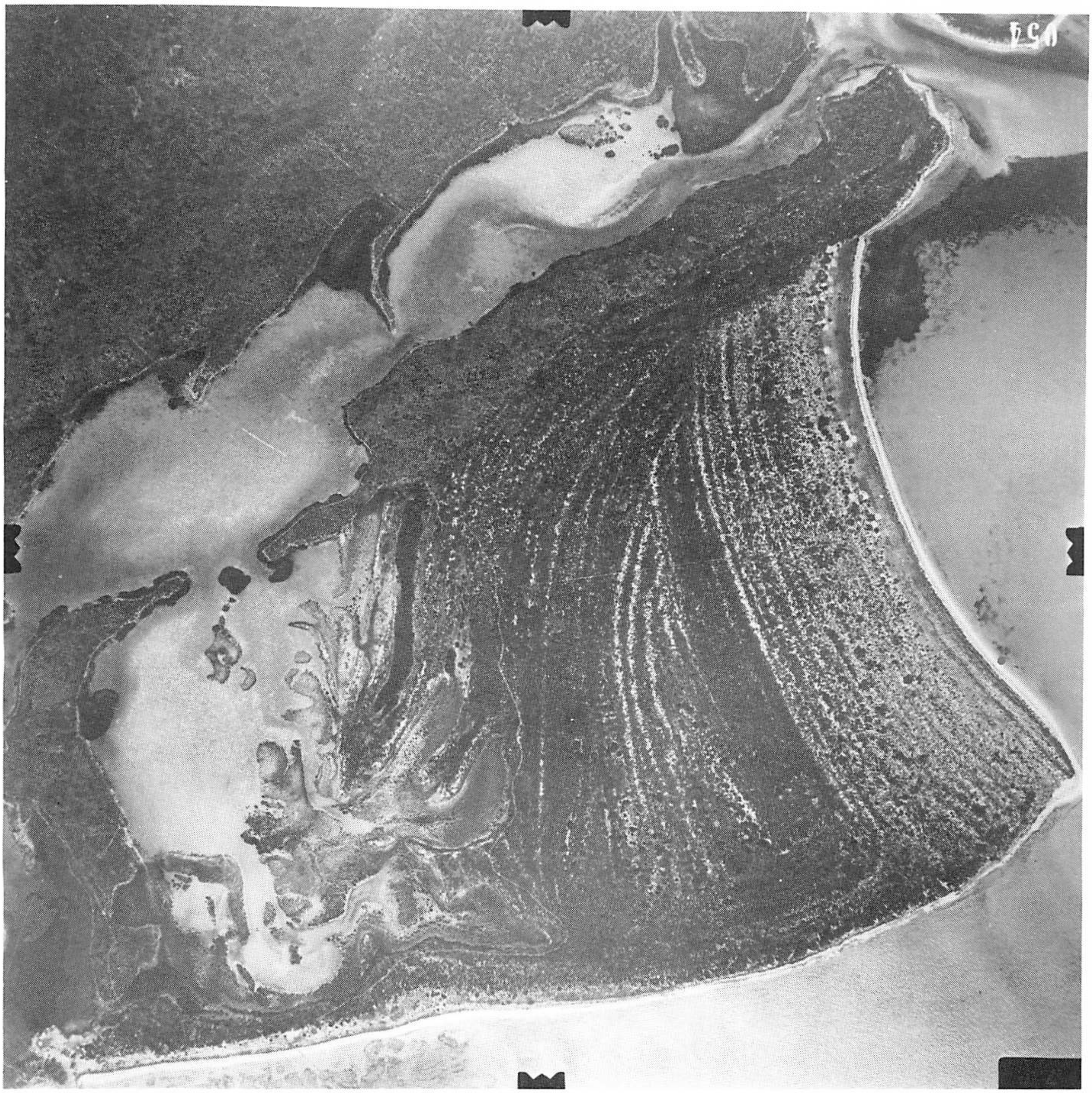
PIGEON CREEK AND TIDAL DELTA

A FIELD TRIP GUIDE

by

Mark Boardman and Cindy Carney



Bahamian Field Station
San Salvador, Bahamas
1996

Cover Photo: Air photo of western arm of Pigeon Creek and Sandy Hook strand plain area. Photo was taken in 1942; original scale 1 : 30,000).

