# The biogeography of corals on seamounts

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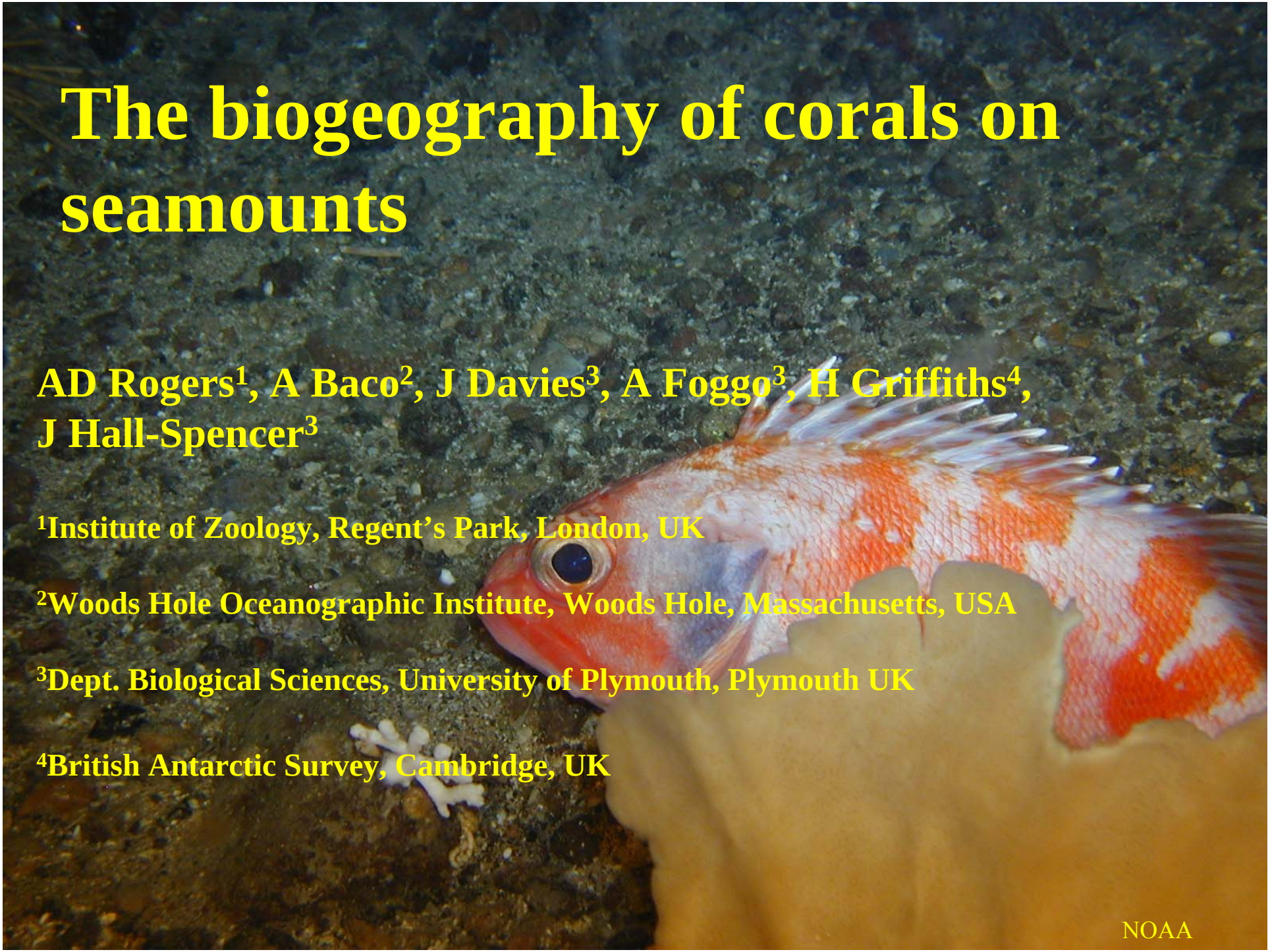


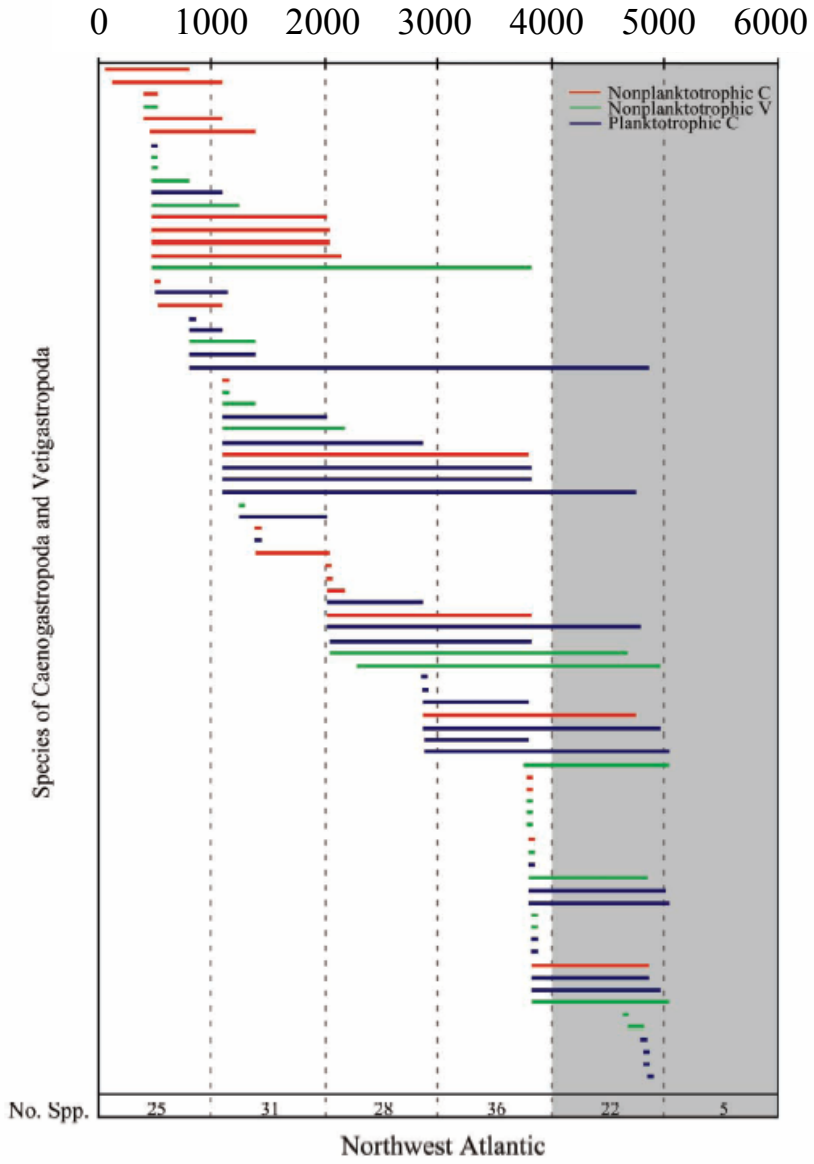
NOAA

Species are generally confined to specific depth range

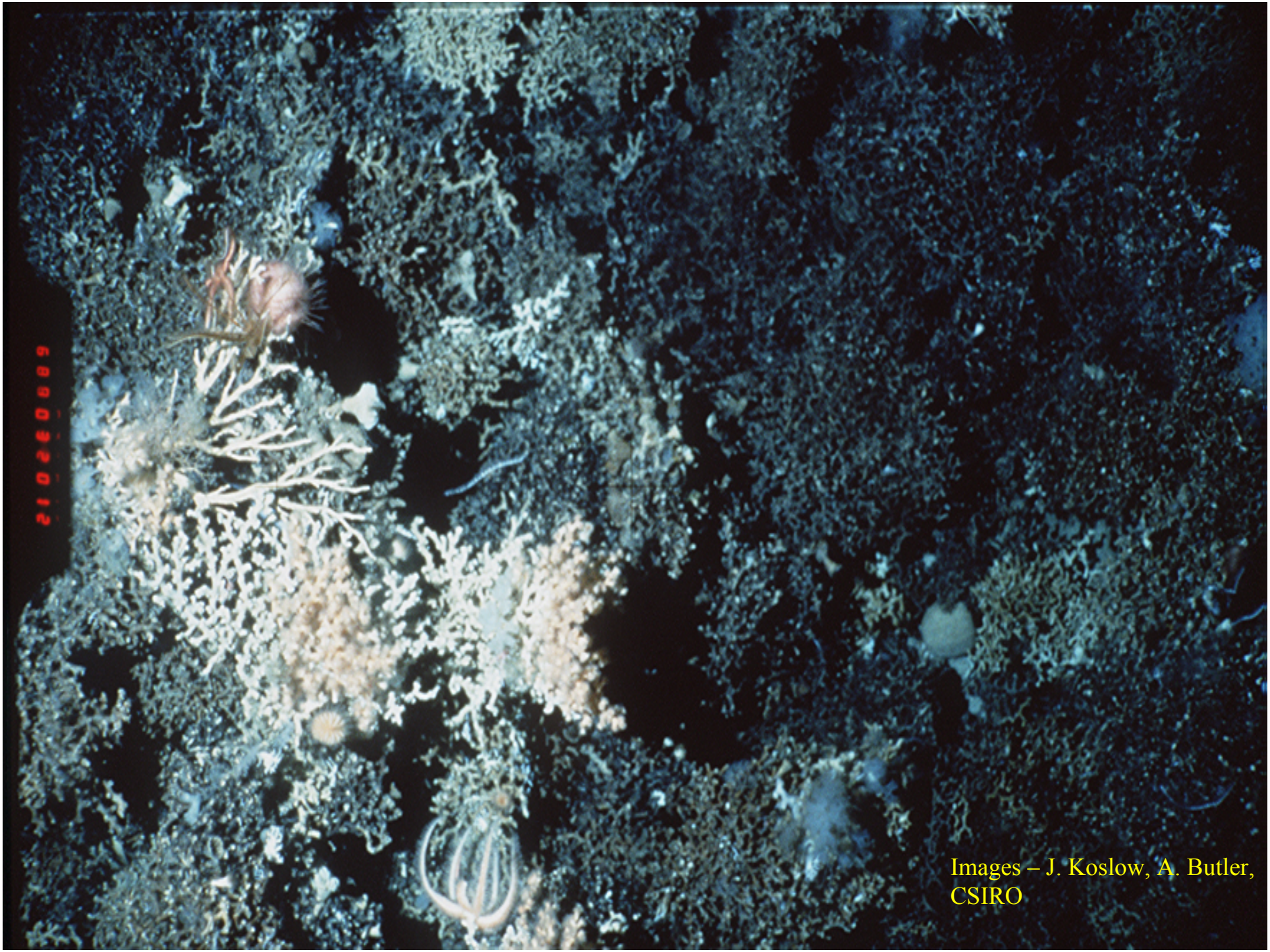
Zonation

(Rex et al., 2005)

Horizontal distribution poorly understood (Are species found in different oceans, within one ocean, or just a single region?)




