Seamount Sponges: Diversity, Extent, Reliability, and Patterns of Distribution and Endemism

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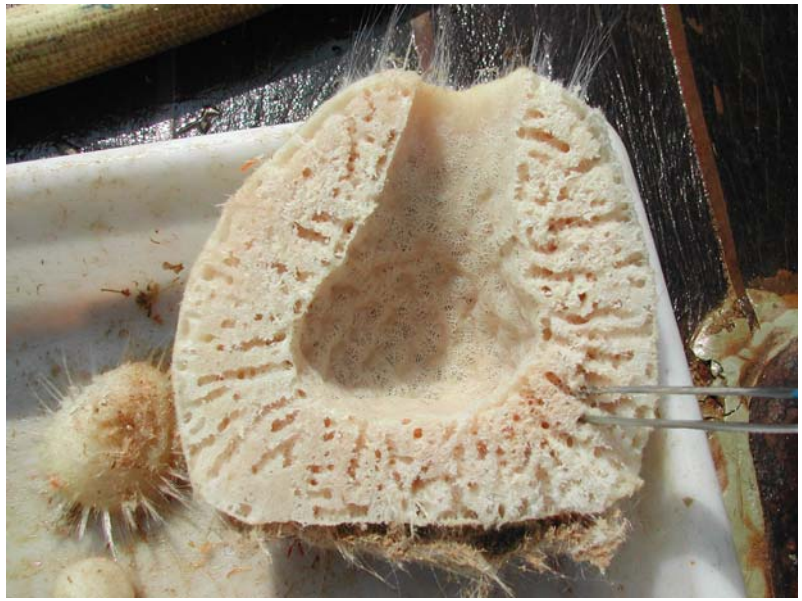

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Why sponges ?

1. locally high **BIOMASS** (~90% of the benthos): "*sponge beds*", "*sponge reefs*"
2. can be abundant on **SEAMOUNTS**
3. structure-forming megabenthos: provide essential **HABITAT** for other invertebrates and fish
4. **'ECOSYSTEM ENGINEERS'** (spicule mats, baffling of currents, trapping of sediments, etc.)

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Why sponges ?

1. **7000+ marine SPECIES described (many more waiting description)**
2. **MICROHABITAT ISLANDS in the deep-sea**
3. **LOW DISPERSAL capability: potentially high rates of endemism and slow recovery following damage**
4. **Susceptible to damage by BOTTOM TRAWLING……**

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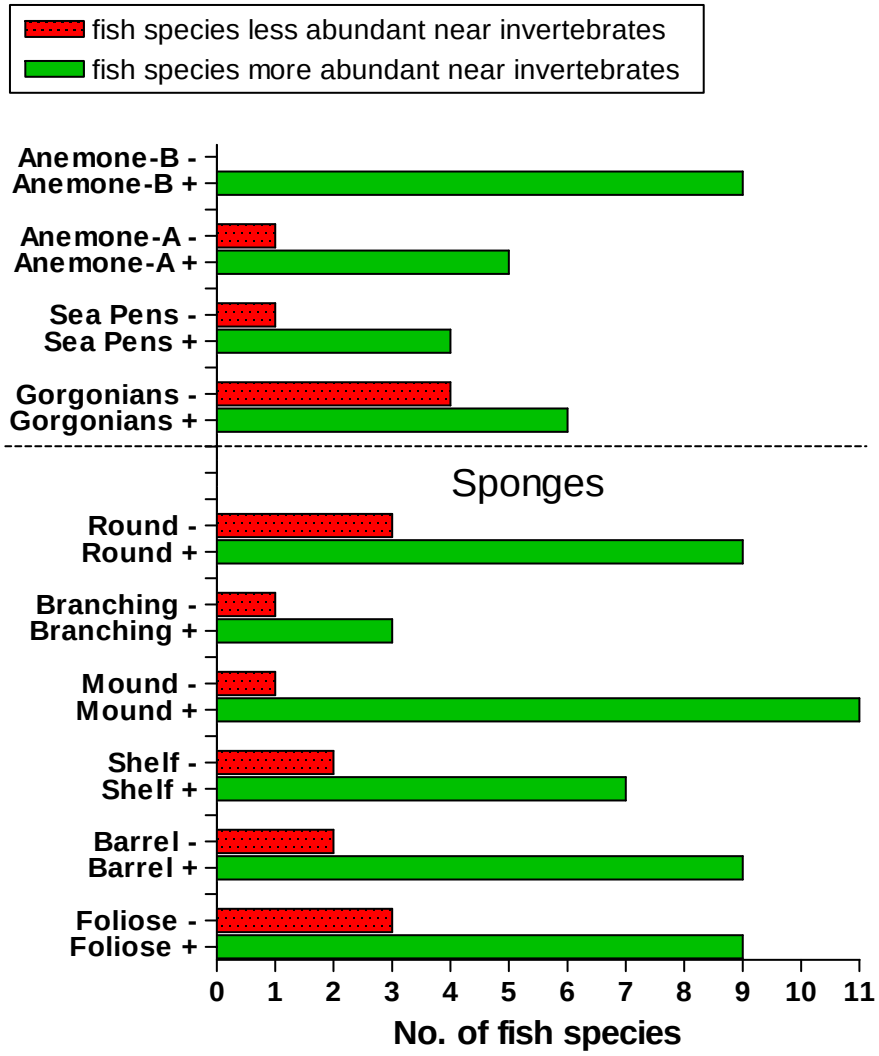

graphed from data tabulated in: *Pirtle JL (2005) Habitat-based assessment of structure-forming megafaunal invertebrates and fishes on Cordelia Bank, California. M.Sc. thesis, Washington State University*

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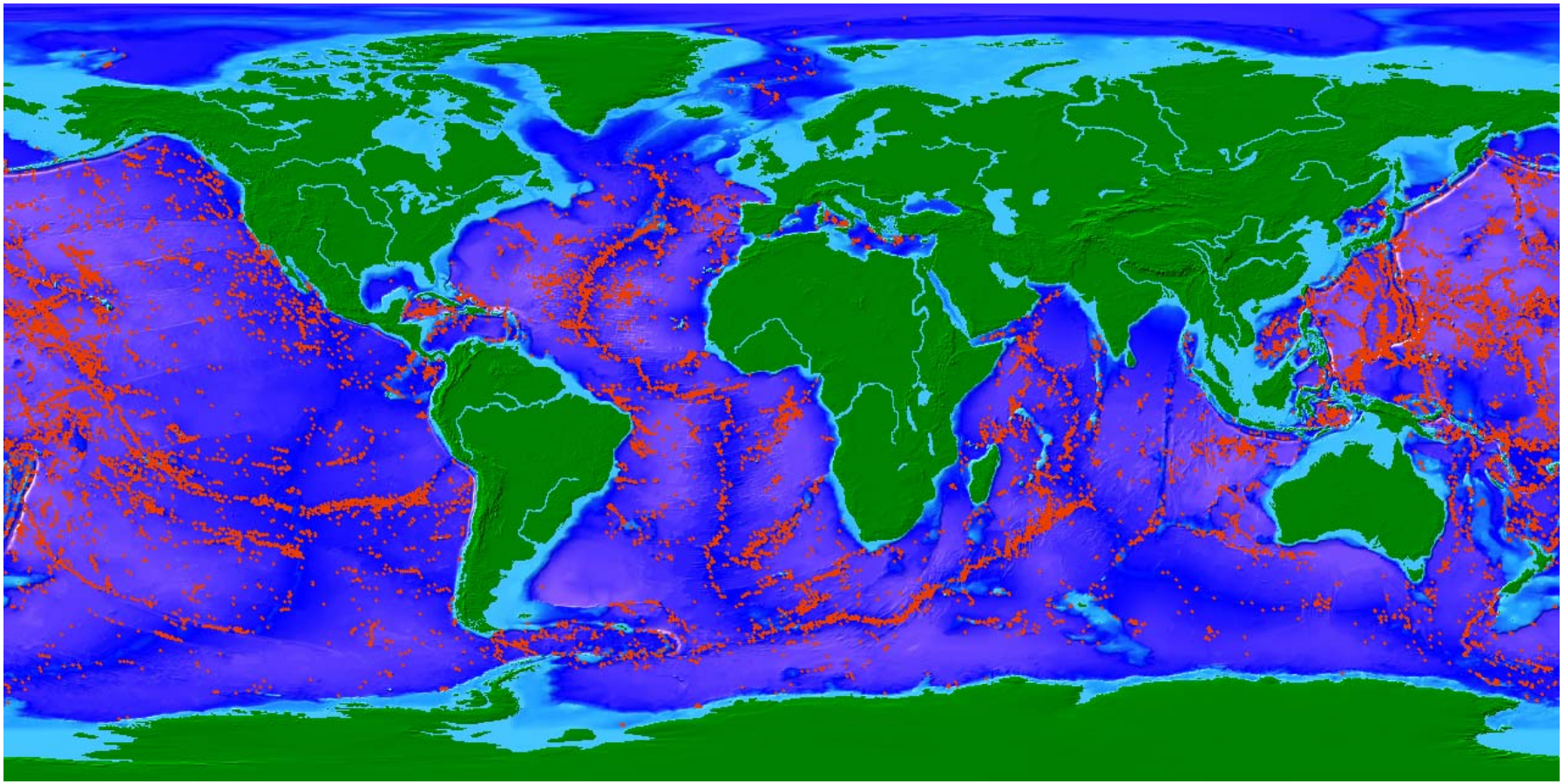
A: Seamounts (> 1km high) global



Raw Data Source: Adrian Kitchingman (pers. comm.)

