

STEYERMARK; and *Pteridophyta* by WIGGINS. The botanical results of our explorations, then, are important and will add substantially to the present knowledge of the botany of Ecuador.

As an illustration of the incredible richness of the Ecuadorian flora, I may cite my experience with the *Rubiaceae*. Out of the 345 numbers which I had collected in the course of my work, Dr. PAUL C. STANDLEY has already identified some 150 species, of which he has tentatively named 56 as new. My field observations convince me that intensive collecting in any other large family would be just as productive.

The following publications concerning our botanical work have already appeared: ACOSTA-SOLÍS, M. "Botánicos que estudian la flora ecuatoriana." *Flora* (Revista Inst. Ecuat. Cienc. Nat.) 3: 235-247, 1943; STEERE, W. C. "*Joosia pulcherrima*, una nueva especie ecuatoriana de Rubiaceae, genero nuevo para el Ecuador." *Ibid.* 3: 195-198, 1943; "El descubrimiento y distribución de la *Cinchona pitayensis* en el Ecuador". *Ibid.* 4: 1-9, 1944; and "The botanical work of the Cinchona missions in South America." *Science* 101: 177-178, 1945; A report of some recent collections of *Rubiaceae* from Ecuador. *Bull. Torrey Bot. Club* 72: 295-311, 1945. — The botanical results of our work may be expected to be published through several years, and the ultimate record will show not only the satisfactory accomplishment of the basic objective, of great necessity during the war emergency, but also a promotion of international cultural and scientific relations which has accrued as a byproduct of the emergency. It may be pointed out that the accurate mapping and delimitation of the *Cinchona* species which has been done will be a necessary basis for intelligent prosecution of work in plant breeding and introduction which may be done in the future.

It has been a privilege indeed to work with CAMP, DREW, PRESCOTT, and WIGGINS, who in the face of arduous and hazardous field conditions, and even while suffering from illnesses, have carried on work so essential to the Allied war effort.

DEPT. OF BOTANY,
UNIVERSITY OF MICHIGAN,
ANN ARBOR, MICH., U. S. A.

RICHARD EVANS SCHULTES: — Glimpses of the little known Apaporis River in Colombia: — Early in 1943*, JULES DE WAEL MAYER, Esq., Special Representative of the Rubber Development Corporation in Bogotá, commissioned me to explore the Apaporis River Basin in eastern Colombia. The purposes of this study were: 1. to determine the species, distribution, abundance, and commercial exploitability of *Hevea* and other lactiferous plants; and 2. to map the river and report on its navigability.

In connexion with this exploration, I found it possible to make a cursory examination of the general flora and a very limited collection of plants from the Upper Basin. I deeply regret that it was impossible to make a larger and more representative collection. In the Middle and Lower Basins, no collections were made; and, in the Upper, only some 350 numbers. Carried out at the cost of a life and innumerable difficulties imposed by distance, inaccessibility, absence of population, treacherous rapids and falls, this trip had as its chief purpose tasks so time-consuming that extensive botanical collecting was out of the realm of feasibility. A very preliminary examination of the small collection, however, has brought to light so many new or rare plants that we can say without fear of exaggeration that it is imperative that a thorough botanical survey of the Apaporis drainage be made. Only with an understanding of the flora of the Apaporis can we hope to arrive at an accurate understanding of the composition, distribution, and history of the western Amazonian flora.

The explorations were carried out from April to October, 1943, and in January, 1944. During the early part of the work, I enjoyed the invaluable collaboration of EVERETT L. VINTON, Esq., forester, Field Technician for the Rubber Development Corporation. In July, CARL O. GRASSL, Esq., of the United States Department of Agriculture, spent several days with me in the mountains of the Upper Basin. In January, 1944, I visited these mountains again and was accompanied by Señor GABRIEL GUTTIEREZ of the Instituto de Ciencias Naturales, Bogotá, who made an excellent collection of 70 numbers.