Depth range of snails along continental slope


Images – J. Koslow, A. Butler,
CSIRO

**Biodiversity**

**South Australian Seamounts**

**297 species of animals on 14 seamounts**

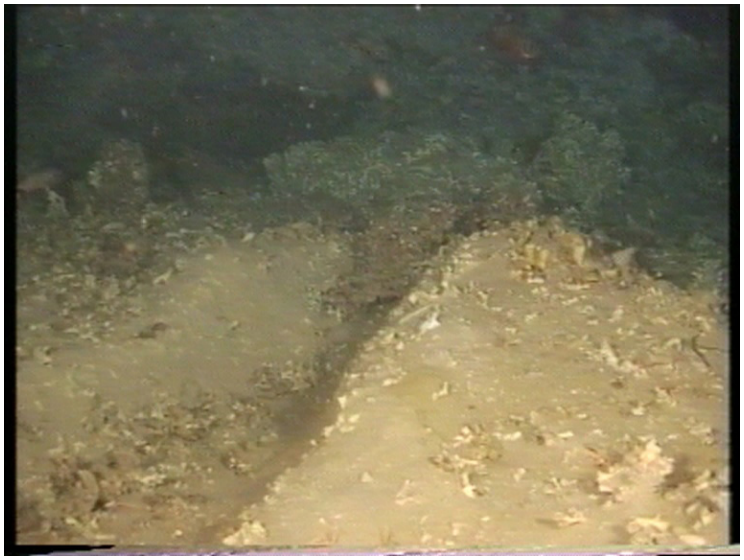
**16 - 33% are new to science and potential endemics**

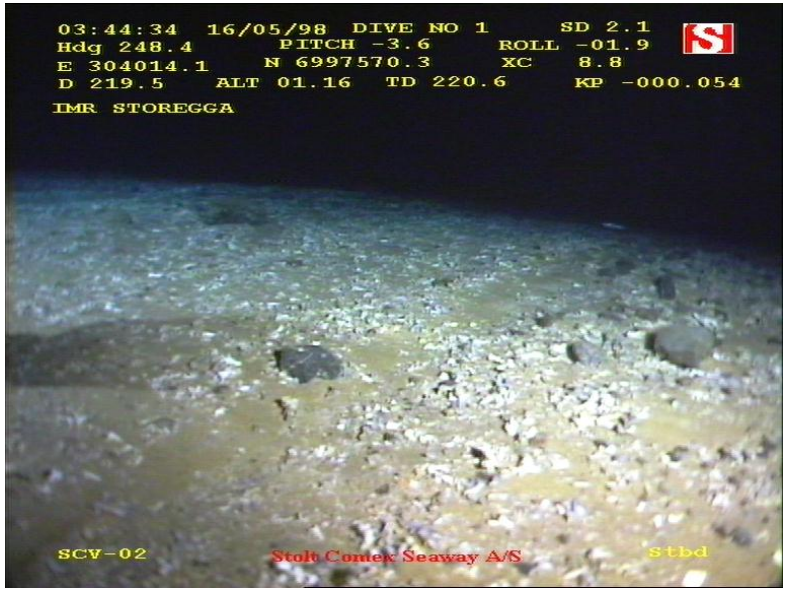
**Low overlap in species present on different seamounts**

**Even lower co-occurrence of species on different chains**

**Richer de Forges et al (2000)**

# Trawl damage – NE Atlantic



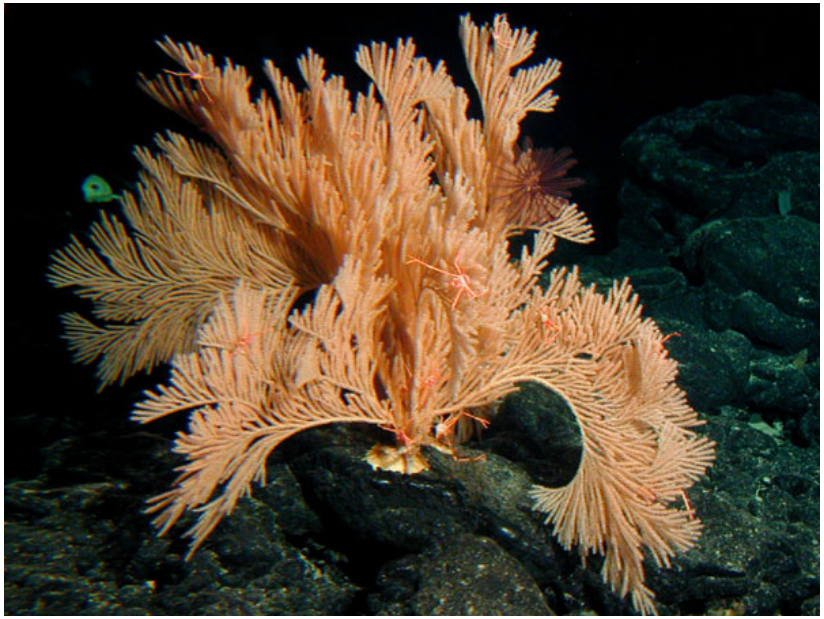



**50% *Lophelia pertusa* reefs lost in Norwegian waters (coral is now protected in N. EEZ)**

**Images by Jan Helge Fosså**

# Corals

Scleractinia



Octocorallia

Antipatharia


Stylasterida

NOAA Ocean explorers & IFREMER

# Questions

- Are coral communities different on seamounts compared to slopes of oceanic islands and continents?
- Are there global hotspots in coral diversity on seamounts?
- Are there differences in the distribution of the different coral groups on seamounts?

# Are Seamounts Different?
# Data collection, North-East Atlantic

Grasshoff (1972, 1973, 1977, 1981a, 1981b, 1981c, 1985a, 1985b, 1986, 1989), Zibrowius (1980), Keller (1985), Pasternack (1985), Tendal (1992), Howson and Picton (1997), Rogers (1999), Opresku (2001), Brito and Ocana (2004), Schröder-Ritzrau et al. (2005), Tyler and Zibrowius (1992), and Molotsova (in press).

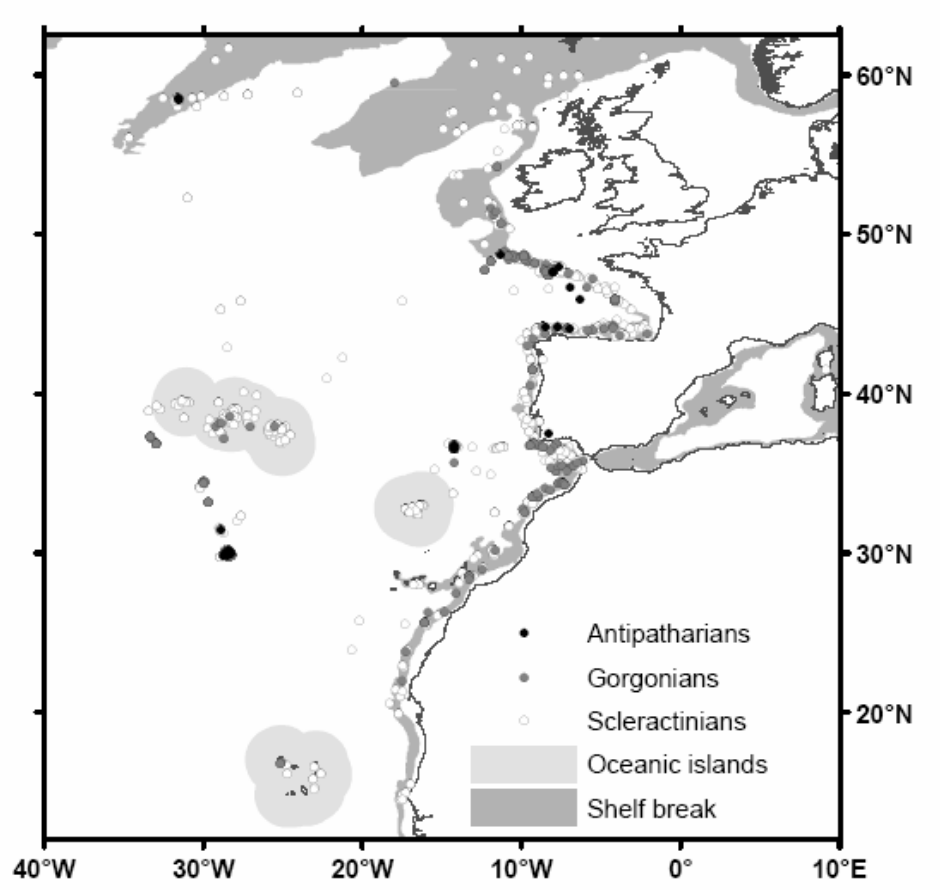
Taxon, position, depth, date collected, cruise details and other notes

