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FIELD GUIDE TO THE SUE POINT FOSSIL CORAL REEF SAN SALVADOR ISLAND, BAHAMAS

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INTRODUCTION

Pleistocene coral reefs and associated facies are exposed in the vicinity of Sue Point on the west coast of San Salvador Island between Bonefish Bay and Victoria Hill Settlement. The Sue Point reefs provide excellent fossil examples of *Montastrea-Diploria-Porites* patch reefs. Such patch reefs are common at the present time in the shallow waters of the shelf around San Salvador Island and at numerous other localities in the Caribbean and warm water areas of the Atlantic Ocean.

As part of an ongoing study to determine the age of fossil corals by uranium-thorium dating (see Curran et al., this volume), three fossil corals from the main part of the more northerly patch reef were dated and gave the following results (Jim Chen, unpublished data, 1988): *Montastrea annularis* 121.5±1.9ky; *M. annularis*: 120.7±1.4ky; *Diploria strigosa*: 121.0±1.6ky. The Sue Point fossil reef has the same age as the Cockburn Town fossil reef on San Salvador Island and the Devil's Point reef on Great Inagua (Curran et al., this volume) and flourished during the Sangamon high stand of sea level.

In his survey of the geology of San Salvador, Adams (1983) mentioned the presence of small scattered heads of *Diploria* and *Montastrea* at Sue Point. Carew and Mylroie (1987) report a uranium-thorium date of 135±8ky for a sample of *Montastrea annularis* from Sue Point.

As part of the Keck Geology Consortium project to study fossil coral reefs, the Sue Point fossil reef area was mapped in June 1987 by Doug Cattel (Colorado College), Storr Nelson (Whitman College), Molly Stark (Smith College), and the author. Topographic base maps were surveyed on a scale of 1:200 using a combined electronic theodolite and laser distance measuring instrument. Map datum was the bench marks located near the dock in Cockburn Town. These bench marks have been tied to accurately measured mean sea level (Adams, 1983; Curran and White, 1985). Rock samples collected in June 1987 were studied by Cattel (1988), Nelson (1988), and Stark (1988a, b), as part of undergraduate independent research projects, to determine the diagenetic history of the Sue Point reef. An area of outcrop at the northeast end of the fossil reef that was covered by beach sand in 1987 was revealed in June 1988 and this was mapped by Kathy White (Smith College) and the author.

DESCRIPTION OF FIELD STOPS

Introduction

The Sue Point fossil patch reefs and associated facies are located along the west shore of San Salvador south of Victoria Hill Settlement (Fig. 1). The shoreline in this vicinity follows a zig-zag pattern and two linear fossil patch reefs are exposed. The geology of these reefs is shown in two separate maps, the northern one on Map 1 and the southern one on Map 2. Although the entire area was mapped in the same detail, the

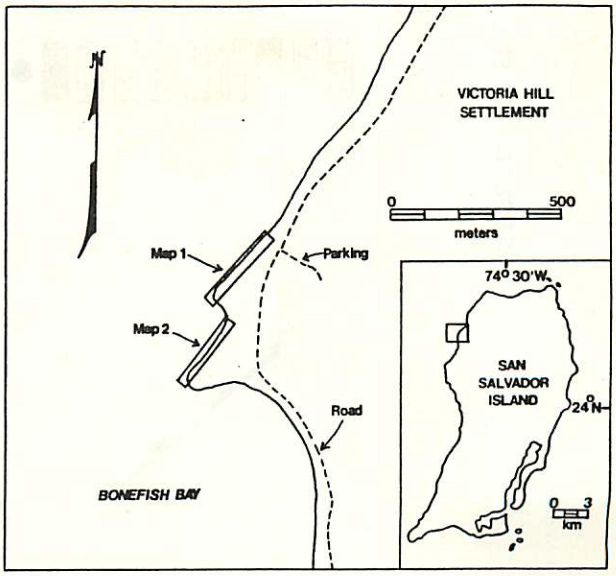
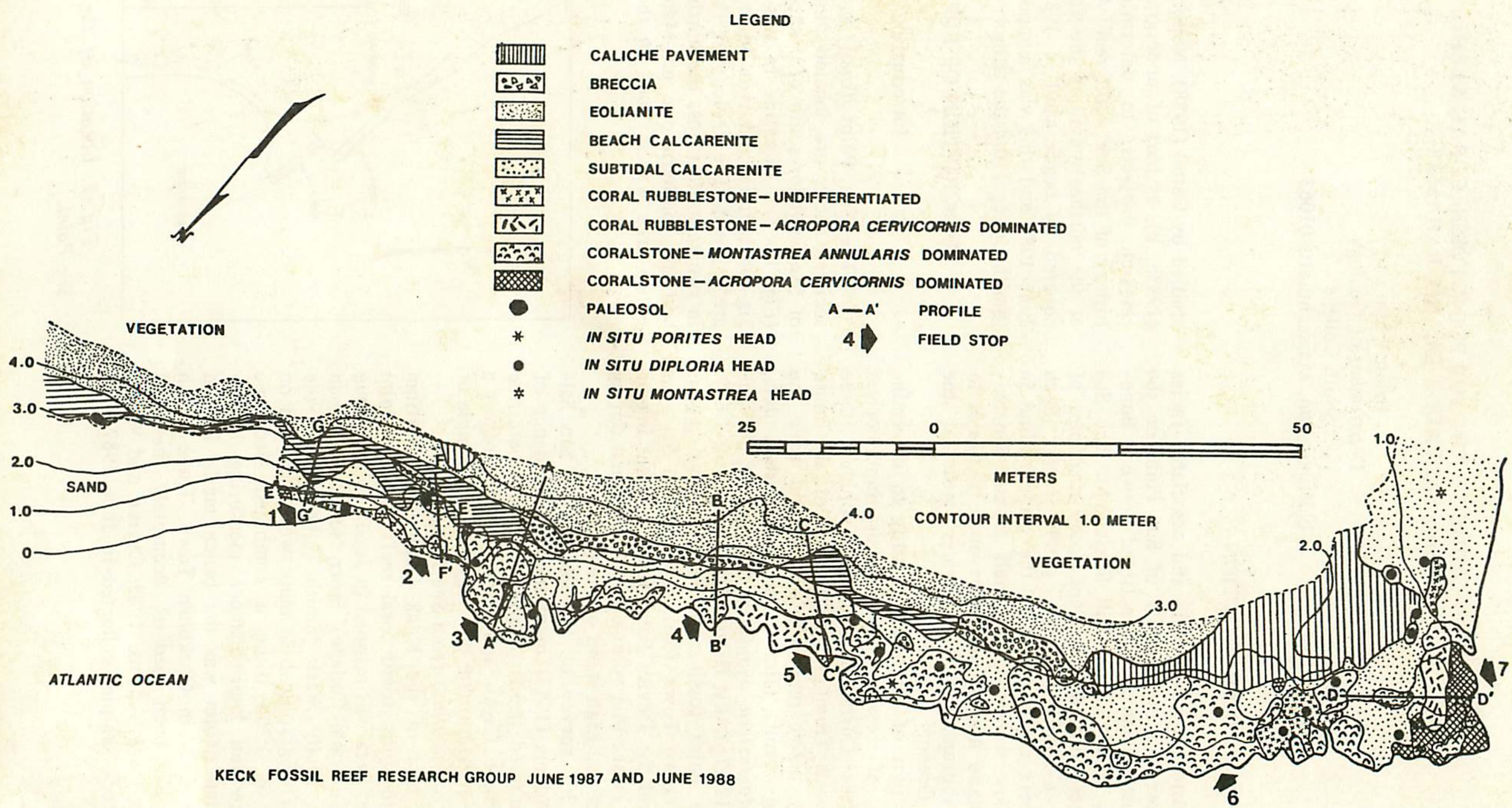


