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Miocene Amber and Lignitic Deposits in Puerto Rico

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ABSTRACT.—This is the first report of the occurrence of small fragments of amber, at the same stratigraphic level as lignitic beds, in an Early to Middle Miocene context of northeastern Puerto Rico. This amber is sparse and of low quality, as the one which occurs in some mines in the eastern Dominican Republic in rocks of the same age and depositional environment.

RESUMEN.—Se informa por vez primera el hallazgo de pequeños fragmentos de ámbar en la región noreste de Puerto Rico, en el mismo nivel estratigráfico de capas de material lignítico, en rocas del Mioceno Inferior al Medio. Este ámbar, escaso y de baja calidad, se asemeja mucho al que ocurre en rocas de la misma edad y ambiente sedimentario en algunas minas de la región oriental de República Dominicana.

INTRODUCTION

In the Greater Antilles amber is known in commercially exploitable quantities only in two mining areas of the northern Dominican Republic (Grimaldi, 1996), but trace and small quantities have been reported from the southwestern Dominican Republic (García and Harms, 1988) and Haiti (Maurrasse, 1982; Iturralde-Vinent and MacPhee, 1996). All of these occurrences were recently dated as Early to Middle Miocene in age (Iturralde-Vinent and MacPhee, 1996). A new discovery of amber, reported here from northeastern Puerto Rico, although in small quantity, is interesting for its implications for the problem of the origin of the amber deposits in the Greater Antilles.

AMBER

The amber discovered in Puerto Rico was collected in May 1975 by E. H. from an active borrow pit located near Bayamón (Fig. 1, Loc. 1: Hartstein's locality #A-801: Coord.: Long 66°9′50″; Lat. 18°24′5″). The amber occurred in gray-blue marls and sandstones of the upper part of the Cibao Formation, associated with shark teeth, ray teeth and a single tail spine, barracuda teeth and unidentified fish elements, crocodilian teeth and vertebrae, sirenian vertebrae and ribs, and many turtle scuts.

The amber consists of two pieces collected from the same horizon. One piece (originally 20 × 20 × 15 mm) is somewhat flattened, deep red, transparent, with subangular edges suggesting that the element suffered some transportation prior to burial. The piece is brittle and several fractures are present (Fig. 2). Compared with amber from the Dominican Republic collected by the senior author, this piece has nearly the same properties as that from some of the eastern mines (Yanigua and Colonia San Rafael), which is of low quality compared to those of the northern mines (Brouwer and Brouwer, 1982; Grimaldi, 1996). A window was polished on one side to permit internal inspection and few very small unidentified dark inclusions were observed. The fragility and low density characteristic of the Puerto Rican amber suggest that it has suffered little diagenetic transformation. This is confirmed by the presence of non-crystalline lignitic beds in the same stratigraphic position as the amber. The second piece of amber was not available to the authors and is stored in the amber collection of the American Museum of Natural History (New York).

