea coral habitats. The Bureau of Ocean Energy Management (BOEM), an agency of the United States Department of the Interior, manages the exploration and development of the offshore energy and marine mineral resources of the United States while protecting the environment. The BOEM has been active in the role of deepwater coral research for over 10 years with a history of successful adaptive management of these sensitive habitats using science derived from their funding of a series of large applied-science studies and the application of study results to regulatory policy. Management of the subject biological communities has presented numerous challenges inherent in adaptive management due to the extreme environment in which they occur.

Virtually all significant Gulf of Mexico (GOM) deepwater coral sites are associated with exposed areas of authigenic carbonate originating from historical chemosynthetic bacterial precipitations at cold hydrocarbon seep sites. Use of industry-acquired 3D seismic data will be described as an important tool for prediction of locations of this hard bottom habitat. This database has recently been released to the public and has been invaluable, both in determining previous study site locations for BOEM research, but also for extensive benthic studies related to the 2010 GOM oil spill. This database is also utilized by BOEM for evaluation of potential impact from energy development activities. Processes include a standard biological review procedure for all industry-submitted plans for deepwater exploration and production, and pipeline applications. Discussion will include the implementation of regulatory policy requiring avoidance of sites that include likely areas for both deep-water corals as well as chemosynthetic communities and the evolution of these avoidance criteria over time.

Updated information will also be presented for several recent studies funded by BOEM and including interagency collaboration with NOAA OER and U.S. Geological Survey investigating deep-water coral habitats. Remaining components of one ongoing study with preliminary observations of extensive cold-water coral development on oil and gas structures will be presented. Of the current total 3,214 offshore platforms in the Gulf of Mexico, extensive development of deep-water corals has been documented on several of the 51 offshore platforms at water depths exceeding 300 m. Additional studies on these deep-water artificial reef communities are planned for 2012 intended to provide information for management decisions regarding structure decommissioning.

9.30-9.45

Impacts of the Gulf of Mexico oil spill on deepwater coral communities

Erik E Cordes*[1] *(ecordes@temple.edu), *Tim Shank*[2], *Amanda Demopoulos*[3], *Helen White*[4], *Andrea Quattrini*[1], *Walter Cho*[2], *Pen-Yuan Hsing*[5] *and Chuck Fisher*[5]

[1] Temple University, USA
[2] WHOI, USA
[3] USGS, USA
[4] Haverford College, USA
[5] PSU, USA

Human impacts in the deep sea are increasing as our pursuit of energy, mineral, and food resources continues to move offshore. The blowout of the Deepwater Horizon drilling rig, the largest accidental release of oil into the marine environment, is a stark example of how profound these impacts can be. More than a year later, in the deep waters of the Gulf, the damage assessment is still ongoing. Corals may serve as effective indicators of hydrocarbon exposure and impacts given their sessile habit and longevity, and the potential retention of hydrocarbon signatures in the mucous released as a first-order stress response. However, deep-sea corals have a limited distribution in the Gulf of Mexico, inhabiting the rare locations where hard substrates are available above the sedimentary background of the continental slope. Before the impact to deepwater coral communities could be fully assessed, the locations of these communities in the vicinity of the Deepwater Horizon incident needed to be discovered. We first re-visited some of the deepwater coral reefs known prior to the spill, and discovered few visual signs of harmful impact among corals and their associates. Continued exploration of the area revealed a gorgonian assemblage approximately 10 km from the former location of the rig that exhibited strong evidence of the direct impact of the spill, and this site was monitored for over a year. Additional targeted exploration revealed a series of other sites in the region that were dominated primarily by *Paramuricea biscaya*, but also *Swiftia palida*, *Madrepora oculata*, and other corals along with their ophiuroid, chirostylid, and other symbiotic associates. Investigation of these sites has revealed impact to some of the sites near the well head, as well as a newly discovered high-diversity coral community further from the source of the spill that appears to be un-impacted by the spill.

9.45-10.00

Methodologies and effect investigations on the scleratininan coral *Lophelia pertusa* in relation to offshore petroleum activities: a laboratory study

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[2] UiS, Norway
[3] NINA, Norway
[4] IMR, Norway

In Norway, the offshore petroleum industry is central to the economy and development of the country. Their activities are mainly developed along the continental shelf where numerous and large cold-water coral (CWC) reefs dating back several hundred to thousand years, are found. The expansion of exploration drilling activities to new areas is increasing awareness for protection of CWC ecosystems. Today, oil and gas operators mostly rely on pictures taken from ROV to estimate the potential effect of their activities. There are still gaps in basic knowledge of CWC biology, and their sensitivity to petroleum exploration and discharges needs better insights. Drilling mud (DM) discharges is of particular concern due to the large content of small particles and other substances that can potentially affect several basic functions with possible consequences for coral survival. This study was launched to assess what impacts the offshore drilling discharges may have on the scleratinian coral *Lophelia pertusa*. This coral species is building the framework and habitats for numerous other commercially and ecologically important species. A series of experiments have been performed to test methodologies and expose *L. pertusa* to DM discharge scenarios in the range 5 to 20 ppm. The methodologies encompassed several measurements from the molecular to the physiological levels. At the physiological level, polyp activity was studied by time-lapse video records and picture analyses to investigate impairment in feeding, oxygen consumption enabled to study metabolic impairment through respiration rate measurement and skeleton growth was measured by the buoyancy weight technique. Histopathological alterations were also investigated following decalcification, and with a special focus on changes in mucocytes in the epidermal cell layer. At the molecular level, gene expression of stress-related target genes (catalase CAT, superoxide dismutase SOD, heat chock proteins HSP70 and HSP 90) was analyzed by q-PCR, using primers and Taqman MGB probes designed after having obtained partial DNA sequences for these *Lophelia* genes. Special focus was made on innovative methodologies applied on coral mucus; A proteomic approach by SELDI-TOF and Nano LC-Orbitrap was used to investigate possible changes in total protein fingerprinting and in an attempt to identify potential protein markers following exposure to DM; Likewise, a microbial approach combining denaturing gradient gel electrophoresis (DGGE) and 454-pyrosequencing was used to investigate the possible changes in the bacterial communities associated to coral mucus. Generally, it appears that *L. pertusa* is a relatively tolerant species, but there are clear indications of changes in some of the parameters that warrant further investigations. This presentation will show some of the results achieved so far and the perspectives envisaged in follow up studies. This study is funded through the Research Council of Norway (program HAVKYST) with additional supports from Total E&P Norge and Statoil AS.

10.00-10.15

What is needed to protect cold-water corals from the potential impacts of oil and gas activities?

***Ingeborg Roenning[1] (ingr@klif.no)**, P.E. Iversen[1] and Ann-Mari Vik Green[1]*

[1] Climate and Pollution Agency, Norway

For all activities which may cause pollution in Norway, e.g. oil and gas exploration and production activities, a permit is needed. The Norwegian Climate and Pollution Agency issues such permits. They include necessary requirements and restrictions for the activity to be executed with least possible harm to the environment. Oil and gas operations may impact cold-water corals in a number of different ways. For oil and gas activities in the vicinity of coral colonies, the agency may use a number of different approaches for protection. These range from not permitting the activity, to requiring monitoring in order to assess the impact of the activity. Discharges of drilling muds and cuttings have been of particular concern, as has mechanical damage from anchoring operations. Traditionally, the agency has not permitted discharges of drill cuttings closer than 500 meters from corals. For some drilling operations, this has also applied in the challenging period at the start of a new well, prior to riser installation. In some instances operators have chosen to relocate the well, whilst others have used different means to transport cuttings away from the well location – and the corals. Anchor handling plans are required to minimise the risk of coral damage; anchors and anchor lines should be placed as far away from known coral structures as possible. Further requirements have included the need for anchoring operations to be visually assisted, and for contingency plans on the moving of anchor locations. So far, monitoring programmes, specifically designed to detect possible impacts on corals, have been required for all oil and gas activities in the vicinity of corals. The areas exposed to disturbances from oil and gas activities are generally small. However, corals are sessile and slow growing. Their potential for recovery is therefore considered to be very low, and damage generally seen as irreversible. We need more scientific information about threshold values of detrimental effects in corals. One example is drilling muds and cuttings, which are not expected to impact bottom communities beyond a few hundred meters from the discharge location. However, the supporting data is limited. Cold-water corals may occur as anything from large, dense reef and reef complexes to just a few coral fragments. There is some uncertainty as to what constitutes is a significant coral structure, and therefore in need of extra protection. There may also be differences in the sensitivity between the different kinds of structures, as well as between different coral species. Despite substantial recent research to provide information for environmentally sound regulatory decisions, oil and gas activities in the vicinity of corals still pose a significant management challenge.

10.15-10.30

Enhancing 'Bottom Fishery Impact Assessments' to reduce impacts on deep sea corals

A. Williams*[1] *(alan.williams@csiro.au) *and F. Althaus*[1]

[1] CSIRO, Australia

Deep sea corals and other erect, fragile and long-lived invertebrate megafauna characterise benthic communities that are vulnerable to direct impacts from bottom fishing. UNGA Resolutions 61/105 and 64/72 call on States to adopt conservation and management measures that prevent significant adverse impacts (SAI) by bottom fishing on 'vulnerable marine ecosystems' (VMEs), such as those characterised by deep sea corals, in High Seas areas. UNGA resolutions also require that the risk of SIA by individual bottom fishing activities on VMEs is assessed, on the basis of the best scientific information available, and that bottom fishing is managed to prevent such impacts, or not authorised to proceed. The assessment uses a 'Bottom Fishing Impact Assessment' (BFIA) based on FAO guidelines. Thus, the BFIA process is the interface between scientific evaluation of impacts and risks, and the development of monitoring, management and mitigation measures by individual nations. BFIAs undertaken in 2011 for Australian vessels in High Seas Areas of the South Pacific and Southern Indian Oceans revealed a variety of key uncertainties in the assessment process that stem from data quality, limited knowledge of VMEs, and/or a lack of specificity in the guidelines. These include (1) the extent to which the weight of landed bycatch underestimates fishing impact, and the relevance of this to bycatch thresholds that trigger 'move on' provisions; (2) the limited collection of information on the identity and quantity of sub-thresholds catches of VME taxa; and (3) a lack of fine-scale mapping for fishing effort and VME distributions, leading to limited understanding of whether they are co-located. More generally there is scant knowledge of, (4) recovery trajectories by different and variously impacted VME communities; (5) regional scale (biogeographic) substructure; and (6) few empirical data linking impacts to effects on ecosystem function and processes at ecologically relevant spatial, temporal and environmental scales. In this talk we identify some options to help reduce these sources of uncertainty and to develop the BFIA process. Enhancements to data collection and monitoring procedures, and broad adoption of specific management arrangement, have the potential to further reduce impacts on deep water corals in High Seas areas. Such arrangements would also be effective in areas under national jurisdiction where fishing impacts on deep sea corals and other benthic megafauna are not yet regulated.

11.00-11.15

Review of global and regional initiatives to protect cold-water corals from the impact of deep-sea fishing

Matthew G. Gianni[1] (matthewgianni@gmail.com)

[1] Deep Sea Conservation Coalition

Over the past 10 years, the UN General Assembly (UNGA) has extensively debated the need for international action to protect cold-water corals and other deep-sea ecosystems from the harmful impacts of bottom fishing. Beginning in 2004, the UNGA adopted a series of resolutions which called on high seas fishing nations and regional fisheries management organizations (RFMOs) to take urgent action to protect vulnerable marine ecosystems from destructive fishing practices. These resolutions commit high seas fishing nations and relevant RFMOs to conduct prior environmental impact assessments of deep-sea fisheries on the high seas, to map and close areas on a precautionary basis where cold-water corals and other vulnerable marine ecosystems are likely to occur, and to ensure that deep-sea fisheries are either managed to prevent significant adverse impacts on such ecosystems or else prohibited. As an integral part of the UNGA resolutions, a set of 'International Guidelines' were negotiated under the auspices of the UN FAO which established global standards for conducting impact assessments of deep-sea fisheries, identifying vulnerable marine ecosystems, and determining whether or not the adverse impacts of fishing would be significant. In most high seas regions individual nations RFMOs have taken a number of measures to implement the UNGA resolutions. However, the actions taken by States and RFMOs to date have been far from complete as was recognized by the UNGA in its 2009 and 2011 reviews of the implementation of the resolutions. Nonetheless, to greater or lesser degrees, States and RFMOs continue to grapple with the challenge of managing fisheries to protect deep-sea ecosystems. Their efforts have been informed by extensive debate within the deep-sea scientific community. The UN General Assembly resolutions have set important precedents for the management of activities with a potential to adversely impact cold-water coral and other deep-sea ecosystems. However, the efficacy of these precedents will be largely determined by how effective the resolutions are implemented in the management of deep-sea fisheries. The presentation will address the current state of the implementation of the UNGA resolutions and highlight key gaps, areas and regulatory initiatives where further work, including advice from deep-sea scientists, is needed.

11.15-11.30

The Government of Canada's National Centre of Expertise in Cold-Water Coral and Sponge Reefs

Jason M. Simms[1] (jason.simms@dfo-mpo.gc.ca)

[1] Government of Canada, Canada

In 2007, as part of Canada's new National Water Strategy, the federal government announced five-year funding for various initiatives to protect fragile marine environments, counter pollution, and strengthen preventive measures. The Health of the Oceans (HOTO) initiative was focused on addressing a number of issues and challenges affecting Canada's marine environment. Under HOTO, Fisheries and Oceans Canada created a National Centre of Expertise (CoE) in Cold-Water Corals and Sponge Reefs with a mandate of the centre is to improve coral and sponge conservation in Canada. The Centre coordinates the Government of Canada's approach to coral and sponge conservation, supports regional, national, and international conservation efforts, and develops tools and approaches to improve coral and sponge conservation in Canada. Specifically, the CoE chairs a National Governmental Working Group involves three federal departments. The Centre supports the development and implementation of regional coral and sponge conservation strategies in Canada and the establishment of marine protected areas (i.e. Glass Sponge Reefs in Hecate Strait/Queen Charlotte Sound). The CoE has published reference material (e.g. Status Report on Coral and Sponge Conservation in Canada) and requested key science advice on coral and sponge conservation (i.e. significant concentrations of coral and sponge, etc). The Centre has also developed an Intranet Web Application as a tool for marine spatial planning which allows access to coral and sponge data in addition to management layers (i.e. fisheries management areas). The Centre's Communications Plan includes the development of various products to raise awareness of coral and sponge conservation in Canada. For example, our DVD, Diving into the Deep: Coral and Sponge Conservation in Canada is targeted toward the Canadian fishing industry. The oral presentation will outline the role of the Centre in the Government of Canada and the current status of this issue in light of international and domestic commitments to protect these species and other vulnerable marine ecosystems. The author will also highlight some of the challenges and opportunities that await Canada in moving forward on coral and sponge conservation.

11.30-11.45

Deep-Sea Corals: Science Threads in the Tapestry of Conservation

Thomas F. Hourigan[1] (Tom.Hourigan@noaa.gov)

[1] Fan Tsao, NOAA Fisheries Service; Dan Dorfman, NOAA Ocean Service, USA

The United States has embarked on a long-term program to provide sound scientific information needed to conserve and manage deep-sea coral ecosystems. The National Oceanic and Atmospheric Administration (NOAA) has developed a Strategic Plan for Deep-Sea Coral and Sponge Ecosystems and in 2009 launched the Deep Sea Coral Research and Technology Program. The Program integrates 3-year targeted field mapping and research of deep-sea coral and sponge communities with analysis of existing data and supported by a national-level data management infrastructure. The Program is distinguished by its long-term commitment and its focus on management-relevant research. This paper shows how the U.S. Program is weaving together new site-specific field mapping and research with analyses of museum specimens, genetic connectivity, and fisheries bycatch along the whole U.S. Pacific Coast. Together with habitat-suitability modeling, this effort provides spatially-explicit information on geographic scales that can be used by resource managers and is part of a five-year review of efforts to protect essential fish habitat off the coast of Washington, Oregon and California. In the process, new species, range extensions, and species associations have been documented. Off the U.S. Atlantic Coast, the Program has discovered new unprotected *Lophelia pertusa* and *Oculina varicosa* habitats and incorporating information on biogenic habitats into fishery management and marine spatial planning. In 2012 and 2013, field research will expand to Alaska and the Northeast U.S. respectively.

11.45-12.00

A regional high resolution habitat suitability model for *Lophelia pertusa* reefs in Irish waters

Anna Rengstorf*[1] *(a.rengstorf1@nuigalway.ie), *Chris Yesson*[2], *Colin Brown*[1] *and Anthony Grehan*[1]

[1] National University of Ireland, Galway, Ireland
[2] Institute of Zoology, Zoological Society of London, United Kingdom

Habitat suitability models (HSMs) provide useful estimates of deep sea coral distributions. Global analyses for framework-building deep sea corals predict a high probability of coral occurrence along the slopes of continental margins, offshore banks and seamounts in the North-East Atlantic. These predictions are useful indicators of global trends in distribution, but cannot provide the detail suitable for local-scale assessments. In order to support marine management, knowledge on the distribution and extent of coral habitat is needed on much smaller scales. As part of the EU FP7 project CoralFISH we used a maximum entropy algorithm to predict the distribution of *Lophelia pertusa* reefs in Irish waters at a spatial resolution of 0.002° (~200 m grid size). *L. pertusa* occurrence points were assembled from public databases, cruise reports and publications as well as from video footage obtained during three CoralFISH cruises. A set of environmental predictor variables was produced by re-sampling gridded data from the World Ocean Atlas, the Global Ocean Data Analysis Project and the Irish Marine Institute's regional hydrographic model to match the Irish National Seabed Survey bathymetry grid of 0.002° spatial resolution. Terrain derived predictors such as slope, bathymetric position index and rugosity were computed based on multiple analysis windows. The resulting habitat suitability model successfully explained the observed distribution of *L. pertusa* reefs within the Irish continental margin area. The integration of high resolution environmental and terrain derived parameters ensured the identification of suitable habitat on small morphological features (e.g. carbonate mounds) while highlighting areas of unsuitable terrain in areas otherwise indicated as suitable by the prevailing oceanography. Such habitat suitability maps can be used to support management decision making particularly in areas where empirical data is sparse or absent.

12.00-12.15

A global habitat suitability model of deep sea Antipatharia

***Chris Yesson[1] (chris.yesson@ioz.ac.uk)**, Faye Hendry[1] and Michelle L Taylor[2]*

[1] Zoological Society of London, United Kingdom
[2] University of Oxford, United Kingdom

Antipatharia are the only exclusively colonial order of Zoantharia, they have c. 250 species and c.3/4 are found in deep waters (>50m). The deepest coral observation and the oldest recorded coral colony are both Antipatharian. Some species are considered habitat forming and are constituent parts of deep sea coral garden habitats. However, knowledge of the ecology and distribution of these corals remains poorly understood. Here we examine the distribution and habitat preferences of Antipatharia by compiling global distribution data for deep sea Antipatharia. The database includes more than 5000 observations encompassing all 7 families. This data is used to examine the ecological preferences of Antipatharia in conjunction with global grids of environmental and bathymetric parameters. A habitat suitability model is presented to estimate the potential global distribution. Global suitability tracks continental shelf margins and other high-relief features such as the Mid Atlantic ridge. The difficulties of studying deep sea biology means we will never have comprehensive data for deep sea corals. Habitat suitability models provide useful estimates where little or no information is known. We use the global distribution estimates to assess the conservation status of Antipatharia in relation to the marine protected area network.

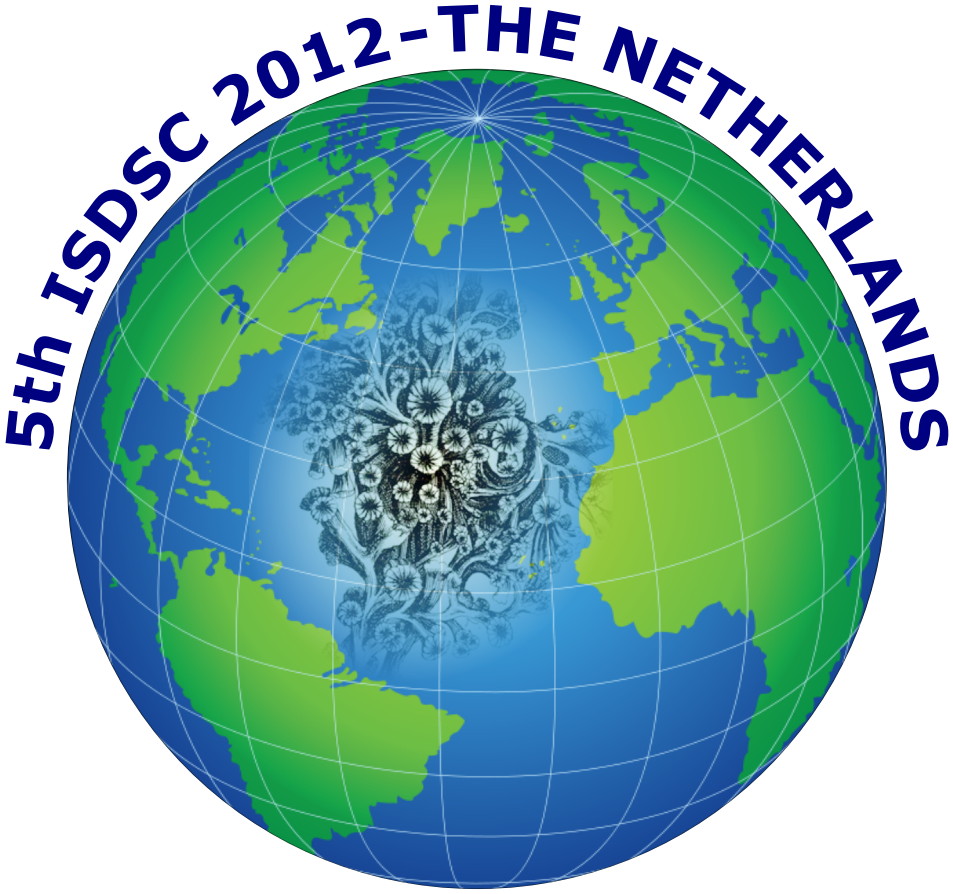
12.15-12.45 [KEYNOTE]

Locating vulnerable marine ecosystems in the greatest wilderness on earth

Andrew J. Davies[1] (andrew.j.davies@bangor.ac.uk)

[1] *Bangor University, United Kingdom*

Predictive habitat models are increasingly being used by conservationists, researchers and governmental bodies to identify vulnerable ecosystems (VMEs) and species' distributions in areas that have not been sampled. Despite improvements in model algorithms, environmental data and species presences, there are still significant limitations in the reliability of this technique, especially in the deep sea. Recent studies have begun to address a key limitation, the quality of data, by using multibeam echosounder surveys and species data from video surveys to acquire high resolution data. Whilst these data are often amongst the very best that can be acquired in the deep ocean, the surveys are highly localised, often targeted towards known VME-containing areas, are very expensive and time consuming. Whilst these local surveys are useful for site-specific management, they are less useful for identifying areas not yet sampled or for influencing regional or basin-scale management. It is impossible to survey whole regions (although Ireland has mapped their entire EEZ) or ocean basins using these techniques, so alternative approaches are required. Predictive modelling in data poor areas is difficult, limited heavily by the quality of data. There is no doubt that the adoption of predictive modelling is increasing amongst researchers who work in areas that are poorly studied. But, there are still significant improvements that need to be made to increase the reliability and thus adoption of this technique.



ABSTRACTS
THURSDAY 5 APRIL

9.00-9.30 [KEYNOTE]

Climate change and deep-sea coral communities: predicting impacts in a data poor environment

Ronald Thresher*[1] *(Ron.Thresher@csiro.au), *John Guinotte*[2], *Stewart Fallon*[3] *and Richard Matear*[1]

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[2] Marine Conservation Institute, USA
[3] Research School of Earth Science, Australia

Climate change has been predicted to have a profound social, economic and environmental impacts globally. Predicting these impacts with confidence is difficult in a terrestrial context, very difficult in shallow water marine environments, and extremely difficult for deep-sea communities. For the last, these difficulties arise from (1) large uncertainties regarding the deep (and shallow) ocean's responses to climate change, compounded by short historical instrumental records against which to calibrate and validate predictive models, and (2) even larger uncertainties with regard to the biological response to these changes in the ocean environments. Deep-sea corals and associated biota are difficult subjects for experimental analyses of environmental tolerances. As a result, such tolerances for the most part need to be inferred, rather then demonstrated from present-day distributions, from proxies and from generalisations derived from studies of related shallow-water taxa. In this talk, we review the efforts we have made over the last several years to fill these gaps for impacts of climate change, in general, and impacts of ocean acidification in particular, on Southern Hemisphere temperate deep-sea reefs. Though not yet complete, the combination of laboratory and field data, and analysis of historical proxies, is beginning to indicate the scale of direct impacts of environmental change on deep-reef communities.

9.30-9.45

Environmental Proxy Development in the deep-sea corals *Corallium sp*. and the Isididae family corals from the southeast of Tasmania

Stewart J. Fallon*[1] *(stewart.fallon@anu.edu.au), *R.E Thresher*[2] *and K.M. Strzepek*[1]

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There is an increasing interest in developing proxy records of oceanographic conditions from intermediate and deep-water environments. Elemental and isotopic ratios incorporated into the calcite skeleton of deep-sea corals have been proposed as a method for obtaining this information. Before elemental proxies can be used, rigorous testing is needed. In this study we examine trace element variability in the deep-sea corals *Corallium sp*. and the Isididae family corals from the southeast of Tasmania. Samples have been dated using 14C for direct comparison of time series between the two groups of corals. Cyclical variations of Ba/Ca are consistent between the two coral groups. Duplicate sections analysed from along the length of the *Corallium* coral reproduce elemental variations of Sr/Ca, Ba/Ca, Mg/Ca. Sr/Ca in the *Corallium* coral suggests water temperatures have been warming over the last few decades.

9.45-10.00

Geochronological potential and patterns of amino-acid racemization in cold-water corals and bivalves

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The organic matrix, which is involved in the precipitation of the calcareous skeletons of cold-water corals and bivalves, does get encased as inter-crystalline matrix. This organic matter can be preserved over long time spans and potentially bears a valuable geochronological archive within its amino-acid fraction. Several amino-acids like e.g. Aspartic acid (ASP) occur in two mirror symmetric forms, the L- and D-form. In living organisms, these mirror-symmetric amino-acids occur to nearly 100 % in their L-form. Through a reversibly process, called amino-acid racemization, this L-form is reversibly transformed into its D-form. With time the ratio of the L- and D-forms reaches a 1:1 distribution. The D/L ratio can hence be used as a relative timescale. The racemization rate is further temperature dependent and is faster under higher temperatures.

In the present study we have used a large set of fossil aragonitic cold-water corals and calcitic bivalves with known calendar ages, to study and calibrate the change of D/L ratios with time. To account for the temperature influence, we have measured the D/L-ratios in a Holocene sample suite from northern Norway (~6°C) and in a Holocene to mid-Pleistocene sample suite from the Mediterranean Sea (~14°C). The corals have previously dated with U-series and the bivalves have been radiocarbon dated.

The D/L ratios of four frequently resolved amino-acids (Aspartic, Glutamic, Alanine and Serine) have been routinely measured with a High-Performance Liquid Chromatograph (HPLC) and show a clear time-progressive change. Our datasets for the last 11 ka further display a clear temperature effect with slower racemization rates at the colder Norwegian sites and faster rates for the warmer Mediterranean sites. Based on the new calibration against their absolute chronological ages, the D/L ratios can now be used to independently infer coral and bivalve ages.

Due to differing racemization rates in warmer interglacial and colder glacial periods the D/L ratios do form characteristic groups for each of the last glacial periods. Since the racemization patterns are similar in bivalves and corals, these D/L groups can now be used to assign ages also to bivalves beyond the range of radiocarbon (>50 ka). First results further show that it might be feasible to establish a D/L based geochronological framework also for mid- to early Pleistocene deposits, by using the combined strength of D/L ratios of multiple amino-acid pairs (e.g. ASP vs. GLU).

10.00-10.15

Sclerochronology of *Primnoa pacifica* from British Columbia, Canada, and Washington State, USA: potential paleoproductivity proxies and geographic variation in radial growth rates.

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Red tree coral, *Primnoa pacifica*, is one of the more common habitat-forming deep-sea gorgonian corals in the Northeast Pacific Ocean, growing in colonies up to 2 m high and living several hundred years. Growth characteristics of *Primnoa pacifica* were studied in Dixon Entrance, northern British Columbia, and the Olympic Coast National Marine Sanctuary (OCNMS), Washington State, USA, based on samples collected in July 2008. To minimize the impact of scientific sampling on coral populations, only dead coral skeletons and dislodged live corals were collected. Ages and growth rates were measured using band counts, and checked against AMS-14C ages of gorgonin rings. Growth band thickness was consistent between the central mixed zone consisting of calcite and gorgonin and the dominantly calcite cortex, implying a constant radial growth rate throughout the coral colony lifespan. Ba/Ca, Mg/Ca, Na/Ca and Sr/Ca ratios in the calcite cortex were measured using radial Secondary Ion Mass Spectrometer (SIMS) transects with a spot size of <20 microns and separation distance of 25 microns. Lack of post-Atomic Bomb radiocarbon in all but one of the gorgonin samples and long radiocarbon reservoir ages in the Northeast Pacific hindered radiocarbon-based estimates of coral ages and growth rates due to wide errors in calibrated age estimates. Average annual radial growth rate of the nine corals analysed ranged from 0.23 to 0.58 mm/yr, with an average growth rate of 0.32 mm/yr in Dixon Entrance and 0.36 m/yr in OCNMS. These growth rates are slightly higher than *P. pacifica* growth rates from the Gulf of Alaska, and more than 4 times the growth rates of sister species *P. resedaeformis* in the Northwest Atlantic. As both Dixon Entrance and OCNMS are areas with high primary productivity and strong tidal currents, we hypothesize that primary productivity, and possibly current strength, drives geographic variation in *Primnoa spp*. growth rates. Mg/Ca and Sr/Ca ratios were inversely correlated in two of the three corals analyzed, and showed evidence of interannual cyclicity. Mg/Ca ratios ranged from 70-136 mmol/mol, and Sr/Ca ratios from 2.04 – 3.14 mmol/mol. Previously published relationships between gorgonian Mg/Ca and seawater temperature cannot account for the variation in Mg/Ca ratios based on modern seawater temperature ranges in the region, which ranged from 5.4-6.9 degrees over the past 70 years. Annual variation in Mg/Ca and Sr/Ca could be related to seasonal changes in precipitation efficiency. Precipitation efficiency is likely a function of short-term fluctuations in coral growth rate, which in turn are related to varying primary productivity. Increased food delivery increases both tissue growth rate and skeletal growth rate in zooxanthellate corals. Seasonal and interannual variations in food availability, controlled by primary production, may drive interannual variation in skeletal growth rate, hence in Mg/Ca and Sr/Ca ratios. Hence Primnoid coral skeletal microgeochemistry may record temporal changes in primary productivity, more than temperature variation. Ongoing research aims to measure geographic variation in *Primnoa spp*. growth rates, measured against two primary variables: primary productivity and bottom current strength within British Columbia waters, other Canadian waters, and elsewhere.

10.15-10.30

Early diagenetic overprint in cold-water coral carbonate mounds: different systems reveal different signatures

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Sub-Recent cold-water coral carbonate mounds provide an excellent opportunity to study the dynamics of early diagenetic processes in mound systems. The interaction between the aragonitic cold-water coral skeletons (as framework builders), the geochemistry of interstitial pore waters, and the alternating siliciclastic to carbonate-rich matrix sediments, creates micro-environments where precipitation (dolomite, calcite, pyrite, gypsum, barite) and/or dissolution (aragonite) prevail. The detailed study of the biogeochemistry of the mound sediments, the mineral fractions and the pore waters, reveal that fluxes in pore water transport and seawater inflow drastically affect the early diagenetic processes in carbonate mounds. On a regional scale fluid seepage can exert a major control on carbonate precipitation and dissolution rates and therefore on the sedimentological appearance of the mound facies. In this study, cold-water coral carbonate mounds from the Porcupine Seabight (SW of Ireland) are compared with those from the Gulf of Cadiz (Moroccan margin) in terms of diagenetic imprints. In the Challenger Mound record, drilled during IODP Expedition 307 aboard the R/V Joides Resolution (Foubert & Henriet, 2009), early differential diagenesis overprints the primary environmental signals. Extensive coral dissolution and the genesis of small-scaled semi-lithified layers in the Ca-rich intervals are the main diagenetic processes affecting (mimicking) the cyclic palaeo-environmental record of Challenger Mound. The low cementation rates compared to the extensive dissolution patterns can be explained by an open-system diagenetic model. Along the Moroccan margins, the sedimentary record of the mounds is affected by a shallow sulfate-methane transition zone (SMTZ) resulting in various intervals containing carbonates depleted in $\delta^{13}C$. Mineral fractions witness changing oxidizing-reducing environments invoking an open-system and dynamic diagenetic model. Different regional areas show the importance of dynamic and open-system diagenetic models. Besides the regional differences – even at close distance, early diagenetic processes in neighboring mound systems may be different. Despite evidences of early diagenesis overprinting the primary environmental record (Foubert & Henriet, 2009), the extent of early diagenetic and biogeochemical processes of carbonate mounds is not yet fully understood. Only through reactive transport modeling the different diagenetic pathways affecting sub-recent cold-water coral carbonate mounds might be better quantified through space and time. Understanding the effect of early diagenetic processes in sub-recent carbonate mounds is a prerequisite to correctly reconstruct the geochemical environmental parameters of the palaeo-record.

References Foubert, A., & Henriet, J.P. (2009) Nature and Significance of the Recent Carbonate Mound Record: The Mound Challenger Code. Lecture Notes in Earth Sciences, Vol. 126. Springer, 298 pp. ISBN: 978-3-642-00289-2.

11.00-11.15

Holocene Reservoir Ages in South Eastern Australia: Chronicles from Deep-Sea Black Corals

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Sea surface reservoir ages must be known to establish a common chronological framework for marine paleoproxies, and are crucial for understanding regional water mass movements. We present a new method to reconstruct sea surface reservoir ages from deep-sea black coral (Anthozoa, Antipathara). Coupled uranium series and radiocarbon measurements were made on black corals from South Australia. Reservoir ages from the mid-Holocene in this region were found to be significantly greater than present day indicating a change in regional circulation. Given the slow growth rates and extreme longevity of black corals, they offer the potential for high-resolution millennial-scale records. By investigating past variability in regional circulation during the Holocene period we will have a good baseline for understanding contemporary natural climate variability. This is critical given that this region has been described as a global "hotspot" because the rate of ocean warming is 3-4 times that of the global average.

11.15-11.30

Gorgonian corals record the ambient seawater neodymium isotopic composition

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The neodymium (Nd) isotopic composition of the aragonitic skeleton of scleractinian deep-water corals is related to the ambient seawater signal (van de Flierdt et al., 2010) and this 1:1 relation has been recently used to reconstruct the water mass circulation in the North Atlantic and in the Southern Ocean (Copard et al., 2010; Colin et al., 2010; Robinson and van de Flierdt, 2009). Motivated by these findings, we have analysed the Nd isotopic composition and concentration of the high-magnesium calcite skeleton of deep-water gorgonian octocorals. These corals are distributed in most ocean basins and are long-lived, representing potential archives of past oceanic circulation at sub-decadal resolution. Corals from the families Isididae (genus *Keratoisis*) and Coralliidae (genus *Corallium*), were retrieved alive from the Atlantic, Pacific, and Southern Oceans as well as from the Mediterranean Sea at water depths between ~500 to ~1300m. Seawater samples from two profiles in the Mediterranean Sea were also collected at the same locations and depths as the coral samples in order to compare seawater Nd isotopic compositions with the coral skeletons. The Nd isotopic composition was obtained using a VG Sector 54-30 thermal ionization mass spectrometer by dynamic multicollection after chromatographic purification. The neodymium concentration was analysed along different tracks parallel to the growth bands using a 193nm laser ablation microsampling system connected to a Varian 820 inductively coupled plasma mass spectrometer. The gorgonian calcite skeletons and the surrounding seawater share equivalent Nd isotopic compositions, which clearly show that these calcite corals are reliable archives of water mass circulation.

