

## Interesting Images

# Unusual Morphotypes of the Giant Barrel Sponge off the Coast of Barbados

Joseph R. Pawlik <sup>1,\*</sup>, Denise C. Manker <sup>2</sup>, James S. Evans <sup>1</sup>, Patrick M. Erwin <sup>1</sup> and Susanna López-Legentil <sup>1</sup>

<sup>1</sup> Department of Biology and Marine Biology and Center for Marine Science, University of North Carolina Wilmington, Wilmington, NC 28409, USA; jse3f@virginia.edu (J.S.E.); erwinp@uncw.edu (P.M.E.); lopezlegentils@uncw.edu (S.L.-L.)

<sup>2</sup> Bayer US, Crop Science, Research and Development, 890 Embarcadero Dr., West Sacramento, CA 95605, USA; denise.manker@bayer.com

\* Correspondence: pawlikj@uncw.edu

**Abstract:** Giant barrel sponges (GBSs) belong to a cryptic species complex (*Xestospongia* spp.) and are found on tropical reefs worldwide. Over their range, including most of the Caribbean, GBSs have a cylindrical shape, with variation in height, diameter and surface complexity. However, off the southwest coast of Barbados, GBSs mostly exhibit a clam shape or a tub shape, interspersed with a few that have the normal barrel morphotype, suggesting that this variation is not due to environmental factors. Haplotype identification (mtDNA-COI) of six clam and six normal sponges indicated no clear genetic differentiation based on morphotype; hence, this morphological variation remains unexplained.

**Keywords:** Porifera; Caribbean; coral reefs; morphology; cryptic species; ecotypic variation; phylogenetics



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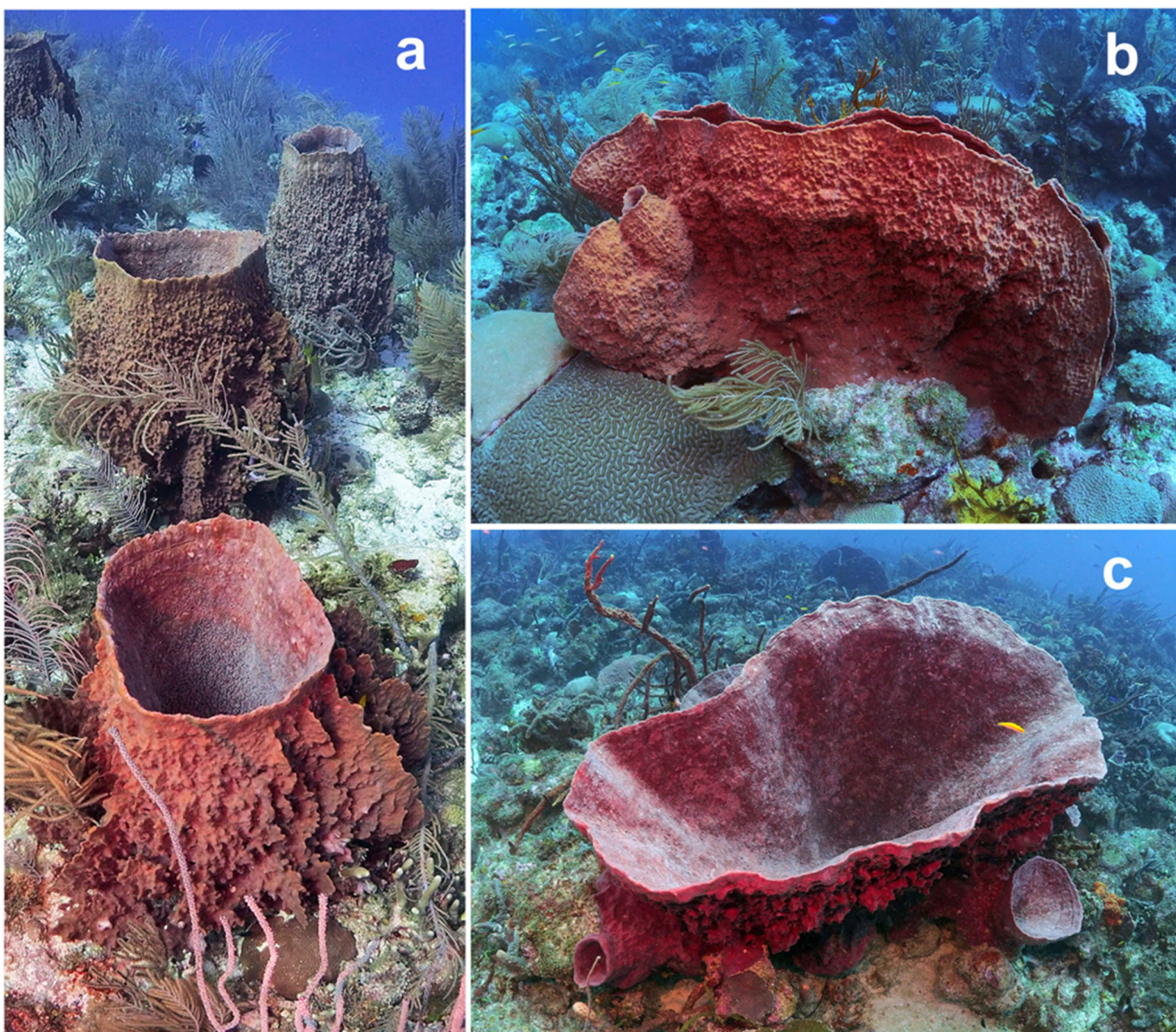
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Morphological variation is foundational in delimiting species in many animal phyla, with notable exceptions among modular and clonal taxa such as sponges [1]. Phylogenetic analyses revealed interesting examples of substantial morphological variations within sponge species [2], and examples of cryptic species with apparently identical morphologies [3]. Clear morphological differences between species are helpful to researchers when visually identifying sponges [4], particularly when choosing experimental subjects or compiling benthic survey data.

