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PHYTOGEOGRAPHIC STUDIES IN THE ATHABASKA–GREAT SLAVE LAKE REGION, II

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With five plates and six text-figures

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ABSTRACT

THE FORESTS of the Athabaska–Great Slave Lake region are described in seven types (pp. 37–61). The first three are composed principally of white spruce, *Picea glauca* s. l., but differ in composition, structure, history, and geographic position. The remaining four are of jack pine, balsam fir and white spruce, black spruce and lodgepole pine, and bog forest of black spruce. Park-like white spruce forests have their greatest development near the arctic timber line, on some of the most youthful land surfaces which the region affords — surfaces exposed at the retreat of the last glacial ice from the lake region and at the drainage of the last glacial lakes. Flood plain white spruce timber is concentrated principally on the great flood plains and deltas of the Athabaska, Peace, and Slave Rivers, also on very young surfaces. Upland mesophytic forests of white spruce are mainly on deposits of glacial till and outwash that overlie rocks of Paleozoic or Cretaceous age. Nearly all of them are on surfaces exposed at earlier stages of ice and lake withdrawal (pp. 24–30). These surfaces are, in general, progressively older from northeast to southwest. Jack pine forests are most extensively developed over the pre-Cambrian rocks of the Laurentian Plateau. They are bounded on the northeast by the park-like white spruce type and on the southwest by flood plain and upland mesophytic white spruce forests. In this region the pine is regarded as a primary type, but in the upland mesophytic spruce it also occurs extensively as a fire tree, along with trembling aspen and balsam poplar. Forests of balsam fir and white spruce are confined to the flood plain of the Athabaska and Clearwater Rivers, in the southern part of the region. Black spruce–lodgepole pine timber has been found thus far only on the Caribou Mt. Plateau north of the lower Peace River. Bog forests of black spruce and larch are widespread in the region, with no obvious relation to age of surface, but with some concentration on the Laurentian Plateau where undrained, bog-filled depressions are extremely numerous (pp. 61–64).

Floristically the region is a part of the meeting-ground of northern Rocky Mountain and eastern Canadian forest elements (pp. 72–74). It is presumed that the late Wisconsin (W_3) ice advance destroyed the interglacial connections between these eastern and western elements, and that the relics thus isolated are still in process of being rejoined. The least mesophytic species in the region — the spruces, white birches, larches, and aspens — probably were least restricted by peri-glacial conditions and have been the most successful at merging their relic populations. The most mesophytic species, the balsam firs, have been least successful, and apparently have not yet overlapped the ranges of their eastern and western components. The pines and probably the balsam poplars appear to be intermediate between the above categories (pp. 74–75). Eastern and western elements are still taxonomically distinct among the firs and pines, but among the species complexes in which merging has occurred only varietal distinctions are possible, with an abundance of intermediate forms.

The advance of forests into the Athabaska–Great Slave Lake region is thought to have been conditioned by the progressive amelioration of climates, by the progressive availability of land surfaces and suitable soils, and by the availability of tree populations from which the immigrants could come (pp. 72–73). The order of appearance of these immigrants was in turn conditioned by their general position in the Canadian forests with regard to subarctic climatic zones (pp. 64–72), and by the extent to which their migratory capacities were altered by the vicissitudes of the late Wisconsin glacial period (p. 74).

The earliest forests are thought to have been of white spruce from the foothills of the northern Rocky Mountain region, and to have entered the lake country from the southwest and west. The eastern elements are presumed to have come later, the jack pines occupying the sterile soils of the Laurentian Plateau, and the eastern white spruces interbreeding with the western forms (var. *albertiana*) on the Alberta Plateau and the river lowlands. The park-like white spruce type is thought to be a relic of the early western population, more or less isolated by the jack pine belt which has been preserved and accentuated by the sterility of the Laurentian area (p. 75).

Evidence is presented which indicates that there were no forests of large extent in central or southern Alberta or in Saskatchewan during late Wisconsin time, and that they did not appear in the southern part of the Mackenzie basin until after the final disappearance of the ice from Great Slave Lake and the drainage of the 800-foot post-glacial lake (pp. 75–78). It is thought that these events may have occurred as late as 7000–9000 years ago, bringing the advent of forests to the Athabaska–Great Slave Lake region into the period of the widely postulated post-glacial climatic optimum (pp. 69–71).

INTRODUCTION

AN ANNOTATED catalogue of the vascular flora of the Athabaska–Great Slave Lake region was published in 1936 as Part I of a phytogeographic study of that district. It was intended that Part I should be followed by another paper which would describe vegetational features; and the whole was to be a companion piece to two of my earlier papers on the plant life of the central and southern portions of the Mackenzie drainage basin (1934, 1935.) Preoccupation with other projects has delayed the completion of the proposed Part II, although sections of it have been written at intervals during the past nine years. Recent interest in our northwestern subarctic engendered by the war suggests the advisability of presenting such of this material as has been prepared. It will be published, therefore, not as a single "Part II," but as a series of parts dealing with the various kinds of plant communities. The present paper will have to do first with an outline of the botanical exploration of the region, some notes on its geological history, a general outline of its types of vegetation, and a discussion of its forests. Part III will be devoted to pond and pond-shore communities, and Part IV to the shore vegetation of the larger lakes. Other parts will deal with the vegetation of sand dunes and the lichen-heath communities of sand plains and rock outcrops.

I have already discussed briefly in earlier papers certain aspects of the vegetation of the Athabaska–Great Slave Lake region. The first of these (1928) were in the form of thesis abstracts dealing with the Shelter Point area on the north shore of Lake Athabaska, and with the Fort Reliance sand plain at the eastern end of Great Slave Lake. The latter paper was subsequently published in expanded form (1930). A brief but somewhat generalized discussion of the distribution and affinities of the vegetation of the whole area was published at about the same time (1930), and some phases of the identity and distribution of forest types were described in a short paper on the white spruce and Banksian pine in northwestern Canada (1933). Suggestions and conclusions set forth in these papers, altered or expanded in the light of later studies, will be summarized here. The greatest amount of overlap, however, will be found between the present and subsequent papers and that treating the vegetation of the Wood Buffalo Park (1935). The Park area is in reality a part of the great lake region of the Mackenzie basin, and although some phases of its plant cover, such as its grasslands, are more or less unique, and although one of the principal floristic boundaries in the region as a whole is approximately at its eastern border, it is difficult to outline the plant geography of the entire area without involving it. Much of my earlier discussion of its vegetational features will therefore be recapitulated here, though with a minimum of detail. The same procedure was followed in the floristic catalogue that appeared as Part I.

The geographic boundaries of the present study are rather arbitrarily drawn (see map, *Fig. 1*). At the south they include the Clearwater River region and the Athabaska River up to Athabaska Landing. Westward they extend roughly to the western borders of the Wood Buffalo Park, and include all of Great Slave Lake. The height of land between Great Slave and Great Bear Lakes marks the northern limit, while at the east the arctic tree line forms the boundary. The arbitrariness of these boundaries is accentuated by the partial and scattered nature of such detailed information as is available. Difficulties of transportation have left huge areas botanically unexplored; and it must be borne in mind constantly throughout the following treatments that the descriptions and conclusions are based upon a relatively small number of samples considering the size of the whole area. It is thought, however, that these samples are fairly representative and that, taken together, they will cover the principal phytogeographic features.

Localities in which more or less detailed studies of vegetation have been made are in most cases the same as those from which I have made collections. Specific data on the positions of these localities will be found in the Introduction to Part I, where latitudes and longitudes are given. For these and other localities mentioned in the following pages reference should also be made to the map (*Fig. 1*).

BOTANICAL EXPLORATION

Our knowledge of the plant life of the Athabaska–Great Slave Lake region began with the observations of the first trader-explorers who found

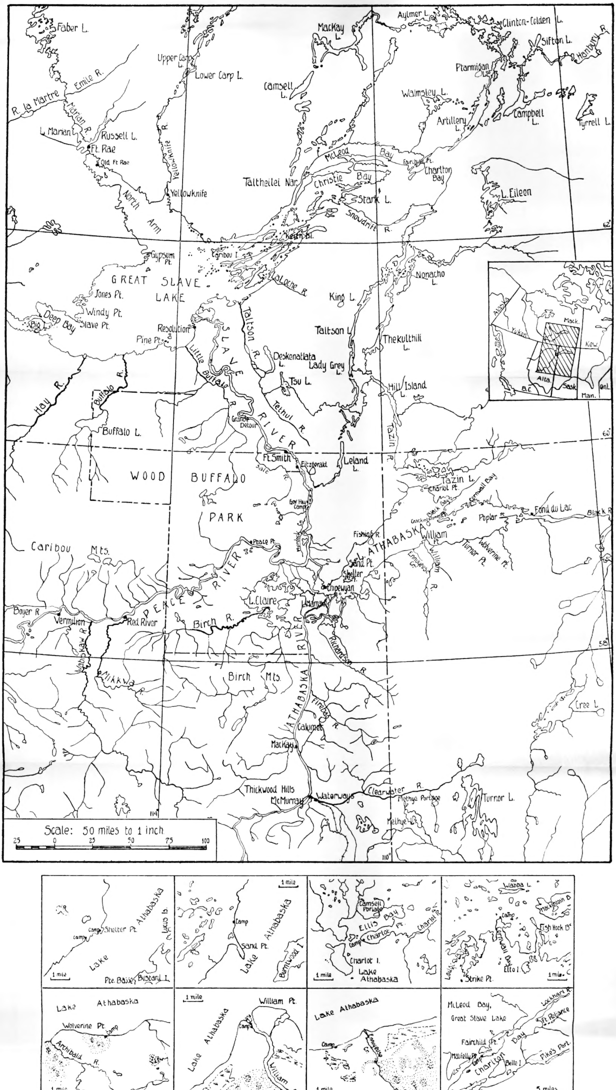

Fig. 1. Map of the Athabaska–Great Slave Lake region.

their way into the Mackenzie basin from Hudson Bay and the Saskatchewan. Samuel Hearne was the earliest of these hardy travelers, arriving at Great Slave Lake in the winter of 1771–72. The next was the Saskatchewan fur-trader, Peter Pond, who came into the lower Athabaska River valley in 1778. White men probably had already settled in the Slave River country before the traders appeared, though they have left no written record. Petitot reports (1885) that the French family name "Beaulieu" was established in that area when Mackenzie came in 1789.

In the development of botanical knowledge through the years the results obtained by explorers and travelers can be divided into two categories. First are those that involved the preservation of actual specimens of plants as well as botanical descriptions of the landscape, and second those that contain only the latter. Of collections there are relatively few. In the course of these studies I have seen most of them and have included records of them in the published Catalogue. Descriptions containing botanical notes, on the other hand, are numerous. In a few instances, such as in the writings of Sir John Richardson and John Macoun, notes on plant life are gathered into more or less formal treatments; but in most cases the information has to be gleaned from careful perusal of survey reports, travel accounts, and miscellaneous descriptive matter. In order to be of much use this kind of material has to be located geographically with reasonable accuracy — a requirement that is often difficult to meet. However, when gathered together and properly evaluated it is surprisingly voluminous and pertinent.

A fully adequate account of the botanical exploration of the region would involve, therefore, a brief recapitulation of virtually all of the exploratory literature. Such a project not only would become very voluminous, but would involve a great deal of duplication of material that I have already published in earlier studies. The papers, cited above, on the Peace River region and the Wood Buffalo Park both contain extended bibliographies and historical discussions. Another paper, on range conditions in the Park area (1933), has a similar discussion and an annotated bibliography. Consequently it is deemed sufficient to present here only a brief summary of the explorations that have made outstanding contributions to knowledge of the botany of the region, with particular attention to those dealing with the country around Great Slave Lake and eastward from the Slave and Athabaska Rivers. This will be supplemented by a bibliography for the whole of the lake district.

Geographic knowledge of the area, with all its botanical aspects, adheres to a pattern of water trade routes that was set in the early days of exploration and not seriously modified until very recently. The advent of air transport is establishing a new pattern, but it is still too early for its effects to be much felt in the field of biological investigation. Peter Pond's canoe route into the Clearwater valley and down the Athabaska River to its delta (see Wallace, 1929; Innis, 1930) was quickly extended westward up the Peace and northward down the Slave by Alexander Mackenzie (1801). The latter carried it across Great Slave Lake to the rich fur country of the Mackenzie River valley. Because the Mackenzie drains from the western end of Great Slave Lake, the crossing involved only the western arm, either by the south shore or by way of a chain of islands to the north shore and thence westward to the river. These became, and still remain, the principal transportation paths through our region. The western end of Lake Athabaska, at the junction of the Peace and Mackenzie systems, became a vital center for the fur trade, and continued as such for over a century. Nearly all the descriptions written by travelers through the Mackenzie basin contain impressions of the landscapes seen along these main routes, usually to the exclusion of all other parts of the lake country. As a result, precise information about the plant life of the region as a whole has been very slow in taking form.

Before taking up the exploratory history of the various parts of the area, it will be well to mention several papers that have particular value because they are of a general nature. The first of these is Sir John Richardson's account of his Franklin search expedition of 1848–49 (Richardson, 1851; see also Richardson, 1825, 1861). This book is a mine of information on the Mackenzie basin so far as it was known at that time. In addition to a journal of the trip, there are appendices dealing with the phenomena of climate, vegetation, fauna, and aboriginal life. It sums up the great store of knowledge about northwest America that had been accumulating during the period of extraordinary British exploratory activity that occurred in the first half of the 19th century.

Two papers by the pioneer Canadian naturalist John Macoun belong in this category. Both were published as parts of a geological survey report prepared by A. R. C. Selwyn as a result of explorations in 1875. Most of the report is concerned with work in central British Columbia, but Macoun left the main party and returned east by way of the Peace River, Athabaska Lake and River, and the Clearwater. His descriptions of the topography and vegetation of the lower Peace and Athabaska River valleys (Macoun, 1877, pp. 87–95, 110–232) are authentic and clear. They have no equals among the early vegetational descriptions of this or any other part of the Mackenzie basin.

Emile Petitot was a Roman Catholic missionary who traveled widely in the Athabaska–Mackenzie country between 1862 and 1883. He seems to have had an overwhelming interest in geographic matters, which led him not only to keep voluminous notes on the more familiar parts of the region, but also to wander widely in the unexplored wilderness. Beginning in 1875 he published, mostly in France, a long series of books and shorter papers on the country and its people (Petitot, 1875, 1876, 1883, 1885, 1887, 1888, 1891, 1893). Few if any individuals have ever acquired so large a first-hand knowledge of this huge territory, and no one has written more extensively about it. Taken together his works form a veritable eldorado of lore, extremely useful provided one has the patience and knowledge to sift it critically for pertinent and authentic material. Petitot's personal observations appear to be thoroughly reliable, but he so interspersed them with legend and hearsay that to sort out of them a body of fact often becomes difficult. Furthermore they are commonly interwoven with his own interpretations of natural phenomena which, due to his limited knowledge of the earth and biological sciences, often went astray.

By far the best general biological description of the Athabaska–Mackenzie region was prepared by E. A. Preble (1908). It was based upon three expeditions, the first two under the auspices of the United States Biological Survey, and the third with E. T. Seton. In the summer of 1901 Preble, accompanied by his brother, A. E. Preble, went north by way of Edmonton, Athabaska Landing, and the usual trade route to Great Slave Lake. They remained there until the latter part of July, collecting on the south shore and in the north arm. In 1903 the party consisted of the Preble brothers and Merritt Cary. They went to Resolution at the mouth of the Slave River and there separated, Cary and A. E. Preble going down the Mackenzie as far as Fort Wrigley, and E. A. Preble traveling to Rae and then northward over the height of land to Great Bear Lake. Cary and his companion returned south that season, but E. A. Preble wintered at Fort Simpson and made a trip to the Mackenzie delta in the following year. In 1907 Preble accompanied Seton to the Barren Grounds northeast of Great Slave Lake (see below). Most of the results of these expeditions were zoölogical, but considerable botanical collections were made throughout. Preble's report is especially valuable in the present instance for its careful and thorough descriptions of physical geography, climate, life zones, and exploratory history. Its extensive annotated bibliography was virtually complete for the time in which it was published.

From a geological standpoint, a paper analogous to that of Preble was published by the Canadian Geological Survey, and prepared by Charles Camsell and Wyatt Malcolm (1921). It contains, in addition to a resumé of the geology of the region so far as it was known in 1921, general descriptions of land forms, climate, fauna and vegetation, transportation facilities, and an excellent bibliography.

Three other "source books" should be mentioned. One is the report of a Canadian senate committee appointed to inquire into the resources of the Mackenzie basin in 1888 (See Schultz, 1888); and another is "The Unexploited West," compiled by Ernest J. Chambers (1914). The first contains a mass of miscellaneous information that requires to be winnowed carefully before its actual wealth of first-hand observation can be culled out and organized. The second presents somewhat similar hazards, though it is much more logically arranged in its presentation. Finally there is the excellent little book on "Canada's Western Northland, its History, Resources, Population and Administration," assembled by W. C. Bethune and published in 1937 by the Lands, Parks and Forests Branch of the Canadian Department of Mines and Resources. This volume contains a wealth of authoritative information on northwestern Canada, brought up to date by a corps of men whose experience in that region and its problems is extensive.

CLEARWATER AND ATHABASKA RIVERS

Peter Pond came into the Mackenzie basin by way of Methye Lake, and over Methye Portage to the Clearwater River. This route continued to be the principal one for the fur trade until the 1880's when, with the completion of the Canadian Pacific Railway, a road was established northward from Edmonton to Athabaska Landing. Consequently the Clearwater and lower Athabaska valleys were traversed by nearly all the explorers who came into our region in the first hundred years of its written history. The lower Athabaska, of course, continues to be a central artery of traffic to this day, for the present railhead is on the Clearwater about seven miles above its junction with the Athabaska. Needless to say there is no dearth of descriptions for these routes, since most of the travelers who published anything at all included their impressions of the Clearwater and Athabaska valleys.

In spite of there being so much traffic in these valleys, the number of plant collections from them is very small. No doubt some of Richardson's material came from them, but the labels give no indication of it. Only two collections are of special note. The first was by Robert Kennicott in 1859 (see below), and the second by J. M. Macoun in 1888. The latter traveled down the Athabaska from the mouth of Lesser Slave River to McMurray, then up the Clearwater and over Methye Portage. No separate list of his plants was published, but they were incorporated in John Macoun's Catalogue of Canadian Plants (1883–1890) or its supplements.

This busy route margins one of the least known parts of the entire Mackenzie basin, a vast tract between the Clearwater on the south, the Athabaska on the west, Athabaska Lake on the north, and Cree River and Lake on the east. There appears to be no published description of any kind for this area. Its eastern border was described by J. B. Tyrrell and D. B. Dowling in the course of a geological reconnaissance along Cree River and around Cree Lake in 1892 (J. B. Tyrrell, 1896). Recent aerial photographs and surveys will undoubtedly facilitate its exploration.

LAKE ATHABASKA

A fairly good map of Lake Athabaska was made by Philip Turnor about 1791. Turnor was sent by the British government to establish the position of Fort Chipewyan, a trading post at the west end of the Lake. He traveled from Chipewyan to Stone River near the eastern end and returned, making a rapid survey of the south and north shores en route. His journals, edited by J. B. Tyrrell, were published by the Champlain Society in 1934. An outstanding feature of his map from our standpoint is that it outlines the great sand dune area south of the lake, a feature not subsequently marked upon any map until the most recent ones done by aerial photography. The journals give rather detailed sailing directions, with abundant notes on shore vegetation.

No significant additions to the map of Lake Athabaska were made until 1880 and 1881, when A. S. Cochrane made a survey of the north shore of the lake from east to west (See Alcock, 1936, p. 5). A track survey of the south shore as far east as William Point was made in 1888 by R. G. McConnell (1893). In the summers of 1892 and 1893, new surveys of both north and south shores were made by J. B. Tyrrell and his associates, J. W. Tyrrell and D. B. Dowling, of the Canadian Geological Survey. These surveys were part of a larger project which extended eastward to Hudson Bay. The work of the Tyrrell brothers and Dowling is perhaps the most significant from a botanical standpoint in all the earlier exploratory history of Lake Athabaska. The principal features of the geological structure of the area were outlined for the first time, and a collection of plants was gathered by J. W. Tyrrell along the entire route of the journey, with extensive notes on vegetation. The plant collection, determined by John Macoun, contained about 196 species of flowering plants and ferns and about 37 species of cryptogams, many of them from Lake Athabaska. The scientific results of the expeditions were published by the Geological Survey of Canada (J. B. Tyrrell, 1896), while a popular account of the long journey of 1893 was published in book form by J. W. Tyrrell in 1898. In both of these papers the list of plants is included as an appendix.

In 1914 Dr. Charles Camsell of the Canadian Geological Survey led an exploring expedition between Athabaska and Great Slave Lakes by way of the Tazin and Taltson River valleys. The geological results were published by Camsell two years later (1916). Attached to this expedition was a naturalist, Dr. Francis Harper, who made collections of both plants and animals. A brief account of his work was published immediately (Harper, 1915), but his detailed botanical results did not appear until 1931, when a list of the collection was published (Harper 1931–C). In the same year he also published a paper on the amphibians and reptiles of the region, and another containing a discussion of its biogeography (Harper, 1931–A, B). His notes on mammals appeared in the following year (1932). Harper again visited Lake Athabaska in 1920, when he traveled eastward along the south shore in company with Dr. Hamilton M. Laing, under the auspices of the United States Biological Survey. Some plants were collected on this occasion, but no report appears to have been printed.

This concludes the summary of significant botanical exploration around Lake Athabaska prior to our own work, which was begun in 1926. It is necessary to mention, however, some notable geological papers and topographic maps that have appeared in recent years. For our purposes the most significant geological reports are by Dr. F. J. Alcock, who spent the summers of 1914 and 1916 on the north shore of the Lake, and who in 1935 was in charge of a large field party in the same region. His papers on the origin of Lake Athabaska (1920) and on the general geology of its surroundings (1915, 1917, 1936) are of particular interest. The whole lake area has now been mapped from aerial photographs. The new maps (Nat. Top. Series, Top. Surv. Can.) show in great detail not only the shore lines and islands of the main lake, but also the complex system of streams and ponds that characterizes the "inland" country. These maps, especially when they can be supplemented by the photographs themselves, enormously facilitate biological investigation.

Region between Athabaska and Great Slave Lakes

East of the Slave River valley, and between Athabaska and Great Slave Lakes, is a vast upland of moderate elevation. It is characterized by thin, stunted timber, and by an extraordinary number of lakes. In some places the lakes are so numerous and so close together that the whole surface, as Alcock remarks (1936, p. 7), gives the impression "of a drowned topography with only the ridge summits projecting above the water." No accurate knowledge of any part of this region became available until after Camsell's expedition on the Tazin and Taltson Rivers in 1914. The Tyrrells had skirted its eastern borders in 1893 on their route to Chesterfield Inlet by way of the Black and Dubawnt Rivers (J. B. Tyrrell, 1897), and they were told by the Indians of the track later used by Camsell. Strangely enough, a rather accurate account of the main canoe routes through the upland was written many years before, purely from Indian reports. Richard King, who was surgeon and naturalist to Back's expedition in 1834 (see below), wrote a personal account of his journey which was published separately (1836). During the planning of Back's journey the Indians had urged the use of a canoe route through the country southeast of Great Slave Lake. The Indians said that this would lead into a northward flowing river from which the arctic watershed could be reached. King published an Indian sketch map of the route at the close of his narrative. The Back expedition chose the eastern arm of Great Slave Lake, however, and the Indian route was not investigated until 1925, when G. H. Blanchet of the Canadian Topographic Survey followed it through to the Thelon River (Blanchet, 1926–C). Starting from Fitzgerald on the Slave River he crossed the upland in a northeasterly direction through a long series of lakes, streams and portages to the upper Thelon, then returned by way of the Snowdrift River and Great Slave Lake.

Blanchet made another journey in this general region in 1926. On this occasion he set out from Tazin Lake in an attempt to find a route into the Thelon, but after a long and difficult journey northeastward over a broad height of land he found himself in the Dubawnt drainage by which he returned to the Black River and Lake Athabaska (Blanchet, 1927).

Except for the material gathered by Harper in 1914 (see above), detailed botanical information on the upland east of the Slave River is practically non-existent. From Blanchet's notes it is possible to place on the map a few facts about the distribution of forest types, but otherwise the country remains to be explored.

Great Slave Lake and the Lockhart Basin

In spite of the fact that a major trade route led through Great Slave Lake from Mackenzie's time on, details of the geography of the whole lake were not available for many years. In fact some glaring inaccuracies, particularly as to the eastern arm, remained on the maps until 1926, when the first comprehensive government survey was made. Even today, in some of our standard atlases, the corrections have not yet been entered. The first known description of the lake was written by Samuel Hearne (1795), who crossed the eastern arm from north to south in the winter of 1771–72. He called it "Athapuscow Lake," and for a long time it was thought that he actually crossed Lake Athabaska; but studies of his track made by D. B. Dowling (1893) and J. B. Tyrrell (1911) show clearly that he came overland from the Coppermine River by way of Mackay Lake, crossing Great Slave Lake in such a way as to arrive on the south shore at a point not far east of the Slave River delta. Earlier in the season, on his way northeastward to the Coppermine, he passed through the Lockhart basin, probably just east of Artillery Lake.

Mackenzie's description (1801) of the western arm was written in 1789, when he made his remarkable journey down the Mackenzie River, but he was preceded at Great Slave Lake by a trader named Leroux, who built a house near the eastern side of the Slave delta in 1786. There is also some evidence that associates of Peter Pond had a trading establishment in the same locality as early as 1781 (see J. B. Tyrrell, 1934, p. 518). Leroux also built a post in the north arm, probably near the present site of Rae, about 1789.

The earliest plant collections from Great Slave Lake were made by John Richardson, surgeon and naturalist to the Franklin expeditions of 1819–22 and 1825–27 (See Franklin, 1823, 1828). They came from the west and north arms of the lake, but specific localities are lacking on most of their labels. On the first journey the party went to Yellowknife Bay on the east shore of the north arm, and ascended Yellowknife River to a height of land by which they reached Point Lake and the Coppermine. They returned to Slave Lake by the same route after a trip down the Coppermine and eastward along the arctic coast, and after a disastrous adventure on the way back through the treeless country northeast of Point Lake. Most of the second expedition was devoted to surveys of Great Bear Lake and the arctic coast west of the Coppermine, but some plants were collected at Great Slave Lake. Botanical results of the first expedition were published by Richardson in an appendix to Franklin's narrative of that journey (Franklin, 1823); and the material from both expeditions later became the basis for a large proportion of the classic "Flora Boreali-Americana" by W. J. Hooker (1840).

The Franklin Expedition specimens were all placed in the herbarium of the British Museum, from which duplicates were from time to time sent to America. A large number of these came to Asa Gray and John Torrey during the period when Torrey's "Flora of North America" and Gray's "Synoptical Flora" were being prepared. As a result they are now more or less concentrated in the Gray Herbarium and the Herbarium of the New York Botanical Garden, although a considerable number are in the National Herbarium of Canada. Another group was acquired by John A. Lowell of Boston, and these were at the Boston Society of Natural History until recently, when they were moved to the Gray Herbarium. The latter institution now has by far the best representation in America of the early Mackenzie basin collections, as well as of the Arctic and Rocky Mountain material that formed the basis for "Flora Boreali-Americana."

The first extensive descriptions of the eastern arm of Great Slave Lake were made in 1833 and 1834 on the occasion of Capt. George Back's expedition (Back, 1836; King, 1836). Back's party traveled northward by the Slave River, and through the eastern arm of the lake to its extremity, where they established Fort Reliance as winter quarters. From here they went northeastward through the lake country of the Lockhart River basin, and across a height of land to Back River, which they descended to the arctic coast. Only a few plants were collected on this expedition, but the published narratives and appendices are replete with notes on topography and vegetation.

Captain W. J. S. Pullen of the British Navy came southward through our region in 1852, collecting a few plants along the upper Mackenzie and possibly along the western arm of the lake (Pullen, 1852). He had been engaged in the search for the lost Franklin Expedition, and had spent the two preceding winters at Fort Simpson. A list of his plants is to be found in the Botany of the Voyage of H. M. S. Herald (Seemann, 1852–57). It was in the 60's and 70's that Emile Petitot was gathering material for his extensive writings on the geography of the Mackenzie basin. His map of Great Slave Lake is surprisingly accurate considering the limited means of surveying at his disposal. Richardson's account of his Franklin Search Expedition of 1848–49 should also be mentioned here, although it did not contain much specific description of Slave Lake. An early attempt to penetrate the upland north of McLeod Bay, in the eastern arm, was made in the summer of 1855, when James Anderson (1856) of the Hudson's Bay Company went northward by canoe from near Mountain River. He followed a chain of lakes that brought him to Lake Aylmer, and then returned to McLeod Bay by another route farther east.

Strangely enough one of the most important plant collections ever made in the Mackenzie country dates from this period, though no account of it was ever published. It was the work of Robert Kennicott, who made a long journey down the Mackenzie and into the Yukon valley in 1859 and 1860 under the auspices of the Smithsonian Institution and the Chicago Academy of Sciences. Not only did Kennicott himself gather large collections of both plants and animals along the Athabaska, Slave and Mackenzie Rivers, but he so inspired Hudson's Bay Company officials in the region that they continued to send material to the Smithsonian for many years thereafter. The zoölogical collections were studied and published upon many years ago by E. A. Preble (1908), but the plants were never listed until 1936, when I incorporated those from our region in the Catalogue. Most of the plant specimens are now in the herbarium of the New York Botanical Garden. A biography of Kennicott containing his northern itinerary was published by the Chicago Academy of Sciences in 1869.

The maps of shores in the western and northern arms of the lake were somewhat improved by William Ogilvie in 1887–88 (1890), and by R. G. McConnell (1891). McConnell wrote some excellent descriptions of the topography in the country around the western arm, pointing out the possible significance of the old terraces above the present shore. Also he made overland trips between Rae and Providence, and he is one of the very few people who have described the semi-open country in that district.

A few descriptive notes on the eastern arm of Great Slave Lake and the Lockhart basin were written by James McKinlay in 1890, in the course of a trip from Resolution to Beechy Lake on Back's River. The material is in the form of a diary, edited and published by D. B. Dowling in 1893.

In the summer of 1892 Elizabeth Taylor traveled through the country by the usual trade routes, making numerous zoölogical and botanical collections. Although I have been unable to find any published narrative of her journey, her collections of plants are well preserved and bear excellent data as to localities and dates. They are distributed among the herbaria at the National Museum of Canada at Ottawa, the New York Botanical Garden, and at Harvard, while a few have found their way into other institutions. Unfortunately, most of the collection was originally numbered serially by specimens, with some duplication and omission of numbers, so that duplicates cannot now be recognized from the numbers on the labels.

A number of sportsmen and explorers passed through Great Slave Lake during the 1890's, but for the most part they contributed little to our knowledge of the vegetation. A notable exception was Frank Russell, a zoölogist from the University of Iowa, who spent the seasons of 1893 and 1894 in the Mackenzie basin. The first part of the summer of '93 was spent in the Athabaska delta; then he went to Rae and used that as his base of operations until May of the following year. He made several long hunting trips from Rae, among them one to Providence overland. His report, published in 1898, contains many useful botanical observations. Warburton Pike traversed the eastern arm of the lake in 1889 and again in 1890, on hunting trips to the Barren Grounds. His narrative, published in 1892, has been one of the most widely read books of travel in northern Canada. Others whose primary interest was big-game hunting were Henry T. Munn, who went into the country east of Slave Lake in the summer and fall of 1894 (Munn, 1932), and Caspar Whitney, who spent the winter of 1894–95 hunting with the Indians eastward from Rae (Whitney, 1896). Another colorful figure to appear on the scene about this time was "Buffalo" Jones. He and a companion named Rea, in the summer of 1897 and in the following winter, made a vain attempt to secure live musk-oxen from the region northeast of Fort Reliance. Jones himself published no account of his adventures, but entertaining descriptions of them were written by Emerson Hough (1898) and Henry Inman (1899).

The first comprehensive geological investigations around Great Slave Lake were made in 1899 by Robert Bell and his assistant J. M. Bell of the Canadian Geological Survey (R. Bell, 1900; see also J. M. Bell, 1929). They made track surveys of Christie and McLeod Bays in the eastern arm and of parts of the north arm. Their report contains many significant botanical observations and valuable notes on the post-glacial shore lines that are so closely related to the history of the vegetation.

In 1900 J. W. Tyrrell, under the auspices of the Canadian Department of Interior, made a remarkable journey from Great Slave Lake to Chesterfield Inlet and return. His report (1902) includes appendices giving many valuable meteorological and geographic data and a list of 83 species of plants collected. While most of the material concerns the country beyond the Lockhart basin, there are some significant notes on the eastern arm of Great Slave Lake and on Artillery Lake.

Some notes on arctic vegetation and the geography of the timberline northeast of Great Slave Lake are found in the travel narratives of David T. Hanbury (1900, 1903, 1904). Hanbury first came into our region in 1899 from Chesterfield Inlet. He traveled up the Thelon River, crossed to Artillery Lake, and reached Great Slave Lake by way of the Lockhart River. In 1901 he went eastward from Resolution through the eastern arm and Artillery Lake, and over the height of land to the Hanbury River, which he descended to the Thelon.

E. A. Preble's important work in 1901 and 1903–04 has already been discussed, but his journey with E. T. Seton in 1907 should have special mention. The description of this expedition was published by Seton in 1911, in one of the most charming books of travel in the Athabaska–Great Slave Lake region that has appeared. It is filled with lively descriptions of the plants and animals encountered, and of the people and their life. Its account of the summer pest of mosquitoes and flies is second to none. A list of plant collections is given in an appendix, and most of the specimens are in the National Herbarium of Canada.

A few notes on the vegetation of the eastern arm of Great Slave Lake are to be found in the report of E. A. Pelletier published in 1910. Pelletier was an Inspector in the Royal Northwest Mounted Police who made a journey in 1908 through the Athabaska and Great Slave Lake country and to Chesterfield Inlet by way of the Lockhart basin and Thelon River.

A few data on the country east of Rae were published by David E. Wheeler in 1914. Wheeler made two trips in this area, in 1910 and 1913. On the latter he traveled as far east as Clinton-Colden Lake in the Lockhart basin.

Geological survey work was carried out in 1916 by A. E. Cameron in the country south of the western arm of the lake. Some excellent notes on topography and vegetation are found in his reports (1917, 1918, 1922–B), and they are of particular interest here because they were the beginning of the field studies that led to Cameron's discussion of the post-glacial lakes of the Mackenzie basin (1922–A). This paper has proved extremely stimulating for investigations of vegetational development.

The discovery of oil along the lower Mackenzie led to greatly increased geological survey activity throughout the Mackenzie valley and around the western arm of Slave Lake. Papers of significance for our purposes were prepared by G. S. Hume (1921) and A. E. Cameron (1922–B), both of the Geological Survey of Canada. New geological maps were made for most of the western arm, and for part of the west shore of the north arm. A number of small plant collections were gathered from time to time by members of the field parties under Cameron and Hume. These collections are in the National Herbarium of Canada and are incorporated in the Catalogue.

Some descriptive matter on the eastern arm of the lake was written by J. C. Critchell-Bullock in 1925. An account of his journey, mostly in the country northeast of the lake, was published in 1931. It contains a great deal of miscellaneous data on vegetation, animal life, weather, and seasonal changes.

About 1924 the Topographical Survey of Canada undertook to make new maps of the complex shores and islands of Great Slave Lake and the Lockhart basin. G. H. Blanchet was placed in charge of the work, and during his extensive travels he made voluminous notes on topography, geology, and natural history. These were published in three papers (1925, 1926–A and B) filled with authentic, first-hand information on a great variety of subjects of interest to the bio-geographer. A few geological notes by W. L. MacDonald appear as an appendix to one of these papers (1926–A).

Two geologists, George M. Douglas and Carl Lawson, spent the summer of 1928 investigating the southern shores and islands of the eastern arm. Douglas' account of the trip (1929) contains the narrative, while a paper by Lawson (1929) gives a description of the geological findings.

The Geological Survey of Canada began further investigations in 1929 at Great Slave Lake, with a field party in charge of C. H. Stockwell. Between 1929 and 1931 all the country immediately around the eastern arm was studied, and in 1932 Stockwell made a reconnaissance trip up the Yellowknife to the Coppermine, then east to Thonokied Lake and south to the eastern arm of Slave Lake. Stockwell's report (1933) has much information on glaciation and plant life that is useful for present purposes. The discovery of gold in the Yellowknife Bay area has greatly stimulated geological survey activity around the north arm. Papers by F. Jolliffe (1936), C. S. Lord (1939), J. F. Henderson (1938, 1940), and A. W. Jolliffe (1939) contain some of the results of this work. One of the members of Stockwell's party of 1929 was H. W. Fairbairn, an amateur naturalist who later published (1931) a paper on the birds and mammals seen during that summer. He included a few notes on forest types.

Two recent papers on the region northeast of Great Slave Lake are of particular significance to biologists. The first is by W. H. B. Hoare (1930), and results from his extensive travels while studying grazing conditions for musk oxen and caribou. The second reports a general biological investigation of the Thelon Game Sanctuary by C. H. D. Clarke (1940). This paper contains extensive observations on timberline vegetation in the region of Artillery Lake and on the Thelon River.

Region West of the Slave and Athabaska Rivers

Summaries of the exploration of this part of our region will be found in my earlier papers (1933, 1934, 1935) and need not be repeated. Attention should be called, however, to an excellent recent article by J. D. Soper on the Wood Buffalo Park (1941). This paper is devoted to the "History, Range, and Home Life of the Northern Bison," and contains significant additions to our knowledge of the plant geography of the Park.

TOPOGRAPHIC FEATURES OF THE ATHABASKA–GREAT SLAVE LAKE REGION

The Athabaska–Great Slave Lake region may be divided topographically into four provinces which are reflections of major events in its geologic history. They are: the Caribou and Birch Mountain Plateaus, the Alberta Plateau, the Laurentian Plateau, and the Mackenzie Lowland. These divisions were first outlined by Camsell and Malcolm in 1921.

The Caribou and Birch Mountains are isolated plateaus of Cretaceous rock in the southwestern part of the area. The former reach an altitude of about 3500 feet, and the latter about 2300 feet above the sea. The Thickwood Hills west of McMurray are of similar nature. These plateaus are the highest land surfaces to be found in our region. Very little descriptive matter concerning them has ever appeared, but judging from a few scattered notes and from my own observations in the Wood Buffalo Park, they are rather flat-topped, with margins deeply dissected by rapid streams (Raup, 1935). Similar outlying plateaus elsewhere in the Mackenzie basin are the Buffalo Head Hills and the Eagle, Horn, and Watt Mountains.

The Caribou Mountains lie between the lower Peace River and Buffalo Lake. Eastward they extend into the Wood Buffalo Park, and westward to the valley of Hay River. The Birch Mountains are immediately west of the lower Athabaska River and south of the Birch River. The surfaces underlain by Cretaceous rock, of which they are the highest part, are to be seen on both sides of the Athabaska above the Firebag River, and in the McMurray district they form high bluffs along the main streams.

Stretching northward and eastward from the Caribou and Birch Mountains is the Alberta Plateau. It is a gently rolling plain, rather poorly drained, and characterized by morainic ridges, outwash plains, and glaciolacustrine deposits. Its northern boundary, west of the Slave River, is indicated by a well-defined escarpment making a fall-line for streams draining in that direction. In our area this fall-line appears in the region southwest of Fort Smith, where it is known locally as Salt Mountain. From there it trends in a northwesterly direction into the northern part of the Wood Buffalo Park, then southwesterly to cross the Buffalo River drainage above Buffalo Lake and Hay River at Alexandra Falls. The elevation of the plain southwest of Fort Smith is about 1100 feet. Camsell and Malcolm (1921, pp. 17–18) consider the Alberta Plateau to be a part of the northward extension of the great central plain of the continent: "It corresponds to the second and third prairie steppes in the Great Plains region south of the height of land. . . ." They point out that the "surface rises gradually southwest and west to the foothills of the Cordillera. The slope, however, is so gradual that the smaller streams which have not the power to cut graded valleys from the plateau to the lowland, are comparatively sluggish in the plateau and are rapid and broken only where they descend through the escarpment. The surface, therefore, is monotonous and outcrops of the solid rocks are rare, and because the drainage is immature, muskegs are abundant and lakes fairly numerous." In our area the Alberta Plateau is underlain by Paleozoic shales and limestones. Some of the latter are highly gypsiferous and cavernous, giving rise to an extensive sinkhole topography. For further discussion of its physical features and soils see Camsell, 1903; Raup, 1933, 1935; Soper, 1941.

Approximately the northeastern half of the Athabaska–Great Slave Lake region lies in the Laurentian Plateau. This is one of the major physiographic provinces of the continent, extending eastward to Labrador. Nearly all of Lake Athabaska lies within it, as well as the eastern arm and the eastern shore of the northern arm of Great Slave Lake. In characterizing it I can do no better than quote parts of Camsell and Malcolm's description (1921, pp. 11–14).

"The western border of this province, where it abuts against the central plain, is a fairly well-defined line marked by the contact between the Precambrian crystalline or metamorphic rocks and the flat-lying Palaeozoic sedimentary rocks. The line of contact enters the Mackenzie basin from the south at Methye portage on Clearwater river in longitude 110 degrees west. Running northwesterly from there it passes the west end of Athabaska lake and follows the valley of Slave river to Great Slave lake. Crossing Great Slave lake in northwesterly direction it runs from the northern end of the north arm of the lake to the southern point of McTavish bay on Great Bear lake. . . ."

"The physical features of this province are typical of the whole Laurentian plateau generally. When viewed broadly the topography is that of a broad plain sloping gradually to the west and north with a gradient towards the great lake depressions which rarely exceeds 6 or 8 feet to the mile. Here and there residual round-topped hills or monadnocks rise a few hundred feet above the general level, but these hills are not as a rule connected into definite ranges nor aligned in any particular direction. In detail, however, the plateau is very irregular, broken, and rocky, with an uneven hummocky or mammillated surface." "The greatest relief is found on the shores of the great lakes where it reaches a maximum of about 1,000 feet." The maximum altitudes above sea-level for the various parts of our region do not vary greatly. Camsell and Malcolm give the following figures: at Cree and Wollaston Lakes, 1650 feet; on the north shore of Lake Athabaska, 1490 feet, at Great Slave Lake, 1520 feet; and on the divide between Great Slave and Great Bear Lakes, about 1700 feet.

"The Laurentian plateau portion of the Mackenzie basin is essentially a lake country, and its surface is covered with thousands of lakes of all sizes, ranging from mere ponds to lakes hundreds of square miles in extent. So numerous are these lakes and so rocky and irregular the country between them that the only method of travel used by the natives or travelers in summer in this region is by canoe. By portaging from one lake to another it is possible to travel by canoe in almost any direction required. . . ."

"[The lakes] are usually very irregular in outline and their shape and alignment have been determined partly by the structure and composition of the rocks in which they lie and partly by the direction of movement of the glacial ice-sheet."

"The Laurentian plateau in the Mackenzie basin has as a rule little or no mantle of soil or other loose material covering its bedrock. . . . A very large proportion of the region has a rocky surface. Boulder clay is found frequently filling depressions on the surface and here and there occur sand plains or other accumulations of glacial drift. The whole region has been subjected to intense glacial erosion by which the surface has been worn down to the live rock and denuded of its loose material which has been carried westward and deposited in the lowland portion of the basin. South of Athabaska lake is a large area underlain by horizontally bedded sandstone which on decomposition forms wide plains of sand or gently rounded hills and ridges. . . ." The youth of the surface, together with the scarcity of finely divided materials, have resulted in highly disorganized drainage systems, with clear water in the lakes and streams.

The Mackenzie Lowland province is represented in our region by a low plain around the western arm of Great Slave Lake, with long extensions up the valley of the Slave River and into the lower valleys of the Peace and Athabaska. Nowhere does its surface rise much above the levels of the main streams and lakes. According to Camsell and Malcolm (1921, p. 20), "The elevation of the lowland at the west end of Athabaska lake is about 700 feet above the sea and the slope of the surface from that point to the Arctic averages about 8 inches to the mile. . . ."

The surface of the lowlands is a rather monotonous flat plain made of alluvial or glacio-lacustrine soils. There are many shallow, marshy lakes and meandering, sluggish streams. Soils on the banks of the larger rivers are well-drained and suitable for a limited agriculture, but the back country holds vast expanses of muskeg and swamp. The main streams, such as the Peace, Slave, Little Buffalo, Buffalo, and Hay Rivers, wind through broad flood plains with many islands, bars, and abandoned channels.

As will be shown later, the boundaries between the four physiographic provinces just described are coincident with some of the principal floristic and vegetational boundaries in this region. This is particularly true of the border of the Laurentian plateau and of the margins of the Cretaceous uplands. The Alberta Plateau escarpment is also significant botanically, as I have pointed out elsewhere (1935). Some further elaboration and subdivision of the four provinces becomes necessary when their surface geology is examined.

GEOLOGY AND SOILS

Introduction

The contribution of geological science to the study of vegetation may be said to be three-fold. First, it offers a rational explanation for the topographic patterns with which maps of vegetation or of species are commonly correlated; and at the same time it outlines geomorphic processes to account for change in topography and, in many cases, for change in vegetation.

Second, it supplies the basis for the study of origin, distribution, and development of soils. And third, it outlines sequences of events in the formation of topography and soils, with time scales of greater or lesser accuracy, which may be related to suspected sequences in the development of the plant cover. It may be said that within broad limits the positive correlation of vegetation patterns with those of topography and soils, especially the latter, is inversely proportional to the length of time during which the surfaces and soils have remained unaltered by major geomorphic events. This is based upon the theory in modern soil science that, given time enough, soils and vegetations tend to become uniform under given climates, regardless of the geologic origins of the soils.

The soils and surfaces of the Athabaska–Great Slave Lake region are for the most part youthful in terms of time and soil-forming processes. Most if not all of them have been exposed for the acquisition of vegetation only since the retreat of the last glacier or of its adjacent lakes. A positive correlation should be expected, therefore, between the distribution of vegetation and the patterns of geologic features. Although the final episodes of the last glaciation are of outstanding significance, it is necessary to look first at the distribution of the major kinds of bedrock, for they determine in large measure the amount and condition of the existing soils, whether the latter are of glacial origin or have weathered from the rocks since they were exposed.

In the present state of our knowledge of the relations between rocks and vegetation in this region, it will be unnecessary to describe the rock formations in detail. Of greatest importance are the relative rates at which the rocks have produced soils, and, in general terms, the history, position, and physical and chemical properties of these soils. ***Figure 2*** is a map showing the surface distribution of principal rock formations.

Pre-Cambrian Formations

The topographic province of the Laurentian plateau is in our region composed entirely of pre-Cambrian rocks. The oldest of these rocks are variously metamorphosed sedimentaries usually considered to be of early pre-Cambrian (Archean) age. These ancient sediments are widely scattered in the country north of Lake Athabaska and around the eastern arm of Great Slave Lake. North of Lake Athabaska they are known as the "Tazin Group," and are composed of "dolomite, limestone, quartzite, argillite, conglomerate; mica schist and gneiss; volcanic flow and fragmental rocks" (Alcock, 1936, p. 10). These rocks are commonly found in small masses, and are surrounded and much intermingled with younger magmatic granites and granitoid gneisses, the welling up of the magma having caused the disruption and alteration of the sediments. About the eastern arm of Slave Lake, rocks thought to be of similar age are called the "Point Lake–Wilson Island Group." They include "conglomerate, arkose, quartzite, phyllite, dolomite, specularite iron formation, gneiss, schist, basalt, andesite, trachyte, and rhyolite" (Stockwell, 1933, p. 46). They likewise are highly altered by granitic intrusives.

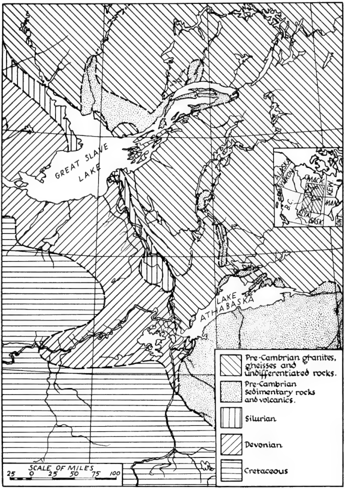

FIG. 2. Map of the principal geological formations in the Athabaska–Great Slave Lake region.

Above the Archean rocks is an unconformity and then come late pre-Cambrian (Proterozoic) deposits characterized by conglomerates, sandstones, quartzites, shales, and volcanic intrusives. One group near the base of this section at Great Slave Lake contains some dolomites and limestones. North of Athabaska Lake the oldest of the late pre-Cambrian groups is composed of quartzite, conglomerate, and iron formation, and is known as the "Beaverlodge Series" (Alcock, l. c.). It is much altered by basic intrusives and some granite, and is topped by an unconformity and finally by the "Athabaska Series" of "conglomerate, arkose, sandstone, shale. Balsalt flows and dikes."

Late pre-Cambrian formations at Great Slave Lake as described by Stockwell (1933, pp. 55–60) have at their base the "Great Slave Lake Group" of sediments and volcanics. There is a great variety of rocks in this group, including conglomerates, sandstones, shales, slates, dolomites, and limestones. They are disrupted and altered by dioritic intrusives. Above them is an erosional unconformity, followed by another group of sediments called the "Et-Then Series." This series, composed of conglomerates, sandstones, and quartzites, is thought to be of the same age as the Athabaska Series. Still later intrusives of diabase cut the Et-Then rocks.

By far the most widespread of the pre-Cambrian rocks, in surface exposure, are the Archean granites and granitoid gneisses, and the late pre-Cambrian sandstones and quartzites. The former are the rocks most commonly seen in the vast country between Athabaska and Great Slave Lakes and in the region around the eastern arm of Great Slave Lake. The latter predominate south of Lake Athabaska and apparently underlie most of the lake itself, for they outcrop on the islands and in places on the north shore. Scattered throughout the granitic areas are the older and younger sediments and intrusives.

When translated into terms of immediate significance to plant distribution, these rock formations may be correlated with a rough phytogeographic boundary at the north shore of Lake Athabaska. Northward from the boundary most of the surface is of hard granitic rocks so resistant to weathering that they have produced scarcely any soil since they were cleaned off by the last advance of the glacier. Most of what soil there is has developed from local till deposits, small alluvial beds, or peat accumulations around lakes. Southward from the boundary are sandstones and quartzites that have weathered more rapidly to form extremely light sandy soils in post-Glacial time, or have been the origin of sandy outwash from the glaciers themselves. In the granitic country is a third kind of surface which, though scattered and often of small extent, is none-the-less distinctive. Its rocks have weathered faster than either the granites or the sandstones, and in many places have produced a thin residual soil in the short time since they were exposed. Most conspicuous in this respect are the limestones, shales, and dolomites of the Tazin and Et-Then Series and of the Great Slave Group. Intermediate between the softer rocks and the

Athabaska sandstones are the conglomerates of all the sedimentary series.

Botanical effects of these major variations in rocks and soils are seen at once in the landscapes of the Laurentian Plateau. South of Lake Athabaska are broad plains and rounded hills of sand and gravel, while on the south shore of the lake itself are many miles of shelving sandy beaches backed by a complex array of sand ridges and terraces with here and there outcrops of flat-lying sandstones. Immediately south of the shore are huge areas of shifting dunes. Sand beaches are also characteristic of many parts of the north shore, particularly toward the western end of the lake. Sand beaches and sandy plains also appear on Great Slave Lake wherever there are large outcrops of the sandstones of the Great Slave Lake group or of the Et-Then Series, such as in the Snowdrift River and Fort Reliance areas. The granitic country is a dreary waste of stunted, scattered timber, with a large total area of rock that is covered only by lichens, mosses, and a few herbaceous or shrubby plants that cling to the rock surfaces or find small pockets of soil in crevices and glacial till. Scattered through it are what might almost be called oases, where the rounded hills are green with grasses and sedges, and the slope and valley forests are of well-formed trees. These are the limestone and dolomitic outcrops whose surfaces have been broken by frost and subaerial weathering to form thin but rich, fine-textured soils. In addition to their fineness in texture, these soils have a chemical composition that attracts calcicolous species of plants, thereby further enriching their flora.

Botanical correlations with the principal rock differences just described are to be found also in the distribution of lake shore and pond vegetation, and in the arrangement of forest types over the landscape. Further discussions along these lines will be found in other parts of this paper.

PALEOZOIC FORMATIONS

The physiographic provinces of the Alberta Plateau and the Mackenzie Lowland are underlain, so far as is known, by Paleozoic rocks of Silurian and Devonian age. These rocks are relatively undisturbed, flat-lying, and composed principally of dolomite, limestone, and shale. The present surface materials, as previously stated, form a mantle of till, outwash, glaciolacustrine, and alluvial deposits which so cover the bedrock that few exposures are seen. Those studied by geologists are along the lower Athabaska and Peace Rivers, at a few places along the Slave River and around the western shores of Great Slave Lake, in the valleys of Hay and Buffalo Rivers, and at several places along the Alberta Plateau escarpment.

Silurian deposits are principally represented in our area by a formation called the Fitzgerald Dolomite (See Camsell, 1917; Cameron, 1922–B). It consists of gray dolomitic limestone with gypsum and anhydrite. Exposures of it can be seen along the Peace River near Little Rapids and at Peace Point, at several places along the Slave River, in the escarpment southwest of Fort Smith, and at Gypsum Point on the northwest shore of Great Slave Lake. Extensive sink-hole development over these beds indicates their gypsiferous nature, and an elaborate system of underground drainage appears to have been set up in them. Salt springs issue from them in some places, particularly south and west of Fort Smith, where nearly all of the surface water immediately below the Salt Mountain escarpment is brackish. On the basis of their high gypsum content, and to some extent on fossil evidence, these dolomites have been placed in the Upper Silurian. Some red beds of calcareous shale, red gypsum, salt, and red arenaceous shale have been found beneath them at Gypsum Point, however, and are also classed as Silurian.

The lower Devonian does not appear to be represented in our region, but on the south and north shores of the western arm of Great Slave Lake Middle Devonian rocks outcrop in many places (Cameron, 1921). These rocks have been divided, on lithological and fossil grounds, into three groups, called the Pine Point Limestones, Presqu'ile Dolomites, and the Slave Point Limestones. They vary from soft shaly limestone to hard crystalline dolomite.

Upper Devonian strata are widespread around the western extremity of Great Slave Lake and along the upper Mackenzie. They appear in the Hay and Buffalo River sections, and at Vermilion Chutes on the Lower Peace River. It is assumed that they underlie most of the Alberta Plateau southwest of Great Slave Lake. Although they contain some limestones, most of them are shales. In our region they are divided into the Simpson Shales, the Hay River Shales, and the Hay River Limestones. Along the lower Athabaska River are gently arching beds of limestone that are commonly seen on the banks between McMurray and the Firebag River. These are generally regarded as of Upper Devonian age, possibly to be correlated with the Hay River Limestones.

The phytogeographic significance of the Paleozoic formations results in large measure from their attitude and relative softness. Being nearly horizontal, they offered but little resistance to glacial movement; and upon the retreat of the ice they presented a series of comparatively level plains upon which till and outwash could be widely spread, and upon which broad lake deposits could be laid down. At the same time they were composed of rocks sufficiently soft for the formation of thick deposits of glacial debris. Other botanical aspects are significant locally. The presence of the limestones has encouraged a certain amount of calcicoly in the flora, apparent chiefly near actual outcrops or in ponds and lakes. The saline springs from the Silurian formations have already been mentioned. The spread of their waters over the "Salt Plains" south and west of Fort Smith has given rise to a halophytic flora containing many species uncommon or unknown elsewhere in the region. Another aspect of great importance in the country immediately underlain by Silurian rocks is in the peculiar topography and drainage of the sink-holes. Many of them are dry, but others contain ponds whose levels are apt to fluctuate widely and lead to extraordinarily complex vegetational development (See Raup, 1935).

CRETACEOUS FORMATIONS

Cretaceous rocks underlie most of the southwestern uplands of our region, comprised in the Caribou and Birch Mountain Plateaus as well as in the uplands around McMurray and the Clearwater River. They have been studied chiefly along the lower Athabaska and Peace Rivers, and in the valley of the Hay River. I shall make no attempt to describe the entire sections in these areas, but will mention only the formations immediately concerned with our region.

One of the most striking features of the landscape in the Clearwater–McMurray district is the thick deposit of "Tar Sand" that forms the bluffs along the rivers. It is a highly bituminous sandstone called the McMurray Formation (McLearn, 1917; Camsell and Malcolm, 1921), directly overlying the Devonian limestones. It is black in color and contains so much petroleum that on warm summer days it becomes viscous where exposed to the sun. Along the Athabaska just above McMurray it is overlain by gray or black shales and gray or green sandstones of the Clearwater Formation. This and four other Cretaceous formations are to be seen along the Athabaska within 75 miles above McMurray, and they have also been noted in the valley of Moose River, a small western tributary that comes into the Athabaska near McKay. These formations are the Grand Rapids Sandstone, Pelican Shale, Pelican Sandstone, and La Biche Shale.

On the Peace River at Vermilion Chutes are outcrops of the Loon River Shales which are correlated with the McMurray and Clearwater Formations of the Athabaska section (McLearn, 1918). Likewise on the Hay River Cameron (1922–B) has described marine shales that he has correlated tentatively with the Loon River Formation. Although the Caribou Mountain Plateau has not been explored by geologists, it is presumed to contain a Cretaceous section analogous to those of the Athabaska and Peace Rivers.

The full botanical significance of the Cretaceous uplands is not yet known. Their elevation must have a profound effect upon their climates, while their soils, whether glacial or residual, differ widely from those in other parts of our region. It is known that they harbour outliers of Cordilleran or foot-hill vegetation, and their northern and northeastern margins have already been noted as a prominent floristic boundary (Raup, 1930). Whether or not they were entirely covered by the latest advance of the Pleistocene ice remains to be checked. I have seen some clayey soils high on the eastern slopes of the Caribou Mountains that appeared to be residual. In any case the upper parts of the plateaus must have been the first land in our region to be exposed for plant cover after the retreat of the ice. By their height and position the Cretaceous plateaus had a large influence upon the direction of movement of the ice sheet, and subsequently upon the disposition of glacial and post-glacial deposits laid down at the retreat of the ice. The main features of these events, so far as they are known, will be brought out in the following discussion of Pleistocene history.

Pleistocene and Post-Pleistocene Geology

Although brief notes on the Pleistocene deposits of the Athabaska–Great Slave Lake region are to be found in nearly all the survey reports that have been published, attempts to fit the material into a consistent Glacial and post-Glacial history are rare. The most satisfactory to date is in a short paper by A. E. Cameron (1922–A) on post-Glacial lakes in the Mackenzie basin. In most of the discussion that follows I shall draw freely upon this paper, using also interpretations that I have made in connection with earlier work (1930–A, B, 1935).

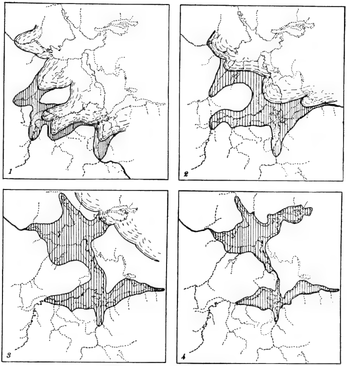

FIG. 3. Post-Glacial lake expansions in the Athabaska–Great Slave Lake region when the water, impounded against the front of the Keewatin ice sheet, stood at about the 1600-foot level (1), the 1100-foot level (2), the 800-foot level (3), and the 700-foot level (4). (Reproduced by permission of A. E. Cameron.)

The dating of the last advance and retreat of ice in this region is still problematical. According to earlier concepts, centers of glacial activity moved progressively from west to east around Hudson Bay (Tyrrell, 1898), so that the surface in our region would be older than those in Labrador and Quebec. In recent years, however, Antevs (1934, 1936, 1938) has proposed that the final event of the last, or Wisconsin, glaciation was a rejuvenation of the Keewatin and Cordilleran glaciers. Flint (1943) maintains, further, that the evidence from striae, upon which the old idea of a progression of centers was based, can be applied only to the late stages of glacial activity. He believes that there was a single continental ice mass on the occasion of each advance and retreat. In the event that either Antevs or Flint is correct, the land surfaces in our region, instead of being old in terms of post-Glacial time, would be among the youngest. As will be shown below, there is some biological evidence in support of this concept.

The Keewatin glacier is thought to have come into this region from the northeast, following drainage lines that had long been established in the Laurentian Plateau. These lines probably occupied depressions that now, much deepened, hold Athabaska and Great Slave Lakes (See Alcock, 1920, for a discussion of the origin of Lake Athabaska). The ice crossed the valley now occupied by Slave River and sent tongues into the Cretaceous uplands by way of the ancient valleys that had been carved out of them. The outlying Cretaceous plateaus are thought to have been sufficiently high and resistant to determine the direction of movement of the ice and to divide it into lobes. According to Cameron, "At least three definite glacial lobes are apparent in the area. One extending up the valley of Hay River; a second swung west, south of the Caribou Mountains, and probably sent tongues up the valleys of the Peace and Wabiskaw rivers; while a third lay in the basin of Athabaska lake with its tongue pointing up the valley of Athabaska river."

A correlation of this ice advance with one of the three now commonly recognized for Wisconsin time (Iowan, Tazewell-Carey, Mankato) has not been definitely established. Rutherford (1941) and Bretz (1943) have outlined the terminal Late Wisconsin moraine in central Alberta and southern Saskatchewan. This is called the Altamont or Coteau, and is correlated with the Des Moines, Mankato, and Port Huron moraines farther to the southeast. It enters Canada at the Montana–North Dakota boundary, and extends northwestward in a slightly arcuate pattern so as to cross the North Saskatchewan River about 75 miles east of Edmonton, Alberta. Halliday and Brown (1943) have drawn a provisional connection between a southern portion of this moraine in Saskatchewan and the lobate ice front proposed by Cameron in the Athabaska–Great Slave Lake region. They have carried the hypothetical moraine northward entirely within the province of Saskatchewan, whereas, according to Rutherford and Bretz, it should continue northwestward into Alberta nearly to lat. 55°, northeast of Edmonton. If the latter is the case the extreme limits of the Late Wisconsin (W_3) glacial lobes in the southwestern part of the Mackenzie basin probably were farther up the Athabaska and Peace Rivers than Cameron placed them as dams for his 1600-foot lake (see below). In fact there is no evidence in Cameron's paper (1922–A) that he considered these to be terminal lobes. In any event it seems reasonable to look upon the lake stages and moraines in the Athabaska–Great Slave

Lake region as representing recessional stages of the Late Wisconsin (Mankato) ice, approximately equivalent to similar stages noted in Manitoba and Ontario.

As the fronts of the lobes receded, the waters from the upper basins of the Hay, Peace, and Athabaska Rivers were impounded against them to form large post-Glacial lakes. *Figure 3,* reproduced from Cameron's paper, will show the approximate boundaries of the lakes and ice lobes at the four stages. From studies of terraces in the valleys of the main rivers, elevated shore lines on the great lakes, and from the results of meridional and base-line surveys and the distribution of moraines, Cameron has designated four of these ancient lakes, formed successively at levels which are now about 1600 feet, 1100 feet, 800 feet, and 700 feet above the sea. Outlets for at least the earlier of these lakes were probably toward Hudson Bay, since the normal route to the Mackenzie valley would have been blocked by ice.

The lowest of the lake stages is at approximately the same level as modern Lake Athabaska (699 feet). It will be noted that at this time there were probably long extensions of this lake southward into the lower Athabaska valley, westward up the Peace, and northward down the Slave. Great Slave Lake was somewhat larger than it is now, with a long southern arm that probably reached to the present site of Fort Smith. The lake may have been somewhat lower than Lake Athabaska then, as it is now (495 feet). The Athabaska and Peace Rivers are huge streams, rising in the Rocky Mountains and bearing heavy loads of debris. In the interval since the drainage of the 800-foot lake they have filled the southern, western, and northern arms of Lake Athabaska with alluvium, and have completely eliminated the southern arm of Great Slave Lake. In doing so they have formed most of the Mackenzie Lowland physiographic province in our region (for further discussion of these great alluvial deposits see Kindle, 1918).

From the above notes it will be seen at once that most of the soils and surfaces in the Mackenzie Lowland and Alberta Plateau Provinces, as well as those on the slopes if not the summits of the Cretaceous plateaus, acquired their modern form as a result of late Glacial and post-Glacial events. From southwest to northeast on the Alberta Plateau there are at least four recognizable surfaces that are progressively younger in that direction. They are covered by fine-textured lacustrine soils interspersed with morainic ridges and outwash laid down as the successive ice fronts receded. Above the four is the still older surface on the tops of the Cretaceous plateaus. The botanical significance of these surfaces in the Wood Buffalo Park has already been discussed at some length (Raup, 1935) and will not be duplicated here. Studies similar to those on the Wood Buffalo Park should be made in the country around the western arm of Great Slave Lake, particularly in the tract bounded on the east by the north and west arms and on the west by the Horn Mountain plateau.

The phytogeographic importance of Pleistocene erosion and deposit in the Laurentian province is fully as great as over the Paleozoic and younger rocks, but in quite different terms. The complete removal of residual or earlier morainic soils from most of the surface, without any large or continuous deposits by the ice as it receded, has given the region much of its sterile aspect. The excavation of countless small and large depressions, the disruption of old drainage patterns, and the removal of the fine materials which, carried by streams, could act as eroding agents, have served to accentuate the sterile condition and to retard for a long period the development of integrated drainage systems. At the same time there has been a phenomenal development of lake and pond shore vegetation, resulting in wide expanses of muskeg and swamp.

Of great interest in the problem of vegetational development are time and space relations analogous to those west of the pre-Cambrian boundary. The present shores of Athabaska and Great Slave Lakes are subtended by complex systems of ancient shore lines reaching hundreds of feet above the present lake levels. At Charlot Point on the north shore of Lake Athabaska I have measured them up to about 200 feet, and Stockwell (1932) has found them 540 feet above the eastern end of Great Slave Lake (See also Blanchet, 1926). Not only has the fall in water levels made possible a series of successional stages in the development of vegetation on the main lake shores, but it also caused a time sequence in the development of upland pond and ridge vegetation.

If Cameron's disposition of the ice lobes at his various lake stages is correct, then approximately the western half of Lake Athabaska and large areas of the Laurentian plateau north and south of it were under the 1100-foot lake. At the same time Great Slave Lake and most of the Laurentian Plateau north of Lake Athabaska were still under ice, while a vast area of the Athabaska sandstones south of the 1100-foot lake was exposed. Except for the last, therefore, no part of the Laurentian Plateau in our area was finally exposed for the development of its modern vegetation until after the drainage of the 1100-foot lake and the next retreatal stage of the ice. Even then, according to Cameron, the McLeod and Christie Bay areas of Great Slave Lake were still under the ice. It is presumed that when the lake reached its 800-foot stage most of the Tazin and Taltson and upper Thelon basins between Athabaska and Great Slave Lakes were exposed. This would make their present surfaces of about the same age as the Alberta Plateau in the western part of our area. Pre-Cambrian areas just east of the north arm of Great Slave Lake would be of about the same age, but the exposure of the region around McLeod and Christie Bays, as well as the Lockhart basin, would date from the drainage of the 800-foot lake and the further retreat of the ice front, and so would not be much older than the alluvial deposits of the lower Athabaska, Peace, and Slave Rivers. There is an apparent inconsistency in the high ancient shore-lines at the eastern end of Great Slave Lake, for they extend far above 100 feet. This, however, is considered due to differential uplift following the retreat of the ice to the northeastward (See R. Bell, 1900;

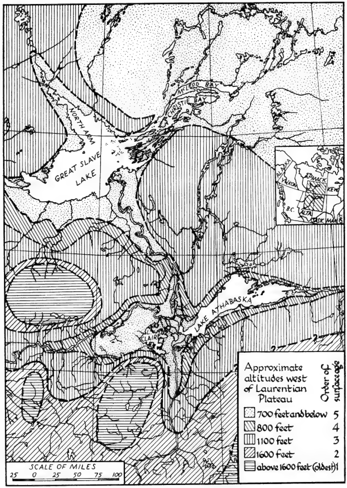

FIG. 4. Map showing the relative ages of land surfaces in the Athabaska–Great Slave Lake region, with approximate altitudes in the area west of the Laurentian Plateau.

Cameron, 1922–A, B; and Raup, 1930–A, for discussion of ancient shore lines at Great Slave Lake). If such an uplift has occurred since the drainage of the 800-foot lake and the recession of the ice from McLeod and Christie Bays, then the surfaces immediately around these Bays, and possibly also parts of the Lockhart basin, are still younger than the Mackenzie Lowland alluvium.

Following the hypothesis just outlined, therefore, the oldest surface in the Laurentian Plateau is probably somewhere in the upland country south of Lake Athabaska. It would correspond in age possibly to the bottom of the 1600-foot lake. Next would come the area between and around the two great lakes except for the eastern part of Great Slave Lake and the Lockhart basin. It would correspond in age to the Alberta Plateau surface. Third would be the strip of country, comparatively narrow, around Lake Athabaska. It would be of about the same age as the bottom of the 800-foot lake which is now occupied by the "Salt Plain" southwest of Fort Smith, and which has extensions in the lower Peace and Athabaska valleys as well as below the Alberta Plateau escarpment south of Great Slave Lake. Fourth in age are the uplands around McLeod and Christie Bays and the Lockhart basin, which would be of about the same age as the Mackenzie Lowland; and finally there would be the most recent surfaces, exposed around the eastern arm of Great Slave Lake by differential uplift. Some vegetational evidence for such a sequence will be found in subsequent discussions, but more exploration is necessary before conclusions can be reached. This is especially true for the country between the Clearwater River and Lake Athabaska, and between the latter and Great Slave Lake. *Figure 4* is a map on which I have attempted to show areas of approximately equal age. Some light eventually may be thrown upon the more recent changes of water levels in Great Slave Lake by a study of the extensive peat deposits which occur near the head of the Mackenzie River. Some of the islands at the western end of the lake appear to be composed entirely of peat, remnants of an ancient muskeg area that has been for the most part eroded away in old river channels or by wave action.

CLIMATE

An adequate description of the climates of the Athabaska–Great Slave Lake region is at present beset by well-nigh insurmountable difficulties. Most of the published meteorological data, like those on other natural phenomena, have come from the older fur-trade settlements along the main routes of travel. Observations in the Laurentian Plateau, therefore, are exceedingly scanty, and for most of that area there are only miscellaneous notes made by travelers. Observations made in connection with air navigation have not yet become available, but it is hoped that they will greatly enlarge our knowledge of the climate of the whole region. Even if we had adequate meteorological observations, there would still be difficult problems of interpretation. The relation, for instance, between summer precipitation and soil moisture, expressed in terms of its significance to plant growth, is complicated by soil-frost phenomena and low air temperatures. Evaporation data, now non-existent, will be needed before these problems can be attacked. Furthermore, this appears to be a region of steep micro-climatic gradients which need to be recorded and analyzed before the climate of the area as a whole can be understood.

In general the region has a northern continental climate, with long cold winters, short comparatively warm summers, and low annual precipitation. It is further distinguished from more southern districts by its long summer days (See Koeppe, 1931, pp. 1–5).

TEMPERATURE

Table of Temperatures (degrees F.) Averaged over a Period of Ten Years, 1917–1926

		Chipewyan	Fort Smith	Resolution	Hay River
Monthly mean minimum	Jan.	−19.6	−24.0	−22.4[1]	−22.4
	July	51.1	46.7	51.2	50.0
Absolute minimum	Jan.	−49.0	−53.9	−47.9[1]	−49.4
	July	35.3	33.3	40.0	38.4
Monthly mean maximum	Jan.	− 2.1	− 7.5	− 8.6[1]	− 4.3[2]
	July	72.8	72.8	68.6	68.1
Absolute maximum	Jan.	26.2	19.2	15.5[1]	25.1[2]
	July	86.4	88.1	83.4	86.8

[1] Averaged over seven years (1920–26) due to lack of records.
[2] Averaged over nine years, records for 1918 being absent.

Of particular significance to the growth of plants are the lengths of summer frost-free periods, the rates of seasonal progression, and the incidence of soil frost. Very few data have been compiled on the average lengths of frostless seasons. To be truly significant, such data should be gathered in specific areas over periods of years, with observations not confined to actual minimum temperatures but including local effects upon growing plants. In the absence of such information we must be content with minimum temperature data recorded at weather stations; and we must use them with the understanding that microclimatic variations in local situations around the various stations may be so great that the data do not present average local conditions. Albright's findings at Beaverlodge, in the upper Peace River region (1933), will serve to illustrate this point, and probably could be duplicated in many places throughout our area. He found that the length of the frost-free season on the top of a hill 134 feet high was about 96.7 days (averaged over a three-year period), while in a slough at the foot of the hill it was only 29.3 days.

Average frost-free periods have been computed from absolute minimum temperatures of 32° F. or below for McMurray, Fort Chipewyan, and Vermilion. The averages are from records for nine years at McMurray and Chipewyan, and for eight years at Vermilion (Raup, 1934). McMurray shows an average frostless season of about 65 days, Fort

Chipewyan 72 days, and Vermilion 79 days. The amount of variation in the length of the seasons during the same period is perhaps of greater significance than the average. At McMurray the longest was 101 days and the shortest only 29 days. Corresponding figures for Chipewyan are 106 days and 58 days, and for Vermilion 104 and 48 days. Further evidence that the growing season is apt to be short or interrupted comes from data gathered over longer periods. July can be regarded as the warmest month of the summer, yet minimum temperatures of 32° F. or lower were recorded in July at Chipewyan nine times in the forty-five years between 1884 and 1928, five times at Vermilion between 1905 and 1928, and six times at Fort Smith between 1913 and 1928. Such low temperatures are much more common in June and August. In forty-five years' records at Chipewyan they were recorded twenty-eight times in June and twenty-four times in August. At Resolution, where July minima of 32° did not occur at all between 1914 and 1928, the June minima fell to 32° or below thirteen times, and the August minima twice. Even from these scanty figures it is clear that the summer frostless season is short and extremely hazardous. It centers in July, but over most of our region frost may occur even in this month.

The above data suggest that the large lakes have an ameliorating influence upon temperatures in their immediate surroundings. The monthly mean and absolute minimum and maximum temperatures for January and July given in the table indicate that in winter lower temperatures are experienced at Fort Smith and Vermilion than at settlements on the lakes, and cool periods in summer reach lower temperatures inland than on the lakes. It has already been noted that Resolution shows no July minima as low as 32° for the period studied, while Hay River shows only one in the long period between 1893 and 1928. Next to the Great Slave Lake stations is Chipewyan, but this is at the narrow western end of Lake Athabaska where the water is shallow.

The opening of spring near the lakes is conditioned to a considerable extent by the dates at which the lake ice finally disappears. The effects are seen in the figures for June and August minima. The ice usually leaves Lake Athabaska during the first half of May, but it commonly remains in Great Slave Lake until late June. Minima of 32° or below occurred at Chipewyan about an equal number of times in June and August, while at Resolution they occurred thirteen times in fifteen years during June, and only twice in August. At Great Slave Lake, therefore, the frost-free season is not only longer, but comes later in the season.

The dates of opening and closing of rivers and lakes have been recorded for many years in the north, for they set the time limits of summer travel. The lower reaches of the Athabaska and Peace Rivers usually open about the first of May, but the western part of Lake Athabaska is not free of ice until about May 10th. Floes of ice blown to and fro by the wind may remain in the lake until mid-June. In the fall the shallow western end commonly freezes over about mid-October, but at Fond du Lac not until about the middle of November. Some of the wider and deeper parts of the lake are open until well into December (Alcock, 1936). There is considerable variation in these dates from year to year, as pointed out by Kindle (1920).

Blanchet (1926) gives the following dates for the disruption and setting of ice at several places on Great Slave Lake: Resolution, June 1 to 20, October 15 to November 15; Rae, May 25 to June 15, October 5 to 25; Old Fort Reliance, June 25 to July 5, October 1 to 20. The upper Mackenzie River usually opens between May 5 and May 20, and sets again in the latter half of November. Lakes in the Lockhart basin are commonly not completely free of ice until late July, and set again in October or late September (Clarke, 1940).

The vegetation in the Wood Buffalo Park usually has its spring aspect well developed during the first week of June. At that time the early *Pulsatilla ludoviciana* is rather past the height of its flowering and *Calypso borealis* is in its best development. The upland areas, away from the main rivers, are apt to be several days later in the growth of their spring flora than the lowlands. The autumn is usually reckoned to begin about mid-August, and frosts are likely to be frequent after that date. The fall flora, typified by the goldenrods and asters, and by the ripening of the fruits of raspberries, dogwoods, roses, mooseberries, and blueberries, is well advanced by the third week in August. Throughout the season there is a notable "telescoping" of the seasonal aspects of the flora. *Calypso* has been found in flower as late as June 26, and goldenrods as early as July 19.

One of the most significant effects of the subarctic climate, biologically speaking, is soil frost. A permanently frozen condition in some kinds of subsoil, and the comparatively short season during which the surface layers are thawed, greatly influence the distribution of plants by limiting root development, maintaining high water tables, affecting the nature of the drainage, slowing down the processes of humus formation and the maturation of soils, and by allowing only a short period in the year for erosion and deposit. There are also the effects of solifluction upon the development of vegetation, now and in the past. Very few data have been gathered with which to attack any of these problems in our region, so that the whole field remains to be investigated.

Solidly frozen ground was found at a depth of about five feet on a cleared bank of the Slave River early in August, and at 37 inches in an open prairie near the base of the Caribou Mountain Plateau on June 26. It was found one foot beneath the surface on an exposed sunny hillside high in the Caribou Mountains on July 12. On the other hand a pit six feet deep in a sand plain on the north shore of Lake Athabaska in July showed no frost at all. Lefroy (1886) reported the ground thawed to about 4 feet in summer at Fort Rae, and to eleven feet at Fort Simpson on the Mackenzie. Preble (1908) states that "In excavating a cellar on a sandy ridge in the midst of a field [at Fort Simpson] on July 21, 1903, frozen ground was reached at a depth of seven feet. In October, 1903, an excavation made in the yard of a dwelling house revealed frozen ground at seven feet." Richardson (1851) reported a thawed layer ten feet seven inches deep in "a heavy mixture of sand and clay" at Simpson in 1836. McConnell states that "Around Great Slave Lake the soil seldom thaws out to a greater depth than eight feet, and in many of the muskegs and marshes ice remains throughout the year at a depth of about two feet." Richardson (1828) says that the soil at Fort Franklin, on Great Bear Lake, did not thaw deeper than 21 inches in the summers of 1825 and 1826.

The permanently frozen subsoil tends to lessen the amount of seepage and to increase the run-off. In poorly drained areas it encourages the widespread development of muskegs, with their typical vegetation of plants suitable to acid soils. The low temperatures and acid conditions render very slow the successive movements in the development of vegetation which are dependent upon chemical and physical changes in the soil. Such movements, also, which follow topographic change and the formation of new barren areas for colonization by plants, are greatly retarded by the shortness of the season available for erosion and deposit. These retarding influences are especially significant in a study of the probably young vegetations just beginning their development upon land surfaces recently exposed in the Athabaska–Great Slave Lake region.

The effects of frost as a soil-forming and soil-disturbing agency are not readily seen in most parts of this region, though they must have had a large influence upon the early stages of the vegetation. How great this influence was, and how long it lasted, are as yet unknown. Newly formed soils on the limestone hills in the Laurentian region have undoubtedly been derived from rocks disintegrated at least in part by frost action.

As will be shown in another part of this paper, there seems to be a relationship between the ranges of certain trees and the depth to which the ground thaws during the growing season. Sandy soils that thaw deeply will support plants that require a deep tap root, while heavier soils and muskegs in which frost remains near the surface throughout the year preclude the growth of such plants.

Precipitation

Total precipitation for the year in the western part of our region (rain plus snow reduced to a water equivalent) probably averages between ten and fifteen inches (Koeppe, 1931, p. 109). Alcock estimates that it is about thirteen inches around Lake Athabaska, and Koeppe (ibid.) gives average totals of twelve or thirteen inches for Chipewyan and Vermilion. According to Connor (1938) it is about 11.3 inches at Hay River. A considerable part of this is in the form of snow. Yearly snowfalls, averaged over ten years (1917–1926), are as follows: Chipewyan, 53.3 inches; Vermilion, 34.3 inches; Fort Smith, 37.3 inches; Hay River, 45.4 inches; Resolution, 50.6 inches.

Rainfall during the months of June, July, and August is probably the most important element in the precipitation so far as plants are concerned. Soil moisture in spring is abundant due to melting snow; but in summer the lighter upland soils become droughty, and rain must supply the needed moisture. Heavier soils, having a higher permanent frost line, commonly remain moist throughout the year in spite of very low summer precipitation. The following statement shows some average rainfall totals for June, July, and August.

Average in inches: McMurray, 7.08; Chipewyan, 5.3 (43 yrs.); Fond du Lac, 5.29 (8 yrs.); Vermilion, 6.05 (22 yrs.); Fort Smith, 5.36 (9 yrs.); Resolution, 4.11 (10 yrs.); Hay River, 4.9 (10 yrs.).

From these few figures it is clear that summer rainfall is extremely low throughout our region. It seems to be greatest at "inland" stations, away from the shores of the main lakes, and progressively lower from south to north. No data are available for the eastern end of Great Slave Lake, but it is to be presumed that the rainfall decreases in that direction also. It is about 3 inches at Coppermine on the Arctic coast, and about 4.7 inches at Simpson (see Connor, 1938). By way of contrast, rainfall in June, July, and August at Edmonton in central Alberta totals about 9 inches. A more reasonable comparison is possible if a longer growing season is allowed for the Edmonton area, including May and September and making a total summer rainfall of about 12 inches.

It may be said, therefore, on the basis of the scanty climatic data at hand, that the climate of our region "deteriorates" from south to north, or more probably from southwest to northeast. Summer rainfall decreases in that direction, and the open seasons are progressively shorter. The large bodies of water tend to ameliorate temperatures in their vicinity, and at the same time tend to make the open season somewhat later in the northern districts than farther south.

TYPES OF VEGETATION IN THE ATHABASKA–GREAT SLAVE LAKE REGION

Types of vegetation in the Athabaska–Great Slave Lake region fall naturally into five categories: forest, marsh or muskeg (including various shore line communities), grassland, lichen-heath communities, and dune scrub. The following is an outline of types to be treated in this and ensuing papers (see map, *Fig. 5*).

1. Forests
    - White spruce
        - Park-like white spruce
        - Flood plain spruce
        - Upland mesophytic spruce
    - Jack pine
    - Balsam fir–white spruce
    - Black spruce–lodgepole pine
    - Bog forests
2. Shore and muskeg vegetation
    - In ponds and small lakes
    - On the shores of larger lakes
    - River flood plain and delta communities
3. Grassland
4. Lichen-heath
5. Dune scrub

The forest is predominantly coniferous, and it is bounded at the northeast by arctic tundra which appears in the Lockhart basin. Marsh and muskeg are of wide occurrence over the entire area, due not only to the immature condition of drainage systems, but also to the presence of a permanently frozen subsoil which keeps the water-table relatively high. There is a concentration of grass and sedge marsh in the deltas of the great rivers, such as the Peace, Athabaska, and Slave, while muskegs are more extensively developed on the uplands. Grasslands are mainly confined to the gently sloping lacustrine soils of the country west of the Slave River, but counterparts of them have been described in the region northwest of Great Slave Lake and in the Liard River country. Modified grasslands have also been found associated with certain soils on the north shore of Lake Athabaska. Lichen-heath covers vast areas of rock outcrop and sand plain. It is one of the most characteristic vegetation forms of the entire region, varying from associations of crustose lichens, interspersed with a few mosses, to thick masses of fruticose species with or without mats of trailing heaths or heath-like plants. Dune scrub occurs on the larger sandy beaches, but it is best developed on the great shifting dunes which are found south of Lake Athabaska.

Most of the more mesophytic forests surrounding Athabaska and Great Slave Lakes are of white spruce (*Picea glauca*) and jack pine (*Pinus Banksiana*). The relations between these will be discussed in more detail in another place, but some further notes on the divisions of the white spruce forests are in order. These occur in three phases which are geographically rather distinct. On the river flood plains of the Athabaska, Peace, and Slave Rivers the trees grow to large size (75–100 feet high and 2–3 feet in diameter), and in close, nearly pure stands. The undergrowth is relatively thick, but the ground flora is sparse, with a relatively thin carpet of mosses. Closely related to this type is that of the better-drained soils on the uplands. Here the stands are not quite so dense, and the undergrowth is thinner. The ground is covered, however, with a mat of mosses and duff 4–10 inches thick. The trees themselves are often larger than those of the flood plains. The third phase of the spruce forests is quite different, consisting of open park-like stands with practically no undergrowth. The ground is usually covered with a lichen-heath mat, and the soils are usually light and sandy. This type is best developed in the northeastern part of the lake region, but representatives of it are occasionally met with in the regions west of the Slave River and about Lake Athabaska.

Muskeg forest throughout the region is distinguished by black spruce (*Picea mariana*) and larch (*Larix laricina*). The former is by far the more abundant and often forms thick, nearly pure stands.

Two other types of forest, not widely spread in our area, are those of balsam fir (*Abies balsamea*) and white spruce, and those of lodgepole pine (*Pinus contorta* var. *latifolia*) and black spruce. These occupy, respectively, the flood plains of the lower Athabaska and Clearwater Rivers, and the higher slopes of the Caribou Mountains.

The semi-open prairie or parkland vegetation of the Wood Buffalo Park is characterized by abundant stands of trembling aspen (*Populus tremuloides*) which are locally known as "poplar bluffs," and which margin and subdivide the grassland areas. Whether these are stable types of forest is uncertain, since the aspen most commonly follows fire on the lighter upland soils in this region. Also, some prairies which are margined by white spruce have been described at the base of the Caribou Mountains (Raup, 1935). The prairies themselves occur in several phases, ranging from xerophytic types on dry south-facing bluffs to wet types on poorly drained uplands.

Shore vegetation is extremely variable throughout the region, but it can be subdivided roughly, for purposes of description, into the communities of ponds and small lakes, those on the shores of larger bodies of water such as Athabaska and Great Slave Lakes, and those of local river deposits and delta plains.

FORESTS

Park-Like White Spruce Forests

Great Slave Lake

The park-like spruce forest which grows about the eastern arm of Great Slave Lake may be divided into four phases which intergrade freely. They are developed most extensively on the ancient lake beaches and sand plains that abound in this district, and the variations in the content, density, and relative mesophytism of their flora are determined largely by the nature of the substratum. The most xerophytic type inhabits stony beach ridges whose water-holding capacity is extremely low. Such ridges contain almost no fine materials. Somewhat more mesophytic is the sand plain type which is the commonest association at Old Fort Reliance. Between this and the stony ridges in degree of mesophytism are old beaches formed of small flat pebbles weathered out of slates which occur near the tip of Fairchild Point (see Stockwell, 1933). These pebbles disintegrate rapidly under the influence of wave action and subsequent weathering to form a clayey admixture to the otherwise very permeable soils. At the other end of the scale of mesophytism are the rocky hills with their crevice floras. In some places, particularly on the metamorphosed sedimentary rocks of Fairchild Point, considerable residual soil has accumulated and supports an open but relatively rich forest of spruce. Some of the higher sand plains whose timber has not recently been disturbed by fire have also developed a considerable humus layer which also supports rather rich woods.

The trees in the park-like spruce forest are widely spaced and branched all the way to the ground. There is little or no shrubbery, but the soil is frequently covered with a dense growth of bunch lichens and mat-forming shrubs. The following list is typical of the timber which is common on sand plains.

