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**PALYNOLOGY AND PALEOECOLOGY OF A
LIGNITIC PEAT FROM TRAIL RIDGE, FLORIDA**

by

Frederick J. Rich

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**BUREAU OF GEOLOGY
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September 15, 1985

**Governor Bob Graham, Chairman
Florida Department of Natural Resources
Tallahassee, Florida 32301**

Dear Governor Graham:

This paper presents the results of a study of peaty sediments underlying Trail Ridge, a prominent physiographic feature in northeast Florida. Examination of the peat provided important clues to Florida's past climate and flora.

Respectfully yours,

**Steve R. Windham, Chief
Bureau of Geology**

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CONTENTS

	Page
Abstract	vi
Acknowledgements	vi
Introduction.	1
Location and Characteristics of Trail Ridge	2
Nature and Origin of the Trail Ridge Peat Deposit	4
Sample Preparation and Analysis	4
Palynological Composition of the Samples	5
Paleoecological Interpretations.	8
Age of the Trail Ridge Lignite Peat	10
Summary.	11
References	14

ILLUSTRATIONS

Figure	Page
1 Location map of Trail Ridge	2
2 Location map of core holes	3
3 Palynological composition of lignitic peat from core TR 1.	6
4 Palynological composition of lignitic peat from core TR 2.	7

Plate	
1	Pollen of trees and shrubs identified in Trail Ridge core samples. 13

ABSTRACT

A bed of lignitic peat underlies an extensive area of Trail Ridge, in Bradford and Clay counties, Florida. Trail Ridge is composed largely of heavy-mineral-bearing quartz sand which was deposited as a beach ridge by a transgressing sea. Fossil molluscs found within the sand suggest that the beach ridge is of Late Pliocene or Early Pleistocene age. Palynological analysis of the lignitic peat shows that small trees, shrubs, and aquatic herbs grew in a freshwater swamp which stood adjacent to the accumulating sand ridge. *Myrica*, *Ilex*, *Magnolia*, *Gordonia*, and *Cyrilla* are among the genera which indicate that the climate in northern Florida was subtropical at the time of peat deposition. The palynoflora has a modern aspect, and supports the contention that Trail Ridge is of post-Miocene age.

ACKNOWLEDGEMENTS

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PALYNOLOGY AND PALEOECOLOGY OF A LIGNITIC PEAT FROM TRAIL RIDGE, FLORIDA

by

Frederick J. Rich

INTRODUCTION

An extensive bed of lignitic peat lies beneath the sands of Trail Ridge, in Bradford and Clay counties, Florida (figure 1). The organic sediment is commonly very woody and is associated with tree trunks, stumps, and limbs. It is usually encountered during sand dredging at the E. I. du Pont de Nemours and Company Trail Ridge Mine, where the organic layer underlies heavy-mineral bearing sands.

Early in 1979, the Florida Bureau of Geology, in cooperation with du Pont was able to take two cores of dark brown, lignitic sediment from Sections 30 and 31, T 7 S, R 23 E of the Starke, Florida, quadrangle (figure 2). This paper is a report on the palynological composition of the sediment, and presents a discussion of the relationship between the organic sediments and the origin and age of Trail Ridge.

LOCATION AND CHARACTERISTICS OF TRAIL RIDGE

Trail Ridge is a linear sand body which lies on the Atlantic Coastal Plain of Georgia and northern Florida. It extends from a position near the Altamaha River in Georgia to a point 209 kilometers south in Bradford and Clay counties, Florida (figure 1). According to Pirkle (1984) the ridge ranges from about 43 m (meters) to a little more than 52 m above sea level in Georgia, and lies between 51 m and about 76 m above sea level in Florida. The ridge is composed primarily of loose to slightly indurated quartz sand which, in some places, may have three percent heavy minerals. Important ore minerals include ilmenite, leucoxene, rutile, and zircon. In addition, tourmaline, kyanite, staurolite and other minerals are present (Pirkle, et al., 1977).