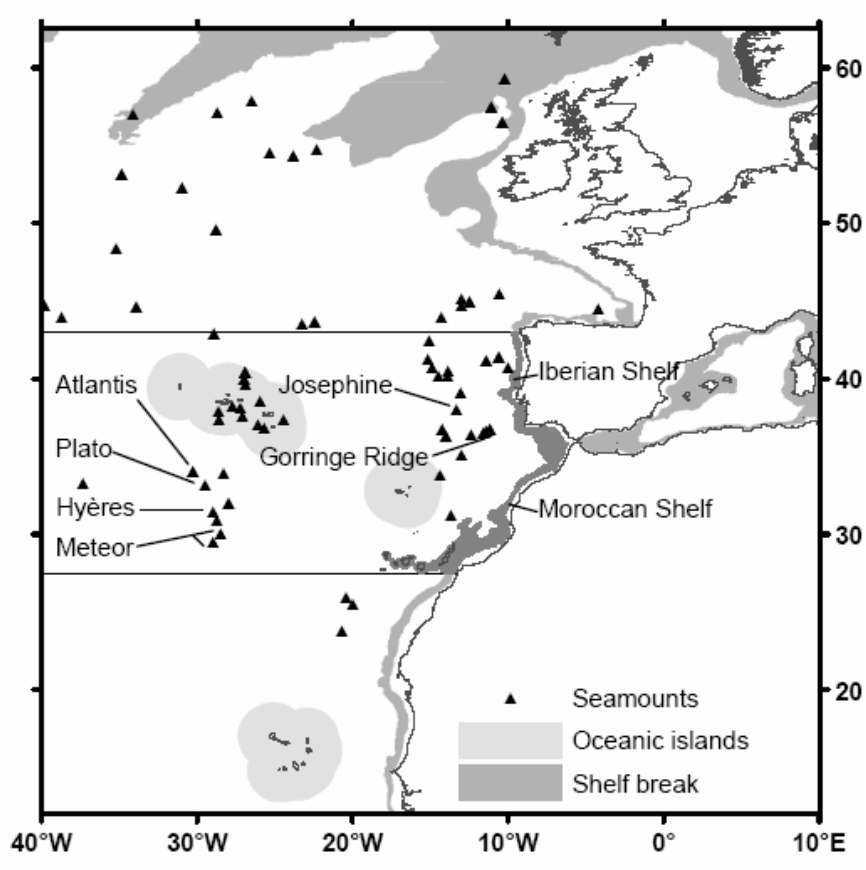
Stylasterids excluded (not enough data)

# Coral records used (>2100 records)

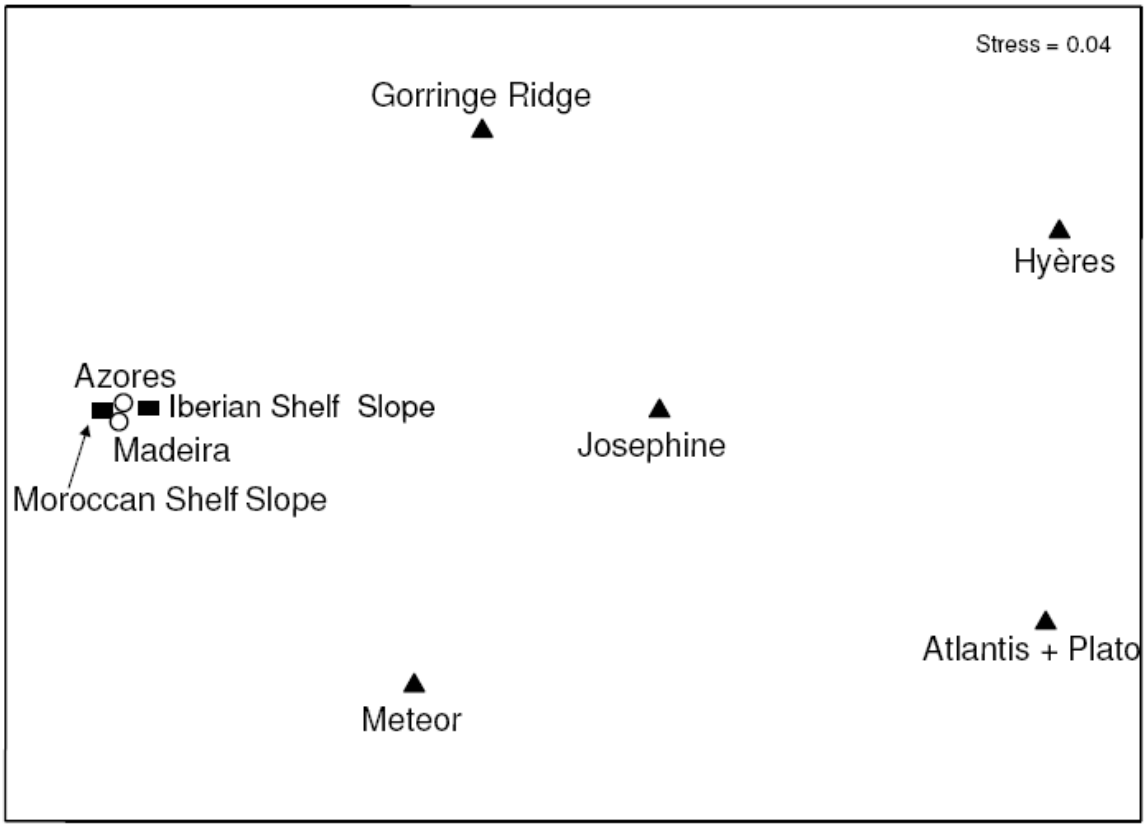
| Expeditions | Date | Antipatharians | Gorgonians | Scleractinians |
|---|---|---|---|---|
| RV Josephine | 1869 | 0 | 2 (1) | 19 (8) |
| RV Porcupine | 1869-1870 | 0 | 0 | 40 (38) |
| Prince of Monaco | 1869-1911 | 0 | 55 (11) | 153 (98) |
| RV Challenger | 1873 | 0 | 1 (1) | 31 (21) |
| RV Travailleur | 1881-1883 | 0 | 21 (18) | 19 (18) |
| RV Talisman | 1883 | 0 | 50 (45) | 51 (44) |
| RV Calypso | 1958-1959 | 0 | 0 | 38 (21) |
| RV Sarsia | 1958-1974 | 0 | 0 | 54 (43) |
| RV Jean Charcot | 1966-1976 | 11 (4) | 92 (38) | 325 (189) |
| RV Meteor | 1967-1970 | 11 (6) | 117 (81) | 105 (97) |
| RV Thalassa | 1967-1973 | 2 (2) | 39 (36) | 158 (142) |
| RV Bartlett | 1975 | 0 | 20 (16) | 19 (16) |
| RV Cryos | 1984 | 0 | 36 (36) | 0 |
| Others | 1868-1983 | 52 (11) | 196 (70) | 409 (289) |
| Totals | | 76 | 629 | 1421 |

Records of deep-water corals for the NE Atlantic compiled from (>200m depth) pre-1985 cruise and literature reports showing the oceanic island and shelf slope areas considered (200-2000 m) (b) Seamounts in region



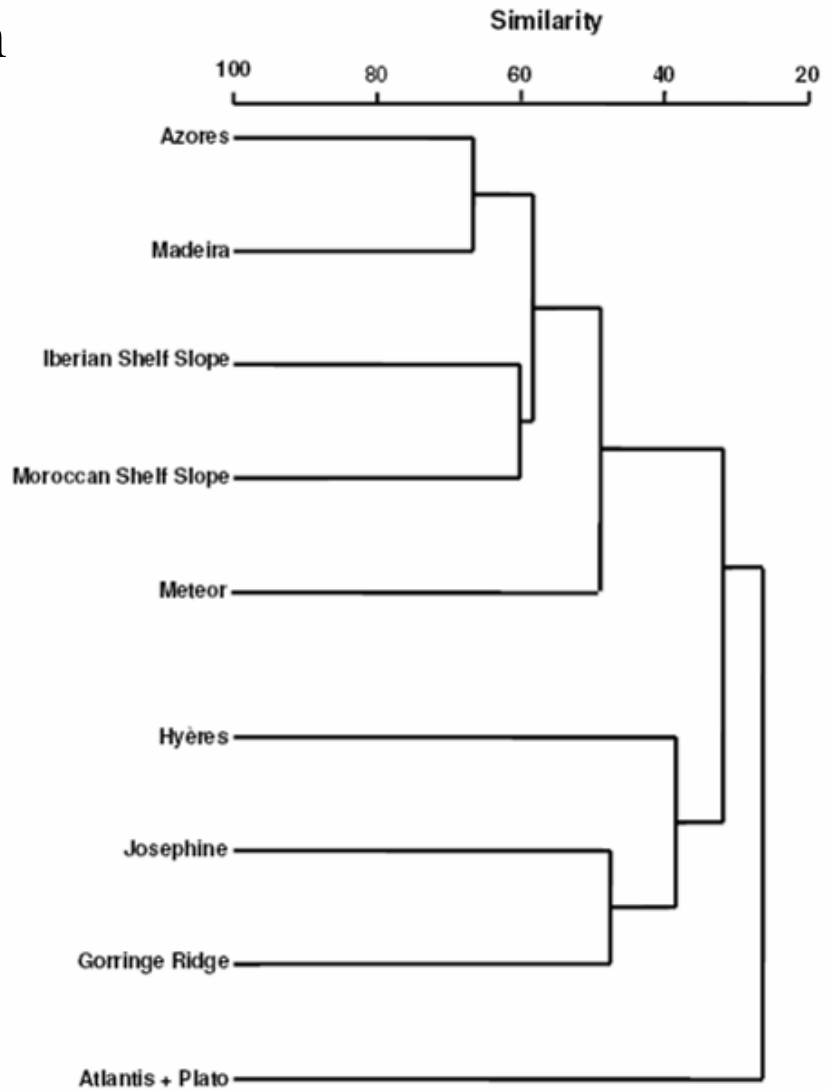
n-MDS ordination of coral assemblages in the warm temperate NE Atlantic. Ordination based upon Bray-Curtis similarity values calculated using species presence/absence. ▲= seamounts, ■ = continental shelf slope, ○ = oceanic islands.



