

**PROCEEDINGS
OF THE
SIXTH SYMPOSIUM
ON THE
NATURAL HISTORY OF THE BAHAMAS**

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**Bahamian Field Station, Ltd.
San Salvador, Bahamas
1996**

Cover Photo: Dr. Lynn Margulis, Symposium Keynote Speaker, describes the structure and ecology of living stromatolites. Some, visible as grayish mounds near her feet, line the shore of Storrs Lake whereas others occur farther out in deep water. (See paper by D. C. Edwards, this volume).

Back Cover Photo: Group photo of the 6th Symposium participants and speakers.

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Printed in USA by Don Heuer

ISBN 0-935909-60-5

THE INLAND SALINE WATERS OF THE BAHAMAS AS DISTINCTIVE SCIENTIFIC RESOURCES

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ABSTRACT

Islands have proven to be exceptional natural laboratories for the study of ecology and evolution, e.g., Darwin's finches or the local *Cerion* snails, but their biotas have also proven extremely vulnerable to human intrusions and introduced species. The Bahamas, owing to their geological history, carbonate composition, and geography, provide an unparalleled array of as yet little studied or disturbed inland saline waters with distinctive features and singular communities. These anchialine habitats (i.e., fed by saline cave waters) are "islands" of marine habitats lying isolated within land islands that are themselves often separated by very deep ocean waters. Owing to their unique colonizing histories, these "islands" provide natural experiments under a range of physical conditions from the stability of deep caves to the varied salinity regimes of surface waters to the tidal stilling well conditions of inland blue holes. My aims in sketching what can be learned from these "islands" are to stimulate research and to provide a possible basis for their protection, e.g., U.N. Biosphere Reserve status. If they are treated only as exotic "bottomless" swimming pools and adventure cave-dive sites, their ecological stories will be rewritten and lost to science.

These inland waters have given us examples of the history of life and living conditions on Earth from the world's oldest fossils through a Paleozoic-like community dominated by cephalopods to a new class of living crustaceans dating from Pangean times (Remipedia), Sangamon landscapes read from fossil facies, salinity regimes of the Holocene and even present day rates of rise in sea level. These "islands" have yielded new species and afford us natural experiments, study sites for

manipulative experiments, examples of island biogeography, and even new communities and life styles. Protection of these sites could promote managed ecotourism and employment; open access could result in unintended introductions of species and altered communities.

INTRODUCTION: THE PROMISE AND THE PROBLEM

Ecological islands, which can be any type of fragmented habitat (land islands, inland bodies of water, alpine peaks, etc.), have proven to be exceptional natural laboratories for the study of ecology, biogeography, and evolution. The evolution of Darwin's finches on the Galapagos Islands (14 species from one ancestral species) is the most famous example (Grant 1986), though many other well known cases could be cited, e.g., the radiation of *Cerion* land snails in the Bahamas (Gould 1993), the competition among *Anolis* lizards on Caribbean islands (Roughgarden 1994), or the radiation of cichlid fishes in Lake Victoria (>300 species from one ancestral species [see Wilson 1992]). The problem is that the distinctive and simplified (relative to mainlands) biotas of islands have repeatedly proven exceptionally vulnerable to human intrusions and introduced species since prehistory, and modern travel and technologies greatly exacerbate the situation (see Wilson 1992; Eshbaugh and Wilson, this volume). It may be a fortunate accident that Darwin met his incredibly tame birds in the Galapagos, which, uniquely for Pacific island groups, had not been inhabited by humans prior to their discovery by Europeans in 1535 A.D.; the avifauna of Pacific Islands elsewhere was already decidedly unnatural, and the loss of birdlife in the tropical Pacific may now exceed

2,000 species, or a 20% global reduction in the avifauna (Steadman 1995). A sport fish introduced into Lake Victoria in 1959 is now projected to eventually eliminate over half of the endemic cichlids and alter the ecosystem as a whole (Wilson 1992). On a lesser scale the land islands of the Bahamas have had their share of endemics, extinctions, and extirpations, e.g., the endangered rock iguana of San Salvador, *Cyclura rileyi rileyi* (Hayes, *et al.* 1995) or the near extinction of the hutia, *Geocapromys ingrahami* (see Campbell 1978, for this and other examples). Essentially where humans have gone extinctions have occurred.