Van de Flierdt et al. (2010) GCA 74, 6014-6032.
Copart et al. (2010) QSR 29, 2499-2508.
Colin et al. (2010) QSR 29, 2509-2517.
Robinson and van de Flierdt (2009) Geology 37, 195-198.

11.30-11.45

Water Mass Distribution in the Northwest Atlantic During MIS 3

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Cold water corals have been shown to be useful archives of rapid changes in ocean chemistry during the last glacial cycle. Their aragonitic skeleton can be absolutely dated by U-Th data, freeing radiocarbon to be used as a water mass proxy. For certain species of deep-sea corals, the growth rate allows time resolution that is comparable to ice cores. An additional proxy is however needed to exploit this opportunity and turn radiocarbon data into rates of ocean overturning in the past.

Neodymium (Nd) isotopes in seawater can serve as a quasi-conservative water mass tracer. Applied to reliable archives, water mass configurations and ocean circulation patterns on millennial and million year time scales can be reconstructed. In previous studies it has been shown that at least six different genera of modern cold water corals (*Caryophyllia*, *Desmophyllum*, *Enallopsamia*, *Flabellum*, *Lophelia*, *Madrepora*) from global locations record ambient seawater Nd isotopic compositions. Furthermore, stepwise cleaning experiments on fossil cold water corals revealed that careful physical and chemical cleaning is necessary to acquire a signal of past seawater Nd isotopes.

Here we will present preliminary results on the Nd isotopic composition of cold water corals (*D. dianthus*) from the New England seamounts that grew in intermediate to deep waters (1200-1700m) during marine isotope stage 3 (MIS 3). Initial data indicate a significant shift towards lower Nd isotopic compositions during MIS 3 compared to the Holocene. Such values can be interpreted to represent admixture of Southern Ocean waters in the intermediate depth North Atlantic (assuming an unchanged endmember composition for glacial northern component waters). New data will constrain whether this shift is a robust feature, and possible interpretations will be considered in the context of existing palaeoceanographic data.

11.45-12.00

Deep-sea coral records of surface water properties in Gulf of Mexico and the southeastern United States over the last millennium

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Deep-sea corals are a relatively new and unique paleoclimate and paleoceanographic archive that can extend our observations of ocean physics and climate into the relatively unexplored ocean interior. In this study we use radiocarbon measurements to investigate growth rates and age distributions of deep-water black corals (*Leiopathes sp.*) in the Gulf of Mexico and the southeastern Unites States. Results from five specimens show that these animals have been growing continuously for at least the last two millennia, with growth rates ranging from 8 to 22 μm yr-1, very similar to specimens from the Pacific Ocean that exhibit extreme longevities (~4000 years) and very slow growth rates (~4 μm yr-1). Results from SEM work to image growth rings (90x and 900x) and measure relative trace elements concentrations are also reported. Both independent observers visually counting growth rings on the SEM images and a tree ring counting software program were used. Both methods yield counts of growth rings in good agreement (typically within the 14C uncertainty and a 10% counting uncertainty) with the radiocarbon results. Peaks in iodine concentration associated with the glueing regions of the growth bands are also in good agreement with the radiocarbon results suggesting annual ring formation. The presence of bomb-derived 14C in the outermost samples confirms sinking particulate organic matter (POM) as the dominant carbon source and illustrates a clear link between the deep-sea and surface ocean. The robust radiocarbon age results allow for the development of reliable age models that can be applied to multi-decadal paleoclimate reconstructions derived from the skeletal geochemistry and the independent annual growth band chronometers allow for the use of the radiocarbon results as tracers of ocean circulation. In this study we also use discrete stable isotope samples to better understand the combination of biological and physical factors controlling the biogeochemistry of these deep-sea coral skeletons. Changes in the geochemical records are interpreted to reflect changes in the surface water environment. The $\delta^{15}N$ and $\delta^{13}C$ signatures most likely reflect food source which is recently exported particulate organic matter with the $\delta^{15}N$ tracing trophic level dynamics and sources of nitrogen at the base of the food web. $\delta^{13}C$ may be useful as a tracer of carbon dynamics in the surface ocean. In GOM of specimens we note increase variability in both $\delta^{15}N$ and especially in $\delta^{13}C$ beginning ~900 years ago. $\delta^{15}N$ also shows a gradual increase over the same period with a 1‰ increase in the last century perhaps indicative of increased nitrate inputs into the GOM from the Mississippi river. These records can be used to infer changes in surface water conditions related to nutrient loading, eutrophication, and hypoxia in the Gulf of Mexico over the last millennium.

12.00-12.15

'The growth history of a shallow inshore *Lophelia pertusa* reef: the Mingulay Reef Complex'

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Two vibrocores from the Mingulay Reef Complex (~56°N, 7°W and 120-190 m water depth) have been studied to reconstruct the growth history of a shallow inshore *Lophelia pertusa* reef. Growth history was investigated using U-series dates on *L. pertusa* fragments from cores +56-08/929VE and +56-08/930VE (3.61 m and 5.25 m recovery, respectively). The 40 acquired dates show that coral fragments within the cores were in chronological order spanning the mid- to late-Holocene (1.75 - 4.29 kyrs). These two sediment cores have been intensively dated over a short period of time enabling to define accurately the accumulation rates of the reef and define periods of interruption/reduction of its growth. The sediment cores show exceptionally high accumulation rates around 5 - 6 mm yr^{-1}. These are at least 20 times greater than accumulation rates estimated for coral carbonate mounds from the European continental margin but are more comparable with estimates from other equivalent inner shelf reef systems such as offshore Norway. The accumulation rates of the Mingulay Reef Complex are also temporally variable and slow during 3 episodes: 1.8 - 2.7 kyrs, 3.3 - 3.5 kyrs and 3.8 - 4.2 kyrs. In order to date the reef surface, 20 samples of dead cold-water coral fragments were collected from random locations across the surface of the complex by video-grab. These surface samples were radiocarbon dated and show that mound-like structures from Mingualy stopped their growth at 1.9 - 2.3 kyrs, 3.2 - 3.3 kyrs and 3.8 - 3.9 kyrs ago. Together, our results suggest that although there is reef growth today, the mound-like structures appear to have begun re-growing 1.75 kyrs ago and there were interruptions/reduction in growth around 1.8 - 2.7 kyrs, 3.3 - 3.5 kyrs and 3.8 - 4.2 kyrs BP. Environmental factors, such as temperature, salinity or food availability are likely to restrict *Lophelia pertusa* distribution. We hypothesize that hydrological changes that occurred within the northeast Atlantic during the mid to late-Holocene might have affected cold-water coral growth within the Mingulay Reef Complex (and potentially the entire NE Atlantic) at least 3 times over the past 5 kyrs and that we are presently in a situation conducive to coral growth in this area.

12.15-12.30

Benthic foraminifera associated to a cold-water coral reef from Lopphavet, Northern Norway

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The distribution of cold-water coral (CWC) ecosystems distribution is mainly controlled by environmental parameters such as salinity, temperature and nutrients availability (Roberts et al., 2006). Cold Water Coral settlement in Northern Norway is strongly related to the outlet-glaciers of the Fennoscandian Ice-sheet and dating of known structures show clearly post-glacial ages. A detailed micropaleontological study was performed on a 282 cm long gravity core (POS391 559/3) recovered at 237 m water depth on a CWC reef in the area of Lopphavet, Northern Norway. The lithological description documents high abundances of *Lophelia pertusa* from the top of the core down to 67 cm. A 20 cm thick layer containing abundant dropstones characterizes is observed at the base of the coral-rich interval. The remaining sediments consist of fine silt without any apparent structures except for two thinner (up to 4 cm) dropstone layers at 184 cm and 274 cm. AMS 14C dating on the benthic foraminifera *D. coronata* provides ages of 6800 ± 150 yr BP for the top of the core, 10725 ± 20 yr BP for the interface corals/dropstones and 15300 ± 55 yr BP for the base of the core. Ninethy-four samples, with a 3 cm resolution were washed using the 63-125µm, 125-250µm and >250µm mesh sieves and the three obtained size fractions were quantitatively studied at species level for their benthic foraminiferal content. One hundred and thirty-five benthic and seven planktonic species were identified. Univariate and multivariate statistics were applied to the data set using the Software PRIMER 6. Diversity indices (e.g., Shannon-Wiener and Fisher-alpha) show that benthic foraminiferal diversity is higher within the coral-rich layer. The Bray-Curtis Similarity Term Analyses highlighted that assemblages can be divided in three groups according to the three sedimentary facies, as also shown by the distribution patterns of selected species in Figure 1. The distribution of benthic foraminiferal indicator species of oxygen, phytodetritus and organic carbon flux (Murray, 2006) shows that a clear and major shift in the oceanographic settings occurred during the Holocene in North Atlantic. Epifaunal attached species are present throughout the core, whereas, the species *Discanomalina coronata* only occur in the coral-rich interval supporting the hypothesis that it may be considered as a bioindicator for active CWC reefs/mounds (Margreth et al., 2009). A preliminary investigation of ostracod assemblages shows that these crustaceans may be also used to characterize on- and off- CWC reef facies.

References: Margreth, S., et al., 2009. Deep-sea research I, 56, 2216-2234 Murray, J. W., 2006. University Press Roberts, J. M., et al. 2006. Science, 312, 543-547

13.30-14.00 [KEYNOTE]

Historic distributions of deep-sea corals and their links to climate

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Scleractinian coral populations exist in every ocean basin from shallow reefs in the tropics to the depths of the Southern Ocean. These corals have aragonite skeletons and when they die their skeletons can be preserved for hundreds of thousands of years forming a long-term record of their biogeography. Dating these corals has the potential to allow us to test hypotheses that link climate change to major changes in the coral populations. We have collections of fossil corals from the Atlantic, Pacific and Southern Oceans, including more than 20,000 solitary deep-sea coral fossils collected on three cruises from locations that cross the Drake Passage (Southern Ocean) with a depth range of 120-2941 m. In order to examine long-term ecosystem regime shifts we have radiocarbon dated hundreds of solitary scleractinian corals and lesser numbers of colonial corals. For example, in the Southern Ocean we have examined corals from four distinct locations crossing the major polar frontal zones; Burdwood Bank on the South American continental shelf, Sars Seamount in the Antarctic Circumpolar Current, and two sites south of the Polar Front, Interim Seamount and Shackleton Fracture Zone. We focused on four species of coral: *D. dianthus*, *G. antarctica* (a species that has never been sampled before in this region), *B. malouinesis* and *F. curvatum*. A subset of more than sixty of these corals were also dating using the decay of uranium to thorium with calendar ages ranging from modern to quarter of a million years before present. Within this age range there are clear changes in the distributions of the corals, both by location and by depth. Similarly we have dated populations of corals from the Pacific and Atlantic oceans, and they also show distinct changes in population structure over time. The differences and similarities in these coral-based ecosystems are explored with reference to the changes in climate and oceanography that occurred in the oceans during the major transition from glacial to interglacial conditions. As a major part of this effort we have used chemical signatures contained within the coral skeletons themselves to investigate changes in ocean chemistry in the past. These data are used to explore interactions within the climate system, allowing us to make direct comparisons between oceanic and atmospheric data because of the absolute uranium series based dating of the coral skeletons. Eventually we hope to be able to combine our age surveys with paleoclimate data to address questions on the major drivers behind ecosystem regime changes in coral habitats.

14.00-14.15

Dual Control on The Distribution of Newly Discovered Large Mounds on The Slopes of Great and Little Bahama Bank

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Newly acquired multibeam data along western Great Bahama Bank (GBB) and north of Little Bahama Bank (LBB) document the abundance and rich diversity of cold-water coral (CWC) mounds in the Florida-Bahamas region. In addition, the aerially extensive data sets place the CWC mound distribution into the context of slope morphology, slope processes and basinal current patterns. Cores from the flank and base of a 110 m tall mound prove the un-cemented nature of the mound living in a high-energy environment. The Straits of Florida is a large CWC province with extensive mound fields in a variety of settings. A recent study using high-resolution data collected with an Autonomous Underwater Vehicle (AUV) and combined with submersible observations (Grasmueck et al., 2006; Correa et al, 2011a), documents variable controls on the CWC mound distribution, height and architecture across the Straits of Florida. While this AUV study relied on high-resolution bathymetric, subsurface and hydrodynamic data from a total area of 80km^2, the new multi-beam bathymetry data covers 5500 km^2 and 5000 km^2, respectively. This large aerial cover allows assessment of the CWC mound distribution and height within the entire slope-basin system. The new multi-beam echo sounder data image a very large number of giant cold-water coral mounds along the slopes of GBB and fewer north of LBB. Along the slope of GBB, the abundance and distribution of CWC mounds vary from north to south, with the largest abundance north of Bimini. Along both slopes, the mounds preferably grow on ridges, debris from mass wasting, and sides of canyons. At the toe-of-slope, the downslope alignment of mounds gives way to a north-south oriented mound alignment. These basinal mounds are generally smaller (~20m), but very regular in height and distribution. This dual mode distribution is interpreted to be the result of two competing processes. Along the slope, the distribution of the mounds is controlled by slope processes that produce topography for mound initiation, whereas currents control mound distribution and orientation in the basinal areas. A 3D CT scan of a 7.03 m long core of the CWC mound reveals a network of growing corals with sediments between coral frameworks, corroborating the growth model put forward by Mullins et al. (1981). The core consists of soft layers of boundstone and floatstone with high content of the cold-water coral alternating with 7 wackestone layers. The onlapping sediments, recovered in a 3.26 m core from base of the mound in 807 m water depth, consist mainly of very coarse, sand-sized pteropod grainstone, in which some grains are more than 6 mm in diameter. Planktonic and benthonic foraminifera, sponge spicules and few echinoderms make up the sand size fraction. The core displays abundant inclined and cross bedding that indicates a high-energy bi-directional current regime within this CWC mound complex on the slope of GBB.

14.15-14.30

Cold-Water Coral carbonate mounds as palaeo-archives: the Plio-Pleistocene sediment record from the Challenger Mound (NE Atlantic)

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10 Department of Geosciences, University of Massachusetts, USA
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During IODP Expedition 307, the first (and so far only) complete sequence through a cold-water coral carbonate mound was successfully drilled. After decades of research on contemporary to sub-recent coral carbonate mound environments, the complete recovery of the Challenger Mound record, sampling one of the large mounds along the Irish sector of the NE Atlantic continental margin (eastern Porcupine Seabight; Belgica mound province), allowed for the first time the investigation of long-term mound development, from mound initiation to decline. Here, we present an overview of the palaeo-environmental (i.e. hydrodynamic, oceanographic and climatic) signal captured in the entire Challenger Mound sequence (Hole U1317E). A high-resolution multi-proxy characterisation of the ca. 155m long mound matrix sediment record was conducted, encompassing a wide array of sedimentological, mineralogical, geochemical and stratigraphic techniques. These included, amongst others, siliciclastic particle-size analysis, X-ray diffraction phase quantification, isotopic fingerprinting of target elements for provenance purposes, calcareous nannofossil and planktonic foraminifer biostratigraphy and assemblage counts. In this way we aimed to (1) identify the controls on Challenger Mound development throughout the different phases of its entire Plio-Pleistocene to recent build-up, and (2) assess the unique character of coral carbonate mounds as recorders of Quaternary palaeo-environmental change at intermediate water depth in the NE Atlantic. Overall, Challenger Mound development shows a strong affinity to the general climate variability of the Northern Hemisphere, although not being completely in phase with it. The major oceanographic and climatic rearrangements of the Plio-Pleistocene, such as those associated with the Late Pliocene/Early Pleistocene intensification of continental ice-sheet development (ca. 2.75 – 2.55 Ma)1 or the orbital frequency changes during the mid-Pleistocene climate transition (ca. 1.2 – 0.6 Ma)2, seem responsible for the two significant thresholds in Challenger Mound development: its Late Pliocene origin and its Middle-Late Pleistocene to recent decline. However, local influences such as proximal (British-Irish) ice-sheet dynamics and on-mound changes in cold-water coral density seem to have a stronger control on Challenger Mound development and may have induced the offset between global climate and Challenger Mound proxy record variability. On the other hand, owing to this, a unique, high-resolution palaeo-record of regional Early-Pleistocene environmental change (including early British-Irish ice-sheet development3) is preserved in the lower Challenger Mound, covering a period that is not recorded in the general sedimentary sequence of the area. The Challenger Mound record, albeit with restricted Late Quaternary preservation, highlights the potential of coral carbonate mounds as excellent palaeo-recorders, providing us with unique records from 'complex' continental margin environments.

1: e.g. Maslin, M.A., et al., 1998. The contribution of orbital forcing to the progressive intensification of Northern Hemisphere glaciation. Quaternary Science Reviews 17, 411-426.
2: e.g. Clark, P.U., et al., 2006. The middle Pleistocene transition: characteristics, mechanisms, and implications for long-term changes in atmospheric pCO2. Quaternary Science Reviews 25, 3150-3184.
3: Thierens, M., et al., 2011. Ice-rafting from the British-Irish ice sheet since the earliest Pleistocene (2.6 million years ago): implications for long-term mid-latitudinal ice-sheet growth in the North Atlantic region. Quaternary Science Reviews, 10.1016/j.quascirev.2010.12.020.

14.30-14.45

Carbonate budget of cold-water coral mounds: First results from the Norwegian and Mediterranean Seas

***Jürgen Titschack[1,2] (titschack@uni-bremen.de)**, H.G. Fink[1], M. López Correa[2,3], R. De Pol-Holz[4], N. Joseph[2,3], D. Hebbeln[1] and A. Freiwald[2]*

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Cold-water coral ecosystems are a global carbonate factory, which occur from low to high latitudes and from 9 to over 1000 m water depth. So far little is known on their carbonate budget and their role in the global carbonate-, hence the CO_2-cycle. The focus of the present study is the evaluation of the carbonate storage capacity of cold-water coral ecosystems in different environmental settings. Therefore, the carbonate budget of three Norwegian cold-water coral mounds from a fjord, an inner and outer shelf setting and three cold-water coral occurrences (ridge, slope and cliff setting) from the Mediterranean Sea were studied. The combination of X-ray computed tomography with XRD (from the matrix sediment) data allows the discrimination of different carbonate sources, so that the benthic carbonate (dominantly aragonite and high magnesium calcite) and the planktonic carbonate (dominantly low magnesium calcite) production can be evaluated separately. The comparison of sediment cores from cold-water coral mounds and adjacent 'off-mound' areas allows their evaluation as carbonate sink.

14.45-15.00

KONGSBERG

17.30-18.00 [KEYNOTE]

What do cold-water corals tell us about climate change and ocean circulation?

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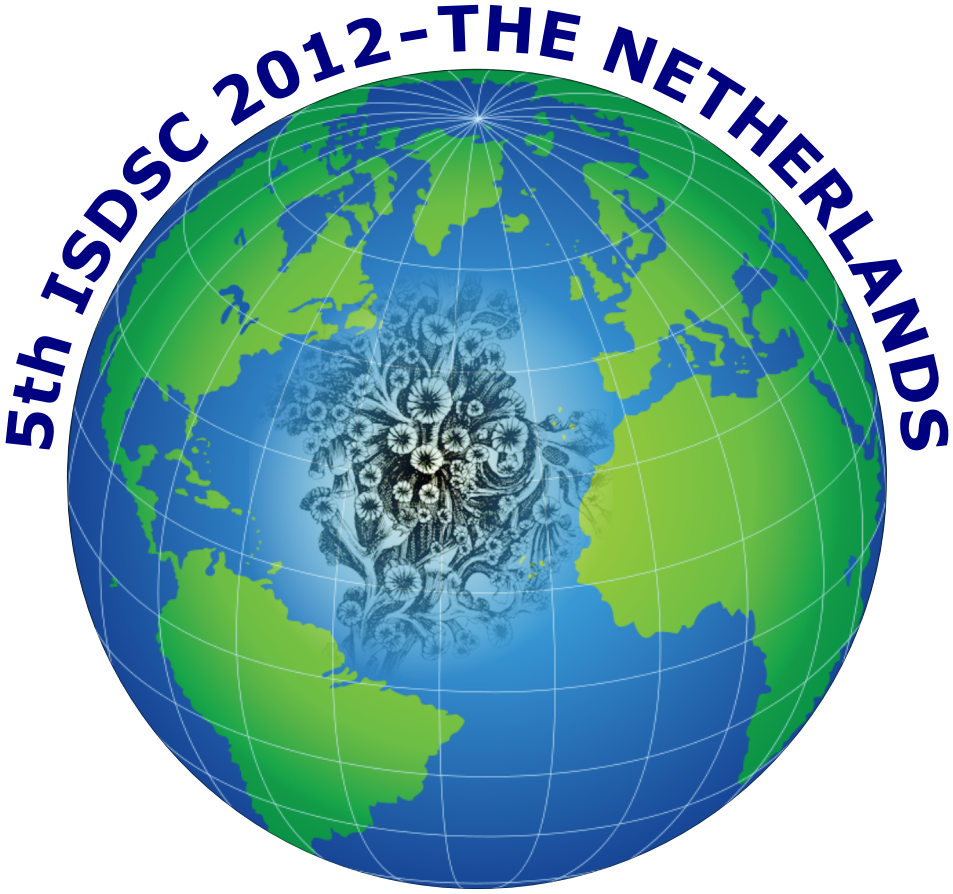
In the late 90's deep water corals known since very long to fisherman and marine biologists came into the focus of climatologists. Stable C and O isotope measurements on their skeletons had shown significant changes in deep water temperatures across a rapid climate change event. The main focus was set however a year later by the finding that coupled U-series and 14C ages provided a measure of rapidly changing deep water ages, i.e. mid-depth ocean reorganization, during rapid climate change events. The oceans are the largest carbon reservoirs and play a crucial role in the global heat transport, hence discovering a new a accurately datable recorder of the deep ocean that has the capacity of recording ocean circulation changes on annual scales over thousands of years seemed a long awaited toolbox to resolve pressing question on past ocean dynamics. However, every start is driven by enthusiasm for the new but paved with difficulties. Quite some effort is needed getting corals covering the time and location of interest. Moreover, conducting two complicated and still expensive measurements (MS - U-series and AMS - 14C dating) to get one number is not as efficient as a simple stable isotope measurement on foraminifera for example. In addition, so called vital effects steering isotope fractionation during the buildup of the skeletons took away some excitement about temperature reconstructions and most other classical tracers were likely to be affect by the organism's complex calcifying mechanism. It is solely 15 years since the initial findings but fortunately isotope geochemistry and seabed observing tools have been revolutionized and the number of dated corals and geochemical tracers increase quickly every year. Some fundamental questions on ocean circulation changes have been answered and the ecosystems themselves have appeared of increasing interest as they are under environmental and climate pressure. Here, it will be shown how corals allowed reconstructing the mid-depth North Atlantic gyre dynamic from radiocarbon and neodymium isotopes, how accurate temperatures can be reconstructed and what corals may tell about ocean acidification. Other processes affecting the ocean dynamic and carbon budget will be further covered such as surface productivity, oxygen level, fresh water discharge, local volcanism and water mass stratification.



ABSTRACTS
FRIDAY 6 APRIL

9.00-9.30 [KEYNOTE]

Carbonate Mounds: from Paradox to World Heritage

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Over fifteen years of investigations of giant carbonate mounds in the modern ocean have provided a wealth of information about the natural environment of such mounds and about potential controls on their development, yet some fundamental questions about their origin and significance remain conjectural. In many aspects, carbonate mounds are giant paradoxes. An interesting observation is that over one hundred fifty years of investigations of giant carbonate mounds in the fossil record have led to a similar *status questionis*, yet approached through different pathways, and viewed from different perspectives.

In a way, both science communities involved have opted for highly complementary strategies. While the study of Recent carbonate mounds builds upon an unprecedented and focused deployment of the highly sophisticated, multidisciplinary analytical approaches of modern oceanography on selected sites, within a highly confined time window in Earth's history, the visitors of the Ancient mounds largely built upon discipline-selective approaches on observational spaces limited by the availability of outcrops, however along virtually the whole evolutionary tract of Life on Earth.

The complementary nature of these approaches invites for convergence. The international network Cocarde forges opportunities for these communities to meet and confront ideas and paradoxes, in joint actions of pedagogic value on key sites of interest, to jointly breed innovating operational strategies in both domains and to spark fresh insights – for the advancement of Science and for the benefit of Industry.

A recent initiative is the development of a unique set of exceptional carbonate bio-construction settings in Morocco, which spans the whole Phanerozoic and links with active offshore natural laboratories on Recent mounds, towards a potential qualification as World Heritage route under the terms of reference of the UNESCO World Heritage convention, as this set truly represents *outstanding examples representing major stages of Earth's history, including the record of Life, significant on-going geological processes in the development of landforms, and significant geomorphic and physiographic features.*

In addition, the remarkable occurrence along this "Voie Royale des Monts Carbonatés du Maroc" of imperial cities already recognized as UNESCO World Heritage sites offers a unique opportunity to blend mound science with culture and history, thus shaping a "broadband" heritage route of high societal interest.

9.30-9.45

A case of coral-knolls potentially linked to deep seepage: Geological and geochemical approaches of deep-coral buildups from the Melilla Mound Field (Alboran Sea, Western Mediterranean)

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Remarkable deep-water coral buildups develop extensively in the Moroccan margin of the Alboran Sea forming the Melilla Mound Field (MMF). The MMF lays at water depths from 250 to 490 m, occupies the seafloor for more that 800 km^2, and represents a significant case of cold-water coral carbonate factory in the Western Mediterranean. Swath bathymetry and seismic profiles show their morphology, internal structure and relationships with the substratum. Sampling proves the knolls consist of muddy calcareous-clayed sediments baffled by coral frameworks (*Lophelia pertusa*, *Madrepora occulata*, *Caryophyllia sp*, *Desmophyllum sp*). Mounds exposed at the seabed are dozens of round, elongated or branched buildups (100–250 m wide and 2-3 km long) and spectacular ridges (up to 10 km in length), rising up to 250 m and surrounded by deep moats. On seismic-acoustic profiles, buried or partly buried mound-clusters appear as elongated and domed families of connected buildups (transparent acoustic facies) with dome-size increasing with depth. Some mounds nucleated on former ones so that mound constructions built through time by at least three growth phases. Sedimentary patterns suggest that mounds built-up during sea-level drop or slope-uplifting conditions at sites where contour currents create pervasive dynamic current-flows. Radiocarbon dating gives coral ages ranging from 1.000 BP to 30.000 BP years. Extrapolations based on accumulation-rate estimates versus major mound thickness suggest that the coral buildups start to develop during the Pleistocene. Down-core geochemical profiles from baffled sediments assess variations in coral habitat indicators (i.e., contrast in Sr/Ca, U/Th, Ba/Al, Si/Al ratios) that point to notable changes on siliciclastic input, organic-matter content, nutrient flux, and red-ox conditions during mound growing. New results on CTD water-sampling and pore-water geochemistry (nutrients, biomarkers, alkalinity, salinity, methane, sulfate, sulfide) from on- and off-mound sites shed light on fluid influences for the location, origin and evolution of the MMF. Furthermore, recent faulting beneath the buildups, mound arrangement, and bending patterns of coral-ridges suggest fault-associated seabed mounds in the MMF. Therefore, the initiation and development of the MMF is thought influenced by deep-fluid migrations, in addition to the climatic, oceanographic and productivity controls generally accepted for other deep-water coral knoll settings. The Alboran Sea is proved as an area of mud volcanism, pockmarks, and hydrocarbon venting through the seafloor.
Acknowledgements: Projects GASALB-CTM2009-07715, TOPOMED-CGL2008-03474 and CONSOLIDER-CSD2006-00041 (MICINN and FEDER funds, Spain).

9.45-10.00

Bedload Sediment Transport prevents Colonization of Sand Dunes and controls Distribution of Biogenic Cold Water Coral Ridges

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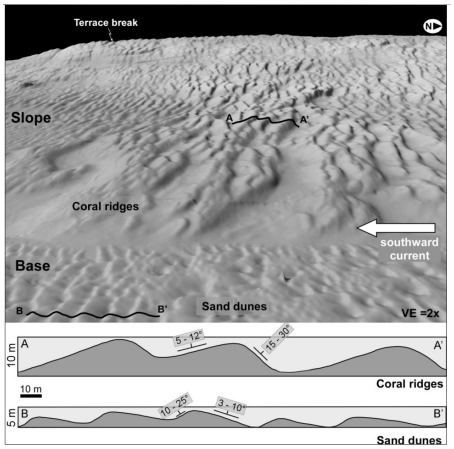
At the base of the Miami Terrace in 630-870 m water depth a 20 km^2 field of cold-water coral ridges is juxtaposed by a carbonaceous sand dune field. The key question addressed in this paper is whether corals are the ridge constructors or just superficial drapers colonizing the sand dunes. An AUV survey consisting of multibeam bathymetry and backscatter, sidescan sonar, chirp subbottom profiler and ADCP bottom currents provides 0.5 to 3m grid resolution maps of both coral ridges and sand dunes. The AUV data were ground truthed with five Johnson Sealink-II submersible dives.

The integrated data analysis shows that the coral ridges are entirely bioconstructed features based on the following evidence: 1) Morphology: The steeper side of the coral ridges faces the southward flowing bottom current (Figure 1). The asymmetric sand dune profiles face in the opposite direction. 2) Internal acoustic character: The coral ridge material consists of coral rubble floatstone allowing propagation of acoustic energy to image the underlying Miocene unconformity and clinoforms. In contrast, the coarse sand dune material consists of hollow pteropods. They absorb the acoustic energy and prevent imaging below the sand dunes. 3) Based on the subbottom profiles the coral ridges are independent of antecedent topography. If sand dunes were the cores of the coral ridges, they would influence the coral mound internal structure and their topography. 4) No active bedload transport on live coral ridges: Small scale current ripples are only found on the surface of sand dunes and on the upper terrace level where linear sand streaks smother remnants of dead coral ridges. 5) Troughs between live coral ridges are filled with cohesive muddy sand. In contrast, the sand dunes are composed of coarse sand. Maximum current velocities are 0.4-0.5 m/s for both domains but current direction variability is higher within the coral ridges on the slope.

Despite the quite similar environmental parameters within the 27 km^2 surveyed area, the boundaries between coral colonization and barren sand dunes are meter sharp (Figure). The key factor determining active coral mound ridges is the lack of bedload sediment transport. Mapping the boundary of active bedload sediment transport requires meter resolution sonar surveys combined with ground truthing and sampling. As cold-water corals rely on currents for food delivery there is a delicate balance between conditions suitable for coral growth and smothering by bedload sediments. When corals find a suitable environmental window they build their own topography optimized for nutrient uptake from the prevailing bottom current regime.



10.00-10.15

Decoupled Holocene Coral Growth in the Strait of Sicily (Central Mediterranean)

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Live cold-water coral (cwc) communities with *Lophelia* and *Madrepora* have been identified in the Strait of Sicily (Central Mediterranean) next to the volcanic edifice of Linosa Island. As documented in 2006 by ROV images (cruise M70-1 of RV Meteor, ROV Quest), these healthy and diverse coral grounds occur in a depth range of 669-679 m. Recently, a series of small-sized but widespread *Madrepora*–dominated coral mounds have been identified, imaged by ROV and sampled on the sedimentary margin immediately southeast of Linosa at ca. 340 m during cruise DECORS onboard RV Urania. All stony corals from such mounds are dead but still unburied and often in growth position. U-series dating of *Madrepora* reveals that these reefs were alive until ca. 6000 yrs BP. Somewhat puzzlingly, this sector of the Strait of Sicily next to Linosa contains therefore both live and recently-dead cold water coral communities distributed at contrasting depth ranges. This observation calls for a mechanism responsible for the demise of the shallower *Madrepora* coral reefs while apparently deeper colonial scleractinian growth remains unaffected. The observation that the dead mounds are exposed permit to discard excess silting as a potential cause for their death, as it is the case on other Mediterranean margins. Episodic limited oxygen supply in the water column has been recently invoked as another important control mechanism for the survival of Mediterranean cwc (H. Fink, in review). However, this would not easily explain why deeper settled corals at Linosa are still lush while their counterparts were lethally impinged. A possible scenario to account for the shallower corals death might envisage a significant decrease in the strength of currents (and related nutrient load) bathing this bathymetric part of the Linosa margin. The present somewhat sluggish hydrodynamic condition seems also supported by the lack of any strong bedform evidence marking significant bottom energy. Another possible scenario might involve a rise in seawater temperature above the physiological threshold for this species at shallower depths at ca. 6000 yrs. Although no definitive argument does exist at present to unambiguously single out a precise forcing mechanism, it is interesting to notice the occurrence of decoupled coral growth along a bathymetric gradient at the same site. In order to unravel the possible mechanisms leading to this decoupled coral growth we are currently measuring neodymium isotopes and trace elements in living and fossil corals. The geochemical investigation will also enable to reconstruct seawater temperature and water mass circulation along the Strait of Sicily.

10.15-10.30

What lies beneath? Compound Specific Isotope Analyses reveals shifting oceanographic regimes in Southeast Australian waters.

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[2] CSIRO Marine and Atmpospheric Research, Australia

Southeast Australian waters have been identified as climatically sensitive, with surface waters warming 3-4 times that of the global average. Key uncertainties remain as to how oceanic feedback mechanisms and ecosystems will respond to current anthropogenic perturbation. Nitrogen isotope geochemistry is a common tool used to assess environmental change and trophodynmaic histrory. However, the interpretation of this isotopic signature can be difficult in mixed tissue samples due to multiple signals, and sources, being combined. To overcome this, we have used compound specific isotope analyses (CSIA) of individual amino acids to provide an internal index of trophic enrichment. Preliminary studies of the organic nodes of deep-water bamboo corals (*Lepidisis spp*.) reveal that while bulk isotope analyses of the node detect little change beyond intra-/inter species variability and no long-term trends, CSIA suggests a steady increase over time in trophic level and heterotrophic reprossessing of the coral's food source. CSIA thus reveals changes in trophodynamic structure in the region that could logically be a response to the poleward shift of the subtropical regime. The methods and caveats involved in these analyses are detailed in the presentation, which could prove a valuable general tool to decipher the influence of natural versus anthropogenic climate forcing.

11.00-11.15

Cold-water coral ecology in the Cap de Creus submarine canyon (northwestern Mediterranean): 7 years of multidisciplinary research

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[5] ZMT, Germany

Since 2005 a multidisciplinary team of marine researchers has investigated Cold-water coral (CWC) communities at the Cap de Creus submarine canyon (NW Mediterranean) in the frame of National and International research projects. Today, after 7 years of investigations, our knowledge on this underwater canyon, close to the sea village of Cadaqués and reaching more than 2200 m water depth, has significantly improved. We are now much more familiar with the hydrodynamics and physical characteristics of the locations and the substrate, which harbor the CWC populations. Furthermore, remotely operated vehicles (ROVs), and especially the research submersible JAGO (IFM-GEOMAR) also allowed not only for the acquisition of high quality images and video records, but also made it possible to study CWC occurrences, abundances and distribution patterns. These state-of-the-art technical tools also enabled the non-invasive sampling of selected specimens, as well as the study of planktonic communities close to the coral populations. In 2005 we started to maintain live specimens of different CWC species in aquaria, of which many are still alive at present day. Those specimens allowed diverse short and long term experiments since 2006. The outcomes of these studies increase our understanding of CWC ecophysiology, in particular feeding ecology and growth, as well as of the potential effects of climate change on these animals. In this presentation we would like to summarise the research conducted during 7 years of work in a multidisciplinary team, which has grown and developed by adding new expertise and young scientists through time.