The Apaporis River, navigable (with numerous interruptions) for more than 2100 kilometers, is believed to arise in the Mesa de Pardaos, Intendencia del Meta. It

* At this time, I was serving the Rubber Development Corporation as Field Technician.

empties into the Caquetá or Japurá at the Colombo-Brazilian border. From its source to its confluence with the Macaya River (some 300 kilometers), it is called the Ajaju; only below the Macaya does the name Apaporis apply. Solitary, uninhabited, meandering first through flat mesa-like grasslands, then twisting between grotesque mountains, finally scouring its way through flat, unbroken Amazonian jungle with many picturesque rapids and cascades ("cachiveras") and forming, in its last few kilometers, part of the Colombo-Brazilian boundary, the Apaporis is one of the mightiest and certainly the most majestic Colombian affluent of the Amazon.

For convenience, and purely arbitrarily, I divide the Apaporis into three parts: Upper, Middle and Lower Basins. I. The upper Basin, by far the most critically interesting botanically and geologically, includes the Ajaju (with its sole affluent, the Yaya), the Macaya, the Majaya, and the upper fifty kilometers of the Apaporis proper. This stretch is interrupted by the long series of rapids known collectively by the name Cachivera de Chiribiquete. II. The Middle Basin, an uninterrupted, easily navigable stretch of 500 kilometers (with the Tacunema, Pacoa, Macayari, and Cananari as its affluents) from the Cachivera de Chiribiquete to the great falls and rapids of Jerijerimo. III. The Lower Basin, from Jerijerimo to the Caquetá, a stretch repeatedly interrupted by extraordinarily beautiful but treacherous rapids (and receiving the large affluents Popeyacá, Piraparaná, and Taraira).

The Upper Basin, consisting of a sandstone base and laterite gravel, is characterized by numerous isolated, sandstone mountains. The region abounds in rills, brooks, and creeks of crystalline water. One searches in vain for the muddy waters heavily charged with suspended yellow clay, so common in other parts of the Amazonian drainage. A number of the creeks pour forth the so-called "black-water," strangely brown-tinted with tannins from rotting vegetation. The mountains are of two forms: either 1. long, flat-topped, tilted ridges with one face (usually the northeastern) in the form of a cliff surmounted on two or three jutting strata which provide extensive flat shelves, the other face gently and gradually sloping to the forest floor; or 2. knob- or dome-shaped elevations with perpendicular cliffs on all sides, often grotesquely eroded and often with deep fissures and faults, and surmounted at the base with broad, flat sandstone shelves. All of these mountains in the Upper Basin are of approximately the same height, ranging between 800 and 1200 feet above the forest floor or 1700 and 2100 feet above sea-level. The quartzite of these mountains, with its general red-brown or yellow-brown hue, varied here and there with brilliant streaks of red and green, presents a pleasing picture. The traveller can often see from great distances, slender and ribbon-like against the coloured cliffs, graceful cascades. The lower parts of the Ajaju and Macaya bore their way through these mountains which, arising abruptly out of the vast carpet of unbroken jungle in irregular fashion, are suggestive of scenic reconstructions of long-gone geologic ages. When we know more of the curious flora of these hills, it may perhaps be learned that they are the repositories of many old and ancestral forms of plants which, finding the luxurious environment of the river basin below more congenial, evolved and differentiated into varieties and species more complex or more advanced.

