Gorgonian Biogeography in the Indo-Pacific: An Understudied Mecca of Biodiversity

Gorgonian Corals: Definition & Importance

Gorgonians (Cnidaria: Anthozoa: Octocorallia) are an extremely widespread, diverse, and charismatic group of soft corals comprised of over 100 genera in 23 families.

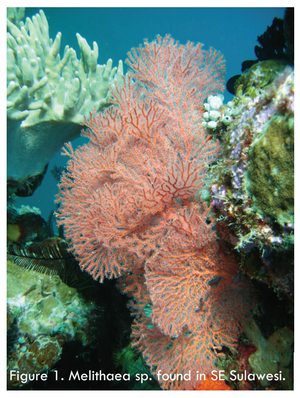


Figure 1. Melithaea sp. found in SE Sulawesi.

They can be found at all depths and all over the world. In addition to their staggering biodiversity, gorgonians are also an integral component of reef ecosystems increasing habitat complexity and therefore reef biodiversity by providing protection, food, and shelter for other marine benthic organisms. Given their essential role in these ecosystems and their wide distribution, gorgonians make useful indicators of reef health, and are a growing area of ecological research.

Recent research and anecdotal evidence has shown that biodiversity and abundance of gorgonians increases with depth as habitats transition from shallow-water to mesophotic reefs. Biodiversity on mesophotic reefs is exceptionally high compared to that of shallow-water, with communities comprised of zooxanthellate corals, azooxanthellate scleractinian and black corals, macroalgae, and sponges, as well as their associated microbial communities.

These coral-reef ecosystems are found from 30m to 200m and are characterized by steep light gradients, high levels of nutrients and particulate organic material delivered by upwelling and internal wave action, and lower temperatures. Importantly, they are protected from stressors created by destructive wave and storm energy, high UV radiation, and extreme sea surface temperatures. The Center of Refuge hypothesis posits that due to its thermally benign and stable environment, the mesophotic zone is a center of refuge for Indo-Pacific biodiversity and that these intermediate depths may serve as nurseries, and sources/sinks of larval recruits for many marine organisms including gorgonians. However, despite its apparent importance, very little research has been conducted in the mesophotic zone due to limited technology and expenses.

The Indo-Pacific and the Coral Triangle is a region encompassing Indonesia, Malaysia, Papua New Guinea, the Philippines, Timor Leste, and the Solomon Islands, and is generally considered the global epicenter of marine biodiversity. However, knowledge of species distributions, population dynamics, and diversity in this area, especially in regards to gorgonians, are extremely lacking compared with other locations such as the Caribbean. This region is also threatened by climate change and anthropogenic impacts. Further understanding and research is needed in order to preserve not only the biodiversity, but also the economic services provided by these resources to the surrounding communities.

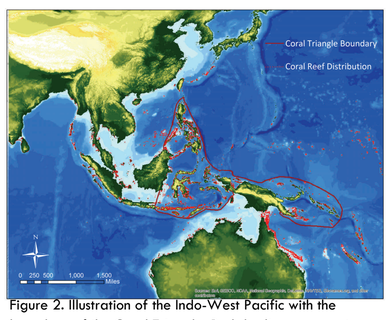


Figure 2. Illustration of the Indo-West Pacific with the boundary of the Coral Triangle. Red shading represents distribution of coral reefs in this region.

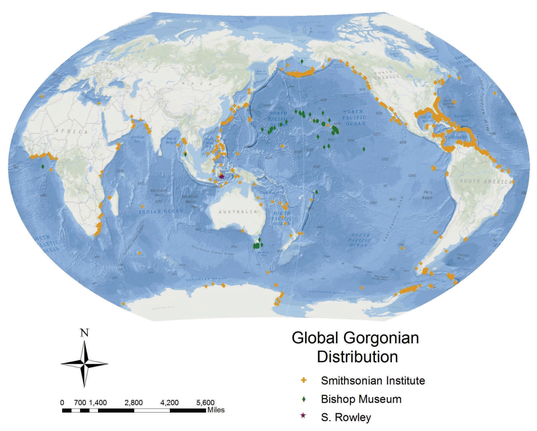


Figure 3. Global distribution of gorgonian corals based on museum and field specimen collections.