11.15-11.30

Cold-water coral communities: Hotspots of carbon processing along continental margins

Dick van Oevelen*[1] *(d.vanoevelen@nioo.knaw.nl), *Cecile Cathalot*[1], *Tom Cox*[1], *Marc Lavaleye*[2], *Gerard Duineveld*[2], *Tina Kutti*[3], *Jan-Helge Fosså*[3], *Karline Soetaert*[1] *and Filip Meysman*[1]

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[3] Institute of Marine Research, Norway

Cold-water corals form complex 3D habitats on hard substrates at places of elevated current velocities along the continental margin. The high filtration capacity of the reef community implies that these reefs may be important sites of faunal biomass and carbon mineralization along the margins. Traditional methods to measure the community respiration of benthic communities, i.e. closed chamber incubations or microsensor profiling, are challenging and prone to artefacts in complex cold-water coral habitats. Therefore we applied the novel non-invasive Eddy correlation (EC) technique to measure community respiration at two reefs within the Traena reef complex (Norwegian Shelf). The EC system was mounted on a frame that was positioned 20-30 meter behind the head of the reef. Video observation by ROV confirmed the correct positioning of the frame. Respiration rates for sediments outside the reef were low and agreed well between incubation chambers and EC (2.96±1.0 and 5±4 mmol C m 2 d^{-1}, respectively). Respiration rates on the reef were substantially higher than off-reef sediments, with 178±21 and 146±28 mmol C m 2 d^{-1} as measured with the EC. In comparison with respiration rates from open slope sediments, this suggests that respiration rates of cold-water coral communites are 3 - 38 times higher, making their contribution to organic carbon processing is substantially larger than expected from areal coverage alone. A preliminary estimate for the Norwegian Shelf suggests that cold water-coral communities contribute ~11% to the total organic carbon processing in sediments, which emphasizes their role as hotspots of carbon cycling.

11.30-11.45

Comparative net prey capture rates of a selection of Scleractinia species under various environmental conditions

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The ability of a filter feeding species to catch food from suspension is essential for growth and development. As has been observed in tropical coral communities and elsewhere, there can be great variability in capabilities of species to successfully feed under different environmental conditions. Here we report on the net prey capture rates observed in various deep water and temperate Scleractinia species under a selection of environmental conditions. In the laboratory, using recirculating flumes (50 l volume) coral branches of *Lophelia pertusa* (polyps collected from both the Norwegian Margin and Mediterranean canyon coral ecosystems), *Madrepora oculata* (Mediterranean canyon) and individual specimens of *Caryophyllia smithii* (Mediterranean canyon) were exposed to a range of flow regimes and suspended particulate exposures. Following collection and during experimental runs, all environmental conditions save those under manipulation were maintained as at coral source location. Into the experimental flumes *Artemia salina nauplii* were supplied at known concentration as a prey organism for the corals. The removal of *Artemia salina* from suspension over a 4 hr period following delivery was measured across treatments. By dividing this reduction in *Artemia salina* concentration by the number of polyps within an experimental flume, the net prey capture rates polyp-1 were determined. For the first time (we believe) net prey capture of *Artemia salina nauplii* by *Lophelia pertusa* polyps collected from both the Norwegian Margin and Mediterranean canyon ecosystems were compared. We report here on the variations across species (and within species by sample origin location) in prey capture rates under various flow and particulate exposure conditions. In general, prey capture rates were lower for colonial Scleractinians exposed to even environmentally low concentrations of suspended material than observed for *Caryophyllia smithii*. Net prey capture rates by Mediterranean *Lophelia pertusa* were higher than those achieved by specimens collected on the Norwegian Margin. *Madrepora oculata* had the lowest *Artemia salina* capture rate polyp-1 observed, given comparable particulate concentrations in suspension. The findings presented here may help explain some of the distribution patterns of scleractinian species across the European seafloor and beyond.

11.45-12.00

Trophic structure of deep-sea coral habitats in the Gulf of Mexico

Amanda W.J. Demopoulos*[1] *(ademopoulos@usgs.gov), *Jennifer McClain-Counts*[1]*, Steve W. Ross*[2]*, Tara McIver*[2] *and Martha Nizinski*[3]

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Deep-sea coral ecosystems are ecologically complex and little is known of their trophic structure and function. New results are presented here from an ongoing food-web study designed to evaluate the extent coral-associated fishes and invertebrates utilize local resources for nutrition in the Gulf of Mexico (GOM) deep-coral ecosystems. *Lophelia pertusa* habitats located in the northern GOM on the continental slope off Louisiana in Bureau of Ocean Energy Management Lease Blocks Viosca Knoll 826, Viosca Knoll 862, and Mississippi Canyon 751, and on the West Florida Slope were investigated. Fishes, invertebrates, and primary producers were collected on cruises from 2008-2010 using a submersible, ROVs, otter trawls and baited traps. Stable carbon (delta-^{13}C) and nitrogen (delta-^{15}N) isotope analyses (SIA) revealed a simple food web, encompassing 4-5 trophic levels. Delta-^{13}C results were consistent with phytodetritus serving as the primary basal food source for these communities. At all sites, delta-^{15}N of *L. pertusa* was similar to other corals (e.g., *Leiopathes sp*., gorgonians) as well as several mobile invertebrate taxa, including crabs (*Munidopsis sp*., *Bathynectes longispina*) and urchins (*Cidaris sp*., *Echinus sp*.). Similar delta-^{15}N values among these taxa indicate that they feed at similar trophic levels, possibly serving as trophic siblings. Data from the West Florida Slope exhibited a wider range in delta-^{15}N values, encompassing 5 trophic levels, indicating a more trophically diverse system than the 4 trophic levels estimated from the three other reef sites. Based on extensive video analysis (Sulak et al., 2007), the following fishes appeared to be highly associated with live coral: *Conger oceanicus*, *Helicolenus dactylopterus*, *Grammicolepis brachiusculus*, and *Hoplostethus spp*. *Conger oceanicus* stomachs were dominated by crabs from the family Goneplacidae. *Helicolenus dactylopterus* stomachs contained mostly pyrosomes, followed by squid remains, unidentified fish, and the caridean shrimp *Leptochela sp*. Caridean shrimp (Decapoda) dominated stomach contents examined from *Hoplostethus occidentalis*. All stomachs examined from *G. brachiusculus* (n=2) were empty. SIA results appear to support stomach content analyses. While SIA was not performed on many of the species found in fish stomachs, representative taxa from the local coral habitat could be used as proxies for fish prey items. Given that these fishes are often observed in close proximity to the live-reef habitats and are presumed to feed on local resources, the shrimps, lobsterettes and crabs that were analyzed are likely prey items. Shrimp and lobsterette (Decapoda, *Nephropsis sp*.) stable isotope values were consistent with food sources of *Hoplostethus spp*. Stable isotope values for *Eumunida picta* and *Munida sp*. were consistent with *C. oceanicus* feeding on crustaceans. While stomachs of *G. brachiusculus* were empty, SIA indicate that they feed on similar food resources as *Hoplostethus spp*., potentially small shrimp. Additional SIA coupled with stomach content analyses will improve our understanding of trophic linkages among these fauna.

12.00-12.15

Uptake of various food sources by the cold water coral *Lophelia pertusa*

***Christina E. Mueller[1] (c.mueller@nioo.knaw.nl)**, Dick van Oevelen[1] and Jack J. Middelburg[2]*

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In contrast to tropical corals, cold-water corals (CWCs) lack endosymbiotic zooxanthellae and live heterotrophically in deep and cold oceanic waters. Cold-water corals are predominantly found at hard substrates where elevated current velocities supply various dissolved and particulate organic matter sources. Various field studies suggested that a combination of phytoplankton and zooplankton are likely the primary food sources of CWCs. In this study we investigated food selectivity by the cold-water coral *Lophelia pertusa*. Uptake of ^{13}C and ^{15}N labeled food sources ranging from dissolved amino acids (DOM), bacteria, phytoplankton to zooplankton was studied in circulation flumes during 4 days. Coral pieces were sampled and analyzed for isotope incorporation in bulk tissue (^{13}C, ^{15}N), specific fatty acids (^{13}C) and specific amino acids (^{13}C, ^{15}N) using GC-c-IRMS (gas-chromatography-combustion-isotope ratio mass spectrometry). Uptake of ^{13}C and ^{15}N into coral tissue was measured for all food sources. The carbon uptake of particulate sources was related to their size, showing highest uptake for zooplankton fed corals. N uptake was generally lower than C and did not show a clear relation with particle size. Uptake of dissolved amino acids however was high and comparable to zooplankton uptake, with uptake rates of 2ugC /day g dry weight coral and 0.8 ug N/day g dry weight coral. All offered food sources resulted in incorporation of C and N into tissue amino acids. For all food sources, except for bacteria, ^{13}C enrichment was higher in essential amino acids than in non essential. This distinction was however not evident for ^{15}N uptake. The uptake of food substrates in specific fatty acids revealed especially high enrichment in the bacterial fatty acid C18:1w7c within all treatments. This specific fatty acid has also been found as a dominant part of coral mucus and might indicate that bacteria associated with the coral may aid in food acquisition.

12.15-12.30

Ecohydrodynamics of Mingulay Reef complex

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The determination of the hydrodynamic constrains on ecosystems with different time and length scales has been coined by the term 'ecohydrodynamics'. This term encapsulates the physical parameters of the water body alongside its chemical and biological properties. Suspension-feeding cold-water coral communities rely on the delivery of phytoplankton, zooplankton and organic matter derived from near-surface primary productivity. The interaction between currents, internal waves and the topography creates suitable conditions for the development of cold-water corals and are critical in their wider larval dispersal. Thus the ecohydrodynamic conditions around coral reefs determine the supply of food particles and larvae. The lateral and vertical advection of particles may therefore play an important role in the functioning of coral ecosystem. A 3D ocean model, coupled to a particle tracking model have been applied to provide an adequate assessment of the water exchange and renewal in the Mingulay Reef complex located to the east of the island of Mingulay in the Sea of Hebrides. The area was mapped using multibeam echosounder revealing a reef complex formed by *Lophelia pertusa*. Previous studies revealed that the Mingulay complex has two dominant food supply mechanisms to the reefs, a regular rapid downwelling of surface water delivering pulses of warm water and periodic advection of high turbidity bottom waters. The model has been used to study the circulation patterns and the water transport to better understand food supply, larval transport, community composition, sediment movement and provide spatial and temporal aspects of circulation, including the influence of atmospheric forcing via wind speed and direction. This modelled information has been integrated into a 3D GIS, using ArcGIS 9, thus providing a user interface for visualization interrogation of results and as an input into other spatial modeling projects.

13.30-14.00 [KEYNOTE]

Response of cold-water corals to ocean acidification

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The rise of atmospheric CO_2 and anticipated ocean acidification has resulted in great concern about the future of the marine environment in general and cold-water coral reefs in particular. Ocean pH has already declined by 0.1 units since pre-industrial times and is predicted to further decline by another 0.3 units until the end of the century. Due to this potential threat to coral calcification, it is pivotal to understand and quantify the reaction of cold-water corals to past and predicted changes in ocean pH. Several experiments were carried out to establish short- and long-term (acclimation) response to ocean acidification. Short-term, repeated incubation of the same coral fragments of *Madrepora oculata* (N=15) revealed, that calcification rates have already dropped by 50% since pre-industrial times (pCO_2 ~280 ppm), while an increase from ambient to higher pCO_2 as projected until the end of the century (1000 ppm) had no further effect on calcification rates. This was substantiated by long-term experiments (9 months) on 3 Mediterranean cold-water coral species (*M. oculata*, *Lophelia pertusa* and *Desmophyllum sp*.) that were subjected to a pCO_2 range between 400 and 1000 ppm. A chronological comparison between initial calcification rates at ambient pCO_2 and at different time intervals after adjustment of pCO_2 (directly after and in 1-month intervals), revealed that no acclimation to ocean acidification actually takes place when corals are subjected over a longer-term to higher pCO_2. As there was no response to ocean acidification at a pCO_2 level of up to 1000 ppm, *M. oculata* was subjected to a larger range in pCO_2 with up to 2000 ppm. This study again confirmed that calcification rates remain unaffected up to a pCO_2 level of 1000 ppm, but a significant decline could be observed for pCO_2 levels of 1600 and 2000 ppm. Results from various experiments thus reveal that calcification response to ocean acidification is non-linear, and that cold-water corals appear to be able to maintain their calcification rate relatively constant within a certain range of CO_2 concentration, while significant negative and positive responses above and below a certain pCO_2 threshold could be shown. The metabolic response to ocean acidification was established by measuring respiration rates; and the hypothesis was tested, if higher food (energy) supply can compensate for negative effects of ocean acidification. Contrary to the results found for calcification, there was no effect of ocean acidification on cold-water coral respiration, and the decline in calcification rates at pCO_2 levels of 1600 and 2000 ppm could not be compensated by providing more energy via food to the coral. Last, but not least, the diversity of cold-water coral associated bacteria under various pCO_2 levels was studied. There was a shift in bacterial community when cold-water corals were subjected to higher pCO_2 levels, but, if this shift plays a compensatory role or renders cold-water corals more resilient to ocean acidification remains to be explored.

14.00-14.15

Ocean acidification changes gene expression in the cold-water coral *Lophelia pertusa*

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Ocean acidification, the reduction of ocean pH due to the uptake of anthropogenic CO_2, is predicted to have an effect on most marine calcifying organisms. *Lophelia pertusa* is the most important cold-water coral species in the NE Atlantic were it creates ecosystems along the European continental margin that are biodiversity hotspots. The coral skeleton creates a complex habitat that give rise to many different microhabitats that attracts various species for food and shelter. *Lophelia* uses aragonite, a more soluble form of calcium carbonate, to build it's skeleton, and the distribution area of *Lophelia* is overlapping with the high-latitude regions and deep-water areas that will be impacted first by ocean acidification. The physiological effects of ocean acidification on *Lophelia* have recently been tested experimentally but effects at the molecular level have until now been unknown. We therefore used microarray-based transcriptome analysis to assess the physiological response of acidification. We used next generation sequencing (Roche 454 pyrosequencing) to develop an EST-library (Expressed Sequence Tag). The assembly of the 454 transcriptome of *L.pertusa* resulted in 47528 contigs with an average size of 510bp. Gene expression profiling on microarrays showed that more than a hundred genes were significantly down/up regulated in response to elevated CO_2, with the majority of the genes down-regulated. The altered genes are involved in essential biological processes such as cell growth, protein stabilization, reproduction, and genes involved in regulation of ligand-gated calcium channels.

14.15-14.30

Cold water corals grow under future pH conditions in situ

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Ocean acidification (OA) caused by anthropogenic induced climate change via increasing CO_2 release may be one of the main threats to the marine realm. OA will be a challenge to most marine calcifiers, but cold water corals are thought to be particularly affected owing to the nature of their cold and often deep habitat – further facilitating CO_2 dissolution. The 'Fjordo Comau' (Chilean Patagonia) already exhibits pCO_2 values that are generally predicted for the year 2100 in the IPCC scenarios, comprising pH gradients up to 0.6 within the upper 225 m (depending on the site, e.g. pH 8.1 – 7.5). Nevertheless, the cosmopolite cold water coral *Desmophyllum dianthus* thrives apparently unimpaired along these gradients. *D. dianthus* is commonly distributed along a large depth range (mostly deep-sea on seamounts and the continental slope) and forms dense banks along the Comau fjord moreover occurring as a member of a deep water emergence community as shallow as 12 m. Here, we present results of an in situ experiment cross-transplanting corals between two sites (mid and mouth of fjord) with a pH difference of ~ 0.15 (pH of 7.93 ± 0.09 and 7.78 ± 0.11). Control corals were maintained at the site of origin. Short-term growth rates were obtained via the buoyancy weight method and two weeks were sufficient to show clear weight increase. However, growth rates were relatively variable (all specimens: 5.75 ± 3.26 [mg $CaCO_3$ cm^{-2} projected calyx area d^{-1}] and 0.29 ± 0.19 [% d^{-1}]). No influence of site or origin on short-term growth rates could be detected. Either there are factors that outbalance the adverse effects of low pH, and/or cold water corals in general or *Desmophyllum dianthus* in particular may have a great ability to acclimatize or even adapt to a broad range of environmental conditions including pH. Nevertheless, existing limits of CWC distribution - determined by low pH or reduced oxygen availability - may narrow in the future, when pH values will further decline.

14.30-14.45

Ocean acidification effects on the physiology and gene expression profiles of the cold-water coral *Desmophyllum dianthus*

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Ocean acidification, (decreases in carbonate ion concentration and pH), as a consequence of the rising atmospheric pCO_2 is predicted to affect marine calcifying organisms. While potential effects of future levels of pCO_2 on tropical coral species has been relatively well studied, there is currently limited information on their effects on cold-water corals. Here we describe a long-term experiment to compare the calcification, basal metabolism (measured as respiration rates) and gene expression responses of the azooxanthellate solitary coral *Desmophyllum dianthus*, at pH levels of their natural environmental (pH=8.1) with those predicted for the year 2100 (pH= 7.8). Corals were collected from 450 m depth in the Azores (NE Atlantic) and maintained in aquaria under controlled pH levels using a CO_2-bubbling system in flow-through aquaria under constant water temperature, over a period of 8 months. Calcification rates were measured using the buoyant weight and the alkalinity anomaly techniques. Gene expression profiles were studied by means of RT-qPCR, targeting representative genes involved in biomineralization, cellular stress and metabolism. Calcification rates did not significantly differ between treatments, although respiration rates were slightly enhanced under of acidified conditions. In view of this, the differential gene expression profiles supported the participation of specific stress-related genes during physiological responses to the experimental variations of pH. This study demonstrates how the use mRNA expression-based tools can assist in better understanding the response of cold-water corals to ocean acidification.

14.45-15.00

Carbonate Dynamics and Calcification of *Lophelia pertusa* in the Northern Gulf of Mexico

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Ocean acidification lowers the pH in the surface ocean and has also induced shoaling of the aragonite saturation horizon (ASH) – the depth at which aragonite ceases to be saturated in the water column. Continued shoaling of the ASH is expected to alter the depth distributions of framework-forming scleractinians, including the widely distributed *Lophelia pertusa*. Despite these threats, few empirical data on the carbonate chemistries of cold-water coral bioherms currently exist. On a recent cruise, we sampled bottom waters and conducted CTD casts from surface to 2600m at 14 stations across a range of 600km in the northern Gulf of Mexico – a region where very little data on carbonate chemistry currently exists. We measured total alkalinity and pH and discovered coral sites that are nearly undersaturated with aragonite. In waters deeper than 300m, pH ranged from 7.85-8.03, TA ranged from 2264.17-2381.51 µmol/kg-SW, and Ωarag ranges from 0.98 to 1.69. At sites where *Lophelia pertusa* is present, Ωarag ranges from 1.25-1.69. To test the effects of ongoing ocean acidification on *Lophelia pertusa* calcification, we exposed coral nubbins to short-term experiments at pH 7.90 (Ωarag 1.40) and pH 7.60 (Ωarag 0.75). At pH 7.90, *L. pertusa* sustains calcification at a rate of 0.009%•d^{-1} or 4.4 mg $CaCO_3$•d-1. At pH 7.60 (Ωarag = 0.75), net calcification ceases and skeletal dissolution occurs at a rate of 0.003%•d^{-1} or 1.4 mg CaCO3•d^{-1}. We are currently in the process of measuring growth at pH 7.75 (Ωarag = 1.0). Our results indicate that a pH decrease of 0.3 units will likely inhibit future expansion of *L. pertusa* bioherms, which will reduce habitat availability for the consortium of invertebrate fauna that utilize *L. pertusa* framework.

15.00-15.15

ACCLIMATION OF THE COLD WATER CORAL *LOPHELIA PERTUSA* TO PREDICTED RISES IN ATMOSPHERIC CO_2 AND SEA TEMPERATURES

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Cold-water corals are amongst the most three-dimensionally complex deep-sea habitats known and are associated with high local biodiversity. Despite their importance, little is known about how these organisms will fare in the face of predicted future climate change. Currently, the long-term synergistic effects of projected increases in atmospheric pCO_2 and sea temperatures upon the cold-water coral *Lophelia pertusa* are unknown, and studies to date have only examined *L. pertusa* response to either increased temperature or increased pCO_2 on short time scales. Here, we present data on the effects of increased sea temperatures (by 3^{o}C) and increased pCO_2, (750 and 1000ppm) upon the metabolism and growth of cold-water coral *Lophelia pertusa*, collected from the Mingulay Reef Complex, Scotland, UK. Results from short-term exposure to increased temperature and pCO_2 on freshly collected corals will be contrasted with current data from an ongoing 18-month experiment. Comparison of short and long-term data will help define the impact of ocean acidification and increased temperatures upon the growth, physiology and structural integrity of the reef framework forming coral, *Lophelia pertusa*.

15.45-16.00

Oxygen-minimum zones: a threat to deep-sea corals and other cnidarians?

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Oxygen-minimum zones (OMZs) are regions of the ocean that typically occur below the photic zone in areas where there is high oxygen consumption and minimal mixing of water layers; dissolved oxygen concentrations within these zones range from 0.5 ml/L (severe hypoxia) to virtually no oxygen (anoxia). In addition to the oxygen level being low, the level of CO_2 is high. While many OMZs are naturally occurring, their number and size is increasing, a change attributed to human alterations in circulation and nutrient concentrations. Size, particularly of some of the human-caused OMZs, is also increasing, and oxygen levels are declining in many. Most OMZs are features of the pelagic zone but some intersect the benthos, thereby impacting a diverse fauna. Some organisms are adapted to life in hypoxic conditions, either permanently or, more commonly, temporarily. However, those that are not adapted to hypoxia and cannot escape these adverse conditions do not survive. Places where dissolved oxygen concentrations have fallen to such low levels that the biota has been unable to cope are referred to as dead zones. Although most cnidarians are tolerant of low oxygen concentrations, even they cannot survive in anoxic conditions. Additionally, habitats characterized by the combination of physical features typical of OMZs are particularly inhospitable for calcifying organisms, among them the animals referred to as corals. Examples of OMZs in US waters where benthic cnidarians may be affected are the Gulf of Mexico near the mouth of the Mississippi River, and the coast of Oregon. The increasing prominence of both these OMZs has been associated with human activity. Current climate models predict an increase in size and intensity of OMZs as a result of climate change; the intensification of OMZs throughout the world's oceans may threaten cnidarians and other species that inhabit these zones.

16.00-16.15

Long-term time-lapse observations in situ in a cold-water coral habitat

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The Tisler reef is a relatively large (c. 1200 X 300 m live coral) inshore reef, situated in the Norwegian NE Skagerrak, close to the Swedish border. The reef has been approximately twice as long, but has been reduced in size at the distal parts, most likely due to damages inflicted by primarily trawl fisheries. The reef was protected from bottom-impacting fishery techniques in late 2003.

In 2005, a bottom transect (weighted line) was established through a trawl-damaged part of the reef, as a navigation aid for studies on possible recovery of the coral habitat as a result of protection. The fauna along the transect was documented (video and still photos) by ROV-surveys 1 - 2 times per year over the period 2005 - 2011.

The transect (c. 40 m in length) covers an area progressing from bedrock to dead coral structure to scattered small colonies of live coral (*Lophelia pertusa*) into gradually more undisturbed coral reef. The documentation permitted detailed studies on growth and development in colonies and individual coral polyps, as well as studies on more large-scale changes within the transect area. Growth rates in *Lophelia pertusa* (measured as longitudinal extension) varied between 0 - 7 mm $year^{-1}$, depending on the position of individual polyps in relation to water flow. During the initial 3 - 4 years of study, no tendency of recovery in *Lophelia* was observed. Death and disappearance of small colonies and polyps balanced growth. During the last two years of study, however, a tendency of recovery was observed, resulting in increased cover of live coral. A single stand of the gorgonian coral *Paramuricea placomus*, occurring in the transect area, permitted growth measurement in this species. The mean annual extension of branches was found to be approximately 4 - 5 mm. Growth rates in dominating megafaunal sponge species, such as *Geodia barretti*, *Phakellia ventilabrum* and *Mycale lingua* could also be studied, and were found to be generally very low, but with the fastest growth in *Mycale lingua*.

Observed large-scale changes in the habitat included destruction and fragmentation of a large patch of live coral, possibly as a result of a large anchor being dragged through the area. Also, over 90% of the population of the originally dominating sponge species *Geodia barretti* died during the course of the study, probably as a result of repeated occurrences of abnormally high temperatures. Over the study period, three instances of high temperatures in late autumn were recorded (2006, 2008, 2009), each followed by high mortality rates in *Geodia*. The results are discussed in relation to conservation strategies and climate change.

16.15-16.30

Distribution and Characterization of Deep-Sea Coral Ecosystem Habitats off Southeastern United States

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The deep-sea (200-1000 m) floor of the Western Atlantic off the southeastern U.S. supports a variety of deep-sea coral ecosystem (DSCE) habitats, including: coral mounds, rock terraces (Miami Terrace and Pourtalès Terrace), canyons (Agassiz and Tortugas Valleys), and island slopes (western Bahamas and northern Cuba). Large-scale NOAA bathymetric contour maps and digital elevation models were used in ArcGIS to identify and delineate the areal extent of potential DSCE habitat in this region from northeastern Florida (31^{o}N) through the Straits of Florida between Florida and the Bahamas and Cuba. An estimated total planar area of 39,910 km^2 of DSCE habitat was delineated. These maps were ground-truthed with over 250 dives with submersibles and remotely operated vehicles (ROV) revealing that all high-relief topographic features provided DSCE habitat. Portions of the region have been further verified with higher resolution multibeam sonar and ROV observations. In this region, it appears that high-relief features, including steep escarpments, are good predictors of DSCE habitat. Elsewhere, of course, other processes may also generate high-relief submarine features that are not hard bottom and our hypothesis is only relevant to this region of the Western Atlantic. The benthic biota varied widely within this study's region; for example, *Lophelia* and *Enallopsammia* corals dominated the mounds of the northern and eastern Straits of Florida, whereas stylasterid corals dominated the southern and western Straits. Gorgonians, black coral, and sponges were common to most sites but showed site-specific variability in distribution. These studies indicate that local cold-water coral mounds are significantly more diverse and abundant than previously thought. In 2011, our ROV dives in the southern Straits of Florida discovered the southernmost *Lophelia* coral mound known in the continental United States. This may lead to the discovery of many more *Lophelia* mounds in this region, which was previously thought to be devoid. It appears that coral mound distribution and development in this region are influenced by current regime, sedimentation, antecedent topography, and temperature. In 2010, the South Atlantic Fishery Management Council and NOAA established five deep-water Coral Habitat Areas of Particular Concern (CHAPCs) encompassing a total area of 62,714 km^2 from North Carolina to south Florida; an estimated 69% of the total area of the CHAPCs is off Florida (43,393 km^2). Of the 22,057 km^2 of DSCE habitat estimated in U.S. waters off Florida, 15,503 km^2 (70.3%) is within the Florida CHAPCs. This leaves approximately 6,554 km^2 of DSCE habitat that remains unprotected (29.7%) and outside the boundaries of the CHAPCs in U.S. waters off Florida. Meanwhile, the entire Bahamian and Cuban deep-sea coral habitat remain unprotected. Many activities affect DCSEs, including bottom trawling, pipelines, cables, and energy production. Cuba has recently opened its north slope for deep-sea oil/gas drilling and Florida may also open its coastline. Baseline community data is critical to understanding the effects of these anthropogenic activities on DSCEs. High-resolution sonar surveys combined with visual ground-truthing to create deep-water benthic habitat maps are necessary to further refine the extent of DSCEs in order to protect and conserve these critical habitats.

16.30-17.00 [KEYNOTE]

Summing up the ISDSC5 - a personal view

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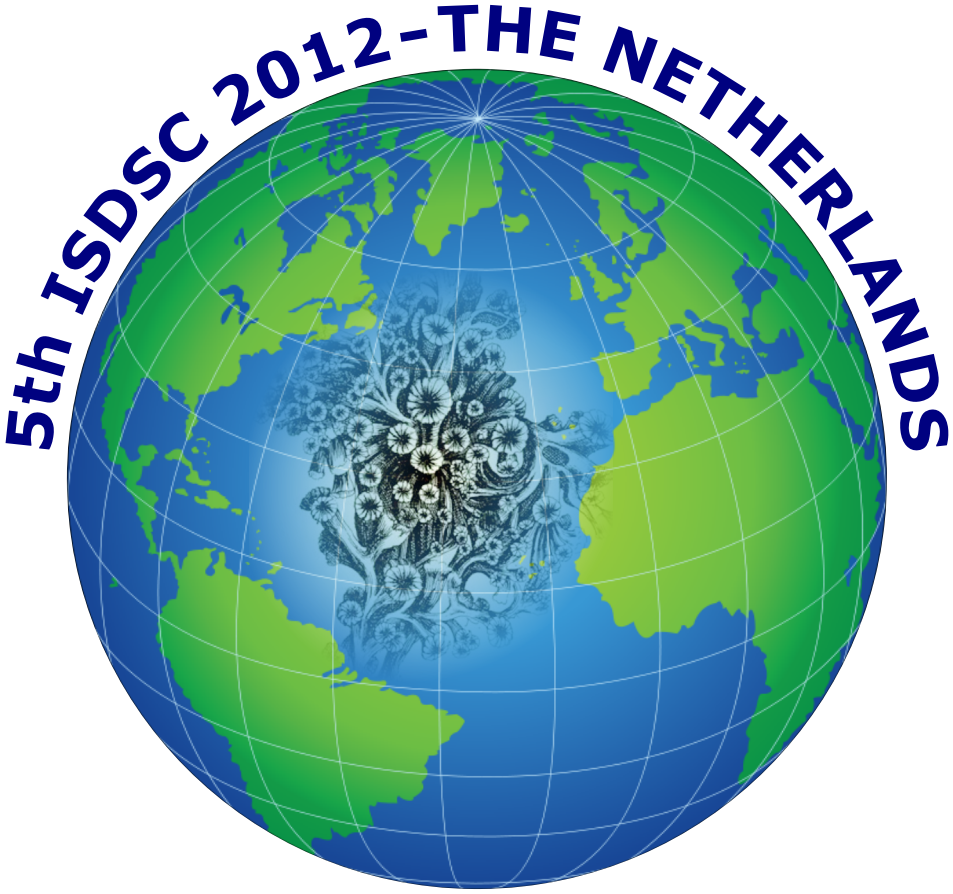
Based on all the presentations and the posters at this conference, a summary of what we have learned will be made and discussed.



ABSTRACTS
POSTERS THEME I

New records of Primnoidae (Cnidaria: Octocorallia) from Brazilian deep waters

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The knowledge of octocorals occurring in Brazilian deep waters still lacking, with only a few works conduced so far, most of which with an environmental approach. Primnoidae are common and characteristic of seamounts and deepwater coral banks, often providing habitat for other marine species. Although primnoids occur in all ocean basins, only *Primnoella Gray*, 1858 was recorded before this study along Brazilian coast, represented by three species: *P. delicatissima*, *P. polita* and *P. delicatissima*. Specimens of this family were obtained through dredging, collected by research projects conducted in this Atlantic region, between 15-34o S, 640-1700 m: REVIZEE Program, OCEANPROF I and II, and PROBORDO Projects. Also ROV images data of this family obtained through other projects on Campos Basin, conducted by CENPES/Petrobras, were analyzed. Taxonomic assessment resulted in six new records of genera for Brazil: *Calyptrophora Gray*, 1866, *Candidella Bayer*, 1954, *Dasystenella Versluys*, 1906, *Narella Gray*, 1870, *Plumarella Gray*, 1870 and *Thouarella Gray*, 1870. Four of these records were reported to Campos Basin. The occurrence of *Plumarella*, *Narella* and *Calyptrophora* are reported for the first time in South Atlantic. Descriptions of morphological variation of collected specimens, and comparisons with closely related described species are given. Geographical, bathymetrical and habitat distribution of this family off Brazil based on collected specimens, and also on ROV images, is presented and discussed.

Developing sets of genetic markers in Octocorals for higher-level phylogenetic reconstruction and for species-level classifications

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Octocorals belong to the Class Anthozoa, Phylum Cnidaria. They can be the dominant megafaunal organisms in deep-sea hard-substrate habitats, such as seamounts, providing an ecologically essential structural substrate that supports numerous other organisms. There are roughly 3000 named species whose current subordinal and family level taxonomy based on morphological characters does not agree with molecular phylogenetic analyses. In addition to the uncertainty in deep-level phylogeny of octocorals, species and genus level distinctions are difficult to make morphologically due to the complexity of currently utilized taxonomic characters that lack clearly defined synapomorphies. Attempts have been made to reconcile molecular based phylogenies with morphological taxonomy by mapping morphological characters onto a molecular phylogeny. These studies are demonstrably useful in identifying synapomorphic characters at the family and genus levels, but new genetic markers need to be developed to obtain similar approaches to both higher-level phylogenetic reconstruction and species-level classifications.

The objective of this project is to develop two sets of genetic markers; one that can be used to resolve deep-level phylogenies in octocorals and another set that can distinguish species and could be suitable for barcoding studies. Attempts at classification of octocorals at the species and genus level using mitochondrial genes and nuclear markers (i.e. ITS1, ITS2, and 18SSU rDNA) have failed due to the very slow evolution of the coral mitochondrial genome, the high degree of intragenomic variation of the ITS markers, and the poor suitability of highly conserved ribosomal genes as low level phylogenetic markers.

We used next generation sequencing and reduced representation libraries to analyze the partial genome from a wide phylogenetic range of octocorals. The DNA from 20 species was extracted, including representatives of 6 octocoral families, along with an antipatharian, a zoanthid, and a deep-water scleractinian. The DNA samples were digested with the enzyme EcoRV. Libraries were then prepared following the protocol of Meyer and Kircher (2010). The libraries were then sequenced on an Illumina platform, with 4 libraries multiplexed per lane. This poster presents the preliminary results of this research, identifying potential genetic markers for deep-level phylogenetics as well as markers that might distinguish species to be tested for use in barcoding.

Spatial trends in the characteristics of two dominant sea pens in the Northwest Atlantic

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Anthoptilum grandiflorum and *Halipteris finmarchica* are two of the most common Pennatulacean corals of the continental slope of eastern Canada. *A. grandiflorum* is also widespread worldwide. Despite their abundance these species were never really characterized. A biometric analysis of various parameters, i.e. length, wet weight, density of sclerites, diameter and density of polyps, biomass and proportion of inorganic matter, showed some variations according to depth and geographical area. A significant decrease in colony length occurred with increasing depth in *A. grandiflorum*. A latitudinal decrease in length, from the South to the North, was detected in both species. Also, for both species the diameter and density of polyps varied along the length of the colony. The biometrics of sea pens provides insight into their ecology and their interactions with associated species. For example, the presence of fish larvae has been recorded on both species but more commonly on *A. grandiflorum*. This difference may be explained by the virtual absence of sclerites in *A. grandiflorum*. Furthermore, fish larvae shelter mostly in larger colonies, a parameter that is correlated with depth.

Shedding light on deep-water oyster environments: Habitat characterisation of live *Neopycnodonte zibrowii* and its Atlantic-Mediterranean distribution

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As recently as in 2009, a new oyster species, named as *Neopycnodonte zibrowii*, has been described from the bathyal zone in the Azores archipelago (Northern Atlantic). Further live records have already been reported from the Bay of Biscay, the Celtic Sea and the Western Mediterranean. The finding of live *N. zibrowii* occurrences during the RV Poseidon cruise 385 carried out in June 2009 along the slopes of El Idrissi Seamount (Alboran Sea) and subsequent findings off Mauritania during the RV Merian cruise MSM16-3 in October 2010 lead to this study, which characterises live and dead occurrences of this gregarious deep-water oyster based on ROV video footage and collected samples.