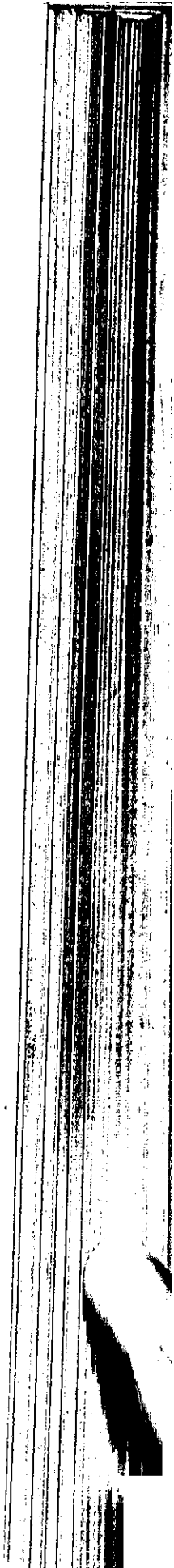
Peculiar ecological conditions prevail on these mountains, and their flora varies most strikingly from that of the surrounding jungle. The summits, flat extensions of sandstone periodically washed by cloud-bursts, are nearly devoid of soil. Here and there are pockets or depressions where accumulations of sand lodge. On the exposures, the flora comprises grasslands or "savannas" or a dense brush of low, gnarled shrubs. It is difficult to picture the extreme conditions of drought existing on these dry islands set in the midst of the notoriously humid Amazonian basin. Due to psammophytic or chersophytic conditions, drought prevails, even in the rainy season. In the small cracks and depressions where water does collect, physiological drought, without doubt caused by acidic or mineral constituents, is in evidence. During the height of the dry season, when no rain may fall for a month and a hot sun bakes the rock substratum, actual drought due to lack of water prevails. From April through June, a curtain of thick mist drops over the hills every evening. I have camped in this mist and have found that it drenches everything as thoroughly as would a light rain. But the next morning, the sun disperses the mist, and the vegetation is exposed, without the slightest protection, to the most intense heat and radiation. In the dry season, this mist-cover is not so dense and, in the driest months, is lacking altogether.

It is obvious, then, that only those plants of a highly xerophytic nature can sur-