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Pigeon Creek is the name given to two elongate, narrow arms of a lagoon located in the southeast corner of San Salvador (figs. 1 and 2 on following pages). The two arms (or branches) are oriented north-south and east-west and are approximately 30 m wide and 2 km long. The arms are connected at the southeast corner where the lagoon is in contact with the more open lagoon, Snow Bay. Portions of the lagoon are shallow subtidal, and other areas are intertidal. Each branch of the lagoon contains a central channel 1 to 3 m deep and is lined by mangroves. Arms of the lagoon are not connected to a continuous source of fresh water (i.e., they are not elongate estuaries). Salinity is generally highest at the enclosed ends and lowest (normal marine) at the connection with Snow Bay. Tidal fluctuations alternately fill and empty the lagoon, and tidal currents are very strong. The two branches converge at a narrow inlet, and the resulting tidal currents attain speeds of >70 cm/s (1.5 knots; fig. 3). These high currents are responsible for creating and maintaining the deep scour pits seen in the channel throat and the sandy ebb-tidal delta located seaward of the throat.

Pigeon Creek has been the site of several research projects. Teeter and Thalman (Thalman, 1983; Thalman and Teeter, 1983; Teeter and Thalman, 1984) determined from sedimentological and faunal characteristics of the northern branch that Pigeon Creek began as an open-marine environment. The area became restricted as a beach/dune ridge was built to the east. They compared Pigeon Creek to a possible Pleistocene equivalent (Quarry E, located at the northern extremity of the north-south branch of Pigeon Creek; Teeter, 1989). Mitchell (1987) described the surface sediment distribution and physical parameters of both branches. On the basis of texture and grain composition, Mitchell (1987) divided Pigeon Creek sedimentary facies into 12 groups. He agreed that Pigeon Creek is a modern analog to sediments at Quarry E except that peloids are the dominant grain type today, whereas ooids were dominant during the Pleistocene. Slone, Boardman, and Cummins (Slone, 1990; Slone and others, 1990; Cummins and others, 1991) examined sediment texture, density of seagrass, mollusc communities, and taphonomy of molluscs from the west branch of Pigeon Creek and compared this portion of Pigeon Creek to the ebb-tidal delta and open-ocean lagoon (Snow Bay). Their results show that, although sedimentary and taphonomic facies exist, considerable mixing of shells among environments has occurred. In addition, it is apparent that density of seagrass does not directly and dominantly control the quantity of mud accumulated or the species composition of the molluscs.

