



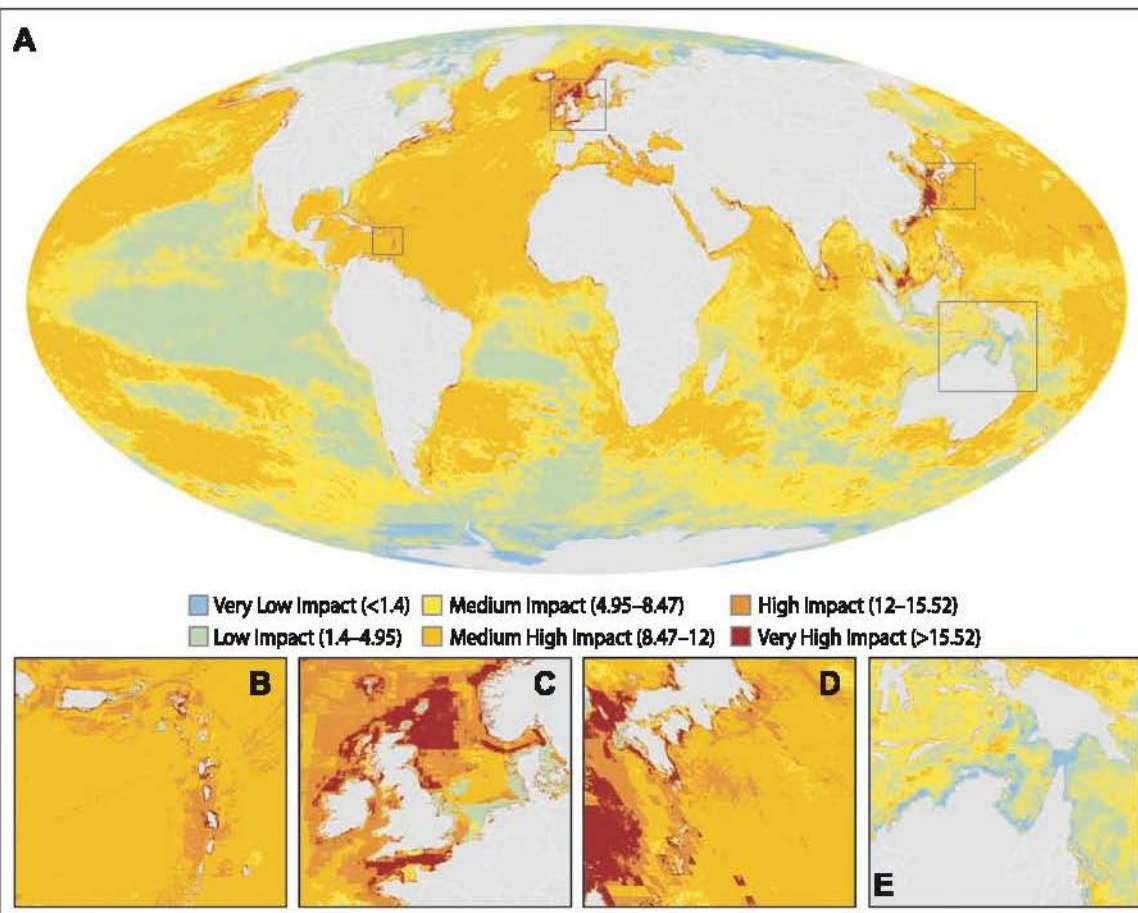
Methods for long term monitoring of Rhodolith beds

Rafael Riosmena-Rodríguez

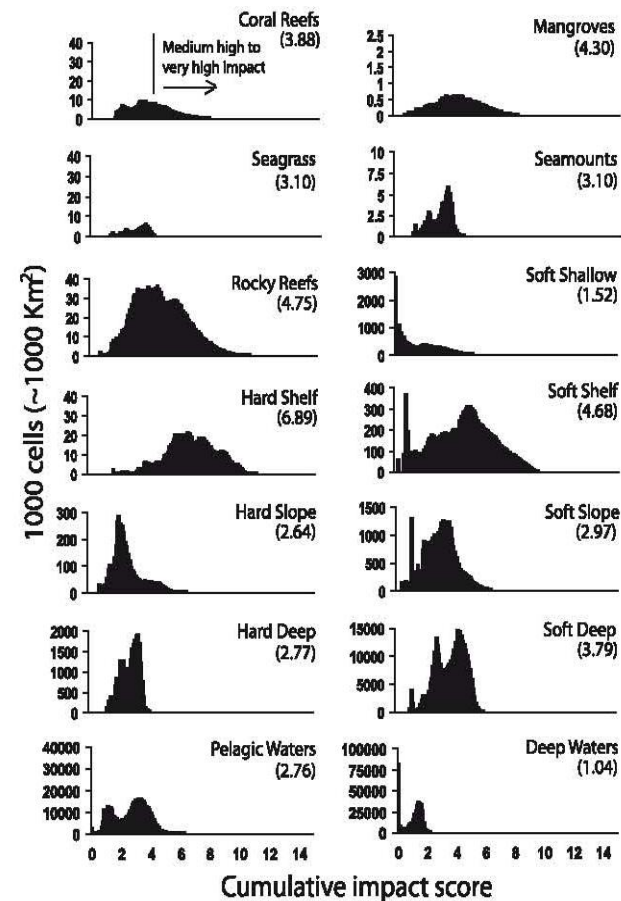
Programa de Investigación en Botánica Marina,
Departamento de Biología Marina, UABCS

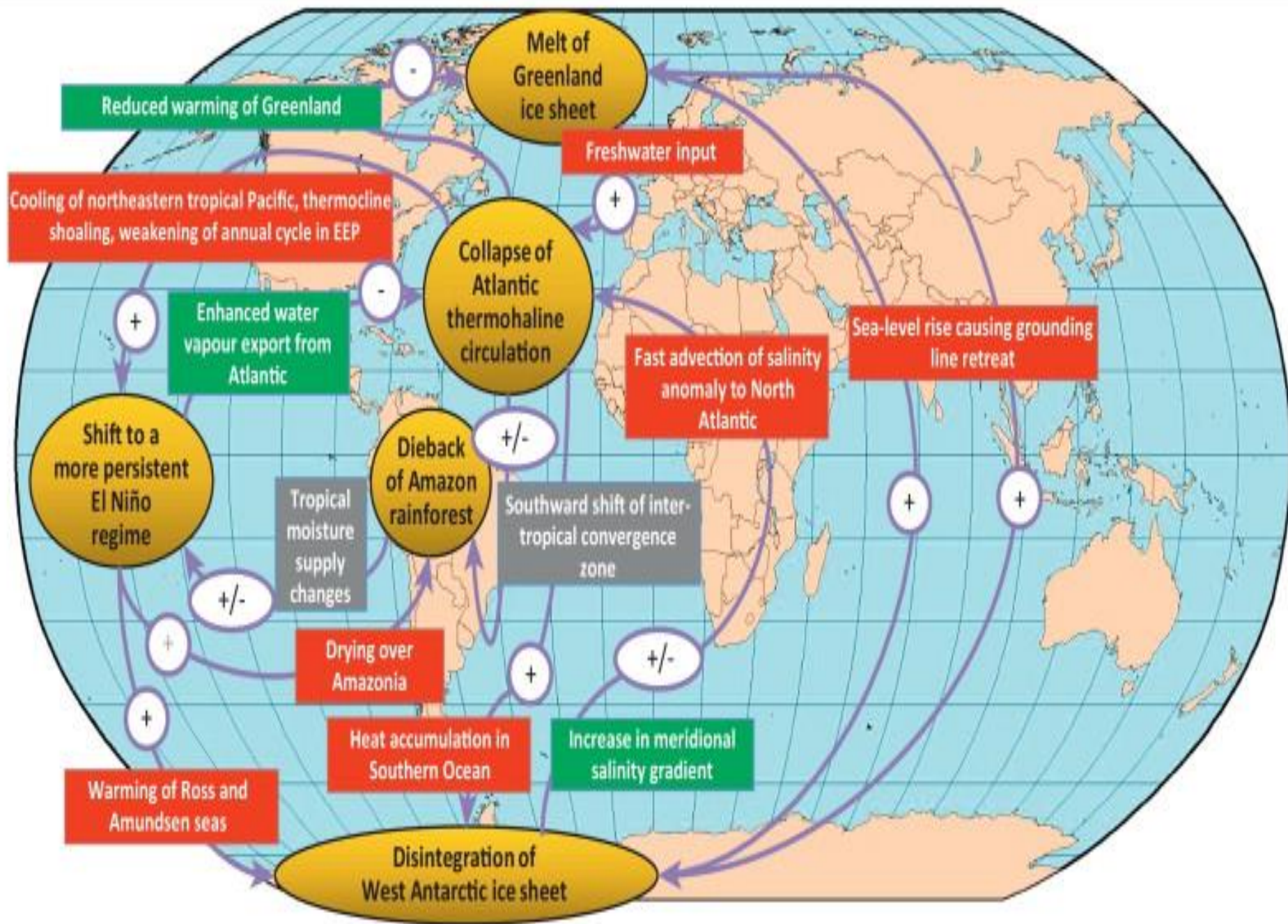
A Global Map of Human Impact on Marine Ecosystems

Benjamin S. Halpern,^{1†} Shaun Walbridge,^{1*} Kimberly A. Selkoe,^{1,2,*} ‡ Carrie V. Kappel,¹ Fiorenza Micheli,³ Caterina D'Agrosa,^{4†} John F. Bruno,⁵ Kenneth S. Casey,⁶ Colin Ebert,¹ Helen E. Fox,⁷ Rod Fujita,⁸ Dennis Heinemann,⁹ Hunter S. Lenihan,¹⁰ Elizabeth M. P. Madin,¹¹ Matthew T. Perry,¹ Elizabeth R. Selig,^{6,12} Mark Spalding,¹³ Robert Steneck,¹⁴ Reg Watson¹⁵



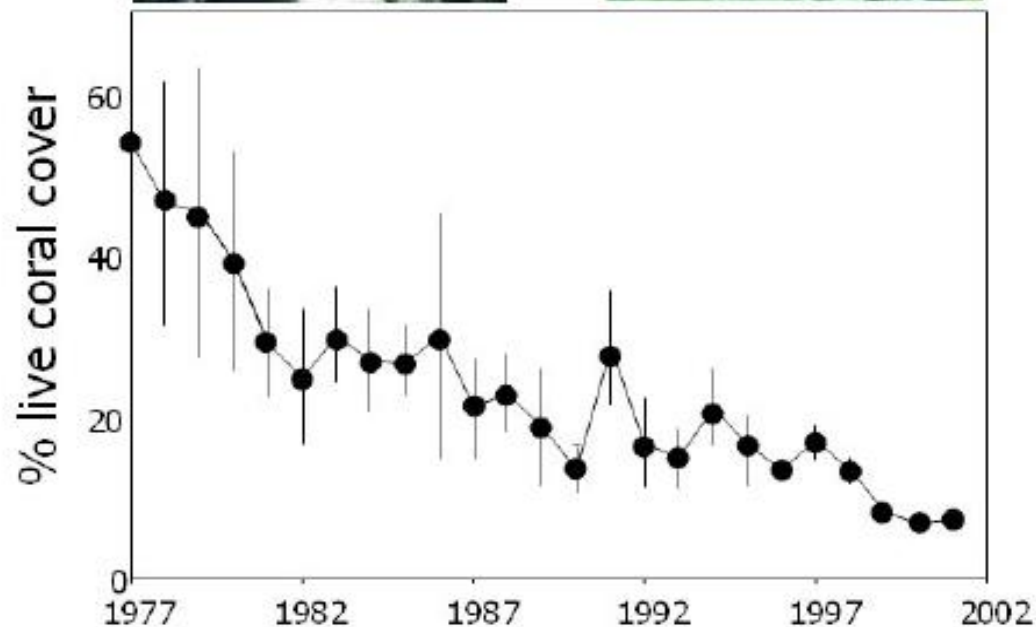
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Temporal Variation in Foundation Species

Caribbean Coral Cover



Loss of live coral cover on
Caribbean reefs since 1977
(Côté 2008)

International legal instruments commonly used to protect, manage and use the environment

- ✓ Ramsar sites
- ✓ Fisheries reserves
- ✓ IUCN Natural Protected Areas
- ✓ UNESCO site
- ✓ European Water Directive
- ✓ Geoparks