On most tropical reefs, giant barrel sponges (GBSs) of the genus *Xestospongia* have a normal barrel morphology (Figure 1a), with variation in height, diameter, and surface complexity (smooth to highly papillate) [5], and a generally cylindrical inner cavity of the sponge (atrium). In surveys of sponges on reefs across the Caribbean [6], the GBS (as *Xestospongia muta*) was the second most common sponge species as a percentage of reef surface area, and was found to almost exclusively exhibit this normal barrel morphology. However, on reefs off the southwest coast of Barbados [7], the most common morphology is similar to that of a clam (Figure 1b), with the atrium forming a long slit. The second most common morphology is similar to a tub (Figure 1c), with the atrium opening widely, and the outer lip exceeding the diameter of the base of the sponge. These two morphotypes co-occur with the normal barrel-shaped morphotype, which is least common on reefs off the southwest coast of Barbados. Morphology has important implications for pumping rates of GBSs [8], but how these very different morphologies affect water processing is not yet known. Both clam and tub morphotypes are known from other locations in the southeast Caribbean: in Tobago, the clam morphotype is common [9], and the tub form was photographed in Curaçao [10], but all three are present in proximity to each other in Barbados.

What is the reason for the morphological variation seen in GBSs off the coast of Barbados? The co-occurrence of all three morphotypes next to each other suggests that the

variation in morphology is not due to environmental factors, such as localized water flow. Is there a genetic difference between the morphotypes? GBSs were recently found to include several cryptic species [11–13], with evidence of genetic differentiation among sponges with different surface morphologies on reefs off the coast of Indonesia [5]. We sequenced a fragment of the barcoding gene (mtDNA-COI) on tissue samples from six sponges each with the clam and normal barrel morphotypes from Barbados and compared these with samples of normal barrel morphotypes from a long-term study of GBSs on Conch Reef, Florida Keys [12,14] and the global network of GBS haplotype diversity [11,13] (Table 1). While the sponges with the clam morphotype shared the same haplotype (C2/H1), they also shared this haplotype with sponges having the normal barrel morphotype from Barbados, other locations in the Caribbean Sea, and other ocean basins (Table 1). Therefore, an explanation for the morphological variation among GBSs off the coast of Barbados remains elusive.



**Figure 1.** (a) *Xestospongia muta*, showing examples of the normal barrel morphotype off Carrie Bow Cay, Belize. (b,c) The clam and tub morphotypes, respectively, off the SW coast of Barbados. (a) Photograph taken at ~20 m depth on Carrie Bow Cay reef, March 2019. (b,c) Photographs taken at ~20 m depth on Pine Shallows reef, near Needhams Point, January 2019. Sponges are ~0.5 m, ~1.5 m and ~2 m across, respectively.

**Table 1.** Genetic classifications and morphotype diversity of giant barrel sponges (GBSs) of the genus *Xestospongia*, highlighting shared haplotypes between clam and normal morphotypes in Barbados based on partial mitochondrial cytochrome oxidase subunit I (COI) gene sequences. GenBank accession numbers for sequences obtained here: OL693693-704.

Microsatellite Cluster [12]	COI Haplotype [11,13,15]	Morphotypes (This Study)	Location [5,11,15]
1	C2/H1	Clam (n = 6), Normal (n = 2)	Caribbean Sea, Indo-Pacific Ocean, Indian Ocean
2	C5/H3	Normal (n = 4)	Caribbean Sea, Indo-Pacific Ocean, Indian Ocean, Red Sea

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