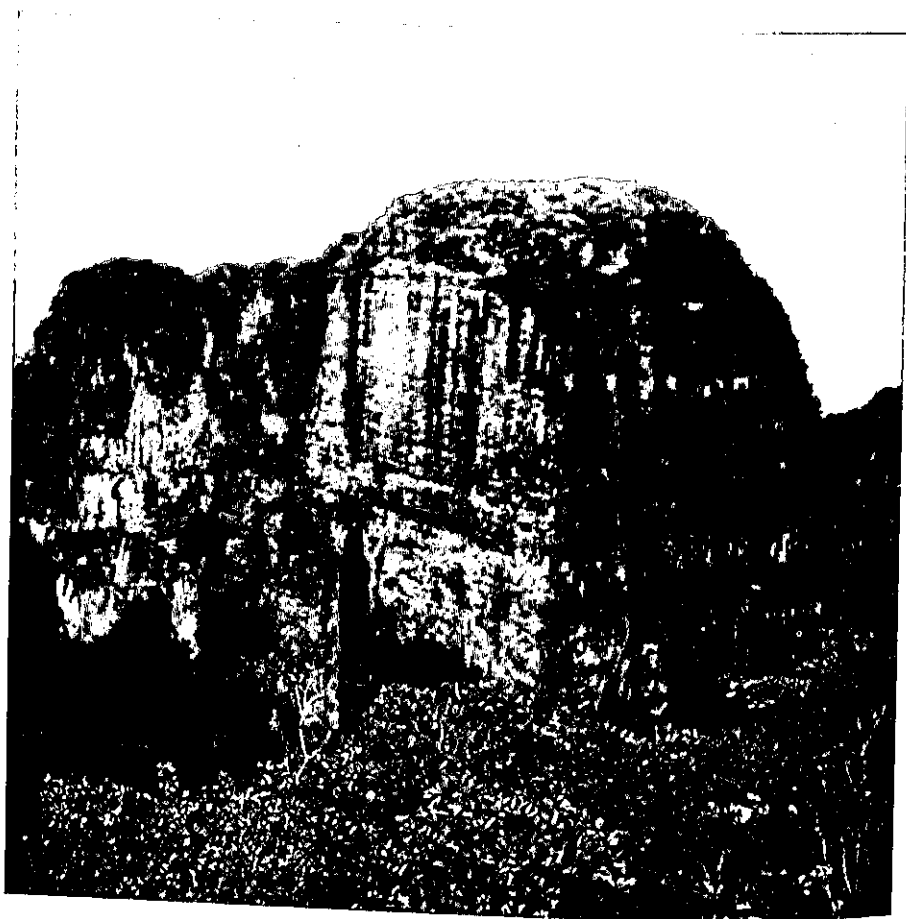


EXPLORING THE APAPORIS RIVER IN COLOMBIA I

The flat sandstone summit of Cerro, Chiribiquete at the confluence of the Ajaju and Macaya Rivers (photograph by R. E. SCHULTES).



CHRON. BOT., PLATE 11



EXPLORING THE APAPORIS RIVER IN COLOMBIA II

One of the several dome-like sandstone masses which collectively are known as the Cerros de la Campaña, on the Ajaju River (photograph R. E. SCHULTES).

vive conditions of such drought. One can find all kinds of xerophytic adaptations on the hills. All plants are reduced in size. Many species have glossy, leathery or fleshy leaves, sometimes with waxes. Others have leaves the position of which is strongly reclinate. Still others fold, collapse, or completely close up their leaves. Petioles are frequently foreshortened and thickened. Barks are commonly thick and suberous, or thin and coated with wax. Epiphytic forms with enormously exaggerated pseudobulbs and much-contracted rosette-forms are abundant. Many species are highly resinous. Roots are exceptionally well developed.

These summits and the flat, jutting shelves of the hills are clothed with patches of low, herbaceous plants, the most notable of which are several interesting primitive ferns (*Schizaea* and others); numerous species of grasses and sedges; a number of bromeliads (*Navia acaulis*, *N. Schultesiana*, *Pitcairnia* sp.); a surprising variety of *Orchidaceae* (including *Bifrenaria sabulosa*, *Epidendrum caespitosum*, *E. nocturnum*, *Habenaria heptadactyla*, *Sobralia*, *Schomburgkia*, etc.). The bushy species which grow, sometimes isolated, sometimes in dense tangles, include: several species of *Clusia*; a red-flowering *Calliandra*; a stubby, abbreviated shrub which is probably an undescribed species of *Vellozia* of the *Velloziaceae*; *Ficus chiribiquetensis*; *Ternstroemia* sp.; a beautiful shrubby, white-flowered *Plumeria*; the extraordinary *Bombax coriaceum*; a shrubby, leathery-leaved *Stiffia*; a small, bushy variety of *Hevea viridis*; the low, abundant *Senefeldera chiribiquetensis*; an extremely fragrant, white-flowered rubiaceous bush; a leathery-leaved *Cassia*-relative; and numerous other less noticeable species. In localized dips and depressions, where sediments (and, in the rainy season, water) can accumulate, myriads of minute individuals of a yellow *Utricularia* and a purplish *Polygala*; several interesting juncaceous and xyridaceous species; and many clumps of *Paepalanthus* spp., are found. In amongst grasses and sedges, burmanniaceous (*Apteria* and *Dictyostegia* spp.) and gentianaceous (*Leiphaimos*) root-parasites abound.

The mountains of the Upper Basin are apparently a part of the interrupted range that "begins" at La Chorrera (Río Igaraparaná) and Araracuara (Río Caquetá) and stretches across the Comisariás del Caquetá and Vaupes in Colombia, the valley of the Río Negro in Brazil, and on into southern Venezuela and the Guianas. We do not have botanical material from many of these hills. The mountains of the Upper Apaporis represent the westernmost extent of this interrupted range, unless the botanically unknown Macarena, south of San Martín, should prove to be a part of the same range.