The Bahamas are unique in the extent and purity of their carbonate rocks, which, being soluble in normal rain water, produce a karst landscape riddled with, and underlain by dissolution features such as sinkholes and caves (Myroie 1988; Myroie and Carew 1995). With changing sea levels during and since the Pleistocene, conduits to the sea developed at different horizons with shafts connecting them. The result is a maze of passages through which the tides rise and fall within the limestone islands, producing an unparalleled array of as yet little studied or disturbed inland saline waters, which may be tidal (large conduits) or nontidal (small conduits or seepage through the porous limestone). These diverse anchialine habitats (i.e., fed by saline cave waters; cf. Davis and Johnson 1989) are "islands" of marine habitat lying isolated within land islands that have themselves in many cases been separated by deep (>1,000 m) ocean waters since the Cretaceous. Their distinctive physical features are numerous: depths range from seeps wetted only at higher high tides through hypersaline lakes whose levels may be above or below sea level owing to seasonal or annual imbalances in evaporation and precipitation to the world's deepest known blue hole at 201 m depth (Wilson 1994); physical conditions range from the stability of deep caves to the varied regimes of shallow ponds; salinities range from very brackish (even to freshwater overlying tidal salt water) to saturation levels; oxygen levels range from anaerobic to supersaturated; and inland lakes and blue holes, lacking ocean waves or currents, afford stilling well conditions where sediments build without disturbance, tidal

zonations can be measured in cms, and dense communities of planktonic microorganisms can occur. What can we learn from the inland saline "islands" of the Bahamas, and can their biotas be spared many of the losses of other islands?

Owing both to their unusual physical regimes and their unique histories of colonization, these "islands" thus provide a broad range of natural experiments and singular, even unique, communities and life styles. My aims in sketching what can be learned from these "islands" are to stimulate interest and research and to provide a possible basis for their protection. If they are treated only as exotic "bottomless" swimming pools and adventure cave-dive sites, their ecological stories will be rewritten and lost to science and future generations.

A BRIEF HISTORY OF THE BIOSPHERE

The inland saline "islands" of the Bahamas have given us examples of the history of life and living conditions on Earth from the oldest known fossils (Walter 1980) to present day rates of rise in sea level. Noteworthy cases, which repeat the theme of "the promise and the problem," include the following:

- 1) As Lynn Margulis, our keynote speaker, has described (Margulis and Sagan 1986, 1995), microbial mats with fossil stromatolite community structures have been in continuous existence for over 3 billion years. These mats have stabilized sediments and built up hypersaline shores; they also afford us the oldest known living fossil, the coccoid cyanobacterium *Entophysalis*, which has existed for over half the history of life on Earth (Golubic 1992a, 1992b). Owing in part to the high, but variable salinities and shallow, but variable depths of several of our inland lakes, these "living fossil" stromatolites and their precursor microbial mats have not only survived, but thrived here on San Salvador, thus permitting their modern-day biology to be studied. Elliott (1992, 1994) has described the largest and most species-rich stromatolites on San Salvador and compared them with others found here and elsewhere in the Bahamas. Paerl *et al.* (1993) have compared the primary productivity and nitrogen fixation of the microbial mats of San Salvador with

those elsewhere in the world. Stromatolite-forming mats are living examples of the bacterial empire that dominated much of the history of life on Earth, but they occur outside the Bahamas only in a few places, e.g., the Persian Gulf and Western Australia. Nonetheless, their habitats are viewed by the uninformed as nothing more than wastelands, and a developer has recently proposed opening one of our best sites for stromatolites, Storr's Lake, to the sea to increase the value of future vacation homes.

2) We can also examine the ecology of a Paleozoic-like community dominated by predatory cephalopods (*Octopus briareus*) and suspension feeding echinoderms (*Ophiothrix oerstedii*) at Sweetings Pond, a weakly tidal saltwater lake on Eleuthera Island (Aronson and Harms 1985; Aronson 1986). The absence of competition and predation by predatory fishes, which had not colonized the lake, may account for the success of both the present dominants and their ancient ancestors, the early ammonoids and crinoids (which predated higher fishes). If sport fishes were introduced here, this exceptional community could be totally altered, as is occurring in Lake Victoria (see Introduction).