The origin of Trail Ridge has been a matter of debate for many years. Doering (1960) and Alt (1974), for example, envision the ridge as having been a spit which built southward from Georgia into Florida during some ancient period of marine transgression. White (1970) and Pirkle (1972), on the other hand, consider the ridge to have formed as a beach ridge along the shore line of the coastal plain at the height of a marine transgression. The favored theory seems to be the beach ridge hypothesis advanced by Pirkle and Yoho (1970) and refined by Pirkle (1972), Pirkle (1977) and Pirkle, et al. (1977). According to

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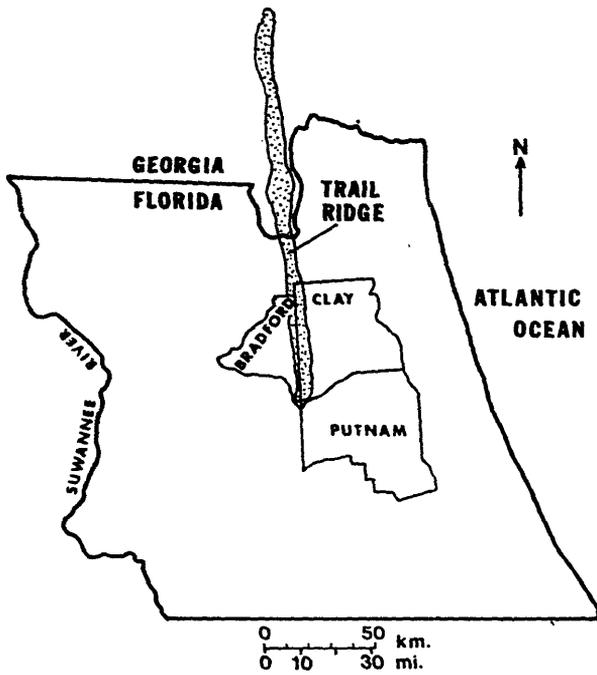


Figure 1. Position of Trail Ridge with respect to Clay, Bradford, and Putnam counties, Florida.

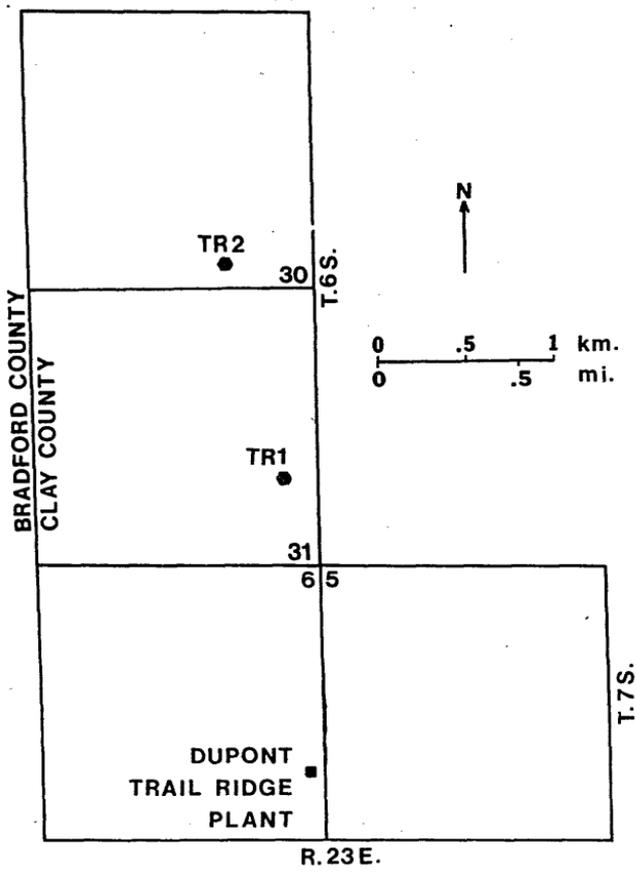


Figure 2. Locations of core holes TR 1 and TR 2, Starke, Florida, quadrangle.