Group-averaged cluster plot of coral assemblages from 200-2000m depth in the NE Atlantic (Bray-Curtis similarity values calculated from species presence/absence

Islands 64% similar to continental slope sites

Seamounts are 26-49% similar to continental slope sites



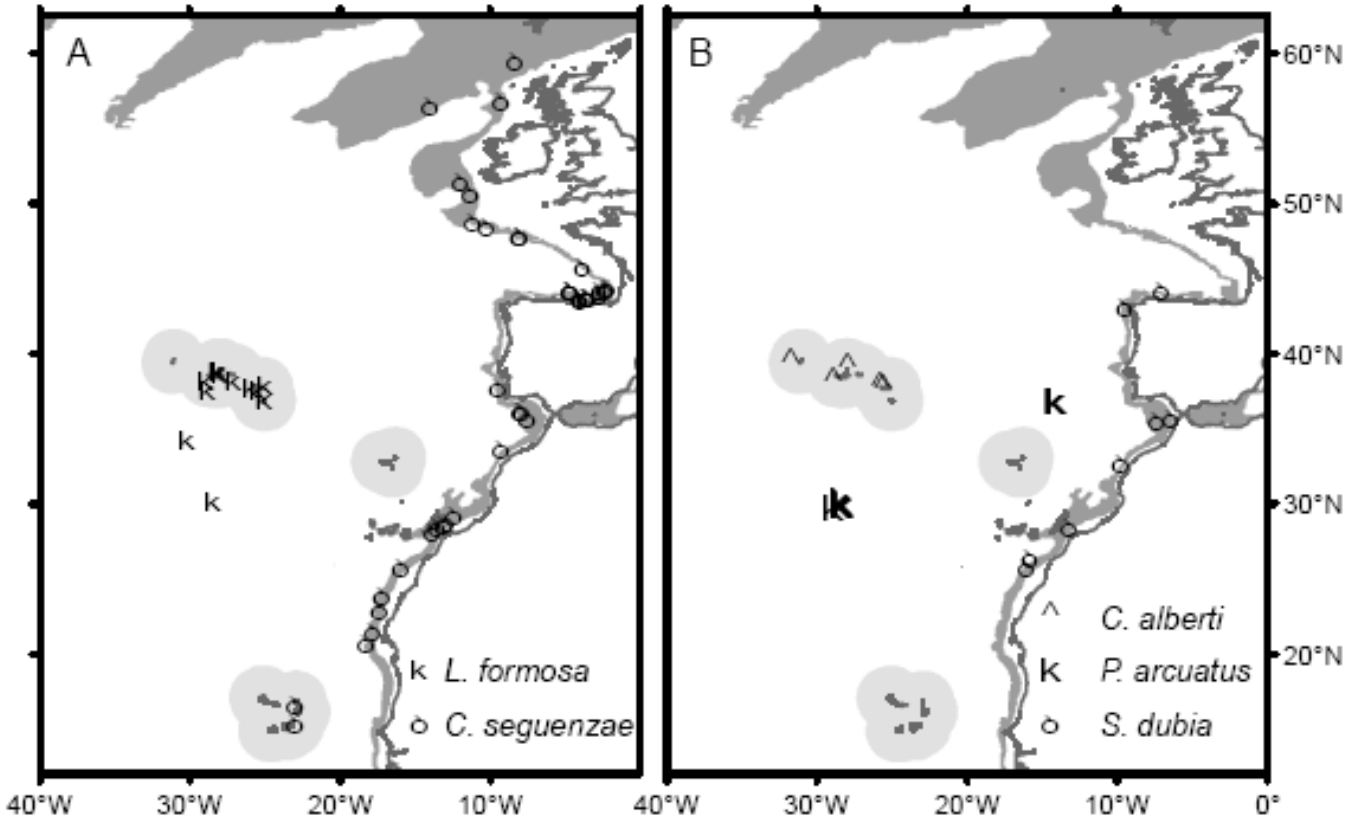
# Reasons for differentiation between seamounts & non-seamount habitat

Some species only on seamounts; examples are: *Dentomuricea meteor* (Grasshoff, 1977) and *Tubigorgia cylindrica* (Pasternack, 1985) only found on Great Meteor. However, endemism to seamounts here is only <4%.

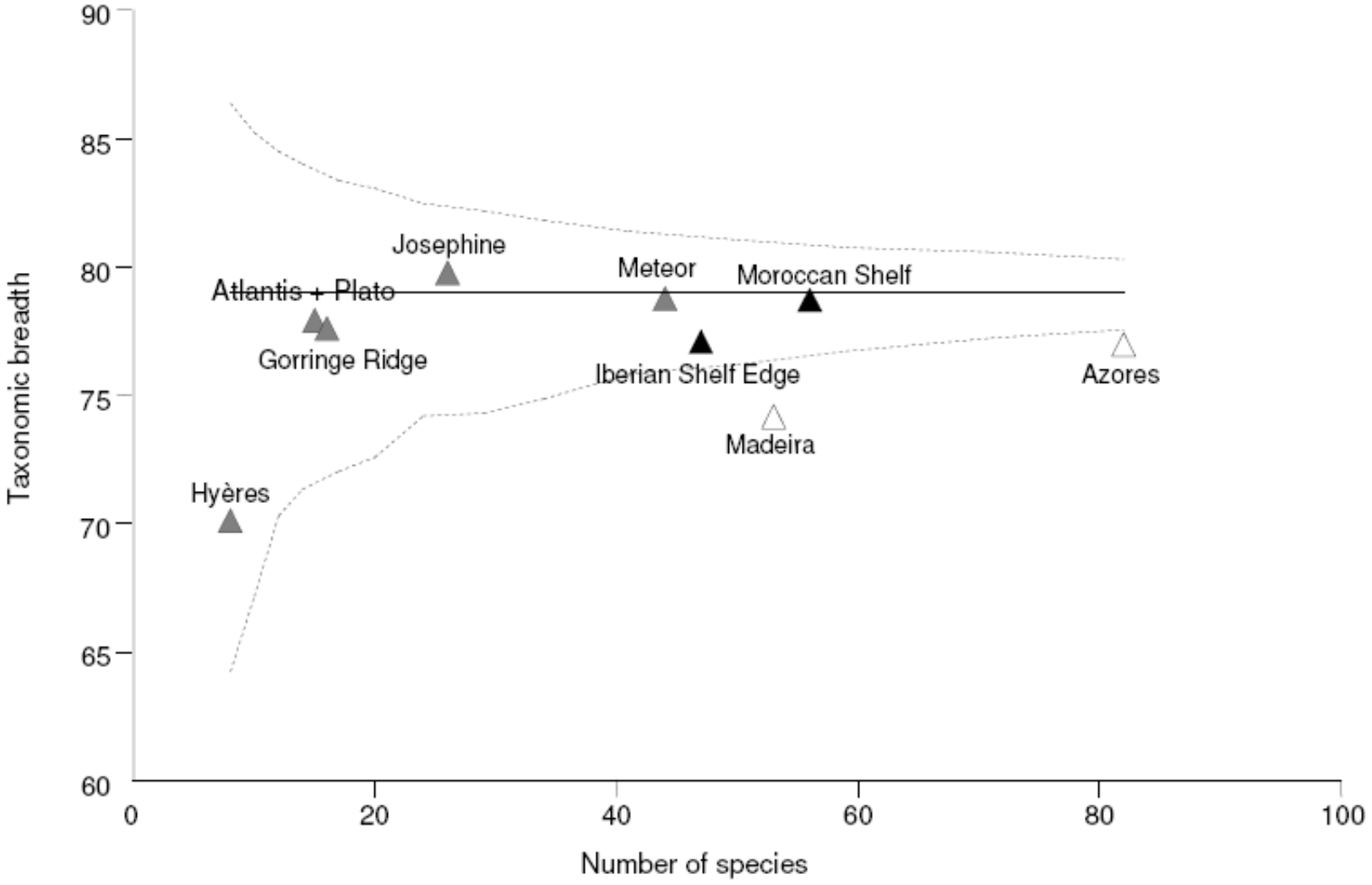
A suite of scleractinian species are only found in oceanic conditions (e.g. *Caryophyllia alberti* Zibrowius 1980, *Caryophyllia foresti* Zibrowius 1980, *Leptopsammia formosa* Gravier, 1915, *Paracyathus arcuatus* Lindström, 1877).

Also for antipatharians:*Antipathes erinaceus* (Roule, 1905), *Distichopathes* sp., *Phanopathes* sp. and *Stauropathes punctata* (Roule, 1905) (Molodstova in press).

Shelf-slope vs. open ocean affinities of A) *Caryophyllia seguenzae* vs. *Leptopsammia formosa* and B) *Swiftia dubia* (Thomson, 1929) vs. *Caryophyllia alberti* and *Paracyathus arcuatus*.



Funnel plot of taxonomic breadth for deep-water coral assemblages. Dotted lines indicate the 95% confidence intervals for taxonomic breadth at any given level of species richness (x-axis); sites lying outside these bounds have lower or higher taxonomic breadth than expected at their richness level given the taxonomic composition of the pool of species from which they are drawn.



# Taxonomic distinctness

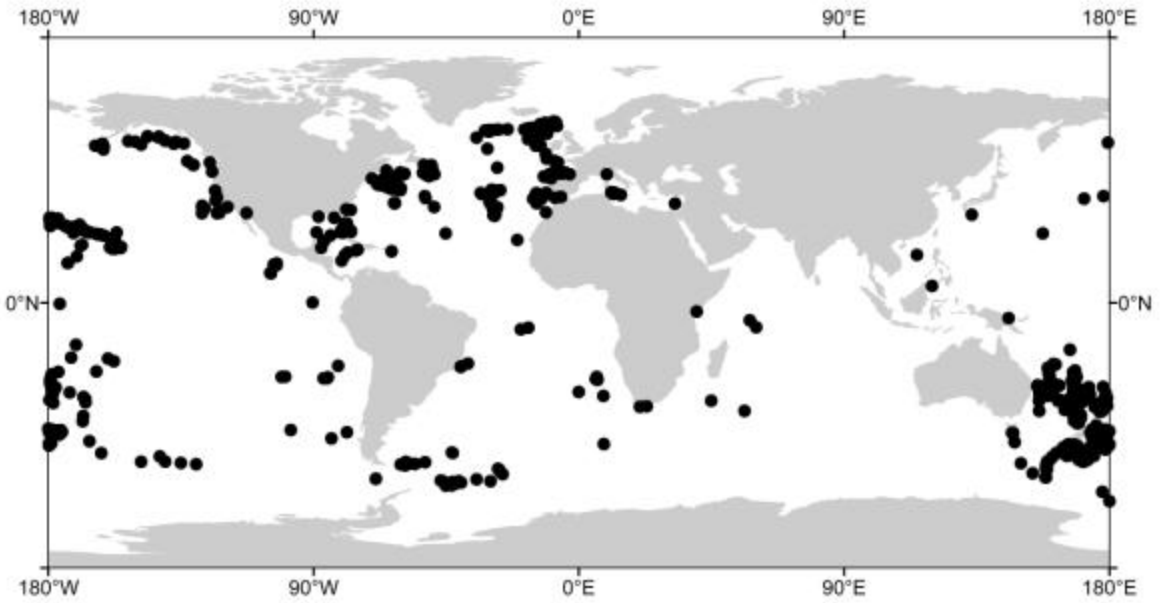
For islands there is lower high-level (e.g. families, orders) taxonomic variation, or more low-level (species) taxonomic variation than expected.

This low taxonomic breadth in the island sites suggests proliferation of taxa in a few genera, whilst other genera from different higher families or orders remain relatively species poor.

Seamounts emerge as impoverished in species richness compared to islands although taxonomic distinctness is within confidence levels predicted for the region.