3) Diving in a cave on Grand Bahama Island, Jill Yager (1981) discovered a new class of living crustaceans, Remipedia, now known to have existed at least 310 million years ago (Emerson and Schram 1990). Presumably the stable, nearly anoxic (<0.10-~2 ppm) physical conditions of deep (>15-70 m) caves afforded a refugium for these animals, as well as a distinctive community of species largely new to science (Yager 1987, 1991, 1994). Essentially every island with accessible caves yields new species. To date a total of 11 species of remipedes have been found in anchialine caves, including 7 for the Bahamas alone and one from as far away as Western Australia (Yager 1994). This odd biogeographic distribution makes sense for organisms that have been around since before there were separate ocean basins. Human disturbances here include the bubble trails of scuba divers; fish follow divers into denser, low oxygen waters to feed on otherwise inaccessible prey (Yager pers. comm.). The effects of humans on the as yet little studied microbiology and biogeochemistry of cave

waters (Herman *et al.* 1994) is unknown. Meanwhile, we do know that elsewhere macrofaunal troglobitic species are being destroyed by sewage, pesticides, and hazardous wastes before they can be discovered and named -- like the extinctions going on in rain forests (Stolzenburg 1995a). To protect the organisms, the waters must be protected.

4) The waters of a single shallow Pleistocene cave on San Salvador, Lighthouse Cave, have yielded at least five species new to science. Three of these are sponges that may have originated here from marooned populations (Van Soest and Sass 1981), one is a new genus and species of cirrolanid isopod (Carpenter 1981), and one is a new genus and species of calanoid copepod (Barr 1984). In protecting caves, we would not only protect the species living in them, but also the processes that have created species. Meanwhile troops of tourists, students, and scientists regularly visit the cave, carrying with them dust, lint, various bacteria and fungal byproducts, and chemicals ranging from hair spray to cosmetics, insect repellent, sun screens, fungicides, and ointments, as well as what lives on or clings to their gear. (See previous case.)

5) In surveys of the inland saline ponds of San Salvador, we (James W. Teeter, since 1977, and I, since 1986) found a typical assemblage (usually the total assemblage) of just five ecologically little known molluscs (Edwards *et al.* 1990): three Cerithiacean gastropods and two bivalves. Hagey (1991) and Hagey and Mylroie (1995) then used this core group, as a fossil assemblage, to distinguish inland saline waters from the transgressions of coastal lagoons during the Sangamon Interglacial. Meanwhile, a fossil-rich lagoonal facies was discovered by Paul J. Godfrey and me in 1989 south of the Bahamian Field Station (Godfrey, Edwards, *et al.* 1994). Noble *et al.* (1995), by comparing the molluscan fossils and casts of *Upogebia* shrimp burrows from this facies with modern materials from the south arm of Pigeon Creek lagoon, found remarkable similarities. Our little disturbed sites are enabling geologists to reconstruct the San Salvador of the last period of serious global warming -- when much of the island was under water.

6) The undisturbed sediments and

complete stratigraphic record of inland saline lakes and ponds have permitted Teeter (1989, 1995) and his associates to reconstruct the parallel histories of salinity changes in these waters over the last three millennia of the Holocene. Based on salinity-controlled assemblages of ostracodes (freshwater, marine, and euryhaline) and the salinity-controlled Mg concentrations in the carapace of a euryhaline species, it has been possible to define four levels whose zonal boundaries are marked by salinity minima that correlate with low stands of sea level.

7) The tidal stilling well conditions of inland blue holes are enabling Godfrey *et al.* (1994) to measure today's rates of sea level rise based on the zonation of mangrove species. Rising sea level may be causing a kind of "reverse succession," as red mangrove seedlings are colonizing higher elevations than the typically higher level species of black and white mangroves, some of which are dying. Godfrey's estimates of the rate of rise, 2-3 mm/yr, correlate well with the findings of others and would indicate rates similar to those at the end of the Wisconsin glaciation, rather than the slower rates of much of the Holocene.