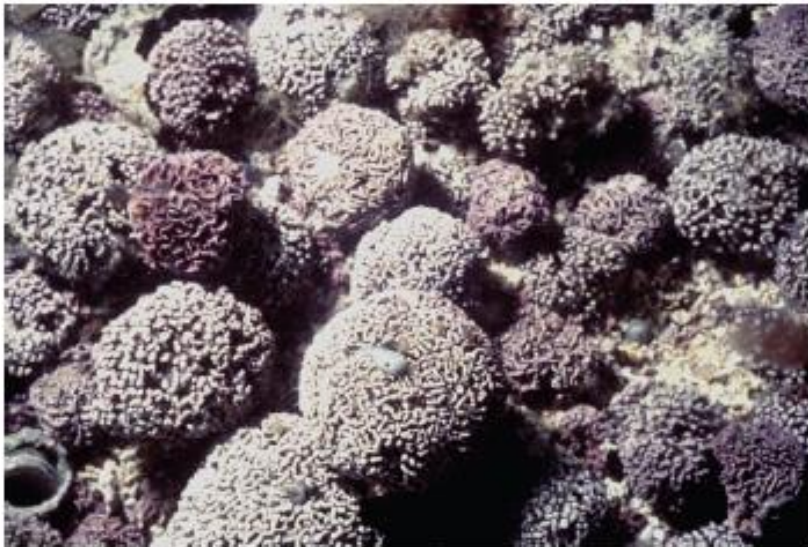
Rhodolith bed definition

Rhodolith/mäerl beds are living and dead aggregations of non-geniculate coralline algae that cover dense and extensive benthic areas in recent oceans and are widely represented in fossil deposits



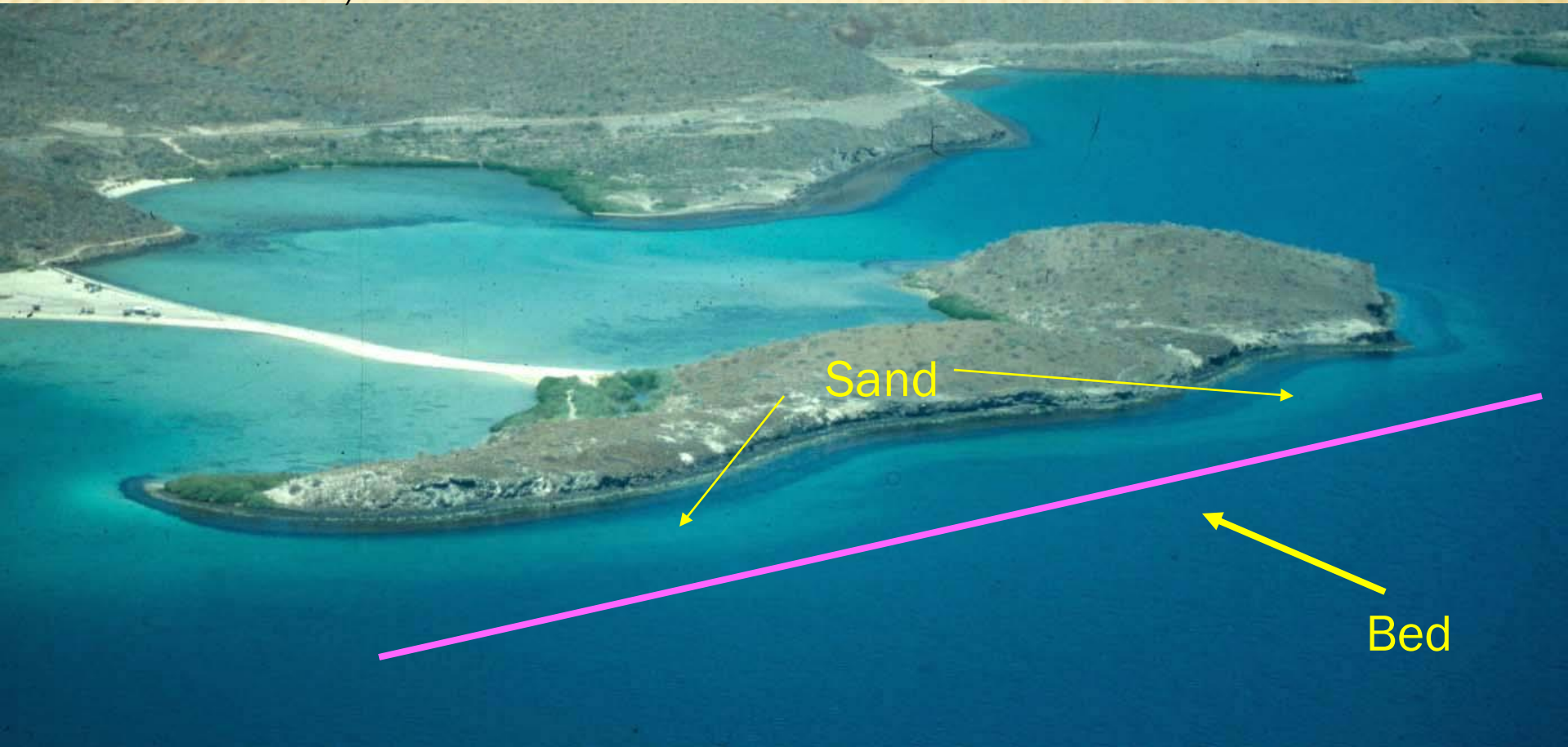
Rhodoliths are foundation species

- Unattached, complex coralline algae that collectively form beds
- Support high species diversity, abundance
- Dynamic systems, rely on water motion
- Slow growth rates, susceptible to disturbance
- Worldwide Distribution



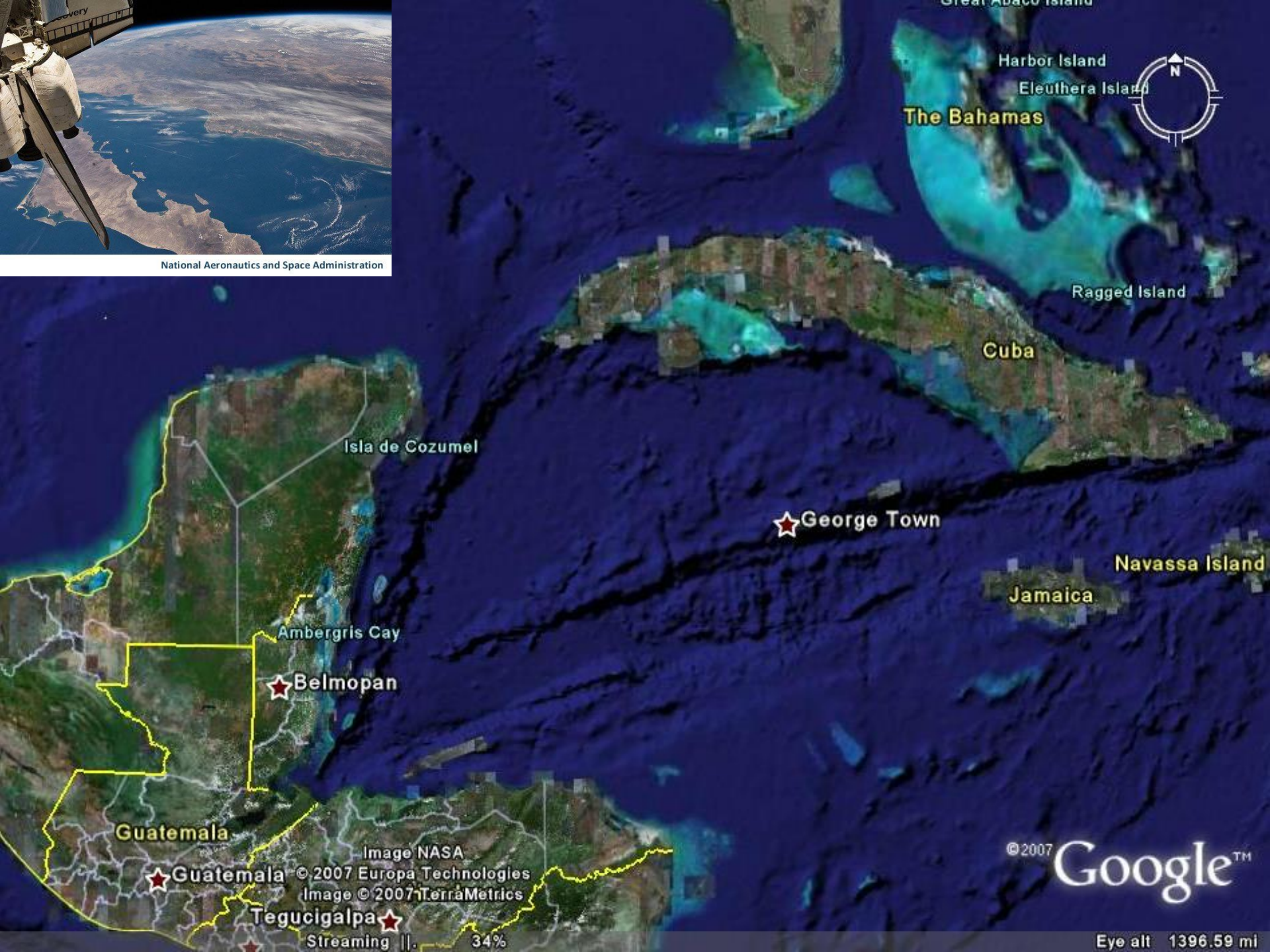
► What boundary conditions determine lateral distribution?

Need bed maps and long term measurements of water motion, sedimentation and light (?) (extension of Mitchell & Collins)