At El Idrissi Seamount *N. zibrowii* appeared as: 1. Sediment-clogged valve debris admixed with *Dendrophyllia* rubble; 2. Valves and valve fragments cemented to steep walls and below overhangs; 3. Shells, individual valves/valve fragments and live oysters cemented to steep walls and overhangs. Larger-sized walls and overhangs were either plastered in mono-layer by autochthonous *N. zibrowii*, or, especially in sediment-protected areas, the individuals clustered as stocks, each comprising up to ten generations. The valves documented are generally about 10 cm in length, rarely up to 20 cm. CTD data show that they thrive in temperatures of ~13.2°C, salinity of ~38.1 psu and oxygen concentrations of ~3.5 ml/l. *N. zibrowii* offers a suitable ecospace for a multitude of epi-, chasmo-, crypto- and euendolithic organisms, amongst live *Lophelia pertusa*; in situ *N. zibrowii* show the highest colonisation densities in sediment-protected and current-exposed zones. Beyond, valves provide shelter for mobile organisms, as observed for shrimps, *Munida sp*. and fish (like *Conger conger*). The Mediterranean habitat of live *N. zibrowii* at El Idrissi Seamount is more similar to that described from the Celtic Sea than from the Azores Archipelago. Ongoing examination characterises the environment of live and dead *N. zibrowii* occurrences off Mauritania.

An additional compilation of live and dead *N. zibrowii* occurrences from to date published sources and further non-published data show its known biogeographical distribution, which spans from the Northern Atlantic, in particular the Celtic Sea, the Bay of Biscay and the Azores archipelago to the Mediterranean with occurrences in the Alboran Sea, the Balearic Sea, Western Mediterranean Basin, Ligurian Sea, the Tyrrhenian Sea and the Eastern Basin. However, known live occurrences of *N. zibrowii* appear in sediment-protected zones on seamounts, canyons and tectonic escarpments in the North Atlantic Ocean and the Mediterranean Sea (Alboran Sea and Western Basin) in depth ranges between 846-388 m. One live specimen collected during dredge sampling in a depth interval of 430-300 m carried out NE off Menorca might eventually plot even shallower. Ongoing studies try to clarify further abiotic and biotic essential factors for the survival of this giant oyster.

The impact of cold-water coral structures on fish communities in the NE Atlantic

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Cold-water coral reefs form complex three-dimensional habitats, which are thought to act as refuge and nursery areas and to harbour a diverse macro- and megafaunal community. However, quantitative data of these communities is very scarce. In our research we tried to prove that there is a clear relation between fish and CWC reefs. By using a tethered video system with lasers we surveyed several cold-water coral communities in the NE Atlantic (Rockall Bank – 2006, Hatton Bank – 2008, Belgica Mound – 2009, 2010 & 2011), to be able to identify and quantify the present fish fauna. The videos were analysed to identify the abundance and composition of the megafauna including fish, as well as the habitat structure. Estimates of the fish biomass were acquired by converting the measured fish length into weight using length-weight relationships. For getting quantitative data on the coral cover (living and dead) and the non-coral areas, frame grabs were usually taken in a 1-minute interval. The total area of each video survey was estimated, using GPS data (to get the length of the track) and frame measurements (to get the average width of the track). Here, we show the first results of this study. We hope this research helps to increase our knowledge about cold-water coral reefs and their associated communities in order to improve the management of these important habitats, which are very vulnerable to deep-sea trawling, oil and gas exploration.

Cold-water coral communities in the Condor Seamount (NE Atlantic)

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Located just ten miles to the southwest of Faial island (Azores, NE Atlantic), Condor seamount has been an important fishing bank during the last decades, where main activities included bottom longline and hand-line fishing. This study focuses on video surveys conducted with remote operated vehicles (ROV Luso-6000m - EMEPC and ROV SP-300m – DOP-UAz) on the Condor seamount at depths between 185 and 1100 m, which is now a temporary no-fishing area, to describe the distribution of coral communities and their associated fauna. Benthic observations consisted of invertebrate megafauna that were distinctly identifiable in the images (mainly >15 cm) using the image analysis software COVER (v0.7.0 beta; Ifremer). With less than 1% of surveyed seabed so far, we have already identified 26 coral taxa. This number corresponds to 16% of the coral diversity ever recorded in the Azores EEZ, showing that the coral communities of Condor seamount are highly diverse. Alcyonacea is the best-represented group (69%) and the most important habitat-forming structures together with Porifera. No live or dead massive reefs were observed, although a few patchy areas of coral rubble were recorded. Distinct coral-dominated biotopes were recognized along the northern slope of the seamount, which was characterized by consolidated and unconsolidated substrates. At shallow depths gardens of whip corals *Viminella flagellum* reaching heights of 1.5-2.0 m (470-480m) were frequent while at highest depths these were replaced by assemblages of *Narella* gorgonians and the hexactinellid sponge *Pheronema carpenteri* (730-800 m). The deepest community occurred at 980 m and consisted on the gorgonian species *Candidella imbricata* and *Chrysogorgia*, as well as the stony coral *Leptosammia cf. formosa*. Fan-shaped gorgonians *Dentomuricea sp*. of considerable height (up to 0.7 m) and *V. flagellum* (up to 1.5 m) growing on clustered boulders in areas of sediment veneer were the dominant coral fauna at the summit. In total, 32 taxa of associated invertebrate megafauna were identified within coral areas. Many unhealthy gorgonians presented signs of fishing impacts with damaged skeleton being colonized by sessile epibionts. Colonies with partly exposed axis (free of polyps and coenenchyme) were also observed resulting of the feeding activity of some epibionts rather than mechanical injury.

New insights on deep-water zoanthids associated with corals in the Azores (NE Atlantic)

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Zoanthids are a group of cnidarians that are often found in association with marine invertebrates, including corals in shallow and deep-water environments. However, little is known about their taxonomy, and specificity and nature of their association with their coral host. In this study, analyses of morphological data (polyp morphology, histology, and type of cnidae) and molecular data (mtDNA COI, 12S rDNA and 16S rDNA) were used to examine zoanthid specimens associated with cold-water corals at depths between 110 and 600 m from seamounts and island slopes in the Azores region. The zoanthids examined were found in association with living stylasterids (*Errina dabneyi*), antipatharians (*Leiopathes sp*.), and ocotocorals of the family Primnoidae (*Callogorgia verticillata*, *Paracalyptrophora josephinae* and *Candidella imbricata*) and the family Plexauridae (*Dentomuricea sp.*). From the collected specimens several putative new species were identified at the molecular level. The zoanthid associated with the antipatharian *Leiopathes sp.* clustered within the genus *Epizoanthus*, whereas the zoanthid associated with the octocoral *Dentomuricea sp.* clustered within the genus *Parazoanthus*. DNA sequences of zoanthids associated with ocotorals of the family Primnoidae, and the stylasterid coral *E. dabneyi* placed these specimens in a previously undescribed genus of the family Parazoanthidae. Zoanthids associated with octocorals showed evidence of a parasitic relationship, where the zoanthid progressively eliminates gorgonian tissue and uses the gorgonian axis for structure and support and sclerites for protection. In contrast, zoanthids associated with the stylasterid *E. dabneyi* and the antipatharian *Leiopathes sp.*, appear to use the coral host only as support with no visible damage to the host. Results of this study supports the contention that substrate specificity could be used as reliable character for taxonomic identification of some zoanthids in the deep-sea, as it has been suggested in previous studies.

A comparative analysis of microbial communities associated with *Lophelia pertusa* inhabiting the NE Atlantic Ocean: characterizing bacterial diversity, function, biogeography and affiliations with host genotypes

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The symbiotic microbial assemblages associated with scleractinian corals are thought to perform a number of important functions for the holobiont. Whilst much research has focussed on microorganisms associated with shallow-water corals confined to the tropics, comparatively little is known about the composition and function of microbial communities associated with deep-water coral. This project aims to expand the current understanding of deep-water coral-associated microbial communities by assessing their composition, distribution, and function. Using next generation sequencing, we will conduct the most thorough examination of bacterial and picoeukaryotic assemblages associated with the most common and widespread reef-building cold-water coral: *Lophelia pertusa*. Using a remotely operated vehicle (ROV), coral samples will be obtained from multiple locations within both the Mingulay Reef Complex and Rockall Bank to enable small- and large-scale geographical comparisons. Furthermore, each coral will be genotyped to investigate patterns of association between coral-associated microbial communities and the genetic composition of their cnidarian hosts. We will also assess the functionality of these microbes by screening for the presence and diversity of functional genes related to nitrogen cycling. Detailed environmental metadata will also be collected from each sampling site. This information will be used to develop predictive models that will guide the formation of testable hypotheses that explain the roles of abiotic variables in establishing, maintaining, and altering the physiology of the holobiont and therefore the health of these important ecosystems.

Biodiversity and community composition of macrofauna associated with deep-sea coral habitats in the Gulf of Mexico

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Deep-sea scleractinian corals create a highly complex, three-dimensional substrate containing sheltered cavities that facilitate sediment accumulation and enhance colonization of encrusting fauna. These systems can harbor significant levels of biodiversity; however, details of their community structure and function remain unclear. This work represents an ongoing study of the benthic ecology of deep-sea coral ecosystems in the Gulf of Mexico (GOM). Study areas were located in *Lophelia pertusa* habitats found at ~ 400 m in the northern GOM on the continental slope off Louisiana and Mississippi within the Bureau of Ocean Energy Management Lease Block Viosca Knoll 906. Coral-associated sediment benthos were not previously characterized in these habitats in the GOM. Using the ROV Jason in 2009, quantitative in situ coral samples and sediment cores were collected to assess species diversity, composition, and numerical abundance of macrofauna residing near deep-coral ecosystems and in background, non-coral soft sediments. Highest abundances were present in the upper 2 cm of sediment and declined with core depth. Reduced macrofaunal densities were observed in near coral versus background soft sediments. Polychaetes numerically dominated the near coral samples, accounting for 70% of the total individuals, while representing only 44% of the individuals within the background sediments. In contrast, Oligochaeta, Crustacea, Mollusca, and other groups (e.g., Nemerteans, Hydrozoans, Anemones, and Sipunculans) were proportionally more abundant in the background cores than in near coral cores. Certain polychaete families, Eunicidae, Fauveliopsidae, Flabelligeridae, Glyceridae, and Serpulidae, were present only in the near-coral sites. These families represent a broad range of functional groups, including suspension feeders, deposit feeders, and predators; with subsurface deposit feeders and carnivores as the most abundant feeding forms. Enhanced habitat complexity associated with *L. pertusa* may contribute to the dissimilarities in the communities found near corals versus background soft sediment environments. Continued collections and analyses using standardized equipment and statistical comparisons have facilitated regional assessments, including additional deep-sea *Lophelia* sites in the GOM and Southeastern United States.

Insights into the Population Dynamics of the Deep-sea Coral Genus *Paramuricea*

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Species in the genus Paramuricea are common in deep waters (>200 m) of the Gulf of Mexico. *Paramuricea spp*. increase habitat heterogeneity and provide substrate for numerous faunal associates, including ophiuroids that abundantly inhabit the coral colonies. In light of the Deep-Water Horizon oil spill in the Gulf, it has become apparent that data on population dynamics within this genus are critically needed. To date, we have documented at least one species of Paramuricea (*P. biscaya*) that has been negatively impacted by the spill. Using remotely operated vehicles, we documented the abundances and size frequencies of Paramuricea across 18 sites at depths of 250-2500 m. In addition, molecular barcoding (COI+igr+msh) was used to delineate species boundaries. Results suggest that six haplotypes are present in the Gulf, and appear to be segregating into different depths zones [(type C: < 280 m) (type E: 280-445 m) (type A: 445-550 m) (type B1-3: 800-2500m)]. At any one site, abundances ranged from at least 10 colonies (MC506, depth 1040 m) to over 500 colonies (AT357, depth 1050m). Size frequencies measured for all sites range from 0-5cm (DC673) to 100-105cm (GC852) with median heights varying per site. Size frequencies observed indicated variable recruitment patterns. Lack of small colonies (<10cm) at many of the sites for *Paramuricea biscaya* (haplotype B) indicated the non-occurrence of recruitment events for at least 100 years (based on age estimates of *P. biscaya*). In contrast, at AT357 small (<10cm) colonies were abundant. Overall, abundance and height frequencies illustrate that populations of the slow-growing Paramuricea species are rare and exhibit low recruitment rates, making them even more susceptible to anthropogenic threats.

New Distributional Records of Deep-Water Corals from the Rockall Trough and Surrounding Areas

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Some new records of deep sea corals of the orders Alcyonacea, Antipatharia, Scleractinia and Pennatulacea collected during cruises of FRV Scotia during 1995-2011 are presented. Areas surveyed by Scotia included Rockall Bank, the Donegal-Hebridean Shelf, Anton Dorn Seamount and Rosemary Seamount down to a maximum depth of 1800m. Some species of Schizopathidae (Antipatharia) are reported from the area for the first time. Coral catches are discussed in relation to areas closed to fishing on Rockall Bank since 2007.

Annotating optical images from ROVs or drop-frames in Vulnerable Marine Ecosystems studies

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The attention to Vulnerable Marine Ecosystems (VMEs) in the deep-sea has increased in the last few decades for several reasons, such as fishery and oil exploration activities. Consistent Marine Protected Area networks have to be developed and techniques to investigate the seafloor, such as acoustic survey techniques and optical remote sensing play an important role in this. Image footage from Remotely Operated Vehicles (ROVs) or towed camera is a useful tool to non-destructively research several VMEs, such as coral gardens, scleractinian reefs and sponge grounds. Developing of standardized image annotations becomes an important goal to facilitate temporal and spatial comparison. However, due to availability of historical data, technical reasons or budget limitations, teams are often confronted with the use of various imagery sources and have to develop methodologies for optimizing these data.

Within the European fp7-funded project CoralFISH, IFREMER (France) has developed a software which enhances standardization of annotation but keeps a large flexibility. A methodology has been proposed to CoralFISH partners and improved in cooperation; it is based on common knowledge tables with a hierarchical structure where necessary. These tables have been defined taking existing references such as EUNIS, CMECS, Worms Register into consideration. The software COVER is able to visualise and synchronise different types of videos and still images. The snapshot generator allows making frame grabs on a regular time or distancing interval. These frame grabs can be used for a statistical analysis of substrates, habitats etcetera. A strong point of COVER is the annotation interface. It has configurable components: keyboard shortcuts, buttons, combo lists and sliders. These components are linked with knowledge tables that contain the information showed in the interface. It is also possible to enter comments. The user can organize items by blocks following thematic annotations like substrate type, benthic habitat/communities, taxa, anthropogenic impacts, and etcetera. This interface can be adapted to the needs of the area, the type and quality of images.

This adaptation possibility makes it potentially useful in many areas of research (biology, geology, oceanography…) and locations (e.g. canyons, mounts and reefs). Some features of Cover will be introduced into the existing software Adelie (IFREMER).

Looks can be deceiving: Assessing the monophyly of bamboo corals (Cnidaria, Octocorallia, Calcaxonia, Isididae)

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Bamboo corals (sO Calcaxonia, F Isididae) are immediately recognizable by their jointed axial skeleton (proteinaceous nodes alternating with calcium carbonate internodes), however there have been many questions about the evolutionary relatedness of the four isidid subfamilies as well as the placement of some "problematic" genera. The subfamily Isidinae is restricted to shallow waters while the other three subfamilies, Keratoisidinae, Mopseinae and Circinisidinae, are primarily found in the deep sea. Keratoisidinae has a worldwide distribution and is the most speciose subfamily, whereas Mopseinae and Circinisidinae have a more restricted geographic range, being found only in the Southwest Pacific and Southern Ocean. Among the problematic genera, the genus Sclerisis, known only from specimens collected below 1000m in the southern hemisphere, was described as a Mopseinae. However, Alderslade (1998) did not include it in his authoritative monograph on that subfamily as it lacked transversely-arranged, scale-like sclerites on the polyps, which he considered a characteristic of the subfamily; currently, online databases classify Sclerisis in the subfamily Keratoisidinae because of the longitudinally-arranged, rod-like sclerites. Isidoides is a mono-specific genus found in the deep Indo-Pacific Ocean that, when initially described by Nutting (1910), was noted as being very similar to some members of Isididae –although it lacked a jointed axis– but also similar in some respects to Primnoidae; it was classified by Nutting with the Ellisellidae (at the time Gorgonellidae), but since 1979 it has been classified in the family Chrysogorgidae. It was known from only a few fragments until recent collections around New Caledonia recovered eleven additional colonies. We assess the monophyly of Isididae and investigate the placement of the problematic genera Sclerisis and Isidoides using genetic analyses of over 250 colonies collected in the North Atlantic, Caribbean, Southwest and Central Pacific, and Indian Oceans. Our results, based on mitochondrial DNA sequence data, show the Isididae as polyphyletic. In particular, the subfamily Isidinae, which contains the type genus (*Isis*) of the family, forms a clade with members of an entirely different suborder, Holaxonia. Members of the strictly deep-sea subfamily Keratoisidinae form a well-supported monophyletic clade, and are further characterized by a unique mitochondrial gene arrangement; there are more clades and diversity among the keratoisidins than there are currently described genera. Mopseinae and Circinisidinae specimens used in our analysis are intermixed in a single clade that did not cluster with Keratoisidinae; our taxon sampling is inadequate to assess the monophyly of these two subfamilies, however it is clear they are not sister to Keratoisidinae. We found two haplotypes of Sclerisis and in the phylogeny they were intermixed with specimens in the Mopseinae/Circinisidinae clade. Isidoides is consistently placed as the sister taxon to the Keratoisidinae and not with the other genera of deep-sea chrysogorgids (which form their own monophyletic clade). Our molecular phylogeny suggests that "bamboo corals" represent at least three independent and evolutionary radiations, and that a jointed axial skeleton with sclerite-free proteinaceous nodes is therefore convergent.

Models and maps of biodiversity and ecosystem function at the Mingulay Reef Complex, Scotland

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Many hundreds of animal species inhabit or visit the inshore (120-190 m depth) *Lophelia pertusa* reefs off western Scotland. We use cross-disciplinary methods to model and map this biodiversity, and the ecosystem functions these reefs provide to the wider marine landscape. Variability in resource use (space and food) is driven by habitat heterogeneity and stochastic assembly mechanisms, depending on species' functional ecology and spatial scale. Variability in seabed bathymetry and hydrography drive fine- to local-scale community assembly of sessile suspension feeders (e.g. sponges, cnidarians and bivalves). Hydrographical shifts possibly related to the North Atlantic Oscillation Index are manifested as interannual changes in the biogeographical affinity of reef fauna. In contrast, mobile predator and scavenger species composition is driven either by wider regional processes, or by smaller scale stochastic assembly processes including prey availability or behavioural interactions. Reproductive ecology of many reef fauna including crustaceans and hydroids is also related to habitat heterogeneity and hydrography. We also recently discovered that living coral framework at the reef complex provides nursery habitats for oviparous sharks. Our models demonstrate close correspondence between shark egg case distribution, benthic species composition and reef environmental variables. These models allow us to develop maps that predict ecosystem functions (resource use, sources of genetic variability, nursery habitats) across the reef complex that we aim to cross-validate in future research.

NOAA initiates deep-sea coral research in the southeastern United States under the Deep Sea Coral Research and Technology Program

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In 2009, the United States National Oceanic and Atmospheric Administration (NOAA) began the Deep Sea Coral Research and Technology Program, dedicated to providing the scientific information needed to conserve and manage deep-sea coral ecosystems in U.S. waters. That year, a three-year mapping and research initiative began, focused on the deep-sea coral ecosystems of the Southeast U.S. This region was selected for initial field operations based on the importance of its deep-sea coral habitats and the opportunity for the research to inform major conservation efforts.

Seven research cruises used multibeam sonar to map over 10,000 km^2 of habitat along the outer continental shelf and slope between South Carolina and southern Florida, and conducted 22 submersible and 36 ROV dives. These surveys discovered the region's shallowest *Lophelia pertusa* bioherms – at 200 m depths off Florida, and documented 75 unprotected and previously unknown mounds of the reef-forming *Oculina varicosa*. The videos, photos, and over 1,000 biological samples collected over these three years are undergoing analysis. NOAA and its partners are quantifying the abundance of fishes and invertebrates living in deep-sea coral communities, identifying the species encountered, estimating coral ages and growth rates, and using genetic markers to understand coral population structure. Several range extensions for fishes and invertebrates have been identified and several possible new crustacean species were collected. The multibeam maps and groundtruthing video are helping to parameterize a new predictive coral habitat map.

NOAA manages fisheries in the federal waters of the region through fishery management plans developed by the South Atlantic Fishery Management Council. The Council has established five deepwater Coral Habitat Areas of Particular Concern, encompassing more than 60,000 km^2 where the use of all bottom-damaging fishing gear is prohibited. The Council was an integral partner in developing the Program's research objectives, which targeted priority habitats in and near the protected areas. Initial results have been provided to the Council, which has begun a public process to review additional management measures to protect the newly discovered deep-sea coral habitats.

The research was made possible through collaboration with other Federal agencies, academic partners from U.S. and European universities and research institutions, and non-governmental organizations. The approaches pioneered in this region are serving as a model for the Deep Sea Coral Research and Technology Program's subsequent 3-year field research efforts along the West Coast (2010-2012) and Alaska (2012-2014).

Cold water corals exhibit CaCO3 precipitation comparable to their tropical congeners – but only in situ

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Cold water corals (CWC) are commonly known as slow growing organisms compared to their tropical congeners. This has been attributed to their low metabolism reflecting the cold temperature under which they thrive or to their lack of autotrophic symbionts. However, recent sightings of deep-sea corals, e.g. *Lophelia pertusa* growing on oil rigs, indicate high growth rates. The measured growth rate naturally varies on the measure that is applied, for instance length extension versus $CaCO_3$ precipitation. Skeletal characteristics may be different between coral species, for example *Desmophyllum dianthus* grows dense skeletons with pronounced growth in girth compared to the more fragile *L. pertusa*. Furthermore, growth rates of CWC have not been directly measured in situ and thus growth performance may be underestimated. Commonly growth is indirectly measured via dating techniques, estimated or determined in vivo in the laboratory. Corals isolated from their natural habitat and consequently under very different conditions may not show natural metabolic responses. The present study compares in situ (southern Chilean Comau Fjord) buoyant mass increase of *D. dianthus* derived from a 14-days growth experiment with specimens maintained in an on-site flow-through system. Corals kept in aquaria exhibited growth rates of only one third compared to specimens in the field, whereas in situ $CaCO_3$ accretion of *D. dianthus* displayed the same magnitude as massive growing tropical Scleractinians. Accordingly, CWC growth rates may be fairly underestimated when only studied in the laboratory.

Effects of a higher CO_2-level on the reproduction of *Lophelia pertusa*

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Deep living cold-water corals have been recognized as a group that may be particularly vulnerable to the anthropogenic-induced global changes. Reduced calcification rates and reduced growth are some of the expected effects but also reproduction is likely to be vulnerable. We have during five months exposed seven individuals of the white morphology of *Lophelia pertusa* to three pH levels; Ambient (A), A – 0.3 and A – 0.5 pH units. Using standard histological methods we have then investigated the effects on the gametogenic development of *L. pertusa*. We have also looked at the porosity of the skeleton after this prolonged exposure to lower pH levels.

Whole genome sequencing of the cold-water coral *Lophelia pertusa* and sea anemones

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Corals and sea anemones are basal animals with simple tissue level organizations, and represent emerging model systems for environmental stress and gene regulation. We have initiated a genome sequence project (CoralSeq), in part supported by the Research Council of Norway, to study whole genomes and whole transcriptomes of various cold-water species in sub-Arctic Norwegian regions. These include the scleractinian coral *Lophelia pertusa*, but also the sea anemones Urticina eques, Bolocera tuidae, and Hormathia digitata. The sequencing approach includes SOLiD ligation sequencing for ultra-high throughput of short reads (50-100 nt), combined with IonPGM and 454 pyrosequencing for longer reads (2-700 nt). Currently more than 50 billion nt have been generated, and our major effort is to complete the genomes at draft-grade resolution that includes gene annotations. The project aims to obtain genomic resources as well as to gain new comparative insight into animal cold adaptation and climate change impact.

In situ study of survival and growth of transplanted fragments of cold-water coral *Lophelia pertusa* in Swedish waters

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The decline of cold-water coral reefs worldwide calls for exploration and integration of already developed, but also novel restoration techniques. If the damage to a reef is too great, natural recovery processes alone might not be enough to heal the damage in foreseeable time, even when the causes for the degradation have been removed, eg bottom-trawling. The destructive effects of bottom-trawling on the slow growing and brittle calcium carbonate skeletons of cold-water corals have been well documented all around the world. In Swedish waters two reefs still harbour live coral colonies, but both are in a severely degraded state. They have both been protected from all bottom fishing since 2000, but show no evidence of natural recovery. The largest reef was chosen as site for a long-term in situ restoration study with transplanted coral fragments. The origin of the fragments is the Norwegian Tisler reef, a relatively large (with c. 1200 x 300 m live coral cover) inshore reef and situated close to the Swedish border. The fragments were collected using a manipulator on a ROV in order to minimize damages to the donor colonies. The fragments were genotyped using nine species-specific microsatellite DNA-loci. Four racks with 8 plates, each with a minimum of four live fragments on, making a total of at least 32 fragments on each rack, were deployed on the reef in 2007-2009 using ROV-techniques. They were randomly deployed in correlation to the rather strong tidal bottom current in NNW-SSE direction. The racks were manufactured using materials intended to avoid release of contaminating substances and harmful chemicals. The individual fragments have been video-filmed and photographed once a year, but not otherwise disturbed. Survival and area growth rate have been measured using the size of the plates as a reference. Both absolute growth rate per year and relative growth rate in percent per year have been calculated. The racks had been deployed between 27-40,5 months at the latest photo session. Of initial 132 fragments, 106 are still alive. The majority of the missing fragments have broken off, while a few have been overgrown by a crustose sponge (Hymedesmidae). The fastest growing fragment increased in size with 143 % per year. On average during the whole deployment period the fragments on rack 2 and 4 have been most successful with an overall increase in size, while the fragments on rack 1 and 3 have decreased in size. During the first year of deployment most fragments decreased in size, which implies a negative effect of the transplant process, and stresses the importance of long-term transplant studies in order to obtain relevant results.

Fish associated with cold water coral and sponge habitats, northern Norwegian continental shelf

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The present study used acoustic techniques to obtain semi-quantitative information on fish and zooplankton abundance in three cold water coral ecosystems and in nearby topographically complex habitats without corals at medium to large spatial scales (10-100 km), northern Norwegian shelf. The abundance and behavior of non-schooling fish at small spatial scales (1-100 m) was studied in coral, sponge and plain sea-bed habitats in the Traena coral MPA using a towed video system. A total of 32 hours of video data was collected in June 2009 and March 2010. The goal of the studies was to obtain information on the association between cold water coral and fish using fisheries independent sampling techniques. Acoustics showed that zooplankton was evenly distributed throughout the survey areas and was not related to any large-scale topographic features. No relationship between the distribution of large commercial fish stocks (saithe and cod) and the occurrence of corals around the Traena coral field, Korallen and the Røst reef could be detected. 17 fish species were identified from the video. The fish most commonly observed were *Pollachius virens* (saithe), *Sebastes viviparus* (Norway redfish), Trisopterus esmarkii (Norway pout), *Brosme brosme* (tusk) and *Chimarea monstrosa* (rabbit fish). Norway redfish and tusk were more common in coral habitats than in sponge-beds and in the plain sea-bed habitat with the tusk being more active on the plain sea-bed than within the coral reefs. Norway pout was more abundant in the plain sea-bed habitat and rabbit fish was only observed off reef. *Sebastes norvegicus* (golden redfish) was scarce and was only encountered in association with live *Lophelia* colonies. Although several commercially important species (saithe and wolf fish) were often observed in the coral habitats, their abundance were often similar or lower than that observed in sponge-beds and on plain sea-bed. The level of fishery impacts in the Traena coral habitats as observed from the in situ video was very low. We conclude that for the northern Norwegian shelf only Norway redfish, golden redfish and tusk seem to be positively correlated to the presence of corals reefs and with a strong relationship only observed for the golden redfish.

Cnidarian and Echinoderm faunas associated with deep rhodolith beds in Campos Basin, Brazil

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Carbonate bottoms are common environments on Brazilian Continental Shelf, including Campos Basin, and it is mainly composed by rhodolith beds as well as mollusks, bryozoans, and other invertebrate banks. The complexity of these consolidated substrates tends to increase the diversity of the associated fauna. Carbonate beds of Campos Basin Shelf, between 60-130m, were investigated with both remotely operated vehicles and dredging. These areas were previously characterized by acoustic and geological studies. The analysis of eight stations revealed a complex mosaic of rhodolith beds, interspersed with sand areas and larger carbonate concretions. Cnidaria and Echinodermata were the most abundant faunal groups, totalizing 293 ROV image records, and also corresponding to 80% of the specimens collected by dredging. Cnidaria presented 18 taxa identified from images, with Tanacetipathes tanacetum and Muriceopsis metaclados as the predominant species amongst these records (17 and 6, respectively). The station with rhodoliths and sand bottoms presented the greatest richness, total abundance of octocorals, and black corals image records, especially those specimens associated to larger rhodoliths and carbonate concretions. Considering dredging results, Cnidaria was again the most diverse group, with 22 taxa in all studied stations. The station characterized by rhodoliths and boundstone bottoms was the most diverse for Cnidaria, presenting 11 taxa, with *Bebryce cinerea* and *Radicipes sp.* as the predominant species collected. Fifteen echinoderm taxa were identified from ROV images, with *Holothuria sp.* as the dominant taxa (89 records), followed by *Clypeaster sp.* (21 records). As observed for Cnidaria, the station with small rhodoliths and sand bottom was one of the most diverse and abundant for Echinodermata, with a great number of holothurians. The diversity observed on images of the station with rhodolith gravel bottom was also high, with the predominance of Asteriidae and Cidaridae species associated with rhodolith gravel and sand. Twenty echinoderm taxa were collected, and as observed through imaging, the rhodolith gravel station was the richest for this group, presenting 15 taxa, with *Ophiacantha sp*., *Thaumatometra minutissima*, and *Stylocidaris lineata* as the most common species. Comparisons between the ROV imaging and sampling results revealed that some taxa, such as small octocoral colonies and ophiuroids, were not visible on ROV images, although they are abundant on studied areas. On the other hand, larger organisms like black corals and holothurians, frequently observed on the images, are underestimated in dredge samples.

Taxonomy of octocoral family Plexauridae in the deep-sea

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What species of deep-sea corals are being affected by fishing? This study, based on sampling coral diversity from longline fishing by-catch in the Southern Ocean is a preliminary step toward answering this question. Octocorallia are a substantial majority of the by-catch from fisheries of Patagonian toothfish, a highly lucrative industry and cold-water coral reefs may play an important structural and functional role within deep-sea ecosystems, including those supporting commercial fisheries. However, their precise ecological role and geographic distribution remain unclear. Taxonomy of octocorals is considered poorly understood and perpetually under revision. Intrafamiliar relations are particularly enigmatic. A targeted suite of molecular barcoding regions (COI + igr1 + msh1) and morphological characters are being used to elucidate cryptic phylogenetic relationships within the species-rich and paraphyletic family Plexauridae, members of which have a cosmopolitan distribution. Human-associated impacts on these fragile, slow growing, cold-water ecosystems are still poorly understood, despite the ever increasing potential for exploitation of this once isolated realm of life.

Twilight gardens: first record of *Antipathella subpinnata* (Cnidaria: Anthozoa) in the Azores

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The Azores Archipelago comprises 9 volcanic islands and 461 seamount-like features and although it is within an oligotrophic oceanic region, localized enrichment in chlorophyll can be observed associated to many seamounts and island slopes. Although 85 species of cold water corals were already confirmed to occur in the Azores region, few deep-water coral dominated sites are known, and only coral gardens dominated by gorgonians have been reported so far. The "Cabeço do Luís" coral garden was video-documented on July and August 2011 and a sample of one of the colonies collected using the ROV "SP", in the course of deep circalittoral/upper bathyal video surveys which are being conducted under the projects CoralFish and Corazon on the southern slopes of the Faial-Pico Passage. Additional 11 colonies deposited in the Reference Collection of the Department of Oceanography and Fisheries (COLETA) were used in this study applying both classic taxonomy and molecular analysis based on rDNA ITS sequences alignment. *A. subpinnata* was found to occur throughout the Azores Archipelago and some of the adjacent seamounts from approximately 150 to 500 m depths, elevating the specific richness of the Azores Region in black corals to 16 species of the 33 known to occur in the NE Atlantic. The dense aggregation on Cabeço do Luís seamount extends from the summit, at 152 m depth, down to 196 m depth. Colonies height varies from less than 10 cm to approximately 60 cm and width reaches up 140 cm, with the largest colonies found between 150-180 meters depth. *A. subpinnata* is the dominant species in this habitat with the garden harboring few other sessile macro and mega invertebrates of which short encrusting sponges (smaller than 10 cm in diameter) are the most relevant. Several epibionts (e.g. Hydrozoa, Bryozoa, *Pteria hirundo*) were visible in the images as well as numerous schools of planktivorous (*Anthias anthias*, *Calanthias ruber*), territorial macro carnivorous (e.g. *Serranus atricauda*, *Phycis phycis*, *Bodianus scrofa*), and schools of highly mobile demersal fish concentrating over the summit and near the colonies. The eventual rarity of the described assemblage can be induced from the extent area explored by ROV in the region (so far, over 10 kilometers between 100-200 m of depth), without any such aggregations having been found. Although several pieces of legislation aiming to protect vulnerable marine habitats and black corals have already been implemented, it seems insufficient (in this case) as traces of fishing activity such as ropes and weights were found in the area. Further management measures referring to boat size and bottom tending gear, should be established in the scope of finer regulation and an internal zonation scheme of the marine sectors of the Pico Island Nature Park.

Coral-dominated assemblages and associated fishes on the Pourtalès Terrace, Florida Keys, USA

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In September 2011, the Cooperative Institute for Ocean Exploration Research and Technology (CIOERT) and the National Oceanic and Atmospheric Administration (NOAA) conducted a research expedition to the deep-water coral environments on the Pourtalès Terrace, a triangular limestone platform that lies at depths of 250-850 m south of the Florida Keys island chain. Much of the eastern half of the Terrace was designated in July 2010 as the southernmost of five Coral Habitat Areas of Particular Concern (CHAPC) off the southeastern United States, which together total over 60,000 km^2. The NOAA Ship Nancy Foster served as the support platform for the ROV Kraken II from the University of Connecticut which conducted 14 dives to a maximum depth of 875 m. The expedition collected over 50 hr of high-definition video footage, several thousand photographs, and nearly 100 biological samples of corals, sponges and other invertebrates. Video transects supported by multibeam surveys were subdivided into segments of no more than 5 min of continuous and similar habitat for identification and enumeration of all vertebrate and invertebrate taxa to the lowest identifiable taxonomic level. Comparisons were made among and across habitat types as well as inside and outside a small portion of the Pourtalès Terrace CHAPC known as the East Hump Marine Protected Area, which was established in February 2008 as a deep-water grouper and tilefish refuge. Most benthic assemblages were dominated by stylasterid hydrocorals and plexaurid and primnoid octocorals accompanied by a variety of lithistid and other demosponges. Common large fish taxa included snowy grouper (*Epinephelus niveatus*) and big roughy (*Gephyroberyx darwinii*). Antipatharians with basal diameters reaching 10 cm and branch spreads to ~2.5 m attested to local long-term stability, whereas a field of recently dead isidid octocorals reflected some as yet undetermined environmental change. Several range extensions for deep-water species included the discovery of the southernmost *Lophelia pertusa* reef and the first record for the Caribbean roughshark (*Oxynotus caribbaeus*) in US waters.

First report of deep-water non-scleractinian corals from Ampère Seamount (North Atlantic)

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The Ampère Seamount southeast of Madeira is part of the Horseshoe Seamounts chain and rises extending from 4800 m depth to 60 m below the surface. The eastern and southern flanks of Ampère Seamount are extremely steep and in places nearly vertical over several hundred meters. The western and northern flanks have a gentler gradient, but are interrupted by short steep slopes forming a stepped or terraced structure (Kuhn et al., 1996; WWF, 2001).