PRIMARY SPP.: *Picea glauca*,[1] *Betula papyrifera* var. *neoalaskana*, *Cladonia rangiferina*, *Cladonia alpestris*, *Cetraria islandica*.

SECONDARY SPP.: *Juniperus communis* var. *montana*,[2] *Calamagrostis purpurascens*, *Salix Bebbiana*, *Betula occidentalis*,[3] *Pulsatilla ludoviciana*, *Saxifraga tricuspidata*, *Geocaulon lividum*, *Empetrum nigrum*, *Epilobium angustifolium*, *Arctostaphylos Uva-ursi*, *Vaccinium uliginosum*, *Vaccinium Vitis-Idaea* var. *minus*, *Pedicularis labradorica*, *Solidago multiradiata*.

Empetrum and *Arctostaphylos Uva-ursi* are the commonest mat plants.

On sandy ridges, particularly those exposed to storm winds, the surface of the soil is likely to be partially barren of vegetation, and the habitat in general much drier. Here the trees are farther apart, and *Empetrum nigrum* becomes a primary member of the ground flora, acting as a sand-binding agent. Another species which must be considered of first importance on the ground is the psammophilous lichen *Stereocaulon paschale*. It covers extensive areas, and its thallus is fairly impregnated with drifting sand. The secondary species are much the same as those noted above, but they occur in smaller numbers. *Poa glauca*, *Artemisia borealis*, and *Oxytropis splendens* appear occasionally to represent the more xerophytic habitats of the dry sand beach ridges.

Where the spruce woods grow on stony plains and beach ridges, the more xerophytic phase, to be found usually near the lake shore, contains a group of species suggestive of rock crevices or shingle beaches. The surface of the ground is fairly well covered in the depressions between the ridges by lichens (*Cladonia* spp., *Cetraria* sp.) and a mat of *Dryas*. Both *Dryas integrifolia* and *D. Drummondii* function in this manner, but the first is more abundant. *Arctostaphylos Uva-ursi* forms a few mats, and *Calamagrostis purpurascens* is one of the more common herbs. The following list will indicate the general structure of this flora (see also *Plate 1*).

PRIMARY SPP.: *Picea glauca*, *Cladonia* spp., *Cetraria* sp., *Dryas integrifolia*.

SECONDARY SPP.: *Juniperus communis* var. *montana*, *Calamagrostis purpurascens*, *Saxifraga tricuspidata*, *Dryas Drummondii*, *Potentilla nivea* var. *subquinata*, *Hedysarum alpinum* var. *americanum*, *Oxytropis viscidula*, *Shepherdia canadensis*, *Arctostaphylos Uva-ursi*, *Erigeron compositus* var. *trifidus*, *Solidago multiradiata*.

At slightly higher levels, farther away from the lake shores, this rather simple and open association gives way to a much denser one which resembles the drier sand plain flora described above. The ground is covered on both ridge and depression surfaces. *Arctostaphylos Uva-ursi* increases in prominence as a mat plant at the expense of *Dryas*, and the bunch lichens cover relatively more surface. A few species are added

[1] In this and the following discussions of forest types *Picea glauca* is considered in its broad sense, as it was in the published Catalogue. It should be understood, however, that our region appears to contain both the typical eastern form and the western var. *albertiana*, inseparably mixed in most cases but possibly segregated in others. For a discussion of these forms and their distribution see p. 73.

[2] *Juniperus communis* var. *saxatilis* of some recent authors, non Pall.

[3] *Betula microphylla* of the Catalogue. See Rhod. 47: 313–317. 1945.

to the list of secondary ones: *Geocaulon lividum, Arctostaphylos rubra, Empetrum nigrum, Arnica lonchophylla,*[4] and *Habenaria obtusata.*

A more mesophytic forest, closely resembling that of the higher sand beaches and plains described above, develops on the higher stony ridges. There is a thick carpet of woodland mosses with a rich growth of *Empetrum nigrum, Arctostaphylos rubra, Peltigera canina,* and *Vaccinium Vitis-Idaea* var. *minus.* Patches of *Vaccinium uliginosum* appear, and *Pedicularis labradorica* is common. In places a distinct low shrub layer is formed of *Vaccinium uliginosum, Ledum groenlandicum, Ledum palustre* var. *decumbens,* and *Alnus crispa.* With the increase in mesophytism a number of additions are made to the occasional flora of the association:

Equisetum scirpoides, Equisetum pratense, Tofieldia palustris, Cypripedium passerinum, Calypso bulbosa, Arenaria lateriflora, Aquilegia brevistyla, Rosa acicularis, Pyrola secunda, Pyrola virens,[5] *Pyrola asarifolia* var. *incarnata, Gentiana Amarella, Linnaea borealis* var. *americana, Senecio cymbalarioides* var. *borealis.*

To summarize, the park-like spruce forest on beaches and sand plains of Great Slave Lake may be described as an open stand of *Picea glauca* with or without an admixture of *Betula papyrifera* var. *neoalaskana.* The latter is commonest on sand, while the pure spruce is usually on stony soils. In its most mesophytic phase the timber has a thick mat of woodland mosses and lichens and a low shrub layer in which *Vaccinium uliginosum, Vaccinium Vitis-Idaea, Empetrum nigrum, Ledum groenlandicum, Ledum palustre* var. *decumbens, Betula occidentalis,* and *Arctostaphylos rubra* are prominent. More xerophytic phases, whether on sand or shingle, have the trees more widely spaced, the mosses largely replaced by bunch lichens, and the shrub layer reduced to mat-forming plants such as *Empetrum nigrum, Arctostaphylos Uva-ursi, Dryas integrifolia,* and occasional bushes of *Juniperus communis* var. *montana* or *Betula occidentalis. Empetrum* and *Arctostaphylos Uva-ursi* are characteristic of sandy substrata, and *Dryas integrifolia* of stony surfaces. Secondary species are drawn from xerophytic rock crevice associations, all of which will be described further in another paper.

The most mesophytic forest seen by the writer on the eastern arm of Great Slave Lake closely resembles that described above. It occurs on those parts of the rocky hills of Fairchild Point which are not exposed to excessive storm winds, and which have the softer metamorphosed sediments as substrata. Here a thin residual soil has developed in post-Glacial time; and the subsurface drainage, due to the dip of the strata and the presence of soil, has been sufficient to prevent the development of true muskeg. *Viburnum edule,*[6] a characteristic species in rich woods about Lake Athabaska and in the great river lowlands, appears in this upland forest though it is otherwise rare at the eastern extremity of Great Slave Lake. Like other mesophytic spruce forests of our region, this one

[4] *Arnica chionopappa* of the Catalogue. See Brittonia 4: 428–30. 1943.

[5] *Pyrola chlorantha* of the Catalogue. See Rhod. 43: 167. 1941.

[6] *Viburnum pauciflorum* of the Catalogue. See Rhod. 43: 481–483. 1941.

is exceedingly poor in species. It has two phases which are freely intermingled, and which appear to be due to alternating crevice and low ridge areas.

PRIMARY SPP.: *Picea glauca*. Ridges: *Arctostaphylos Uva-ursi, Linnaea borealis* var. *americana, Cladonia alpestris* and woodland mosses. Depressions: *Ledum groenlandicum, Vaccinium uliginosum,* woodland mosses.

SECONDARY SPP.: Ridges: *Calamagrostis purpurascens, Geocaulon lividum, Dryas integrifolia, Rosa acicularis, Epilobium angustifolium, Arnica lonchophylla, Senecio cymbalarioides* var. *borealis*. Depressions: *Empetrum nigrum, Vaccinium Vitis-Idaea* var. *minus, Arctostaphylos rubra, Viburnum edule*.

It will be noted that the ridge, or drier phase of this forest forms a transition to that of the sandy and stony surfaces described above. Also, it is obvious that the more mesophytic phases of the latter are almost identical with the depression phase on the rock hills.

Granite hills in the vicinity have a much poorer forest flora. It is limited to crevices and small glacial deposits, and most of the rock surface bears only lichens and occasional mosses. There is almost no residual soil such as appears on the old sediments, and depressions of any kind are likely to be entirely undrained. Muskegs, therefore, are much more extensively developed. Where an open forest does occur, moreover, it has more white birch in it than grows on the residual soils.

LAKE ATHABASKA

Park-like forests of white spruce are common on the shores of Lake Athabaska. Unlike those at the eastern end of Great Slave Lake, however, they do not usually spread over a broad series of ancient beaches and sand plains, but are confined to one or two ridges immediately above the present shore-line (*Plate 1*). Only two exceptions to this have thus far been observed: one on the conglomerates and dolomites of the north shore of the lake, and the other in certain sand dune habitats near the south shore. As a general rule one has only to pass over those ridges which occur just above the shore to be through the belt of spruce and into the jack pine. The actual elevation of the ridges above the level of the lake seems not to affect this arrangement in the least. Comparatively low, gently sloping sand beaches just west of Ellis Bay and at the base of Cornwall Bay have fully as well defined spruce belts as do the prominent south shore ridges which rise ten to twenty feet above the shore, or as the high spruce-covered sand ridge which forms the backbone of Sand Point.

These open spruce forests bear a close resemblance, both floristically and structurally, to the Great Slave Lake types. The trees are tall and spire-like, widely spaced, and branched from near the base of the trunk. The lower branches commonly rest upon the ground. The amount and nature of the ground cover depends on the degree of exposure and the nature of the substratum; and as on Great Slave Lake the latter may be divided into stony and sandy types. Since the latter are of wider occurrence they will be described first.

The most mesophytic of the sand ridge types are to be found along the south shore of the lake, where they occupy inter-ridge depressions and small plains whose ground surfaces are protected from strong winds and are relatively near the water table. In places such areas are only a few feet wide, while in others they are spread out over a hundred feet or more. They are usually widest where streams entering the lake have built small sand plains.

PRIMARY SPP.: *Picea glauca, Betula papyrifera* var. *neoalaskana, Vaccinium Vitis-Idaea* var. *minus*, woodland mosses.

SECONDARY SPP.: *Lycopodium complanatum, Lycopodium tristachyum, Lycopodium annotinum, Lycopodium obscurum* var. *dendroideum, Cypripedium acaule, Goodyera repens* var. *ophioides, Betula papyrifera* var. *commutata,*[7] *Alnus crispa, Geocaulon lividum, Sorbus scopulina,*[8] *Rosa acicularis, Epilobium angustifolium, Aralia nudicaulis, Cornus canadensis, Chimaphila umbellata* var. *occidentalis, Ledum groenlandicum, Vaccinium uliginosum, Vaccinium canadense, Trientalis borealis, Linnaea borealis* var. *americana, Cladonia rangiferina.*

It should be noted that these narrow belts of relatively rich woods harbor a considerable number of Cordilleran and eastern species rare or otherwise unknown in our region: *Lycopodium tristachyum, Cypripedium acaule,* and the western varieties of *Betula papyrifera, Chimaphila umbellata, Sorbus scopulina,* and *Trientalis borealis.*

Ridges exposed to lake winds have a more xerophytic phase of open spruce woods. The trees are farther apart, and the ground cover changes considerably in composition.

PRIMARY SPP.: *Picea glauca, Betula papyrifera* var. *neoalaskana, Empetrum nigrum, Arctostaphylos Uva-ursi.*

SECONDARY SPP.: *Pinus Banksiana, Oryzopsis pungens, Populus tremuloides, Geocaulon lividum, Prunus pennsylvanica, Epilobium angustifolium, Vaccinium Vitis-Idaea* var. *minus, Campanula rotundifolia, Cladonia rangiferina, Cetraria islandica, Cetraria nivalis.*

This association is one of the commonest in the beach ridge vegetation, and constitutes the first above the present shore which is sufficiently stabilized to carry a forest flora. There are scores of miles of it on the south shore of Lake Athabaska, and it occasionally appears on the north shore. *Vaccinium Vitis-Idaea* var. *minus* is sometimes associated with *Empetrum* as a primary species, the whole making a thick springy mat on the sand. The crowberry fruits so heavily in August that one's shoes or moccasins soon become soaked with the juice of the berries as he walks along the ridges. *Vaccinium uliginosum* sometimes forms thick clumps on what look like old dunes.

The lakeward margins of the association merge with the shore dune types to be described later. Patches of bare sand are being partially held by the actively spreading *Empetrum* and by the roots of a group of species characteristic of such habitats: *Festuca saximontana, Festuca rubra* var. *arenaria, Poa glauca, Calamagrostis purpurascens, Tanacetum huronense* var. *floccosum,* and *Stereocaulon paschale.* On the landward side the spruces give way more or less abruptly to the jack pine woods of the back country.

[7] *Betula papyrifera* var. *occidentalis* of the Catalogue. See Rhod. 47: 312. 1945.

[8] *Sorbus sitchensis* of the Catalogue. See Jour. Arnold Arb. 20: 16–22. 1939.

The high sand ridges which lie a short distance back from the lake shore are in many places being opened by wind action. The most effective winds come from the west and northwest. Gaps thus formed usually have steep faces, and in some places they have so broken up the ridges as to give them the appearance of rows of conical hills. Topography of this sort in a "fossil" condition is to be found many miles inland south of the lake. Where the ridges have but recently been broken, typical "blowouts" are to be seen back of them. The local jack pine wood is destroyed and characteristic dune vegetation appears. An outstanding vegetational feature of such activity is the development of open park-like woods of *Picea glauca* at the *western* sides of the blowouts. It makes only a narrow fringe between the open sand and the neighboring open pine woods. This was observed repeatedly near the south shore of Lake Athabaska and was studied in some detail in the vicinity of Wolverine Point. It is one of the few situations in which the park-like spruce wood has been found away from the actual shore of the lake. The large dune area which lies just east of Wolverine Point has an extensive development of it at the western margin of the open sand (see *Plate 2*).

PRIMARY SPP.: *Picea glauca, Cetraria nivalis.*

SECONDARY SPP.: *Betula papyrifera* var. *neoalaskana, Empetrum nigrum, Arctostaphylos Uva-ursi, Cetraria islandica, Cetraria cucullata,* other lichens.

The spruces are in an exceedingly open stand and are of all ages. Most of them appear to be thriving. Blowouts are frequent in the intervening spaces and bear a flora in which *Empetrum nigrum, Polytrichum* sp., *Hudsonia tomentosa* var. *intermedia,* and certain grasses are characteristic.

That the spruce woods are not permanent is evident from the fact that they do not occur on older blowouts which have become stabilized and forested entirely with jack pine. Furthermore, they do not appear until after the blowouts are started, since they are elsewhere confined to the actual lake shore ridges. There is considerable evidence that even at the margins of the dunes they do not occupy a given area for very long. In the ecotone between spruce and pine there are many young and vigorous spruces, but no young pines. In fact the pines are obviously being destroyed, acquiring in the process a peculiarly gnarled and stunted appearance in which the branching takes on a deliquescent effect, producing rounded irregular outlines to the trees. At the open margin of the spruce strip, on the other hand, old trees are occasionally seen which are still standing but apparently on stilts, with most of the sand blown away from their root systems.

Stony shore ridges have an open stand of white spruce and birch similar in general appearance to those on sand, but the ground flora is somewhat different. The most mesophytic forest thus far studied on this type of terrain is on the complicated series of shore ridges and ancient beaches on the north side of the lake.

PRIMARY SPP.: *Picea glauca, Betula papyrifera* var. *neoalaskana, Populus tremuloides,* woodland mosses, *Vaccinium Vitis-Idaea* var. *minus, Linnaea borealis* var. *americana.*

SECONDARY SPP.: *Equisetum scirpoides, Lycopodium complanatum, Cystopteris fragilis, Juniperus communis* var. *montana, Schizachne purpurascens, Poa glauca, Oryzopsis pungens, Calypso bulbosa, Salix Bebbiana, Betula papyrifera* var. *occidentalis, Alnus crispa, Geocaulon lividum, Arenaria macrophylla, Aquilegia brevistyla, Ribes oxyacanthoides, Mitella nuda, Saxifraga tricuspidata, Amelanchier florida, Rubus idaeus* var. *canadensis, Rosa acicularis, Prunus pennsylvanica, Shepherdia canadensis, Epilobium angustifolium, Cornus canadensis, Aralia nudicaulis, Pyrola virens, Arctostaphylos Uva-ursi, Lonicera glaucescens, Viburnum edule, Campanula rotundifolia.*

The similarity between this forest and the most mesophytic phases of the open spruce woods at the eastern end of Great Slave Lake is at once apparent. The considerable admixture of *Populus tremuloides* makes for somewhat denser woods, and is probably the result of fire.

Near the lake shore the timber is very thin and is confined to depressions between the ridges. *Picea glauca* and *Betula papyrifera* var. *neoalaskana* are still predominant, but the primary species on the ground are reduced to fruticose lichens: *Cladonia* spp., *Cetraria* spp. Common or occasional secondary species are as follows:

Juniperus horizontalis, Festuca saximontana, Poa glauca, Salix Bebbiana, Saxifraga tricuspidata, Amelanchier florida, Rubus idaeus var. *canadensis, Rosa acicularis, Prunus pennsylvanica, Epilobium angustifolium, Pyrola asarifolia, Arctostaphylos Uva-ursi,* mosses (few), *Stereocaulon paschale.*

Isolated stands of open spruce woods have been described in other parts of the subarctic forest by J. B. Tyrrell. His notes on some timber along the Dubawnt and Kazan Rivers (1898) indicate that it closely resembles that described above. In another report (1896) he has this interesting observation, "One small isolated grove of White Spruce was found on a high sandy island in Hatchet Lake, standing out conspicuously in the midst of the surrounding forest of small Black Spruce." Hatchet Lake is about 100 miles southeast of the eastern end of Lake Athabaska. The present writer has noted park-like white spruce in the Wood Buffalo Park (1935). There is a high sandy hill southeast of Lane Lake, about twenty miles west of the upper Slave River, which stands out prominently above the surrounding country. The jack pine of neighboring hills and sand plains disappears on its upper slopes where there is an open timber of white spruce. The ground cover is principally of lichens, *Cetraria nivalis, C. islandica, Cladonia alpestris,* etc., and some mat-forming heaths, *Arctostaphylos Uva-ursi* and *Vaccinium Vitis-Idaea* var. *minus*. Blanchet (1926–C) described forests on the shores of Nonacho Lake that appear to be of open spruce backed by jack pine. It is probable that these isolated outliers or remnants (see below) of the park-like spruce forest which now borders the Arctic tundra are occasional on sandy beaches throughout much of the jack pine country between Athabaska and Great Slave Lakes.

Summary of Park-like White Spruce Forest

Within the Athabaska–Great Slave Lake region an open, park-like forest of *Picea glauca,* often with the addition of *Betula papyrifera* var. *neoalaskana,* is widely distributed on ancient beach ridges and the lake shore terraces. Around the eastern end of Great Slave Lake it spreads to the surrounding uplands. Floristically it is rather uniform over the whole region, but locally it shows varying stages of mesophytism depending upon slope, exposure, and the character of the substratum. The most mesophytic phase usually shows a ground cover of woodland mosses, *Vaccinium Vitis-Idaea* var. *minus, Linnaea borealis* var. *americana,* and admixtures of *Vaccinium uliginosum, Ledum groenlandicum,* etc. More xerophytic phases on stony substrata have a ground flora derived largely from rock crevices, while those on sand are strongly influenced by sandy beach and dune floras.

Although most of the predominating species range throughout the whole region, the secondary species of the association change somewhat from north to south. The following species are occasional to common about Lake Athabaska, but have not been observed on the eastern arm of Great Slave Lake.

Lycopodium tristachyum, Lycopodium obscurum var. *dendroideum, Schizachne purpurascens, Oryzopsis pungens, Cypripedium acaule, Goodyera repens* var. *ophioides, Betula papyrifera* var. *commutata, Mitella nuda, Amelanchier florida, Sorbus scopulina, Prunus pennsylvanica, Cornus canadensis, Aralia nudicaulis, Chimaphila umbellata* var. *occidentalis, Arctostaphylos Uva-ursi* var. *adenotricha, Vaccinium canadense, Trientalis borealis, Lonicera glaucescens, Campanula rotundifolia, Tanacetum huronense* var. *floccosum.*

Although *Pinus Banksiana* has been noted on the portage route between Great Slave and Artillery Lakes, it is so rare toward the eastern end of Great Slave Lake that it cannot be considered an important part of the flora.

On the other hand a considerably smaller number of species of northern affinity in the open spruce woods of Great Slave Lake fail to appear in those on Lake Athabaska:

Tofieldia palustris, Cypripedium passerinum, Dryas integrifolia, Dryas Drummondii, Hedysarum alpinum var. *americanum, Oxytropis viscidula, Ledum palustre* var. *decumbens, Pedicularis labradorica, Solidago multiradiata, Erigeron compositus* var. *trifidus.*

Several of these northern species have been found on Lake Athabaska, but they are there strictly confined to muskegs. It is notable that over half of the northern species not found about Lake Athabaska are those which inhabit the more xerophytic phases of the spruce woods, while nearly all of the southern species that fail to extend north to Great Slave Lake represent the more mesophytic phases of the Lake Athabaska spruce. It is further notable that the richest forest on Fairchild Point — that on the tops of the hills formed of the softer sedimentary rocks — has no species which are not common on Lake Athabaska.

Two other differences between the Athabaska and Great Slave Lake types must be mentioned. One is the broad extension of open spruce woods away from the immediate shore of the lake in the more northern district. Similar situations about Lake Athabaska are invariably occupied by jack pine except at the western margins of active blowouts. The second is the failure of the open spruce forest to occupy the upper south slopes and tops of the hills of conglomerates and dolomites found on Lake Athabaska. As stated above, the richest forest of spruce at the eastern end of Great Slave Lake grows on such sites.

Wherever the shore-forming processes of the great post-Glacial lakes have had an opportunity to work upon the pre-Cambrian sedimentary rocks, they have produced distinctive types of ancient beaches and terraces. Where the Athabaska Series or other formations of coarse-grained sandstones and quartzites have been available, as on the south side of Lake Athabaska or in parts of the eastern arm of Great Slave Lake, extensive sand deposits have been developed. The few stony beaches on Lake Athabaska made of this material are on exposed points of land where actual outcrops of the shelving sandstones occur. On Great Slave Lake the open spruce covers these sandy areas, but at Lake Athabaska the jack pine has covered nearly all of the sand except on the immediate shore of the lake. Stony beaches, on the other hand, both ancient and modern, are characteristic of areas where conglomerates, dolomites, shales, and slates outcrop. They are nearly always occupied by open spruce woods, the jack pine having been unable, for some reason, to invade them. Even on the south shore of Lake Athabaska, where the white spruce grows only on the newest of the stony beaches, the older shores are occupied by black spruce rather than by pine.

Flood Plain White Spruce Forests

The higher parts of deltas and river flood plains in the valleys of the Peace, lower Athabaska, and Slave Rivers are covered with forests of white spruce and balsam poplar (*Populus Tacamahacca*). The most mesophytic of these are pure stands of tall, clean-boled spruce. As one travels along the rivers in small boats one gets the impression of looking into a dense forest of great areal extent (*Plate 2*). This is usually not the case, for the rich woods are limited to natural levees and eddy deposits. A complicated and extensive system of wet meadows often divides the forest into comparatively narrow strips, and the levees themselves are subject to destruction by the meandering of the rivers and by the silting up of the valley floors. Buried trunks and stumps, *in situ,* are commonly seen in newly cut banks, often many feet below the present surface of the land.

Changes in land surfaces and drainage go on so rapidly in river flood plains that it is difficult to think of their forests except in terms of successional development. Stages in these successions involving marshes and wet meadows will be described under shore vegetation (see also Raup, 1935, pp. 62–85).

Forming a transition from the shore and meadow vegetation to timber is a zone of willows. On local river flood plains the willow zone is usually narrow, but in the deltas it forms broad expanses of dense shrubbery. There are two types of succession among the willows, involving different species. At slough margins the first to appear is *Salix planifolia*. This is followed by *S. petiolaris,* and then by *S. Bebbiana*. Locally formed river sand-bars, on the other hand, begin with *Salix interior* var. *pedicellata,* which is followed by *S. lutea*. A zone of *S. lasiandra* sometimes occurs between these two. The culmination of the development here also is with *S. Bebbiana,* which persists into the forest and becomes a primary species in the shrub layer of the flood plain timber.

The first trees to appear are the balsam, or black poplars. Alders, *Alnus tenuifolia,* are usually associated with the upper willows and mark a transition to the poplar forest. The poplar association is widespread throughout the flood plains. It occurs in pure form or is merged with spruce in all sorts of combinations.

PRIMARY SPP.: *Populus Tacamahacca, Equisetum pratense, Salix Bebbiana.*

SECONDARY SPP.: *Picea glauca* (young trees), *Salix arbusculoides, Alnus tenuifolia,*[9] *Actaea rubra, Rosa acicularis, Rubus idaeus* var. *canadensis, Vicia americana, Epilobium angustifolium, Aralia nudicaulis, Cornus stolonifera, Pyrola asarifolia, Viburnum edule, Aster Lindleyanus.*

Although this list is not complete, it contains those species which are most characteristic, and it shows the trend of the forest toward mesophytism. Young spruces germinate in the shade of the poplars, alders, and willows, and gradually occupy larger areas. If undisturbed the dominance of the spruce becomes complete, so that pure stands of it are common along the rivers. With the coming of the spruces a loose mat of mosses is formed, and the herbaceous flora becomes exceedingly scant. The shrubs likewise form a thin undergrowth, although not so scant as that in the upland spruce wood. The general structure of the lowland spruce wood is shown by the following list:

PRIMARY SPP.: *Picea glauca, Salix Bebbiana, Viburnum edule, Cornus stolonifera.*

SECONDARY SPP.: *Equisetum pratense, Maianthemum canadense* var. *interius, Orchis rotundifolia, Goodyera repens* var. *ophioides, Habenaria obtusata, Alnus tenuifolia, Betula papyrifera* var. *neoalaskana, Geocaulon lividum, Actaea rubra, Mitella nuda, Ribes oxyacanthoides, Ribes triste, Rosa acicularis, Rubus pubescens, Rubus acaulis, Rubus idaeus* var. *canadensis, Fragaria glauca, Vicia americana, Shepherdia canadensis, Epilobium angustifolium, Cornus canadensis, Moneses uniflora, Pyrola secunda, Pyrola asarifolia, Mertensia paniculata, Linnaea borealis* var. *americana, Aster Lindleyanus.*

The spruce forest appears to perpetuate itself if not disturbed by fire, clearing, or by the destruction of the land surface upon which it stands. Young poplars do not come up in the mature spruce woods. A frequent mixture is one of vigorous spruces 75–100 feet tall with here and there an ancient poplar, nearly dead and with its top gone. When traveling or camping in the lowland woods one not infrequently hears the loud crack of an old poplar breaking up as it stands, and occasionally a tree is seen falling.

UPLAND MESOPHYTIC WHITE SPRUCE FORESTS

Vast areas on the rolling upland which lies along the lower Athabaska and lower Peace Rivers, and to the west of the valley of the Slave River, are dominated by forests of white spruce. These occur in their simplest form on the Alberta Plateau as it is represented in the Wood Buffalo Park. This is a morainic upland bounded on the east by the so-called Salt Moun-

[9] *Alnus incana* of the Catalogue. See Rhod. 47: 333–362. 1945.

tain Escarpment and on the west by the margin of the Caribou Mountain Plateau. Its soils are prevailingly light and sandy, although some heavier soils occur near its margins. The underlying rocks are limestones of Silurian and Devonian age, the former highly gypsiferous and giving rise to a characteristic sink hole topography.

The spruce timber is found chiefly on soils of medium drainage, which usually occur on the lower slopes of hills and in hollows where there is sufficient drainage to prevent the formation of muskegs. Such conditions are most abundant in the sandy outwash and morainic country which extends from a point a few miles north of Peace Point northward and northwestward beyond the Little Buffalo River. They are probably common also in the northern area of the Wood Buffalo Park between the Little Buffalo River and Buffalo Lake, and also in the morainic country which crosses the Jackfish River south of the broad muskeg region that surrounds Conibear and Thultue Lakes.[10] Parts of the eastern slopes of the Caribou Mountains are covered with a dense spruce forest, much of which is of small trees with an unusually scanty undergrowth.

In general the upland spruce woods have a comparatively small flora, with a much thinner undergrowth than occurs in the lowland forest (*Plate 3*). The mat of mosses and leaf-mould on the other hand is relatively thick, the former four to six inches deep and the latter as much as four inches. The secondary species are much scattered, and in places one may walk a hundred yards or more without seeing any other ground cover than the mosses. The following list will indicate the structure and composition of the forest:

PRIMARY SPP.: *Picea glauca, Salix Bebbiana, Hypnum Crista-castrensis, Hypnum Schreberi.*

SECONDARY SPP.: *Equisetum sylvaticum, Equisetum scirpoides, Lycopodium annotinum, Maianthemum canadense* var. *interius, Goodyera repens* var. *ophioides, Habenaria obtusata, Orchis rotundifolia, Corallorrhiza trifida, Calypso bulbosa, Betula papyrifera* var. *neoalaskana, Alnus crispa, Geocaulon lividum, Ribes lacustre, Ribes triste, Mitella nuda, Rosa acicularis, Shepherdia canadensis, Cornus canadensis, Arctostaphylos rubra, Pyrola asarifolia, Pyrola asarifolia* var. *incarnata, Pyrola virens, Pyrola secunda, Moneses uniflora, Linnaea borealis* var. *americana, Peltigera aphthosa.*

The spruce forests have been greatly altered by fires which have been of common occurrence from time immemorial. The main result has been the introduction of extensive stands of trembling aspen, balsam poplar, and jack pine. Aspen and pine commonly occur in pure stands, and all three appear in complex mixtures with the spruce. Studies of the effects of fire on the uplands of the Wood Buffalo Park have made it possible to designate three kinds of modification depending upon the intensity of the fire and the nature of the soils. A crown fire driven through a spruce wood by a high wind usually kills most of the trees, but it may do little damage to the moss and humus of the forest floor. In such cases the stand usually returns to spruce immediately, with the introduction of occasional pines, aspens, and

[10] Formerly known as Moose and Bog Lakes, respectively.

balsam poplars. A slower, more intense fire, on the other hand, not only kills the spruces but also spoils the chance of immediate spruce reproduction by killing off all young growth and scorching the moss mat beneath. This type of fire gives rise, on the better soils, to practically pure stands of trembling aspen, or to mixtures of aspen and pine. The aspen is a short-lived tree, which apparently does not reproduce itself when growing in dense stands. It is followed by a mixture of spruce and balsam poplar which appear in small clumps and eventually spread to cover the whole area. The poplar likewise fails to reproduce itself further and gives way to the pure spruce much as it does in the flood plain forests.

Well-developed aspen woods, with their occasional patches of spruce and balsam poplar are of wide occurrence on the uplands. Those of the Wood Buffalo Park closely resemble those of the uplands in the McMurray district except for the absence of certain species which will be noted below. The aspens form a close stand of trees fifty to eighty feet high, reaching twelve to twenty inches in diameter, with straight clean boles. A distinct shrub and young tree flora is formed mainly of willow, *Salix Bebbiana,* and sapling poplars or spruces. Other less common shrubs are *Shepherdia canadensis, Amelanchier florida, Rosa acicularis, Lonicera glaucescens, Viburnum edule,* and *Symphoricarpos albus* var. *pauciflorus*. The ground is covered with dead leaves and other plant parts, but there are almost no mosses and lichens. About thirty species of herbaceous plants occur, with none in very great numbers. The commonest is a grass, *Elymus innovatus,* which does not form a turf but is very common considering its woodland habitat.

Very intense burning on dry sites, or repeated burning at short intervals on the same site, completely destroys the plant cover. On the sandy uplands west of the Slave River this usually results in a dense pure stand of jack pine. The flora of the pine woods will be discussed in detail in another part of the paper, since it is of wide occurrence throughout the Athabaska Lake region and appears to be a primary element in the vegetation as well as a stage in the burn succession. In the latter it is apparently quite temporary and gives way directly to a pure spruce forest, sometimes without the interpolation of aspen and poplar. A commonly observed forest type is one of young vigorous spruces mixed with a scattered stand of decrepit and tottering old jack pines. With these is usually abundant evidence of burning in earlier times.

On morainic uplands in the southern part of our region, where the soils rest upon the Cretaceous strata that overlie the Paleozoic sediments, the spruce forest appears to have about the same general structure as that described above. However, just as the lowland forests here differ by the addition of the balsam fir and other eastern species, so also the upland forests are modified by the influx of a group of species which are rare or non-existent farther north. Here also the timber has been highly modified by fire, apparently in much the same manner as in the Wood Buffalo Park, with the incidence of great expanses of aspen and jack pine. The relation of the present timber to its developmental phases has not been studied, but there is a good deal of evidence that the successions are the same as those described above. S. H. Clark, after a forest reconnaissance of the upland northeast of Lac la Biche (1914), concluded that the small amount of spruce forest (less than one per cent in about 1650 square miles) was due to fire and the consequent development of the aspen. Furthermore he has described briefly, in his "poplar loamy-sand-ridge" and "poplar-birch-spruce lake-slope" types what are probably developmental stages in the burn succession, and he notes that in the second of these types "the tolerant spruce promises to play an important role in the development of the climax forest." It is of interest in this connection that Richardson, in 1851, wrote that the spruce was the predominant forest tree in the upland country along his routes north of the Saskatchewan.

The following list is compiled from notes made in the vicinity of Calumet Creek, Waterways, and McMurray in the summer of 1926, the spring of 1928, and the autumn of 1935, respectively.

PRIMARY SPP.: *Picea glauca, Populus tremuloides.*

SECONDARY SPP.: *Dryopteris*[11] *Linnaeana, Dryopteris spinulosa, Pteretis nodulosa, Lycopodium annotinum, Lycopodium obscurum* var. *dendroideum, Pinus Banksiana, Bromus ciliatus, Oryzopsis asperifolia, Oryzopsis pungens, Schizachne purpurascens, Hierocholoë odorata, Carex Deweyana, Carex siccata, Disporum trachycarpum, Lilium philadelphicum* var. *andinum, Maianthemum canadense* var. *interius, Habenaria viridis* var. *bracteata, Salix Bebbiana, Populus Tacamahacca, Alnus crispa, Alnus tenuifolia, Betula papyrifera, Betula papyrifera* var. *neoalaskana, Corylus cornuta, Comandra pallida, Arenaria lateriflora, Stellaria longipes, Anemone cylindrica, Actaea rubra, Mitella nuda, Ribes oxyacanthoides, Rosa acicularis, Rubus idaeus* var. *canadensis, Rubus pubescens, Fragaria glauca, Prunus pennsylvanica, Prunus demissa, Amelanchier florida, Amelanchier humilis, Lathyrus ochroleucus, Vicia americana, Geranium Bicknellii, Viola rugulosa, Viola adunca, Epilobium angustifolium, Aralia nudicaulis, Cornus stolonifera, Cornus canadensis, Pyrola elliptica, Pyrola asarifolia* var. *incarnata, Pyrola virens, Arctostaphylos Uva-ursi, Vaccinium canadense, Gentiana Amarella, Agastache Foeniculum, Mertensia paniculata, Galium boreale, Galium triflorum, Linnaea borealis* var. *americana, Viburnum edule, Lonicera glaucescens, Symphoricarpos albus* var. *pauciflorus, Campanula rotundifolia, Aster conspicuus, Aster Lindleyanus, Aster laevis* var. *Geyeri, Erigeron philadelphicus, Achillea sibirica.*

It is difficult to define primary species among the shrubs, although the commonest are *Shepherdia canadensis, Prunus demissa, Viburnum edule, Corylus cornuta,* and *Rosa acicularis.* There is probably considerable difference between the floras of north and south slopes, and, although this was not studied in detail, it can be illustrated with the distribution of the common asters. *Aster conspicuus* is most abundant on upper northward-facing slopes, while *Aster Lindleyanus* is commonest in shady upland woods. *Aster laevis* var. *Geyeri* is common only on dry southerly slopes.

Several species in the above list reach or approach their northern limits in the lower Athabaska river region or about Lake Athabaska:

Dryopteris spinulosa, Lycopodium obscurum var. *dendroideum, Carex Deweyana, Disporum trachycarpum, Lilium philadelphicum* var. *andinum, Corylus cornuta,*

[11] The following species of *Dryopteris* were listed in the Catalogue under the generic name *Thelypteris: Linnaeana* (= *T. Dryopteris*), *spinulosa, Robertiana, fragrans.*

Betula papyrifera, Anemone cylindrica, Prunus demissa, Pyrola elliptica, Agastache Foeniculum, Galium triflorum, Aster conspicuus.

Two of these, *Lycopodium obscurum* var. *dendroideum* and *Dryopteris spinulosa,* have been found at isolated stations in the northern part of the Mackenzie basin but appear to be rare in intervening territory. *Aster conspicuus* has been found on the eastern slopes of the Caribou Mountains, and *Anemone cylindrica* has been collected in a prairie at Peace Point, in the southern part of the Wood Buffalo Park.

It is a striking fact that only a small number of species in the forests of the lower Athabaska River region are of distinctly Cordilleran affinity. *Prunus demissa* and *Aster conspicuus* are the only ones in the above lists or in the lists of the lowland forest flora that can be so designated. To these can probably be added *Thalictrum sparsiflorum,* for which there is a record at Portage la Loche. This is in strong contrast to the conditions in the Athabaska–Great Slave Lake region proper and in the Lesser Slave Lake district to the southwest, in both of which there is a considerable Cordilleran element. The Rocky Mountain *Abies lasiocarpa* and *Pinus contorta* var. *latifolia* have both been found on the uplands about Lesser Slave Lake, and the latter has been collected on the Caribou Mountain plateau. Neither of these appears on the Cretaceous uplands of the McMurray district.

The aspen-spruce wood studied in the vicinity of Calumet Creek is distinctive for having only a single one of the species which reach the northern margins of their ranges in this district. This is *Lilium philadelphicum* var. *andinum.* It is also notable for having none of the Cordilleran species which are common about Lake Athabaska. In the latter characteristic it resembles the spruce and aspen forests of the Alberta Plateau in the Wood Buffalo Park. Two suggestions are made to throw light on these contrasts. First, the Calumet site is low in elevation above the river and occupies a depression in the dissected margin of the higher Cretaceous levels hereabouts. Second, the glacial debris upon which the forest grows rests upon a very thin layer of the Cretaceous shale or upon the Devonian limestones which outcrop along the river at this point. Such conditions may bring about notable differences in soils and drainage and may produce a habitat more nearly resembling that of the Wood Buffalo Park forest than occurs at higher levels in the McMurray district.

Spruce forests resembling those described above are almost non-existent in country east of the Paleozoic boundary. It is not impossible that representatives of them will be found as more of the area is explored, particularly to the south of Lake Athabaska or on small local flood plains farther north. The only woods seen thus far which at all resemble these spruce types are near the northwest shore of Lake Athabaska. Along a small stream which enters the lake a short distance northeast of Sand Point there is a small piece of timber which has the general appearance of the simpler upland types west of the Slave River. The stream drains through pine-covered sand plains and comes from muskeg and lake areas farther inland. The spruce is confined to what appear to be small local plains in the narrow valley of the stream. The soil is very sandy and gravelly.

PRIMARY SPP.: *Picea glauca, Betula papyrifera* var. *neoalaskana.*

PROMINENT SECONDARY SPP.: *Alnus crispa, Goodyera repens* var. *ophioides.*

The moss mat is three to four inches thick, over a layer of raw humus about two inches thick. The spruces are one to two feet in diameter, and the birches up to a foot. No list of secondary species was made, but the shrub and herb floras were noted as extremely scant, not unlike those described on page 46. The presence of *Alnus crispa* in considerable amounts and the thick moss and humus layers relate it also to this type.

JACK PINE FORESTS

Forests of Banksian or jack pine (*Pinus Banksiana*) are abundant in the southern and central parts of our region. The northeastern limits of the pine as a species are not far short of the limits of the forest itself. It has been noted at Selwyn and Theitaga Lakes in the Dubawnt drainage (Tyrrell, 1897), and at Kipling Lake northeast of Great Slave Lake (J. W. Tyrrell, 1901). Preble noted it as common on the Simpson Islands in Great Slave Lake, and also about the northern arm of this lake (1908). He also saw it on his route between Great Slave and Great Bear Lakes, but states that it is rare north of the height of land. It has been noted on the Mackenzie as far northward as 64° 30′ (Richardson, 1851).

The northern limits of the jack pine as a primary element in the forest are not so well known, but they appear to fall far short of the limit of trees (see map, *Fig. 5*). The pine is characteristic over large land areas around Lake Athabaska and west of the Slave River. It is common about the western arm of Great Slave Lake (Cameron, 1921), and Harper's descriptions (1931) of the Tazin and Taltson region show that it is a predominant species on sand plains and rocky hills throughout that area. Around much of the eastern arm of Great Slave Lake, however, its place is taken by white spruce. Judging by Blanchet's notes the boundary south of the east arm must be somewhere between Nonacho Lake and Lake Eileen (1926–C).

The pine woods may be described in two phases which are closely correlated with the substrata upon which they are found — sandy plains or ridges, and rocky hills of granite or very hard metamorphic rock (*Plates 3, 4*). In both types the primary tree is clearly the jack pine, though in some places the white birch commonly occurs. Primary species in the ground layers of both types include *Arctostaphylos Uva-ursi, Cetraria nivalis,* and *Cladonia rangiferina.* Beyond this the similarity does not go, and one meets with striking differences among both primary and secondary species. On rocky hills *Picea glauca* is sometimes abundant, and in the lower strata *Artemisia frigida, Amelanchier florida,* and *Saxifraga tricuspidata.* The last is exceedingly common as a primary species on the ground. None of these four occur as primary species on sandy soil. On the latter *Alnus crispa, Picea mariana, Vaccinium canadense,* and *V. Vitis-Idaea* var. *minus* commonly grow in this capacity. The contrasts between the primary floras of the two types may be summarized as follows:

PRIMARY SPP.: Common to both rocky and sandy woods: *Pinus Banksiana, Betula papyrifera* var. *neoalaskana, Arctostaphylos Uva-ursi, Cladonia rangiferina, Cetraria nivalis.* Rocky woods: *Picea glauca, Amelanchier florida, Saxifraga tricuspidata, Artemisia frigida.* Sandy woods: *Picea mariana, Alnus crispa, Vaccinium canadense, Vaccinium Vitis-Idaea* var. *minus.*

The SECONDARY SPECIES of the jack pine woods may be treated in the same manner. A list of those commonly found in either type is as follows: *Lycopodium annotinum, Festuca saximontana, Poa glauca, Agrostis scabra, Calamagrostis purpurascens, Elymus innovatus, Carex siccata, Maianthemum canadense* var. *interius, Goodyera repens* var. *ophioides, Populus tremuloides, Salix Bebbiana, Geocaulon lividum, Pulsatilla ludoviciana, Rosa acicularis, Fragaria glauca, Prunus pennsylvanica, Shepherdia canadensis, Epilobium angustifolium, Aralia nudicaulis, Galium boreale, Lonicera glaucescens, Linnaea borealis* var. *americana, Campanula rotundifolia, Solidago decumbens* var. *oreophila, Hieracium canadense, Polytrichum juniperinum, Cladonia alpestris.*

Species found thus far only in sandy pine woods: (1) Wide-ranging species of rich woods: *Lycopodium complanatum, Lycopodium obscurum* var. *dendroideum, Empetrum nigrum, Cornus canadensis, Ledum groenlandicum, Vaccinium uliginosum, Viburnum edule, Peltigera aphthosa, Hypnum Crista-castrensis, Hypnum Schreberi.* (2) Species of dry or rich woods, but here found at the margins of their ranges: *Oryzopsis pungens, Panicum subvillosum, Cypripedium acaule, Salix Scouleriana, Lechea intermedia* var. *depauperata,*[12] *Hudsonia tomentosa* var. *intermedia.*

Species found thus far only in rocky pine woods: *Woodsia ilvensis, Cryptogramma crispa* var. *acrostichoides, Polypodium virginianum, Dryopteris fragrans, Dryopteris Robertiana, Lycopodium clavatum* var. *megastachyon, Juniperus communis* var. *montana, Juniperus horizontalis, Poa palustris, Calamagrostis canadensis, Schizachne purpurascens, Allium Schoenoprasum* var. *sibiricum, Anemone multifida* var. *hudsoniana, Stellaria longipes, Arenaria verna* var. *pubescens, Arenaria dawsonensis, Corydalis sempervirens, Draba aurea, Arabis lyrata, Arabis Holboellii* var. *retrofracta, Heuchera Richardsonii, Ribes oxyacanthoides, Ribes glandulosum, Rubus idaeus* var. *canadensis, Potentilla tridentata, Potentilla arguta, Potentilla multifida, Potentilla pennsylvanica, Potentilla nivea, Geum triflorum, Lathyrus ochroleucus, Androsace septentrionalis, Symphoricarpos albus* var. *pauciflorus, Antennaria campestris, Antennaria nitida, Antennaria rosea, Achillea Millefolium, Arnica lonchophylla, Senecio cymbalarioides* var. *borealis.*

The jack pine forest is the simplest, floristically, of any of the woodlands of our region. The rather long lists given above are composite ones formed from studies in several different regions in the Wood Buffalo Park and around Lake Athabaska. When a single site is considered by itself it is commonly found to have a very small number of species. This condition reaches lowest terms on some sand plains observed near Wolverine Point on the south shore of Lake Athabaska, where the primary species are *Pinus Banksiana, Vaccinium canadense,* and *Cladonia rangiferina* (*Plate 4*). After a careful examination of a large area only half a dozen vascular species could be found among the secondary flora; and over whole acres the pine is the *only vascular plant,* with not even the blueberry appearing. The forest is open and park-like, with trees seventy years old. *Empetrum nigrum* occasionally appears as a mat about the bases of the trees. The ground is clothed with fruticose lichens.

[12] See Rhod. 40: 127, 129–130. 1938.

At the other extreme the sandy pine woods approach a mesophytic condition. *Betula papyrifera* var. *neoalaskana*, *Alnus crispa*, and *Picea mariana* become prominent; and on the ground the lichens and blueberries are in large part replaced by mats of woodland mosses and *Vaccinium Vitis-Idaea* var. *minus*. *Ledum groenlandicum*, *Arctostaphylos Uva-ursi*, *Alnus crispa*, *Cornus canadensis*, *Empetrum nigrum*, *Goodyera repens* var. *ophioides*, *Melampyrum lineare*, *Lycopodium annotinum*, *Viburnum edule* and *Cladonia alpestris* become common. In the Wood Buffalo Park forest of this type appears to develop into one of white spruce, but in the pre-Cambrian country no evidence for such a development was observed (*Plate 4*) (see below for further discussion of developmental trends).

The sandy pine wood occasionally shows a very wet phase at the margins of ponds or lakes. Here the pine is growing in a dense stand of bog shrubs such as *Vaccinium uliginosum*, *Ledum groenlandicum*, *Chamaedaphne calyculata*, *Andromeda Polifolia*, and *Kalmia polifolia*. Characteristic bog or marsh herbs appear also: *Calamagrostis canadensis*, *Spiranthes Romanzoffiana*, *Lycopus uniflorus*.

A very dry phase is to be found at the western margins of dunes and blowouts on the south side of Lake Athabaska, or on occasional beach ridges on the northwest shore. Here the pines are reduced to a decrepit condition, much gnarled and twisted. The sand about them is partly in motion, and partly fixed by fruticose lichens or occasional shrubs. This is the condition in which the pine woods are invaded by park-like white spruce, as previously noted.

The pine woods of the rocky hills, except for their lichen and moss components, are composed largely of a crevice flora (*Plate 3*). Areas of soil are usually small and of gravelly morainic materials. The rocks have not weathered sufficiently to produce a residual soil, so that the principal plants on the vast surfaces of exposed rock are lichens and mosses. Where the slopes are at all steep these are limited to such species as can attach themselves to the rock, while on gentle slopes and hilltops unattached fruticose lichens appear in great abundance (See L. C. Raup, 1930). The association is fairly uniform over most of the granitic parts of the pre-Cambrian country which fall within the range of prominence of the jack pine. It has outliers in the lowlands of the eastern part of the Wood Buffalo Park (Raup, 1935), and it covers those parts of the ancient metamorphosed sedimentary rocks in the Laurentian country which are too hard to have produced a residual soil since they were exposed.

As would be expected from the nature of the substratum this phase of the pine forest is exceedingly open and "scrubby." Most of the vascular flora is in small patches of gravelly till or in rock crevices of varying dimension and aspect. A common sight is a long row of shrubs or ferns, straight as though planted, extending for many yards over a hillside. On either side of the row, which occupies a crevice, will be only the bare or lichen-covered rock. The granitic rocks tend to break up into rhombohedrons, so that surface markings on the glacially scoured hills most commonly assume the form of triangles of all shapes and sizes, with here and there a rhomboidal figure. The vascular flora, therefore, is laid out in strangely regular geometrical patterns. The abundance of fruticose lichens gives the whole rockscape a grayish color in dry weather; but with a little moisture the yellow, orange, cream, and curious sea-green hues of the lichens transform the picture to one of surprisingly bright tints.

An analysis of the associational and geographical affinities of the floras of the two types of pine woods leads to further contrasts. It will be noted that in the above lists the secondary species limited to the sandy woods are divided into two groups: 1, wide-ranging species of rich woods; 2, species of dry or rich woods, here found at the margins of their ranges. Of the species limited to rocky pine forests, practically none are characteristic of rich woodlands, and very few are either notable range extensions into the region or conspicuously at the margins of their ranges. This suggests that mesophytism develops faster in the sandy than in the rocky woods, and that, possibly due to greater local variability, the sandy habitat is more attractive to selective species than the rocky one.

Much of the rocky woodland flora proves at once to be characteristic of dry upland woods and crevices throughout wide areas in boreal America. One notable local parallelism must be stated, however. Over half of its species (51%) also occur in the natural prairies of the Wood Buffalo Park and the Peace River country. A list of these species would include such prominent grasses as *Calamagrostis canadensis* and *Schizachne purpurascens*, and such abundant prairie shrubs and herbs as *Ribes oxyacanthoides, Symphoricarpos albus* var. *pauciflorus, Heuchera Richardsonii, Potentilla arguta, Geum triflorum, Lathyrus ochroleucus,* and *Antennaria campestris*. If only those species are considered which are limited to the rocky pine woods, the percentage common to the prairie is a little greater (56%). By contrast something less than 26% of all the species of the sand plain pine woods also grow in the prairie, and *none* of those which are limited to the sandy woods.

The significance of the prairie affinity of the rocky woodland flora is not evident, but it is clear that it heightens the contrast between the two types of jack pine forest.

Still another kind of analysis of the pine woods is suggestive. Notes on the rocky woodland were derived principally from three regions: the granitic hills of the Peace River delta and the upper Slave River, the hills in the neighborhood of Shelter Point, Lake Athabaska, and those near Charlot Point. Of all the species listed, sixteen were noted in all three regions, twenty-three in two of the regions, and thirty-seven in only one district. Of those common to all three areas 31% were limited to rocky woods; of those common to two areas 48% were so limited; and of those growing in only one of the three districts over 70% were characteristic of rocky woods. Figures from the sandy woods produce somewhat similar results. Of ten species growing in four of the seven areas studied, 20% were limited to sandy woods; and of seventeen species growing in only one of the seven areas, 30% were characteristic.

Two suggestions may be derived from these data: 1, many more species are only occasional in the jack pine woods than are common in them; 2, the plants which are found only occasionally in one or the other of the two types are much more likely to be limited to it and characteristic of it than those which are common there.

Recurring fires have undoubtedly facilitated the spread and establishment of pine forests in our region. In some places, such as on the better soils of the Wood Buffalo Park, fire has sometimes so completely destroyed spruce or aspen woods as to give rise to new stands of jack pine. In fact all stages in the burn succession can be seen, as noted earlier in the paper. These developmental stages are not evident in the pre-Cambrian country, however, and it seems clear that large areas have a natural forest of jack pine which for the time being at least is succeeding itself. I have seen ancient pine woods in the dune region south of William Point, Lake Athabaska (*Plate 4*) which have reached great age, and in which there is little or no evidence of fire.

Where the pine wood is burned off it immediately comes back to pine. The aerial photographs of the sandy country around Wolverine Point, Lake Athabaska, show an anomalous meadow-like appearance over considerable districts. Upon examination these surfaces proved to be clothed with a nearly pure stand of young jack pines one to eight feet high. Many which have reached a height of only one to three feet and a diameter of half an inch are twelve to fifteen years old and fruiting heavily. A study of these pines over a couple of square miles showed three, or perhaps four stages of development following a series of burns.

Large areas are characterized by stands of the small trees twelve to fifteen years old, one to three feet high. Among these are rather thick stands here and there (and sometimes standing singly) of trees six to eight feet high, about two inches in diameter at the base, and about forty years old. A still older stand of pines occurring occasionally showed trees about eight inches in diameter at the base, thirty feet high, and 120 years old. Trees intermediate in size between the last two are sometimes met with. It may be deduced that the country was partly burned off about fifteen years ago, the pines burned then being about twenty-five years old. The remains of this twenty-five-year-old stand are lying everywhere on the ground, many of them still undecomposed so that their rings may be counted. A considerable portion of this stand escaped the fire, however, and is now about forty years old. There must have been a major conflagration, then, about forty years ago, which destroyed a much older stand. Among the remains on the ground are stems two to three inches in diameter which may represent the generation of the 120-year-old trees or of the intermediate age mentioned above, and which escaped the fire of forty years ago but not that of fifteen years ago. In any event, there is no evidence of change in composition throughout a long period, and in the face of repeated destructive fires.

Balsam Fir–White Spruce Forests

The most mesophytic forests of the Athabaska–Great Slave Lake region are in the extreme southern part and are dominated by a mixture of white spruce (*Picea glauca*) and balsam fir (*Abies balsamea*). These constitute a phase of the wide-ranging fir-spruce belt which extends to northern New England and the Gulf of St. Lawrence. In the Cordilleran region the balsam fir is replaced by the alpine fir, *Abies lasiocarpa*. *Abies balsamea* reaches its western limits somewhere in the central Athabaska River country, while *A. lasiocarpa* is known east of the mountains only at isolated stations such as in the Lesser Slave Lake district (See Halliday and Brown, 1943). Within our region the fir is common enough to be regarded as a primary species only along the Clearwater and lower Athabaska Rivers (*Plate 2;* also map, *Fig. 5*). On the latter Robert Bell (1884, p. 8) mentions the fir as a part of the timber between Lac la Biche and Pelican Rivers, and William Ogilvie (1885, p. 51) says that it is only occasional between Lesser Slave Lake River and McMurray. From these notes we may gather that the balsam fir becomes reduced to secondary significance as one ascends the Athabaska from McMurray in the same way that it disappears at the Athabaska delta.

My own observations indicate that the spruce-fir forest is confined to the immediate valleys of the streams, and to local terraces within the valleys. John Richardson (1851, Vol. 2, p. 272) designates spruce as the chief upland tree north of the Saskatchewan and mentions the balsam fir only among those species which are abundant "on the alluvial borders of rivers and lakes." It is abundant on such sites about Waterways and McMurray and down the Athabaska at least as far as the mouth of the Firebag River; but in the heavy forests at the head of the delta it is only occasional. I have not seen it any farther north than this, though it has been reported probably erroneously as far as lat. 62° by Richardson (1823, p. 214). It was also noted in the gorge of the Little Buffalo River by Camsell (1903, p. 159A), but this record also is not verified. I have not seen it at the mouths of any of the lesser streams which drain into the south side of Lake Athabaska, although it may yet be found there. J. B. Tyrrell states (Sci. **22**: 76–77. 1893) that the balsam fir "grows to a large size among the white spruce on the top and sides of Duck Mountain in Manitoba, and between the Saskatchewan and Churchill rivers in the District of Saskatchewan. It extends for a short distance north of the Churchill River, where it appears to reach its northern limit." It is also of interest that the fir was not noted by Tyrrell or Dowling in their extensive travels between Cree and Athabaska Lakes (Tyrrell, 1896), although copious notes on forest types are to be found in their descriptions.

The northeastern boundary of the spruce-fir forests in the region south of Lake Athabaska bears some relation to the division between the "Mixedwood" section and certain phases of the "Northern Coniferous" section of the Canadian forest as outlined by Halliday (1937, pp. 19–21). It would probably be necessary to move Halliday's line somewhat to the northeastward, to include more of the Clearwater and lower Athabaska valleys in his Northern Coniferous section. The correlation does not exist farther northward, however, since this author makes no distinctions within the "Mixedwood" type in all the region between southern Manitoba and the Liard.

The following list will show the general structure of the spruce-fir forest as it appears along the lower Athabaska.

PRIMARY SPP.: *Picea glauca, Abies balsamea, Betula papyrifera* var. *neoalaskana.*

SECONDARY SPP.: *Dryopteris Linnaeana, Pteretis nodulosa, Equisetum pratense, Maianthemum canadense* var. *interius, Cinna latifolia, Orchis rotundifolia, Habenaria obtusata, Habenaria hyperborea, Calypso bulbosa, Listera borealis, Corallorrhiza trifida, Alnus tenuifolia, Caltha palustris, Thalictrum venulosum, Mitella nuda, Ribes triste, Ribes hudsonianum, Rubus pubescens, Rosa acicularis, Rhamnus alnifolia, Viola palustris, Viola renifolia* var. *Brainerdii, Epilobium angustifolium, Aralia nudicaulis, Cornus stolonifera, Pyrola asarifolia* var. *incarnata, Pyrola virens, Pyrola secunda, Trientalis borealis, Viburnum edule, Linnaea borealis* var. *americana.*

The woods are quite wet in the early part of the season, with frequent pools of standing water. Most of the surface is subject to flood in the spring. When we visited the lower Firebag River early in June, 1935, the water must have but recently subsided after having backed up from the main channel of the Athabaska. The ground surface was caked with mud, as were also the tree trunks and branches to a height of six or eight feet. The banks of the river and all of the lowland woods were strewn with drift timber and miscellaneous debris.

The trees often reach considerable size, one to two feet in diameter and 100 feet tall. There is a rather thick mat of woodland mosses, and the shrub layer, consisting principally of *Alnus, Cornus,* and *Viburnum,* is relatively dense compared with that of the upland woods. Characteristic plants of pools and their margins are *Caltha palustris, Rhamnus alnifolia, Ribes triste, Viola palustris, V. renifolia* var. *Brainerdii,* and *Alnus tenuifolia.*

Although most of the species listed above are widely distributed in the spruce forests of Canada, yet several here approach or reach their northern limits in the Mackenzie basin. *Rhamnus alnifolia* has been found nowhere else in the entire basin, and neither *Cinna latifolia* nor *Pteretis nodulosa* have been collected north of the Athabaska delta. *Coptis groenlandica* and *Trientalis borealis* are occasional in rich woods about Lake Athabaska but are not known farther north.

BLACK SPRUCE–LODGEPOLE PINE FORESTS

Although a northern Cordilleran floristic influence is distinctly noticeable in the Athabaska Lake country, the only part of our region which is known to have an outlier of northern Rocky Mountain or foothill forest types is the Caribou Mountain Plateau north of the lower Peace River (see map, *Fig. 5*). Here a timber of *Picea mariana* and *Pinus contorta* var. *latifolia* with a thick mat of woodland mosses is common (Raup, 1935, pp. 21–22). It is possible that this forest is also growing on other erosion plateaus of Cretaceous rock such as the Birch Mountains, the Buffalo Head Hills, and possibly the Eagle Mountains, but none of these uplands has been examined botanically. Lodgepole pine woods are found on the uplands about Lesser Slave Lake, and in the Notikewin district north of the Peace River (Raup, 1934; Halliday, 1937). Mixed forests of black spruce, lodgepole pine, and white spruce are widespread along the Alaska Highway between Fort St. John and Summit Pass (Raup, 1945).

Lodgepole pines were observed in our region near the top of the eastern slope of the Caribou Mountains, but they were not studied extensively. The elevation here is about 2000 feet above sea-level. The pine is most abundant on semi-open knolls which it shares with black spruce. Large areas on the upper slopes of the Caribou Plateau are covered with a dense forest of black spruce mixed with a few birches, *Betula papyrifera* var. *neoalaskana*, and a rather abundant growth of *Alnus crispa*. The moss mat is very deep and there is a scattering of the usual shady woodland herbs: *Equisetum sylvaticum* var. *pauciramosum*, *Calypso borealis*, *Pyrola secunda*, *Mitella nuda*, and *Lycopodium annotinum*. In the more open conditions mentioned above the ground cover is dominated by a lichen mat of *Cladonia rangiferina* and *Cetraria nivalis*. In several places decrepit old pines appear, entirely surrounded by dense thickets of black spruce, suggesting that the latter have arisen in the course of a succession.

There is reason to believe that the black spruce–lodgepole pine woods are not only on the highest, but also the oldest land surfaces in our region. The hills would have risen above the 1600-foot post-Glacial lake level, and are comparable in age to the Cretaceous plateau surfaces west of the lower Athabaska River. As I have noted previously (1935) there are some clayey, boulderless soils on the Caribou Plateau which may be residual. They contrast strongly with morainic deposits on the eastern slopes. This condition suggests that the plateau summit was not all cleaned off by the latest of the Pleistocene ice advances. Part of it may, however, have been submerged for a portion of post-Glacial time under great lakes whose levels rose far above 1600 feet. Soil studies in the Peace River agricultural region (Allan, 1919; Rutherford, 1930) indicate that most of the materials on the long gentle slopes between the uplands and the deep river valleys were laid down in fresh-water lakes; and since these surfaces lie mostly above 2000 feet, it is possible that only the highest parts of the Caribou Plateau remained above water. At any rate, it is not impossible that the highest surfaces on the Caribou Mountains and other Cretaceous plateaus served as refuges or early invasion areas for northern Cordilleran forests during the latest phase of the Pleistocene and during the period of great glacial lakes which followed. They could then have served as centers for the dispersal of Cordilleran species in our region.

Bog Forests

Bog forest constitutes one of the commonest types of timber in the Mackenzie basin. It probably covers more land surface in the pre-Cambrian portions of the Athabaska–Great Slave Lake region than it does farther westward. This follows from the facts that the development of a bog type of vegetation, or muskeg, in our region is dependent upon the presence of some sort of undrained depression in which a supply of moisture is available, and that this type of topography is especially common in the Laurentian country. The succession of vegetation set up in these depressions usually involves characteristic mosses and bog shrubs, and culminates in a forest of black spruce, sometimes accompanied by larch. Almost invariably there is a shrub layer primarily of Labrador tea (*Ledum groenlandicum*) and a thick mat of mosses which are usually arranged in hummocks (*Plate 5*). In the wetter condition the mosses are *Sphagnum*, but in drier ones they are woodland species of ***Hypnum***. Everywhere the forest is of small stature, the larger trees reaching heights of thirty to fifty feet.

The structure and flora of the bog forest may be characterized as follows:

PRIMARY SPP.: *Picea mariana, Ledum groenlandicum, Sphagnum sp., Larix laricina.*

SECONDARY SPP.: *Equisetum sylvaticum* var. *pauciramosum, Equisetum scirpoides, Carex gynocrates, Carex disperma, Carex media,*[13] *Carex capillaris, Eriophorum opacum, Maianthemum canadense* var. *interius, Habenaria hyperborea, Habenaria obtusata, Orchis rotundifolia, Listera borealis, Corallorrhiza trifida, Spiranthes Romanzoffiana, Salix pyrifolia, Salix glauca, Salix myrtillifolia, Betula papyrifera* var. *neoalaskana, Betula glandulosa, Geocaulon lividum, Ranunculus lapponicus, Ranunculus Gmelini* var. *Purshii,*[14] *Drosera rotundifolia, Parnassia palustris* var. *neogaea,*[15] *Ribes hudsonianum, Ribes triste, Mitella nuda, Rubus acaulis, Rubus Chamaemorus, Cornus canadensis, Moneses uniflora, Pyrola secunda, Pyrola asarifolia, Pyrola virens, Chamaedaphne calyculata, Arctostaphylos rubra, Vaccinium Oxycoccus, Vaccinium Vitis-Idaea* var. *minus, Vaccinium uliginosum, Linnaea borealis* var. *americana.*

The selection of a group of secondary species to represent the muskeg habitat is difficult for several reasons. As noted above the bog forest is the result of a hydrarch successional series. Stages which immediately precede the forest are wet and swampy, with open areas of mosses and sedges or bog shrubs. Remnants of these stages persist into the bog forest and make it difficult to draw satisfactory lines between swamp and forest. Such aquatic groups as the sedges are probably inadequately selected in the above list on this account.

Furthermore, the list of secondary species is not entirely complete for our region. It is composed of those forms noted as common in muskegs of at least two areas studied, and therefore it does not include a few species which are geographically somewhat limited. There is a small group, for instance, which appears around the eastern arm of Great Slave Lake or on the bleaker parts of the north shore of Lake Athabaska: *Tofieldia palustris, Rhododendron lapponicum, Vaccinium uliginosum, Pinguicula villosa, Boschniakia rossica.* Another group is allied to these geographically, but its members appear rarely or occasionally on the uplands of the country west of the Slave River: *Carex concinna, Ranunculus lapponicus, Ledum palustre* var. *decumbens, Andromeda Polifolia, Pedicularis labradorica. Alnus crispa,* which is typical of rich upland woods throughout most of the region, becomes a common shrub of muskeg forest at the eastern end of Great Slave Lake.

[13] *Carex Vahlii* var. *inferalpina* of the Catalogue.

[14] *Ranunculus Purshii* of the Catalogue. See Rhod. **41**: 385–386. 1939.

[15] *Parnassia multiseta* of the Catalogue. See Rhod. **39**: 311. 1937.

Further difficulties in determining the floristic confines of our muskeg forest appear when its southern and southwestern relationships are considered. I have already noted (1935) that in the Wood Buffalo Park transition stages are sometimes evident between bog forest and the upland white spruce forest of the region. Questions here arise as to whether such typical woodland species as *Shepherdia canadensis, Viburnum edule,* and *Salix Bebbiana,* which are likely to occur in mossy forests of black spruce, are to be considered parts of the bog forest community. A considerable study of the bog forest type, however, shows that they do not appear except in these transition stages, and had best be related to the forest type which they seem to presage.

There are very few muskeg species in the lower Athabaska River region which fail to extend far northward at least in the Paleozoic or Cretaceous regions. *Rhamnus alnifolia,* which occupies muskeg habitats in the lowland woods along the Athabaska, apparently goes no farther northward, and some of the species of rich woods already mentioned may also be found in muskegs: *Cinna latifolia, Trientalis borealis.* When the whole flora is taken into consideration a considerable number of species do not extend east of the boundary between the Paleozoic and pre-Cambrian rocks. When the bog forest is considered alone, however, this is not the case, and a very small number appear to be so restricted. Representative of these are *Listera borealis, Caltha palustris,* and possibly *Ribes lacustre.* The last has been found in the pre-Cambrian region only on dolomitic rocks north of Lake Athabaska. There is some evidence of a change in flora as one goes northeastward toward the limit of trees. Field notes made about the eastern arm of Great Slave Lake show that *Larix* is more abundant than southward, and that it may sometimes be classed among the primary species. The prominence of *Alnus crispa* in the shrub layer here has already been mentioned.

These notes suggest the same conclusions concerning the bog forests that were reached in studies of the Peace River and Wood Buffalo Park regions (Raup, 1934; 1935): that the type is essentially uniform throughout the entire region, both structurally and floristically. The few secondary species which are geographically limited follow the same demarkation lines marked by the other elements in the flora.

The muskeg habitat which finally gives rise to the bog forest is a physiographic-climatic phenomenon, and the development of the muskegs is dependent upon the existence of undrained depressions and the presence of peculiarly adapted peat-forming mosses which rapidly colonize the open water of lakes and ponds. First among glacial and physiographic causes for undrained depressions are glacial plucking and scouring. These are especially obvious in the pre-Cambrian districts where morainic materials are sparse and do not mask the country rock. Such rock depressions vary in size from small pools a foot in diameter to large lakes. Most of the larger lakes appear to occupy the basins of pre-Cambrian drainage systems, but the latter have been so modified that the ancient lines are now scarcely visible. Many depressions have been formed by morainic dams across main drainage lines. One of the most conspicuous of these is the basin of Conibear (Moose) Lake in the Wood Buffalo Park (Raup, 1935). The continued fall of water levels in the great lakes has produced such characteristic shore phenomena as barrier beaches which impound lagoons. In the vicinity of Shelter Point, on the north shore of Lake Athabaska, there is a long series of these beaches in a "fossil" condition, reaching several miles inland. The intervening lagoons are in various stages of muskeg development. Similar conditions are common along the south shore of Lake Athabaska.

Sand and mud bars along the lower reaches of the great rivers, such as the Athabaska, Peace, and Slave, often subtend, either on islands or on the shore, extensive lagoons and meadows. These usually produce a reed swamp vegetation which develops a typical flood plain forest. Occasionally, however, drainage is cut off in such a way that a muskeg develops instead, and this results in bog forest with a mixture of plants from rich flood plain woods. Such a muskeg has been studied along the Athabaska River near Calumet Creek, on the mainland back of Wheeler's Island.

Another influence which greatly affects the presence or absence of muskegs is the configuration of underlying sedimentary rock strata. Where these are nearly level or only slightly tilted, as on the Athabaska Sandstones, a bog forest type of vegetation occupies nearly every crevice (*Plate 5*). This can possibly be accounted for by the rather free movement of water along joint planes and the consequent formation of "pools" above the levels of permanent frost in the crevices. The same phenomena may be seen where the softer portions of the Tazin series outcrop on the north shore of Lake Athabaska, and where the ancient sediments appear about the eastern arm of Great Slave Lake. The configuration of the strata near the tip of Fairchild Point shows this clearly. The steep ledgy slope on the north side of the hill is covered with small bog forest, developed on the ledges whose floors dip to the south, while the south slopes are dry and breaking up into masses of slide rock and talus. The same arrangement can be seen on Charlot Point, Lake Athabaska. A special case related to this category is to be seen in the Wood Buffalo Park where the flat-lying Silurian limestones are cavernous and give rise to sink holes. Where these holes have subsequently been plugged, or otherwise given a permanent water level, they have developed typical muskegs.

The significance of permanent soil frost in the formation of muskeg habitats has already been discussed. Even in mid-summer the frost-line in muskegs is never far below the surface, perhaps two to three feet at most; and in the autumn (late August and early September) the mossy bogs are the first to freeze.

DISTRIBUTION AND GEOGRAPHIC AFFINITIES OF THE FORESTS

The accompanying map of forest types (*Fig. 5*) is far from complete, and its boundaries must be looked upon as tentative; nevertheless I believe the disposition of its principal areas is sufficiently near the truth to serve

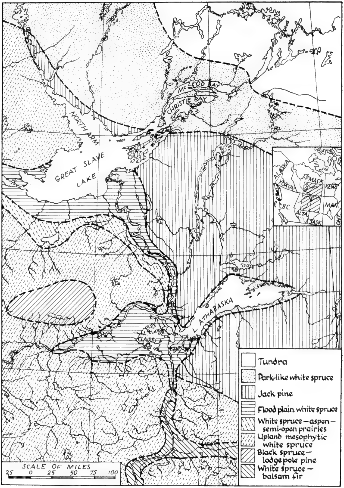

FIG. 5. Map of the principal forest types in the Athabaska–Great Slave Lake region.

for the correlations that follow. These correlations appear when the map is superposed upon others which show the arrangement of geological formations and the effects of glaciation. Due to the youth of the land surface this can be regarded as a correlation with soil factors; and due to the existence of a recognizable sequence of post-Glacial events, a time element can be inserted. A third set of factors, those of climate, is more difficult of comparison, and must be used only in the most general terms. Finally, it will be useful to examine the present distribution of our forest types in the light of the Pleistocene and post-Pleistocene history of the species of which they are made.

Correlation with Geological Formations and Age of Surface (Compare maps, *Figs. 2, 4*)

Park-like white spruce timber is characteristic of the most youthful surfaces in the pre-Cambrian area: those exposed at the final disappearance of the ice and the formation of the 700-foot post-Glacial lake. Most of these surfaces are approximately equivalent in age to the Mackenzie Lowland, and they occupy a broad strip of country covering most of the Yellowknife, Lockhart, and upper Thelon drainage basins, as well as the country around Christie and McLeod Bays in Great Slave Lake. The type also appears here and there on sandy and stony beaches around Lake Athabaska and northward. It has also been found sporadically on high sand hills west of the Slave River where it is on somewhat older surfaces.

Flood plain spruce forests may occur anywhere in the region on recent silt deposits along streams, but they are concentrated in the Mackenzie Lowland physiographic province, all of which is below the shores of the 700-foot post-Glacial lake. Thus they are, with the possible exception of the more recent raised beaches on Great Slave and Athabaska lakes, on some of the youngest surfaces which the region affords.

Upland mesophytic forests of white spruce predominate on most of the surface which is underlain by Paleozoic or younger rocks, and which lies above the shores of the 700-foot post-Glacial lake. They are considerably modified by prairie openings on the youngest surface occupied (the bottom of the 800-foot lake), and to a lesser extent on the next oldest surface (1100-foot lake). They are extremely variable in composition due to the incidence of fire and the admixture of trees induced by fire — jack pine, aspen, and balsam poplar.

Forests of jack pine are most highly developed over the pre-Cambrian rocks on both sides of Lake Athabaska and northward throughout the Tazin and Taltson drainage basins. They extend over the islands in the western half of the east arm of Great Slave Lake and along the eastern shore of the north arm. They are very common on sandy soils throughout the Alberta Plateau, but here they are obviously fire-induced. In the pre-Cambrian country there is considerable evidence that they are not dependent entirely upon fire. Most of them are on surfaces exposed at the drainage of the 1100-foot and 800-foot lakes, and at the retreat of the ice fronts which impounded them.

Balsam fir appears as a primary constituent of our forests only on local flood plains along the Clearwater and lower Athabaska Rivers. The underlying rocks here are Devonian limestones and bituminous Cretaceous sandstones, and the surfaces are probably of about the same age as the 1100-foot lake bottom west of the Slave River. The actual soils, however, are quite recently formed on active flood plains, so that they are perhaps more nearly equivalent to those of the Mackenzie Lowland.

Forests of black spruce and lodgepole pine are known only on uplands based upon Cretaceous rocks in the Caribou Mountain Plateau. These surfaces are also the highest and oldest in the region. Parts of them were not only above the shores of the 1600-foot post-Glacial lake, but also they probably stood out above still higher lakes that existed in the upper Peace River region and may not have been covered by the ice itself. Similar forests are to be expected on the Birch Mountains and on other plateaus of equivalent history.

Muskeg forest of black spruce and larch is widely distributed in all parts of the region without regard to surface age. The large number of undrained depressions in the Laurentian country makes for a somewhat larger development of muskeg there than elsewhere.

Both consistencies and inconsistencies are brought out by this comparison of forest geography with the distribution of geological formations and surface ages. The northeastern limit of the pine forests is nearly coincident with an age boundary, while its southwestern limits are roughly those of the pre-Cambrian rocks. The upland mesophytic forests are bounded approximately by the borders of the 700-foot post-Glacial lake, and the flood plain spruce is clearly correlated with the Mackenzie lowland. Most of the park-like spruce woods are on the most recently exposed surfaces in the pre-Cambrian region.

Both the jack pine and the park-like spruce types, on the other hand, present some anomalies. The pine occupies land of approximately the same age as the upland white spruce. It is very common, of course, in the spruce country, but chiefly as a fire tree. Is this difference to be attributed entirely to the slow development of soils in the pre-Cambrian area, or are there factors of climate and species history to be considered? The presence of park-like spruce on stony and sandy beaches around Lake Athabaska is likewise anomalous. There can hardly be enough difference in surface age to account for the sharp limitation of the spruce to one or two ridges on the lake shores, or to a series of higher beach ridges composed of stones from the Athabaska and Beaverlodge Series of rocks, or to narrow strips on the windward margins of sand blowouts. Also, why should this forest appear on the tops of high sand ridges in the Alberta Plateau west of the Slave River? Here again factors of climate and species history may be effective.

Correlation with Climatic Zones of Vegetation

Comparison of actual climatic zones with the preceding maps is impossible with present knowledge, but there are certain outstanding facts in the zonal distribution of vegetation in the subarctic that are applicable. It has long been assumed that the Arctic, Hudsonian, and Canadian zones of plant and animal life are climatic phenomena, although the demonstration of the limiting climatic factors which determine the boundaries in our region is difficult or impossible. This is particularly true since one of these boundaries is so nearly coincident with the margin of the crystalline pre-Cambrian rocks, and since an intermediate boundary, between jack pine and park-like spruce types, may be related to one of surface age. Nevertheless, as has been shown above, there are climatic gradients in the region which probably radiate from the tundra country at the northeast.

Halliday (1937) has attempted to extend Thornthwaite's classification of North American climates (1931) into northern Canada and to correlate it with his forest sections. His figures are of necessity, however, based upon so few observational data for our region that they are of very doubtful significance. For all of his "Northern Transition Section," for instance, he draws data from only one station, and for his "Northern Coniferous Section" he has no data at all.

An investigation of the root habits of northern trees by H. E. Pulling (1918) lends significance to climatic factors as they are expressed in terms of soil frost. A classification of the common trees on the basis of the relative flexibility of their root habits suggests a measure of their success in coping with permanently frozen subsoils. White spruce, with a shallow flexible root habit, is most successful, and extends far out into the tundra in favored places. Other shallow-rooted species which have a rather inflexible system, such as white birch, larch, and black spruce, also have a wide range in the subarctic, but are not quite so frost-tolerant as the white spruce. Jack pine has a deep inflexible taproot which requires soils in which the level of permanent frost is low. If this hypothesis is tenable there should be concentric zones of white spruce followed by jack pine around the borders of the tundra, much as we have them now.

The northern limit of trees is an irregular line extending in a northwest-southeast direction through the Lockhart basin, and passing to the northeast of Great Bear Lake. The more mesophytic forests at and just south of the timberline are of white spruce in comparatively open stands, in park-like arrangements on sand and gravel plains or in crevices. Flood plains also have a timber of white spruce, though it is smaller and more open that the flood plain timber of the Mackenzie lowland. Muskeg habitats, of course, develop black spruce and larch. This is the "Northern Transition Section" in Halliday's classification of Canadian forests (1937), and it is essentially the "park-like white spruce" of the Athabaska-Great Slave Lake region (map, *Fig. 5; Plates 1, 2*).

Southwestward in the pre-Cambrian region the white spruce is largely replaced by jack pine, in a belt extending northwestward beyond the north arm of Great Slave Lake (*Plates 3, 4*). This forest is the "Northern Coniferous Section" of Halliday, extending from near Great Slave Lake southeastward across northern Saskatchewan, central Manitoba, and far into western Ontario. According to Halliday it is broken only by a somewhat more mesophytic type in the Nelson River area. In our region it can be extended farther northwestward than Halliday has it.

The pine and white spruce types together occupy the "Hudsonian Life Zone" of Merriam (See Preble, 1908; Harper, 1931–A; Anderson, R. M., 1937–A, B; Porsild, 1937). They are bounded at the southwest and south by the "Canadian Zone," characterized by more mesophytic coniferous forests of white spruce or mixtures of balsam fir and white spruce. Upland elements of such forests, much altered by fire, are classed by Halliday in his "Mixedwood Section." They correspond in general to the upland mesophytic spruce forests of the preceding discussions. Their eastern boundary in the Slave River region should extend nearer the river than Halliday has placed it. Most of the flood plain elements are classed by Halliday in the "Mackenzie Lowlands Section," and probably correspond to our flood plain white spruce type.

The faunal boundary between the Hudsonian and Canadian Zones in our region appears to be somewhat in doubt. Preble placed it at the valley of the Slave River, but Harper has proposed that it be put farther eastward, on a line extending roughly from the south shore of Great Slave Lake not far east of the Slave River to Hill Island and Tazin Lakes, thence to the Beaver River near the eastern end of Lake Athabaska. Harper relates the triangular area bounded by this line and by the Slave River and Lake Athabaska to the Canadian Zone. However, he regards it as sufficiently different faunally to set it up as a separate faunal area designated by the name "Tazin Highlands."

With the amelioration of climates and the development of forests after the ice sheet and glacial lakes receded, forest successions must have been initiated. We have already seen that the first two stages on the better drained soils were probably park-like white spruce followed by jack pine, both of which are still abundantly represented. The pine should, in turn, have been followed by another zone of spruce that should have developed as the forest became more mesophytic. That is, under more equable climates heavier stands of timber would appear, with accompanying humus accumulation and the improvement of soils. There is considerable evidence that this succession from pine to spruce has occurred in the region in the "Canadian Zone" west of the Slave River, and that in some places it is not yet complete (Raup, 1935, pp. 23–26). Low sand ridges that have only recently been exposed by the drainage of morainically dammed lakes develop an initial forest of jack pine. In sand plains throughout this area the permanent frost is far below the surface; and when they are so severely burned that all humus is removed, they invariably begin their revegetation with pure stands of jack pine. The pine, however, is not permanent, but is followed directly by white spruce. Stages in this succession are common on sandy uplands in the Wood Buffalo Park.

Further stages in the increase of mesophytism require time for the further development of soils. They would be hastened by an improvement in climate, particularly by more rainfall. In our region the principal evidence of a later stage is to be found on the Cretaceous surfaces in the south, where many plants of rich woods reach their northern limits, and where the balsam fir shares with white spruce the primary situation in the forests of the flood plains. These surfaces are older than those of the Wood Buffalo Park and enjoy a somewhat greater rainfall during the growing season.

Given a uniform distribution of soils throughout the Athabaska–Great Slave Lake region, and no great differences in the age of its surfaces, a group of concentric forest zones such as have just been outlined might be expected on the basis of climate and successional development alone, with boundaries more or less parallel to the arctic timber line. The Paleozoic-pre-Cambrian boundary, however, with its effects upon glacial deposits, has accentuated the jack pine stage. The sterility and scarcity of soils in the pre-Cambrian area seem to have retarded the development of more mesophytic spruce forests, so that the southwestern boundary of the pine becomes locally an edaphic one. At the northeastern margin the correlation with surface age may be more apparent than real, since we know very little about the actual configuration of the transition from park-like spruce to pine. Studies of permanent frost levels in that region would be of great interest. A faunal reflection of a "lag" in the development of more mesophytic forests east of the Slave River may be found in Harper's delineation of a "partially" developed Canadian Zone fauna in his Tazin Highlands area.

There is still the anomalous appearance of park-like spruce at Lake Athabaska and on the Alberta Plateau to be dealt with (map, *Fig. 5; Plates 1, 2*). When I discussed this in an earlier paper (1933) I came to the tentative conclusion that the southern outliers of the open spruce were "relics," persisting on sites which the pines had been unable to invade. Excessive exposure to storm winds seemed the only common limiting factor among the situations examined up to that time. The gradual transition at Sand Point from an old forest of open white spruce, on the outer part, to one of old pines, and then to one of younger more closely grown pines at the base of the point seemed particularly strong evidence that exposure to strong winds off the lake was significant.

Further observations around Lake Athabaska have cast some doubt that this is a sufficient cause in all cases. The spruce was found on ancient stony beaches high above the lake at Charlot Point where it is more or less protected from strong northeast and northwest gales; and it likewise occurs on hills of conglomerate and dolomite in the Charlot Point and Beaverlodge districts where it is not unduly exposed. It may be that extreme xerophytism or instability of the soils may be effective as well as storm winds. In all the areas studied to date both of these factors are present. The conglomerate and dolomite are weathering to form soils that are on steep slopes and subject to frost heaving and creep. The ancient stony beaches are excessively dry, with almost no water-holding capacity at all. All of these habitats may present difficulties which are insurmountable to the invading jack pine. In any case it still seems most reasonable to consider the southern outliers of park-like spruce as relics of a former widespread forest of this type, particularly in view of the possibility that the whole of the pre-Cambrian jack pine region has been held back in its successional development by poor edaphic conditions. Further reason for holding to this view is to be found in the Glacial and post-Glacial history of the species, and in their probable routes of migration into the region (see below.)

The following is a provisional scheme for the post-Glacial development of forests in our region, taking into account the progressively younger surface ages (*Fig. 6*). It also involves a progressive amelioration of climates

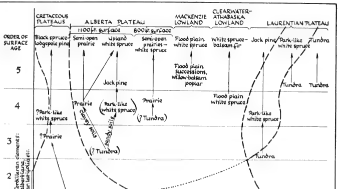

FIG. 6. Provisional outline for the development of forests in the Athabaska–Great Slave Lake region since the retreat of the last Pleistocene glacier and the post-Glacial lakes.

during the retreat of the ice and the drainage of the post-Glacial lakes. It will be noted that I have inserted, tentatively, a park-like spruce stage following tundra in most of the successions, although this is now most evident in the Laurentian province. The occurrence of suspected relics of such a forest on the Alberta Plateau west of the Slave River and the present existence of it on Cretaceous sedimentary rocks northwest of Great Bear Lake (Porsild, 1937) strongly suggest that it occurred over Paleozoic and younger rocks as well as over pre-Cambrian formations. Whether or not tundra was the original vegetation on the clayey soils of the 1100-foot and 800-foot lake bottoms is conjectural (Raup, 1934, pp. 94–105; 1935, pp. 60–61; 1941, pp. 219–21). On the most recent surfaces it may well have started as a grass-sedge tundra that was closely related to prairie.

Stages leading to the black spruce–lodgepole pine forest on the high plateau of the Caribou Mountains are also problematical. It is not improbable that tundra and simple white spruce forest constituted the initial stages at least on the lighter soils, but on heavier soils it may be that tundra persisted for a very long time, perhaps prairie-like in its later aspects. Similar forest on the high plateaus between Fort St. John and Nelson and in the upper Liard region gives some evidence of recent development, possibly from some form of tundra or grassland (Raup, 1945, pp. 40–42).

The timing of events presented in the diagram is undoubtedly subject to modification. We have no way of knowing, for instance, how long it took the tundra on the 1100-foot lake bottom in the crystalline area to develop an open spruce forest on its river bottoms and sand plains, and finally on its rocky uplands. This tundra may have lasted until after the drainage of the 700-foot lake when all the ice disappeared from the Slave Lake basin, rather than to the drainage of the 800-foot lake as I have it. Furthermore, the whole scheme is based upon an amelioration of the climate during which there may have been halts, but no important reverses.

The question is not solved as to whether the central Mackenzie basin has experienced a post-Glacial climate that was milder than that of the present. The evidence for such a climate in the Athabaska–Great Slave Lake region is scanty and equivocal.

A rather imposing body of research in other parts of North America and Greenland, as well as in the Old World, gives strong indication that many of the northern parts of the earth have undergone a "deterioration" of their climates during the past 3000 to 7000 years. It is unnecessary to review this research in detail, for several comprehensive statements of it have been published recently (Cooper, 1942; Cain, 1939; Sears, 1935; Raup, 1941; Bull. Am. Meteorolog. Soc., 1938). The evidence is drawn from many fields: the advance and retreat of modern Alaskan and other Cordilleran glaciers, conditions at arctic and alpine timberlines, the present distribution of temperate and arctic biota, the history of peat deposits as shown by their gross morphology and fossil pollens, ancient dune deposits in the upper Mississippi valley, the history of saline lakes in the Great Basin, geothermal gradients in deep mines, and the migrations and cultures of ancient peoples.

The presence of semi-open prairies in our region might suggest a warmer or drier climate during which they could have acquired their present expansion. Nevertheless there is no evidence whatever that the present sites of the prairies ever had any other vegetation than grassland or some form of tundra. The prairie soils give no indication of ever having had forest on them.

The timber line seems to be advancing in parts of Alaska (Griggs, 1934–A, B), while it has retreated a little in the lower Mackenzie and

Coppermine regions (Porsild, 1938; Richardson, 1851). On the other hand Clarke (1940) thinks that it has been approximately stable for a long period in the upper Thelon country and the Lockhart basin east of Great Slave Lake; and J. B. Tyrrell (1910–A) could find no evidence in the region southwest of Hudson Bay that the forests had ever extended farther north than they do now.

