

# The Atlantic Barrier Reef Ecosystem at Carrie Bow Cay, Belize, I

## Introduction

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The barrier reef off Belize, Central America, has received the concentrated attention of scientists only within the past two decades. Interest in this area dates back to the late nineteenth century, however, the first scientific reference to the Belizean reefs having been made by Charles Darwin, himself, in an 1842 work, *The Structure and Distribution of Coral Reefs* (pages 201–202). Using information provided by Captain B. Allen, Darwin discussed the bathymetry associated with Belizean reefs and included them in his classification of principal reef types.

Early studies of the natural history of Belize, then known as British Honduras, focused not on the reefs but on incidental collections taken along the shore or by dredge hauls by residents of the colony and by visiting individuals and expeditions, most notably the “Pawnee” (1925) and “Rosaura” (1937–1938) expeditions. One of the oldest such records is the description of a new sponge, collected near Belize (now Belize City) by Priest (1881). Other systematic work on early collections dealt with algae (Taylor, 1935), sea-grass *Thalassia* (den Hartog, 1970), sponges (Burton, 1954), cnidarians (Boone, 1928a), crusta-

ceans (Boone, 1927), mollusks (Boone, 1928b; Marcus and Marcus, 1962; Robertson, 1975), echinoderms (Boone, 1928c; John and Clark, 1954), and fishes (Breder, 1927; Tucker, 1954; Robins and Starck, 1965; Birdsong and Emery, 1968). In addition, studies relating to commercial fisheries were reported by Smith (1939, 1941) and Craig (1966).

The first investigations focusing on the cays and reefs of Belize were undertaken by the “Cambridge Expedition to British Honduras” (1959–1960) led by J. E. Thorpe (Thorpe and Stoddart, 1962). Some members of the expedition mapped 40 cays, including Carrie Bow Cay, and collected samples of their flora. They also discussed the origin, formation, and distribution of reef and mangrove cays, and showed the migration of some of these cays on the basis of exposed beach rock (Stoddart, 1960). Another expedition team mapped bottom characteristics and identified coral species from around Rendezvous Cay, and conducted experiments on coral behavior in response to external stimuli (Thorpe and Bregazzi, 1960). Subsequently Stoddart, one of this expedition’s participants, surveyed in detail the biology and geology of the Belizean atolls, that is, Turneffe Islands, Lighthouse Reef, and Glover’s Reef (Stoddart, 1962a). At this time he also initiated an interesting series of studies concerning

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the hurricane destruction and post-storm recovery of cays and coral reefs (Stoddart, 1962b, 1963, 1969, 1974).

A second stage of intensive research activity was spearheaded by E. G. Purdy of Rice University, under whom several major projects—for the most part doctoral dissertations—treating various geological aspects of the barrier reef complex were completed between 1961 and 1967. Most of this work appeared in a volume edited by Wantland and Pusey (1975) that focused on sediments and processes of sedimentation and diagenesis (L. R. High, Jr., pages 53–96; M. R. Scott, pages 97–130; W. C. Pusey III; pages 131–233; W. J. Ebanks, Jr., pages 234–296), paleoecology and diagenesis of Pleistocene limestone (G. E. Tebbutt, pages 297–331), and distribution of benthic Foraminifera (K. F. Wantland, pages 332–339) and Ostracoda (J. W. Teeter, pages 400–499). Another member of this group of doctoral scholars documented elsewhere the genesis of recent lime mud (Matthews, 1966). In addition, Purdy himself produced two thought provoking reports dealing with the origin of the topographic relief of the Belizean reef and its influence on sediment distribution (Purdy, 1974a, 1974b).

Among other studies of the Belizean reefs some of the most notable have been conducted by the University of Miami under the direction of R. N. Ginsburg. This work, to date, has focused on shallow-water submarine cements (Ginsburg and James, 1976; James et al., 1976) and has included geological investigations (James and Ginsburg, 1978) and a study of deep-reef fishes (Colin, 1974) of the deep seaward margins of the barrier reef and Glover's Reef atoll.