National Aeronautics and Space Administration



The Bahamas

Harbor Island

Eleuthera Island

Ragged Island

Cuba

★ George Town

Navassa Island

Jamaica

Isla de Cozumel

Ambergris Cay

★ Belmopan

Guatemala

★ Guatemala

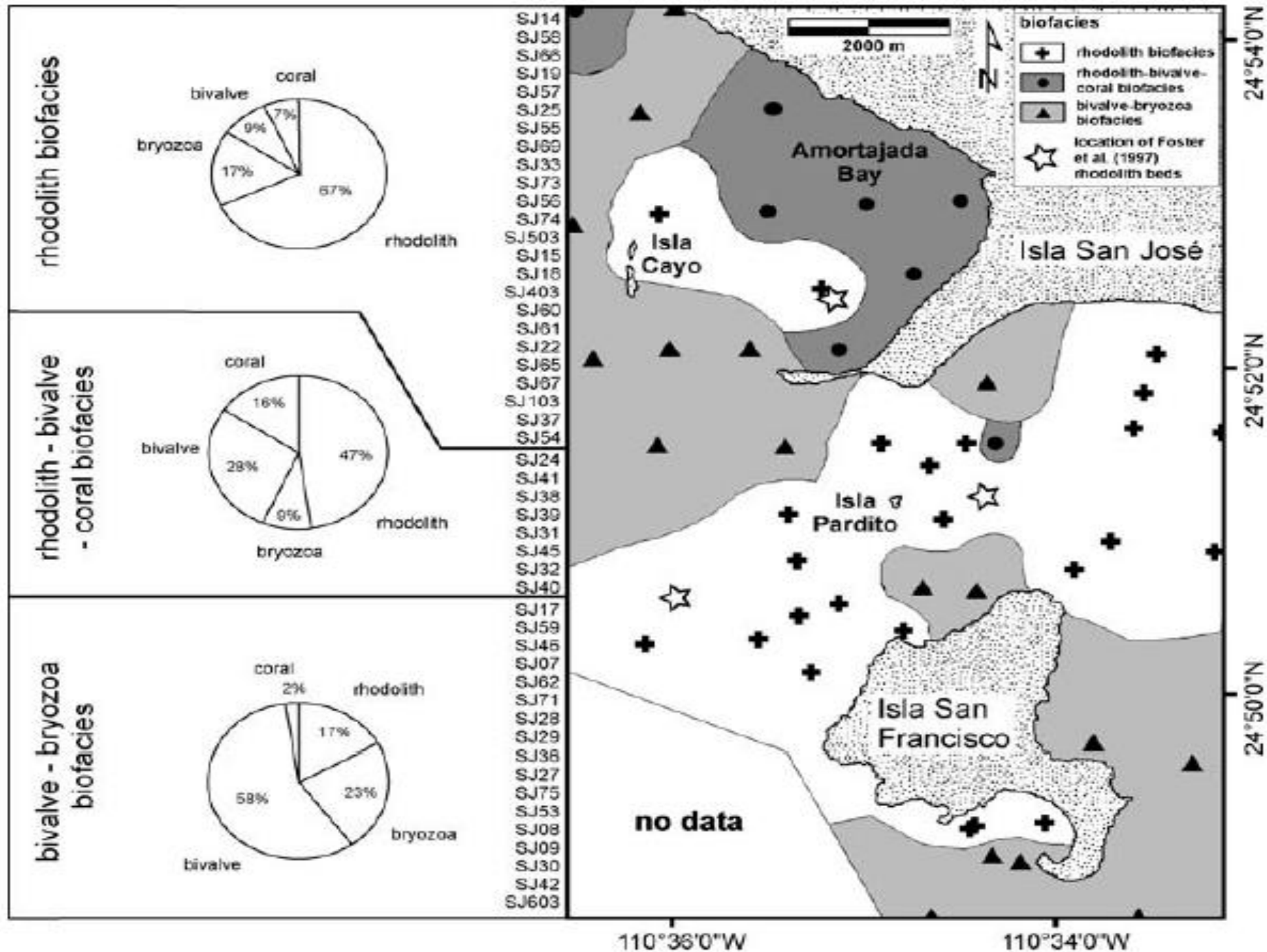
Tegucigalpa ★

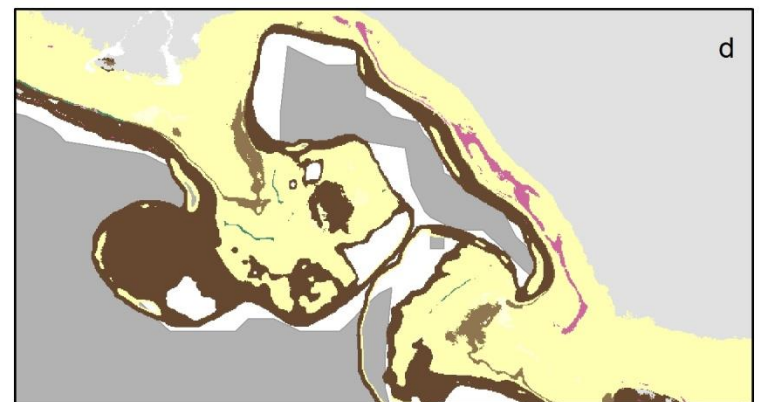
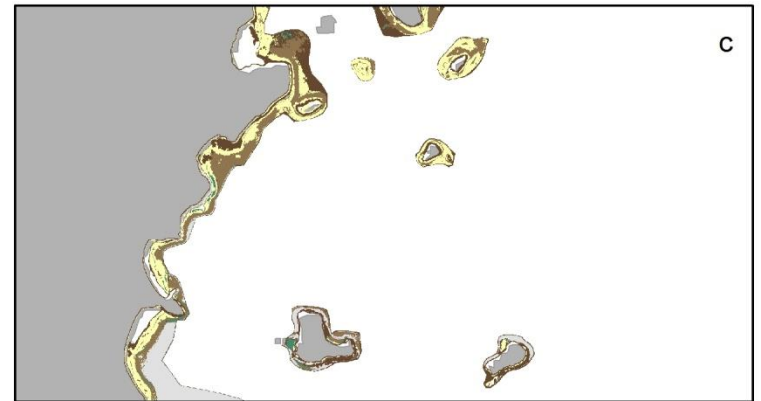
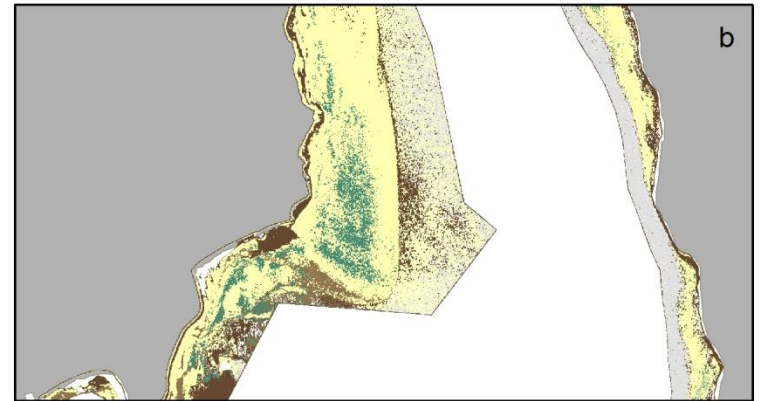
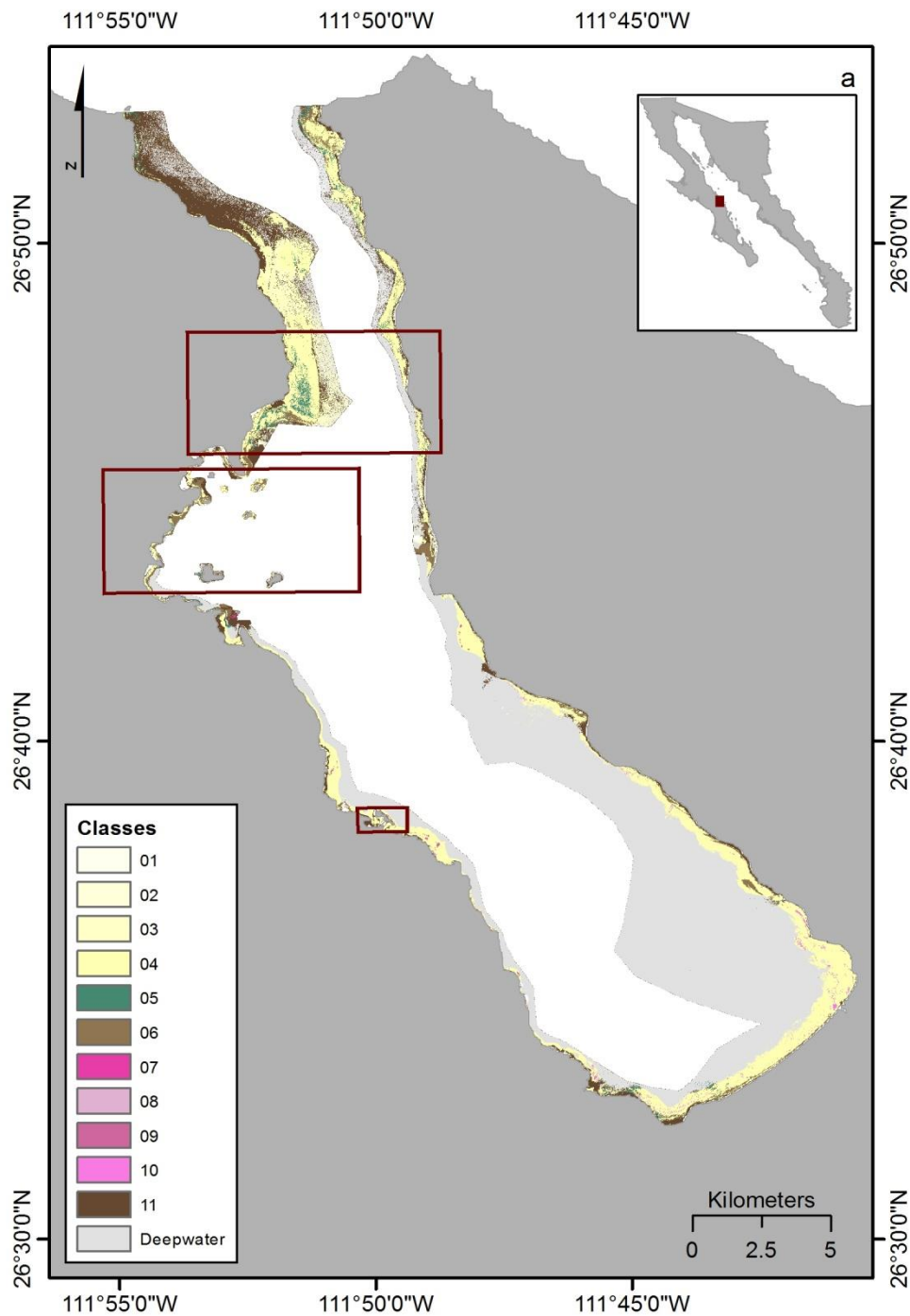
Streaming || 34%

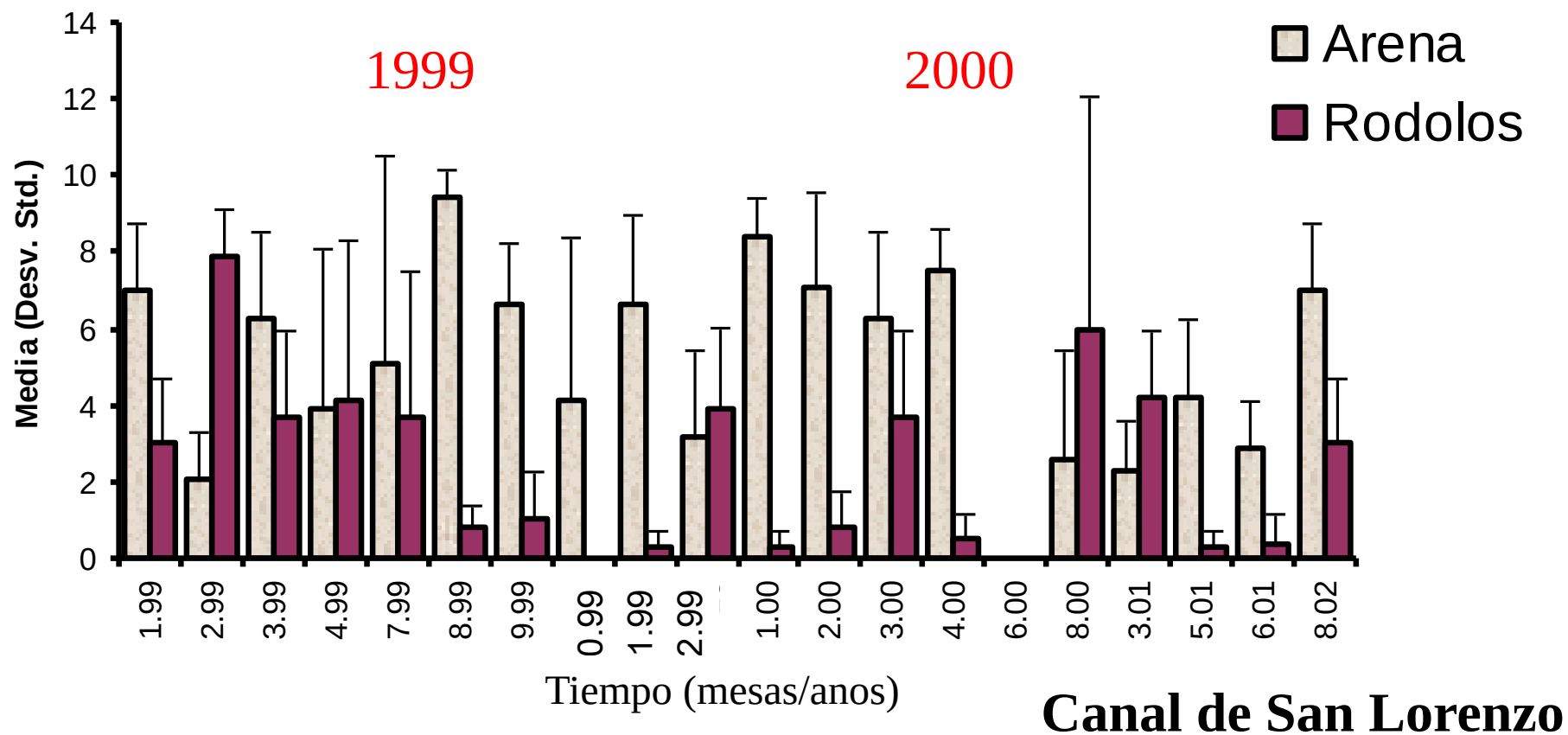
Image NASA
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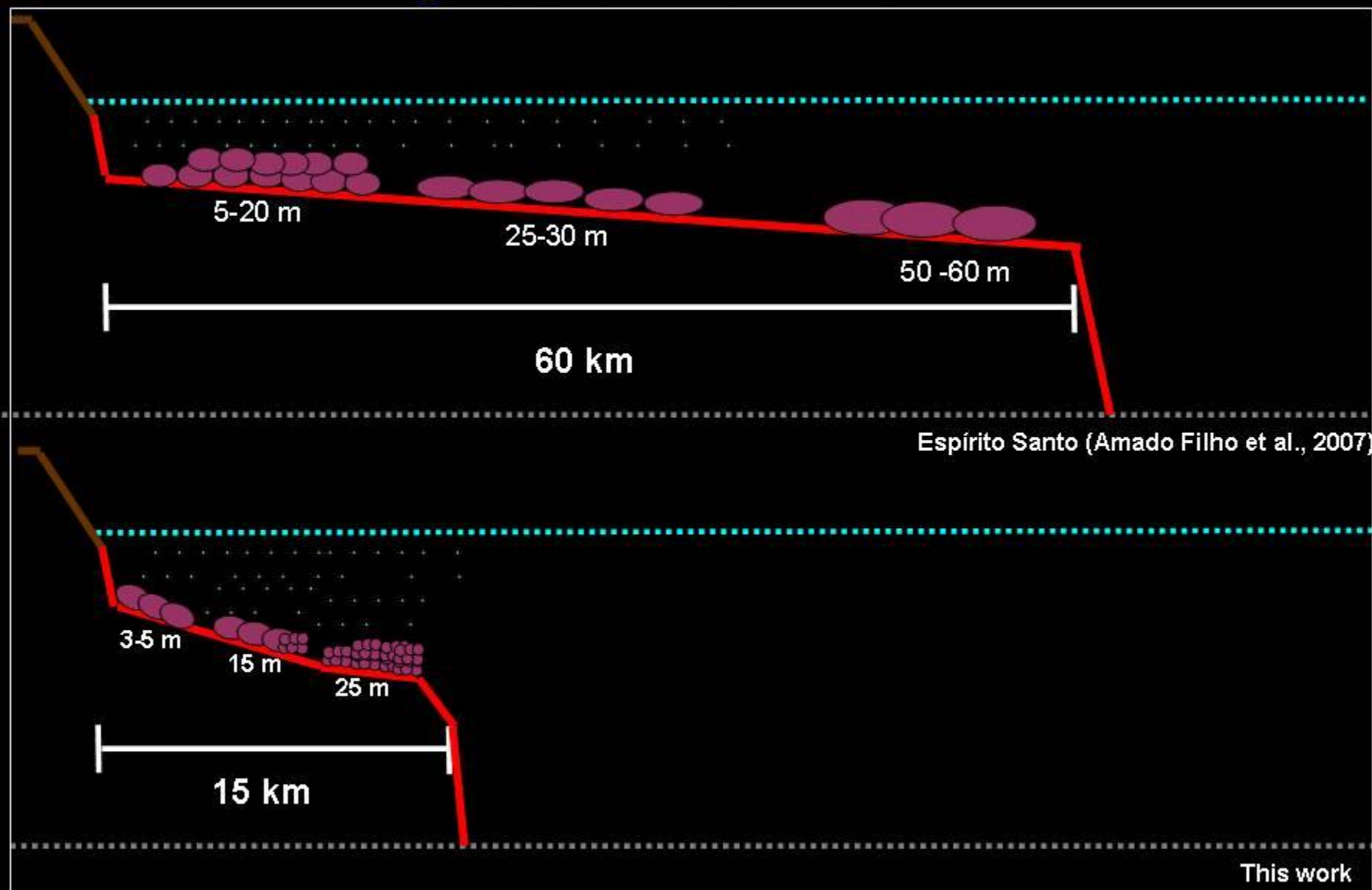
Eye alt 1396.59 mi