Fig. 1. Location of the fossil coral reefs at Sue Point.

MAP 1

GEOLOGY OF SUE POINT PLEISTOCENE CORAL REEF, SAN SALVADOR, BAHAMAS

NORTHERN PART



MAP 2

GEOLOGY OF SUE POINT PLEISTOCENE CORAL REEF, SAN SALVADOR, BAHAMAS

SOUTHERN PART

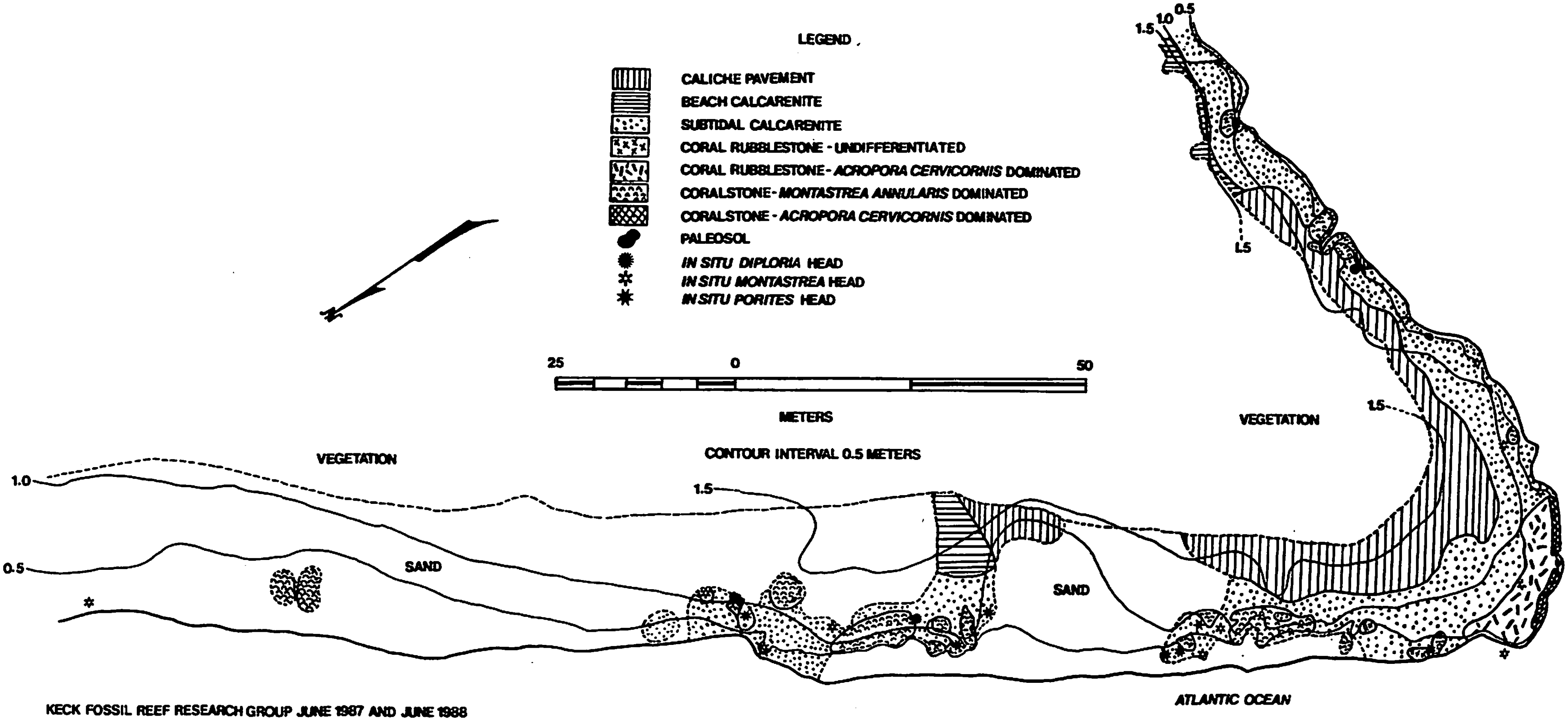


Fig. 2a. View of the northern fossil coral reef and associated facies south from Stop 3. The arrow marks the wave-cut notch.

Fig. 2b. View of Stop 1 showing in situ *fossil corals (1), subtidal calcarenites (2), and beach calcarenites (3).*

Fig. 2c. Paleosol on in situ Montastrea annularis. *Stop 1. Scale = 15cm.*

northern part was chosen for the measurement of profiles and the collection of rock samples because it is better and more continuously exposed (Fig. 2a). This field guide is for the northern part of the area where examples of all the elements of the fossil reef and associated facies are to be found. Some aspects of the southern part are discussed below and a geologic map of the area (Map 2) is included in this guide for those who wish to extend their field trip.