The effects of a previously warmer climate in the Athabaska–Great Slave Lake region might be looked for also in isolated northern relics of southern floristic elements. To draw any conclusions from the few apparent range discontinuities now known, however, is extremely hazardous because of the incomplete exploration of the country. In fact, the number of these cases is so small, and their validity is so doubtful, that the most reasonable conclusion at present is that they give little or no indication of a change in climate. An example is the balsam fir, *Abies balsamea*. Its authenticated northern limit is the Athabaska delta, but it was reported by Richardson at latitude 62° on the Mackenzie. No specimens to substantiate Richardson's record appear to be extant, and no one has ever been able to verify the observation. There is, however, a northwestern variety of the white spruce along the Mackenzie in latitude 62° which has the smooth, resin-blistered bark of the fir and would easily be confused with it. Another instance is that of ***Trillium cernuum*** var. ***macranthum***, a specimen of which in the Gray Herbarium is labeled "Mackenzie River." The plant was collected by Richardson and is the only specimen of ***Trillium*** ever credited to any part of the Mackenzie basin.

In the region of the Mackenzie delta Porsild (1938) has found abundant evidence of a former northern extension of the forest amounting to at least 50 or 60 miles. In the Eskimo Lakes basin he found what he considered to be isolated representatives of several herbaceous plants. Some of these, however, have already been found in the upper or middle Mackenzie country, so that their range discontinuities are somewhat in doubt.

Reasons for the failure to find evidence of a post-Glacial "optimum" climate in our region can only be conjectured. It is not impossible that a general cooling of climates throughout the northwest, with an attendant increase in precipitation in some places (or perhaps an increase in storminess), would allow a continued advance of forests under the relatively equable marine climates of coastal southern and western Alaska, but would have quite dissimilar effects in the continental interior. Under the latter climates, where temperature is more likely to be a controlling influence (see Thornthwaite, 1931), even an opposite effect might be produced, and the northern forest border would retreat as it seems to have done in the Mackenzie delta and the Coppermine region. If this should prove to be the case, it would be possible to postulate a region in which effects of changes in temperature and precipitation would offset each other, and timberlines would remain relatively stable for a long period in spite of a general "deterioration" of climates. The arctic limits of timber south and west of Hudson Bay, thought to have remained nearly stationary for a long time, might be explained in this way.

Giddings, in his studies of Alaskan dendrochronology (1941), found a close correlation between temperature phenomena and tree growth at altitude and latitude timberlines in central and northern Alaska. At the same time he could find no apparent correlation with differences in precipitation in those regions. Climatic correlations with growth in lowland trees were not so clear, though Giddings says that "even here temperature seems more to be considered than does any particular precipitation or ice effect."

If the hypotheses concerning climatic controls just outlined are tenable, disrupted ranges due to deteriorating climates would not be any more probable than migrations of the timberline in the Athabaska–Great Slave Lake region.

Another reason for the failure to find evidence of a more equable climate in our region might be that the establishment of forests there was achieved coincident with the climatic "optimum." It would be entirely possible for the forests to maintain their status or even to spread during a subsequent period of general deterioration provided the interplay of climatic factors has produced for a long time a fairly constant effect similar to that now obtaining. Continued development toward mesophytism would of necessity be slow and would be accompanied by a retarded development in soils. The present immaturity of both vegetation and soils lends some weight to this theory.

Antevs (1931) has estimated that glacial ice still remained somewhere in Keewatin and in the Labrador Peninsula as late as 7500–9000 years ago, to the close of his "Younger Late-Glacial." One of the later stages in the shrinkage of the remnant in Keewatin may well have been that which finally cleared Great Slave Lake of ice and brought the lake nearly to its modern level. As will be shown below, there is evidence that extensive forests did not come into the Athabaska–Great Slave Lake region until after the ice had left Great Slave Lake. Antevs (1935) places the post-Glacial warm period between 7000 and 4000 years ago, but quotes Spitaler (1932–A, B) to the effect that the maximum summer temperatures may have been reached about 8500 years ago. The final disappearance of ice from Keewatin, therefore, may have fallen within the period of the post-Glacial optimum, and the establishment of forests in our region might also have been coincident with it. All of these figures, however, are highly conjectural, especially since relations between the recessional moraines in our region and those studied by Antevs in Ontario and Manitoba are not known.

In any event, much more study is needed before any conclusions can be reached. It should be particularly useful to make a thorough investigation of peat deposits from the oldest to the youngest surfaces, using the methods not only of pollen analysis but also of macroscopic examination. This appears to present an entirely open field of research in our region. Above all, correlations should be made between the lake stages and morainic systems in our region and those of the southern prairie provinces and Ontario.

Correlation with the Glacial and Post-Glacial History of the Species

Some recent studies by Hultén (1937) on the origin and distribution of boreal plants in Pleistocene and post-Pleistocene time have made it possible at least to postulate origins for the tree populations now found in the Athabaska–Great Slave Lake region. Still more recently, Halliday and Brown (1943), using Hultén's hypotheses, have attempted to outline the post-Glacial migrations of the principal forest trees of Canada. The essential ideas involved in Hultén's study have already been discussed at length elsewhere (Halliday and Brown, ibid.; Raup, 1941; Stebbins, 1942) and need not be described here.

Pairs of closely related species have long been recognized in eastern and western America: *Abies balsamea* and *A. lasiocarpa, Pinus Banksiana* and *P. contorta, Tsuga canadensis* and *T. heterophylla, Thuja occidentalis* and *T. plicata,* etc. To these may be added eastern and western varieties within single species: *Picea glauca* and its var. *albertiana, Betula papyrifera* and its vars. *commutata* and *neoalaskana, Larix laricina* and its var. *alaskana* (see Hultén, 1941). It is presumed that these pairs date from pre-Wisconsin time, when they existed in the east and west as geographically separate entities or as geographic varieties in species whose continuous populations stretched across the continent. It is thought that in the latter case the connecting elements were destroyed by the advancing ice sheets, and in either case the eastern and western segregates were kept apart until after the retreat of the glaciers. The rates at which representatives of the pairs have moved into the interior subarctic plain of the continent since the retreat of glacial and glacio-lacustrine conditions should depend upon their requirements as to mesophytism, the progressive availability of lands and climates, and, following Hultén's hypothesis, upon the success with which they maintained their spreading capacity, with large populations and large numbers of biotypes, during the Late Wisconsin period.

The principal refugia for Canadian forest trees during the Late Wisconsin ice advance are thought to have been south of the ice in the western Great Lakes region and the northern Appalachians, on the exposed continental shelf off eastern Canada and the northeastern states, a western continental area centering in the upper Yukon valley or in the mountains south of it, a north Pacific coastal area, and possibly a lower Yukon or Bering Sea area. Of these refugia the ones most likely to have made large and early contributions to the flora of the Athabaska–Great Slave Lake district were in the Great Lakes region, and in the northern Rocky Mountains and the upper Yukon. Later contributions could be expected from more mesophytic elements in both these areas or from more distant ones such as the eastern continental shelf, and to a lesser extent from the Pacific areas.

A scale of mesophytism may be drawn up on the basis of the present distribution of the trees, using also for the more northern species Pulling's scale of adaptability in root habit. The least mesophytic group among the trees in our region would include the white spruce, larch, black spruce, white birch, and possibly aspen. Next would be jack pine, lodgepole pine, and balsam poplar, and finally would come the balsam fir.

Hultén, and later Halliday and Brown, have set up a scale of success among these trees in maintaining genetic variability during the Wisconsin period. All of the species are boreal in their general distribution, and it might be expected that with the progressive destruction of their normal habitats and ranges, the more mesophytic ones would suffer the greatest reduction, while those more tolerant of varied boreal conditions would suffer least. Halliday and Brown suggest that the white and black spruces had ample refugia south of the ice, consequently maintaining large genetic variability and extensive ability to migrate. The same may be said of the aspens and poplars, and possibly also of the birches and larches. The jack pines are thought to have had their refuge in the western Great Lakes region, where they were more or less restricted in space; while the lodgepole pine was restricted to relatively small refugia in the northern Cordillera. The balsam fir is thought to have been restricted to the continental shelf off northeastern America, and to limited areas south of the ice.

The white spruce consists of at least two geographic races or varieties in the region south and west of Hudson Bay. Throughout Quebec and Ontario is typical *Picea glauca,* a tall tree of broadly pyramidal form. In Keewatin, Mackenzie, northern Alberta, and northern Saskatchewan the white spruces are narrowly pyramidal or columnar in form, and represent the so-called "Alberta spruce," *Picea glauca* var. *albertiana*. This is the commonest white spruce also in the northern Rockies and in Yukon and Alaska. Trees intermediate in form between these two are seen in the southern and southwestern parts of our region; and in the Athabaska–Peace delta there are trees that could be called typical white spruce (*Plate 2*). The narrowly pyramidal habit is most accentuated in the park-like spruce type (*Plates 1, 2*).

The larches around Great Slave and Athabaska Lakes prove to be closely related to, if not identical with, the so-called Alaska larch, and it is presumed that there is a transition to the eastern form in this region and southeastward. The Alaska larch, however, has never been widely recognized among botanists, and no specimens of any kind of larch are available from the southern part of our area. Consequently the geography of these forms can at present only be conjectured.

Most of the white birches in our region are *Betula papyrifera* var. *neoalaskana,* which has its principal range from here northwestward through Alaska. Authentic *B. papyrifera* var. *commutata,* the other western variety, has been found at Lake Athabaska. The typical eastern form of the white birch extends scarcely beyond the lower Athabaska River, where it mingles with these western varieties.

Among the aspens there is a rather poorly defined Cordilleran phase called *Populus tremuloides* var. *aurea,* distinguished chiefly by the fact that its leaves turn golden yellow in the autumn. This is the common form in the upper Mackenzie valley and around Great Slave Lake, but in the central and southern parts of our region there appears to be a gradual transition to the eastern forms in which the yellow color is not marked. So far as is known at present the balsam poplars are not divisible into eastern and western races, though it is possible that such will appear upon further study.

The jack and lodgepole pines, more southern in their general distribution, have only slightly overlapped their ranges. They appear to merge in central and western Alberta, and possibly also in the lower Liard River region (see Halliday and Brown, ibid., *Fig. 4*).

The eastern and western firs, *Abies balsamea* and *A. lasiocarpa*, have not joined their ranges at all, although they apparently have come near to doing so in central Alberta. Other still more southern pairs such as the hemlocks and arborvitaes are yet far apart, and are not represented at all in the northern interior plains.

The most widespread species complexes in our forests are the spruces, larches, birches, and aspens. Also it is this group that stands lowest in the scale of mesophytism and highest in the scale of suspected ability to migrate and cope successfully with subarctic conditions. Further, they are the species that have most thoroughly merged their eastern and western racial components. The firs, on the other hand, are the most mesophytic trees we have, and among the most restricted, geographically, in our region. They are also low in the scale of suspected ability to migrate, and have not joined their eastern and western components since the retreat of the glaciers. The pines are intermediate in mesophytism and in the extent of their present northern ranges. Likewise they have been only moderately successful at merging their eastern and western types. The balsam poplars, judging by their present range, probably are to be classed with the pines in this arrangement. Halliday and Brown, however, place them among the species with the greatest spreading capacity.

The above notes suggest further that the more northerly parts of the Athabaska–Great Slave Lake region have the stronger representation of northern Cordilleran and Yukon elements in their forests. These elements are most accentuated in the park-like spruce type, wherein the western varieties of the white spruce, larch, white birch, and aspen are least "contaminated" by eastern strains. The same relationship is to be seen in other parts of the flora. The following is a list of species found around the large lakes but not thus far in the Cretaceous uplands farther south.

Woodsia oregana, Woodsia scopulina,[16] *Poa lanata, Deschampsia mackenzieana, Cyripedium guttatum, Salix MacCalliana, Salix Farrae, Arenaria macrophylla, Sorbus scopulina, Dryas Drummondii, Epilobium leptocarpum* var. *Macounii, Chimaphila umbellata* var. *occidentalis, Arctostaphylos Uva-ursi* var. *adenotricha, Trientalis europaea* var. *arctica, Pedicularis parviflora, Boschniakia rossica, Aster sibiricus,*[17] *Antennaria pulcherrima.*

It should be noted also that the black spruce–lodgepole pine forest of the foothills of the northern Rockies (see Halliday, 1937; Raup, 1945) has

[16] A few of these species have isolated stations in the Great Lakes or Gulf of St. Lawrence regions (see Fernald, 1925).

[17] *Aster Richardsonii* of the Catalogue. See Porsild in Rhod. 41: 291. 1939; Scamman in Rhod. 42: 339. 1940; Hultén, Fl. Kamtch. 4: 157–158. 1927–30, and Fl. Aleut. Isl. 317–318. 1937.

its longest range extension into the west central part of our region rather than into the southern part.

At the same time the more southern and eastern affinities of the vegetation of the lower Athabaska district are substantiated by the presence of species which, like the balsam fir and the eastern white birch, are at or near their northern limits in this vicinity.

Dryopteris spinulosa, Pteretis nodulosa, Lycopodium obscurum var. *dendroideum, Cinna latifolia, Carex Deweyana, Disporum trachycarpum, Lilium philadelphicum* var. *andinum, Corylus cornuta, Anemone cylindrica, Coptis groenlandica, Prunus demissa, Glycyrrhiza lepidota, Rhamnus alnifolia, Pyrola elliptica, Trientalis borealis, Agastache Foeniculum, Galium triflorum, Xanthium italicum, Helianthus giganteus.*

Many more species could be added to this list, but these will serve to characterize the group.

Evidence presented earlier suggests that the initial post-Pleistocene forests in our region were of park-like white spruce, with black spruce and larch in the muskegs. It is now possible to suggest that these forests came into the area from the west or southwest, and that descendants of the initial populations still persist in the pre-Cambrian region (*Fig. 6*). They are more or less isolated there by the zone of jack pine which has been accentuated and retarded in its development toward mesophytism by the scarcity and sterility of the soils. In the light of these suggestions it is reasonable to expect that in our three types of white spruce forests we are dealing with two or possibly three genetic strains within the species. Factors determining the present distribution and structure of the types, therefore, may have to include elements not only of climate, soil, and age of surface (time), but also of the inherent migratory capacities of the genetic strains that make up the populations.

One of the corollaries of the genetic theory as applied to geographic problems is that when two or more separate but closely related populations regain their continuity they acquire increased spreading capacity by the interchange and recombination of biotype material. If this can be applied to the white spruce forests in our region, then the park-like type should have somewhat less ability to colonize than the upland mesophytic and lowland types in which the eastern and western strains seem to have been combined (see *Fig. 6*).

The question naturally arises whether we have also more than one strain of jack pine. The pines that came early into the pre-Cambrian country could have been derived from a limited glacial population which would later have been merged with others to form a more aggressive type. It is not impossible that the pines of the Tazin and Taltson basin, for instance, are descendants from the early immigrants, while the "fire trees" of the Alberta Plateau are later invaders.

It will be noted from preceding discussions and from the diagram in *Fig. 6* that the earliest possible dates for the initiation of forests in the Athabaska–Great Slave Lake region were set by the progressive exposure of the land surfaces. The timing of events during the invasion by forests must have been conditioned by the availability of populations of trees in the areas immediately south and west of the retreating lakes and glaciers. This raises, in turn, the question of whether there was an interglacial vegetation between the Tazewell–Carey (W_2) and the Altamont or Mankato (W_3) glacial substages in western Canada, and of whether this vegetation could have persisted there through Late Wisconsin (W_3) time.

During Late Wisconsin time there must have been a large, roughly triangular area in Alberta and southwestern Saskatchewan that was free of ice. Its western border was at the Cordilleran glacier and its northeastern margin was approximately at the position of the ice front which finally built the Altamont moraine. Presumably its northern angle was somewhere in the upper Mackenzie valley. Its surface must have been broken by the remains of glacial lakes, and by glacial streams swollen with melt water and loaded with detritus (see Bretz, 1943). Drainage was probably southward to the Missouri. As the ice receded northeastward new lakes were formed at its border, among them those in the Athabaska and Peace River valleys. Outlets for the latter must have shifted first to the Saskatchewan, and possibly later to the Churchill.

One of the outstanding characteristics of the modern deltas and flood plains of the Athabaska, Peace and Hay Rivers is the immense amount of vegetable detritus that is being laid down in their alluvial silts. Lake Athabaska receives most of the material brought down by the Athabaska River, and it also receives a considerable quantity from the Peace. Most of the latter, however, is carried on down the Slave River and deposited on the southern shore of Great Slave Lake. Since the drainage of the last of the post-Glacial lakes these streams have nearly filled a huge western extension of Lake Athabaska, leaving only the shallow, weed-filled Lakes Claire and Mamawi. At the same time the Peace and Slave, aided at times of unusually high water by the Athabaska, have filled a great southern arm of Great Slave Lake. Driftwood, much of it in the form of large logs carried from the whole forested watershed of these rivers, is concentrated in the lower flood plains and deltas. The streams meander about in their broad valleys, shifting their channels frequently, depositing here and undercutting there. Undercut banks show thick layers of mud embedding tangles of drift timber. Spring floods often lodge mountainous piles of logs in channels that are abandoned later in the season.

The outer parts of the deltas are mud flats thickly scattered with partially buried logs. Much timber, however, finds its way into the open lakes where it is blown about by winds or carried by currents to be washed up on the beaches. At Lake Athabaska great "windrows" of such drift are common on the beaches forty to fifty miles east of the river delta, while at Great Slave Lake they line the southern shores. The Slave River leaves practically all of its load in Great Slave Lake, for the water is clear when it enters the Mackenzie.

It is of interest to note that evidence of this type of alluvial deposit has not been seen in the Mackenzie basin except in the more recently formed flood plains and deltas. If it had been developed at any of the higher lake stages, remains of it should have come to light in the dissected beds of these lakes as they are exposed in the main river valleys. Such of the older lacustrine deposits as may be interpreted as deltas are mostly of stratified sand and gravel, and contain no logs.

Around the larger lakes only the lowermost of the old beaches contain driftwood. If the earlier lakes had received any quantity of logs, some of the latter should have been embedded in the higher ancient beaches, just as the modern drift is being lodged in the current shore deposits.

A question can be raised as to the likelihood of the preservation of driftwood in the ancient deltas and beaches. There is no reason to believe that conditions here are less suitable for the preservation of vegetable remains than they are in places where interglacial forest beds have been found (see Wickenden, 1931; Wilson, 1932, 1936). Such beds are found associated not only with peat deposits, but also with glacial outwash and till. In fact preservation might be better in the colder climates of the north, where bacterial decay is exceedingly slow. Furthermore, if beds of logs had ever been present in the ancient deltas and beaches, evidence of them would still remain in the distortion and discoloration of the strata. The older deposits show neither of these effects.

The preceding observations indicate that the Peace, Athabaska, and their tributaries were not flowing through a timbered country until after the last ice had disappeared from Athabaska and Great Slave Lakes, and until after the lakes had nearly reached their present levels. They indicate further that, during late Wisconsin time, at least the northern part of the unglaciated area of Alberta had no forests of any consequence, and must have been under some form of tundra. Consequently, for all but the lowest of the old lake bottom surfaces in our region, there must have been a time interval of some length during which tundra persisted.

It is significant that the lacustrine deposits in Lake Agassiz, as well as those in the Souris basin, received driftwood only in the latest stages when most of the bottom of Lake Agassiz was finally exposed. Upham recognized the difference in kind between the sediments of the ancient lake and those of the recent alluvium. He stated it clearly as follows (1895, pp. 201–202): "After the drainage of the glacial lakes by the complete departure of the ice-sheet, the lower portions of their basins, in depressions and along the present river courses, have become filled to a considerable extent by fluvial beds of fine silt. These are similar in material with the lacustrine sediments bordering the deltas, from which they are distinguished by their containing in some places shells like those now living in the shallow lakes and streams of the region, remains of rushes and sedges and peaty deposits, and occasionally branches and logs of wood, such as are floated down by streams in their stages of flood." Again (l. c., pp. 253–254) he says, "Thus the occurrence of shells, rushes, and sedges in these alluvial beds at McCauleyville, Minn., 32 and 45 feet below the surface, or about 7 and 20 feet below the level of the Red River, of sheets of turf, many fragments of decaying wood, and a log a foot in diameter at Glyndon, Minn., 13 to 35 feet below the surface, and numerous other observations of vegetation along the Red River Valley in these beds, demonstrate that Lake Agassiz had been drained away, and that the valley was a land surface subject to overflow by the river at its stages of flood, when these remains were deposited."

The evidence from Lake Agassiz, therefore, strongly suggests that southern Alberta, Saskatchewan, and Manitoba were also devoid of forests during late Wisconsin time and during the retreat of the Mankato ice. They must not have appeared in this region until the ice had left the Lake Agassiz basin, and until after the lake had been drained.

Time relations for Lake Agassiz and the glacial lakes of the Mackenzie basin are not known. If they were contemporaneous, then the arrival of eastern forest elements in the Athabaska–Great Slave Lake region had to await the migration of these trees all the way across Manitoba and Saskatchewan. If Lake Agassiz were drained at an appreciably earlier date, the forests could have moved into southern Saskatchewan and Alberta before the northern lakes reached their lower levels, so that the tundra period for our region could have been proportionately somewhat shorter.

The existence of forest in our area during the interglacial interval between Tazewell-Carey and Mankato time is still a matter for conjecture. So far as I am aware no interglacial deposits of vegetable remains have been described in the Athabaska–Great Slave Lake region nor in the upper Peace and Athabaska River districts. Wickenden (1931) has described interglacial beds in the vicinity of Johnstone Lake in southwestern Saskatchewan. These are in and near the Altamont moraine and lie between two tills, the upper of which is to be regarded as of Mankato origin, and the lower probably of Tazewell-Carey. The beds contain vegetable remains, among them cones, branches, and logs of spruce. Presumably these are to be correlated with the Two Creeks forest bed described by Wilson (1932, 1936) in Wisconsin (See also Wilson, 1938). No species of trees other than spruce were noted by Wickenden at Johnstone Lake. Further discoveries are necessary before it will be known how far northward in the Great Plains the interglacial forests extended, and whether they achieved as great or greater floristic complexity than those now living there.

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ATHABASKA—GREAT SLAVE LAKE REGION, II

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Athabaska–Great Slave Lake Region, II

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EXPLANATION OF PLATES

PLATE I

(Upper) Park-like white spruce on ancient stony beaches near lake shore, northwest side of Fairchild Point, Great Slave Lake.

(Lower) Park-like white spruce forest on sandy beach ridges near Ennuyeuse Creek, south shore of Lake Athabaska.

PLATE II

(Upper) Park-like white spruce at western margin of active sand dune area, Wolverine Point, south shore of Lake Athabaska.

(Lower) Flood plain forest of white spruce and occasional balsam fir, upper part of the Athabaska River delta, near head of Embarras Channel.

PLATE III

(Left) Upland mesophytic forest of white spruce on Alberta Plateau near Pine Lake, west of the upper Slave River.

(Right) Jack pine and white birch on granite hill along the upper Slave River.

PLATE IV

(Upper) Open forest of jack pine in sand dune country southwest of William Point, Lake Athabaska. Note young pines.

(Lower) Jack pine forest on sand plain near Wolverine Point, Lake Athabaska.

PLATE V

(Upper) Forest of black spruce in crevices on ledges of Athabaska Sandstone, about 5 miles east of Poplar Point, Lake Athabaska.

(Lower) Muskeg forest of black spruce, Caribou Mountains.

ARNOLD ARBORETUM,
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STUDIES OF SOUTH AMERICAN PLANTS, XI NOTEWORTHY SPECIES OF HIPPOCRATEACEAE AND VACCINIACEAE

A. C. Smith

With four text-figures

The present paper is based largely upon material made available to the writer by Mr. E. P. Killip, of the U. S. National Museum, and Dr. José Cuatrecasas, of the Escuela Superior de Agricultura Tropical, Cali, Colombia. I am greatly indebted to these colleagues for forwarding such interesting material for study. The large collections made in western Colombia by Messrs. Killip and Cuatrecasas are of the greatest importance in a study of the flora of that country.. As a result of their work on the Pacific coast and slopes, a great number of new species have been discovered and many range-extensions noted. If other families in this region prove as richly represented as the Vacciniaceae, one may suppose that no other part of South America (except possibly the Venezuela–Brazil boundary) offers such fascinating possibilities to future collectors.

Specimens cited in this paper are deposited in the following herbaria: Arnold Arboretum (A), Gray Herbarium (GH), New York Botanical Garden (NY), and U. S. National Herbarium (US).

Hippocrateaceae

Elachyptera floribunda (Benth.) A. C. Sm. in Brittonia 3: 387. *fig. 3, a–n.* 1940.
Hippocratea floribunda Benth. Bot. Voy. Sulph. 78. 1844.

Colombia: El Chocó: Banks of Quebrada Togoromá, in dense tidal forest, *Killip & Cuatrecasas 39138* (A, US); El Valle: Punta Arenas, north shore of Buenaventura Bay, in mangrove swamp, *Killip & Cuatrecasas 38635* (A, US).

Except for the type collection, made by Hinds on Gorgona Island, the cited specimens are the only ones recorded from Colombia. No. *38635* bears mature fruits, which permit an amplification of my description (l. c.). The fruits formerly described and figured by me were from *Schipp 715*, the type collection of *Hippocratea lancifolia* Lundell; these are slightly smaller and proportionately broader than those of no. *38635*, but the essential details are identical.

Mature capsules lanceolate-elliptic, 5.5–7 cm. long, 1.6–2.5 cm. broad, obtuse at apex; seeds 2, the embryoniferous portion coriaceous, lanceolate-ovate, 30–40 mm. long, 11–16 mm. broad, 1.5–2 mm. thick, subacute at apex, rounded at base, the basal wing oblong, coriaceous, 6–9 mm. long, 3–4 mm. broad distally, slightly narrower at base, extended distally into a very narrow flange or inconspicuous ridge along the inner margin of the embryoniferous portion.

Anthodon decussatum R. & P. Fl. Per. 1: 45. *pl. 74, b.* 1798; A. C. Sm. in Brittonia 3: 420. *fig. 8, g–k.* 1940.

COLOMBIA: Santander: Vicinity of Barranca Bermeja, Magdalena Valley, between Sogamoso and Colorado Rivers, alt. 100–500 m., *Haught 1455* (A, US) (flowers white, very fragrant).

Both the genus and the species are here reported from Colombia for the first time. Previously *A. decussatum* has been known from Venezuela, Peru, Bolivia, and Brazil, while a second species of the genus is known from Panama. The Haught specimen was collected in 1934 but was not available when my monograph was prepared.

Tontelea chlorantha sp. nov. FIG. 1.

Frutex parvus (demum scandens?) praeter inflorescentiam ubique glaber, ramulis gracilibus cinereis teretibus (juventute leviter angulatis) inconspicue lenticellatis; foliis oppositis, petiolis rugulosis canaliculatis 7–10 mm. longis, laminis chartaceis vel subcoriaceis in sicco fusco-olivaceis elliptico-oblongis, (6–) 8–13 cm. longis, (2–) 3–4.5 cm. latis, basi obtusis, apice in acuminem 8–12 mm. longum obtusum abrupte cuspidatis, utrinque interdum nigro-punctatis, costa utrinque prominente, nervis secundariis utrinsecus 6–8 patulis subrectis marginem versus leviter curvatis anastomosantibusque et rete venularum intricato utrinque prominulis; inflorescentiis axillaribus gracilibus praeter petala glabris vel distaliter obscure puberulis, e basi 3–5-ramosis, ramulis thyrsoideo-paniculatis 3–5 cm. longis pseudodichotome divisis; bracteis papyraceis deltoideo-ovatis subacutis 0.5–1 mm. longis, bracteolis similibus sed minoribus; floribus (post anthesin mox caducis) in ramulis ultimis solitariis sub anthesi circiter 4 mm. diametro, pedicellis gracilibus 1.3–1.5 mm. longis; calyce cupuliformi circiter 1.5 mm. diametro, sepalis ovato-deltoideis, 0.4–0.5 mm. longis, 0.6–0.8 mm. latis, apice obtusis, margine obscure erosulis; petalis sub anthesi patulis submembranaceis oblongo-obovatis, 2–2.3 mm. longis, 1.3–1.5 mm. latis, apice rotundatis, extus et margine et intus apicem versus copiose (sed minute) papilloso-puberulis; disco tenuiter carnoso suberecto, 1–1.2 mm. diametro, 0.3–0.5 mm. alto, apice in lobos parvos 3 inter stamina undulato; staminibus suberectis, filamentis anguste ligulatis circiter 0.7 mm. longis, antheris transverse ellipsoideis circiter 0.2 $\times$ 0.35 mm. extrorse dehiscentibus; ovario subimmerso, ovulis in quoque loculo 2 oblique superpositis, stylo cylindrico circiter 0.5 mm. longo, stigmatibus 3 staminibus alternatis conspicue bilobatis, lobis angustis linearibus circiter 0.1 mm. longis patentibus.

COLOMBIA: Vaupés: Yuruparí, Río Vaupés, *Cuatrecasas 7312A* (TYPE, Herbario Nacional Colombiano, Bogotá), Oct. 25, 1939 (arbolillo; flor verde pálido).

A member of the species-group *Laxiflorae*, according to my treatment of the genus in Brittonia 3: 463–502. 1940, *T. chlorantha* is closely allied only to *T. corymbosa* (Huber) A. C. Sm., of Amazonian Peru. From this, the new species differs in having leaves with the secondary nerves less conspicuous and less strongly curved, the petals copiously papillose-puberulent without, and the stigmatic lobes more distinctly separate and spreading. In *T. corymbosa* the stigmas, although conspicuously bilobed, have the lobes clearly united in pairs (A. C. Sm. in op. cit. *fig. 10, m*); in *T. chlorantha* the six parts of the stigmatic shield are nearly equally spreading, although close examination reveals that the lobes are paired and alternate with the stamens.

Cheiloclinium meianthum sp. nov.

Frutex scandens ubique glaber, ramulis gracilibus teretibus nodis inconspicue complanato-incrassatis; petiolis rugulosis canaliculatis 10–14 mm. longis, laminis subcoriaceis in sicco viridi-olivaceis subtus pallidioribus, oblongo-ellipticis, 8–11 cm. longis, 3.5–5 cm. latis, basi obtusis et in petio-

FIG. 1. *Tontelea chlorantha*: *a*. flowering branchlet, × ½; *b*. flower, × 7; *c*. flower with sepals and three petals removed, showing disk, stamens, and stylar column, × 7; *d*. petal, inner surface, × 7.

lum decurrentibus, apice breviter (ad 5 mm.) et obtuse cuspidatis, margine integris incrassatis et haud recurvatis, costa utrinque prominente, nervis lateralibus utrinsecus 9–11 patentibus marginem versus leviter arcuatis utrinque inconspicue prominulis, rete venularum immerso; inflorescentiis in axillis foliorum solitariis 4–5.5 cm. longis 5 8-plo dichotome divisis, ramulis brevibus rectis gracilibus, pedunculo 2–2.5 cm. longo, bracteis bracteolisque papyraceis acutis deltoideo-ovatis 0.5–1 mm. longis, ramulis ultimis unifloris, floribus in dichotomiis nullis; pedicellis sub anthesi circiter 1 mm. longis, floribus sub anthesi circiter 2 mm. diametro; sepalis membranaceis semiorbicularibus circiter 0.3 × 0.5 mm. rotundatis erosulis; petalis submembranaceis oblongis, 1–1.3 mm. longis, 0.8–1 mm. latis, apice rotundatis, integris, obscure glandulosis, linea media paullo incrassatis; disci labiis 3 minutis circiter 0.1 mm. altis et 0.3 mm. latis; staminibus 3, filamentis subteretibus circiter 0.4 mm. longis, antheris circiter 0.2 × 0.3 mm. modo generis dehiscentibus; ovario depresso-subgloboso sub anthesi 0.7–0.8 mm. diametro, stigmatibus 3 obscure deltoideis simplicibus circiter 0.1 mm. longis, ovulis 2 in quoque loculo collaterali-superpositis; fructibus juvenilibus ovoideis, pericarpio duro ruguloso.

BRAZIL: Matto Grosso: Salto Belo, Rio Sacre, just below falls, *J. T. Baldwin, Jr. 3122* (A, TYPE, US), Oct. 23, 1943 (woody vine; fruit about the size of a hen's egg and yellowish [not available with specimen]).

Clearly a member of the species-group *Serrata* as outlined in my recent treatment (in Brittonia 3: 528. 1940), *C. meianthum* is most closely related to *C. Jenmani* A. C. Sm., of British Guiana, from which it differs in its smaller leaf-blades, with the apex more shortly cuspidate, the secondary nerves more numerous and less sharply curved, and both secondaries and veinlets much less obvious, and in its slightly more compact inflorescences. The flowers of the two species are essentially identical, but *C. Jenmani* has flowers borne in the ultimate dichotomies, which does not appear to be the case in the new species.

Loesener, in a recent treatment (in Nat. Pfl. ed. 2. 20b: 171. 1942), has unaccountably referred *Cheiloclinium* to the Celastraceae, although *Kippistia* Miers is placed in the synonymy of *Salacia* (op. cit. 221) as *Salacia* § *Kippistieae*. The congeneracy of *Cheiloclinium* and *Kippistia* seems beyond question, and the remarkably distinct characters of the group set it far apart from *Salacia* (for discussion see Brittonia 3: 526–528. 1940).

VACCINIACEAE

One of the most interesting aspects of the extensive collections made in Pacific Colombia in recent years by Messrs. Killip and Cuatrecasas has been the discovery at low elevations of numerous representatives of the Vacciniaceae. This family, in tropical America, is predominantly montane — to such an extent that only a few years ago representatives from an elevation of less than 1000 m. were rarities. Supposed exceptions were *Anthopterus Wardii* Ball and *Macleania pentaptera* Hoer., which already at the time of my study of the group in 1932 (Contr. U. S. Nat. Herb. 28: 311 seq.) had been collected in mangrove swamps around Buenaventura. It now appears that six members of the Vacciniaceae occur in mangrove swamps in this general area, although, to my knowledge, species of the family are nowhere else in America reported from this habitat. Several other species of Pacific Colombia are reported from tidal forest or from essentially sea-level forest.

No fewer than 42 species of Vacciniaceae are now known from Pacific Colombia at elevations of 1000 m. or less. In view of the fact that only a few of these were known and included in my treatment of 1932, that work is entirely inadequate as far as the family in western Colombia is concerned. Therefore it has seemed advisable to list all those species known from the Pacific slopes of Colombia at altitudes of 1000 m. or less. In the following list, the species are those of the present writer unless another authority is indicated; entities described as new in the present treatment are marked by an asterisk.

Anthopterus bracteatus (although the original collection bears the inscription "Timbiquí above Popayán," it is likely that the town close to the Pacific coast near sea-level is intended).
Anthopterus cuneatus (reported from Nariño at 1000 m. alt.).
Anthopterus Wardii Ball (sea-level, sometimes in mangrove swamps, and upward to 1200 m.).
Calopteryx insignis** (near sea-level).
Cavendishia adenophora Mansf. (from about 700 m. upward to 2000 m. alt. or more).
*Cavendishia chlamydantha** (near sea-level).
Cavendishia chocoensis (at low elevations, El Chocó).
Cavendishia coccinea (350–450 m. alt., and also reported at 2500 m.).
Cavendishia compacta (near sea-level, and also reported at 1800 m.).
Cavendishia hispida (at low elevations, El Chocó).
*Cavendishia micrantha** (at low elevations).
Cavendishia palustris (sometimes in mangrove swamps).
*Cavendishia praestans** (at low elevations, and sometimes in mangrove swamps).
Cavendishia Quereme (H. B. K.) Benth. & Hook. f. (from about 400 m. upward to about 1700 m. alt.).
Cavendishia splachnoides (at low elevations, El Chocó).
*Cavendishia striata** (from about 100 m. upward to about 2000 m. alt.).
*Cavendishia tenella** (alt. 200–350 m.).
*Cavendishia urophylla** (sea-level to 100 m. alt.).
Cavendishia venosa (near sea-level, and also upward to 1000 m. alt. or more).
*Cavendishia violacea** (near sea-level).
Killipiella styphelioides (at low elevations, El Chocó).
Macleania pentaptera Hoer. (sea-level, often in mangrove swamps, and upward to 1000 m. alt. or more).
*Macleania tropica** (near sea-level).
*Psammisia aberrans** (alt. 350–450 m.).
Psammisia caloneura (Nariño, probably at about 900 m. alt.).
[*Psammisia chionantha* Sleumer (northwestern Ecuador at low elevations, to be expected in adjacent Colombia).]
Psammisia coccinea Sleumer (at low elevations).
*Psammisia macrocalyx** (alt. 350–450 m.).
Psammisia occidentalis (at low elevations, sometimes in tidal forest or at edges of mangrove swamps).
*Psammisia pacifica** (near sea-level).
*Psammisia pedunculata** (at low elevations, El Chocó).
*Satyria bracteolosa** (near sea-level).
*Satyria dolichantha** (near sea-level, in tidal forest).
Satyria grandifolia Hoer. (near sea-level and upward to 1400 m. or possibly 2100 m. alt.).
*Satyria leptantha** (alt. 900–1180 m.).
Sphyrospermum buxifolium Poepp. & Endl. (in tidal forest and upward to 2000 m. alt. or more).
Sphyrospermum ellipticum Sleumer (near sea-level, and upward to 1000 m. alt. or more).
Sphyrospermum majus Gr'seb. (at low elevations, sometimes in mangrove swamps, and upward to about 2000 m. alt.).
Thibaudia Andrei (Nariño, probably at low elevations).
Thibaudia Archeri (at low elevations).
Thibaudia pachyantha (Nariño, at about 900 m. alt.).
*Thibaudia pachypoda** (near sea-level).
Thibaudia paniculata (Timbiquí, El Cauca; see note under *Anthopterus bracteatus*).

Sphyrospermum buxifolium Poepp. & Endl. Nov. Gen. & Sp. **1**: 4. *pl. 8.* 1835; A. C. Sm. in Brittonia **1**: 207. 1933.

COLOMBIA: El Chocó: Banks of Quebrada Togoromá, in dense tidal forest, *Killip*

& Cuatrecasas 39082 (US) (epiphyte, with drooping branches; corolla white); El Valle: Río Calima (región del Chocó), La Trojita, 5–50 m. alt., *Cuatrecasas 16651* (GH) (frutículo epifito; hoja coriácea, rígida, verde; ramas rojizas; corola blanca; baya lilacina, pálida).

This species has seldom if ever been recorded from lower elevations than 750 m.

Sphyrospermum majus Griseb. Fl. Brit. W. Ind. 143. 1859; A. C. Sm. in Brittonia 1: 209. 1933.

COLOMBIA: El Valle: Buenaventura Bay, in mangrove swamp, *Killip 34963* (NY, US) (epiphytic shrub; corolla white); Estero de Bodegas, south shore of Buenaventura Bay, in mangrove swamp, *Killip & Cuatrecasas 38662* (A, US) (dependent epiphyte with white flowers and fruit); Costa del Pacífico, Río Cajambre: Barco, 5–80 m. alt., *Cuatrecasas 17131* (GH) (frútex epifito con ramas rígidas, colgantes; cáliz verdoso amarillento pálido; corola blanca).

Although *S. majus* has been obtained from fairly low elevations, I have not previously seen specimens from sea-level or from mangrove swamps.

Sphyrospermum ellipticum Sleumer in Rep. Sp. Nov. 41: 121. 1936.

COLOMBIA: El Valle: Dense forest along highway from Buenaventura to Cali, near sea-level, *Killip & Cuatrecasas 39003* (A, US) (epiphyte with drooping branches; corolla white); Cordillera Occidental, vertiente occidental: Hoya del Río Digua, lado izquierdo: Piedra de Moler, bosques, 900–1180 m. alt., *Cuatrecasas 14920A* (GH).

The cited specimens agree perfectly with Sleumer's original description of *S. ellipticum*, previously known only from northwestern Ecuador at low elevation. The species is more likely to be confused with *S. majus* than with *S. buxifolium*, but it is readily recognized by its minute corollas and comparatively large obtuse leaves. Probably *Archer 1872*, from Quibdó, on Río Atrato, El Chocó, which I cited as dubiously representing *S. majus* (in Brittonia 1: 210. 1933), is also referable to *S. ellipticum*.

Macleania tropica sp. nov.

Frutex epiphyticus, ramulis elongatis teretibus gracilibus glabris castaneis mox decorticantibus; foliis glabris vel disperse et minute pilosis, petiolis gracilibus 2–3 mm. longis, laminis in sicco chartaceis viridi-olivaceis oblongo-lanceolatis, (3–) 4–6 cm. longis, 1.3–2 cm. latis, basi obtusis vel cuneatis, superne in acuminem peracutum 5–12 mm. longum gradatim attenuatis, margine leviter recurvatis, costa et nervis utrinsecus 2 paullo supra basim orientibus adscendentibus supra subplanis vel leviter insculptis subtus valde elevatis, rete venularum utrinque haud viso; floribus axillaribus solitariis vel binis, pedicellis, calyce et corolla obscure puberulis glabrescentibus, pedicello gracili sub anthesi 7–10 mm. longo basi bracteis 6–8 circumdato, bracteis parvis imbricatis papyraceis oblongo-deltoideis, interioribus circiter 1.5 mm. longis; calyce sub anthesi 6–8 mm. longo inconspicue angulato, tubo 2–3 mm. longo et lato, limbo papyraceo erecto anguste cylindrico-vasculari 4–5 mm. longo 5-dentato, dentibus minute apiculatis, sinibus complanatis; corolla tenuiter carnosa cylindrico-urceolata, sub anthesi 23–25 mm. longa, basim versus 3.5–4.5 mm. diametro, superne contracta, intus glabra, lobis 5 deltoideis subacutis circiter 2 mm. longis; staminibus 10, 12–14 mm. longis, filamentis in tubum glabrum 6–8 mm. longum connatis, antheris 6–7 mm. longis, tubulo unico quam thecis paullo breviore, rima circiter 1.5 mm. longa; stylo filiformi corollam subaequante truncato.

COLOMBIA: El Valle: Costa del Pacífico, Río Cajambre: Barco, 5–80 m. alt., *Cuatrecasas 17103* (GH, TYPE), 21–30 abril, 1944 (arbusto epifito; hoja coriácea, verde oscuro en el haz, claro en el envés; cáliz verdoso rosado; corola roja).

The new species is closely related only to the montane *M. antioquiae* Fedtsch. & Basil., differing in its more gradually attenuate and sharply pointed leaf-blades, its faintly angled rather than obviously winged calyx, its much longer calyx-limb, its longer corolla, which is strictly glabrous within rather than pilose at the throat, and its longer stamens.

Psammisia pedunculata sp. nov.

Frutex gracilis interdum epiphyticus ubique filamentis exceptis glaber, ramulis elongatis gracilibus teretibus cinereis; petiolis rugulosis subteretibus 1–4 mm. longis; laminis chartaceis vel pergamentaceis in sicco fusco-viridibus lanceolato-oblongis, (6–) 9–13 cm. longis, (2–) 2.5–4.5 cm. latis, basi late obtusis, in apicem gracilem 1–2 cm. longum subacutum conspicue caudato-acuminatis, margine integris, 5(vel 7-)-nerviis, costa nervisque principalibus adscendentibus ad 1.5 cm. concurrentibus supra impressis subtus prominentibus, nervis extimis marginalibus brevibus utrinque haud prominulis, rete venularum intricato utrinque prominulo; inflorescentia apicem ramulorum versus axillari suberecta racemosa 5–13-flora pedunculo conspicuo 3.5–9.5 cm. longo incluso 6–12 cm. longa, pedunculo (inferne interdum inconspicue bracteolatis) et rhachi subteretibus gracilibus; pedicellis teretibus sub anthesi 11–18 mm. longis et 0.5–1 mm. diametro (superne incrassatis), bracteis submembranaceis deltoideis acutis circiter 1.5 mm. longis cito caducis subtentis, basim versus inconspicue bibracteolatis, infra articulationem conspicuam minute glanduloso-denticulatis; calycis tubo cupuliformi sub anthesi circiter 2 mm. longo et 3.5 mm. diametro basi rotundato, limbo submembranaceo erecto-patente circiter 1.5 mm. longo, lobis 5 late deltoideis apiculatis, sinibus complanatis; corolla in sicco membranacea (in vivo ut videtur carnosa) subgloboso-urceolata, circiter 5 mm. longa et medium inflatum versus 7 mm. diametro, basi et apice valde contracta, faucibus circiter 2 mm. diametro, lobis 5 suberectis deltoideis obtusis circiter 1×1.5 mm.; staminibus 10 circiter 3.5 mm. longis, filamentis liberis membranaceis ligulatis circiter 2 mm. longis superne obscure hispidulo-ciliolatis apicem thecarum versus antheris connectis, connectivo brevi nigrescente inconspicue et obtuse calcarato, antheris 2.5–3 mm. longis crassis (circiter 1 mm. diametro), thecis 1.7–2.3 mm. longis valde granulosis basi incurvis et obtusis, tubulis anguste conicis 0.6–1 mm. longis basi subconnatis, rimis ovalibus tubulos subaequantibus; stylo crasso tereti corolla subaequali, stigmate truncato; fructibus obovoideo-globosis rugulosis 7–8 mm. diametro limbo calycis persistente coronatis.

COLOMBIA: El Chocó: La Concepción, 15 km. east of Quibdó, alt. about 75 m., *W. A. Archer 2002* (NY, US no. 1,519,095, TYPE), April 20–May 23, 1931 (slender shrub 1–3 m. high; pedicels Chinese red; corolla pale green), *Archer 2209* (US); Corcovado region, upper Río San Juan, ridge along Yeracüi Valley, alt. 200–275 m., in dense forest, *Killip 35304* (NY, US) (on tree; branches of inflorescence and calyx red; leaves lustrous above); dense forest south of Río Condoto, between Quebrada Guarapo and Mandinga, alt. 120–180 m., *Killip 35681* (NY, US) (epiphyte).

The specimens cited above were originally referred to *P. breviflora* (Benth.) Kl., a montane Colombian species which probably does not occur below 1500 m. However, *P. breviflora* is the closest ally of the new species, which differs in having its inflorescence much longer and with a conspicuous peduncle, its pedicels shorter, its corolla usually shorter and proportionately more inflated at the middle, and its stamens smaller and proportionately stouter.

Psammisia occidentalis A. C. Sm. in Am. Jour. Bot. 27: 452. 1940.

COLOMBIA: El Chocó: Banks of Quebrada Togoromá, in dense tidal forest, *Killip & Cuatrecasas 39110* (A, US); El Valle: Río Calima (región del Chocó), La Trojita, *Cuatrecasas 16278* (GH); Punta Arenas, north shore of Buenaventura Bay, *Killip & Cuatrecasas 38640* (A, US) (non-inundable woods at edge of mangrove swamp); Agua Clara, along highway from Buenaventura to Cali, *Killip & Cuatrecasas 38869* (A, US); Río Cajambre, Barco, *Cuatrecasas 17009* (GH); Río Yurumanguí, Veneral, *Cuatrecasas 15801* (GH); El Cauca: Río Micay, orilla derecha, en Caliche, *Cuatrecasas 14188* (GH).

The cited collections indicate that this species is fairly abundant along the Pacific coast of Colombia and extend its known range slightly southward. All were obtained at elevations of less than 100 meters, some being from sea-level. The cited material includes specimens with excellent flowers, which in size are similar to the larger flowers mentioned in my original description; the type of the species has rather smaller flowers, which are apparently not fully mature. The plant is said to be either an epiphytic or terrestrial shrub; the pedicels and calyces are red, and the corolla is yellow or greenish with green lobes.

Psammisia macrocalyx sp. nov.

Frutex magnus ramulosus 5–6 m. altus corolla filamentisque exceptis glaber, ramis subscandentibus, ramulis crassis obtuse angulatis demum subteretibus; petiolis nigrescentibus rugulosis crassis (2.5–3 mm. diametro) circiter 2 cm. longis; laminis in sicco chartaceo-coriaceis fusco-olivaceis oblongo-ellipticis, 20–25 cm. longis, 8.5–10 cm. latis, basi obtusis et in petiolum decurrentibus, apice in acuminem 8–12 mm. longum obtusum abrupte cuspidatis, margine leviter recurvato-incrassatis, e basi 5-nerviis, costa nervisque (duobus proximis suprabasalibus) supra acute impressis subtus prominentibus, rete venularum copioso supra leviter subtus valde prominulo; inflorescentiis axillaribus breviter racemosis 5–8-floris basi bracteis 4–6 imbricatis minutis circumdatis, rhachi 13–20 mm. longa rugulosa subflexuosa 1.5–2 mm. diametro, floribus bracteis papyraceis deltoideis obtusis 2–3 mm. longis subtentis; pedicellis crassis (1.5–2.5 mm. diametro) teretibus rugulosis 2–3 cm. longis cum calyce conspicue articulatis medium versus 2- vel 3-bracteolatis, bracteolis subcoriaceis deltoideis subacutis 1.5–2 mm. longis; calyce magno coriaceo campanulato 15–18 mm. longo, apice 10–15 mm. diametro, tubo cupuliformi sub anthesi 5–6 mm. longo, limbo erecto-patente quam tubo duplo longiore in lobis 5 subaequalibus profunde fisso, lobis deltoideo-oblongis subacutis 5–6 mm. longis basi 5–7 mm. latis, sinibus acutis; disco annulari-pulvinato crasse carnoso; corolla carnosa cylindrico-suburceolata 30–38 mm. longa, basim versus 7–10 mm. diametro, faucibus paullo angustata, extus distaliter pilis dispersis adpressis glandulosis brunneis 0.2–0.4 mm. longis pilosa, profunde 5-lobata, lobis erectis oblongis subacutis 6–8 mm. longis basi 3–5 mm. latis; staminibus 10, 12–13 mm. longis, filamentis liberis papyraceis ligulatis 5–6 mm. longis 2–2.5 mm. latis margine distali pilis pallidis 0.2–0.5 mm. longis dense ciliolatis, connectivis crassis subcoriaceis conspicue bicalcaratis, calcaribus erecto-patentibus obtusis, antheris rigidis circiter 10 mm. longis, thecis circiter 1.5 mm. crassis basi in appendicem subacutam circiter 0.7 mm. longam productis, tubulis quam thecis duplo brevioribus inferne lateraliter connatis superne liberis per rimas ovales circiter 2 mm. longas dehiscentibus; stylo crasso tereti corollam subaequante apice leviter incrassato.

COLOMBIA: El Valle: Cordillera Occidental, vertiente occidental: Hoya del Río Anchicayá, lado derecho, bosques entre Pavas y Miramar, 350–450 m. alt., *Cuatrecasas 14419* (GH, TYPE), 16 abril 1943 (gran frútex de 5–6 metros, muy ramificado; ramas bejucosas; pedúnculos y cáliz rojo-escarlatas mates; corola carmín, brillante, con el extremo esmeralda, luego rojizo).

Psammisia macrocalyx is a very distinct species, with combinations of characters (e.g., very large flowers and short inflorescences) not found in other described species. Its closest relative is probably *P. chionantha* Sleumer, from northwestern Ecuador, but the new species differs in its longer petioles, slightly larger leaf-blades, much shorter racemes, larger calyx (especially as to the coarse deltoid-oblong lobes), glandular-pilose corolla, and distally ciliolate filaments.

Psammisia coccinea Sleumer in Rep. Sp. Nov. **41**: 120. 1936.

COLOMBIA: El Chocó: Río San Juan, cercanías de Palestina, 5–50 m. alt., *Cuatrecasas 16929* (GH) (frútex epifito; hoja coriácea, verde claro; cáliz y corola rojocárdenos, ⅓ sup. corola blanco); El Valle: Forest along Río Sabaletas, near km. 29 of highway from Buenaventura to Cali, alt. 25 m., *Killip & Cuatrecasas 38858* (US) (epiphytic shrub with elongate branches; old calyx pinkish red); Río Cajambre, Barco, 5–80 m. alt., *Cuatrecasas 17026* (GH) (arbusto bejucoso; hoja coriácea, rígida, verde amarillento medio; cáliz rosado-cárdeno, ápice más claro; corola rosado-cárdena con dientes blancos).

This species, previously recorded only from the type collection from northwestern Ecuador at 150 m. alt., is almost certainly represented by the above-cited Colombian collections. Minor differences between our specimens and the original description are discernible, such as the often caudate-acuminate leaf-apex (1–3 cm. long), the often longer pedicels (7–15 mm. long in flower, up to 40 mm. long in young fruit), the slightly larger calyx (5–8 mm. long), the sometimes shorter corolla (25–28 mm. long at anthesis), and the distally puberulent rather than strictly glabrous filaments. These points appear to be minor variations; in general the species is well characterized by its large 5-nerved leaf-blades, its membranaceous campanulate minutely toothed calyx-limb, its corolla being remarkably thin and papery in texture when dried, and its short stout anthers.

Psammisia pacifica sp. nov.

Frutex epiphyticus corolla juvenili excepta ubique glaber, ramis dependentibus, ramulis elongatis teretibus; petiolis rugosis teretibus crassis (2–3 mm. diametro) 7–10 mm. longis; laminis in sicco chartaceo-coriaceis fuscis anguste oblongo-ellipticis, 17–22 cm. longis, 5–7 cm. latis, basi gradatim angustatis, apice in acuminem 8–15 mm. longum obtusum terminantibus, margine integris, e basi 5-nerviis, costa nervisque duobus proximis apicem fere attingentibus supra valde impressis subtus prominentibus, nervis basalibus duobus marginalibus inconspicuis utrinque prominulis, rete venularum copioso utrinque plus minusve prominulo;

inflorescentiis ex axillis foliorum plerumque delapsorum ortis racemosis 7–15-floris basi bracteis paucis minutis circumdatis, rhachi 3–5 cm. longa leviter angulata 2–3 mm. diametro, floribus bracteis papyraceis oblongis obtusis 4–5 mm. longis mox caducis subtentis; pedicellis teretibus rugulosis crassis (1.5–2 mm. diametro) sub anthesi 16–22 mm. longis, apicem versus conspicue bibracteolatis, bracteolis subcoriaceis oblongo-deltoideis acutis 2–3.5 mm. longis; calyce coriaceo late campanulato sub anthesi 5–7 mm. longo et apice 7–9 mm. diametro, tubo cupuliformi ruguloso 2–3 mm. longo, limbo subpatente quam tubo paullo longiore, lobis 5 late apiculato-deltoideis circiter 1 mm. longis, sinibus rotundatis vel fere complanatis; corolla subcarnosa cylindrico-urceolata sub anthesi 28–35 mm. longa, basim versus 5–7 mm. diametro, faucibus angustata, juventute distaliter obscure et pallide puberula mox glabrescente, profunde 5-lobata, lobis oblongo-deltoideis subacutis 3–4 mm. longis 2–3 mm. latis demum recurvatis; staminibus 10, 11–12 mm. longis, filamentis in tubum subcarnosum circiter 4 mm. longum connatis demum subliberis, connectivis carnosis gracilibus apice bicalcaratis, calcaribus staminum alternorum subobscuris et conspicuis, conspicuioribus patenti-recurvatis obtusis circiter 0.5 mm. longis, antheris 9–9.5 mm. longis, thecis 1–1.2 mm. crassis basi abrupte incurvatis et obtusis, tubulis quam thecis paullo brevioribus inferne connatis apice liberis per rimas ovales circiter 2 mm. longas dehiscentibus; stylo crasso tereti sub anthesi quam corolla paullo longiore apice truncato.

COLOMBIA: El Valle: Costa del Pacífico, Río Cajambre: Silva, 5–80 m. alt., *Cuatrecasas 17616* (GH, TYPE), 5–15 mayo 1944 (frútex epifito con ramas péndulas; hoja coriácea, verde amarillento oscuro; pedúnculos, cáliz y dos tercios corola cárdenos; extremo de la corola blanco).

Psammisia pacifica is a species of the general affinity of the montane *P. macrophylla* (H. B. K.) Kl., from which it differs in having its leaf-blades distinctly narrowed toward the base with the principal nerves oriented from the extreme base, in having its calyx smaller, with a more spreading limb and less obvious lobes, and in having its filaments, at least in fairly mature flowers, connate. In this last character the new species suggests *P. columbiensis* Hoer., a species with smaller leaves, smaller flowers, and more obvious calyx-lobes. From both the mentioned species, *P. pacifica* differs in having the sinuses of its calyx rounded or flattened rather than obviously acute.

Psammisia aberrans sp. nov.

Arbor parva ad 6 m. alta corollis juvenilibus exceptis glabra, ramulis gracilibus teretibus vel hornotinis obtuse angulatis; petiolis rugulosis teretibus crassis (2–3 mm. diametro) 1–1.5 cm. longis; laminis siccitate chartaceis fuscis oblongo-ellipticis, (14–) 18–20 cm. longis, 6–8 cm. latis, basi acutis vel cuneatis, apice in acuminem 13–20 mm. longum obtusum abrupte angustatis, margine leviter recurvatis, e basi 5-nerviis, costa nervisque duobus proximis suprabasalibus apicem fere attingentibus supra leviter impressis subtus prominentibus, nervis basalibus duobus extremis submarginalibus supra paullo subtus valde prominulis, rete venularum conspicuo utrinque prominulo; inflorescentiis e ramulis infra folia ortis breviter racemosis 7–15-floris basi bracteis minutis deltoideis paucis circumdatis, rhachi 1–2 cm. longa obtuse angulata circiter 2 mm. diametro, floribus bracteis papyraceis oblongo-deltoideis subacutis 2–3.5 mm. longis caducis subtentis; pedicellis teretibus 1–1.5 mm. diametro sub anthesi 13–25 mm. longis medium versus bibracteolatis, bracteolis bracteis basalibus similibus; calyce subcoriaceo campanulato sub anthesi 7–9 mm. longo et apice diametro, tubo cupuliformi circiter 4 mm. longo, limbo erecto-patente tubum subaequante, in lobis 4 vel 5 irregulariter fisso, lobis ovato-deltoideis 1.5–3.5 mm. longis 3–5 mm. latis apice acutis vel apiculatis margine leviter incrassatis, sinibus acutis; corolla subcarnosa cylindrico-urceolata sub anthesi 28–32 mm. longa, basim versus 7–9 mm. diametro, superne angustata, juventute distaliter minute brunneo-puberula glabrescente, lobis 5 oblongis subacutis circiter 3×2 mm.; staminibus 10, 12–13 mm. longis, filamentis submembranaceis liberis ligulatis 3–4 mm. longis, connectivis gracilibus carnosis apice alternatim leviter incrassatis ecalcaratis; antheris 10–11 mm. longis gracilibus, thecis circiter 1 mm. crassis in basim subacutam incurvatam leviter productis, tubulis quam thecis paullo brevioribus liberis vel subconnatis per rimas ovales circiter 2 mm. longas dehiscentibus; stylo crasso tereti corollam subaequante apice truncato.

COLOMBIA: El Valle: Cordillera Occidental, vertiente occidental: Hoya del Río Anchicayá, lado derecho, bosques entre Pavas y Miramar, 350–450 m. alt., *Cuatrecasas 14392* (GH, TYPE), 16 abril 1943 (arbolito de 6 metros; tallo 10 cm. diámetro; pedúnculos y cáliz rosado-cárdenos; mitad o dos tercios inferiores de la corola rojo-cárdenos, parte superior blanca; fruto verde).

Psammisia aberrans is superficially very suggestive of the preceding new species (*P. pacifica*), but it is distinguished by obvious characters pertaining to its calyx, of which the lobes are large and the sinuses acute, and its anthers, which are unspurred. Furthermore, the new species differs from *P. pacifica* in having the inner pair of secondaries of its leaves concurrent with the costa for 5–10 mm., its rachis much shorter, its pedicels less highly bracteolate, and its filaments free. From *P. macrophylla* (H. B. K.) Kl., perhaps a closer relative, the new species differs in its leaf-base, its less prominent fourth and fifth basal nerves, its shorter rachis and pedicels, and its unspurred anthers.

The advisability of placing in *Psammisia* a species with ecalcarate anthers may well be questioned, and indeed will be questioned by students following Macbride's suggestion (in Univ. Wyom. Publ. **11**: 43, 44. 1944) that *Psammisia* and *Macleania* be combined and even submerged in *Thibaudia*. Although the presence of anther-spurs has long been used as the most obvious character separating *Psammisia* from *Macleania*, there are also supplementary characters of habit and foliage which serve to distinguish these two groups in the eyes of most students of the family. Other species of *Psammisia*, namely *P. penduliflora* (Dun.) Kl., *P. Hookeriana* Kl., and *P. Ulbrichiana* Hoer., have frequently obscure anther-spurs; but their relationships, like those of *P. aberrans*, are clearly with species of *Psammisia* with spurred anthers.

As to the advisability of reducing *Psammisia* and *Macleania* to *Thibaudia*, this seems to the writer quite unjustified, since at any rate the three groups would presumably be maintained as strong subgenera or sections, thus accomplishing nothing but further confusion of the generally accepted nomenclature. The shifting of coherent groups of species from generic to subgeneric rank does not necessarily clarify the complexities of reticulate phylogeny. Admittedly the problem of small vs. large genera is often solved by personal taste; in the Vacciniaceae I see no reason at present to combine the genera of "Thibaudieae" into larger concepts, merely because some students still maintain *Vaccinium* in an inclusive unwieldy sense. As to the traditional division of the family into Vaccinieae and Thibaudieae, this has been considered unsound by recent students (e.g., the writer in Jour. Wash. Acad. Sci. 33: 243. 1943); but this fact in itself does not prejudice the status of generic concepts.

Thibaudia pachypoda sp. nov.

Frutex epiphyticus ubique filamentis interdum exceptis glaber, ramulis apicem versus 3–6 mm. crassis conspicue angulatis, vetustioribus teretibus cinereis decorticantibus; petiolis crassis (2–3 mm. diametro) 7–15 mm. longis rugosis leviter biangulatis; laminis rigide coriaceis siccitate olivaceis ovato-ellipticis, 8–15 cm. longis, 4–8 cm. latis, in basim cuneatam in petiolum decurrentem angustatis, apicem versus gradatim attenuatis et in acuminem callosum brevem ad 10 mm. longum cuspidatis, margine integris et incrassato-recurvatis, subtus disperse brunneo-glanduloso-punctatis, pinnatinerviis, costa supra paullo subtus valde prominente, nervis secundariis utrinsecus plerumque 3 adscendentibus curvatis anastomosantibus supra prominulis subtus valde elevatis, rete venularum conspicuo utrinque plus minusve prominulo; inflorescentiis axillaribus breviter racemosis 2–5-floris, rhachi crassa angulata 3–10 mm. longa basim versus bracteis minutis paucis caducis ornata, bracteis floriferis subcoriaceis oblongis obtusis circiter 3 mm. longis; pedicellis sub anthesi 3–4 cm. longis crassis (in sicco basi circiter 1.5 mm. diametro superne ad 3–4 mm. diametro incrassatis, in vivo ut videtur carnosis subteretibus), cum calyce conspicue articulatis, 1–4 mm. supra basim bibracteolatis, bracteolis subcoriaceis deltoideis subacutis circiter 2 mm. longis; calyce coriaceo cupuliformi siccitate ruguloso 8–10 mm. longo apice 7–8 mm. diametro, tubo 4–5 mm. longo basi rotundato, limbo erecto tubum subaequante vel paullo excedente inconspicue 5-denticulato, dentibus 0.3–0.5 mm. longis, sinibus complanatis, disco pulvinato centro depresso; corolla carnosa cylindrica sub anthesi 27–31 mm. longa et basim versus 7–8 mm. diametro, superne gradatim angustata, lobis 5 oblongo-deltoideis obtusis 2–2.5 mm. longis et latis; staminibus 10 corollam fere aequantibus, 23–26 mm. longis, filamentis submembranaceis liberis ligulatis 3–5 mm. longis glabris vel margine interdum obscure pallide ciliolatis, antheris elongatis 21–24 mm. longis, thecis circiter 1.5 mm. crassis basi subacutis et leviter incurvatis in tubulos gradatim transeuntibus, tubulis quam thecis duplo brevioribus per rimas elongatas dehiscentibus; stylo crasso tereti quam corolla paullo breviore apice leviter incrassato.

COLOMBIA: El Valle: Río Calima (región del Chocó), La Trojita, 5–50 m. alt., *Cuatrecasas 16616* (GH, TYPE), 19 febr.–10 mar. 1944 (frútex epifito; hoja gruesa, coriácea, rígida, verde claro; pedúnculo cárdeno; cáliz rosado; corola rosada o rosado-blanquecina o blanco-violácea); Costa del Pacífico, Río Yurumanguí: Veneral, bosques, 5–50 m. alt., *Cuatrecasas 15824* (GH) (frútex epifito; hoja rígida, coriácea, verde claro; pedúnculo rojo con el extremo blanco-verdoso; cáliz verdoso-blanquecino; corola blanco-verdosa).

This striking species is characterized by its coriaceous coarsely veined leaf-blades, stout pedicels, large thick flowers, and very long stamens. Its only close allies are *T. Andrei* A. C. Sm. (known only from Nariño at presumably low elevations) and *T. rigidiflora* A. C. Sm. (from montane Colombia). From *T. Andrei* the new species is distinguished by its cupuliform rather than distinctly apophysate calyx-tube and its proportionately short calyx-limb, from *T. rigidiflora* by its distally tapering and pointed rather than obtuse leaf-blades, its larger (but similarly shaped and proportioned) calyx, and its longer stamens. From both of its allies, *T. pachypoda* differs in its shorter rachis and longer and stouter pedicels and corollas.

Thibaudia Archeri A. C. Sm. in Contr. U. S. Nat. Herb. **28:** 426. *pl. 12.* 1932.

COLOMBIA: El Valle: Costa del Pacífico, Río Cajambre: Barco, 5–80 m. alt., *Cuatrecasas 17259* (GH) (frútex bejucoso; pedúnculos y ramas de la inflorescencia rosado-cárdenos; frutos blancos; corola blanca); Costa del Pacífico, Río Yurumanguí: El Papayo, bosques, 10–20 m. alt., *Cuatrecasas 15986* (GH) (epifito).

These gratifying collections, the second and third of the species, extend its range southward from the type-locality in El Chocó. Our plants are identical with the type in all respects, except that they have frequently larger leaf-blades (up to 32 × 9 cm.) and slightly shorter filaments (3–4 mm. long in mature flowers).

Thibaudia parvifolia (Benth.) Hoer. in Bot. Jahrb. **42:** 275. 1909; A. C. Sm. in Contr. U. S. Nat. Herb. **28:** 428. 1932.

COLOMBIA: El Cauca: Cordillera Central, Páramo del Puracé al sur del Volcán en el filo de la Cordillera: San Francisco, 3400–3450 m. alt., *Cuatrecasas 14593* (GH) (frútex de 2 m.; corola rojo vivo; cáliz rojizo), *14674A* (GH) (frútex; hoja crasocoriácea, verde claro; corola roja).

To my knowledge this attractive small-flowered *Thibaudia* has not otherwise been collected since Hartweg obtained the type, also in El Cauca at high altitude. Although our specimens are identical with the type in all essential details, the following variation should be noted: leaf-blades somewhat broader, not quite so strongly revolute or sulcate as those of the type; pedicel longer, up to 14 mm. long; calyx-tube glandular-strigillose at base; corolla dispersed-glandular-strigillose without as well as faintly puberulent. No. *14593* bears essentially mature fruits, which are ellipsoid, about 10 × 7 mm., rugulose, surmounted by the persistent conspicuous calyx-limb.

Thibaudia aurantia sp. nov.

Frutex ramulosus, ubique (i.e. ramulis, foliis, bracteis bracteolisque, pedicellis, calycibus corollisque) pilis mollibus cinereo-albis patulis 0.5–1 mm. longis dense indutus; ramulis gracilibus subteretibus demum glabrescentibus; petiolis subteretibus inconspicuis 2 3 mm. longis; laminis coriaceis ovatis, 2–3 cm. longis, 1.5–2.2 cm. latis, basi rotundato-subcordatis, apice acutis et calloso-apiculatis, margine integris et valde incrassatis, utrinque minute rugulosis, supra demum subglabrescentibus, costa supra subplana subtus paullo elevata, nervis secundariis utrinsecus 2 vel 3 e basi vel intimis e costa prope medium orientibus utrinque obscuris vel subtus leviter elevatis, venulis immersis; inflorescentia uniflora axillari bracteis 2 linearibus 4–5 mm. longis caducis subtenta, bracteis sub floribus ut videtur 2 vel 3 papyraceis oblongo-lanceolatis 3–3.5 mm. longis subacutis intus glabris; pedicellis sub anthesi 2–2.5 cm. longis basim versus bracteolas 2 bracteis similes gerentibus, cum calyce inconspicue articulatis; calyce sub anthesi 7–9 mm. longo, tubo cupuliformi circiter 3.5 mm. longo et diametro basi rotundato, limbo erecto-patente tubum paullo excedente papyraceo intus glabro et multinervio profunde 5-lobato, lobis ovatis acute cuspidatis 3–4 mm. longis circiter 3 mm. latis, sinibus acutis, disco annulari-pulvinato glabro; corolla tenuiter carnosa cylindrica sub anthesi 19–21 mm. longa et circiter 7 mm. diametro, intus praeter apices loborum tomentellos glabra, lobis 5 ovato-deltoideis obtusis circiter 1.5 × 3 mm.; staminibus 10 circiter 11 mm. longis, filamentis membranaceis in tubum 3–3.5 mm. longum dorso distaliter pallide tomentellum connatis, connectivis gracilibus pilosis superne furcatis, antheris 8–8.5 mm. longis, tubulis quam thecis paullo longioribus per rimas ovales 1.2–1.5 mm. longas dehiscentibus; stylo gracili tereti corollam subaequante, stigmate obscure peltato.

COLOMBIA: El Cauca: Cordillera Central, vertiente oriental cerca del filo: Quebrada del Río San Marcos, entre Jardín y San Rafael, 2700–2900 m. alt., *Cuatrecasas 14762* (GH, TYPE), 25 julio 1943 (frútex ramificado; corola anaranjada, ápice blanquecino).

This well-marked species has no close described relatives in Colombia, belonging to a group of species otherwise known from Peru and Bolivia (spp. 36–40 in my treatment in Contr. U. S. Nat. Herb. 28: 410–439. 1932). It is readily distinguished from all of these and from more recently described entities of this group by its pubescent habit, small ovate callose-apiculate leaf-blades with thickened entire margins, one-flowered inflorescences, and deeply lobed calyx-limb.

Thibaudia mundula sp. nov.

Frutex, ramulis teretibus cinereo-puberulis subglabrescentibus; petiolis semiteretibus rugulosis parce puberulis 3–5 mm. longis; laminis coriaceis ovato-ellipticis, 15–21 mm. longis, 9–12 mm. latis, basi late obtusis, apice calloso-apiculatis, margine subintegris (obscure glanduloso-denticulatis) recurvatis incrassatis, utrinque disperse nigro-punctatis juventute minute puberulis mox glabris, costa supra obscure impressa subtus inconspicue elevata, nervis lateralibus paucis venulisque immersis; inflorescentia axillari 1- vel 2-flora bracteis obscuris lineari-oblongis circiter 2.5 mm. longis subtenta, bracteis floriferis papyraceis ovato-deltoideis acutis 1–2 mm. longis extus parce pilosis; pedicellis calycibus corollisque pilis pallidis 0.2–0.5 mm. longis indutis, pedicellis rugulosis subteretibus sub anthesi 10–13 mm. longis basim versus bracteolas 2 bracteis similes gerentibus, cum calyce articulatis; calyce sub anthesi circiter 6 mm. longo, tubo cupuliformi circiter 3 mm. longo et 2.5 mm. diametro basi rotundato obscure brunneo-glanduloso-strigilloso, limbo erecto-patente tubum subaequante papyraceo intus glabro et 5-nervio, lobis 5 deltoideis subacutis circiter 2 × 2.5 mm., sinibus obtusis, disco annulari-pulvinato glabro; corolla tenuiter carnosa cylindrica sub anthesi 13–15 mm. longa et circiter 5 mm. diametro, intus praeter apicem parce pilosum glabra, lobis 5 deltoideis obtusis circiter 1 × 2.5 mm.; staminibus 10 circiter 10 mm. longis, filamentis membranaceis in tubum circiter 5 mm. longum dorso distaliter obscure puberulum connatis, connectivis gracilibus pallide pilosis apice furcatis, antheris circiter 6 mm. longis, tubulis thecas subaequantibus per rimas circiter 2 mm. longas dehiscentibus; stylo gracili corollam subaequante apice paullo incrassato.

COLOMBIA: El Cauca: Cordillera Central en la vertiente occidental del macizo del Huila: Cabeceras del Río Palo, Quebrada del Río López, quebradita del Duende, 3450 m. alt., *Cuatrecasas 19144* (A, TYPE), 6 dic. 1944 (frútex epífito; hoja craso-coriácea, verde claro, brillante en el haz, pálido en el envés; cáliz verdoso; corola vermellón).

Although *T. mundula* is obviously most closely related to the preceding new species (*T. aurantia*), numerous characters readily separate the two plants; the most obvious of these are conveniently expressed in a key:

Leaf-blades 20–30 × 15–22 mm., soft-pilose on both sides, rounded-subcordate at base; pedicels 20–25 mm. long; flowers soft-pilose with hairs 0.5–1 mm. long; calyx-limb with many nerves ascending from base and loosely anastomosing, the sinuses deeply acute; corolla 19–21 mm. long; filament-tube 3–3.5 mm. long, the anthers 8–8.5 mm. long. . . . . *T. aurantia*.

Leaf-blades 15–21 × 9–12 mm., essentially glabrous, broadly obtuse at base; pedicels 10–13 mm. long; flowers closely pilose with hairs 0.2–0.5 mm. long; calyx-limb with 5 nerves, these terminating in lobes and with few lateral branches, the sinuses obtuse; corolla 13–15 mm. long; filament-tube about 5 mm. long, the anthers about 6 mm. long. . . . . *T. mundula*.

Calopteryx gen. nov.

Calyx cum pedicello conspicue articulatus, tubo profunde ruguloso, limbo suberecto 5-lobato. Corolla e basi ad apices loborum conspicue 5-alata. Stamina 10 aequalis quam corolla paullo breviora, filamentis in tubum connatis antheris dorso apicem thecarum versus conjunctis, connectivo inconspicuo angusto, antheris erectis gracilibus, thecis leviter granulosis basi obtusis, tubulis e basi liberis flexibilibus amplis quam thecis multo longioribus per rimas elongatas introrsas dehiscentibus. Stylus quam corolla paullo brevior. Ovarium 5-loculare, placentis axillaribus e basi gracili incrassatis, ovulis minutis numerosissimis obtectis.

Plantae lignosae, ramulis elongatis, foliis alternatis estipulatis petiolatis, laminis magnis e basi plurinerviis. Inflorescentia e ramulis defoliatis orta paniculata ampla, ramulis floribusque bracteis parvis subpersistentibus subtentis, pedicellis bibracteolatis.

The name of this new genus, represented by the single species described below, is derived from καλος, beautiful, and πτερυξ, wing, referring to the long delicate wings of the corolla.

Calopteryx insignis sp. nov. FIG. 2.

Frutex epiphyticus inflorescentiis exceptis ubique glaber, ramulis floriferis robustis ad 2 cm. diametro cortice sublevi brunneo obductis, ramulis foliiferis gracilibus (2–3 mm. diametro) teretibus cinereis; petiolis subteretibus rugulosis incrassatis (2.5–4 mm. diametro) 7–10 mm. longis; laminis siccitate subcoriaceis fusco-olivaceis oblongo-lanceolatis, 27–36 cm. longis, 6–9 cm. latis, basi obtusis, in apicem caudatum plus minusve 2 cm. longum (apice ipso non viso) gradatim attenuatis, margine integris et leviter recurvatis, e basi 5(vel inconspicue 7-)-nerviis, costa nervisque principalibus adscendentibus elongatis supra impressis subtus prominentibus, nervis marginalibus brevibus inconspicuis utrinque prominulis, rete venularum laxo utrinque subprominulo; inflorescentia in specimine nostro floribus inclusis circiter 11.5 cm. longa et 15 cm. lata, pedunculo ramulisque crassis rugulosis parce brunneo-puberulis demum glabratis, pedunculo brevi

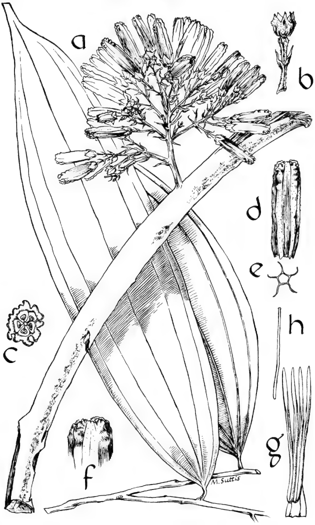

FIG. 2. *Calopteryx insignis:* *a.* flowering branchlet and a branchlet with two attached leaves, $\times \frac{1}{2}$; *b.* pedicel and calyx, $\times$ 1; *c.* cross-section of ovary, $\times 2\frac{1}{2}$; *d.* corolla, $\times$ 1; *e.* cross-section of corolla, $\times$ 1; *f.* apex of corolla, $\times 1\frac{1}{2}$; *g.* two adjacent stamens, $\times$ 2; *h.* style, $\times$ 1.

(circiter 1.5 cm. longo) et rhachi 6–7 cm. longis, ramulis primariis circiter 8 patentibus, ramulis secundariis paucis; bracteis sub ramulis pedicellisque papyraceis concavis lanceolatis, 7–11 mm. longis, basi 2–3 mm. latis, in acuminem gradatim attenuatis, extus puberulis, intus glabris; pedicellis sub anthesi 9–18 mm. longis paullo complanatis validis, basi et apice incrassatis, infra articulationem 2–3.5 mm. diametro, pilis circiter 0.2 mm. longis brunneis dispersis indutis, medium versus conspicue bibracteolatis, bracteolis bracteis similibus 4–7 mm. longis circiter 2 mm. latis; calyce cupuliformi sub anthesi circiter 8 mm. longo et apice diametro, ut pedicellis piloso, tubo carnoso profunde ruguloso-sulcato sed non angulato sub anthesi circiter 5 mm. diametro, disco patelliformi subcarnoso glabro margine crenulato-serrulato, limbo membranaceo tubum subaequante intus glabro e basi inconspicue multinervio, lobis ovato-deltoideis acutis 3–4 × 4–5 mm., sinibus acutis; corolla in sicco membranacea in vivo forsan carnosa, sub anthesi 28–35 mm. longa et alis inclusis 7–10 mm. diametro, ut pedicellis parce pilosa, apice ipso circiter 1.5 mm. diametro, alis membranaceis 2–4 mm. latis basi angustioribus distaliter obscure erosulis, lobis paullo incrassatis deltoideis acutis circiter 1 mm. longis latisque; staminibus ubique glabris 25–27 mm. longis, filamentorum tubo membranaceo pallido 5–6 mm. longo, antheris membranaceis 23–25 mm. longis, thecis 4–5 mm. longis in tubulos 5–6-plo longiores gradatim transeuntibus; stylo filiformi circiter 0.5 mm. diametro, stigmate leviter incrassato truncato.

COLOMBIA: El Valle: Río Calima (región del Chocó), La Trojita, 5–50 m. alt., *Cuatrecasas 16295* (GH, TYPE), 19 febr.–10 mar. 1944 (arbusto epifito; tallo aspecto caneloso; corola rosada o rojiza, dientes blancos).

In its isomorphic stamens with nearly smooth thecae and flexible tubules with clefts of indeterminate length, the entity described above agrees with *Thibaudia* R. & P. and several related genera. From all of these, however, it differs in characters which seem generic in quality. The long corollas with conspicuous wings extending along the entire length, the extremely elongate anther-tubules, and the copiously branching inflorescence are noteworthy characters. *Thibaudia* itself has cylindric or at most lightly angled corollas, and its anthers have tubules rarely more than twice as long as the thecae. In foliage and general type of inflorescence, *Calopteryx* is suggestive of *Thibaudia Archeri* A. C. Sm. and its immediate relatives, and this may indeed represent the closest approach of the new genus to any described group. However, I do not believe that the concept of *Thibaudia* should be expanded to include a plant with such a conspicuously winged corolla and such extremely elongated anther-tubules. Although *Thibaudia* is already a rather heterogeneous aggregate (as noted by the writer in Bull. Torrey Bot. Club **63**: 316. 1936), to include *Calopteryx* in it does not seem warranted. A contrary opinion would doubtless be expressed by students agreeing with Macbride, who (in Univ. Wyom. Publ. **11**: 37–46. 1944) proposes to include in *Thibaudia* such genera as *Anthopterus* Hook., *Macleania* Hook., *Psammisia* Kl., *Diogenesia* Sleumer, and *Demosthenesia* A. C. Sm. It will be admitted that the characters of *Calopteryx* can be approximated here and there among the above genera; but for that matter so can the characters of nearly every other genus of Vacciniaceae. In short, the genera in this family must be based upon combinations of characters, the value of various combinations resting upon personal opinion for the time being — but perhaps eventually upon genetic analysis. The alternative to recognizing small genera (although several have 25–100 species) in the Vacciniaceae seems to be to recognize very few, or perhaps only one. Should the latter course be followed, the resulting maze of subgenera, sections, and subsections would be quite unintelligible to the average student; such a treatment would hardly seem likely to clarify the sequence of species-development (*vide* Macbride, op. cit. 44).

Although perhaps it is most closely allied to *Thibaudia*, the new genus should also be compared with *Anthopterus* Hook. and *Plutarchia* A. C. Sm. From the first of these it differs in having its calyx articulate with the pedicel and unwinged, its anther-tubules much longer in proportion, its inflorescence paniculate, and its flowers much larger. *Plutarchia* is a group of north Andean compact small-leaved plants with unwinged corolla and few-flowered, compact, and axillary or subterminal inflorescence; in its elongate flexible anther-tubules *Plutarchia* suggests *Calopteryx*. In habit these three genera are entirely unlike.

Themistoclesia pterota sp. nov.

Frutex interdum epiphyticus, ramulis cinereis teretibus validis glabris; petiolis inconspicuis ad 1.5 mm. longis, foliis subsessilibus interdum subamplexicaulibus; laminis chartaceo-coriaceis in sicco olivaceis ubique glabris oblongo-ovatis, (4–) 6–9 cm. longis, 2.3–4.3 cm. latis, basi profunde cordatis, apice obtusis vel obtuse cuspidatis (acumine ad 5 mm. longo), margine paullo recurvatis, e basi 7- vel 9(raro 11-)-nerviis, costa et nervis interioribus supra leviter elevatis subtus subprominentibus, nervis secundariis valde arcuatis, exterioribus brevibus inconspicuis, rete venularum utrinque subimmerso haud prominulo; inflorescentia axillari pluriflora racemosa vel saepe in ramulos 2 vel 3 adscendentes divisa, rhachi ramulis pedicellisque gracilibus minute puberulis, bracteis sub ramulis floribusque subpersistentibus elliptico-oblongis 1–2 mm. longis; pedicellis 3–8 mm. longis saepe pluribracteolatis et calyce parce puberulis etiam obscure nigro-pilosis; calyce late turbinato circiter 5 mm. longo et lato, tubo anguste 5-alato, limbo papyraceo erecto-patente lobis inclusis circiter 1.5 mm. longo apice minute 5-denticulato et puberulo-ciliolato; disco conspicuo annulari-pulvinato glabro circiter 1.5 mm. diametro et 0.5 mm. alto; corolla tenuiter carnosa siccitate submembranacea glabra ad apices loborum anguste 5-alata urceolata, 6–7.5 mm. longa, basim versus 4–5 mm. diametro, faucibus ad 1.5 mm. diametro contracta, alis submembranaceis inferne 0.6–1 mm. latis superne angustioribus in lobis exeuntibus, lobis 5 deltoideis subacutis 0.7–1 mm. longis demum recurvatis; staminibus 10 quam corolla paullo brevioribus, filamentis pallidis membranaceis ligulatis alternatim 2–2.5 mm. et 2.5–3 mm. longis, medium versus laxe pilosis superne angustatis, antheris 4–4.5 mm. longis, tubulis quam thecis duplo longioribus per rimas circiter 1 mm. longas dehiscentibus; stylo 5.5–7 mm. longo truncato; bacca modo generis exsucca manifeste angulata quam calyce sub anthesi haud majore.

COLOMBIA: El Valle: Cordillera Occidental, vertiente occidental: Hoya del Río Sanquininí, lado izquierdo, La Laguna, bosques, 1250–1400 m. alt., *Cuatrecasas 15422* (GH) (frútex; epiñta), *15501* (GH TYPE), 10–20 dic. 1943 (frútex epiñto; hoja coriácea, verde claro, brillante en el haz, verde blanquecino en el envés; cáliz verde claro; corola blanca; baya azul, blanda).

Themistoclesia pterota, although the essential characters of its flowers and fruits are those of *Themistoclesia,* differs from the other described species of the genus in its winged corollas, while the deeply cordate and subamplexicaul leaves are scarcely suggestive of the genus. Nevertheless, *Themistoclesia* seems indubitably to be the correct place for this remarkable plant. Its alliance is probably with *T. crassifolia* Sleumer, from which it differs not only in its corolla, but also in its short petioles, its smaller leaf-blades which are more deeply cordate at base and merely obtuse or obtusely cuspidate at apex, its sometimes branched inflorescence, and its shorter pedicels.

Themistoclesia epiphytica A. C. Sm. in Jour. Arnold Arb. **24**: 470. 1944.

COLOMBIA: El Cauca: Cordillera Central: Páramo del Puracé al sur del Volcán en el filo de la Cordillera: San Francisco, 3400–3450 m. alt., *Cuatrecasas 14674* (GH) (frútex; hoja craso-coriácea verde claro; corola roja).

The cited collection represents a slight extension of range of this species, previously known from the highlands of Nariño and Putumayo. Both earlier collections are indicated as epiphytic, but at this altitude it is not surprising to find individuals of a species either terrestrial or epiphytic.

Cavendishia striata sp. nov.

Cavendishia complectens sensu A. C. Sm. in Contr. U. S. Nat. Herb. **28**: 468. 1932, non Hemsl. nec A. C. Sm. op. cit. 448.

Frutex (semper?) epiphyticus ubique glaber, ramulis teretibus gracilibus (apicem versus 1.5–3 mm. diametro) interdum ruguloso-striatis; foliis subsessilibus saepe valde amplexicaulibus, petiolis validis angulatis ad 5 mm. longis sed plerumque subnullis; laminis coriaceis in sicco viridi-olivaceis late ovatis vel suborbicularibus, (5–)8–18 cm. longis, (5–)7–16.5 cm. latis, basi profunde cordatis, apice rotundatis, margine leviter recurvatis, 7–11-nerviis, nervis principalibus secundariis e basi vel ad 3 cm. supra basim orientibus arcuato-patentibus cum costa supra leviter elevatis vel subplanis subtus prominentibus, nervis basalibus extimis inconspicuis submarginalibus utrinque prominulis, rete venularum intricato utrinque perspicue prominulo; inflorescentia terminali vel subterminali racemosa 8–12-flora, basi bracteis parvis paucis imbricatis circumdata, pedunculo subnullo, rhachi sub anthesi 1.5–2.5 cm. longa obscure angulata 1.5–2 mm. diametro; bracteis floriferis papyraceis oblongo-ellipticis, 8–12 mm. longis, 5–8 mm. latis, apice rotundatis, margine obscure et saepe decidue glanduloso-ciliolatis, utrinque nervis adscendentibus parallelis numerosis conspicue striatis, interdum extus rugulosis; pedicellis teretibus 1–1.5 mm. diametro sub anthesi 1.5–8 mm. longis basim versus decidue bibracteolatis, bracteolis papyraceis oblongis subacutis fimbriolatis 2–4 × 1–2 mm.; calyce campanulato sub anthesi 5.5–7.5 mm. longo et apice 3.5–6 mm. diametro, tubo cupuliformi 2–2.5 mm. longo basi truncato-rotundatis, limbo papyraceo vel subcoriaceo suberecto 3.5–5 mm. longo intus venis parallelis validis striato profunde 5-lobato, lobis oblongis 1.5–3 × 1.5–2.5 mm. apice rotundatis vel obtusis margine glanduloso-ciliolatis et anguste imbricatis, sinibus acutis; corolla tenuiter carnosa cylindrico-urceolata, sub anthesi 6–10 mm. longa et medium versus 2.5–4 mm. diametro, apice contracta, lobis 5 oblongo-deltoideis subacutis circiter 1 × 1 mm.; staminibus 10 subaequalibus 5–7 mm. longis, filamentis membranaceis ligulatis alternatim 2–2.5 mm. et 3–3.5 mm. longis interdum distaliter inconspicue hispidulis, antheris alternatim 2.5–5.5 mm. et 2–5 mm. longis, thecis 1–2 mm. longis, tubulis quam thecis longioribus fere ad basim fissis; stylo gracili tereti quam corolla paullo breviore, stigmate truncato.

