Functional Roles of Sponges on Coral Reefs

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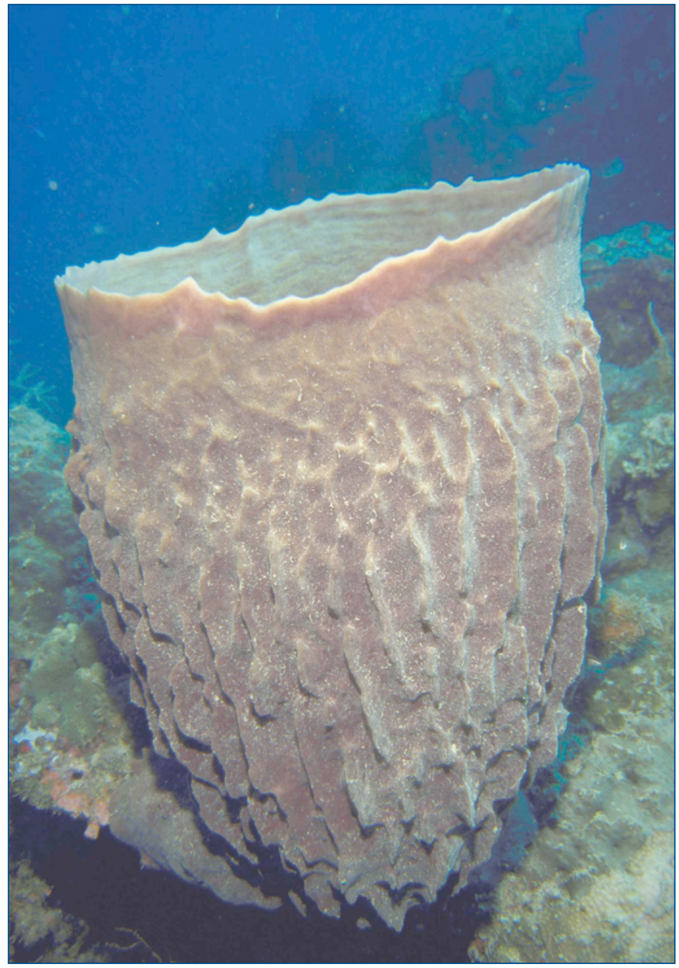
Statement of the Issue

ALTHOUGH a small group of carbonate excavating sponges can dismantle reefs, and some sponges can overgrow corals, it is now known that sponges also substantially benefit coral reefs and associated ecosystems. Sponges benefit reefs by efficiently filtering small (<5um) organic particles from the water column, binding live corals to the reef frame, facilitating regeneration of broken reefs, providing food for spongivores, sheltering juvenile crustaceans such as spiny lobsters, and harboring nitrifying and photosynthesizing microbial symbionts. Sponges uniquely perform many of these functional roles, and possibly others not yet known. However, sponges have not been included in most monitoring programs and assessments due to difficulties in identification and quantification. At the 9th ICRS, it was agreed that greater attention should be focused on sponges and their roles in reef function, particularly in light of recent documentation of rapid losses of sponges from coral reefs and closely associated ecosystems.



Barrel sponge on patch of reef in Raja Ampat, Indonesia

State of Knowledge

Interrelated aspects of the functional roles of sponges on coral reefs can be categorized as (1) interactions with unicellular organisms as symbionts, pathogens, and food; (2) interactions with macroscopic organisms as mutualists, competitors, and predators; and (3) distribution and abundance patterns on geographic and habitat scales.

1) Interactions with unicellular organisms as symbionts, pathogens, and food: Sponges simultaneously feed on, are inhabited by, and suffer disease caused by microorganisms, and it is not known how, or even if, these different interactions influence each other. Concern that sponge disease may be increasing is raised by recent documentations of dramatic losses of sponges from a diverse sponge community in Panama, from large areas of Florida Bay in the USA, from a population of a common species in New Guinea, and from various populations of a conspicuous species throughout the Caribbean. Losses from coral reefs of commercially harvested species to disease have previously been documented. Disease may also be devastating other sponges, but it is difficult to determine because long-term monitoring of sponges in permanent quadrats is rare, and sponges can die and deteriorate quickly, rendering losses invisible without prior detailed site-specific information.