Because of the rugged topography, the fish fauna of the Ampere seamount was never really exploited with bottom trawls, and benthic samples were only sporadically collected in that area. A few benthos samples from the Ampere seamount were collected during the 30th cruise of Akademik Kurchatov (1979), the 2nd cruise of Moskovsky Universitet (1974), the 8th cruise of Ikhtiandr (1982) and the cruise POS322 of Poseidon (2004). The first intensive sampling program at the Ampère Seamount was organized by the Musée Nationale de l´Histoire Naturelle (MNHN) in 1987 as Seamount 1 (Bouchet, Metivier, 1988). However, besides photographs of undetermined antipatharian and gorgonian published by Heezen and Hollister (1971: 41), no other anthozoan fauna and particularly no deep-water corals have been reported so far from this area. In the SeamountsOnline database only 5 species of Scleractinia are reported from the Ampère Seamount (Stocks, 2011).

During the cruise M83-2 of Meteor a comprehensive collection of deepwater non-scleractinian corals was obtained from the plateau and the slope of the Ampère Seamount. Corals were collected as by-catch of bottom longlining, from Shipek grab and Van Veen grab samples and in one bottom trawl. The list of taxa collected on the M83-2 cruise includes Scleractinia, Alcyonaria, Pennatularia and Antipatharia. The most common anthozoan species on the plateau (120-300 m) were *Callogorgia verticillata* (Primnoidae), *Villogorgia bebrycoides* (Plexauridae) and black corals *Stichopathes gracilis* and *Antipathes dichotoma*. The most abundant taxa in the only trawl haul taken from the middle slope of the Ampere seamount (1950 m) were chrysogorgids *Metallogorgia melanotrichos* and *Chrysogorgia sp*.

Black corals (Anthozoa: Antipatharia) of the Hatton Bank (North Atlantic)

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Until recently, black corals (Antipatharia: Anthozoa) were only sporadically reported from higher latitudes of the North Atlantic. In detailed account of antipatharians of the North East Atlantic, Molodtsova (2006) mentioned only four species occurring North of 52ºN. However, this number is seriously underestimated. Black corals are important and rich components of suspension feeding fauna of the North-East Atlantic banks and carbonate mounds. Weinberg et al. (2008) reported 10 morphospecies of black corals from Franken mounds (western Rockall Bank, NE Atlantic) and Roberts et al. (2008) indicated 3 species of black corals from the Hatton Bank on the base of underwater images. In 2008 Spanish Institute of Oceanography organized deep-sea longline survey at Hatton and Edoras Banks to study potential for sustainable longline fishery over rocky outcrops of the Hatton Bank area and also to estimate effects of longlining on fish communities and benthic ecosystem (Durán Muñoz et al, 2009; Durán Muñoz, Sayago-Gil, 2011; Durán Muñoz et al, 2011). In three of eight sampling blocks (Edoras Bank, Ridges and Mounds Area and the eastern flank of the bank), black corals were reported in by-catches. We compiled a list of black corals of the Hatton Bank based on material collected in this and previous surveys, fishery by-catches in the area and published data. The list includes 10 species of black corals of the families Antipathaidae, Aphanipathidae, Cladopathidae, Leiopathidae, Stilopathidae and Schizopathidae. Some of recorded species are new to science and remain to be described.

Unrecognised diversity and interesting biogeographic patterns in two octocoral genera.

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Deepwater octocorals in the Southern Ocean, including the waters around Antarctica, are poorly known even though they represent one of the most diverse and abundant coral groups in this region. Trawling, long-line fishing and climate change all pose significant threats to these vulnerable coral communities and there is an urgent need to increase understanding of the diversity and extent of the populations. In this study I have focussed on diversity within two octocoral genera *Primnoisis* (Isididae) and *Anthothela* (Anthothelidae). Samples used in the study included material from the Antarctic continental shelf, Tasmanian and New Zealand seamounts, Macquarie Island and Heard Island plateaus as well as international museum specimens. Using a combination of morphological and molecular approaches, I found significant unrecognised diversity within these two genera, including a suspected new genus, as well as possibly 5 new species within *Anthothela* and 3 new species within *Primnoisis*. For example, many specimens regularly thought to be *Anthothela grandiflora* actually consist of two quite distinct species, one undescribed and the misidentification of this undescribed species has been going on for over a hundred years. There is both molecular and morphological support for the separation of the two species. Additional molecular results indicate a confused systematic relationship between *Anthothela* and *Alcyonium*. Interesting biogeographic patterns were also revealed in this study. Preliminary molecular results based on msh1, COI-igr1 and ITS gene regions suggest a world-wide distribution of *Anthothela grandiflora*, till now considered a chiefly northern Atlantic Ocean species. The genus *Primnoisis* is restricted to the Southern Ocean and appears to be circumpolar but species assemblages are clearly differentiated between Antarctic and sub-Antarctic areas and even distinct between islands and seamount groupings suggesting a lack of connectivity between these areas. These findings are particularly important when informing management decisions regarding these deep, isolated communities and the taxonomic review will enhance biodiversity assessments world-wide.

Genetic connectivity among populations of the squat lobster, *Eumunida picta*, associated with *Lophelia pertusa* reefs in the western Atlantic Ocean

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Patterns of connectivity are important to consider when investigating processes that may cause populations to become isolated and eventually lead to speciation. Thus, connectivity between populations is critical to the protection of biodiversity and the design of marine reserves. Recent studies examining regional and basin-wide patterns of genetic connectivity in the cold-water coral *Lophelia pertusa* have improved our understanding of gene flow in the deep sea. But our knowledge is limited to very few species, particularly sessile invertebrates. Gene flow in cold-water corals appears to be moderate among slope populations, but can be restricted regionally or between offshore and fjord populations. Whether this pattern of connectivity is species- or taxon-specific or is a pattern more general in nature remains unknown. *Lophelia pertusa* reefs are hotspots of biodiversity and as such host a variety of megafaunal mobile invertebrates. Members of this associated faunal assemblage are key organisms to examine to determine gene flow and test the hypothesis that patterns of connectivity are similar between associated species. In the western Atlantic Ocean, the squat lobster *Eumunida picta* (Eumunididae) is a dominant megainvertebrate associated with *Lophelia* reefs. Preliminary data suggests that *E. picta* are more abundant on *Lophelia* reefs off North Carolina than Florida, suggesting that abundance of *E. picta* off the coast of the southeastern United States decreases with decreasing latitude. Thus, there appears to be regional differences in abundance and distribution of this species. Knowledge of the larval stages of chirostyloids is extremely scarce. Therefore, larval duration and behaviors that may affect dispersal ability are unknown. However, the first zoeal stage of several *Eumunida* species appear equivalent to galatheoids, in that development is not direct, although the number of zoeal stages is unknown. While data regarding geographic and spatial distributions, relative abundances, and behaviors of the megafaunal invertebrates associated with *L. pertusa* continues to be gathered, addressing broad-scale ecological questions remains difficult. Additional methodologies are necessary to compare connectivity patterns across large spatial (both geographic and bathymetric) and temporal scales. In this study, approximately 170 *E. picta* individuals were analyzed using species-specific microsatellite markers developed from next-generation pyrosequencing. Ten populations, five populations from the Gulf of Mexico and five populations from the western Atlantic Ocean (off the southeastern U.S. coast) were sampled. Patterns of connectivity among populations and between Gulf and Atlantic regions will be compared and contrasted with patterns observed in the structure-forming coral *Lophelia pertusa*. Inferences will be drawn regarding physical factors (e.g. currents, temperature, depth) that may commonly affect dispersal of *Lophelia* and the associated squat lobster.

Cold water coral occurrence in the Eastern Ionian Sea based on experimental long line fishery

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Cold water Corals (CWC) data were collected in the framework of CoralFISH project from experimental long line fishing using two different hook sizes. Sampling was carried out in summer and autumn 2010 in the Eastern Ionian Sea at depths ranging between 300 and 800 m. A total of 9 long-lines were deployed, 3 equipped with hooks No9 and 6 with hooks No7. Data on the condition and catch of each gear were recorded by hook. A higher percentage of hooks with corals was found for the long lines with hook size No9. Corals were identified to the lowest possible taxonomic level. Four species, *Antipathes dichotoma*, *Leiopathes glaberrima*, *Isidella elongata* and *Desmophyllum dianthus* were identified and a *Pennatula sp*. Other corals are under further examination. The depth distribution of CWC was examined in total and by species. CWC distribution in the study area ranged between 343-719 m depth. *A. dichotoma* was found between 516-600 m; *Leiopathes glaberrima* between 367-634 m, *Isidella elongata* between 472-719 m, *D. dianthus* between 483-634 m and *Pennatula sp*. between 519-571 m depth. Coral catches in number and weight were analysed in order to estimate the catch of corals per unit effort (CPUE) by hook size and to define differences in the impact on two gears on cold water corals. Higher coral CPUE values were found for long-lines with hook size No9. The relation of the coral catch with season, station, longitude, latitude, hook size and depth was discussed according to the results of GLM ANOVA analysis.

Is Isidoides a bamboo coral? Evidence from DNA phylogenies, mitochondrial gene order and morphology

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The genus *Isidoides Nutting*, 1910 was originally described as a genus of the family Gorgonellidae (now Ellisellidae) even though it showed a remarkable similarity to the Isidae (now Isididae), but was not classified in that family mostly based on the fact that the type specimen lacked skeletal nodes. Bayer later assigned the genus to the Chrysogorgiidae based on sclerite morphology. Specimens were recently collected on the Norfolk Ridge (southeastern Pacific), corresponding to three distinct mitochondrial (mt) MutS haplotypes. Placement of these sequences in a multi-gene (mt MutS, cox1, nuclear 18S) phylogeny allowed us to reject with confidence monophyly with the Chrysogorgiidae, and infer a close relationship with the Keratoisidinae. While scanning for molecular variation across mt genes, we discovered a novel gene order that is, based on available data, unique to Isidoides. Some specimens are characterized by structures that appeared to be proteinaceous nodes. We investigated the morphology and chemical make-up of these structures using elemental analysis and rejected that hypothesis. Our results on the phylogenetic placement, mt gene order and morphology of these newly collected Isidoides strongly support the hypothesis that this rare calcaxonian is not a Chrysogorgiidae coral, and is sufficiently distinct from the Isididae to be classified into a new family.

A global approach to the study of endemism on seamounts: the case of Chrysogorgia

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Seamounts are underwater mountains commonly characterized by accelerated currents and exposed hard-substrates, features that differentiate them from surrounding soft-sediment plains. Seamounts are therefore physically isolated habitat patches, a condition that led authors to hypothesize that seamount fauna experience genetic isolation and high endemism levels. Here we report data on the geographic isolation of chrysogorgiid octocorals from four seamount chains: the New England Seamounts (NES) and Corner Seamounts (CS) chains in the NW Atlantic, and the Norfolk and Loyalty Ridges (NR and LR) in the SW Pacific. We used specimens from slope environments in proximity to these chains (NE USA Continental slope and Bahamas Escarpment in the Atlantic; slopes of New Caledonia, the Solomon Islands and Papua New Guinea in the Pacific) as well as other isolated seamounts (Azores in the Atlantic, Hawaiian Archipelago and Kermadec Ridge in the Pacific) to establish faunal connectivity across a wider geographical range. Over 800 specimens of Chrysogorgia were collected, and to date 237 colonies from 24 seamounts (14 from the NES and CS, 10 from the NR and LR) were genotyped at the mitochondrial gene mtMutS (the remainder of the material is currently being processed). Twenty-three haplotypes were identified. Integrative taxonomic analyses comparing molecular and morphological variation suggest that these haplotypes can be used to represent morphospecies. NW Atlantic chrysogorgiids showed no evidence of endemism, either at the seamount or the chain scale, and they had a wider distribution than their SW Pacific counterparts. New Caledonian chrysogorgiid haplotypes were never found on more than 3 seamounts (out of the 10 sampled) on the Norfolk and Loyalty Ridges, and only 3 out of 15 haplotypes were shared between the SE New Caledonian slope and the NR/LR seamounts. However, 6 of 15 haplotypes had a geographic range > 400 km. No haplotype was found on both chains, but most haplotypes were rare (73% represented by <12 colonies). Rarefaction analyses suggest that New Caledonia seamounts and slopes are equally diverse. Data from Atlantic and Pacific locations suggest that seamount endemism of Chrysogorgia is rare, both on slopes and seamounts, and that sampling artifacts may be the most significant factor affecting the apparent geographical restriction recorded. The apparently higher levels of genetic connectivity recorded in the Atlantic, compared to Pacific locations, might be due to differences in the sampling depth range (Atlantic: 1000-4000 m; Pacific: 100-1200 m), a hypothesis that can be tested by deeper sampling on New Caledonian seamounts. Data from this project are currently being used to inform Marine Protected Area planning in New Caledonia.

Spatial patterns in the colonization of gold coral (*Gerardia sp*.) across the Hawaiian Archipelago

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Analysis of dive video from a 2007 submersible survey of coral beds across the Hawaiian Archipelago found more host colonies in the early stages of colonization by the predatory gold coral (*Gerardia sp*.) at the south end of the island chain. Bamboo coral (*Isidella*) was the primary host and comprised 14% of the total soft corals seen, where as gold averaged 20% of total. The relative proportion of gold to the number of bamboo colonies across sites was roughly equal with the average height of the gold colonies growing well beyond the branch tips of the host it colonizes. The tallest bamboo colonies also were found at the south end of the archipelago. The observed differences between sites couldn't be attributed to depth, latitude or bottom topography, but the number of colonies in early stage colonization and a taller mean height of potential host colonies did correspond to the geologically youngest portion of the archipelago. Patterns in the data suggests that gold coral prefers a branched bamboo coral host, particularly those of a larger mean size (e.g. *Acanella sp*.), and the availability of the host is likely to limit the abundance of gold coral.

Interactions of deep sea benthic fish and cold-water corals from bathyal habitats in the Azores (NE Atlantic)

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Circalitoral and bathyal communities of mid-depth seamounts are less studied than coastal modified assemblages living at the summits of shallow oceanic seamounts. At the lower circalittoral and bathyal hard bottoms, cold-water coral gardens, hydrarians and sponge aggregations create complex habitats for other invertebrates and fishes. These biogenic habitats distribute patchily over seamounts and island slopes, varying with depth, substrate type and local hydrography, and are more diverse than adjacent unconsolidated and barren rocky bottoms. This work describes fish assemblages associated to circalitoral and bathyal habitats in Condor seamount and Faial-Pico islands slope, observed by submersibles. Fish species occurrence, distribution, behaviour and density are related to habitat type, bottom depth, and substrate type. Video imagery at the University of the Azores and Portuguese Task Group for Maritime Affairs (EMAM) was investigated: ca. 40 surveys, by 2 ROV's and one manned submersible, between 180 m and 1200 m depth. Each fish sighting was considered as a separate event. Over 75 fish species were identified. Exuberant coral gardens dominated by *Dentomuricea spp*. and *Viminella flagellum*, occur on the shallowest depths (200-350m) of Condor Seamount. Small body, gregarious, particle feeders or microinvertebrate predators such as *Anthias anthias*, *Callanthias ruber*, *Epigonus sp., Antigonia caprus*, *Benthocometes robustus* and *Lapanella fasciatus* live associated to aggregations of large sessile invertebrates. Isolates of *Pontinus kuhli, Chaunax suttkusi*, *Helicolenus dactylopterus* and *C. conger* are the dominant carnivores. However, these are not linked specifically to coral habitats and distribute over a wider bathyal habitat type and depth range. Schools of the vagrant Pagellus bogaraveo and *Polyprion americanus* are seen swinging over corals. Unconsolidated sediments are less diverse that biogenic habitats. *Macrouridae spp*., *Gadiculus argenteus* and the flatfish *Lepidorhombus whiffiagonis* dominate these habitats. Scattered individuals of *Hoplostethus mediterraneus* and *Beryx splendens* appear on the videos at about 350 m. Meso and deep bathyal assemblages are sparser, less species dominated and formed by shorter sessile invertebrates. Large vagrant fish species living at those depth layers are less associated to specific types of habitat. Individuals of *Trachyscorpia cristulata*, *Mora mora*, *Macruridae spp.*, *Nettastomidae sp*., deepwater sharks (e.g. *Hexanchus griseus*), among others, were observed across a mosaic of bathyal habitats. Some feed on bottom fauna, while others rely more on preys advected to the seamount slopes. No specific fish fauna were associated to habitats dominated by gorgonians, like *Candidella sp*. or *Chrysogorgia sp.*, or sponges, like *Pheronema carpenteri*. A comparison of fish fauna observed by submersibles and caught by bottom lines show that fishing is unable to sample many fish species that are important on the ecology of coral gardens. Another striking difference between the two methods is the absence of the catch dominant squaloid sharks which are unobserved by the submersibles. This knowledge is relevant for habitat modeling approaches and for ecosystem-based management of these Vulnerable Marine Ecosystems (VMEs) of conservation priority.

Are cold-water corals important habitat for fish? A further analysis of the Irish case

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In situ ROV video observations of fish community structure and behaviour, amongst coral habitat and in non-coral controls, were made at three different locations off the west coast of Ireland. A standard experimental sampling design was employed consisting of two km^2 boxes for both coral and non-coral control areas. A 2 km survey line was chosen within each box. Collected video was annotated using COVER, a software developed for the FP7 CoralFISH project, to support standard video data analysis. All fish were counted and identified to the lowest taxonomic level possible. Three locomotion activity categories were identified: sitting on bottom, hovering (including no locomotion and station holding) and swimming. Furthermore, the frequency of association with coral framework, isolated coral and boulders was described for the most abundant species. Multivariate analysis using PRIMER-6 software was performed to unravel patterns in fish community structure among sites and between coral and non-coral habitats. As the extent of actual coral habitat encountered during 'coral' dives varied, data were standardized as fish counts per minute in coral and non-coral habitat. Results from this study will be presented and their significance in terms of assessing the importance of coral habitat discussed in the light of previous work.

Community phylogenetics of octocorals in the deep Gulf of Mexico, with notes on the evolutionary relationships of their ophiuroid associates

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Processes responsible for the assembly and maintenance of cold-water coral communities are little understood, yet knowledge of these dynamics is imperative for successful conservation, particularly in the face of global climate change and continued oil exploration. The Gulf of Mexico (GoM) harbors diverse cold-water coral communities, including numerous species of octocorals that are abundantly inhabited by ophiuroid associates. To help elucidate the nature of the symbiotic relationship between ophiuroids and their coral hosts, we examined the potential for the co-evolution between the ophiuroids and corals. In addition, we tested the hypothesis that similar habitat types in different areas of the GoM contained octocoral and ophiuroid assemblages with similar phylogenetic community structure. Recent cruises (2008-2011) to 23 deep-water sites (250-2500 m) in the region collected 380 octocorals representing at least 45 taxa and 158 ophiuroids representing at least 5 taxa. The extended mitochondrial barcode (COI+igr+msh) and mitochondrial 16S were amplified and sequenced for octocorals and the ophiuroids, respectively. Evidence of co-evolutionary processes between ophiuroid species and their coral hosts was not readily observed when comparing the tree topologies of both groups. Interestingly, however, the phylogenetic histories of both groups appear to correlate with a bathymetric trend, with certain lineages restricted to > 1000 m and others to < 1000 m. Furthermore, phylogenetic clustering of octocorals > 1000 m indicated that habitat matching is a driving force in community assembly whereas limiting similarity leads to phylogenetic overdispersion at depths < 1000 m. Many sibling species further sort out into different depth zones along the upper to middle slope. Incorporating the use of phylogenies into understanding meta-community dynamics across different spatial scales and taxonomic groups helps to gain insight into the evolutionary and ecological mechanisms that influence cold-water coral community assembly.

An Unusually Shallow and Productive Deep-Water Coral Community Discovered Off the Southeastern United States Coast

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During an ROV bottom survey of the shelf edge and upper slope off northeastern Florida (May 2010), we discovered living colonies of the cold-water scleractinian coral *Lophelia pertusa* attached to abundant hard substrate. This coral and other typically deep-water organisms occurred in unusually shallow depths around 180-220 m. A more extensive survey of this site and nearby deeper sites was undertaken with the ROV Jason II in Nov 2010. Living, apparently healthy colonies of *L. pertusa* were common on the rocky substrate. In one area coral colonies appeared to have formed small bioherms as typically found in deeper waters, and dead *L. pertusa* rubble was common in places, indicating long-term occurrence in this area. In addition, other normally deep- water fauna not only occurred here, but were much more abundant and larger than observed elsewhere. The most common fishes on hard substrate at this site were *Helicolenus dactylopterus*, *Dysommina rugosa*, *Laemonema barbatulum*, and *Anthias spp*. Most common hard substrate macro-invertebrates were *Eumunida picta*, various octocorals, cup corals, antipatharians, *Echinus spp*., and *Chaceon fenneri*. Bottom temperatures at this site were colder than expected at these depths (8-10° C), similar to those normally encountered at 400-600 m. The well developed cold water sessile community and the abundance of associated fauna suggest this site is a long-term feature, rather than short-term opportunistic colonization. The Gulf Stream pulls away from the coast in this region, creating a semi-permanent upwelling of deep, cold water. Also a long-term primary productivity envelope was documented in the area associated with the nutrient rich upwelling. Both of these oceanographic features could explain the unusual occurrence of a deep sea community at this site. Considering the unusual depth, long-term colonization by the corals, and the apparent productivity of benthic fauna, this site should be further documented and should be protected under the existing Coral Habitat Areas of Particular Concern.

A preliminary reconstruction of phylogenetic relationships among deep-sea octocorals from the Azores (NE Atlantic) based on mtDNA sequence data

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Ongoing efforts to map the distribution of benthic communities on the Azores island slopes and seamounts are unveiling numerous coral habitats of conservation importance from shallow to bathyal depths. Although all major taxonomic groups of deep-sea corals occur in this region, the most common structure-forming species belong to the order Alcyonacea. Based on classical morphological taxonomy, a total of 40 morphospecies of Alcyonacea, distributed by 11 families, were so far identified among the material sampled during scientific surveys or collected as by-catch during commercial fisheries. There is, however, a need for molecular phylogenetic studies to assess the degree of genetic diversity and clarify the evolutionary relationships within this ecologically important group. Moreover, molecular data may also reveal cryptic taxonomic diversity that was previously overlooked on the basis of morphological characters. Here we present a preliminary assessment of the phylogenetic relationships among members of families Acanthogorgiidae, Plexauridae and Primnoidae, through the analysis of mitochondrial DNA sequence data. The molecular data set comprises partial sequences of the mutS homologue mismatch repair gene msh1 and a fragment encompassing the Folmer region of COI plus an adjacent intergenic region, igr1. Sequences were obtained for 68 specimens assigned to 16 taxa, which were collected throughout the 1.6 million km^2 area of the Azores EEZ, at depths ranging between 160-1500 metres.

Catalogue and identification guide of deep-sea Alcyonacea of the Azores archipelago (NE Atlantic)

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The conservation and sustainable exploitation of deep-sea resources, along with minimization of significant adverse impacts over the ecosystems, are among the most critical challenges today. Life history characteristics of deep-sea corals such as slow growth rates and long life-span make them particularly sensitive to anthropogenic perturbations such as fishing activities. For that reason cold-water coral ecosystems (reefs and gardens) have been listed as Vulnerable Marine Ecosystems (VME´s) of utmost conservation priority (UNGA resolution 61/105). Yet, meaningful conservation strategies require extensive knowledge on the diversity and distribution of the concerned taxa. Within Cnidaria, the *Alcyonacea Lamouroux*, 1812 is the most diverse and speciose order comprising over 3000 species. Members within this order are considered indicators and key components of VMEs. In this study we made an extensive literature review of historical records of Alcyonacea for the Azorean EEZ and complemented it with occurrence data from recent surveys. Furthermore an identification guide of the species most commonly caught in demersal fisheries (handline and longline) was produced. For each species we produced an identification sheet, containing on deck photos, scientific and common names, main morphological characters (color, shape, branching pattern, general size), as well as information on the known distribution, habitat and depth range. This guide will be a useful tool assisting those on-board fishing and research vessels as well as biologists observing ROV images to most accurately identify and record the various species of soft corals likely to be observed and caught in the central northeast Atlantic. We expect this guide will improve the reporting of VME's occurrence in the region and therefore provide baseline knowledge of major relevance for their conservation and sustainable management.

Serpula/*Madrepora* (serpulid/coral) bioconstructions in deep-water settings from the Adriatic Sea (Mediterranean)

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Serpulid worms represent one of the most important groups among epibionts associated to deep-water coral framework. However, despite the abundance in individuals these organisms only secondarily contribute to biomass and carbonate production, due to their relative small sizes. Serpulid specimens on corals are often clustered, suggesting an attraction for cospecifics at settlement. Particularly, *Serpula vermicularis* Linnaeus, 1767, the species which presently reaches the main sizes, is normally rare.

A remarkable aggregation of serpulids dominated by *S. vermicularis* on coral colonies has been discovered at bathyal depths (600-700 m) in the Bari Canyon (Southern Adriatic Sea) during cruises performed in the frame of the EU-FP7 Hermes Project. There, this serpulid is quite common, showing large-sized tubes which locally form clusters. The species is particularly abundant on *Madrepora oculata* (Linnaeus, 1758) colonies up to 80 cm high, which grow on blocks, vertical walls and overhangs.

S. vermicularis specimens settle on tissue-barren branches of living colonies, and continue to grow jointly with the coral, becoming progressively overgrown and enveloped by the host skeleton. Tubes of adult specimens form in turn the substratum for new corallites, enabling the species to largely contribute to the frame construction and to act actually as a primary framework constructor. Tubes also strengthen the carbonate frame by binding adjacent branches of the coral colonies.

Differences exist in the distribution pattern and the growth geometry of *S. vermicularis* on coral colonies: on the "colony front" side, generally concave in shape, tubes form raised distal ends, whereas on the "colony back" sides tubes grow attached to the coral branches for all their length. Relations with other co-occurring taxa of the framework among which the solitary coral *Desmophyllum dianthus* (Esper, 1794) have been also investigated.

Serpulid/coral build-ups were hitherto unknown for bathyal environments. Gregarious tubes of *S. vermicularis* are so far known only from shallow environments. Possible factors leading to the unusual serpulid aggregations in the Bari Canyon and to the formation of the Serpula-Madrepora-Desmophyllum- facies are discussed.

Evidence of bioerosion by echinoids in deep-sea coral habitats of the Northeast Atlantic

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In situ video observations of deep-sea echinoids interacting with reef building coral are common in the deep-sea literature. Paradoxically, the latter is devoid of reports of bioerosion by extant echinoids. Here we present evidence of contemporary bioerosion of cold-water coral by deep-sea echinoids, *Gracilechinus elegans*, *Gracilechinus alexandri*, *Cidaris cidaris*, and *Araeosoma fenestratum*, showing that they actively predate on the living framework of reef building corals, *Lophelia pertusa* and *Madrepora oculata*, in the NE Atlantic. Echinoids were collected in canyons on the north side of the Porcupine Bank and Goban Spur, Ireland; and six canyons in the Bay of Biscay, France. A total of 44 specimens from these four taxa showed recent ingestion of the coral infrastructure. Upon dissection of the gastrointestinal tract, living coral skeleton encased in a thick mucus layer was observed in the gastrointestinal tract of *G. elegans* and *G. alexandri*. Both living and/or fossil forms of the coral were found in *C. cidaris* and *A. fenestratum*. The taxa may be an important factor to consider for the conservation of deep-sea coral reefs; echinoid bioerosion might affect deep-sea reef stability therefore possibly changing the predicted survival timeline for these habitats.

Molecular systematics of precious corals (Coralliidae: Octocorallia)

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Members of the family Coralliidae, composed of 2 genera (Corallium and Paracorallium) that known as precious corals, are ecologically and economically important deep-sea organisms with worldwide distribution. Due to intensive commercial harvesting or bottom trawling, the conservation of these organisms has been a global concern in recent years. However, no recent reviews of their taxonomy are available and the conservation of precious corals has been hindered by their taxonomic ambiguity. For instance, morphological characters for species distinction are often obscure and overlapping. In addition, the monophyly of Corallium has been challenged in previous studies. In this study we examined the taxonomic and evolutionary relationships of precious corals by molecular data and morphological characters. Both mitochondrial (16S, MSH, and control region), and nuclear (28S and EF1) genes from 18 species and 7 unidentified species were used to infer their phylogenetic relationships. The phylogenetic trees constructed by both mitochondrial and nuclear markers are similar and strongly supported the non-monophyly of Corallium and Paracorallium. However, the Coralliidae can be divided into 2 major clades, one contains most of Paracorallium species (except *P. inutile*) and Corallium species with non-retractile autozooids and long spindles in their tentacles, and the other includes *P. inutile* and the remaining Corallium species with retractile autozooids and without long spindles in their tentacles. This study revealed that the Coralliidae need to be revised and the genera be redefined.

Community recruitment and coral transplantation in the Santa Maria di Leuca cold-water coral province (Mediterranean): a pilot study

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Two settlement panel racks were deployed and recovered after one year in the cold-water coral area of Santa Maria di Leuca (SML), eastern Mediterranean, at c. 600 m water depth. Before deployment, live specimens of *Madrepora oculata*, *Desmophyllum dianthus* and *Lophelia pertusa* were fixed to the rack supporting frames in order to test the feasibility of their transplantation. The two studied racks, each consisting of 9 horizontal and 9 vertical plates, were placed in a densely-packed coral site and in a neighbouring mud-dominated one, respectively. In order of abundance, cnidarians, polychaetes, foraminiferans, bivalves and bryozoans recruited on the plate surfaces of the two racks. Serpulids and scleractinians were remarkably more abundant in the coral-rich area, but the abundance of hydrozoans, scyphozoans and agglutinant polychaetes was similar in both racks. The latter groups preferentially settled on the upper surfaces of the horizontal plates and on the upper edges of the vertical ones. Serpulids and scleractinians, on the other hand, were almost exclusively found on the sediment-free undersides of the horizontal plates and on the vertical ones. The taxa distribution in the two racks and the comparison with coral communities from neighbouring sites, suggests that in the SML cold-water coral area: (1) the recruit abundance of scleractinians and serpulids on newly available hard substrata decreases with increasing distance from densely-packed live coral colonies, (2) the larvae, and/or early metamorphosed juveniles, of scleractinians and serpulids are less tolerant to sediment deposition than other sessile groups (3) foraminiferans, hydrozoans and scyphozoans behave as pioneer organisms whereas sponges, octocorals and bryozoans seem to be late successional taxa. Among the transplanted corals, *M. oculata* showed a linear growth of 7 mm yr-1 and the ability to overgrow any available surface, *D. dianthus* exhibited much slower linear growth but good regeneration potential of broken septal portions and only one juvenile corallite of *L. pertusa* grew 3 mm in length but died before recovery. The results exposed herein represent the first observations so far carried out on both recruitment and transplantation of Mediterranean frame-building bathyal corals and associated organisms. Further studies are planned in order to support our preliminary findings.

Exploration of Mesophotic Coral Reef Ecosystems in the Northwestern Hawaiian Islands

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The Papahānaumokuākea Marine National Monument surrounding the Northwestern Hawaiian Islands represents one of the largest marine protected areas on the planet. The marine biodiversity of this remote region has previously been surveyed in shallow water (30 m) using SCUBA, as well as in deep water (>100 m) through trawling, remotely operated vehicles and submersibles. However, as in many other regions around the world, little is known about the marine biodiversity between these two depth ranges. This intermediate depth range hosts mesophotic coral reef ecosystems (MCEs), which are light-dependent coral reef ecosystems found below the depth limit of conventional SCUBA diving (30 m), and extend to the deepest portion of the photic zone, which may be up to 150 m in some locations with high water clarity. Since 2009, several research expeditions have been launched to survey MCEs within the Papahānaumokuākea Marine National Monument using mixed-gas technical diving technologies. Multiple significant discoveries have resulted from these expeditions including the collection of previously undescribed species, geographic range expansions of known species, the discovery of endosymbiotic Symbiodinium within black corals, and important insights into sexual reproductive processes of numerous black coral species. Perhaps the most significant finding is that fish assemblages of MCEs within the Northwestern Hawaiian Islands are dominated by Hawaiian endemic species, which comprise ~90% of the numerical abundance and ~80% of the total number of fish species. These findings indicate that MCEs represent important reservoirs of biodiversity, and highlight the importance of surveying the deeper depth range of coral reef ecosystems, which remain largely unexplored.

Southern Ocean Corals: Surprising diversity and abundance.

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The widespread distribution of cold-water reefs is becoming better documented through deep-sea exploration and discovery, though historically these efforts have focused on the waters of N. America and Europe, leaving large gaps in our knowledge of the rest of the deep ocean. Though the Southern Ocean is not usually a location associated with large coral aggregations, deep-water species have been collected here for more than a century. In 2008 we explored seamounts in the Drake Passage, between the tip of South America and the Western Antarctic Peninsula. This expedition located areas of both low and high coral abundance, for scleractinians, octocorals and stylasterids.

In May-June 2011, the RV Nathaniel B. Palmer 11-03 expedition set out to further examine cold-water coral habitats spanning the Drake Passage in the Southern ocean. During this expedition a combination of swath bathymetry, towed camera and drop camera images, environmental water chemistry, ArcGIS databases, dredges and trawls were used to find, examine and map cold-water coral locations and habitats. We located areas of spectacular coral growth in areas off Cape Horn, Burdwood Bank, Sars Seamount, Interim Seamount and the Shackleton Fracture Zone – spanning the entire Drake Passage. This poster presents the first benthic images of these diverse and abundant deep-water corals.

Recent progress in our understanding of the distribution of Black Corals (Anthipatharia: Anthozoa: Cnidaria) throughout the North Atlantic

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International efforts are now underway to assemble new information on antipatharians geographic and bathymetric distributions in the North Atlantic. Here we present new records of two genera, Stauropathes and Bathypathes, found along the continental margins of Atlantic Canada, mid-Atlantic Ridge and from seamounts in the North Atlantic.

Antipatharian specimens were collected using Remotely Operated Vehicles (ROVs), rock dredges, research/survey otter trawls, as well as samples submitted by fisheries observers on commercial fishing vessels using various benthic gear types.

The geographic and bathymetric distributions of Bathypathes and Stauropathes, (primarily *S. arctica*) were widespread, and occurred over a depth range of 600-4300 m with average depth of 1000 m.

Specimens were identified to the lowest taxonomic level of certainty from samples and remotely taken specimen photos. Only data that could be verified with physical samples and/or photo identifications with a high level of confidence were used.

Many more antipatharian by-catch records have been reported by fisheries observers monitoring deep-water fisheries but were not verified beyond Order. As a result, antipatharian data presented here most likely underestimates the occurrences of these two genera in the North Atlantic.

In general antipatharians are a poorly studied group with information on geographical distributions collected sporadically. New information provided here not only complement earlier studies but greatly improve the know occurrences of Stauropathes and Bathypathes in the North Atlantic.

The carbon budget of *Lophelia pertusa*: the importance of determining multiple parameters in stressor studies

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Determining an organism's response to stress typically focuses on changes in their metabolic rate and growth. However, environmental stress often results in a change in the net energy balance due to a reduction in assimilation of energy and/or its conservation, as well as increases in basal metabolic demands, with resulting adverse effects on performance of organisms. We examined energy budget parameters of the cold-water coral *Lophelia pertusa*, comparing respiration, excretion, calcification and tissue growth of freshly collected fragments with those maintained in aquaria for 20 days. Whereas respiration and growth rates did not vary over the experimental period, the amount of carbon excreted as mucus declined over time, suggesting corals are conserving carbon under stressful conditions. Feeding experiments indicated *L. pertusa* preferentially graze on *Artemia nauplii* when offered a mixed diet of *Artemia nauplii* and microalgae (*Skeletonema costatum*). Furthermore, *L. pertusa* is suggested to be an opportunistic feeder, with no significant differences between the percentage of *Artemia* consumed when starved (5 days) than when fed within the previous 24 h. This study highlights that complexities in energy conservation and allocation should not be overlooked when examining how organisms will respond to environmental stress.