Great Meteor is the possible exception to this as it has a richness similar to continental slope sites (extremely large seamount)

# Global distribution of corals sampled from seamounts (hotspots)




>270 seamounts & banks; > 3,200 records of corals

Almost no samples from Indian Ocean. Few from central, SE, NW Pacific, S. Atlantic and Southern Ocean

# Relative number of records and diversity of each coral group

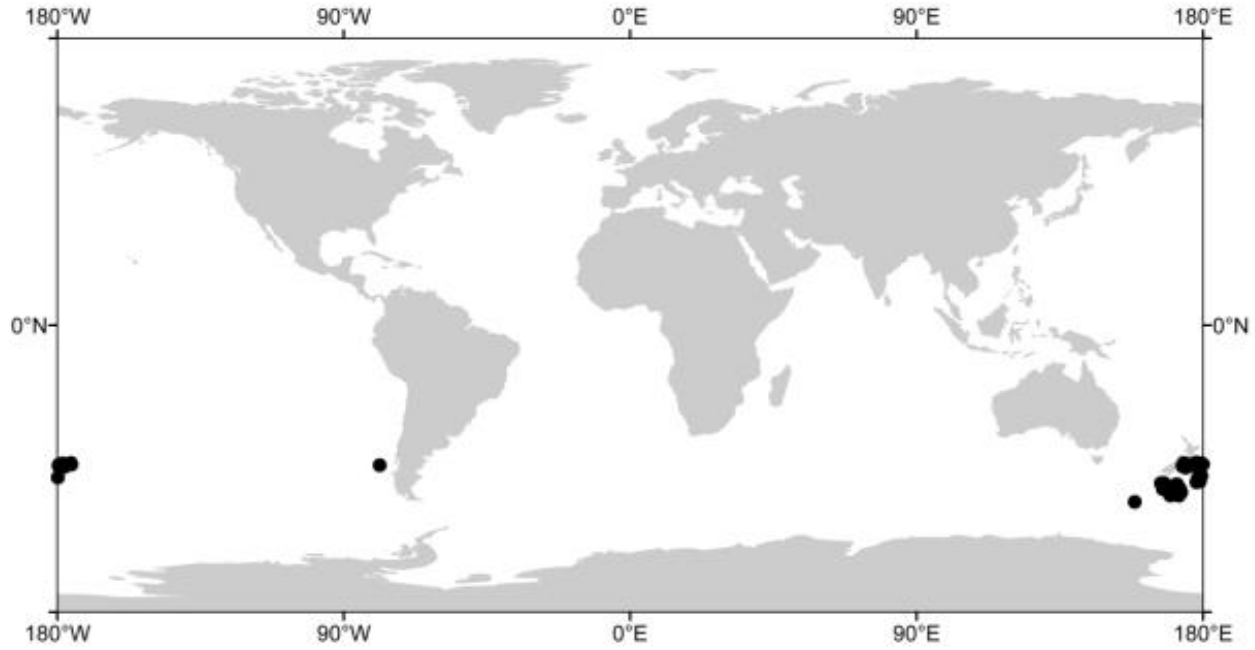
| Taxonomic Category/ Taxon | Total number of records | Number of Species | Number of Genera | Number of Families |
|---|---|---|---|---|
| Scleractinia | 1713 | 249 (165) | 85 (61) | 20 (14) |
| Octocorallia | 957 | 161 (110) | 68 (49) | 21 (17) |
| Antipatharia | 157 | 34 (24) | 22 (17) | 6 (6) |
| Zoanthidea | 28 | 14 (2) | 6 (2) | 3 (2) |
| Stylasteridae | 372 | 68 (53) | 18 (17) | 2 (2) |

# Regionalisation of coral species

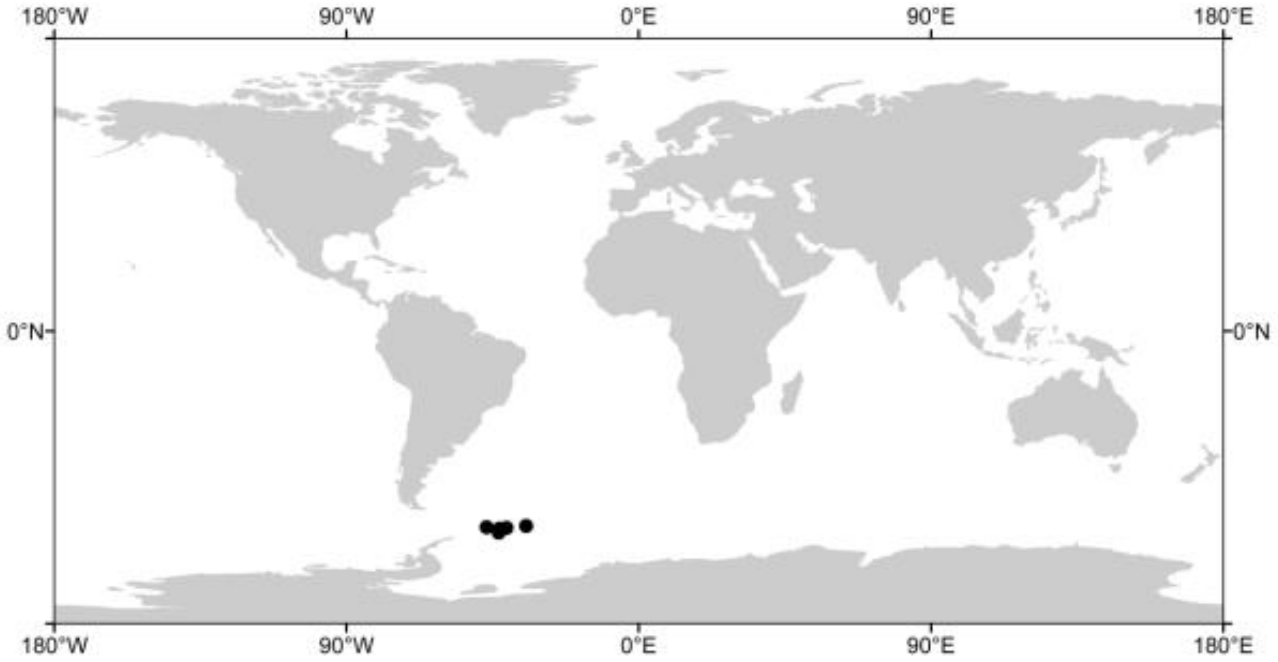
| | | | | | | |
|---|---|---|---|---|---|---|
| Taxon/<br>Geographic scale | Scleractinia | Octocorallia | Antipatharia | Stylasterida | Zoanthidea | Total |
| Species occurring in 1 ocean or inland sea | 218 | 156 | 27 | 64 | 14 | 479 |
| Species occurring in 2 oceans or inland seas | 30 | 5 | 7 | 4 | 0 | 46 |
| Species occurring in 3 oceans or inland seas | 4 | 0 | 0 | 0 | 0 | 4 |
| Species occurring in 1 region in one ocean | 204 | 134 | 26 | 63 | 13 | 440 |
| Species occurring in 2 regions in one ocean | 22 | 22 | 2 | 1 | 1 | 48 |
| Species occurring in 3 regions in one ocean | 5 | 0 | 0 | 0 | 0 | 5 |

Most species appear to be restricted to a single ocean on seamounts and most of these to one region in one ocean – sampling artefact??