Pirkle (1984), "... those hypotheses explaining Trail Ridge as a beach ridge deposited in a wind-wave environment are more consistent with the features of Trail Ridge sediments than are those hypotheses that explain Trail Ridge as a spit developed in an environment dominated by current action."

While the origin of the sand which comprises the ridge may be debatable, it seems most likely that the sand was reworked from high terraces of the Northern Highlands, which lies west of Trail Ridge. Reworking occurred as transgressing seas eroded into the ancient terrace deposits (Pirkle, et al., 1977).

NATURE AND ORIGIN OF THE TRAIL RIDGE PEAT DEPOSIT

The organic sediment beneath Trail Ridge has been described as a peat (Pirkle and Yoho, 1970), though its petrographic appearance and chemical composition are more suggestive of brown coal or lignite. Rich, et al., (1978) note that the state of alteration of the sediment is "... similar to some lignites from the Gulf Coast Region ...", and that because of the unusual nature of the peat, "... it is viewed as representing an important intermediate stage in the alteration of organic materials from peat to brown coal or lignite."

The sediments examined in this study ranged from brownish-black, dense, indurated material to unconsolidated peaty sand. Some core intervals consisted of solid plugs of wood (J. Yeakel, personal communication).

If one examines the elevation of the upper surface of the woody layer, as located by coring in the vicinity of Starke, Florida, it may be seen that the sediment forms a fairly continuous bed beneath that part of the ridge. Unpublished data acquired by E. I. du Pont de Nemours and Company show that though the peat surface is irregular, it is remarkably level. Where the peat does not exist elsewhere on the ridge, the stratigraphic interval within which it would be expected to occur (15 to 18 m depth) is occupied by drab to olive-green clays which appear to represent a weathered horizon (Pirkle, et al., 1977). Both peat and weathered clay seem to have developed at the same time and occupied the land surface atop older, sandy sediments associated with the Northern Highlands.

Preliminary palynological investigation by Rich, et al. (1978) and Rich (1982) show that the peat deposit near Starke was produced by freshwater trees, shrubs, and a variety of herbaceous species. Upright trunks found at the top of the peat layer indicate that the swamp was buried in place as marine transgression occurred, and the sands of Trail Ridge began to accumulate (Pirkle, et al., 1977).

SAMPLE PREPARATION AND ANALYSIS

Samples were taken from two core holes, designated TR 1 and TR 2. The cores were taken about 1.5 km apart (figure 2) and, because the organic sediment

came from approximately the same depth in both holes (15 - 19 m below land surface), it is assumed that the same layer of lignitic peat was cored at both locations.

Twenty samples were crushed, then boiled for 10 minutes in a 10 percent solution of potassium hydroxide. After thorough washing, residues were mixed with glycerine jelly, and slides prepared. At least 200 pollen grains and spores were counted for each sample. It was not assumed that any particular pollen/spore type would be overrepresented, though this is often the case in modern environments. Every grain of each identifiable taxon was included in the total pollen/spore count.

Figures 3 and 4 display the results of the palynological analyses of core holes TR 1 and TR 2, respectively. Each family or genus on the graphs was present in at least one sample in an amount greater than one percent. In cases where taxa never occurred in amounts greater than one percent [e.g., *Alnus* (alder), *Carya* (hickory), and *Liquidambar* (sweet gum)], those forms were not graphed. Taxa which have been graphed, but which periodically were not actually counted due to their infrequency are indicated on the graphs by a T (trace).

PALYNOLOGICAL COMPOSITION OF THE SAMPLES

The palynological composition of samples from cores TR 1 and TR 2 shows that the vegetation of the Trail Ridge swamp was generally composed of shrubs, small trees, and herbs. Among the shrubs and small trees, *Ilex* (holly), *Myrica* (wax myrtle), *Cyrilla* (ti - ti), *Corylus* (hazel), and *Gordonia* (loblolly bay) were significant. Important Herbaceous taxa included the Cyperaceae (sedges), the fern *Osmunda*, and the moss *Sphagnum*.

In all cases, the palynoflora is composed of genera and families which are still common in the southeastern United States.