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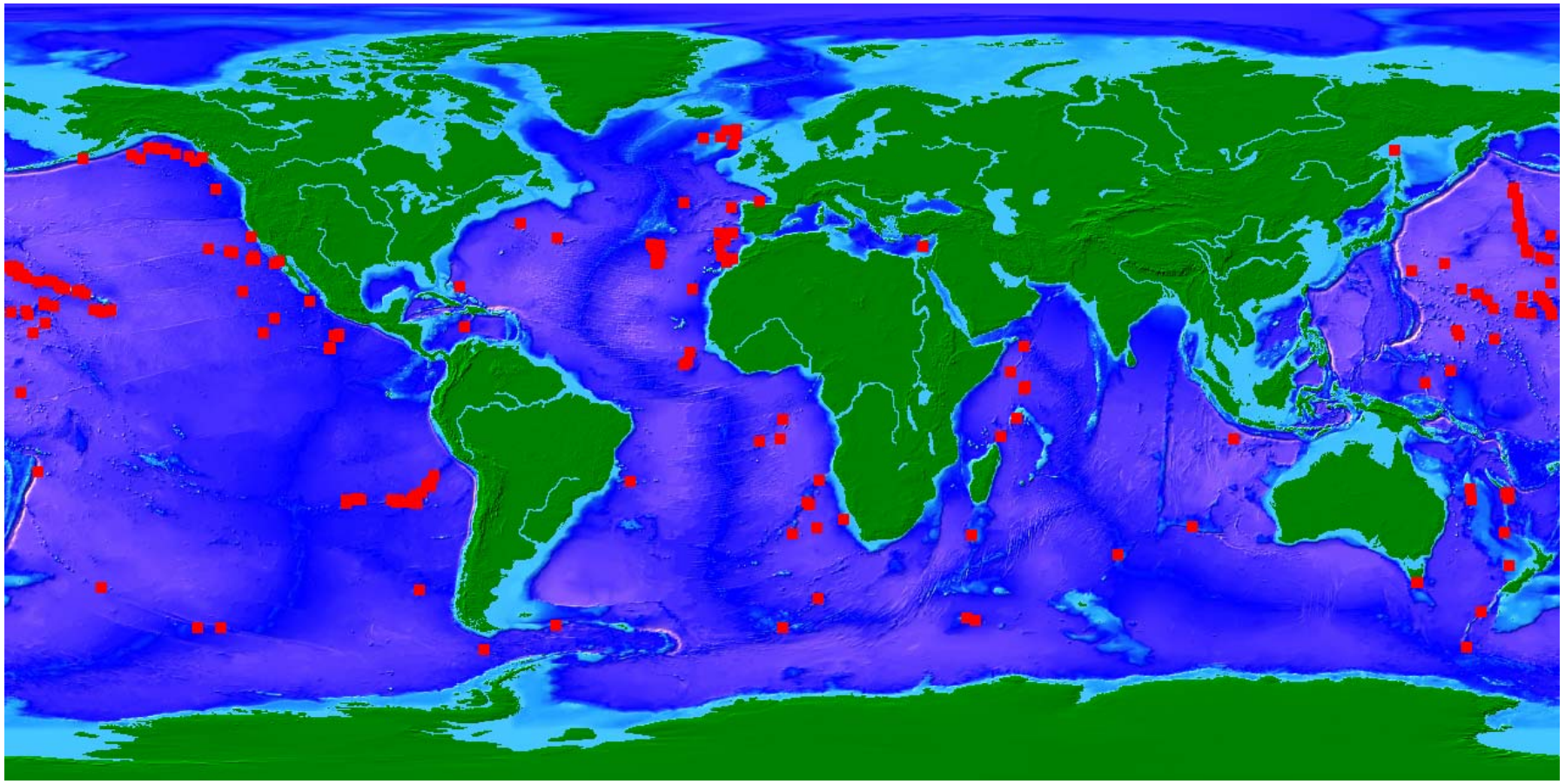
B: Seamounts sampled



Raw Data Source: Karen Stocks & Paul Brewin at SeamountsOnline (http://seamounts.sdsc.edu/)

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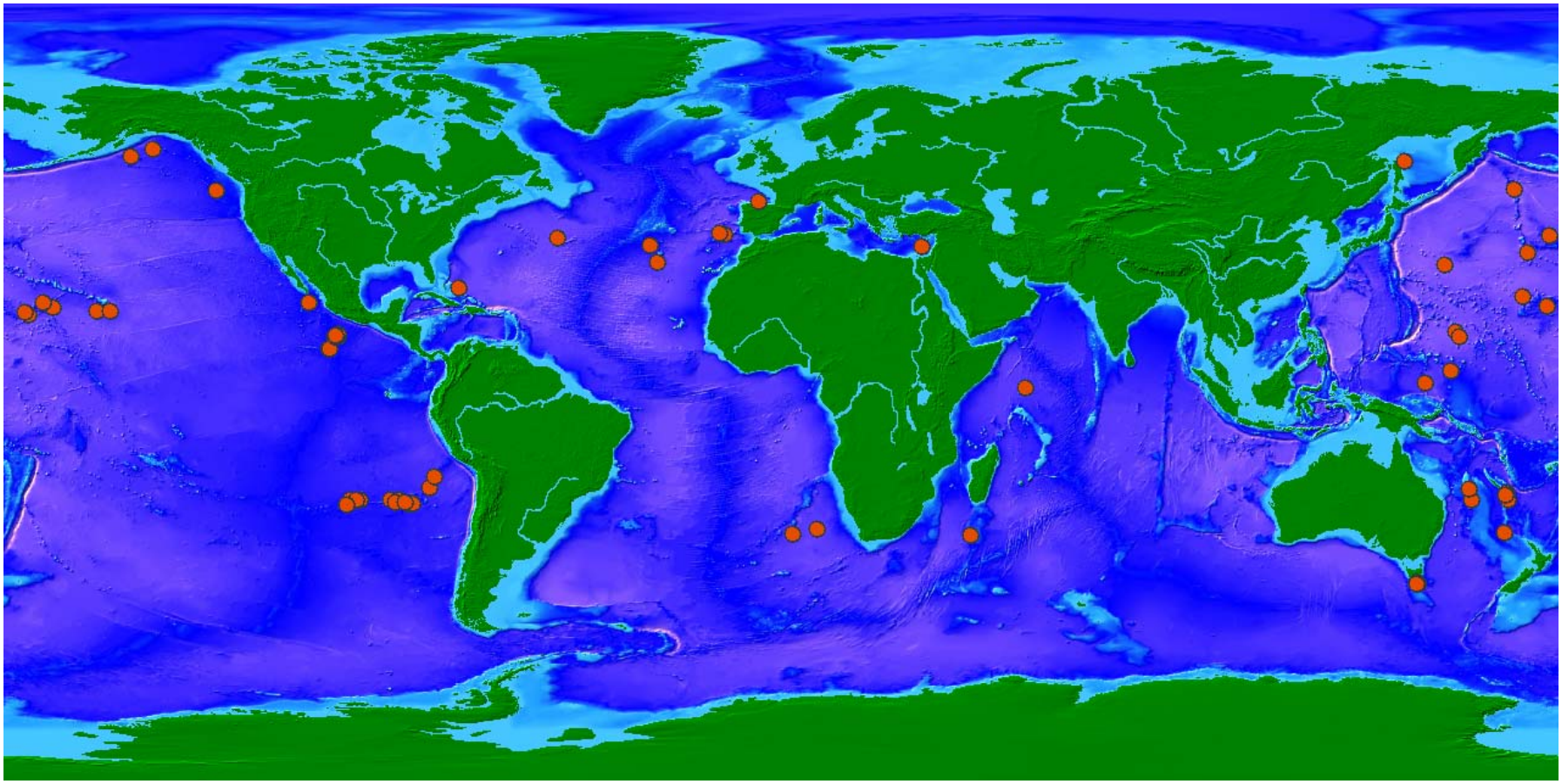
C: Seamounts with Sponge records



Raw Data Source: Karen Stocks & Paul Brewin at SeamountsOnline (http://seamounts.sdsc.edu/)

