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# Distribution and abundance of Ophiothrix suensonii on sponge vs. non-sponge habitat at Whale Shoals patch reef, Belize

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## INTRODUCTION

In Caribbean patch reef environments, space is limited and fish predation is heavy. Therefore, habitat competition and limited mobility often force cryptic invertebrates to become associated with sessile organisms for survival. For example, a strong association between various Porifera and brittle stars has been observed throughout Caribbean reef systems (Henkel 2004; Pawlik 2004). The unique morphology of tube and barrel sponges may offer excellent protection to brittle stars, which can intermingle and hide within the sponges' rigid oscula.

The chemical nature of sponges is a potential deterrent for predatory fish, making many sponges ideal hosts to brittle stars (which are often immensely vulnerable to fish predation) (Henkel 2004; Pawlik 2004). For instance, many sponges contain defensive secondary metabolites, which are harmful to most reef fish species (Pawlik 1995). Sponge habitat is also beneficial to suspension-feeding and deposit feeding brittle stars, providing greater access to food particles (Henkel 2004; Pawlik 2004). For instance, the unique morphological protection offered by tube sponges allows suspension-feeders to remain regularly exposed to the open flow of food particulates (with a more elevated feeding stance at night). Tubular morphology would appear to be even more advantageous to deposit feeders, which can further conceal themselves within the sponge's structure while ingesting mucus from the sponge's inhalant surface (Henkel 2004; Pawlik 2004). Overall, brittle stars may have developed a dependence on sponges as habitat given the benefits accrued from chemical/structural protection and access to food.

In this study, I examined the distribution of the brittle star *Ophiothrix suensonii* in a patch reef environment with particular interest in its association with *Callyspongia* *vaginalis,* a tube sponge noted by Henkel and Pawlik (2004) to be chemically undefended against generalist fish predators (Fig. 1). Is the visual abundance of brittle stars significantly greater on tube sponges than on surrounding reef structure such as gorgonians, hard coral, detritus, other sponges, and algae? To test this question, I surveyed a patch reef located near South Water Caye in Belize. I hypothesized that *O. suensonii* abundance would be significantly greater on subplots containing a *C. vaginalis* cluster than on those without the tube sponge.

## Materials and methods

Data were collected on June 9, 2011 at Whale Shoals, several miles south of South Water Caye, Belize. Dominant fauna across the patch reef included a variety of hard and soft corals. Porifera were also abundant. I observed eight sample areas, each containing a set of paired, adjacent plots: one with a *C. vaginalis* cluster and one without. Plots were marked out by 1 x 1 meter PVC quadrants submerged by 2 lb diving blocks. Paired plots were deliberately chosen so that reef surface area was similar (including distribution of corals, detritus, other sponge species, and algae), except for the presence of a tube sponge cluster (Fig. 2). I quantified the abundance and distribution of brittle stars in each subplot. Data were analyzed using a paired T-Test (MS EXCEL).

## Results

The final data support my hypothesis that *O. suensonii* abundance would be significantly greater in subplots containing a *C. vaginalis* cluster than in those without the tube sponge. Brittle stars were frequently found in direct contact with tube sponges and hardly present on any other reef structures. The visual abundance of *O. suensonii* in subplots containing a *C. vaginalis* cluster was significantly greater (p=. 0013, n=8) than in plots without the tube sponge (Fig 3). Plots containing *C. vaginalis* had an average visual brittle star abundance of 14 individuals (Fig. 3). Adjacent plots without *C. vaginalis* had an average visual brittle star abundance of one individual (Fig. 3). Plots with larger tube sponge clusters tended to host a greater number of brittle stars than plots with smaller clusters.

*Ophiothrix suensonii* was only found in direct contact with sponges and gorgonians. (Soft corals were left unidentified in the study; however, only one species was noted.) The vast majority of *O. suensonii* were found clinging to *C. vaginalis*, as indicated by Fig. 4. Four sponge species were found in contact with *O. suensonii*: *Callyspongia vaginalis, Niphates digitalis, Ircinia felix,* and *Verongula rigida*. The observed ratio of brittle star abundance between *C. vaginalis* and the combined abundance of the other three Porifera species was estimated to be 4:1—a pooled ratio that further supports the brittle star's preference for the one sponge species.