Several other conclusions can be drawn from the graphs. If one considers the data for TR 1 first, the following interpretations are apparent:

- 1) Taxa which are commonly abundant in great amounts (e.g., 20 percent or more) in modern southeastern swamp peats are not especially abundant at any level [note especially *Quercus* (oak) and *Pinus* (pine)].
- 2) Pollen of sub-tropical genera are present, notably *Cyrilla*, *Gordonia*, and *Magnolia* (Plate 1).
- 3) Pollen of shrub genera are very common, especially *Myrica* (28 - 47 percent) and *Ilex* (22 percent) (Plate 1).
- 4) Some of the principal genera, including *Cyrilla*, *Gordonia*, and *Taxodium* (cypress) display distinct trends in their relative abundances. The first two forms decrease in abundance with depth, while *Taxodium* increases.

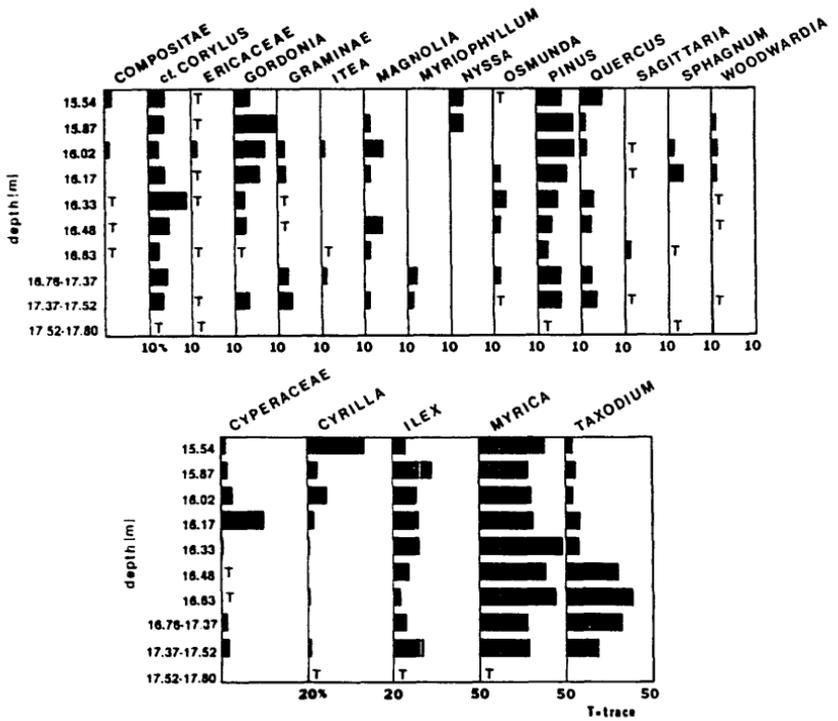


Figure 3. Palynological composition of lignitic peat from core TR 1. Relative abundance expressed as percentage of total pollen and spores, ranges: 0 - 10%, 0 - 20%, and 0 - 50%.

