PROCEEDINGS

OF THE

12th SYMPOSIUM

ON THE

NATURAL HISTORY OF THE BAHAMAS

Edited by
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and
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Conference Organizer
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Gerace Research Centre
San Salvador, Bahamas
2009

Cover photograph –Barn Owl (*Tyto alba*) at Owl's Hole Pit Cave courtesy of Elyse Vogeli

ISBN 0-935909-89-3

AEQUOREA FLORIDANA: AN ENIGMATIC HYDROMEDUSAE FROM AN ANCHIALINE LAKE ON SAN SALVADOR ISLAND, BAHAMAS

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ABSTRACT

As part of a long term ecological survey of Mermaid Pond, an anchialine lake on San Salvador Island, specimens of the hydromedusae *Aequorea floridana* were collected in successive sampling periods during June 2004 and June 2005. As with many Hydrozoans, the life cycle of the Aequoreidae is complex and consists of an asexual benthic polyp and sexual pelagic medusae stage. Although the asexual stage of *A. floridana* is undescribed, the presence of hydromedusae in two consecutive years suggests that ecological conditions in Mermaid Pond may be suitable for completion of the life cycle in order to maintain a resident population. The origins of this Hydrozoan in Mermaid Pond remain unclear. Larval transport through the conduit system is possible, as is the accidental introduction by seabirds observed to use the pond for refuge. Regardless of the origins, this is the first record of *A. floridana* from Bahamian waters and its presence in an anchialine lake provides additional evidence that the inland waters of San Salvador Island support truly unique ecosystems.

INTRODUCTION

Anchialine ponds and lakes, which are landlocked bodies of water connected to the ocean via subterranean conduits, typically possess distinctive faunal components. These unique environments exhibit many features of adjacent marine ecosystems that are often greatly reduced in complexity and scale. Additionally, local geological and climatic factors may influence the chemical and physical characteristics of these isolated bodies of water, which may affect the inhabitants of these enclosed ecosystems (Davis and Johnson, 1989). Thus, anchialine ponds and lakes form ecological "islands within islands" that offer interesting opportunities for research because of their isolated nature (Edwards, 1996).

One of the most unusual anchialine lake inhabitants is the golden-jellyfish *Mastigias* spp., a scyphomedusae that perennially inhabits isolated marine lakes in Palau, Western Caroline Islands (Hamner, 1982). These medusae are behaviorally, morphologically and physiologically unique, as a result of long periods of isolation. While their origins in these remote bodies of water remain unknown, they are interesting examples of adaptive evolution in isolated anchialine environments (Dawson et al, 2001).

We report on the presence of the hydromedusae *Aequorea floridana* (Hydrozoa: Aequoreidae) from an anchialine lake on San Salvador Island. Not only is this the first record of this species from Bahamian waters, its occurrence in the unusual environment of an anchialine lake provides additional evidence that the inland waters of San Salvador Island support truly unique ecosystems.

Environmental Setting

A prominent feature of San Salvador Island is the presence of numerous inland ponds and lakes. Many are seep-fed with high evaporation rates and exhibit hypersaline conditions while others are conduit fed and are marine in nature (Davis and Johnson, 1989). Most inland ponds and lakes on the island are nearly undisturbed ecosystems which form ecological "islands" within islands, each somewhat unique from other ponds and lakes. These "islands" typically contain faunal components of reduced ecological diversity and may be dominated by just a few groups of marine organisms (Edwards, 1996; Lanterman et al, 2007.

Mermaid Pond is an anchialine body of water located in the southeastern part of San Salvador Island. The pond is approximately 15 hectares in size with an average depth of 2.5 m. Flow is supplied by 2 large and 2 small conduits with circulation sufficient to maintain marine conditions (31 to 38 $^{0}/_{00}$) throughout the pond (Winters 1993; Button et al, 2007). The pond bottom is characterized by a carbonate shell substrate with layers of organic flocculent around the pond margins. Unlike many other ponds and lakes on San Salvador, Mermaid Pond is completely encircled by red mangrove (*Rhizophora mangle*) with no areas of exposed rocky shoreline (Button et al 2007). Lanterman et al (2007) reported that benthic invertebrate assemblages of Mermaid Pond were comprised of bivalve and gastropod mollusks, polychaetes, amphipods, sponges and anemones. Invertebrate species composition (where identifications were possible) is comparable to other marine ponds and lakes on San Salvador.