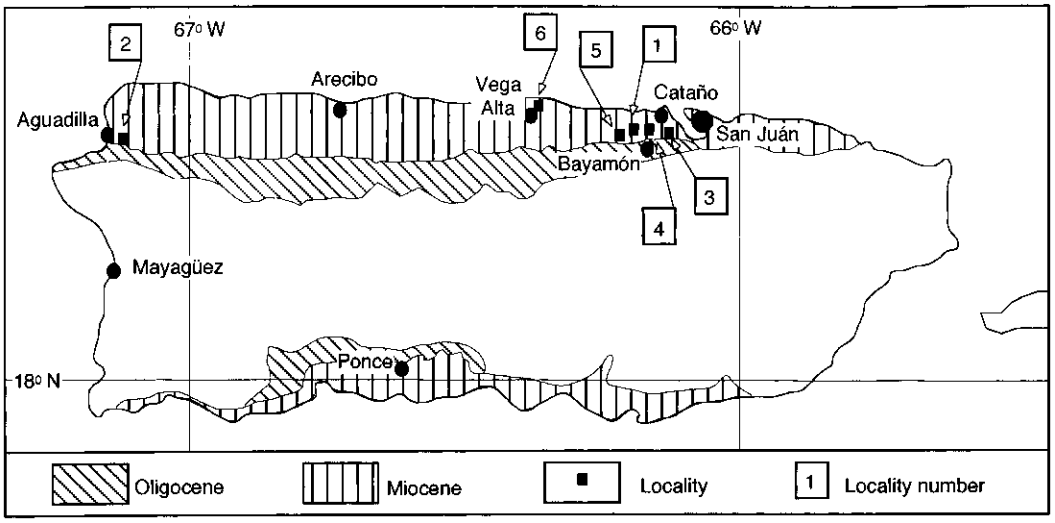

FIG. 1. Map of Puerto Rico showing late Tertiary rocks and localities mentioned in the text.

The senior author revisited the amber-producing and other nearby localities, but was unable to find amber, probably because: 1) the burrow pit is now covered by soil, grass and new construction; 2) the type of amber known from Puerto Rico is easily destroyed by weathering; and 3) occurrence of amber is evidently rare in Puerto Rico, as the Cibao Formation extensively outcrops in the northern half of the island and has been repeatedly prospected by geologists and paleontologists with no report of amber (Monroe, 1980; MacPhee and Wyss, 1990; MacPhee and Iturralde-Vinent, 1995).

The most interesting point concerning this amber occurrence is the age of the sedimentary rocks, as the uppermost part of the Cibao Formation can be dated as transi-

FIG. 2. Photographs of one of the specimens of amber recovered from Puerto Rico. Left) Under normal light. Right) Under transmitted light.

tional Early to Middle Miocene in age (with large *Sorites marginalis*, but without *Miogypsina* and *Lepidocyclina*, which occur stratigraphically lower). The Cibao Formation underlies the Aguada Formation of Middle Miocene age (with *Archaias angulatus*, *Sorites marginalis* and *Peneroplis* sp.; Monroe, 1980; MacPhee and Wyss, 1990; and additional microfossil identification by the senior author). These data places the age of the amber-bearing bed of Puerto Rico within the same time frame as those of the Dominican Republic (Fig. 2; Iturralde-Vinent and MacPhee, 1996).

LIGNITIC BEDS

The Miocene lignitic beds are within the transitional Early to Middle Miocene upper part of the Cibao Formation. Monroe (1980) described a bed of carbonaceous silts containing strings of lignite 15 m below the top of Cibao Formation (Fig. 1: Loc. 2: SE of Aguadilla, Coord.: 83.850 E, 63.510 N, Moca quadrangle). MacPhee and Wyss (1990) reported another occurrence in the upper part of Cibao Formation (Fig. 1, Loc. 3: Coord.: 178.700 E; 63.000 N; Bayamón quadrangle) where a prominent lens (0.5 m thick) of lignite (*sic*) contains twigs and a few leaves. These authors probably refer to lignitic silt, not crystalline lignite.

Few new localities with lignitic beds were recently discovered by the senior author in Bayamón. In a new excavation for the construction of a commercial block, just west of the main entrance to Parque de las Ciencias along road 29, in the upper Cibao Formation, 10-15 m below the limestones of the Aguada Formation, an isolated lens (10-20 cm thick) of lignitic silts with freshwater mollusks was found, within a section of gray marls with large *Sorites marginalis*, overly quartz sandstones and lenticular conglomerates with one oyster bed (Fig. 1, Loc. 4). In a new section excavated south of the hospital along road 862 in Hato Tejas, below the limestones and calcarenites of the Aguada Formation, there is an outcrop of gray marls with assorted mollusks (gastropods and bivalves) and a bed of oysters, underlain by 10-15 cm thick lignitic silts that rest above quartz sandstones (Fig. 1, Loc. 5). A good exposure is found along the southern side of highway 22, west of the exit to Vega Alta (Fig. 1, Loc. 6). In this place, a bed of light brown clay was located just below the limestones of the Aguada Formation. This bed contains a lens (10-30 cm thick) of lignitic silts with freshwater gastropods and bivalves. Features common to all these lignitic occurrences are the deep black color of the sedimentary rocks, the presence of freshwater mollusks, and the position within the uppermost part of the Cibao Formation, near the contact with the limestone of the Aguada Formation.