Using gorgonian museum specimen and field collection data from the Coral Triangle, I test whether gorgonian coral diversity increases with depth.

Conclusions and Implications for the Future

Despite regional variation, the overall depiction of gorgonian distribution in the Indo-Pacific clearly demonstrates not only the incredible breadth of these charismatic animals, but also the need for further research regarding the mechanisms behind gorgonian biodiversity. Surprisingly little research has been conducted on gorgonians within the Indo-West Pacific and Coral Triangle, despite their known enormous presence, and even less research has been conducted in the mesophotic zone. Financing further research will be integral to a better understanding of the role of mesophotic reefs as refugia and sources of shallow water larval recruits for a wide variety of organisms, including gorgonians. This knowledge will be essential in developing conservation strategies to preserve ecosystems in the face of rapid climate change and destructive anthropogenic impacts. Additionally, this project highlights the importance of museum collections, which provide key insight, inspiring new research questions. Results from this project suggest that further research should encourage greater sampling effort and the examination of sub-zones within mesophotic reefs to investigate at which depths gorgonians become the dominant presence in mesophotic coral ecosystems.

Methodology

Gorgonian distributions were compiled and synthesized using databases provided by author S. Rowley (unpublished) and two museums, courtesy of the Smithsonian Institute and the Bernice Pauahi Bishop Museum. Decimal degree locations were entered into ArcGIS10.1 and the layers were projected into the World Winkel Tripel NGS with a central meridian of 156.000. Shallow (0-29m) and mesophotic (30-200m) zones were compared and count tables based on the families were created for the whole sample and sub-regions.