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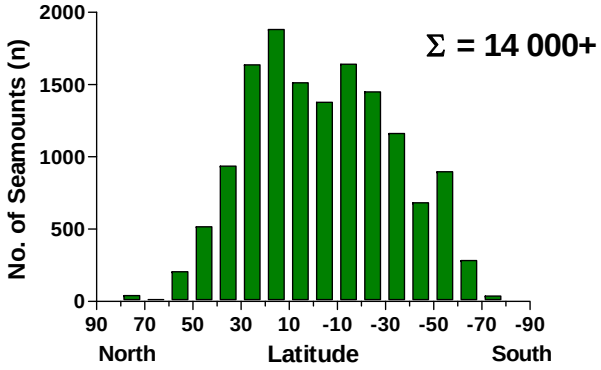
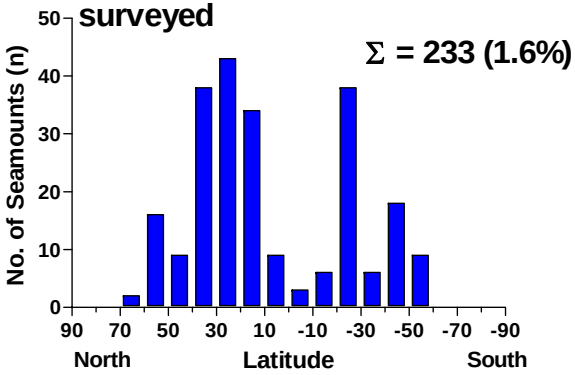
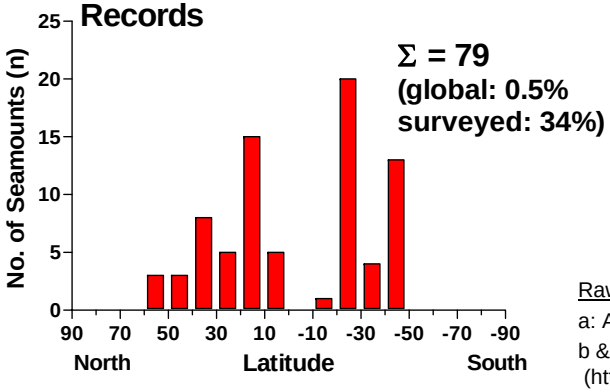
a) Global Seamounts > 1 km Height



b) Seamounts biologically surveyed



c) Seamounts with Sponge Records



"Tropical doldrums in seamount research"

- **Tropical seamounts are severely under-sampled**
- **Deep tropical sponge fauna associated with seamounts essentially undocumented**

Raw Data Sources:

a: Adrian Kitchingman (pers. comm.)

b & c: Karen Stocks & Paul Brewin at SeamountsOnline (http://seamounts.sdsc.edu/)

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Taxonomic resolution -1

Available records [(1)]:

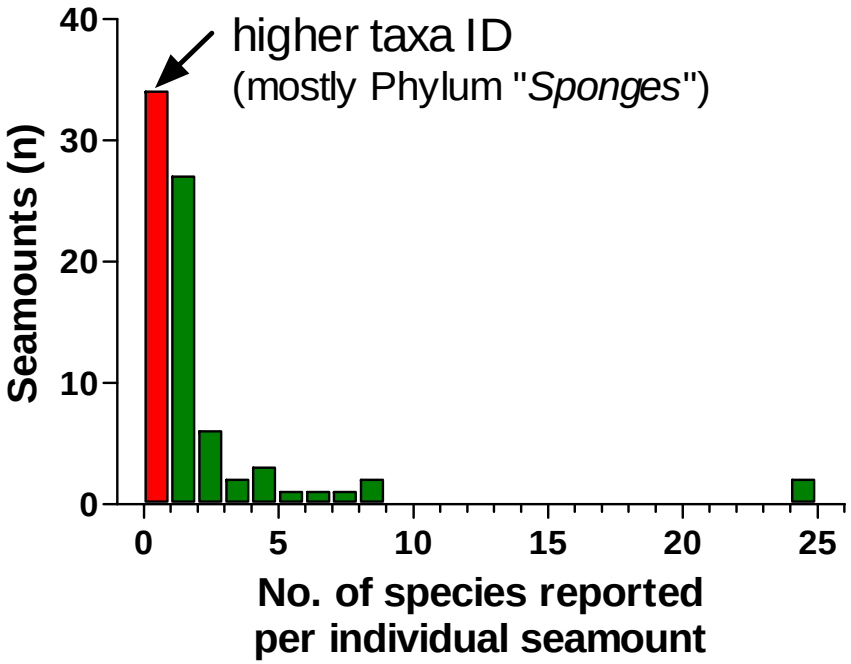
- **318 Sponge records**

- **66 Phylum level (21%)**
- **5 Class level (2%)**
- **31 Genus level (10%)**
- **216 Species level (68%**

- **139 species of seamount-associated sponges in database**

[(1)] SeamountsOnline (http://seamounts.sdsc.edu/)

Taxonomic resolution - 2



Species records for individual seamounts [(1)]:

79 seamounts with sponge records, of which

-45 (56%) with species-level ID

- 34 (44%) report on occurrence of higher taxa only, mostly "Porifera"

Thus, patterns of species richness, diversity, distributions etc. not extractable for many seamounts

[(1)] SeamountsOnline (http://seamounts.sdsc.edu/)

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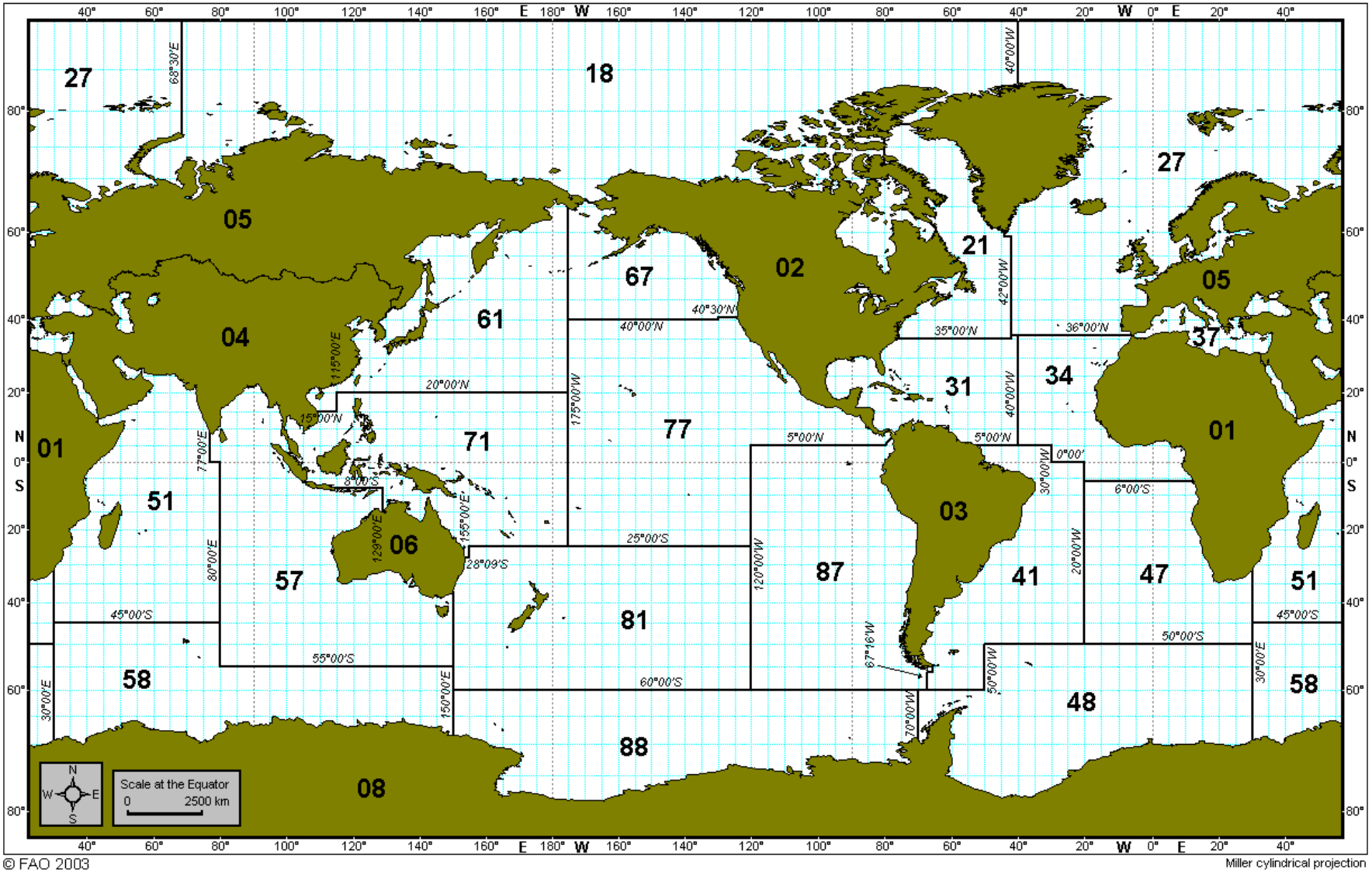