PRESENT OPPORTUNITIES

So long as the inland saline waters of the Bahamas and their adjacent lands remain minimally disturbed by human activities, they offer many special advantages for scientific studies and new discoveries. From an ecological perspective, anchialine ponds and lakes 1) afford simple, replicate ecosystems of manageable sizes for quantitative and experimental field studies, 2) offer a mosaic of physical regimes and biotic assemblages available for both natural and manipulative field experiments, 3) provide model marine systems of differing sizes for testing the predictions of island biogeographic theory under the novel circumstance of overland colonization, and 4) permit distinctive communities and life styles to develop. Some illustrative examples will follow, but they are still only part of the story. No one can say what new living species may be found (see earlier examples), what new marine fossil beds may be located (see earlier example), or what geological processes or paleontological finds

may be discovered in deep blue holes. At present serendipity and multidisciplinary synergisms among botanists, zoologists, and geologists are occurring. In little explored areas, the key to discovery is simply the presence of observers with complementary skills who can recognize what is new or exceptional. Important findings then often occur by chance or incidentally in the course of studies designed for other purposes. So on San Salvador James Teeter (pers. comm.) has taken a deep sea ostracod in a core in our most landward blue hole, and visiting investigators regularly record unusual or new species occurrences for this and other islands. On Grand Bahama, Yager and Williams (1988) have even noted a seasonal subterranean navigation by gray snappers, *Lutjanus griseus*, which prey on bats, *Erophylla sezekorni*, that fall into the water from a maternity colony.

Each isolated inland saline body of water affords us a natural experiment of some kind, if only to show us what a simplified, and easier to study, tropical community would look like. Gould (1968) treated a fully marine anchialine pond on Bermuda as such an experiment, but found the molluscan assemblage did not differ between the pond (24 species) and coastal controls. (Such ponds on Bermuda are much richer in species and biomass [Thomas *et al.* 1992] than those on San Salvador [Godfrey, Edwards, *et al.* 1994]). In contrast, I am using blue hole ponds of differing salinities as treatments (three replicate sites each of brackish, fully marine, and hypersaline waters) in a natural experiment on the effect of salinity on competition and dominance relations in our very simple molluscan assemblages. Among the gastropods, for example, either *Batillaria minima* or *Cerithidea costata* can overwhelmingly dominate a brackish site, in which case either dominant is essentially of the same size. However, at the third replicate site, both of these species occur in numbers, but now differ in size (a parallel case occurs with congeners on the Pacific Coast). The snail that is scarce in brackish waters, *Cerithium lutosum*, seems so far to be the dominant in fully marine ponds, at least at subtidal depths (with the other two species occupying narrower intertidal bands). Our chief concern with these ponds, which can differ markedly in

their biotas even over short distances, is that tiny snails, clams, a variety of other propagules, and even the microbiota will be carried from site to site in the mud on hikers's boots or as gunk on their gear and clothes. (See cautions in Godfrey *et al.* 1995).

Because the Bahamas have inland mangrove habitats that support neither, only one, or both red (*Rhizophora mangle*) and black mangroves (*Avicennia germinans*), there are excellent opportunities for both comparative studies and manipulative experiments. How does the biology of the mangroves and their associated species, including their herbivores and pollinators, differ with these deletions of mangrove species? How does community structure change? Which species are actually dependent on mangroves? Rathcke *et al.* (this volume) are now extending their observations from a site with only red and white mangroves to one with red, white, and black mangroves. The sites with neither red nor black mangroves, which have probably been isolated by lithified dunes from sources of the heavy water-borne seedlings of these trees since the Wisconsin glaciation, afford excellent prospects for an experimental field test of the effects of epibiota on the growth rates of the prop roots of red mangroves. These prop roots, which arise above high water level and grow down into the water to reach the substrate, are usually covered by a dense and diverse epibiont community comprised of hundreds of species worldwide. In coastal Belize, Ellison and Farnsworth (1992) tallied at least 52 taxa on mangrove roots at a single site and 63 such taxa overall. A single wood-boring isopod, *Phycolimnoria clarkae*, can reduce root growth by 55%, but common sponge and ascidian species can inhibit isopod colonization, facilitating root growth (Ellison and Farnsworth 1990). Seedlings could be lab-reared without contact with natural sea water and then transplanted as saplings to sites that had not supported a red mangrove (or an epibiont?) since the late Pleistocene to see how fast prop roots grow in the absence of a diverse fouling community. (The problem of saplings normally occurring in the intertidal zone and the epibionts being predominantly subtidal -- and vulnerable to the heat and drying of midday low tides -- might be