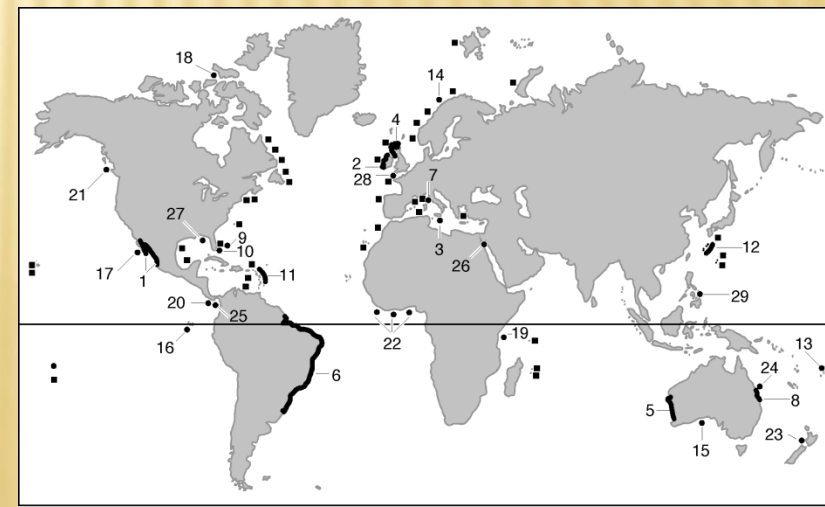
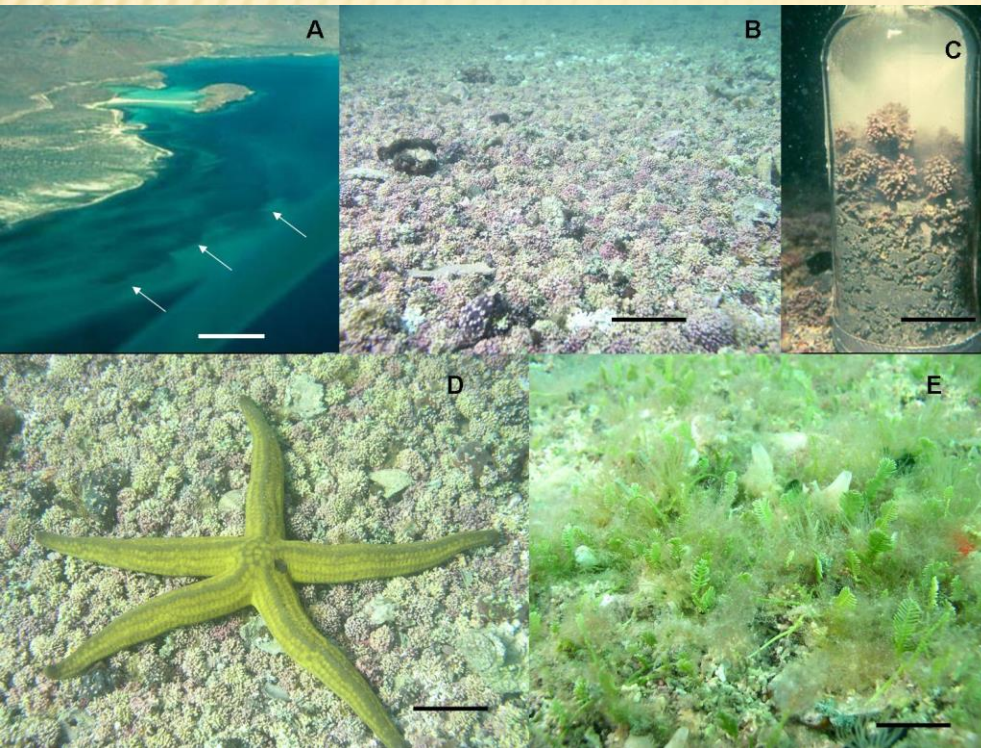


Schematic representation of continental shelf

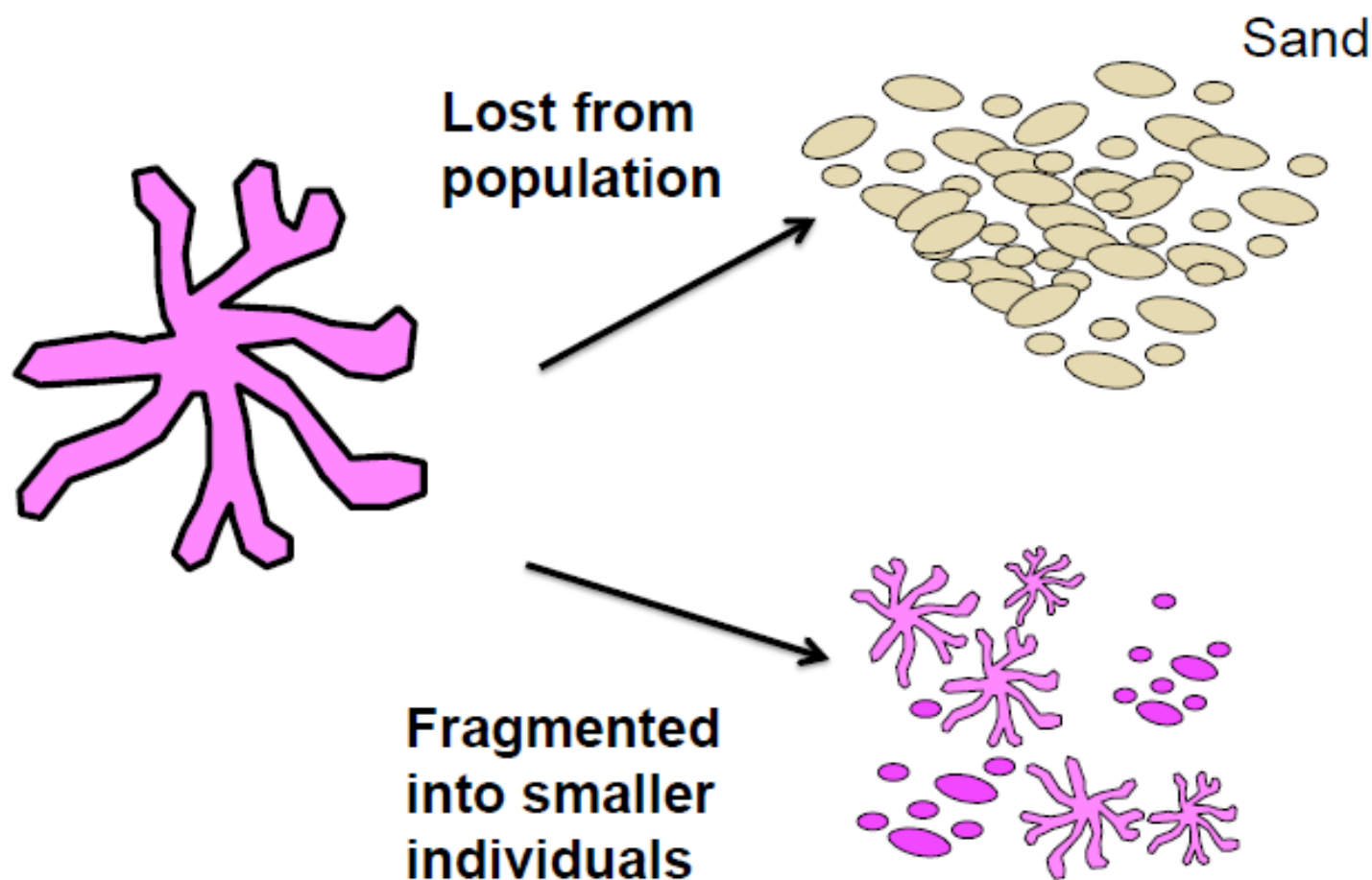


Knowns - how they are: world-wide distribution, “soft” substrate, moderate water motion, low sedimentation, depth: light & water motion-sedimentation, foundation species for a diverse associated flora & fauna

Knowns - what they do: grow slow, important carbonate producers, net consumers of O_2 , net producers of dissolved inorganic N, provide heterogeneous habitat & settlement substrate



What happened to large individuals?



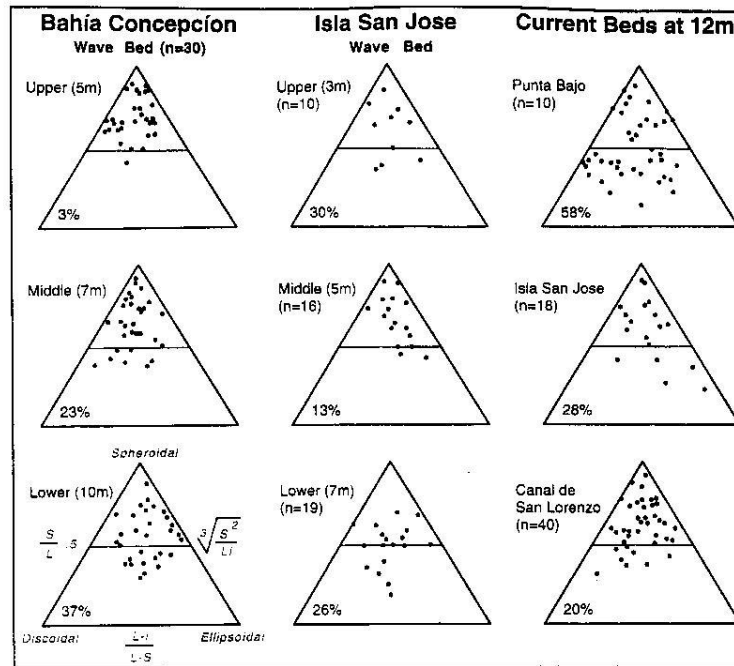


Figure 6. Sphericity diagrams for rhodoliths within two wave beds and from three current beds. Points falling above the internal horizontal line are more spheroidal. Percent of individuals falling below this line is given in lower left of each diagram. m, depth in meters; n, number of samples.