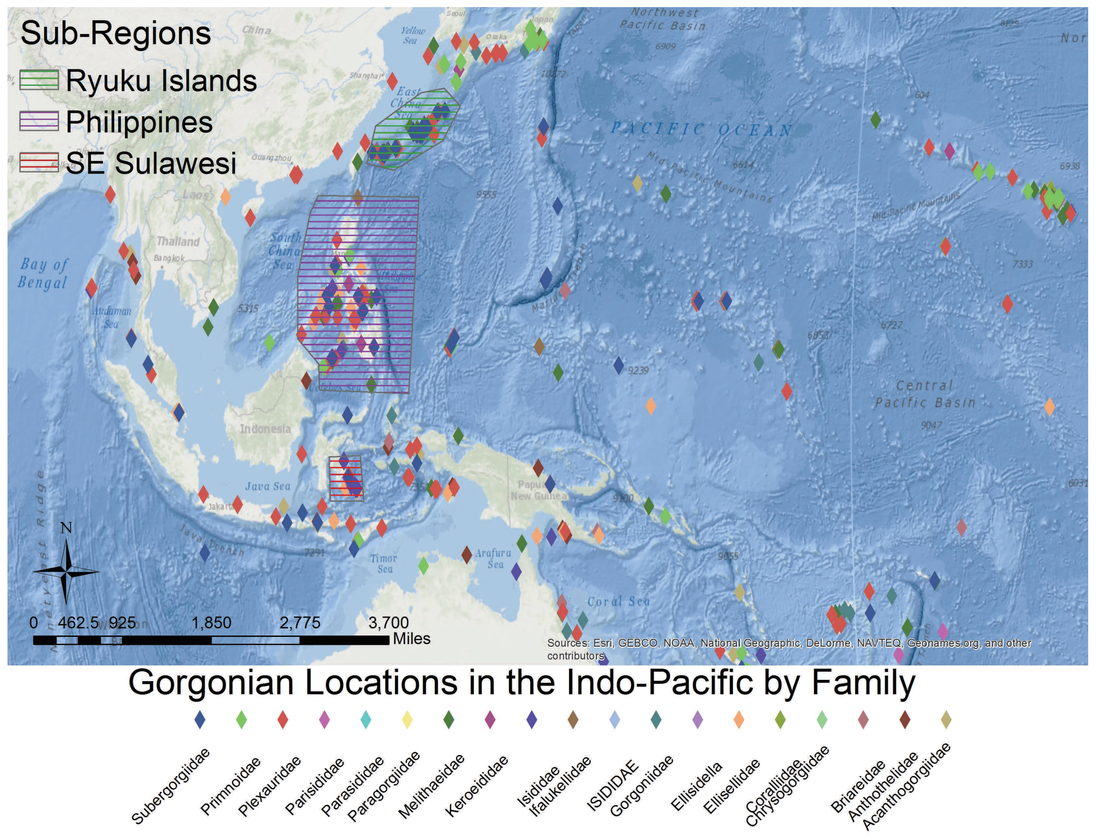


Figure 4. Gorgonian biodiversity within the Indo-Pacific and Coral Triangle based on scientific family, using museum and field specimen collections (n = 4,763).

Results

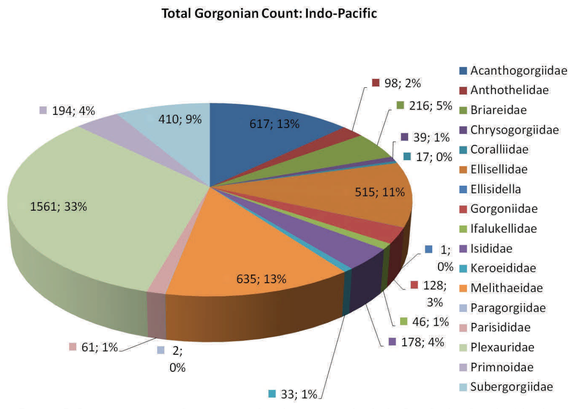
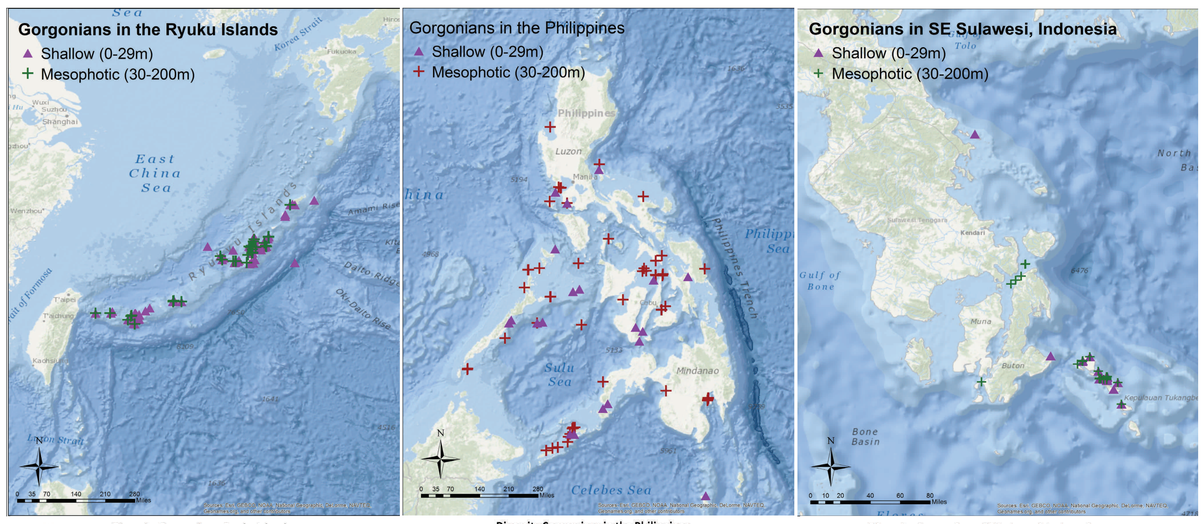


Figure 5. Representation of gorgonian biodiversity in the Indo-Pacific by family. Number represents total count of individuals followed by percentage of total gorgonian specimens.