Distribution of samples of *Flabellum knoxi* on seamounts globally

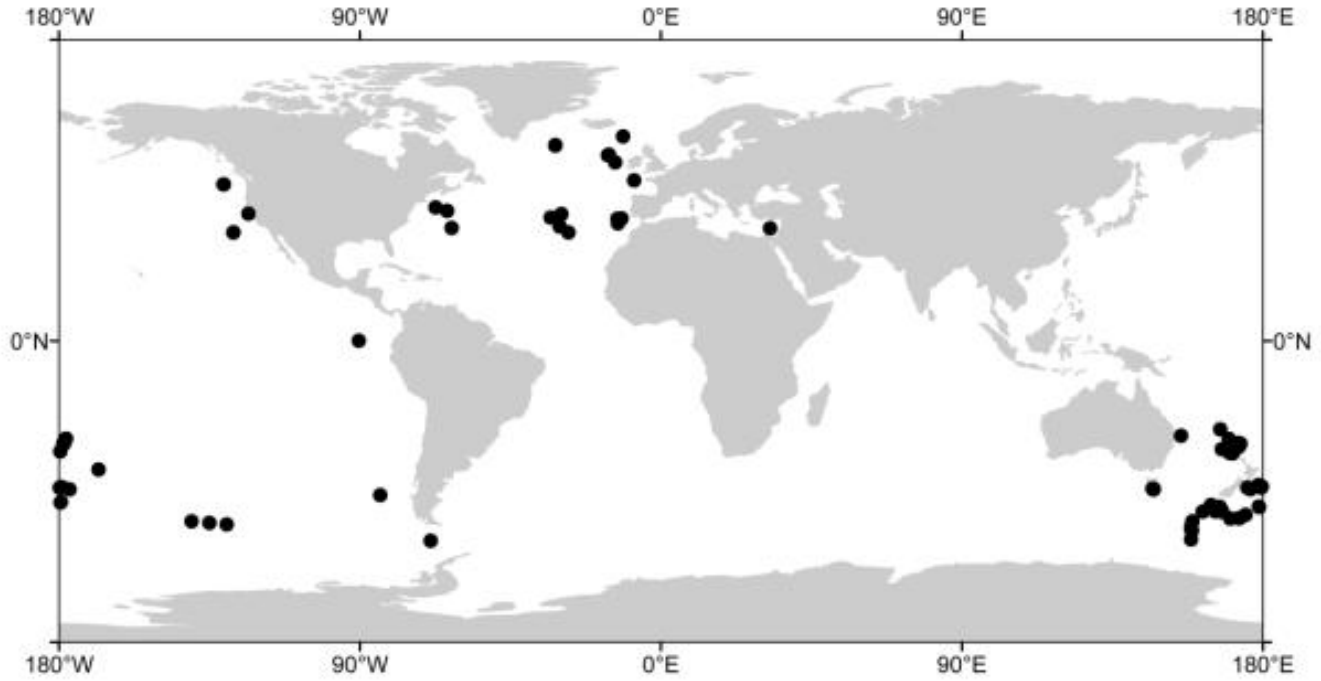


Distribution of samples of *Caryophyllia antarctica* on seamounts globally

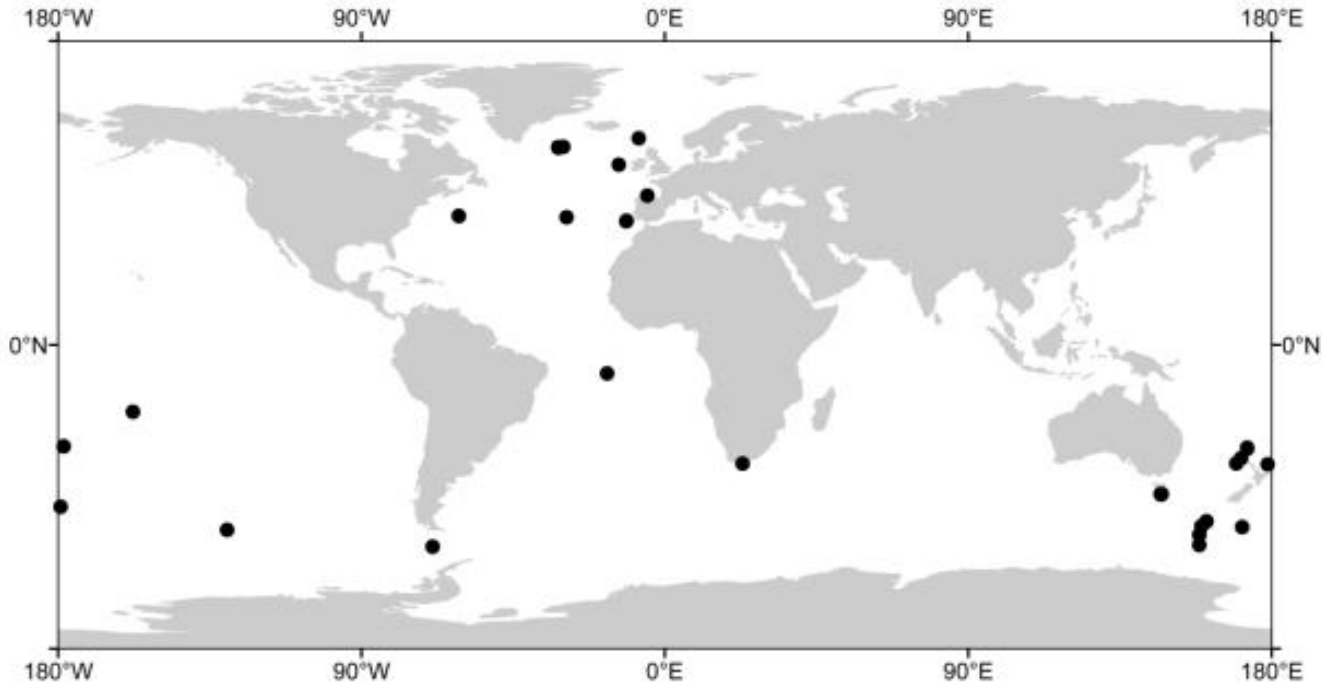


A few species have very wide geographic distributions:

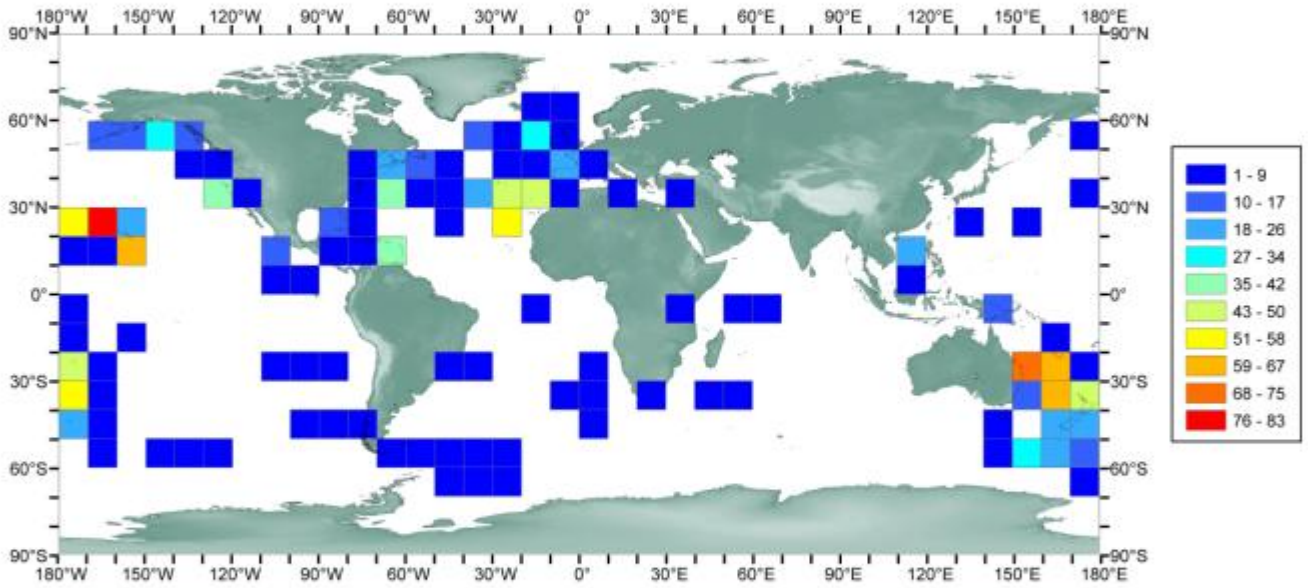
Distribution of samples of *Desmophyllum dianthus* on seamounts globally



Distribution of samples of *Solenosmilia variabilis* on seamounts globally



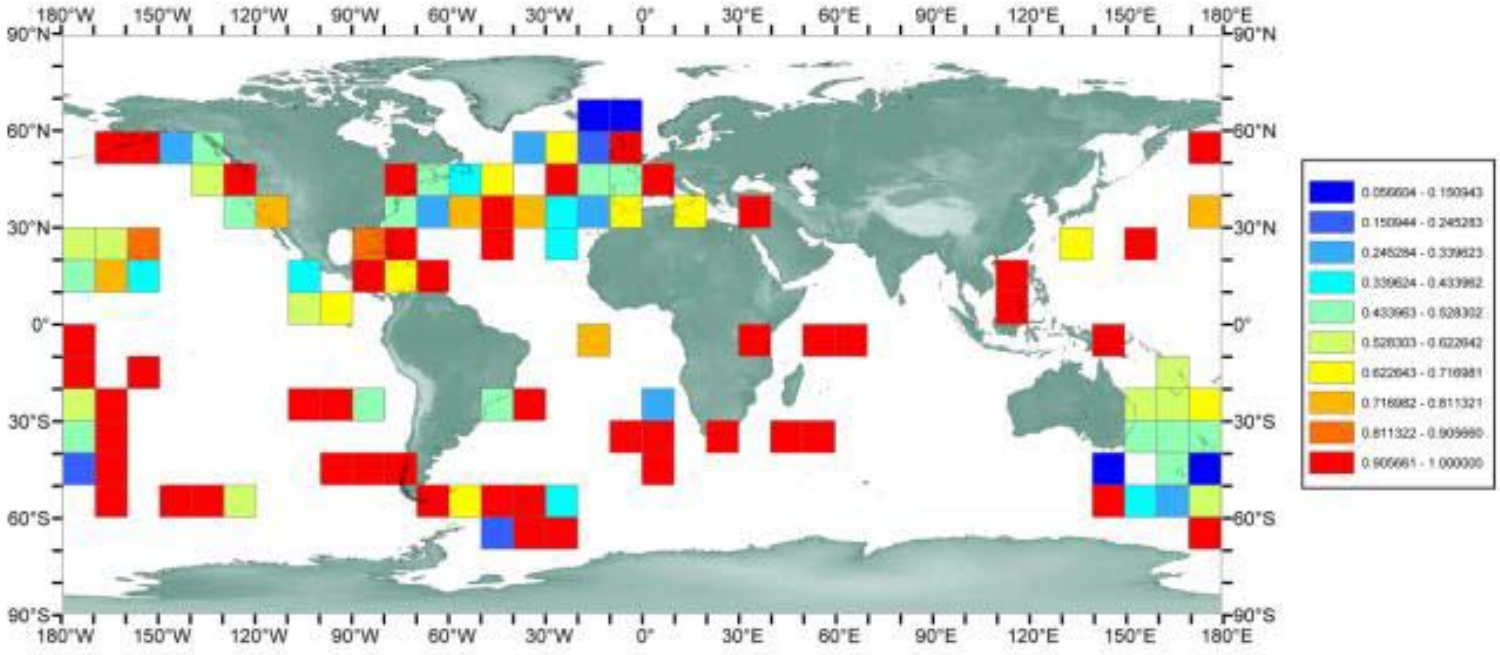
# Species richness of corals in $10^o$ x $10^o$ boxes of latitude & longitude