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Ocean	FAO area (1)	Potential large seamounts (2)	Surveyed Mounts (3)	Mounts with Sponge Records (3)	Sponge Species per Mount (3)
Pacific	All	**8955**	**161 (1.8%)**	**53 (0.6%)**	**1 - 24**
Eastern Central	77	2735	45 (1.6%)	14 (0.5%)	1 - 8
North-East	67	265	12 (4.5%)	3 (1.1%)	1 - 1
North-West	61	1350	43 (3.2%)	7 (0.5%)	1 - 2
South-East	87	939	27 (2.9%)	14 (1.5%)	1 - 4
South-West	81	996	16 (1.6%)	8 (0.8%)	1 - 24
Western Central	71	2670	18 (0.7%)	7 (0.3%)	1 - 5
Atlantic	All	**2704**	**44 (1.6%)**	**10 (0.4%)**	**1 - 24**
Eastern Central	34	536	15 (2.8%)	2 (0.4%)	3 - 6
North-East	27	325	13 (4.0%)	4 (1.2%)	1 - 1
North-West	21	83	2 (2.4%)	1 (1.2%)	2 - 2
South-East	47	639	10 (1.6%)	2 (0.3%)	1 - 24
South-West	41	452	2 (0.4%)	0 (0.0%)	- - -
Western Central	31	669	2 (0.3%)	1 (0.1%)	$ - $
Indian	All	**1658**	**24 (1.4%)**	**15 (0.9%)**	**1 - 1**
Eastern	57	588	16 (2.7%)	13 (2.2%)	$ - $
Western	51	1070	8 (0.7%)	2 (0.2%)	1 - 1
Mediterranean & Black Sea	37	**59**	**1 (1.7%)**	**1 (1.7%)**	**1 - 1**
Southern Ocean	All	**898**	**3 (0.3%)**	**0 (0.0%)**	- - -
Atlantic, Antarctic	48	498	1 (0.2%)	0 (0.0%)	- - -
Indian Ocean, Antarctic	58	212	2 (0.9%)	0 (0.0%)	- - -
Pacific, Antarctic	88	188	0 (0.0%)	0 (0.0%)	- - -
Arctic	18	**13**	0 **(0.0%)**	0 **(0.0%)**	- - -
GLOBAL		**14287**	**233 (1.6%)**	**79 (0.6%)**	**1 - 24**

$: insufficient taxonomic resolution (usually Phylum level only)

(1) www.fao.org, (2) Adrian Kitchingman (pers. comm.), (3) SeamountsOnline: http://seamounts.sdsc.edu/

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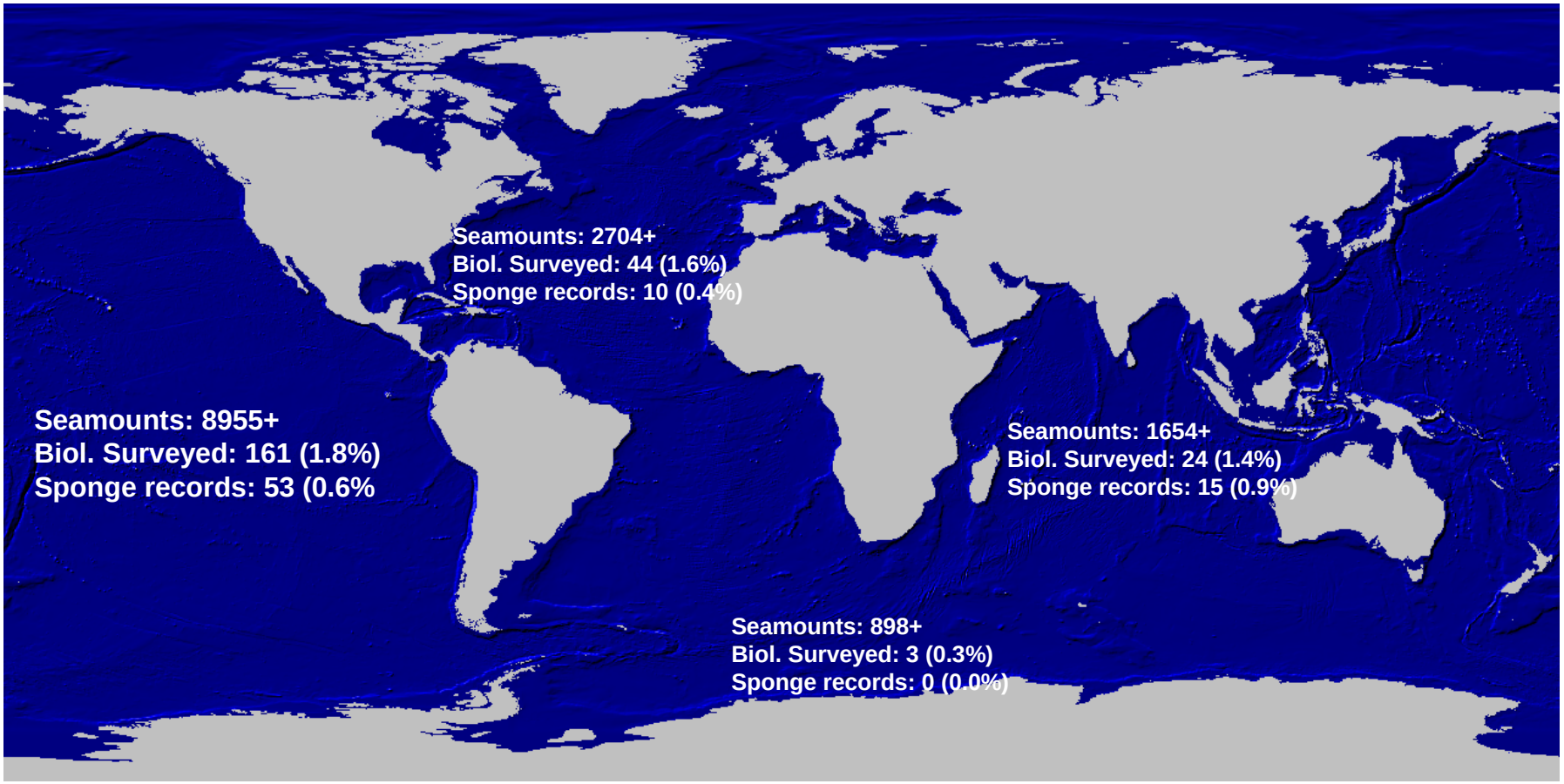

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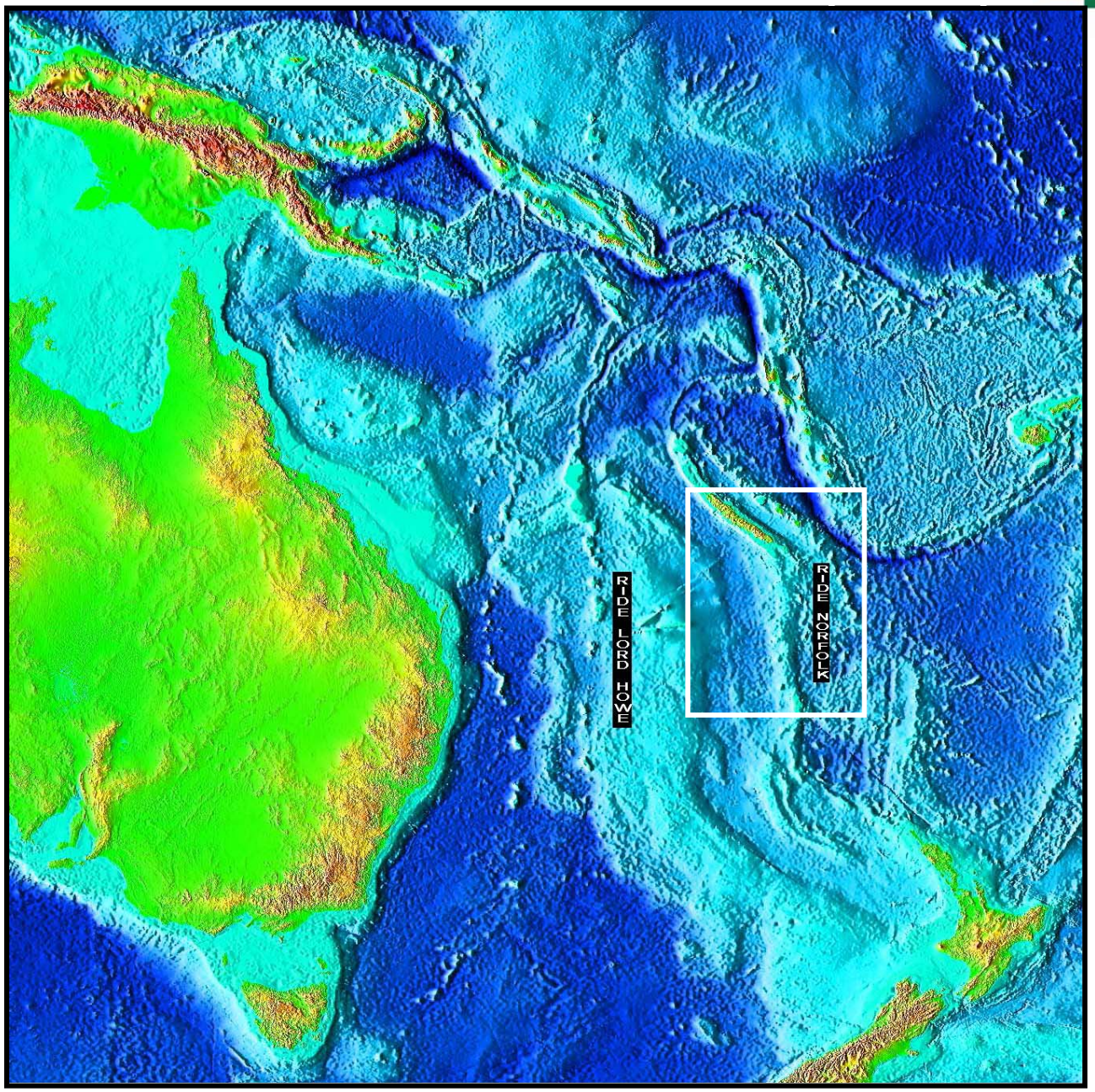