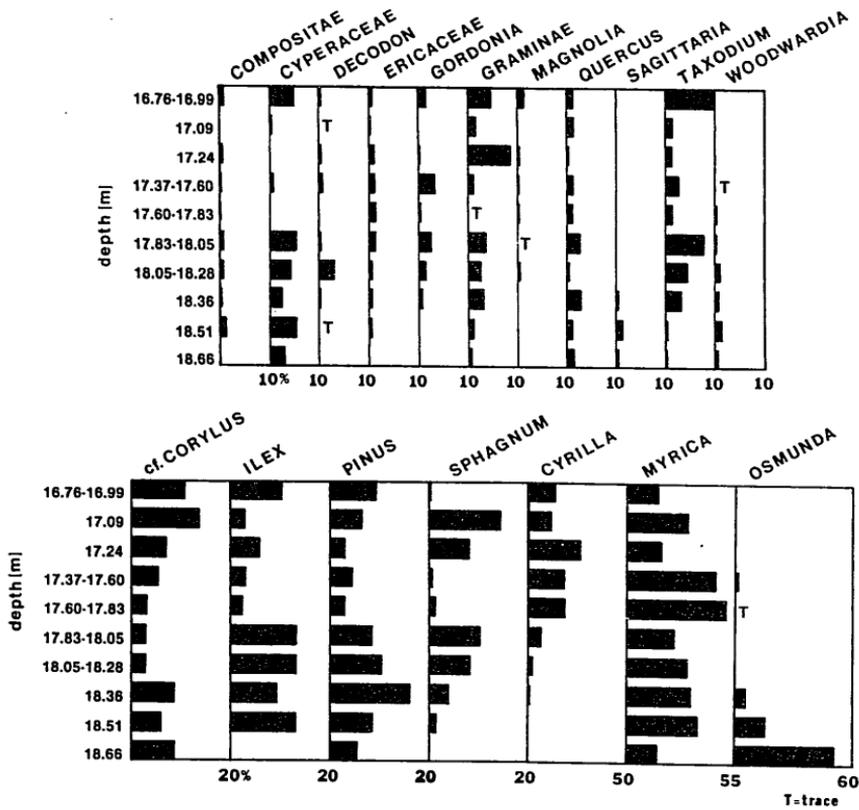


Figure 4. Palynological composition of lignitic peat from core TR 2. Relative abundance expressed as percentage of total pollen and spores, ranges: 0 - 10%, 0 - 20%, 0 - 50%, 0 - 55%, and 0 - 60%.

Graphs for core hole TR 2 also lead to several conclusions, as follows:

- 1) Common over-producers of modern pollen in southeastern swamps are, again, not overly abundant. Note the *Quercus* is generally uncommon, *Taxodium* is never more than 10 percent of total pollen/spores, and *Pinus* is always less than 20 percent.
- 2) Pollen of sub-tropical genera are present, including *Cyrilla*, *Magnolia*, and *Gordonia*.
- 3) Shrub pollen comprises the highest percentage of palynomorphs at most levels, including cf. *Corylus*, *Ilex*, *Cyrilla*, and *Myrica*.
- 4) The fern *Osmunda* is quite abundant near the bottom of the core, and *Sphagnum* is common in many samples.
- 5) There are distinct stratigraphic changes in the relative abundances of certain taxa. *Cyrilla*, for example, gradually rises in abundance in the upper half of core TR 2, while *Osmunda* is most abundant at the base and diminishes rapidly as one proceeds upward in the core.

PALEOECOLOGICAL INTERPRETATIONS

The fact that Trail Ridge is believed to be a marine shoreline deposit poses the possibility that the peat-producing swamp buried beneath the ridge could have been of either freshwater or brackish water origin. Some of the common genera from the Trail Ridge samples are, unfortunately, paleoenvironmentally undiagnostic in this regard. Certain modern species of *Ilex* and *Myrica*, for example, are common inland (*I. cassine* and *M. cerifera*) while others are common very near shore (*I. vomitoria* and *M. gale*). These genera could, thus, be expected to occur in both freshwater and brackish water sediments. However, many of the other fossil genera strongly indicate that the peat-forming plants grew in freshwater. *Nyssa*, *Magnolia*, *Taxodium*, *Cyrilla*, and *Sphagnum* are among the freshwater indicators. Furthermore, *Nyssa*, *Magnolia*, *Gordonia*, and *Cyrilla* have been shown to exhibit very restricted pollen dispersal potential (Rich and Spackman, 1977; 1979). The presence of their pollen in the TR 1 and TR 2 samples is interpreted to mean that the plants actually grew at the sites of deposition.

Taxodium is present in unexpectedly small amounts in the Trail Ridge samples. This is especially true of the TR 2 samples, where relative abundance varies from 0.40 - 9.6 percent. Rich (1979) encountered *Taxodium* in amounts of 25 - 50 percent in a wide variety of Okefenokee Swamp peats. Cohen (1975) found that *Taxodium* values ranged between 4.8 - 55.6 percent for peats from seven modern Okefenokee environments. *Taxodium* percentages in the TR samples are usually less than 10 percent. This indicates that the trees were not dominant, or even common during much of the time of peat deposition.

