

Appendix C Past Development of Forests

The information that follows is summarized from a study by Unesco (United Nations Educational, Scientific, and Cultural Organization), UNEP (United Nations Environment Programme), and the Food and Agriculture Organization (FAO) (Anon. 1978b).

After the Paleozoic Era, some 230 million years ago, Earth's only continent separated into northern and southern land masses. Subsequently, plant and animal life evolved divergently, adapting to distinct and changing conditions. Thus, the flora of Central and South America are different.

Until the late Cretaceous Period, possibly 100 million years ago, what are now South America and Africa were joined and had similar flora (Herngreen 1974). At that time, the southern land mass separated into two continents, which drifted apart. However, until the Cenozoic Era, which began 65 million years ago, they were separated by only 600 km; intermediate islands linked the species of the two areas until the Eocene Epoch, about 38 million years ago (Prance 1978). At that time, western North America was still joined to Asia, and floral and faunal migration continued into what is now Central America. Since then, the climate of northern South America has been tropical.

During the Cenozoic Era, about 10 million years ago, the uplift of the Cordillera, which had begun long before, continued. By the mid-Pliocene Epoch, some 6 million years ago, North and South America were rejoined (Prance 1978). However, even while the two continents approached one another, there was an intermingling of plants and animals that may have begun as early as 16 million years ago. The severe topography of the upland environment of the Central American isthmus slowed this process. The Cordillera reached its present height about a million years ago.

Changes during the last half million years of the Pleistocene Epoch produced glaciation in the cooler regions of the Earth but also affected the Tropics. However, glaciers did not eliminate many species at low elevations (Vuilleumier 1971). Nevertheless, the advancing and retreating glaciers caused the sea level to fluctuate in the vast lowlands of the Amazon Basin, periodically flooding much of the area. This left only isolated refugia (areas of unaltered climate during periods of continental climatic change) of former terrestrial ecosystems (Prance 1978). When floods subsided, the terrestrial systems advanced from these refugia. That this process may still be in

progress is evident in the high endemism (restriction of species to a particular locality) of two large refugia, the Brazilian and Guyana shields (continental nuclei covered by sedimentary rocks), even though these refugia are not far apart.

Rainfall has also fluctuated since the Amazon Basin was formed (Prance 1978). The area was wet and forested 9 to 10 million years ago, subsequently dried, and then returned to forests during the past 2 million years.

More detailed evidence of development of the biota of tropical America is as yet fragmentary and comes largely from plant remains (chiefly pollen grains) and animal remains found in lake sediments that have resisted decay in anoxic, acid environments.

Modern tree taxa began to make their appearance in the region some 70 million years ago. Certain Bombacaceae appeared in the Paleocene Epoch (55 to 65 million years ago), *Rhizophora* in the Oligocene Epoch (25 to 35 million years ago), and *Symphonia* in the Miocene Epoch (10 to 25 million years ago). Most extant mammalian families arose during the Tertiary Period (1 to 65 million years ago). The present South American mammalian fauna include forms of both northern and southern origin.

The present tree flora of tropical America reflect both north-south and east-west migration. Included are families with subtropical affinities as well as many genera that are pantropical. Juglandaceae (*Juglans*) relates to the north, whereas Cunoniaceae (*Weinmannia*), Magnoliaceae (*Talauma*), and Myrtaceae (*Eugenia* and *Psidium*) relate to the south. Pantropical tree genera in tropical America include the following (Anon. 1978b):

Genus (Family)	Genus (Family)
<i>Beilschmiedia</i> , <i>Persea</i> (Lauraceae)	<i>Dendropanax</i> (Araliaceae)
<i>Calophyllum</i> , <i>Clusia</i> (Guttiferae)	<i>Diospyros</i> (Ebenaceae)
<i>Casearia</i> , <i>Homalium</i> (Flacourtaceae)	<i>Erythroxylon</i> (Erythroxylaceae)
<i>Cassia</i> , <i>Cynometra</i> (Caesalpinaceae)	<i>Eschweilera</i> (Lecythidaceae)
<i>Celtis</i> (Ulmaceae)	<i>Fagara</i> (Rutaceae)
<i>Cordia</i> (Boraginaceae)	<i>Guarea</i> , <i>Trichilia</i> (Meliaceae)
<i>Dacryodes</i> , <i>Protium</i> (Burseraceae)	<i>Ixora</i> , <i>Psychotria</i> (Rubiaceae)

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Genus (Family)	Genus (Family)
<i>Licania</i> (Chrysobalanaceae)	<i>Simarouba</i>
<i>Manilkara</i> (Sapotaceae)	(Simaroubaceae)
<i>Pentaclethra</i> (Mimosaceae)	<i>Sloanea</i> (Eleocarpaceae)
<i>Pterocarpus</i> (Papilioaceae)	<i>Sterculia</i> (Sterculiaceae)
<i>Rauwolfia</i> (Apocynaceae)	<i>Terminalia</i> (Combretaceae)
<i>Sapium</i> (Euphorbiaceae)	<i>Vitex</i> (Verbenaceae)

Studies of the eastern Cordillera of Colombia (van Geel and van der Hammen 1973, van der Hammen 1974, van der Hammen and Gonzalez 1960, van der Hammen and Wijmstra 1964, van der Hammen and others 1973) show early lowland tropical forests containing the family

Bombacaceae and the genera *Alchornia*, *Hieronyma*, *Humiria*, *Ilex*, *Iriartia*, and *Mauritia*. Elevation controlled the distribution of these species. The present flora appeared some 3 million years ago. From the north, *Alnus* reached the area about 2 million years ago and *Quercus* less than 1 million years ago.

Forest development during the Quaternary Period, the past 600,000 years, and particularly during late Pleistocene ice ages of the past 50,000 years greatly influenced the location and character of the present forests. The sequence of climatic changes that characterized glacial and interglacial periods in the Northern Hemisphere was mirrored in the Tropics.