overcome in anchialine ponds affording some shade and very limited tidal ranges.) Other treatments could make the experimental study of growth rates multifactorial: simplified inland "island" sites with 0, 1, or 2 mangrove species present vs. diverse coastal ("mainland") sites; different salinity or tidal regimes; etc. To preclude the introduced species problem, the experimental trees could be removed at the end of the experiment. Conversely, the effect on the growth of the lab-reared plants could be tested using single species commonly occurring on prop roots. This is but an example of the type of future experimental studies that could be done in the anchialine waters of the Bahamas.

Do inland saline waters ("marine Islands") fit the rules of island biogeographic theory? As usual, the biotic diversities of physically similar sites (i.e., salinity, tidal range, etc.) of different sizes, distances from sources of colonizers, and ages would be compared with the expectations of theory. To date the data for San Salvador's anchialine ponds are at best ambiguous. Godfrey *et al.* (1995) have found that larger saline ponds have more halophytic plants around them, but the pattern is limited to species with wind-borne seeds. Odd omissions also occur (see the mangroves above). My work with molluscs indicates that only modest numbers of eurytopic species of broad distribution occur, regardless of the size of the saline pond or lake. Only fully marine sites have a few more or different species. Virtually all lakes and ponds regardless of size, location, or salinity (ranging from brackish to $\leq 60 \text{ ‰}$) have just two species of fish, the sheepshead minnow, *Cyprinodon variegatus*, and the mosquito fish, *Gambusia puncticulata* (personal observation; M. Barton 1993, pers. comm.). The exceptions are a small brackish blue hole, where *Tilapia* has been introduced, and a large fully saline blue hole, where a hard-head silverside, *Atherinomorus stipes* was taken at night by Eric Cole (1995, pers. comm.). The latter site, Oyster Pond, presents the paradox of being the furthest inland fully marine site while having by far the greatest diversity of marine species. Clearly colonizers reaching shallow marine "islands" over land (or by deep conduits?) may differ from those colonizing islands by sea -- and turnover rates of species might differ as

well. Introduction of mangroves (see above) could show not only the effects of increased structural heterogeneity and a major producer on consumer assemblages, but also afford a direct comparison with the first experimental studies of island biogeography (Simberloff and Wilson 1969, 1970).

Finally, the stilling well conditions of inland saline waters, both tidal and non-tidal, enable dense communities of planktonic microorganisms to occur as a living flocculent layer overlying the muddy substrate. Such assemblages, amounting often to a false bottom, could not persist in the face of coastal ebbs and flows of the tides, much less currents and waves. These are essentially new communities (which may resemble others in continental salt lakes) and make possible, or require, new life styles for some "infaunal" animals. Marshall (1982) found coccoid cyanobacteria were dominant in two hypersaline lakes on San Salvador Island; these organisms likely cause the distinctive colorations of such lakes when one observes Bahamian islands from the air. In contrast, the flocculent layers of fully marine to moderately hypersaline sites with active conduits seem to be dominated by Protoctista (see Margulis, this volume), especially unicellular phototrophs, but include many species. Single microscopic transects across slides comprising one drop of sample material from each of three sites yielded at least 93 species (Hicks 1993). The flocculent layers vary in color from pink through various browns and greens (even among nearby sites), probably depending on the relative abundances of the dominant phototrophs; they may lie close to the mineral bottom or rise to within 0.5 m of the water's surface; their biological activity may make them warm to the touch of one's hand; and they are layered, with oxygen levels dropping precipitously within them (personal observation; C. Wilderman, pers. comm.). Probably owing to the physical conditions under and within the living microbial layer, we find classic infaunal species living within the layer (e.g., the lugworm, *Arenicola cristata*; see Godfrey *et al.* 1995) or nestling on it (e.g., the venerid bivalve, *Anomalocardia auberiana*; personal observation). Like the flocculent layers themselves, this new mode of living, which I will term "epibenthic infauna,"

remains virtually unstudied.