Although our knowledge of the floras of the hills of these ranges is very sporadic and incomplete, we have enough data on several widely separated hills in Colombia to say that each one has certain peculiarities. Each has its endemics, and each has its widely distributed forms. The interesting collection (1943) of PAUL H. ALLEN, Esq.,¹ on the savanna of Cuduyarí, an affluent of the Lower Vaupes River, indicates that the characteristic plants are, in part, palms which are absent on Cerros Chiribiquete and Campana in the Upper Apaporis: *Mauritia Carana*, *Mauritiella aculeata*, *Parascheelia* sp., and others. The collections of JOSÉ CUATRECASAS (1939) and of myself (1944) on Cerro Circasia, Lower Vaupes, establish the similarity of the savanna flora of this locality to that of Cuduyarí. When I visited (1944) the high, sandstone plateau of Araracuara (type locality of a number of MARTIUS' plants), I saw that the flora was more like that of Circasia than that of Chiribiquete, but that Araracuara has species (e.g., the extremely abundant *Schoenocephalum Martianum*) not found on the other two hills. On all of these savannas, however, one can find the curious *Hevea viridis* var. *toxicodendroides*, but not in the abundance of Chiribiquete; at Araracuara and Circasia, it is rare. Apparently, the same undescribed species of *Vellozia* exists on far-separated Chiribiquete and Cuduyarí, but the former has certain very striking endemics such as *Ficus chiribiquetensis*, *Senefeldera chiribiquetensis*, *Navia Schultesiana* and others which have never been seen outside of the Upper Apaporis. It is interesting to note in passing that the flora of Cerro de la Pedrera, on the Caquetá River near the mouth of the Apaporis, is completely different from that of the other mountains of eastern Colombia.

It is my belief that these hills are repositories for a number of primitive plants. Many species of Amazonian plants are known to have been extended by water and to have had their origins on or near the highlands at the headwaters of the important affluents. It is striking to follow the distribution of various species by river-

¹ Cf. ALLEN, P. H. in Mo. Bot. Gard. Bull. 22(1944)50.

systems. We may cite: many palms, *Cecropia*, *Ficus*, *Hevea*, *Paullinia*, *Serjania*, and *Vochysia*, to name only a few groups which follow river systems. With further studies of the floras of these sandstone hilltops, we may be able more accurately to appreciate the history of many species. One example will serve for the present. The hills of the Upper Apaporis are very densely populated with the small, shrubby, xerophytic variety *toxicodendroides* of *Hevea viridis*. As one goes eastward in Colombia, this shrub appears to be less abundant on the hills. But, in the rocky swamps or "igapós" of far eastern Colombia, the huge and more advanced *Hevea viridis* becomes increasingly abundant. I believe that *Hevea viridis* var. *toxicodendroides* represents a very primitive stock of this genus. It is obviously not the parent stock, but it is by far the most primitive form yet known with the possible exception of the very poorly understood and, in habit, similar *Hevea camporum* of the hills of the Upper Madeira River in Brazil.