Graphs comparing the biodiversity between shallow and mesophotic zones showed regional variation within the Indo-Pacific. In the Philippines, mesophotic gorgonians appear to be more abundant than shallow gorgonians, whereas in SE Sulawesi the shallow gorgonians were more abundant. The mesophotic and shallow gorgonian abundances appear to be similar in the Ryuku Islands. These differences are most likely attributed to sampling, but the abundance of mesophotic gorgonians in the Philippines provides evidence for the hypothesis that gorgonians grow more abundant at greater depths.



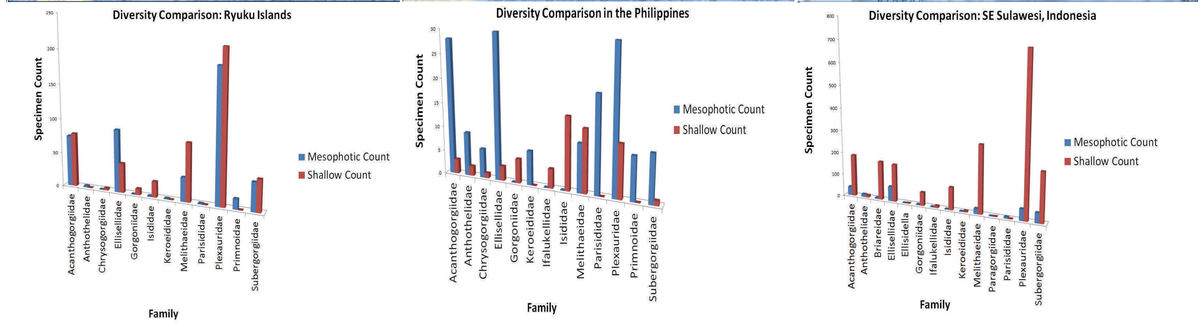


Figure 6. Shallow-water and mesophotic gorgonian biodiversity examined by sub-region.

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Course Intro to GIS
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Projection World Winkel Tripel NGS
Data Sources Gorgonian distribution data courtesy of the Smithsonian Institute, the Bernice Pauahi Bishop Museum, and Sonia Rowley (unpublished data), Coral Triangle Atlas (ctatlas.com)

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References

Kahng, S.E., Garcia-Sais, J.R., Spalding, H.L., Brokovich, E., Wagner, D., Weil, E., Hinderstein, L., Toonen, R.J. 2010. Community ecology of mesophotic coral reef ecosystems. Coral Reefs. 29: 255-275.

Kinzie, R.A. 1974. *Plexaura homomalla*: the biology and ecology of a harvestable marine resource. Prostaglandins from *Plexaura homomalla*: Ecology, Utilization and Conservation of a Major Medical Marine Resource A Symposium. 22-38.

Lesser, M.P., Slattery, M., Leichter, J.J. 2009. Ecology of mesophotic coral reefs. Journal of Experimental Marine Biology and Ecology. 375:1-8.

Mora, C., Chittaro, P.M., Sale, P.F., Kritzer, J.P., Ludsin, S.A. 2003. Patterns and processes in reef fish diversity. Nature. 42: 933-936.

Olson, J.B., Kellogg, C.A. 2010. Microbial ecology of corals, sponges, and algae in mesophotic coral environments. FEMS: Microbial Ecology. 73:17-30.

Sanciangco, J.C., Carpenter, K.E., Etnoyer, P.J., Moretzsohn, F. 2013. Habitat availability and heterogeneity and the Indo-Pacific warm pool as predictors of marine species richness in the tropical Indo-Pacific. PLOS One. 8(2): 1-18.