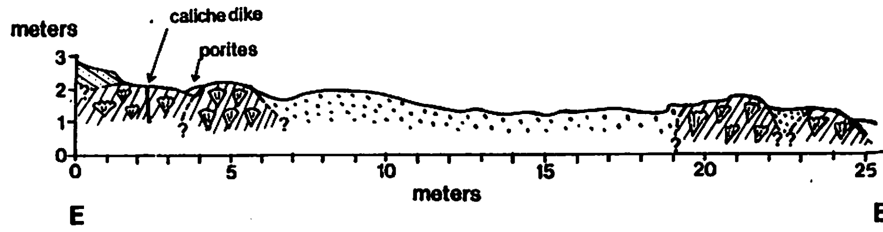
Much geologic research remains to be done on the Sue Point fossil reef, and it would be appreciated if no rock hammers or spray paint are used on the rocks. Your help in preserving these fine examples of fossil patch reefs will be valued by geologists and biologists who visit them in the future.

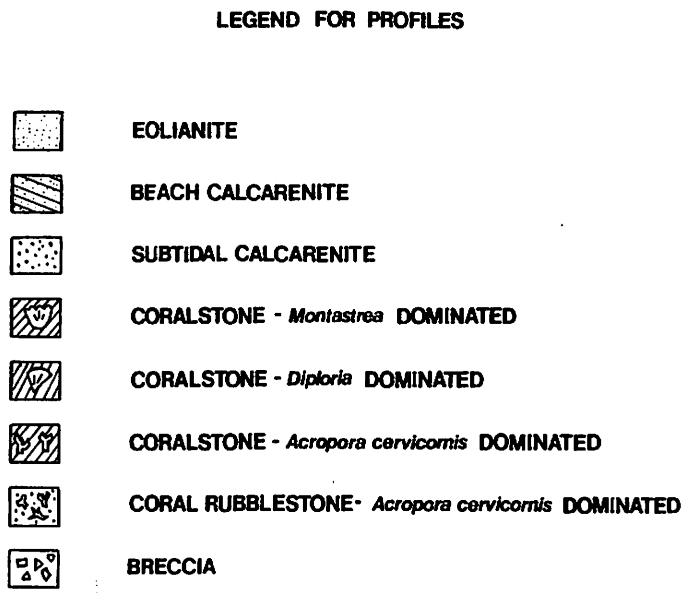
Some rock exposures described in this field guide extend into the present day intertidal zone, and the optimum time to visit the fossil reef is during the two hours around low tide. The upper, gray part of the rocky intertidal zone commonly is very rough with sharp edges and jagged points that are a result of bioerosion. The lower, yellow part of the rocky intertidal zone commonly is very slippery because of a thin cover of algae. Great care should be taken when walking in the intertidal zone, and sturdy footwear is recommended.

Visitors to the reef should park their vehicles along the small road located on the east side of the main road near the crest of the hill south of Victoria Hill Settlement (see Fig. 1). A short trail starts on the west side of the main road opposite the above mentioned small road and visitors should follow this westward down to the first outcrops at the extreme northeast end of the fossil reef. The locations of measured profiles and field stops are shown on Map 1.

In the area of Stops 1 and 2 and profiles E-E', F-F', and G-G', the amount of rock exposed varies greatly depending on the most recent events in the erosion/deposition cycle of modern beach sand. In June 1987 when the initial mapping of the fossil reef was done, most of this area was buried by sand. In early June 1988 recent extensive beach erosion had revealed considerable rock outcrop, which was surveyed and added to the 1987 map. A few days later the outcrop was being buried progressively by beach sand accretion.

Fig. 3. Profile E-E' and legend for all profiles.





These exposures do illustrate important aspects of the geology of the Sue Point fossil reef and associated facies, as described in this guide, but they may not be visible always to visiting geologists.

Stop 1

The sequence in the vicinity of Stop 1 is illustrated by the NE end of profile E-E' (Fig. 3), by profile G-G' (Fig. 4), and by Fig. 2b. The lowest exposed rocks are coral rubblestones and coralstone with heads of *in situ Montastrea annularis* and some *Diploria strigosa*. Small patches of reddish-brown paleosol occur on the coralstone heads (Fig. 2c). Coarse, shelly subtidal calcarenites surround and overlie the fossil corals. The lowest of these subtidal rocks contain specimens of the trace fossil *Ophiomorpha* sp., which represent the fossilized burrows of callianassid shrimps (Curran, 1984). Above the burrowed calcarenites the rocks contain well-developed trough cross beds. A similar sequence was described from Great Inagua Island (White and Curran, 1987), and subtidal calcarenites with *Ophiomorpha* sp. burrows and trough cross beds also occur in association with *in situ* fossil corals at the Cockburn Town fossil coral reef (Curran and White, 1985). The burrowed calcarenites indicate relatively immobile subtidal sands that permitted the formation and preservation of the callianassid burrows, whereas the trough cross beds indicate mobile sand transported and deposited by longshore currents.

The subtidal calcarenites are overlain with an overstepping contact by calcarenites deposited in the beach zone (Fig. 5a). These beach calcarenites are not as coarse as the subtidal calcarenites, and they contain far fewer fossil shells. They are characterized by gently dipping

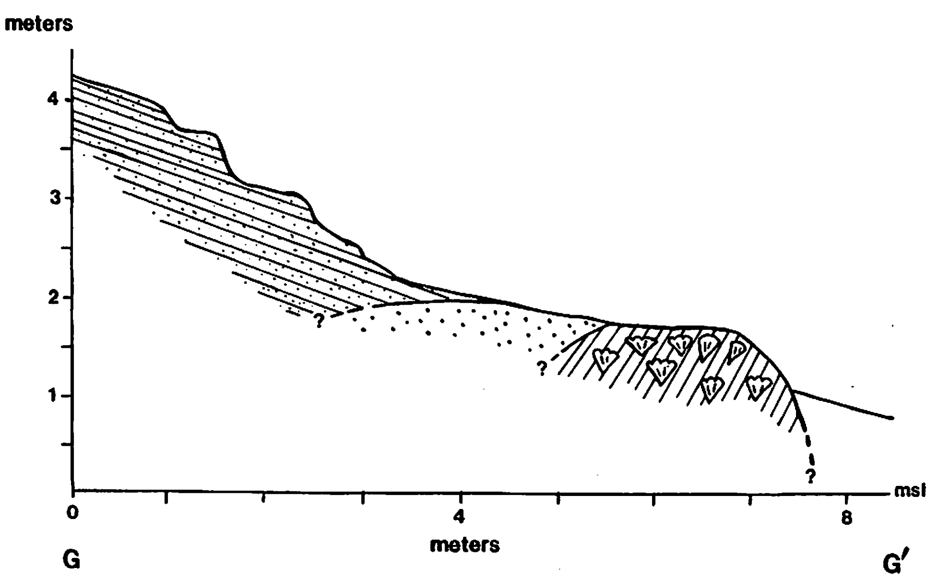


Fig. 4. Profile G-G'.

