



CHAPTER 6 QUATERNARY VEGETATION AND DEPOSITIONAL HISTORY OF ST. CATHERINES ISLAND

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The Quaternary vegetation history of the southeastern United States has not been well studied, particularly in comparison to more northerly regions of North America, and this is even more apparent on the coastal plain of Georgia (e.g., Watts, 1971; Rich and Spackman, 1979; Rich 1984a, 1984b, 1996; Rich and Pirkle, 1998). The coastal region of Georgia is characterized by a string of barrier islands that formed during the late Pleistocene and have been continually modified during the Holocene through depositional and erosional processes. These processes continue to shape the geomorphology and hydrology of the barrier island region, resulting in a dynamic mosaic of salt, brackish, and freshwater marshes and sandy, well-drained upland soils dominated by southern pine and oak forests.

St. Catherines Island is one of the least disturbed of the barrier islands along the Georgia coastline, and has been the subject of a suite of studies over the past several decades aimed at better understanding its geological development, current vegetation, and vegetation history. For example, maps and descriptions of the principal plant communities currently on the island have been developed (Somes and Ashbaugh, 1972; Coile and Jones, 1988; Reitz et al., 2008) and ethnobotanical studies have revealed information on the composition of plant communities prior to European disturbance (Thomas, 2008). However, a longer-term perspective on the vegetation and developmental history of the island has been provided by lithostratigraphic studies of pollen preserved in a range of depositional environments. The following report is a distillation and summary of the palynological work performed on St. Catherines Island

over the past decade. The distribution of sites is scattered, the ages of deposits are not systematically distributed, and the available records are discontinuous, so this compilation cannot be seen as the result of a comprehensive study. However, the accumulation of data of different ages from many localities shows that the sediments of St. Catherines Island contain a wealth of palynological and paleoecological information that bears on our understanding of ancient terrestrial ecosystems of the Georgia coastal plain.

SITE NETWORK

Palynological samples from St. Catherines Island have been collected from various locations and include exposed dune sections as well as sediment cores; our site network includes areas within the northern portion of the island, which is Pleistocene in age, as well as sites within the accretionary complex of the southern, Holocene-aged portion of the island (fig. 6.1). In addition to samples from St. Catherines Island, we discuss samples of probable late Pleistocene age collected from Gray's Reef, located about 32 km southeast of St. Catherines Island. Data from some localities have been published elsewhere (Booth and Rich, 1999; Booth, Rich, and Bishop, 1999; Booth et al., 1999; Russell et al., 2009), and others are presented here for the first time.

METHODS

In some cases, sediments were collected merely as grab samples (e.g., South Beach samples); in other cases, sediment cores were col-

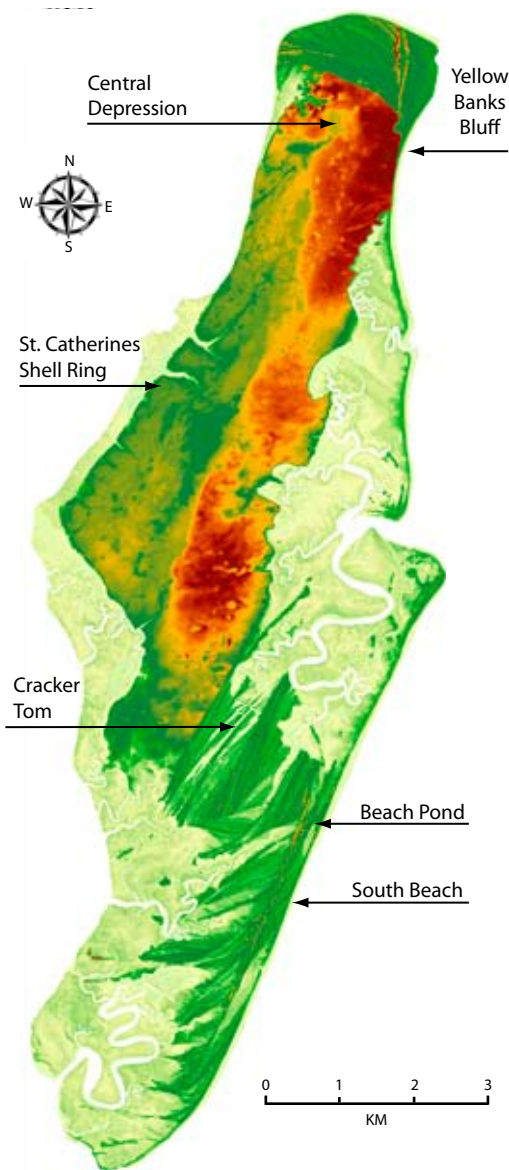


Fig. 6.1. Contrast-enhanced aerial photograph of St. Catherines Island showing the location of sites where palynological samples have been collected and analyzed.

in each sample, and for most samples more than 500 grains were counted. Percentages for arboreal taxa were calculated using a total arboreal sum, and percentages for other taxa were calculated using a total sum. To facilitate comparison of pollen samples analyzed from the island, and particularly to compare the composition of late Pleistocene and Holocene samples, pollen data were subjected to hierarchical cluster analysis (flexible- β linkage method, $\beta = -0.25$) using Sørensen's distance measure (McCune and Grace, 2002).

Ages of Holocene sediments discussed in this chapter are presented in both radiocarbon years and calendar years, following the conventions set out in the preface (see also appendix 1). 2σ ranges for calendar-year ages were determined using the INTCAL 2004 calibration curve (Reimer et al., 2004). Ages of Pleistocene samples are reported in radiocarbon years only.

A note concerning nomenclature is also appropriate at this point. Taxonomists periodically change the names we use to identify plant families or even species. Thus, to the extent that the works we have compiled here span a period of years, and because some of those names have changed with time, there are differing names that are actually synonyms. A good case in point is the grasses, known earlier by the familial name Gramineae, but more recently as Poaceae. Both terms will be found in this text, depending upon when the data were collected, which name was used at the time, and when a particular publication appeared. Families such as the composites are so large and complex that the nomenclature dealing with them is equally complex. You will see Compositae, Tubiflorae, and Asteroideae appearing in this text. These all refer to plants that are related to daisies, sunflowers, or dandelions. We have tried to identify synonymies where they do occur. Additionally, scientific names and common names appear, and we have attempted to include the common name in the first use of every scientific name.