Microsatellite genetic characterization of *Lophelia pertusa* populations from Campos and Santos Basins, Rio de Janeiro, Brazil

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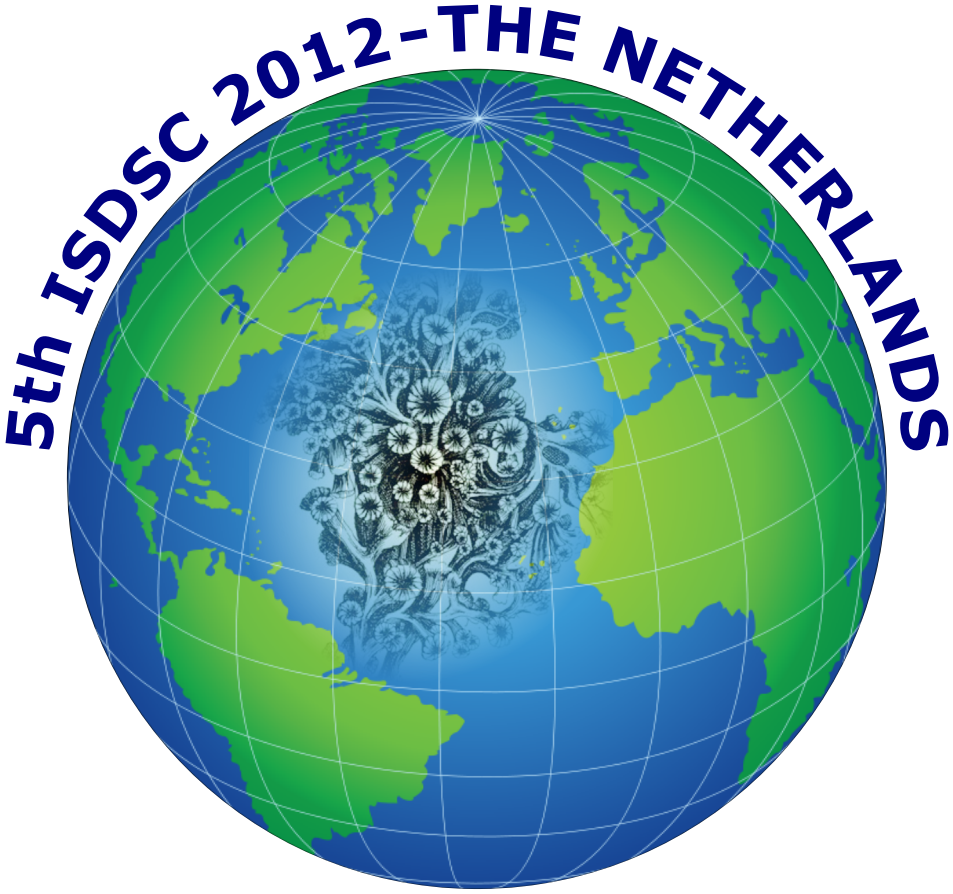
Deep water coral reefs are highly diverse ecosystems, however, due to sampling difficulties, the biology of their main reef building taxa is poorly known. As with all marine ecosystems, these deep reefs have been suffering from anthropogenic threats, and in this case the greatest impacts are from bottom trawling and off-shore oil and gas exploration and production. The ability of a population to persist large impacts is often related with its level of gene diversity. Populations with low genetic diversity are less resilient to environmental changes and more susceptible to extinction. Additionally, the supply of new recruits coming from adjacent areas may help the re-colonization of the impacted area. Therefore, understanding how populations are connected is also important to predict the response of a population in face of a pronounced environmental change. Highly variable markers, such as microsatellites, have been extremely useful to evaluate population's gene diversity and infer levels of genetic connectivity. The azooxanthellate scleractinian coral *Lophelia pertusa* is one of the major deep-sea reefs building taxa throughout the world. However, very little is known about the reproductive biology, including the larval dispersal capability of this species. Genetic studies have already investigated levels of genetic diversity within North Atlantic Ocean populations (NEAO, NWAO and GOM) of *L. pertusa* and connectivity among them. The present study used microsatellites to evaluate levels of gene diversity and connectivity of two *L. pertusa*'s populations in areas of extensive oil and gas drilling in Brazil. Samples of *L. pertusa* were collected (from August 2008 to September 2011) between 572-636m of depth at Campos Basin (N = 39) and between 239-483m of depth at Santos Basin (N = 8), Rio de Janeiro, Brazil, with the help of a remotely operated vehicle through the project "Deep Sea Coral Assessment Project", conducted by the R&D Center of the Brazilian Energy Company (Petrobras). All samples were fixed in ethanol 95% until molecular analyses. Analyses of eight microsatellite loci revealed high levels of observed and expected heterozygosities on both populations. Only two out of 39 samples from Campos basin had identical multi-locus genotypes. High allelic diversity was found particularly at Campos with a maximum of 31 alleles found at one locus and a minimum of six alleles. No evidence of linkage disequilibrium and no significant deviations from H-W equilibrium were found. Population structure analyses revealed a low and not significant value of FST (0.0182) between Campos and Santos basins and a K of 1 (highest log likelihood) was found using the program Structure. These results demonstrate that the two studied Brazilian populations of *L. pertusa* display high levels of genetic diversity and gene flow. Consequently, reefs of *L. pertusa* at Campos and Santos basins can be considered as one panmictic population. This study provides a baseline data of *L. pertusa*'s genetic diversity for environmental management programs (governmental or oil companies), including conservation policies of deep-water coral habitats.



ABSTRACTS
POSTERS THEME II

First insights into physiological responses of the cold-water coral *Lophelia pertusa* towards isolated and combined effects of ocean acidification and rising temperature

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Ocean acidification caused by anthropogenic CO_2 uptake is projected to expose 70 % of the presently known cold-water coral bioherms to waters corrosive for their carbonate structures by 2100, if CO_2 emissions proceed unabated. Despite their critical role as bioengineers and importance as habitat and nursery grounds for a diverse species community, very little is known about the sensitivity of reef-building deep-sea scleractinians towards ocean acidification and global warming. Here, we present results from various incubation experiments on the abundant and widespread scleractinian cold-water coral *Lophelia pertusa*, regarding elevated CO_2 concentrations and increased temperatures separately and in combination. Short-term (1 week) high CO_2 exposure resulted in a decline of calcification by 26-29 % for a pH decrease of 0.1 units and net dissolution of calcium carbonate. In contrast, *L. pertusa* was capable to acclimatise to acidified conditions in long-term incubations (6 months), leading to even slightly increased calcification rates. Respiration rates measured across a pCO_2 gradient from 410 to 1200 µatm decreased significantly and showed that in higher CO_2 treatments with enhanced calcification, metabolic costs were not increased in terms of oxygen consumption. However, if only temperature was increased over a range experienced in the field (7.5 – 11°C), fitness (RNA/DNA ratios) was significantly depressed, whereas oxygen consumption increased up to 59 %. These results indicate the relevance of synergistic impacts of higher CO_2 conditions and rising temperatures on physiological responses of *L. pertusa*. As all experimental studies conducted so far dealt with unifactorial manipulations, we present early results on the first long-term experiment combining elevated levels of pCO_2 with enhanced temperatures in order to examine the acclimatisation potential of *L. pertusa* towards two climate change related threats.

Coral gardens in the Bay of Biscay (NE Atlantic)

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Coral gardens are listed as 'threatened or declining' (under OSPAR) and vulnerable marine ecosystems (VMEs). These habitats are of great conservation concern, and in order to adequately protect them, knowledge of their ecology, biogeography and ultimately the ability to map and predict their distribution is necessary.

The OSPAR definition of coral gardens is very broad and incorporates both hard and soft substrate assemblages. To date, there have been few coral garden communities described, which is in contrast to other vulnerable habitats such as cold-water coral reefs. Within the French EEZ, along the French Margin, hosts an impressive and rugged topography with 130 submarine canyons. The environment within these canyons varies significantly and thus plays host to a diverse range of coral species. Early knowledge of these diverse coral fauna can be attributed to the work of Le Danois (1949) who described the regional fauna. Whilst this historical data has proven useful for understanding the coral fauna of the region, to better understand coral garden communities, we need better descriptions at a community level to aid conservation efforts.

Between 1981 and 2011, there have been 14 cruises in the Bay of Biscay, with over 100 dives using a range of imagery techniques. There is a diverse range of soft sediment coral gardens found in these canyons, with varying dominant taxa. Here we present a description of the coral garden communities from the submarine canyons in the Bay of Biscay (France).

Mapping coral and sponge habitats in a shelf-depth coral-rich environment, Learmonth Bank, Northern British Columbia, Canada, using multibeam sonar and ROV video observations.

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Habitat mapping of cold-water corals and sponges can provide useful guidance for coral and sponge conservation, fisheries management, and has largely focused on continental slope environments. Habitat mapping with multibeam sonar provides high-resolution detailed predictions of where coral and sponge species will occur within a mapped area. This study focuses on habitat mapping within a shelf-depth environment in northern British Columbia, Canada. Learmonth Bank is a large granite massif at the western end of Dixon Entrance, a tidally-influenced inlet that includes the boundary between British Columbia, Canada and Southeast Alaska, USA. The bank shoals from over 480 m to 26 m depth, and is composed of glacially scoured granitic bedrock above roughly 200 m, surrounded by a variety of glacial deposits. Multibeam sonar of the area was acquired in August 2008, and processed to a 5m grid of bathymetry, backscatter (acoustic return strength), and slope calculated from the bathymetric raster. Video transects were recorded in July 2008 and August 2009. The 32 km of video transects recorded using the ROV ROPOS in 2008 covered the deeper glacial deposits surrounding the bank and bedrock areas deeper than 170 m, limited in part by the deep-water configuration of ROPOS. The 2009 video surveys covered an additional ~10 km of transects shallower waters, mainly on bedrock bottoms on the southern end of the bank, using a small Phantom ROV. ROV video processing classified bottom types using dominant and secondary substrates, and identified 16 benthic biotopes described as biological roughness categories. Video analysis produced a database with substrate and biological observations every second, which was queried for various substrate categories, biological roughness classes, and particular taxa or growth forms of interest. The spatial correspondences between the query results and the values for bathymetry, backscatter, and slope rasters were used to generate classification rules based on the interquartile range of each variable for each substrate type and biological roughness element. The dominant corals were the red tree coral, *Primnoa pacifica*, and small styasterids, of which *Stylaster parageus* was quite common. Demosponges and hexactinellid sponges, including reef-forming species, were quite common, but no sponge reefs were observed, and the reef-forming sponge species were less common than other hexactinellids. While biological roughness categories were not based upon substrate characteristics, there was a high degree of correspondence between some of the biological roughness categories and substrate types. For example, *Primnoa pacifica* was mostly found growing on glacial erratic boulders within the glacial deposits in deeper waters, and on bedrock in shallower waters. While multibeam sonar data readily separated bedrock from glacial deposits, and identified glacial landforms, especially moraines, multibeam recognition of the finer substrate categories used in the video processing was more challenging. Ongoing analyses determine the reliability with which benthic biotopes and biological roughness categories could be differentiated based on combined analysis of bathymetry, backscatter, and slope, benthic position index.

Low pH and the role of endolythic algae in CWC

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The declining pH in our world's ocean caused by ongoing OA, will affect marine calcifiers. Low pH has adverse effects on the crystal structure of cold water corals (CWC). Nevertheless, CWC are able to calcify in lowered pH in general – as it is characteristic for some deep-sea areas. Furthermore may a sufficient heterotrophic input provide enough energy to calcify under low aragonite saturation. CWC in the Comau fjord in Chilean Patagonia thrive under pH conditions that are predicted for future dates (approx. 850 µ atm atmospheric CO_2 by 2100). One particularity of Patagonian shallow-water corals is the presence of endolithic photoautotroph symbionts, inhabiting mainly the outermost layer of the distal portion of some corallites that is still covered with polyp tissue. We studied metabolic interactions between coral polyps and endoliths with unlabeled stable N and C isotopes. The stable isotope study indicates metabolic interaction between algae and host, but to a minor extent than in their tropical congeners. It can be concluded that under optimum nutrition conditions as they might be present for CWC in the highly productive Comau fjord 1.) Corals might be able to compensate adverse effects for calcification due to low pH 2.) Metabolic interactions between endoliths and polyp, if present at all, are of minor importance in comparison to the overall metabolic rate. Due to the fact that primary production in the Comau fjord shows strong fluctuations, metabolic interactions, although minor, may play a role in times of low food supply.

Uptake rates of dissolved organic matter by four cold-water coral species from the Cap de Creus canyon (northwestern Mediterranean)

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It has recently been demonstrated that dissolved organic matter (DOM) may be an important carbon and nitrogen source for several symbiotic and asymbiotic tropical coral species. Conversely, there is still no information on the possible DOM uptake by cold-water coral (CWC) species. DOM contains many compounds, such as sugars or amino acids. It is generated in the surface ocean from the degradation by microorganisms, of the primary and secondary productions (remineralization), on time scales of hours to days. However it is also exported from the surface into deeper waters, especially during the high-density water masses formation. In this study we investigated for the first time the uptake rates of DOM in the form of amino acids by *Madrepora oculata*, *Lophelia pertusa*, *Dendrophyllia cornigera* and *Desmophyllum dianthus* from the Cap de Creus canyon, located in the northwestern Mediterranean. This work aims to get a better understanding of the feeding ecology and ecophysiology of Mediterranean CWC species. Results are discussed in the light of recent studies on the ecology of these species, as well as of tropical and temperate corals, and interpreted in order to improve our understanding of the geographical and bathymetrical distribution of CWC populations.

A preliminary description of the Arc Mounds, a province of mid-sized carbonate mounds on the south-west Porcupine Bank.

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The Arc (archipelago) Mounds located on the south-west Porcupine Bank off the west coast of Ireland consists of 30+ raised seafloor features varying in size between 30 and 90 m. ROV investigations have revealed that these mounds are capped with vigorously growing coral colonies. Recent preliminary geological investigations (multibeam and sub-bottom profiles) show that a number of these features are clearly aligned along a linear fault suggesting locally enhanced hydrographic conditions provide optimal conditions for coral growth. ROV mounted multibeam provides unprecedented bathymetric detail of several complete mounds and shows the interplay between accumulation and erosion processes. The Arc Mounds are a unique feature of the Irish continental margin and warrant consideration for protection under the European Union Habitat's Directive.

Overview of CWC mounds in the Eastern Alboran Sea (Western Mediterranean)

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Cold-water coral mounds (CWC) are prominent features in the Eastern Alboran Sea and have been mapped both in the northern Spanish Margin and in the southern Moroccan margin. Based on the integration of high-resolution geophysical methods, seafloor sampling and video images, we present the main morphological characters of the mounds and their associated benthic habitats. CWC mounds have been observed as isolated ridges on seamounts (e.g. Chella Bank in the Spanish margin) and as large clusters of circular and elongated mounds (e.g. Melilla Mound Field, West and East Cabo Tres Forcas in the Moroccan margin). Mounds range in 100-400 m large, 50-100 m high from the surrounding seafloor and a high density has been observed in some of the clusters of the Moroccan Margin (up to 34 mounds in almost 4300 ha). Parametric echo-sounder data reveal that a number of mounds built above a thick pack of chaotic deposits, interpreted as a landslide. On the other hand, some older mounds appear to be buried, suggesting different phases of mound construction. Video tracks and seafloor sampling showed the occurrence of CWC frameworks composed of dead and patchily alive *Madrepora oculata*, *Lophelia pertusa* and *Dendrophilia cornigera* in a fine to medium coarse bioclastic sediments matrix. Most common associated macrobenthic communities correspond to gorgonian assemblages (*Callogorgia verticillata*, *Paramuricea sp.*) and echinoderms (*Ophiotrix sp*.). A first approach has been attempted in order to describe the interplay between the regional physical characters and the evolution of the CWC mounds. The mixing of Atlantic and Mediterranean Waters in the Alboran Sea provokes a peculiar oceanographic regime in the area, where an increment of bottom currents and of the primary production has been proved in the regions surrounding the CWC mounds. Additionally, relevant Plio-Quaternary and still active tectonics involves the Eastern Alboran Sea, where uplifted and tilted blocks delimited by steep escarpments played an important role in control mound distribution.

Set up of in situ mark and recapture technique to assess cold water coral growth process

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Since the first dives in the 60s using the submersible SP 600 of Commandant Cousteau, the Lacaze-Duthiers submarine canyon, off Banyuls-sur-mer in the Gulf of Lion, is known to host cold-water coral reefs. The recent explorations of this canyon (OOB-DIREN 2008-2009; MEDSEACAN 2009-2010) revealed the abundance of hermatypic cold-water coral species (*Lophelia pertusa* and *Madrepora oculata*) and deep oysters (Neopycnodonta cochlear), which form reefs and structures providing niches and nursery grounds for a variety of species, including commercial fish species. The international community highlights the importance of protecting those vulnerable marine ecosystems. However owing to the difficulty in accessing their habitat, growth rhythms and factors influencing reef builder cold-water coral growth remain poorly studied. Experiments of growth were acquired in aquaria (Orejas et al., 2011), but they do not represent the whole environmental variability. In situ estimations for *Lophelia* and *Madrepora* come from the observation of colonization of anthropogenic wastes such as long-lines or fishnets (Roberts et al., 2009), which cannot give enough precise estimation of growth. The accretionary growth of calcifying species provides intra-annual to centennial information of growth rate, and life span assessment, but sclerochronological profile calibrations are necessary to establish a chronological time scale. Recently, chemical markers using fluorochromes have been tested for internal growth increment identification (Lartaud et al., 2010). According to the chair 'Extreme environment, biodiversity and global change' supported by Fondation TOTAL and UPMC, in situ mark and recapture experiments of *Lophelia* and *Madrepora* cold-water corals in the Lacaze-Duthiers canyon (at 520m depth), were developed using ROV dives since November 2010. Additionally, nubbins of the two species were cultured at laboratory to compare the growth performances between aquaria and environmental conditions. The chemical markings can be revealed by observation of thin sections of the skeleton under fluorescence microscope, and provide an interesting tool to measure the growth rate. Preliminary results raised clear differences in the increase of polyp number for *Madrepora* breed in situ compared with nubbins cultured at laboratory. A seasonal growth influence in the canyon is also observed for *Madrepora* but not for *Lophelia*.

"Squires' Coppice" revisited

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A biological survey of the Campbell Plateau undertaken in 1964 by the HMNZS Endeavour uncovered a local bathymetric rise consisting of quantities of coral including Gonicorella dumosa, *Desmophyllum cristagalli*, and *Flabellum sp*. The position of the rise was published as 50° 38'S, 167° 38'E and it was interpreted as a deep-water coral "coppice" (Squires 1965). The EDO echo sounding trace showed it to be 40m high sitting on top of a local rise of the Auckland Island High. But subsequent surveys have failed to relocate this feature. A recent analysis of ~500,000 depth soundings in the region showed that there were no matching bathymetric rises at the published position of the "coppice", however, a nearby rise 12km to the southeast was identified as a likely candidate. In 2011 the RV Tangaroa ran three multibeam lines over this rise and identified a reef-like structure on the summit. Bathymetric profiles from the sub-bottom profiles and multibeam data match the original EDO echo sounding trace identifying this structure as the "Squires' coppice". A further two reef-like structures were also partially mapped lying immediately to the north of "Squires' coppice". All three reefs sit upon a rise, approximately 95km east of Auckland Island, which rises 90m from the surrounding seafloor at 440m to a rounded top at 350m deep. The reefs are aligned west-east and have a shallowest depth of 272m. The boundaries of these reefs have been calculated by bathymetric analysis. The main "Squires' Coppice" reef is approximately 6,500m long and 700m wide and up to 50m high. Data from 3.5kHz sub-bottom profiler show that the reef does not sit on bedrock, with evidence of ice berg scours on the surrounding seafloor which is comprised of foraminiferal ooze. Photographic surveys are planned to confirm that the reef structures detected by the multibeam survey represent the largest and most biologically significant coldwater coral reefs in the southern hemisphere. The presence of these cold water coral reefs on the Campbell Plateau may be due to the unique oceanographic conditions that occur to the east of Auckland Island.

Squires, D. F., 1965. Deep-water coral structure on the Campbell Plateau, New Zealand. Deep-Sea Res., 12, 785-788.

Acoustic and visual seabed classification of a deep-water *Oculina varicosa* coral reef offshore southeast Florida, USA

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The accuracy of automated acoustic seabed classification software was tested against visual seabed classification from video and still photos collected by remotely operated vehicle (ROV) on *Oculina varicosa* coral reef bioherms within the *Oculina* Habitat Area of Particular Concern (OHAPC) offshore southeast coast, Florida USA. Previous studies have shown that these declining deep-water coral habitats are important spawning and nursery areas for fish populations. Developing effective methods to create habitat maps is essential to help future conservation efforts. Two sites were investigated in the OHAPC. The first site, Chapman's Reef (1.6km^2) at 91 mbsl was used to create a primary acoustic and visual classification with five ROV transects and XXX (put number here) seafloor grab samples. In the second site, the North Study Area (3.7km^2) at 54 mbsl, two ROV transects and XXX (put number here) grab samples were used to test the supervised classification from the Chapman's Reef study area. Within the Chapman's Reef study area the visual classification delineated five distinct bottom types: standing dead and live coral, coral rubble and gravelly sand, and sand/shell hash. In addition, three seabed relief classes were identified: low-relief, high-relief (located on bioherm), and high-relief, off-mound (>1m relief within 10m radius and not on bioherm). The QTC MultiviewTM automated seabed classification software was applied to multibeam bathymetry and backscatter data collected within the study areas. The unsupervised classification of Chapman's Reef yielded an overall 62% accuracy when tested against visual classification data. A supervised classification was then conducted on Chapman's Reef using the five visual habitats and three relief classes. Supervised results showed 30% overall accuracy with high-relief coral rubble and gravelly sand and low-relief sand/shell hash having 53% and 60% accuracy, respectively. The same supervision was applied to the North Study Area resulting in over all accuracy of only 10%. We hypothesize that the low accuracy of the supervised classification resulted because the North Study Area has different bioherm morphology and includes low relief 'fingers' on the shelf edge oriented NWN-SES direction not present in the Chapman's Reef study area. Additionally, higher accuracy results may be possible by using autonomous underwater vehicles to collect near-bottom bathymetry and backscatter data thereby reducing water column effects inherent in ship-mounted systems. Along with the automated classification, areas of live O. varicosa coral were identified from visual surveys to determine where successful mounds were growing and to document the distribution of these mounds on habitat maps. The results from this study will be used by fisheries management entities for review of the OHAPC's protected status in 2014, as well as fish population analysis for many species including the snapper/grouper complex.

Response of four species of Mediterranean cold-water corals exposed to a future low-pH scenario

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A significant fraction of anthropogenic CO_2 released to the atmosphere is being absorbed by the oceans, causing unprecedented changes in its chemical balance and alterations in the physiology of a wide variety of marine organisms. Predictions for the future based on different scenarios indicate that ocean pH will decrease by 0.3 to 0.4 pH units by the year 2100. Such pH reduction could have major effects especially on coral reef communities, which may be unable to calcify effectively under these new conditions. The effect of ocean acidification on shallow water coral species from tropical and temperate areas has been extensively studied. However, up to date very few studies have been conducted to test how cold-water coral (CWC) species react to such changes in seawater chemistry. To give some insight into this topic, we have developed a medium-term manipulative experimental set-up to investigate the effect of ocean acidification on the growth rates of four CWC species form the Cap de Creus canyon (northwestern Mediterranean): *Madrepora oculata*, *Lophelia pertusa*, *Dendrophyllia cornigera*, and *Desmophyllum dianthus*. Colonies of the four species were maintained during 314 days at two pH levels (8.16 and 7.84). Changes in coral growth under the different experimental conditions were evaluated from measurements of buoyant weight. In addition, the possible impact of low pH on the calcium carbonate structures was determined by means of micro-density and porosity calculations as well as SEM observations. Composition of coral tissue in carbohydrate, lipid and protein are also planned, which will provide a more global picture of possible changes in the energetic balance related to acidification.

Acclimatisation of key physiological processes in the cold-water corals *Lophelia pertusa* and *Madrepora oculata* over their ambient temperature range

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The key reef-forming cold-water coral (CWC) species *Lophelia pertusa* and *Madrepora oculata* thrive at contrasting temperature regimes, ranging from deep-sea cold-water bioherms in the northern Atlantic (ca. 4 – 9 °C) to temperate conditions in the Mediterranean Sea (11 – 14 °C). While recent research suggests that environmental parameters, such as seawater density and/or vertical and horizontal transport, as well as availability of particulate food, may represent essential precursors for CWC occurrence, the potential influence of seawater temperature is still unresolved. Seawater temperature may affect CWC key physiological processes, such as growth (i.e. calcification), respiration and dissolved organic carbon (DOC) flux, thus importantly influence the role of CWC as ecosystem engineers. Here, we investigate rates of the above physiological processes in the cosmopolitan CWC species *L. pertusa* and *M. oculata* after mid-term acclimatization periods (1 month) in the laboratory under 3 different temperature conditions (6, 9 and 12 °C). Our results for calcification, respiration as well as DOC net flux rates showed no significant change for corals maintained at between 6 and 12 °C, except for respiration rates of *M. oculata*, which were positively correlated to ambient temperature. These findings reveal an effective acclimatization capacity to persistently modified seawater temperature by both coral species, which may further help to explain their global occurrence over these relatively wide temperature ranges. In addition, species-specific capacity for temperature acclimatization by CWC will likely represent an essential tool to physiologically withstand climate change related temperature anomalies announced for deep-sea habitats. Conclusively, in a warming ocean, reef-forming CWC species with a higher temperature acclimatization capacity may replace thermally intolerant species and further continue to control deep-sea reef functioning by sustaining their ecosystem engineering capacity.

Post glacial hummocky biogenic (coralline algae) formations in South Cyclades, Greece

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The Cyclades plateau in the Central Aegean Sea is a morphologically complex shallow marginal platform consisting of numerous small rocky islands. Following the general water circulation pattern of the Aegean Sea, the water masses flow towards the south, although there is evidence that they change direction and circulate through the narrow island straits. Bedforms on the seafloor indicate near bed currents up to 100cm/sec and locally higher. The surface sediments consist mainly of biogenic sands with large amounts of coralline algae fragments. This study examines the post glacial biogenic formations between Sikinos and Folegandros islands (south Cyclades), aiming to discuss aspects regarding their development during the last sea-level rise. A high resolution digital data set of multi-beam echo sounder, side-scan-sonar and 3.5kHz sub-bottom profiling was used. Few sediment samples were collected for ground truthing, however detail laboratory results are still not available. The seabed consists of a thin surficial layer of recent sandy sediments, having a maximum thickness of ~5m but usually being less than ~1.5-2m, which overlies a hard substrate that corresponds to the last glacial unconformity. However, between the ~70 and 95m water depth an intense micro-relief was detected in the sonar and multi-beam images related to hummocky morphology and increasing sediment thickness in the seismic profiles, in conjunction with peculiar acoustic characters (hyperbolic and/or mounded acoustically transparent structures). The latter acoustic returns precluded the existence of a rocky micro-relief, which is also widespread in the wider region. This seabed morphology is attributed to biogenic formations that build hummocks up to 5m relative to the surroundings, resulting most probably from coral algae assemblages. Acoustically similar formations have been also documented from the eastern part of the Cyclades plateau. The biogenic formations cover 18% of the study area but do not appear a uniform distribution, occupying mainly the north-eastern part of the region, offshore the elongated and protected Sikinos island, instead of the in between the islands areas where higher current speeds are expected. It seems that they prefer the soft and smoother Sikinos substrate for their development, since more complex and rocky relief is observed towards Folegandros. It has been also observed that clusters of biogenic formations at the same water depths present varying thickness probably as a result to the different distances from the shoreline and consequently to the different levels of nutrient availability. Using existing sea-level curves it was estimated that the biogenic formations have developed the last 14000 years. The average sedimentation rate for the study region is ~13cm/kyr^{-1}, which increases up to 22cm/ kyr^{-1} along areas with biogenic formations. Faint trawling marks in the limits of the study area comprise a possible threat for these communities. Since the onshore area of Sikinos-Folegandros is already a Natura 2000 site, the results of this work could be used by the relevant authorities to expand the protected section further offshore. Moreover, investigations in the Cyclades plateau would help to allocate areas of densely distributed biogenic formations in order to better study and to protect/ manage them.

Habitat characterisation of deep-water coral on the Aviles Canyon's system (Cantabrian Sea)

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The complex Avilés canyon´s system are located in the Cantabrian Sea (Bay of Biscay), whose study is currently being carried out by the INDEMARES (LIFE+) project. The main objective of this project is identifying and charting its habitats and the biological communities that inhabit them. On this study we try to identify the reason why this deep-sea canyon's system may provide suitable environmental conditions for cold-water corals growth. The abundance of sandy ripples of very poorly-sorted granulometry on some canyon's suggest the existence of high dynamic associated to the zone. Accordingly, high-frequency near-bottom current and thermal structure profiles revealed the arrival thermal fronts (bores) at each tidal cycle, causing the sudden enhancement of along-axis velocities over 50 cm/s and vertical velocities over 5 cm/s. A year-long near-bottom current record showed events with near-bottoms velocities well over 1 m/s lasting for several days. The different seabed facies in the canyon were identified based on underwater imagery using a towed sled. Two cold-water coral setting were distinguished in the area: a coral reef located on steeped rocky bottoms of the canyon flanks and carbonate mounds (20-30 m high) located on canyon floor. In the flanks exists a dense cold-water coverage with both living and dead species. Mounds are located at a deeper water setting that occurs in areas relatively flat or with low gradient. Video and still images verify the presence of dropstones and rippled sand sheets surrounding the mounds and emphasize changes in the coral population (live or death; total or patchy coverage) on coral-reef and carbonate mounds areas. The dominant species of reefs are *Madrepora oculata* and *Lophelia pertusa* that considerably increases the habitat´s complexity. Other species of gorgonians, antipatarians, crystal sponges, echinoderms, crustaceans and fish also inhabits this habitat. This fact increases considerably the biodiversity in relation to others facies described in the canyon. The cold-water corals occur just beneath the physical boundary between the Eastern North Atlantic Central Water (ENACW) and the Mediterranean Outflow Water (MOW). Also, the canyon setting where living corals have been observed is located in water density (sigma-theta) range of 27.30-27.60 kg m-3 which is in accordance with the potential density values for cold-water coral distribution in the North Atlantic. This study indicates that the Aviles Canyon's system plays an important role in the shaping of habitats suitable for coral settlement, due to the food availability, the strong bottom currents and the presence of hard substratum.

Multi-scale spatial distribution and characterization of CWC habitats in the northern Ionian sea

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Here we report the main results obtained from multi-scale acoustic investigations carried out within the Santa Maria di Leuca (SML) Cold-Water Coral (CWC) province (south eastern Italy – northern Ionian Sea). From the data collected we gained a qualitative and quantitative insight into the spatial distribution of benthic habitats that were characterised and mapped at different spatial scales, through the support of ROV videos and a number of core and grab samples. Data were collected over more than 1700 km^2, between 80 and 1400 m of water depth within the framework of national (APLABES) and European research programmes (EU-FP6 Hermes and EU-FP7 CoralFISH). Video data and seafloor samples identified the occurrence of CWCs habitats (mostly represented by the scleractinian species *Madrepora oculata*, *Lophelia pertusa* and *Desmophyllum dianthus*) at 8 different sites, along a bathymetric gradient ranging from 500 and 900 m. On the whole, three main meso-habitat groups (coral-, hardground- and mud-dominated habitats) which contain diverse sub-habitats (macro- and microhabitats) have been distinguished. Geomorphological maps produced at different scales (from 1:100.000 up to 1:1000) by accurate interpretation of acoustic and ground-thruthing data were instrumental for the identification of a list of meso-scale morphological features that revealed to be strongly associated with the documented CWC occurrences, such as: (1) A number of mass wasting-related seafloor morphologies (e.g.: detached block-like features, extensional and compressional ridges, small scarps, ...) over a huge hummocky area where corals grow at suitable locations forming coral mounds. (2) An erosive and gently-sloping surface located to the west of a prominent central ridge (that also documents drift sedimentation to the east) where sparse debris deposits were sampled and where coral colonies, along with hardground facies, appear to be patchily distributed (3) A series of western narrow ridges and fault scarps that outline large erosive features (e.g. canyon) where small-scale bioconstructions (dominated by the solitary gregarious species *D. dianthus*) preferentially occur along sub-vertical and overhanging walls and where extensive coral thicket was documented at the top of the ridges. Furthermore, 5 high-resolution backscattering maps (1/1000 - that were produced trough the elaboration of 100 kHz side-scan sonar data) have been investigated in an attempt to associate, through a quantitative approach, the visually-described habitats with the above-listed meso-scale seafloor morphologies. With this analysis we attempted to quantify the 3D geometry and spatial distribution of the relevant morphologies whose substrate hosts CWCs.

Benthic Habitat Mapping and Characterization of *Lophelia pertusa* Bioherms and Associated Sessile Invertebrates

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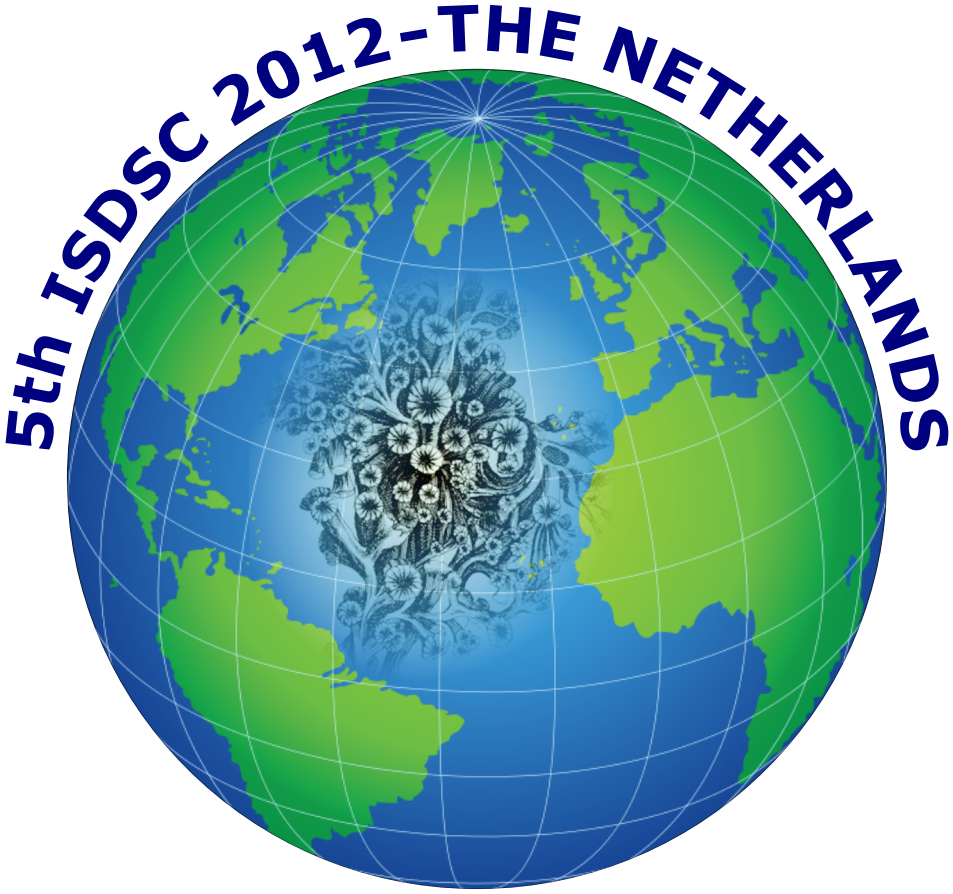
Detailed mapping and characterization of deep-sea coral habitats provide information on the distributions of structure forming corals and their associated fauna, and help elucidate the underlying factors controlling distributions. Data are limited by the difficulty and expense of observing these habitats in situ. Multibeam sonar data in conjunction with photo and video data from ROV's and submersibles have proven effective for mapping and characterizing fauna-habitat relationships in deep-sea coral ecosystems. I have analyzed relationships between terrain variables (e.g., bathymetric position index, fractal dimension, slope, and aspect) with the occurrence patterns of *Lophelia pertusa* and associated sessile invertebrates on selected deep-sea coral mounds off the southeastern United States. I have also examined relationships among aspects of *Lophelia pertusa* growth structure (e.g., % live cover, % bottom cover, vertical profile) and the distribution and abundance of associated sessile invertebrates. This characterization of coral banks in multiple locations allows comparisons of *Lophelia pertusa* bioherm community structures on local and regional scales. Benchmark data for deep-sea coral ecosystems are important for current and future conservation measures for several reasons: these habitats are not well understood, they provide habitat for valuable species, and they are threatened by a variety of activities (e.g. fishing, climate change, fossil fuel extraction).