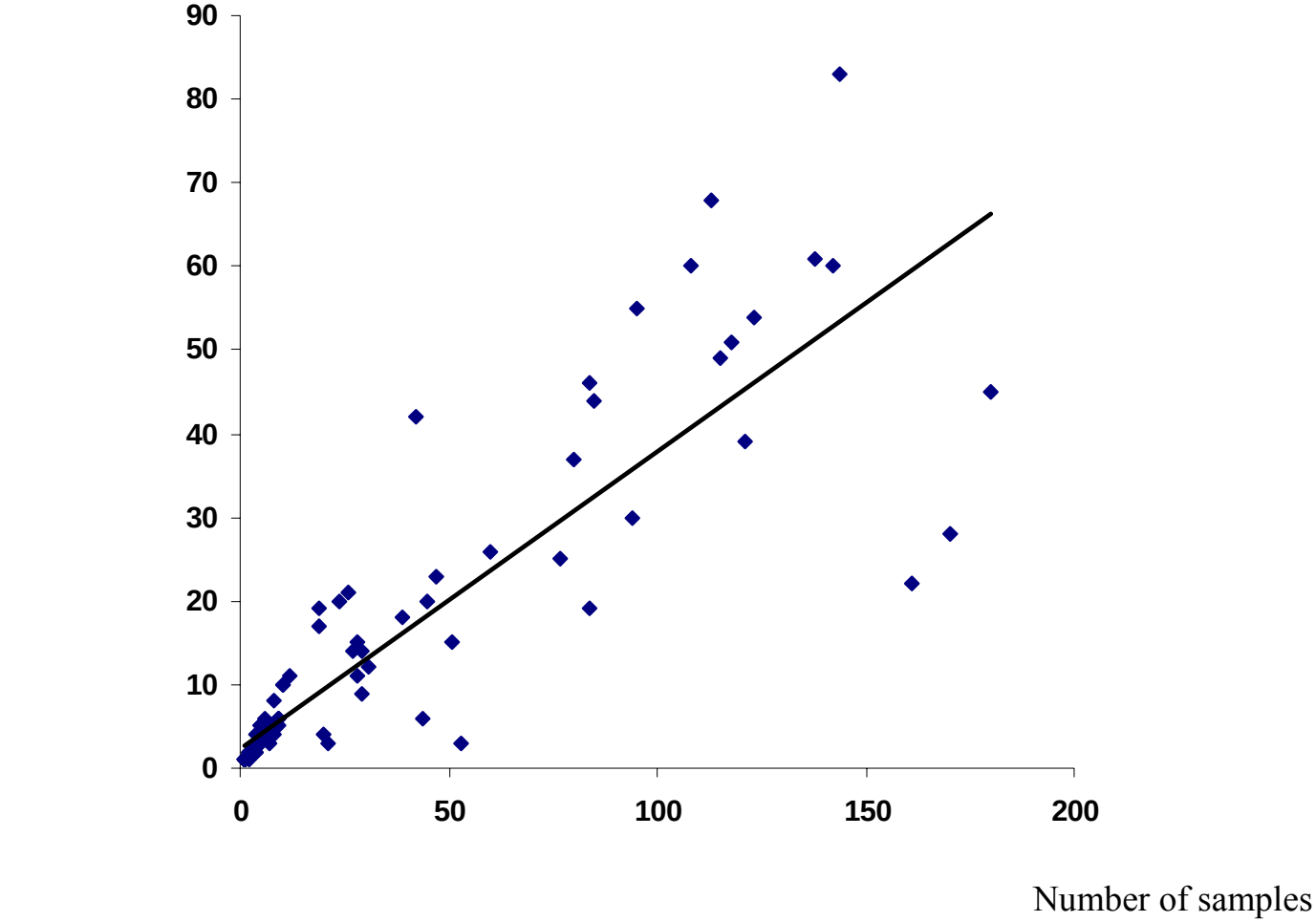

Southwestern Pacific, northeastern Pacific and North Atlantic are rich in coral species found on seamounts

Ratio of number of samples vs number of species of corals observed on seamounts and banks in each $10^{o}$ x $10^{o}$ latitudinal and longitudinal box of a global grid.

Red = high number of species per sample
Blue = low number of species per sample.



Numbers of samples vs numbers of species found on seamounts and banks in each $10^{o}$ x $10^{o}$ box of a global grid. Line of best fit shown.

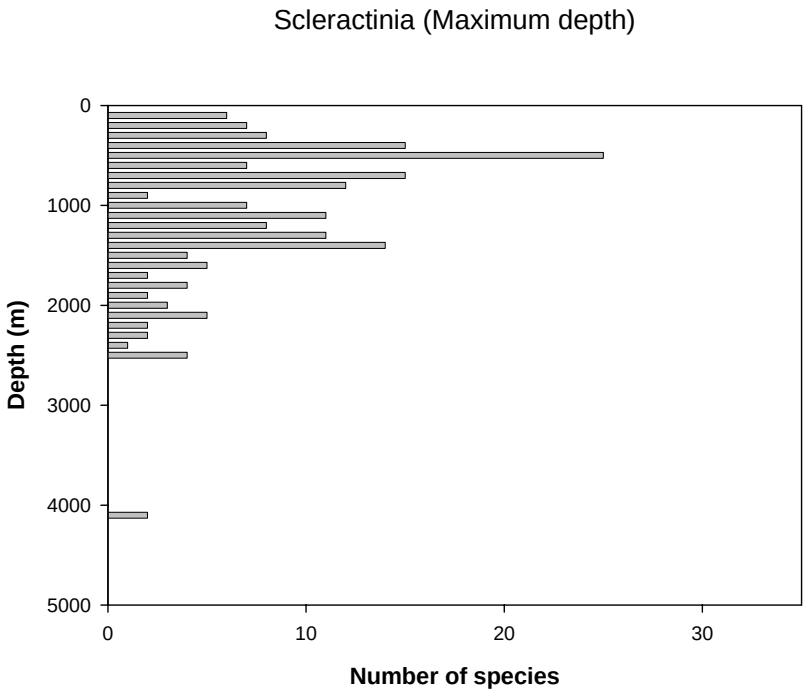


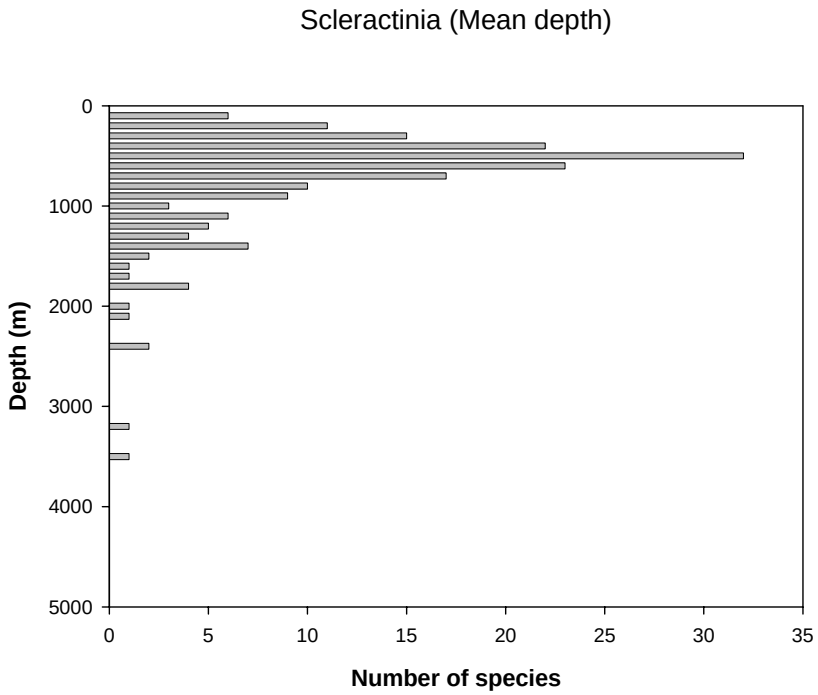
Numbers of species of the different coral groups that occur on (a) Seamounts and (b) Banks in different geographic regions. **NEA** = North East Atlantic; **NWA** = North West Atlantic; **SEA** = South East Atlantic; **SWA** = South West Atlantic; **Med** = Mediterranean; **Car** = Caribbean; **NEP** = North East Pacific; **NWP** = North West Pacific; **SEP** = South East Pacific; **SWP** = South West Pacific; **Cel** = Celebes Sea; **SCS** = South China Sea; **WIO** = western Indian Ocean; **EIO** = eastern Indian Ocean; **SO** = Southern Ocean.

| Group/ Region | Scleractinia | | Octocorallia | | Antipatharia | | Zoanthidea | | Stylasterida | |
|---|---|---|---|---|---|---|---|---|---|---|
| NEA | 48 | 24 | 27 | 3 | 8 | 1 | - | 1 | 7 | 4 |
| NWA | 9 | 9 | 7 | 17 | 2 | - | 1 | 2 | - | - |
| SEA | 10 | - | 1 | - | - | - | - | 4 | - | - |
| SWA | 5 | 5 | 1 | - | - | - | - | - | - | - |
| Med | 2 | 7 | - | - | - | - | - | - | - | - |
| Car | - | 31 | - | 21 | - | 8 | - | 3 | - | 3 |
| NEP | 15 | 29 | 54 | 25 | 13 | 9 | 1 | 1 | 1 | - |
| NWP | 3 | 5 | 3 | 19 | 3 | - | - | 1 | - | 2 |
| SEP | 3 | - | - | - | - | - | - | - | - | - |
| SWP | 108 | 17 | 20 | 1 | - | - | - | - | 46 | 19 |
| SCS | - | 18 | - | - | - | - | - | 1 | - | - |
| Cel | - | - | - | 1 | - | - | - | - | - | - |
| WIO | - | 3 | - | - | - | - | - | 1 | - | - |
| EIO | - | 1 | - | - | - | - | - | - | - | - |
| SO | 8 | - | 4 | - | 1 | - | - | - | 4 | - |