FUTURE SOLUTIONS ...?

The underlying theme of this symposium, whether explicitly addressed in papers or raised in discussion periods and workshops, has been the conservation of the singular biota of the Bahamas. My approach differs only in addressing the values of a set of habitats, most of which are underappreciated and some of which are unseen (subterranean) or considered unsightly, and their organisms ranging through all five kingdoms of life. Our shared aim then is to conserve as much as is feasible of the vulnerable species and habitats of the Bahamas for not only science and future generations but also for the sustainable use and support of the local people. In practice this means protecting the ecosystems. The only certainties about the future are change and altered ecological interconnections. Colonizations and extinctions are natural and never cease; their rates are the basis for the "rules" of biogeography. What is new and is greatly accelerating these processes are human intrusions, development, rapid transportation, and artificially introduced species. See Campbell (1978, ch. 7) on earlier invasions of the Bahamas by exotics. The islands, as islands, could suffer an even worse fate than Florida, where currently, despite expenditures of \$25 million a year, the native biota is being displaced by newcomers and communities are being greatly altered over large areas (Burdick 1995). Large-scale commercial development, were it feasible (see below), would speed up these processes. Some restrictions on human intrusions and some protection of distinctive ecosystems are essential if we are to learn as much as possible about the natural history of the Bahamas before it is greatly altered. After 500 years, we are still discovering a "New World" on San Salvador and the other islands of the Bahamas. (These issues are global, as precisely the same problems confront the unique marine lakes and their biotas on Palau in western Micronesia [Stolzenburg 1995b].)

In terms of both human development and conservation in the Bahamas, we have learned important lessons and made significant strides forward. The huge failure of the Columbus Landings land development on the

south shore of San Salvador shows the ecological importance of limiting factors, in this case unpolluted water. The building of a single isolated house near Inkwell Blue Hole changed this site from one where tannin-stained pure freshwater floated on crystal clear tidal marine waters to one where the upper lens became fresh/brackish (Myroie 1988); the dominant vegetation here is now the halophytic marsh fern, *Acrostichum aureum* (I.D. by Paul Godfrey). On an island largely occupied by saline waters, lenses of fresh groundwater are necessarily limited. These lenses may experience gains or losses seasonally, annually, or over longer periods due to the many factors affecting climate (Sealey 1994); however, as the average annual precipitation of 102.4 cm is moderate and quite variable (S.D. = 26.3 cm.) and is usually exceeded by the average annual potential evapotranspiration of 142.8 cm (Foos 1994), the net effect should be variable with net losses. The hydrologic miscalculations for Columbus Landings may have been due to the local rock being porous, but of low permeability, thus not conforming to theoretical expectations concerning water yields (L. Davis, pers. comm.). Brackish intrusions into the drinking water have occurred elsewhere on the island, and the new Club Med, our only sizable development, illustrates the costs of both obtaining potable water and disposing of wastewater on a porous limestone site. Because the municipal well-water is high in salinity and organics, the Club desalitates its drinking water; it then uses a tertiary sewage treatment system, with the resulting "gray" water being used to water the landscaping. The remaining problem is garbage disposal, as garbage at the dump on Little Lake is being bulldozed into this saline lake with as yet unknown effects on the waters of either the lake or its large central conduit. The groundwater of karst lands "... is as susceptible to pollution as surface water..." necessitating "... stringent efforts to protect the quality of water resources..." (White *et al.* 1995). Limiting factors alone imply that large-scale development, while perhaps yielding maximal monetary flows in the short-term, is neither sustainable nor desirable in the long-term (cf. Eshbaugh and Wilson as well as others in this volume).