ABSTRACTS
POSTERS THEME III

Taphonomy of *Desmophyllum dianthus* in a coral graveyard, Orphan Knoll, NW Atlantic Ocean

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Coral graveyards are time-averaged accumulations of cold-water corals, usually found in sediment-starved environments. Coral graveyards composed mostly of the solitary scleractinian *Desmophyllum dianthus* occur near the base of underwater cliffs on Orphan Knoll, a foundered continental fragment off the continental margin of Newfoundland, Atlantic Canada. Previous dredge sampling of a similar accumulation from Orphan Knoll found an age spectrum of 4-55 ka. A new suite of approximately 50 *D. dianthus* skeletons from the Orphan Knoll mounds was collected using an ROV in July, 2010. The samples were found near the base of a ~20 m tall bedrock cliff in approximately 1750 m water depth. Live *D. dianthus* and antipatharians were observed on the cliff, but live *D. dianthus* were present in relatively low numbers compared to the abundance in the coral graveyard. Most of the dead corals are heavily stained with Fe-Mn oxides on their upper side, and lightly stained on the bottom side. This project evaluates a series of taphonomic characteristics of corals in this collection, in relation to the ages of the individual corals. Coral ages are determined through U/Th dating. Preliminary U/Th ages obtained on one live *D. dianthus* specimen and one from the graveyard gave 687+/-22 years and 4528 ± 147 years, respectively. The first result highlights the difficulty of obtaining uncontaminated ages, despite the rigourous cleaning protocol employed here. Taphonomic characteristics considered include discolouration by Fe-Mn oxides, etching and dissolution, microbioerosion, macroborings, and loss of skeletal detail. 14C and U/Th ages of corals are compared in to estimate changes in radiocarbon ventilation rates of the deep North Atlantic during and after the last glacial maximum, whereas Nd-isotope data will provide information on the source and trajectory of water masses which have bathed the knoll through time.

Geochemistry and age distributions of Stylasterid corals from the Southern Ocean

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Stylasterid corals are widely distributed, being found in both shallow and deep waters. Their global distribution makes them an excellent target for comparative studies of ocean geochemistry. Additionally, their banded structure may make them suited to high-resolution reconstructions of the history of the ocean in places where it is difficult to collect sediment cores. Palaeoceanographic reconstructions are needed if we are to understand how and why the ocean experiences changes in circulation and environmental conditions. As yet, we have very little knowledge of the geochemistry of these coral, particularly with regards to their use as archives of past climate. In this study we will examine stylasterid corals collected from a wide depth range (450m-1900m) from across the Drake Passage in the Southern Ocean. As the main connection between all the major ocean basins, the Southern Ocean is crucial in the transmission of climate signals around the globe. Changes in ocean chemistry and circulation of the Southern Ocean are therefore likely to have significant impacts on heat and nutrient distributions around the world's oceans. Radiocarbon dating of a subset of these samples reveals ages spanning the past 18,000 radiocarbon years. Most of samples are from the Holocene (last 10ky), though some appear to be older, including samples from the last deglacial period and even the last glacial maximum (LGM). Besides insights into the historic distributions of stylasterids in the region, these data indicate that these corals have the potential to record climate from the LGM through to the modern day. We have collected and analyzed depth profiles of $\delta^{18}O$ in the seawater in which these corals are growing today to allow direct comparison between coral and seawater geochemistry. Our preliminary findings indicate that the skeletal $\delta^{18}O$ is controlled in large part by temperature. If this finding is borne out with further samples, then stylasterid $\delta^{18}O$ may provide one of the best ways of looking at rapid changes in temperature in the past ocean. Such data from the Southern Ocean are limited so any results will have implication for our understanding of the climate system, and will be useful in indicating how marine ecosystems cope with changes in this region. For example, studies on deep-water corals already reveal higher growth rates in some oceans during glacial periods, due to altered upwelling and nutrient distribution. By understanding the changes that have occurred in the sensitive Southern Ocean since the LGM we may be able to more accurately predict likely future changes to the global circulation and marine ecosystems.

The εNd of ocean circulation as we know it? Changes in the deglacial NW Atlantic from deep sea corals

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Sequestration of carbon in the deep ocean during glacials and its subsequent release during deglaciation undoubtedly play a role in glacial/interglacial variation of atmospheric CO_2, although concrete evidence of the ocean's role has yet to be established. One route of investigation is to determine ocean ventilation rates. To do so requires combining dynamic tracer data, such as radiocarbon, with a conservative tracer to identify the water masses involved and their mixing ratios. We describe the use of deep sea corals as an archive material providing same-sample U/Th ages, radiocarbon, and conservative water mass tracer data in the form of Nd isotope compositions. The majority of corals in this study are deglacial in age and span intermediate water depths of 1000 to 2600 m on the New England Seamounts (NW Atlantic), where pronounced changes in water column radiocarbon across the last glacial/interglacial cycle have been identified [1, 2]. In the modern ocean, North Atlantic Deep Water has an offset to atmospheric radiocarbon of ~-65‰ (Δ14C), whereas Antarctic Bottom Water has a larger offset of ~-165‰ due to longer storage time in the deep ocean. During the last glacial maximum, this storage time probably increased, leading to offsets of perhaps as much as -300‰ for Southern source water [3]. Circulation of these waters in the Atlantic should be identifiable from Nd isotope compositions due to their distinct compositional source regions, resulting in unradiogenic North Atlantic Deep Water (~-13.5 εNd; [4]) and more radiogenic Antarctic Bottom Water (~-9 εNd; [5]). These are not thought to have changed significantly over the last glacial/interglacial cycle [6]. The most pronounced shifts in radiocarbon occur between 15 and 17 ka, demonstrating incursion of radiocarbon-depleted water masses (i.e. -150 to -200‰ Δ14C) up to depths of ~1700 m in the NW Atlantic [2]. The corresponding Nd isotope compositions are -13 to -14.5 εNd, typical of Northern source waters. Overlying this are comparatively well ventilated waters (-100 to -150 ‰ Δ14C) with εNd compositions in the range of -11 to -12 εNd, suggestive of mixing between Northern and Southern source waters. It is emphasised that these Nd isotope data are contrary to expectations, where shifts to more radiogenic compositions were forecast to reflect incursion of Southern source water against the less radiogenic background of the North Atlantic. These data raise several questions concerning our current understanding of ocean circulation changes during the deglaciation as well as the Nd isotope proxy as a tracer of ocean circulation, which we will discuss in this presentation.

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Under the skin: the internal structure of coldwater coral reefs; Pen Duick Escarpment compared to Rockall Trough

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Cold water coral mounds are known from several locations along the continental margins of various continents. In this study we will not only show the sediments and morphology, but also the internal seismic structure of two contrasting mound provinces. The environmental parameters, sedimentology and seismic structure of the first province, located along the western Rockall Trough margin (NE Atlantic Ocean) have been well described by various authors. From sedimentological and seismic data it is concluded that these mounds started to form when corals colonised an unconformity of Late Early Pliocene age (about 4.5 million years old). This unconformity formed a hard substrate suitable for the attachment of coral larvae. Sediments were trapped in the coral framework, resulting in a vertical growth of the coral reefs. The entire mound sequence consists of a coral framework and sediments trapped by this framework. This results in a continuous chaotic seismic facies, from the base of the mound to the top.

The second mound province is located at the Pen Duick Escarpment (PDE), offshore Morocco in the Gulf of Cadiz. The hydrodynamic conditions and sedimentary processes in relation to the presence of coldwater corals in this area are at present not as well described in literature as for the Rockall Trough site. The PDE forms the western margin of the Renard Ridge. As a result of the local tectonic history and related mud and salt diapirism many mud volcanoes and mud diapirs are present in the Renard Ridge area. On the relatively steep PDE various carbonate mud mounds are found characterised by mostly dead (often buried) layers of coldwater corals. A detailed seismic survey across the area reveals that the internal structure of the mounds at the PDE is completely different from the structure of the mounds located at the W Rockall Trough Margin. Internally the PDE mounds show a combination of chaotic and strong parallel and continuous reflectors. The mounds at the PDE originate from tectonic and erosional processes deforming originally parallel laminated sediments. This resulted in an irregular sea bed topography, consisting of mounds placed on an escarpment. These mounds on their turn were colonised by coldwater corals, increasing the height of the individual mounds. The strong seismic reflectors within the mounds represent the original sedimentary bedding, faults, slide planes, etc.

These results show that coldwater coral mounds do not all originate in the same manner and reflection seismics can help in understanding these different origins.

'Accumulation rates and characteristics of shallow inshore *Lophelia pertusa* cores from the Mingulay Reef Complex'

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We present sedimentological and microfossil analysis of 2 vibrocores from the Mingulay Reef Complex in the Sea of Hebrides. The complex of Mingulay consists of a series of coral-carbonate mound-like structures and is located 13 km east of the island of Mingulay (~56°N, 7°W) in 120-190 m water. High resolution U/Th and 14C dates of fossil *L. pertusa* have shown that this site has unprecedented accumulation rates of around 5 - 6 mm yr-1 with periods of reduction/cessation of growth around 1.8 - 2.7 kyrs, 3.3 - 3.5 kyrs and 3.8 - 4.2 kyrs ago. We attempt to explain these changes in growth by reconstructing the regional hydrology and circulation patterns using sediment parameters and microfossils. High resolution planktonic *Globigerina bulloides* and benthic *Cibicides lobatulus* foraminiferal isotopic (C-O) measurements were acquired from the "coral-sediment" cores +56-08/929VE and +56-08/930VE (3.61 m and 5.25 m recovery, respectively). In parallel, grain size analyses as well as counts of coral fragments and of the fossil fauna associated with cold-water coral framework were obtained every 10 cm corresponding to a temporal resolution of about 20 yrs. The stable isotopes of planktonic and benthic foraminifera record changes of about 0.8 and 0.5‰ (PDB) surface and bottom water respectively. These changes are correlated with distinct current strength revealed using the mean sortable silt, implying that changes in the hydrological conditions within the Mingulay Reef Complex have occurred during the mid-to late-Holocene (from 1.75 to 4.29 kyrs). These changes affected both coral and associated fauna within the Mingulay Reef Complex, and perhaps also the entire NE Atlantic. The accumulation rates estimated for the Mingulay Reef Complex are higher than those estimated for reefs along the Norwegian shelf (2 - 3 mm yr^{-1}) and very much greater than from the coral carbonate mounds of the European continental margin (on average 0.2 mm yr^{-1} for the Holocene). Such accumulation rates may allow high resolution palaeo-environmental reconstructions using palaeo-proxies such as foraminifers' geochemistry, the faunal composition, and grain size analyses and therefore may improve our understanding of cold-water coral occurrence within the North-East Atlantic.

Small-scale sediment accumulation dynamics within a cold-water coral mound – a case study from the Mauritanian margin

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Cold-water corals form an important global carbonate factory in cold- and deep-water environments. While information on cold-water coral distribution and on environmental controls of cold-water coral growth is available for many regions, foremost for the NE Atlantic, information on cold-water coral mound development and their internal growth structure is still limited.

The present study aims to provide new insight into the small-scale sediment accumulation dynamics within a cold-water coral mound. For that purpose, the unconformity-bound glacial sequence (135 cm thick; 45-32 ka BP) of a coral-bearing sediment core collected from the slope of a cold-water coral mound in the Banda Mound Province off Mauritania was analysed. U/Th datings obtained from the mound-forming coral species *Lophelia pertusa* were compared to 14C datings of planktonic foraminifers of the adjacent matrix sediments to study the relation between coral framework growth and its filling by hemipelagic sediments. The coral ages exhibited no clear depositional trend with several outliers (45-32 ka BP), while the 14C datings of the matrix sediment provide ages within a very narrow time window of < 3,000 yrs (34.6-31.8 cal ka BP) at the end of the coral growth period. The complex internal age structure of this sequence makes three depositional scenarios possible: (1) the build-up of a free-standing cold-water coral framework and its rapid posterior filling by matrix sediments. However, this model cannot explain dating outliers and the good preservation of the coral skeletons, which lack intense bioerosion. Moreover, a 135-cm-high cold-water coral framework having a free-standing position for a 13–ka-lasting period appears unrealistic. (2) A redeposition of the glacial unit by a slumping event with three decimetre-thick 'overthrusting' units. This would result in repetitive subunits with similar age patterns. This scenario would better resample the internal age structure of the analysed unit and would explain the outlier coral ages within a sedimentological context. Furthermore, only a decimetre-thick exposed coral framework is needed to explain the time gap between coral and matrix sediment ages. Or (3) a redeposition of the glacial unit by a debris flow resulting in a nearly complete mixing of the mound deposits. This would result in a narrow age range for the planktonic foraminifer 14C datings (caused by the averaging over tens of individual foraminifer ages from one depositional period due to the sample size for dating) and randomly scattered coral ages from that period. However, the short potential transport distance makes a complete mixing of the sediment unlikely.

Scenario 1 and 3 might be seen as depositional end-members with an autochtonous or allochthonous origin, respectively. However, the position of the studied core on the slope of a cold-water coral mound, as well as the arguments provided above, might favour scenario 2 or 3. Consequently, internal age structure, outlier ages, and age scatter of coral and matrix sediment ages should not be neglected but might provide important indications for the (small-scale) process of deposition within cold-water coral mounds.

Depth-Age Distribution of Solenosmilia corals from South/Southeast Tasmania

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Fossil reefs of *Solenosmilia* have been mapped at depths of 1200-1800m from the Southern Hills, Cascade Plateau and Tasman Fracture Zone on the south/southeast of Tasmania, Australia. There are two phases of coral growth ~15,000 Cal BP and ~11,500 Cal BP at a depth of ~1600m, this is 200m deeper than the current distribution of *Solenosmilia* which has a maximum depth of ~1450m. These two peaks of deeper growth coincide with H1 (Heinrich 1) and the Younger Dryas. These time periods bracket the Antarctic cold reversal (ACR) when no corals were found at that depth suggesting conditions were briefly not suited to coral growth. From 8,000 Cal BP to present few corals have not been found below 1450m. Additional depth-age relationships from samples from shallower reefs will also be presented.

High productivity during the Late Pleistocene and Early Holocene triggered intense cold-water coral growth in the Alboran Sea (western Mediterranean Sea)

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Cold-water corals are common along the Moroccan continental margin off Melilla in the Alboran Sea (western Mediterranean Sea), where they colonise and even built substantial mound and ridge structures. Radiocarbon ages of the two reef-forming coral species *Lophelia pertusa* and *Madrepora oculata* revealed that they were prolific in the area during the last glacial-interglacial transition with pronounced growth periods covering the Bølling-Allerød interstadial (13.5-12.9 ka, and probably before) and the Early Holocene (11.2-9.6 ka). Their proliferation during the Early Holocene is expressed in impressive vertical growth rates of more than 260 cm ka^{-1} as obtained for an individual coral ridge that consists of coral fragments embedded in hemipelagic sediment matrix. Following a period of coral absence, cold-water corals re-colonised the area during the Mid Holocene (5.4 ka) and thrive there until today. It appears that periods of sustained cold-water coral growth in the Melilla Coral Province are closely linked to phases of high marine productivity. Those phases were related to the deglacial formation of the most recent organic rich layer 1 (ORL1) in the western Mediterranean Sea and the development of modern circulation patterns in the Alboran Sea.

Norwegian Sea acidification and ventilation during the past four decades recorded in cold-water coral *Madrepora oculata*

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The capacity of the North Atlantic to absorb CO_2 has decreased in the past 20 years. As the North Atlantic is the largest carbon sink of all the oceans, understanding the reasons of this change are crucial in order to estimate future climate change. Indeed, it is unclear whether this is a passing trend related to natural variations in the climate or whether it indicates a permanent change related to climate change or ocean chemistry. Hence high resolution time series reconstructions of physical and chemical properties of water masses are essential. These can be successfully performed with geochemical tracers recorded in cold-water corals. Here, we present the first annual multiproxy time series including tracers as Δ14C, δ^{13}C, boron isotopes and Li/Mg ratio measures in the Scleractinian coral *Madrepora oculata*. This coral was collected alive at Rost Reef in the Norwegian Sea (67°N, 9°E, 340 m of depth) in 2007. Its age has been estimated to 39±2 years based on ^{210}Pb and radiocarbon dating. Our results indicate that the deep-sea coral records the environmental seawater characteristics such as pH, radiocarbon concentration and temperature. 14C time series (Δ14C) reveals the increase of radiocarbon values due to the penetration of bomb 14C in the ocean which were released during nuclear weapon tests in the early 1960's. This bomb 14C signal shows a more rapid increase than those of the western Atlantic indicating a more rapid equilibration of intermediate waters in the Norwegian Sea with the atmosphere. Furthermore, boron isotopes reveal a significant drop tendency possibly reflecting a decrease of seawater pH at 340 m water depth over the last four decades. We estimate a seawater acidification rate of 0.0016±0.0002 pH units per year, which is in agreement with other published seawater surface acidification rates. Moreover, the δ^{13}C isotopes trend indicates a significant uptake of anthropogenic CO_2. All the results seem to point out the large penetration of anthropogenic CO_2, superimposed with decadal secular variations of ocean proprieties as temperature, likely reflecting ocean circulation changes.

Comparative geochemical study of two cold-water coral systems in the Bay of Biscay: Pajès Escarpment (off-shore Gijón, Spain) versus St. Nazaire Canyon (off-shore La Rochelle, France).

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Pore-water samples have been taken from box cores and gravity cores of cold-water coral areas on Pajès Escarpment (PE) and in the St. Nazaire Canyon (SNC) during cruise M84/5 with RV Meteor. Pore-water analyses reveal the importance of local geochemical fluxes which influence the early diagenetic processes in cold-water coral-rich sediments. Dissolved oxygen (O2 diss), salinity, pH and Total Alkalinity (TA) have been measured immediately on board. SO42-, Cl-, Ca2+, Mg2+, Sr2+, Fediss, Mndiss have been analyzed with ICP-OES in the lab of the Earth & Environmental Sciences Department of the KU Leuven. Additionally, X-ray CT scans have been taken at the Radiology Division of the KU Leuven to elucidate the coral quantities in whole core sections. CT scans show that cold-water corals are present in the upper part of most gravity cores. However, only a few gravity cores reveal the presence of cold-water corals throughout the whole cored interval. Pore-water analysis shows different results for the two studied regions. pH and TA reveal small-scaled variations in the cores on PE, but the overall trend is constant with depth. However, there is an increasing downcore trend for both parameters in the St. Nazaire Canyon. pH values are varying between resp. 7 – 7.5 on PE and 6.5 – 7.7 in the SNC. Alkalinity values range between 1.6 – 3.4 mmol/L in the cold-water coral-rich sediments of the PE and between 1.6 – 11.5 mmol/L in the sediments of the SNC. Ca2+ concentrations are varying within the same range (20 – 50 ppm) in both locations, but a clear decrease with depth is noted in the SNC. Fediss (0 – 0.8 ppm), Mg2+ (100 – 150 ppm), Mndiss (0 – 0.1 ppm) and Sr2+ (0 – 1 ppm) reveal small-scaled variations for both locations. It should be noted that fluctuations of Fediss are similar as pH fluctuations, which can be correlated with coral quantity variations. The anions Cl- and SO42- show a constant trend in PE, but Cl- concentrations are higher (12000 – 19000 ppm) than SO42- (2000 – 2600 ppm) concentrations. The Cl- concentrations of SNC are similar as those from PE, but SO42- values decrease with depth, for some cores even up to 1200 ppm. These results reflect a clear distinction between the cold-water coral systems in Pajès Escarpment and St. Nazaire Canyon. There is evidence for the presence of a shallow sulphate methane transition zone in SNC.

Trace Element Records from Deep-sea Black Corals

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Deep-sea black corals (Anthozoa, Antipatharia) have enormous potential as environmental archives to provide valuable long-term, high-resolution records. They are extremely slow-growing, have millennial-scale life-spans and the trace elements in their skeletons have significant potential as a proxy for reconstructing past environmental change in the ocean. Black corals from South Eastern Australia were studied using micro-analytical techniques (laser ablation inductively coupled plasma mass spectrometry, LA ICP-MS, and electron microprobe analysis). 2D element maps revealed notable elemental partitioning between the inter-layer zones and the skeletal matrix. The distribution of the different elements gives insight into incorporation mechanisms of trace elements into the antipatharian skeleton, which is crucial to decode any signals recorded. Elemental composition and variability analysed by LA ICP-MS on coral cross-sections are reproducible between corals growing in different sites hundreds of kilometers apart. Coupled with their longevity and slow growth rates, antipatharians provide a prospective method of extending our limited available instrumental environmental records, for the South East Australian region in particular.

Major and trace elements in recent cold-water corals from the Azores archipelago

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The reconstruction of oceanic environmental parameters, such as seawater temperature, is accomplished by the application of geochemical climate proxies, such as the Sr/Ca ratio of coral skeletons. Despite biologically induced geochemical modifications ("vital effects") cold-water corals have thereby served as invaluable climate archives in previous studies. Here we investigated the solitary scleractinians *Caryophyllia cyathus* and *Desmophyllum cristagalli*, collected live at 500 m water depth in the Azores. Ambient temperatures were logged over one year at high-resolution. Two methods were applied to investigate the elemental composition of aragonite, electron microprobe analysis (EMPA) for mappings and quantification of Ca, Mg, Sr and S, and laser-ablation-ICP-MS for high-resolution quantitative analysis of Mg, Sr, U, Li, B, P and Ba. Sampling profiles ran perpendicular to the corals' vertical growth axis, and crossed optically white and dark increments of the theca or followed the line of centers of calcification in the septa. Temperatures were computed via established temperature equations based on the element/element ratios (e.g. Sr/Ca, Mg/Ca, Li/Mg etc.) of tropical and cold-water coral skeletons.

Skeletal incremental banding patterns are reflected best by the distribution of Ca and Mg in EMPA mappings while Sr displays little variation. Optically white increments and centers of calcification are enriched in Mg and S, but depleted in Ca. The elemental banding is clearer in the wall of *D. cristagalli* than in *C. cyathus*. Quantitative profiles show strong, short-scale element-variations for Ca, Mg/Ca, Sr/Ca and S/Ca molar ratios. Thereby Mg and Ca signals show inverse correlations, while Mg/Ca and S/Ca display positive correlations, which indicate that Mg is also related to organic skeletal compounds. LA-ICP-MS profiles show negative correlation between Mg/Ca and U/Ca, and positive correlation among Mg/Ca and Li/Ca or B/Ca and P/Ca molar ratios along the theca of *C. cyathus*. These geochemical heterogeneities point towards a strong biological influence on the incorporation of major and trace elements into the corals' skeleton. Reconstructed temperatures by far exceed the measured annual mean temperature of 12.30 ± 0.25°C. From all selected temperature equations, those based on Sr/Ca and Mg/Ca data from non-tropical corals give results closest to ambient conditions (i.e. 11.78 ± 1.93°C and 14.53 ± 0.54°C, respectively).

Gulf Stream variability at Cape Lookout, North Carolina

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Cold-water coral mounds are common on the SE slope of the US (SEUS) from Florida to Cape Hatteras between depths of 400-600 m. The coral areas lie in the vicinity of the Gulf Stream, which is characterized by strong currents transporting relatively warm water northwards along the SEUS slope. Thus far little is known about the environmental conditions inside the SEUS coral communities and particularly the effects of the nearby Gulf Stream.

Near Cape Lookout (North Carolina margin) cold-water corals have formed mound structures, which have a teardrop shape with a sediment tail at the lee side of the mounds, indicating the presence of a strong uni-directional current. The mounds were found to be partly covered with living *Lophelia pertusa* colonies and partly with sediment and dead coral framework. A 3.4 m long piston core was collected in 2010 during a cruise with the RV Pelagia. This pistoncore was used to determine the changes of the current strength in time in the study area. Different measurements including foraminiferal counts, stable oxygen and carbon isotopes, XRF and magnetic susceptibility were carried out to determine the changes in current strength in the area. Furthermore, cold-water coral fragments were dated with U/Th and foraminifera from the same depth intervals were dated with C14. Datings show that all corals have the same age around 5500 years. However, the sediment in between the corals showed ages ranging between 4700 and 13000 years. Based on the foraminifera data 3 three zones could be observed in the core. Zone 1 ranged between 13000 and 10000 years, zone 2 between 10000-7200 years and zone 3 between 7200-4700 years. These zones all show the gradual onshore movement of the Gulf Stream, that can be related to a rapid rise in sea level as a response to the last deglaciation. This movement has gradually widened the band of the Gulf Stream, thereby compressing the surface and deeper water masses. The strength of the current decreased when fresh water outflow to the North Atlantic weakened the thermohaline circulation, which was especially clear in zone 2. Around 8200 years the thermohaline circulation was even more reduced, due to a meltwater pulse of lake Agassiz and Ojibway. At this time the foraminifera indicate that the current at Cape Lookout was very weak.

Deep Sea Coral Record of Rhenium Variability over the last Millennia

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Recent examination of major world rivers suggests that rhenium (Re) enrichment is related to human activity, such as mining, fossil fuel combustion and biomass burning. Anthropogenic mass flux of Re exceeds natural near-surface mass fluxes with human mobilization of Re exceeding natural mobilization. However, there are no long-term measurements of Re, and chronological variations of anthropogenic Re accumulated in sediments cannot be accurately determined due to its redox sensitive behavior. Biogenic archives can be used as historical recorders of trace metal pollution and variability in marine environments. As some of the longest living marine organisms, deep-sea corals can serve as paleo-recorders of the marine environment. Using newly developed LA-ICP-MS methods to measure Re concentrations in black corals collected from the Gulf of Mexico, we present the first record of Re variability over the last millennia. Isotopic studies indicate that the dominant source of carbon is from surface-derived particulate organic matter (POM). Similar $\delta^{13}C$ signatures of surface POM to the coral tissue and skeleton demonstrate a link between the surface ocean, the deep sea, and the coral skeleton as a result of uptake from rapidly sinking POM. As a dominant source of organic matter to invertebrate communities, brown macroalgae may also provide a mechanism for Re accumulation in the deep-sea corals. In marine environments, high Re enrichment (thousand fold relative to seawater) is reported for brown algae. Given its high mobility in biogeochemical cycles, Re is readily absorbed by algae. Analysis of brown algae and POM for Re was undertaken to investigate the likelihood model of Re uptake by corals. Rhenium concentrations in the black coral skeleton, composed of chitin and protein, range from 0.40 to 2.0 ppm, showing a marked rise during the last 150-200 years, which coincides with the rise in coal production in the US in the late 1800s. The Mississippi River Watershed encompasses the major US coal producing regions and because of the high mobility of Re in oxic waters, Re released to the environment can be easily leached from ash fallout and carried to the rivers. Present day studies suggest that the Mississippi River Re concentration is ~40 times greater than the global average. Analysis of coal samples from the US yields Re concentrations between 2.4 to 6.6 ppb. Rhenium concentrations in the Mississippi River estuary are inversely related to salinity, indicating a low salinity, freshwater source. The enriched Re coral signal is coupled to increased coral nitrogen isotope ($\delta^{15}N$) values. The synchronous rise in Re and $\delta^{15}N$ is indicative of draining of adjacent agricultural watersheds. Activities in the Mississippi watershed including those associated with industry and agriculture are likely captured in the black coral skeleton record. With the Mississippi River draining at least 40% of the contiguous US, the Mississippi River is a natural conduit for Re flux to the Gulf of Mexico. Deep sea coral records provide an unprecedented record of natural and human-induced Re concentrations over thousands of years.

Intermediate water Δ14C off Brazil between 3-40 ka BP

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Here we present reconstructed marine Δ14C activities from corals of intermediate depth off Brazil. The corals stem from two new sediment cores in the direct vicinity to our cores already reported in [1]. This new dataset expands the older one and encompasses now ages from 3-40 ka BP. First measurements validated our Δ14C findings already published in [1]. The new data show that the continuous Δ14C decline starting in our previous study with the Younger Dryas (YD) extends to 5 ka BP reaching an absolute minimum with an apparent ventilation age of over 6200 14C years! The shape of the decline of Δ14C fairly following the decay curve and are compatible with the scenario suggesting the existence of an abyssal reservoir in the Pacific Ocean that was isolated and being flushed for several thousand years. After that modern Δ14C values were reached. The observed continuous Δ14C decline during Heinrich stadial 1 (HS1) and the YD would suggest a further weakening of ventilation of deep water with injection of a old carbon dioxide signature from the deep Pacific reservoir into the Circumpolar Water around Antarctica that is the source of Atlantic Intermediate Water. This follow-up study also attempts to trace back the history of the Δ14C activity beyond HS1 (HS2, HS3 and HS4). First results lead to the conclusion that even during HS4 (35-38 ka), the water on the continental slope off Brazil was highly depleted in Δ14C with apparent ventilation ages exceeding several thousand years. The occurrence of such isolated abyssal water is apparently not a phenomenon limited to the last deglaciation. Recurring events of old water masses advance at intermediate depth off Brazil indicate a coupling between the intensity of deep water formation in the North Atlantic and the ventilation of the deep Pacific Ocean.

[1] Mangini et al., EPSL 293 (2010) 269-276

COCARDE: new view on old mounds – an international network of carbonate mound research

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Carbonate mounds are important contributors of life in different settings, from warm-water to cold-water environments, and throughout geological history. Research on modern cold-water coral carbonate mounds over the last decades made a major contribution to our overall understanding of these particular sedimentary systems. By looking to the modern carbonate mound community with cold-water corals as main framework builders, some fundamental questions could be addressed, until now not yet explored in fossil mound settings. The international network COCARDE (http://www.cocarde.eu) is a platform for exploring new insights in carbonate mound research of recent and ancient mound systems. The aim of the COCARDE network is to bring together scientific communities, studying Recent carbonate mounds in midslope environments in the present ocean and investigating fossil mounds spanning the whole Phanerozoic time, respectively. Scientific challenges in modern and ancient carbonate mound research got well defined during the ESF Magellan Workshop COCARDE in Fribourg, Switzerland (21.–24.01.2009). The Special Volume Cold-water Carbonate Reservoir systems in Deep Environments – COCARDE (Marine Geology, Vol. 282) was the major outcome of this meeting and highlights the diversity of Recent carbonate mound studies. The following first joint Workshop and Field Seminar held in Oviedo, Spain (16.–20.09.2009) highlighted ongoing research from both Recent and fossil academic groups integrating the message from the industry. The field seminar focused on mounds from the Carboniferous platform of Asturias and Cantabria, already intensively visited by industrial and academic researchers. However, by comparing ancient, mixed carbonate-siliciclastic mound systems of Cantabria with the Recent ones in the Porcupine Seabight, striking similarities in their genesis and processes in mound development asked for an integrated drilling campaign to understand better the 3D internal mound build-up (see Poster Foubert et al.). The Oviedo Workshop and Field Seminar led to the submission of a White Paper on Carbonate Mound Drilling and the initiation of the ESF European Research Network Programme Cold-Water Carbonate Mounds in Shallow and Deep Time – The European Research Network (COCARDE-ERN) launched in June 2011. The second COCARDE Workshop and Field Seminar was held in Rabat, Morocco (24.–30.10.2011) and thematically focussed on carbonate mounds of(f) Morocco. The compact workshop invited students from Moroccan Universities to experience ongoing carbonate mound research in Recent and Ancient environments of Morocco. Two Round Tables discussed innovative approaches in carbonate mound research in Morocco (Recent vs. Ancient - offshore vs. Onshore) and reviewed together with oil industry opportunities of international collaboration. The outcome of this workshop will lead into joint research projects, drilling campaigns on- and offshore, and expansion of COCARDE onto the African continent.

Drilling Carbonate Mounds in Shallow and Deep Time: Puebla de Lillo Carbonate Mound Drilling (LIMO-DRILL)

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Carbonate mounds are important contributors of life in different settings (from warm-water to cold-water environments) and throughout geological history. Research on modern carbonate mounds over the last years contributed significantly to our overall understanding of these particular sedimentary systems. By analyzing the modern carbonate mound community, some fundamental questions could be addressed, until now not explored in fossil mound settings. Important topics in understanding recent mound settings were tackled by numerous scientific campaigns during the last two decades. Fundamental questions arose and formed the base for advanced discussions: - physical and environmental factors that control mound position and initial growth - contribution of biogenic versus non-biogenic components to mound growth (accretion) - early diagenetic pathways (from early aragonite dissolution, over early cementation to hard ground formation) - internal structure (single body versus mosaic of smaller structures) - overall geometry in 3D (mound core versus mound flanks, mound sediments versus intermound sediments, and the respective facies distribution) - overall porosity/permeability distribution and evolution through time Most data on modern carbonate mounds are based on seismic profiles, surface sampling and coring. During IODP Expedition 307 aboard the R/V Joides Resolution four complete drilling cores were obtained through the 155-m high Challenger Mound unveiling partly the internal structure of the mound body. However, seismic studies and IODP drilling did not provide an image of the mound body in three dimensions. Thus, field studies are required to understand the overall architecture of carbonate mounds in all dimensions. This ICDP proposal aims to present well-selected drill sites through Carboniferous carbonate build-ups in the Puebla de Lillo area in northern Spain (70 km NE of Leon). These large, well-exposed and spectacular mounds alternating with clay and silt intervals developed just south of the equator on a Moscovian terrigenous-carbonate low-angle ramp (the Lena Group) located in the south-eastern sector of the Central Asturian Coalfield Basin Province (Cantabrian Zone). The carbonate mounds, displaying internally patchy growth forms of boundstone and wackestone, started to grow on a microbial bindstone substrate. The main components of the intermound area carbonates (including the build-ups) are mud- to wackestone and clotted peloidal or Donezella-rich boundstone alternating regularly with shales. It is noteworthy that the flanks of the mounds are very steep with depositional dips of up to 40°. Mound growth was regularly interfered by siliciclastic input, well apparent in the layers separating the intermound beds and leaving only faint traces in the mounds themselves. Drilling the Puebla de Lillo mound structures in a comparable way as through recent carbonate mounds offers a unique opportunity to study recent and ancient mound systems through space. Only by bringing the recent and ancient mound world together, the functioning of complex mound systems can be understood and the controlling factors of mound growth constrained.

Origins of coral diversity in Southeast Asia

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Southeast Asia hosts the maximum centre of coral diversity. Evidence from palaeontological and molecular studies suggests that the Miocene was an important period for diversification in the region. However, the fossil record is markedly undersampled. Of the ~200 species of azooxanthellate corals present in the region, only 49 species are known in the fossil record. As part of the Throughflow ITN project, we are collecting new data to document the Miocene diversity of zooxanthellate and azooxanthellate scleractinians from shallow and deep-water habitats preserved in outcrops of East Kalimantan (5-20 Million years old). This project has completed two five-week long field seasons and is currently processing samples. So far, we have identified the azooxanthellate taxa *Caryophyllia*, *Stephanocyathus*, *Flabellum*, *Heterocyathus*, and *Madrepora*. Preservation can be excellent allowing geochemical analysis to understand the paleoenviromental conditions in which these species were living. In combination with parallel studies on shallow water ecosystems, these new data provide insights to the origins of the high diversity in this region.

