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BIOGEOGRAPHIC ATLAS OF THE SOUTHERN OCEAN

New Insights into Antarctic and sub-Antarctic sponge diversity and distribution

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Introduction

Sponges play a key role in Antarctic marine benthic community structure, forming heterogeneous habitats supporting rich benthic communities. Compiling, reviewing and analysing new sponge data enables us to better understand regional benthic biodiversity patterns in this region. Two new complementary syntheses of Southern Ocean sponge research have been produced to provide an up-to-date benchmark of biogeographic knowledge at the end of the successful CAML (Census of Antarctic Marine Life) program. The first publication provides an updated biogeographic review of Southern Hemisphere high-latitude sponges, assessing over 10,000 distribution records (Downey et al. 2012). The second publication reviews and summarises the key advances in Southern Ocean sponge research, highlighting new knowledge gained in the areas of taxonomy, ecology, habitat importance, and biogeography in the last 40 years (Janussen & Downey, 2014).

Methods

All sponge occurrence records from the Southern Ocean and adjacent regions were compiled into a Microsoft Access database and mapped utilising ArcGIS software. The taxonomic status of sponges were verified using the World Porifera Database. Endemism rates were estimated as the number of species only found in the Southern Ocean. Species richness and sampling intensity were analysed using rarefaction curves from well-sampled 3° latitude by 3° longitude cells in PRIMER. Geographic ranges were calculated for species by subtracting minimum and maximum latitudinal values; and longitudinal ranges were calculated based on the minimum continuous arc of all distribution points for each species. Depth ranges were calculated by subtracting maximum and minimum depth values. Biogeographic relationships among species were analysed using Bray-Curtis dissimilarity index on grid cells of presence/absence demosponge species data in PRIMER.

Key Results

In the last 40 years, increased scientific expeditions have more than doubled the number of Southern Ocean sponge records (Fig. 3). Despite recent initiatives, sampling intensity is still low, with greater levels of sampling found on shelf regions around the Antarctic Peninsula, E. Weddell Sea, and South Georgia; whereas abyssal, oceanic sectors are poorly sampled (Fig. 1). Currently, 400 sponge species are known from the Southern Ocean (Table 1). Overall, moderate levels of endemism are found in sponges (44%). Considerably higher levels are found within the Hexactinellida (69%) and Calcarea (53%) classes. In contrast to previous studies, eurybathic and circumpolar distributions are not dominant characteristics in Southern Ocean sponges (Figs. 2 & 4). A single, distinct Southern Ocean marine biogeographic region is found to encompass all areas within the Polar Front and parts of the sub-Antarctic (Fig. 5). Faunal analyses indicate strong links with S. America, and weaker links found with other Southern Hemisphere regions.

	Antarctic Families	Antarctic Genera	Antarctic species
Porifera	70	139 (10)	400 (175)
Demospongiae	47	97 (4)	293 (112)
Hexactinellida	7	21 (4)	53 (36)
Calcarea	14	19 (2)	51 (27)
Homoscleromorpha	2	2 (0)	3 (0)

Table 1: Numbers of Antarctic families, genera, and species within the Porifera phylum, and within each sponge class. Numbers in brackets indicate Antarctic endemic genera or species.