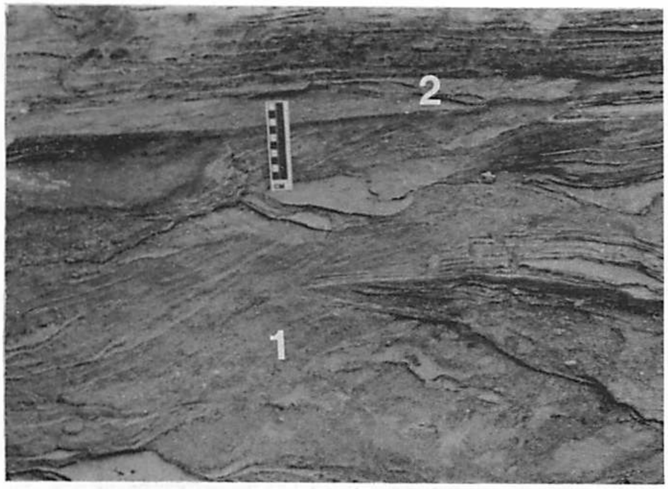


Fig. 5a. Subtidal calcarenites (1) overlain by overstepping beach calcarenites (2). Stop 1. Scale = 10cm.

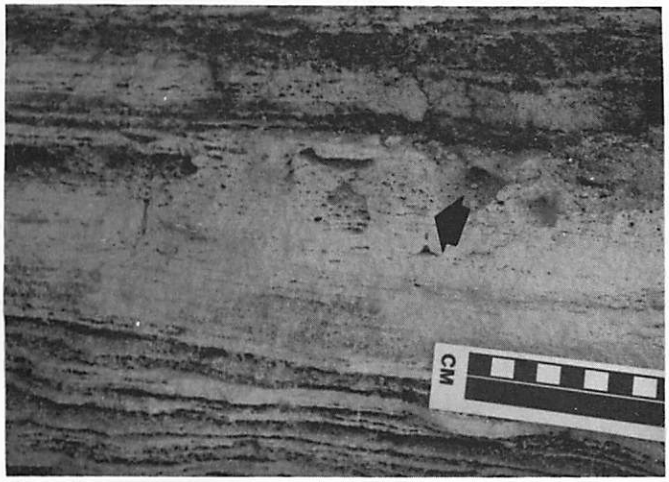


Fig. 5b. Laminated beach calcarenites. The arrow marks keystone vugs. Stop 1.

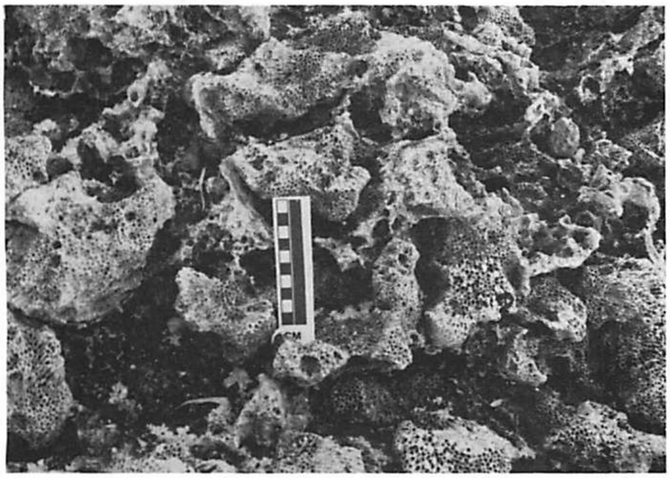


Fig 5c. In situ Montastrea annularis. *Stop 2. Scale = 10cm.*

laminations typically produced by wave swash on the seaward-dipping foreshore (Inden and Moore, 1983). These laminations dip at low angles in a northwesterly direction, showing that the landward direction was to the southeast and implying the presence of an emergent ancient San Salvador. The direction of dip of the beach bedding is almost exactly perpendicular to the long axis of the linear fossil patch reef, suggesting that the reefs grew approximately parallel to the ancient coastline. Many of the beach calcarenites contain very porous layers with keystone vugs (Fig. 5b) that are indicative of the beach zone (Dunham, 1970). These features are well exposed in a small cliff that extends along the outcrop in this vicinity and which normally is exposed above the encroaching modern beach sands. The highest rocks exposed in the sequence are eolianites. These are fine-grained, well-laminated calcarenites with cross beds that have a wide range of dip directions and some convex-upward doming of laminations.

The rocks at Stop 1 illustrate a shallowing-upward sequence from shallow subtidal marine coral reefs and subtidal sands through beach sands to a capping of wind-blown dune deposits. Such regressive sequences are common in equivalent Sangamon interglacial deposits (Curran and White, 1985; White et al., 1984; White and Curran, 1987), and they result from falling sea level caused by the onset of Wisconsinan glaciation.