Symbionts of a wide variety of unicellular taxa have become associated with sponges, apparently benefiting both partners in some cases, and influencing the entire system by contributing biochemical talents not inherent to sponges. Some sponge disease might be caused by

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normally beneficial or benign microbial symbionts, if environmental conditions change such that associations are no longer favorable.

It is not known if vulnerability of sponges to microbial pathogens is influenced by their constant internal exposure to water column microbes by feeding currents, or if sponges can consume potential pathogens. Ecosystem level importance of efficient water column clearing by sponges as they feed, first demonstrated by Reiswig, is confirmed by cascading problems associated with recent sponge die-offs in Florida Bay.

2) Interactions with macroscopic organisms – mutualists, competitors, and predators: Apparently more than other reef organisms, sponges live intimately associated with a variety of sessile and mobile organisms, which may significantly influence the success of both partners. Negative repercussions of losses of sponges engaged in these associations range from the loss of juvenile spiny lobster shelter to dramatically increased coral mortality. Some interactions of sponges, especially with predators and competitors, are mediated at least in part by chemistry; presumably the intriguing bioactive chemistry of sponges, that has made them so interesting to pharmaceutical developers, has evolved in this context of protection from potential enemies. Understanding the ecological context for evolutionary development of novel chemistry, e.g., deterence of specific predators or pathogens, can help to focus attention on potentially useful species and contribute to understanding the mechanisms of evolution of bioactive chemistry. However, while pharmaceutical interest in sponges can provide additional sources of funding and impetus for biodiversity conservation, it also raises serious concerns about resource ownership and irresponsible collecting practices.

3) Distribution and abundance patterns on geographic and habitat scales: Surprising results from studies of geography of species boundaries and similarities among sponge assemblages caution us to take care in inferring connections between distant sites. Geographic history plays a large but not a readily predictable role in determining how closely related faunas of adjacent regions or provinces are. High estimates of degrees of endemism, which will increase much more if cryptic species continue to be identified at the present rate, compel us to pay attention to details of distribution data in the design of protected areas aiming to conserve diversity. On a smaller spatial scale, local physical features and environmental factors are more important in determining differences among adjacent local faunas. Understanding constraints on distribution of sponges in adjacent habitats can serve as the basis for using sponges as environmental indicators; sponges may be especially useful for habitats in which stresses (for example, turbidity, storm waves, predators) are difficult to evaluate directly because they are intermittent. Understanding how the reef dismantling action of excavating species may be enhanced by human activities, especially nutrient overloading, may be of particular importance in some areas.

Chief concerns about sponges include: 1) the extent of disease may be increasing, but is not documented due to inadequate monitoring; 2) what appear to be large populations of wide-spread species may actually be more vulnerable small populations of distinct species; 3) environmental change may alter associations with symbionts and other intimately associated organisms; and 4) sponges may play additional functional roles not yet