COLOMBIA: El Chocó: Andagoya, alt. 70–100 m., *Killip 35066* (A, NY, US) (epiphytic shrub in second growth forest; bracts white); El Valle: Cordillera Occidental, vertiente occidental: Hoya del Río Digua, lado derecho, La Elsa, bosques, 1000–1200 m. alt., *Cuatrecasas 15306* (GH, TYPE), 9 nov. 1943 (frútex epifito, ramoso, divaricado; hoja craso-coriácea, verde claro, brillante en el haz, mate envés; brácteas rojo carmín; pedúnculos rosados; cáliz verde blanquecino; corola en los tercios inferior y superior blanca, en la mitad negra); Hoya del Río Sanquininí, lado izquierdo, La Laguna, bosques, 1250–1400 m. alt., *Cuatrecasas 15430* (GH) (frútex epifito; hoja craso-coriácea verde claro, rígida; brácteas rosado-cárneas; cáliz blanco; corola en la ⅓ inf. gris o negra, ⅓ sup. blanca); El Cauca: "La Gallera," Micay Valley, alt. 1800–2000 m., *Killip 7909* (NY) (in forest); ad pag. El Tambo, La Costa, alt. 800 m., *von Sneidern 838* (NY) (in silva primaeva). [ECUADOR: Pichincha: Nono, *Sodiro 92/36* (Bot. Mus. Berlin, not now available).]

In 1932 I cited two South American collections as representing *C. complectens* Hemsl., the type of which is Costa Rican, but the accumulation of additional good flowering collections from Colombia in the interim has made a reconsideration of this complex desirable. It now seems that rather obvious characters of the bracts and calyx make it inadvisable to include the Colombian material in *C. complectens,* which is, however, closely allied. The chief differences between the two entities may be summarized as follows:

Flower-subtending bracts striate, the principal veins parallel, ascending, strongly raised on both surfaces; rachis 1.5–2.5 cm. long; calyx-lobes oblong, longer than broad (1.5–3 × 1.5–2.5 mm.), narrowly imbricate, striate within with strong parallel veins; western Colombia and Ecuador............................*C. striata.*

Flower-subtending bracts smooth on both surfaces, not striate, the venation obscurely reticulate, immersed; rachis 3–10 cm. long; calyx-lobes broadly ovate-suborbicular, broader than long (2.5–4 × 3–4.5 mm.), conspicuously and broadly imbricate, narrowed at base, smooth on both surfaces, the venation reticulate, immersed; Costa Rica and Panama....................................*C. complectens.*

In texture of bracts, *C. striata* is suggestive of two Panamanian species recently described by the writer — *C. gaultherioides* and *C. Allenii* — but characters of foliage and flowers readily separate these two species from both the new entity and *C. complectens*. *Cavendishia striata* has an unusually broad altitudinal range, extending from near sea-level up to 1800–2000 m.

Cavendishia compacta A. C. Sm. in Contr. U. S. Nat. Herb. **28**: 468. 1932.

COLOMBIA: El Valle: Río Calima (región del Chocó), La Trojita, 5–50 m. alt., *Cuatrecasas 16316* (GH) (arbusto epifito; hoja coriácea, rígida, verde brillante en el haz, mas claro el envés; brácteas rosado-cárdenas; cáliz y corola blancos o blanco-rosados; fruto azul); El Chocó: Entre Carmen de Atrato y Tutunendo, valle del alto Atrato, 500–600 m. alt., *Garcia-Barriga 11124* (US), *11127* (US) (arbol 3–4 m.; brácteas amarillo-rojas; flores rosadas).

The cited specimens are fundamentally similar to the type of this very distinct species, but they are slightly more robust throughout, having leaf-blades up to 9 cm. broad, corollas up to 24 mm. long, and other inflorescence-parts correspondingly large. As in the case of *Satyria grandifolia,* discussed below, there is reasonable doubt as to the actual locality and altitude of the Triana type-specimen. The label of the type-sheet at Kew reads: "Cordillère du Choco, Prov. de Cauca & Choco, hauteur 1800 metr." It is quite possible that the species has a narrower altitudinal range than indicated by the Triana label.

Cavendishia tenella sp. nov.

Frutex ubique glaber, ramulis crassis (distaliter 4–7 mm. diametro) in vivo ut videtur molliter teneribus in sicco acute angulatis; petiolis foliorum maturorum rugulosis validis 1–2 cm. longis canaliculatis superne conspicue alatis; laminis maturis chartaceo-coriaceis in sicco supra metallico-viridibus subtus pallidioribus brunneo-glanduloso-punctatis, elliptico-oblongis, 8–13 cm. longis, 4–7 cm. latis, basi obtusis et subito in petiolum late decurrentibus, apice obtuse cuspidatis, margine leviter revolutis, plerumque 7-nerviis, costa et nervis 4 superioribus e basi orientibus (vel intimis ad 1 cm. concurrentibus) adscendentibus supra impressis subtus prominentibus, nervis extimis submarginalibus inconspicuis utrinque prominulis, rete venularum copiose intricato utrinque prominulo; inflorescentia subterminali (vel axillari?) racemosa ad 10 cm. longa basi cicatricibus pluribus bractearum caducarum notata, plus minusve epedunculata, multiflora, rhachi crassa (2.5–4 mm. diametro) leviter angulata basi pedicellorum incrassata; floribus ut videtur 35–50, bracteis floriferis submembranaceis ellipticis, circiter 15 mm. longis, paullo angustioribus, apice rotundatis, margine integris scariosis; pedicellis teretibus 3–7 mm. longis crassis (1–1.5 mm. diametro, apice ad 3 mm. conspicue incrassatis) medium versus bibracteolatis, bracteolis subcarnosis oblongis obtusis circiter 1.5 mm. longis margine copiose glanduliferis; calyce carnoso-coriaceo campanulato sub anthesi 7–8 mm. longo et 5–7 mm. diametro, basi rotundato, tubo brevi 1.5–2.5 mm. longo, disco centro depresso, limbo erecto tubum multo excedente, lobis 5 oblongis 4–4.5 mm. longis circiter 5 mm. latis, apice rotundatis vel leviter emarginatis, margine glanduloso-incrassatis et valde imbricatis; corolla molliter carnosa cylindrico-urceolata 10–11 mm. longa, medium versus 5–6 mm. diametro, apice ad 3 mm. diametro contracta, lobis 5 deltoideis obtusis circiter 1×1.5 mm.; staminibus 10 subaequalibus circiter 9 mm. longis, filamentis membranaceis primo subconnatis mox liberis ligulatis, alternatim circiter 2.5 mm. et 3.5 mm. longis, superne angustatis et obscure pilosulis, antheris alternatim circiter 8.5 mm. et 7.5 mm. longis, thecis circiter 3 mm. longis, tubulis thecas excedentibus, rimis elongatis; stylo tereti corollam subaequante, stigmate obscure peltato.

COLOMBIA: El Valle: Cordillera Occidental, vertiente occidental: Hoya del Río Anchicayá, lado derecho, bajando a La Planta, bosques, 200–350 m. alt., *Cuatrecasas 15210* (GH, TYPE), 27 sept. 1943 (gran frútex; brácteas blancas; cáliz verde claro, luego con bordes rosado-violáceos; corola verdoso-pálida con el extremo más o menos rosado, semi-transparente, cérea, con estrecha coronita rosada, con 5 dientes cortos de borde violáceo; ramas muy tiernas (cogollos) con un penacho de hojas cárdeno vivo, ténues, con un invólucro de estípulas blancas).

This striking plant is to be associated with a small group of species characterized by imbricate calyx-lobes and very short pedicels, occurring from Costa Rica to Pacific Colombia. The closest ally of *C. tenella* is doubtless *C. compacta* A. C. Sm., from which it differs in having its branchlets apparently softer and hence angled in drying, in having its petioles conspicuously angled by means of the long-decurrent bases of leaf-blades, in its differently shaped leaf-base, much shorter leaf-apex, and more basally oriented secondaries, in its more densely flowered racemes, and in its much shorter corolla and stamens.

Cavendishia praestans sp. nov.

Frutex plerumque epiphyticus ubique corollis filamentisque exceptis glaber, ramis saepe crassis nodosis, ramulis subteretibus cinereis rugulosis; petiolis subteretibus rugulosis validis (5–) 8–17 mm. longis; laminis subcoriaceis in sicco fusco-olivaceis oblongis vel anguste elliptico-oblongis, (7–) 15–25 cm. longis, (2–) 5–11 cm. latis, basi truncato-rotundatis vel leviter subcordatis, in apicem plerumque 1–3 cm. longum obtusum vel subacutum subito angustatis, margine anguste recurvatis, subtus interdum brunneo-punctatis, 5- vel 7-nerviis, costa et nervis 4 principalibus e basi orientibus vel paullo suprabasalibus supra impressis subtus prominentibus, nervis extimis marginalibus inconspicuis, rete venularum intricato utrinque prominulo; inflorescentia terminali vel apicem ramulorum versus axillari racemosa multiflora basi bracteis numerosis imbricatis (extimis minoribus, intimis bracteis floriferis similibus) circumdata, rhachi robusta 2–4 mm. diametro obtuse angulata (5–) 8–15 cm. longa, bracteis floriferis (juventute valde imbricatis) submembranaceis vel papyraceis ovato- vel obovato-oblongis 15–30 $\times$ 10–20 mm. apice rotundatis; pedicellis subteretibus crassis (basi circiter 1 mm. diametro superne ad 2 mm. infra articulationem incrassatis) sub anthesi 5–15 mm. longis, basim versus bibracteolatis, bracteolis papyraceis ovato-oblongis acutis 3–4.5 mm. longis 1.5–2 mm. latis distaliter calloso-incrassatis; calyce oblongo sub anthesi 6–8 mm. longo et apice 5–7 mm. diametro, tubo sulcato 2–3 mm. longo superne leviter constricto, limbo erecto subcoriaceo 4–5.5 mm. longo, lobis 5 deltoideis acutis 1.5–2.5 $\times$ 2.5–3 mm. ubique conspicue calloso-incrassatis, sinibus obtusis; corolla in sicco submembranacea (in vivo forsan tenuiter carnosa) cylindrica, 17–23 mm. longa, 5–7 mm. diametro, utrinque leviter angustata, extus pilis 0.5–1 mm. longis pallidis copiose hispidula, lobis 5 oblongo-deltoideis obtusis 1.2–2 mm. longis latisque; staminibus subaequalibus corollam fere aequantibus (15–21 mm. longis), filamentis submembranaceis ligulatis angustis interdum sparse hispidulis alternatim 2.5–5 mm. et 7–10 mm. longis, antheris alternatim 14–19 mm. et 10–13 mm. longis, thecis 6–9 mm. longis basi obtusis, tubulis thecas subaequantibus, rimis elongatis; stylo corollam subaequante tereti circiter 0.5 mm. diametro, stigmate truncato; fructibus juvenilibus ad 7 mm. diametro basi incrassatis apice limbo calycis coronatis.

Colombia: El Chocó: Dense forest south of Río Condoto, between Quebrada Guarapo and Mandinga, alt. 120–180 m., *Killip 35127* (A, US) (epiphyte; bracts pink); banks of Quebrada Togoromá, in dense tidal forest, *Killip & Cuatrecasas 39145* (A, US) (epiphytic shrub; calyx pinkish white, shiny; corolla pink, with white hairs); Río San Juan, cercanías de Palestina, 5–50 m. alt., *Cuatrecasas 16917* (GH) (frútex epifito; hoja coriácea, rígida, verde claro; pedúnculos blancos; cáliz blanco-rosado; brácteas rosadas); El Valle: Estero de Bodegas, south shore of Buenaventura Bay, in mangrove swamp along Río Potedó, *Killip & Cuatrecasas 38678* (A, TYPE, US), June 2, 1944 (shrub; bracts pink; corolla white); Agua Clara, along highway from Buenaventura to Cali, alt. about 100 m., in dense forest, *Killip & Cuatrecasas 38880* (A, US) (epiphytic shrub; bracts pink; calyx pinkish white; corolla white); Río Dagua, in forest about 20 km. east of Buenaventura, alt. about 40 m., *Killip & García 33305* (US) (shrub, along stream; bracts red; corolla white); Costa del Pacífico, Río Cajambre: Quebrada del Corosal, 0–5 m. alt., *Cuatrecasas 17733* (arbusto epifito; hoja coriácea, rígida, verde brillante haz, claro y brillante envés; brácteas rosado-cárdenas; corola peluda, blanca); Estero del Cangrejal, entre las bocanas de los Ríos Yurumanguí y Naya, *Cuatrecasas 16020* (GH) (arbusto epifito del mangle; brácteas y cáliz rosados; corola blanca; hoja rígida coriácea, verde pálido); Antioquia: Guapá, 53 km. south of Turbo (Golfo de Uraba), alt. about 60 m., *Haught 4603* (A, US) (epiphytic shrub in crown of forest; bracts pink; corolla white).

From *C. hispida* A. C. Sm., its closest ally, the new species differs primarily in having its branchlets and leaves, even in a young state, strictly glabrous rather than copiously hispid-pilose. The leaf-blades of *C. hispida* are more or less subbullate, the principal veinlets being impressed above, whereas in *C. praestans* the veinlets are prominulous on both surfaces. The inflorescence of the new species is more robust and more copiously floriferous than that of *C. hispida,* and its corollas (similarly pubescent) are somewhat shorter. Although these differences are not of a striking nature, they are constant among the available specimens. Admittedly the group composed of these two species, *C. bomareoides,* and *C. splachnoides* needs further consideration on the basis of more ample material.

The occurrence of the new species in the Atlantic littoral of Antioquía is particularly interesting, suggesting that other species of the Pacific coast are to be expected around the mouth of the Río Atrato.

Cavendishia violacea sp. nov.

Frutex epiphyticus post anthesin ubique glaber, ramulis apicem versus gracilibus (2–3 mm. diametro) dense foliatis leviter angulatis subviolaceis mox subteretibus et cinereis; petiolis 2–5 mm. longis subteretibus rugulosis; laminis coriaceis subbullatis oblongis, (4–) 7–10 cm. longis, (1.7–) 2.5–4.5 cm. latis, basi truncato-rotundatis, apice in acuminem 1–2 cm. longum acutum attenuatis, margine paullo recurvatis, pinnatinerviis, costa supra conspicue elevata subtus prominente, nervis secundariis utrinsecus 3–5 e costa infra medium orientibus adscendentibus parallelis subrectis supra in sulculis leviter prominulis subtus valde elevatis, rete venularum copiose intricato utrinque paullo prominulo; inflorescentia axillari vel terminali racemosa 10–15-flora basi bracteis imbricatis ad 15 mm. longis (extimis multo minoribus) circumdata, bracteis floriferis submembranaceis ellipticooblongis, 15–17 mm. longis, 7–12 mm. latis, basi et apice rotundatis, inconspicue nervatis, pedunculo subnullo, rhachi post anthesin crassa obtuse angulata 5–10 cm. longa; pedicellis teretibus post anthesin 7–13 mm. longis, basim versus circiter 1 mm. diametro, apice leviter incrassatis et articulatione glandulas parvas oblongas 6–8 gerentibus, basim versus minute bibracteolatis, bracteolis subcoriaceis oblongis obtusis 0.5–0.7 mm. longis; calyce post anthesin circiter 5 mm. longo et apice 6 mm. diametro, tubo brevi valde apophysato basi truncato, limbo erecto quam tubo paullo longiore carnoso, lobis 5 deltoideis obtusis circiter 1 mm. longis conspicue calloso-incrassatis, basi discretis, sinibus subcomplanatis; corolla juvenili glabra, staminibus non visis; stylo post anthesin filiformi 12–14 mm. longo, stigmate subpeltato; fructibus irregularibus apophysatis ad 7 mm. diametro, lobis calycis persistentibus inflexis, seminibus oblongo-obovoideis 0.6–0.8 mm. longis conspicue reticulatis.

COLOMBIA: El Valle: Costa del Pacífico, Río Cajambre: Barco, 5–80 m. alt., *Cuatrecasas 17063* (GH, TYPE), 21–30 abril 1944; Río Yurumanguí: Entre Isla de Golondro y La Amargura, 10–40 m. alt., *Cuatrecasas 16048* (GH) (frútex epifito; pedúnculo y brácteas violáceos; cáliz blanquecino liláceo; corola pálido-violácea, cérea; hoja rígida, coriácea, verde claro).

This new species is a relative of *C. amalfiensis* Mansf. and *C. Purdiei* A. C. Sm., differing from both in its more distinctly apophysate calyx-tube and the proportionately larger callose-thickened portion of its calyx-lobes. From *C. amalfiensis* it also differs in its shorter and proportionately broader leaf-blades, with the upper secondaries more definitely parallel and ascending, in the presence of apical pedicellary glands, and in its shorter corolla (judging from the length of the style in our material). From *C. Purdiei* the new species differs obviously in its larger leaf-blades with a very different type of venation, in its longer inflorescence with more numerous flowers, and in its longer pedicels.

Cavendishia adenophora Mansf. in Notizbl. Bot. Gart. Berlin **9**: 439. 1925; A. C. Sm. in Contr. U. S. Nat. Herb. **28**: 473. 1932.

COLOMBIA: El Valle: Río Digua Valley, in dense forest along Río Engaña, alt. about 675 m., *Killip 34759* (A, NY, US) (native name: *queremé*); Cordillera Occidental, vertiente occidental: Hoya del Río Digua, lado izquierdo, Piedra de Moler, bosques, 900–1180 m. alt., *Cuatrecasas 15096* (GH); Hoya del Río Sanquininí, lado izquierdo, La Laguna, bosques, 1250–1400 m. alt., *Cuatrecasas 15394* (GH).

The cited specimens are listed because in 1932 I mentioned 1500 m. as the lowest altitude for the species, which is conspicuous for its brilliant red glandular-margined floriferous bracts. These recently collected specimens from lower elevations are slightly more robust throughout than my earlier description indicates; the leaf-blades are up to 17 $\times$ 8.5 cm., the rachis up to 3 cm. long, the basal and floriferous bracts as much as 7 cm. long (the glands of the latter sometimes with stalks 1.5 mm. long), the pedicels up to 17 mm. long (and both glandular and puberulent rather than glabrous as previously stated), the calyx-lobes up to 3 mm. long, and the corollas sometimes 25 mm. long. In spite of these differences from material known from higher elevations in Antioquía and Caldas, I believe that the specimens from El Valle represent merely a more vigorous phase of the species.

It should be noted that these are probably the first collections from El Valle to be accurately referred to *C. adenophora*. In 1932 I placed here two collections from La Cumbre, which Sleumer (in Notizbl. Bot. Gart. Berlin **12**: 120. 1934) later — and I think correctly — placed with his *C. nitens*, a species with a caudate-acuminate leaf-apex.

Cavendishia coccinea A. C. Sm. in Bull. Torrey Bot. Club **60**: 115. 1933.

COLOMBIA: El Valle: Cordillera Occidental, vertiente occidental: Hoya del Río Anchicayá, lado derecho, bosques entre Pavas y Miramar, 350–450 m. alt., *Cuatrecasas*

14405 (GH) (frútex epifito; ramas finas, resistentes, tortuosas; hoja coriácea verde pálido; brácteas foliáceas carmín con dientes puntiformes verdes, resinoso-viscosas; cáliz rosado-cárdeno con dientes verdosos; corola blanco-lilácea, pálida, viscosa).

This beautiful small-leaved species has previously been known only from the type-collection (*Triana 2698*, "Acostadero, Cordillera del Chocó, alt. 2500 m.") and possibly from a sterile specimen (*Jervise*) from Antioquía. Its occurrence at low elevation in El Valle suggests the possibility that Triana's altitudinal record was inaccurate.

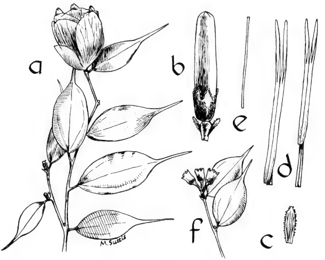

FIG. 3. *Cavendishia urophylla:* *a.* flowering branchlet, × ½; *b.* flower, × 1; *c.* flower-subtending bract, × 1; *d.* stamens, × 2; *e.* style, × 1; *f.* an inflorescence soon after anthesis, × ½; *figs. a–e* drawn from the type, *fig. f* from *Cuatrecasas 16164*.

Cavendishia urophylla sp. nov. FIG. 3.

Frutex epiphyticus ubique glaber, ramulis gracilibus subteretibus cinereis; petiolis rugulosis subteretibus vel canaliculatis 4–6 mm. longis; laminis coriaceis in sicco fusco-olivaceis elliptico-ovatis, (4–) 5–8 cm. longis, 1.7–2.7 cm. latis, basi obtusis, in apicem pergracilem acutum 15–30 mm. longum conspicue et abrupte caudato-acuminatis, margine leviter recurvatis, utrinque subnitidis, subtus inconspicue punctatis, e basi 5-nerviis, costa supra leviter impressa subtus elevata, nervis intimis costa similibus inconspicuioribus, nervis extimis immersis haud visis, venulis immersis; inflorescentia terminali vel axillari breviter racemosa ut videtur 2–4-flora bracteis pluribus imbricatis membranaceis involuta, bracteis elliptico-obovatis apice rotundatis integris eglandulosis, maximis (intimis) ad 4 cm. longis et 2–3 cm. latis, rhachi crassa (3–4 mm. diametro) irregulari 3–6 mm. longa inferne cicatricosa; bracteis floriferis submembranaceis vel papyraceis elliptico- vel obovato-oblongis, 8–15 mm. longis, 3–5 mm. latis, obtusis, obscure nervatis, glandulis sessilibus vel breviter stipitatis transverse ellipsoideis copiose marginatis; pedicellis subteretibus sub anthesi 5–7 mm. longis crassis infra articulationem ad 2.5–3 mm. incrassatis, basim versus decidue bibracteolatis, bracteolis bracteis floriferis similibus sed lanceolatis circiter 6–7 $\times$ 1 mm.; calyce oblongo-campanulato sub anthesi 8–12 mm. longo et apice 7–8 mm. diametro, tubo leviter ruguloso basi truncato-rotundato, limbo suberecto quam tubo multo longiore, lobis 5 deltoideo-oblongis 2–3 mm. longis latisque subacutis, glandulis subapicalibus elongatis sessilibus etiam glandulis basalibus subglobosis conspicue marginatis, sinibus rotundatis; corolla in sicco submembranacea cylindrica sub anthesi circiter 30 mm. longa et 7 mm. diametro, lobis 5 oblongo-deltoideis subacutis circiter 2.5 mm. longis latisque; staminibus subaequalibus corollam fere aequantibus liberis, filamentis membranaceis ligulatis alternatim 2–3 mm. et 9–11 mm. longis, antheris alternatim circiter 27 mm. et 21 mm. longis submembranaceis, thecis alternatim circiter 16 mm. et 11 mm. longis, tubulis quam thecis paullo brevioribus per rimas elongatas dehiscentibus; stylo gracili tereti corollam fere aequante, stigmate truncato.

COLOMBIA: El Valle: Agua Clara, along highway from Buenaventura to Cali, alt. about 100 m., in dense forest, *Killip & Cuatrecasas 38893* (A, TYPE, US), June 6, 1944 (epiphytic shrub; bracts light pink; calyx white; corolla white at base, bluish-tinged above); Costa del Pacífico: Estero del Encanto, entre los Ríos Yurumanguí y Cajambre, 0–5 m. alt., *Cuatrecasas 16164* (GH) (arbusto epifito; hoja craso-coriácea, verde brillante en el haz, clara en el envés; pedúnculo rojizo en la base; cáliz blanco verdoso; corola blanca, con el margen de los dientes pardusco); Río Yurumanguí, Veneral, bosques, 5–50 m. alt., *Cuatrecasas 15844* (GH) (frútex epifito; hoja coriácea, verde claro); Río Naya, Puerto Merizalde, bosques, 5–20 m. alt., *Cuatrecasas 14047* (GH) (frútex epifito; hoja y ramas verde tierno).

From its only close ally, *C. coccinea* A. C. Sm., which it resembles in its small caudate-acuminate leaves, the new species differs in obvious inflorescence characters. Its rachis is very short (scarcely 5 mm. long) and few-flowered rather than 4–9 cm. long and many-flowered, its outer sterile bracts are large and conspicuous, its flower-subtending bracts are much smaller and differently shaped, and its anther-tubules are proportionately shorter.

Cavendishia venosa A. C. Sm. in Contr. U. S. Nat. Herb. **28**: 474. 1932.

COLOMBIA: El Valle: Costa del Pacífico, Río Cajambre: Barco, 5–80 m. alt., *Cuatrecasas 17042* (GH) (frútex grande epifito; hoja coriácea, rígida, verde claro; brácteas inf. rosado-cárdenas, sup. blancas; cáliz blanco; corola blanca, extremo esmeralda).

Another collection of this distinct and beautiful species is very welcome, particularly as it is accompanied by better data than any of the four collections upon which I based the species. Of these, three were collected by André, including the type, which was without notes. The two remaining André collections came from Altaquer and Armada, both in the valley of the Río Cuaiquer in southern Nariño at altitudes of about 1000 meters (see André, L'Amerique Equinoxiale, pp. 364–366, map on p. 354. 1883). In 1932 I erroneously listed Armada as in Ecuador. The

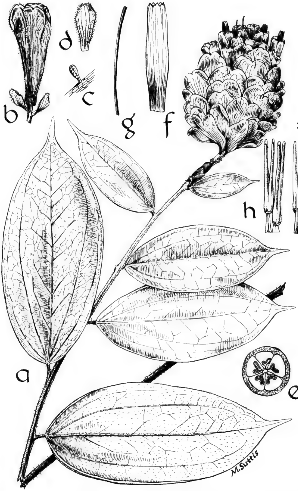

FIG. 4. *Cavendishia chlamydantha*: *a*. flowering branchlet, × ½; *b*. pedicel and calyx, × 1; *c*. gland from calyx-limb, × 50; *d*. pedicellary bracteole, × 2; *e*. cross-section of ovary, × 4; *f*. corolla, × 1; *g*. style, × 1; *h*, *i*. stamens, introrse and extrorse views, × 2.

Sodiro locality which I cited in 1932, Río Pilatón, is in Pichincha, Ecuador, being one of the headwaters of the Río Esmeraldas.

The Cuatrecasas collection differs from those previously described in having its leaf-blades slightly shorter and broader in proportion, in having its pedicels and calyx-tube softly pale-pilose rather than glabrous (probably younger than those previously seen), and in having its corolla up to 32 mm. long. I believe that these features are of no more than individual significance. The stamens (incomplete in earlier collections) are completely glabrous, about 10 mm. long, with slender filaments alternately about 1.5 mm. and 4 mm. long, and with anthers alternately about 9 mm. and 7 mm. long, the tubules being much longer than the thecae.

Cavendishia chlamydantha sp. nov. Fig. 4.

Frutex epiphyticus, ramulis gracilibus (apicem versus 2.5–4 mm. diametro) subteretibus stramineis pilis ad 2 mm. longis copiose hispidis demum glabrescentibus; petiolis validis (circiter 2 mm. diametro) rugulosis nigrescentibus subteretibus 5–7 mm. longis ut ramulis stramineo-hispidis; laminis in sicco subcoriaceis pallide olivaceis oblongo-ellipticis, 9–17 cm. longis, 3.5–7 cm. latis, basi rotundatis vel late obtusis, in apicem caudatum ad 2 cm. longum subacutum abrupte angustatis, margine integris et anguste recurvatis vel subrevolutis, utrinque pilis inconspicuis circiter 1 mm. longis hispidulis demum subglabratis, 5- vel 7-nerviis, costa supra prominula subtus prominente, nervis 4 principalibus e basi adscendentibus (vel intimis paullo suprabasalibus) curvatis supra prominulis subtus leviter elevatis, nervis extimis submarginalibus inconspicuis, rete venularum laxe intricato utrinque subprominulo; inflorescentia terminali (vel subterminali?) multiflora racemosa ellipsoidea bracteis inclusis ad 12 cm. longa et 8 cm. lata, basi bracteis imbricatis papyraceis oblongis ad 15 mm. longis (extimis minoribus) circumdata, pedunculo subnullo, rhachi crassa (3–4 mm. diametro) ut videtur ad 7 cm. longa basi bractearum incrassata, bracteis inferioribus sterilibus oblongo-obovatis ad 3 $\times$ 2.5 cm. apice rotundatis saepe fissis extus ut calyce glandulosis intus glabris, nervis conspicue anastomosantibus, bracteis superioribus floriferis similibus sed angustioribus ad 4 $\times$ 1.5 cm.; pedicellis subteretibus rugulosis sub anthesi 5–6 mm. longis, infra articulationem ad 2 mm. diametro incrassatis, medium versus bibracteolatis, bracteolis suboppositis membranaceis lanceolato-obovoideis, 8–10 mm. longis, circiter 3 mm. latis, basi angustatis, apice rotundatis vel subemarginatis, paucinerviis, margine obscure ciliolatis, extus ut calyce glandulosis, cito caducis; calyce amplo cum pedicello conspicue articulato, tubo levi oblongo-cupuliformi sub anthesi 3–4 mm. longo et circiter 4 mm. diametro, basi truncato-rotundatis, disco annulari-pulvinato inconspicuo glabro, limbo membranaceo infundibulari corollam fere aequante 28–32 mm. longo, apice circiter 15 mm. diametro, copiose longitudinaliter venoso (nervis superne ramosis non anastomosantibus), extus glandulis stipitatis circiter 0.15 mm. longis copiose obtecto, intus glabro, profunde 5-lobato, lobis obovoideo-oblongis, 12–14 mm. longis et circiter 8 mm. latis, laxe imbricatis, apice emarginatis (et obscure calloso-apiculatis), margine pilis pallidis circiter 1 mm. longis copiose setuloso-ciliatis, sinibus acutis; corolla cylindrica praeter apicem limbo calycis obtecta, in sicco membranacea in vivo ut videtur tenuiter carnosa, sub anthesi circiter 37 mm. longa et medium versus 7–8 mm. diametro, apice ad 4 mm. diametro angustata, ubique glabra, 5-lobata, lobis oblongo-deltoideis obtusis circiter 1 × 2 mm.; staminibus 10 quam corolla multo brevioribus ubique glabris alternatim circiter 15 mm. et 15.5 mm. longis, filamentis liberis membranaceis stramineis ligulatis alternatim circiter 2 mm. et 5 mm. longis, basi circiter 1.3 mm. latis superne angustatis, antheris alternatim circiter 13.5 mm. et 11.5 mm. longis, thecis leviter granulosis 3–3.5 mm. longis basi rotundatis, tubulis quam thecis subtriplo longioribus apice obtusis per foramines ovales 0.7–1.3 mm. longos dehiscentibus; stylo corollam subaequante tereti circiter 0.6 mm. diametro, stigmate truncato et obscure papilloso.

COLOMBIA: El Valle: Costa del Pacífico, Río Cajambre: Barco, 5–80 m. alt., *Cuatrecasas 17004* (GH, TYPE), 21–30 abril 1944 (frútex epifito; hoja coriácea, verde claro; brácteas inferiores rosadas, las superiores blanco-pálido-verdosas; corola blanca, con el extremo esmeralda; cáliz blanco verdoso).

The entity described above is so unlike the known species of *Cavendishia* in its large membranaceous infundibular calyx-limb, with imbricate lobes enveloping the corolla except at the tip, that it is referred to the genus with hesitation. In the other described species of the genus the calyx-limb, although often exceeding the calyx-tube to a certain extent and occasionally with imbricate lobes, never approaches the corolla in length and is never of such delicate and filmy texture. Furthermore, the stamens of the new species are proportionately very short, less than half as long as the corolla, and the tubules are about three times as long as the thecae and dehisce by short oval introrse pores. As a rule *Cavendishia* has stamens nearly as long as the corolla, with tubules rarely more than twice as long as the thecae and dehiscing by elongate clefts of indeterminate length.

It would seem desirable to base a new genus upon this remarkable species, were it not for the occurrence of certain characters in two other species which demonstrate a transition toward more typical *Cavendishiae*. One of the few species of *Cavendishia* which has comparatively short stamens (only about one-third as long as the corolla) is *C. venosa* A. C. Sm., discussed above as occurring also in the vicinity of Barco. This species also has the tubules unusually long for *Cavendishia*, about three times longer than the thecae; the dehiscence, however, is indeterminate and typically cavendishioid, while the calyx is normal for the genus. Curiously, *C. venosa* is perhaps the species of *Cavendishia* which most nearly suggests the new plant in texture of leaves and inflorescence-bracts; the alliance of *C. chlamydantha* is probably in this vicinity, although it is a remarkably distinct entity.

A second ally of *C. chlamydantha* is *C. micayensis*, described below, a species which provides further transitional features connecting *C. chlamydantha* and the more typical species of the genus.

Cavendishia micayensis sp. nov.

Frutex, ramulis rugulosis subteretibus gracilibus (superne 2–3 mm. diametro) pilis pallidis circiter 1 mm. longis disperse hispidis cito glabrescentibus; petiolis 2–3.5 mm. diametro subteretibus rugulosis nigrescentibus (5–) 8–12 mm. longis ut ramulis hispidis; laminis in sicco chartaceosubcoriaceis olivaceis anguste oblongo-ellipticis vel ellipticis, (6–) 12–25 cm. longis, (1.5–) 4–10 cm. latis, basi subacutis vel obtusis, in apicem peracutum ad 1–2.5 cm. longum gradatim caudato-acuminatis, margine anguste revolutis, supra glabris, subtus pilis circiter 1 mm. longis dense hispidulis demum glabratis, 5- vel 7-nerviis, costa nervisque intimis 1–4 cm. concurrentibus supra impressis (basi prominulis) subtus prominentibus, nervis extimis supra subplanis vel prominulis subtus leviter elevatis, rete venularum utrinque prominulo vel subimmerso; inflorescentia subterminali sessili bracteis inclusis 6–9 cm. longa et 3.5–6 cm. lata, basi bracteis imbricatis venosis oblongis ad 15 mm. longis (extimis minoribus) circumdata, rhachi crassa (3–7 mm. diametro) 3.5–7 cm. longa, floribus bracteisque numerosissimis confertis; bracteis inferioribus sterilibus superioribus floriferis papyraceis oblongo-obovatis, 15–27 mm. longis, 9–20 mm. latis, apice rotundatis saepe fissis, margine decidue ciliolatis, conspicue nervosis, extus minute glanduloso-farinosis cito glabratis, intus glabris; floribus in axillis bractearum subsessilibus, pedicellis minutis ebracteolatis; calyce sub anthesi 14–16 mm. longo, tubo oblongo-obconico sub anthesi 3–3.5 mm. longo et summo 2.5–3 mm. diametro, ad basim obtusum gradatim angustato, disco annulari-pulvinato inconspicuo glabro, limbo papyraceo vel submembranaceo infundibulari corollam fere aequante, 11–13.5 mm. (in fructu ad 15 mm.) longo et apice 4–6 mm. diametro, obscure venoso, extus glandulis stipitatis circiter 0.1 mm. longis sparse obtecto, intus glabro, lobis 5 deltoideo-lanceolatis, 3.5–5 mm. longis et 1.5–3 mm. latis, apice subacutis, margine sparse et decidue stipitato-glandulosis, sinibus acutis vel obtusis; corolla tenuiter carnosa subcylindrica, sub anthesi 12–14 mm. longa et basim versus 3.5–4 mm. diametro, faucibus angustata, ubique glabra, lobis 5 oblongo-deltoideis obtusis $1–2 \times 1$ mm.; staminibus 10 quam corolla paullo brevioribus alternatim 9–11 mm. et 10–12 mm. longis, filamentis liberis membranaceis ligulatis superne angustatis alternatim circiter 1 mm. et 3–4 mm. longis, longioribus margine medium versus pilosis, antheris alternatim 9–10 mm. et 8–9 mm. longis, thecis obscure granulosis 3–4 mm. longis basi obtusis, tubulis quam thecis 1½–2-plo longioribus per foramines ovales 1–1.5 mm. longos dehiscentibus; stylo tereti gracili corollam subaequante, stigmate leviter incrassato et truncato; fructibus rugulosis subgloboso-turbinatis ad 7 mm. diametro (immaturis?) bracteis obtectis calycis limbo persistente coronatis.

COLOMBIA: El Cauca: "La Gallera," Micay Valley, alt. 1400–2100 m., *Killip 7691* (GH, TYPE, Acad. Nat. Sci. Phila., US), June 29 or 30, 1922 (shrub, in forest; bracts red or carmine; corolla white).

Killip 7691 includes two species; the sheet of this number in the herbarium of the New York Botanical Garden is the type of *C. marginata* A. C. Sm. (in Contr. U. S. Nat. Herb. **28**: 499. 1932), while the sheets cited above represent an entirely different plant. Although I was aware of this fact in 1932, the flowering specimen at the Gray Herbarium was not then available to me; the National Herbarium and Philadelphia Academy sheets lack the corollas and stamens which make an adequate description feasible.

Cavendishia micayensis is very similar in foliage and general inflorescence characters to the preceding new species (*C. chlamydantha*), like which it has a calyx-limb of unusual shape and texture which nearly equals the corolla in length. The present species differs from *C. chlamydantha* in its shorter inflorescence and smaller bracts, its much smaller and essentially sessile flowers with ebracteolate pedicels, its differently shaped calyx-tube, its obscurely veined calyx-limb with comparatively small non-imbricate lobes, its thicker corolla, and its differently proportioned stamens. In characters pertaining to its calyx, this new species is more or less intermediate between *C. chlamydantha* and typical *Cavendishiae;* in the proportions of its stamens and in their length, *C. micayensis* is quite typical of the genus, but in its anther-dehiscence it is suggestive of *C. chlamydantha.* In the three species of this general alliance, namely *C. venosa, C. micayensis,* and *C. chlamydantha,* one can observe a remarkable trend within the genus, culminating in *C. chlamydantha.*

Cavendishia palustris A. C. Sm. in Am. Jour. Bot. 27: 543. 1940.

COLOMBIA: El Valle: Río Calima (región del Chocó), La Esperanza, 5–10 m. alt., *Cuatrecasas 16757* (GH) (arbusto bejucoso, epifito; hoja coriácea, verde claro; ramillas inflorescencias y pedúnculos purpúreos; cáliz verde blanquecino; corola blanco-lilácea o blanco-morada); El Forge, near Buenaventura, sea-level, *Killip & Cuatrecasas 38961* (A, US) (epiphytic shrub; corolla white, pink-tinged in upper half; in region inundated only at high tide).

The cited collections agree excellently with the type and only previously known specimen, collected in mangrove swamp in Buenaventura Bay.

Cavendishia micrantha sp. nov.

Frutex epiphyticus staminibus exceptis ubique glaber, ramulis gracilibus subteretibus stramineis vel cinereis; petiolis subteretibus rugulosis 8–17 mm. longis inferne incrassatis; laminis chartaceis in sicco fusco-viridibus oblongo-lanceolatis, (7–) 9–17 cm. longis, (1.3–) 2.5–5.5 cm. latis, ad basim attenuatam in petiolum decurrentem angustatis, apice caudato-acuminatis (acumine gracili acuto 1–2.5 cm. longo), margine integris et paullo recurvatis, 5 (vel obscure 7-)-nerviis, costa nervisque 4 supra leviter insculptis vel obscure prominulis subtus plus minusve prominentibus, nervis intimis costa 5–25 mm. concurrentibus apicem fere attingentibus, nervis inferioribus e basi orientibus vel suprabasalibus inconspicuioribus, nervis extimis marginalibus obscuris, rete venularum conspicue intricato utrinque prominulo; inflorescentia axillari vel subterminali racemosa 12–25-flora (floribus saepe mox delapsis) 3–5 cm. longa, pedunculo subnullo, rhachi simplici obtuse angulata circiter 1 mm. diametro basi ut videtur decidue bracteata, floribus in foveolis insertis, bracteis floriferis papyraceis oblongo-deltoideis subacutis 1–1.5 mm. longis; pedicellis teretibus sub anthesi 12–17 mm. longis, basi circiter 0.7 mm. diametro, superne ad 1–1.5 mm. diametro incrassatis, basim versus obscure 1- vel 2-bracteolatis, bracteolis papyraceis lanceolatis acutis circiter 1 mm. longis obscure glanduloso-marginatis; calyce cupuliformi vel oblongo-pyriformi sub anthesi circiter 4 mm. longo et apice 3–4 mm. diametro, tubo coriaceo basi rotundato, limbo suberecto papyraceo tubum subaequante, lobis 5 deltoideis acutis sub anthesi 1–1.4 mm. longis et ad 1.7 mm. latis, margine sinus acutos versus obscure glanduloso-incrassatis; corolla submembranacea breviter conico-subglobosa, sub anthesi circiter 3 mm. longa et 3.5 mm. diametro, apice ad 1–1.5 mm. diametro contracta, lobis 5 deltoideis acutis circiter 0.6×0.8 mm.; staminibus 10 subaequalibus 2–2.4 mm. longis, filamentis submembranaceis ligulatis 0.6–1.3 mm. longis ciliolato-marginatis, antheris 1.5–2 mm. longis ubique ad apicem pallide hispidulis, tubulis thecas subaequantibus, rimis elongatis interdum in thecas extensis; stylo tereti corollam subaequante apice truncato; fructibus juvenilibus rugulosis subglaucis globosis ad 5 mm. diametro limbo calycis persistente coronatis.

COLOMBIA: El Valle: Agua Clara, along highway from Buenaventura to Cali, alt. about 100 m., in dense forest, *Killip & Cuatrecasas 38923* (A, US); Costa del Pacífico, Río Cajambre: Barco, 5–80 m. alt., *Cuatrecasas 17000* (GH, TYPE), 21–30 abril 1944 (frútex epifito; hoja coriácea, delgada, verde-grisácea; pedúnculos blanco-verdosos; cáliz blanco verdoso; corola blanca (cerrada); frutos immaturos morado-claros).

This extraordinary species, with the smallest flowers known in *Cavendishia,* scarcely suggests the genus in its floral characters, but in habit it is reminiscent of those atypical *Cavendishiae* related to *C. spicata* A. C. Sm. From *C. chocoensis* A. C. Sm., apparently its closest ally, the new species differs not only in its even smaller flowers, but also in its more obviously hispidulous stamens, longer pedicels, much shorter and essentially epedunculate inflorescences, longer petioles, and attenuate-based leaf-blades. A curious relationship between *Cavendishia* and *Psammisia,* not suspected before abundant material from Pacific Colombia became available, is suggested by *C. micrantha* and *C. chocoensis* on the one hand and *Psammisia occidentalis* A. C. Sm. and its relatives on the other.

Cavendishia Quereme (H. B. K.) Benth. & Hook. f. Gen. Pl. 2: 570. 1876; A. C. Sm. in Contr. U. S. Nat. Herb. 28: 495. 1932.

COLOMBIA: El Valle: Cordillera Occidental, vertiente occidental: Hoya del Río Anchicayá, lado derecho, bosque bajando a La Planta, 400 m. alt., *Cuatrecasas 14878* (GH) (frútex epifito; frutos blancos).

The cited specimen is listed because it provides a new low altitude record for this species, which I previously had seen only from elevations of 1000–1700 m.; it is fairly common in El Valle, the type being from the vicinity of Cali.

Satyria dolichantha sp. nov.

Frutex epiphyticus, ramulis apicem versus gracilibus (2–3 mm. diametro) teretibus obscure puberulis, vetustioribus cinereis glabris robustis; petiolis crassis subteretibus rugulosis 6–12 mm. longis juventute puberulis cito glabratis; laminis glabris subcoriaceis in sicco olivaceis oblongo- vel ovato-ellipticis, (8–) 12–17 cm. longis, (3.5–) 4–7 cm. latis, basi late obtusis vel rotundatis, apice in acuminem 5–12 mm. longum obtusum gradatim productis, margine integris et leviter recurvatis, 5(raro 7-)-nerviis, costa supra elevata subtus prominente, nervis 2 intimis cum costa ad 2 cm. concurrentibus vel paullo suprabasalibus adscendentibus apicem versus costa anastomosantibus utrinque elevatis, nervis inferioribus e basi divergentibus submarginalibus inconspicuioribus, rete venularum intricato supra leviter subtus evidenter prominulo; inflorescentia ubique (rhachi, bracteis bracteolisque, pedicellis, calycibus corollisque) minute sed uniformiter pallido-puberula, axillari elongata racemosa 7–12-flora, basi bracteis paucis imbricatis deltoideis obtusis 1–1.5 mm. longis circumdata, pedunculo (circiter 2 cm. longo) et rhachi 4.5–7 cm. longis gracilibus (1–1.5 mm. diametro) leviter angulatis, bracteis floriferis ut bracteis basalibus; pedicellis subteretibus 8–18 mm. longis in vivo ut videtur carnosis, basi 1–1.5 mm. diametro superne ad 2–3 mm. incrassatis, supra basim (1–5 mm.) bracteolas 2 papyraceas ovato-deltoideas acutas 1–1.5 mm. longas obscure ciliolatas gerentibus; calyce sub anthesi 3–5.5 mm. longo, tubo cupuliformi 2.5–3 mm. longo et diametro ruguloso interdum obscure luteo-glanduloso basi rotundato, limbo patente papyraceo intus glabro, lobis 5 ovato-deltoideis apiculatis 0.7–1.5 mm. longis et 2–3 mm. latis, sinibus acutis; corolla in sicco submembranacea in vivo ut videtur carnosa intus glabra cylindrica sub anthesi 40–47 mm. longa, basim versus 4–6 mm. diametro, superne paullo angustata, lobis 5 lanceolato-oblongis obtusis 3–4 mm. longis; staminibus 10 glabris alternatim 10–13 mm. et 11.5–14.5 mm. longis, filamentorum tubo castaneo submembranaceo vel papyraceo 6–7 mm. longo, antheris rigidis alternatim 6.5–8 mm. et 8–9.5 mm. longis, tubulis quam thecis paullo longioribus apice acutis per rimas ovales circiter 2 mm. longas dehiscentibus; stylo tereti sub anthesi leviter protruso apice truncato; fructibus subglobosis rugulosis glabratis 7–9 mm. diametro limbo calycis persistente coronatis.

COLOMBIA: El Chocó: Banks of Quebrada Togoromá, in dense tidal forest, *Killip & Cuatrecasas 39108* (A, TYPE, US), June 13, 1944 (epiphytic shrub; corolla red in lower two-thirds, green in upper third, the tips of the lobes purplish; style greenish white); El Cauca: Costa del Pacífico, Río Micay, Brazo Noanamito, orilla derecha: El Chachajo, 2–5 m. alt., *Cuatrecasas 14249* (GH) (arbusto epifito; cáliz verde; corola carmín con el extremo verde oscuro).

This striking and very distinct species is characterized by its long inflorescences and flowers (the corollas being the longest known for the genus) and its puberulent inflorescence-parts. Its closest relative is *S. panurensis* (Benth.) Benth. & Hook. f., of the Amazon basin and eastern Andean foothills, from which the above-mentioned characters, the more obvious calyx-lobes, and the longer stamens readily distinguish it.

Satyria grandifolia Hoer. in Bot. Jahrb. **42**: 319. 1909; A. C. Sm. in Contr. U. S. Nat. Herb. **28**: 526. 1932.

COLOMBIA: El Valle: Río Calima (región del Chocó), entre La Esperanza y Bellavista, 5–10 m. alt., *Cuatrecasas 16789* (GH) (gran frútex epifito; hoja coriácea, rígida, verde claro; cáliz rosado cárdeno; pedúnculo rojo cárdeno; corola rojo carmín, ⅓ superior blanco); Cordillera Occidental, vertiente occidental: Hoya del Río Sanquinini, lado izquierdo, La Laguna, bosques, 1250–1400 m. alt., *Cuatrecasas 15592* (GH) (frútex epifito; bayas caulinares blancas, maduras violáceas, 15–20 mm. diám., dulzainas).

Satyria grandifolia has otherwise been recorded only from the type collection of Triana. Although the two specimens cited above have considerable altitudinal range, they are referred here with reasonable confidence, agreeing with the type in foliage and all essential details. No. *15592* has the calyx somewhat more robust than indicated in previous descriptions, the tube being about 4.5 mm. in diameter at anthesis and the limb about 4 mm. long.

The type, *Triana 2694*, was obtained at "Cienegueta," Cordillera del Chocó. Although in 1932 I cited this locality as in El Chocó, it is possible that Triana used this name more broadly and that his locality was actually in El Valle or even El Cauca. The type at Berlin bore the inscription "Prov. del Cauca," and it was so cited by Hoerold. The Berlin sheet also bore the note "Alt. 2100," and Hoerold cited this as 2100 m. If this is correct, the species would appear to have an unusual altitudinal range of essentially 2100 m., but it is possible that Triana's measurement was inaccurate or that the label was not actually written by him.

Satyria leptantha sp. nov.

Frutex epiphyticus ubique glaber, ramulis crassissimis (floriferis ad 1.5 cm. diametro) teretibus rugosis cinereis; petiolis subteretibus rugosis 1–2 cm. longis crassis (3–5 mm. diametro); laminis coriaceis siccitate olivaceis oblongo-lanceolatis, 23–40 cm. longis, 4–9.5 cm. latis, basi late obtusis et in petiolum leviter decurrentibus, superne angustatis (apice ipso non viso ut videtur acuto), margine integris et leviter recurvatis, 5-nerviis, costa nervisque 2 interioribus adscendentibus cum costa 2.5–6 cm. concurrentibus apicem fere attingentibus supra leviter impressis subtus valde prominentibus, nervis 2 inferioribus e basi divergentibus submarginalibus inconspicuioribus, venulis supra immersis subtus in reticulum laxum prominulum anastomosantibus; inflorescentiis e ramulis defoliatis in glomerulis aggregatis fasciculatim breviter racemosis 3–5-floris, bracteis basi rhachis et bracteis floriferis papyraceis deltoideis acutis 1–1.5 mm. longis obscure ciliolatis caducis, rhachi minuta 1–4 mm. longa; pedicellis gracilibus (basi circiter 0.5 mm. diametro, superne ad 2 mm. diametro gradatim incrassatis) teretibus rugulosis 19–24 mm. longis, supra basim (3–7 mm.) bracteolas 2 oblongas obtusas circiter 1.5 mm. longas gerentibus; calyce brevi sub anthesi 2–3 mm. longo, tubo ruguloso circiter 1.5 mm. longo et 3.5 mm. diametro basi truncato, limbo patente 1–1.5 mm. longo papyraceo, lobis 5 ovatis apiculatis circiter 1×2.5 mm. praeter partem apicalem incrassato-marginatis, sinibus obtusis; corolla tenuiter carnosa graciliter cylindrica sub anthesi 24–27 mm. longa, basim versus circiter 3 mm. diametro, superne paullo angustata, lobis 5 deltoideis subacutis circiter 0.7×1.5 mm.; staminibus 10 alternatim 7 mm. et 8 mm. longis, filamentorum tubo circiter 3 mm. longo, antheris rigidis alternatim circiter 5 mm. et 6 mm. longis, tubulis thecas subaequantibus per rimas apertas ovales circiter 1.5 mm. longas dehiscentibus; stylo gracili tereti sub anthesi corollam excedente apice paullo incrassato.

COLOMBIA: El Valle: Cordillera Occidental, vertiente occidental: Hoya del Río Digua, lado izquierdo, Piedra de Moler, bosques, 900–1180 m. alt., *Cuatrecasas 14963* (GH, TYPE), 19–28 agosto 1943 (frútex grande epífito; pedúnculos rojo-cárdenos; corola rojo-cárdena con el extremo blanco).

Satyria leptantha is closely related only to *S. grandifolia* Hoer., differing in its very long and proportionately narrower leaf-blades with the inner secondaries more highly concurrent, and in its very short and comparatively few-flowered inflorescences, longer pedicels, very slender corolla, and shorter anthers.

Satyria arborea A. C. Sm. in Jour. Arnold Arb. **24**: 469. 1943.

COLOMBIA: Antioquía: Cerro del Tabor, Yarumal, *Daniel 3401* (US) (fr.); Páramo de Sonsón, alt. 2700–2850 m., *Daniel 3438* (US) (fl.).

The cited collections are the second and third known of the species, the type of which was obtained between Valdivia and Yarumal, in Antioquía. The fruiting specimen has the petioles often negligible (1–4 mm. long), the leaf-blades (5–) 7–9 cm. long and 2.5–3.5 cm. broad, the pedicels up to 28 mm. long, and the fruits strongly rugulose (apparently very fleshy when fresh), depressed-subglobose, 5–8 mm. in diameter, flattened at apex, and surmounted by the inconspicuous calyx-limb.

Satyria bracteolosa sp. nov.

Frutex epiphyticus ubique inflorescentia excepta glaber, ramulis apicem versus gracilibus (2–4 mm. diametro) brunneis obtuse angulatis, vetustioribus validis subteretibus cinereis; petiolis 1–2 mm. diametro 5–10 mm. longis rugulosis inconspicue angulatis; laminis coriaceis in sicco olivaceis oblongo-ellipticis, 8–22 cm. longis, 3–7 cm. latis, basi obtusis et in petiolum decurrentibus, apice in acuminem 5–15 mm. longum obtusum vel subacutum cuspidatis, margine integris et leviter recurvatis, 5(vel 7-)-nerviis, costa supra valde elevata subtus prominente, nervis intimis cum costa 1–3.5 cm. concurrentibus, extimis e basi orientibus vel paullo suprabasalibus, nervis omnibus adscendentibus supra prominulis subtus elevatis, rete venularum intricato utrinque subprominulo vel supra immerso; inflorescentiis e ramulis defoliatis ortis glomerulatis vel inconspicue breviter racemosis 4–7-floris basi bracteis pluribus circumdatis, ubique (bracteis bracteolisque, pedicellis, calycibus corollisque) obscure pallido-puberulis, bracteis basalibus imbricatis papyraceis oblongo-deltoideis obtusis 2–3 mm. longis et latis ciliolato-marginatis, rhachi brevissima; pedicellis teretibus crassis (1.5–2 mm. diametro) 5–8 mm. longis apice incrassatis et cum calyce articulatis, apicem versus conspicue bibracteolatis, bracteolis papyraceis late ovatis vel reniformibus, 2–3 mm. longis, 4–5 mm. latis, intus glabris, margine ciliolatis, margine basali imbricatis, apice rotundatis, liberis sed pseudocupulam basim calycis tubi amplectentem formantibus; calyce cupuliformi sub anthesi circiter 4 mm. longo, tubo brevi disco lato pulvinato coronato, limbo papyraceo intus glabro erecto-patente circiter 2 mm. longo, lobis 5 oblongo-deltoideis obtusis circiter 1.5 × 3 mm. interdum subconnatis, sinibus acutis; corolla carnosa intus glabra cylindrico-urceolata, sub anthesi 14–19 mm. longa, basim versus 3–5 mm. diametro, superne gradatim angustata, lobis 5 oblongis subacutis circiter 2–3 × 1.5 mm.; staminibus 10 alternatim 5–6 mm. et 7–8 mm. longis, filamentorum tubo papyraceo glabro 2–2.5 mm. longo, antheris rigidis alternatim 4–4.5 mm. et circiter 6 mm. longis, thecis basi subacutis et leviter productis, tubulis thecas subaequantibus per rimas ovales circiter 2 mm. longas dehiscentibus; stylo tereti apice truncato quam corolla conspicue longiore.

COLOMBIA: El Chocó: Río San Juan, cercanías de Palestina, 5–50 m. alt., *Cuatrecasas 16894* (GH, TYPE), 12–14 mar. 1944 (frútex epifito; hoja coriácea, rígida, verde claro; cáliz id.; corola roja, ⅓ superior amarillo); El Valle: Río Calima (región del Chocó), La Trojita, 5–50 m. alt., *Cuatrecasas 16604* (GH) (frútex epifito; hoja coriácea, rígida, verde medio; cáliz verde claro; corola roja, ¼ superior rojo amarillento, dientes verdosos); Costa del Pacífico, Río Cajambre: Quebrada del Corosal, 0–5 m. alt., *Cuatrecasas 17732* (GH) (arbusto epifito; hoja coriácea, rígida; cáliz verde; corola con el extremo blanco).

This remarkable species differs from all others of the genus in its subapical pedicellary bracteoles, which form a pseudocupule clasping the base of the calyx-tube. Another distinguishing feature is the very short puberulent inflorescence; there is a striking contrast between the long and short anthers, the latter being comparatively inconspicuous and appearing dorsal to the larger ones.

ARNOLD ARBORETUM,
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THE AUSTRALIAN SPECIES OF ANTIRHEA, AND A NEW NAME FOR A CUBAN SPECIES

C. T. WHITE

With one plate

THE GENUS *Antirhea* Commerson ex Jussieu was established in 1789 on the basis of a Mauritius tree, there known as "Bois de Losteau". Since that time many species have been described from widely different places in the tropics and subtropics of both hemispheres, including three from Australia. A search through Index Kewensis and its supplements showed that two of these had not been listed and the third one by error was wrongly entered as to the spelling of the specific epithet. A query from Dr. Lily M. Perry prompted me to look up the Australian species (all of which are confined to Queensland), when the above omissions were noted.

The three species, with correct citations, synonyms, and distribution, are here listed:

Antirhea tenuiflora F. Muell. ex Benth. in Fl. Austr. 3: 418. 1867 (as *Antirrhaea*); F. Muell. Fragm. Phytogr. Austr. 7: 48. 1869 (as *Antirrhoea*); non Urban (1900).

Guettarda tenuiflora F. Muell. Fragm. Phytogr. Austr. 9: 183. 1875, First Census 75. 1882.

Antirrhoea tenuifolia Jackson, Ind. Kew. 1: 155. 1893, sphalm.

QUEENSLAND: From the Johnstone River to Cape York.

By a curious slip this species was listed in the Index Kewensis as *A. tenuifolia*, a mistake repeated in certain other publications. Perhaps this erroneous entry accounts for Urban giving the preëmpted specific epithet *tenuiflora* to a West Indian species. For the latter a name change becomes necessary, and the following is proposed:

Antirhea Urbaniana nom. nov.

Antirrhoea tenuiflora Urban, Symb. Antill. 1: 438. 1900; non F. Mueller (1867). CUBA.

Antirhea putaminosa (F. Muell.) F. M. Bailey, Queensl. Fl. 3: 760. 1900 (as *Antirrhaea*).

Timonius putaminosus F. Muell. Fragm. Phytogr. Austr. 4: 92. 1864.

Bobea putaminosa F. Muell. loc. cit. in syn. and op. cit. 5: 212. 1866.

Guettardella putaminosa Benth. Fl. Austr. 3: 419. 1867.

Guettarda putaminosa F. Muell. op. cit. 9: 183. 1875.

Antirrhoea putaminosa F. Muell. op. cit. 9: 183. 1875, in syn.

QUEENSLAND: Central coastal region; in "dry rain forest" a few miles north and south of Rockhampton, i. e. the tropic of Capricorn.

Mueller, in the original publication of *Guettarda putaminosa,* credits the binomial *Antirrhoea putaminosa* to "J. Hook. in B[enth]. & H[ook]. Gen. Pl. ii. 100," and F. M. Bailey cites the joint authors also as the authority. Very few actual combinations were made in the Genera Plantarum, but none in this instance. Bentham & Hooker did not mention the species; however, some earlier Australian authors have translated Bentham & Hooker's inference in many cases as proposed new names.

This species is a small tree common in a rather dry type of mixed forest characteristic of coastal and mid-inland Queensland and in the more inland places merging into "Brigalow" (*Acacia*) and "Beelah" (*Casuarina*) forest ("scrub"). However, this type of vegetation has been designated by some as monsoon forest, because some of the larger soft-wooded trees such as *Gyrocarpus* and *Brachychiton* lose their leaves in the dry period, although these genera are not always present. "Box wood scrub" is a name sometimes given to this forest, for the majority of the trees are of slow growth and possess a box-like (*Buxus*) wood. Vegetative parts generally show a tendency toward xerophytism.

Antirhea myrtoides (F. Muell.) F. M. Bailey, Queensl. Fl. 3: 760. 1900 (as *Antirrhaea*). PL. I.

Guettarda myrtoides F. Muell. Fragm. Phytogr. Austr. 9: 184. 1875.

Bobea myrtoides (F. Muell.) Valeton in Bull. Dep. Agric. Ind. Néerl. 26: 7. 1909.

QUEENSLAND: Rockingham Bay (known only from the type-collection).

Valeton, in his introductory remarks on the genus *Timonius,* said that *Guettarda myrtoides* F. Muell. was a true *Bobea* and actually made the combination in his discussion of the species. Alston, Hand-book Fl. Ceyl. 6, Suppl.: 151. 1931, suggested that "though *Nelitris* Gaertn. is one of the 'nomina rejicienda' of the International Rules, I think that it should be adopted in preference to *Bobea* Gaud." By the keys and descriptions in the Genera Plantarum I judge that this species would come under *Antirhea* Comm. ex Juss. By the key in the Pflanzenfamilien it would come under *Bobea* Gaud. on account of a rather deeply 2-cleft style. Unfortunately the plant is known only from the type-collection. Mr. Jessep, Government Botanist, National Herbarium, Melbourne, kindly sent me a part of the type including a single flower, one of three on the type sheet. I carefully dissected this as far as I could without destroying it and found the style to be deeply 2-cleft.

EXPLANATION OF THE PLATE

Part of type specimen of *Antirhea myrtoides* (F. Muell.) F. M. Bailey.

QUEENSLAND HERBARIUM,
BOTANIC GARDENS,
BRISBANE, AUSTRALIA.

ANTIRHEA MYRTOIDES (F. MUELL.) F. M. BAILEY

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A REVISION OF THE PERUVIAN SPECIES OF MONNINA

RAMÓN FERREYRA

With ten plates

INTRODUCTION

THE GENUS *Monnina*, of the Polygalaceae, is a strictly American group of approximately 150 species, occurring principally in northwestern South America, the greater number of species being concentrated in Colombia, Ecuador, and Perú. No comprehensive monographic study of the genus in South America has been published, although between 1894 and 1934 Prof. R. Chodat described numerous species of *Monnina* and on one occasion published a synoptic treatment. The present paper is limited in scope to the Peruvian species; at a later date the author hopes to undertake a revision of all the South American species.

Monnina was founded in 1798 by Ruiz & Pavón and included the following species: *M. polystachya, M. salicifolia, M. conferta, M. linearifolia, M. macrostachya,* and *M. pterocarpa*. Of these species, five had been discovered in the central part of Perú and one, *M. linearifolia,* in the "Regni Chilensis." The type of the genus is *M. polystachya*. The generic name was dedicated in honor of Don José Moñino, Conde de Floridablanca, who was a patron of scientific expeditions of his period.

MORPHOLOGY

ROOT. Of the 46 species studied and included in the present treatment, the roots of only the annual species have been examined. Among these annual species, *M. graminea* was not available in the material at hand, and the specimens of *M. pterocarpa* all lacked roots. *Monnina amarella, M. filifolia, M. Macbridei,* and *M. arenicola* have a more or less perpendicular and simple root. In contrast, *M. herbacea, M. ramosa, M. Weberbaueri,* and *M. macrostachya* have a root that is much branched, sinuous, and with very flexuous branches.

STEM. Although the stems of some species are herbaceous and not very firm, the predominant type of stem in the genus is distinctly woody.

Among the species with herbaceous stems may be mentioned *M. amarella, M. filifolia, M. graminea, M. herbacea, M. Macbridei, M. arenicola, M. Weberbaueri,* and *M. macrostachya.* The remaining species have woody stems, which are either erect or twining. Characteristic of the species with twining stems are *M. ovata, M. polystachya, M. Pavoni, M. pseudo-polystachya,* and *M. Mathusiana. Monnina marginata* and *M. pilosa* are arborescent species. The stem is sometimes terete, as in all the annual species except *M. herbacea* and in many of the suffruticose species, and sometimes striate, as in *M. herbacea* and the bulk of the suffruticose species. As a rule the stems are branched from the base, but in some cases the branching is corymbose, as in *M. filifolia, M. graminea, M. macrostachya,* and *M. conferta.* Rarely, as in the arborescent *M. marginata,* the crown of the plant is strongly and copiously branched. Furthermore, the branches may be either decurrent or divaricate. They are decurrent in *M. longibracteata, M. huallagensis, M. Vitis-Idaea,* and *M. pseudo-polystachya,* and divaricate in *M. tomentella.* In *M. Vitis-Idaea* the branches are not only corymbose, but also decurrent. Most species are more or less pubescent, but *M. huallagensis, M. glabrifolia, M. marginata, M. Vitis-Idaea,* and *M. ovata* are glabrous. The stem may also be characterized by having conspicuous nodes, as in *M. andina, M. Vitis-Idaea, M. salicifolia,* and *M. peruviana.*

LEAVES. In all the species of *Monnina* the leaves are alternate; occasionally they are crowded into groups. The leaf-blades are prevailingly lanceolate or elliptic. Occasionally they are linear, as in *M. filifolia, M. graminea, M. ramosa,* and *M. Macbridei,* and rarely, as in *M. amarella,* oblanceolate. Foliar dimorphism is present, at least among our species, only in *M. pterocarpa,* of which the upper leaves are linear and the lower ones ovate. The leaf-apex is usually obtuse or acute, but in some species it is acuminate. In *M. amarella* and *M. arenicola* the leaves are obtuse and emarginate at apex, while in *M. graminea* they are acute and mucronate. *Monnina pachycoma* also has the leaf-apex lightly mucronate. The leaf-margins are entire; although Chodat has stated that the leaves of *M. menthoides* are more or less sinuose-dentate, I have not seen herbarium specimens which permit me to verify this observation. Usually the leaf-margins are flattened, being more or less revolute only in *M. ramosa, M. andina, M. Vitis-Idaea, M. conferta, M. stipulata, M. Lechleriana, M. salicifolia, M. decurrens, M. densecomata,* and *M. pachycoma.* The nervation of the lamina is pinnate, the lateral nerves varying from four to ten pairs. For example, *M. pterocarpa* has four or five pairs of secondaries, while *M. glabrifolia, M. macrosepala, M. ovata,* and *M. densecomata* have nine or ten pairs. Only *M. filifolia, M. ramosa,* and *M. Macbridei* have leaf-blades which are essentially 1-nerved. The midrib is always conspicuous on the lower leaf-surface, with the exception of *M. ramosa.* In texture the blades vary from herbaceous, as in most of the species, to coriaceous in such species as *M. glabrifolia.* Except for *M. filifolia,* the leaves of which lack a petiole, the Peruvian species of *Monnina* have petiolate leaves, although in *M. ramosa* the petiole is only 1 mm. long. The leaf-surfaces are usually more or less pubescent, but most often becoming glabrescent. They are glabrous even when young only in *M. glabrifolia, M. ovata,* and *M. decurrens,* while in *M. Ruiziana, M. pilosa,* and *M. tomentella* they are most densely pubescent.

Pubescence. The presence of both simple and multicellular hairs has been observed. As a rule the indument is composed of short hairs which are soon lost, leaving the plant glabrescent. In the few species which have a dense pubescence the hairs are lax and somewhat yellowish, as in *M. polystachya,* where they attain a length of 2 mm.

Inflorescence. The annual species and some of the suffruticose ones have simple racemes, which are either terminal or axillary, while in the other species the inflorescence is paniculate. However, in a few species the racemes may be either simple or aggregated in groups of two or three, as in *M. acutifolia, M. Vargasii, M. Herrerae,* and *M. pachycoma.* The peduncle varies greatly in length from species to species, being essentially suppressed in *M. decurrens.* The racemes are usually ascending, but in *M. divaristachya, M. Ruiziana,* and *M. connectisepala* they are conspicuously divaricate. All the climbing species have striate peduncles.

Flowers. The flowers of *Monnina* are zygomorphic and bisexual. The persistent calyx is composed of five concave sepals, three exterior and two interior. The outer sepals are free, while the two inner ones are sometimes united. The inner sepals, or wings, are petaloid and commonly dark blue in color, being pale pink only in *M. arenicola.* The two lower sepals, except in *M. glabrifolia,* are always shorter than the upper sepal. In some species, such as *M. macrosepala* and *M. pachycoma,* the three outer sepals are more or less equal in size to the wings. The wings always have the margin involute, or bent inward; their dorsal surfaces may be either glabrous or pubescent. The measurements of these parts, as given in my descriptions, represent the maximum and minimum observed in the available specimens, but in preparing the illustrations I always referred to the maximum measurements.

The corolla is composed of three petals, a median inferior one called the keel and two superior lateral ones, these being usually ligulate in shape and united with the staminal tube. The keel is usually yellow, but in *M. arenicola* it is essentially white and in *M. macrosepala* var. *latifolia* it is orange in color. The measurements given for the keel were made in its natural position in the flower, being actually measurements of the silhouette. The apex of the keel is commonly trilobed, although in *M. Macbridei, M. Vitis-Idaea,* and *M. decurrens* it is bilobed. Numerous species have pubescence on the interior surface of the keel, and some species, such as *M. callimorpha* and *M. pseudo-polystachya,* have the external and convex parts of the keel pubescent. The superior petals are usually spatulate and are more or less similar from species to species, differing only in size; in such species as *M. Weberbaueri* and *M. conferta* they are short, while in *M. Clarkeana* they are conspicuously elongated.

In *M. tomentella* the upper petals are densely pubescent, while in *M. ramosa* and *M. Lechleriana* they are essentially glabrous.

The stamens are six or eight. The only Peruvian species observed by me to have six stamens are *M. amarella* and *M. filifolia*, although it is probable that *M. graminea* (of which I have seen no material) also has six stamens. The stamens are partially or completely united into two groups. The free portion of the stamen is usually glabrous, but in *M. huallagensis* and *M. macrosepala* it is adorned with a few hairs. The length of the free part of the filaments varies from species to species, and the measurements given usually state the maximum and minimum observed. The anthers are bilocular, apically dehiscent, and usually subemarginate, being mucronate in *M. huallagensis, M. macrosepala, M. Vitis-Idaea, M. divaristachya,* and *M. Pavoni.* The apex of the pore may be ascending or outwardly reflexed.

The ovary is generally ellipsoid and glabrous, although when pubescent the hairs may be very dense (as in *M. herbacea*) or merely scattered toward the base, as in *M. divaristachya, M. polystachya,* and *M. Vargasii.* Sometimes the ovary bears numerous elongate hairs distally, as in *M. marginata, M. ovata, M. pseudo-polystachya,* and *M. peruviana.* The style is usually cylindric and geniculate, but in *M. ramosa, M. Macbridei,* and *M. arenicola* it is more or less straight, with a small inflexion near the stigma. The style may also be auriculate, as in *M. pterocarpa, M. amarella, M. filifolia,* and *M. graminea.* Most species have a glabrous style, but in *M. Pavoni, M. pseudo-polystachya, M. decurrens,* and *M. peruviana* the style bears hairs around its base or toward the middle. The stigma is bilobed, the lower lobe being usually acute and the upper lobe either bituberculate or simply tuberculate and papillose. It is to be noted that Chodat, in his descriptions, referred to the upper lobe of the stigma as the "inferior" one. In *M. filifolia* the stigma is more or less denticulate, the lobes being almost acute. The disk is generally reduced to a gland at the base of the ovary.

The fruit is a one-celled and one-seeded drupe or samara. Sometimes it is intermediate in character between a drupe and a samara, as in *M. herbacea, M. glabrifolia, M. menthoides, M. andina,* and *M. cyanea.* The last four species listed have the fruit cordate and margined and all occur in the same general region in southeastern Perú. *Monnina* has its fruits either glabrous or pubescent; certain of the annual species, such as *M. filifolia, M. ramosa,* and *M. macrostachya,* have samaras which are at first finely pubescent but eventually glabrescent.

The pedicels are always terete and usually pubescent; they vary in length but are generally not very conspicuous.

POSITION OF THE GENUS

Monnina is a very distinct genus, being not very closely related to others in the Polygalaceae. It is perhaps most closely allied to *Polygala*, from which it is readily distinguished by the caducous sepals, the stamens conspicuously grouped into two fascicles, the filaments united almost up to the attachment of the anthers, the more or less truncate stigma with two dissimilar lobes, and finally the indehiscent fruit, which is either a drupe or a samara.

DISTRIBUTION

In South America the distribution of the species of *Monnina* comprises chiefly the region of moderate climates of the Andes, from northern Colombia, with *M. parviflora* and *M. Smithii*, to southern Chile, with *M. linearifolia*, at a latitude of approximately 39°.

It seems evident that the largest concentration is in the Peruvian territory, where there are actually 46 species. The habitat is very distinct. Some species are endemic to the dunes near the ocean, such as *M. arenicola*, and others to the uplands or "punas" between 3500 and 4000 meters altitude, such as *M. densecomata* and *M. pachycoma*. Some are indigenous to the rainy subtropical region called "ceja de montaña," such as *M. macrosepala*.

Colombia also has an important concentration of species. According to the available material, the species of this country are distributed in the Oriental, Central, and Occidental Ranges of the Andes. Apparently there are centers in the Departments of Santander, Tolima, Caldas, Antioquía, and El Cauca, in regions called "templadas y frescas" at an altitude between 1500 and 3500 meters. The concentration decreases to the south, and Chile appears to have only two species, *M. linearifolia* and *M. retusa*. Probably *M. salicifolia* occupies the largest geographic area. It is present in the Andes of Ecuador, Perú, and Bolivia, between 1800 and 3600 meters altitude.

MATERIAL

All the material in the following important herbaria has been examined:

Arnold Arboretum, Harvard University	(A)
Chicago Natural History Museum	(Ch)
U. S. Department of Agriculture (National Arboretum)	(DA)
Gray Herbarium, Harvard University	(GH)
Missouri Botanical Garden	(M)
New York Botanical Garden	(NY)
Academy of Natural Sciences of Philadelphia	(Ph)
University of California	(UC)
United States National Herbarium	(US)

Many types and photographs and much authentic material belong to these herbaria. The morphological characters of the majority of the species have been illustrated by the author in order to show their differences. Sometimes the plates show only the floral structure of the species, without the habit, due to the absence of material; some species are not represented in the plates because there is no material available.

To the Directors and Curators of these institutions I am deeply grateful for the many courtesies they have extended.

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SYSTEMATIC TREATMENT

Monnina R. & P. Syst. Veg. 169 (1798); Bonpland in Ges. Nat. Freunde Berlin Mag. 2: 40 (1808); H.B.K. Nov. Gen. et Sp. 5: 409 (1821); DC. Prodr. 1: 338 (1824); Presl, Reliq. Haenk. 2: 101 (1827); Benth. & Hook. f. Gen. Pl. 1: 139 (1862); Chodat in E. & P. Nat. Pfl. III. 4: 340 (1896).

Herbs, shrubs, or trees, sometimes scandent. Leaves alternate, entire or rarely denticulate, stipulate or without stipules, glabrous or pubescent, lanceolate, elliptic, linear, or rarely spatulate, sometimes more or less clustered, penninerved or rarely 1-nerved, petiolate or subsessile. Flowers in terminal or axillary racemes, rarely in aggregate racemes; peduncle short to very long, the upper part usually with bracts, rarely bractless. Sepals 5, the 3 outer herbaceous, free or the 2 lower united, the 2 inner (wings) petaloid and usually much larger, more or less concave. Petals 3, the lowermost (keel) carinate, the 2 upper ones ligulate, usually elongate, united below to the staminal sheath. Stamens 8 or 6, the filaments united nearly to apex into a sheath split on the upper side; anthers 1- or 2-celled, sometimes emarginate or mucronate. Ovary 1-celled, rarely 2-celled; style geniculate, very rarely more or less straight, auricled or without auricles, glabrous, sometimes pubescent; stigma with 2 dissimilar lobes, the lower more or less acute, the upper papillose with 1 or 2 tubercles. Disk usually reduced to a gland at base of ovary (hypogynous). Fruit a drupe with thin fleshy coat, the surface rugose, glabrous or pubescent, sometimes samaroid, narrowly and subequally winged, glabrous or strigillose.

KEY TO THE SPECIES

Plants annual, small; fruit usually winged, rarely without wings.
- Androecium with 6 stamens, rarely with 8 stamens; style with 2 auricles.
  - Stem relatively thick, to 25 dm. high; lower leaves ovate-lanceolate, the upper linear-lanceolate. .... 1. *M. pterocarpa.*
  - Stem slender, always less than 10 dm. high; lower leaves linear-lanceolate or oblanceolate.
    - Racemes usually with a short axis, 1–2.8 dm. long; apex of leaves obtuse or emarginate, sometimes acuminate; wing of fruit almost always purple. .... 2. *M. amarella.*
    - Racemes always with a long axis, 1.8–4.5 dm. long; apex of leaves acute; wing of fruit greenish.
      - Lower leaves filiform; fruit puberulous; stamens united....... 3. *M. filifolia.*
      - Lower leaves lanceolate; fruit glabrous; stamens free in the upper part, unequal.......... 4. *M. graminea.*
- Androecium always with 8 stamens; style without auricles.
  - Ovary puberulous; stamens united for two-thirds their length, the free part conspicuous; style geniculate from near its base; fruit cordiform, densely puberulous .... 5. *M. herbacea.*

Ovary glabrous; stamens entirely united; style nearly straight or geniculate below the apex; fruit ovate, glabrescent, sometimes finely puberulous.
Blade of leaves linear; keel glabrous within, the apex emarginate; upper petals elongate-spatulate.
Root thick, subfrutescent; stem sparsely branched; margin of leaves revolute; lower sepals 3-nerved, ciliate; style thicker toward apex; fruit finely puberulous..6. *M. ramosa.*
Root thin, herbaceous; stem simple or with a few branches; margin of leaves not at all revolute; lower sepals 1-nerved, not ciliate; style cylindric; fruit glabrescent.....................................7. *M. Macbridei.*
Blade of leaves ovate-lanceolate; keel puberulous within, the apex acute; upper petals short.
Flowers white; lower sepals glabrous; base of keel obtuse, glabrous; fruit finely puberulous....................................8. *M. arenicola.*
Flowers not white; lower sepals ciliate; base of keel acute, ciliate; fruit more or less glabrescent.
Drupe to 3 mm. long; upper sepal 3-nerved, glabrous beneath; upper stigma-lobe short...............................9. *M. Weberbaueri.*
Samara to 5 mm. long; upper sepal 5-nerved, puberulous beneath; upper stigma-lobe elongate, ciliate.....................10. *M. macrostachya.*
Plants perennial, frutescent or arborescent, sometimes scandent; fruit without wings, rarely with a very small wing.
Lower sepals united.
Inflorescence to 3.2 dm. long; flowers not crowded, with filiform and conspicuous bracts.
Bracts of racemes with involute apex; leaves usually acute; upper petals short; anthers obtuse or emarginate......................11. *M. longibracteata.*
Bracts of racemes with straight apex; leaves acuminate; upper petals elongate-spatulate; anthers mucronate.........................12. *M. huallagensis.*
Inflorescence to 2.2 dm. long; flowers crowded, without filiform bracts.
Racemes simple, terminal; leaves usually lanceolate, rarely more or less elliptic.
Ovary pubescent.
Apex of racemes with oblanceolate bracts to 2 mm. wide, lax; fruit cordiform, strongly flattened; lower sepals 5-nerved and larger than the upper sepal......................................13. *M. glabrifolia.*
Apex of racemes without bracts or with narrow bracts less than 1 mm. wide; fruit ovate, slightly flattened; lower sepals 1–3-nerved, always smaller than the upper sepal.
Leaves to 4.5 cm. long; racemes slender, lax; fruit ovate-cordiform, with a very small wing.
Branches tomentose; leaves lanceolate, densely puberulous, acute-mucronate, sinuous-dentate; racemes hirsute...14. *M. menthoides.*
Branches glabrescent; leaves more or less elliptic, glabrescent, obtuse, entire; racemes glabrescent.......................15. *M. andina.*
Leaves to 10 cm. long; racemes thicker, straight; fruit elliptic, not at all winged.
Stem with branches corymbose; leaves narrowly lanceolate; lower sepals 1-nerved, the upper 3-nerved; wings puberulous beneath; central Perú.................................16. *M. marginata.*
Stem with branches not corymbose; leaves elliptic or more or less lanceolate; lower sepals 3-nerved, the upper 5-nerved; wings glabrous beneath; northern Perú........17. *M. pseudo-salicifolia.*
Ovary glabrous.
Bracts of racemes conspicuous, linear-lanceolate, 3–6 mm. long; leaves linear-lanceolate, acuminate; outer sepals to 5 mm. long; free part of filaments puberulous............................18. *M. macrosepala.*
Bracts of racemes inconspicuous, ovate-triangular, less than 2.5 mm. long;

leaves elliptic, rarely more or less lanceolate, obtuse; outer sepals to 3 mm. long; free part of filaments glabrous.

Branches conspicuously corymbose; leaves usually deciduous, to 4.5 cm. long.

Stem 3 dm. high; axis of inflorescence less than 1.6 cm. long; lower sepals 1-nerved, the nerve conspicuous; keel 2-lobed, glabrous within; upper petals elongate-spatulate; anthers mucronate...... ....19. *M. Vitis-Idaea.*

Stem 18 dm. high; axis of inflorescence 3–10 cm. long; lower sepals 3-nerved, the nerves inconspicuous; keel 3-lobed, puberulous within; upper petals short, narrow; anthers not mucronate. ....20. *M. conferta.*

Branches not corymbose; leaves not deciduous, to 9 cm. long.

Leaves with prominulous nerves, strongly revolute, largely petiolate, the petiole to 6 mm. long; branches densely puberulous; outer sepals 5–7-nerved; wings glabrous within; southern Perú.............. ....21. *M. stipulata.*

Leaves without prominulous nerves, not revolute, inconspicuously petiolate, the petiole to 2 mm. long; branches almost glabrescent; outer sepals 1–3-nerved; wings more or less puberulous within; central Perú..................................22. *M. canescens.*

Racemes in wide panicles; leaves usually elliptic, rarely more or less lanceolate.

Ovary pubescent.

Erect shrub, glabrescent, rarely slightly puberulous.

Axis of panicle to 25 cm. long, the racemes glabrous; leaves to 13.5 cm. long, the costa with 8 or 9 pairs of lateral veins, the axil without leaflets; outer sepals 3–5-nerved; wings almost acute at the base; anthers mucronate; ovary with a few hairs near its base............ ....23. *M. divaristachya.*

Axis of panicle to 13 cm. long, the racemes puberulous; leaves to 9.8 cm. long, the costa with 5 or 6 pairs of lateral veins, the axil with spatulate leaflets; outer sepals 1-nerved; wings obtuse at the base; anthers not at all mucronate; ovary entirely puberulous.................... ....24. *M. callimorpha.*

Scandent, usually densely hirsute, rarely glabrous.

Leaves elliptic or ovate, glabrescent, obtuse; branches striate, glabrescent; lower sepals 3-nerved; obtuse.......................25. *M. ovata.*

Leaves almost lanceolate, puberulous, acute; branches terete, densely hirsute; lower sepals 1-nerved, acute.

Hairs of branches to 2.5 mm. long, lax; leaves densely puberulous above; style glabrous; ovary slightly puberulous near its base. ....26. *M. polystachya.*

Hairs of branches to 1 mm. long, rigid; leaves more or less glabrescent above; style puberulous; ovary totally puberulous.

Axis of panicle to 24 cm. long; branches more or less glabrescent; outer sepals glabrescent or slightly puberulous beneath; wings glabrous; keel densely puberulous within, glabrous on convex longitudinal line; ovary with short, strigose, inconspicuous hairs, sometimes glabrescent; style puberulous near its base; anthers mucronate ....27. *M. Pavoni.*

Axis of panicle to 12 cm. long; branches puberulous; outer sepals strongly puberulous beneath, the hairs rigid; wings more or less puberulous beneath, ciliate; keel glabrescent or with a few inconspicuous hairs within, puberulous on convex longitudinal line; ovary with larger, numerous, rigid, ascendent, conspicuous hairs; style puberulous on the upper part; anthers not at all mucronate. ....28. *M. pseudo-polystachya.*

Ovary glabrous.
Panicles with divaricate racemes; leaves elliptic; androecium with puberulous filaments.
Branches terete, densely hirsute; leaves to 5 cm. long....29. *M. Ruiziana.*
Branches striate, more or less glabrescent; leaves to 10 cm. long........ ....30. *M. connectisepala.*
Panicles with decurrent or ascendent racemes; leaves lanceolate; androecium with glabrous filaments.
Racemes and flowers conspicuously crowded; lower sepals obtuse, the upper 5–7-nerved; upper petals short............31. *M. Lechleriana.*
Racemes and flowers not crowded; lower sepals acute, the upper 3-nerved; upper petals elongate-spatulate..................32. *M. Clarkeana.*
Lower sepals free.
Inflorescence in simple racemes, axillary or terminal.
Ovary glabrous.
Apex of racemes with ovate-acute and conspicuous bracts; branches glabrescent; lower sepals glabrous beneath, the upper sepal 7-nerved. ....33. *M. ligustrifolia.*
Apex of racemes with triangular-acuminate and inconspicuous bracts; branches puberulous; lower sepals puberulous beneath, the upper sepal 3–5-nerved.
Peticles to 2.5 mm. long; leaves to 7 cm. long, elliptic, obtuse; wings ciliate on lower margin..................................34. *M. salicifolia.*
Petioles to 5 mm. long; leaves to 11 cm. long, lanceolate, acuminate; wings glabrous on margin.................................35. *M. hirtella.*
Ovary pubescent.
Branches conspicuously canescent-hirsute; length of leaves always less than 3 times their width; drupe cordiform, flattened; lower sepals usually 1-nerved; keel glabrous within, the lateral lobes elongate; style glabrous. ....36. *M. cyanea*
Branches more or less glabrescent; length of leaves almost always more than 4 times their width; drupe ovate or elliptic; lower sepals 3-nerved; keel puberulous within, the lateral lobes short; style puberulous.
Leaves elliptic, crowded, to 2.8 cm. long, obtuse; bracts of racemes to 1 mm. long, inconspicuous; outer sepals puberulous beneath; wings puberulous within...37. *M. decurrens.*
Leaves linear-lanceolate, not crowded, to 10.5 cm. long, acute; bracts of racemes to 2.8 mm. long, conspicuous; outer sepals glabrous beneath; wings glabrous within.............................38. *M. peruviana.*
Inflorescence in panicles or aggregate racemes.
Apex of leaves acuminate or acute.
Stem scandent, slightly hirsute; racemes numerous, lax, slender, with filiform bracts...39. *M. Mathusiana.*
Stem not scandent, erect, densely hirsute; racemes not numerous, aggregate, ascendent, thicker, usually with ovate-lanceolate bracts.
Axis of racemes to 31 cm. long; blade of leaves thin, with 5 or 6 pairs of lateral veins......................................40. *M. acutifolia.*
Axis of racemes to 10 cm. long; blade of leaves thicker, with 7 or 8 pairs of lateral veins.
Leaves lanceolate; wings ciliate; ovary more or less puberulous; southern Perú..41. *M. Vargasii.*
Leaves oblong; wings glabrous; ovary glabrous; northern Perú........ ....42. *M. pilosa.*
Apex of leaves usually obtuse, rarely acute.
Racemes numerous; wings puberulous beneath.
Margin of leaves conspicuously revolute, the apex not attenuate; racemes lax, the axis to 12.5 cm. long; upper sepal obtuse; wings glabrous within; keel puberulous within; southern Perú....43. *M. densecomata.*

Margin of leaves not revolute, the apex more or less attenuate; racemes rigid, the axis to 18 cm. long; upper sepal acute; wings puberulous within; keel glabrous within; northern Perú........44. *M. tomentella.*

Racemes aggregate, sometimes simple, terminal; wings glabrous beneath.