Several recent studies have concentrated on the barrier reef and the atolls. Devaney (1974) has reported on shallow-water echinoderms collected off Turneffe Island and Lighthouse and Glover's reefs. Wallace and Schafersman (1977) have examined the ecology and sedimentology of patch reefs in the Glover's Reef lagoon. This atoll was also the point of origin for a series of ichthyological studies that were expanded to the barrier reef complex and are still under way (Greenfield,

1972, 1975a–c, 1979; Greenfield and Greenfield, 1973; Greenfield and Johnson, 1981).

With the establishment of the Smithsonian Institution's field laboratory at Carrie Bow Cay in 1972, most of the marine research in Belize concentrated on this part of the barrier reef; only some early site surveys and comparative studies included other locations. Smithsonian-sponsored physiographic surveys (Dahl et al., 1974; Miller and Macintyre, 1977) were important early steps of our programs, while hurricane reports and damage and recovery surveys (Antonius, 1972; Stoddart, 1974; Highsmith et al., 1980) appear to have become a continuing necessity. Among the methods developed or modified during our reef research were mapping (Rützler, 1978a), underwater coring (Macintyre, 1975), and ecological sampling techniques (Dahl, 1973; Kirsteuer, 1978; Rützler, 1978b; Rützler et al., 1980).

Early in our program, attempts were made to monitor the physical environment of Carrie Bow Cay and the surrounding waters. Cooperation with colleagues at the University of South Carolina who contributed specialized equipment produced information on the diurnal energy balance on the island (Kjerfve, 1978) and on tidal patterns relative to the Caribbean system (Kjerfve, 1981).

Inventory of flora and fauna was a prerequisite for the new program and produced an increasing number of checklists, distributional tabulations, taxonomic revisions, and descriptions of new taxa: algae and seagrasses (Tsuda and Dawes, 1974); nemertean (Kirsteuer, 1974, 1977); polychaetes (Fauchald, 1980); sipunculans (Rice, 1976); copepods (H. B. Cressey, 1981; R. Cressey, 1981); ostracods (Kornicker, 1978, 1981; Kornicker and Cohen, 1978); decapods (Kensley, 1981; Kensley and Gore, 1981), bivalves (Waller, 1978), holothuroids (Pawson, 1976); echinoids (Kier, 1975); and fishes (Greenfield, 1981; Greenfield and Johnson, 1981; Johnson and Greenfield, 1982). A comparable inventory of novel chemical compounds from algae, sponges, and gorgonians is the subject of a series of publications of W. Fenical's group at Scripps Institution of Oceanography (McEnroe and Fenical, 1978; Mc-



Connell and Fenical, 1978; Kokke et al., 1979; Kokke et al., 1981).

Participants of several programs have examined organisms producing limestone and calcareous sand. Environmental influences on skeletal development of corals were studied by Barnard et al. (1974), Macintyre and Smith (1974), Graus and Macintyre (1976), and Highsmith (1979). Related work on mollusks has dealt with growth rates of gastropods (*Cerithium*: Houbriek, 1974) and shell calcification of bivalves (Arcoida: Waller, 1980). Calcium carbonate breakdown by biological processes, on the other hand, was the subject of studies by Rützler (1975), Rice (1976), and Highsmith (1981), and the contribution of noncalcareous (siliceous) components to reef sands was treated by Rützler and Macintyre (1978).

Another topic of research at Carrie Bow Cay has been the availability and quality of food as a major factor determining growth and distribution of invertebrates and fishes. Primary production by benthic algae, including spatial and temporal

variability, were discussed by Dahl (1974, 1976). Distribution of many algae is controlled by herbivores (Hay, 1981) but some plants can defend themselves from grazers by producing toxic compounds that act as feeding deterrents (Gerwick et al., 1979; Sun and Fenical, 1979; Paul and Fenical, 1980; Gerwick and Fenical, 1981). On the other hand, strong symbiotic ties exist between certain algae and invertebrates that were studied by Kokke et al. (1980) and Rützler (1981). Another report on invertebrate feeding presents behavioral observations on coronate medusae captured in plankton tows near Carrie Bow Cay (Larson, 1979).

The earlier work summarized here will give the reader an indication of research projects under way at the Carrie Bow Cay laboratory or sponsored by the Smithsonian reef study program elsewhere in Belize. The following papers in this volume will add further data and important new perspectives to our knowledge. Many more contributions can be expected to follow.

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