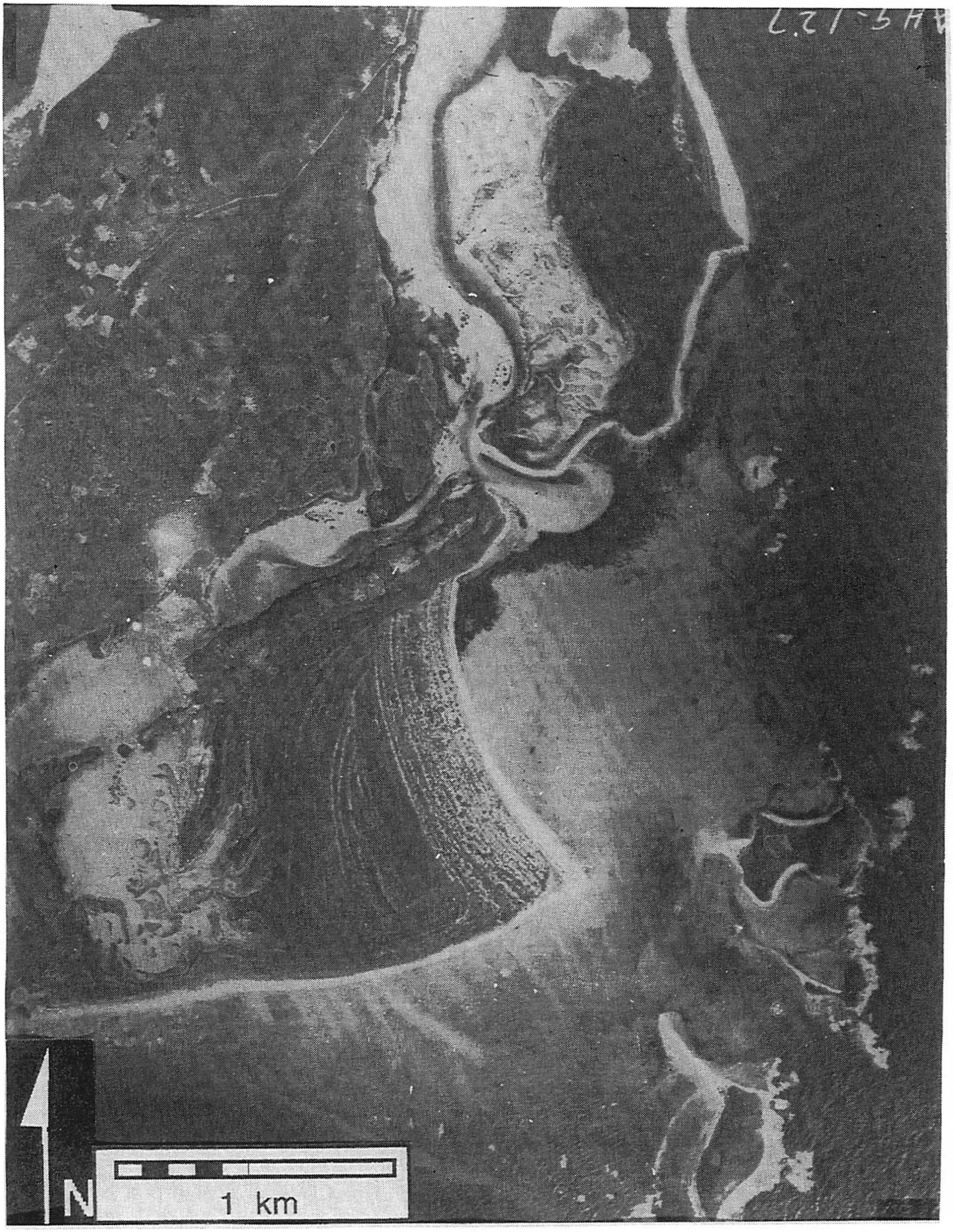

Fig. 1. Air photo of Pigeon Creek and Sandy Hook area (1942; original scale 1 : 30,000).