Leaves acute, to 9 cm. long; petioles to 7 mm. long; outer sepals to 3.5 mm. long, puberulous beneath, the apex straight, the two lower 1-nerved; keel to 6 mm. long.................................45. *M. Herrerae.*

Leaves obtuse, to 6 cm. long; petioles to 4.5 mm. long; outer sepals to 7 mm. long, glabrous beneath, the apex involute, the two lower 3-nerved; keel to 8 mm. long..................................46. *M. pachycoma.*

1. **Monnina pterocarpa** R. & P. Syst. Veg. 174 (1798); Chodat in Bull. Herb. Boiss. **2:** 168 (1894), in Bot. Jahrb. **42:** 102 (1908).

Monnina angustifolia DC. Prodr. **1:** 340 (1824).

Monnina chanduyensis Chodat in Bull. Herb. Boiss. **2:** 167 (1894).

Monnina pterocarpa var. *exauriculata* Chodat in Bull. Soc. Bot. Genève II. **25:** 202 (1934).

Annual, more or less herbaceous, 3–25 dm. high; stem 3.5–7 mm. in diameter, erect, terete, branched, the branches 8–78 cm. long, glabrescent; leaves linear (upper) or ovate-lanceolate (lower), 11–55 mm. long, 3–22 mm. wide, usually acute, rarely obtuse, glabrescent above, slightly pubescent beneath, entire, attenuate at base, the costa prominulous beneath, with 4 or 5 pairs of lateral veins; petioles 1–2.5 mm. long, pubescent; racemes more or less conical, acute, 8–11 mm. wide, simple, terminal, with a short peduncle, the axis 7–22 cm. long, finely pubescent, bracteate, the bracts filiform, 2–2.2 mm. long, deciduous, ciliate, 1-nerved, pubescent beneath; flowers 4–4.6 mm. long; pedicels 0.6–1 mm. long, glabrous; outer sepals free, lanceolate, concave, ciliate, acute, pubescent beneath, the two lower 1.6–2 mm. long, 0.8–1.2 mm. wide, 3-nerved, the upper one 2–2.5 mm. long, 0.9–1.4 mm. wide, 3–5-nerved; wings purple, 4–5 mm. long, 3–4 mm. wide, obovate, acute at base, 3–5-nerved, glabrous; keel yellow, 4–4.8 mm. long, 2.2–3.4 mm. wide, almost orbicular, plicate, glabrous within, obtuse at base, 3- or 4-nerved, 3-lobed, the middle lobe obtuse-emarginate, larger; upper petals elongate, pubescent within; stamens 8, the filaments 3–4 mm. long, united almost throughout, the apex acute, pubescent, the anthers emarginate; ovary elliptic, 1–1.4 mm. long, 0.6–0.8 mm. wide, glabrous; style 1.8–2.2 mm. long, geniculate near its base, glabrous, the apex 4–5 times as wide as the base, 2-auricled, the auricles usually conspicuous; stigma with 2 lobes, the lower more or less acute, the upper 2-tubercled; samara ovate, 3.5–8 mm. long, 3–7 mm. wide, gray-strigillose, becoming glabrescent, the wing 1–2.5 mm. wide, membranaceous, deeply emarginate at apex and base, the body rugose-reticulate. (PL. I, FIGS. 1–11.)

DISTRIBUTION: Northern and central parts of the Peruvian coast, between 20 and 2000 meters; also in the southwestern part of Ecuador, Province of Guayas.

ECUADOR: GUAYAS: Puntilla, Salinas, *Svenson 11221* (US); Punta Centinela, *Svenson 11390* (US); Chanduy, without date, *Spruce 6398* (type photograph of *Monnina chanduyensis,* US). PERU: TUMBEZ: Caucas, Province of Tumbez, *Weberbauer 7757* (isotypes of *Monnina pterocarpa* var. *exauriculata,* US, Ch); PIURA: Talara, *Johnston 3512* (Ch, GH, US), *Haught 7* (Ch, NY, US); Pariñas Valley, *Haught 91* (Ch); Paita, *Pennell 14812* (Ch, GH, NY, Ph, US); LIMA: Lima, 1838–42, *Wilkes Expedition,* without number (GH, US); near Lima, December 27, 1874–78, *Martinet* without number (Ch, US); Quives, *Pennell 14298* (Ch, GH, Ph); near Viscas, *Pennell 14467* (Ch, GH, NY, Ph, US); near Santa Eulalia, Province of Huarochiri, Chosica, *Goodspeed 11308* (DA, GH, UC); above Chosica, *Mexia 4007* (GH, M, UC);

vicinity of Chosica, *Rose & Rose 18545* (NY, US); Chosica, *Macbride 2874* (Ch, US), *Macbride & Featherstone 494* (Ch, US), *Grant 7393* (GH, US), *Soukup 2049* (US); DEPT. ?: Without locality and date, *Dombey 28* (Ch), *Gay* without number (fragments, US), *Pavón* without number (type photograph, US); "ex Lima," 1807, *Lagasca 54* (type photograph of *Monnina angustifolia,* US).

The original description of *Monnina angustifolia* indicates the characteristics of *M. pterocarpa;* moreover, the locality is cited as "circa Lima," and most of the specimens identified came from the Department of Lima. A. Gray, Bot. U. S. Expl. Exped. **1:** 107 (1854), in his brief description of *M. angustifolia,* collected "between Lima and Yanga," states: "Perhaps not distinct from *M. pterocarpa.*"

It was not possible to find important characters to separate *M. chanduyensis* from *M. pterocarpa;* on the contrary the photographs and the original descriptions of both seem to indicate that they are the same species. The species of Chodat was found in Chanduy (*Spruce 6398*), Province of Guayas, situated in the southwestern part of Ecuador; fortunately it was possible to see some specimens, *Svenson 11221* and *11390,* from localities near Chanduy. It has been possible also to examine some material from the northwestern part of Perú near the Province of Guayas. All of these specimens are essentially similar to the material from the Department of Lima. Chodat pointed out the similar qualities of the two species when he said: "Les feuilles, les petites stipules cornées, l'inflorescence et la grandeur des fleurs sont les mêmes." He established the differences in the shape of the samara, which in *M. pterocarpa* is regularly winged and symmetrical, while in *M. chanduyensis* it is irregular and asymmetrical. However, some specimens from Piura show the samara to be symmetrical and, on the contrary, material from Lima appears to have asymmetrical samaras. Therefore the writer prefers to combine the two species. It is desirable to indicate that the specimens *Pennell 14812* and *Svenson 11221* present an inconspicuous winged style; *Pennell 14467* shows small anthers and filaments with the upper part more or less free.

It is probable that Hooker made an error, in Bot. Mag. 58: *t. 3122* (1831), in identifying a specimen from Lurín, Department of Lima, as *M. obtusifolia,* which is a species from Colombia. The specimen illustrated is the same as *M. pterocarpa.*

2. **Monnina amarella** Chodat in Bull. Soc. Bot. Genève II. 25: 200 (1934).

Annual, herbaceous, 0.6–8 dm. high; root 3–7 cm. long, 0.8–1.2 mm. in diameter, usually simple, perpendicular; stem erect, terete, branched, the branches 3–50 cm. long, finely pubescent; leaves oblanceolate or linear-lanceolate, 10–44 mm. long, 2–10 mm. wide, usually obtuse, sometimes emarginate, glabrescent, entire, attenuate at base, the costa prominulous beneath with inconspicuous lateral veins; petioles 0.8–1.5 mm. long, glabrescent; racemes conical, acute, 7–9 mm. wide, simple, terminal, with a short peduncle, the axis 2–32 cm. long, slightly pubescent, bracteate, the bracts filiform, 1.5–1.8 mm. long, deciduous, glabrous, inconspicuous; flowers 3–3.8 mm. long; pedicels 0.5–0.7 mm. long, glabrous; outer sepals free, lanceolate, concave, glabrous, acute, the two lower 1–1.4 mm. long, 0.4–0.7 mm. wide, 1-nerved, the upper one 1.5–2.2 mm. long, 1–1.4 mm. wide, 3-nerved, rarely ciliate; wings purple, 2.8–3.2 mm. long, 2–2.2 mm. wide, obovate, acute at base, 3-nerved, glabrous; keel yellow, 3.5–3.8 mm. long, 1.8–2 mm. wide, orbicular, plicate, glabrous, acute at base, 4- or 5-nerved, 3-lobed, the middle lobe obtuse-emarginate, larger; upper petals elongate-spatulate, pubescent within; stamens 6, the filaments 2.8–3 mm. long, united, glabrous, the anthers sessile, emarginate; ovary elliptic, 1–1.8 mm. long, 0.8–1 mm. wide, glabrous; style 1.5–1.6 mm. long, conspicuously geniculate above the base, glabrous, 2-auricled; stigma with 2 lobes, the lower acute, the upper 1-tubercled; samara ovate, 3.5–5 mm. long, 3–3.8 mm. wide, strigillose, becoming glabrescent, the wing 0.8–1.2 mm. wide, membranaceous, deeply emarginate at apex and base, the body rugose-reticulate. (PL. I, FIGS. *12–22*.)

DISTRIBUTION: In the central and southern Andes, Departments of Junín and Cuzco, between 2900 and 3600 meters.

PERU: JUNÍN: Between Viques and Ingahuasi, Mantaro Canyon, south of Huancayo, *Killip & Smith 22152* (US); CUZCO: Canyon Chicón, Prov. Urubamba, *Vargas 11061* (Ch, UC); Pampa de Anta, vicinity of Huarocando, *Herrera 3538* (Ch); colinas del Saxaihuamán, *Herrera 2388* (Ch); San Sebastián, *Pennell 13529* (TYPE Ch, ISOTYPES GH, NY, Ph, US); vicinity of Acomayo, Prov. Acomayo, *Vargas 491* (Ch); Cuzco, *Herrera 2393* (Ch); near Cuzco, *Herrera 681* (Ch, US); Ollantaytambo, *Cook & Gilbert 522* (US), *530* (US), *Pennell 13578* (Ph); Cuzco, July, 1923, *Herrera* without number (US); Saxaihuamán, *Pennell 13589* (Ph); "Urco," Calca, *Vargas 1774* (GH).

This species is close to *M. filifolia* Chodat, but it differs clearly from the latter in the oblanceolate leaves with an obtuse-emarginate apex; the axis is almost always short and the samara usually has a purple wing.

3. **Monnina filifolia** Chodat in Bull. Soc. Bot. Genève II. 25: 198 (1934).

Annual, herbaceous, 3–7.5 dm. high; root 6–9 cm. long, 1.2–3.5 mm. in diameter, simple or somewhat branched, perpendicular, sometimes curved; stem erect, terete, branched, the branches 10–50 cm. long, corymbose, slightly pubescent; leaves linear, 20–70 mm. long, 1.5–5 mm. wide, acuminate, sometimes acute, glabrescent, entire, attenuate at base, 1-nerved, sessile, the costa prominulous beneath; racemes conical, acute, 6–8 mm. wide, simple, terminal, pedunculate, the peduncle 14–35 mm. long, the axis 18–45 cm. long, finely pubescent, bracteate, the bracts filiform, 1.8–2.5 mm. long, deciduous, ciliate, 1-nerved; flowers 3–3.5 mm. long; pedicels 0.8–1 mm. long, glabrous; outer sepals free, lanceolate, concave, the two lower ones 1.2–1.8 mm. long, 0.5–0.6 mm. wide, glabrous, 1-nerved, acute, the upper one 2–2.2 mm. long, 1–1.2 mm. wide, ciliate, 3-nerved, acuminate; wings purple, 3.2–3.5 mm. long, 2–2.2 mm. wide, obovate, acute at base, 3-nerved, glabrous; keel yellow, 3.4–3.8 mm. long, 1.8–2 mm. wide, orbicular, plicate, glabrous, obtuse at base, 3- or 4-nerved, 3-lobed, the middle lobe obtuse-emarginate, larger; upper petals elongate-spatulate, conspicuously pubescent; stamens 6, the filaments 2–2.5 mm. long, united, pubescent at the apex, the anthers sessile; ovary elliptic, 1–1.5 mm. long, 0.5–0.6 mm. wide, glabrous; style 2–2.4 mm. long, geniculate at the middle, glabrous, with 2 conspicuous auricles; stigma more or less denticulate with 2 lobes, the lower acute, the upper 1-tubercled; samara ovate, 4–5.5 mm. long, 2.5–4.5 mm. wide, gray-strigillose, becoming glabrescent, the wing 0.8–1 mm. wide, membranaceous, deeply emarginate at apex and base, the body rugose-reticulate. (PL. I, FIGS. *23–33*.)

DISTRIBUTION: Known only from the Department of Huancavelica in the general region of the central Andes, between 1900 and 2400 meters.

PERU: HUANCAVELICA: Valley of the Mantaro river, below Colcabamba, Province of Tayacaja, *Weberbauer 6454* (TYPE Ch, ISOTYPES GH, NY, US); Mejorada, Prov. Huancavelica, *Stork & Horton 10909* (Ch, UC).

This plant is very close to ***M. graminea*** Chodat, from northern Perú (Cajamarca), but differs in the lower leaves being filiform, the samara being conspicuously puberulous, and the filaments of the stamens being united throughout. No herbarium material of ***M. graminea*** is available to the author, and the differences here noted are derived from the original description and a photograph of the type.

4. **Monnina graminea** Chodat in Bot. Jahrb. **42:** 103 (1908).

Annual, herbaceous, 2–4 dm. high; root small, branched; stem erect, terete, simple or branched, the branches more or less pubescent, corymbose; leaves lanceolate or linear-lanceolate, 25–40 mm. long, 3–8 mm. wide, acute-mucronate, pubescent, entire, attenuate at base, the costa prominulous beneath; petioles short; stipules 1–1.5 mm. long, cylindric; racemes simple, terminal, the axis 10–20 cm. long, finely pubescent, bracteate, the bracts deciduous, inconspicuous; flowers 2–3 mm. long; pedicels 0.5 mm. long; outer sepals acute, glabrous; wings obovate, glabrous, cuneiform at base, the nerves fan-shaped; keel hemispherical, 3-lobed, the lobes obtuse; upper petals short, broad; staminal tube with hairs on the upper part, the filaments united, free in the upper part, glabrous; ovary elliptic, glabrous; style geniculate, 2-auricled; stigma with 2 lobes, the lower acute, the upper 1-tubercled; samara 2–3 mm. long, the wing glabrous, the body rugose-reticulate.

DISTRIBUTION: Confined to the northern part of the Peruvian Andes, Department of Cajamarca, at about 2200 meters.

PERU: CAJAMARCA: Below San Miguel, Prov. Hualgayoc, *Weberbauer 3919* (photograph of TYPE, US).

Material of this species has not been available, and the description given above is adapted from the original. It has also been possible to see the photograph of the type in the United States National Herbarium.

5. **Monnina herbacea** DC. Prodr. **1:** 340 (1824).

Monnina polygonoides Chodat in Bull. Soc. Bot. Genève II. **25:** 200 (1934).

Annual, herbaceous, 1–4.6 dm. high; root 5–7 cm. long, 1.5–2 mm. in diameter, curved, usually branched; stem almost erect, striate, branched at base, the branches 8–44 cm. long, more or less corymbose, pubescent; leaves usually lanceolate, rarely oblanceolate or elliptic, 8–40 mm. long, 3–12 mm. wide, obtuse, pubescent, becoming glabrescent, entire, attenuate at base, the costa prominulous beneath, with 5 or 6 pairs of lateral veins; petioles 0.6–1.5 mm. long, pubescent; racemes conical, acute, 7–8 mm. wide, simple, terminal, with a short peduncle, the axis 1.6–8 cm. long, finely pubescent, bracteate, the bracts filiform, 1.8–2.2 mm. long, deciduous, conspicuous, glabrous; flowers 3.5–4.2 mm. long; pedicels inconspicuous; outer sepals free, lanceolate, concave, ciliate, acute, the two lower 1.4–1.6 mm. long, 0.8–1 mm. wide, usually 3-nerved, sometimes 1-nerved, the upper one 2–2.4 mm. long, 1.2–1.4 mm. wide, 5-nerved; wings purple, 3.5–4.8 mm. long, 2.5–3.5 mm. wide, obovate, acute at base, 3-nerved, ciliate; keel yellow, 3.8–4.8 mm. long, 2–2.5 mm. wide, orbicular, plicate, glabrous within, obtuse at base, 4-nerved, 3-lobed, the middle lobe obtuse-emarginate, larger, ciliate; upper petals elongate-spatulate, pubescent within; stamens 8, the filaments 3–3.8 mm. long, united two-thirds their length, the free part 1–1.2 mm. long, glabrous, the anthers emarginate; ovary elliptic, 1–1.5 mm. long, 0.6–1 mm. wide, densely pubescent, the hairs rigid, ascendent, short; style 2–2.8 mm. long, geniculate above the base, glabrous, the apex thicker; stigma with 2 lobes, the lower acute, the upper 1-tubercled; fruit more or less samaroid, cordiform, 4–4.2 mm. long, 2.2–2.8 mm. wide, conspicuously pubescent, usually acute at apex, emarginate at base, the wing inconspicuous, the body rugose-reticulate. (PL. I, FIGS. 34–43.)

DISTRIBUTION: Indigenous in the central Andes, Departments of Huánuco and Junín, between 2100 and 2800 meters.

PERU: HUÁNUCO: Ambo, April 5, 1923, *Macbride 3181* (type of *M. polygonoides* Ch, isotypes GH, NY, US); JUNÍN: Huaraca, *Macbride 3116* (Ch, GH, NY, US); DEPT. ?: Without locality and date, *Dombey 625* (fragments of authentic material from the Paris Herbarium, Ch, US); without locality, 1862, *Mathews* without number (NY); "ex Lima," 1807, *Lagasca 53* (photograph of TYPE, US).

Fortunately it was possible to see authentic material and also a photograph of the type of this species. The label of the type reads: "ex Lima," and the original description by de Candolle gives: "prope Lima"; nevertheless it seems probable that this material was collected in the Departments of Huánuco or Junín, regions visited several times by Ruiz, Pavón, and Dombey. On the other hand, the annual species common about Lima, *M. macrostachya* and *M. Weberbaueri,* are very different from the present species. It has been possible to see the type of *M. polygonoides* Chodat, and obviously it is equal to *M. herbacea.*

6. **Monnina ramosa** I. M. Johnston in Contrib. Gray Herb. 70: 77 (1924).

Annual, more or less herbaceous, 1.5–2 dm. high; root 1.5–2 mm. in diameter, branched, curved; stem erect, terete, conspicuously branched, the branches 4–12 cm. long, canescent-pubescent; leaves linear, 10–30 mm. long, 1–2.5 mm. wide, obtuse, rarely acute, finely pubescent, entire, revolute, attenuate at base, 1-nerved; petioles 0.5–1 mm. long, slightly pubescent; racemes conical, acute, 5–8 mm. wide, simple, terminal, with a short peduncle, the axis 5–10 cm. long, canescent-pubescent, bracteate, the bracts linear or lanceolate, 2.5–3 mm. long, 0.8–1 mm. wide, deciduous, ciliate, 1-nerved, pubescent beneath; flowers 3.5–4.8 mm. long; pedicels 0.5–0.7 mm. long, glabrous; outer sepals free, lanceolate, concave, ciliate, acute, 3-nerved, glabrescent beneath, the two lower ones 1.4–1.7 mm. long, 0.9–1 mm. wide, the upper one 2–2.2 mm. long, 1.2–1.3 mm. wide; wings white, 4–5 mm. long, 2.5–3 mm. wide, obovate, acute at base, 3-nerved, glabrous; keel yellowish, 4–5 mm. long, 2–3 mm. wide, orbicular, plicate, glabrous, obtuse at base, 3-nerved, 3-lobed, the middle lobe emarginate; upper petals elongate-spatulate, pubescent within; stamens 8, the filaments 3–3.5 mm. long, united, glabrous, the anthers subsessile, emarginate; ovary elliptic, 0.8–1 mm. long, 0.5–0.6 mm. wide, glabrous; style 1.5–2.5 mm. long, straight, becoming slightly geniculate in the upper part, glabrous, almost cylindric; stigma 3–4 times as wide as the base of style, with 2 lobes, the lower acute, the upper 1-tubercled, elongate, cylindric; samara ovate, 3.5–4 mm. long, 3–3.5 mm. wide, gray-strigillose, the wing 0.8–1 mm. wide, membranaceous, deeply emarginate at apex and base, the body rugose-reticulate. (PL. II, FIGS. 1–10.)

DISTRIBUTION: This entity has been found in the southern part of the Department of Arequipa, at about 3300 meters.

PERU: AREQUIPA: On sandy pampa at 3300 m. alt. on south slope of Chachani Mountain near Arequipa, *Hinkley & Hinkley 13* (TYPE GH); Arequipa desert, August 21, 1925, *Cockerell* without number (US).

This species is related to *M. Weberbaueri* Chodat, from which it differs strongly in its leaves being linear with a revolute margin, the fruit being winged and puberulous, the lower sepals with 3 nerves, the keel glabrous, and the upper petals elongate. Furthermore the style is differently shaped.

7. **Monnina Macbridei** Chodat in Bull. Soc. Bot. Genève II. 25: 199 (1934).

Annual, herbaceous, 1–3.9 dm. high; root 3.5–8 cm. long, 0.8–1.4 mm. in diameter, usually simple, perpendicular; stem erect, terete, finely canescent-pubescent, simple, sometimes branched, the branches 4–16 cm. long; leaves linear or narrowly lanceolate, 14–45 mm. long, 1.5–5 mm. wide, acute, glabrescent, entire, attenuate at base, 1-nerved, the costa prominulous beneath; petioles 0.8–1.4 mm. long, glabrescent; racemes attenuate, acute, 5–7 mm. wide, simple, terminal, pedunculate, the peduncle 20–60 mm. long, the axis 2–14 cm. long, glabrescent, bracteate, the bracts filiform, 1.5–2 mm. long, deciduous, ciliate, 1-nerved, inconspicuous; flowers 3.5–4 mm. long, pedicels 0.5–0.6 mm. long, glabrous; outer sepals free, lanceolate, concave, glabrous, acute, the two lower ones 1.5–2 mm. long, 0.8–1 mm. wide, 1-nerved, the upper one 2–2.4 mm. long, 1–1.4 mm. wide, 3-nerved; wings purple, 4–4.2 mm. long, 2.4–2.6 mm. wide, obovate, acute at the base, 3- or 4-nerved, glabrous; keel yellow, 3.8–4 mm. long, 1.8–2 mm. wide, orbicular, plicate, obtuse-emarginate at the apex, glabrous, more or less acute at base, 3-nerved; upper petals elongate-spatulate, pubescent within; stamens 8, the filaments 2.8–3.2 mm. long, united, glabrous, the anthers subsessile; ovary elliptic, 0.8–1.5 mm. long, 0.6–0.8 mm. wide, glabrous; style 1.6–2.2 mm. long, straight, glabrous, almost cylindric; stigma with 2 lobes, the lower acute, the upper 1-tubercled, larger, papillose; samara ovate, 2.5–4.5 mm. long, 3–4 mm. wide, glabrous, the wing 0.8–1.2 mm. wide, membrañaceous, deeply emarginate at apex and base, the body rugose-reticulate. (PL. II, FIGS. 11–20.)

DISTRIBUTION: Endemic in the southeastern Andes, Department of Arequipa, between 2100 and 3355 meters.

PERU: AREQUIPA: Chachani Mountain, north of Arequipa, *Hinkley & Hinkley 18* (GH); Arequipa, *Pennell 13167* (TYPE Ch, ISOTYPE GH, Ph); Tingo, *Pennell 13110* (Ch, GH, NY, Ph, US).

Very close to *M. ramosa* Johnston, from which it differs in the few-branched stem, the 1-nerved glabrous lower sepals, and the more or less cylindric style.

8. **Monnina arenicola** sp. nov.

Planta herbacea annua, radici gracili perpendiculari simplici 4–7 cm. longa; caulis teres breviter pilosus 0.3–1.6 dm. altus simplex vel plus minusve ramosus; folia herbacea lanceolata vel elliptica 10–25 mm. longa 4–9 mm. lata basim versus elongato-attenuata apice emarginata vel obtusa glaberrima integerrima, nervo medio prominulo, inconspicue et breviter petiolata, petiolo 0.8–1.5 mm. longo glaberrimo; racemi simplices breves conici 5–6 mm. crassi, rhachi 3–8 cm. longa breviter pilosa, bracteis linearibus 1.5–2 mm. longis 0.4–0.5 mm. latis ciliatis deciduis; flores 2.8–3.2 mm. longi, pedicello 0.4–0.6 mm. longo glabro; sepala exteriora libera lanceolata acuta, duo inferiora 1.4–1.5 mm. longa 0.6–0.8 mm. lata plus minusve patentia glabra uninervia, sepalo superiore 1.6–1.8 mm. longo 1–1.2 mm. lato concavo ciliato 3-nervio; alae plus minusve albae 3–3.5 mm. longae 1.8–2 mm. latae obovatae glabrae basi acutae 3–5-nerviae; carina 3.2–3.5 mm. longa 1.5–1.6 mm. lata orbicularis plicata intus pilosa apice trilobata, lobo mediano acutiusculo, lobis lateralibus minoribus, basi plus minusve obtusiuscula 3-nervia, petalo superiore limbo breviter elongato extus glabro intus piloso; stamina 8 in fasciculis 2 disposita, filamentis 2.5–2.8 mm. longis connatis; antheris sessilibus; ovarium 1–1.2 mm. longum 0.5–0.7 mm. latum oblongum glabrum; stylus 1.2–1.6 mm. longus plus minusve geniculatus glaber cylindricus; stigma apice superiore bituberculatum apice inferiore acutum; samarae 4–5.5 mm. longae 3–4.8 mm. latae ellipticae reticulato-venosae canescentes strigillosae, alis 1–1.6 mm. latis membranaceis apice et basi conspicue emarginatis. (PL. II, FIGS. 21–30.)

DISTRIBUTION: Southern Perú, Department of Arequipa, in sandy plain near ocean, between 15 and 175 meters altitude.

PERU: AREQUIPA: East of Mollendo, sandy plain, *C. R. Worth & J. L. Morrison 15762* (DA, GH, M); south of Mollendo, sand dunes near ocean, November 17, 1935, *Mexia 4175* (TYPE Gray Herb., ISOTYPE M, UC).

Related to *M. macrostachya* R. & P. and also to *M. Weberbaueri* Chodat, differing from the first in the puberulous samara, the lower sepals, the glabrous wings and keel, and the stigma with the upper short lobe; from the second it is distinguished by its winged and puberulous fruit and the glabrous wings and keel. It is less closely related to *M. ramosa* Johnston, from which it differs in the lanceolate or elliptic leaves, the more or less simple stem, the lower sepals being 1-nerved, the keel being puberulous within, and the short upper petals.

9. **Monnina Weberbaueri** Chodat in Bot. Jahrb. 42: 102 (1908).

Annual, herbaceous, 1–4.8 dm. high; root 4–12 cm. long, 1–3 mm. in diameter, branched, curved; stem erect, terete, pubescent (hairs short, yellowish), ascendent, branched, the branches 7–26 cm. long; leaves usually lanceolate, rarely elliptic-spatulate, 12–46 mm. long, 6–26 mm. wide, obtuse, sometimes acute, glabrescent, entire, attenuate at base, the costa prominulous beneath with 6 or 7 pairs of lateral veins; petioles 1–2 mm. long, pubescent; racemes conical, acute, 8–12 mm. wide, simple, terminal, pedunculate, the peduncle 15–42 mm. long, the axis 2.5–16 cm. long, finely pubescent, bracteate, the bracts filiform, 1.2 1.6 mm. long, deciduous, ciliate, 1-nerved, inconspicuous; flowers 2.8–5 mm. long, the pedicels 0.5–0.6 mm. long, glabrescent; outer sepals free, lanceolate, concave, ciliate, acute, the two lower ones 1.4–1.6 mm. long, 0.4–0.5 mm. wide, 1-nerved, the upper one 2–2.2 mm. long, 0.6–0.8 mm. wide, 3-nerved, sometimes 1-nerved; wings purple, 2.8–4.2 mm. long, 1.8–2.8 mm. wide, obovate, acute at base, 3- or 4-nerved, ciliate; keel yellow, 3.4–5 mm. long, 1.5–2.8 mm. wide, orbicular, more or less plicate, pubescent within, acute at base.

3- or 4-nerved, 3-lobed, the middle lobe acute, larger, ciliate; upper petals short, pubescent within; stamens 8, the filaments 2.4–3 mm. long, united, glabrous, the anthers sessile, emarginate; ovary elliptic, 1–1.5 mm. long, 0.6–0.8 mm. wide, glabrous; style 1.5–2.8 mm. long, straight, becoming slightly geniculate near apex, glabrous, almost cylindric; stigma with 2 lobes, the lower acute, the upper 2-tubercled; drupe ovate, 1.8–2 mm. long, 1.4–1.5 mm. wide, glabrescent, rugose-reticulate. (PL. II, FIGS. 31–41.)

DISTRIBUTION: In "lomas" of central and southern Perú, Departments of Lima and Arequipa, between 20 and 550 meters.

PERU: LIMA: Lomas Pasamayo, south of Chancay, *Stork & Vargas 9351* (DA, GH, M, UC); lomas south of Lima, *Grant 7440* (GH, M, US); AREQUIPA: Mollendo, hillside directly back of the port, *I. M. Johnston 3551* (Ch, GH, US); Mollendo, *Hitchcock 22422* (US); Posco, between Mollendo and Arequipa, *Cook & Gilbert 47* (US); Mollendo, loma, *Weberbauer 1505* (TYPE photograph, Ch).

This may possibly be related to ***M. macrostachya*** R. & P., but it is distinguished by its fruit without wings and its slenderer and shorter racemes. Moreover, this species is endemic to the lomas near the ocean, while the species of Ruiz and Pavón comes from the sierra up to 1300 meters.

10. **Monnina macrostachya** R. & P. Syst. Veg. 173 (1798); Chodat in Bull. Herb. Boiss. **2**: 168 (1894).

Polygala lanceolata Poir. Encycl. Méth. **5**: 498 (1804).

Monnina lanceolata DC. Prodr. **1**: 339 (1824).

Monnina macrostachya var. *pumila* A. Gray, Bot. U. S. Expl. Exped. **1**: 107 (1854).

Monnina Weberbaueri var. *elongata* Chodat in Bot. Jahrb. **42**: 103 (1908).

Monnina Weberbaueri var. *pachyantha* Chodat, l. c.

Monnina Weberbaueri var. *maxima* Chodat, l. c.

Annual, herbaceous, 1.5–5.5 dm. high; root 2.5–8 cm. long, 1–3 mm. in diameter, usually branched, conspicuously curved; stem erect, terete, branched, the branches 7–30 cm. long, ascendent, pubescent, the hairs short, yellowish; leaves lanceolate, rarely more or less spatulate, 10–50 mm. long, 4–20 mm. wide, usually acuminate, sometimes obtuse, glabrescent, entire, attenuate at base, the costa prominulous beneath, with 5 or 6 pairs of lateral veins; petioles 1–2.5 mm. long, slightly pubescent; racemes conical, acute, 9–13 mm. wide, simple, terminal, pedunculate, the peduncle 20–95 mm. long, the axis 3–22 cm. long, finely pubescent, becoming glabrescent, bracteate, the bracts filiform, 1.8–2.5 mm. long, deciduous, ciliate, 1-nerved; flowers 4–6 mm. long; pedicels 0.8–1 mm. long, pubescent; outer sepals free, lanceolate, concave, ciliate, acuminate, the two lower ones 2–2.4 mm. long, 0.9–1 mm. wide, 1-nerved, rarely 3-nerved, the upper one 2.2–3 mm. long, 1.6–1.8 mm. wide, pubescent beneath, 3–5-nerved; wings purple, 4–5.4 mm. long, 3–3.6 mm. wide, obovate, acute at base, 3-nerved, ciliate; keel yellow, 4.4–6 mm. long, 2–2.8 mm. wide, orbicular, plicate, pubescent within, ciliate, acute at base, 3-nerved, 3-lobed, the middle lobe acute, larger; upper petals short, narrow, densely pubescent within; stamens 8, the filaments 3.4–4 mm. long, united, glabrous, the anthers sessile, emarginate; ovary elliptic, 0.8–1.4 mm. long, 0.5–0.8 mm. wide, glabrous; style 2–3 mm. long, straight, becoming geniculate near the apex, glabrous, almost cylindric, thicker in the upper part; stigma with 2 lobes, the lower acute, the upper 2-tubercled, acuminate, ciliate, larger; samara ovate, 3–5 mm. long, 2.5–4 mm. wide, usually glabrescent, rarely gray-strigillose, the wing 0.6–1 mm. wide, membranaceous, deeply emarginate at apex and base, the body rugose-reticulate. (PL. III, FIGS. 1–10.)

DISTRIBUTION: The central and southern part of the Peruvian Andes, Departments of Huánuco, Lima, and Moquegua, between 1300 and 3200 meters.

PERU: HUÁNUCO: Mito, *Macbride & Featherstone 1548* (Ch); LIMA: Canta, *Pennell 14343* (Ch, GH, NY, Ph, US); Obrajillo, *Pennell 14372* (Ch, GH, NY, Ph, US); below Obrajillo, *Pennell 14436* (Ch, GH, NY, Ph, US); below Obrajillo, 1838–42, *Wilkes Expedition* without number (type of *Monnina macrostachya* var. *pumila* US); above Obrajillo, *Pennell 14373* (Ph); Obrajillo, 1838–42, *Wilkes Expedition* without number (GH); Yanahuanca, *Macbride & Featherstone 1168* (Ch, US); Purruchuca, *Collector ? 461* (GH); Cajatambo Province, *Stork 11451* (GH, UC); above Santa Eulalia, *Goodspeed 33016* (UC); quebrada southwest of Matucana, *Goodspeed 11332* (DA, GH, UC); Matucana, *Macbride & Featherstone 311* (Ch, US), *88* (Ch, US), *Stork & Horton 9143* (GH, UC); Valley of Lima, *Mathews 394* (GH); MOQUEGUA: Estuquiña, Province of Moquegua, *Weberbauer 7451* (Ch, US); Carumas, Province of Moquegua, *Weberbauer 7301* (Ch, US); DEPT. ?: without locality, *Mathews 1001* (NY); without locality, 1838–42, *Wilkes Expedition* without number (NY, US); without locality, without date, *Dombey* without number (probably fragments of authentic material of *Polygala lanceolata,* Ch); without locality, without date, *Collector ?* without number (type photograph of *Polygala lanceolata,* US).

The description given by Ruiz & Pavón and also the additional description by Chodat of *M. macrostachya* indicate the characters of this species. According to Ruiz & Pavón the locality of the type is "Cercado et Chancay," situated in the eastern and northern parts of Lima respectively. The majority of the specimens of this species have been collected in this vicinity.

There is no available authentic material of *Polygala lanceolata*. However, it seems that the photograph of the type and the brief original description correspond to *M. macrostachya*.

Asa Gray described *M. macrostachya* var. *pumila* from material collected "below Obrajillo" near Lima; the type appears to the writer to be essentially identical with that of the species.

The three varieties of *M. Weberbaueri* cited above, proposed by Chodat, are based on the following material: var. *elongata* on *Weberbauer 2724* from Ocros, Province of Cajatambo; var. *pachyantha* on *Weberbauer 185* from Matucana; and var. *maxima* on *Weberbauer 3125* from Hacienda Cajabamba, between Samanco and Caraz. These localities are situated in the Andean region at elevations up to 1300 meters. All the available material of *M. macrostachya* comes from this region or from the sierra, while the related *M. Weberbaueri* and *M. arenicola* are strictly confined to the "lomas" and sand-dunes near the ocean. Therefore it is to be presumed that the varieties proposed by Chodat are synonymous with *M. macrostachya*.

11. **Monnina longibracteata** Chodat in Bull. Herb. Boiss. 3: 130 (1895).

Frutescent, branched, the branches 5 mm. in diameter, decurrent, striate, more or less glabrescent; leaves lanceolate or elliptic, sometimes linear-lanceolate, 80–90 mm. long, 25–27 mm. wide, usually acute, rarely acuminate, slightly pubescent, becoming glabrescent, entire, attenuate at base, the costa prominulous beneath, with 8 or 9 pairs of lateral veins;

petioles 4–8 mm. long, pubescent; racemes elongate, almost acute, 8–11 mm. wide, simple, terminal, the axis to 15 cm. long, pubescent in the upper part, bracteate, the bracts conspicuously filiform, 5–6.5 mm. long, 0.8–1 mm. wide, glabrescent, 1-nerved; flowers 3.6–5 mm. long; pedicels 1.2–1.5 mm. long, finely pubescent; outer sepals lanceolate, acute, glabrous, the two lower ones 2.4–2.6 mm. long, 0.6–0.8 mm. wide, almost $\frac{1}{2}$ united, 1-nerved, the nerve conspicuous, the upper sepal 2.6–3 mm. long, 1.2–1.4 mm. wide, 3-nerved; wings 4–4.2 mm. long, 3.6–3.8 mm. wide, obovate, obtuse at base, 3- or 4-nerved, glabrescent beneath, sometimes with a few hairs on the lower part; keel 3–3.2 mm. long, 2–2.2 mm. wide, orbicular, plicate, pubescent within, glabrous on margin, obtuse at base, 3- or 4-nerved, 3-lobed, the middle lobe obtuse-emarginate; upper petals elongate, attenuate, pubescent within; stamens 8, the filaments 2.8–3 mm. long, almost entirely united, the free part 0.5–0.7 mm. long; ovary elliptic, 0.8–1 mm. long, 0.5–0.6 mm. wide, glabrous; style 2–2.2 mm. long, geniculate above the base, glabrous, cylindric; stigma with 2 lobes, the lower more or less obtuse, the upper 1-tubercled, the tubercle papillose; fruit unknown. (PL. III, FIGS. 11–17.)

DISTRIBUTION: Probably found in the northern part of Perú, Department of Amazonas.

PERU: "Habitat in America australi," 1835, *Mathews 2075* (fragments and photograph of the TYPE, US).

This species has elongated terminal or axillary racemes, with the flowers not crowded and the bracts conspicuously linear with an involute apex.

The material of the type was probably collected in the Department of Amazonas, northern Perú, where Mathews lived for several years.

11a. **Monnina longibracteata** var. **ainensis** Chodat in Bull. Soc. Bot. Genève II. 25: 222 (1934).

This variety differs from the typical form in the following characters: acuminate, larger leaves (42–170 mm. long, 11–65 mm. wide); axis of inflorescence to 33 cm. long, the outer sepals ciliate, the lower 3-nerved, the wings strongly pubescent beneath; upper petals densely pubescent; ovary more or less pubescent. (PL. III, FIGS. 18–25.)

PERU: AYACUCHO: Aina, between Huanta and Apurímac River, *Killip & Smith 23188* (TYPE Ch, ISOTYPE NY).

12. **Monnina huallagensis** Chodat in Bull. Soc. Bot. Genève II. 25: 223 (1934).

Plant frutescent, branched, the branches glabrous, decurrent; leaves lanceolate, 38–125 mm. long, 7–38 mm. wide, acuminate, rarely more or less acute, glabrescent, entire, attenuate at base, the costa prominulous beneath, with 7 or 8 pairs of lateral veins; petioles 2–4 mm. long, pubescent, stipulate, the stipules 1–1.4 mm. long, acute, pubescent; racemes elongate, acuminate, 9–11 mm. wide, simple, terminal, pedunculate, the peduncle 16–70 mm. long, the axis 15–30 cm. long, glabrous, bracteate, the bracts conspicuously linear, 3–5 mm. long, 0.6–1 mm. wide, glabrous, 1-nerved; flowers 4–4.8 mm. long; pedicels 1.4–2 mm. long, glabrous; outer sepals lanceolate, acute, the two lower ones 1.8–2 mm. long, 0.6–1 mm. wide, more or less $\frac{2}{3}$ united, 1-nerved, glabrous, sometimes ciliate, the upper one 2.4–2.6 mm. long, 1.2–1.3 mm. wide, 3-nerved, ciliate, glabrous beneath; wings 4–4.6 mm. long, 3.8–4 mm. wide, obovate, obtuse at base, 3-nerved, more or less pubescent beneath; keel 3.5–4.2 mm. long, 2.4–2.6 mm. wide, orbicular, plicate, pubescent within, glabrous on margin, obtuse at base, 3–5-nerved, 3-lobed, the middle lobe obtuse-emarginate; upper petals elongate-spatulate, pubescent within; stamens 8, the filaments 2.8–3.2 mm. long, almost united entirely, the free part 0.6–1 mm. long, pubescent, the anthers mucronate; ovary elliptic, 1.2–1.5 mm. long, 0.8–1 mm. wide, glabrous; style 2.2–2.5 mm. long, straight, becoming geniculate, glabrous, cylindric; stigma with 2 lobes, the lower acute, the upper 1-tubercled; drupe ovate, 4–6 mm. long, 2.5–3 mm. wide, glabrous, conspicuously reticulate. (PL. III, FIGS. 26–33.)

DISTRIBUTION: Probably limited to the Department of Huánuco, central Perú.

PERU: HUÁNUCO: Pampayacu, *Kanehira 290* (GH); DEPT. ?: Huallaga, 1600 meters, *Weberbauer 6805* (TYPE Ch, ISOTYPES GH, NY, US).

Very close to *M. longibracteata* Chodat, from which it differs in the rigid bracts, the acuminate leaves, the stamens with the free upper part of the filaments pubescent, and the mucronate anthers. It is also related to *M. macrosepala* Chodat, from which it is distinguished by its larger inflorescence-axis (to 30 cm. long), the flowers not crowded, the leaves with 7 or 8 pairs of lateral veins, the outer sepals smaller, 1-nerved, the mucronate anthers, etc.

12a. **Monnina huallagensis** var. **pachyphylla** Chodat, l. c.

Differs from the typical form in the stronger branches, the glabrous leaves with reticulate nerves, and the axis of the inflorescence being conspicuously shorter. (PL. III, FIG. 34.)

PERU: HUÁNUCO: Cueva Grande, estación near Pozuzo, alt. 3500 meters, *Macbride 4786* (TYPE US, ISOTYPE GH).

13. **Monnina glabrifolia** sp. nov.

Frutex ad 20 dm. altus, ramis 2–7 mm. crassis glabris tenuiter striatis; folia lanceolata 4.5–14 cm. longa, 2–6 cm. lata basim versus elongato-attenuata apice acuta vel breviter acuminata integerrima utrinque glabra, nervo medio prominulo, nervis lateralibus 9 vel 10, petiolo 2–3 mm. longo glabro; racemi simplices plus minusve conici 5–7 mm. crassi, rhachi 3.5–23 cm. longa breviter puberula striata, pedunculati, pedunculo 1.5–4.5 cm. longo, bracteis lanceolatis 4.5–6.5 mm. longis, 1.5–2 mm. latis puberulis uninerviis; flores 4.2–4.6 mm. longi, pedicello 1.2–1.8 mm. longo plus minusve puberulo; sepala exteriora concava ciliata lanceolata subtus puberula, duo inferiora 2.6–3 mm. longa 1.3–1.5 mm. lata obtusa ad $\frac{2}{3}$ connata 5-nervia, sepalo superiore minore 2–2.2 mm. longo 1.2–1.4 mm. lato acutiusculo 7-nervio; alae 4.8–5 mm. longae 3.2–3.4 mm. latae obovatae basi plus minusve obtusae ciliatae 3- vel 4-nerviae subtus pubescentes; carina 5–5.2 mm. longa 3–3.4 mm. lata orbiculari-obovata glabra apice trilobata, lobo mediano emarginato, lobis lateralibus obtusiusculis, basi obtusiuscula 3- vel 4-nervia breviter ciliata, petalo superiore breviter elongato pubescente; stamina 8, filamentis 3.5–3.8 mm. longis, antheris subsessilibus vel filamentorum parte libera 0.6–1.2 mm. longa glabra; ovarium 1.5–1.6 mm. longum 1.2–1.3 mm. latum oblongum dense pubescens; stylus 2–2.2 mm. longus geniculatus glaber cylindricus; stigma apice superiore tuberculatum papillosum, apice inferiore acutum; drupae cordatae 4.5–6 mm. longae 3.8–5 mm. latae breviter alatae conspicue pubescentes reticulato-venosae. (PL. IV, FIGS. 1–9.)

DISTRIBUTION: Known only from the type collection.

PERU: PUNO: Trail from Santo Domingo to Chabuca mine, Province Carabaya, May 30–June 1, 1942, alt. 1900 meters, *Metcalf 30661* (TYPE UC 690169, ISOTYPE US).

The new species is related to *M. andina* Chodat, but has acuminate and larger leaves (more or less 3 times larger); the racemes with crowded and larger bracts also distinguish it from the latter species. It is also close to *M. Lechleriana* Chodat, from which it sharply differs in the terminal and simple racemes, the pubescent ovary, etc.

14. **Monnina menthoides** Chodat in Bull. Soc. Bot. Genève II. 25: 219 (1934).

Frutescent, branched, the branches 2.5–3 mm. in diameter, canescent-tomentose; leaves lanceolate, 30–40 mm. long, 8–9 mm. wide, acute, sometimes mucronate, pubescent above, densely pubescent beneath, sinuate-denticulate, attenuate at base; petioles 3 mm. long, hirsute; racemes elongate, simple, terminal, 6–8 cm. long, the axis 6–12 cm. long, densely hirsute, bracteate, the bracts linear, pubescent beneath; flowers 5 mm. long; pedicels 1 mm. long, pubescent; outer sepals lanceolate-triangular, ciliate, the two lower united; wings more or less orbicular, slightly unguiculate, ciliate; upper petals linear-spatulate, pubescent; filaments of stamens more or less united; ovary pubescent; style geniculate; samara cordate, 5 mm. long, 5 mm. wide, pubescent, the apex slightly emarginate, the body canescent, reticulate.

DISTRIBUTION: In the southeastern part of Perú, Department of Cuzco.

PERU: CUZCO: Marcapata, Province Quispicanchis, *Weberbauer 7786* (not seen).

Material of the present species has not been available, and therefore the description given above is adapted from the original. It appears to be closely related to *M. andina* Chodat and *M. cyanea* Chodat. It differs from *M. andina* in the tomentose branches and the lanceolate, hirsute, sinuate-dentate leaves with an acute-mucronate apex; it is distinguished from *M. cyanea* chiefly by the sinuate-dentate leaves and the lower sepals being united.

15. **Monnina andina** Chodat in Bot. Jahrb. 42: 104 (1908).

Plant frutescent, about 10 dm. high, branched, the branches nodose; leaves lanceolate-elliptic, 25–45 mm. long, 9–15 mm. wide, obtuse, entire, slightly revolute, attenuate at base, the costa prominulous beneath, pubescent; petioles short; stipules to 0.5 mm. long; racemes thin, simple, terminal, 5–10 cm. long, glabrescent, the axis bracteate, the bracts conspicuous, linear; flowers 2–3 mm. long; outer sepals ovate, obtuse, ciliate, the two lower united; wings orbicular, oblique, attenuate at base, ciliate; upper petals narrow, the apex incurvate; androecium pubescent at the apex, the filaments almost entirely united, the anthers subsessile; ovary oblong, pubescent, the style straight, becoming geniculate; stigma with 2 lobes, the lower more or less acute, the upper globose, sessile; fruit ovate-cordiform, 3–4 mm. long, slightly winged, pubescent, emarginate at apex.

DISTRIBUTION: Known only in the southeastern part of the Peruvian Andes, Department of Puno, between 1800 and 2200 meters altitude.

PERU: PUNO: Between tambo Yuncacoya and tambo Cachicachi, between Sandia and Chunchusmayo, *Weberbauer 1146* (photograph of TYPE, US).

Although there is no available material of this species, the photograph of the type shows some conspicuous characters, such as the following: thin and glabrous branches, short and thin racemes, and the axis of the inflorescence with linear bracts. Some measurements given above were adapted from the photograph.

16. **Monnina marginata** Presl, Reliq. Haenk. 2: 102 (1827).
Monnina laurifolia Chodat in Bull. Soc. Bot. Genève II. 25: 208 (1934).
Monnina petiolaris Chodat, l. c. 214.
Monnina petiolaris var. *elliptica* Chodat, l. c. 215.

Slender tree, 15–45 dm. high, the crown to 10 dm. in diameter, strongly branched, the branches striate, glabrous, to 1 cm. in diameter; leaves lanceolate, 25–100 mm. long, 11–28 mm. wide, acute, rarely more or less obtuse, glabrescent above, slightly pubescent beneath, entire, attenuate at base, the costa prominulous beneath, with 6–8 pairs of lateral veins; petioles 2–10 mm. long, articulate, almost cylindric, finely pubescent, becoming glabrescent; racemes conical, acute, 8–9 mm. wide, shortly pedunculate, simple, terminal, conspicuously corymbose, the axis 2–3 cm. long, finely pubescent, striate, bracteate, the bracts triangular, 1–1.2 mm. long, 1.1–1.3 mm. wide, deciduous, inconspicuous; flowers 4–5 mm. long; pedicels 0.5–1.8 mm. long, slightly pubescent; outer sepals ovate-triangular, ciliate, obtuse, pubescent beneath, the two lower ones 1.8–2 mm. long, 1.2–1.4 mm. wide, $\frac{1}{2}$ united, 1-nerved, the upper one 2–2.4 mm. long, 1.4–1.6 mm. wide, 3-nerved; wings deep blue, 4.5–5.5 mm. long, 3.5–4.4 mm. wide, obovate, more or less obtuse at base, 5-nerved, pubescent beneath, ciliate at base; keel yellow, 4.2–5.5 mm. long, 2.5–3.2 mm. wide, orbicular, plicate, pubescent within, glabrous at margin, obtuse at base, 3- or 4-nerved, 3-lobed, the middle lobe obtuse-emarginate, larger; upper petals spatulate, densely pubescent; stamens 8, the filaments 2.8–3.5 mm. long, united to near the apex, the free part 1–1.2 mm. long, glabrous; ovary elliptic, 1.5–1.6 mm. long, 1–1.1 mm. wide, conspicuously pubescent, the upper longitudinal line with rigid larger hairs; style 2–3 mm. long, geniculate in the middle part, glabrous, cylindric; stigma with 2 lobes, the lower acute, the upper 1-tubercled, papillose; drupe ovate, 4–6 mm. long, 2–3 mm. wide, glabrous, reticulate. (PL. IV, FIGS. 10–17.)

DISTRIBUTION: Endemic in central Perú, Department of Huánuco, between 2800 and 3900 meters altitude.

PERU: HUÁNUCO: Pampayacu to Huánuco, *Kanehira 190* (A, Ch); Carpish, *Stork & Horton 9908* (Ch, DA, M, UC); Tambo de Vaca, *Macbride 4908* (type of *M. petiolaris* var. *elliptica*, Ch); Panao, *Macbride 3620* (type of *M. petiolaris*, Ch, isotypes A, NY, US); 6 miles south of Mito, *Macbride & Featherstone 1855* (type of *M. laurifolia*, Ch).

This plant is closely related to *M. conferta* R. & P., but differs in the lanceolate and larger leaves, the racemes being conspicuously corymbose, the lower sepals 1-nerved, the wings pubescent beneath, and the ovary more or less pubescent; finally, this is a tree.

In Bull. Herb. Boiss. 4: 253 (1896), Chodat considers *M. marginata* as a doubtful species. However, the original description is quite adequate. Moreover, Presl stated that this species was found, "in montibus huanoccensibus Peruviae." Therefore, in the opinion of the writer, the species of Presl must be maintained.

17. **Monnina pseudo-salicifolia** sp. nov.

Frutex ramosus, ramis 17–26 cm. longis ad 2–4 mm. crassis lignosis tenuiter striatis glabrescentibus; folia elliptica vel plus minusve lanceolata 3.5–9.2 cm. longa 1.8–3.6 cm. lata, basim versus elongato-attenuata, apice acuta vel obtuso-emarginata, supra glabrescentia subtus breviter pubescentia, integerrima, nervo medio prominulo, nervis lateralibus 7 vel 8, petiolo 1–2 mm. longo pubescente basi plus minusve articulato et circumscripto; racemi simplices breves conici 6–8 mm. crassi, rhachi 30–55 mm. longa puberula striata, tenuiter pedunculati, pedunculo 18–20 mm. longo, bracteis lanceolatis 2–2.2 mm. longis 1–1.2 mm. latis subtus minutissime puberulis uninerviis; flores 4.6–5.5 mm. longi, pedicello 1.8–2 mm. longo puberulo; sepala exteriora lanceolata ciliata concava subtus puberula obtusa, duo inferiora 2.3–2.6 mm. longa 1.3–1.5 mm. lata breviter connata 3-nervia, sepalo superiore 3–3.2 mm. longo 1.6–1.8 mm. lato 5-nervio; alae 5–6 mm. longae 4–4.8 mm. latae obovatae basi plus minusve acutae, breviter ciliatae vel eciliatae, 3-nerviae, subtus glabrae, supra basi puberulae; carina 4.5–5 mm. longa 3–3.2 mm. lata orbicularis obovata glabra apice trilobata, lobo mediano obtuso emarginato, lobis lateralibus obtusiusculis, basi plus minusve obtusa trinervia breviter ciliata, petalo superiore elongato-spathulato utrinque conspicue puberulo; stamina 8, filamentis 4–4.4 mm. longis, antheris subsessilibus vel filamentorum parte libera 0.6–1.2 mm. longa glabra; ovarium 1.2–1.5 mm. longum 0.6–0.8 mm. latum oblongum pubescens vel plus minusve glabrescens; stylus 2.5–3 mm. longus brevis erectus deinde geniculatus et subhorizontalis glaber cylindricus; stigma apice superiore tuberculatum papillosum apice inferiore plus minusve acutum; fructus ignotus. (Pl. IV, figs. 18–25.)

Distribution: In the sierra in the northern part of Peru, Department of Piura, at about 3000 meters altitude.

PERU: Piura: Above Palambla, Province of Huancabamba, April, 1912, *Weberbauer 6055* (type US 1473497, isotypes Ch, GH).

This species is near *M. marginata* Presl, from central Perú, but it is less robust, the leaves are more or less elliptic, the lower sepals are 3-nerved and slightly united, the upper sepal is 5-nerved, the wings are glabrous beneath but pubescent within, the keel is glabrous within, and the upper petals are densely pubescent. Superficially the new species closely resembles *M. salicifolia* R. & P., from which it differs in its united lower sepals, pubescent ovary, etc.

18. **Monnina macrosepala** Chodat in Bull. Soc. Bot. Genève II. 25: 218 (1934).

Frutescent, 6–24 dm. high, branched, the branches terete, 6 mm. in diameter, slightly pubescent, becoming glabrescent; leaves linear-lanceolate, 55–125 mm. long, 12–28 mm. wide, acuminate, sometimes acute, glabrescent, entire, attenuate at base, the costa prominulous beneath, with 9 or 10 pairs of lateral veins; petioles 2–4 mm. long, pubescent; racemes cylindric, acute, 4–5 mm. wide, with a short peduncle, simple, terminal, the axis 6–15 cm. long, pubescent, striate, bracteate, the bracts linear, 3–6 mm. long, lax, conspicuous, deciduous, ciliate, 1-nerved; flowers 4.2–4.8 mm. long; pedicels 1–1.2 mm. long, glabrescent; outer sepals lanceolate, acute, glabrous beneath, the two lower ones 4.4–4.6 mm. long, 3.8–4 mm. wide, $\frac{2}{3}$ united, 5-nerved, ciliate, the upper one 4.5–5 mm.

long, 3–3.2 mm. wide, rarely ciliate, sometimes obtuse, 7–9-nerved; wings 4.6–5 mm. long, 3.6–4 mm. wide, obovate, more or less acute at base, 4- or 5-nerved, pubescent beneath; keel 4–4.5 mm. long, 3–3.2 mm. wide, almost orbicular, plicate, pubescent within, obtuse at base, 4- or 5-nerved, 3-lobed, the middle lobe obtuse-emarginate; upper petals elongate-spatulate, pubescent; stamens 8, the filaments 2.8–3 mm. long, almost entirely united, the free part pubescent, the anthers more or less mucronate; ovary elliptic, 1.4–1.6 mm. long, 0.6–0.7 mm. wide, glabrous; style 2–2.4 mm. long, geniculate above the base, glabrous, cylindric; stigma with 2 lobes, the lower acute, the upper 1-tubercled, papillose; fruit unknown. (PL. IV, FIGS. 26–33.)

DISTRIBUTION: Endemic in the "ceja de montaña," Department of Junín, central Perú, between 900 and 2400 meters.

PERU: JUNÍN: Chanchamayo Valley, *C. Schunke 487* (TYPE Ch); Huacapistana, *Killip & Smith 24515* (US); San Ramón, *Killip & Smith 24754* (US), *24765* (US).

The species is distinguished by large sepals. It resembles *M. longibracteata* Chodat, but is quite distinct in its shorter inflorescence and the absence of filiform bracts.

18a. **Monnina macrosepala** var. **latifolia** Chodat, op. cit. 219.

The variety differs from the typical form in its broad leaves (to 64 cm. wide), longer petioles (4–6 mm. long), smaller upper sepal (to 4.4 mm. long), and the orange keel.

PERU: JUNÍN: La Merced, along sunny stream, 600 meters altitude, *Macbride 5410* (TYPE Ch).

19. **Monnina Vitis-Idaea** Chodat, Bull. Soc. Bot. Genève II. 25: 208 (1934).
Monnina arbuscula Chodat, op. cit. 222.

Frutescent, to 3 dm. high, stem erect, woody, 5–7 mm. in diameter, glabrous, nodose, branched, the branches 9–18 cm. long, decurrent, corymbose, glabrescent; leaves usually elliptic, rarely ovate, 10–20 mm. long, 5–8 mm. wide, obtuse, glabrescent, entire, slightly revolute, the costa prominulous beneath, with 4 or 5 pairs of inconspicuous lateral veins; petioles 1–1.5 mm. long, cylindric, more or less pubescent; racemes conical, acute, 6–8 mm. wide, with a short peduncle, simple, terminal, the axis 1.2–1.6 cm. long, finely pubescent, bracteate, the bracts triangular, inconspicuous, deciduous; flowers 4–4.2 mm. long; pedicels 0.6–0.8 mm. long, finely pubescent; outer sepals ovate-triangular, ciliate, glabrous beneath, the two lower ones 1.8–2 mm. long, 1–1.2 mm. wide, $\frac{1}{2}$ united, obtuse, conspicuously 1-nerved, the upper one 2–2.4 mm. long, 2–2.2 mm. wide, acute, 5-nerved; wings 4–5 mm. long, 3.6–3.8 mm. wide, obovate, obtuse at base, pubescent within, glabrous beneath, 3- or 4-nerved, the nerves conspicuous; keel 3.5–4 mm. long, 2.5–3 mm. wide, more or less orbicular, plicate, glabrous, obtuse at base, 3- or 4-nerved, 2-lobed, the lobes obtuse; upper petals conspicuously elongate-spatulate, pubescent; stamens 8, the filaments 3–3.2 mm. long, almost entirely united, the anthers mucronate; ovary ovate-truncate, 1–1.2 mm. long, 0.6–0.8 mm. wide, glabrous; style 1.8–2 mm. long, geniculate, glabrous, cylindric; stigma with 2 lobes, the lower acute, the upper 1-tubercled, papillose; drupe ovate, 5–8 mm. long, 2–3.6 mm. wide, glabrous, reticulate. (PL. V, FIGS. 1–8.)

DISTRIBUTION: Northern Perú, Department of Piura, at about 3500 meters altitude.

PERU: PIURA: Cordillera east of Huancabamba, Province of Huancabamba, *Weberbauer 6129* (TYPE GH, and type of *M. arbuscula*, Ch).

This glabrous plant has a strong woody and nodose stem. It is a distinct species characterized by its small and coriaceous leaves, its sepals with conspicuous nerves, its keel with 2 lobes rather than 3, and finally by its mucronate anthers.

A duplicate of the type of *M. Vitis-Idaea* was inadvertently described by Chodat as *M. arbuscula*. Weberbauer's collection was definitely not a mixture.

20. **Monnina conferta** R. & P. Syst. Veg. 173 (1798).
Monnina myrtilloides DC. Prodr. 1: 339 (1824).

Shrub, 5–18 dm. high, the stem erect, more or less pubescent, becoming glabrescent, branched, the branches 8–29 cm. long, striate, corymbose; leaves usually elliptic, rarely more or less lanceolate, 11–45 mm. long, 5–14 mm. wide, obtuse, glabrescent above, slightly pubescent beneath, entire, sometimes revolute, the costa prominulous beneath, with 4 or 5 pairs of inconspicuous lateral veins; petioles 1.5–2.4 mm. long, concave above, convex beneath, pubescent; racemes conical, acute, 8–10 mm. wide, simple, terminal, pedunculate, the peduncle 6–11 mm. long, the axis 3–10 cm. long, striate, pubescent, bracteate, the bracts triangular, concave, 1.2–1.4 mm. long, 1–1.2 mm. wide, pubescent beneath, acute, ciliate, 1-nerved, inconspicuous; flowers 5–6 mm. long; pedicels 1–1.2 mm. long, finely pubescent; outer sepals ovate-triangular, obtuse, ciliate, pubescent beneath, the two lower ones 2–2.6 mm. long, 1.4–1.8 mm. wide, almost $\frac{2}{3}$ united, 3-nerved, the upper one 2.8–3 mm. long, 1.8–2.4 mm. wide, 5–7-nerved; wings deep blue, 5.2–6 mm. long, 4.4–5.5 mm. wide, obovate, obtuse at base, 4- or 5-nerved, ciliate, usually glabrous beneath, rarely slightly pubescent, sometimes pubescent within; keel yellow, 5.2–6.5 mm. long, 3.4–4 mm. wide, orbicular, plicate, pubescent within, obtuse at base, 4- or 5-nerved, 3-lobed, the middle lobe obtuse-emarginate, larger; upper petals short, narrow, pubescent; stamens 8, the filaments 3.8–4.2 mm. long, almost entirely united, the free part 0.6–1.4 mm. long; ovary elliptic, 1.2–2 mm. long, 0.8–1.4 mm. wide, glabrous; style 2.8–3.6 mm. long, geniculate in the middle part, glabrous, cylindric; stigma with 2 lobes, the lower acute, the upper 1-tubercled, papillose; drupe elliptic, 4.5–7 mm. long, 2–4 mm. wide, glabrous, reticulate. (PL. V, FIGS. 9–16.)

DISTRIBUTION: In the sierra from northern Perú, Department of Cajamarca, to southern Perú, Department of Ayacucho, between 2500 and 3600 meters altitude.

PERU: CAJAMARCA: Pass south of Conchán, Province of Chota, *Stork & Horton 10064* (Ch, UC); LA LIBERTAD: Cachicadan, Province Santiago de Chuco, *Stork & Horton 9955* (Ch, UC); HUÁNUCO: Between Huánuco and Pampayacu, *Kanehira 244* (A, Ch); Mito, *Macbride & Featherstone 1514* (Ch, US); "Tambo nuevo," *Pavón* without number (photograph of authentic material, GH); JUNÍN: Ocopa, *Killip & Smith 21977* (Ch, NY, US); near Huancayo, *Killip & Smith 23348* (Ch, NY, US). *Soukup 1982* (US); HUANCAVELICA: Quebrada south of Salcabamba, Province Tayacaja, *Stork & Horton 10298* (Ch, UC); AYACUCHO: Above Yanamonte, between Tambo and Apurimac, *Weberbauer 5659* (Ch, GH, US); Totorabamba, Province Huamanga, *Weberbauer 5488* (Ch, GH, US); DEPT. ?: Without locality and date, *Dombey* without number (fragments of authentic material, Ch, US); without locality, 1807, *Lagasca 56* (photograph of the TYPE, US).

This species has corymbose branches and simple and terminal racemes.

The fragments of authentic material from the Herbarium in Paris and also the photographs fit well the specimens the author refers to this species.

De Candolle described *M. myrtilloides* very briefly. Apparently it is equal to *M. conferta;* Chodat, in Bot. Jahrb. **42:** 102 (1908), places it as a synonym.

The specimen *Weberbauer 5488* shows a certain pubescence beneath the wings.

21. **Monnina stipulata** Chodat in Bull. Herb. Boiss. **2:** 170 (1894).

Frutescent, to 10 dm. high, branched, the branches 4–7 mm. in diameter, striate, densely pubescent (hairs yellow, lax), becoming more or less glabrescent on the lower part; leaves ovate-elliptic, 35–90 mm. long, 15–40 mm. wide, obtuse, sometimes almost acute, finely pubescent above, becoming glabrescent, conspicuously pubescent beneath, canescent, entire, strongly revolute, the costa prominulous beneath, with 7 or 8 pairs of lateral veins; petioles 3–6 mm. long, densely pubescent, articulate, cylindric; racemes conical, acute, 8–27 mm. long, 7–9 mm. wide, simple, axillary or terminal, subsessile, the axis 1.4–3 cm. long, densely pubescent, bracteate, the bracts triangular, concave, 1.8–2.5 mm. long, 1.6–2 mm. wide, pubescent beneath, acute, ciliate, 1-nerved; flowers 4–6 mm. long; pedicels 0.6–0.8 mm. long, pubescent; outer sepals ovate-triangular, ciliate, obtuse, pubescent beneath, the two lower ones 2–2.2 mm. long, 2.4–3 mm. wide, $\frac{2}{3}$ united, 5-nerved, the upper one 2.8–3 mm. long, 2.2–2.4 mm. wide, 7-nerved; wings 5–6 mm. long, 4–5.2 mm. wide, obovate, obtuse at base, 4- or 5-nerved, slightly pubescent beneath, ciliate at base, glabrous within; keel 5.5–7 mm. long, 4–4.4 mm. wide, orbicular, plicate, pubescent within, obtuse at base, 7- or 8-nerved, 3-lobed, the middle lobe obtuse-emarginate, larger; upper petals more or less spatulate, pubescent; stamens 8, the filaments 4–4.4 mm. long, almost entirely united, the free part 1–1.4 mm. long, the anthers mucronate; ovary elliptic, 1.6–2.2 mm. long, 1–1.6 mm. wide, glabrous, rarely with a few hairs on the upper part; style 2.8–3.2 mm. long, geniculate in the middle part, glabrous; stigma with 2 lobes, the lower acute, the upper 1-tubercled, papillose; fruit unknown. (PL. V, FIGS. 17–24.)

DISTRIBUTION: Southeastern part of the Peruvian Andes to northwestern Bolivia, between 2800 and 3200 meters altitude.

PERU: PUNO: On road 4 km. north of Limbani, Province of Sandia, *D. Metcalf 30511* (UC, US). BOLIVIA: DEPT. ?: "In silvulis viciniis Acanca; carro de Uacani," *Mandon 834* (ISOTYPE GH).

This species is characterized by its short, simple, and terminal racemes and its ovate-elliptic and strongly revolute leaves.

22. **Monnina canescens** sp. nov.

Frutex, ramis 13–28 cm. longis ad 1.5–3.5 mm. crassis lignosis striatis canescentibus breviter puberulis; folia lanceolata 25–60 mm. longa 11–22 mm. lata, basim versus elongato-attenuata, apice acuta, supra tenuiter pubescentia vel glabrescentia, infra canescens pubescentia, integerrima, nervo medio prominulo, nervis lateralibus 4 vel 5, petiolo 1.5–2 mm. longo pubescente basi plus minusve articulato; racemi simplices conici 7–10 mm. crassi, rhachi 6.5–12.5 cm. longa puberula striata, pedunculati, pedunculo 30–35 mm. longo; bracteae ovato-acutae 1.5–2 mm. longae 0.8–1 mm.

latae ciliatae uninerviae subtus pubescentiae; flores 5.5–6.5 mm. longi, pedicello 1–1.2 mm. longo puberulo tereti; sepala exteriora concava ciliata lanceolata obtusa subtus pubescentia, duo inferiora 2–2.4 mm. longa 1.2–1.4 mm. lata $\frac{2}{3}$ connata uninervia, sepalo superiore 2.5–3 mm. longo 1.4–1.6 mm. lato 3-nervio; alae 5.5–6.8 mm. longae 4.2–5 mm. latae obovatae basi plus minusve obtusae ciliatae 4- vel 5-nerviae, nervo mediano conspicuo, subtus breviter puberulae vel glabrae, supra basi breviter puberulae; carina 5.2–7 mm. longa 3–4.2 mm. lata orbiculari-obovata glabra apice trilobata, lobo mediano obtuso emarginato, lobis lateralibus minoribus obtusiusculis, basi obtusa, 3- vel 4-nervia, breviter ciliata, petalo superiore tenuiter elongato spathulato utrinque dense pubescente; stamina 8, filamentis 4.5–5 mm. longis, antheris subsessilibus, filamentorum parte libera 0.6–1 mm. longa glabra; ovarium 1.5–2.4 mm. longum 1.2–1.5 mm. latum oblongum glabrum; stylus 3–3.5 mm. longus erectus deinde geniculatus et subhorizontalis glaber cylindricus; stigma apice superiore tuberculatum papillosum apice inferiore acutum; drupae ovato-oblongae acutae 4.8–6 mm. longae 3–3.6 mm. latae glabrae. (PL. V, FIGS. 25–32.)

DISTRIBUTION: In the central region of the Peruvian Andes, Department of Lima, between 2700 and 3000 meters altitude.

PERU: LIMA: Along Chillón River, above Obrajillo, June 13–23, 1925, *Pennell 14376* (TYPE US 1340799, ISOTYPES Ch, GH).

The new species seems to be near *M. stipulata* Chodat, but it is distinct in the lanceolate and not revolute leaves, the shorter petiole, and the almost glabrescent branches. The proposed species comes from central Peru, while *M. stipulata* is from southern Peru and Bolivia. *Monnina canescens* is less closely related to *M. conferta* R. & P., from which it differs in having acute leaves, its branches not corymbose, a larger axis of the inflorescence, the keel glabrous within, etc.

23. **Monnina divaristachya** sp. nov.

Frutex ad 18 dm. altus ramosus, ramis 3–4 mm. crassis teretibus glabrescentibus; folia lanceolata 5.2–13.5 cm. longa 1.5–4.8 cm. lata basim versus elongato-attenuata apice acuminata, supra glabrescentia subtus breviter pubescentia, integerrima, nervo medio prominulo, nervis lateralibus 8 vel 9, petiolo 3–5 mm. longo breviter puberulo supra concavo; panicula ampla, ramis simplicibus fragilibus tenuiter pubescentibus striatis divaricatis 7–10 mm. crassis, rhachi 20–25 cm. longa brevi puberula striata, pedunculo 2.5–4.5 cm. longo, bracteis filiformibus 2–2.8 mm. longis ciliatis deciduis uninerviis; flores 3.2–3.5 mm. longi, pedicello 1.2–1.5 mm. longo puberulo; sepala exteriora plus minusve lanceolata ciliata concava subtus puberula vel glabra obtusa, duo inferiora 1.4–1.8 mm. longa 0.6–0.8 mm. lata $\frac{2}{3}$ connata 3-nervia, sepalo superiore 2–2.2 mm. longo 1.4–1.8 mm. lato 5-nervio; alae 3.8–4.2 mm. longae 4–4.2 mm. latae plus minusve obovatae basi acutae 3-nerviae subtus pubescentes; carina obovata 4.2–5.2 mm. longa 2.2–3.2 mm. lata intus puberula apice trilobata, lobo mediano obtuso emarginato, lobis lateralibus obtusiusculis majoribus, basi acuta 3-nervia, petalo superiore elongato spathulato utrinque puberulo; stamina 8, filamentis 3.2–4 mm. longis plus minusve connatis, parte libera 0.5–0.8 mm. longa glabra, antheris mucronatis; ovarium 1–1.6 mm. longum 0.6–0.8 mm. latum ovatum basi breviter puberulum vel glaberrimum; stylus 3–3.2 mm. longus erectus deinde geniculatus et horizontalis glaber cylindricus; stigma apice superiore tuberculatum papillosum apice inferiore acutum; drupae ellipticae 5.5–7.5 mm. longae 4.2–5.5 mm. latae glabrae conspicue reticulatae. (PL. VI, FIGS. 1–8.)

DISTRIBUTION: Confined to the "ceja de montaña" of Central Perú, Department of Junín, between 1600 and 1900 meters altitude.

PERU: JUNÍN: Pichis Trail, Eneñas, June 30–July 2, 1929, *Killip & Smith 25778* (TYPE US 1359873, ISOTYPES Ch, NY); Pichis Trail, *Killip & Smith 25427* (US).

This species suggests *M. callimorpha* Chodat but differs in several respects, namely the glabrescent branches, larger and glabrescent leaves with 8 or 9 pairs of lateral veins, and the broader panicle with larger and lax racemes.

24. **Monnina callimorpha** Chodat in Bot. Jahrb. 42: 101 (1908).
Monnina Killipii Chodat in Bull. Soc. Bot. Genève II. 25: 204 (1934).

Shrub, 24–30 dm. high, branched, the branches to 15 dm. long and 4 mm. in diameter, striate, conspicuously pubescent, the hairs yellow, lax; leaves lanceolate, 35–98 mm. long, 16–40 mm. wide, usually acuminate, rarely obtuse or acute, finely pubescent above, canescent-pubescent beneath, entire, attenuate at base, the costa prominulous beneath with 5 or 6 pairs of lateral veins; petioles 4–7 mm. long, concave above, convex beneath, pubescent, articulate; stipules 2–4 mm. long, 1–1.5 mm. wide, more or less cylindric, densely pubescent; inflorescence paniculate, the axis 8–13 cm. long, 1.5–2 mm. diameter, almost striate, canescent-pubescent, the racemes subsessile, more or less acute, 2–4 cm. long, 6–8 mm. wide, bracteate, the bracts triangular, 1–1.5 mm. long, 0.7–1 mm. wide, acute, pubescent beneath, deciduous, inconspicuous; flowers 4–5 mm. long, the pedicels 1–2 mm. long, finely pubescent; outer sepals ovate-lanceolate, ciliate, obtuse, slightly pubescent beneath, 1-nerved, the two lower ones 1.8–2 mm. long, 1–1.2 mm. wide, ½ united, the upper one 2–2.2 mm. long, 1.6–1.8 mm. wide; wings blue, 4.4–4.8 mm. long, 3.6–4 mm. wide, obovate, obtuse at base, 3- or 4-nerved, finely pubescent at base, ciliate; keel yellow, 4.6–5 mm. long, 3–3.2 mm. wide, orbicular, plicate, pubescent within, obtuse at base, 3- or 4-nerved, 3-lobed, the middle lobe obtuse-emarginate, larger, slightly pubescent on a convex longitudinal line; upper petals almost elongate-spatulate, pubescent; stamens 8, the filaments 3.4–3.6 mm. long, almost entirely united, the free part 0.7–1.2 mm. long; ovary elliptic, 1.6–2.4 mm. long, 1–1.6 mm. wide, finely pubescent, the hairs short, strigose, becoming glabrescent; style 2.8–3 mm. long, geniculate above base, glabrous, cylindric; stigma with 2 lobes, the lower acute, the upper 1-tubercled, papillose; drupe ovate, 4.2–4.5 mm. long, 3.2–3.5 mm. wide, glabrescent, reticulate. (PL. VI, FIGS. 9–16.)

DISTRIBUTION: In the Andes of central Perú, Department of Junín, between 1800 and 3200 meters altitude.

PERU: JUNÍN: Huacapistana, *Killip & Smith 24253* (US); Carpapata, above Huacapistana, *Killip & Smith 24421* (type of *Monnina Killipii* Ch, isotype NY); Huacapistana, *Weberbauer 2070* (photograph of the TYPE, Ch).

This shrub occurs in the region called "ceja de montaña." It is close to *M. Pavoni* Chodat but is not scandent, has obtuse outer sepals, pubescent wings, a glabrous style, and the anthers not mucronate.

It seems desirable to accept *M. Killipii* as synonymous, since its type shows the same characters as that of *M. callimorpha* and was found in the same region.

25. **Monnina ovata** sp. nov.

Frutex scandens ramosus, ramis 2–5 mm. crassis lignosis conspicue striatis glabris; folia ovata 3.2–8.6 cm. longa 1.6–3.5 cm. lata apice obtusa utrinque glabra integerrima, nervo medio prominulo, nervis lateralibus 9 vel 10, petiolo 4–6 mm. longo breviter puberulo vel glabro supra concavo; panicula ampla ramosissima, racemis laxis plus minusve elongatis striatis breviter puberulis vel glabris 8–10 mm. crassis conicis, rhachi 12–16 cm. longa glabra striata, tenuiter pedunculatis, pedunculo 4–4.5 cm. longo, bracteis inconspicuis deciduis; flores globosi 4.5–5.5 mm. longi, pedicello 1–1.2 mm. longo breviter puberulo; sepala exteriora lanceolata ciliata concava obtusa, duo inferiora 2.2–2.4 mm. longa 1.6–1.7 mm. lata ½ connata 3-nervia subtus glabrescentia, sepalo superiore 2.8–3 mm. longo 2.6–2.8 mm. lato 5-nervio subtus puberulo; alae 5–5.8 mm. longae 4.5–5 mm. latae obovatae basi plus minusve obtusae 3- vel 4-nerviae conspicue ciliatae subtus breviter pubescentes; carina obovata 5–6 mm. longa 3.2–3.8 mm. lata intus puberula apice trilobata, lobo mediano obtuso emarginato, lobis lateralibus obtusiusculis conspicue ciliatis basi acutis, 3- vel 4-nervia, petalo superiore dilatato vel spathulato utrinque puberulo; stamina 8, filamentis 4–4.4 mm. longis, filamentorum parte libera 0.6–1 mm. longa glabra; ovarium 1.5–2 mm. longum 0.9–1 mm. latum ovatum puberulum; stylus 2.2–2.6 mm. longus geniculatus circa basim glaber; stigma apice superiore tuberculatum papillosum apice inferiore plus minusve obtusum; drupae ellipticae 5.5–7 mm. longae 3.5–4 mm. latae glabrae reticulatae. (PL. VI, FIGS. 17–24.)

DISTRIBUTION: Known only in Central Perú, Department of Huánuco, at about 2700 meters altitude.

PERU: HUÁNUCO: Playapampa, June 16–24, 1923, *Macbride 4493* (TYPE US 1191510, ISOTYPE Ch).

Monnina ovata seems closely related to *M. Ruiziana* Chodat, from which it differs in its glabrous and scandent habit, striate branches, obtuse leaves, and pubescent ovary. From *M. callimorpha* Chodat, another ally, the new species differs in its glabrous habit, obtuse leaves, 3-nerved lower sepals, etc.

26. **Monnina polystachya** R. & P. Syst. Veg. 171 (1798).

Scandent, to 45 dm. high, branched, the branches 4–5 mm. in diameter, striate, densely pubescent, the hairs yellow, 1.2–2 mm. long; leaves lanceolate, 25–76 mm. long, 10–35 mm. wide, usually acute, rarely obtuse, pubescent above, canescent-pubescent beneath, entire, attenuate at base, the costa prominulous beneath, with 5 or 6 pairs of lateral veins; petioles 2–6 mm. long, concave above, convex beneath, densely pubescent, articulate at base; inflorescence paniculate, the axis 7–12 cm. long, 1.5–2.5 mm. in diameter, striate, pubescent, the racemes 4–7, subsessile, more or less acute, 3–10.5 cm. long, 8–10 mm. wide, bracteate, the bracts lanceolate, 2–3.2 mm. long, 0.8–1.2 mm. wide, acuminate, pubescent beneath, ciliate, deciduous, 1-nerved; flowers 4.6–5 mm. long, the pedicels 1–1.2 mm. long, pubescent; outer sepals almost lanceolate, acute, ciliate, the two lower ones 1.4–1.6 mm. long, 1.8–2 mm. wide, $\frac{2}{3}$ united, 1-nerved, glabrous beneath, the upper one 2.2–2.4 mm. long, 1.6–1.8 mm. wide, 5-nerved, pubescent beneath; wings 5–5.4 mm. long, 4.5–5 mm. wide, obovate, obtuse at base, 4- or 5-nerved, glabrous beneath, ciliate at base; keel 4.8–6 mm. long, 3–3.4 mm. wide, orbicular, plicate, pubescent within, obtuse at base, 3- or 4-nerved, 3-lobed, the middle lobe obtuse-emarginate, larger; upper petals slightly spatulate, pubescent within; stamens 8, the filaments 3–3.8 mm. long, more or less united, the free part 1–1.5 mm. long; ovary ovoid, 1.2–1.6 mm. long, 1–1.2 mm. wide, pubescent near its base, sometimes becoming glabrescent; style 3–3.5 mm. long, geniculate above base, glabrous, cylindric; stigma with 2 lobes, the lower acute, the upper 1-tubercled, the tubercle papillose; drupe elliptic, 5–7.5 mm. long, 3–5 mm. wide, glabrescent, reticulate. (PL. VII, FIGS. 1–8.)

DISTRIBUTION: Central Perú, Department of Huánuco, at about 3000 meters altitude.

PERU: HUÁNUCO: 6 miles south of Mito, *Macbride & Featherstone 1848* (Ch, US); "in Huanuci Provincia," *Ruiz & Pavón* without number (photograph of TYPE, US).

This species, which in habit is scandent and densely puberulous, with lax racemes, is the type of the genus *Monnina*.

27. **Monnina Pavoni** Chodat in Bull. Herb. Boiss. 3: 132 (1895), in Bot. Jahrb. 42: 102 (1908).

Monnina huacachiana Chodat in Bull. Soc. Bot. Genève II. 25: 210 (1934).

Scandent, branched, the branches 3–7 mm. in diameter, conspicuously pubescent, becoming more or less glabrescent, striate; leaves lanceolate, 32-90 mm. long, 12-30 mm. wide, usually acute, sometimes acuminate, pubescent above, conspicuously canescent-pubescent beneath, entire, attenuate at base, the costa prominulous beneath, with 5 or 6 pairs of lateral veins; petioles 2.5–7 mm. long, almost cylindric, pubescent; leaflets occurring in the axils; inflorescence paniculate, the axis 10–24 cm. long, 1.5–2 mm. in diameter, striate, pubescent, the racemes numerous, more or less acute, 7–19 cm. long, 7–10 mm. wide, pedunculate (peduncle 12–24 mm. long), bracteate, the bracts lanceolate, 3–3.6 mm. long, 1–1.2 mm. wide, acuminate, pubescent beneath, ciliate, deciduous, 1-nerved; flowers 4–4.8 mm. long, the pedicels 1.2–1.8 mm. long, pubescent; outer sepals lanceolate, more or less acuminate, ciliate, slightly pubescent beneath, the two lower ones 1.8–2.4 mm. long, 0.8–1 mm. wide, $\frac{1}{2}$ united, 1-nerved, the upper one 2–2.5 mm. long, 1.4–1.6 mm. wide, 3-nerved; wings deep blue, 4–5 mm. long, 3.2–4.8 mm. wide, obovate, more or less obtuse at base, with 3 or 4 nerves, glabrous; keel yellow, 4.6–5.6 mm. long, 2.6–3.2 mm. wide, orbicular, plicate, pubescent within, obtuse at base, 3- or 4-nerved, 3-lobed, the middle lobe obtuse-emarginate, larger; upper petals elongate-spatulate, pubescent; stamens 8, the filaments 3.5–4 mm. long, almost entirely united, the free part 1.2–1.5 mm. long, the anthers mucronate; ovary elliptic, 1.2–1.6 mm. long, 0.9–1.3 mm. wide, pubescent, the hairs short, strigose, sometimes more or less glabrescent; style 2.5–3.2 mm. long, geniculate above base, pubescent near base, cylindric; stigma with 2 lobes, the lower acute, the upper 1-tubercled, the tubercle papillose; drupe elliptic, 4.2–5.4 mm. long, 2.2–3.2 mm. wide, usually glabrescent, rarely inconspicuously pubescent, reticulate. (PL. VII, FIGS. 9–16.)

Distribution: Central Andes of Perú, Department of Huánuco, between 2000 and 2700 meters altitude.

PERU: Huánuco: Huacachi, Estación near Muña, *Macbride 3885* (Ch, US), *4124* (type of *M. huacachiana*, Ch); Panao, *Macbride 3622* (A, Ch, NY).

This species is near *M. polystachya* R. & P. but has the following differences: glabrescent branches, larger panicle up to 24 cm. long, outer sepals almost acuminate, style pubescent near its base, and anthers mucronate.

In Bull. Herb. Boiss. **4:** 247 (1896) Chodat states that *M. Pavoni* is synonymous with *M. polystachya*, but later the same author, in Bot. Jahrb. **42:** 102 (1908), says: "Non est eadem ac *M. polystachya* Ruiz et Pavón, ut erronee indic. Bull. Herb. Boiss. IV., 247."

The type of *M. huacachiana* agrees well with Chodat's description of *M. Pavoni* and furthermore comes from the same region as the type of the earlier binomial.

28. **Monnina pseudo-polystachya** Chodat in Bull. Soc. Bot. Genève II. 25: 217 (1934).

Scandent, branched, the branches decurrent, 22–34 cm. long, terete, pubescent; leaves more or less lanceolate, 25–100 mm. long, 9–42 mm. wide, acute, pubescent above, conspicuously pubescent beneath, entire, attenuate at base, the costa prominulous beneath, with 4 or 5 pairs of lateral veins; petioles 3–6 mm. long, concave above, convex beneath, densely pubescent; leaflets occurring in the axils; inflorescence paniculate, the axis 8–12 cm. long, 1.2–2 mm. in diameter, more or less striate, densely pubescent, the racemes numerous, 2.5–6 cm. long, 8–10 mm. wide, acute, subsessile, bracteate, the bracts inconspicuous, deciduous; flowers 4.5–5.2 mm. long, the pedicels 0.8–1 mm. long, pubescent; outer sepals triangular, acute, ciliate, strongly pubescent beneath, 1-nerved, the two lower ones 1.4–1.6 mm. long, 0.9–1 mm. wide, ½ united, the upper one 2–2.2 mm. long, 1.4–1.5 mm. wide; wings 4.4–5 mm. long, 4.5–5 mm. wide, obovate, obtuse at base, 4- or 5-nerved, pubescent beneath near base, ciliate at base; keel 4.5–5 mm. long, 3–3.5 mm. wide, orbicular, plicate, glabrescent within, sometimes with a few hairs, obtuse at base, 3- or 4-nerved, subemarginate at apex, slightly pubescent on a convex longitudinal line, the hairs 0.5–0.6 mm. long, almost rigid; upper petals spatulate, pubescent; stamens 8, the filaments 3.5–4 mm. long, almost entirely united, the free part 1–1.8 mm. long; ovary elliptic, 1.4–2.2 mm. long, 1–1.3 mm. wide, strongly pubescent, the hairs rigid, ascendent; style 2.5–3.2 mm. long, geniculate above base, conspicuously pubescent in the upper part, cylindric; stigma with 2 lobes, the lower acute, the upper 1-tubercled, the tubercle papillose; fruit unknown. (Pl. VII, figs. 17–24.)

Distribution: The sierra of central Perú, Department of Huánuco, at about 2400 meters altitude.