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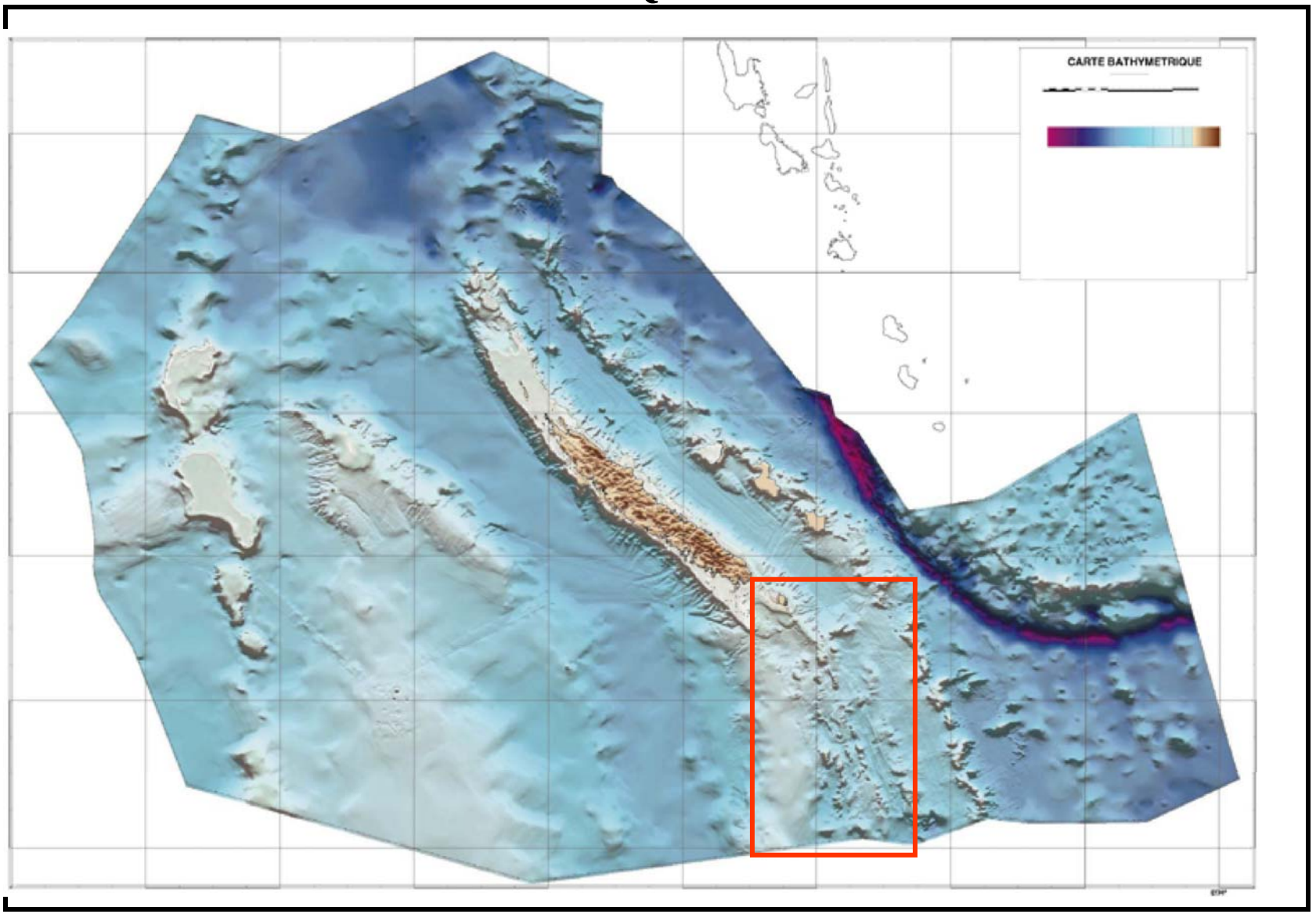
CARTE BATHYMETRIQUE DE LA ZONE ECONOMIQUE EXLUSIVE



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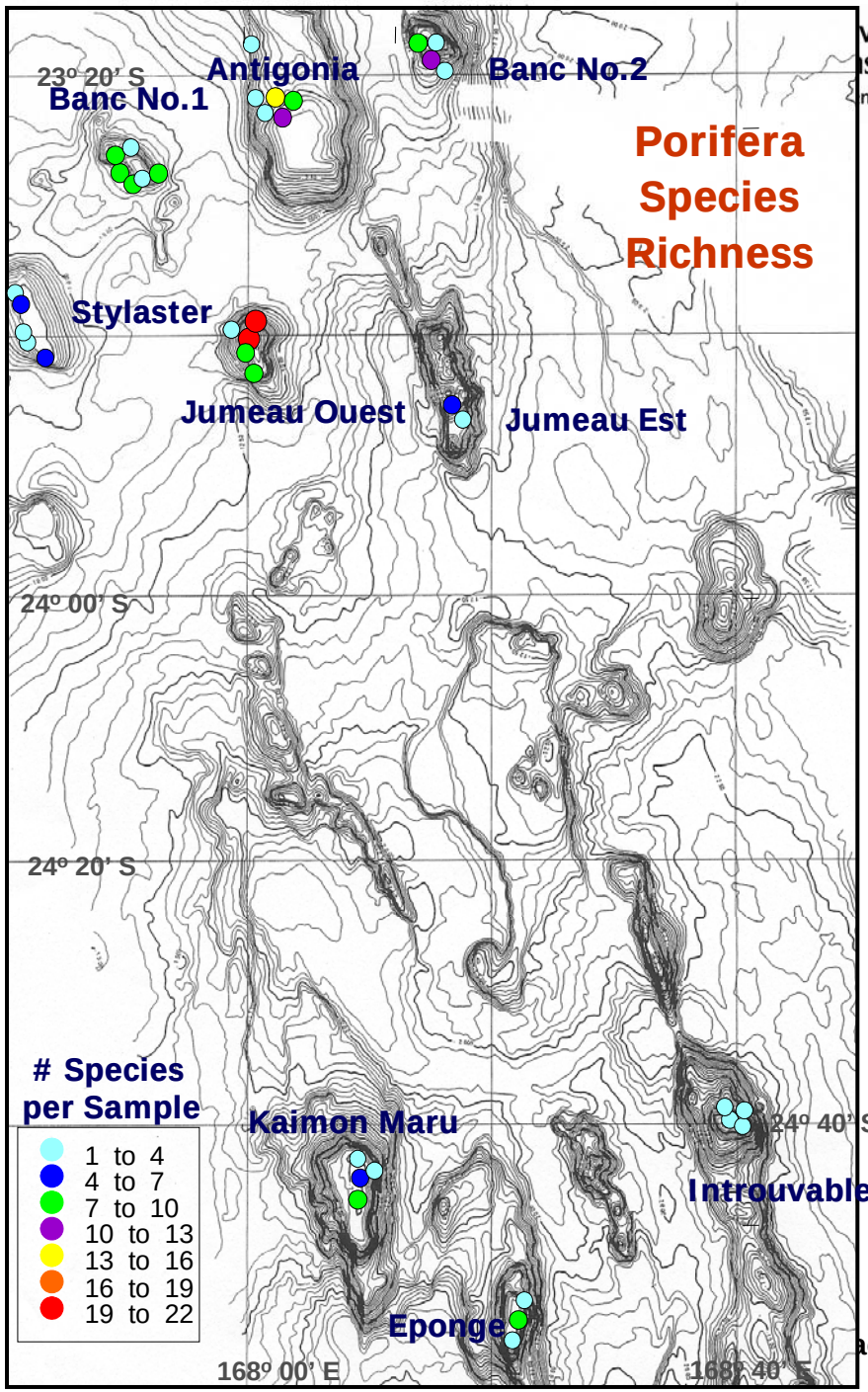
Case Study: Norfolk Sponge Diversity:

Spatial heterogeneity

Diversity of sponge assemblages highly **PATCHY**, both within seamounts and between seamounts