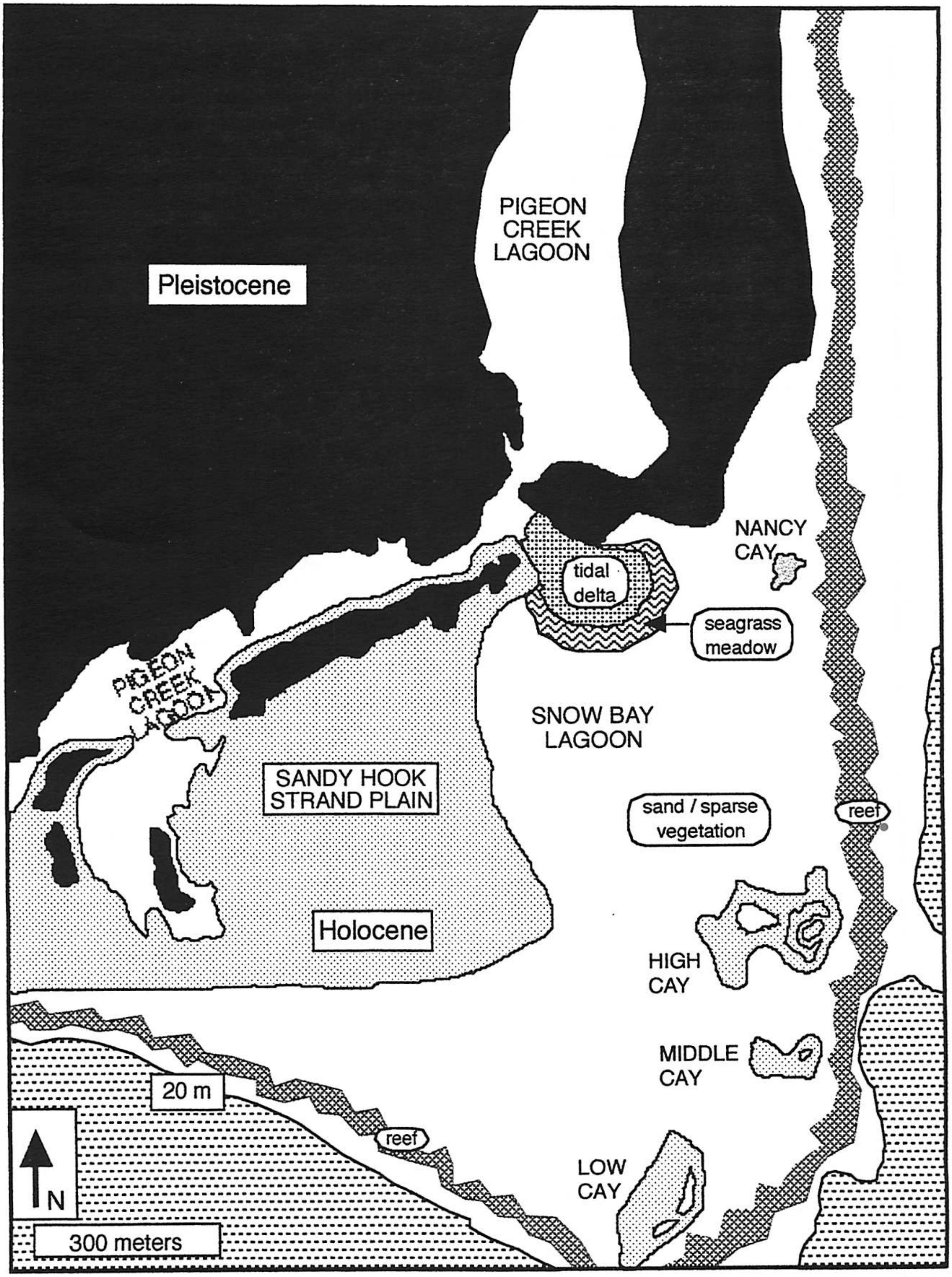

Fig. 2. Map of Pigeon Creek and Sandy Hook area.

We will enter the water at a public dock. The area near the dock contains a *Thalassia* meadow about 1 m deep along the channel margin, scour pits (up to 5 m deep) in the central channel, and mangroves at the edges of the lagoon. Depending on the tidal currents, when we jump in the water and begin our snorkel, we will be (1) swept up the channel towards the intertidal portions of the west branch, or (2) swept out of the throat of Pigeon Creek to the ebb-tidal delta.

Thalassia meadow

The seagrass encountered in this area is more dense than any we encountered in Graham's Harbour, yet there is surprisingly little mud (generally <5%). The currents (up to 70 cm / s) apparently winnow any mud that is generated here. In addition to *Thalassia*, there are areas of abundant *Halimeda*; in places, the sediment is composed of nearly 100% coarse *Halimeda* flakes. Abraded grains (peloids, ooids, and skeletal fragments) are also a component of the sediment.