PERU: Huánuco: Muña, trail to Tambo de Vaca, *Macbride 4317* (type Ch, isotype US).

This plant is close to *M. polystachya* R. & P., from which it differs in having larger and thicker leaves, the outer sepals strongly pubescent beneath, the wings more or less pubescent beneath, the keel slightly pubescent on a convex line, the ovary strongly pubescent, and the style with conspicuous hairs. It differs from *M. Pavoni* Chodat in having the axis of the panicle to 12 cm. long, the branches densely pubescent, the outer sepals with rigid and conspicuous hairs beneath, the ovary strongly pubescent, etc.

29. **Monnina Ruiziana** Chodat in Bot. Jahrb. 42: 100 (1908).

Shrub, to 30 dm. high, branched, the branches terete, densely hirsute; leaves elliptic, 45–50 mm. long, 35–40 mm. wide, more or less acute, conspicuously hirsute, entire, the costa prominulous beneath; petioles 4–6 mm. long, pubescent; inflorescence paniculate, the racemes divaricate, densely hirsute, lax, bracteate, the bracts almost filiform, deciduous, inconspicuous; flowers 3.5–4 mm. long, with a short pedicel; outer sepals ovate-triangular, obtuse or more or less acute, ciliate, pubescent beneath, the two lower ones united; wings orbicular, attenuate at base; keel hemispheric, yellow, 3-lobed, the lobes obtuse; upper petals linear, or dilated; androecium pubescent in the upper part, the filaments almost entirely united; ovary glabrous, rarely more or less pubescent; style geniculate; stigma with 2 lobes; fruit unknown.

DISTRIBUTION: In the region of Central Perú, Department of Huánuco, between 2000 and 2900 meters altitude.

PERU: HUÁNUCO: Monzón, Province of Huamalíes, *Weberbauer 3355* (photograph of TYPE, US).

The writer has seen no material of this species except the photograph of the type; it would seem to be near *M. polystachya* R. & P. but distinct from it in being a shrub, being more pubescent, having a glabrous ovary, etc. It is also related to *M. Pavoni* Chodat but differs in having terete and densely pubescent branches, lanceolate leaves, a glabrous ovary, and in its shrubby habit.

29a. **Monnina Ruiziana** forma **longepetiolata** Chodat, op. cit. 101.

According to Chodat, the form differs from the typical specimen in having longer petioles, to 7.8 mm. long.

PERU: HUÁNUCO: Monzón, Province of Huamalíes, 2000–2500 meters, *Weberbauer 3527* (TYPE, not seen).

The writer has seen no material of this form.

30. **Monnina connectisepala** Chodat in Bull. Soc. Bot. Genève II. 25: 213 (1934).

Monnina tenuifolia Chodat, op. cit. 212; not Chodat (1895).

Monnina stipulata var. *tenuibracteata* Chodat, op. cit. 205.

Shrub, 15–25 dm. high, branched, more or less pubescent, becoming glabrescent, the branches 3–6 mm. in diameter, conspicuously striate; leaves usually elliptic, rarely more or less lanceolate, 30–100 mm. long, 15–40 mm. wide, acute, sometimes obtuse, glabrescent, entire, attenuate at base, the costa prominulous beneath, with 9 or 10 pairs of lateral veins; petioles 4–8 mm. long, articulate, pubescent; stipules conical-cylindric, 2–3 mm. long, glabrescent; inflorescence paniculate, the axis 7–18 cm. long, 1.5–2.5 mm. in diameter, striate, usually glabrescent, sometimes finely pubescent, the racemes lax, divaricate, acute, 3–14 cm. long, 7–10 mm. wide, bracteate, the bracts ovate, acute, sometimes lanceolate, 2.2–3 mm. long, 1–2 mm. wide, pubescent beneath, 1-nerved, ciliate, deciduous; flowers 5–5.8 mm. long, the pedicels 1–1.6 mm. long, finely pubescent; outer sepals ovate-lanceolate, ciliate, usually obtuse, rarely more or less acute, the two lower ones 1.8–2.2 mm. long, 1–1.5 mm. wide, united almost $\frac{2}{3}$, glabrescent beneath, 1–3-nerved, the upper one 2.5–3.2 mm. long, 1.8–2.5 mm. wide, finely pubescent beneath, 5–7-nerved; wings dark blue, 5–6 mm. long, 4.6–5.2 mm. wide, obovate, obtuse at base, 3-nerved (middle nerve conspicuous), slightly pubescent beneath, sometimes with a few hairs within, ciliate at base; keel yellow, 5–6 mm. long, 3.2–4.2 mm. wide, orbicular, plicate, pubescent within, rarely glabrescent, obtuse at base, 3- or 4-nerved, 3-lobed, the middle lobe obtuse-emarginate, larger, rarely with a few hairs on a convex longitudinal line; upper petals spatulate, pubescent; stamens 8, the filaments 3.5–4.2 mm. long, unequally united, the free part 0.4–1.6 mm. long; ovary ovoid, 1.4–2.2 mm. long, 1–1.4 mm. wide, glabrous; style 2.6–3.4 mm. long, geniculate above base, glabrous, more or less cylindric; stigma with 2 lobes, the lower acute, the upper 1-tubercled, the tubercle papillose; drupe elliptic, 4–8 mm. long, 2–5 mm. wide, glabrous, reticulate, rarely more or less marginate. (PL. VII, FIGS. 25–32.)

DISTRIBUTION: Found only in the Andes of southern Perú, Department of Cuzco, between 2200 and 3200 meters altitude.

PERU: CUZCO: Pillahuata, cerro de Cusilluyoc, ***Pennell 13977*** (type of ***Monnina tenuifolia*** [1934] Ch, isotypes GH, Ph), ***Pennell 14095*** (TYPE Ch, ISOTYPE Ph), *14022* (Ch, GH, Ph), *14122* (type of ***Monnina stipulata*** var. ***tenuibracteata*** Ch, isotypes GH, M, Ph, US); Laderas de Pillahuata, Province of Paucartambo, *Vargas 81* (Ch); near Pillahuata, Province of Paucartambo, *West 7071* (GH, UC); Distrito Marcachea, Province of Paucartambo, *Vargas 11130* (Ch, UC); summit of Huayna Picchu, *West 6430* (M, UC); Canyon of Cachu-pampa, Araza River, Distrito Marcapata, Province of Quispicanchis, *Vargas 9672* (Ch, UC).

Fortunately it has been possible to see the types of the names above cited, collected in the same locality, and the whole of the material agrees well with the type of the species. Chodat, in 1895, described *M. tenuifolia* from specimens found in Colombia, which is very different from this entity.

The present species is close to ***M. Ruiziana*** Chodat but differs in the glabrescent branches, the larger leaves (to 10 cm. long), and in its more southern distribution.

31. **Monnina Lechleriana** Chodat in Bull. Herb. Boiss. 3: 129 (1895).

Frutescent, branched, the branches 3–4 mm. in diameter, striate, hirsute in the upper part; leaves lanceolate-elliptic, 60–85 mm. long, 20–32 mm. wide, acute, glabrescent, entire, somewhat revolute, petiolate, the costa prominulous beneath; stipules to 2 mm. long and 0.3 mm. wide, cylindric; inflorescence paniculate, narrow, the axis striate, bracteate, the bracts deciduous, inconspicuous; flowers 4–4.5 mm. long, the pedicels 1.4–1.5 mm. long, slightly pubescent; outer sepals ovate-lanceolate, ciliate, the two lower ones 1.5–1.6 mm. long, 0.8–1 mm. wide, $\frac{1}{2}$ united, 1-nerved, glabrous beneath, obtuse, the upper one 2.2–2.4 mm. long, 1.2–1.3 mm. wide, 5–7-nerved, finely pubescent beneath, acute; wings 4–4.2 mm. long, 4–4.3 mm. wide, obovate, obtuse at base, 5-nerved, glabrous; keel 4–4.4 mm. long, 2.5–2.8 mm. wide, orbicular, plicate, more or less pubescent within, obtuse at base, 4- or 5-nerved, 3-lobed, the middle lobe obtuse-emarginate, larger; upper petals elongate-spatulate, finely pubescent; stamens 8, the filaments 2.6–3 mm. long, united almost $\frac{1}{3}$, the free part 1–1.2 mm. long, glabrous; ovary ovoid, 1–1.2 mm. long, 0.5–0.6 mm. wide.

glabrous; style 2.8–3 mm. long, geniculate, glabrous, cylindric; stigma with 2 lobes, the lower more or less acute, the upper 1-tubercled, the tubercle papillose; fruit unknown. (PL. VIII, FIGS. 1–7.)

DISTRIBUTION: Andes of southern Perú.

PERU: DEPT. ?: "Tabina," *Lechler 2072* (fragments of TYPE Ch, US; photograph of type US).

It seems probable that this species was found in the southeastern part of Perú, since Lechler collected chiefly in the Department of Puno. The description given above is adapted from the original description and the cited photograph.

32. **Monnina Clarkeana** Chodat in Bull. Herb. Boiss. 4: 246 (1896).

Frutescent, branched, the branches numerous, slightly hirsute on the upper part; leaves numerous, lanceolate, sometimes more or less ovate-lanceolate, 18–54 mm. long, 6–22 mm. wide, acute, finely pubescent, becoming glabrescent, entire, attenuate at base, the costa prominulous beneath, with inconspicuous lateral veins; petioles to 7 mm. long, cylindric, pubescent; inflorescences paniculate, numerous, axillary, conspicuously pedunculate, with a leaflet at base, the leaflet to 35 mm. long, the racemes numerous, lax, 4–6 cm. long, bracteate, the bracts almost filiform, conspicuous in the upper part; flowers 3.8–5 mm. long, the pedicels 1.8–2 mm. long, finely pubescent; outer sepals lanceolate, ciliate, acute, glabrous beneath, the two lower ones 1.2–1.4 mm. long, 0.8–1 mm. wide, ⅓ united, 1-nerved, the upper one 1.6–1.8 mm. long, 1–1.2 mm. wide, 3-nerved; wings 3.2–4 mm. long, 3.4–3.6 mm. wide, obovate, obtuse at base, with 5 nerves, glabrous; keel 3.6–4.2 mm. long, 2.6–2.8 mm. wide, orbicular, plicate, pubescent within, obtuse at base, 4- or 5-nerved, 3-lobed, the middle lobe obtuse-emarginate, larger; upper petals strongly elongate-spatulate, pubescent; stamens 8, the filaments 3–3.5 mm. long, united almost ⅔, the free part 1–1.2 mm. long; ovary ellipsoid, 1.2–1.4 mm. long, 0.6–0.8 mm. wide, glabrous; style 2.5–3 mm. long, geniculate, glabrous, cylindric; stigma with 2 lobes, the lower obtuse, the upper 1-tubercled, the tubercle papillose; fruit unknown. (PL. VIII, FIGS. 8–14.)

DISTRIBUTION: Known only from the northern part of the Peruvian Andes.

PERU: DEPT. ?: "in Peruvia," *Mathews 1192* (fragments and photograph of the TYPE US).

Presumably found in northern Perú, Department of Amazonas, where Mathews spent many years collecting in the Chachapoyas area. The species is near *M. Lechleriana* Chodat, from which it differs in having elongate, numerous, and separate racemes, the lower sepals acute, the upper petals conspicuously elongate-spatulate, etc.

33. **Monnina ligustrifolia** H.B.K. Nov. Gen. et Sp. 5: 417 (1821).

Frutescent, branched, more or less terete, finely pubescent, becoming glabrescent; leaves lanceolate, 36–65 mm. long, 10–20 mm. wide, acute, finely pubescent, entire, attenuate at base, the costa prominulous beneath, the veins more or less reticulate; petioles 1.5–3 mm. long, semiterete, pubescent; racemes conical, acute, simple, terminal or axillary, the axis 3–6.5 cm. long, striate, slightly pubescent, bracteate, the bracts conspicuous, ovate, acute, deciduous, ciliate; flowers 4–4.2 mm. long; pedicels 1.6–1.8 mm. long, pubescent; outer sepals free, ovate-triangular, ciliate, the two lower ones 1.5–1.6 mm. long, 1.6–1.7 mm. wide, glabrous beneath, obtuse, 5-nerved, the upper one 2–2.2 mm. long, 1.6–1.8 mm. wide, pubescent beneath, acute, 7-nerved; wings 4–4.2 mm. long, 3.5–3.6 mm. wide, obovate, obtuse at base, 3- or 4-nerved, glabrous beneath, ciliate at base; keel 3.8–4 mm. long, 2.3–2.5 mm. wide, orbicular, plicate, pubescent within, obtuse at base, 3-nerved, ciliate, 3-lobed, the middle lobe obtuse-emarginate; upper petals short, finely pubescent; stamens 8, the filaments 2.8–3 mm. long, almost entirely united, the free part 0.6–1 mm. long, glabrous; ovary ellipsoid, 1–1.2 mm. long, 0.6–0.7 mm. wide, glabrous; style 2.2–2.4 mm. long, straight, becoming geniculate in the middle part, cylindric; stigma thicker than the style, with 2 lobes, the lower obtuse, the upper 1-tubercled, the tubercle papillose; drupe ovoid, 4.5–4.8 mm. long, 2.8–3 mm. wide, glabrous, reticulate. (PL. VIII, FIGS. 15–22.)

DISTRIBUTION: Andes of northern Perú, Department of Piura.

PERU: PIURA: Ayavaca, *Bonpland 3491* (fragments and photograph of TYPE US).

Characterized by the simple terminal or axillary racemes with conspicuous ovate acute bracts. The measurements of the leaves are taken from the photograph.

34. **Monnina salicifolia** R. & P. Syst. Veg. 172 (1798).
Monnina crotalarioides DC. Prodr. 1: 339 (1824).
Monnina crotalarioides var. *glabrescens* Chodat in Bot. Jahrb. 42: 99 (1908).
Monnina crotalarioides var. *pseudo-loxensis* Chodat, l. c.
Monnina crotalarioides var. *macrophylla* Chodat, l. c.
Monnina crotalarioides var. *leptostachys* Chodat, l. c.

Shrub 5–25 dm. high, branched, the branches 7–34 cm. long, 1–5 mm. in diameter, nodose, pubescent, becoming glabrescent, striate; leaves usually elliptic, rarely more or less lanceolate, 12–70 mm. long, 7–25 mm. wide, obtuse, sometimes acute, finely pubescent, becoming more or less glabrescent, entire, slightly revolute, attenuate at base, the costa prominulous beneath, with 4 or 5 pairs of lateral veins; petioles 1–2.5 mm. long, concave above, convex beneath, articulate, pubescent; racemes conical, acute, 9–12 mm. wide, simple, terminal, pedunculate, the peduncle 5–12 mm. long, the axis 1–8 cm. long, pubescent, striate, bracteate, the bracts acute-triangular, 1.4–3 mm. long, 1.4–1.8 mm. wide, deciduous, ciliate, 1-nerved, finely pubescent beneath; flowers 4.5–6.5 mm. long, the pedicels 1–1.4 mm. long, finely pubescent; outer sepals free, ovate-triangular, obtuse, ciliate, more or less pubescent beneath, the two lower ones 1.4–2.2 mm. long, 1.6–2 mm. wide, 3-nerved, the upper one 2.2–3 mm. long, 1.8–2.4 mm. wide, 5-nerved; wings indigo-blue, 5.6–6.8 mm. long, 4.8–6 mm. wide, obovate, obtuse at base, 3- or 4-nerved, usually slightly pubescent beneath, glabrescent within, sometimes with a few hairs at base; keel yellow, 5–7 mm. long, 3–4 mm. wide, orbicular, plicate, pubescent within, sometimes glabrescent, obtuse at base, 3- or 4-nerved, 3-lobed, the middle lobe obtuse-emarginate; upper petals more or less elongate, spatulate, pubescent; stamens 8, the filaments 3.8–4.2 mm. long, almost entirely united, the free part 0.8–1.4 mm. long, glabrous; ovary ovoid, 1.6–2.8 mm. long, 1–1.6 mm. wide, glabrous; style 2.8–3.5 mm. long, geniculate, glabrous, cylindric; stigma with 2 lobes, the lower acute, the upper 1-tubercled, the tubercle papillose; drupe ellipsoid, 4.8–6 mm. long, 2.5–3.5 mm. wide, glabrous, reticulate. (PL. VIII, FIGS. 23–31.)

DISTRIBUTION: Along the Andes from southern Ecuador to the northwestern part of Bolivia, between 1800 and 3900 meters altitude.

ECUADOR: AZUAY: Road from Cuenca towards Cumbe, *Haught 3347* (US). PERU: LA LIBERTAD: Eastern base of Cerro Huaylillas, Province of Huamachuco, *West 8125* (GH, M, UC); HUÁNUCO: 6 km. south of Huánuco, *Stork & Horton 9375* (Ch, DA, UC); LIMA: Río Blanco, *Killip & Smith 21621* (Ch, NY, US), *21609* (US), *Macbride & Featherstone 664* (Ch, US); Matucana, *Macbride & Featherstone 95* (Ch, US); vicinity of Huarochirí, *Hrdlicka* without number (US); vicinity of San Damián, *Hrdlicka* without number (US); JUNÍN: vicinity of Oroya, *Rose & Rose 18698* (US); Huancayo, *Museo de Historia Natural de Lima 83* (US); quebradas east of Huancayo, *Stork & Horton 10220* (Ch, DA, UC); between Viques and Ingahuasi, south of Huancayo, Mantaro Canyon, *Killip & Smith 22175* (Ch, NY, US); AYACUCHO: "Tambillo," *West 3651* (UC); HUANCAVELICA: Near Córdova, Province of Castrovirreina, *Metcalf 30276* (US, UC); APURIMAC: Pincos, Province of Andahuaylas, *Stork & Horton 10680* (Ch, UC); Chincheros, near town, *West 3693* (UC); CUZCO: Paucartambo Valley, *Herrera 2965* (NY, US); Hacienda Churu, Province of Paucartambo, *Herrera 1029a* (US); Huaillabamba, Paucartambo, *Balls 6739* (US); near Quencomayo, below Colquipata, Paucartambo, *Pennell 13784* (Ph); Cerro Macchu Picchu, Province of Urubamba, *Mexia 8074a* (US); summit of Huayna Picchu, *West 6430* (GH); Ollantaytambo, *Cook & Gilbert 1219* (US), *273* (US); San Miguel, Urubamba Valley, *Cook & Gilbert 1154* (US); Urubamba, *Soukup 33* (Ch); Sacsahuaman, above Cuzco, *Pennell 13549* (Ch, GH, NY, Ph, US); Colinas del Sacsahuaman, *Herrera 2376* (Ch); Colinas del Sacsahuaman, *Herrera* without number (Ch); Colinas del Rodadero, *Vargas 3147* (Ch); Vilcanota, below Caicai, *Pennell 14188* (Ch, GH, NY, Ph, US); Marcapata, Province of Quispicanchis, *Vargas 1334* (Ch); Province of Quispicanchis and Cuzco, *Herrera 682* (US); San Sebastián, *Pennell 13617* (Ch, GH, NY, Ph); Convención, *Vargas 1838* (GH); Cuzco, *Herrera* without number (NY, US), *3096* (US); DEPT. ?: Mantaro, *Herrera 763a* (US); without locality and date, *Dombey 627* (Ch), *Mathews 3024* (GH); without locality, 1862, *Mathews* without number (NY); without locality, 1839–40, *Gay* without number (Ch); without locality and date, *Neé* without number (photograph of TYPE US), *Paris Herbarium* without number (fragments of authentic material of *M. salicifolia*, US), *Collector ?* without number (fragments of authentic material of *M. crotalarioides*, US). BOLIVIA: LA PAZ: Sorata, *Rusby 1910* (US), *R. S. Williams 2381* (US); vicinity of Sorata, *Bang 1305* (US); DEPT. ?: Titicaca, March, 1924, *Buchtien* without number (US); without locality, *Bang 2804* (US).

This plant is very common in the sierra. Ruiz & Pavón cited as localities, "Huarocheri, Tarmae et Panatahuarum Provincias." These places are situated in the Departments of Lima and Junín, and most of the available specimens of this species came from that region. Fragments of authentic material of this entity, and also of *M. crotalarioides*, and a photograph of the type were available to the writer. The brief descriptions given by Chodat for his varieties of *M. crotalarioides* agree with *M. salicifolia*. In addition, the localities are in the region of the sierra and some are from essentially the type-locality.

34a. **Monnina salicifolia var. pilostylis** var. nov.

A varietate typica differt stylo conspicue piloso.

PERU: LIMA: Río Blanco, April 15–17, 1929, *Killip & Smith 21569* (TYPE Ch, 632059, ISOTYPES NY, US); HUANCAVELICA: 4 km. north of Yauli, Prov. Huancavelica, *Stork & Horton 10882* (Ch, UC).

35. **Monnina hirtella** sp. nov.

Frutex ad 15 dm. altus conspicue canescenti-pubescens, ramis 2.5–5 mm.

crassis striatis; folia lanceolata 3.5–11 cm. longa 1–3.4 cm. lata basim versus elongato-attenuata apice acuminata, utrinque conspicue pubescentia, integerrima, nervo medio prominulo, nervis lateralibus 6 vel 7, petiolo 2–5 mm. longo puberulo; racemi simplices terminales vel axillares plus minusve conici 7–9 mm. crassi, rhachi 3.5–13 cm. longa puberula striata, pedunculo 8–28 mm. longo, bracteis lanceolatis acutis 1–1.8 mm. longis 0.6–1 mm. latis subtus puberulis uninerviis ciliatis deciduis; flores 4–5 mm. longi, pedicello 1.2–1.4 mm. longo puberulo; sepala exteriora libera plus minusve lanceolata ciliata concava obtusa subtus puberula, duo inferiora 1.8–2.2 mm. longa 1.5–1.6 mm. lata 3-nervia, sepalo superiore 2.4–2.6 mm. longo 1.4–1.6 mm. lato 5-nervio; alae 4.8–5 mm. longae 3.6–4 mm. latae obovatae basi obtusae 3-nerviae subtus basi pubescentes; carina 4.6–5.2 mm. longa 2.6–3 mm. lata orbicularis obovata intus puberula apice trilobata, lobo mediano obtuso emarginato, lobis lateralibus obtusiusculis, basi obtusa 3-nervia, petalo superiore elongato spathulato utrinque conspicue pubescente, pilis 1.2–1.5 mm. longis; stamina 8, filamentis 3.8–4 mm. longis, antheris subsessilibus, filamentorum parte libera 0.8–1 mm. longa glabra; ovarium 1.2–2 mm. longum 0.8–1 mm. latum oblongum glabrum; stylus 3.4–3.5 mm. longus conspicue geniculatus glaber cylindricus; stigma apice superiore tuberculatum papillosum apice inferiore acutum; drupae ellipticae 5.5–7 mm. longae 3.5–4 mm. latae glabrae reticulatae. (PL. VIII, FIGS. 32–41.)

DISTRIBUTION: In the eastern range of the Andes of northern Perú, Department of San Martín, between 1100 and 1200 meters altitude.

PERU: SAN MARTÍN: Jepelacio, near Moyobamba, October-November, 1933, *Klug 3337* (TYPE US 1457745, ISOTYPES A, Ch, GH); San Roque, *L. Williams 7105* (Ch, NY).

The new species suggests *M. ligustrifolia* H. B. K., but the leaves are almost twice as large and acuminate, and the axis of the racemes is longer, conspicuously pubescent, and without acute-ovate bracts at its apex. It is less closely related to *M. salicifolia* R. & P., from which it differs in the larger and acuminate leaves, to 11 cm. long, the longer petiole, and the pubescent habit.

36. **Monnina cyanea** Chodat in Bot. Jahrb. **42:** 100 (1908).

Frutescent, 5–10 dm. high, conspicuously branched, the branches 25.5–57 cm. long, 1.5–3 mm. in diameter, striate, canescent-pubescent, the hairs 0.5–0.7 mm. long, lax; leaves lanceolate, sometimes more or less oblanceolate, 22–60 mm. long, 10–20 mm. wide, usually acute, rarely acuminate, sometimes almost obtuse, finely canescent-pubescent, entire, attenuate at base, the costa prominulous beneath, with 5–7 pairs of lateral veins; petioles 1–2 mm. long, concave above, convex beneath, pubescent; stipules 0.3–0.5 mm. long, glabrous, coriaceous; racemes conical, more or less acute, 8–10 mm. wide, simple, terminal, pedunculate, the peduncle 8–14 mm. long, the axis 2.5–12 cm. long, pubescent, striate, bracteate, the bracts linear-lanceolate, 1.2–2.8 mm. long, deciduous, ciliate, 1-nerved, pubescent beneath; flowers 3.5–3.8 mm. long, the pedicels 1.2–1.3 mm. long, pubescent; outer sepals free, lanceolate, obtuse, ciliate, glabrescent beneath, sometimes more or less pubescent, the two lower ones 1.4–1.5 mm. long, 0.7–0.8 mm. wide, usually 1-nerved, rarely 5-nerved, the upper one 1.8–2 mm. long, 1–1.2 mm. wide, 3–5-nerved; wings deep blue, 3.6–4.2

mm. long, 3.5–3.8 mm. wide, obovate, obtuse at base, ciliate, 2- or 3-nerved, slightly pubescent beneath; keel yellow, 3.8–4.5 mm. long, 3.8–4.2 mm. wide, more or less orbicular, plicate, glabrous within, finely ciliate at base, 3-nerved, 3-lobed, the middle lobe obtuse-emarginate, smaller; upper petals narrow, attenuate, pubescent; stamens 8, the filaments 3-3.2 mm. long, almost entirely united, the free part 0.8–1 mm. long, glabrous; ovary ovoid, 1–1.3 mm. long, 0.6–1 mm. wide, densely pubescent, the hairs ascendent, rigid; style 2.4–2.5 mm. long, geniculate above base, glabrous, almost cylindric; stigma thicker, with 2 lobes, the lower obtuse, the upper 1-tubercled, the tubercle papillose; fruit drupaceous, cordiform-flattened, 4.4–5 mm. long, 4–5 mm. wide, conspicuously pubescent, acute, emarginate at base, slightly reticulate. (PL. VIII, FIGS. 42–51.)

DISTRIBUTION: Southeastern part of Perú, Departments of Cuzco and Puno, between 1800 and 3500 meters altitude.

PERU: CUZCO: Chaupichaca, Marcapata Valley, Province of Quispicanchi, *Weberbauer 7835* (Ch); PUNO: Between Sandia and Cuyocuyo, *Weberbauer 878* (photograph of TYPE, Ch); near Limbani, Province of Sandia, *Metcalf 30480* (UC, US).

Characterized by its canescent-hirsute branches, flattened and cordiform drupe, terminal and simple racemes, etc.

37. **Monnina decurrens** sp. nov.

Frutex breviter pubescens, ramis 4–20 cm. longis 1.4–2 mm. crassis striatis plus minusve glabrescentibus; folia decurrentia elliptica 1.2–2.8 cm. longa 5–7 mm. lata basi attenuata apice obtusa utrinque glabrescentia integerrima revoluta, nervo medio prominulo, nervis lateralibus 5 vel 6 inconspicuis, petiolo 1.5–2 mm. longo puberulo supra concavo subtus convexo; racemi simplices conici 6–8 mm. crassi subsessiles, rhachi 1.2–2.5 cm. longa breviter puberula striata; bracteae ovatae 0.6–1 mm. longae inconspicue uninerviae subtus puberulae ciliatae; flores 4.4–5.2 mm. longi, pedicello 1.6–2.5 mm. longo puberulo; sepala exteriora libera triangularia ciliata concava obtusa subtus puberula, duo inferiora 1.5–1.6 mm. longa 1.4–1.5 mm. lata 3-nervia, sepalo superiore 2–2.2 mm. longo 2–2.3 mm. lato 5-nervio; alae 5.6–6 mm. longae 4.3–4.5 mm. latae obovatae basi plus minusve acutae 5- vel 6-nerviae ciliatae subtus et intus plus minusve puberulae; carina 4.2–5 mm. longa 2.6–3 mm. lata obovata intus puberula apice inconspicue trilobata, lobo mediano emarginato, lobis lateralibus minoribus obtusiusculis, basi acutiuscula 4- vel 5-nervia, petalo superiore elongato spathulato utrinque puberulo; stamina 8, filamentis 3–3.4 mm. longis, antheris subsessilibus, filamentorum parte libera 0.6–1 mm. longa glabra; ovarium 1.2–1.6 mm. longum 1–1.2 mm. latum oblongum dense puberulum; stylus 2.8–3 mm. longus conspicue geniculatus puberulus plus minusve cylindricus; stigma apice superiore tuberculatum papillosum apice inferiore acutum; drupae ellipticae 5–7 mm. longae 2.5–3.2 mm. latae puberulae reticulatae. (PL. IX, FIGS. 1–10.)

DISTRIBUTION: The sierra of northern Perú, Department of Cajamarca, between 2800 and 3000 meters altitude.

PERU: CAJAMARCA: Cordillera east of Huancabamba, Province of Jaén, April, 1912, *Weberbauer 6100* (TYPE GH, ISOTYPES Ch, US).

This species is near *M. Vitis-Idaea* Chodat but differs in that it does not have a nodose stem, in the larger and conical racemes, the lower sepals being 3-nerved, the ovary and style being conspicuously pubescent, etc.

It is close also to *M. peruviana* Chodat, from which it is distinguished by its smaller, numerous, and elliptical leaves, and by the wings being pubescent within.

38. **Monnina peruviana** Chodat in Bull. Herb. Boiss. **3:** 133 (1895).

Frutescent, strongly branched, the branches nodose, 5–7 mm. in diameter, striate, finely pubescent, becoming glabrescent; leaves more or less decurrent, linear-lanceolate, 80–120 mm. long, 16–26 mm. wide, acute, rarely almost obtuse, finely pubescent, entire, attenuate at base, the costa prominulous beneath, with 7 or 8 pairs of lateral veins; petioles 2–6 mm. long, concave above, convex beneath, pubescent; racemes more or less cylindric, acute, 5–7 mm. wide, simple, axillary or terminal, subsessile, the peduncle short, the axis 2.8–6.8 cm. long, 1.5–2.5 mm. in diameter, densely pubescent, striate, bracteate, the bracts ovate-triangular, 2.2–2.8 mm. long, 2–2.2 mm. wide, deciduous, ciliate, 1-nerved, pubescent beneath; flowers 4.2–4.5 mm. long; pedicels 1.2–1.4 mm. long, pubescent; outer sepals free, ovate-lanceolate, obtuse, ciliate, glabrous beneath, the two lower ones 1.8–2 mm. long, 1.6–1.8 mm. wide, 3-nerved, the upper one 2.4–2.5 mm. long, 1.6–1.8 mm. wide, 5-nerved; wings deep blue, 4.4–4.6 mm. long, 3.8–4 mm. wide, obovate, obtuse at base, ciliate, 5- or 6-nerved, glabrous within; keel yellow, 4–4.4 mm. long, 2.5–2.6 mm. wide, orbicular, plicate, densely pubescent within, finely ciliate at base, almost obtuse, 3-lobed, the middle lobe obtuse, slightly emarginate; upper petals spatulate, pubescent; stamens 8, the filaments 3.6–4 mm. long, almost entirely united, the free part 0.8–1 mm. long, glabrous; ovary ellipsoid, 1–1.3 mm. long, 0.6–0.7 mm. wide, densely pubescent, the hairs numerous on the upper part, ascendent, rigid; style 2.6–2.8 mm. long, geniculate in middle part, conspicuously pubescent, cylindric; stigma with 2 lobes, the lower obtuse, the upper 1-tubercled, the tubercle papillose; fruit unknown. (Pl. IX, figs. 11–19.)

Distribution: Northern Perú, probably in the Department of Amazonas.

PERU: Dept. ?: Without locality, 1862, *Mathews* without number (NY).

Presumably this entity is endemic to the northern region of the Peruvian Andes. According to the original description, Mathews gave "prope Chachapoyas" as the type-locality; this is situated in the Department of Amazonas. The species has linear-lanceolate leaves, racemes with conspicuous ovate-triangular bracts, and the ovary and style densely pubescent.

39. **Monnina Mathusiana** Chodat in Bull. Herb. Boiss. **3:** 134 (1895).
Monnina scandens Chodat in Bot. Jahrb. **42:** 98 (1908).

Scandent, branched, the branches slightly hirsute, striate; leaves lanceolate, 35–80 mm. long, 10–30 mm. wide, acute, sometimes more or less acuminate, finely pubescent above, becoming glabrescent, pubescent beneath, entire, attenuate at base, the costa prominulous beneath, with 4 or 5 pairs of lateral veins; petioles 3–4 mm. long; inflorescence paniculate, the axis to 20 cm. long, striate, pubescent, the racemes numerous, lax, bracteate, the bracts filiform, hirsute, deciduous; flowers to 4.5 mm. in diameter, subglobose, with a short pedicel; outer sepals free, ovate-triangular, ciliate, slightly concave, 1- or 3-nerved; wings 3 times larger than the outer sepals, ovate, obtuse; keel yellowish, 3-lobed, the lobes acute; upper petals fan-like, glabrescent; androecium pubescent, the filaments almost entirely united; ovary glabrous; style straight, becoming geniculate; stigma with 2 lobes, the lower denticulate, the upper 1-tubercled, the tubercle papillose; fruit unknown.

DISTRIBUTION: In the forest of northern Perú, Departments of Amazonas and Cajamarca, between 2700 and 2900 meters altitude.

PERU: AMAZONAS: Chachapoyas, *Mathews 1190* (photograph of the TYPE, Ch); CAJAMARCA: Chugur, Hualgayoc, *Weberbauer 4072* (photograph of type of *M. scandens*, Ch).

I have seen no material of this species other than the cited photographs of the types. The original description of *M. scandens* and also the photograph of its type show the characters of *M. Mathusiana*.

40. **Monnina acutifolia** Chodat in Bull. Soc. Bot. Genève II. **25**: 206 (1934).

Shrub, to 30 dm. high, branched, the branches 3–6 mm. in diameter, striate, slightly pubescent, becoming glabrescent, the hairs 0.5–0.8 mm. long; leaves lanceolate, 22–75 mm. long, 7–20 mm. wide, acuminate, sometimes acute, more or less pubescent, becoming glabrescent, entire, attenuate at base, the costa prominulous beneath, with 5 or 6 pairs of lateral veins; petioles 2–7 mm. long, almost cylindric, pubescent; racemes aggregate, sometimes simple, terminal, more or less acute, 8–11 mm. wide, subsessile, the axis 4.5–31 cm. long, pubescent, the hairs 0.5–0.7 mm. long, striate, bracteate, the bracts filiform, deciduous; flowers 4–5.5 mm. long, the pedicels 0.8–1 mm. long, pubescent; outer sepals free, almost triangular, acute, ciliate, pubescent beneath, the two lower ones 2–2.3 mm. long, 1–1.4 mm. wide, 3-nerved, the upper one 2.4–2.5 mm. long, 1.4–1.7 mm. wide, 5-nerved; wings 4–4.4 mm. long, 3.8–4.2 mm. wide, obovate, obtuse at base, 3-nerved, glabrous; keel 4.6–5.5 mm. long, 3–3.2 mm. wide, orbicular, plicate, glabrous, obtuse at base, 3-nerved, 3-lobed, the middle lobe obtuse-emarginate; upper petals elongate, more or less spatulate, pubescent; stamens 8, the filaments 3.2–3.8 mm. long, almost entirely united, the free part 0.6–1.2 mm. long, glabrous; ovary elliptic, 1.2–1.8 mm. long, 0.8–1.2 mm. wide, glabrous; style 2.6–3 mm. long, geniculate above base, glabrous, cylindric; stigma with 2 lobes, the lower acute, the upper 1-tubercled, the tubercle papillose; drupe elliptic-acute, 5–6 mm. long, 2.6–3.5 mm. wide, glabrous, conspicuously reticulate. (PL. IX, FIGS. 20–28.)

DISTRIBUTION: Southern part of the Peruvian Andes, Department of Ayacucho, between 1000 and 2000 meters altitude.

PERU: AYACUCHO: Ccarrapa, between Huanta and Apurimac River, *Killip & Smith 22448* (ISOTYPE Ch), *23228* (Ch, NY, US).

Monnina acutifolia is related to *M. salicifolia* R. & P., from which it differs in the lanceolate and acuminate leaves, the racemes more than 3 times longer, the filiform bracts, the acute-triangular outer sepals, the glabrous wings, etc.

41. **Monnina Vargasii** sp. nov.

Planta herbacea perennis hirsuta, ramis 2–3 mm. crassis striatis conspicue hirsutis; folia lanceolata 4.5–12 cm. longa 1.4–4.2 cm. lata basim versus elongato-attenuata apice plus minusve acuminata utrinque breviter puberula integerrima, nervo medio prominulo, nervis lateralibus 7 vel 8, petiolo 3–7 mm. longo dense puberulo; racemi pauci aggregati (2–3) plus minusve conici 6–9 mm. crassi apice canescenti-tomentosi, rhachi 5–8.2

cm. longa dense puberula subsessili, bracteis lanceolatis 2.6–4.8 mm. longis 0.8–1.2 mm. latis subtus puberulis uninerviis ciliatis; flores 5–6 mm. longi, pedicello 1.2–1.5 mm. longo puberulo tereti; sepala exteriora libera lanceolata ciliata concava subtus puberula, duo inferiora 2.2–2.4 mm. longa 1.5–1.6 mm. lata 3-nervia acuta, sepalo superiore 2.8–3 mm. longo 1.8–2 mm. lato 5-nervio obtuso; alae 6–7 mm. longae 6–6.2 mm. latae obovatae basi obtusae 4- vel 5-nerviae ciliatae utrinque glabrae; carina 6–6.8 mm. longa 4–4.2 mm. lata orbicularis obovata intus glabrescens vel sparse puberula apice trilobata, lobo mediano obtuso emarginato, lobis lateralibus minoribus obtusiusculis, basi obtusa 4- vel 5-nervia, petalo superiore elongato spathulato utrinque puberulo; stamina 8, filamentis 3.6–4 mm. longis, antheris subsessilibus, filamentorum parte libera 0.8–1.6 mm. longa glabra; ovarium 1.6–2.8 mm. longum 1.2–1.6 mm. latum plus minusve puberulum; stylus 3–3.4 mm. longus geniculatus deinde horizontalis glaber; stigma apice superiore tuberculatum papillosum apice inferiore obtusum; fructus ignotus. (PL. IX, FIGS. 29–37.)

DISTRIBUTION: In the southern part of the Peruvian Andes, Department of Apurimac, at about 3300 meters altitude.

PERU: APURIMAC: Bosques de Ampai, Province of Abancay, January–April, 1938, *Vargas 771* (TYPE Ch 942479, ISOTYPE GH).

This species is near *M. pilosa* H. B. K., which occurs in northern Perú, from which it differs in its herbaceous habit, lanceolate leaves, and more or less pubescent ovary. It also suggests *M. acutifolia* Chodat, from which it is distinguished by its smaller racemes and the blade of its leaves with 7 or 8 pairs of lateral veins.

It is a pleasure to dedicate this species to Dr. César Vargas, Professor of Botany at the University of Cuzco.

42. **Monnina pilosa** H.B.K. Nov. Gen. et Sp. 5: 419 (1821).

Tree, the branches densely hirsute, terete; leaves oblong, 76–96 mm. long, 32–40 mm. wide, more or less obtuse, sometimes acuminate, densely pubescent, entire, attenuate at base, the costa prominulous beneath, with 7 or 8 pairs of lateral veins; petioles 3.5–5 mm. long, semiterete, pubescent; panicle corymbose, the axis hirsute, lax, bracteate, the bracts pubescent, deciduous; flowers with a short pedicel; outer sepals free, ovate, ciliate, concave, the two lower ones 3-nerved, acute, the upper one 5-nerved, obtuse; wings twice as large as the sepals, fan-like, 7-nerved, glabrous; keel more or less oblong, plicate, pubescent within, glabrous beneath; upper petals short, glabrous; stamens 8, the filaments united in the lower part, the anthers ovate-obtuse; ovary ovoid, glabrous; style thicker in the upper part, geniculate, glabrous; stigma with 2 lobes, the lower denticulate, the upper 1-tubercled, the tubercle papillose; fruit unknown.

DISTRIBUTION: From the Andes of Ecuador and northern Perú, between 1130 and 1700 meters altitude.

ECUADOR: DEPT. ?: Without locality, 1856, *Remy* without number (fragments US). PERU: PIURA: "prope pagum Ayavacae," without date, "1400 hex.," *Bonpland 3490* (fragments of TYPE Ch, photograph of TYPE Ch).

The description given above was adapted from the original and also from fragments of the type. This species is distinguished by its dense puberulous indument and by having its panicle more or less corymbose.

42a. **Monnina pilosa** var. **glabrescens** var. nov.

A varietate typica differt indumento paucipiloso et folia majoribus ad 166 mm. longis plus minusve spathulatis acutiusculis. (PL. X, FIGS. 1–10.)

PERU: PIURA: Canchaque, Province of Huancabamba, April 6, 1939, *Stork 11425* (TYPE GH, ISOTYPE DA, UC).

43. **Monnina densecomata** Chodat in Bull. Soc. Bot. Genève II. 25: 209 (1934).

Shrub, branched, the branches 4–5.5 mm. in diameter, striate, densely pubescent, the hairs 0.6–1 mm. long; leaves elliptic, 36–68 mm. long, 20–40 mm. wide, obtuse, pubescent, becoming more or less glabrescent, entire, revolute, the costa prominulous beneath, with 5 or 6 pairs of lateral veins; petioles 3–6 mm. long, almost cylindric, pubescent; stipules conical, to 3 mm. long, hirsute in the lower part; inflorescence paniculate, the axis 8.5–12.5 cm. long, striate, pubescent, the racemes subsessile, lax, almost acute, 7–9 mm. wide, conspicuously pubescent, bracteate, the bracts lanceolate, 3.6–5 mm. long, 1.6–2 mm. wide, acuminate, densely pubescent beneath, lax, conspicuous; flowers 4.5–5.5 mm. long, the pedicels 0.8–1.2 mm. long, pubescent; outer sepals free, lanceolate, ciliate, pubescent beneath, the two lower ones 3–3.4 mm. long, 1.5–1.6 mm. wide, usually acute, 3-nerved, sometimes 1- or 2-nerved, the upper one 3.2–3.8 mm. long, 1.8–2 mm. wide, more or less obtuse, usually 5-nerved, rarely 3-nerved; wings blue, 4.6–5 mm. long, 4–4.8 mm. wide, obovate, obtuse at base, 4- or 5-nerved, pubescent beneath, ciliate at base; keel yellow, 5.4–6 mm. long, 2.6–3.5 mm. wide, orbicular, plicate, pubescent within, obtuse at base, 3- or 4-nerved, ciliate at base, 3-lobed, the middle lobe obtuse, slightly emarginate; upper petals spatulate, pubescent, the hairs 0.8–1 mm. long; stamens 8, the filaments 3.5–4.2 mm. long, almost entirely united, the free part 0.5–1.2 mm. long, glabrous; ovary ovoid, 1.8–2.2 mm. long, 1.2–1.4 mm. wide, glabrous; style 2–2.8 mm. long, geniculate above base, glabrous, cylindric; stigma with 2 lobes, the lower acute, the upper 1-tubercled, the tubercle papillose; drupe ellipsoid-acute, 4.2–4.6 mm. long, 3–3.2 mm. wide, glabrous, reticulate. (PL. X, FIGS. 11–19.)

DISTRIBUTION: Endemic in the southern part of the Peruvian Andes, Department of Cuzco, between 3800 and 4000 meters altitude.

PERU: CUZCO: Paso de Tres Cruces, Cerro de Cusilluyoc, *Pennell 13821* (TYPE Ch, ISOTYPES GH, Ph); Paucartambo, *Soukup 391* (Ch).

Monnina densecomata is characterized by its densely pubescent habit and conspicuously lax racemes, which are pubescent and have lanceolate bracts toward the apex.

44. **Monnina tomentella** Chodat in Bull. Soc. Bot. Genève II. 25: 210 (1934).

Shrub, branched, the branches divaricate, 2.5–3 mm. in diameter, strongly ligneous, densely canescent-pubescent, the hairs 1–1.2 mm. long, yellow, lax; leaves elliptic or lanceolate, sometimes more or less oblanceolate, 27–82 mm. long, 14–40 mm. wide, obtuse, conspicuously tomentose, entire, the costa prominulous beneath, with 4 or 5 pairs of lateral veins; petioles 2–5 mm. long, concave above, convex beneath, pubescent; inflorescence paniculate, semicorymbose, the axis 10–18 cm. long, canescent-tomentose, the racemes subsessile, with an obtuse apex, 8–10 mm. wide, tomentose, bracteate, the bracts lanceolate, 3–4 mm. long, 0.8–1 mm. wide, acuminate, densely pubescent beneath, 1-nerved; flowers 4.4–4.6 mm. long, the pedicels 1–1.2 mm. long, pubescent; outer sepals free, more or less lanceolate, ciliate, concave, acute, densely pubescent beneath, the two lower ones 2–2.2 mm. long, 1.3–1.4 mm. wide, 3-nerved, the upper one 2.4–3 mm. long, 1.6–1.8 mm. wide, 5-nerved; wings 4.8–5 mm. long, 4–4.2 mm. wide, suborbicular, obtuse at base, 3-nerved, densely pubescent beneath, more or less pubescent within, ciliate; keel 4.8–5 mm. long, 2.5–2.6 mm. wide, orbicular, plicate, glabrous within, obtuse at base, 3- or 4-nerved, glabrous at margin, 3-lobed, the middle lobe obtuse-emarginate; upper petals elongate, spatulate, densely pubescent; stamens 8, the filaments 3.2–3.8 mm. long, pubescent (hairs 1.2–1.5 mm. long, lax, yellow), almost entirely united, the free part 1–1.4 mm. long, glabrous; ovary ovoid, 1.2–1.8 mm. long, 0.6–0.8 mm. wide, glabrous; style 2.5–2.8 mm. long, geniculate, glabrous, cylindric; stigma with 2 lobes, the lower acute, the upper 1-tubercled, the tubercle papillose; drupe more or less ellipsoid, subacute, 4.5–5 mm. long, 2.4–2.6 mm. wide, glabrous, almost truncate at base, reticulate. (Pl. X, figs. 20–28.)

Distribution: In the sierra of northern Perú, Department of Piura, between 2600 and 2700 meters altitude.

PERU: Piura: Above Huancabamba, eastern cordillera, *Weberbauer 6139* (type Ch, isotype GH).

This plant is closely related to *M. densecomata* Chodat, of southern Perú, from which it differs in the following characters: leaves not revolute, the apex more or less attenuate, the racemes ascendent, larger and almost rigid, the upper sepals acute, the wings more or less pubescent within, and the keel glabrous within.

45. **Monnina Herrerae** sp. nov.

Frutex pubescens, ramis 2.8–3 mm. crassis lignosis conspicue pilosis, pilis 0.6–0.8 mm. longis laxis flavescentibus; folia lanceolata 4.5–9 cm. longa 1.5–3 cm. lata basim versus elongato-attenuata apice acuta, supra plus minusve puberula, subtus flavescenti-puberula, integerrima, nervo medio prominulo conspicue puberulo, nervis lateralibus 6 vel 7, petiolo 4.5–7 mm. longo flavescenti-puberulo; racemi simplices vel aggregati plus minusve acuminati 7–10 mm. crassi, rhachi 6–7.8 cm. longa puberula, pedunculo 5–12 mm. longo, bracteis lineari-lanceolatis 3.8–5 mm. longis 1.2–1.4 mm. latis subtus puberulis uninerviis ciliatis; flores 4.8–5.2 mm. longi, pedicello 1–1.2 mm. longo puberulo; sepala exteriora libera lanceolata ciliata concava acuta subtus puberula, duo inferiora 2.8–3 mm. longa 1.5–1.7 mm. lata uninervia, sepalo superiore 3.2–3.5 mm. longo 2–2.2 mm. lato 3–5-nervio; alae 5–5.6 mm. longae 5–5.2 mm. latae obovatae basi obtusae 4- vel 5-nerviae ciliatae utrinque glabrae; carina 5–6 mm. longa 3.2–3.6 mm. lata orbicularis obovata utrinque glabra apice trilobata, lobo mediano obtuso emarginato, lobis lateralibus minoribus obtusiusculis, basi obtusa 3- vel 4-nervia, petalo superiore spathulato utrinque puberulo; stamina 8, filamentis 3.8–4.2 mm. longis, antheris subsessilibus, filamentorum parte libera 0.7–1.4 mm. longa glabra; ovarium 1.2–1.5 mm. longum 0.7–0.9 mm. latum ovatum glabrum; stylus 2.8–3.2 mm. longus geniculatus glaber; stigma apice superiore tuberculatum papillosum apice inferiore acutum; fructus ignotus. (Pl. X, figs. 29–37.)

DISTRIBUTION: Andes of southern Perú, Department of Apurimac, at about 3400 meters altitude.

PERU: APURIMAC: Between Rio Pinkos and Rio Apurimac, June 11, 1911, *Weberbauer 5864* (TYPE GH).

The new species is related to *M. Vargasii* Ferreyra, from which it is distinguished by its conspicuously woody branches, its smaller leaves, which are acute at the apex, its 1-nerved lower sepals, its glabrous ovary, etc. From *M. pachycoma* Chodat, another ally, *M. Herrerae* differs in its larger and acute leaves and its much smaller outer sepals, which are 1-nerved and densely pubescent beneath.

The writer is honored to name this interesting species after Dr. Fortunato L. Herrera, the late distinguished Professor of Botany at the Universities of Cuzco and San Marcos, whose unremitting efforts toward making known the flora of Cuzco are appreciated by his many colleagues.

46. **Monnina pachycoma** Chodat in Bull. Soc. Bot. Genève II. **25**: 220 (1934).

Shrub, to 20 dm. high, branched, the branches 2–3.5 mm. in diameter, densely pubescent, the hairs 0.8–1.2 mm. long, yellow, lax; leaves lanceolate, sometimes more or less elliptic, 18–60 mm. long, 8–21 mm. wide, obtuse, rarely slightly mucronate, pubescent above, becoming glabrescent, conspicuously pubescent beneath, entire, rarely slightly revolute, the costa prominulous beneath, with 5 or 6 pairs of lateral veins; petioles 2.5–4.5 mm. long, concave above, convex beneath, pubescent; stipules densely hirsute; racemes aggregated, sometimes simple, terminal, almost conical, acute, 11–16 mm. wide, subsessile, the axis 3.5–10 cm. long, densely pubescent, bracteate, the bracts linear-lanceolate, conspicuous, 5–6.5 mm. long, 0.4–0.5 mm. wide, acuminate, pubescent beneath, ciliate, 1-nerved, deciduous; flowers 6–6.8 mm. long, the pedicels 1.5–2 mm. long, pubescent; outer sepals free, lanceolate, ciliate, concave, glabrous beneath, the two lower ones 5.6–6.8 mm. long, 2.3–2.6 mm. wide, 3-nerved, the apex involute, acute, the upper one 6–7 mm. long, 2.8–3 mm. wide, 5–7-nerved, obtuse, the apex slightly involute; wings deep blue, 6.5–7 mm. long, 5.5–6.4 mm. wide, almost elliptic, obtuse at base, 3-nerved, rarely 4- or 5-nerved, glabrous, ciliate at the base; keel yellow, 6–8 mm. long, 3.8–4 mm. wide, orbicular, plicate, glabrous within, obtuse at base, 3–5-nerved, ciliate at base, 3-lobed, the middle lobe obtuse-emarginate, larger; upper petals spatulate, pubescent; stamens 8, the filaments 4.6–5 mm. long, pubescent, almost entirely united, the free part 1–1.5 mm. long, glabrous; ovary ovoid, 2–2.2 mm. long, 1.4–1.5 mm. wide, glabrous; style 2.8–3 mm. long, geniculate above base, glabrous, cylindric; stigma with 2 lobes, the lower acute, the upper 1-tubercled, the tubercle papillose; drupe ellipsoid, 6–9 mm. long, 3.5–5 mm. wide, glabrous, more or less reticulate. (PL. X, FIGS. 38–46.)

DISTRIBUTION: Southeastern part of the Peruvian Andes, Department of Cuzco, between 3500 and 3900 meters altitude.

PERU: CUZCO: Paso de Tres Cruces, Cerro de Cusilluyoc, *Pennell 13834* (ISOTYPES Ch, GH, Ph), *13823* (Ch, GH, NY, Ph, US); Acanacu Pass, Province of Paucartambo, *West 7036* (GH, UC).

The conspicuous outer sepals with their strongly involute apex characterize this species.

EXCLUDED SPECIES

Monnina calophylla Poepp. & Endl. Nov. Gen. ac Sp. 3: 66 (1835) = **Securidaca Corytholobium** A. W. Benn.

DOUBTFUL SPECIES

Monnina polygaloides Chodat in Mém. Soc. Phys. Hist. Nat. Genève, Suppl. 7: *t. 9, f. 5*(1891).

The cited figure illustrates a pistil, but I have been able to find no subsequent mention of this binomial.

Monnina nitida Chodat in Bull. Herb. Boiss. 3: 130 (1895).

This species, based upon a specimen collected by Pavón in Perú, without other locality, cannot be placed from the description alone. Concerning it, Chodat writes: "Racemi elongati, bracteis et foliis nitidis primo aspectu cognoscenda."

Monnina rugosa Chodat in Bull. Herb. Boiss. 4: 251 (1896).

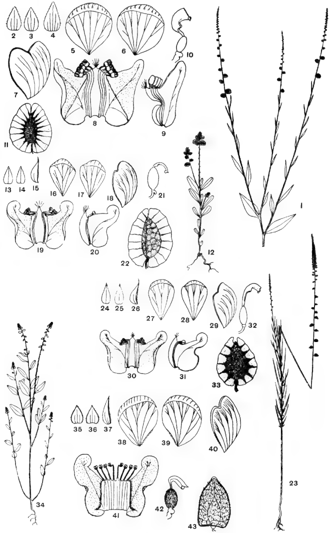
I am unable accurately to place this species, which is based upon a plant collected in Perú (without other data). The author writes: "Indumento affinis *M. Rusbyi* Chod. differt alis haud distincte unguiculatis, antheris distincte petiolatis, habitu robustiore, etiam affinis *M. cariocarpae* St-Hil., differt foliis irregulariter denticulatis et indumento crassiore."

Universidad Mayor de San Marcos,
Lima, Perú

EXPLANATION OF PLATES

PLATE I

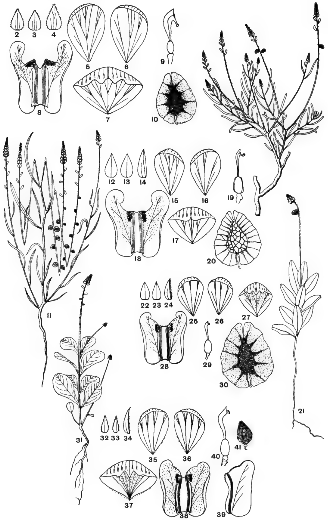
FIGS. 1–11. *Monnina pterocarpa* R. & P. (*Macbride 2874*): 1. habit, × ½; 2, 3. lower sepals, × 8; 4. upper sepal, × 8; 5, 6. wings, × 8; 7. keel, × 8; 8, 9. androecium and upper petals, × 8; 10. ovary and style, × 8; 11. samara, × 4. FIGS. 12–22. *Monnina amarella* Chodat (*Pennell 13629*): 12. habit, × 1; 13, 14. lower sepals, × 8; 15. upper sepal, × 8; 16, 17. wings, × 8; 18. keel, × 8; 19, 20. androecium and upper petals, × 8; 21. ovary and style, × 8; 22. samara, × 8. FIGS. 23–33. *Monnina filifolia* Chodat (*Weberbauer 6454*): 23. habit, × ½; 24, 25. lower sepals, × 8; 26. upper sepal, × 8; 27, 28. wings, × 8; 29. keel, × 8; 30, 31. androecium and upper petals, × 8; 32. ovary and style, × 8; 33. samara, × 6. FIGS. 34–43. *Monnina herbacea* DC. (*Macbride 3181*): 34. habit, × ½; 35, 36. lower sepals, × 8; 37. upper sepal, × 8; 38, 39. wings, × 8; 40. keel, × 8; 41. androecium and upper petals, × 8; 42. ovary and style, × 8; 43. fruit, × 8.



THE PERUVIAN SPECIES OF MONNINA

Plate II

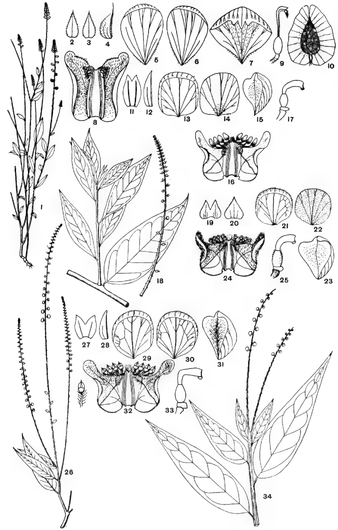
Figs. 1–10. *Monnina ramosa* Johnston (*Hinkley 13*): 1. habit, × 1; 2, 3. lower sepals, × 8; 4. upper sepal, × 8; 5, 6. wings, × 8; 7. keel, × 8; 8. androecium and upper petals, × 8; 9. ovary and style, × 8; 10. samara, × 8. Figs. 11–20. *Monnina Macbridei* Chodat (*Pennell 13110*): 11. habit, × 1; 12, 13. lower sepals, × 8; 14. upper sepal, × 8; 15, 16. wings, × 8; 17. keel, × 8; 18. androecium and upper petals, × 8; 19. ovary and style, × 8; 20. samara, × 8. Figs. 21–30. *Monnina arenicola* Ferreyra (*Mexia 4175*): 21. habit, × 1; 22, 23. lower sepals, × 8; 24. upper sepal, × 8; 25, 26. wings, × 8; 27. keel, × 8; 28. androecium and upper petals, × 8; 29. ovary and style, × 8; 30. samara, × 8. Figs. 31–41. *Monnina Weberbaueri* Chodat (*Grant 7440*): 31. habit, × 1; 32, 33. lower sepals, × 8; 34. upper sepal, × 8; 35, 36. wings, × 8; 37. keel, × 8; 38, 39. androecium and upper petals, × 8; 40. ovary and style, × 8; 41. fruit, × 8.



THE PERUVIAN SPECIES OF MONNINA

PLATE III

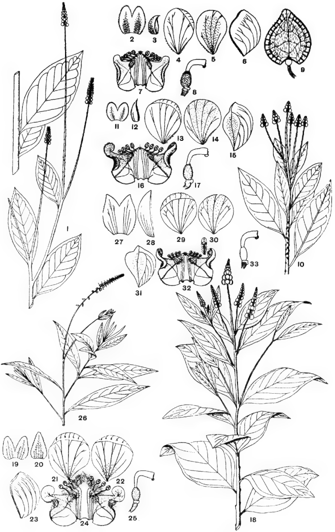
FIGS. 1–10. *Monnina macrostachya* R. & P. (*Pennell 14436*): 1. habit, × ½; 2, 3. lower sepals, × 8; 4. upper sepal, × 8; 5, 6. wings, × 8; 7. keel, × 8; 8. androecium and upper petals, × 8; 9. ovary and style, × 8; 10. samara, × 8. FIGS. 11–17. *Monnina longibracteata* Chodat (*Mathews 2075*): 11. lower sepals, × 8; 12. upper sepal, × 8; 13, 14. wings, × 8; 15. keel, × 8; 16. androecium and upper petals, × 8; 17. ovary and style × 8. FIGS. 18–25. *Monnina longibracteata* var. *ainensis* Chodat (*Killip & Smith 23188*): 18. habit, × ½; 19. lower sepals, × 6; 20. upper sepal, × 6; 21, 22. wings, × 6; 23. keel, × 6; 24. androecium and upper petals, × 6; 25. ovary and style, × 6. FIGS. 26–33. *Monnina huallagensis* Chodat (*Weberbauer 6805*): 26. habit, × ½; 27. lower sepals, × 8; 28. upper sepal, × 8; 29, 30. wings, × 8; 31. keel, × 8; 32. androecium and upper petals, × 8; 33. ovary and style, × 8. FIG. 34. *Monnina huallagensis* var. *pachyphylla* Chodat (*Macbride 4786*): habit, × 1.



The Peruvian Species of Monnina

Plate IV

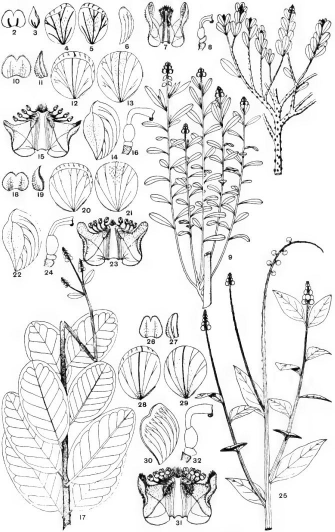
FIGS. 1–9. *Monnina glabrifolia* Ferreyra (*Metcalf 30661*): 1. habit, × ⅔; 2. lower sepals, × 6; 3. upper sepal, × 6; 4, 5. wings, × 6; 6. keel, × 6; 7. androecium and upper petals, × 6; 8. ovary and style, × 6; 9. drupe, × 6. FIGS. 10–17. *Monnina marginata* Presl (*Kanehira 190*): 10. habit, × 1; 11. lower sepals, × 6; 12. upper sepal, × 6; 13, 14. wings, × 6; 15. keel, × 6; 16. androecium and upper petals, × 6; 17. ovary and style, × 6. FIGS. 18–25. *Monnina pseudo-salicifolia* Ferreyra (*Weberbauer 6055*): 18. habit, × 1; 19. lower sepals, × 6; 20. upper sepal, × 6; 21, 22. wings, × 6; 23. keel, × 6; 24. androecium and upper petals, × 6; 25. ovary and style, × 6. FIGS. 26–33. *Monnina macrosepala* Chodat (*C. Schunke 487*): 26. habit, × ⅔; 27. lower sepals, × 6; 28. upper sepal, × 6; 29, 30. wings, × 6; 31. keel, × 6; 32. androecium and upper petals, × 6; 33. ovary and style, × 6.



The Peruvian Species of Monnina

PLATE V

FIGS. 1–8. *Monnina Vitis-Idaea* Chodat (*Weberbauer 6129*): 1. habit, × 1; 2. lower sepals, × 6; 3. upper sepal, × 6; 4, 5. wings, × 6; 6. keel, × 6; 7. androecium and upper petals, × 6; 8. ovary and style, × 6. FIGS. 9–16. *Monnina conferta* R. & P. (*Weberbauer 5488*): 9. habit, × 1; 10. lower sepals, × 6; 11. upper sepal, × 6; 12, 13. wings, × 6; 14. keel, × 6; 15. androecium and upper petals, × 6; 16. ovary and style, × 6. FIGS. 17–24. *Monnina stipulata* Chodat (*Metcalf 30511*): 17. habit, × 1; 18. lower sepals, × 6; 19. upper sepal, × 6; 20, 21. wings, × 6; 22. keel, × 6; 23. androecium and upper petals, × 6; 24. ovary and style, × 6. FIGS. 25–32. *Monnina canescens* Ferreyra (*Pennell 14376*): 25. habit, × 1; 26. lower sepals, × 6; 27. upper sepal, × 6; 28, 29. wings, × 6; 30. keel, × 6; 31. androecium and upper petals, × 6; 32. ovary and style, × 6.



THE PERUVIAN SPECIES OF MONNINA

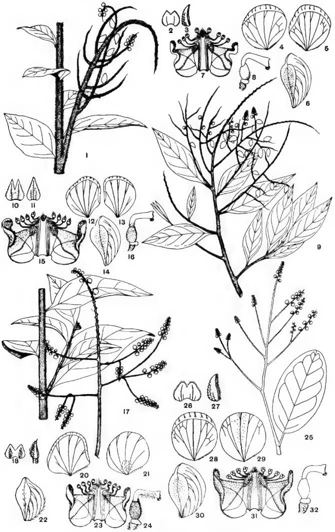
PLATE VI

FIGS. 1–8. *Monnina divaristachya* Ferreyra (*Killip & Smith 25778*): 1. habit, × ½; 2. lower sepals, × 6; 3. upper sepal, × 6; 4, 5. wings, × 6; 6. keel, × 6; 7. androecium and upper petals, × 6; 8. ovary and style, × 6. FIGS. 9–16. *Monnina callimorpha* Chodat (*Killip & Smith 24421*): 9. habit, × 1; 10. lower sepals, × 6; 11. upper sepal, × 6; 12, 13. wings, × 6; 14. keel, × 6; 15. androecium and upper petals, × 6; 16. ovary and style, × 6. FIGS. 17–24. *Monnina ovata* Ferreyra (*Macbride 4493*): 17. habit, × 1; 18. lower sepals, × 6; 19. upper sepal, × 6; 20, 21. wings, × 6; 22. keel × 6; 23. androecium and upper petals, × 6; 24. ovary and style, × 6.

The Peruvian Species of Monnina

Plate VII

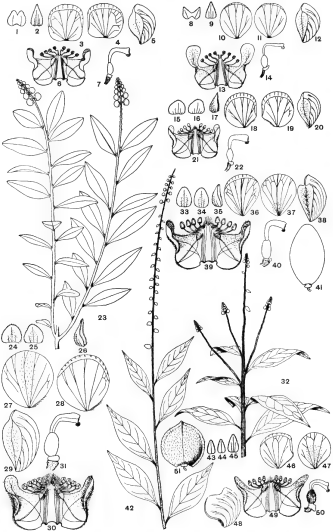
Figs. 1–8. *Monnina polystachya* R. & P. (*Macbride & Featherstone 1848*): 1. habit, × 1; 2. lower sepals, × 6; 3. upper sepal, × 6; 4, 5. wings, × 6; 6. keel, × 6; 7. androecium and upper petals, × 6; 8. ovary and style, × 6. Figs. 9–16. *Monnina Pavoni* Chodat (*Macbride 4124*): 9. habit, × 1; 10. lower sepals, × 6; 11. upper sepal, × 6; 12, 13. wings, × 6; 14. keel, ×6; 15. androecium and upper petals, × 6; 16. ovary and style, × 6. Figs. 17–24. *Monnina pseudo-polystachya* Chodat (*Macbride 4317*): 17. habit, × 1; 18. lower sepals, × 6; 19. upper sepal, × 6; 20, 21. wings, × 6; 22. keel, × 6; 23. androecium and upper petals, × 6; 24. ovary and style, × 6. Figs. 25–32. *Monnina connectisepala* Chodat (*Pennell 13977*): 25. habit, × 1; 26. lower sepals, × 6; 27. upper sepal, × 6; 28, 29. wings, × 6; 30. keel, × 6; 31. androecium and upper petals, × 6; 32. ovary and style, × 6.



THE PERUVIAN SPECIES OF MONNINA

Plate VIII

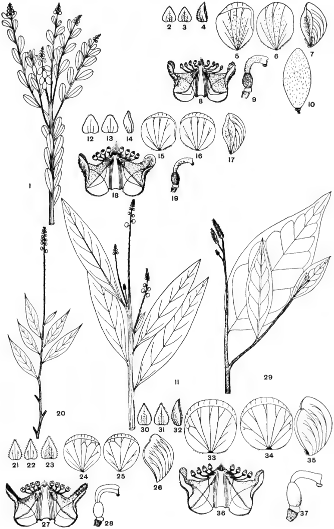
Figs. 1–7. *Monnina Lechleriana* Chodat (*Lechler 2072*): 1. lower sepals, × 6; 2. upper sepal, × 6; 3, 4. wings, × 6; 5. keel, × 6; 6. androecium and upper petals, × 6; 7. ovary and style, × 6. Figs. 8–14. *Monnina Clarkeana* Chodat (*Mathews 1192*): 8. lower sepals, × 6; 9. upper sepal, × 6; 10, 11. wings, × 6; 12. keel, × 6; 13. androecium and upper petals, × 6; 14. ovary and style, × 6. Figs. 15–22. *Monnina ligustrifolia* H.B.K. (*Bonpland 3491*): 15, 16. lower sepals, × 6; 17. upper sepal, × 6; 18, 19. wings, × 6; 20. keel, × 6; 21. androecium and upper petals, × 6; 22. ovary and style, × 6. Figs. 23–31. *Monnina salicifolia* R. & P. (*Stork & Horton 9375*): 23. habit, × 1; 24, 25. lower sepals, × 6; 26. upper sepal, × 6; 27, 28. wings, × 6; 29. keel, × 6; 30. androecium and upper petals, × 6; 31. ovary and style, × 6. Figs. 32–41. *Monnina hirtella* Ferreyra (*Klug 3337*): 32. habit, × 1; 33, 34. lower sepals, × 6; 35. upper sepal, × 6; 36, 37. wings, × 6; 38. keel, × 6; 39. androecium and upper petals, × 6; 40. ovary and style, × 6; 41. drupe, × 6. Figs. 42–51. *Monnina cyanea* Chodat (*Weberbauer 7835*): 42. habit, × 1; 43, 44. lower sepals, × 6; 45. upper sepal, × 6; 46, 47. wings, × 6; 48. keel, × 6; 49. androecium and upper petals, × 6; 50. ovary and style, × 6; 51. fruit, × 6.



THE PERUVIAN SPECIES OF MONNINA

Plate IX

Figs. 1–10. *Monnina decurrens* Ferreyra (*Weberbauer 6100*): 1. habit, × 1; 2, 3. lower sepals, × 6; 4. upper sepal, × 6; 5, 6. wings, × 6; 7. keel, × 6; 8. androecium and upper petals, × 6; 9. ovary and style, × 6; 10. drupe, × 6. Figs. 11–19. *Monnina peruviana* Chodat (*Mathews* without number): 11. habit, × 1; 12, 13. lower sepals, × 6; 14. upper sepal, × 6; 15, 16. wings, × 6; 17. keel, × 6; 18. androecium and upper petals, × 6; 19. ovary and style, × 6. Figs. 20–28. *Monnina acutifolia* Chodat (*Killip & Smith 22448*): 20. habit, × 1; 21, 22. lower sepals, × 6; 23. upper sepal, × 6; 24, 25. wings, × 6; 26. keel, × 6; 27. androecium and upper petals, × 6; 28. ovary and style, × 6. Figs. 29–37. *Monnina Vargasii* Ferreyra (*Vargas 771*): 29. habit, × 1; 30, 31. lower sepals, × 6; 32. upper sepal, × 6; 33, 34. wings, × 6; 35. keel, × 6; 36. androecium and upper petals, × 6; 37. ovary and style, × 6.



THE PERUVIAN SPECIES OF MONNINA

PLATE X

FIGS. 1–10. *Monnina pilosa* var. *glabrescens* Ferreyra (*Stork 11425*): 1. habit, × ½; 2, 3. lower sepals, × 6; 4. upper sepal, × 6; 5, 6. wings, × 6; 7. keel, × 6; 8. androecium and upper petals, × 6; 9. ovary and style, × 6; 10. bract, × 6. FIGS. 11–19. *Monnina densecomata* Chodat (*Pennell 13821*): 11. habit, × 1; 12, 13. lower sepals, × 6; 14. upper sepal, × 6; 15, 16. wings, × 6; 17. keel, × 6; 18. androecium and upper petals, × 6; 19. ovary and style, × 6. FIGS. 20–28. *Monnina tomentella* Chodat (*Weberbauer 6139*): 20. habit, × ½; 21, 22. lower sepals, × 6; 23. upper sepal, × 6; 24, 25. wings, × 6; 26. keel, × 6; 27. androecium and upper petals, × 6; 28. ovary and style, × 6. FIGS. 29–37. *Monnina Herrerae* Ferreyra (*Weberbauer 5864*): 29. habit, × 1; 30, 31. lower sepals, × 6; 32. upper sepal, × 6; 33, 34. wings, × 6; 35. keel, × 6; 36. androecium and upper petals, × 6; 37. ovary and style, × 6. FIGS. 38–46. *Monnina pachycoma* Chodat (*Pennell 13834*): 38. habit, × 1; 39, 40. lower sepals, × 6; 41. upper sepal, × 6; 42, 43. wings, × 6; 44. keel, × 6; 45. androecium and upper petals, × 6; 46. ovary and style, × 6.

THE PERUVIAN SPECIES OF MONNINA

NOTES ON SOME CULTIVATED TREES AND SHRUBS, III*

ALFRED REHDER

Chamaecyparis Lawsoniana (A. Murr.) Parl. f. **glaucescens** [Otto], comb. nov.

Cupressus Lawsoniana erecta glaucescens Sieb. ex [Otto in] Hamburg. Gart.- & Blumenzeit. **24:** 141 (1868), non *C. L.* var. *erecta* Jäger (1865).

Cupressus Lawsoniana erecta glauca R. Smith, Pl. Fir Tribe, 15 [1874?].

Chamaecyparis Lawsoniana var. *erecta glauca* Beissner in Jäger & Beissner, Ziergeh. ed. 2, 451 (1884). — Schneider in Silva Tarouca, Uns. Freil.-Nadelh. 168 (1913) "var. *pyramidalis* f. *e.* subf. *g.*" — Non *C. L.* var. *erecta* (Jäg.) Schneid. (1913).

Chamaecyparis Lawsoniana erecta glaucifolia Sudworth in U. S. Dept. Agric. For. Serv. Bull. **14:** 83 (Nomencl. Arb. Fl. U. S.) (1897).

Chamaecyparis Lawsoniana var. ***monumentalis nova*** [hort. ex] Schneider in Silva Tarouca, Uns. Freil.-Nadelh. 168 (1913), pro syn.

Chamaecyparis Lawsoniana var. *erecta-glauca* Rehder, Man. Cult. Trees Shrubs, 18 (1927).

The varietal epithet *"glaucescens,"* published by Otto in 1868 in a quaternary combination, is apparently the oldest available epithet for this form; the other epithet, *"erecta,"* is preoccupied by *erecta* in the combination *Cupressus Lawsoniana* var. *erecta* Jäger, Ziergeh. 200 (1865).

Corylaceae Mirbel, Elém. Phys. Vég. **2:** 906 (1815), exclud. *Fagus;* emend. — Fernald in Rhodora, **47:** 303 (1945), nom.

Amentaceae P. F. Gmelin, Otia Bot. 49, 90 (1760), p. p.

Betulaceae Bartling, Ord. Nat. Pl. 99 (1830), sensu stricto. — Horaninov, Prim. Lin. Syst. Nat. 63 (1834), sensu stricto. — A. Br. in Ascherson, Fl. Prov. Brandenb. 618 (1864). — Winkler in Engler, Pflanzenreich, IV. 61(Heft 19): 1–149, *fig. 1–28, t. 1–2* (1904).

Trib. I. **Betuleae** [Dumort.], comb. nov.

Salicineae Mirbel, Elém. Phys. Vég. **2:** 905 (1815), p. p. quoad sect. II.

Amentaceae b. *Betulaceae* C. A. Agardh, Aphor. Bot. 208 (1825). — Dumortier in Bijdr. Natuurk. Wetensch. **1:** 45 (Verh. Wilg. 4) (1825) "Afd. 1."; Florula Belg. 11 (1827) "trib. *Betuleae*."

Betulaceae Bartling, Ord. Nat. Pl. 99 (1830), sensu stricto. — Regel in Nouv. Mém. Soc. Nat. Moscou, **13,**2: 63 (Monog. Betul. 5) (1861).

Xylophyta 1. *Betuleae* Döll, Erklär. Laubkn. Ament. 10 (1848).

Betulaceae trib. *Betuleae* Ascherson, Fl. Prov. Brandenb. 619 (1864). — Winkler in Engler, Pflanzenreich, IV. **61**(Heft 19): 56 (1904).

Castanacées I. *Betuleae* Baillon, Hist. Pl. **6:** 254 (1877).

Cupuliferae trib. I. *Betuleae* Bentham & Hooker f., Gen. Pl. **3:** 403 (1880).

Betulaceae trib. *Alneae* et *Betuleae* Nakai, Fl. Sylv. Kor. **2:** 7 (1915).

Trib. II. **Coryleae** (Meissn.), comb. nov.

Corylaceae Mirbel, Elém. Phys. Vég. **2:** 906 (1815), exclud. *Fagus.* — Horaninov, Prim. Lin. Syst. Nat. 63 (1834), p. p. typ. — Lindley, Veg. Kingd. 290 (1846), p. p. typ. — A. de Candolle in De Candolle, Prodr. **16,**2: 124 (1864).

Amentaceae d. *Corylaceae* Agardh, Aphor. Bot. 208 (1825), p. p. quoad *Corylus.*

Cupuliferae trib. *Corylaceae* Dumortier, Florula Belg. 14 (1827). — Meissner, Pl. Vasc. Gen. **1:** 346 [1842] "trib. *Coryleae*."

Xylophyta 2. *Carpineae* Döll, Erklär. Laubkn. Ament. 15 (1848) "Carpineen."

* For nos. I and II see vol. **26**, pp. 67 and 472.

Betulaceae trib. *Coryleae* Ascherson, Fl. Prov. Brandenb. 618 (1864).
Corylaceae trib. *Carpineae* et trib. *Coryleae* A. de Candolle in De Candolle, Prodr. 16,2: 124, 128 (1864).
Castanacées II. *Coryleae* Baillon, Hist. Pl. 6: 255 (1877).
Betulaceae trib. *Coryleae* (Meissn.) et trib. *Carpineae* (Döll) Nakai, Fl. Sylv. Kor. 2: 7 (1915).

As is shown by the synonymy given above, the oldest name for the family called Betulaceae should bear, according to the rules of priority, the name Corylaceae, as called recently by Fernald, though without any explanation or reference to earlier publications. The first author to unite the group published in 1815 by Mirbel as Corylaceae and that published in 1830 by Bartling as Betulaceae was apparently A. Braun, in Ascherson in 1864 (l.c.), who unfortunately chose Bartling's later name as the name for the amplified family, possibly because Mirbel had included *Fagus* in his Corylaceae, although the name shows that the family is based on *Corylus*. The acceptance of Corylaceae as the name of the family makes necessary new combinations for the two tribes into which this family is usually divided.

Amelanchier arborea (Michx. f.) Fern. f. **nuda** (Palmer & Steyerm.), comb. nov.
Amelanchier canadensis f. *nuda* Palmer & Steyermark in Ann. Mo. Bot. Gard. 25: 772 (1938).

As Fernald has shown (in Rhodora, **43**: 563, *t. 672, fig. 2.* 1941), the oldest specific epithet for the *Amelanchier* generally called *A. canadensis* is "*arborea*" (*Mespilus arborea* Michx. f.). Therefore, the above new combination becomes necessary for the form with glabrous leaves of this species, described as *A. canadensis* f. *nuda* by Palmer & Steyermark, of which we have collections ranging from W. Virginia to Illinois, Kansas, and Oklahoma.

Pyrus macropoda Rehder, nom. nov.
Pyrus longipes Cosson & Durieu in Bull. Soc. Bot. France, 2: 310 (1855). — Trabut in Bull. Stat. Recherch. For. N. Afr. 1: 116, *fig. 1, t. 4* (Poir. Indig. Afr.) (1916) "*Pirus.*" — Non Poiteau & Turpin [1808].
Malus longipes Wenzig in Jahrb. Bot. Gart. Mus. Berlin, 2: 292 (1883).

The existence of an earlier homonym of *P. longipes* Coss. & Dur. makes necessary a new name for that species. Though the older homonym is based on a pomological form of *P. communis* and has never been taken up as a valid name by any later author, it has been validly published with a complete description and a colored plate as *P. longipes* Poiteau & Turpin in Duhamel, Traité des arbres fruitiers, nouv. éd. 4: *P.* no. 22; *t. 57*, fasc. 10 [1808], and cannot be rejected under the Rules of Botanical Nomenclature. In Index Kewensis, unfortunately, the names proposed by Poiteau & Turpin have not been correctly cited; they are credited to a later edition of Duhamel's work which was published by Poiteau under the title Pomologie française from 1838–46 in four volumes. The fact that Wenzig transferred *P. longipes* Cosson & Durieu together with *P. betulaefolia* Bge. to *Malus* shows that Wenzig had no clear concept of the characters of the genera of the Pomoideae; this is shown even more strikingly by his referring *Chaenomeles sinensis* (Dum.-Cours.) Koehne as a variety to *P. communis L.*

Rosa multiflora f. roseiflora (Focke), f. nova.

Rosa multiflora v. *roseiflora* Focke ex Baenitz, Herb. Dendrol. in sched. (coll. 1902).
Rosa multiflora var. *Dawsoniana* hort. Rochester (Highland Park, Rochester, N. York).

CULTIVATED SPECIMENS: Breslau, Germany, Scheitniger Park, coll. *C. Baenitz,* July 9 and Aug. 8, 1902; Highland Park, Rochester, N. Y., *Wm. L. G. Edson,* June 14 and Oct. 11, 1922.

A typo speciei differt praecipue floribus semiplenis pallide roseis; folia 2.5–6 cm. longa, subtus sparse pubescentia; pedicelli glabri, sparse stipitato-glandulosi; ovarium glabrum vel fere glabrum; sepala extus pubescentia et stipitato-glandulosa, intus dense villosa; flores semipleni 2–3 cm. diam.; styli glabri.

Between the two specimens cited above, I can see no difference except that the flowers of the specimen from Rochester are somewhat smaller, about 2–2.5 cm. wide, while in the other specimen they are up to 3 cm. wide. The rose known as *R. multiflora* var. *carnea* Thory, introduced about 140 years ago, differs in its larger, fully double, deeper pink flowers, more densely pubescent leaves, and pubescent pedicels. The origin of the form described above is not known; the plant cultivated in Rochester is supposed to have come from the Arnold Arboretum about thirty years ago, but no such plant is now growing at that institution nor can any record of it be found.

Prunus avium f. mamillaris (Ser.), comb. nov.

Cerasus decumana M. D. L. [Mordant de Launay] in Bon Jard. 1808: 103 (1808). — Seringe in De Candolle, Prodr. 2: 536 (1825), pro syn.
Cerasus nicotianaefolia Mordant de Launay, l. c. (1808) "*nicotinaefolia,*" pro syn. — Hort. ex Seringe, l. c. (1825), pro syn.
Prunus macrophylla Poiret, Encycl. Méth. Bot. Suppl. 4: 584 (1816).
Cerasus duracina γ. *mamillaris* Seringe in De Candolle, Prodr. 2: 536 (1825).
Cerasus bigarella rostrata Poiteau & Turpin in Duhamel, Traité Arb. Fruit. nouv. éd., 2: *C.* no. 13; *t. 377,* fasc. 47 [1828]. — Poiteau, Pomol. Franç. 2: *C.* no. 10, p. 161, *t. 377* (18 [38–] 46).
Prunus nicotianaefolia Loiseleur ex Steudel, Nomencl. Bot. ed. 2, 2: 403 (1841), pro syn.
Prunus avium f. *decumana* Schneider, Ill. Handb. Laubh. 1: 616 (1906, May). — Ascherson & Graebner, Syn. Mitteleur. Fl. 6, 2: 152 (1906, Nov.) "*P. a.* B. I. b. *d.*"

As Schneider's combination under *P. avium* is not based on the oldest subspecific epithet, the combination proposed above becomes necessary. It may also here be pointed out that Poiret's name, *Prunus macrophylla*, of 1816 invalidates the later homonym *P. macrophylla* Sieb. & Zucc. of 1843, which has to receive a new name since it has no synonym to take its place.

Prunus Gondouini [*P. avium* × *Cerasus*] (Poit. & Turpin), comb. nov.

Cerasus sativa multifera Poiteau & Turpin in Duhamel, Traité Arb. Fruit. nouv. éd., 2: *C.* no. 28, *t. 3,* fasc. 1 [1807] non *Prunus sativa* Rouy & Camus (1900).
Cerasus Gondouini Poiteau & Turpin in op. cit., *C.* no. 29; *t. 66,* fasc. 11 [1808] "*Gundouini.*" — Poiteau, Pomol. Franç. 2: *C.* no. 27; p. 127, *t. 66* (18 [38–] 46).

Cerasus regalis praecox Poiteau & Turpin in op. cit. *C.* no. 26, *t. 123,* no. 2, fasc. 21 [1811].

Cerasus anglica praecox Poiteau & Turpin in op. cit., *C.* no. 27, *t. 132,* fasc. 22? [1811].

Cerasus regalis communis et *C. r. serotina* Poiteau & Turpin in op. cit., *C.* no. 24, *t. 196,* no. 25, p. 197, fasc. 33 [1826].

?*Cerasus effusa* Host, Fl. Austr. 2: 6 (1831).

Prunus Cerasus δ. *Aproniana* Schübler & Martens, Fl. Würtemb. 313 (1834).

Cerasus caprioniana κ. *regalis* Roemer, Fam. Nat. Reg. Veg. Syn. 3: 74 (1847).

Prunus aproniana Beck, Fl. Nieder-Oester. 820 (1892).

Prunus avium var. *regalis* Bailey, Cycl. Am. Hort. [3]: 1453 (1901).

Prunus effusa (Host) Schneider, Ill. Handb. Laubh. 1: 616 (1906, May).

Prunus Cerasus × *avium* Ascherson & Graebner, Syn. Mitteleur. Fl. 6, 2: 153 (1906, Nov.).

Prunus avium × *Cerasus* Hedrick, Cherries New York, 31, *t.* (1915).

For the group of hybrids between *Prunus avium* and *P. Cerasus* known as Duke Cherries, the name *Prunus effusa* (Host) Schneid. has been used by recent authors as a binary name based on *Cerasus effusa* Host. There are, however, several older Latin binomials used for different forms of this hybrid by Poiteau & Turpin between 1807 and 1826 which have been generally overlooked; in Index Kewensis they are ascribed to Poiteau, Pomologie française (1838–46), which is a later edition under a new title of Poiteau & Turpin's edition of Traité des arbres fruitiers by Duhamel. The much enlarged edition by Poiteau & Turpin was published in 71 fascicles between 1807 and 1835, but the text and plates were rearranged according to genera and published finally in six volumes, all bearing the date 1835.

As the synonymy given above shows, the oldest binomial is *Cerasus sativa,* but its specific epithet cannot be transferred to *Prunus* on account of *P. sativa* Rouy & Camus (Fl. Franç 6: 4. 1900), a name proposed to include as subspecies *P. domestica, P. ambigua,* and *P. insititia.* The next oldest name, *Cerasus Gondouini,* is based on "Belle de Choisy," a well-known form and one of the best of the Duke Cherries (cf. Hedrick, Cherries New York, 116. 1915), representing one of the forms of the hybrid *P. avium* × *P. Cerasus.*

According to Poiteau & Turpin (l.c.) this hybrid was raised about 1760 by Gondouin, gardener of the royal gardens at Choisy near Paris. As Poiteau & Turpin apparently intended to name this cherry in honor of its raiser, Gondouin, it must be assumed that the spelling *C. Gundouini* is a mistake and the name should be *C. Gondouini,* as later spelled by Poiteau (l.c.).

Vitis acerifolia Rafinesque, Med. Fl. 2: 130, *t. 99, fig. C* (1830, pref. May); Am. Man. Grape Vines, 14, *fig. 3* (1830).

Vitis Longii Prince, Treat. Vine, 184 (1830), copyright Sept. 20. — Rehder, Man. Cult. Trees Shrubs, 602 (1927) "? *V. rupestris* × *arizonica.*" — Bailey in Gent. Herb. 3: 228, *fig. 103, 121* (1934).

Vitis rubra var. *Solonis* Planchon, Vignes Amér. 118 (1875).

Vitis Solonis Hort. Berol. ex Planchon, op. cit. 119 (1875), pro syn. — Planchon ex Rehder, Man. Cult. Trees Shrubs, 602 (1927), pro syn.

Vitis Nuevo Mexicana Lemmon ex Munson in Trans. Am. Hort. Soc. 3: 132 (1885). — Munson in Wine & Fruit Grower, 7: 85 (1885).