## Conclusions

My finding that *O. suensonii* abundance was significantly greater in plots containing *C. vaginalis* corroborates the work of Henkel and Pawlik (2004), who found that sponges serve as a primary habitat to *Ophiothrix* species. Henkel and Pawlik (2004) also noted that *O. suensonii* does not select *C. vaginalis* for chemical protection. Pawlik (1995) found that crude organic samples from *C. vaginalis* yielded no clear chemically deterrent extracts when digested by a common Caribbean wrasse. Referencing Randall's reef fish gut-content analysis of 1968, Pawlik (1995) also noted that *C. vaginalis* was commonly preyed upon by five Caribbean reef fish species. Although brittle stars, including *Ophiothrix suensonii,* are also commonly preyed upon, making up < 10 % of the stomach contents of ten coral reef fish species, only one fish, the filefish (*Cantherhines pullus)*, has been found to ingest both *Ophiothrix* species and sponges (Randall 1967; Randall and Hartman 1968). Therefore, although *C. vaginalis* lacks chemical defense, the sponge serves as a physical barrier nonetheless (Henkel 2004; Pawlik 2004).

The vast majority of brittle stars were found in direct contact with *C. vaginalis*. Several individuals were also found on gorgonians and other sponge species, which supports the finding by Henkel and Pawlik (2004) that *O. suensonii* is not an obligate sponge dweller (unlike *O. lineata,* which they found on *C. vaginalis* 99% of the time). Other Porifera that the brittle stars associated with at Whale Shoals included *Ircinia felix*, *Verongula rigida*, and *Niphates digitalis*. The first two sponges carry defensive secondary metabolites but do not offer equivalent structural protection as *C. vaginalis* and *N. digitalis* (personal communication, Klaus Ruetzler, Smithsonian Institution). *C. vaginalis* and *N. digitalis* are structurally more complex than *I. felix* and *V. rigida*, which lack both sizable oscula and the security offered by such morphological features. *C. vaginalis* and *N. digitalis* were found by Henkel and Pawlik (2004) to host 99% of all the brittle stars they observed. However, *Callyspongia vaginalis* abundance across Whale Shoals was observed in this study to be far greater than *N. digitalis* abundance, making *C. vaginalis* a more common habitat to brittle stars at this location.

Unlike *O. lineata,* a deposit feeder and mutual symbiont of *C. vaginalis*, *O. suensonii* is a passive suspension-feeder and does not clean the sponge's inhalant surface (Hendler 1984). The obvious protection provided by *C. vaginalis* oscula makes this sponge an ideal host to *O. suensonii*, which can intertwine within and around the tubes while maintaining access to passing particles. Overall, *O. suensonii* depends primarily on the sponge's morphological characteristics for protection from fish predation, making *C. vaginalis* a specialized and commensalistic habitat of the brittle star. Henkel and Pawlik (2004) found this same relationship to be prevalent in their six study sites off of Key Largo, Florida. Although *Callyspongia vaginalis* is one of the most common species of Porifera in the Caribbean, this study (in addition to those carried out by Pawlik and Henkel) demonstrates that *Ophiothrix suensonii* prefers *C. vaginalis* to morphologically less complex sponge species, gorgonians, and other reef habitats—which exhibited the presence of little to no brittle stars at Whale Shoals patch reef.