DISCUSSION

The Cibao Formation is lithologically, fossiliferously and sedimentologically very similar to the partially isochronous amber and lignite-bearing lagoonal beds of the Yanigua Formation of the eastern mining area of the Dominican Republic, which also lies below a thick, shallow-water limestone section. The Maissade Formation of Haiti and the Arabos Formation of eastern Cuba can also be correlated with the Cibao Formation on the basis of age, lithology and environment of deposition, but contain lignite rather than amber (Table 1). This is not the case of the amber-bearing La Toca Formation of the northern mining area in the Dominican Republic, which represents a different lithology and depositional environment, although lignite and amber are present within the same time frame (Fig. 3; Iturralde-Vinent and MacPhee, 1996). The fact that the Puerto Rican lignitic and rarely amber-producing deposits occur within the same time interval as the Miocene ligntic deposits of Hispaniola and Cuba (Fig. 3; Iturralde-Vinent and MacPhee, 1996) suggests that the unusual accumulation of Early to Middle Miocene lignitic deposits in the Greater Antilles is probably correlated with some non-sedimentological event. This may be, for example, a global warming event, as the one recorded in the Pacific Ocean 16 Ma ago (Tsuchi, 1993). However, this single factor probably was not sufficient for the production and accumulation of large quantities of amber, as demonstrated by the uniqueness of the