Vitis novo-mexicana Munson in Proc. Soc. Prom. Agric. Sci. 1887: 59 (1887), "*Novo Mexicana*."—Foëx, Cours Compl. Vitic. éd. 2, 876 (1888), "*Novo-Mexicana*."—Bailey in Gent. Herb. 3: 228 (1934).

In the discussion under *Vitis Longii* regarding the priority of the names *V. Longii* and *V. acerifolia*, Bailey (l.c.) makes the following statement: "As both *Longii* and *acerifolia* were published in 1830, one cannot choose between them by priority. One description is about as good as the other, but Prince had the plant in fruit. Inasmuch as the name *Longii* has been adopted for many years it may be retained."

However, there can be hardly any doubt that Rafinesque's publication has priority, for the preface is dated May, 1830; the copyright date of Prince's Treatise is September 20 of the same year. The American Manual of the Grape Vines by Rafinesque, with the exception of a few slight changes and corrections, is an exact reprint apparently from the same type (pp. 121–180) of his Medical Flora, vol. 2, and issued soon after. The references in the text of the Manual to the figures of the two plates give both the letters used in the Medical Flora and the numerals used in the Manual; also the mistake in the Medical Flora of calling fig. G "*V. multiflora*" is corrected in the Manual to *V. multiloba*.

Pieris japonica (Thunb.) D. Don f. **crispa**, f. nova.

A typo recedit foliis insigniter crispato-undulatis, acumine plus minusve torto, 5–7 cm. longis et 1–1.8 cm. latis.

CULTIVATED: Garden of Carl S. English, Jr., Seattle, Washington, coll. December 31, 1945 (Herb. Arnold Arb.).

The strongly undulate crispate margin of the leaves gives this form a rather striking appearance and makes the foliage look denser and more attractive.

Fraxinus sect. **Fraxinaster** DC. subsect. **Petlomelia** (Nieuwl.), comb. nov.

Fraxinus sect. *Fraxinaster* subsect. *Dipetalae* Lingelsheim in Bot. Jahrb. 40: 215 (1907).

Petlomelia Nieuwland in Am. Midland Nat. 3: 187 (1914).

The subdivision of *Fraxinus* based on *F. dipetala* Hooker & Arnott was first distinguished as a subsect. of the sect. *Fraxinaster* DC. by Lingelsheim (l.c.) and called subsect. *Dipetalae*. As the names of the other subsections are nouns, it seems logical that the names of the coördinated subdivisions should also be nouns. To have the name of coördinated divisions partly nouns and partly adjectives in plural prevents a clear presentation of the grouping of subordinated divisions in a large genus and is against general usage. The Rules of Botanical Nomenclature in this case are rather vague and I therefore proposed about six years ago a change in Art. 26 of the Rules (see Jour. Arnold Arb. 20: 269. 1939) which, I hope, will be considered at the next Botanical Congress and will lead to a modification of that article.

Lavandula officinalis f. **alba** (Gingins-Lass.), comb. nov.

Lavandula vera β. alba de Gingins-Lassaraz, Hist. Nat. Lavandes, 147 (1826).

Lavandula Spica β. alba Sweet, Hort. Brit. 316 (1827), nom. subnud.; non Weston (1770).

Lavandula officinalis f. *albiflora* Rehder in Jour. Arnold Arb. 20: 428 (1939).

When I proposed in 1939 the combination *L. officinalis* f. *albiflora* (l.c.) for the white-flowered form of *L. officinalis* Chaix (*L. spica* L., p.p.), because *L. Spica* β. *alba* Sweet was invalidated by the older homonym *L. Spica* var. *alba* Weston, Bot. Univ. 1: 146 (1770), which is a form of *L. latifolia* Villars, I had not seen the publication of 1826 by Gingins-Lassaraz of *L. vera* β. *alba* which antedates *L. Spica* β. *alba* Sweet and presents the oldest available epithet for the white-flowered form of *L. officinalis*.

Senecio puffini H. H. Allan in litt., nom. nov.

Senecio rotundifolius Hooker f., Fl. Nov.-Zeland. 1: 149 (1853). — Cheeseman, Man. New Zealand Fl., ed. 2 (W. R. B. Oliver), 1026 (1925).—Non Stokes (1812), nec Lapeyrouse (1813).

Brachyglottis rotundifolia Forster f., Char. Gen. Pl. Austral. 92 (1776).

Cineraria rotundifolia Forster f., Fl. Ins. Austral. Prodr. 56 (1786).

The fact that *S. rotundifolius* Hook. f. is antedated by two earlier homonyms, namely *S. rotundifolius* Stokes, Bot. Mat. Med. 4: 215 (1812) = *S. aureus* L., and Lapeyrouse, Hist. Abr. Pl. Pyrén. 517 (1813) = S. *Doronicum* L., makes necessary a new specific epithet. Dr. H. H. Allan, of Wellington, New Zealand, whom I had asked if perhaps some New Zealand botanist had not already proposed a new name for this homonym, suggests that it might be named *Senecio puffini*, since this shrub is a haunt of the mutton bird (*Puffinus griseus*) and is locally known as mutton bird scrub; this proposition has been accepted here.

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A TAXONOMIC REVIEW OF EUPTELEA

A. C. SMITH

With one text-figure

INTRODUCTION

IN STUDIES of the Trochodendraceae and Tetracentraceae, Nast and Bailey (1) and the writer (3) have briefly pointed out some of the fallacies of the commonly accepted inclusion of *Euptelea* in the Trochodendraceae. The purpose of the present paper is to summarize the data pertaining to the nomenclature and taxonomy of the Eupteleaceae. In agreement with van Tieghem and several other students, we have come to the conclusion that *Euptelea* is so isolated that it must logically be placed in a unigeneric family. The genus appears to us to consist of only two species, one Japanese and the other Chinese-Indian. Full citations to the pertinent literature will be found in the bibliography of my earlier paper (3), and the same herbarium abbreviations are here utilized. In the following paper in this Journal, Nast and Bailey (2) discuss the morphology of *Euptelea* and compare it with *Trochodendron*.

TAXONOMIC TREATMENT

Eupteleaceae v. Tiegh. in Jour. de Bot. **14:** 274 (Eupteléacées). 1900; Harms in E. & P. Nat. Pfl. Nachtr. **3:** 111, as synonym. 1906; Hayata in Bot. Mag. Tokyo **39:** (230) (Euptelaeaceae). 1925; Makino & Nemoto, Nippon-Shokubutsu-Sôran (Fl. Jap.) ed. 2. 306. 1931; Wettst. Handb. Syst. Bot. ed. 4. **2:** 686. 1935; Nemoto, Nippon-Shokubutsu-Sôran-Hoi (Fl. Jap. Suppl.) 207. 1936.

Magnoliaceae IV. [sér.] *Eupteleeae* Baill. Hist. Pl. **1:** 191, p. p. (excl. *Trochodendron*). 1868–69.

Eupteléées Parment. in Bull. Sci. Bot. Fr. & Belg. **27:** 175, 318, p. p. (excl. *Trochodendron*). 1896.

Trochodendraceae sensu Lee, For. Bot. China 449. 1935; Chen, Ill. Man. Chin. Trees & Shrubs 257. 1937; non Prantl.

In attempting to ascertain the proper authority for the family Eupteleaceae, one encounters the same problem as in the Tetracentraceae and various other families proposed by van Tieghem in the French spelling only. According to Art. 23 of the International Rules of Botanical Nomenclature (ed. 3. 1935), family names (with specified exceptions) must end in -aceae, and therefore van Tieghem's French names are not validly published. In the case of the Tetracentraceae (3), I proposed to accept van Tieghem's authorship, but perhaps I should be cited as the publishing author for that name. In the same way, the Eupteleaceae might best be referred to the authorship of "van Tieghem ex Hayata," since Hayata's brief note (in Japanese) in 1925 apparently first takes up the family name in the Latin form, citing van Tieghem's treatment of 1900.

Euptelea Sieb. & Zucc. Fl. Jap. **1**: 133. 1841; Endl. Gen. Pl. Suppl. **2**: 29. 1842; Meisn. Pl. Vasc. Gen. Pars Alt. 370. 1843; Lindl. Veg. Kingd. ed. 2. 580. 1847, ed. 3. 580. 1853; Seem. in Jour. Bot. **2**: 237 (***Euptelia***). 1864; Eichl. in Flora **48**: 13. 1865, in Jour. Bot. **3**: 150 (***Euptelia***). 1865; Benth. & Hook. f. Gen. Pl. **1**: 954. 1867; Baill. Hist. Pl. **1**: 162, 191. 1868–69; Hook. f. Fl. Brit. Ind. **1**: 39. 1872; Pfeiff. Nomencl. Bot. **1**: 1305. 1874; Eichl. Blüthendiagr. **2**: 150. 1878; Durand, Ind. Gen. Phan. 4. 1888; Prantl in E. & P. Nat. Pfl. 3(2): 23. 1888; King in Ann. Bot. Gard. Calcutta **3**: 199. 1891; Harms in Ber. Deutsch. Bot. Ges. **15**: 350. 1897, in E. & P. Nat. Pfl. Nachtr. **1**: 159. 1897; v. Tiegh. in Jour. de Bot. **14**: 270. 1900; Solereder in Ber. Deutsch. Bot. Ges. **17**: 397. 1900; Rehder in Bailey, Cycl. Am. Hort. **2**: 565. 1900; Hall. f. in Ber. Deutsch. Bot. Ges. **23**: 89. 1905, in New Phyt. **4**: 160. 1905; Finet & Gagnep. in Bull. Soc. Bot. Fr. **52**: Mém. 4: 24. 1905 [repr. Contr. Fl. As. Or. **2**: 24. 1907]; Harms in E. & P. Nat. Pfl. Nachtr. **3**: 111. 1906; Lotsy, Vortr. Bot. Stammesg. **3**: 457. 1911; Bean, Trees and Shrubs **1**: 544. 1914; Rehder in Bailey, Stand. Cycl. Hort. **2**: 1175. 1914; Chun, Chin. Econ. Trees 129. 1922; Rehder, Man. Cult. Trees & Shrubs 213. 1927, ed. 2. 244. 1940; Wettst. Handb. Syst. Bot. ed. 4. **2**: 686. 1935; Lee, For. Bot. China 450. 1935; Chen, Ill. Man. Chin. Trees & Shrubs 257. 1937.

Trees or shrubs, the branchlets alternate, slender, with small scattered elliptic lenticels, marked at the base of each year's growth by the numerous concentric scars of bud-scales, the main branchlets often elongate and with numerous short lateral shoots; buds always axillary (terminal bud aborted, replaced by the distal axillary bud), subtended by a dilated and semi-sheathing petiole-base, ovoid or ellipsoid, in resting condition 5–10 mm. long and 3–6 mm. broad, acute at apex, both vegetative and floriferous buds composed of numerous papyraceous glossy entire castaneous or nigrescent often ciliate-margined scales; vegetative buds composed of 15–20 scales, the outermost broadly deltoid, 2–3 mm. long, 1.5–5 mm. broad, the inner one progressively larger, elliptic, up to about 10×7 mm., the young leaves strongly concave, the innermost ones conduplicate, the growing point terminal; floriferous buds composed of about 10–15 sterile scales, above which are about 6–12 floriferous bracts, these progressively more membranous, smaller, and narrower (elliptic to obovate to spatulate to linear), the innermost often about 3 mm. long, the flowers spiralled and greatly flattened in the bud, the floriferous bracts succeeded by one or two sterile bracts and several young leaves, the incipient branchlet terminated by the growing point; stipules none; leave alternate, 3–10 per season on the longer branchlets (or more on vigorous juvenile plants), often crowded and pseudowhorled on the short lateral branches and fewer (up to 7), the first-formed leaves (basal on the year's growth) often remaining small and undeveloped, sometimes subentire; petioles of mature and fully developed leaves slender, shallowly to deeply canaliculate above, often conspicuously dilated into a chartaceous sheathing bud-subtending base up to 6 mm. long and broad; blades of mature leaves smooth on both surfaces, acuminate at apex, serrate at margins, pinnate-nerved; inflorescence composed of about 6–12 flowers borne in the axils of bracts around the growing point and subsequently lateral by the vegetative development of the axis, the bracts (both sterile and floriferous) soon caducous, the flowers single, maturing before the development of leaves, often persistent in fruiting stage for more than a single season, hermaphrodite, proterandrous, anemophilous; pedicels subterete or slightly flattened, straight, slender, slightly swollen distally into a flattened torus sometimes becoming minutely hirtellous at margin after anthesis, the flowers otherwise glabrous; perianth none; stamens borne in a single whorl on the torus near its margin, slender, the filaments filiform or slightly flattened, at length often twisted, slightly broadened distally, the anthers basifixed, linear-oblong, dehiscing by elongate lateral clefts and eventually twisting, the thecae 2, the connective produced apically into a flattened or subulate acute or subacute appendage; carpels free, borne in a single whorl just within the stamens but not definite in relation to these, conspicuously stalked, the stalks terete, gradually swollen distally, the ovary flattened, oblong or elliptic or dolabriform with the stigmatic margin ventral, or falcate with the stigmatic margin distal, obtuse at apex, the dorsal edge nearly straight or convex, the ventral edge concave and stigmatic for its entire length or merely distally, the stigmatic area covered with minute tangled sticky processes, the locule single, essentially circumalate, the ovules 1–3 (possibly very rarely 4), suborbicular, flattened, anatropous, attached to the ventral edge of the locule, horizontal or slightly pendulous, the micropyle superior; fruit a cluster of small samaras, each conspicuously stipitate, the stipes filiform at base, gradually swollen and flattened distally and expanded into the wing of the carpel; mature carpels (samaras) strongly flattened, essentially circumalate with papyraceous wings, obovate to oblong, tapering into the stipe at base, rounded at apex, the dorsal edge nearly straight or convex, the ventral edge more or less deeply indented (occasionally nearly straight) and stigmatic near the middle, the apical and basal portions of the wing conspicuous, the dorsal and apical margins thickened and vascularized, the locule usually situated slightly below the middle; seeds 1–3 (possibly very rarely 4), ellipsoid or obovoid, slightly flattened, rounded or subacute at base to an apiculate attachment, rounded at apex, the upper margin (distal in fruit) rounded, the lower margin subacute or keeled, the testa black or castaneous, papery, shining, the pericarp brittle, the endosperm oily, granular, copious, the embryo small, near basal end of seed.

Key to the species

Blades of mature and fully developed leaves broadly cuneate or rounded or truncate at base, terminating in a conspicuous acumen 1–4 cm. long, conspicuously and irregularly serrate, the largest lateral teeth up to 15 mm. long, greatly exceeding the inconspicuous smaller teeth; seeds usually solitary, sometimes 2; Japan..... ....1. *E. polyandra*.

Blades of mature and fully developed leaves acute to broadly cuneate (very rarely subtruncate) at base, terminating in an acumen 0.8–2 (rarely to 3) cm. long, comparatively regularly serrate, the largest lateral teeth not exceeding 4 mm. in length, not greatly exceeding the inconspicuous smaller teeth; seeds often 2, frequently 1, occasionally 3 (possibly very rarely 4); China and northeastern India..2. *E. pleiosperma*.

1. **Euptelea polyandra** Sieb. & Zucc. Fl. Jap. **1:** 134. *pl. 72.* 1841; Hoffm. & Schultes in Jour. Asiat. **20:** 293. 1852 [repr. Noms Indig. Pl. Jap. Chin. 37. 1853, ed. 2. 22. 1864]; Miq. in Ann. Mus. Bot. Lugd.-Bat. **3:** 66 [Prol. Fl. Jap. 254]. 1867; Baill. Hist. Pl. **1:** 162. 1868–69; Franch. & Sav. Enum. Pl. Jap. **1:** 18. 1873; Pfeiff. Nomencl. Bot. **1:** 1305. 1874; King in Ann. Bot. Gard. Calcutta **3:** 199. 1891; Sargent in Garden and Forest **6:** 52. 1893, For. Fl. Jap. 15. 1894; Parment. in Bull. Sci. Fr. & Belg. **27:** 320. *pl. 11, f. 49.* 1896; Harms in Ber. Deutsch. Bot. Ges. **15:** 350. 1897; Shirasawa, Ic. Ess. For. Jap. **1:** 74. 1899, *pl. 41, f. 17–30.* 1900; v. Tiegh. in Jour. de Bot. **14:** 271. 1900; Solereder in Ber. Deutsch. Bot. Ges.

17: 399. 1900; Schneider, Ill. Handb. Laubholzk. 1: 270. *f. 179.* 1904; Vilmorin & Bois, Frut. Vilmorin. 8. 1904; Finet & Gagnep. in Bull. Soc. Bot. Fr. 52: Mém. 4: 24. 1905 [repr. Contr. Fl. As. Or. 2: 24. 1907]; Harms in E. & P. Nat. Pfl. Nachtr. 3: 111. 1906; H. Mayr, Fremdl. Wald- und Parkbäume 467. *f. 188.* 1906; Purpus in Mitteil. Deutsch. Dendr. Ges. **1906**: 35. *fig.* 1906; Boodle & Fritsch, Solereder's Syst. Anat. Dicot. 809. 1908; Lotsy, Vortr. Bot. Stammesg. *f. 278, 279* (as ***Euptelea***). 1911; Matsum. Ind. Pl. Jap. 2(2): 97. 1912; Rehder & Wilson in Sargent, Pl. Wils. 1: 315. 1913; Silva Tarouca, Unsere Freil.-Laubgehölze 217. *f. 250.* 1913; Bean, Trees and Shrubs 1: 544. 1914; Rehder in Bailey, Stand. Cycl. Hort. 2: 1175. *f. 1450, 1451.* 1914; Hayata in Bot. Mag. Tokyo 39: (230). 1925; Mottet, Arbres et arbustes d'ornement 43. 1925; Rehder, Man. Cult. Trees & Shrubs 213. 1927, ed. 2. 244. 1940; Makino & Nemoto, Nippon-Shokubutsu-Sôran (Fl. Jap.) ed. 2. 306. 1931; Terasaki, Nippon Skokubutsu Zuhu (Ic. Fl. Jap.) *pl. 30.* 1933; Nemoto, Nippon-Shokubutsu-Sôran-Hoi (Fl. Jap. Suppl.) 207. 1936.
Euptelea polygama Sieb. & Zucc. ex Rehder in Bailey, Cycl. Am. Hort. 2: 565, sphalm. 1900.

Slender tree or shrub, often freely branching and spreading, usually 5–15 m. high, the bark grayish and often rough; branchlets subterete, (1–) 1.5–3 mm. in diameter distally, purpurascent or brownish distally, grayish below, sometimes evanescently pale-strigose toward base of the yearly growth, the internodes on main branchlets 1.5–6 cm. long and on lateral shoots insignificant or occasionally up to 3 cm. long; petioles 0.6–1.2 mm. in diameter, 3–7 cm. long, sometimes sparsely strigose when young, soon glabrescent; leaf-blades papyraceous, when dried brown above and paler or greenish beneath, ovate or deltoid-ovate, 6–15 cm. long, 5–16 cm. broad, broadly cuneate or rounded or truncate at base and decurrent on the petiole, conspicuously acuminate at apex, terminating in a deltoid-lanceolate tooth 1–4 cm. long, conspicuously and irregularly serrate (teeth 2–5 per centimeter, obtusely callose, the largest ones deltoid-lanceolate, up to 15 mm. long, the smallest ones often only 0.5 mm. long), stramineous-strigose on principal nerves on both surfaces when young, at length essentially glabrescent or barbellate in nerve-axils beneath, the costa impressed or nearly plane above, prominent beneath, terminating in the apical acumen, the secondary nerves 5–10 per side, erecto-patent, straight or slightly curved, often branching distally, nearly plane or slightly impressed above, strongly raised beneath, terminating in the larger marginal teeth, the veinlets forming a copious reticulum, faintly impressed or nearly plane above, prominulous or plane beneath, the larger ones toward margin terminating in the smaller teeth; pedicels at full anthesis and in fruit 5–11 mm. long, the torus about 1–1.5 mm. in diameter; stamens 8–18, usually 10–15 mm. long at full anthesis, the filaments 4–7 mm. long at anthesis, the anthers with thecae 3–7 mm. long and an apical appendage 0.7–2 mm. long; carpels 8–18, the stalks usually 1–1.5 mm. long at maturity of stamens, the ovary at this stage 0.8–1.3 mm. long and 0.4–0.7 mm. broad, the stigmatic area 0.6–0.8 mm. long, the ovules 1 or 2; stipes of mature samaras 3–7 mm. long, the mature carpels (samaras) 6–8 mm. long and 3–4 mm. broad, the stigmatic portion 1.5–4 mm. long; seeds usually solitary, sometimes two, 2–2.5 mm. long, 0.9–1 mm. broad.

DISTRIBUTION: Japan, in central Honshu and on Shikoku and Kyushu, at elevations between about 400 and 1500 m. The type was collected by Siebold on Mt. Hakone (in the present Kanagawa Pref., Honshu). The plant is said to occur in mountain woods, usually in wet valleys or near streams, and it is apparently fairly common in some localities. Although not of great ornamental value, the species is quite widely cultivated, apparently as a curiosity.

In the following citations, the localities are arranged in general from northeast to southwest, and the spelling used in S. Gerr's A Gazetteer of Japanese Place Names (Cambridge, Mass., 1942) is followed when possible.

JAPAN: (Without other locality): *Ex Herb. Lugd.-Bat.* (GH), *M. Kuenburg 1699a* (NY), *T. Hogg* (NY), *Collector?* (NY). HONSHU: Fukushima Pref.: Hills above Fukushima, *C. S. Sargent*, Oct. 26, 1892 (A); Kami-ogawa, near Taira, *R. K. Beattie & Y. Kurihara 10033* (US); Tochigi Pref.: Shiobara Mt., *U. Faurie 4184* (NY); Nikko, *E. H. Wilson 6704* (A), *O. Warburg 1302* (A), *K. Sakurai*, July 25, 1905, and Apr. 12, 1911 (A); Nikko to Lake Chuzenji, *C. S. Sargent*, Sept. 8, 1892 (A), *J. G. Jack*, Aug. 10, 1905 (A, GH); Gumma or Saitama Pref. [Prov. Musashi]: *G. Masamune*, June 20, 1926 (NY); Titibu, *Collector? 20* (US); Mt. Burozan, *Collector?*, May 10, 1911 (US); Yamanashi Pref.: Between Shojiko and Kofu, *P. H. Dorsett & W. J. Morse 543* (US); Kanagawa Pref.: Mt. Hakone, *Maximowicz*, in 1862 (GH, US); Odawara, in jugo Hakone, *Maximowicz*, in 1862 (GH); Miyanoshito, Hakone Mts., *C. S. Sargent*, Aug. 25, 1892 (A); Hakone, Ninotaira, *T. Sawada*, Apr. 9, 1927 (UC); Nagano Pref. [Prov. Shinano]: *Maximowicz*, in 1862 (GH), *Tschonoski*, in 1864 (M, NY); Tsubakura-dake, *E. H. Wilson 7478* (A); Utake-gawa, *E. H. Wilson 7762* (A); Nojiri, *J. G. Jack*, Sept. 6, 1905 (A, GH); Gifu Pref. [Prov. Mino]: *K. Shiota 1950* (A), *5100* (A), *6567* (A); Pref. ?: "Jizogatake," *U. Faurie 5388* (UC), *5389* (A). SHIKOKU: Kochi Pref.: Shimokiragawa, *S. Watanabe*, May 23, 1886 (UC); Nanokawa, *K. Watanabe*, Mar. 26, 1886 (GH), May, 1888 (GH), *Collector?*, Mar. 26, 1891 (A), July 1, 1892 (US); Shimonanokawa, *S. Watanabe*, Mar. 22, 1887 (UC); Ehime Pref. [Prov. Iyo]: *Herb. K. Shiota 9458* (A). KYUSHU: No specimens seen, but cited from this island by Finet & Gagnepain (1905) and Matsumura (1912). CULTIVATED: *G. Nicholson 2315* (A) (Royal Gardens, Kew); *J. A. Purpus*, May 8, 1924 (A) and Sept., 1927 (A) (Darmstadt); *C. Schneider*, from seed coll. C. S. Sargent in 1892); *Collector ?*, Sept. 26, 1916 (A) (Arnold Arb.). *C. E. Faxon*, May 11, 1911, Apr. 13 and 23 and May 11, 1912 (all A) (Arnold Arb.); *E. J. Palmer*, Apr. 5 and 17, 1913 (A) and Apr. 11, 1936 (M) (Arnold Arb. no. 865, from seed coll. C. S. Sargent in 1892); *Collector?*, Sept. 26, 1916 (A) (Arnold Arb.).

NATIVE NAMES: The most widely applied name is *Fusa-zakura*, but the following are also recorded: *Koja mansak* (by Siebold & Zuccarini), *Tani kouva* (by Hoffmann & Schultes), *Fani kuja* (by Miquel and Franchet & Savatier), and *Taniguwa* (by Matsumura).

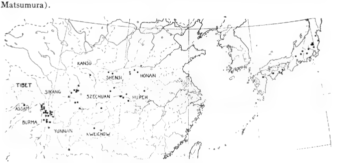

FIG. 1. Distribution of *Euptelea polyandra* (solid squares) and *E. pleiosperma* (solid dots). Each record represents an approximate locality from which herbarium specimens are available or have been reliably cited. From many of these localities numerous collections are known. From Goode's series of base maps, no. 226.

Euptelea polyandra is a deciduous tree, being leafless during the winter months. In its native habitat, the buds open toward the end of March and about the first of April the flowers are fully developed, the anthers shedding their pollen at this time. The carpels, although very small, probably have receptive stigmatic surfaces soon after this time. By the middle of May the stamens have fallen, the carpels are rapidly developing, and the leaves begin to appear. By the end of May or the first part of June the leaves are fully developed and the fruits are maturing. Essentially mature fruits are found on specimens collected during July, August, and September, during which period the next year's buds rapidly enlarge. By the first of November all the leaves have fallen and the buds are fully formed, while some of the fruits still persist. In this winter condition the plant rests until the following spring, the fruits being sometimes persistent for the entire winter.

2. **Euptelea pleiosperma** Hook. f. & Thoms. in Jour. Linn. Soc. Bot. **7**: 243. *pl. 2.* 1864; Hook. f. Fl. Brit. Ind. **1**: 39. 1872; Maxim. in Acta Hort. Petrop. **11**: 39. 1889; King in Ann. Bot. Gard. Calcutta **3**: 199. *pl. 38, A.* 1891; v. Tiegh. in Jour. de Bot. **14**: 271. 1900; Solereder in Ber. Deutsch. Bot. Ges. **17**: 399. 1900; Diels in Bot. Jahrb. 29: 346. 1900; Vilmorin & Bois, Frut. Vilmorin. 8. 1904; Finet & Gagnep. in Bull. Soc. Bot. Fr. **52**: Mém. 4: 25. 1905 [repr. Contr. Fl. As. Or. **2**: 25. 1907]; Harms in E. & P. Nat. Pfl. Nachtr. **3**: 111. 1906; Boodle & Fritsch, Solereder's Syst. Anat. Dicot. 809. 1908; Rehder & Wilson in Sargent, Pl. Wils **1**: 313, 315. 1913; Wilson, Nat. in W. China **1**: 126, 224, **2**: 11. 1913; Bean, Trees and Shrubs **1**: 544. 1914; Rehder in Bailey, Stand. Cycl. Hort. **2**: 1175. 1914; H. Lév. Cat. Pl. Yun-Nan 174. 1916; Chun, Chin. Econ. Trees 129. *pl. 49.* 1922; Rehder, Man. Cult. Trees & Shrubs 213. 1927, ed. 2. 245. 1940; Hu in Contr. Biol. Lab. Sci. Soc. China 5(5): 11. 1929; Lee, For. Bot. China 451. *pl. 128.* 1935; Chen, Ill. Man. Chin. Trees & Shrubs 258. 1937; Fang in Ic. Pl. Omeiens. 1(2): *pl. 57.* 1944.

Euptelea Griffithii Hook. f. & Thoms. ex Baill. Hist. Pl. **1**: 162. 1868–69.

Euptelea Davidiana Baill. in Adansonia **11**: 305. 1875; Franchet in Nouv. Arch. Mus. Paris II. **8**: 193. 1886 [repr. Pl. David. **2**: 11. 1888]; Harms in Ber. Deutsch. Bot. Ges. **15**: 351. 1897; Bretschn. Hist. Eur. Bot. Disc. China 856. 1898; v. Tiegh. in Jour. de Bot. **14**: 271. 1900; Solereder in Ber. Deutsch. Bot. Ges. **17**: 398. 1900; Vilmorin & Bois, Frut. Vilmorin. 8. 1904; Hemsl. in Hook. Ic. Pl. **28**: *pl. 2787.* 1905; Finet & Gagnep. in Bull. Soc. Bot. Fr. **52**: Mém. 4: 25. 1905 [repr. Contr. Fl. As. Or. **2**: 25. 1907]; Harms in E. & P. Nat. Pfl. Nachtr. **3**: 111. 1906; H. Lév. Fl. Kouy-Tchéou 268. 1915.

Euptelea pleurosperma Groppler in Bibl. Bot. 6[Heft 31]: 21. *pl. 1 & 2, f. 8, pl. 3, f. 9,* sphalm. 1894.

Euptelea Francheti v. Tiegh.[1] in Jour. de Bot. **14**: 271, 273. 1900; Vilmorin & Bois, Frut. Vilmorin. 8, 9. *fig.* 1904; Finet & Gagnep. in Bull. Soc. Bot. Fr. **52**: Mém. 4: 25. 1905 [repr. Contr. Fl. As. Or. **2**: 25. 1907]; Harms in E. & P. Nat. Pfl. Nachtr. **3**: 111. 1906; Vilmorin, Hort. Vilmorin. 2. 1906; Rehder & Wilson in Sargent, Pl. Wils. **1**: 314, 315. 1913; Wilson, Nat. in W. China **1**: 52. 1913; Bean, Trees and Shrubs **1**: 544. 1914; Rehder in Bailey, Stand. Cycl. Hort. **2**: 1175. 1914; H. Lév. Fl. Kouy-Tchéou 268. 1915, Cat. Pl. Yun-Nan 174. 1916; Chun, Chin. Econ. Trees 129. *pl. 48.* 1922; Hers in Jour. N. China Branch Roy. Asiat. Soc. **53**: 110 [repr. Liste Ess. Lign. Honan 12]. 1922; Rehder in Jour. Arnold Arb. **4**: 181. 1923; Mottet, Arbres et arbustes d'ornement 42. *f. 18.* 1925; Rehder, Man. Cult. Trees & Shrubs 213. 1927, ed. 2. 245. 1940; Hu & Chun, Ic. Pl. Sin. **1**: 22. *pl. 22.* 1927;

[1] Although this epithet was spelled *Francheti* by van Tieghem, many subsequent authors have changed it to *Franchetii*.

Hu in Contr. Biol. Lab. Sci. Soc. China 5(5): 10. 1929; Lee, For. Bot. China 450. *pl. 127*. 1935; Chen, Ill. Man. Chin. Trees & Shrubs 258. *fig*. 1937.

Euptelea Delavayi v. Tiegh. in Jour. de Bot. 14: 271, 273. 1900; Harms in E. & P. Nat. Pfl. Nachtr. 3: 111. 1906.

Euptelea polyandra sensu Diels in Bot. Jahrb. 29: 346. 1900, in op. cit. 36: Beibl. 82: 45. 1905; Pampanini in Nuov. Giorn. Bot. Ital. n. s. 17: 267. 1910, in op. cit. 18: 115. 1911; non Sieb. & Zucc.

Euptelea minor Ching in Sunyatsenia 6: 15. *pl. 1*. 1941.

Slender tree or shrub, 2–15 m. high, the trunk up to 30 cm. (or more?) in diameter, the bark tawny brown or grayish, lenticellate; branchlets terete, striate when dried, usually 1.5–2.5 mm. in diameter distally, purpurascent distally, grayish below, glabrous, the internodes on main branchlets 1.5–3 cm. long and on lateral shoots usually inconspicuous; juvenile leaves often somewhat larger than those of mature plants, the blades up to 19 × 15 cm., often truncate to deeply cordate at base (unlike mature leaves); petioles 0.4–1.3 mm. in diameter, 2.5–6 cm. long, glabrous; blades of mature and fully developed leaves chartaceous or papyraceous, when dried brown above and paler or glaucous beneath, ovate or elliptic, 7–16 cm. long, 4–12.5 cm. broad, acute to broadly cuneate (very rarely subtruncate) at base and shortly decurrent on the petiole, acuminate at apex, terminating in a lanceolate or narrowly deltoid obtusely callose tooth 8–20 (rarely to 30) mm. long, regularly or somewhat irregularly serrate (teeth 2–4 per centimeter, callose-tipped, the largest ones deltoid, 1–4 mm. long, the smallest ones often only 0.5 mm. long or merely apiculate), glabrous or evanescently scattered-strigose or puberulent in groove of costa above, glabrous or sparsely barbellate in nerve-axils or subpersistently strigose on principal nerves beneath, the secondary nerves 6–11 per side, the venation similar to that of *E. polyandra;* pedicels inconspicuous at anthesis, 4–19 mm. long in fruit, the torus 0.7–1.5 mm. in diameter; stamens 6–14 in number, 8–19.5 mm. long at anthesis, the filaments 2–8 mm. long at anthesis, the anthers with thecae 4–10 mm. long and an apical appendage 0.7–2 mm. long; carpels 6–17, the stalks 0.5–1.5 mm. long at maturity of stamens, the ovary at this stage 0.5–1.5 mm. long and 0.3–0.6 mm. broad, the ovules usually 2, often 1 or 3 (possibly very rarely 4); stipes of mature samaras 4–16 mm. long, the mature carpels (samaras) 5–11 mm. long and 3.5–6 mm. broad, the stigmatic portion 1–4 mm. long; seeds often 2, frequently 1, occasionally 3 (possibly very rarely 4), obliquely superposed if more than one, 1.7–2.5 mm. long, 0.8–1.5 mm. broad, 0.7–1 mm. thick.

DISTRIBUTION: South-central China, in the Provinces of Honan, Shensi, Kansu, Hupeh, Szechuan, Kweichow, Sikang, southeastern Tibet, and Yünnan, and in northeastern India (Assam), at altitudes between approximately 900 and 3600 m., doubtless to be expected in northern Burma and possibly in northern Indo-China. The species is apparently fairly common in parts of its range, occurring in woodlands and forests of hills and mountains, often in dense shade, sometimes in gulches on open slopes.

Localities cited below are arranged in general from northeast to southwest. Dr. J. F. Rock has kindly suggested the correct English spelling here used.

CHINA: HONAN: Tsi-yüan Hsien, Tien-tan Shan, *J. Hers H1798* (A); Yung-ning, Tsi-li-p'ng, *J. Hers 1340* (A); Sung Hsien, San-kuan Miao, *J. Hers 549* (A); Sung Hsien, Shih-tzu Miao, *J. Hers 1244* (A); Lu-shih, Kiaoho (Ch'iao-ho), *J. Hers 972* (A); Lu-shih, Lao-chün Shan, *J. Hers 1148* (A), *1177* (A); Lu-shih, Hiung-erh Shan, *J. Hers 925* (A), *930* (A). SHENSI: Tsing-ling, 60 km. s. w. of Sian-fu, *J. Hers 2997* (A); Tai-pai Shan, *W. Purdom 1036* (A, US); Lung-tung-wan, in Tai-pai Shan, *G. Fenzel 908* (A); "Mt. Kin-tou-san" (Chin-t'ou Shan), *J. Giraldi*, July 14, 1897 (A, UC); "Thui-kio-tsuen, Miao-wang-san, Houan-tou-san, Kan-y-san, Ngo-san, Lao-y-san, and Lean-san," *Fr. Hugh* (*Scallan*), 1899 (A, 11 sheets). KANSU: "Ad fl. Dschombunon, 10 Julii, '85" [not seen, but this collection, by G. N. Potanin, was cited by Maximowicz in 1889; according to Bretschneider, Hist. Eur. Bot. Disc. China 1013. 1898, Potanin's party was in extreme southern Kansu, south of Siku, on July 10, 1885]. HUPEH: "Monte Si-ho, Ou-tan-scian," *C. Silvestri 2960* (A); Hsing-shan Hsien, *E. H. Wilson 139* (A, GH), *588* (A, GH, US); Chang-yang Hsien, *E. H. Wilson 139a* (A, GH, US); Pa-tung Hsien, *E. H. Wilson 219* (A, US); L'ang-sung-kou, *W. Y. Chun 3768* (A), *4114* (US); Wan-tsao Shan, *W. Y. Chun 3939* (A); near Lung-men-ho, *W. Y. Chun 4924* (A); western Hupeh (no other data), *A. Henry 6455* (A, GH, US), *6918* (GH, US), *E. H. Wilson 1048* (A, NY, US), *3133* (A). SZECHUAN: South Wu-shan, *A. Henry 7337* (A, GH); Kai Hsien, *W. P. Fang 10157* (A); Nan-chuan Hsien, *C. Y. Hwang 161* (A); Chin-ting Shan, e. of Mou-chou, *E. H. Wilson 3746* (A, GH, US); Kuan Hsien, *W. P. Fang 2110* (A, NY), *2214* (A, NY), *2351* (A, NY), *2379* (A, NY); w. and s. w. of Kuan Hsien, *F. T. Wang 20905* (A), *20666* (A); Niu-t'ou Shan, w. of Kuan Hsien, *E. H. Wilson 3545a* (A); Wei-kuan, *C. Bock & A. v. Rosthorn 2517* (A); O-mei Hsien, *W. P. Fang 2387* (A, NY), *S. S. Chien 6142* (A); O-mei Shan, *T. T. Yü 449* (A), *F. T. Wang 23159* (A), *Y. S. Liu 1177* (A), *C. Y. Chiao & C. S. Fan 426* (A); *W. P. Fang 6109* (A), *7555* (A, US), *7794* (NY), *7884* (A, NY), *12650* (A, US), *12829* (US); Ping-shan Hsien, *F. T. Wang 22801* (A). KWEICHOW: Tu-yün, *Y. Tsiang 5672* (A, NY, US); Kuei-yang, *Y. Tsiang 8449* (A). SIKANG: Vicinity of K'ang-ting (Tachienlu), *A. E. Pratt 77* (GH), *W. C. Cheng 1650* (A, NY, US). Southeastern TIBET: Tshawarung Border, western range of Mekong on Khawakarpo, Dokar La, and Tshawarung, *J. F. Rock 23064* (A, NY, UC); Tshawarung Border, Yung-chi Mt., *J. F. Rock 23474* (A, UC). YÜNNAN: Mt. Kenichunpo and region of Ch'ang-p'u-t'ung, Salwin-Irrawady watershed, *J. F. Rock 11224* (A, US); Mt. Kenichunpo, eastern and western slopes, *J. F. Rock 22980* (A, NY, UC); mountains of Lendre, Mekong-Salwin watershed, *J. F. Rock 8892* (A, NY, UC, US); mountains above Tzu-ku and Tz'u-chung, Mekong-Salwin watershed, *J. F. Rock 9350* (A, NY, UC, US); Salwin River near Ch'ang-p'u-t'ung, *P. Genestier 9948* (A); Der-la, Ch'ang-p'u-t'ung, *C. W. Wang 66803* (A); "Dzung-duei," Ch'ang-p'u-t'ung, *C. W. Wang 66929* (A); between Chung-tien and Ch'i-tsung, *H. F. v. Handel-Mazzetti 7786* (A); S. Chung-tien, Ch'iao-t'ou on Yangtze bank, *K. M. Feng 3994* (A); mountains of Lü-dü (Lu-tien), n. w. of Li-chiang, w. of Yangtze, *J. F. Rock 18509* (A, NY, US); Ta-hou Shan, near Ta-ku, n. e. Li-ch'ang Snow Range, *K. M. Feng 621* (A); Mekong-Yangtze divide, *G. Forrest 19539* (A); Yangtze-Mekong divide, near Da-mu-chong (Ta-mu-chung), *G. Forrest 21604* (A, UC, US); Mekong-Yangtze divide, n. of Pien-tien, *G. Forrest 25460* (US); Mekong Valley, mountains of K'ang-p'u, Yeh-chih, and An-wa, *J. F. Rock 8934* (A, NY, UC, US), *9069* (A, UC, US); Wei-hsi Hsien, Yeh-chih, *C. W. Wang 68216* (A), *68249* (A), *68664* (A), *71736* (A); Wei-hsi Hsien, *C. W. Wang 63606* (A), *63894* (A), *64950* (A), *67841* (A), *67847* (A), *H. T. Tsai 57931* (A), *59596* (A), *63095* (A); Chung-tien Hsien, north flank of Ha-ba (Ha-pa) Snow Range, *K. M. Feng 1198* (A); Mekong-Salwin divide, "Alulaka," *T. T. Yü 19104* (A); Salwin Valley, Peng-ta, *T. T. Yü 23102* (A); n. w. Li-chiang, Ta-mu-chung, *R. C. Ching 21474* (A); Ho-ch'ing, Hsiang-shu-ho by Ma-erh Shan near Sung-kuei, *K. M. Feng 748* (A, type coll. of *E. minor*); Ch'en-ch'uan–Mekong divide, *G. Forrest 22253* (A, UC, US); between Chien-ch'uan plain and the Mekong drainage basin to La-chih-ming, *J. F. Rock 6813* (A, UC, US), *8623* (A, NY, UC, US); San tchang kiou (San-chiang-k'ou), Ho-ch'ing, *J. M. Delavay 3749* (NY, cotype coll. of *E. Delavayi*); "Ié-ma-tchouan," *E. E. Maire 250* (A); "Pé-long-tsin," *E. E. Maire 495* (A); "Liang-shan La'mi," *H. T. Tsai 51245* (A); Meng-tzu, *A. Henry 10746* (A, M, NY, US); Yünnan, without further data, *G. Forrest 13914* (A), *16206* (A), *T. T. Yü 11287* (A), *H. T. Tsai 57191* (A), *57356* (A), *57590* (A), *57602A* (A), *57697* (A), *63132* (A). INDIA: ASSAM: *W. Griffith 5022* (GH, source of the name *E. Griffithii*; probably also a duplicate of the unnumbered Griffith collection from Mt. Thumathaya, Mishmi Hills, which is the TYPE of *E. pleiosperma*). CULTIVATED: *A. Rehder*, June, 1901 (A) (Hort. Vilmorin); *Arnold*

Arb. (A, several collections made on grounds between 1912 and 1933, from plants originating from collections of Purdom, Hers, and Wilson).

NATIVE NAMES: *Shui-tao* and *Shui-tao-tzu* are apparently the only regularly used local names, being recorded by several collectors. Numerous local names from Honan and Shensi, recorded by Hers and possibly not reliable, are: *Cheng-sin, Chen-sin-mu, Ho-ma-tzu, Lin-chuen-mu, Mo-yeh, Ta-yeh-tuan,* and *Yeh-chen-tzu.* Diels records the use of the name *Shan ye hao* in Szechuan.

The annual cycle of *E. pleiosperma* is essentially similar to that of *E. polyandra* as described above. Spring development is very rapid, and by the end of April the leaves are often nearly mature. The carpels mature quickly during May, and by July the fruits appear fully developed. Some specimens collected in November have both fruits and leaves persisting, but as a rule both are lost at this time, although the pedicels often persist over the winter. According to collectors' color notes, the anthers of *E. pleiosperma* are crimson or brownish, while the young samaras are white to green, becoming reddish or purplish at maturity.

The first mention of the occurrence of *Euptelea* outside of Japan was made by Hooker and Thomson in 1864, in a paper discussing the relationships of the genus. Although their discussion shows definitely that Hooker and Thomson regarded *Euptelea* as a distinct genus worthy of family rank, they refrained from proposing a new family and placed the genus provisionally in Magnoliaceae Sect. Wintereae. *Euptelea pleiosperma* is based upon a plant collected by Griffith in the Mishmi Hills of Assam, apparently collected late in the year, as the fruit is fully mature, the buds are well-formed, and "the specimens have a very few old leaves only." The Griffith specimen cited above (no. *5022*), which was distributed from Kew under the name *Euptelea Griffithii,* is in similar condition and is almost certainly a duplicate of the type. The epithet *Griffithii* was unfortunately recorded by Baillon and must therefore be cited in synonymy.

Euptelea Davidiana Baill., described in 1875, was based on a flowering specimen collected in western Szechuan by David; Baillon's only discussion of its position states: "Species, a congener. chinensi et indica valde diversa, . . . " Baillon made the usual error of taking the flowers to be imperfect ("Carpella in flore masculo sterilia. . ."). Oliver (in Hook. Ic. Pl. **24:** *pl. 2361.* 1895) and Harms (in Ber. Deutsch. Bot. Ges. **15:** 351. 1897, in E. & P. Nat. Pfl. Nachtr. **1:** 159. 1897) suggested that *Euptelea Davidiana* might be conspecific with *Eucommia ulmoides* Oliv. (1890), but they refrained from making the implied combination. There is no reason for such an assumption, as both Solereder (in Ber. Deutsch. Bot. Ges. **17:** 398. 1900) and van Tieghem (in Jour. de Bot. **14:** 271. 1900) have pointed out. Solereder, discussing the species at some length, refers it to the synonymy of *E. pleiosperma;* van Tieghem retains it as distinct on the grounds that the two types — one in fruit and the other in flower — could not be properly compared. Most subsequent authors have reduced *E. Davidiana* to *E. pleiosperma* without question, and this is doubtless its correct position.

Van Tieghem (op. cit. 271–273) recognized five species in *Euptelea* — the already described *E. polyandra*, *E. pleiosperma*, and *E. Davidiana*, and two new ones, *E. Francheti* and *E. Delavayi*. *Euptelea Francheti* was based on two collections of Farges from eastern Szechuan ("prés de Tchen-Kéou"); *E. Delavayi* is typified by three collections made in Yünnan by Delavay. The characters utilized by van Tieghem to distinguish his two novelties from *E. pleiosperma* are not very convincing, and indeed *E. Delavayi* has been consistently referred to synonymy. *Euptelea Francheti,* however, has been maintained by most students for the eastern portion of the Chinese population of the genus.

In attempting to maintain more than one species of *Euptelea* in China, writers since 1900 have resorted to various characters of presumed diagnostic value. Finet and Gagnepain (in Bull. Soc. Bot. Fr. **52**: Mém. **4**: 24–25. 1905) utilized the shape of the fruit and the apex of the leaf to distinguish *E. Francheti* and *E. pleiosperma*. Other students have sought differences in the length of filaments and anthers and the number of seeds. Rehder and Wilson (in Sargent, Pl. Wils. **1**: 313–315. 1913), on the basis of considerably more material than was available to previous workers, concluded that "The appearance of the under surface of the leaves, however, affords a constant character by which the species, and especially the two Chinese species, may easily be recognized." This difference is summarized as follows:

E. Francheti: Under surface of leaves green, non-papillose, the epidermis being perfectly smooth.

E. pleiosperma: Under surface of leaves glaucescent, papillose.

The abundant material cited above has been carefully examined under high magnification with this difference in mind. The lower leaf-surface of many specimens is indeed "papillose," the papillae being minute protrusions of epidermal cells. Furthermore, many specimens have the leaves obviously glaucous beneath, while others have them greenish or pale brown when dried. It is possible that the papillose texture is, on the whole, more marked toward the west and that it often accompanies a certain characteristic paleness. On the other hand, both glaucous and papillose surfaces are frequently found among the eastern specimens. These characters, therefore, do not seem to be associated with geographical distribution (as supposed by Rehder and Wilson), and one may doubt that they have any important genetic basis.

The most recent binomial referred to *Euptelea, E. minor* Ching, is based upon *Feng 748* from Yünnan (isotype cited above). This specimen bears young developing carpels and half-developed leaves and is in all respects typical of *E. pleiosperma*.

The most exhaustive examination of the available specimens fails to disclose any constant characters by which the Chinese population of *Euptelea* can be divided into groups for nomenclatural purposes. In spite of a high degree of variation in number and dimensions of parts, the species is fundamentally very constant. In fact, examination of my key to the species, above, indicates that the only usable differences between the Japanese and Chinese populations are themselves somewhat unsatisfactory. However, characters pertaining to the shape and dentation of the leaves, together with the predominance of 1-seeded samaras in Japan and 2-seeded samaras in China, make the recognition of two species in the genus desirable.

POSITION OF THE FAMILY

In the discussion by Nast and Bailey (2) which follows this paper, the numerous and striking differences in morphology between *Euptelea* on the one hand and *Trochodendron* and *Tetracentron* on the other are taken up. In view of the nature and number of these differences, it must be assumed that tradition alone has been responsible for the long-continued placing of *Euptelea* in the Trochodendraceae. Even the character most often cited as a reason to combine *Euptelea* and *Trochodendron* in the same family — the absence of a perianth — is seen to be unreliable, since the toral bracteoles of *Trochodendron* may possibly be interpreted as perianth-remnants. There appears to be no other existing genus with which *Euptelea* can be satisfactorily compared, and the family Eupteleaceae may be said to be without close allies. That it is a member of the Ranales, in the broad sense, appears to be reasonably certain, but it is anticipated that an eventual revision of the entire order will result in the proposal of a separate suborder to include only the family Eupteleaceae.

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MORPHOLOGY OF EUPTELEA AND COMPARISON WITH TROCHODENDRON

CHARLOTTE G. NAST AND I. W. BAILEY

With four plates

INTRODUCTION

IN PRECEDING papers (3, 4), we have discussed various fundamentally significant similarities between *Tetracentron* and *Trochodendron* which are indicative of relatively close genetic relationship. We shall now concern ourselves with a discussion of salient morphological features of *Euptelea* in an endeavor to determine whether this genus actually belongs in the family Trochodendraceae.

WOOD

The most significant difference between the wood of *Euptelea* and that of *Trochodendron* is the presence of well developed vessels in *Euptelea* and the absence of such structures in *Trochodendron*. The thin-walled, more or less angular vessels (*Fig. 1*) of *Euptelea* are numerous and diffusely distributed, but exhibit conspicuous size differences as between the early and late wood. The vessel members are relatively long with extensively overlapping ends and have scalariform perforation plates with numerous bars. The intervascular bordered pitting is transitional between scalariform and opposite-multiseriate, the former type tending to predominate in the smaller vessels, e.g. of young stems, the latter type in the larger vessels of older stems. The pitting between vessels and parenchyma is scalariform with transitions to opposite. The non-perforate tracheary elements are thick-walled fiber tracheids, having pits with reduced but conspicuous borders.

The wood parenchyma, which fluctuates from scanty to fairly abundant (*Fig. 1*), is distributed diffusely or in short tangentially oriented aggregates. As in *Trochodendron,* the wood parenchyma strands have a high ratio of obliquely oriented partitions. The rays in the outer parts of large stems are of the so-called heterogeneous type II, the multiseriate rays having fusiform outlines with short uniseriate wings as seen in tangential sections (*Fig. 2*) and the low uniseriate rays being composed of upright cells. In young stems, e.g. twigs from herbarium specimens, the rays are of the heterogeneous type I and the first-formed multiseriate rays extend outward from the interfascicular parts of the eustele. The most conspicuous difference between the rays of *Euptelea* and those of *Trochodendron* and *Tetracentron* is the precocious and extensive sclerification of the multiseriate rays in the phloem of *Euptelea*.

NODAL ANATOMY AND LEAF

The nodal anatomy of *Euptelea* is distinctive of the genus and is of a type that has not been encountered by us in any other large woody dicotyledon. At the base of normally enlarged leaves of mature plants, there are 5–11 foliar vascular strands (*Figs. 3* and *6*), preliminary investigations indicating that such strands tend to be more numerous in *E. pleiosperma* than in *E. polyandra*. At certain levels of the attachment of the leaf (*Figs. 7* and *8*), these strands *commingle* with those of the axillary bud forming an arc of vascular strands that confronts a single broad parenchymatous region of the eustele. Thus, the node is of a much modified unilacunar type in which the vascular strands of the axillary bud extend[1] downward *between* the foliar strands of the leaf. In passing outward through the petiole, the foliar vascular strands first aggregate into an arc (*Fig. 4*) and subsequently into a vascular cylinder (*Fig. 5*) which extends into the midrib of the lamina.

The lamina of the leaf contains no branching idioblasts, either sclerotic or secretory, such as occur so characteristically in *Trochodendron* and *Tetracentron*. The epidermal cells surrounding the stomata are not of special form and orientation, and the stomatal apparatus as a whole bears no resemblance to the bizarre and highly modified stomatal structures of *Trochodendron*.

REPRODUCTIVE PARTS

The development of both the vegetative and the flower-bearing shoots of *Euptelea* is sympodial, no functional terminal buds being formed at the end of the growing season. This is in contrast to *Tetracentron* and *Trochodendron,* where extension of purely vegetative shoots is monopodial and that of flower-bearing ones is sympodial. The flower buds of *Euptelea* have numerous sterile scales which are succeeded on incipient shoots by 6–12 floriferous bracts and these subsequently by a varying number of leaves. The flowers are born singly in the axils of the floriferous bracts. The inflorescences of *Trochodendron* and *Tetracentron* are terminal, whereas the flower-bearing part of a fertile shoot of *Euptelea* is succeeded by a more or less extensive leaf-bearing prolongation. The fertile part of the shoot thus resembles the so-called intercalary inflorescences of *Drimys,* but in the latter genus monopodial extension of the axis does not terminate at the end of a growing season.

The flowers of *Euptelea* have long pedicels (*Fig. 9*), the apex of which flares into a disc-like receptacle devoid of perianth. A variable number of stamens are born in a whorl on the outer rim of this receptacle. At least in the case of specimens of *E. polyandra* growing at the Arnold Arboretum, the stamens are protandrous and caducous, stamen scars only (*st. sc., Fig. 9*) being present at a stage when the enlarging carpels become receptive. The conspicuously stipitate carpels are likewise borne in a whorl. The vascular system of the flower is remarkably simple. A

[1] The wording used in this paragraph is purely descriptive and bears no implications regarding developmental sequences.

eustele of many small strands extends throughout the pedicel. This eustele resolves at the base of the receptacle into a whorl of staminal traces, the remaining vascular tissue becoming carpellary strands, one to each carpel. There is no residual vascular tissue in the torus.

The microsporophyll of *Euptelea* is differentiated into a slender filament, an extensive connective, and an acuminate vascularized apex which projects above the thecae (*Fig. 13*). The four elongated and conspicuously protruding sporangia are laterally oriented in pairs. A single vascular strand extends throughout the microsporophyll, terminating at its apex. The endothecia may completely jacket the sporangia (*Figs. 14* and *15*) as in the Winteraceae. Occasionally they may extend across the adaxial side of the connective (*Fig. 14*).

The pollen grains are of two types, a tricolpate form which is characteristic of most specimens of *E. pleiosperma* and a polycolpate (mostly hexacolpate) one which predominates in a majority of the examined specimens of *E. polyandra*. However, one collection of *E. polyandra* (*Sawada*, April 9, 1927 [UC 382263]) has tricolpate pollen, and two collections of *E. pleiosperma* (*Forrest 16206* and *Wilson 1048*) have polycolpate grains. The grooves of the hexacolpate pollen are arranged in several patterns, two of the commonest of which are illustrated in *Figs. 16* and *17*. The reticulation of the exine (*Fig. 18*) is extremely fine, giving to the exine at times the appearance of being minutely pitted. The floor of the grooves is covered with small slightly embossed papillae which may be aggregated into chains. The contrast between the papillate and reticulate areas of the exine is slightly intensified in the drawing.

The megasporophylls (*Fig. 9*) have much elongated stipes and superficially resemble those of *Drimys stipitata* Vickery, except that the stigmatic surfaces of the conduplicate lamina do not protrude to form conspicuous double stigmatic crests as in the Winteraceae and Schisandraceae. The carpels, both during their earlier stages of development (*Fig. 10*) and at anthesis (*Figs. 11* and *12*), fluctuate markedly in external form. They are particularly significant from both developmental and phylogenetic points of view in illustrating successive morphological modifications in the closure of primitive conduplicate ranalian megasporophylls and in the restriction of their stigmatic surfaces. The stipe contains a single vascular strand which divides in the base of the conduplicate lamina (*Fig. 12*) into a dorsal vein and a strand which bifurcates just below the stigmatic level of the carpel into two ventral veins. The dorsal vein, which parallels the contour of the dorsal edge of the carpel, forms a conspicuous lateral branch which traverses the carpel above its locule and unites with the ventral veins (*Figs. 12* and *19*).

In addition to an over-all enlargement of the carpel to form the fruit, there is a marked elongation in the region below the stigmatic surfaces (compare *Figs. 12* and *19*). The fruit is papyraceous and contains 1–3 (rarely 4) small anatropous seeds (*Fig. 20*). The outer seed coat consists of an external layer of large thin-walled cells, which give a reticulate appearance to the seed, and an inner sclerenchymatous layer. The inner seed coat is composed of small thin-walled cells. There is an abundant endosperm in which is embedded a small embryo with incipient cotyledons. A foot-like structure composed of very small parenchymatous cells is located at the chalazal end of the endosperm and presumably is a structure derived from the antipodal cells of the megagametophyte.

DISCUSSION

Tetracentron and *Trochodendron* exhibit numerous morphological similarities, the *totality* of which provides convincing evidence of relatively close genetic relationship. Particularly significant in this connection are similar trends of morphological specialization of the vesselless xylem, the stomata, carpels, stamens, ovules, and seeds. None of these salient developmental and structural peculiarities occur in *Euptelea*.

The evolutionary gap between the vesselless xylem of *Trochodendron* and *Tetracentron* and the vessel-containing wood of *Euptelea* is so wide that it alone serves as a serious, if not insuperable, obstacle to the inclusion of *Euptelea* in the Trochodendraceae, and completely neutralizes any structural similarities between the rays and the wood parenchyma of the three genera. So-called heterogeneous type II rays occur in diverse families of dicotyledons which have attained comparable levels of parallel phylogenetic development and of themselves are not indicative necessarily of close genetic relationships. Furthermore, the precocious and extensive sclerification of multiseriate rays in the phloem of *Euptelea* — as in Winteraceae and certain other families of dicotyledons — is a type of structural specialization that does not occur in *Trochodendron* and *Tetracentron*. Nor is the occurrence of a high ratio of diagonal partitions in wood parenchyma strands, by itself, indicative necessarily of close genetic relationship, since such partitions occur for example in certain representatives of such remotely related families as the Magnoliaceae (sensu stricto) and the Saxifragaceae.

The extension of vegetative shoots of *Euptelea* is sympodial, whereas that of *Trochodendron* and *Tetracentron* is monopodial. The normally enlarged leaves of adult *Eupteleae* have unilacunar nodal attachments that are characteristically modified by peculiarities in the vascularization of the axillary buds. On the contrary, comparable leaves of *Tetracentron* and *Trochodendron* have trilacunar and multilacunar nodes and the vascularization of the axillary buds is of a commonly occurring and fundamentally different dicotyledonous type. The vascularization patterns of the petiole and lamina differ in the three genera, but such patterns should not be unduly emphasized in discussions of relationships, since they frequently fluctuate widely not only within the limits of specific genera and families but also in different leaves of a single plant. The stomata of *Euptelea* do not exhibit the peculiar structural specializations that occur so characteristically in *Trochodendron* and *Tetracentron*. Nor does *Euptelea* form branching idioblasts of either sclerotic or secretory types.

The inflorescences of *Trochodendron* and *Tetracentron* are truly terminal, whereas the fertile part of the axis in *Euptelea* subtends a leaf-bearing terminus. The flowers of the two categories of genera differ markedly both in the external form and the internal structure of their constituent parts. The conspicuously stipitate, style-less carpels of *Euptelea* illustrate a distinct trend of specialization and closure of the primitive, open, conduplicate, ranalian megasporophyll which is entirely unlike that which has given rise to the style-bearing carpels and basally incipient syncarpy of *Trochodendron* and *Tetracentron*. Furthermore, the ovules of *Euptelea* do not have the vascularized subchalazal projection which is such a distinctive feature of the ovules of the latter genera. The fundamental differences in the carpels are reflected in the fruits, those of *Euptelea* being clusters of samaras and those of *Tetracentron* and *Trochodendron* being folliceta with ventral loculicidal dehiscence. The slender much elongated seeds of the latter genera have characteristic extensions of the vascularized subchalazal projections and resemble those of *Euptelea* only in characters, e.g. copious endosperm, small embryo, etc., which are indicative of general rather than of specific ranalian affinities.

The stamens of *Euptelea* differ from those of *Trochodendron* and *Tetracentron* not only in their external form but also in the development of their endothecia. They are attached to the rim of a flattened torus, whereas in *Trochodendron* the free parts of the filaments arise from the dorsal surfaces of the carpels. The pollen of *Euptelea* fluctuates from tricolpate to polycolpate, tricolpate grains tending to be dominant in *E. pleiosperma* and hexacolpate ones in *E. polyandra*. In *Tetracentron* and *Trochodendron*, the pollen grains are prevailingly tricolpate, are smaller than those of *Euptelea*, have narrower grooves, a more coarsely reticulate exine, and in *Trochodendron* a crestlike median thickening of the floor of the grooves. Tricolpate pollen having reticulate exines and papillate thickenings on the floor of the grooves occurs in various dicotyledons. Furthermore, transitions from tricolpate to polycolpate grains occur in Ranunculaceae, Berberidaceae, and in other families. Thus, the morphology of the pollen, by itself, is not indicative necessarily of close relationship between *Euptelea* and *Trochodendron* or *Tetracentron*.

The chromosomes of the two categories of genera differ in size, form, and number, the basic number in *Euptelea*, as in *Illicium* and the Schisandraceae, being 14, whereas in *Trochodendron* and *Tetracentron*, as in *Cercidiphyllum* and certain Magnoliaceae and Winteraceae, it is 19 (see Whitaker, 7).

The morphological differences between *Euptelea* and *Trochodendron* are numerous and indicative of divergent trends of phylogenetic specialization in all organs of these plants. Significant structural similarities are few and are suggestive of common ranalian ancestry rather than of actual close genetic relationship between the two genera. Why then should the genera have been placed in the same family? The decision to do so appears to have been based largely, if not entirely, upon the absence of a perianth, resulting in the inclusion of such strange bedfellows as *Eucommia, Cercidi-*

phyllum, Euptelea, and *Trochodendron* in the Trochodendraceae. *Eucommia* and *Cercidiphyllum* have subsequently been placed in separate unigeneric families, and we agree with van Tieghem (6) and Smith (5) that *Euptelea* should similarly be placed in an independent family, the Eupteleaceae.

As in the case of the Winteraceae (see Bailey and Nast, 1), the family Eupteleaceae exhibits evidences of general ranalian affinities, but does not appear to be closely related to any specific surviving family of the ranalian complex. It obviously cannot be placed in close proximity to those woody ranalian families (see Bailey and Nast, 2), which are characterized by having monocolpate and derived types of pollen and numerous aromatic secretory cells. Although it appears to belong in the category of ranalian families having tricolpate and derived types of pollen and no aromatic secretory cells, it cannot be placed in close proximity to any of them, e.g. Ranunculaceae, Berberidaceae, Lardizabalaceae, Menispermaceae, or Trochodendraceae. It remains to be determined whether the family Cercidiphyllaceae is of ranalian rather than of rosalian affinities, but in any case it is not closely related to the Eupteleaceae. Nor does the latter family form a natural compact grouping with the Schisandraceae.

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EXPLANATION OF PLATES

PLATE I

FIG. 1. *Euptelea polyandra.* Transverse section of the wood, × 120. FIG. 2. The same. Tangential longitudinal section of the wood, × 120.

PLATE II

FIG. 3. *Euptelea polyandra.* Transverse section of lower part of petiole, × 20. FIG. 4. The same. Transverse section of middle part of petiole, × 20. FIG. 5. The same. Transverse section of upper part of petiole, × 20.

PLATE III

FIGS. 6–8. *Euptelea polyandra.* Transverse sections of node, showing vascular strands of leaf and bud, approx. × 16. FIG. 9. *E. pleiosperma, Forrest 25460.* Flower, showing mature carpels after stamens have fallen. Stamen scar, *st. sc.*, approx. × 6½. FIG. 10. The same, *Hers 930.* Young carpel, approx. × 77. FIG. 11. *E. polyandra, Wilson 6704.* Mature carpel, approx. × 13. FIG. 12. *E. pleiosperma, Forrest 25460.* Mature carpel. Dorsal bundle, *d. b.*; dorsal branch, *d. br.*, approx. × 10.

PLATE IV

FIG. 13. *E. pleiosperma, A.A. 14796* (cult.). Stamen showing extension of sporophyll above the thecae, × 15. FIG. 14. *E. polyandra, A.A. 865* (cult.). Transverse section of stamen, × 825. FIG. 15. *E. pleiosperma, A.A. 14796* (cult.). Transverse section of stamen, × 825. FIGS. 16, 17. *E. polyandra.* Hexacolpate pollen grains showing position of grooves. FIG. 18. *E. pleiosperma, Feng 621.* Tricolpate pollen grain, × 7500. FIG. 19. *E. pleiosperma, Tsai 63095.* Fruit, approx. × 4½. FIG. 20. The same. Seed, approx. × 12½.

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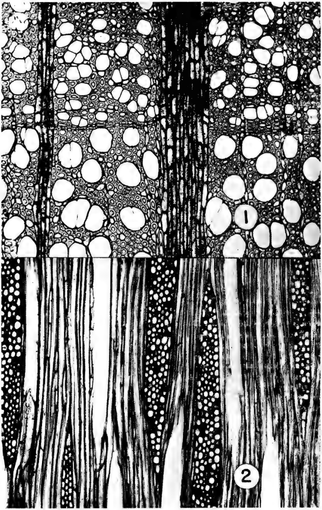
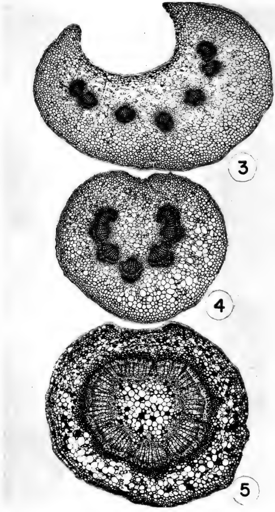


Morphology of Euptelea



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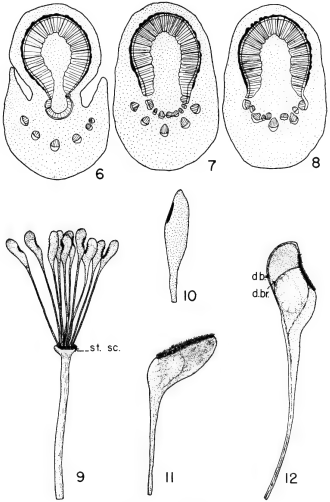
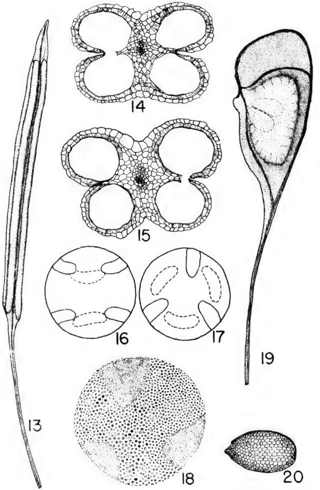


MORPHOLOGY OF EUPTELEA



Morphology of Euptelea

PLANTAE PAPUANAE ARCHBOLDIANAE, XVII*

E. D. Merrill and L. M. Perry

This article contains the remaining genera of the Psychotrieae not considered in previous papers. It includes *Psychotria, Calycosia, Cephaelis, Lasianthus, Saprosma,* and *Amaracarpus,* as well as we can determine them without more material for comparison. Of all the Rubiaceae dealt with in this series of papers, these genera are by far the most difficult to delimit. In some instances the variation of single characters is so constant that it is most troublesome to decide whether this is of generic significance or not. For example, we have placed in *Saprosma* only those plants characterized by stiff or bristle-like elongated glands(?) on the stipules or bracts of the inflorescence; yet, the specimen which we have described under *Calycosia* has a few fairly long and widely scattered callose teeth (or glands?) on the margins of the exceedingly large stipules. These teeth or glands are not on the margins of the bracts, but within at the base is a row of rather large colleters. However, the habit of the plant is much more like that of *Calycosia,* and on account of its agreement in other characters we have placed it there at least for the present. After hastily scanning the definitions of *Psychotria* in the literature from various parts of the world, we have been somewhat puzzled to know what to include or to exclude as border species, hence we began our study with those plants which would be recognized universally as *Psychotria* (including *Grumilea*), and worked toward the periphery of the genus. There are bound to be borderline species which some might place in this genus and others in closely related ones. In such instances we have endeavored to adhere to the generic concepts used by Valeton in this area, believing that he had available much more material for comparison than we, although we have not located any publication in which he defined the genera. One species from the Solomon Islands we have placed in *Cephaelis,* although we are not unaware of a tendency to separate the Old and the New World genera of this type. The decision in such matters should rest with those workers who consider the group in its entirety and not on the basis of material from a small geographic area. As for *Amaracarpus* and the genus *Dolianthus* C. H. Wright, we have given a fairly detailed discussion of our position at the beginning of our treatment of the former genus.

RUBIACEAE (concluded)

Psychotria Linnaeus (including *Grumilea* Gaertner)

In the Papuasian region are three species of *Psychotria* with pre-empted specific names: *P. ixorioides* Val., non Bartl. ex DC.; *P. polyneura* Val.,

* Botanical results of the Richard Archbold Expeditions. See Jour. Arnold Arb. **26**: 229–266. 1945.

non DC.; and *P. puberula* K. Schum. non Wright. These do not appear to be represented in our material.

Psychotria carstensensis Wernham, Trans. Linn. Soc. II. Bot. **9**: 75. 1916, vel aff.

BRITISH NEW GUINEA: Mount Tafa, *Brass 4857*, Aug., 1933, alt. 2400 m., very common, conspicuous in tree tops (large liane; dark glabrous leaves, shining above, midrib white; peduncle, pedicels and corolla white; calyx and ovary green; fruit yellow-green, about 6 × 5 mm.).

It seems best at present to place this collection here until it can be compared with the type. It does not wholly agree with the original description, in which the leaves are described as obovate but later in the comment designated as ovate. In the Brass collection the leaves are slightly smaller and the petioles a little shorter; on the two specimens at hand only one stipule and remnants of two others are present; the stipule is lanceolate, hairy inside, but broken at the apex, it is only 1.3 cm. long and 4 mm. wide; the inflorescence is apparently sessile; the corolla-tube is 4.5 mm. long and densely short-villose within the upper half; the fruit is slightly sulcate, and the albumen strongly ruminate.

Psychotria Leonardii nom. nov.

Psychotria Brassii S. Moore, Jour. Bot. **65**: 268. 1927, non Hiern (1877).

In naming this species, Moore apparently overlooked the fact that another species had already received the specific epithet *Brassii;* in order to preserve the original intention of the author, we have used a specific epithet based on the collector's given name.

Psychotria olivacea Val. Bot. Jahrb. **61**: 77. 1927.

BRITISH NEW GUINEA: Palmer River, 2 miles below junction Black River, *Brass 7341*, July, 1936, alt. 100 m., large liana of forest canopy (leaf-nerves prominent above, less so below; flowers yellow outside, red within). SOLOMON ISLANDS: Bougainville: Siwai, *Waterhouse 64*, Jan., 1933 (vine used in Taro cultivation); Torge-galla, *Kajewski 1783 bis, 2194*, May and September, 1930, alt. 150 m. and 40 m., vine climbing up rain-forest trees (petals light green-brown; fruit white when ripe, 7–8 mm. long, 8–9 mm. diameter); Pour-gor-kucki, *Kajewski 1884*, June, 1930, alt. 150 m. rain-forest (vine; petals dirty green; fruit 7 mm. long, 5 mm. diameter, white-green when ripe); Guadalcanal: Uulolo, Tutuve, *Kajewski 2520*, April, 1931, alt. 1200 m., rain-forest (fruit cream-colored when ripe, 8 mm. long, 5 mm. diameter); San Cristoval: Waimamura, *Brass 2677*, Aug., 1932, lowland rain-forests, common (large glabrous fleshy liane; flowers pale brown; fruit smooth, immature).

These specimens so strongly resemble each other that in spite of their wide geographic range we have placed them together for the present at least. Likewise, they correspond very well with the description of Valeton's *Psychotria olivacea*. However, in our herbarium is a specimen from Australia labeled *P. coelospermum* F. M. Bailey, lacking flowers and fruit, but which, in foliar characters, type of inflorescence, and bracts, so strongly resembles the Papuasian material above cited that it seems possible these may all be representatives of the same species. We have not yet located a description of the flowers of the Australian species. Further study with more complete material is necessary to determine relationship of these specimens.

Psychotria barbatiloba sp. nov.

Planta scandens; ramulis ultimis glabris subteretibus vel obtuse angulatis; stipulis 2 cm. longis, lineari-lanceolatis, obtusiusculis, cito caducis, cicatricibus glabrescentibus; foliis 5–7 cm. longis, 2.5–4 cm. latis, apice probabiliter recurvis in sicco plerumque plicatis, acuminatis, basi obtuse cuneatis, chartaceis, utrinque glabris, nervis lateralibus utrinsecus 7–10 oblique adscendentibus, venis inconspicuis; petiolo 1–1.5 cm. longo; inflorescentiis sessilibus, trichotomis 4–6 (–10 in fructu) cm. latis, 4–6 cm. longis, breviter patenti-pubescentibus, multifloris, bracteatis; bracteis minutis triangularibus interdum apice subulatis, pubescentibus; floribus in apice ramorum brevium dense confertis subsessilibus; calyce 1 mm. longo, glabro, dentato, minute ciliolato; corolla extus minute pubescente, tubo 1.5 mm. longo intus fauce dense barbato infra glabro, lobis 5 linearibus, intus parte inferiore dense barbatis, 2–2.5 mm. longis; staminibus in fauce insertis, filamentis 1 mm. longis, antheris 1 mm. longis; stylo 3 mm. longo, glabro, stigmatibus 0.5 mm. longis, patentibus, exsertis; fructibus vix maturis, ovoideis, apice calyce coronatis, ±4 mm. longis, 2.5 mm. diametro, extus leviter obtuse costatis; albumine paulo ruminato.

BRITISH NEW GUINEA: Palmer River, 2 miles below junction Black River, *Brass 7215* (TYPE), July, 1936, alt. 100 m., common in ridge forests (large canopy liane; flowers white).

The general appearance of this collection is much like that of *Psychotria sarmentosa* Blume. The latter differs in the following characters: veins not so strongly ascending; flowers less crowded; flower buds more rounded than elongate; fruits larger and less crowded; bracts and calyx more spreading.

Psychotria purpurea sp. nov.

Planta scandens, inflorescentiis minute puberulis exceptis glabra; ramis striulatis, subangulatis, internodiis circiter 2 cm. longis; stipulis non visis, cicatricibus intus minute pubescentibus; foliis lanceolato-ellipticis, apice acuminatis, acumine ± 1 cm. longo, acuto, basi cuneatis, subcoriaceis, nervis lateralibus utrinsecus 6 vel 7 utrinque aequaliter manifestis, venis obscuris; petiolo circiter 1 cm. longo, gracili; inflorescentiis a basi ramosis, puberulis, 7 cm. latis, 4.5 cm. longis, cymoso-paniculatis; ramis divaricatis, tenuibus, bracteatis; bracteis lanceolatis, 2 mm. vel minus longis; floribus 1.5 mm. pedicellatis; calyce brevissimo, patenti, glabro, 4–5-angulato; corolla in alabastro tantum visa, dense puberula cinerea, intus fauce barbata; antheris probabiliter exsertis, in alabastro 1 mm. longis; fructibus glabris, subglobosis, 4 mm. diametro, immaturis.

SOLOMON ISLANDS: San Cristoval: Hinuahaoro, *Brass 2874* (TYPE), Sept., 1932, alt. 900 m., mountain rain-forests, common (small climber; leaves thick, shining; flower white; fruit smooth, purple).

This species suggests *P. sarmentosa* Bl. but is smaller in all its parts, and the leaves are much more acuminate. Both flowers and fruits seem to be stung by insects.

Psychotria orgyalis sp. nov.

Planta scandens circiter 2 m. alta, inflorescentiis minute leviter pulverulentis exceptis glabra; ramis ultimis leviter angulatis vel in sicco compressis, internodiis 0.5–3 cm. longis; stipulis caducissimis in gemmis tantum visis, 1 cm. longis, lanceolatis; foliis ovatis vel lanceolatis, 2.5–4.5 cm. longis, 1–1.8 cm. latis, basi cuneatis vel late acutis, apice acuminatis chartaceis, nervis lateralibus tenuibus utrinsecus 5–7 supra manifestis subtus prominulis, venis paucis sub lente manifestis; inflorescentiis sessilibus, 5–7 cm. longis latisque, bracteatis, bracteis linearibus, inferioribus circiter 5 mm. longis; floribus bracteolatis, sessilibus vel breviter pedicellatis, plerumque in triadibus in apice ramulorum ultimorum dispositis alabastris tantum visis, glabris; calyce 4–5-lobato; corolla utrinque glabra disco elongato quam calyce paulo longiore; fructibus ellipsoideis, 5 mm. longis, 4 mm. diametro; endocarpio crassiusculo; seminibus immaturis.

BRITISH NEW GUINEA: East Mount Tafa, *Brass 4140* (TYPE), May, 1933, alt. 2100 m., foothill forest, common (small climber forming a bushy top about 2 m. above ground; leaves rather thick, with pale midrib; inflorescence greenish yellow).

Among the species of *Psychotria* already described this collection is most like *P. Wernhamiana* S. Moore and *P. Wollastonii* Wernham. It differs from both, however, in the entirely glabrous corolla; in foliar characters it seems to be intermediate between the two mentioned species. The high disk is a feature it has in common with *P. Wernhamiana* S. Moore and *P. vaccinioides* Val., a fairly rare character among the Papuasian species.

Psychotria vaccinioides Val. in Gibbs, Phytogr. & Fl. Arfak Mts. 181. 1917.

NETHERLANDS NEW GUINEA: 18 km. southwest of Bernhard Camp, Idenburg River *Brass 12182, 12626*, Jan., Feb., 1939, alt. 2100 and 2150 m., in shrubberies of a steep summit, and in stunted scrub on an exposed summit, mossy forest (scrambling to 1 m. leaves concave; flowers white).

For comparison we have at hand a topotype, *Kanehira & Hatusima 13657*, in which specimen the leaves show considerable variation in size, the larger being almost as large as the smaller ones of *P. Lorentzii* Val. (the latter species being represented by *Brass 9239* from Lake Habbema, and *Brass 10594* from 9 km. northeast of Lake Habbema); it is true that the habit of *P. vaccinioides* Val. is more compact than that of the related species. Another character common to all three specimens cited is a relatively long disk which does not appear in either *P. Lorentzii* Val. nor in *P. densifolia* Stapf. This disk persists in the fruit and without the aid of a hand lens looks like a rather long apiculus projecting from the apex of the fruit.

Psychotria lolokiensis S. Moore, Jour. Bot. 67: 49. 1929, in C. T. White, Jour. Arnold Arb. 10: 269. 1929.

BRITISH NEW GUINEA: Rona, Laloki River, *Brass 3671*, March, 1933, alt. 450 m., gully rain-forest associations, rare; Kanosia, *Carr 11083*, Feb., 1935, forest on edge of mangrove swamp; Daru Island, *Brass 6277*, common in rain-forest margins; Tarara, Wassi Kussa River, *Brass 8527*, tidal terraces in rain-forest and mangrove contact zone. Upper Wassi Kussa (left branch), *Brass 8630*, margin of mangroves. Slender small tree 3–7 m. high, with dark glossy leaves, white peduncles, pedicels, and flowers, fruit shining red (Carr: reddish orange), soft and fleshy, persistent calyx-tube yellow.

This rather distinctive species ought to be compared with the type of Valeton's *Psychotria bracteosa*, the type-locality of which is Merauke. If they should prove to be the same species, Valeton's name has priority. Although the descriptions are very similar, we have hesitated to make the reduction on this alone, after seeing the similarity between *P. montensis*

S. Moore and *P. micralabastra* (Lauterb. & K. Schum.) Val., species very much alike in appearance but different in minute details.

Psychotria chrysocarpa sp. nov.

Arbor usque ad 6 m. alta, glabra, vel frutex; ramis ultimis teretibus vel compressis, internodiis 1–3.5 cm. longis; stipulis 1–2 cm. longis dimidio inferiore connatis, apice obtusis, margine libero subpectinato-pubescentibus, deciduis, cicatricibus pubescentibus, pilis rufis; foliis coriaceis, ellipticis, 4.5–12 cm. longis, 1.5–6 cm. latis, apice et basi breviter acutiusculis, novellis margine rufo-pubescentibus, pilis cito caducis, nervis lateralibus utrinsecus 8–12 utrinque prominulis, oblique patenti-adscendentibus prope marginem arcuatis, reticulo laxo manifesto; petiolo 1–1.8 cm. longo, supra plano, subtus convexo; inflorescentiis 5 (in fructu usque ad 10) cm. longis, 2.5–4 cm. pedunculatis, ramosis, ramis verticillatis, verticillis 3 vel 4, bracteatis, bracteis late ovatis, 2–3 mm. longis, basi ± connatis; floribus sessilibus vel 2–4 mm. pedicellatis; calyce cupuliformi, ± dentato, 2.5 mm. longo; corolla crassiuscula, tubo 5 mm. longo, intus sub apice staminum basin circum dense barbato, lobis 5.5 mm. longis, lanceolato-oblongis; disco haud 1 mm. longo; filamentis circiter 2 mm. longis, antheris aequilongis, exsertis; stylo 3 mm. longo, lobis stigmaticis 2 mm. longis, 1 mm. latis; fructibus pyriformibus utrinque leviter sulcatis, levibus, 7 mm. longis, 5 mm. latis, apice calyce coronatis; pyrenis 5 vel 6 mm. longis, dorso haud costatis, apice medio leviter sulcatis, ventre planis; albumine ruminato.

NETHERLANDS NEW GUINEA: 9 km. northeast of Lake Habbema, *Brass 10989* (TYPE), Oct., 1938, alt. 2650 m., common on open banks of streams (tree 3–6 m. high; flowers white; fruits orange); Bele River, 18 km. northeast of Lake Habbema, *Brass 11578*, Nov., 1938, alt. 2350 m., in a small clearing in forest (somewhat fleshy shrub 1 m. high; flowers white).

This species is very closely related to *Psychotria lolokiensis* S. Moore or *P. bracteosa* Val. The plants are of similar habit, and the leaves are very much alike in texture, shape, and venation. The mode of branching differs in the inflorescences. In *P. lolokiensis* S. Moore the peduncle is rather long, and at its apex the branches are verticillate and for the most part similar in size, so that the main axis as such is not conspicuously marked; the branches themselves are dichotomous. In *P. chrysocarpa*, on the other hand, the branches are in whorls around a main axis. In addition to this distinguishing character, *P. chrysocarpa* differs in having ovate rather than orbicular bracts, glabrous floral axis (and branches), more markedly dentate calyx; the pubescence in the upper part of the corolla-tube is just below the apex rather than projecting from the throat, and the pyrenes are rounded on the dorsal surface rather than angled as in *P. lolokiensis* S. Moore.

Psychotria sphaerothyrsa Val. Bot. Jahrb. 61: 99. 1927.

BRITISH NEW GUINEA: Sogeri, *Brass 635*, Nov., 1925, alt. about 450 m., rain-forest (tall shrub 2.5–4 m.; trunk soft and sappy; leaves glossy above).

This collection, apart from the fact that it is only in very young bud, is an excellent match for an isotype of Valeton's species which is fortunately in our herbarium. *Psychotria sphaerothyrsa* Val. was based on a collection from Northeast New Guinea, and has previously been reported only from the type-collection.

Psychotria heterophylla sp. nov.

Frutex magnus; ramulis ultimis angulatis puberulis, internodiis 1–7 cm. longis; stipulis 1–1.3 cm. longis, puberulis, ovatis, apice breviter bi-lobatis, subpersistentibus; foliis oblongo-lanceolatis vel leviter obovato-lanceolatis vel lineari-lanceolatis, majoribus 29–33 cm. longis, 9 cm. latis, minoribus 16 × 6 cm. etiam 13–14 × 1.5 cm., tenuiter chartaceis, apice sensim longe acuminatis, acumine 1.5–3 cm. longo, angusto, basi cuneatis, supra glabris, subtus costa et nervis puberulis, nervis lateralibus in foliis majoribus utrinsecus ± 25, in minoribus utrinsecus 15–17, utrinque prominulis, venis utrinque manifestis, reticulo supra obscuro, subtus sub lente conferto manifesto; petiolo 1.3–2.5 cm. longo, puberulo, supra canaliculato et plano; infructescentia terminali puberula, probabiliter circiter 16 cm. diametro; pedunculo 5.5 cm. longo, compresso, angulato, ramulis similibus; fructibus 1.5 mm. pedicellatis, pyriformibus, subdicoccis, 5 mm. longis, vix 5 mm. diametro, calyce minute ciliato coronatis; pyrenis dorso convexis, endocarpio extus ruguloso, intus subscrobiculato; albumine ruminato.

British New Guinea: Ihu, Vailala River, *Brass 918* (TYPE), Feb., 1926, rainforests (large bush; leaves dark and glossy above, pale beneath, fleshy, midrib on upper surface white; fruit red).

In several characters this species is similar to *Psychotria alata* Val. The latter species differs, however, in its complete glabrousness and the comparatively short branchlets of the inflorescence, as well as in its narrower leaf-base. Both have persistent stipules, although those of *P. heterophylla* are more or less broken and somewhat shredded, yet they are present on all nodes of the specimen; the main nerves of the leaves are similar, and both have the long narrow acumen at the tip of the leaf, but even under a lens the fine reticulation seen in the Brass collection is lacking in Schlechter's material. In Schlechter's collection the lower branches of the inflorescence are only 2 cm. long, whereas those of *P. heterophylla* are about 9 cm. long including the branching part which is about 6 cm. long and broad. In spite of the likeness between the two specimens it seems best to regard them as separate species at least until sufficient material has been collected to cover the differences between the two.

Psychotria Randiana sp. nov.

Frutex erectus 1–1.2 m. altus, sparsim ramosus; ramulis ultimis glabris, compressis, internodiis 1–7.5 cm. longis; stipulis oblongo-ovatis 2 cm. longis, 1 cm. latis, obtuse bi-dentatis, glabris; cicatricibus plerumque latis, intus leviter pubescentibus cito glabratis; foliis leviter obovato-ellipticis, 6.5–19 cm. longis, 2.5–8 cm. latis, apice subabrupte acuminatis, acumine obtusiusculo, 7–9 mm. longo, basi circiter 7 mm. lato, basi in petiolo angustatis, glabris, firme chartaceis, nervis lateralibus utrinsecus 8–13 supra manifestis, subtus prominulis, patenti-adscendentibus et arcuatis; venis et reticulo utrinque ± manifestis; petiolo 1–2 cm. longo; inflorescentiis (pedunculo incluso) 13–15 cm. longis, pyramidalibus, bracteatis, ramis verticillatis, puberulis, divaricatis, ultimis cymosis; bracteis linearibus apice subulatis; pedunculo 5.5–7 cm. longo; pedicellis 2–3 (in fructu

–5) mm. longis; calycis tubo circiter 1 mm. longo, lobis inaequalibus linearibus 1.5–2 (–2.5) mm. longis; corollae tubo 7 mm. longo, extus glabro, intus supra medium piloso-barbato, lobis 4 mm. longis, oblongis, glabris; antheris 2 mm. longis, inclusis, filamentis 1 mm. longis; disco 1 mm. alto; stylo 9 mm. longo, glabro; stigmatibus paulo exsertis; fructibus vix maturis ovoideis, circiter 1 cm. longis, 6 mm. diametro, calyce coronatis, non costatis; albumine ruminato.