Data Sources:
TA Schlacher & MA Schlacher-Hoenlinger

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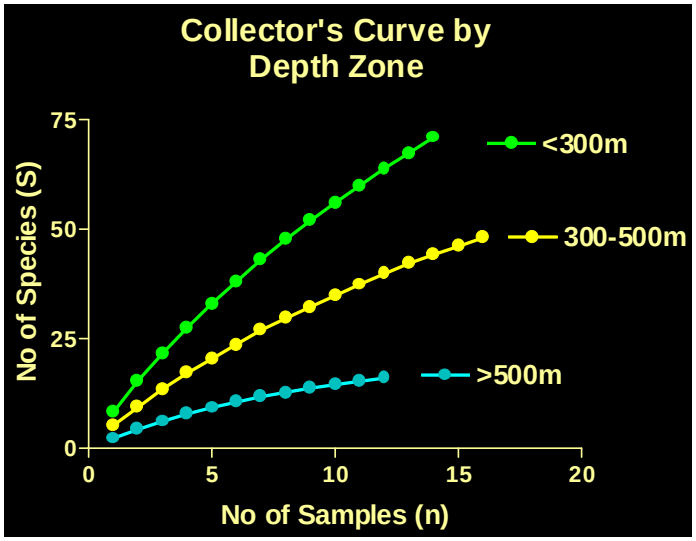
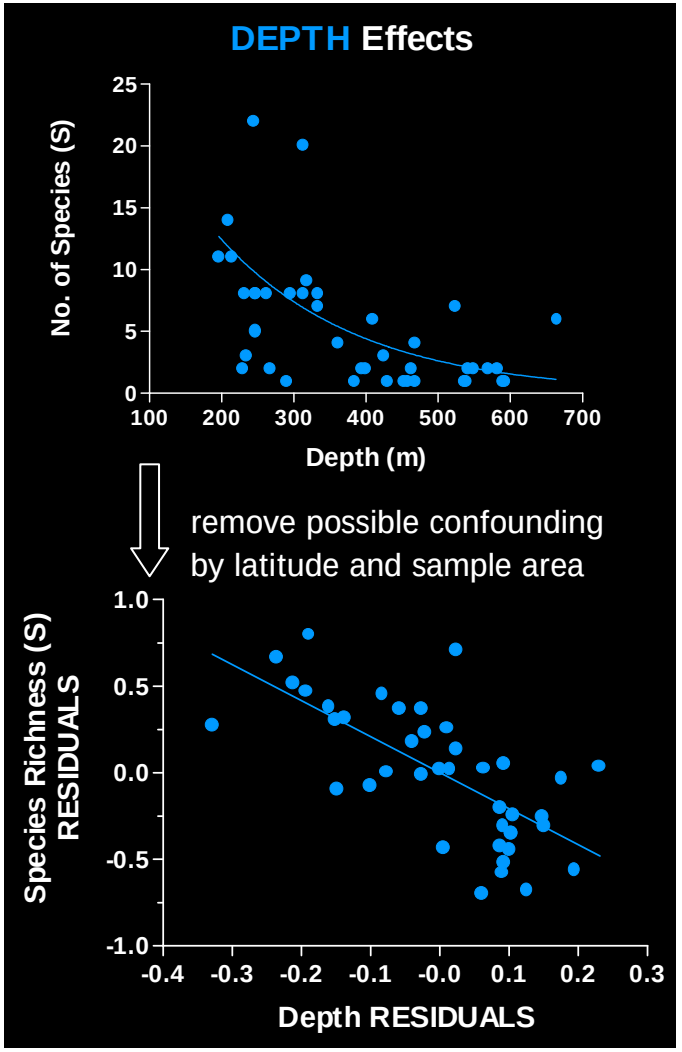
Case Study: Norfolk Sponge Diversity:

Bathymetric Clines

Deeper seamounts harbour sponge assemblages with fewer species





Data Sources:
TA Schlacher & MA Schlacher-Hoenlinger (unpubl. data)

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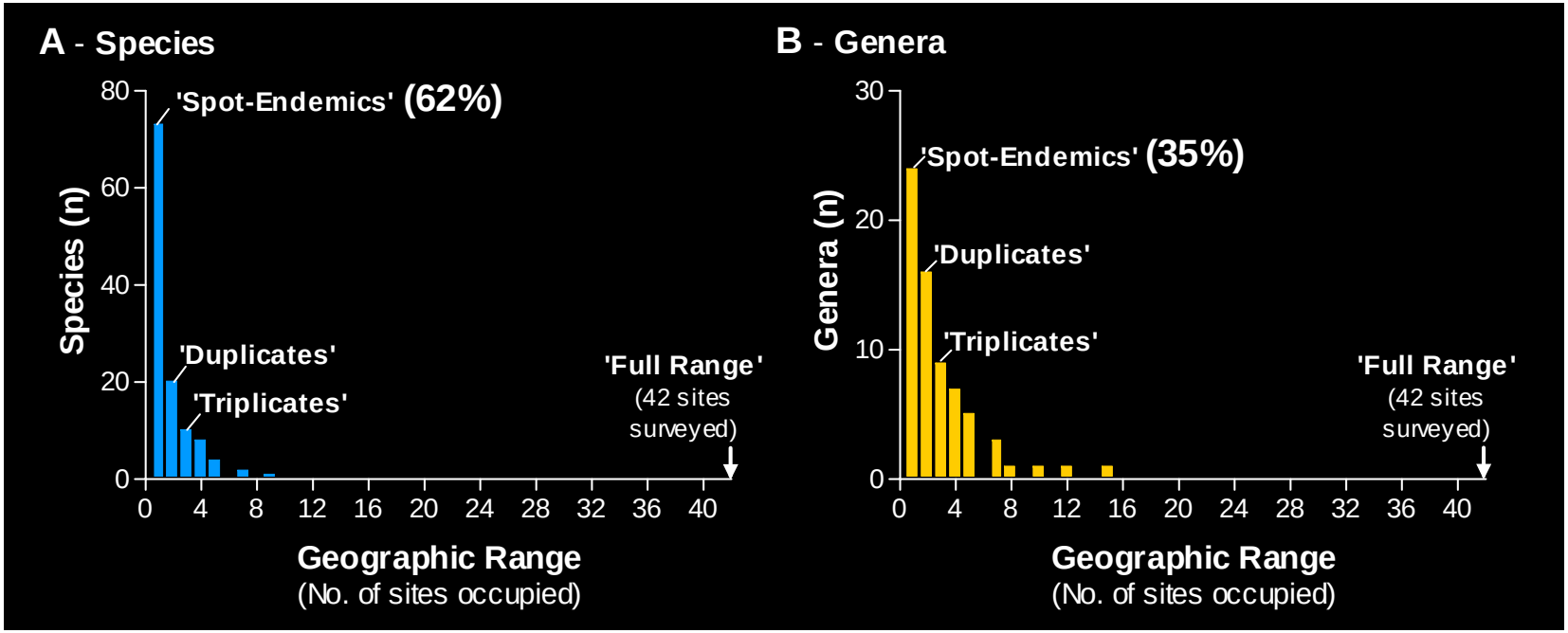
Case Study: Norfolk Sponge Diversity:

Range sizes & distribution 1

Highly compressed **geographic** range sizes on seamounts: prevalence of *"spot endemism"*



Data Sources:

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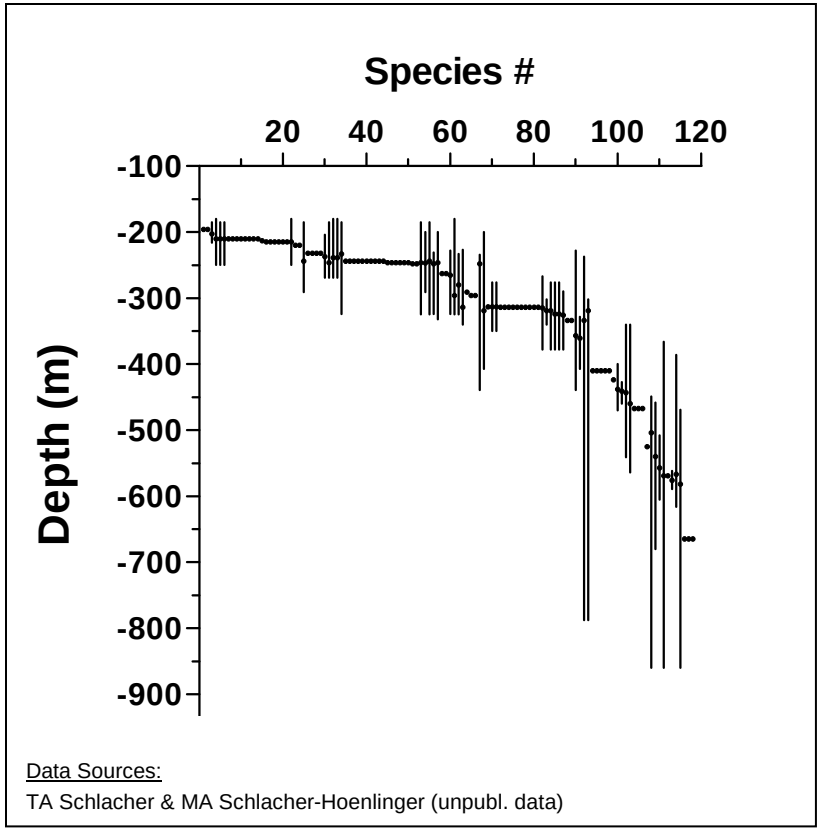
Case Study: Norfolk Sponge Diversity:

Range sizes & distribution 2

Rapoport's Rule in action ? Deep-occurring species have significantly broader bathymetric ranges