The forest of the Upper Apaporis Basin floor does not differ markedly from the jungles of the Vaupes Basin. Between the composition of the forest of the Upper and Lower Apaporis Basins there is a gradual, almost imperceptible change, but there is nothing of sufficient importance to discuss in the present short article. In general the Upper Basin has more species of "tierra firme"; the Lower has many swamp species. To the rapid traveller, the preponderance of representatives of the *Leguminosae*, *Palmae*, and *Euphorbiaceae* is at once apparent. The abundance of *Araceae*, *Bombacaceae*, *Moraceae*, *Sapotaceae*, and *Vochysiaceae* is likewise striking. Notably absent or rare are species of *Boraginaceae*, *Compositae*, *Gramineae*, *Orchidaceae*, *Rosaceae*, *Rutaceae*, *Scrophulariaceae*, etc. Overlooking ferns, tree-ferns and many herbaceous genera, we may note the following important groups which compose the Apaporis jungle: *Gutteria* and other genera (*Amonaceae*); *Couma*, *Neocouma*, etc. (*Apocynaceae*); *Anthurium*, etc. (*Araceae*); numerous bignoniaceous groups, especially trees of *Jacaranda*; the gigantic *Bombax* and *Ceiba*, as well as *Matisia* and, in clearings, *Ochroma* (*Bombacaceae*); numerous bromeliaceous epiphytes; several interesting climbing cactaceous epiphytes related to *Epiphyllum* or similar genera; *Cochlospermum* (*Cochlospermaceae*); a large number of species of *Carludovicia* and *Cyclanthus* (*Cyclanthaceae*); the abundant *Hevea*, as well as *Micrandra*, *Phyllanthus*, *Sapium*, and (in the Lower Basin only) *Cunuria* (*Euphorbiaceae*); many epiphytic *Gesneriaceae*; *Clusia* (*Guttiferae*); *Nectandra* and possibly other lauraceous genera; *Grias* and *Lecythis* (*Lecythidaceae*); *Albizia*, *Brounea*, *Copaifera*, *Coumarouna*, *Erythrina*, *Inga*, *Lonchocarpus*, *Mimosa*, *Ormosia*, *Pseudoacacia*, *Swarizia*, etc. (*Leguminosae*); *Strychnos* (*Loganiaceae*); a surprising number of ubiquitous loranthaceous parasites; colourful vines belonging to *Banisteria* or *Banisteriopsis* (*Malpighiaceae*); many melastomaceous genera, mostly low trees or shrubs; the valuable *Castilla*, abundant *Ficus*, *Cecropia* (curiously, not common in this river basin), *Perebea*, *Piratinera* and other lesser genera (*Moraceae*); many *Heliconiae* (*Musaceae*), a few myrsinaceous genera; innumerable palms of *Astrocaryum*, *Bactris*, *Chamaedorea*, *Desmoncus*, *Euterpe*, *Jessenia*, *Mauritia*, *Mauritiella*, and many other interesting genera; many *Piper* species and a few *Peperomias* (*Piperaceae*); few *Rubiaceae*; showy vines of *Paullinia* and *Serjania* (*Sapindaceae*); gigantic trees and low shrubs of sapotaceous genera such as *Bumelia*, *Chrysophyllum*, *Manilkara*, *Oxythece*, etc.; interesting *Sterculiaceae* belonging to *Theobroma* and *Herrania*; a few tiliaceous plants; the water-vine of the *Vitaceae*; extraordinarily showy trees of *Vochysia* (*Vochysiaceae*); and others too numerous to consider here.

The opportunity has not yet presented itself for making a careful study of the small collection from the Apaporis. But, as stated above, the number of new or rare plants which a casual inspection has brought to light justifies our belief that the Apaporis and its affluents hold many botanical treasures. *Ficus ajajuensis*, from the uppermost reaches of the great Apaporis, shows relationships with a distant Brazilian species but is very distinct. *Ficus chiribiquetensis*, known only from the sandstone exposures of Cerro Chiribiquete, is a highly xerophytic, bushy species with no close allies.² A new species of the melastomaceous genus *Graffenrieda* remains to be described. The widespread *Hevea viridis* var. *toxicodendroides*, the type of which was collected on Cerro Chiribiquete, may, upon later and more comparative examination, appear to deserve specific distinction.³ A gigantic highland form of *Hevea*, apparently

² Cf. DUROAND, A. in *Caldasia* 9(1944)375.

³ Cf. SCHULTZ, R. E. in *Caldasia* 11(1944)25.