Stop 2

The SW end of profile E-E' (Fig. 3) and profile F-F' (Fig. 6) show the geologic relations in the area of Stop 2. The sequence is similar to that seen at Stop 1 with some differences that will be described here. The most landward *in situ* fossil corals are *Montastrea annularis* (Fig. 5c) and *Diploria strigosa* (Fig. 7a) with a small patch of *Porites porites* between the two more prominent species. These fossil corals differ from others in this vicinity in being directly overlain by beach calcarenites (Fig. 7b), reflecting a high point of the variable relief that typifies many patch reefs. Just landward of these corals, a patch of breccia drapes the front of a small cliff formed in the beach calcarenites (Fig. 7c). Exposures of this breccia occur at approximately the same elevation (2 to 3m above mean sea level) south along the next 100m of the shore. The possible significance of this breccia is discussed in the description of

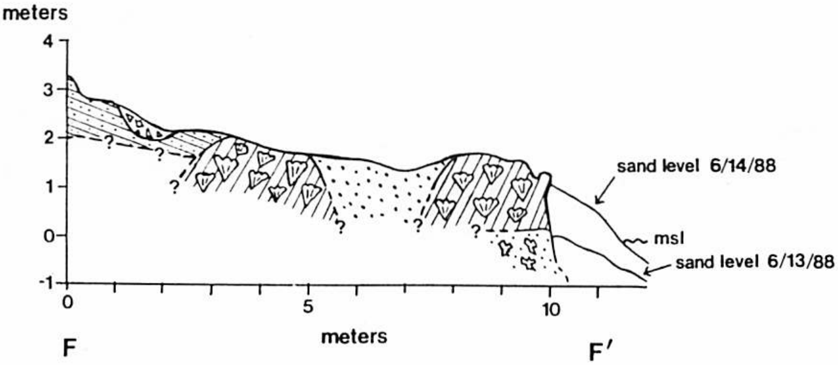


Fig. 6. Profile F-F'.

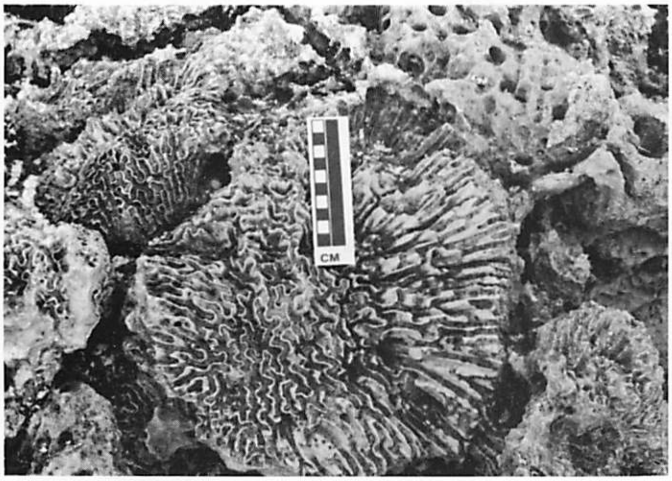


Fig. 7a. In situ Diploria strigosa. *Stop 2. Scale = 10cm.*

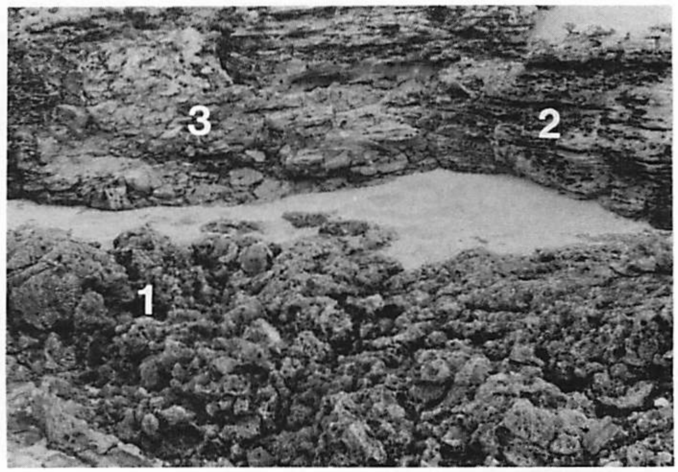


Fig. 7c. View of Stop 2 showing in situ *fossil corals (1), beach calcarenites (2), and breccia (3).*

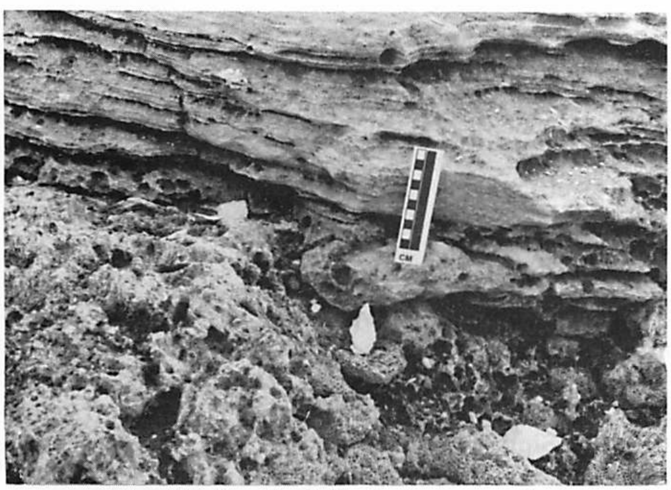


Fig. 7b. In situ Montastrea annularis *overlain directly by beach calcarenites. Stop 2. Scale = 10cm.*

Stop 4. The seaward part of the outcrop near stops 1 and 2 is subject to rapid changes in the amount of modern beach sand present. This is illustrated by profile F-F' (Fig. 6) which was measured on 13 June 1988. The following morning fifteen hours and two high tides later, a 104cm thicker layer of sand had been added to the seaward end of the profile.

Stop 3

The rocks are exposed more reliably at Stop 3 where the shallowing-upward sequence from subtidal to subaerial lithologies can be seen, as illustrated in profile A-A' (Fig. 8). Prominent *in situ* fossil corals are exposed next to the ocean in this area. The dominant coral species is *Montastrea annularis*, but some searching will reveal several others, including *M. cavernosa* (Fig. 9a), *Diploria strigosa, Porites porites, P. furcata, P. astreoides, Agaricia* sp., and *Manicina aveolata.* Patches of reddish-brown paleosol occur directly on top of the fossil corals and provide graphic evidence of the change from marine to non-marine environments. Some patches of the paleosol contain blackened pebbles of limestone (Fig. 9b). Such dark pebbles commonly are found in paleosols, and their blackening has been ascribed to fire (Shinn et al., 1984) or to terrestrial exposure in the vicinity of hypersaline lakes (Ward et al., 1970). The origin of black micrite

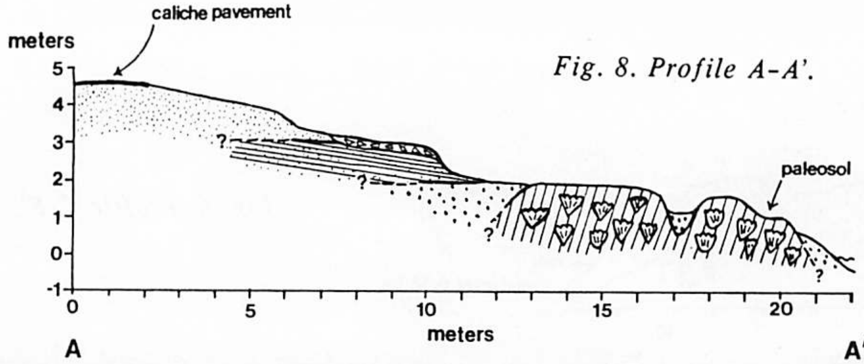


Fig. 8. Profile A-A'.