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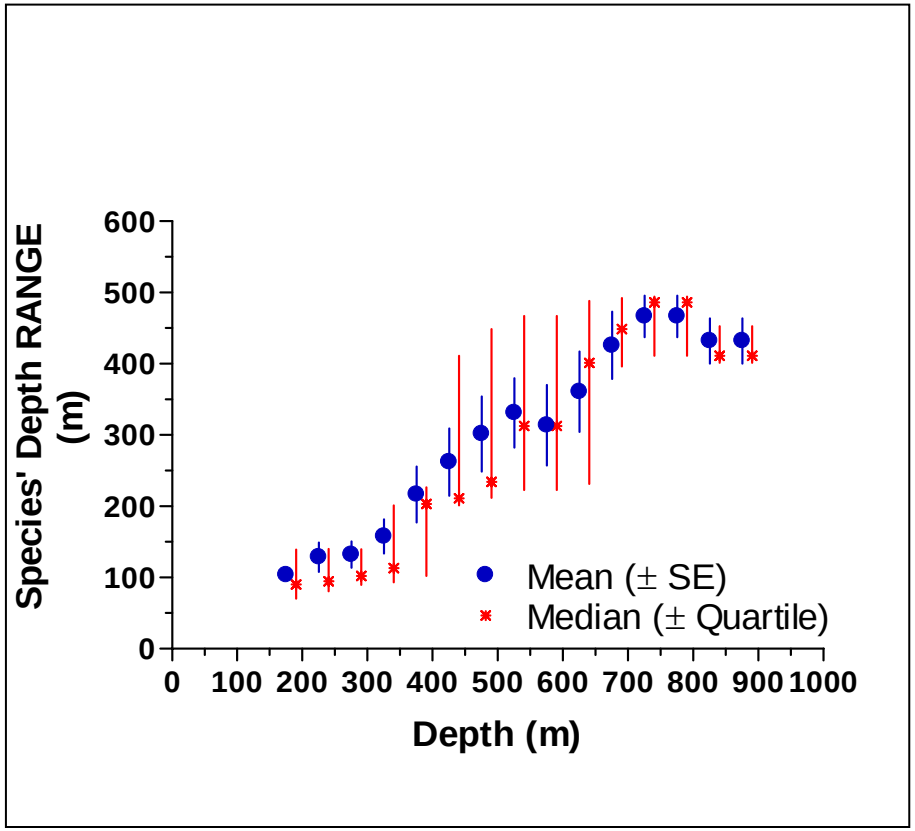

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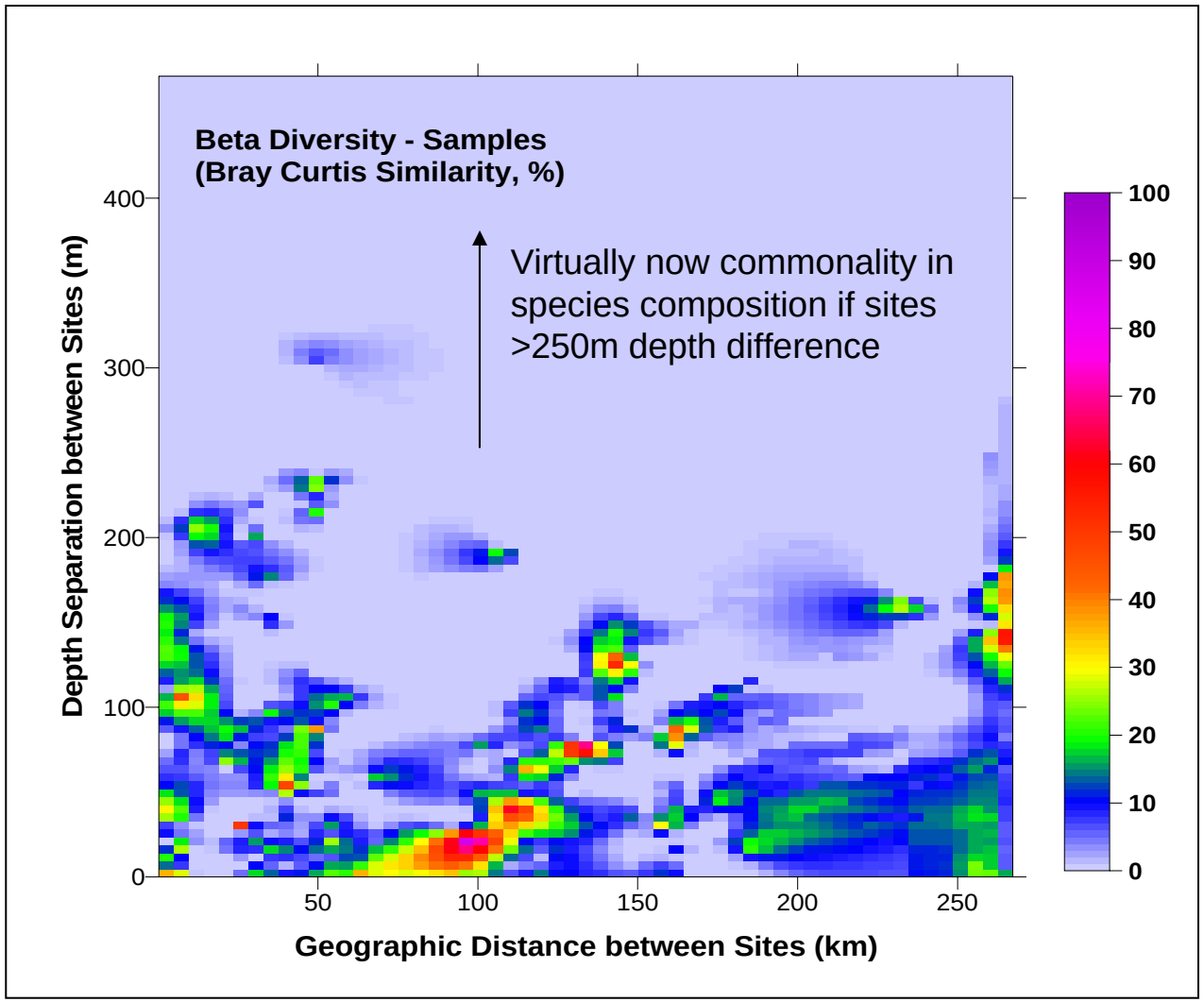
Case Study: Norfolk Sponge Diversity:

Species-turnover

(beta diversity)

Small geographic and bathymetric range sizes combine to create highly distinct assemblages in space



Data Sources:

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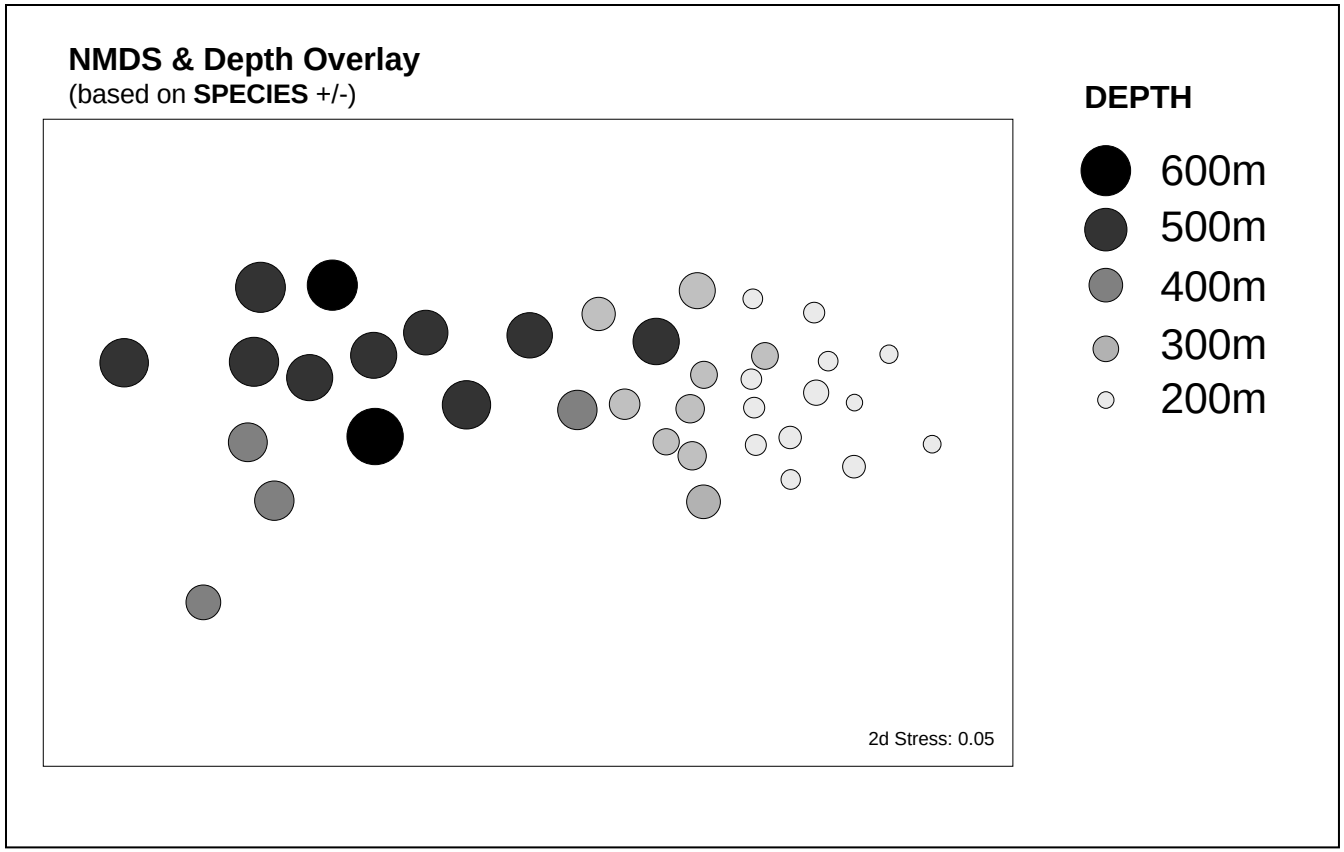
Sponge assemblages in 3-d space:

Does bathymetry rather than geographic position of seamounts drive species composition ?