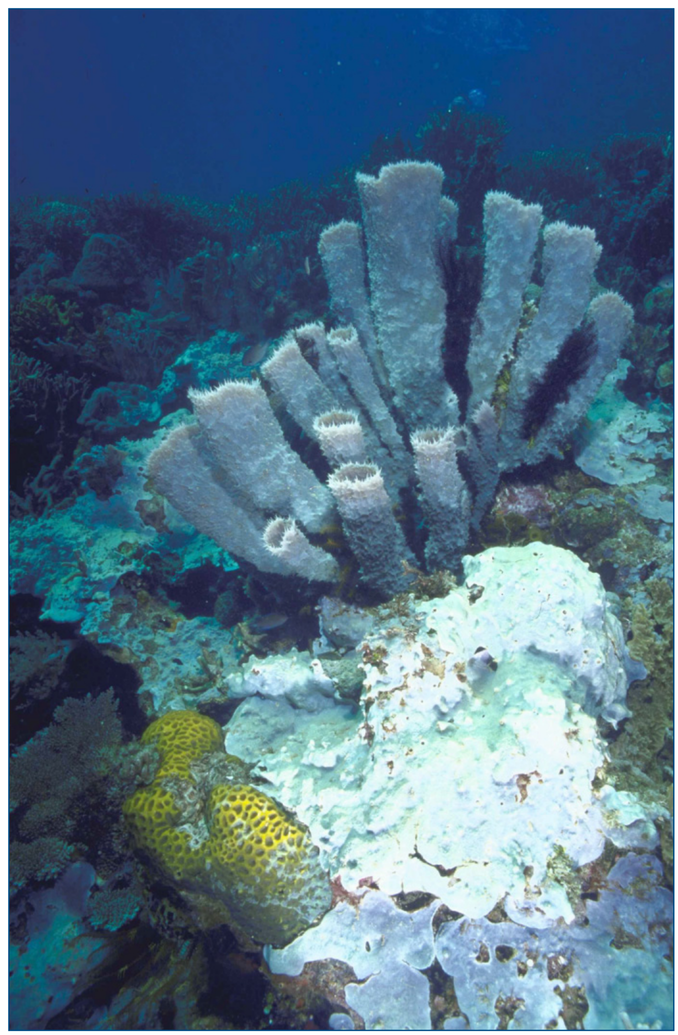

Photo: Roger Steene

Sponges with crinoids and corals on reefs of the Calamaines Islands, Philippines documented but yet vital to reef health – some of the roles that sponges play on reefs that now seem obvious were unknown a short while ago.

Management and Policy Implications

Priorities for sponge monitoring and assessment include:

- keeping track of the abundance of sponges and signs of disease;
- documenting boundaries of species and of faunal assemblages so that appropriate areas can be protected;
- learning about specific constraints on sponge distribution in order to make use of sponges as environmental monitors; and
- continuing to learn about functional roles of sponges on coral reefs.

Specific Recommendations for Action

Careful taxonomy is necessary for clear communication about using particular species as environmental indicators, for bioprospecting, and for determining species boundaries and degrees of endemism for conservation purposes. Guidance for taxonomy can be found in Rützler (1978) and Hooper & van Soest (in press). Emphasis should be given to training the next generation of taxonomists, and incorporating sponge identification in training modules for monitoring.

Permanent transects or quadrats must be used for monitoring sponges if there is any possibility that disease is an issue, because diseased sponges can disappear quickly, without a trace. While repeated random sampling can be demonstrated to provide statistically reliable results, it does not provide confident information on disappearance of organisms between sampling dates and is not adequate for monitoring sponges. Guidance for various aspects of monitoring can be found in Rützler (1978) and Wulff (in press).

The volume of sponges present in an area—even crudely estimated—is a better measure of their abundance than percent cover or number of individuals. Sponges consume food (clearing the water column), provide food for spongivores, and possibly even bind live corals and broken corals to the reef, in proportion to the volume of live sponge present on the reef.

Sponges living within crevices and under corals can be quite abundant, filter seawater efficiently, and may be especially important in enhancing coral survival and stabilizing coral rubble. However, cryptic sponges are invisible to video and other photographic monitoring methods and so must be assessed and monitored more directly.

Useful References and Resources

This paper is based upon papers and posters presented at the 9th ICRS, in Symposium A15, *Functional Role of Sponges on Coral Reefs*, as well as in minisymposia on Bioerosion and on Biogeography.

Rützler, K. 1978. In: Stoddart, D.R. & Johannes, R.E., eds. *Coral Reefs: Research Methods. Monographs on Oceanographic Methodology 5*, UNESCO, Paris: 299-313.

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Wulff, J.L. in press. "Proc. Int. Conf. on Scientific Aspects of Coral Reef Assessment, Monitoring, and Restoration." *Bull. Mar. Sci.*

Hooper, J.N.A, van Soest, R.W.M. in press. *Systema Porifera.*

Requests for help with any aspect of sponge biology, ecology, systematics, chemistry, and monitoring, can be addressed to an internationally subscribed Sponge List at: http://www.PORIFERA@JISCMAIL.AC.UK