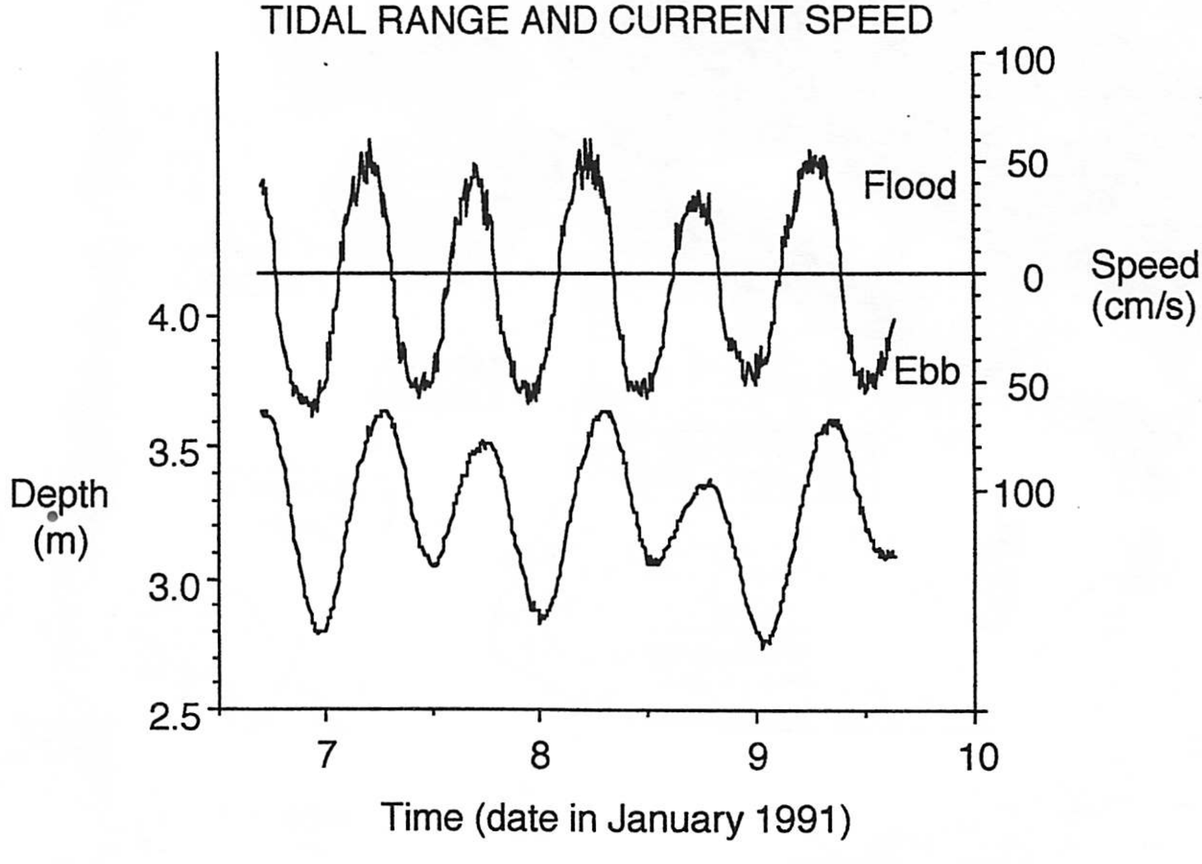

Fig. 3. Tidal range and current speed at the throat of the inlet connecting the western arm of Pigeon Creek with the more open lagoon of Snow Bay (refer to cover photo or Figures 1 and 2). The meter was emplaced in January, 1991 and left for several days. Tidal fluctuation (lower curve, left scale) is uneven, semi-diurnal, and approximately 80 cm. Current speeds (upper curve, right scale) are clearly related to tidal fluctuation and attain maximum velocities of > 70 cm / s. There is very little time when currents are not strong in Pigeon Creek.

Scour Pits

The *Thalassia* meadow ends abruptly at the scour pits located in the central channel. The walls of the scour pits expose the rhizome system of the seagrass and show its powerful binding capability. Embedded on the sides of the scour pits are large molluscs in life position (prominent are a bivalve, *Codakia costata*). Chunks of the *Thalassia*-bound sediment have calved off and lie on the floor of the scour pit.

The scour pits are incredibly energetic environments, and their position within the channel is constantly changing. Covering the floor of the scour pits is a lag deposit of coarse sand and shells. Chunks of peat crop out beneath the carbonate sediment. This peat and peat layers from sediment cores in this channel have been dated (C-14) at 6,000 to 3,000 years B.P. From these dates sedimentation rates have been estimated at approximately 100 cm/1000 years. The scour pits are elongate parallel to the current flow, and the steepest ends are located on the western edges (up channel). Apparently the ebb current is the most active erosional force, and the scour pits are migrating up channel. On the eastern ends, the scour pits slope more