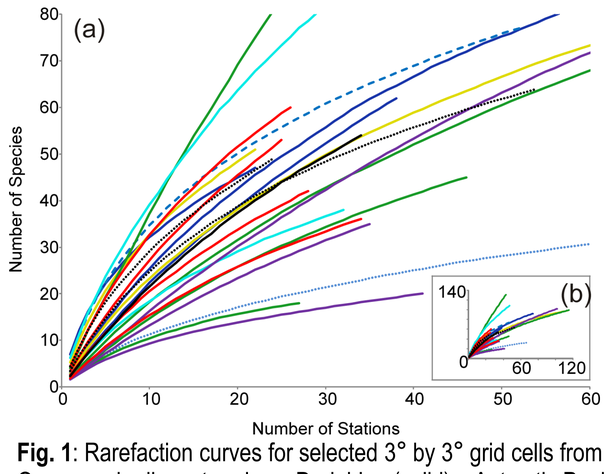

Fig. 1: Rarefaction curves for selected 3° by 3° grid cells from the Southern Ocean and adjacent regions. Dark blue (solid) = Antarctic Peninsula; Blue (dashed) = E. Weddell Sea; Blue (dotted) = E. Antarctic; Turquoise (solid) = Ross Sea; Black (solid) = S. Shetland Islands; Black (dotted) = S. Georgia; Yellow (solid) = Kerguelen Islands; Red (solid) = S. America and Falkland Islands; Green (solid) = NZ (North Island); and Purple (solid) = S. Africa.

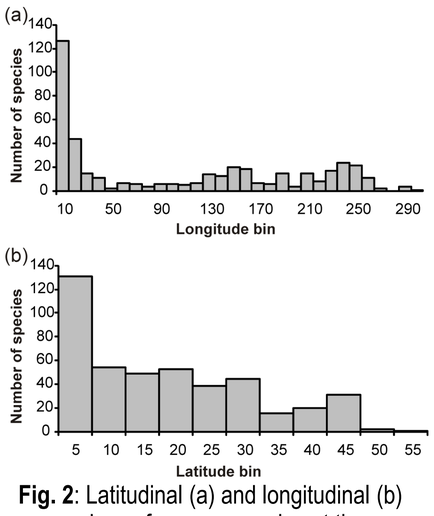

Fig. 2: Latitudinal (a) and longitudinal (b) range sizes of sponge species at three or more locations in the Southern Ocean and adjacent regions

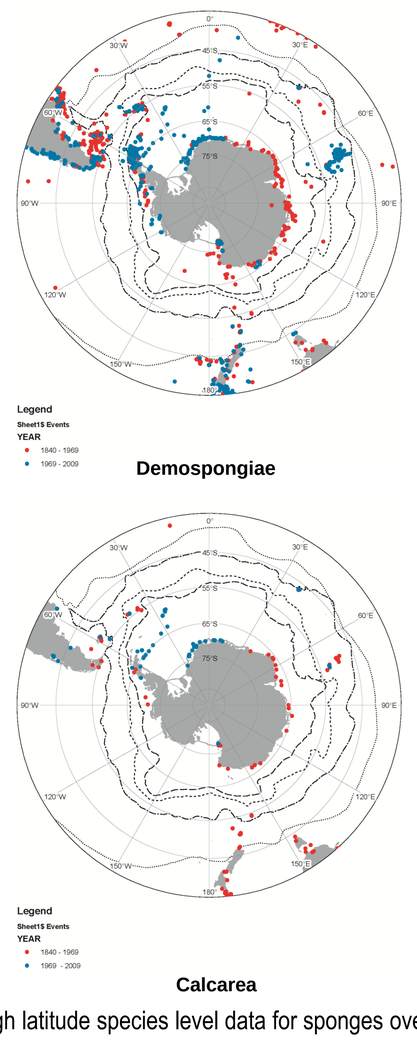

Fig. 3: High latitude species level data for sponges over time. Data separated into each of the four orders in the Porifera phylum.

Future Outlooks

Increased sampling and taxonomic work is required in all oceanic, bathyal and abyssal regions, and in several sectors of the sub-Antarctic. Further biogeographic studies of hexactinellid and calcareous sponges of the Southern Ocean. Research focused on sponge faunal connectivity between the sub-Antarctic, Antarctic, and cold temperate Southern Hemisphere regions. Regional studies of sectors and islands of the Southern Ocean to better determine unique drivers of species diversity and distribution. Future studies focused on the impacts of environmental change on sponge communities. Greater collaborations between geneticists and taxonomists to improve taxonomy and evolutionary history of sponges.