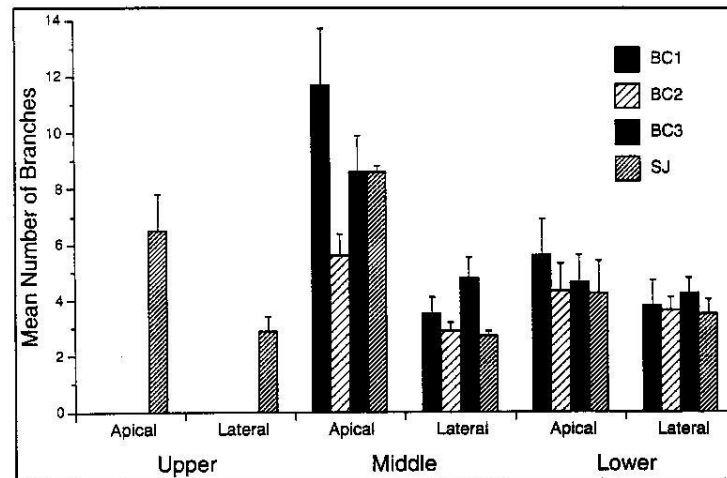
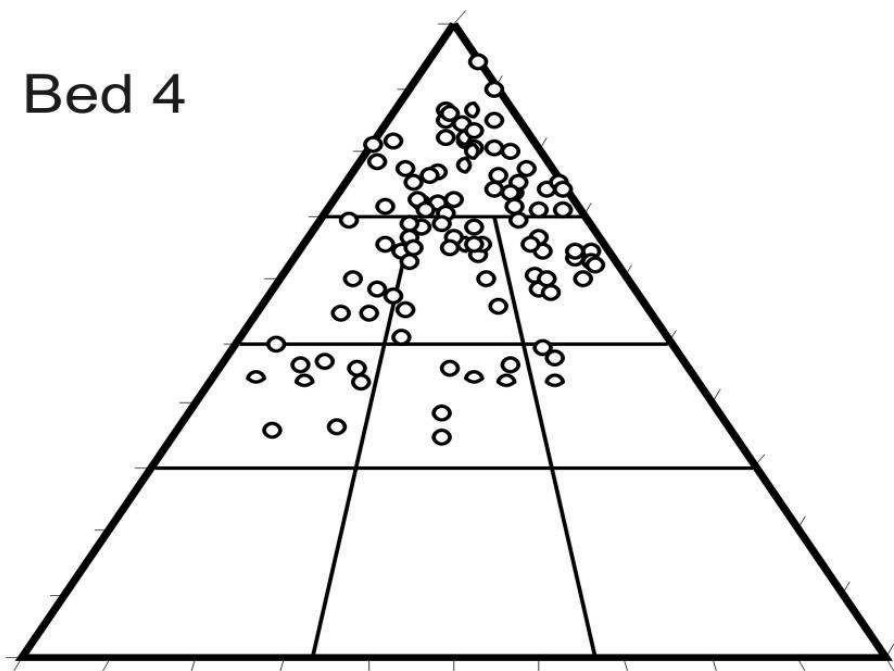
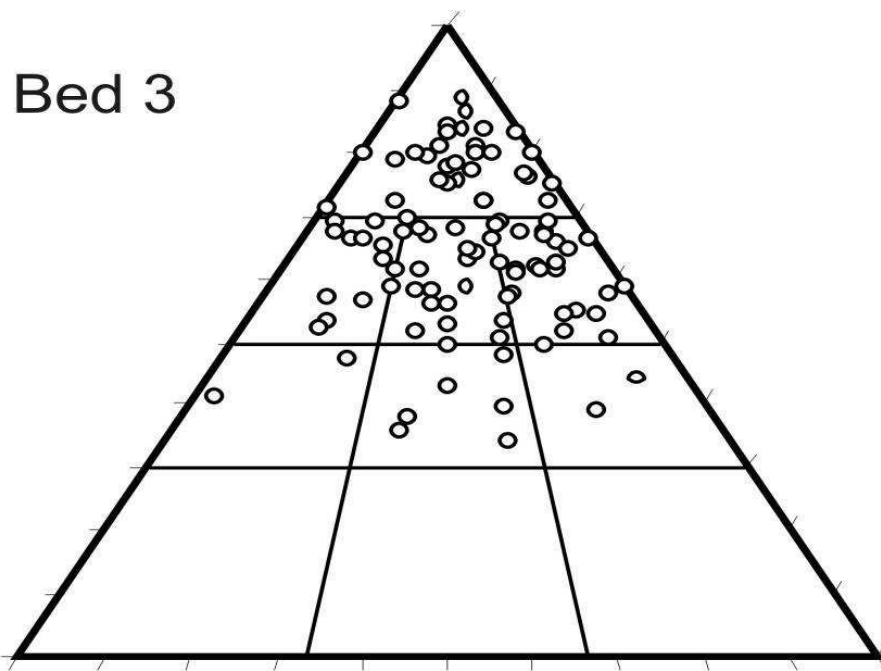
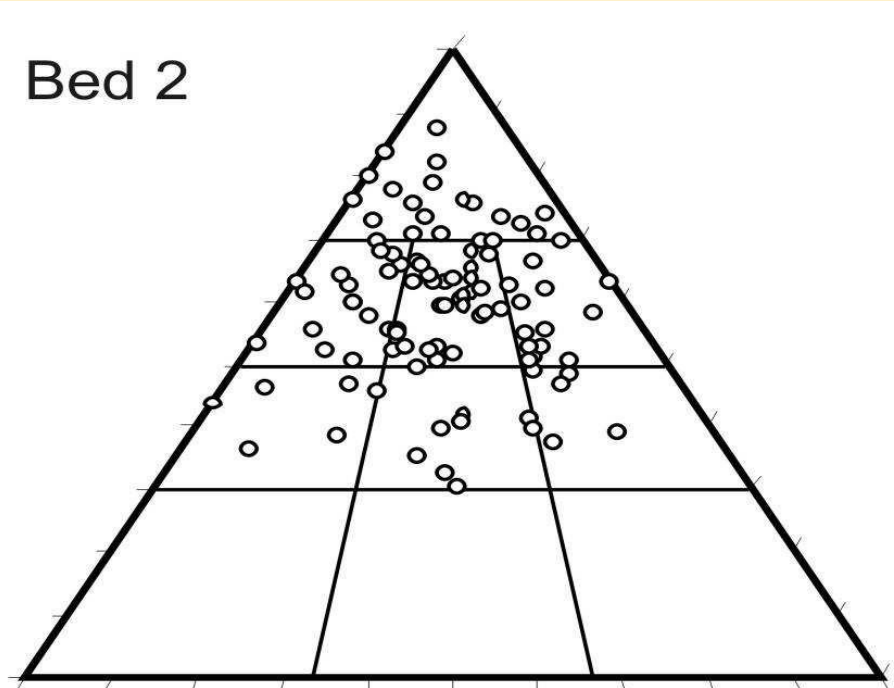
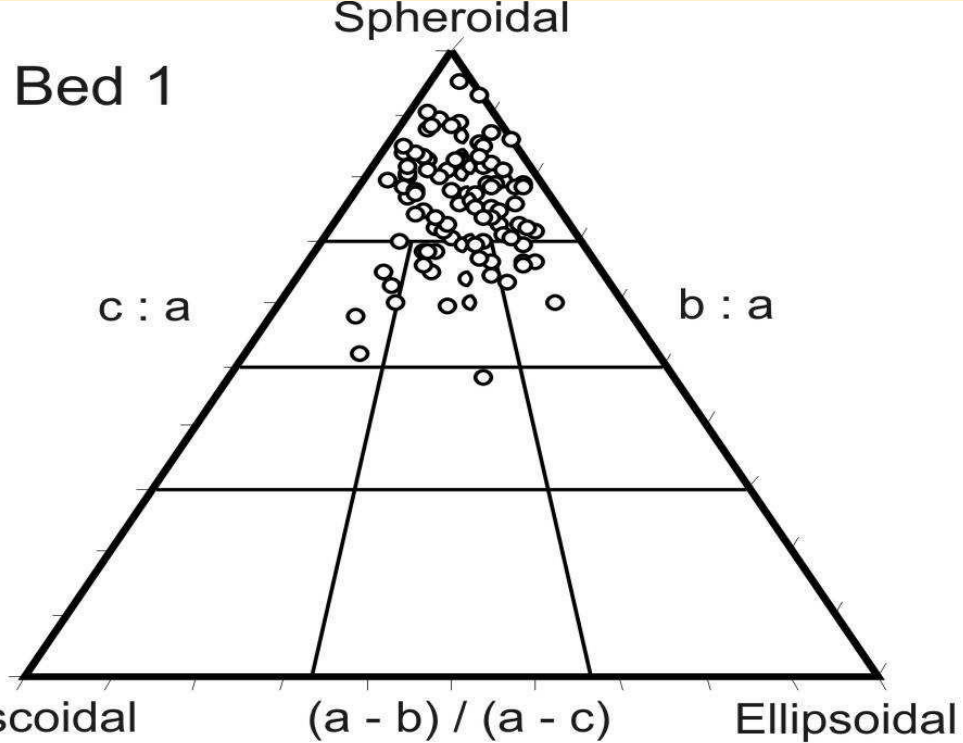
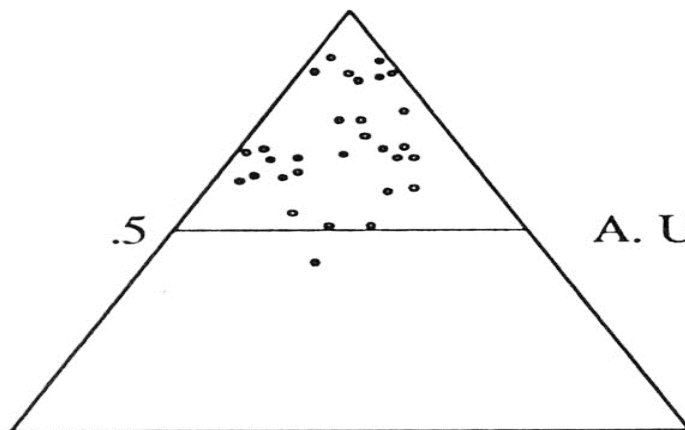


Figure 7. Number of apical and lateral branches per main branch on rhodoliths from three depths (Upper, Middle, Lower) in the wave bed at Isla San Jose (SJ) and two depths (Middle, Lower) within three wave beds in Bahía Concepción (BC1, BC2, BC3). Error bars are +1 SD; n = 4.

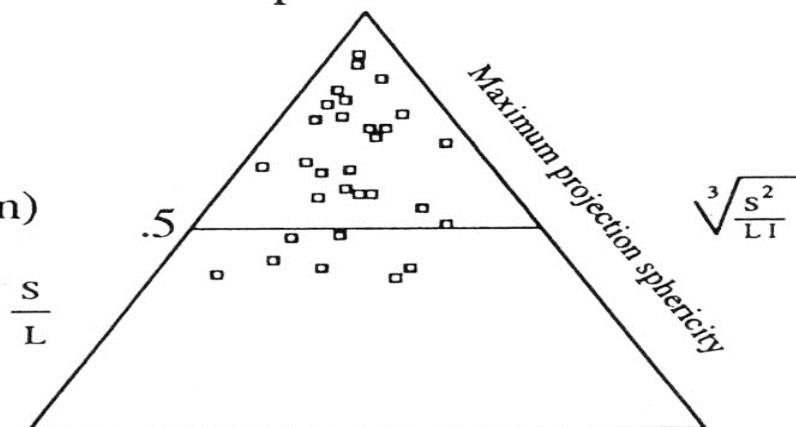




A. Upper (4-5 m)

Spheroidal

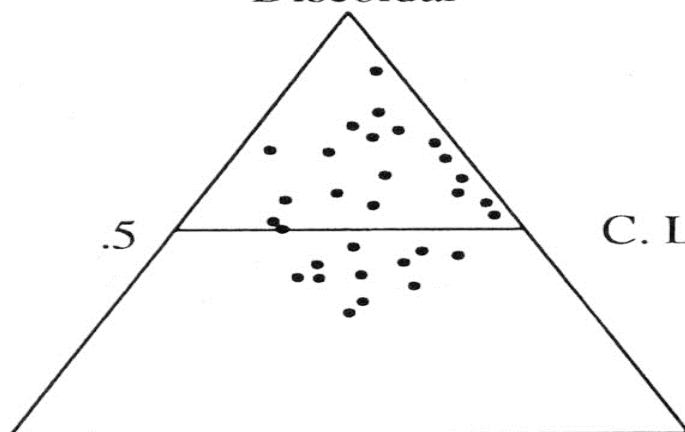
B. Middle (6-8 m)