MATERIALS AND METHODS

As part of an ongoing ecological investigation of Mermaid Pond, seven individuals of the medusae stage of *A. floridana* were hand-collected while snorkeling using plastic bags during June 2004. All specimens were initially fixed in SafeFix II and transferred to 70% ethanol. Thirteen additional hydromedusae were collected from the same sample site during June 2005 using the same collection methods. Ten individuals were fixed in 5% buffered formalin and three individuals in 70% ethanol. Initial identifications were based on Mayer (1910) and Kramp (1959); all specimens were sent to the US National Museum of Natural History for confirmation of identifications and subsequent cataloging.

RESULTS AND DISCUSSION

This is the first recorded occurrence of *A. floridana* from Bahamian waters and serves as a new range extension for this species. Previous records include Key West, Florida (Mayer, 1910), Bermuda (Bigelow, 1938; Russell, 1940), the Gulf of Batabanó, Cuba (Campos, 1981) and the Mexican Caribbean (Segura-Puertas et al, 2003), which suggests a tropical Western Atlantic/Northern Caribbean distribution pattern for this species. Although *A. floridana* has been reported from Long Island Sound, New York, the taxonomic status of that material is questionable (A. Collins, pers. comm.). Mayer's survey of the medusa of the Bahamas did not record the presence of any species of *Aequorea* (Mayer, 1904).

The genus *Aequorea* has been the subject of numerous investigations due to the presence of Green Fluorescent Protein (GFP). Initially isolated from *A. victoria*, common to the Pacific Northwest of the United States, GFP has received considerable interest as a marker for gene expression and has been widely used to study cellular and molecular processes (Kendall and Badminton, 1998). As a secondary photoprotein involved in bioluminescence, GFP in the presence of Ca^{+2} couples with the primary light producer aequorin to produce green rather than the usual blue light characteristic of marine bioluminescence. In *A. victoria*, this green luminescence is characteristically present as a series of dots around the margin of the bell (Mills, 2007). Logistics prevented us from observing *A. floridana* after dark so it is unknown if this species is also bioluminescent when disturbed.

As with many Hydrozoans, the life cycle of the Aequoriadae is complex and consists of an asexual benthic polyp and sexual pelagic medusae stage. The presence of *A. floridana* over two successive years in Mermaid Pond suggests that ecological conditions may be suitable for completion of the life cycle in order to maintain a resident population. The prop roots of Red mangrove (*Rhizophora mangle*) would presumably provide a suitable habitat for the benthic polyp stage of *A. floridana*, as would areas of the pond bottom where the shell hash substrate is not covered with organic flocculent (Lanterman et al, 2007).

Hydromedusae have been reported from other marine lakes on San Salvador but identifications have not been verified. Cohen et al (2001) reported unidentified hydromedusae in Crescent Pond and Pain Pond during a study of conduit associated zooplankton. Individuals recorded in Crescent Pond were only present in conduit flood tide samples and not collected from the pond proper. The lone specimen recorded in Pain Pond was not associated with conduit samples. It is unlikely that a fragile medusae stage could have survived the passage through the conduit system intact. However, Cohen et al's data suggests that minimal exchange may occur between the ocean and ponds over a given tidal cycle. It is therefore possible that the medusae collected from the conduit may have been entrained during ebb tide flow and then returned to the pond on the next flood tide. Additional hydromedusae, possibly *Aequorea,* have also been reported from Little Granny Lake (E. Cole and E. Brill; pers. comm.).

One of the most intriguing questions in the study of inland marine ponds and lakes on San Salvador is the origin of resident fauna such as A. *floridana*. A plausible explanation is that larval recruitment may occur via conduits with subsequent metamorphosis occurring following settlement. Additionally, seabirds observed to use the ponds and lakes for refuge may also be responsible for the accidental introduction of many species (Edwards, 1996). Regardless of the mechanisms, further studies on transport mechanisms through conduits are needed to clarify the significance of these features relative to recruitment and maintenance of organisms inhabiting these unique "islands within islands".

ACKNOWLEDGMENTS

We are grateful to Dr. Donald T. Gerace, Chief Executive Officer, and Vincent Voegeli, Executive Director of the Gerace Research Center, San Salvador, Bahamas for their invaluable assistance while conducting this research. We are also extremely indebted to A. Collins for assistance with identifying the specimens. Special thanks go to J. Winter, M. DeVore and D. Freile for assistance in the field. Thanks also to E. Cole and E. Brill for additional information on medusae in other anchialine lakes on San Salvador. This research was funded in part by the Elmira College Summer Science Research Program and through an Elmira College Faculty Development Award. Additional support was provided by the Whitaker Center and the Office of the Provost at Florida Gulf Coast University.

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