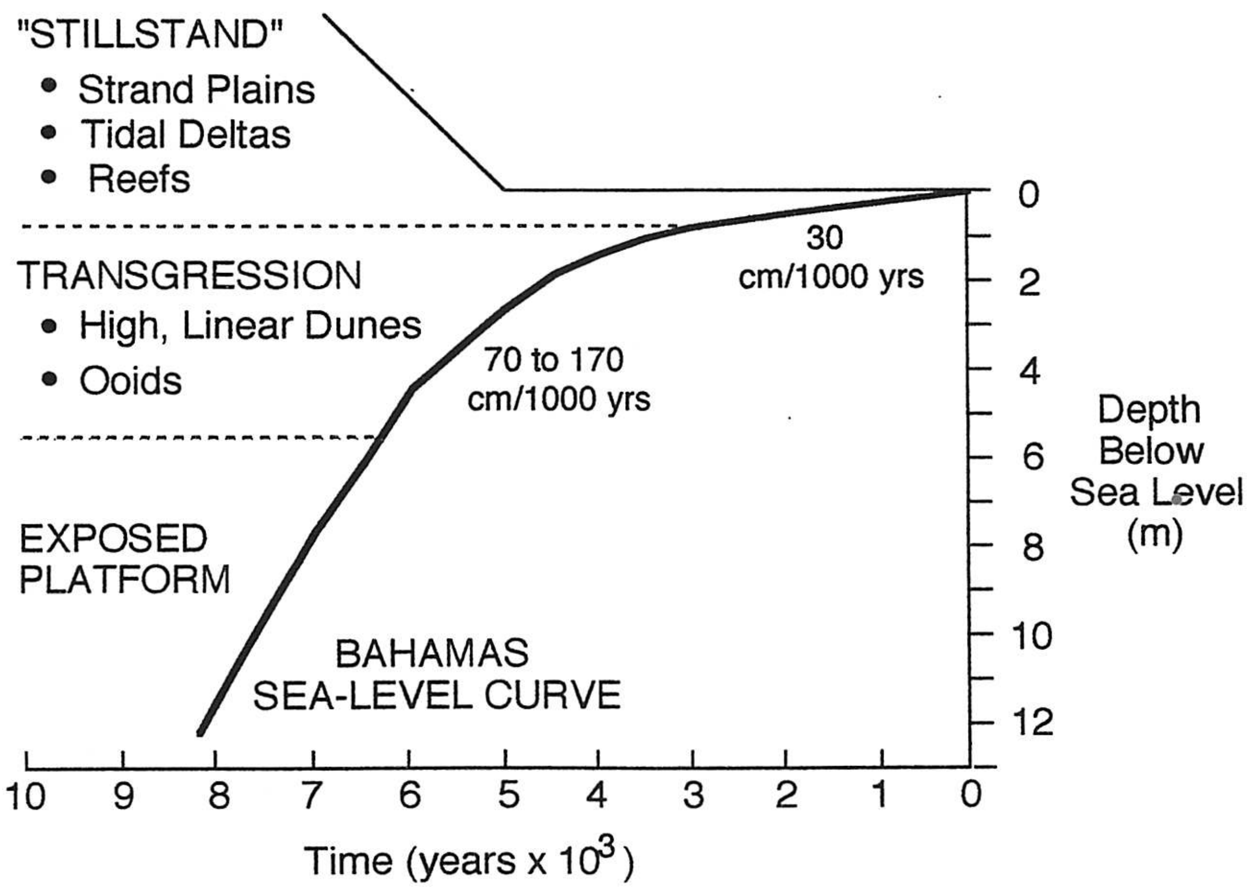

Fig. 4. This sea level curve for the Bahamas (modified from Boardman et al., 1989) is derived from C-14 dates of basal peat deposits from a variety of depths and locations within the Bahamas. The rate of rise of sea level has decreased from 170 cm/1000 years to 30 cm/1000 years. This change of the rate of sea-level rise superimposed on the elevation (depth) of the platform controlled the type and distribuiont of sedimentary accumulations.

gradually. During both the ebb and flood currents sand can be seen moving over the thin carpet of seagrass.

In the floor of the scour pits, notice that the shells, which seem to be dominated by *Codakia costata*, are mostly concave up. In 1990, we marked and measured 25 shells and placed them concave down in the bottom of the scour pit. One week later, we returned and located 14 of the shells. The shells had been transported up to 20 m seaward (to the east). Nearly all (13 of 14) of the shells were found concave up. No shell was found west (up channel) of the site of emplacement. Apparently, all coarse-sediment transport occurs during ebb flow.

Would a channel sequence similar to this be misinterpreted as a storm layer (sharp base, shell/sand lag, fining upward) in an ancient sequence?

In 1991, a portion of a heavily encrusted and rusting chain was found protruding from the base of a scour pit. The chain was buried under approximately 2 m of sediment. Visions of Spanish galleons, gold, jewels, and perfectly preserved artifacts rushed into our minds. Typical sedimentation rates in lagoons are in the neighborhood of 20 to 60 cm/ 1,000 years. Sediment cores taken from this area have shown that sedimentation in Pigeon Creek is much higher, but could this chain have been buried about 500 years ago. Upon our return to the Bahamian Field Station, carefully concealed questions about the Pigeon Creek area revealed that in the past the owner of the house located about 50 m away was known to bring his 20-foot powerboat into the channel and that he had a mooring located right where the chain was found. The boat was removed, and the mooring abandoned 18 years ago! Apparently, sedimentation in this channel can be very rapid—2 m in 18 years or 11,000 cm/1,000 years! The chain mooring was located in a scour pit 18 years ago. The scour pit migrated, and the *Thalassia* meadow has prograded over the scour pit, filled it in, and is presently eroding again. What does this tell us about the rate of progradation of seagrass beds? Consider how this seagrass environment compares to the seagrass environments of Graham's Harbour. Could we tell the difference between the two in an ancient sequence?