There are promising beginnings for conservation of the country's natural resources, and programs and people to do much more in the future. The present national parks of the Bahamas are managed by The Bahamas National Trust, which proposes to expand the system. Current parks protect anchialine waters either directly, e.g., the Lucayan National Park on Grand Bahama with its extensive underwater cave system, or indirectly, e.g., the Inagua National Park with both its flamingos and the associated "salinas." The focus on birds, whether flamingos on Inagua or parrots on Abaco, is understandable, but threatened conspicuous species ("charismatic megafauna"), like the infamous spotted owl in the old growth forest of the U.S. Pacific Northwest, are essentially the proverbial canary in the mine, a warning of a dangerous breakdown in the system. The primary functions of a healthy ecosystem are largely run by the invisible microbiota and the inconspicuous invertebrates. The Exuma Cays Land and Sea Park seems to be a successful and productive example of protecting whole systems. The resources to do more in the future include programs in the Ministries of Tourism, Health and Environment, Education and Culture, and especially the Conservation Unit in the Ministry of Agriculture and Fisheries; the College of the Bahamas, a baccalaureate institution as of July 1, 1995; the Bahamian Field Station, with its diversity of visiting scientists; the Forfar Field Station on North Andros; and the Caribbean Marine Research Center in the Exumas. The better the relationships and cooperation among these affiliated programs and people, the better the prospects will be for conserving the distinctive resources of the Bahamas.

Finally, there are successful international models and programs that could prove useful in protecting not only inland saline waters but other natural historical and archeological features of the Bahamas through managed eco- or adventure tourism that provided sustainable use through small-scale development and expanded employment for the local people. There is no lack of unique and striking resources to support such tourism. A real adventure tourist could appreciate even a mud flat and hypersaline lagoon that, while possibly smelly, replicated the world of the

Archean and Proterozoic Eons (billions of years ago) when all life, including our early ancestry, was dominated by microbial mats and stromatolites. Conversion of such sites to yet more Floridian style developments would have no such appeal. The very lack of appeal of the turbid, hypersaline inland lake system of San Salvador may have afforded partial refuges for the endangered local iguana on two cays there (Hayes et al. 1995). Similarly, such a tourist would much prefer a Bahamian dinner to the foods available at home or on a cruise ship. The biota of an inland blue hole, e.g., the bright red shrimp, *Barbouria cubensis*, would appeal much more than yet another outdoor swimming pool. Costa Rica may offer a useful model. A large portion of the country is in national parks and nature refuges, and locally trained naturalists and stewards take great pride in their national heritage as they guide eco-tourists and protect natural systems. The College of the Bahamas and its affiliated institutions might provide such training. International programs could offer technical assistance and support, including some financing. These could include the United Nations Biosphere Reserve Program, the Last Great Places Program of the Nature Conservancy, and the model ecotourism proposals of the Pew Charitable Trust. All are programs that work in cooperative partnerships with government agencies and the local people to protect natural ecosystems, while including and accommodating the local people as part of the ecosystem. Merely protecting endangered species or habitats, we have learned, is not enough.

As a visitor in a foreign country and a guest of some of the most hospitable and friendly people anywhere, it is not my place to say what should be done. That is the role of the Bahamian people. My aim, and that of the others at this symposium, is only to provide as strong a basis as possible for informed discussions and wise decisions for the long-term future of The Bahamas.

ACKNOWLEDGMENTS

I am grateful to the directors and staff of the Bahamian Field Station (BFS) for the friendly and helpful way in which they have made most of my work in the Bahamas

possible. Partial travel support was provided at times by the Five-College Coastal & Marine Sciences Program and, for this Symposium, by my department's Graduate Program in Organismic and Evolutionary Biology. In temporal order, those who got me involved in long-term field studies on San Salvador Island were H. A. Curran, J. W. Teeter, and P. J. Godfrey. Their valuable contributions to my work over the years would be in the reverse order. The amount of cooperation among scientists at BFS has been such that I am much indebted to many of those cited in the text -- and probably at least as many more. The students of the Five-College Coastal & Marine Sciences Program have contributed much to our ongoing studies. A draft of this paper benefited from advice, suggestions, and/or new references supplied by Nancy Elliott, Aaron Ellison, Donald Gerace, Paul Godfrey, Lynn Margulis, John Mylroie, Beverly Rathcke, Neil Sealey, and Jill Yager.

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