## ACKNOWLEDGMENTS

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## Tables and figures

**Fig. 1.** Brittle star **(***O. suensonii*) inside tube sponge (*C. vaginalis*) at Whale Shoals, Belize.

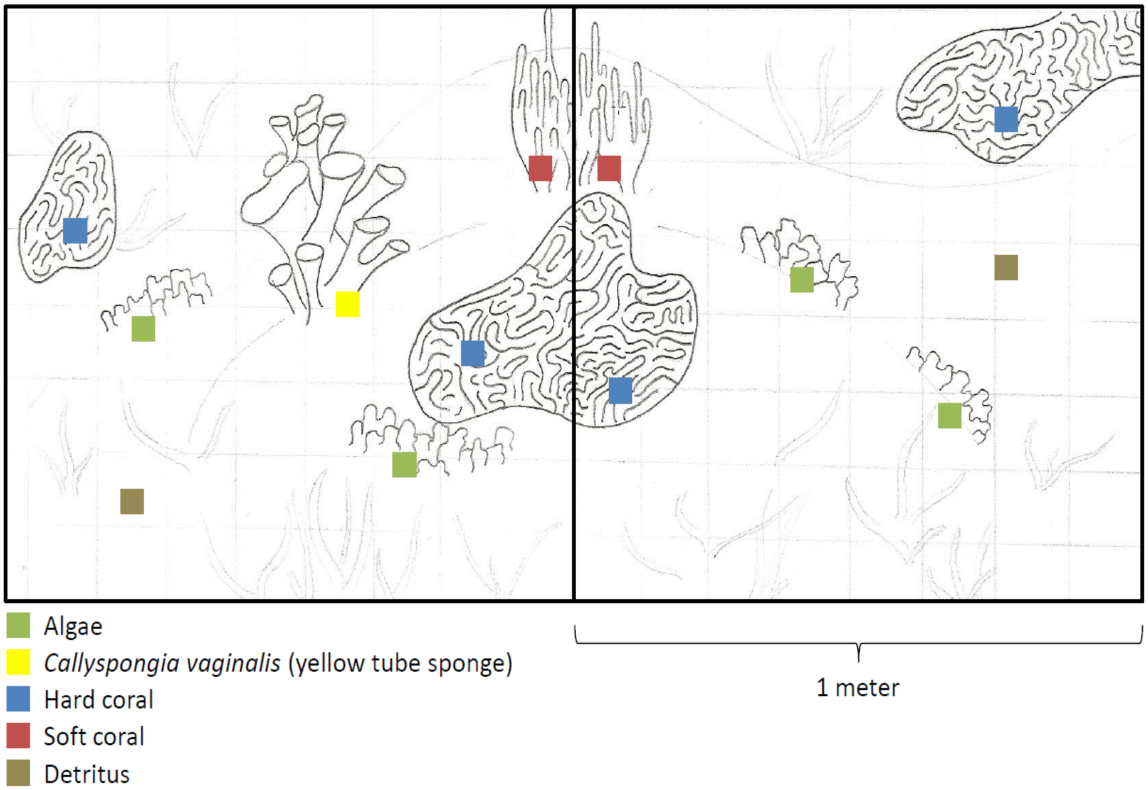


**Fig. 2.** Reef structure distribution diagram of sample area (paired plots).


**Fig. 3**. Comparison of mean (+/- SEM) visual brittle star abundance between subplots with and without *C. vaginalis* clusters (p=.0017, n=8).

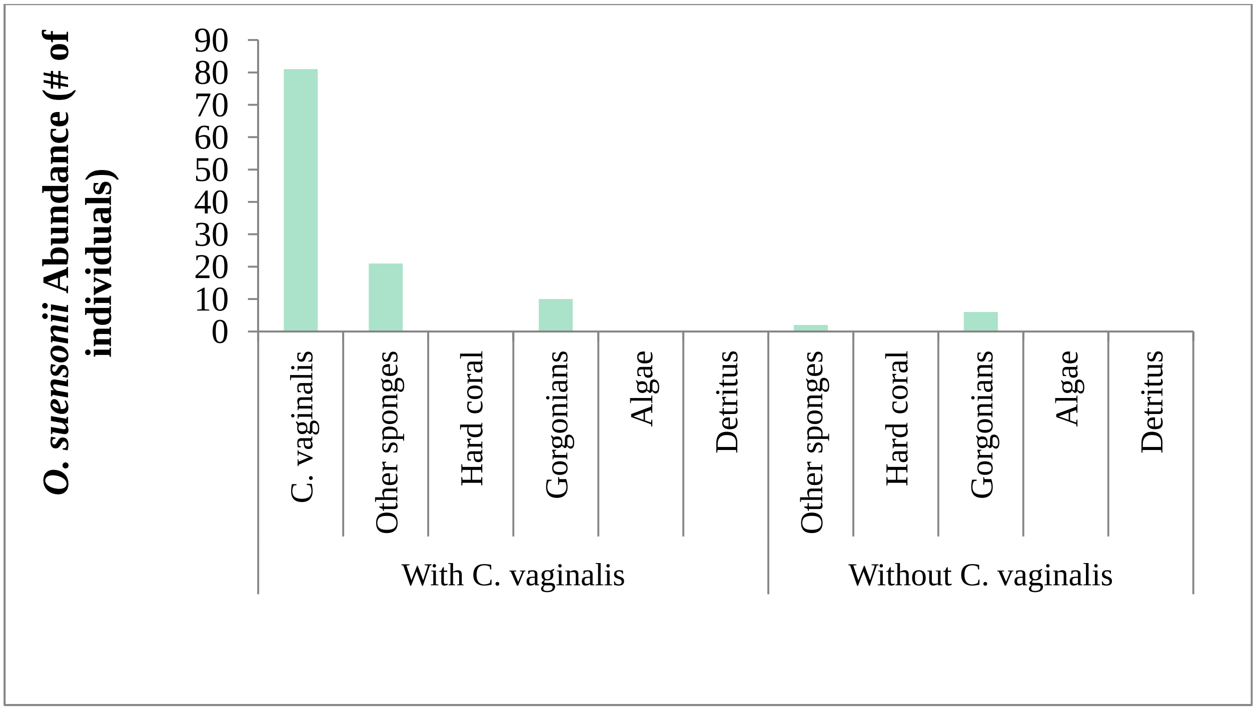


**Fig. 4.** Pooled brittle star abundances on various abiotic and biotic reef habitats in paired plots. Plots were chosen to have similar reef habitat cover.

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