Recent benthic foraminifera from cold-water coral substrates of Rockall and Porcupine Bank, NE Atlantic Ocean

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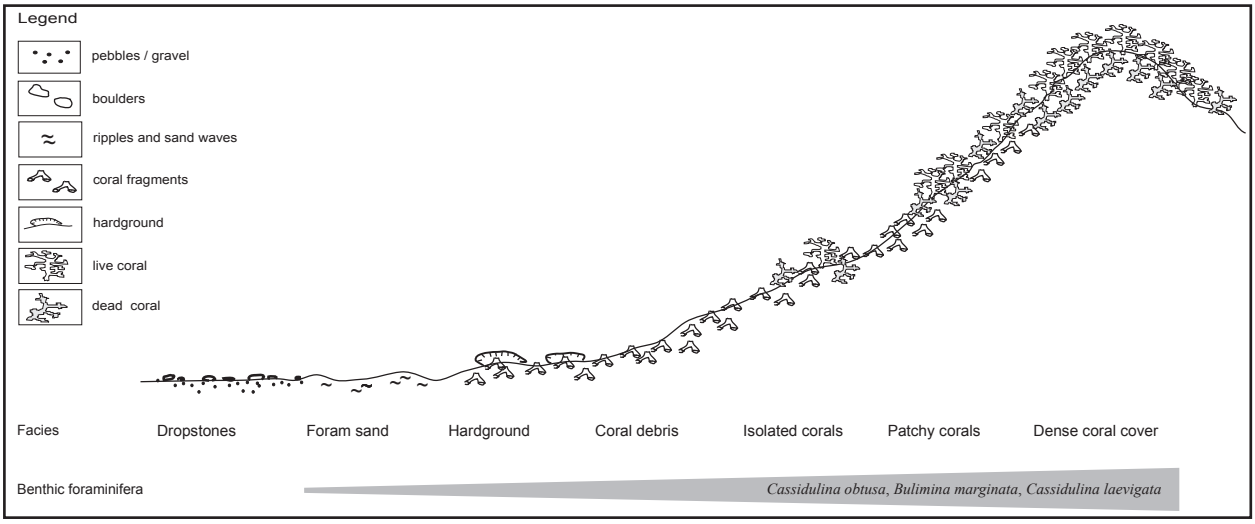
A facies model (figure) is presented for the various environmental settings presently encountered on and around cold-water carbonate mounds of Rockall and Porcupine Bank. The model is based on analysis of recent sediments and benthic foraminifera from twenty-six box core samples, in combination with analysis of available multibeam bathymetric data and underwater camera footage. The model may be used for reconstruction of fossil coral habitats from long sediment cores, improving our knowledge on carbonate mound development. In the study area seven different types of seabed substrate were distinguished. On carbonate mounds we identified hardgrounds, coral debris, and substrates characterised by a variable density of living coral framework. The carbonate mounds are surrounded by relict glacial sediment blanketed by mobile foraminiferal sand. Whereas sediment characteristics only provide a basis for distinguishing on- and off-mound habitats and the loci of most prolific coral growth, benthic foraminifera are the key to identify different mound substrates in more detail, as several foraminiferal assemblages were distinguished that are characteristic for specific environments. Assemblages from off-mound settings are dominated by (attached) epifaunal species such as *Cibicides refulgens* and *Cibicides variablis*. The attached epibenthic species *Discanomalina coronata* is also common in off-mound sediments, but it is most abundant where hardgrounds have formed. In contrast, attached epifauna are virtually absent in settings with coral debris or living corals, which generally attract shallow infaunal species that are usually associated with fine-grained soft sediments on deeper parts of the shelf. The typical 'living coral assemblage' has *Cassidulina obtusa*, *Bulimina marginata*, and *Cassidulina laevigata* as its main representatives. The abundance of these species shows an almost linear increase with the density of the living coral cover. The benthic foraminifera encountered from off-mound to top-mound setting appear to represent a gradient of decreasing current intensity and availability of suspended food particles, and increasing availability of organic matter associated with fine-grained sediment trapped in between coral framework. The specific distribution of foraminifera that results from the gradient of micro-environments is promising as a tool for interpretation of fossil coral habitats.



Reappearance of deep-sea corals around the Faroe Island in association with oceanographic changes during the Medieval Warm Anomaly

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Using material from two gravity cores recovered off the eastern Faroese shelf we investigated changes in the oceanographic conditions prevailing in this area of the North Atlantic during the past 5000 years. Changes in sea surface and bottom water temperature were evaluated based on variations in the isotopic composition of planktic (*Globigerina bulloides*) and benthic (*Cibicides wuellerstorfi*) foraminifera as well as by measuring the alkenone saturation rate in the sediments. Temperature variability was then correlated with the presence/absence of deep-sea corals along the sedimentary record. Our results show that ca. 2800 y BP water near the bottom (~300-400 m depth) became rapidly warmer following a trend first observed in surface waters. This temperature variation appears associated with a decrease in surface primary productivity and a corresponding change in the organic carbon input to the bottom. Following this oceanographic shift, deep-water corals reappeared in the area as shown by the presence of densely packed coral fragments in one of the cores. This reappearance occurred after a 2000 years absence from the sedimentary record. Foraminiferal faunal analyses further indicate a change in the bottom environmental conditions, suggesting both an increase in bottom current strength and a decrease in sedimentation rates.

Keeping up appearances: The effect of preservation technique on the geochemical signature of bamboo corals.

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The purpose of this study is to assess the effect of preservation technique on the integrity of the geochemical archive in bamboo corals (Isididae*: Lepidisis*). Specimens are rare and preservation protocols vary between disciplines, with freeze-drying standard in geochemical research, and ethanol preservation standard for taxonomic and biological research. In the case of fossil deep-sea corals, specimens may have remained exposed to seawater for hundreds, to many thousands of years. To this end a comparison study was conducted in which a live-caught colony was sectioned into three parts after collection, and then stored; 1) dry, 2) in chilled (ca 8 degrees C) seawater and 3) in ethanol for one year, prior to analyses. The organic fraction (node) of each section was submitted for radiocarbon, stable carbon and nitrogen isotope analyses, as well as compound specific isotope analyses of individual amino acids. The Mg-calcite fraction (internode) was also submitted for radiocarbon analyses, as well as trace metal laser ablation. The results of this work demonstrate that with certain caveats, all samples, despite their method of preservation, can be used and are comparable within the same study.

Mediterranean Scleractinian corals: from Miocene to present

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Scleractinian corals are considered as important archives for reconstructing the history of oceans and seas. Their growth is affected by various environmental factors such as temperature, food supply and sedimentation rate, thus presence or absence of particular species and different growth forms may provide valuable insights into paleoenvironmental conditions. Also elemental and stable isotope contents of coral skeletons are acknowledged as useful paleoceanographic proxies although exact pathways of isotopic fractionation and ion transport are not fully elucidated. The Mediterranean area boasts extensive Miocene to Pleistocene coral deposits - a treasure house of potentially important paleoenvironmental data. Nevertheless, in the last 50 years only limited effort has been devoted to the systematic revision and paleoecological interpretation of Mediterranean fossil coral assemblages. In this study, which is based on field observations, museum records, and literature data, we discuss the diversity of Mediterranean scleractinians through time and attempt to relate coral assemblage variations to small- and large-scale geological, climatic and oceanographic events.

Our research supports the view that at the end of the Miocene, the Mediterranean coral fauna underwent drastic modifications which led to the disappearance of the well established shallow-water coral-reef province. However, our studies also highlight that the Messinian Salinity Crisis did not have a catastrophic impact on azooxanthellate and deep-water corals, whose diversity was instead strongly affected by paleoceanographic changes that took place at the end of the Pliocene and of the Pleistocene. Most Miocene azooxanthellate taxa, typically showing Indo-Pacific affinity, persisted in the Pliocene but disappeared before the Quaternary. In fact, well preserved Early Pleistocene coral associations from southern Italy lack typical Indo-Pacific taxa and are almost exclusively characterized by species living today in the NE Atlantic. The existence of Mediterranean and NE Atlantic oceanographic connections both in shallow- and deep-water environments during the Early Pleistocene is supported by the Atlantic affinities of other groups of organisms (e.g., molluscs, bryozoans, serpulids, crinoids, and ostracods) and it is substantiated by the well developed Atlantic-like *Lophelia-Madrepora* bioconstructions which characterise the Early Pleistocene deposits of the Messina Strait margins. The NE Atlantic affinity of Mediterranean scleractinians has endured till the present day, nonetheless most cold-water stenothermic genera (e.g., *Deltocyathus*, *Fungiacyathus*, *Stephanocyathus*, *Flabellum*) disappeared at the end of the Pleistocene leaving the Holocene Mediterranean coral fauna very impoverished.

In terms of changes in generic diversity of Scleractinians through time, we can distinguish two main groups: (i) The Winners, taxa which have persisted in the Mediterranean since the Miocene (e.g., *Cladocora*, *Dendrophyllia*). Here belong also those Miocene genera which underwent significant morphological modifications but whose evolutionary lineages persist in the Mediterranean till now (e.g., *Ceratotrochus multispinosus* - *Conotrochus typus* - *Ceratotrochus magnaghi*). (ii) The Losers, taxa highly sensitive to environmental modifications which went extinct at the end of the Miocene, of the Pliocene and of the Pleistocene.

The Great Wall of(f) Mauritania: Cold-water corals in an upwelling region

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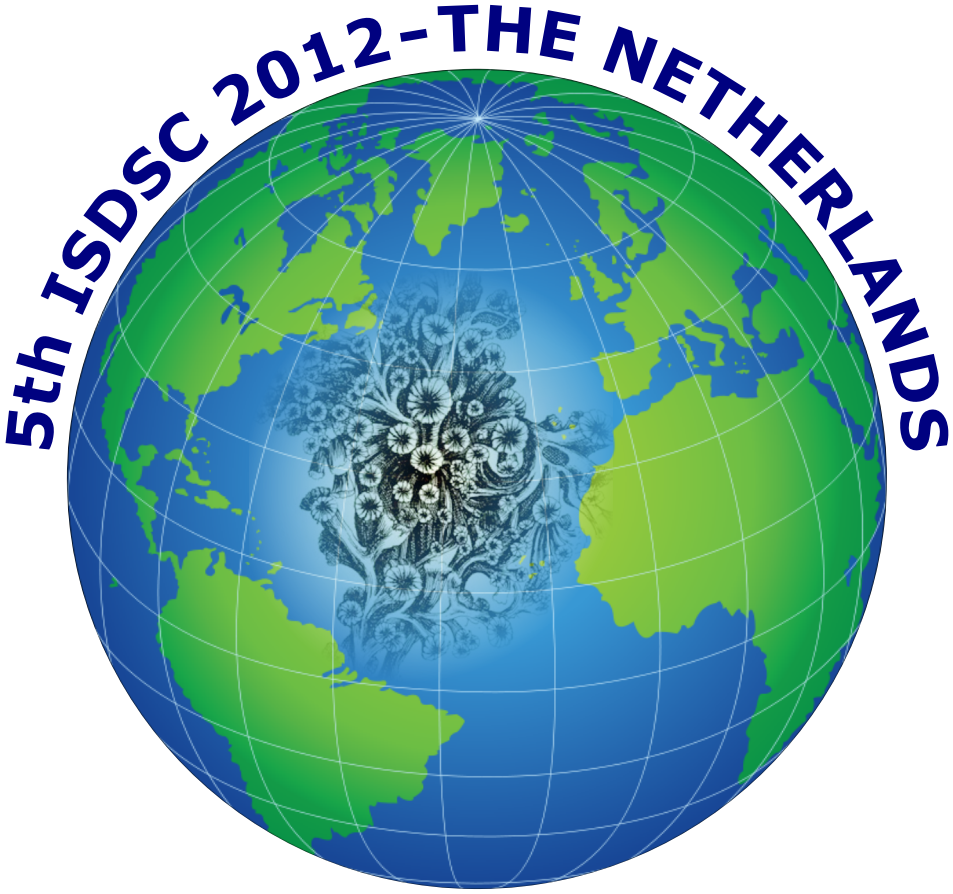
Cold-water corals along the Mauritanian margin were first discovered during hydrocarbon exploration revealing the presence of numerous buried and exposed coral mound structures (Colman et al. 2005). During MARIA S. MERIAN cruise MSM 16/3, a 400-km-long continental margin sector off Mauritania (between Cap Timiris and the Senegal river) was MB-mapped and ROV-surveyed in search for cold-water coral habitats to unravel their present and past environmental conditions. The Mauritanian shelf separates the hostile Sahara desert from the fertile and cool waters, which are forced by the Trade winds to generate a seasonal to permanent upwelling cell in the central East Atlantic. The high primary production supports one of the most productive fishing areas in the world. The northern part of the Mauritanian margin is dissected by several canyon heads that feed into the large Timiris canyon system in the deep sea. The central part of the margin exhibits an open slope with few canyons only, and the southern sector is characterised by the big Mauritanian slide. Cold-water corals were found in substantial accumulations in any of the three different margin types. In the canyon-rich sector, up to 60 m high conical coral mounds with actively growing thickets and small *Lophelia-Madrepora*-reefs were documented. Along the open slope and at the foot of the hanging-wall of the slide, 60 to 100 m high mound chains, each several kilometer in length are developed. In places a fully developed double wall was mapped. Signs of bottom trawling are very common. However, the steep canyon flanks form a natural protection for the corals against trawling activity. The coral community thrives under low oxygen conditions. While the epibenthic organisms are oxygen-consumers, infaunal chemosynthetic bivalves (Lucinoma and vesicomyids) were found alive in the muddy biostromal sediments adjacent to active coral reefs. Characteristic features of the Mauritanian coral community are large clustered accumulations of Acesta byssate bivalves strongly resembling the NE Atlantic-Mediterranean Acesta excavata. Sediment cores collected during RV POSEIDON cruise POS346 confirmed that the mound-shaped seabed structures found off Mauritania are indeed formed by cold-water corals. Uranium-series dating of the reef-forming coral *Lophelia pertusa* revealed sustained coral growth off Mauritania during the last glacial (32-65 ka; Eisele et al. 2011). Sediment cores with maximum recoveries of 10 m collected from various coral sites during the MSM 16/3 cruise document an impressive dominance of *Lophelia pertusa* frameworks, and a consistent association with large Acesta shells and large bryozoans. Preliminary U-series ages indicate that coral growth along the Mauritanian margin was not just restricted to the last glacial but prolonged into the Holocene.

Literature: Colman JG, Gordaon DM, Lane AP, Forde MJ, Fitzpatrick J (2005) Carbonate mounds off Mauretania, Northwest Africa



ABSTRACTS
POSTERS THEME IV

Are there any deep sea corals living in the Croatian part of the Adriatic Sea?

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The Adriatic Sea is avery shallow part of the Mediterranean. Nevertheless, along the rims of the South Adriatic Pit flourishing communities of deep sea corals and sponges were found (e.g. in Bari Canyon on its western side). Except for the South Adriatic Pit (depths around 1200 m) and Middle Adriatic Pit (Jabuka/Pomo Pit, depth 275 m) there are only a few locations in the Adriatic where depth exceeds 100 m. The preliminary research in the Jabuka Pit done during ARCO Cruise 2008 on board of r/v Urania (in which TBP participated through personal collaboration with Dr. Marco Taviani from ISMAR – CNR, Bologna) revealed an intriguing existence of subrecent deep sea coralmounds buried under a veneer of mud on depths around 200 m. However, so far no living deep sea corals were found in the Croatian part of the Adriatic Sea. Our discovery of deep sea carnivorous sponge *Asbestopluma hypogeaa* few years ago in a shallow marine cave in the middle Eastern Adriatic, hundreds of kilometres away from the real deep sea, pointed that there must be some suitable habitats - for at least some of deep sea organisms - along that distance. Up to now deep sea living communities on hard grounds in the Croatian part of the Adriatic Sea have not been properly researched.It is clear that for such research a wider international scientific and expert collaboration - intra and interdisciplinary - is required as well as development and application of new technologies. Some of these were obtained and preliminary tested in coastal waters of Croatia through our collaboration on the European FP 7 program "Developing the Croatian Underwater Robotics Research Potential"(coordinatorProfessor Zoran Vukićfrom University of Zagreb, Faculty of Electrical Engineering and Computing). On the poster we will present some of the preliminary work and discus Croatian potential for research and conservation of deep sea habitats and species, especially those on hard grounds in the Croatian part of the Adriatic.

Examining interactions between fisheries and coral areas in Icelandic waters using high resolution effort estimated from electronic logbook and VMS data.

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Cold-water coral (CWC) habitats, comprised mainly of *Lophelia pertusa*, are distributed along the south Icelandic continental shelf. Possible locations of CWC habitats were identified based on the analysis of high resolution bathymetry, bottom sampling, and from interviews with fishermen. The presence of CWC habitats have been verified at several sites. A total of seven marine protected areas have been established (2005 and 2012) in Icelandic waters with the explicit objective to protect cold-water coral-habitats.

The main threats to CWC habitats in Icelandic waters is the physical damage caused by commercial fishing gears, in particular bottom trawls and bottom longlines. The spatial distribution of CWC habitats is patchy and often restricted to specific bottom types or bathymetric features. Hence, to characterize the direct impact of commercial fisheries on CWC habitat it is necessary to quantify fishing effort and catch of coral-associated species at the highest spatial resolution possible. Vessel monitoring systems (VMS) and Electronic Logbook (ELB) can provide this information.

VMS data has been collected for most Icelandic vessels since 2007. VMS data has relatively high resolution (a GPS fix every hour or less) but it does not contain information on vessel activity (fishing, steaming, etc). An Electronic Logbook (ELB) system was introduced in Iceland in 2009. For a subset of trawlers (20%) the ELB data contains GPS fixes every 10 minutes during fishing events. Analysis of ELB data allows producing very high resolution fishing effort maps, and for validating effort estimates obtained from VMS data. ELB data allows for compiling very high resolution fishing effort maps, and for validating effort estimates obtained from VMS data. ELB data also is linked directly to catch data, allowing evaluation of the catch per unit effort of coral-associated fish species in the vicinity of coral areas.

In this poster we demonstrate the use of VMS and ELB data to produce high resolution fishing effort estimates and to evaluate the overlap between fishing effort and CWC habitat. We compare the catch-per-unit effort of coral-associated fish species on and off CWC habitats. We also evaluate the compliancy of Icelandic fishermen with the MPAs established in 2005, and demonstrate how VMS and ELB data was used to delimitate the MPAs established in 2012.

Assessment of sediment resuspension on deep-sea coral communities due to submarine pipeline installations off Brazilian coast (SW Atlantic)

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Deep-sea coral ecosystems, have acquired special importance from the time they were recognized not only by forming high diversity habitats but also by providing place of refuge, feeding and breeding for several species, many of them with highly commercial interest. The lack of knowledge of these ecosystems has lately increased the focus of environmental authorities in permitting processes of submarine facilities. Some human activities developed in deep sea environments have impacted these ecosystems, and among them, the bottom trawling appears at the top of the list. Activities related to oil and gas exploration and production, such as drilling and pipeline-laying, may also have negative consequences for coral communities, but generally the effects are considered localized. Studies on shallow-water species show that these organisms may be affected when exposed to high sedimentation rates causing morphological and physiological changes. Moreover, little is known about the effects of sediment resuspension on deep-sea corals. This paper presents an assessment of sediment resuspension effects on deep-sea coral communities due to the installation of three submarine pipelines in Campos, Santos and Espirito Santo basins, SE-Brazil.

Biomarker Identification and Monitoring of Oil Exposed Cold-water *Lophelia pertusa* Coral

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Reefs formed by the cold-water scleractinian coral *Lophelia pertusa* occur along the continental slopes of most oceans and form habitat for many invertebrate and fish species. Cold-water corals often occur in close proximity to oil drilling and extraction sites; therefore, they are at risk to exposure following spills. Experience from past oil spills and laboratory experiments suggested that warm-water corals may be negatively affected by direct exposure to crude oil and xenobiotics, such as dispersants. However, collection of samples and monitoring deep sea ecosystem health is difficult and costly. We are developing assays of coral health that can be used to identify initial exposures to potential stressors/contaminants (oil, dispersant). An early response to environmental stressors includes the alteration of gene expression and the synthesis of proteins that drive homeostatic physiology. Sub-lethal, chronic effects may include shifts away from normal homeostasis at the molecular and cellular levels that are difficult to observe, yet may be indicative of pathophysiological effects. Through examination of transcriptomes, or the set of all RNA molecules present at a particular time, identification of genes (or gene systems) that are actively expressed can be interrogated. The magnitude and patterns of gene expression can be used as a holistic biomarker. We are assembling and annotating the transcriptome from 454 sequence data for *L. pertusa*. Nearly 500,000 sequences have been generated from cDNA libraries constructed from total RNA extracted from Gulf of Mexico and western Atlantic *L. pertusa* samples. Through comparisons with the well annotated cnidarian genome of the anemone Nematostella vectinsis, we have identified numerous putative *L. pertusa* protein coding genes. Our *L. pertusa* reference transcriptome includes genes homologous to those from other species involved with chemical stress response, such as: efflux pump enzymes such as ATP Binding Cassette that actively export substrates from cells; cytochrome p450, an oxidizing enzyme involved in the initial phase of excretion of toxins; catalase, involved in reactive oxygen detoxification; and heat shock proteins. Dose-response laboratory experiments that expose *L. pertusa* to various concentrations of crude oil and dispersants will be followed by RNA-Seq experiments to quantify transcripts. The annotated transcriptome will be used to identify and count transcripts, which will elucidate which biomarkers will respond predictively to chemical stressors. This genome-wide survey of chemical defense genes in *L.pertusa* will identify putative stress response genes, or candidate biomarker genes, that will facilitate the development of quantitative PCR assays for monitoring coral health through the complex recovery process. Developing a suite of biomarkers that reflect cold water coral health could provide an inexpensive, less labor intensive, and more effective method of monitoring the state of a fragile and important ecosystem.

Policy driven fundamental coral research can lead to useful applied outcomes: the example of the EU FP7 CoralFISH project

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Success in attracting funding for large scale environmental research projects under the European Union's research framework programme invariable requires evidence of a demonstrable societal impact. The four year, large integrating FP7 project, CoralFISH, with participants from 11 countries, is improving the scientific knowledge required to support the implementation of an ecosystem-based management approach in the deep-sea through the study of the interaction between cold-water coral habitat, fish and fisheries. The project has assembled a unique consortium of deep-sea fisheries biologists, ecosystem researchers/modellers, economists and a fishing industry SME, who have collaborated to collect data from key European marine eco-regions. This paper will highlight some of the key outputs of the CoralFISH project that should lead to a more sustainable management of offshore seafloor resources.

NOAA's Deep-sea coral and sponge research program on the West Coast of the United States

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The National Oceanic and Atmospheric Administration's (NOAA's) Deep Sea Coral Research and Technology Program, has launched a three-year research initiative on the West Coast of the United States to locate, study, and provide information for the protection of deep sea coral and sponge habitats. The newly collected information will inform proposals to decrease adverse impacts to these habitats from fishing.

During the first two years of research 2010-2011), surveys using remotely operated vehicles (ROVs), a submersible, an autonomous underwater vehicle (AUV), and multibeam bottom mapping sonar have been conducted at sites from Olympic Coast National Marine Sanctuary in Northern Washington, to the Gulf of the Farallones and Cordell Bank National Marine Sanctuaries in central California, to the southern California Bight. This latitudinal gradient allowed study of a rich variety of deep-sea coral and sponge habitats and fishes associated with them. Study sites were chosen primarily on their relevance to informing resource management decisions.

Surveys for deep-sea corals and sponges were conducted at depths of 280-900 meters on Piggy Bank, an underwater mountain off Southern California. The most abundant corals (depending on depth) included Christmas tree black coral (*Antipathes dendrochristos*), mushroom coral (*Anthomastus ritteri*), several species of Primnoidae and Plexauridae (*Swiftia spp*.), dense but low relief stands *Lophelia pertusa* and *Desmophyllum dianthus*, and the sea pen (*Halipteris californica*; only on soft sediment). The most abundant sponges generally were mound, foliose, upright flat, vase, and barrel groups. Thirty-four specimens, including 14 corals, 13 sponges, and 7 other invertebrates (e.g., worms, tunicates, and nudibranchs), were collected and sent to taxonomic experts for further identification. On a second bank at shallower depths (110-475 m), research quantified habitat-specific abundance and size composition of Christmas tree black corals, evaluating change in coral communities eight years after initial baseline surveys, and determining fish associations with black corals.

An area that had been previously described as having a high density of structure-forming sponges associated with methane seeps off Grays Harbor, Washington was explored and the distribution of these sponges and associated fish were quantified using an AUV. The area was of low relief and much was covered with sediment, but there was a high abundance of sponges, including Heterochone calyx, *Aphrocallistes vastus* and *Poecillastra spp*. Many of the rockfishes in the area were associated with sponges and a high percentage were either touching or within one body length of the structure-forming sponges.

Working amongst DWCRs off mid Norway

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Since 1990, several hydrocarbon production fields and transport pipelines have been developed and constructed offshore mid Norway. This is despite the region being well renowned for some of the world's largest deep-water coral reefs, including the Sula Reef. The poster will illustrate some of the scenarios that have been accomplished without any harm to coral reefs.

New evidence underpinning the North-West Rockall Bank candidate Special Area of Conservation (cSAC)

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Rockall Bank is situated in the North East Atlantic, 400 km west of the Outer Hebrides. It is approximately 450 km in length and 200 km wide. Depth ranges from over 1000 m at the base of the Rockall Bank, to 200 m across much of the top. On account of their sheer size, oceanic banks such as Rockall cause the deviation of ocean currents along their flanks which facilitate the colonization of habitat-forming corals which depend on a consistent supply of current-transported organic matter and zooplankton. Rockall Bank occurs in an area managed under the European Union's Common Fisheries Policy and extends slightly into the area regulated by the North East Atlantic Fisheries Commission (NEAFC). In 2005, ICES recommended to the European Commission (EC) and NEAFC a closure to demersal fishing activities in North-West Rockall to protect vulnerable cold water corals (ICES, 2005). This closure was put in place in 2007. In 2010, North-West Rockall was submitted to the EC as a candidate Special Area of Conservation (cSAC) by UK Government for its biogenic and stony reef listed under Annex I of the EC Habitats Directive. Justification for the SAC used information on the distribution of cold water corals and stony reef in the area, including the data on which the ICES advice to EC/NEAFC was based, plus more recent survey data gathered by JNCC and Marine Scotland Science in 2009 and newly acquired fishermen's plotter records of cold water coral occurrences and trawling locations. The boundary of the cSAC based on these new data sources was therefore different to the 2007 EC/NEAFC fisheries closure. In 2011, a recommendation to extend the fishery closure area, and align it with the NW Rockall cSAC boundary, was made by ICES to the EC and NEAFC. This recommendation was not adopted as there was further uncertainty caused by records of coral in an area that ICES recommended should be opened. To further underpin the suggested new boundary, JNCC were invited by joined cruise JC060 to the Rockall area, led by the National Oceanography Centre (NOC) in May/June 2011. JNCC were interested in surveying areas within the cSAC that also occurred either inside the current fisheries closure or within the area recently recommended for inclusion within the fisheries closure in 2011. High resolution side scan data from the Autosub6000 AUV were used to identify possible areas of coral and these were targeted in subsequent ROV reconnaissance dives. The most extensive patches of reef were found in an area which is included within the current cSAC boundary but outside the current EC/NEAFC fisheries closure. Report of the ICES Advisory Committee on Fishery Management, Advisory Committee on the Marine Environment and Advisory Committee on Ecosystems, 2005. Report of the ICES Advisory Committee on Fishery Management, Advisory Committee on the Marine Environment and Advisory Committee on Ecosystems, 2007.

Age and growth of habitat-forming *Solenosmilia variabilis* – an assessment of recovery potential

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Some species of cold water corals can form large reef-like structures that provide habitat for numerous other species. These corals can be removed or their integrity affected by physical disturbance from the likes of bottom trawling and seabed mining. Our ability to assess the recovery rate of these habitats and their associated communities is at present compromised by our lack of knowledge on the age and growth of the main matrix-forming coral species.

Whilst some research on the age and growth of some corals has been conducted by NIWA, estimates for the key matrix-forming species remain elusive (globally). Such matrices are constructed by only a few coral species in deep waters throughout the South Pacific, of which four species are common reef formers in deep waters throughout the South Pacific: *Madrepora oculata*, *Solenosmilia variabilis*, *Goniocorella dumosa*, *Enallopsammia rostrata* and the endemic species *Oculina virgosa* (Cairns 1995, Tracey et al. 2007). A scoping study to determine the feasibility of ageing NZ's deep sea habitat forming corals has been conducted on specimens of *Solenosmilia variabilis*. Two primary concerns need to be considered when selecting samples from deep cold-water corals for age analysis: reservoir age of the bathing waters and the potentially slow growth rate. The reservoir age of deep waters around New Zealand are poorly known, however we can correct for this by also analysing coral skeletons directly beneath live tissue i.e. a growing tip or polyp of the colony. This proof-of-concept study confirmed the viability of using radiocarbon difference analyses across a single coral colony within NZ waters.

Linear growth rates calculated range from 0.3 to 1.3 mm/yr, in keeping with growth rates reported for matrix/reef forming *Lophelia* (e.g. Mortensen & Rapp, 1998; Mortensen, 2000). Using a conservative estimate of matrix height of ~20cm, it could take hundreds of years (~150-570 years) for a colony to attain this height, or ~750-2800 years to build a diameter of 1m. Defining the age, growth and restoration timeframes of deep-sea coral matrices in the NZ region has implications for ecosystem management and aids the required development of ecological risk assessments for this SW Pacific region.

Expanding oil and gas exploration into areas with unique cold-water coral ecosystems

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In the deep ocean, cold-water coral (CWC) ecosystems are oasis of life with a diverse associated fauna. However, damages from fisheries are documented. In near future these ecosystems will be influenced by added stress related to temperature change and ocean acidification, as well as potential threats resulting from more direct forms of human activity, including oil and gas (O&G) exploration. This presentation will address aspects related to CWC biology, their sensitivity towards drilling operations and the mitigation actions taken by O&G operators that were discussed at an international CWC workshop (WS), held in Stavanger/Norway in spring 2010. The WS was attended by representatives from the industry, governmental and non-governmental organisations and research. It was agreed by all parts that protecting and safeguarding these ecosystems while recognizing the economical and political importance of future O&G activities, require a thorough understanding of CWC sensitivity and the implementation of dedicated management policies. If discharges of drill cuttings and drilling mud cannot be avoided, they have to be minimised and released at a safe distance from the corals. This distance must be based on the exposure and the vulnerability of the CWC and should be defined by threshold levels and validated by particle distribution models. For monitoring purposes, the development of potential indicators as supplement to visual mapping was identified as crucial. As a basis, all relevant information regarding corals and their environment needs to be collected, reviewed and coordinated, and the best available technology should be employed during drilling operations. Biotic and abiotic variability between sites and ecosystems involves regulating this under site and season specific conditions. In parallel, research should continue to fill knowledge gaps on basic biology and ecology on CWCs and their ecosystems, and search for possible short- and long-term biological effects following drilling events. Together this will form a scientific basis to development of common guidelines for continued O&G exploration and management of CWC ecosystems. The CWC Workshop (WS) was financed by the Norwegian Oil Industry Association (OLF).

The impact of bottom longline on cold-water coral communities

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Cold-water corals (CWC) are recognised as key components of deep-water systems worldwide, forming essential habitats that support a high biodiversity. Whilst quantitative studies on the effect of deep-water trawling on CWC communities are widespread, the impacts of other types of fishing gear, such as bottom longlines and handlines have so far received little attention. In this study, we provide an assessment of the impact of these two fishing gear on CWC based on data collected during research longline fishing surveys and a fisheries observers program in the Azores, North Atlantic. In addition, 12 video transects using a Remote Operated Vehicle (ROV) were performed on a single seamount in order to quantify the amount of lost gear and obtain in situ information on the effect of fishing on CWC. We analyzed data from 238 longline fishing sets (132 = research cruises; 106 = observers) and 61 handline sets, between 2007 and 2010. Fishing sets during the research surveys were located in diverse locations around the Azores at depths ranging from 40 to 2500 metres, whilst sets from commercial vessels (long and handline) were restricted to 200 and 700 metres and concentrated around the islands of Faial and Pico. CWC (together with sponges and hydrozoa) formed the bulk of the by-catch for both fishing surveys and commercial vessels. On the other hand, handlines sets had insignificant by-catch levels. Overall, CWC bycatch values ranged between 0 to 14 corals 1000 hooks-1 with gorgonians being the principal group affected (71.03%). The remaining fraction included Stony corals (13.37%), Stylasterids (8.54%) and black corals (7.05%). Analysis of ROV surveys identified 21 lost fishing gears over a total transects distance of 6.4 km. Of the total number of colonies present in the vicinity of the lines, we recorded 47% colonies with sign of impacts. 5.1% of those colonies were unlikely to survive from the impact of fishing while the other were either bent or had major missing parts but with signs of recovery. These results show that long-line fishing do have negative impact on CWC communities although at a lower intensity when compared to the effect of bottom trawling.

The Government of Canada's Coral and Sponge Web Application

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In 2007, as part of Canada's new National Water Strategy, the federal government announced five-year funding for various initiatives to protect fragile marine environments, counter pollution, and strengthen preventive measures. The Health of the Oceans (HOTO) initiative is focused on addressing a number of issues and challenges affecting Canada's marine environment. Under HOTO, Fisheries and Oceans Canada (DFO) created a National Centre of Expertise (CoE) in Cold-Water Corals and Sponge Reefs with a mandate of the centre is to improve coral and sponge conservation in Canada. As a portion of its mandate, the Centre is committed to the development of tools to improve coral and sponge conservation in Canada. The Coral and Sponge Atlas Application which was created as an online marine spatial planning tool for DFO staff. It is national in scope allowing staff across Canada to create their own maps based on their needs such as fisheries management, integrated oceans management, environmental assessment, and marine protected area planning. In terms of content, the atlas contains over 320 layers of information. Of these, well over two hundred are species layers for coral and sponge in Canada. The remaining layers consist of fisheries management, coral and sponge closures or conservation areas, scientific advice, regional management initiatives, substrate information, and environmental impacts such as oil and gas leases. Users can avail of tools, such as a regional summary query tool, identify tool, and a depth query tool. They can add text and other information to the application and print the result. The atlas contains links to species information and metadata for each layer. The application has been built using Adobe Flash Builder 4.5 and ArcGIS Server 10 platform. The layers were created using ArcGIS 10. The Coral and Sponge Atlas represents a collaborative effort across many sectors of DFO and other government departments such as Natural Resources Canada and Parks Canada. The Centre solicited feedback during the entire development process from potential users to develop the design template for the atlas. While this created challenges along the way (eg. layer design, functionality), the final product has become a valuable interactive conservation tool. The poster will outline the function and scope of the Coral and Sponge Web Application. It will also illustrate the relevance of this tool in helping government staff respond to the Canada's commitments, nationally and internationally, to coral and sponge conservation.

Cold-water coral reef habitat restoration within the Koster Sea National Park, Sweden.

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Over the last decades there has been a global decline of deep-water coral reef habitats due to destructive fishing methods. Heavy bottom-trawling gears severely reduce habitat complexity, leaving fields of dead coral rubble with little or no capacity for recovery. In the Northeast Skagerrak several reefs in the Koster Sea have been destroyed, leaving only one live reef in Sweden. In the adjacent Outer Hvaler area (Norway), reef coverage has been reduced by up to 50%. The managers of the recently inaugurated Koster Sea Marine National Park explicitly aim to restore reef habitats and replant cold-water corals in the area. During my doctoral studentship I aim to test different types of artificial reefs to find the most suitable method for CWC habitat restoration. The ARs will be designed to mimic the natural CWC habitats of the area, and use hydrodynamics to enhance settling rates of particles and larvae. The CWC associated fauna largely reflect the regional assemblage, although greatly enhanced in diversity and abundance at CWC reefs due to the complex matrix of coral branches that act as a trap for particles and larvae. The ARs should function as a substitute for the dead basal parts of a CWC reef and give a solid foundation for coral transplants seeded onto the ARs. A second aim of the doctoral studentship is to test substrate choice of coral larvae, both in laboratory and in the field. Possible chemical cues for settling will also be investigated. Transplantation experiments to test environmental suitability at the sites targeted for replantation is ongoing, and recovery transects in disturbed areas has been followed since 2005. The natural recovery has been slow, and instead of recovery, continued loss of corals has been observed. Active measures to aid the recovery seem necessary.