RESULTS AND DISCUSSION

We discuss the vegetational and developmental history of the island by first presenting the results obtained from the individual sites and then concluding with a more synthetic discussion of the geological and vegetation development of the island.

lected using a vibracorer (Bishop et al., chap. 10). Standard techniques were used to isolate pollen, spores, and other palynomorphs from collected samples (Traverse, 2007). A minimum of 300 palynomorphs were identified and tallied

YELLOW BANKS BLUFF

A sample of humate-bearing sand was collected from just above the active beach at Yellow Banks Bluff (fig. 6.1), and given its location and stratigraphic context, it is probably late Pleistocene in age. The preservation of pollen in the sample was not ideal, as the grains were all unusually small, suggesting anomalous conditions during deposition and/or diagenesis of the deposit. Likewise, many pollen grains were nondescript in appearance and difficult to identify, perhaps representing poorly preserved *Alnus* (alder) or Tubuliflorae (composites) grains that had lost part of the external pollen wall (ektexine). Among the numerous identifiable grains, the most abundant arboreal taxa were *Carya* (hickory and pecan) and *Pinus* (pine); however, a very large amount of pollen from herbaceous plants and woody shrubs characterized the sample, including abundant Tubuliflorae (41% of the palynoflora), *Alnus* (17%), Poaceae (grasses, 10%), and *Ambrosia* (ragweed, 5%; table 6.1).

The palynoflora of the Yellow Banks Bluff sample suggests the local presence of an alder-composite grass community unlike anything that occurs on the island now. This community appears to have been deposited in or near an alder-dominated wetland, perhaps similar to the tag alder wetlands of the upper Midwest, which are commonly dominated by *Alnus rugosa*, species of the composite *Eupatorium*, and several species of grasses. Additionally, there is little or no indication of halophytic species in the Yellow Banks Bluff sample; there were no Chenopodiaceae/Amaranthaceae (lamb's quarters, goosefoot, etc.), and *Iva* (marsh elder, a common seaside inhabitant) constituted less than 1% of the pollen/spores.

GRAY'S REEF

The palynological composition of three samples from Gray's Reef National Marine Sanctuary illustrates yet another aspect of the coastal flora as it probably appeared during the Last Glacial Maximum (table 6. 1). Russell et al. (2009) noted that the transient cooccurrence of "warm-" and "cool-climate" taxa may have been common in the Southeast during the Late Glacial Maximum. A coastal/maritime forest appears to have occupied the vicinity of Gray's Reef National Marine Sanctuary, east of the Georgia mainland in an area currently submerged beneath about 18 m of seawater. Sediment cores from the reef in-

cluded medium gray clay with shell fragments; palynological samples were recovered 5–10 cm below the tops of two sediment cores. Pollen/spore recovery was excellent, and included such common taxa as *Pinus*, *Quercus* (oak), *Carya*, and *Liquidambar* (sweet gum). Other taxa, however, including *Alnus*, *Picea* (spruce), and *Tsuga* (hemlock) typically occur today in more northerly latitudes (Rich and Pirkle, 1994), or higher altitudes, such as the Piedmont.

ST. CATHERINES SHELL RING

The St. Catherines Shell Ring (aka Long Field Crescent, Long Field Shell Ring; Bishop et al., 2007; Thomas, 2008; Sanger and Thomas 2010; Bishop et al., this volume, chap. 10) is on the western margin of the island (fig. 6.1), and is the location of a large shell ring of Native American construction. In chapter 10 (this volume), Bishop and colleagues illustrate the stratigraphy of six cores collected from the site and inferred stratigraphic correlations (see fig. 10.6). Several samples from these cores have been analyzed palynologically, including a sample from a shell bed located at 322 cm below the surface and dated at $>44,800$ ^{14}C yr B.P. (Beta-217823). Several peat samples from just over 4 m deep were recovered from shell ring vibracore #2, and two radiocarbon dates were obtained from these peat samples. These dates indicate that deposition of the peat occurred at $39,130 \pm 660$ ^{14}C yr B.P. (Beta-217824) and $29,440 \pm 260$ ^{14}C yr B.P. (Beta-217825 (fig. 10.6).

The pollen assemblage from the deep shell bed was dominated by *Pinus* (common names have already been given) and *Quercus*; these occurred in approximately equal percentages (table 6.1). Other arboreal types that were likely present in the region include *Carya*, *Liquidambar*, *Nyssa* (black gum/tupelo), *Betula* (birch), Cupressaceae/Taxodiaceae (probably cypress), and *Ulmus* (elm). Abundant nonarboreal types included Chenopodiaceae/Amaranthaceae type (probably salt marsh chenopods) and Poaceae, consistent with deposition in or near a salt marsh environment. The palynology of the sample is quite similar to that of the lowermost sample from a core from Cracker Tom Hammock (CTH559; discussed in the next section), which is also presumably late Pleistocene in age and characterized by codominance of *Pinus* and *Quercus*, and significant amounts of *Carya*, *Liquidambar*, Cupressaceae/Taxodiaceae, Poace-

ae, and Chenopodiaceae/Amaranthaceae type. Trace amounts of *Fagus* (beech) also occurred in both the shell bed sample and the lowermost Cracker Tom Hammock sample.

The lowermost peat captured in St. Catherines Shell Ring core #2 was dominated by *Pinus* (table 6. 1). Other common arboreal types include *Quercus*, Cupressaceae/Taxodiaceae, *Carya*, *Betula*, *Fagus*, *Liquidambar*, and *Nyssa*. The relatively high *Fagus* percentage (3%) suggests the local presence of beech populations. Beech currently does not occur in coastal Georgia, except for some disjunct populations on north-facing bluffs of the Savannah River. The nonarboreal pollen of the peat indicates deposition in a freshwater peatland environment, dominated by ferns (*Osmunda*, *Woodwardia*-type), grasses, and sedges.

Additional analyses of subsamples of the St. Catherine Shell Ring peat collected from core 2 (location indicated on fig. 10.2) revealed similar results. These samples came from 4.06–4.13 m below land surface, and consisted of subsamples of a single piece of dense, brittle, grayish black (N2) sediment. Grasses were the most abundant pollen type in these three subsamples, and these were associated with abundant cypress-type (Cupressaceae/Taxodiaceae/*Taxodium*), royal/interrupted/cinnamon fern (*Osmunda*), and monolete fern spores likely attributed to Virginia chain fern-type (*Woodwardia*). The peculiar abundance of grape (*Vitis*) in one subsample is also notable. The palynoflora suggests a fern-and-grass-dominated wetland with nearby cypress trees that hosted grape vines. Similar landscapes can be seen in the eastern Okefenokee Swamp, particularly in areas of Chesser and Coward Lake prairies where vast grassy wetlands (locally referred to as prairies) are dotted with groves of cypress. An otherwise significant taxon in the Okefenokee (*Nymphaea*, the white water lily) is absent from the St. Catherines Shell Ring peat, a condition that might indicate shallow, or completely absent standing water at the time of its deposition.