Up channel

The system of scour pits and seagrass meadows extends up the channel for several hundred meters. The channel shoals to less than 1 m water depth, the seagrass becomes less dense, and the topography of the seagrass-covered sediment becomes hummocky.

On the north side of the channel is an intertidal area of mounded sandy sediment. Sediment from a 2-m sediment core taken from this area was composed of a monotonous fine sand. Thin-section analysis of this sediment shows that the grains are dominated by peloids (48%), ooids (18%), molluscs (12%), aggregates (9%), and various other skeletal fragments.

Down channel

The scour pits grade into a deeper, sandy region located at the confluence of the two branches of Pigeon Creek. Large sand waves (1 m high) are seen on the bottom. Most of the sand waves are ebb oriented (but then we only go down the creek during the ebb tide). To the left (north) the northern branch of Pigeon Creek can be seen.

Tidal delta

As we continue down the channel and out the mouth, a sandy tidal delta (ebb-tidal delta) is encountered. The surface geometry of the delta is concave up. An intertidal portion is located in the center, and deeper areas lie around it. The outer margin of the delta is marked by an abrupt transition to seagrass. In places the seagrass / sand margin is an escarpment in which the seagrass rhizome system is exposed, and the sand is up to 50 cm deeper than the seagrass. This suggests that the seagrass has eroded. In other areas, there is no difference in topography, the seagrass density gradually changes over a distance of several meters, and it is not clear whether the sand delta is prograding over the seagrass or the seagrass meadow is prograding over the delta. How fast is this progradation occurring? When did it start? The history of this progradation is estimated from four sources of information.

(1) In 1986, we embedded PVC and aluminum tubing at the seagrass / sand boundary, in the seagrass 1 m from the sand edge. These tubes were placed every 10 m. As you snorkel around the edge of the delta, tubes may be encountered stuck in the sediment. In the sand areas, the tubes will be recognized because they are covered with tufts of algae, and fish may have made a home of the tube. Some tubes are located up to 10 m from the edge of the delta, indicating that, in that area, the delta has prograded 10 m in the last few years. In other areas the tubes are still in the seagrass, 1 m from the edge of the sand, indicating no movement of the sand / grass boundary. In no place have we found that the seagrass meadow has prograded over the sand delta.

(2) Sediment cores taken from the seagrass meadow near the edge of the delta contains muddy sand with abundant whole molluscs and other skeletal material. Sediment cores from the delta reveal a meter or so of abraded, well-sorted sand underlain by a muddy sand with abundant whole molluscs and other skeletal material. These sequences confirm that the delta is prograding over the seagrass meadow.

(3) C-14 dates of the sand in the delta indicate that the sand is approximately 2,000 years old. However, C-14 dates from the mud fraction of the sediment immediately beneath the delta sand are much younger than the overlying sand (a C-14 date inversion). In a core from the central portion of the delta, at the boundary between muddy sand (seagrass sediment) and delta sand (60 cm deep in the core), the underlying mud is 600 years old; whereas the overlying sand is 2,560 years old, indicating that the delta has indeed enlarged significantly during the last 600 years. The delta sand is anomalously old because it is a mixture of early Holocene sand and modern sand.

(4) When Dr. Don Gerace, the director of the Bahamian Field Station, first came to San Salvador, he piloted a 55-foot ketch across the delta and into Pigeon Creek. He went up the creek, anchored, turned around, and left. Today, that would not be possible. He reports that the entry to the channelway and the channel itself have certainly changed.

It is also interesting to note that, at the confluence of the two branches of Pigeon Creek, there are remains of an Indian village. It is thought that the Indians would probably not have located in an area where access to the sea would be restricted.

Based on these various sources of information, it seems evident that the delta is a geologically recent and dynamic feature. What caused it to form? What is its genetic relationship to Pigeon Creek, to the Sandy Hook strand plain, to the relict offshore sand dunes (e.g., High Cay), and to the upward growth of reefs?

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