a variety of *H. guianensis*, was collected in rocky fissures at an altitude of 1500 feet above sea-level on Cerro del Castillo in the Upper Apaporis; unfortunately, flowering material is lacking. What seems to be a very small species of *Couma*, perhaps related to the Brazilian *C. catingae*, was seen on the wooded slopes of Cerro Chiribiquete. From numerous isolated colonies of what is probably a new species of *Mauritiella* were made several collections which are now being examined. The bromeliaceous *Navia Schultesiana*, growing in huge mats on the dry top of Cerro del Castillo, is an endemic of this small genus. The Upper Apaporis has yielded several very interesting new *Paullinias*: *P. emetica*, *P. splendida*, *P. splendida* fma. *chrysocarpa*, and *P. vaupesana* var. *macayana*.⁴ The extraordinary, new *Senefeldera chiribiquetensis*, the most abundant shrub on the tops of the mountains of the Upper Basin (occurring in dense stands on Cerro de la Campana, 8000 per hektar!), represents an interesting endemic of this small euphorbiaceous genus. A curious, lily-flowered species of *Vellosia*, common on Cerro Chiribiquete, has yet to be described. At least two very reduced new species of *Clusia* were collected. Several possible novelties in ferns, a new species of diminutive grass, and what is perhaps a new variety of a Vaupes species of *Oxythece* await attention.

As the collection is studied, we expect to find a number of specimens of plants which MARTIUS found on Araracuara and other standstone areas in southeastern Colombia more than a century ago. One example can be presented here, namely the extraordinary *Bombar coriaceum* which I found on Chiribiquete in May, 1943, and later collected at the same locality in July and in January, 1944—all collections in various stages of fruiting.⁵ ALLEN found it in flower on Cuduyarí in November, 1943, establishing its existence far to the east of its type locality at Araracuara. This species, belonging to a genus noted for its forest giants, is a low, prostrate shrub only two to four feet tall and occurs in abundance on the most sterile sandy and rocky exposures where little or no soil accumulates. Apparently it had not been collected since MARTIUS found it over a century ago.

It is likewise probable that our list of *plantae colombiae* will grow very appreciably when the Apaporis is systematically studied. Many of its species show definite affinities with Brazilian species, especially those of the Río Negro valley. This is shown in any number of plant groups, but perhaps the most interesting to cite here in passing are the species of *Vochysia*, *Hevea*, a number of ferns, *Ficus*, and certain orchids (such as *Bifrenaria sabulosa*, *Epidendrum caespitosum*) and others.

In closing, it might be of interest to outline the distribution of species of *Hevea* in the Apaporis Basin. By far the most abundant, especially in the Upper and Middle Basins, on the high, sandy banks which are not subjected to annual flooding, is *Hevea lutea*.⁶ Less frequent and coexistent with *lutea* is *Hevea guianensis*. Whereas, in the Upper Basin, *Hevea Benthamiana* is not very frequent, it is the dominant species of the low, floodable river banks of the Lower Basin. In the Lower Basin, *Hevea lutea* is found in the hinterland, that is, on the higher, sandy mesas at the headwaters of small creeks. *Hevea viridis* is exceedingly abundant at certain localities in the Middle, but, more especially, in the Lower Basin where rock outcrops are frequent. It becomes a very tall and corpulent tree, especially in *Mauritia*-swamps, but is generally met as a medium-sized tree on sterile, sandy soil. It is exceptionally abundant in the vicinity of the Cachivera de Jerijerimo. *Hevea viridis* var. *toxicodendroides* is known to occur only in the mountains of the Upper Basin, but it is a widespread plant in eastern Colombia, and further search in the Middle and Lower Basins might uncover it there. *Hevea pauciflora* was not found in the Apaporis, but it could be expected to occur in the Lower Basin.

The regions with floras most closely related to that of the Apaporis are: the Vaupes, the Yari and Mesai, the Miritiparaná in Colombia, and the Río Negro valley in Brazil. Of these, only the Vaupes and Río Negro are at all well known. I collected a very few plants in the Miritiparaná in 1944. But the great tableland over which the Yari and the Mesai flow before falling south towards Araracuara are completely unknown to botanists.

HARVARD BOTANICAL MUSEUM
Cambridge, Mass.

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⁴ Cf. SCHULTES, R. E. in *Caldasia* 10(1944)419.

⁵ Cf. DUGAND, A. in *Caldasia* 8(1943)298; 10(1944)435.

⁶ I expect to consider this as a variety of *Hevea guianensis* in a study shortly to be published.