CRACKER TOM TRANSECT

The area of Cracker Tom Hammock/Cracker Tom Causeway contains some of the oldest accretionary ridges on the island (see chap. 10: fig. 10.7), as it is directly adjacent to the northern Pleistocene-age island core. Cores have been collected from this area and studied on three occasions, by different investigators, and the results of these analyses appear to be central to our un-

derstanding the Pleistocene and Holocene depositional histories of St. Catherines Island.

A core was collected from the Cracker Tom Bridge locality in 1990 by Gale Bishop, and a small sample of a basal peat was radiocarbon dated (UGA-6267) and determined to be $28,370 \pm 340$ ^{14}C yr B.P. (fig. 6.2). The palynological composition of the samples was dominated by monolete spores (spores resembling microscopic kidney beans) of what could most easily be attributed to a common wetland fern of the southeastern United States, *Woodwardia* spp. Two species, *W. virginica* and *W. areolata*, are common in the Southeast. Though Gleason and Cronquist (1963) identify both species as living in "swamps," Rich (personal obs.) has seen *W. virginica* to be more common in extensive flooded wetland situations, while *W. areolata* seems to prefer occupation of cypress knees, other areally limited exposed surfaces within freshwater wetlands, and mainland areas that lie upslope of perennially flooded locations. *W. virginica* forms large communities (probably clones) that occupy emergent vegetative mats in the Okefenokee Swamp. These mats are most common in open, sunny areas where there is little competition from any other species; Coward Lake Prairie in the Okefenokee is a characteristic site. The coincidental appearance of other herbaceous species such as the Chenopodiaceae/Amaranthaceae, Compositae, Gramineae, and Cyperaceae (sedges) is fully consistent with the presence of *Woodwardia*. The sample was almost certainly derived from a fern-dominated freshwater wetland.

Booth (1998) collected and analyzed three cores for their palynological content from the Cracker Tom area, and recovered what appears to represent the same peat deposit at the base of a core from Cracker Tom Bridge (CTB). The peat from this core was dated to $47,620 \pm 2500$ ^{14}C yr B.P. (USGS WW 1197), and if this radiocarbon date is accurate, the peat is considerably older than the peat collected from the same area by Bishop in 1990. However, the pollen assemblage in the peat of the Cracker Tom Bridge core was essentially the same as the sample analyzed from the 1990 core (table 6. 1). Monolete fern spores dominated the sample, and other taxa in the sample included insect-pollinated composites (aka Asteroideae), the Chenopodiaceae/Amaranthaceae, grasses, the Cyperaceae, *Polygonum* sp. (common freshwater herbs, generally known as knotweed), *Sagittaria* sp. (arrowhead, also com-

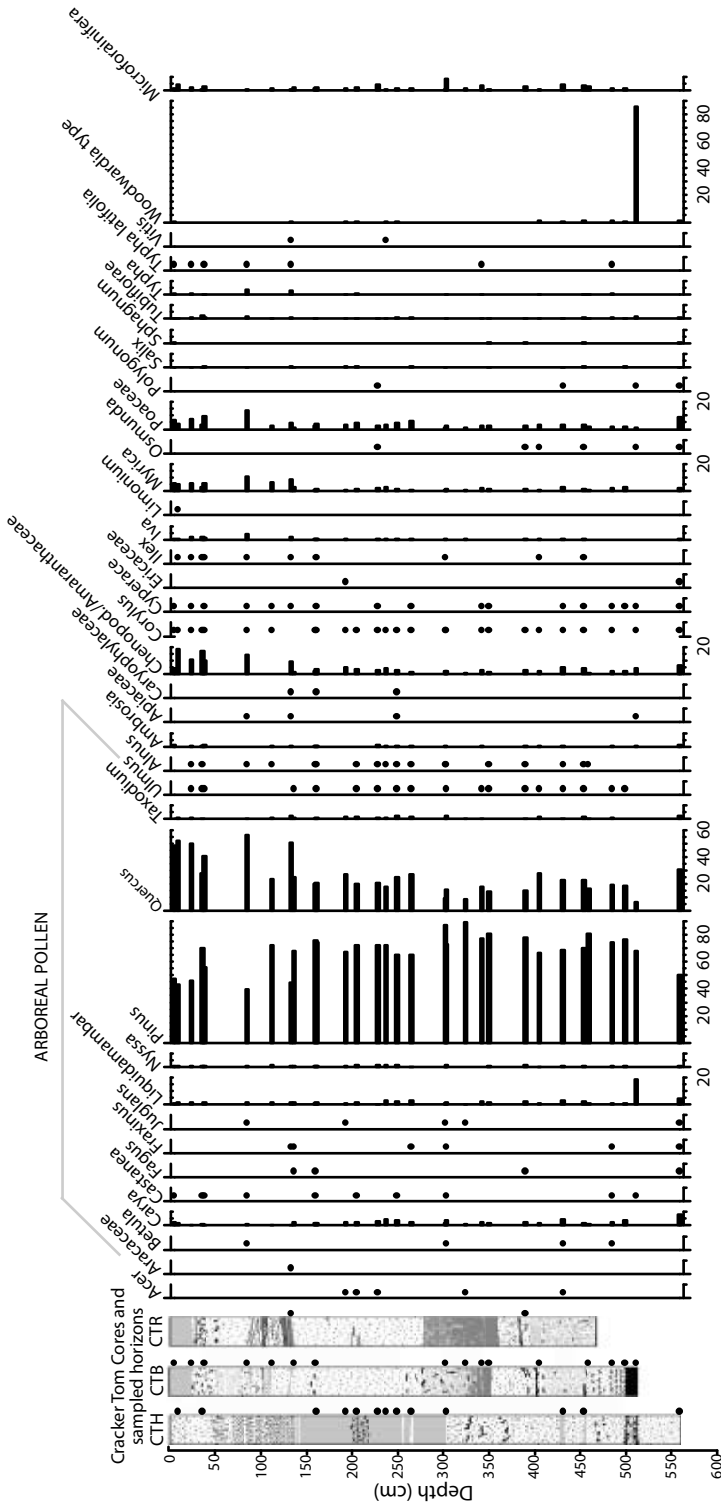


Fig. 6.2. Relative abundance of pollen and spores from three cores collected from the Cracker Tom area (modified from Booth, Rich, and Bishop, 1999). Core stratigraphy and stratigraphic position of the samples are shown to the left.

mon in freshwater), and *Sambucus* sp. (elderberry). A detailed morphological analysis of the fern spores suggested that they were most similar to spores produced by the Virginia chain fern (Booth and Rich, 1999), *Woodwardia virginica*. The pollen and spore composition of the peat sample indicated the presence of a terrestrial hydrophytic community that is common in southeastern Georgia today. Even extralocal taxa, including pine, oak, sweet gum, cypress, and wax myrtle (*Myrica*) are typical of freshwater wetlands; there was no indication of northern taxa in the peat.