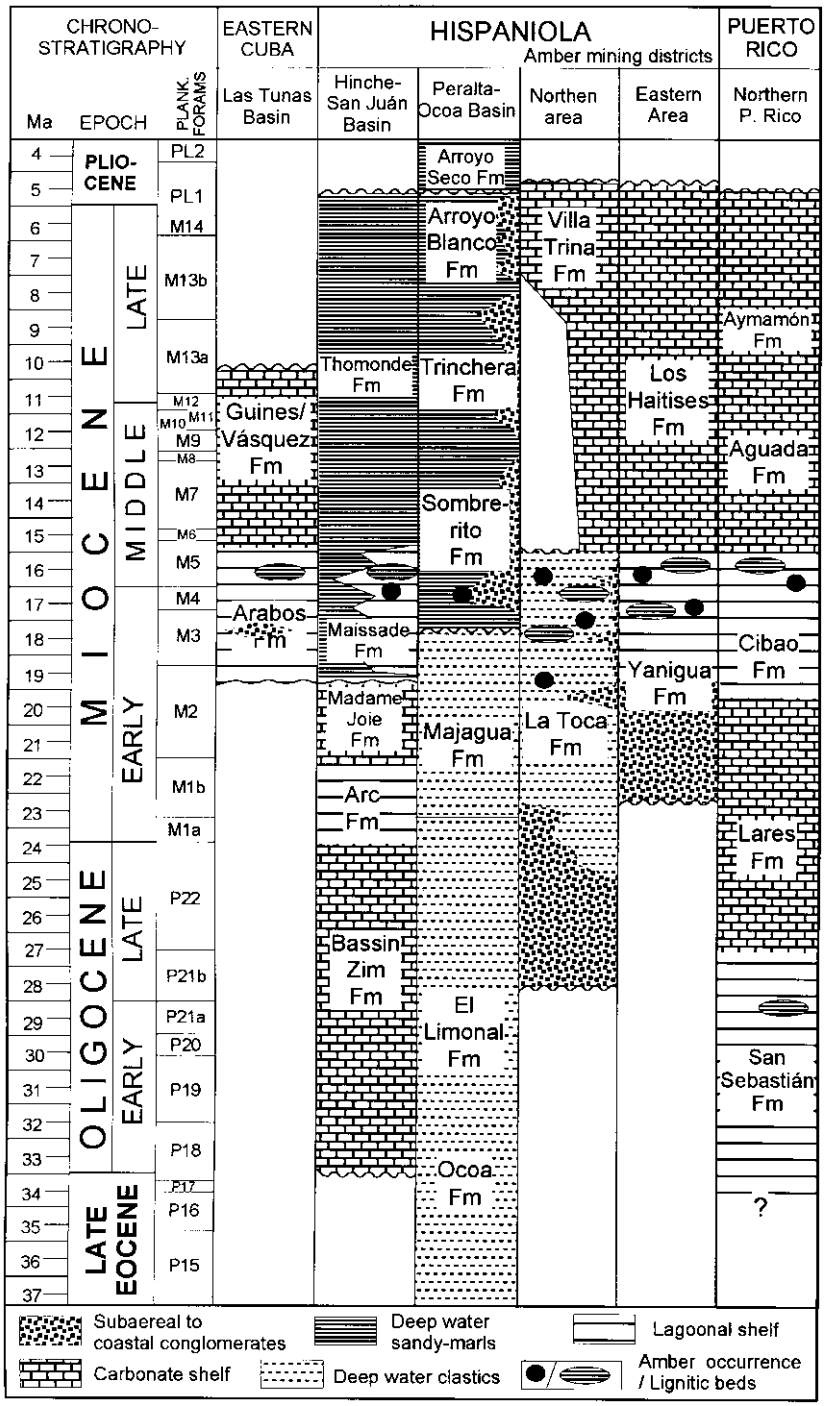

FIG. 3. Stratigraphic columns of the Miocene amber- and lignitic-bearing areas in the Greater Antilles, with data from Iturralde-Vinent (1969), Monroe (1980), Brouwer and Brouwer (1982), Maurrasse (1982), MacPhee and Iturralde-Vinent (1995) and MacPhee and Iturralde-Vinent (1996). Observe the lignitic beds located within the Early to Middle Miocene transition, around the 16 Ma old warming event recorded in the Pacific Ocean realm (Tsuchi, 1993).

TABLE 1. Lower-Middle Miocene amber and lignite occurrence in the Greater Antilles.

Location	Formation	Type of lignite (thickness)	Amber Occurrence
Eastern Cuba	Arabos	lignitic silt (<1 m)	unknown
Haiti	Maissade	lignitic silt and lignite (<1 m)	traces
Eastern Dominican Republic	Yanigua	lignitic silt and crystalline lignite (up to 1.5 m)	abundant
Puerto Rico	Cibao	lignitic silt (0.1-0.5 m)	rare

commercially exploitable amber deposits in the Dominican Republic (Iturralde-Vinent and MacPhee, 1996).

There are important differences between the lignitic deposits in the Dominican Republic, and those found in Cuba, Haiti and Puerto Rico (Table 1), notably the state of diagenesis and the thickness of the lignitic beds. Lignite in the Yanigua Formation of the Dominican Republic is brittle, crystalline and comparatively thicker, which suggests larger amounts of primary accumulation of plant remains in the original basin and deeper post-depositional burial. However, these two factors cannot explain the absence of economic amber deposits elsewhere in Cuba, Haiti, and Puerto Rico, where lignite is thinner and not crystalline.

The intriguing singularity of the large Miocene deposits of amber in the Dominican Republic is in stark contrast to the isolated occurrence of amber in other islands of the Greater Antilles, where sedimentary rocks of the same age and environment of deposition occur. This puzzle can probably be explained due to the combination of several climatic and sedimentological factors discussed elsewhere (Grimaldi, 1996; Iturralde-Vinent and MacPhee, 1996). For example: 1) adequate conditions of humidity, soil and relief for the development of a large local population of resin-producing trees in the Dominican Republic; 2) a global climatic warming event which affected the resin-producing trees and enhanced the production of resin, maybe as a consequence of an attack by large populations of tree-dwelling bacteria, insect, fungi, etc.; 3) adequate conditions for the rapid transportation and concentration of the resinites near the source in the marine basin; and 4) special conditions of diagenesis due to deep burial of the resinite-bearing sediments.

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