Quercus and *Pinus* are similarly uncommon in the TR cores. Within TR 1 samples, *Quercus* pollen ranges from 0.0 - 4.5 percent of total pollen and spores, and in TR 2 samples the range is 0.41 - 2.7 percent. Cohen (1975) determined a range of average values of 4.2 - 10.3 percent for *Quercus* in seven Okefenokee environments and found that the pollen never occurred as less than 3.0 percent of total pollen/spores. *Pinus* appears in TR 1 samples in amounts between 2.2 - 8.4 percent, while in TR 2 samples the range is 3.1 - 16.0 percent. Cohen (1975) identified at least 6.0 percent *Pinus* in all his modern Okefenokee environments, and identified average values of 12.4 - 36.0 percent.

The low levels of *Quercus* and *Pinus* pollen in the TR samples indicate that the trees did not grow near the sites of peat deposition. This is somewhat paradoxical because the nearby sandy beach ridge should have been a very suitable place for the trees to live. It is possible that the trees lived just far enough from the swamp that their pollen failed to accumulate in large quantities and were masked by the local, heavy production of shrub pollen.

Aside from the gross compositional characteristics of the TR samples, there are detailed vertical changes in palynomorph composition which reflect the plant community successions at the sample sites. In the lower half of TR 1, an abundance of *Taxodium*, *Ilex*, *Myrica*, and cf. *Corylus*, accompanied by *Myriophyllum* (water-milfoil) and Graminae pollen suggests that cypress forest, with shrubby undergrowth and clear, standing water occupied the site. At 16.33 m below the surface, *Taxodium* pollen declines noticeably, while pollen and spores of herbaceous species become more abundant (Cyperaceae, *Osmunda*, and eventually, *Sphagnum* and *Woodwardia*). Between 16.33 - 15.74 m *Gordonia* and *Cyrilla* both occupied the site, accompanied by *Ilex*, *Myrica* and cf. *Corylus*. The change from a bald cypress-dominated community to one inhabited by shrubs and herbs could have been due to environmental changes brought about by a period of drought and forest fires. J. Yeakel (personal communication) reports that a layer of charcoal was found in core TR 1 at 16.5 m, just below the level of palynofloral transition.

Plant succession at the TR 2 site was similar in some respects to that at TR 1, though there were differences in detail. For example, between 17.83 - 18.66 m an herbaceous assemblage with abundant ferns and scattered shrubs dominated. This is shown by an abundance of *Osmunda* spores, with Cyperaceae, *Sagittaria* (arrowhead, or duck potatoe), and Graminae pollen, *Woodwardia* spores and *Myrica*, *Ilex*, and cf. *Corylus* pollen. Virtually all taxa, including *Taxodium*, decrease in abundance markedly at 17.83 m. *Myrica* and *Cyrilla* show obvious increases at that depth. This stratigraphic level is the same as that within the TR 1 core where *Taxodium* concentrations dropped. The fire and dry conditions which altered vegetation at the TR 1 site evidently had a similar affect on plants at TR 2. Following the disturbance, a shrub-dominated swamp developed and produced the sediment between 17.83 - 16.76 m. Note that, at both locations, *Cyrilla* rose to prominence toward the end of peat deposition.

AGE OF THE TRAIL RIDGE LIGNITE PEAT

The lignitic peat must be somewhat older than Trail Ridge, and if the age of the ridge were well-established, the peat could be dated. Unfortunately, the age of Trail Ridge is as debatable as its origin. Alt (1974) has proposed a Miocene age for the ridge, while Pirkle and Yoho (1970) contend that the sandy body is no older than Pliocene. Other authors (Cooke, 1939; Hoyt and Hails, 1969) maintain that the ridge, also known as the Wicomico shoreline, is of Early Pleistocene age.

Pirkle and Czel (1983) have identified mollusc fossils taken from a series of drill holes which penetrated Trail Ridge in southern Georgia. The molluscs all represent extant, shallow marine species. The lack of extinct species adds weight to the idea that the fossils and, hence, the ridge can be no older than Late Pliocene age.