Booth's (1998) analysis of his three cores resulted in the identification of 50 taxa among the cores. The general characteristics of the three cores were similar; *Pinus* and *Quercus* dominated every sample, except for the ancient peat from CTB. High percentages (40%–55%) of broken pine pollen were common in all samples. Though broken pines (i.e., grains broken in halves) are not unusual in samples of any provenance, the clear abundance of them in some samples has been related to deposition in nearshore coastal environments (Rich and Pirkle, 1998). Strata above the peat in the CTB core included a sequence of clastic sediments; fortuitously, immediately above a clear disconformity (i.e., a depositional break separating sedimentary units) on the upper surface of the peat lay unconsolidated sand with abundant shells. One *Americardia media* L. valve was removed from the core, and it bore beneath it a small cluster of charcoal fragments. Both the shell and the charcoal were sent to the USGS for radiocarbon analyses. The shell was determined to have a radiocarbon age of 4060 ± 50 ^{14}C yr B.P. (USGS WW1198: 4420–4810 cal B.P.) while the charcoal was dated at 6020 ± 50 ^{14}C yr B.P. (USGS WW1262: 6740–6990 cal B.P.).

Linsley and Rollins (in Bishop et al., 2007) conducted sedimentological investigations of four additional cores from the same vicinity and their paleoenvironmental interpretations are discussed in chapter 10, this volume (esp. fig. 10.7). The peat illustrated at the base of the Linsley and Rollins Cracker Tom Bridge core is almost certainly the same peat that was recovered in the previous cores from the area, and was dated by $22,600 \pm 310$ ^{14}C yr B.P. (Pitt-831). This age is more similar to the age obtained from the peat collected by Bishop in 1990 than it is to the older radiocarbon date obtained by Booth (1998). However, the relationships that the Bishop and Linsley/Rollins peats described above have to the

sample described by Booth (1998) and Booth and Rich (1999) have yet to be determined with certainty. The great differences in dates must be reconciled, though the range of ages over a 10,000 year period are similar to the range of ages determined for the deeply buried peat samples from the St. Catherines Shell Ring (see above).

BEACH POND

Beach Pond is one of the remaining freshwater enclaves that lies close to the coast on the eastern shore of St. Catherines Island. Booth (1998) and Booth et al. (1999) provided an analysis of a core recovered from Beach Pond that represents a record of Holocene deposition in that area of the island. The core was 4.5 m long, and consisted of sand, clay, and peat. Palynostratigraphy revealed dynamic changes in environments of deposition and plant communities during the time of sediment accumulation. The lower portion of the core accumulated under nearshore marine conditions, and probably represents deposition in a shallow lagoon that would have been located south of the island at that time.

The pollen composition of the lower sediments in the Beach Pond core was characterized by abundant pollen of *Pinus*, and, similar to the Cracker Tom results, many broken grains were encountered (fig. 6.3). A wood fragment was recovered from the uppermost portion of the lagoonal facies, and was dated at 1210 ± 40 ^{14}C yr B.P. (1010–1260 cal B.P.; Beta-115910). Tidal-flat strata overlay the wood-bearing unit, and were in turn overlain by a thin peat layer derived from what was probably an interdunal swale community dominated by *Myrica*. A return to brackish marsh conditions subsequently occurred, as indicated by the peculiar presence of the pollen of *Limonium* (sea lavender) and species common to upper areas of the salt marsh environment. Pollen possibly attributable to *Salicornia* (glasswort, or a similar member of the Chenopodiaceae or Amaranthaceae) and abundant grass pollen accompanied the *Limonium*, consistent with a brackish marsh community. The freshwater pond community that stands at the site now was established as the salinity at the site decreased over time and was indicated by the abundance of freshwater taxa, including *Typha* (cattail), sedges, and the very distinctive megaspores of the floating fern *Azolla*. Fluctuations in sea level, the advent of erosional episodes and storm overwash events, and anthro-

TABLE 6.1
Relative Abundances of Pollen and Spores from Late Pleistocene-Age Samples at Yellow Banks Bluff, Gray's Reef, Long Field (near St. Catherines Shell Ring), and Cracker Tom Bridge Collected in 1990

	Yellow Banks Bluff ^b	Gray's Reef ^a	Gray's Reef ^a	Gray's Reef ^a	Long Field shell ^b	Long Field peat ^b	Long Field core 2, sample 1 (4.06–4.13 m) ^a	Long Field core 2, sample 2 (4.06–4.13 m) ^a	Long Field core 2, sample 3 (4.06–4.13 m) ^a	Cracker Tom Bridge, 1990 core, basal peat
<i>Acer</i>	0	0	0	0	0	0	0.5	0.6	0.8	0
<i>Betula</i>	0	0.9	1.3	1.1	0.8	2.9	2.1	0	0.8	0
<i>Carya</i>	25.3	5.3	2.6	1.4	4	7.6	1.6	3.1	1.5	0
<i>Castanea</i>	2.3	0.4	2.2	0.7	0	0	0.5	0.6	1.5	3.6
<i>Fagus</i>	2.3	0.9	0.4	0	0.4	2.9	3.8	4.4	5.4	0
<i>Fraxinus</i>	1.1	0.4	0.4	0.7	0	0	0.5	0	0	0
<i>Liquidambar</i>	0	2.6	0	0.4	2.0	1.1	2.2	1.3	0.8	3.6
<i>Nyssa</i>	0	0	0	0	0.7	0.7	0	1.3	0.8	0
<i>Pinus</i>	62.1	61.7	75.0	78.6	45.2	57.8	22.6	40.6	20.0	82.1
<i>Quercus</i>	4.6	19.8	16.8	15.2	42.8	19.1	7.5	8.8	10.8	7.1
<i>Taxodium</i>	1.1	3.1	0	1.1	3.6	8.7	58.1	39.4	57.7	3.6
<i>Ulmus</i>	1.1	0.9	1.3	0.7	1.2	0	0.5	0	0	0
<i>Alnus</i>	19.3	2.0	0.7	1.7	0	0.5	1.5	0	0.3	0
<i>Ambrosia</i>	5.3	0.8	0.6	0.5	1.6	0.7	0	0.3	0.6	0
Apiaceae	0	0	0	0	0	0.2	0	0.6	0	0
Caryophyllaceae	0	0.3	0	0	0	0	0.3	0	0	0
Chenopodiaceae / Amaranthaceae	0	12.8	4.8	4.3	5.2	2.4	0.6	0.6	0.3	6.7
<i>Corylus</i>	0	0	0.2	0.5	0.7	0.5	0	0	0	0
Cyperaceae	0	1.0	0.2	0	0.3	2.6	0	0	0	2.1
Ericaceae	0.1	0	0	0	0	0	0	0	0	0
<i>Ilex</i>	1.4	0	0	0	0	0.2	0	0.6	0	0
<i>Iva</i>	0.3	0.5	0.4	0	0.3	0	0	0	0	0
<i>Myrica</i>	0.8	1.0	0.2	0.2	0.3	0.2	1.5	1.8	0.3	0
<i>Osmunda</i>	0.3	0.5	0.2	0	0.3	7.5	6.4	9.1	5.8	0
Ostrya-Carpinus	0.3	0	0.2	0	0	0	0.3	0.3	0.3	0
Poaceae	11.2	2.3	4.0	0.7	5.2	19.2	25.0	30.0	28.4	5.0
<i>Polygonum</i>	0	0.5	0	0	0	0	0	0	0	0
<i>Salix</i>	1.7	0.5	0	0.5	0	0.2	0	0	0.6	0.8
<i>Sphagnum</i>	0	0.2	0.2	0	0.7	0	0	0	0	0
Tubiflorae	45.1	1.3	0	0	0.7	0	0.3	0	0.3	3.3
<i>Typha</i>	0	0	0	0	0	0	0	0	0.3	0
<i>Typha latifolia</i>	0	0	0	0	0	0	0	0	0	0
<i>Vitis</i>	0	0	0	0	0	0	0	0.9	10.3	0
Woodwardia type	1.9	1.7	0.6	0	1.0	19.7	7.3	7.0	9.4	70.0
Microforaminifera	0	17.8	42.4	25.1	1.3	0	0	0	0	0