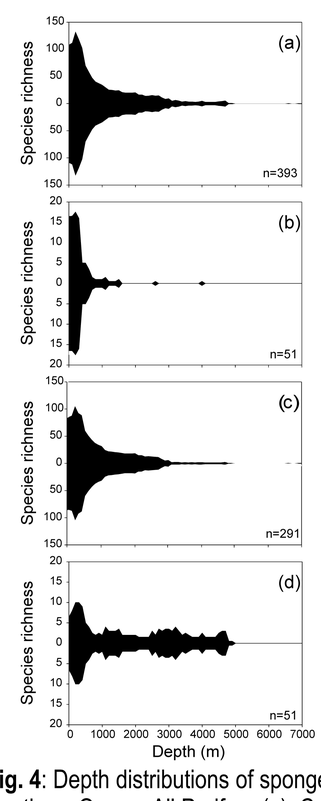

Fig. 4: Depth distributions of sponges in the Southern Ocean. All Porifera (a), Calcarea (b), Demospongiae (c), and Hexactinellida (d).

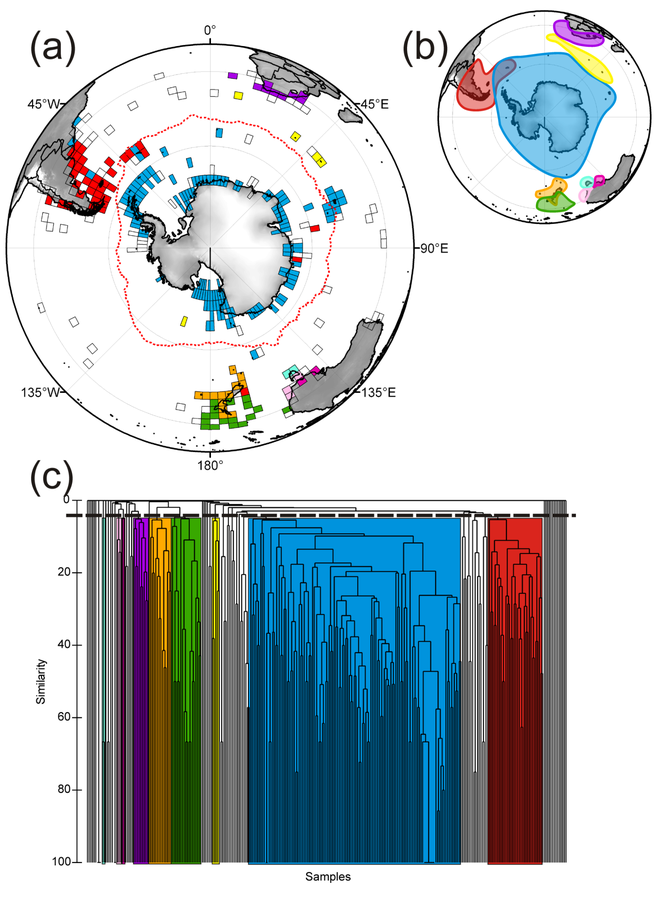

Fig. 5: Large scale biogeographic relationships in demosponge species assemblage (3° by 3° grid cells) from the Southern Ocean and adjacent regions. Each grid cell contains 3 or more species of demosponge. (a) Geographic representation of the relationships shown in c. (b) A simplified representation of the biogeographic relationships found in a. (c) Cluster analysis of the percentage faunal similarity between grid cells. Colours represent geographic regions: Antarctica (blue), S. America (red), S. Africa (purple), sub-Antarctic (yellow), NZ temperate (orange), NZ tropical (green), S. Australia (magenta), Tasmania (light blue), & SE Australia (pink).

References

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Downey R. V., Griffiths H. J., Linse K. , Janussen, D. 2012. Diversity and distribution patterns in high southern latitude sponges.- PLoS One, 7 (7), 1-16

Acknowledgements

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