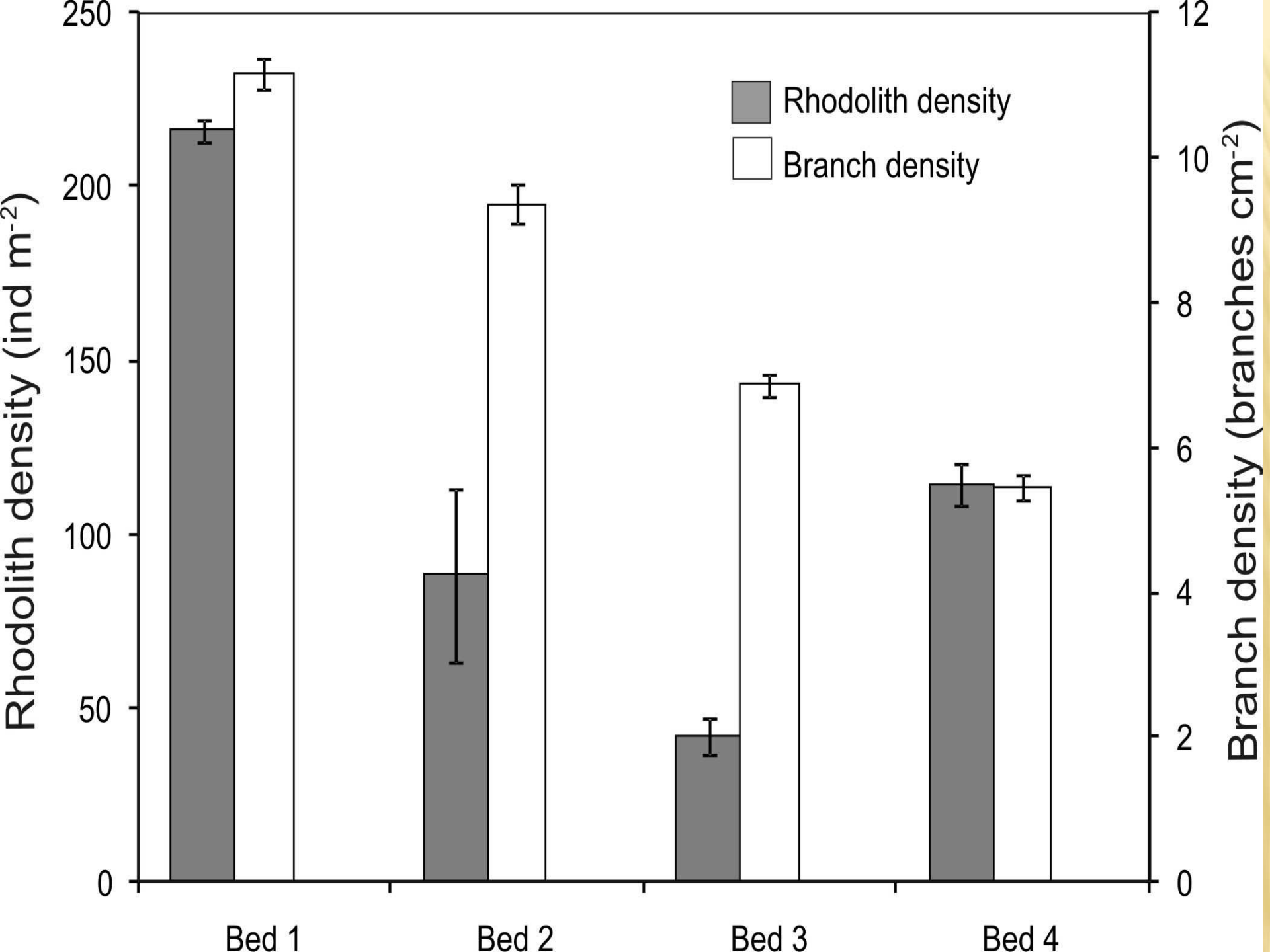
Discoidal

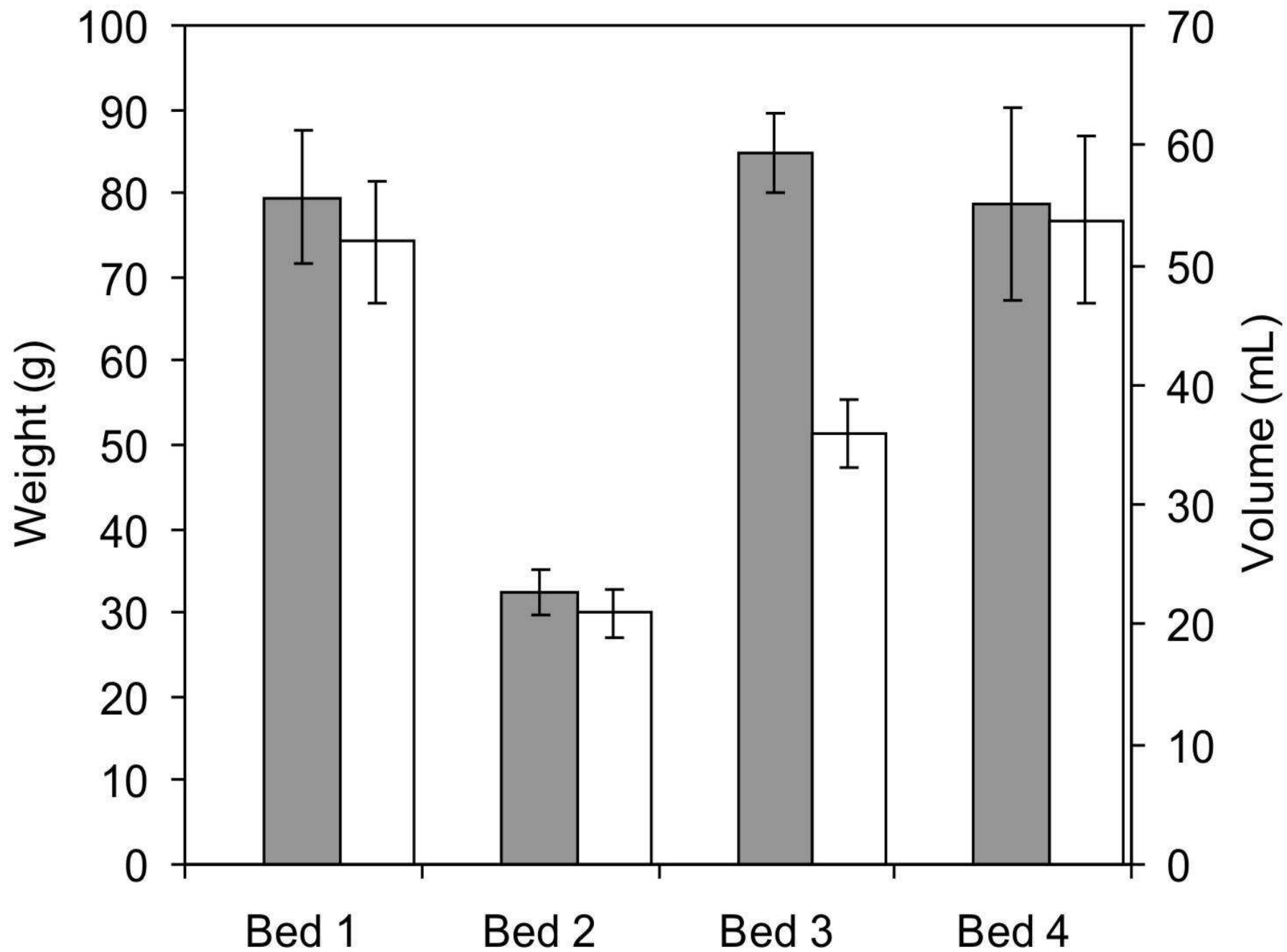
$$\frac{L-I}{L-S}$$

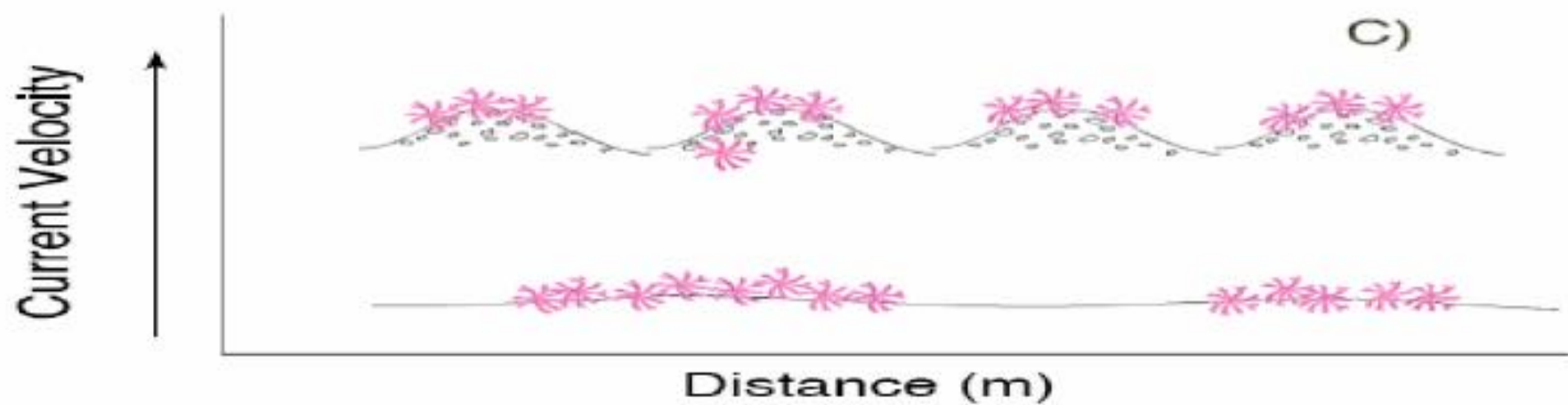
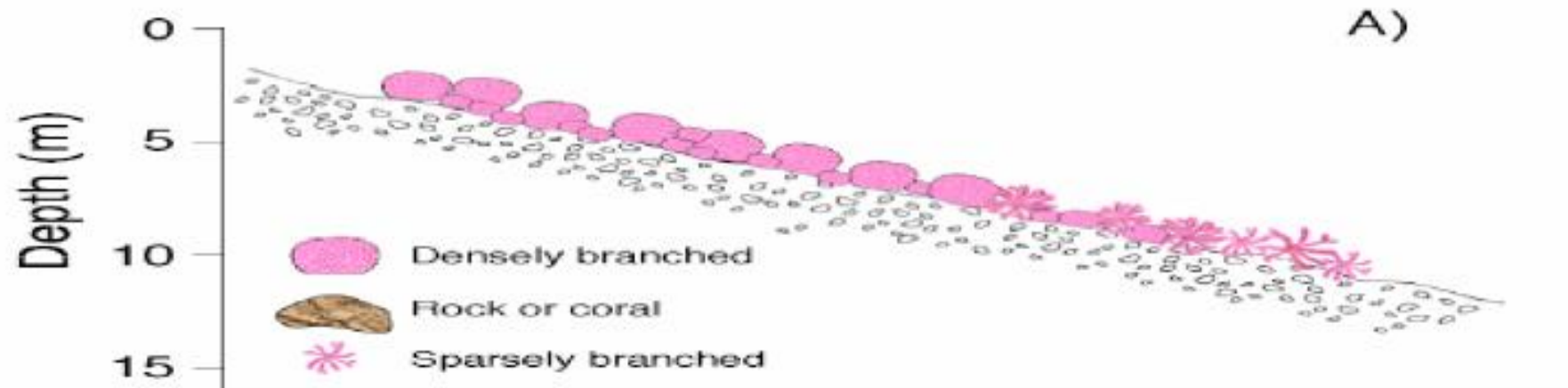
Ellipsoidal



C. Lower (8-10 m)

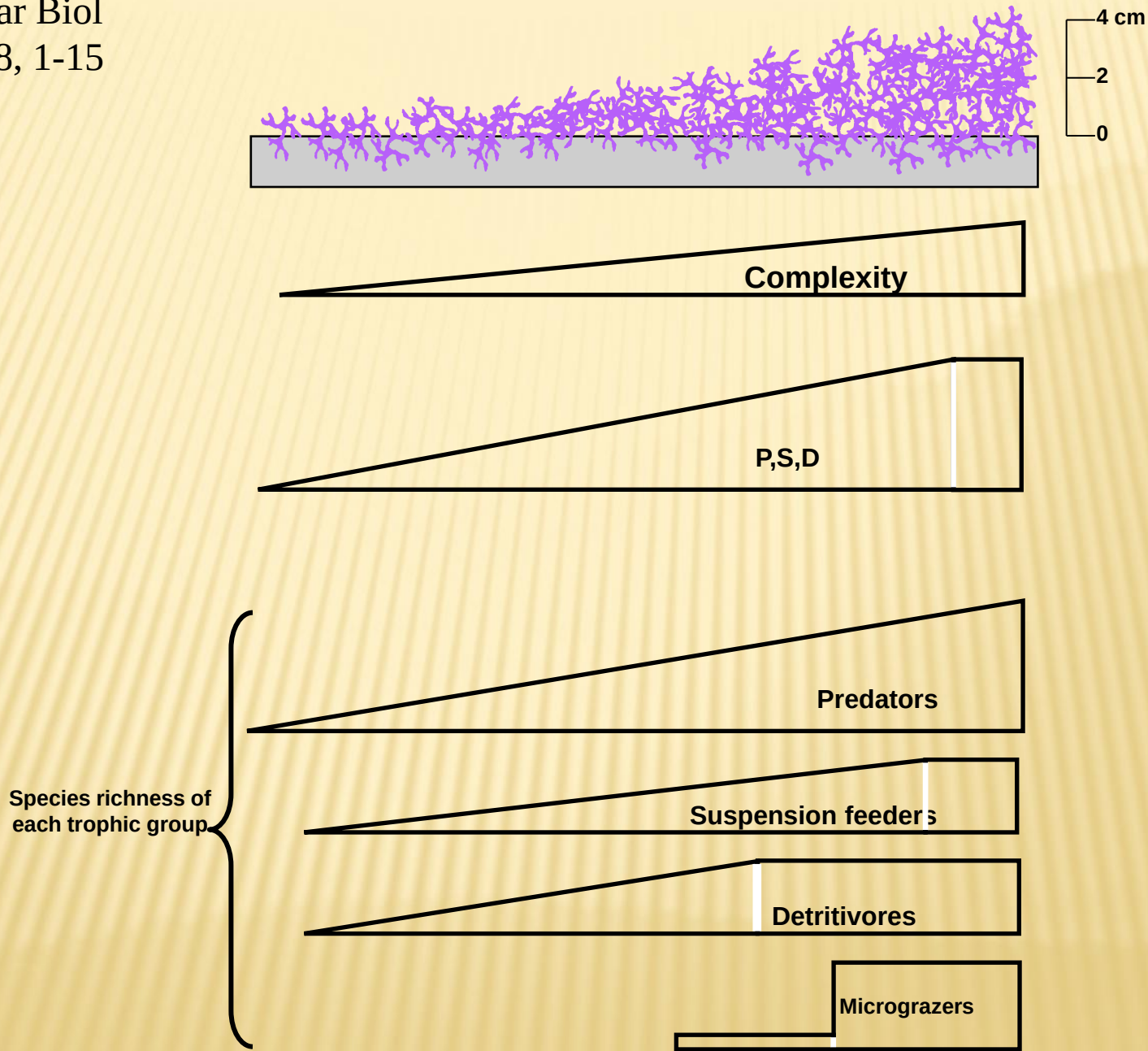








Incrementando el espacio vital



Ecology of Rhodolith Bed Communities (Systems)

► Effects of epiphytes:

Negative: reduce light & survivorship, increase sedimentation?