^aAnalyst F.J. Rich.

^bAnalyst R.K. Booth.

pogenic changes such as road building and well drilling have probably all influenced the development of communities at Beach Pond by altering hydrological flow patterns and the relative influence of saltwater and freshwater at the site.

SOUTH BEACH PEAT

Three samples of sediment were recovered from shells that were entombed in peat that was exposed on South Beach, St. Catherines Island (Rich and Pirkle, 1998). The shells were articulated and were removed from their original points of burial, so the sediments are believed to faithfully represent the nature of the vegetation at the time of burial, at least as it is represented by pollen and spores.

Shells of *Mercenaria mercenaria* (quahog), *Crassostrea virginica* (eastern oyster), and *Geukensia demissa* (Atlantic ribbed mussel) are very common in modern-day salt marshes on the Atlantic coast of Georgia. These genera are also common in the South Beach deposit, and radiocarbon dates on shells revealed ages of 500 ± 80 ^{14}C yr B.P. (*Crassostrea*, UGA-6161), 670 ± 90 ^{14}C yr B.P. (*Mercenaria*, UGA-6162), and 580 ± 90 ^{14}C yr B.P. (*Geukensia*, UGA-6163). A sample of wood was removed from the deposit as well and yielded an age of 430 ± 90 ^{14}C yr B.P. (UGA-6160). All four radiocarbon dates are statistically indistinguishable at the 95% level (t-test), and the calibrated range of the pooled mean indicates an approximate age of cal A.D. 1310–1440 (2σ range). In cultural terms, this falls within the latest Irene phase, immediately prior to establishment of the mission Santa Catalina de Guale (Thomas, personal commun.).

The vegetation existing on or near the island during the time of shell and peat deposition at South Beach was essentially the same as current vegetation. The pollen/spore content of the shell fillings (see Rich and Pirkle, 1998) consisted of trace amounts of monolete fern spores, *Alnus*, and *Castanea* (American chestnut) and minor amounts of *Corylus* (hazelnut), *Fraxinus* (ash), *Nyssa*, *Salix* (willow), and *Ulmus* (table 6.2). *Carya*, Poaceae, *Liquidambar*, and *Myrica* were also present in small amounts, with the latter three taxa being most consistently present. Chenopodiaceae/Amaranthaceae, Tubuliflorae, and *Taxodium* were all common in the samples, with *Taxodium* being the most consistently abundant of these three taxa. Finally, *Quercus* and *Pinus* clearly dominated the samples (table 6.2). Re-

sults indicate that at the time of deposition of the shells and peat, sources of abundant pollen that could accumulate in an intertidal setting were the same plants that occur in such a setting on the island now. Clearly this is not surprising given the young age of the deposit; however, the fact that an intertidal salt-marsh occurred in an area where there is now open beach and pounding surf highlights the dynamic nature of the surficial processes that continually modify barrier island environments.

Beach retreat on South Beach was dramatically demonstrated in March 1993 when Flag Pond (a former freshwater marsh on South Beach) was made a saltwater lagoon by breaching of the sand ridge that had separated it from the ocean (Bishop et al. 2007). Since that date, the development of a tidal channel, known as Flag Inlet, and the continuing retreat of the beach ridge have changed the former cattail marsh to a system of tidal flats and salt marsh. Thus the shoreline retreat we have witnessed in the recent past appears to have been a factor in island development nearly 600 years ago.

THE CENTRAL DEPRESSION

The Central Depression is an enigmatic topographic feature of St. Catherines Island that has only been recently investigated from a geological perspective. Bishop et al. (2007) illustrate its general location on the island, and Reitz et al. (2008) relate the Central Depression to both the hydrologic characteristics and soil types of the island. According to the latter authors, accounts written by Jonathan Bryan (1753, as reported in Thomas, 2008) describe a “perfect Meadow being a large Savanna of about a Mile or Mile and half wide and four or five Miles long, and finely water’d with Springs.” Additionally, “crystal [crystal] Streams in winding rills proceeds the rising Mounts and flow the verdant meads...” It does not take much imagination to construct a vision of well-watered wetlands that lay over a large portion of the middle of St. Catherines Island. Reitz et al. (2008) note that the “perfect Meadow” was drained by the construction of dragline ditches in the 1930s. The legacy of the meadow is now preserved in the subsurface, if it exists at all, and recent attempts have been made to recover strata from the Central Depression that might tell us something of its history.