Rich (1982) stated that the Trail Ridge peat is of Early Pleistocene age, though his conclusion was based upon the work of Pirkle and Yoho (1970) and other authors previously cited here. Further palynological investigation of the TR samples has not gone much further toward establishing the age of the Trail Ridge peat, though some useful observations can be made which relate Trail Ridge samples to other deposits from the southeastern United States.

Elsik (1969) has been able to construct a generalized pollen profile for Gulf Coast sediments of Miocene through Pleistocene age. Within the Miocene, *Quercus* is abundant, constituting as much as 20 percent of the pollen assemblage. The Miocene-Pliocene transition is difficult to delineate though Elsik states that *Ambrosia* and *Helianthus*-type composites are most common in the Pliocene, even more common than oak. There is a decrease in Compositae (sunflowers, daisies, etc.) and *Quercus* pollen as Pleistocene deposits are encountered, and a general increase in the relative abundance of *Pityosporites*, *Alnus*, and *Taxodium*. The fungal spore, *Exesisporites* also increases in abundance in Pleistocene deposits. Darrell (1975) reported on the palynological composition of strata from the Georgia coastal plain. There, Miocene and Pliocene deposits are characterized by *Quercus*-type pollen, while gymnosperm pollen generally are either missing or are of minor significance. The exception is that *Pinus* pollen is more abundant in Pliocene deposits than it is in Miocene sediments.

In light of Elsik's and Darrell's conclusions, the following observations can be made regarding the Trail Ridge pollen assemblages:

1. *Quercus* is of very low abundance in the TR samples. This would suggest a post-Miocene age for the peat.
2. Composite pollen are very low in abundance at all TR sample intervals. TR 1 samples average 0.50 percent, while TR 2 samples average 0.52 percent. These would suggest a Pleistocene age for the peats.

3. *Alnus* is missing from all but two Trail Ridge samples, and then it appears as less than one percent. The absence of *Alnus* makes the TR samples unlike known Pleistocene deposits.

4. *Taxodium* pollen is present at very low levels in TR 2 especially, and *Pinus* is low in TR 1 samples. These facts make the samples unlike Pleistocene deposits from the Gulf Coast.

The palynological composition of the Trail Ridge samples is equivocal as regards the age of the deposit. This is unfortunate because all other means of dating the ridge are equally ambiguous. Perhaps the one safe conclusion that can be drawn is that, because no extinct species were identified in the TR samples, and because oak pollen is not abundant in them, the peat and, therefore, the ridge are not of Miocene age.

SUMMARY

Samples of dark brown lignitic peat were taken from beneath Trail Ridge, in northern Florida. Palynological analysis of the samples shows that a sub-tropical swamp composed mostly of small trees, shrubs, and aquatic herbs existed in the area prior to deposition of the ridge. The swamp developed near sea level on the reworked terrace sands of the Northern Highlands during Pliocene or Early Pleistocene time. As sea level rose, beach-ridge sands migrated laterally over the swamp and eventually killed and buried the plants and the peat they produced. The actual age of the swamp, and the age of Trail Ridge are difficult to determine except that neither appears to be of Miocene age.

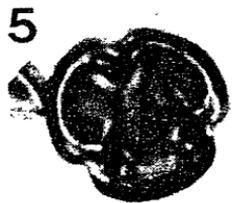
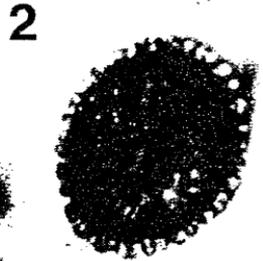
PLATE 1

Pollen of trees and shrubs
identified in Trail Ridge core samples.

All figures 900x.

1. *Myrica* sp.
2. *Ilex* sp.
3. *Magnolia* sp.
4. *Gordonia* cf. *lasianthus*
5. *Cyrilla* cf. *racemiflora*

PLATE 1



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