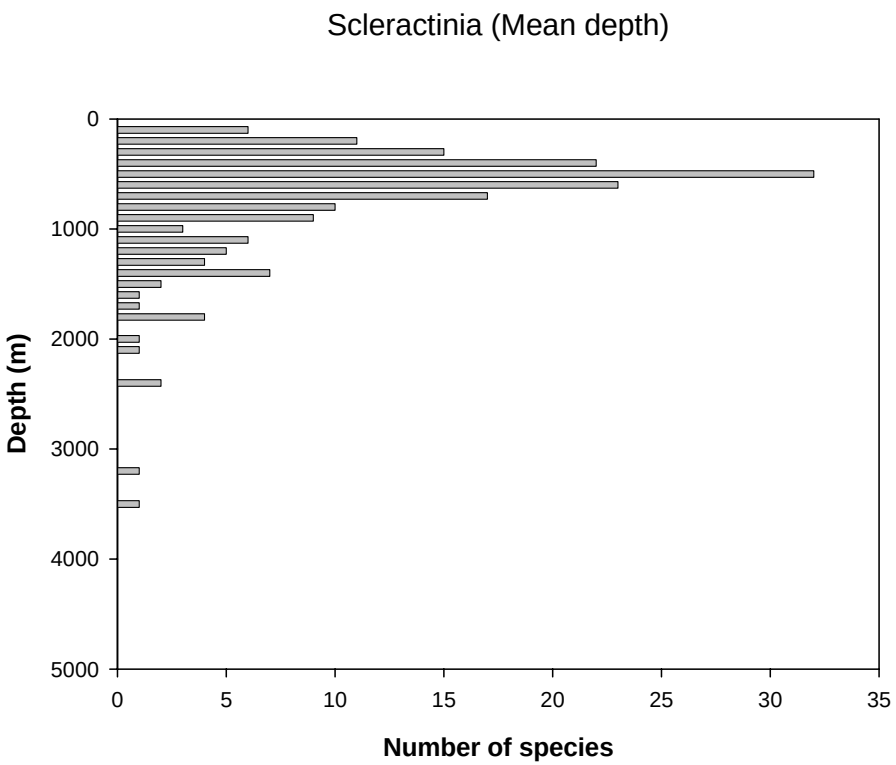
# Distribution of corals with depth

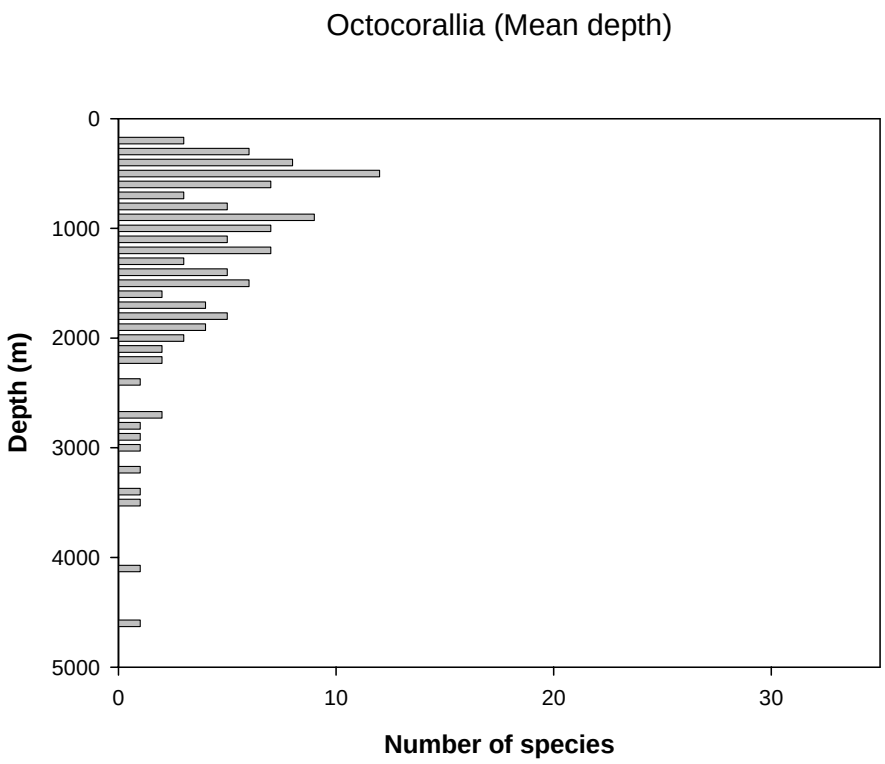
Numbers of species occurring at each depth band for Scleractinia estimated from maximum depth of occurrence and mean depth of occurrence for each species



# Distribution of corals with depth

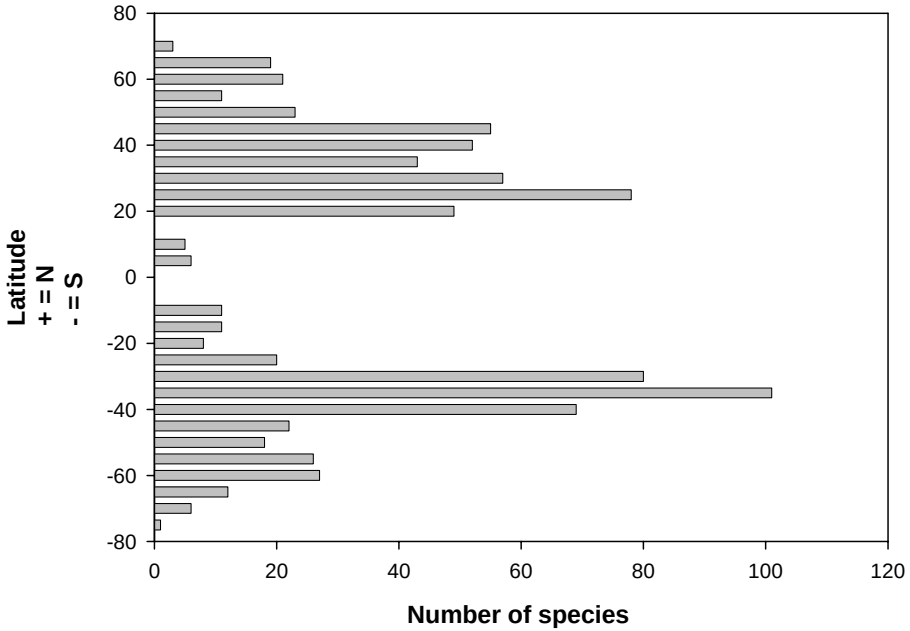


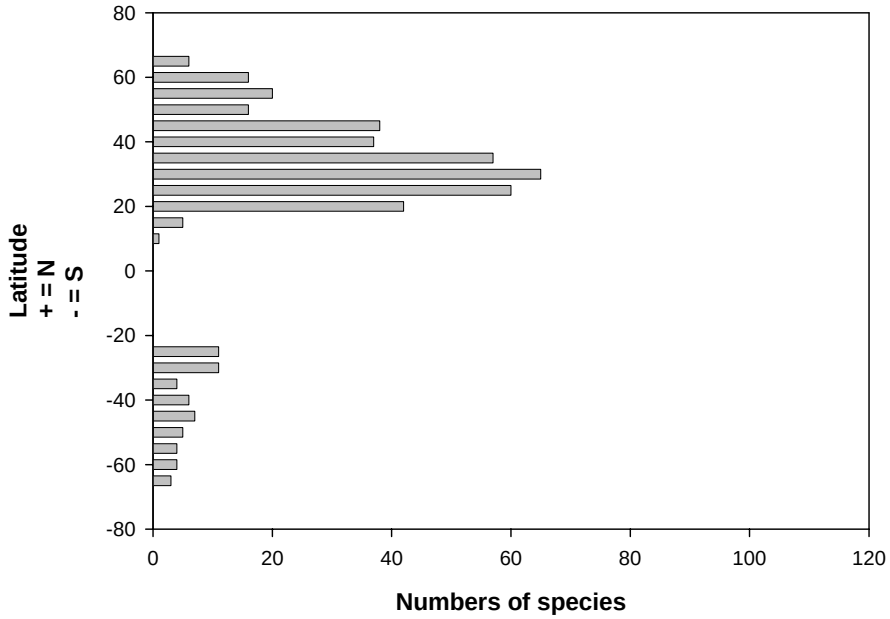

GLM indicated significant differences in depth between the groups
Mean depth was more significant than maximum depth
Most diverse groups are mainly distributed above 2000m depth

# Latitudinal gradients in coral species diversity?

A. Numbers of species
of Scleractinia at different latitudes

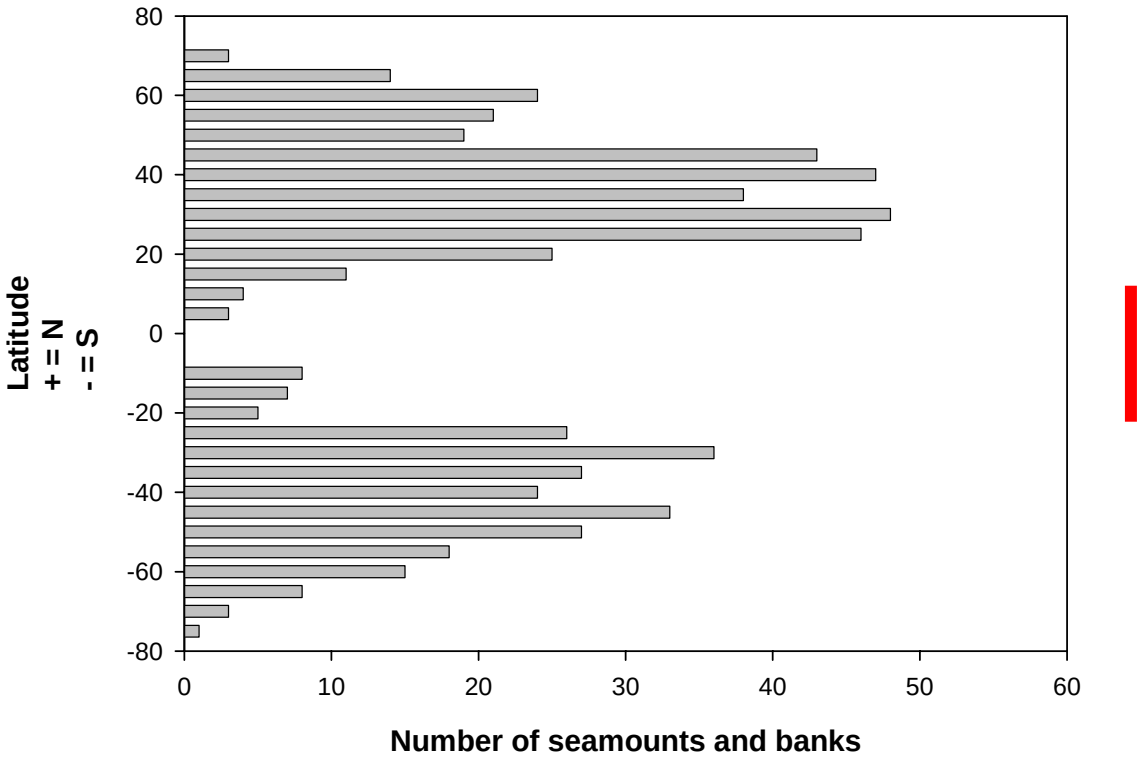



B. Numbers of species
of Octocorallia at different latitudes




Apparently coral are most diverse at mid-latitudes, but…….

# Equatorial sampling gap



# Conclusions

- The coral communities on continental slopes, the slopes of oceanic islands and seamounts appear different in the NE Atlantic
- The biodiversity of seamounts is unsampled for large areas of the ocean and there is an equatorial sampling gap for seamounts
- Sampling effort has a large influence on the dataset
- Most coral species are found on seamounts in a single region or ocean
- Most coral abundance and diversity occurs above 2000m depth
- Vertical distribution of the different coral groups is different and may reflect trophic ecology
- There are also differences in the relative diversity of different coral groups in different parts of the world's oceans, possibly reflecting differential dispersal ability, different patterns of productivity or differences in the carbonate compensation depth

# Acknowledgements

Malcolm, Telmo Morato, Paul Hart, Tony Pitcher for getting the book together & organising the Azores meeting

Huw Griffiths for all of the GIS work

Amy Baco, Jason Hall-Spencer in contributing to the database

Steve Cairns for making the Smithsonian records accessible

UNEP / CENSEAM for taking this work further in predictive modelling (over to Derek……)

# References

Rogers, Baco, Griffiths & Hall Spencer in submission – Seamounts: Ecology, Fisheries & Conservation - Blackwells)