In the spring of 2008, R.K. Vance and three students from Georgia Southern University

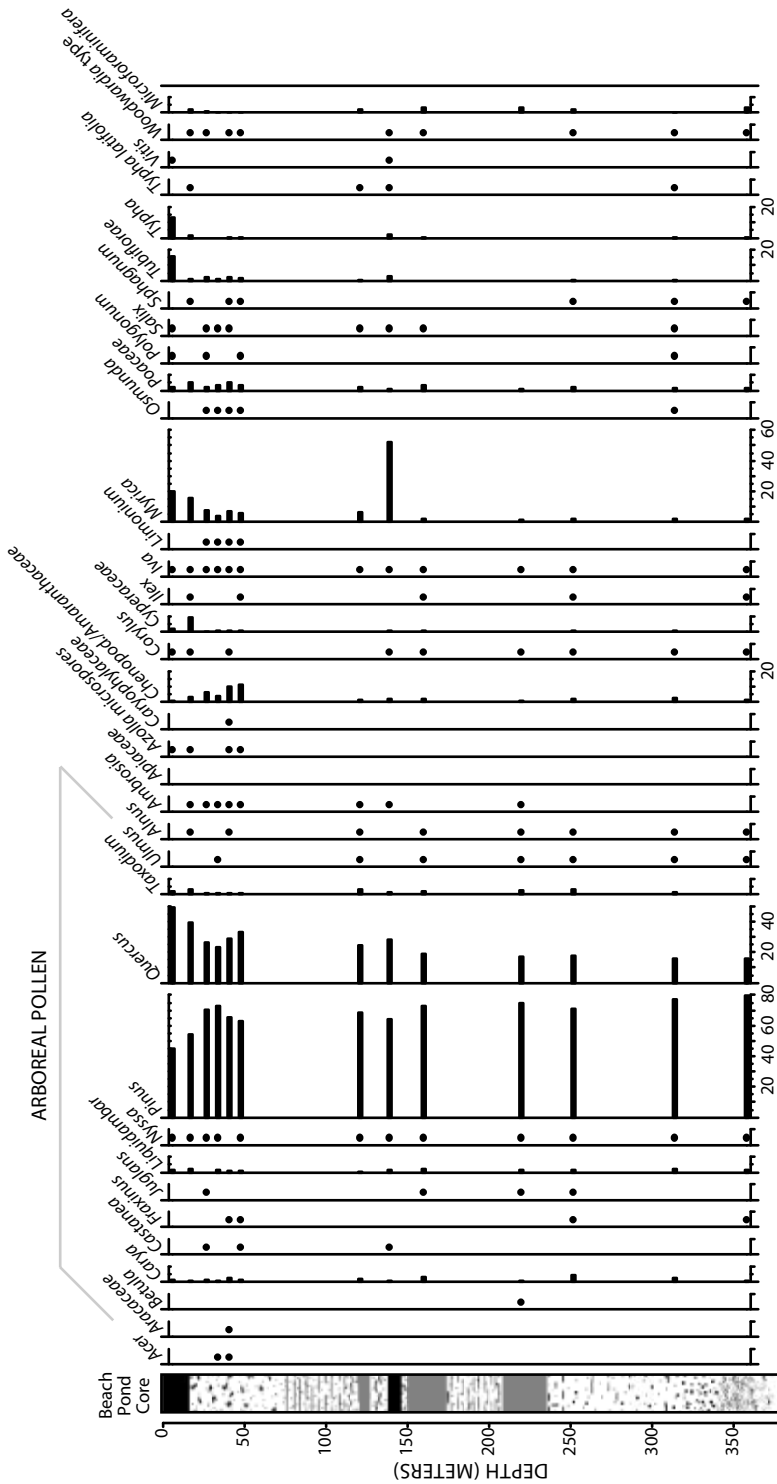


Fig. 6.3. Relative abundance of pollen and spores from three cores collected from the Beach Pond area (modified from Booth et al., 1999). Core stratigraphy and stratigraphic position of the samples are shown to the left.

TABLE 6.2
**Relative Abundances of Pollen and Spores
 from Peat Exposed on South Beach**
 Analyst: F.J. Rich.

	South Beach <i>Geukensia</i> infilling	South Beach <i>Crassostrea</i> infilling	South Beach <i>Mercenaria</i> infilling
Aracaceae	0	0.6	0
<i>Betula</i>	0	0	0.5
<i>Carya</i>	1.0	1.2	0.5
<i>Castanea</i>	1.0	0.6	0
<i>Fraxinus</i>	0	0	1.5
<i>Liquidambar</i>	2.6	1.8	2.0
<i>Nyssa</i>	0.5	0.6	1.0
<i>Pinus</i>	69.1	59.3	68.7
<i>Quercus</i>	17.8	26.7	17.2
<i>Taxodium</i>	7.9	9.1	7.6
<i>Ulmus</i>	0	0	1.0
<i>Alnus</i>	0.4	1.0	0.9
Chenopodiaceae / Amaranthaceae	4.3	2.9	2.6
<i>Corylus</i>	0.4	1.0	0
Cyperaceae	0.4	0	0
<i>Ilex</i>	0	0	0.9
<i>Myrica</i>	3.8	7.1	2.2
<i>Osmunda</i>	0	0.5	0.4
<i>Ostrya-Carpinus</i>	0	0.5	0
Poaceae	3.8	6.7	6.1
<i>Salix</i>	0.4	0	0.4
Tubiflorae	4.2	1.9	0.4
Woodwardia-type	0.4	0	0
Microforaminifera	4.5	8.6	6.1

Central Depression based on palynological analyses of the sediments, sedimentological analyses, and geophysical interpretations of the GPR data. Preliminary results were described by Ferguson et al. (2009).

Sediments recovered from the Central Depression using a soil bucket auger show that dark, humic acid- or humate-rich sediments can be recovered to a depth of at least 2 m; below that depth the water is high enough to preclude recovery of meaningful auger samples. However, vibracore samples taken toward the northern terminus of the Central Depression were recovered from the ground intact, and core #2 produced productive pollen samples to a depth of 85 cm. Palynological data from 50–55 cm revealed a dominance of *Myrica*, with the typically accompanying taxa *Pinus*, *Quercus*, *Liquidambar*, and the Ericaceae (heaths, such as blueberry). Other components of the pollen flora suggest the presence of a typical southeastern wetland flora, with one notable exception. *Tsuga* was present in more than trace amounts. This typically northern, or Piedmont species occurs rarely in samples from St. Catherines Island. *Tsuga* pollen is wind-borne, so its presence in the Central Depression does not necessarily indicate local presence of the plants, but it suggests that the plants probably grew on the coastal plain. *Tsuga* and other indicators of cooler climatic conditions provide substantive evidence that cool temperate vegetation grew on or near the core of the island, probably during the Pleistocene. Further results from Ferguson and her coworkers will hopefully provide a significant body of knowledge relating to the ancient history of the Central Depression.