Positive (facilitative): shade, food for fauna & nutrients for rhodoliths?





(A) Richness			Habitat	
			Sandflat	Rhodolith bed
Organism type	Subhabitat	n	No. species (unique)	No. species (unique)
Epiflora	Surface	10	2(0)	4(1)
Epifauna	Surface	10	9(5)	7(3)
Cryptofauna	Rhodolith	3	×	33(26)
Infauna	Sediment	3	19(11)	14(5)
Total			30	52*

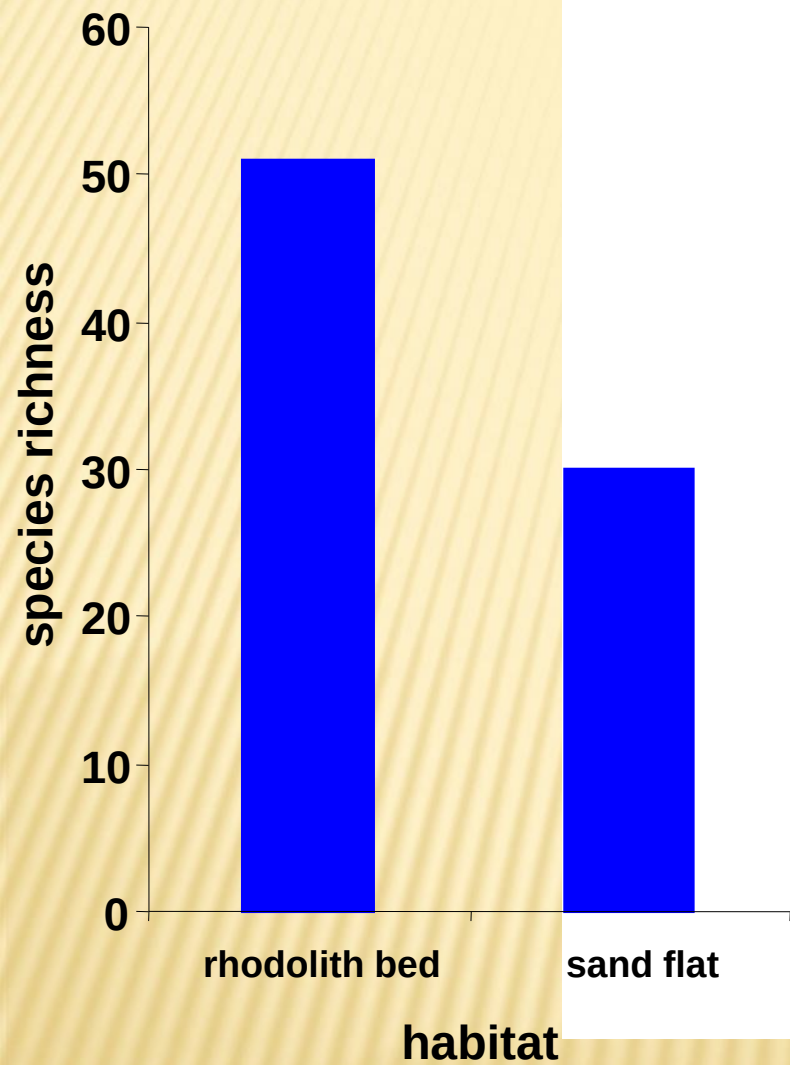
(B) Density				
#organisms per unit subhabitat	Subhabitat	n	(avg + S.E.)	(avg + S.E.)
Epifauna(#. m ⁻²)	Surface	8	0.72 + 0.32	1.44 + 0.72
Cryptofauna(#. m ⁻²)	Rhodolith	8	×	1 402 000 + 243 604
Infauna(#. m ⁻² to 10 cm depth)	Sediment	8	1466 + 322	2473 + 393
Estimated total abundance(#. m ⁻²)		8	1466 + 322	1 402 000 + 243 997

*Total species in rhodolith bed is 52 due to 6 shared species between the cryptofauna and infauna.

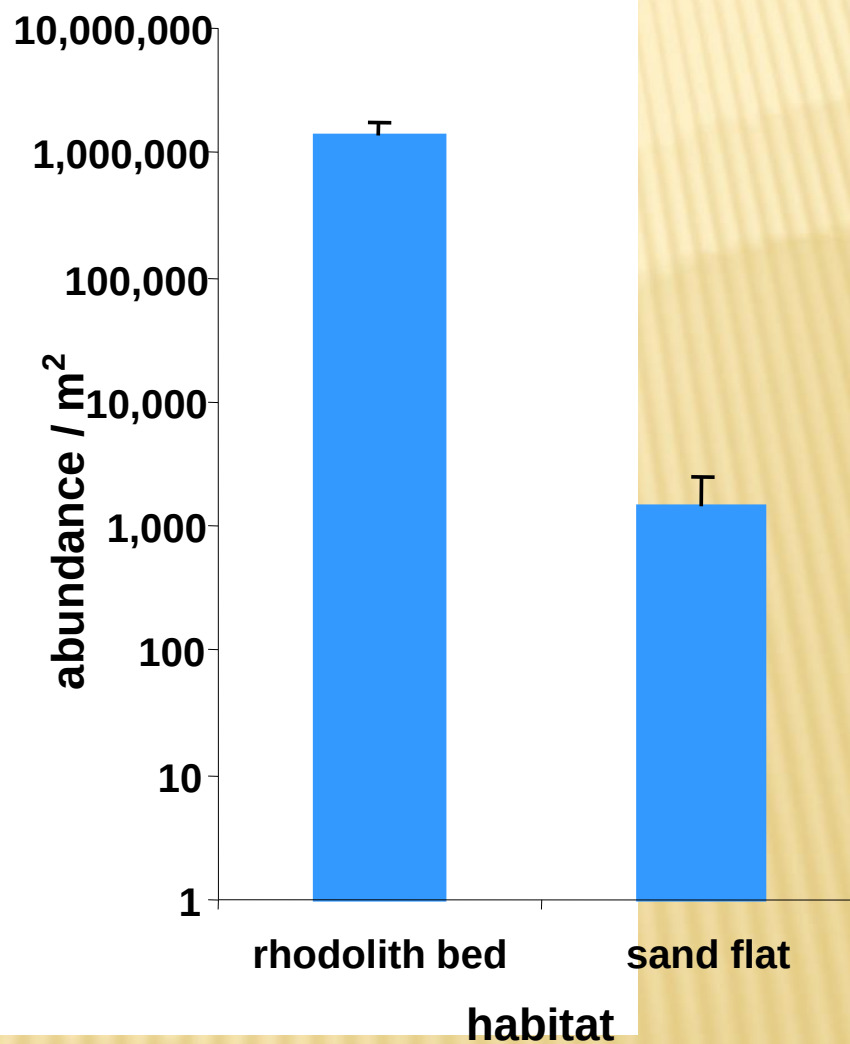


Over the last 20 years taxonomic publications of associated species have shown the relevance of the habitat in where Amphipods, Tunicates, Sponges are the most studied taxa.

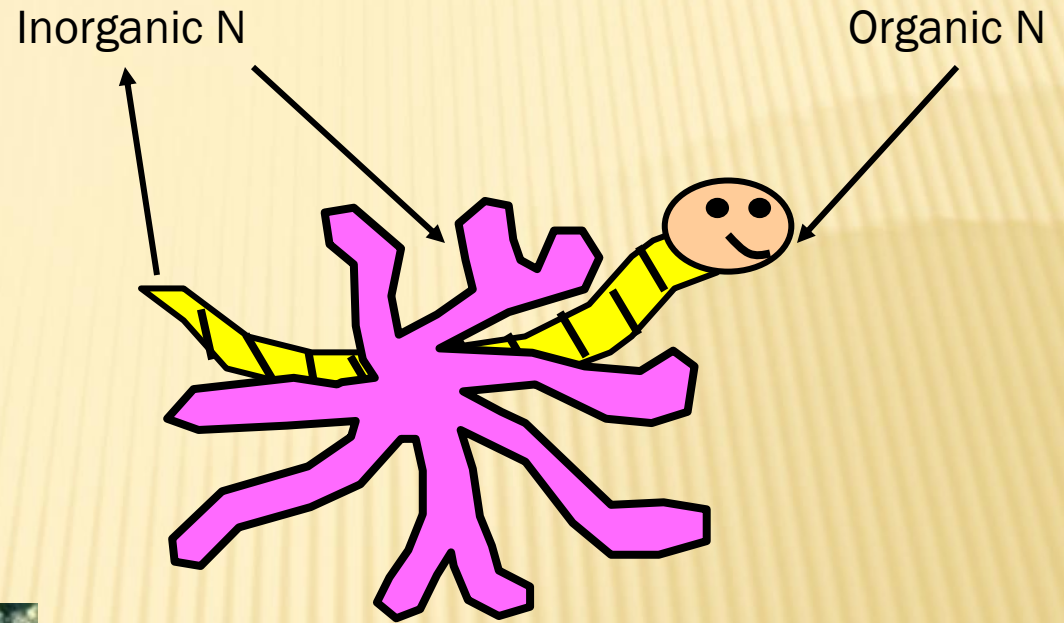
Richness



Abundance

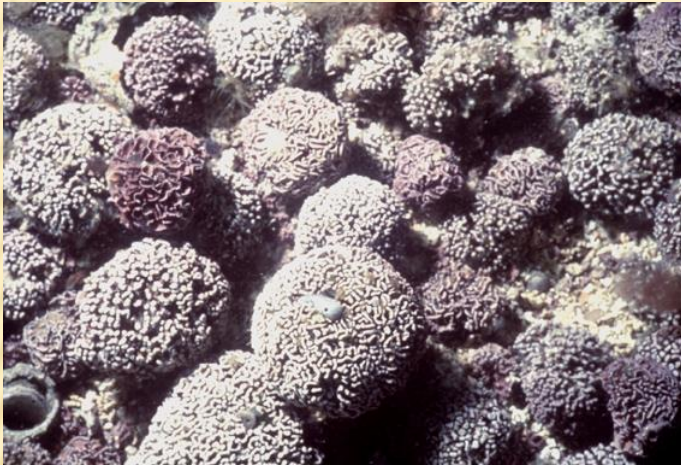


- Provide nutrients (Martin et al.)



Are rhodoliths dependent on inorganic N
in the surrounding ocean?

► What is the relative importance of movement?



Lithophyllum margaritae

Shape &
branching



Fouling

Riosmena



Prevent
anoxia &
remove
sediment

Field movement rates and lengths of time buried?