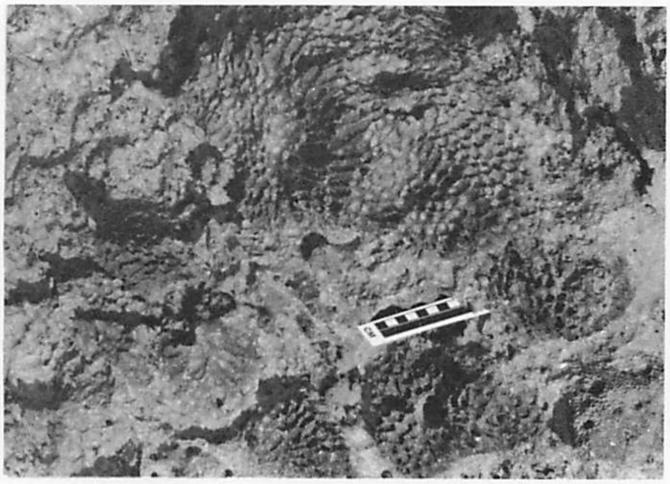


Fig. 9a. In place Montastrea cavernosa. *Stop 3. Scale = 10cm.*

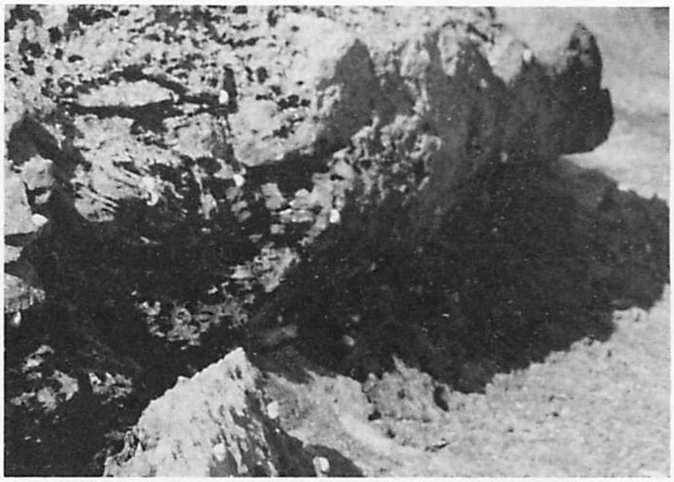


Fig. 9c. Wave-cut notch and breccia. Stop 4.

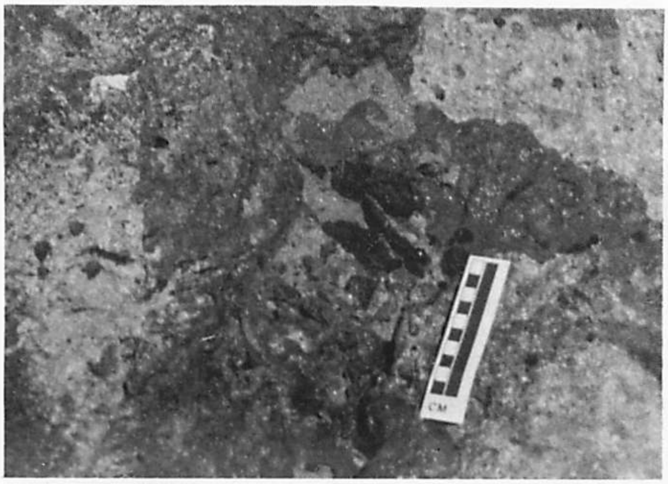


Fig. 9b. Black micrite clasts in paleosol. Stop 3. Scale = 10cm.

pebbles on San Salvador and their stratigraphic significance was discussed at length by Bain (1984). He concluded that pre-existing limestones, commonly grainstones, underwent diagenetic micritization in the presence of fungi and algae in a subaerial environment. Carbonization of the contained organic matter produces the black color. Reworked fragments of these blackened micrities are incorporated into a variety of subsequent deposits, including paleosols as seen at Sue Point. Their presence is a clear indication of subaerial exposure, and they mark a disconformity or unconformity.

Stop 4

The shallowing-upward sequence is exposed continuously along the outcrop to Stop 4 in the vicinity of profile B-B' (Fig. 10). The breccia first described above under Stop 2 extends from Stop 3 to Stop 4, and along here it is associated with a wave-cut notch (Figs. 2a and 9c). At several localities this notch has a caliche layer draped over it, demonstrating that it was formed during a pre-modern sea level high stand. The breccia may have formed during this same period of higher sea level and may represent patches of talus debris associated with the erosion of small sea cliffs. The breccia clasts are angular and some have the characteristic microscopic texture of eolianites described by White and Curran (1988). This suggests that the wind deposited sands that formed during the post-Sangamon

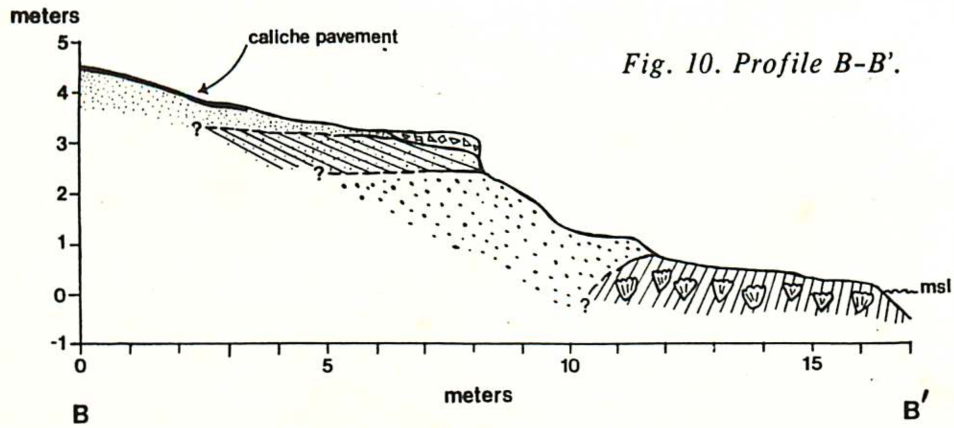


Fig. 10. Profile B-B'.