QUATERNARY VEGETATION HISTORY AND THE DEVELOPMENT OF ST. CATHERINES ISLAND

went to the island and recovered nine vibracores from the Central Depression and surrounding ridges, mostly at the northern end of the island (see chaps. 10 and 11). The desirability of obtaining cores from the depression was suggested not only by the written historical record, but by a profile of the feature that Vance had earlier recovered using ground penetrating radar (GPR); GPR provided unmistakable evidence that a substantial synformal sag structure existed in the subsurface. The purposes of the coring were several, among them a desire to reconstruct a vegetational and developmental history of the

Although our picture of the vegetation history of the island is still incomplete, collectively the palynology of the various core and grab samples that have been analyzed provide some insights. Vegetation and depositional changes on the island can also be linked to changes that occurred on the broader coastal plain and provide information on the potential effects of Quaternary sea level and climatic changes in this understudied region. Although many of the species that are found on the island today are present in Holocene and late

Pleistocene sediments, there are subtle differences between the palynological composition of older and younger sediments (fig. 6.4).

The consistent presence, in both Holocene and late Pleistocene age sediments, of characteristically southeastern plant taxa such as *Pinus*, *Quercus*, *Taxodium*, *Nyssa*, and *Liquidambar* attests to the stability of these plants on the coastal plain during the late Pleistocene and Holocene (fig. 6.4). Most taxa present even in trace amounts in the records from the island are still found in the Southeast. Even considering the extent of late Pleistocene and Holocene sea level changes, when the island was alternately incorporated onto the mainland, or separated from it by tidal waters (see chap. 3, fig. 3.3), many elements of the southeastern flora we are familiar with on the island remained largely in place. However, there is some evidence of small amounts of northern species that probably cooccurred with southeastern species on the coastal plain (fig. 6.4). For example, the occurrence of *Tsuga* pollen in the Central Depression, along with abundant *Pinus*, *Quercus*, and *Liquidambar*, suggests that these taxa likely cooccurred in the region. Similarly, relatively abundant *Fagus* and *Taxodium* pollen was found in the peat from below the St. Catherines Shell Ring as well as other late Pleistocene age samples from the island (fig. 6.4), suggesting a similarly unique association of plants.

The occurrence of some characteristically north-temperate species has become a hallmark of floras of the southeastern United States during the late Pleistocene (Russell et al., 2009). Rich et al. (2000) found *Alnus*, *Liquidambar*, *Pinus*, *Picea*, *Quercus*, *Taxodium*, and *Gordonia* (loblolly bay) cooccurring in a beaver pond deposit from Deepstep, Georgia, dated >47,470 ¹⁴C yr B.P. (Beta-98688). Since that time a number of additional sites (including vertebrate sites) have demonstrated the extent to which northern and southern elements were mixed on the Georgia coast during the Late Glacial Maximum. For example, Booth, Rich, and Jackson (2003) identified southern pines from needle macrofossils in 37,000 year old peat recovered from Skidaway Island; interestingly, small amounts of both *Picea* and *Fagus* pollen were found in the same sediments.

For the most part, late Pleistocene sediments from the island are dominated by freshwater, terrestrial assemblages. These include sites from Cracker Tom and the St. Catherines Shell Ring

(fig. 6.4). The occurrence of freshwater peatland deposits on the island during the late Pleistocene is not surprising, given that sea level is estimated to have been as much as 120 m below its current position (Adams and Faure, 1998; Delcourt, 2002; Russell et al., 2009). Even a conservative estimate of the position of the Late Glacial Maximum shoreline places it well to the east of the island, probably as far as Gray's Reef (Russell et al., 2009). St. Catherines Island would have been a part of the mainland, not unlike Yamacraw Bluff, the present-day ridge that lies in the heart of Savannah and well inland of the Atlantic Ocean. There is the suggestion that late Pleistocene sea level changes along the Georgia coast may have been quite dynamic, and/or the coastline has experienced episodes of tectonic activity; a marine shell bed was deposited at a depth of 322 cm below the surface of the St. Catherines Shell Ring, but well above the expected sea level of its age. The anomalous appearance of intact marine shells at elevations on the Georgia coast where one might not expect to find them is not a new phenomenon (Pirkle et al., 2007). Oyster beds standing at 2 m elevation on the St. Marys River, and reliably dated at about 36,000 ¹⁴C yr B.P. (Pirkle et al., 2007; Rich and Pirkle, 1994), suggest that the influence of regional tectonics needs to be considered in any discussion of the topographic and geographical placement of coastal features in Georgia.

Pollen records from Florida indicate that the late Pleistocene of the Southeast was likely much drier than the Holocene, although it was also extremely dynamic at millennial timescales (Watts and Hansen, 1988, 1994; Jackson et al., 2000). Depositional hiatuses caused by low water brought on by increased aridity and/or the regional drop in sea level are also present throughout much of the region (Watts, 1971; Watts and Hansen, 1988; Rich, 1996; this volume, chap. 3). Late Pleistocene sediments on St. Catherines Island appear to be separated from Holocene age sediments by a depositional hiatus spanning at least 15,000 years, suggesting that the regional drop in sea level that accompanied the Late Glacial Maximum is manifest on the island.

Bishop et al. (2007; see also chap. 3, this volume) provide an excellent synopsis of the development of St. Catherines Island through time. In very general terms, the core of the island is of Pleistocene age, though it is unclear just when the island first took form, or if it developed over a