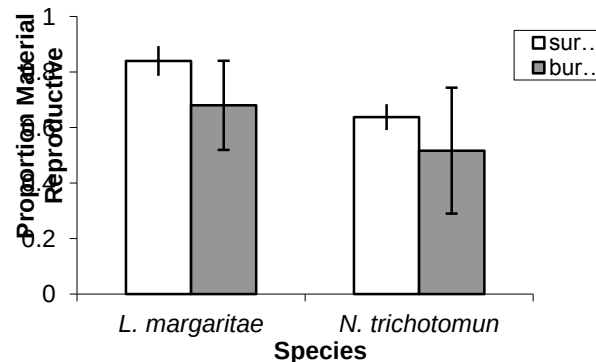
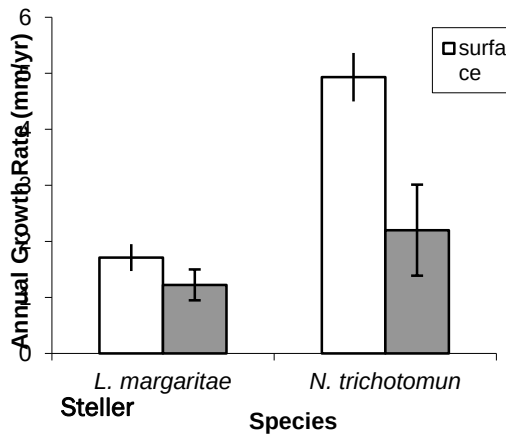
Biology of Individuals

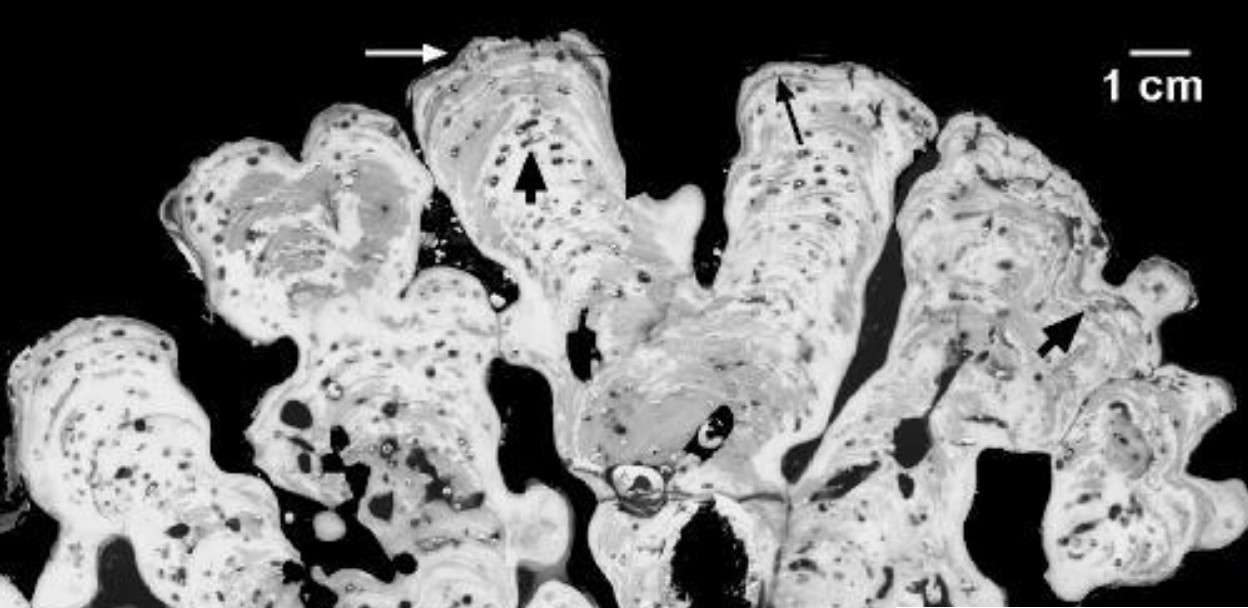
► How respond to and recover from disturbance (stress)?

Relationship to cell biology & physiology

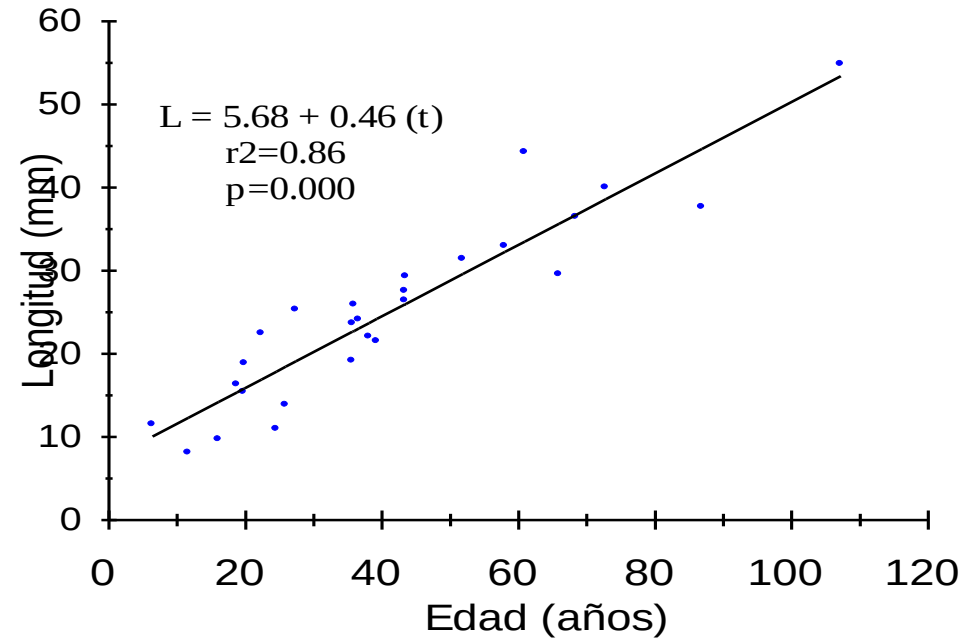
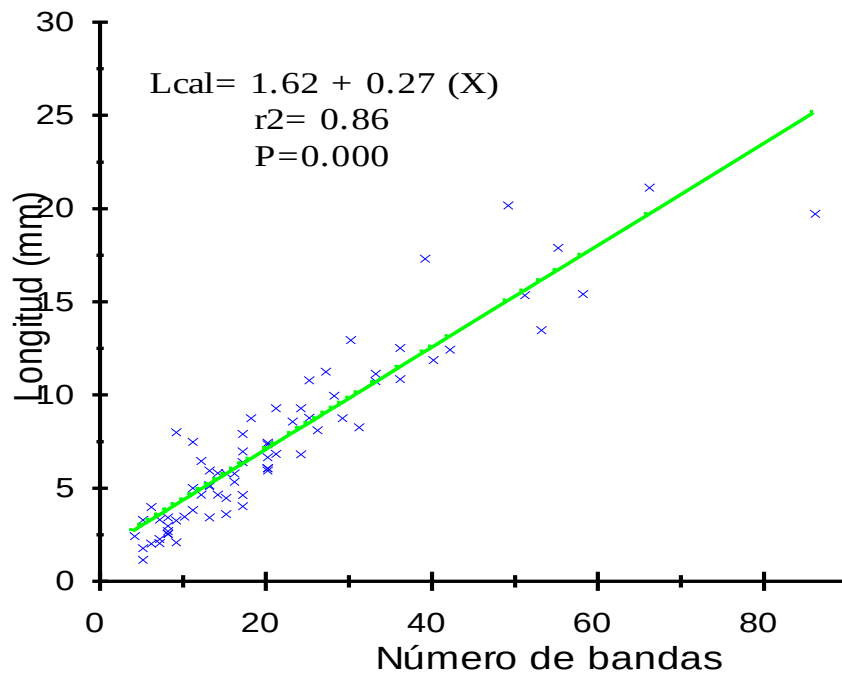
Observations:

- recovery after bleaching
- pigment may be concentrated on surface away from stress
- grow & reproduce while buried in coarse sediment
- anoxia kills (Hall-Spencer et al., Wilson et al.)





Donde para *L. muellerii* la tasa de crecimiento promedio anual fue de 0.60 mm/año con individuos de hasta 120 años de antigüedad.



(M. Rivera et al. 2004)

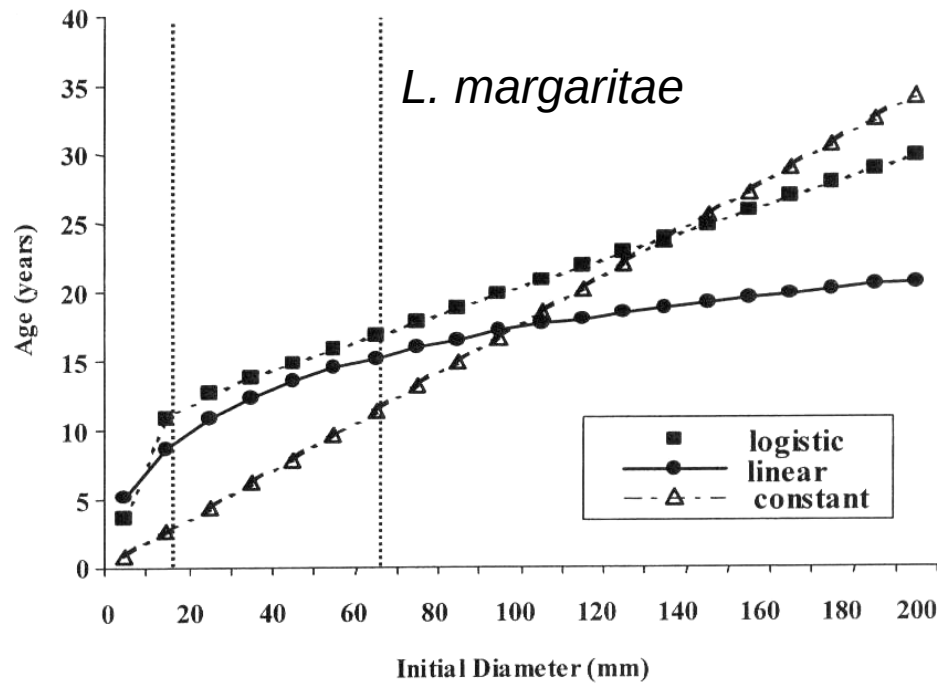


Tasa de Crecimiento

L. muellerii 0.6mm/yr

L. margaritae 5.6mm/yr

S. trichtomum 7-8mm/yr

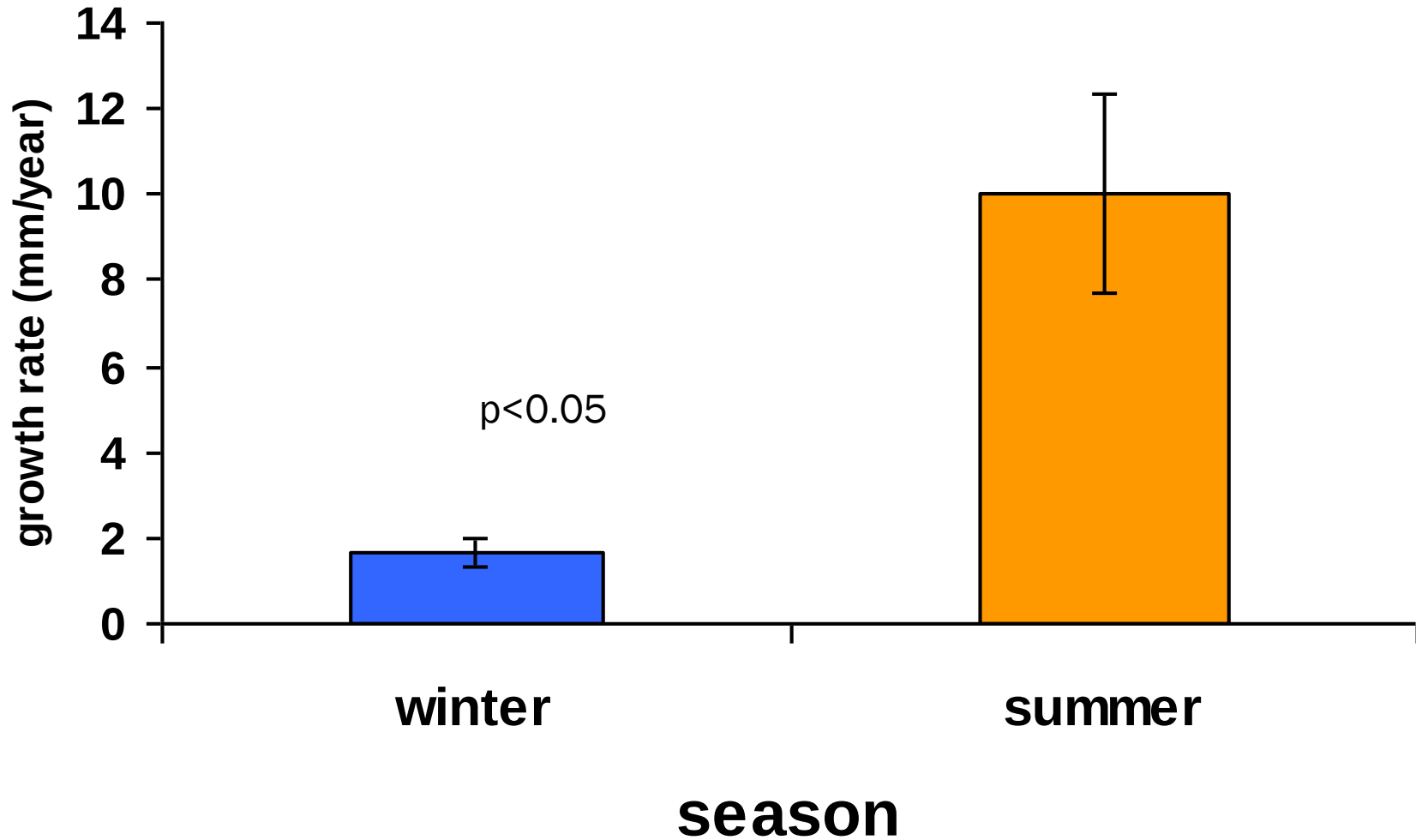


(Steller 2003)



Seasonal variation

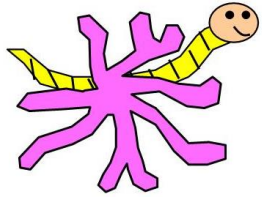
(2-4 cm tamaño)



Tasa de crecimiento anual

5.62+1.19mm/year

2nd International Rhodolith Meeting



La Paz, BCS, Mexico
Sponsored by UABCS/MLM/BCSES



III International
Rhodolith Workshop



Over the last decade approximately 130 papers related to rhodolith/mäerl ecosystem has been published in a peer reviewed/indexed journals and is bringing the international attention to this ecosystem.