regression were lithified and later subjected to erosion during a high stand of sea level between the Sangamon and the present. Other workers have presented evidence from San Salvador for such a sea level high stand. Titus (1984) describes former sea cliffs, wave-cut notches, and lake deposits and attributes their formation to a latest Pleistocene sea level high stand of +2.5m relative to present sea level. He describes a wave-cut bench with a low sea cliff on the landward side that extends from Victoria Hill Settlement, just northeast of the Sue Point fossil reef, to Line Hole Settlement. Holocene rocks overlie the wave-cut bench. Using the age data of Carew (1983), Titus proposes that the wave-cut bench was cut into rocks that are approximately 75,000 years old during a sea level high stand 35,000 to 40,000 years ago. Based on their analysis of the formation of Lighthouse Cave and speleothems from within it, Mylroie and Carew (1988) propose two post-Sangamon sea level high stands. In the interval 37,000 to 49,000 years B.P. sea level temporarily reached approximately its present level, probably not high enough to cut the notch at Sue Point. An earlier high stand of +1 to +6m above present sea level occurred 70,000 to 85,000 years B.P. and this postulated sea level high stand seems the best candidate for the formation of the wave-cut notch at the Sue Point fossil reef locality.

Stop 5

The sequence in this area is shown by profile C-C' (Fig. 11). Exposed here is a rubblestone composed of broken "branches" of *Acropora cervicornis* (Fig. 12a). Some of the *A. cervicornis* may be in growth position or close to it, although it is difficult to be certain in this particular instance. There is a good cross section of a *Montastrea annularis* head in growth position overlying coral rubblestone.

Beyond Stop 5 the main *Montastrea-Diploria-Porites* patch reef extends for approximately 75m to the SW. In places the reef is cut by small gullies that are floored by shelly calcarenites (Fig. 12b) and that are reminiscent of similar features found in many modern patch reefs. Several small patches of paleosol occur along this stretch of the fossil reef. Landward there

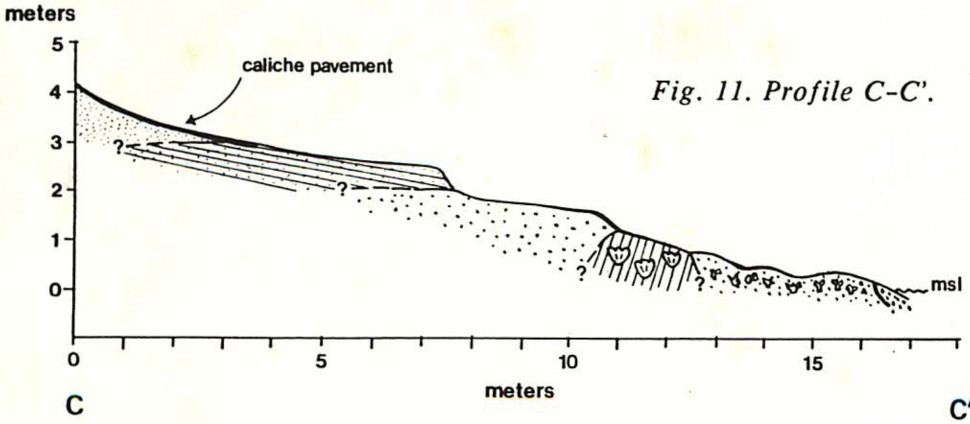


Fig. 11. Profile C-C'.

Fig. 12a. Coral rubblestone containing clasts of Acropora cervicornis. *Stop 5.*

Fig. 12b. Shelly calcarenites. Stop 5.

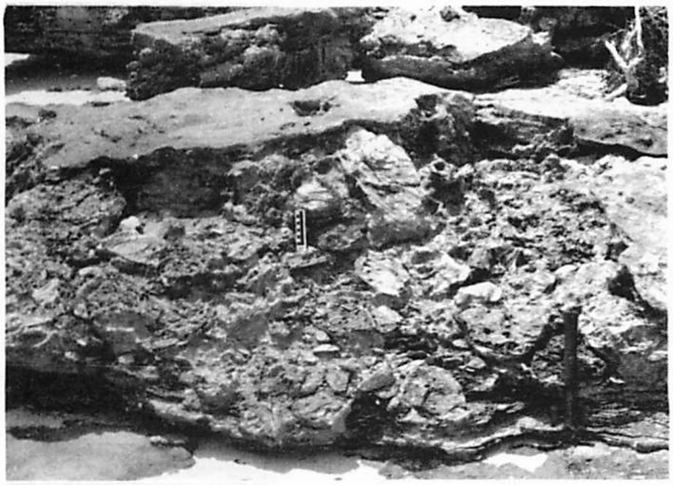


Fig. 12c. Caliche draped over breccia. Stop 5. Scale = 10cm.

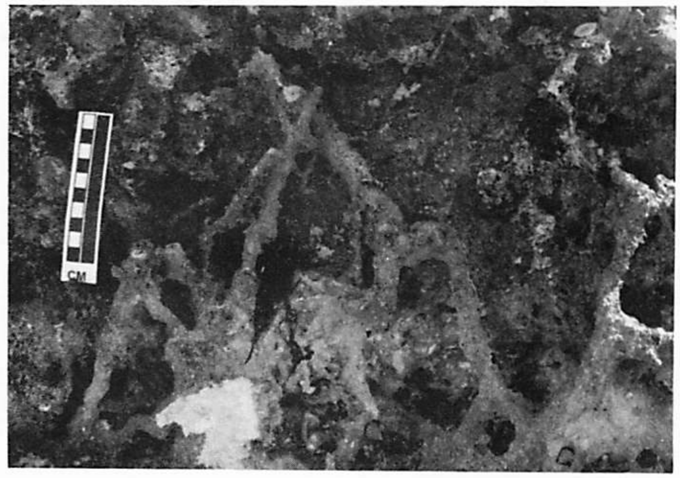


Fig. 13a. Rhizomorphs formed by the precipitation of micrite around the roots of terrestrial plants. Stop 5. Scale = 10cm.