Data Sources:
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Achilles Heels – Future Challenges

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The question of "true records": 4 pitfalls

1.) Sampling Gear efficient ?

NO — Specimens lost / Not captured

YES → **2.) Sorted / kept from bulk samples on deck ?**

NO — Specimens not available

YES → **3.) Identified / taxonomic work done?**

NO — No information on specimens

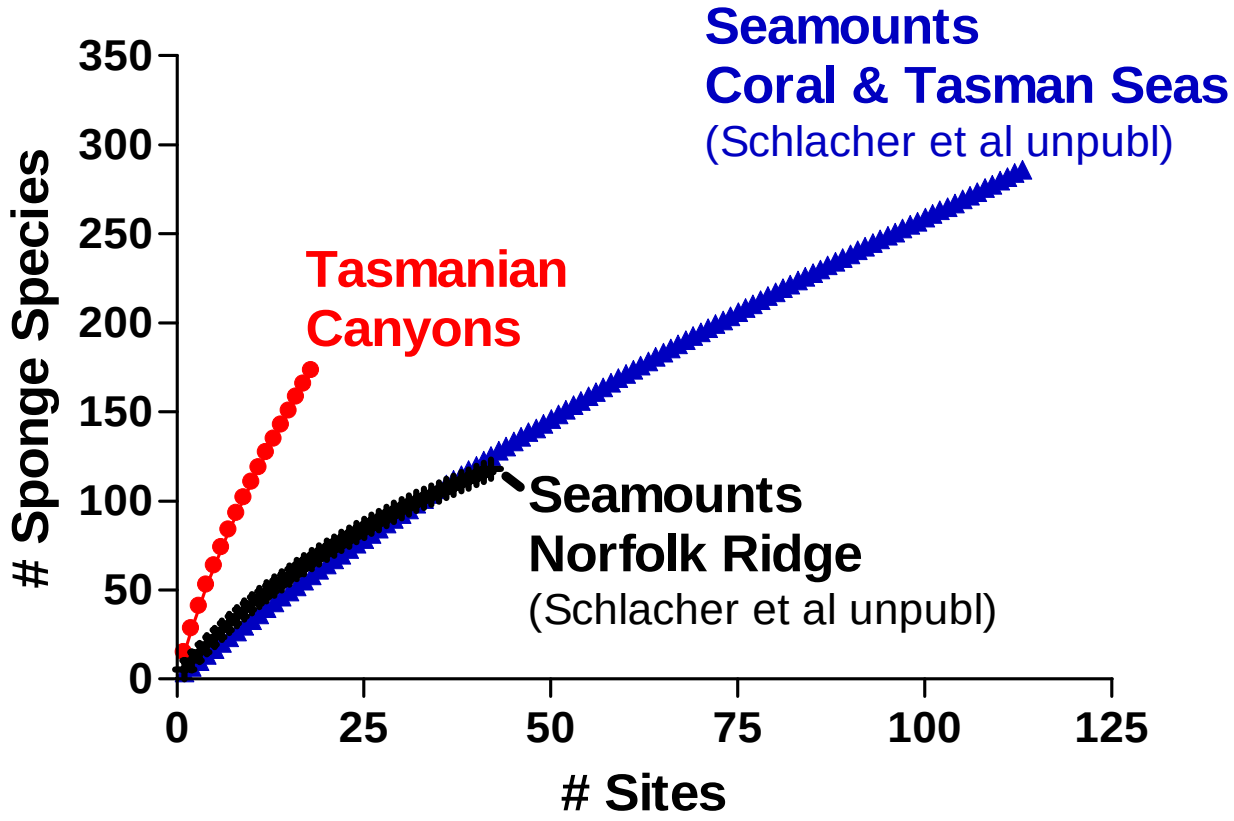
YES → **4.) Reported / published / in data-base?**

NO — Not available for analysis

YES — Amenable to analysis (biogeography, bathymetric patterns, Diversity, Endemism etc etc

Achilles Heels – Future Challenges

Are collecting efforts adequate to document the “true” richness of seamount sponges ?



Data Sources:
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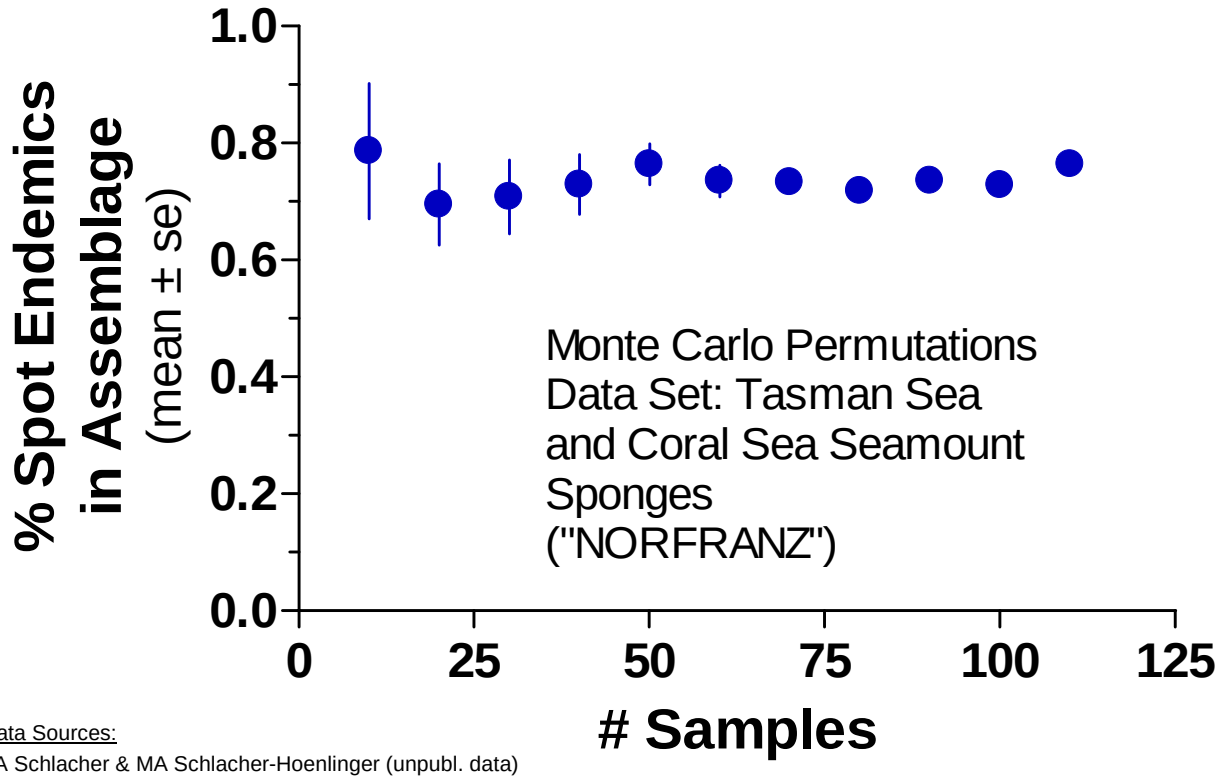
Achilles Heels – Future Challenges

Does limited sampling on some seamount inflate estimates of restricted range sizes ("spot endemic species") ?



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Achilles Heels – Future Challenges

1. **up-scaling of patterns from local to regional to ocean-basin to global scales – GLOBAL database needed !!!**
2. **hierarchical models of endemism and depth ranges ?**
3. **distribution patterns related to dispersal capabilities of groups** (e.g. larval ecology of sponges rudimentary known) **?**
4. **bathymetric trends/patterns of diversity universal (e.g. mid-depth peak paradigm) ?**

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Achilles Heels – Future Challenges

1. dispersal barriers for sponges ?
2. ecological role of sponges on seamounts (e.g. food-partitioning, bentho-pelagic coupling) ?
3. historical factors and assembly rules (e.g. age of seamounts ?)
4. sponges as proxies for benthic diversity ?

Acknowledgements:

- **$$$: ISA, USC Large Initiative Grant, CenSeam, CSIRO, Univ. Vienna**
- **Sponge taxonomy: *Monika Schlacher-Hoenlinger***
- **Ship time: *Bertrand Richer de Forges***
- **Seamount positions: *Adrian Kitchingmann***
- **Sponge records from SeamountsOnline: *Karen Stocks, Paul Brewin***