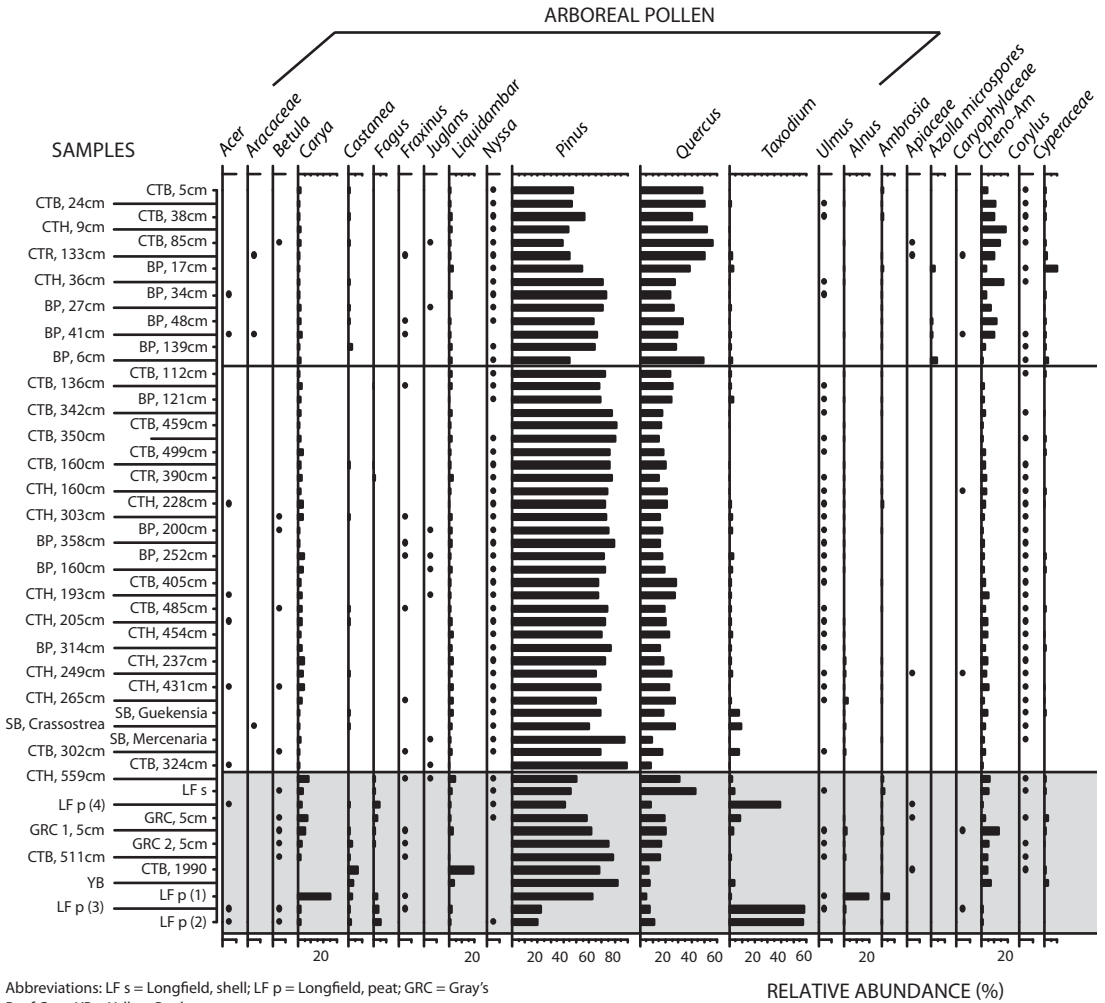
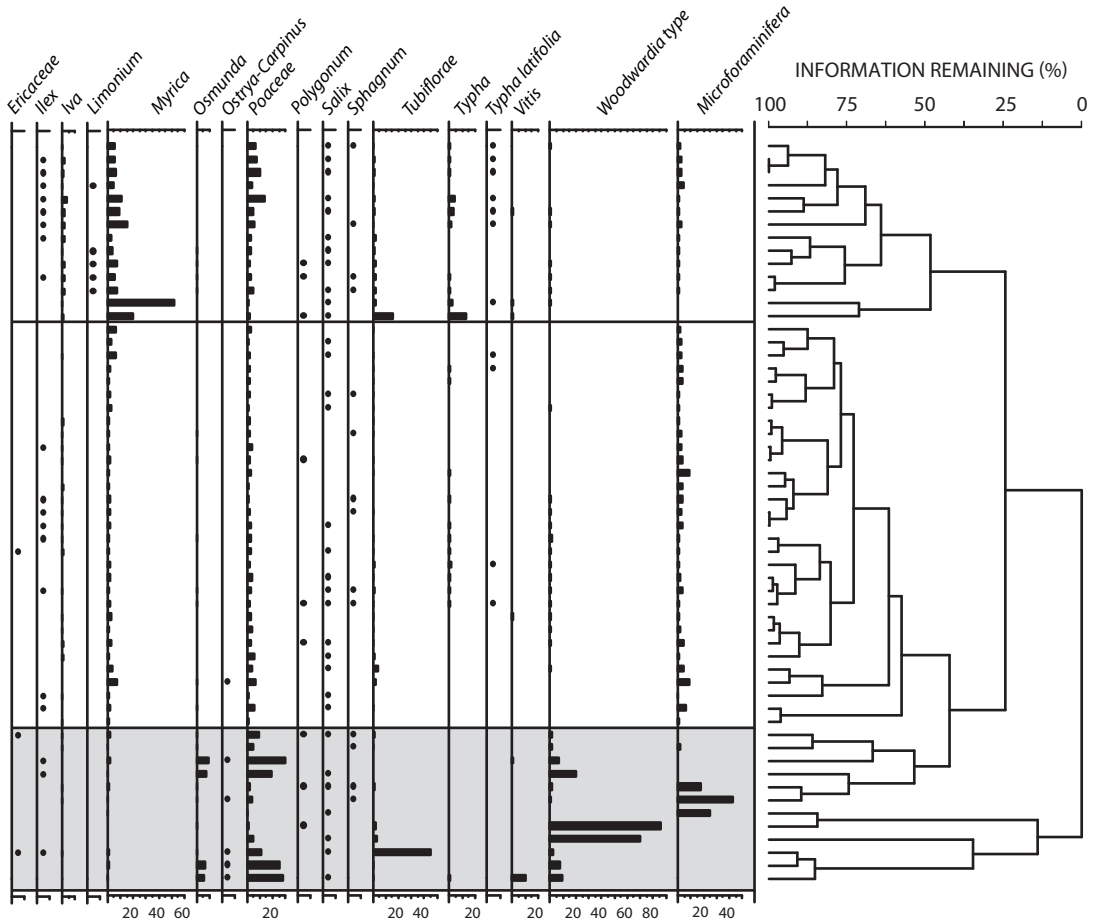


Fig. 6.4 (above and on opposite page). Palynological composition of all samples from St. Catherines Island, comparing late Pleistocene (gray shading) and Holocene samples. Sample names are given as a core number/abbreviation followed by the depth (cm), or sample number from table 6.1. The samples are arranged according to the results of cluster analysis, which is shown to the right and objectively groups samples that are similar in composition. Arboreal pollen percentages are based on an arboreal pollen sum and all other percentages are based on the total palynomorph sum.



long period of time and intermittently. The oldest floras from that ill-defined period of island development appear to come from Yellow Banks Bluff and the greatest depths at Cracker Tom and the shell ring. Between about 6000 and 4000 years ago, the island began to flood, and the now-vanished island known as Guale Island (Bishop et al, 2007) disappeared as rising sea levels brought the forces of erosion and longshore drift to the eastern margin of St. Catherines Island (see this

volume, chap. 3, fig. 3.3). The establishment of current hammock and marsh plant communities at the Cracker Tom locality occurred some time after 3200 ¹⁴C yr B.P. The southern end of the island (south of the Cracker Tom locality) subsequently developed, and the flora that was discovered by Spanish explorers arose. The rapidity of the physical and biological changes that occurred during that episode of island development probably cannot be overstated.