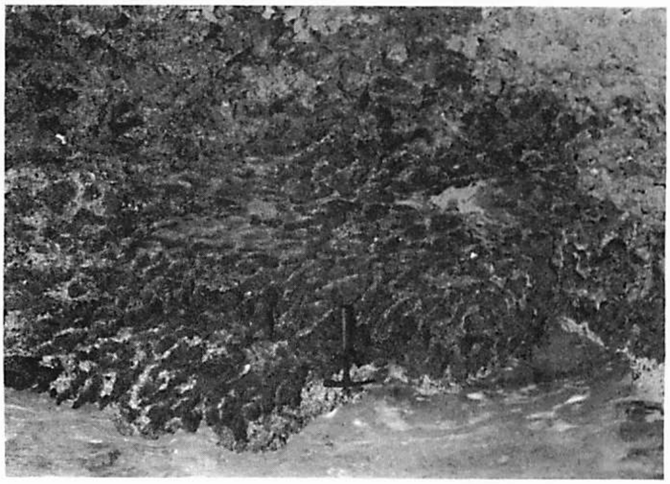


Fig. 13b. Large in place heads of Montastrea annularis. *Stop 6.*

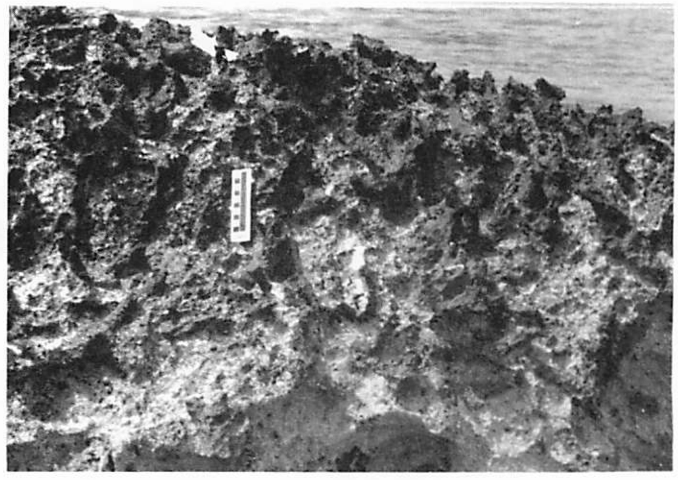


Fig. 13c. Acropora cervicornis *preserved in growth position. Stop 7. Scale = 10cm.*

are good examples of breccia (Fig. 12c), which commonly contain rhizomorphs (Fig. 13a) formed by the precipitation of micrite around the roots of terrestrial vegetation. Rhizomorphs also can be found directly on fossil corals, again demonstrating graphically the effects of falling sea level on the environments and associated biota. Similar plant trace fossils are abundant in many of the Quaternary carbonate rocks of the Bahamas and have been known for a century since they were described by Northrop (1890) and given the name rhizomorphs.

Stop 6

At this stop there are large heads of *Montastrea annularis* several meters in diameter preserved in their original growth position (Fig. 13b).

Stop 7

Near Stop 7 the coastline makes a sharp swing to the SE, and here *Acropora cervicornis* becomes the dominant coral species of the fossil reef, as illustrated in profile D-D' (Fig. 14). *A. cervicornis* in growth position is exposed prominently along the SE-facing cliff edge (Fig. 13c), where it may be examined most easily at low tide. *A. cervicornis* fragments are abundant in coral rubblestones exposed adjacent to the *in situ* corals.

Examples of all the important features of the Sue Point fossil coral reefs can be seen somewhere between Stops 1 and 7. Exposures of a second fossil patch reef extend along the coast south of Stop 7 (see Map 2). A similar lateral distribution of facies is evident as the one described above for the more northerly patch reef. From NE to SW there is a trend from scattered *in situ* heads of *Montastrea annularis* amidst subtidal calcarenites, to a more continuous *Montastrea-Diploria-Porites* fossil patch reef, ending with *Acropora cervicornis* in rubblestones and preserved in growth position in the SE-facing sea cliff. The zig-zag pattern of the modern coastline formed by the outcrops of the Sue Point fossil coral reefs is paralleled by living patch reefs. It is possible that the configuration of the Sue Point fossil reefs reflects a similar geography along a Sangamon shoreline.

The fossil *Acropora cervicornis* may represent the somewhat deeper water end of linear patch reefs. In several places along the fossil reef, heads of *Montastrea annularis* can be seen to have grown on top of *Acropora cervicornis* rubblestone, indicating that *A. cervicornis* was already present somewhere in the area. This may represent a succession of coral species as water depth decreased over the reef, either by upward growth of the reef or by absolute fall in sea level, or some combination of the two. In comparison with the Sangamon fossil reefs at Devil's Point, Great Inagua, and at Cockburn Town, San Salvador (Curran and White, 1985; Curran et al., this volume), fossil *Acropora palmata* is notably absent from the Sue Point fossil reefs. This implies that the Sue Point reefs were not located at the higher energy edge of a shallow shelf nor did they grow up to mean sea level. By comparison with Sangamon sea level elevations determined from the Cockburn Town fossil reef (Curran and White, 1985), the tops of *Montastrea annularis* heads reached to within 2 to 4m of mean sea level. Thus they were similar to living *Montastrea annularis* in the patch reefs of Fernandez Bay and elsewhere on the shelf around San Salvador.

The field trip can be continued by walking SE along the coast until reaching the main road, or by retracing one's path to the starting point.

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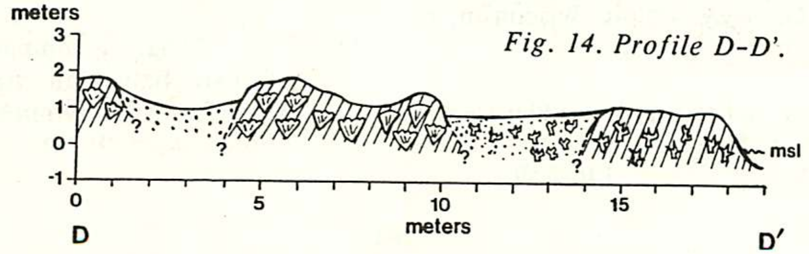

Fig. 14. Profile D-D'.

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