British New Guinea: Murray Pass, Wharton Range, *Brass 4607* (type), July, 1933, alt. 2840 m., sporadic in forests (erect sparsely branched bush 1–1.2 m. tall; branches pale, mottled; dark smooth thick leaves, paler beneath; flowers white; soft greenish white fruit ± 1 cm. diameter).

This species has leaves somewhat broader and fewer-nerved than those of *Psychotria nana* Val. There are also floral differences. In Valeton's species the calyx is minute; although the corolla-tube is described as equalling the lobes in length, unless the flower were approaching anthesis the proportionate length of the two would be difficult to estimate, for the tube elongates as the flower develops. In *P. Randiana* the calyx-lobes are obvious even in fruit, the flower is relatively large, and the inflorescence is fairly long-pedunculate. The species is named for Dr. A. L. Rand, the ornithologist of the expedition.

Psychotria Kanehirae sp. nov.

Planta 3 m. alta; ramulis glabris, internodiis 1–2 cm. longis, compressis; stipulis membranaceis, 1.7 cm. longis, basi circiter 8 mm. latis, ad medium bifidis, lobis lanceolatis, acutis, extus glabris, intus basi pubescentibus, caducis, cicatricibus hirtellis; foliis 10–16.5 cm. longis, 4.5–6 cm. latis, etiam 7 × 1.8 cm., ellipticis vel leviter oblanceolato-ellipticis, apice acuminatis, acumine 1–1.5 cm. longo, basi 7–10 mm. lato, acutiusculo, valde chartaceis vel tenuiter coriaceis, supra glabris subtus novellis costa patenti-pubescente excepta glabris, maturis glabris, nervis lateralibus utrinsecus ± 14, oblique patentibus deinde arcuatis, reticulo sub lente supra vix manifesto, subtus obscuro; petiolo 1–2.3 cm. longo; inflorescentiis terminalibus, circiter 8 cm. longis, cymoso-paniculatis, pedunculatis (pedunculo 2 cm. longo), bracteatis, bractea basi rami imi foliiformi 1.2 cm. longa, 2 mm. lata, axilla pubescente, bracteis reliquis 2 mm. longis vel minus, linearibus; ramis plerumque oppositis, divaricatis, ramo imo 3.5 cm. longo, paniculato, summo 1.5 cm. longo, iteratim ramoso; floribus solitariis vel in triadibus in apice ramulorum ultimorum, ± 1.5 mm. pedicellatis, glabris; calyce 0.5 mm. longo, 5-dentato; corollae tubo 1 mm. longo, intus fauce barbato, lobis 1 mm. longis, obtusiusculis; antheris partim exsertis; stylo 2 mm. longo; fructibus non visis.

Netherlands New Guinea: Dalman, 45 km. inland from Nabire, *Kanehira & Hatusima 12248* (type), Mar., 1940, alt. 500 m., margin of forest (plant 3 m.; flowers white).

In foliar characters and size of stipules this plant strongly suggests *P. ramulosa* Merr. & Perry, but the flowers are very much smaller in this plant. The stipules here are thin enough to show striations. The branches of the inflorescence are opposite, whereas in *P. ramulosa* they tend to be verticillate. It is interesting to note that the lower bract is leaf-like, though very small, and also that the axil is pubescent just as one would expect if a stipule had fallen. Whether this indicates a sessile branching inflorescence at times we cannot say.

Psychotria luteola sp. nov.

Arbor parva 3 m. alta; ramulis ultimis glabris, internodiis 1–3 cm. longis, superioribus subangulatis vel sulcatis; stipulis in gemma terminali 5 mm. longis tantum visis, caducissimis, verisimiliter lanceolatis vel ovatis, cicatricibus primum subsuberosis deinde obsolete pubescentibus; foliis ellipticis, 10–18 cm. longis, 5.5–9.5 cm. latis, apice acuminatis, acumine ± 1 cm. longo, acuto, basi obtusis, firme chartaceis, utrinque glabris vel subtus minute puberulis, nervis lateralibus utrinsecus 10–13 supra impressis, subtus prominentibus, venis inconspicuis, reticulo sub lente densissimo, vix manifesto; petiolo 1.5–2 cm. longo; inflorescentiis sessilibus trichotomis, 12–14 cm. longis, ± 10 cm. latis, cymoso-paniculatis, puberulis; floribus in apice ramulorum ultimorum plerumque 3, sessilibus vel exterioribus vix 1 mm. pedicellatis; calyce valde 5-dentato, calyce et ovario circiter 1 mm. longis, puberulis; corollae tubo 1.5 mm. longo utrinque glabro, lobis 1 mm. longis, extus minute puberulis; antheris 0.8 mm. longis, dimidio supero exsertis; stylo 1.5 mm. longo.

BRITISH NEW GUINEA: Mafulu, *Brass 5226* (TYPE), Oct., 1933, alt. 1250 m., undergrowth of limestone belt forests (straggling small tree 3 m. high; leaves dull; terminal panicles of small yellow flowers).

A species closely related to *P. sogerensis* Wernh. but with a flower half the size, a glabrous corolla, and definitely acuminate leaves.

Psychotria chrysantha sp. nov.

Arbor parva cicatricibus stipularum pubescentibus exceptis glabra; ramis ultimis compressis vel sulcatis, internodiis 0.5–2.5 cm. longis; stipulis caducissimis, ovatis acuminatis, in gemmis tantum visis; foliis ellipticis vel leviter obovatis, 4–10 cm. longis, 1.5–4 cm. latis, firme chartaceis, apice acuminatis, acumine 5–10 mm. longo, acutiusculo, basi cuneatis, nervis lateralibus utrinsecus 10–12 supra manifestis, subtus prominulis, patentibus prope marginem arcuatis, venis inconspicuis; petiolo 7–12 mm. longo; inflorescentiis 7–10 cm. longis, pedunculatis, pedunculo 2–4 cm. longo vel interdum nullo, cymoso-paniculatis; floribus sessilibus vel breviter pedicellatis; calyce circiter 0.5 mm. longis, plerumque 4-lobatis; corollae tubo vix 1.5 mm. longo utrinque glabro, campanulato, lobis circiter 1 mm. longis, ovatis, intus minute papillulatis; antheris in fauce insertis, apice exsertis; stylo brevi; fructibus subpyriformibus, 5 mm. longis, apice circiter 4 mm. latis; pyrenis fere levibus; albumine ruminato.

BRITISH NEW GUINEA: Mount Tafa, *Brass 4881* (TYPE), Aug. 1933, alt. 2400 m., forest substage (small tree with pale green leaves; small yellow flowers; smooth green fruits).

Psychotria chrysantha is closely related to *P. micralabastra* (Lauterb. & K. Schum.) Val. but the venation of the leaves is more spreading and prominent; the leaves also are broader and less tapering at the base in our species.

Psychotria myrsinoides sp. nov.

Frutex haud 1 m. altus; ramulis novellis minute puberulis cito glabris, internodiis 1–4 cm. longis, superioribus subsulcatis; stipulis 5–8 mm. longis, 4–6 mm. latis, ovatis, apice obtusis vel erosis vel bidentatis, extus puberulis, intus pubescentibus, caducis; foliis 5.5–13 cm. longis, 2.5–4.5 cm. latis, tenuiter coriaceis, oblongo-lanceolatis vel elliptico-lanceolatis, apice acutis vel breviter acuminatis, basi cuneatis, nervis lateralibus utrinsecus 9–12 utrinque manifestis non prominulis, patentibus, venis obscuris, petiolo 0.5–1.5 cm. longo, puberulo; inflorescentiis paniculatis, puberulis, 6–10 cm. longis, 4–7 cm. latis, pedunculo 2–5 cm. longo, ramis oppositis vel 4-verticillatis, verticillis 4 vel 5, bracteis lanceolatis subulatis ± 2 mm. longis; floribus in apice ramulorum ultimorum ± confertis, extus dense puberulis, sessilibus vel breviter pedicellatis; calyce valde 5-lobato, lobis vix 1 mm. longis, ovatis, acutis; corollae tubo 3 mm. longo, intus tertio supero et fauce dense barbatis, lobis 1.5 mm. longis, oblongis; antheris 1 mm. longis, inclusis; fructibus subglobosis, ± 4 mm. diametro; pyrenis dorso leviter 3-costatis, ventre planis; albumine ruminato.

Netherlands New Guinea: Hollandia, *Brass 8810* (type), June, 1938, alt. 20–100 m., occasional in small forest patches on secondary savannas (fleshy shrub under 1 m. high; flowers and fruit white).

This plant suggests *P. pallida* Val. but the leaves and inflorescence are smaller, the venation of the leaves is less conspicuous, and the base is cuneate rather than rounded and abruptly constricted.

Psychotria tafaensis sp. nov.

Arbor 3–4 m. alta, fere glabra; ramulis ultimis compressis, crassiusculis, circiter 5 mm. diametro, internodiis 1–1.5 cm. longis; stipulis rotundato-oblongis, 1–1.4 cm. longis, 5–9 mm. latis, deciduis, cicatricibus novellis crassiusculis, intus dense pilosis; foliis oblongis utrinque angustatis, apice acutis, basi cuneatis, margine leviter recurvis, 5–13 cm. longis, 1.8–5 cm. latis, firme chartaceis vel subcoriaceis, nervis lateralibus utrinsecus 8–13 utrinque prominulis, patenti-adscendentibus marginem versus arcuatis, venis inconspicuis; petiolo 1–1.3 cm. longo; inflorescentiis 7–8 cm. longis, 4.5–6 cm. latis, interdum pedunculatis (pedunculo 2.5–3 cm. longo) vel a basi ramosis, pyramidalibus, bracteatis, bracteis lanceolatis, ramulis verticillatis vel trichotomis, ramulis ultimis cum rhachi summo puberulis; floribus breviter pedicellatis; calyce 5-lobato, vix 2 mm. longo, lobis ovatis; corollae tubo extus glabro, intus fauce dense barbato, 4 mm. longo, lobis oblongis, circiter 3 mm. longis; antheris inter pilos insertis, verisimiliter sessilibus, apice leviter exsertis; stylo 4 mm. longo; fructibus subglobosis, 7 mm. longis, 6 mm. diametro, leviter costatis, pyrenis transverse sectis fere semi-orbicularibus, dorso leviter trisulcatis; endocarpio subcorneo; albumine ruminato.

British New Guinea: Mount Tafa, *Brass 4838* (type), May-Sept., 1933, alt. 2400 m., bank of forest stream, common (small loosely branched tree 3–4 m. tall, flowers white).

Psychotria ramulosa sp. nov.

Arbor parva 2–4 m. alta valde ramosa, glabra; ramulis subteretibus, internodiis 2–4 cm. longis; stipulis magnis, late ellipticis, versus apicem angustatis, 2 cm. longis, 1.2–2 cm. latis, basi leviter angustioribus, tertio supero bifidis, intus parte inferiore pubescentibus, caducis; foliis valde chartaceis, ellipticis vel oblanceolato-ellipticis, 6.5–21.5 cm. longis, 2.2–8.5 cm. latis, apice sensim vel subabrupte acuminatis vel foliis minoribus acutis, acumine 1–1.5 cm. longo, acutiusculo, basi elongato-cuneatis, nervis lateralibus tenuibus utrinsecus 8–15 supra manifestis, subtus prominulis venis inconspicuis vel subobscuris; petiolo 1–3 cm. longo, gracili; inflorescentiis laxe cymoso-paniculatis pyramidalibus pedunculatis (pedunculo 5–10 cm. longo), 13–27 cm. longis, 10–25 cm. latis, ramis oppositis vel 4- vel 8-verticillatis, patentissimis, bracteatis, bracteis lineari-lanceolatis, acutis; floribus in apice ramulorum ultimorum ± 3 mm. pedicellatis; calyce vix 1 mm. longo, 4- vel 5-dentato; corollae tubo 6 mm. longo, intus tertio infimo excepto villosulo; lobis 2 mm. longis, intus minute papilloso-puberulis; staminibus in fauce insertis, antheris 1.5 mm. longis, partim exsertis; stylo glabro, 3 mm. longo; fructibus obovoideis vel pyriformibus, 6 mm. longis, 4 mm. latis, leviter sulcatis; pyrenis leviter 3-sulcatis; albumine extus paulo lobatis vix ruminatis.

NETHERLANDS NEW GUINEA: 15 km. southwest of Bernhard Camp, Idenburg River, *Brass 12396* (TYPE), Jan., 1939, alt. 1500 m., common in undergrowth of a rain-forest ravine (much branched tree 2–4 m. high; inflorescence white; fruit green).

Possibly this species is related to *Psychotria nana* Val. The latter is described as a large herb, whereas this is a small tree with flowers on pedicels about 3 mm. long. The flowers of *P. nana* Val. were not mature and so they are hardly comparable. The stipules also are striking in the Brass specimen but are incomplete in *P. nana* Val. From the description it would seem as if Valeton's species should be recognized by the obovate-lanceolate multinerved leaves, and an inflorescence, a little longer than the leaves, bearing long-pedicellate (6 mm.) flowers.

Psychotria aquatilis sp. nov.

Frutex vel arbor parva; ramulis ultimis glabris, compressis, vix 5 mm. diametro, internodiis 2.5–6 cm. vel longioribus; stipulis circiter 1 cm. longis, connatis, apice tantum liberis, glabris, cicatricibus + pubescentibus; foliis 19–31 cm. longis, 4–10 cm. latis, lanceolatis, chartaceis, utrinque aequaliter angustatis, apice breviter acute acuminatis, basi breviter decurrentibus, supra glabris, subtus costa nervisque rufo-pubescentibus, nervis lateralibus utrinsecus 12–16 adscendentibus leviter arcuatis, supra impressis, subtus prominentibus, reticulo laxo utrinque distincte manifesto; petiolo 1–1.5 cm. longo, glabro; infructescentiis 5–8 cm. longis, 7–8 (fructibus inclusis) cm. latis, pedunculatis; pedunculo 0.7–1.5 cm. longo; axi et ramis minute et dense patenti-pubescentibus vel dense puberulis; ramis verticillatis, verticillis 2; fructibus pedicellatis; pedicellis 3 mm. longis, puberulis; fructibus in sicco subpyriformibus, ± 1 cm. longis, 9 mm. latis, consperse minute pubescentibus, calyce truncato undulato leviter patenti coronatis; pyrenis 1 cm. longis, 9 mm. latis, basi cuneatis, levibus, dorso convexis basin versus compressis, ventre planis, albumine ruminato.

BRITISH NEW GUINEA: Fly River, 528 mile Camp, *Brass 6667* (TYPE), May, 1936, alt. 80 m., abundant on river flood banks and backwater creeks (gregarious shrub or small tree; leaves shining; short terminal panicles; fleshy red fruit ± 1.5 cm. diameter).

Possibly this species is related to *Psychotria papuana* (Wernh.) St. John. The leaves are somewhat similar in outline but tend to be narrower than those shown in the plate of the latter species; also the veins are more ascending, the petiole is longer, and the peduncle is very much shorter than in *P. papuana*. The plants differ in other characters, noticeably the apparent lack of a calyx in the Forbes collection, but we cannot suggest at present any more closely related species.

Psychotria paludicola sp. nov.

Arbor 2–4 m. alta; ramulis ultimis glabris compressis; stipulis non visis, cicatricibus suberosis margine brunnescenti-pubescentibus; foliis firme chartaceis, ellipticis vel oblongis, 9–21 cm. longis, 4–9 cm. latis, apice subabrupte acuminatis, acumine ± 1 cm. longo basi 7–8 mm. lato, basi late cuneatis, utrinque glabris, nervis lateralibus utrinsecus 12–14, patenti-arcuatis, utrinque prominulis, venis et reticulo laxo utrinque manifestis sed inconspicuis; petiolo 1–2.5 cm. longo glabro; inflorescentiis terminalibus ± 9 cm. diametro, in fructu tantum visis; pedunculo brevi, 0.5–1.5 cm. longo, ramis 2- vel 3-ramulosis; fructibus 2–4 mm. pedicellatis, subglobosis, circiter 1 cm. diametro, calyce dentato coronatis; pyrenis circiter 7 mm. diametro, ventre planis, dorso convexis basim versus leviter compressis et late et obtuse costatis; albumine ruminato.

NETHERLANDS NEW GUINEA: 4 km. southwest of Bernhard Camp, Idenburg River, *Brass 13637* (TYPE), March, 1939, alt. 850 m., rain-forest, abundant on banks of streams and on swampy ground (tree 2–4 m. high; fruit white, soft and fleshy).

The species is probably related to *Psychotria apiculata* Warb. The infructescence is only about half as large as in the latter species, but both are apparently without bracts; both have corky stipular scars, but in our species the upper scars all have an upper hairy margin; the leaves have fewer lateral nerves and the acumen is twice as large as in Warburg's species.

Psychotria misimensis sp. nov.

Planta glabra; ramulis teretibus, internodiis 2–2.5 cm. longis, superis tantum visis; stipulis oblongis, obtusis, 4 mm. longis, caducis, cicatricibus dense rufo-pubescentibus; foliis tenuiter coriaceis, obovatis, 5.5–9 cm. longis, 2–3.7 cm. latis, apice breviter acuminatis, acumine vix 5 mm. longo, obtuso, basi sensim attenuato-acutis, nervis lateralibus utrinsecus 8–10 utrinque distincte manifestis, patentibus deinde arcuatis, reticulo laxo inconspicuo; petiolo ± 1 cm. longo; inflorescentiis circiter 9 cm. longis, 5 cm. latis, cymoso-paniculatis, pedunculatis (pedunculo 4.5 cm. longo), bracteatis; bracteis linearibus vel subulatis; ramis oppositis; ramulis ultimis, pedicellis, bracteis, et calycibus minute puberulis; floribus saepe in apice ramulorum ultimorum congestis; calycis tubo 0.5 mm. longo, lobis 1 mm. longis, acutis; corollae tubo 4 mm. longo, intus fauce villosulo, lobis 3 mm. longis, intus granulari-puberulis in sicco albescentibus; antheris 1.5 mm. longis, linearibus, apice tantum exsertis; stylo fere 7 mm. longo, granulari-puberulo; stigmatibus vix 1 mm. longis; fructibus non visis.

NORTHEAST NEW GUINEA: Mt. Misim, Mowlee District, *Stevens* (TYPE), 1932–33, alt. ± 1700 m.

The distinctive characters of this species are the oblong stipules with a rounded or obtuse apex, obovate leaves, and fairly large flowers with whitened corolla-lobes.

Psychotria membranifolia Bartl. ex DC. Prodr. **4**: 522. 1830; Merr. Enum. Philip. Fl. Pl. **3**: 559. 1923.

BRITISH NEW GUINEA: Lower Fly River, east bank opposite Sturt Island, *Brass 8051*, Oct., 1936, rain-forest (weak sparsely foliaged small tree of undergrowth; leaves rather thick and fleshy; flowers cream-colored); Penzara, between Morehead and Wassi

Kussa Rivers, *Brass 8463*, rain-forest along streams (shrub 1.5 m.; flowers yellow); Dieni, Ononge Road, *Brass 4008*, May, 1933, alt. 500 m., rain-forest floor (very small white-flowered shrub 30 cm. high); Kubuna, *Brass 5588*, Nov. 1933, alt. 100 m., rain-forest regrowths (small tree with pale glabrous shining leaves and cream-colored flowers); Veiya, *Carr 11708, 11709*, Mar., 1935, forest (shrub about 2 m. tall; flowers pale olive below, the upper half pale flesh color); Koitaki, *Carr 12642*, June, 1935, alt. 450 m.

The above material is so much like some of the Philippine material of this species at hand that we have hesitated to consider it as new. It is true that most of the leaves are smaller here (9–20 cm. long, 3.5–8 cm. broad), the peduncle of the inflorescence is longer, and the inflorescence is much less compact, further, all the material is glabrous, but these are only minor characters when one considers the texture of the leaves, the likeness in the flowers, and some fruits; unfortunately we have only two specimens in fruit and one is immature, so it is hardly comparable.

Psychotria leiophloea sp. nov.

Arbor usque ad 7 m. alta, inflorescentiis puberulis exceptis glabra; ramulis pallidis, ultimis valde compressis, levibus, internodiis 1.5–3.5 cm. longis; stipulis elliptico-ovatis, circiter 8 mm. longis, 5 mm. latis, cito caducis, cicatricibus paulo pubescentibus; foliis ellipticis, tenuiter chartaceis, 10–21.5 cm. longis, 4–10.5 cm. latis, apice acutis vel breviter et late acuminatis, basi obtuse cuneatis, nervis lateralibus utrinsecus 10–12 utrinque perspicuis, patentibus, prope marginem valde arcuatis, venis distincte manifestis, reticulo obscuro; petiolo 1–3 cm. longo; inflorescentiis paniculatis, puberulis, circiter 13 cm. diametro, pedunculo ± 5 cm. longo, bracteatis, bracteis caducissimis haud visis; ramis 4-verticillatis; floribus in apice ramulorum confertis, sessilibus vel brevissime pedicellatis; calyce puberulo 0.5 mm. longo, leviter 5-dentato; corolla extus glabra, tubo 3 mm. longo, intus dimidio supero dense barbato, lobis 1.5 mm. longis; antheris 1 mm. longis, apice vix exsertis; stylo 4.5 mm. longo; fructibus subglobosis, 5 mm. longis, 4 mm. diametro; pyrenis dorso convexis inconspicue 3-costatis ventre planis utrinque rugulosis; albumine paulo ruminato.

BRITISH NEW GUINEA: Tarara, Wassi Kussa River, *Brass 8506* (TYPE), Dec., 1936, common in rain-forest semi-shade (shapely tree 6–7 m. high; bark smooth, white; leaves coriaceous, nerves pale; panicles white); Wuroi, Oriomo River, *Brass 5899*, Feb., 1934, alt. 10–30 m., common about rain-forest borders and often found on savannas (small tree or little more than a bush 2.5–4 m. high; smooth leaves with prominent yellowish nerves, stiff panicles of small red fruit).

In some respects the species reminds us of *P. micrococca* (Lauterb. & K. Schum.) Val. but in our species the corolla is glabrous outside, the bracts of the inflorescence have fallen or are very minute for there is only a hairy margin left, the flower is somewhat larger, the fruits are only inconspicuously ribbed, and the albumen is only a little ruminate.

Psychotria axilliflora sp. nov.

Arbor 10–12 m. alta; ramulis glabris, internodiis 6–12 cm. longis, superis sulcatis, cito teretibus; stipulis tantum in gemma terminali visis, parvis glabris, cicatricibus non pubescentibus; foliis 13–23 cm. longis, 5–8.5 cm. latis, chartaceis, ellipticis, apice acuminatis, acumine 1–1.5 cm. longo, obtusiusculo, basi rotundato-cuneatis vel obtusis, utrinque glabris, nervis lateralibus utrinsecus 11–15 supra distincte manifestis, subtus prominentibus, oblique patentibus prope marginem arcuatim confluentibus, venis gracilibus, reticulo laxissimo utrinque inconspicuo; petiolo $\pm$ 1.5 cm. longo; inflorescentiis axillaribus vel terminalibus, pedunculatis, cymoso-paniculatis, puberulis, minute bracteatis; pedunculo 3–5.5 cm. longo, gracili, ramis 1–2.5 cm. longis; floribus non visis; fructibus 1 cm. longis latisque puberulis, apice calyce truncato 1 mm. longo coronatis, in parte infera leviter dorsiventraliter compressis, basi in ambitu rotundato-cuneatis, in dimidio supero sensim vel subabrupte angustatis et subcostatis, in sectione transverse 4-angulatis; pyrenis vix 1 cm. longis latisque ventre planis, dorso convexis in dimidio supero leviter costatis (deorsum costa obscura) deinde basi valde compressis et latioribus; albumine ruminato.

SOLOMON ISLANDS: Bougainville: Koniguru, Buin, *Kajewski 2018* (TYPE), Aug., 1930, alt. 900 m., rain-forest (small tree up to 12 m. high; fruit orange colored when ripe, length 1.1 cm., diameter at base 1.2 cm. tapering to a diameter of 7 mm. at blunt point); same locality, *Kajewski 2055*, alt. 950 m., rain-forest (tree 10 m. high; fruit shiny red when ripe, 9 mm. long, 1 cm. diameter).

The leaves of this species are very much like those of *P. leptothyrsa* Miq. and *P. Schmielei* Warb. but the fruits are more nearly like those of the subgenus *Piptilema* A. Gray, described from Fiji. The dry fruits are broad and compressed basally, upward they are either gradually or subabruptly narrowed, and in cross section they are 4-angled. Of the five infructescences on the two specimens at hand, only one seems to be terminal on a short (2 cm. long) axillary branch.

Psychotria inconspicua sp. nov.

Planta vix 1 m. alta, non ramosa, glabra; internodiis apicem versus 0.5 mm. longis, subangulatis, deorsum 1–2.5 cm. longis; stipulis 1.5 mm. longis, apice rotundatis, caducis; foliis 9–11 (–19.5) cm. longis, 3.2–4 (–7) cm. latis, anguste obovatis, vel ellipticis, apice breviter acuminatis, basi sensim anguste cuneatis, tenuiter chartaceis, nervis lateralibus utrinsecus 8–10, supra impressis, subtus prominulis, venis costalibus inter nervos conspersis, supra inconspicuis, subtus distincte manifestis, reticulo laxissimo subtus perspicuo; petiolo 4 (–10) mm. longo; inflorescentiis 5.5 cm. pedunculatis, ramosis; ramis verticillatis, verticillis 3; ramis ramulosis; floribus in apice ramulorum breviter pedicellatis; calyce vix 1 mm. longo, 4-angulato; corollae tubo subcampanulato 3.5 mm. longo, fauce puberulo vel pubescente, lobis 4, ovatis, obtusis, 1.5 mm. longis; antheris circiter 1 mm. longis, partim exsertis; fructibus non visis.

BRITISH NEW GUINEA: Palmer River, 2 miles below junction Black River, *Brass 7045* (TYPE), June, 1936, alt. 100 m., sporadic in ridge-forest undergrowth (unbranched shrub less than 1 m. high; leaves somewhat iridescent; flowers white).

A species possibly related to *P. leptothyrsa* Miq. but much smaller in size of flowers and upper leaves, and with more crowded nodes.

Psychotria dieniensis sp. nov.

Frutex 50–60 cm. altus; ramulis ultimis dense pilosis, pilis leviter crispis; stipulis 1.7 cm. longis, patenti-pilosis, apice bilobatis, lobis subulato-lanceolatis circiter 7 mm. longis, caducis; cicatricibus brunnescenti-pilosis; foliis lanceolatis basi et apice aequaliter angustatis, longe subacutis, 6.5–15 cm. longis, 2–4 cm. latis, supra costa prope basim pilosa excepta glabris, subtus minute, costa et nervis dense pilosis, nervis lateralibus utrinsecus 10–14 supra manifestis, subtus prominulis, venis subobscuris; petiolo 1.2–1.7 cm. longo, gracili, breviter piloso; infructescentiis 2.5–3.5 cm. longis latisque, prope basim ramosis, patenti-pilosis, ramis 2- vel 3-ramosis, bracteolis linearibus; fructibus rotundatis circiter 7 mm. diametro, extus leviter costatis, apice calyce consperse piloso 5-dentato 2 mm. longo coronatis, sparsissime pilosis; pyrenis 5 mm. longis, 4 mm. latis, ventre planis, dorso obtuse et inconspicue 3-costatis; albumine ruminato.

BRITISH NEW GUINEA: Dieni, Ononge Road, *Brass 3827* (TYPE), April, 1933, alt. 500 m., rain-forest floor (shrub 50–60 cm.; leaves paler beneath, margins slightly recurved; globose white fruit ± 1 cm. diameter).

Psychotria dieniensis in some ways suggests *P. multicostoides* Val.; however, the pubescence is still on the upper parts of the fruiting specimens at hand and is too heavy to pass as either fugacious or puberulous, while the whole surface of the stipules is hairy, not just the margin. There is a great similarity between the characters of the leaves of both species, but in our species the fruit is crowned by the calyx, which has five pubescent lobes, and the disk is slight and inconspicuous, whereas in Valeton's species the fruit is crowned by the disk, a feature suggesting that the calyx is rather small and insignificant.

Psychotria camptodroma sp. nov.

Frutex; ramulis ultimis villosis cito glabrescentibus, internodiis 1–6 cm. longis; stipulis ovatis, circiter 2 cm. longis, villosis deinde glabrescentibus, apice bifidis, lobis 6–7 mm. longis, lineari-lanceolatis; cicatricibus subvillosis; foliis 6–12 cm. longis, 3–5 cm. latis, late oblongis, apice breviter acuminatis, acumine lato et obtuso, basi cuneatis, supra glabris, subtus sparsim rufo-pilosis, nervis lateralibus utrinsecus 9–12, supra impressis, subtus prominentibus, patentibus deinde arcuatim anastomosantibus, venis paucis sub lente utrinque manifestis; petiolo 1–2 cm. longo, dorso glabrescente; inflorescentiis (in fructu) circiter 6 cm. longis (pedunculo 2–2.5 cm. longo incluso), 4 cm. latis, axi et ramis breviter villosis; floribus pedicellatis, pedicellis ± 3 mm. longis; calyce et ovario glabrescentibus, calycis lobis 4, ovatis, circiter 1.5 mm. longis, corollae tubo 9 mm. longo, utrinque glabro, lobis 4, triangularibus, 4 mm. longis, extus apice interdum paulo pubescentibus; staminibus supra basin 6 mm. insertis, filamentis circiter 1.5 mm. longis, antheris vix 2 mm. longis; stylo 9 mm. longo, stigmatibus lineari-oblongis; fructibus subglobosis, circiter 7 mm. diametro, calyce coronatis, immaturis; albumine ruminato.

BRITISH NEW GUINEA: Mount Tafa, *Brass 5102* (TYPE in Herb. New York Bot. Gard.), Sept., 1933, alt. 2400 m., bush in valley forest, rare (leaves dark and shining, nerves deeply impressed above, prominent beneath; flowers white).

Psychotria camptodroma is to be distinguished from *P. malacorrhax* (Lauterb. & K. Schum.) Val. by the pubescence on the lower surface of the leaves and by the lobed calyx. Both are species with short inflorescences and large flowers.

Psychotria malaloensis sp. nov.

Probabiliter frutex; ramulis dense patenti-pilosulis, pilis rufis, demum glabratis, internodiis superis 1–3.5 cm. longis; stipulis 6–8 mm. longis, basi connatis, apice bifidis, bi-costatis, extus dense pilosulis, lobis attenuatis filiformibus, in ramulis novellis subpersistentibus; foliis oblongo-lanceolatis vel anguste ellipticis, 4.5–9 cm. longis, 2.2–3.5 cm. latis, apice leviter acuminatis, summo apice obtusiusculis, basi obtusis, subcoriaceis, supra glabris, subtus consperse costa nervisque dense patenti-pilosulis, nervis lateralibus utrinsecus 7 vel 8, supra impressis, subtus prominulis, venis tenuibus inconspicuis; petiolo 5–7 mm. longo, crassiusculo, dense patenti-pilosulo; inflorescentiis totis patenti-pubescentibus, immaturis 2 cm., in fructu 3 cm. longis, basi trichotomis, ramis $\pm$ 1 cm. longis in apice 1 vel 3 flores ferentibus; floribus circiter 3 mm. pedicellatis; calyce $\pm$ 3 mm. longo, tubo campanulato, lobis 1.5 mm. longis, 2 mm. latis, patentibus; corolla valde immatura, fauce villosula; fructibus pyriformibus, 12 mm. (calycis tubo incluso) longis, 7 mm. diametro, sparsim pubescentibus, pyrenis 9 mm. longis, 6 mm. latis, obovatis, apice leviter concavis, dorso convexis, ventre planis; albumine subruminato.

NORTHEAST NEW GUINEA: Malalo Mission, *Clemens 4412* (TYPE), Nov., 1936, alt. 600 m.

The fruit of this species is similar in shape to that of *P. diplococca* (Lauterb. & K. Schum.) Val. but the leaves are very much smaller and have many less nerves.

Psychotria ihuensis sp. nov.

Frutex parvus; ramulis ultimis patenti-pubescentibus, pilis rufis, internodiis 2–5 cm. longis; stipulis 2–2.5 cm. longis, ultra medium bifidis, basi triangulari dense pubescentibus, lobis alatiformibus glabris margine pubescentibus, deciduis; foliis valde chartaceis, 18–22 cm. longis, 5.5–8.5 cm. latis, ellipticis, basi elongato-cuneatis, apice acuminatis, supra glabris, subtus costa dense, nervis sparsim pubescentibus, nervis lateralibus utrinsecus 15 vel 16 utrinque perspicuis, venis inconspicuis; petiolo 2 cm. longo, in sicco supra bisulcato, subtus convexo pubescente; inflorescentiis circiter 5 cm. longis latisque, pedunculatis (pedunculo vix 1.5 cm. longo), tantum cum fructibus immaturis visis, fructibus (calyce excluso) glabris reliquis pubescentibus, pilis rufis patentibus; ramis 4-verticillatis vel superioribus oppositis; bracteis linearibus 1–5 mm. longis; ramulis ultimis brevissimis; fructibus 1–1.5 mm. pedicellatis, apice calyce persistente coronatis; calyce valde 5–6-dentato, dentibus acutis; albumine probabiliter ruminato.

BRITISH NEW GUINEA: Ihu, Vailala River, *Brass 962* (TYPE), Feb., 1926, rain-forest (softwood shrub; leaves somewhat fleshy).

This collection was previously reported, Jour. Arnold Arb. 14: 65. 1933, as *Psychotria polyneura* Val. vel aff. It differs in several characters from that species; in this new species the stipules are split beyond the middle, the thickened basal triangular part is pubescent on both surfaces, the rest of the stipule is thinner in texture and pubescent only on the margin, each lobe being somewhat like a wing attached to the sides of the triangular pubescent part, the veins are mostly inconspicuous except for the main one which splits, each branch lying fairly close to the inner margin of each lobe, the nerves ascending rather than spreading, and the inflorescence is densely pubescent and the bracts are linear. The specimen more nearly answers the description of *P. ochnidiophora* Wernh. but in the latter the inflorescence is much more ample, and the calyx-lobes are three times as long.

Psychotria dolichosepala sp. nov.

Frutex 1.5 m. altus; ramulis ultimis compressis rufo-pubescentibus, internodiis 1–8 cm. longis, stipulis 1.2–2.5 cm. longis, 5–9 mm. latis, bifidis, extus ± pubescentibus, intus dense pubescentibus, fere villosis, lobis 5–8 mm. longis, lineari-lanceolatis, subpersistentibus; foliis 5.5–13 cm. longis, 2.5–5.5 cm. latis, ellipticis vel lanceolatis, utrinque angustatis, apice obtuse acuminatis, basi acutis, supra glabris, subtus sparsim, nervis venisque dense rufo-pilosulis, nervis lateralibus utrinsecus 11–16 arcuato-patentibus prope marginem adscendentibus et interdum confluentibus, supra impressis, subtus prominentibus, venis et reticulo supra manifestis, subtus vix prominulis; petiolo 1–2 cm. longo, pubescente vel glabrato; inflorescentiis in alabastro 4 cm. (in fructu 4.5 cm.) longis, trichotomis, pedunculatis, pedunculo 1–1.5 cm. longo, ex toto (corollae tubo excepto) rufo-pubescentibus; bracteis linearibus; floribus breviter pedicellatis; ovario circiter 3 mm. longo, oblongo; calyce 4 mm. longo, 5-fisso, lobis angustatis, elongatis; corolla tantum in alabastro visa, tubo extus glabro intus dimidio superiore barbato-pilosulo, lobis extus pubescentibus; antheris probabiliter exsertis; fructibus ellipsoideis, 7 mm. (calyce incluso 11 mm.) longis, 5 mm. latis, pubescentibus, calyce coronatis, medianis leviter sulcatis; pyrenis fere levibus, 6 mm. longis, 5 mm. latis, dorso convexis, ventre planis, albumine ruminato.

NETHERLANDS NEW GUINEA: 9 km. northeast of Lake Habbema, *Brass 10871* (TYPE), Oct., 1938, alt. 2700 m., forest undergrowth in valley bottom (shrub 1.5 m.), Bele River, 18 km. northeast of Lake Habbema, *Brass 11224*, Nov., 1938, alt. 2300 m., frequent in forest undergrowth (flowers white).

In several characters this species is similar to *Psychotria Wichmannii* Val. The latter differs in having larger leaves with prominent venation, much larger inflorescence, and costulate pyrenes.

Psychotria dolichosepala forma **glabra** forma nov.

A forma typica differt planta glabra; stipularum cicatricibus tantum rufo-pubescentibus; foliis saepe acute acuminatis, venis inconspicuis; infructescentiis paulo latioribus (6 cm. latis); antheris inclusis.

NETHERLANDS NEW GUINEA: 15 km. southwest of Bernhard Camp, Idenburg River, *Brass 12096* (TYPE of form), Jan., 1939, alt. 1800 m., occasional in mossy forest seral growths (shrub 1 m. high; flowers white).

Apart from the lack of pubescence this collection very closely resembles the species described above. Possibly it is only a variation brought about by altitude or by habitat.

Psychotria trichocarpa Val. Bot. Jahrb. **61**: 100. 1927.

BRITISH NEW GUINEA: Wuroi, Oriomo River, *Brass 5720*, Jan., 1934, alt. 10–20 m. light rain-forest (low spreading shrub under 1 m. high; leaf-nerves prominent and whitish beneath; flowers white).

Although the type came from Northeast New Guinea at 600 m. altitude the habit is so striking and our specimen fits the original description so well that we have no hesitancy in assigning it to this species.

Psychotria balimensis sp. nov.

Frutex parvus, 1 m. altus, inflorescentiis exceptis glaber; ramis cinereis, teretibus, longitudinaliter sulcatis, internodiis 5–15 mm. longis; stipulis 7–9 mm. longis, elongato-ovatis, apice acutiusculis, caducis, cicatricibus pubescentibus; foliis leviter obovato-oblongis vel elliptico-oblongis, 3.5–8.5 cm. longis, 1.5–3.5 cm. latis, apice acutis vel breviter acuminatis fere apiculatis, basi cuneatis, valde chartaceis, nervis lateralibus utrinsecus 10–15 patentibus prope marginem arcuatis, utrinque prominulis, venis subobscuris vel manifestis; petiolo $\pm$ 5 mm. longo; inflorescentiis 3–6 cm. longis, pedunculatis, pedunculo 1.5–2.5 cm. longo, axi et ramis puberulis, ramis verticillatis; floribus glabris, sessilibus vel subsessilibus; calyce undulato, circiter 0.5 mm. longo; corollae tubo 2.5 mm. longo extus glabro, intus fauce inferiore et inter stamina villoso-barbato, lobis 2 mm. longis; filamentis brevissimis, antheris ellipsoideis, 1 mm. longis, dimidio superiore exsertis; disco fere 1 mm. longo; stylo $\pm$ 4.5 mm. longo, exserto.

NETHERLANDS NEW GUINEA: Balim River, *Brass 11679* (TYPE), Dec., 1938, alt. 1600 m., muddy banks of stream (shrub 1 m. high; flowers white).

This species may be allied to *Psychotria Wernhamiana* S. Moore; from the original description of the latter it would seem as if the two are similar in habit. Moore's species has a bracteate inflorescence, whereas in *P. balimensis* the branches are subtended by little more than ciliate slightly protruding margins, the calyx is not dentate, and the corolla is villous in the lower part of the throat; further, the leaves are not striolate.

Psychotria multifurca Val. Bot. Jahrb. **61:** 90. 1927.

NETHERLANDS NEW GUINEA: 15 km. southwest of Bernhard Camp, Idenburg River, *Brass 12261, 12355,* Jan., 1939, alt. 1800 m. and 1650 m., open place in mossy forest, and open side of a ravine (shrub 1–1.5 m. high; leaf-margins crinkled; flowers white); 6 km. southwest of Bernhard Camp, Idenburg River, *Brass 12800,* Feb., 1939, alt. 1200 m., rain-forest undergrowth (tree 3 m. high; leaf-margins crinkled).

These collections agree in large measure with the original description of Valeton's species. It is to be noted that Brass has recorded in each collection that the leaf-margins are crinkled, this is not a common character in the group under consideration, nor is it mentioned in the original description of this species; in the dried specimens it appears in varying degrees. The leaves are almost caudate-acuminate (acumen 1.5–2 cm. long) rather than shortly or moderately acuminate as indicated in Valeton's remarks, and the lateral nerves although distinctly manifest hardly project at all beyond the lower leaf-surface. The inflorescences seen are 12–15-flowered but scarcely multiflorous. Another collection apparently belonging to this alliance is *Brass 3990* from Dieni, Ononge Road, collected at 500 m. alt. from the rain-forest floor, a very small shrub with leaves 11–15 cm. long and 1.5–2.5 cm. broad, very thin in texture, at base and apex acute and acuminate.

Psychotria multicostoides Val. Bot. Jahrb. **61:** 92. 1927, vel. aff.

BRITISH NEW GUINEA: Mafulu, *Brass 5304,* Oct., 1933, alt. 1250 m., in oak forest (small shrub; leaves smooth, dull; flowers white, perfumed; soft white fruit).

This collection, in practically all characters except those of the flowers and fruit, corresponds to the original description of *Psychotria multicos-*

toides Val. In his comment after the citation of specimens Valeton indicates that the material is not sufficiently complete for a good description. Whereas Valeton describes the calyx as cupular, obsoletely dentate or truncate, and the young fruit as pyriform crowned by the disk, in the Papuan collection the flowers are fairly large, the calyx is cupular, 1.5 mm. long, and varying from undulate to irregularly dentate; the corolla-tube is 5 mm. long and barbate in the upper half, with lobes 2 mm. long; anthers 1.5 mm. long, exserted; style and stigmas 5 mm. long; the fruit is more or less subglobose, 5 mm. long, 4 mm. diameter, and obviously crowned by the calyx, the pyrenes are slightly 2-costate and rugulose on the dorsal surface, and the albumen is ruminate.

Psychotria miniata sp. nov.

Arbor parva ad 5 m. alta, sparsim ramosa, glabra; ramis ultimis compressis, internodiis circiter 1 cm. longis; stipulis non visis, cicatricibus glabrescentibus; foliis obovato-ellipticis, 24–28 cm. longis, in tertio supero 9–11 cm. latis, deorsum sensim angustatis, basi elongato-cuneatis, apice subabrupte acuminatis, acumine circiter 1 cm. longo, chartaceis, utrinque glabris, nervis lateralibus utrinsecus ± 21 utrinque prominulis, oblique adscendentibus vel patenti-adscendentibus prope marginem arcuatis, reticulo supra obscuro, subtus sub lente conferto; petiolo ± 1 cm. longo, supra plano, subtus convexo; infructescentiis 5 cm. longis, prope basin ramosis; floribus non visis, probabiliter in apice ramulorum subfasciculatis; fructibus subglobosis, in sicco 1.3 cm. diametro, pyrenis 1 cm. longis, 7–8 mm. latis, ventre fere planis, dorso convexis, in tertio infero abrupte cuneato-angustatis et valde compressis, supero 3-costatis, costis acutis, apice leviter concavis, semine pyrenae conformi, albumine ruminato.

SOLOMON ISLANDS: Ysabel: Garona River, *Brass 3362* (TYPE), Dec., 1932, swampy lowland forests (small sparsely branched tree attaining 5 m. in height; leaves fleshy, grayish beneath; fruit smooth, scarlet, about 2 cm. diameter).

The distinguishing features of this species are the large leaves with relatively short petioles, the short infructescences with large fruits barely pedicellate, and the pyrenes with three acute ribs or narrow wings on the upper two-thirds of the dorsal surface.

Psychotria Kajewskii sp. nov.

Arbor circiter 15 m. alta; ramis ultimis glabris, compressis, internodiis vix 1 cm. longis (ramis visis tantum 10 cm. longis); stipulis non visis, cicatricibus novellis suberosis intus leviter pubescentibus; foliis oblongis, 14–22 cm. longis, 4.5–8 cm. latis, apice subabrupte acuminatis, acumine vix 1 cm. longo, basi anguste cuneatis, utrinque glabris, tenuiter chartaceis, nervis lateralibus utrinsecus 13–16, supra manifestis, subtus prominulis, patentibus, versus marginem arcuatis ± confluentibus, reticulo supra inconspicuo subtus manifesto, sub lente conferto; petiolo 2–4.5 cm. longo; inflorescentiis glabris, plerumque e basi ramosis, 4–6 cm. longis, ramis verticillatis vel oppositis, brevibus, verticillis saepe 2; floribus 1–3 (in fructu 7) mm. pedicellatis; calyce et ovario 1.5 mm. longis, calyce brevissimo et undulato; corolla sub anthesin 2.2 cm. longa (intus glabra), lobis 3–4 mm. inclusis; antheris 2–3 mm. longis, probabiliter anthesis tempore exsertis; filamentis antheris aequaliter longis; stylo 1.8 cm. longo; fructibus globosis, ± 1 cm. diametro; pyrenis 1 cm. longis, 7.5 mm. latis, ventre planis, dorso medio carinatis marginem versus convexis deinde compressis; albumine ruminato.

Solomon Islands: Bougainville: Kupei Gold Field, *Kajewski 1652*, April, 1930, alt. 950 m., rain-forest; same locality, ***Kajewski 1707*** (type), April, 1930, alt. 1000 m., rain-forest (small tree up to 15 m. tall; flowers white; fruit brown when ripe, globular, 1.1–1.2 cm. diameter).

Psychotria Kajewskii has several characters in common with the description of *P. aurea* Lauterb. The lateral veins of the leaves are, however, definitely spreading rather than ascending, the flowers are considerably larger, and the throat of the corolla is not barbate as in the latter species. In our species the calyx-tube is so short that at the apex of the fruit the disk is more prominent than the calyx.

Psychotria melanocarpa sp. nov.

Arbor 6–7 m. alta; ramulis ultimis glabris, nigrescentibus, internodiis 1–3 cm. longis; stipulis 1.5–2 cm. longis, ± 1.2 cm. latis, basi connatis, bilobatis, lobis basi latis, apice circiter 3–4 mm. lineari-subulatis, extus ± dense pubescentibus deinde glabrescentibus, subpersistentibus; foliis ellipticis vel oblongo-ellipticis, 7–20 × 3–12 cm. etiam 10 × 4 cm., 22 × 9 cm., 24 × 12.5 cm., apice vel abrupte acuminatis (acumine 7–10 mm. longo) vel sensim acuminatis (acumine circiter 1.5 cm. longo), basi rotundatis vel obtusis deinde cuneatis vel breviter decurrentibus, coriaceis, supra glabris, subtus consperse puberulis deinde glabratis, costa nervisque ± dense pubescentibus, nervis lateralibus utrinsecus 10–18 oblique patentibus deinde arcuatim adscendentibus, supra impressis, subtus prominentibus, venis subtus prominulis laxum reticulum formantibus, supra manifestis; petiolo 3–5.5 cm. longo, glabro; inflorescentiis immaturis 3 cm. longis, ramis et ramulis dense minute pubescentibus, verisimiliter non bracteatis; alabastris sessilibus vel subsessilibus in apice ramorum brevium, glabris; calyce et ovario 2.5 mm. longis, calycis limbo 1 mm. longo, minute dentato; corolla 2.5 mm. lobis 2 mm. inclusis longa (probabiliter maturitate longiore), fauce et loborum basi barbatis; infructescentiis 10–12 cm. longis, circiter 10 cm. latis, pedunculo vix 3 cm. longo, ramis verticillatis, verticillis 3 vel 4, fructibus subglobosis basi leviter angustatis, 1.2 cm. diametro, pyrenis levibus, dorso convexis, ventre planis, basi late cuneatis; albumine ruminato.

British New Guinea: Palmer River, 2 miles below junction Black River, *Brass 7090* (type), June, 1936, alt. 100 m., subseral forest on an old garden site in ridges (tree 6 m. tall; leaves stiff, prominently nerved; flowers white); Fly River, 528 mile Camp, *Brass 6735*, May, 1936, alt. 80 m., common in rain-forest second growths (small tree 6–7 m. tall; stiff branching habit; leaves pale, shining above; fruit subglobose, fleshy, black, ± 1.2 cm. diameter).

It is difficult to suggest some species which might be considered as nearly related to this. In some features of the leaves, and also in the cupular almost truncate calyx, there is a little similarity with *Psychotria sentanensis* Val., but the former species seems to be amply distinct from the others described on the following combination of characters: prominent leaf-venation, sparsely reddish hairy along the main nerves; glabrous long petiole; ebracteate inflorescence with pubescent axis and branches; glabrous flowers with short cupular minutely dentate calyx; black shining fruit with smooth pyrenes.

Psychotria solomonensis sp. nov.

Arbor parva, usque 8 m. alta, inflorescentiis leviter puberulis exceptis glabra; ramulis ultimis teretibus, vel leviter compressis, levibus, internodiis superioribus 0.7–2.5 cm. longis; stipulis elliptico-oblongis ± 1 cm. longis, apice late acutis, ad medium connatis, cito caducis; foliis oblongo-ellipticis vel leviter obovato-oblongis, 6–12 cm. longis, 1.5–4.5 cm. latis, apice subabrupte acuminatis, acumine 0.6–1.5 cm. longo, acutiusculo, basi angustatis acutis vel cuneatis, firme chartaceis, nervis lateralibus utrinsecus 8–12 utrinque prominulis, arcuatim adscendentibus, reticulo utrinque ± manifesto, sub lente conferto; petiolo 1–2 cm. longo; inflorescentiis 2.5–4 cm. longis, e basi ramosis, minute puberulis, minute bracteatis; floribus in apice ramulorum breviter vel vix pedicellatis, glabris; calyce ± 1 mm. longo, cupuliforme, minute 5-dentato; corollae tubo 3.5 mm. longo, fauce dense barbato, lobis 1.5 mm. vel vix 2 mm. longis; antheris 1 mm. longis, exsertis, filamentis 1 mm. longis; fructibus 7 mm. diametro, subpyriformibus; pyrenis dorso subrugosis et leviter 3-costatis, ventre planis; albumine ruminato.

SOLOMON ISLANDS: Ysabel: Tatamba, *Brass 3419*, Jan., 1933, alt. 50 m., hardwood forests (slender small tree with smooth green branches; leaves with recurved apex, lower surface of petiole and midrib brown; fruit smooth, shining brown); Malaita: Quoimonapu, *Kajewski 2367* (TYPE), Dec., 1930, alt. sea level, rain-forest (small tree up to 8 m. tall; flowers white; fruit red when ripe, 7 mm. diameter); Guadalcanal: Uulolo, Mount Tutuve, *Kajewski 2567*, April, 1931, alt. 1200 m., rain-forest (small tree or large shrub-like tree up to 4 or 5 m. high; fruit brown-green when ripe, 1.2 cm. diameter); same locality, *Kajewski 2609*, alt. 1500 m., rain-forest (small tree up to 8 m.; fruit red when ripe, 1.8 cm. long, 1.6 cm. diameter); San Cristoval: Hinuahaoro, *Brass 3063B*, Sept., 1932, alt. 900 m., mountain rain-forests (small tree 2–3 m., underside of leaves gray-green; flower white; fruit green).

We have not seen the flowers of the last specimen cited above, but in general habit it seems to agree with the others. The species somewhat resembles *P. luconiensis* (Cham. & Schlecht.) F. Villar. It is readily distinguished from the latter by the closer reticulation of the leaves, the fewer lateral veins, the less definitely dentate calyx, and relatively much longer tube and shorter lobes of the corolla.

Psychotria hebecarpa sp. nov.

Arbor parva; ramulis ultimis dense patenti-pilosis, pilis crispulis, internodiis 0.7–1.5 cm. longis; stipulis 1–1.2 cm. longis, 3–4 mm. latis, dense patenti-pilosis, ad medium bifidis (lobis lineari-subulatis) mox caducis, cicatricibus annularibus intus dense pilosis; foliis oblongis, 3.5–10 cm. longis, 1.8–3.5 cm. latis, apice acutis, basi truncatis, chartaceis, supra glabris, subtus molliter pubescentibus, nervis lateralibus utrinsecus 8–13 supra manifestis, subtus subprominulis, subpatentibus, prope marginem ± confluentibus; venis inconspicuis; petiolo 1–2.5 cm. longo, gracili, dense crispule patenti-piloso; inflorescentiis 1.5 (in fructu 2) cm. longis, breviter pedunculatis (pedunculo 0.6–1 cm. longo), totis dense patenti-pilosis vel subvillosis, bracteatis, bracteis subulatis, parvis; floribus ante anthesin tantum visis; calycis lobis 5, lanceolatis, 1 mm. longis; corolla 5 mm. longa, tubo leviter supra medium dense barbato, lobis 1.5 mm. longis; filamentis

1 mm. longis, antheris linearibus, 1 mm. longis; stylo glabro, 3 mm. longo. fructibus oblongis, calyce coronatis, in sicco leviter costatis, 5 mm. longis, 3 mm. diametro; pyrenis dorso leviter 3-costatis, albumine aequabile.

British New Guinea: Aisa River, Central Division, *Brass 1419* (type), May, 1926, in light pole forests (small tree; fruit white, succulent).

A species readily recognized by the contour of the leaves, the crisply hairy inflorescence, the oblong costate fruits, and the linear-subulate lobes of the stipules.

Psychotria tenuipes sp. nov.

Arbor usque 6 m. alta, glabra; ramulis ultimis teretibus, internodiis 1.5–2.5 cm. longis; stipulis gemmae evolutae deciduis in apice ramorum in vaginam longissimam (10–25 mm. longam) subteretem gemmam includentem connatis, apice 4-furcatis; foliis oblongo-lanceolatis, 5.5–11.5 cm. longis, 1.5–4 cm. latis, acutis vel acuminatis basi cuneatis, chartaceis, nervis lateralibus utrinsecus 8–13 utrinque prominulis, reticulo laxo utrinque manifesto; petiolo 1–1.4 cm. longo; inflorescentiis ± 3 cm. longis, plerumque bis ramosis, paucifloris; pedunculo gracili, ± 1.5 cm. longo; floribus circiter 5 vel 6, pedicellatis, pedicello 1.5–2 mm. longo; calyce cupulari tubo 1.5–2 mm. longo, lobis 1.5 mm. longis; corolla glabra, tubo 5 mm. longo, lobis 3 mm. longis; antheris 2 mm. longis; fructibus oblongis, circiter 1 cm. longis, 5 mm. latis, ± obtuse 4-angulatis; calyce vix persistente; pyrenis 7 mm. longis, 4 mm. latis, dorso medio manifeste costato, costa lata et obtusa, ventre plano; albumine aequabile.

Solomon Islands: Bougainville: Kupei Gold Field, *Kajewski 1708* (type), April, 1930, alt. 1000 m., rain-forest (small tree up to 6 m. high; flower white; fruit brown when ripe, oblong ending in a sharp point, 1 cm. long, widest diameter 6 mm.).

Psychotria tenuipes is best recognized by the very slender inflorescence (sometimes axillary) and the oblong obtusely angled fruit. The type is fragmentary and more material is needed, but it looks like none of the other species which we have seen.

Psychotria tenuis sp. nov.

Arbuscula 3 m. alta, glabra; ramulis gracilibus, 4-angulatis, internodiis 0.5–2 cm. longis; stipulis 1 mm. longis in tubum vaginatum connatis, apice bidentatis, caducis; foliis 3–5 cm. longis, 0.6–1.4 cm. latis, anguste lanceolatis, apice attenuato-acuminatis vel caudatis, cauda ± 1 cm. longa, angusta, obtusiuscula, basi cuneatis, chartaceis, nervis lateralibus utrinsecus circiter 5, supra obscuris, subtus vix manifestis; petiolo 3 vel 4 mm. longo, tenui; inflorescentiis 1–2 cm. longis, pedunculatis, pedunculo ± 5 mm. longo, ramosis, ramis vix 5 mm. longis, bracteatis, paucifloris; bracteis minutis; calyce vix 1.5 mm. longo, minute 5-dentato; corollae tubo 5.5 mm. longo, tereti, basi leviter tumido, intus in dimidio supero patenti-pubescente vel barbato, lobis ovatis, 1.5 mm. longis; filamentis 1 mm. longis, antheris 1 mm. longis, apice tantum exsertis; disco 1 mm. longo, ultra calycem protuberante; stylo 4 mm. longo, stigmatibus 1 mm. longis; fructibus ovoideis, 7 mm. longis, 4 mm. diametro, circiter 8-costatis, costis obtusis; pyrenis dorso 3-costatis, sulcis inter costas rotundatis, ventre planis, albumine aequabile.

Netherlands New Guinea: 6 km. southwest of Bernhard Camp, Idenburg River, *Brass 12983* (type), Feb., 1939, alt. 1050 m., rain-forest undergrowth (tree 3 m. high; flowers white).

The habit of this species is very much like that of *Psychotria subcaudata* Val. but it is more slender in every way, the leaves are longer petioled and the apex is very much narrower, and also the flowers differ in the relative lengths of the corolla-tube and lobes.

Psychotria trichostoma sp. nov.

Arbor parva glabra; ramulis subteretibus, internodiis 1–5 cm. longis; stipulis lanceolatis, apice (in specimine typico) caudatis, caducis, cicatricibus non pubescentibus; foliis lanceolato-ellipticis vel ellipticis, 13–18 cm. longis, 5–7.5 cm. latis, apice breviter acuminatis, acumine 0.5–1 cm. longo, basi 5–7 mm. lato, basi elongatis et anguste cuneatis vel acutis, chartaceis, nervis lateralibus utrinsecus 8–10 utrinque prominulis, oblique patenti-adscendentibus, venis subtus manifestis sed inconspicuis, reticulo sub lente conferto manifesto vel obscuro; petiolo 2–3 cm. longo; inflorescentiis breviter (5–10 mm.) pedunculatis, non bracteatis; ramis 5–7 circiter 1–2 cm. longis deinde cymoso-ramosis, ramulis ultimis 3–4 mm. longis; floribus in apice ramulorum subfasciculatis, pedicellatis, pedicellis circiter 1 mm. longis; calyce et ovario obconicis, calyce truncato ± 1 mm. longo; corollae tubo 3 mm. longo, fauce dense barbato, lobis 2 mm. longis, ovatis; antheris 1.2 mm. longis partim exsertis; stylo 3 mm. longo; fructibus 8 mm. diametro, vix maturis, subgloboso-pyriformibus, leviter compressis; pyrenis dorso convexis, apice subtruncatis, latere infra medium subabrupte paulo latioribus, basi late cuneatis, ventre subplanis; albumine aequabile ventre sulcato.

SOLOMON ISLANDS: Florida (N'Gela): north end of the island, *Brass 3515* (TYPE), Jan., 1933, coastal rain-forests (small tree with dull leaves, pale beneath; flower cream-colored; fruit smooth, green); Ysabel: Sigana, *Brass 3529*, Jan., 1933, rain-forest (small tree); Bougainville: Kieta, *Kajewski 1611*, Mar., 1930, alt. 100 m., rain-forest, near fresh-water creek (shrub up to 2 m. high; flower cream-green; fruit brown-green, 1 cm. long, 9 mm. diameter).

In Valeton's treatment of the genus *Psychotria* in Northeast New Guinea, under *P. Schmielei* Warb. he cites the collection *Warburg 21454*. We have at hand another specimen from the Bismarck Archipelago, *Warburg 21453*. Whether this is a duplicate or an isotype, we do not know, but apart from lacking fruit the specimen seems to agree well with the original description. Our species is very closely related to this one. The leaves are the same shape and the mode of inflorescence is comparable, but in Warburg's species the texture of the leaves is thinner, the branches and branchlets of the inflorescence are much less robust, perhaps one should say much more thread-like, the flower is smaller, and the corolla is glabrous in the throat; the fruit, according to the description, is 1-costate.

Psychotria trichostoma var. **macrophylla** var. nov.

A forma typica differt foliis majoribus, 29 cm. longis vel ultra, 13 (–19) cm. latis, inflorescentiis multifloris, floribus (in alabastris tantum visis) multo minoribus.

SOLOMON ISLANDS: Bougainville: Marmarromino, *Kajewski 2203* (TYPE of var.), Sept., 1930, alt. 50 m., rain-forest (small tree up to 10 m. high; leaves large dark shiny green; flower-buds cream-colored; fruit red when ripe, 9 mm. long, 7 mm. diameter).

When further material has been collected this may prove to be a distinct species; the specimens at hand, however, are too fragmentary to permit a final decision. The flower-buds are very much smaller than those on the type and much more crowded and profuse, but their structure is similar with indications of a very densely hairy corolla-throat. The pyrenes are essentially alike in outline but lack the slight broadening at the middle which characterizes those of the species. The leaves are very much larger, and in those which are little broken have 14 or 15 pairs of lateral nerves. The leaves on the fruiting specimen are very much broken and incomplete, but one is 19 cm. broad, and the lateral nerves (about 12 cm. above the base) are 2–3.5 cm. apart; the petiole varies from 2 to 5 cm. in length. In both flowering and fruiting speçimens the peduncle is only 1 cm. long.

In addition to the above citations we have at hand another collection from Bougainville, *Kajewski 2001,* which has leaves, in size, intermediate between the species and the variety, but the fruit is orange-colored when ripe and when dry has a much thicker somewhat spongy exocarp. The pyrene closely resembles that of the species. Unfortunately we have no flowering material of this collection.

Psychotria sarcodes sp. nov.

Frutex ramosus 1.5 m. altus; ramulis ultimis compressis vel sulcatis, breviter patenti-pubescentibus, internodiis 1–5 cm. longis; stipulis brevibus, bilobis, extus rufo-pubescentibus, cito caducis, cicatricibus annularibus; foliis obovatis, 10–18 cm. longis, 4–6 cm. latis, tenuiter chartaceis, apice breviter acuminatis, basi elongatis anguste cuneatis vel acutis, supra glabris, subtus costa nervisque pubescentibus, nervis lateralibus utrinsecus 13–18 utrinque prominulis, oblique patentibus, venis vix manifestis, tenuibus; petiolo 1–1.5 cm. longo, supra glabro, plano, subtus pubescente, convexo; inflorescentiis circiter 2 cm. longis, e basi ramosis, minute puberulis, floribus glabris, 1 mm. pedicellatis; calyce vix 1 mm. longo, 5-dentato, dentibus caducis; corollae tubo 4 mm. longo, fauce ampliato, dense villoso-barbato; lobis 2 mm. longis; staminibus 5, sub dimidio corollae tubi insertis; stylo 4 mm. longo; stigmata bilobata, lobis planis; fructibus late ellipticis, in sicco 1 cm. longis, 9 mm. latis, compressis; pyrenis paulo minoribus, ventre planis, dorso complanatis sed ab apice ad medium carinatis, carina inclusa 3 mm. crassis; albumine aequabile.

SOLOMON ISLANDS: San Cristoval: Waimasi, *Brass 2782* (TYPE), Aug., 1932, alt. 100 m., rain-forests, common (bushy shrub 1.5 m. tall; leaves rather fleshy, petioles purple; flower white); Ulawa: *Brass 2954,* Oct., 1932, alt. 100 m., rain-forests (shrub 1.5 m. tall; flower white; fruit red, soft and fleshy, about 2 cm. diameter).

The distinctive characters of this species are the obovate leaves with elongated narrow base, the short inflorescences, and the flattened pyrenes with the sharp thin keel on the upper half.

Psychotria leiophylla sp. nov.

Arbor parva gracilis glabra, vel frutex magnus; ramis ultimis gracilibus compressis, internodiis 1–4 cm. longis; stipulis membranaceis intus dense pubescentibus, cito caducis, parvis, ± 2 mm. longis, acutiusculis, ± annularibus; cicatricibus saepe dense pubescentibus; foliis elliptico-lanceolatis vel lanceolatis, in specimine typico 11.5–18 cm. longis, 4.5–7 cm. latis, in ceteris 9.5–14 × 3.5–7 cm. etiam 12–16 × 3–4.5 cm., apice et basi acutis vel leviter acuminatis, tenuiter chartaceis fere membranaceis, nervis lateralibus utrinsecus 8–10 utrinque subprominulis, oblique patentibus versus marginem arcuatim adscendentibus, reticulo laxo inconspicuo; petiolo 1–2.5 cm. longo, gracili; inflorescentiis 3–5 cm. longis latisque, cymoso-paniculatis; pedunculo 1–2 cm. longo; bracteis lineari-lanceolatis, inconspicuis; floribus in apice ramorum brevium subfasciculatis pedicellatis, pedicellis 1 mm. longis; calyce 0.5 mm. longo, dentato; corollae tubo 4 mm. longo, intus fauce densissime barbato, lobis 1.5 mm. longis, basi barbatis; antheris linearibus vix 1.5 mm. longis magna ex parte exsertis, filamentis brevissimis; stylo 5 mm. longo in parte superiore puberulo; fructibus late ovoideo-ellipsoideis, basi fere truncatis, apice late rotundatis calyce coronatis, 4–5 mm. longis, basi 4–5 mm., apice 3–4 mm. latis, 3 mm. crassis; pyrenis dorso subrotundatis, ventre bisulcatis; albumine aequabile.

SOLOMON ISLANDS: San Cristoval: Huro River, *Brass 3008*, Oct., 1932, riverine rain-forest (small slender tree; under surface of leaves very pale green; flowers pale yellow); Star Harbor, *Brass 3133* (TYPE), Oct., 1932, coastal rain-forest (large shrub); Owa Raha (Santa Anna, southeast of San Cristoval), *Brass 3086*, Oct., 1932, alt. 100 m., rain-forest (small tree with very smooth and somewhat fleshy leaves).

A rather striking looking collection with very thin leaves, relatively short inflorescence, small flowers with the throat densely hairy, a character drawing instant attention to an open flower, unusual shaped fruit slightly broader at the base than at the apex, and lastly the sharp rib in the ventral surface of the pyrene emphasized on either side by a narrow sinus.

Psychotria waimamurensis sp. nov.

Frutex 1.5–2 m. altus; ramulis fusco-puberulis, internodiis 1.5–3 cm. longis; stipulis non visis, cicatricibus pubescentibus; foliis lanceolatis vel elliptico-lanceolatis, 11–19 cm. longis, 3.5–6 cm. latis, utrinque sensim angustatis, apice acuminatis acumine acuto vel obtusiusculo, basi anguste cuneatis, chartaceis, supra glabris, subtus costa nervisque inconspicue puberulis, nervis lateralibus utrinsecus $\pm$ 14 oblique patentibus, supra manifestis, subtus prominulis, venis inconspicuis, reticulo laxissimo vix manifesto; petiolo 7–10 mm. longo, supra plano; inflorescentiis terminalibus, sessilibus, compactis, bracteatis; bracteis circiter 4, parvis, $\pm$ 2 mm. longis, subrotundatis, extus minute pubescentibus; floribus non visis; fructibus $\pm$ 12, breviter pedicellatis; pedicellis circiter 2 mm. longis, glabris; fructibus in sicco pyriformibus, costatis 12 mm. longis, 6 mm. diametro, glabris; pyrenis 10 mm. longis, 5 mm. latis, ventre planis, dorso convexis, medio alatiformi-costatis, interdum etiam costis 2 minoribus; albumine aequabile.

SOLOMON ISLANDS: San Cristoval: Waimamura, *Brass 3203* (TYPE), rain-forests; common (shrub 1.5–2 m. high; fruit red, fleshy).

This species suggests *Psychotria capitulifera* Merr. & Perry, but the leaves are more narrowed at both ends, the inflorescence is sessile, and the bracts subtending it are very much smaller than in the species from Ysabel Island.

Psychotria capitulifera sp. nov.

Arbor parva; ramulis ultimis subteretibus vel compressis et obtuse angulatis, pubescentibus, pilis patentibus, circiter 0.5 mm. longis, rubiginosis; stipulis $\pm$ 17 mm. longis, fere ad medium bifidis, parte inferiore utrinque pubescentibus, lobis lineari-lanceolatis, cicatricibus pubescentibus; foliis ellipticis vel obovato-ellipticis vel novellis oblongis, 9–20 cm. longis, 3–8.5 cm. latis, apice acutis vel breviter acuminatis, basi obtusis vel anguste rotundatis, chartaceis, supra glabris, subtus inter nervos sparsim nervis dense patenti-pubescentibus, nervis lateralibus utrinsecus 8–14, oblique adscendentibus, utrinque prominulis, venis supra obscuris, subtus inconspicuis, subparallelis, subtransversis vel obliquis; petiolo 0.5–1 cm. longo, dense patenti-pubescente; inflorescentia solitaria terminali erecta probabiliter globosa densiflora pedunculata, in sicco circiter 2 cm. diametro, involucrato, bracteis involucralibus $\pm$ 1 cm. longis, pedunculo 2 cm. longo, glabro; floribus dense confertis; pedicellis 2 mm. longis; calyce campanulato, tertio supero lobato, lobis circiter 1 mm. longis, inaequalibus, longe ciliatis ceterum glabris; corollae tubo 5–6 mm. longo, fauce dense barbato, lobis 5, 2.5–3 mm. longis, oblongo-lanceolatis, extus interdum pubescentibus, intus glabris; antheris paulo infra medium tubum insertis; disco plano, circiter 0.5 mm. longo, 1.5 mm. lato; stylo 5 mm. longo, glabro; stigmatibus planis, membranaceis, minute papillosis, patentibus.

SOLOMON ISLANDS: Ysabel: Tasia, *Brass 3277* (TYPE), Dec., 1932, common in lowland rain-forests (small tree; lower surface, midrib and main nerves pink; flowers and bracts pink).

Psychotria capitulifera is readily separated from the other species of the genus at hand from the Papuan region by the pedunculate head of flowers surrounded by an involucre. The individual flowers, however, as far as we can see without mutilating the head too much, are not subtended by bracteoles, but at the base of the short pedicel there are occasionally a few hairs. The calyx-lobes are ciliate with long fairly crowded hairs; the mouth of the corolla-tube is crowded with hairs protruding from the throat; the stamens are below the hairy region of the throat; and the stigmas are very thin, flattened and spreading above the barbate throat. The young branchlets and the under surface of the leaves are pubescent with short spreading hairs. The structure of the throat and the position of the stamens suggest a dimorphic flower, but further material is necessary before making any positive statement on this character.

Calycosia A. Gray

Calycosia Kajewskii sp. nov.

Planta usque ad 2 m. alta, glabra; ramulis internodio supero 1 cm. longo excepto non visis; stipulis magnis, 8 vel 9 cm. longis, in sicco irregulariter plicatulis, margine supero consperse dentato, dentibus apice callosis; foliis magnis, obovatis, $\pm$ 50 cm. longis, in tertio supero 12–15 cm. latis deorsum sensim attenuatis, basi acutis, apice acuminatis, acumine circiter 2 cm. longo, nervis lateralibus utrinsecus $\pm$ 45 adscendentibus, utrinque prominentibus, venis inter nervos subregulariter transversis, inconspicuis; petiolo $\pm$ 10 cm. longo, supra valde canaliculato; inflorescentiis subterminalibus; capitulo circiter 5 cm. lato, 4 cm. longo, bracteato; bracteis exterioribus ellipticis, obtusis, vix 4 cm. longis, pluribus; floribus inter bracteolas dispositis; bracteolis inaequaliter magnis, lanceolato-ellipticis, apice obtusis, basi intus glandulas elongatas suffultis; pedicellis 4 mm. longis; calyce tubulato, 6 mm. longo, undulate 5-lobato, glabro; corollae tubo 1.5 cm. longo, extus glabro, intus sub staminibus annulo-puberulo, lobis 5, circiter

3 mm. longis; antheris linearibus 2.5 mm. longis, inclusis, in fauce insertis; stylo gracili; stigmatibus exsertis; fructibus non visis.

SOLOMON ISLANDS: Bougainville: Kupei Gold Field, *Kajewski 1693* (TYPE), April, 1930, alt. 1000 m., on creek bank in rain forest (plant up to 2 m. high, with large green leaves and liking wet places; petals white, pistil transparent, almost water color, anthers white).

For the time being we have placed this collection in the genus *Calycosia,* since it has a fairly long tubular calyx, flowers in a capitate inflorescence surrounded by submembranous bracts, and large leaves. Although the general habit of the specimen is like that of *Calycosia,* the stipules are exceedingly large, also so folded and wrinkled that it is hard to say exactly what is their size and shape. The capitate inflorescence and the new vegetative bud apparently are between the two terminal leaves, one centimeter below this node and enclosing it are two stipules belonging to the node below. The bracts and bracteoles of the inflorescence are numerous and the bracteoles vary in size possibly with the age of the flower which they subtend, but all are similar in outline. We removed only a small part of the head for examination, and some flowers are already past anthesis and the corolla has fallen, while others are very young, the corolla-lobes protruding about 1 mm. above the margin of the calyx. The genus has not previously been recorded from the Solomon Islands.

Cephaelis Swartz

Cephaelis Kajewskii sp. nov.

Arbor parva usque ad 6 m. alta; ramulis minute patenti-pubescentibus, demum glabratis, internodiis 2–4 cm. longis; stipulis in gemma terminali tantum visis, apice fractis, extus rufo-pubescentibus, caducis; foliis oblongo-lanceolatis vel oblongo-ellipticis, 10–14 cm. longis, 3–5.5 cm. latis, apice breviter et obtuse acuminatis, basi anguste cuneatis, supra glabris, subtus novellis ± dense, maturis consperse (costa dense) pubescentibus, nervis lateralibus utrinsecus ± 9 oblique patenti-arcuatis utrinque prominulis marginem versus gracillimis, venis costalibus intermixtis, tenuibus; petiolo 1–1.5 cm. longo, pubescente; inflorescentiis terminalibus vel axillaribus, sessilibus, capitulo circiter 3 cm. diametro, novellis 1.3 cm. longis, 7 mm. diametro; bracteis usque ad 3 cm. longis, extus ± pubescentibus, ciliolatis; bracteolis usque ad 1 cm. longis, late rotundatis vel ovatis, membranaceis, glabris, ciliolatis; floribus ± 1 mm. pedicellatis; calycis tubo circiter 2 mm. longo, glabro, lobis 1 mm. longis, ovatis, ciliatis; corollae tubo 4.5 mm. longo, extus glabro, fauce dense villosulo, lobis 2 mm. longis; antheris vix 1.5 mm. longis, sub fauce villosula positis; stylo 4.5 mm. longo, stigmatibus leviter exsertis; fructibus subglobosis, ± 1 cm. diametro, calyce coronatis; pyrenis subrotundatis, 7 mm. longis latisque, dorso 3-costatis, costis alatiformibus deorsum angustatis, basi obscuris.

SOLOMON ISLANDS: Malaita: Quoi-mon-apu, *Kajewski 2333* (TYPE), Dec., 1930, sea level (small tree up to 6 m. high; fruit shiny red when ripe, 1.2 cm. diameter, with a small tubular protuberance at the end, pulp of fruit pink).

This species seems readily distinguishable from the other species of the genus reported from Papuasia by its smaller leaves, heads and flowers. We have not located any previous reports of the genus from the Solomon Islands.

Lasianthus Jack

Lasianthus cyanocarpoides Val. Bot. Jahrb. **61:** 108. 1927.

Northeast New Guinea: Upper Ramu, *Clemens 10741*, Aug.-Dec., 1939. British New Guinea: Dieni, Ononge Road, *Brass 3983*, May, 1933, alt. 500 m., rain-forest (one of several closely related plants common as rain-forest bushes). Previously known from Northeast New Guinea.

Lasianthus cyanocarpus Jack, var. **novaguineensis** Val. Nova Guin. Bot. 8: 498. 1911.

British New Guinea: Fly River, 528 mile Camp, *Brass 6850*, May, 1936, alt. 80 m., uncommon in ridge forest undergrowth (shrub 2 m. tall). Described from Netherlands New Guinea, previously known only from the type collection.

Lasianthus chlorocarpus K. Schum. in K. Schum. & Lauterb. Fl. Deutsch. Schutzgeb. Süds. Nachtr. 399. 1905; Val. Bot. Jahrb. **61:** 109. 1927.

Netherlands New Guinea: Mamberamo, near Prauwenbivak, *Lam 793, 1217*, Aug., Sept., 1920, alt. 100, 150 m.; Nabire, Geelvink Bay, *Kanehira & Hatusima 11632*, Feb., 1940, alt. 50 m., in tall rain-forest. British New Guinea: Koitaki, *Carr 12648;* Bisiatabu, *Brass 585*, Nov. 1925, alt. 450 m.; Dieni, Ononge Road, *Brass 3982*, May, 1933, alt. 500 m. Solomon Islands: Guadalcanal: Uulolo, Tutuve Mt., *Kajewski 2612*, May, 1931, alt. 1200 m. (shrub 1–2 m. tall; fruit blue, 8 mm. long, 6 mm. diameter, white flesh, black seeds).

Most of these collections are in fruit, very few flowers being available for comparison, and hence we are unable to tell whether this is conspecific with the Queensland material of *L. strigosus* Wight or not. The latter species is not represented in our herbarium from Ceylon, the type-region.

Lasianthus sylvestroides Val. Bot. Jahrb. **61:** 109. 1927.

Netherlands New Guinea: 6 km. southwest of Bernhard Camp, Idenburg River, *Brass 12811, 13025*, Feb., Mar., 1939, alt. 1200 and 1250 m., rain-forest undergrowth (slender near-tree 1.5 m. high; flower-buds conspicuously white hairy; fruit soft, yellow; and in *13025* fruit white).

These specimens so closely fit the description of Valeton's species that we are adding a brief diagnosis of the flower-bud, since, although he mentions the flowers, he says nothing about them except what might be drawn by inference from a fruiting specimen. The leaves in our two specimens are 8.5–14 cm. long, 2–4.5 cm. broad; in the younger specimen between the horizontal parallel veins there is an inconspicuous reticulation which is lacking in the older more coriaceous leaves. The flower-buds are up to 13 mm. long, none of them yet open. Ovary 2 mm. long; calyx-lobes 6, linear-lanceolate, subulate, 3 mm. long, tube about 1 mm.; corolla 10 mm. long, outside particularly above the calyx densely spreading hirsute, within the lower 4 mm. of the tube is glabrous, then the tube begins to be pubescent and here are the 2 mm. long anthers (6), it is difficult to say where the lobes begin as the inside of the lobes is also densely pubescent; the style is 7 mm. long, glabrous, and topped by the 1 mm. long stigmatic lobes.

Lasianthus papuanus Wernham, Trans. Linn. Soc. II. Bot. 9: 78. 1916; Val. Bot. Jahrb. 61: 106. 1927.

Netherlands New Guinea: 4 km. southwest of Bernhard Camp, Idenburg River, *Brass 13639*, March, 1939, alt. 850 m., rain-forest; occasional in the undergrowth of gullies (fruit blue).

Our plant does not wholly fit this description; the base of the leaves is cuneate, not subrounded, the upper surface of the leaves is glabrous, there are several flowers in an inflorescence rather than one or two, and the calyx-lobes on the fruit are only 1 mm. long. The buds are too young to disclose anything about the floral characters.

Saprosma Blume

Saprosma subrepandum (Lauterb. & K. Schum.) Val. Nova Guin. Bot. 8: 500. 1911. Bot. Jahrb. 61: 118. 1927

Psychotria (?) *subrepanda* Lauterb. & K. Schum. Fl. Deutsch. Schutzgeb. Süds. 579. 1900.

NETHERLANDS NEW GUINEA: Nabire, Geelvink Bay, *Kanehira & Hatusima 11559*, Feb., 1940, in tall rain-forest (plant 1 m. tall; fruit blue). BRITISH NEW GUINEA: Palmer River, 2 miles below junction Black River, *Brass 7178*, July, 1936, alt. 100 m., forest undergrowth on crests of high ridges (shrub 80–100 cm. high; fruit blue, ± 1 cm. long); Dieni, Ononge Road, *Brass 3996*, May, 1933, alt. 500 m., rain-forest understorey (slender bush or tree 2 m. tall; very thin dull leaves darker above; fleshy pale blue ovoid fruit ± 1 cm. long, 7 mm. diameter); Koitaki, *Carr 12543*, June, 1935, alt. 450 m., forest (shrub little over 1 m. tall; flowers white). SOLOMON ISLANDS: San Cristoval: Magoha River, *Brass 2733*, Aug., 1932, alt. 150 m., rare; steep side of rain-forest ravine (much branched little shrub 50 cm. high; leaves wrinkled, very pale beneath).

These collections seem to have the characteristic stipular glands of the genus *Saprosma*. The species has been reported previously from Netherlands New Guinea and Northeast New Guinea. Several of the fruits cut transversely showed only one seed which would normally be called a pyrene, but one showed two locules and here the crustaceous thickening of the endocarp did not extend over the ventral wall of the seed as one would expect in the case of two pyrenes. More material is desirable.

Saprosma Brassii sp. nov.

Frutex circiter 2 m. altus; ramulis teretibus, novellis compressis vel leviter sulcatis, rufo-pubescentibus, pilis crispis; stipulis non visis vel fractis; foliis 13–16 cm. longis, 5.5–6.5 cm. latis, elongato-ovatis, apice obtuse acuminatis, basi rotundato-cuneatis vel obtuse cuneatis, supra glabris, subtus consperse costa nervisque ± dense pubescentibus, pilis brevibus et crispis, nervis lateralibus utrinsecus 12 vel 13 distincte manifestis, subtus prominulis, oblique patentibus prope marginem arcuatim confluentibus, venis costalibus intermixtis, versus marginem reticulo laxo praesertim subtus distincte manifesto; petiolo 1.5–2.2 cm. longo, rufo-pubescente; inflorescentiis axillaribus, sessilibus, bracteatis, bracteis fractis; floribus confertis, probabiliter subsessilibus, bracteolatis; bracteolis ± oblongis, 2–4 mm. longis, 1 mm. latis, extus sparsim, marginem versus dense pilosulis et margine 3–5-glandulosis, pilis glandulosis circiter 0.5 mm. longis; calycis tubo circiter 1 mm. longo, lobis 1.5–2 mm. longis, lanceolato-oblongis, extus pubescentibus, ciliatis; corolla in alabastro tantum visa, tubo extus glabro, 2 mm. longo, intus dimidio supero dense villosulo, lobis 1.5 mm. longis, extus sparsim pubescentibus; antheris in fauce insertis, 1.5 mm. longis; stylo glabro, stigmatibus lineari-oblongis; fructibus non visis.

SOLOMON ISLANDS: Florida (N'Gela or Tulagi): *Brass 3519* (TYPE), Jan., 1933, alt. up to 20 m., rain-forest slopes (compact shrub about 2 m. tall; leaves deeply wrinkled, upper side very dark and shining; flowers pink).

This is not closely comparable with any other species of *Saprosma* which we have seen. In the first place the dried plant is reddish brown rather than olive-brown as in the other species. The shape of the leaves is somewhat similar to that of the leaves of *S. pubescens* Ridl. but the venation is more crowded than in the latter, also the inflorescence is axillary in the Solomon Islands material, sessile and many-flowered, whereas in Ridley's species it is terminal with about 5 flowers.

Amaracarpus Blume

The genus *Amaracarpus* as here treated roughly includes three groups: (1) plants with large leaves and for the most part with almost filiform pedunculate axillary inflorescences; (2) plants generally pubescent with rather thick hairs on young shoots and with a very distinctive habit marked by horizontally placed small leaves and branches, flowers solitary and sessile or very short pedicellate, usually subtended by reduced leaves and stipules or stipule-like bracts; (3) glabrous plants with more irregular branching, often crowded leaves, rounded-oblong or ovate stipules, flowers larger than in either of the other groups, mostly with a granular-puberulent throat and relatively long filaments. It should be noted that none of these groups are exclusive in their characters. The first two usually have similar stipules, i. e. more or less connate into a tube and each terminated by two setae very often separated by a rounded sinus; on the lower surface along the midrib of the leaf is a spreading pubescence of very short hairs. The last group is least like the others, and it is this group which we should have liked to have placed in *Dolianthus* C. H. Wright, but we could not make our plants fit either the description of Wright or the emended one of Bremekamp. There are six species in this aggregate, *A. bicolor, A. caeruleus, A. buxifolius* (C. H. Wright), *A. Clemensae,* and *A. Archboldianus,* and one of these, *A. Clemensae,* has the pubescence characteristic of *Dolianthus* and a large number of species of *Amaracarpus,* but Wright does not mention any bracts on the inflorescence and Bremekamp clearly specifies that the flower is ebracteolate. In the material of *A. Clemensae* the bracts are conspicuously longer than the calyx. Only one species of this group is without subtending floral bracts and that is *A. Archboldianus.* Whatever may be the ultimate disposition of these species, it seems best at present to point out these differences and leave them here until such time as more material and types are available. It might be added that these species do not have the regular branching of *Amaracarpus* in the narrower sense, but it is also to be noted that in Valeton's key he indicates that not all species show clearly the dorsiventral branching.

Amaracarpus urophyllus sp. nov.

Frutex 1.5–2 m. altus; ramulis lineis decurrentibus pubescentibus a basi stipulorum exceptis glabris, internodiis 2–4 cm. longis, superioribus compressis; stipulis 1.5–2 cm. longis, basim versus et margine pubescentibus, apice setulosis (setis circiter 1.5 mm. longis), caducis, cicatricibus pubescentibus; foliis 7–14 cm. longis, 1.8–4 cm. latis, lanceolato-ellipticis vel lanceolato-oblongis, utrinque angustatis deinde apice longe et anguste caudato-acuminatis, basi cuneatis, supra glabris, novellis subtus costa nervisque patenti-puberulis ceterum glabris, nervis lateralibus utrinsecus 10–12 in sicco utrinque prominulis, venis costalibus intermixtis, reticulo laxo utrinque manifesto; petiolo 5–7 mm. longo, glabro, supra canaliculato; inflorescentiis longe pedunculatis, axillaribus; pedunculo 3–5 cm. longo, gracillimo, glabro, apice 1–3-floro, bracteato; bracteis ± 5 mm. longis; floribus sessilibus, glabris, vix maturis, bracteolatis; bracteolis minimis; calycis tubo 2 mm. longo, lobis 1.5 mm. longis, obtusiusculis; corollae tubo 6 mm. longo, intus glabro, lobis 2.5 mm. longis, antheris 3 mm. longis. partim exsertis; stylo 4 mm. longo, stigmatibus 1.5 mm. longis; fructibus oblongis, basi angustatis, 11.5 mm. longis (calyce incluso), vix 5 mm. diametro; pyrenis dorso rotundatis, ventre subplanis.

BRITISH NEW GUINEA: Mount Tafa, *Brass 4998* (TYPE), Sept., 1933, alt. 2400 m., common in undergrowth of valley forest (bush 1.5–2 m. high; branches short and flat-spreading; leaves dark and smooth, midrib whitish underneath; flowers white; fruit smooth, green).

This species suggests *A. longifolius* Val. in general aspect, but the branchlets are pubescent only on two lines decurrent from the base of the stipules, the leaves are more abruptly and much more narrowly caudate-acuminate, the corolla is glabrous within the throat, the stamens have very short filaments, the stigmas are oblong and inconspicuously papillate, and the inflorescence at the insertion of the peduncle seems to be surrounded only by hairs.

Amaracarpus attenuatus sp. nov.

Frutex arborescens; ramulis plerumque glabris, internodiis 2–7 cm. longis, compressis interdum leviter sulcatis; stipulis in alabastris tantum visis, in latere uno fissis, caducis, cicatricibus intus dense pubescentibus; foliis ovato-lanceolatis vel lanceolatis, 8–15.5 cm. longis, 2.5–5 cm. latis, apice longe acuminatis, acumine 1.5–2.5 cm. longo, acuto, basi cuneatis, chartaceis, supra glabris, subtus costa nervisque patenti-pubescentibus, nervis lateralibus utrinsecus 9–11 supra impressis, subtus prominulis venis costalibus intermixtis, reticulo supra vix manifesto, subtus sub lente distincto, laxo; petiolo 6–10 mm. longo, glabro, supra canaliculato, dorso rotundato; inflorescentiis axillaribus paucifloris, gracillimis, 5–11 cm. longis, pedunculatis, pedunculo pubescente, 3.5–7 cm. longo, cymoso-ramosis, ramulis basi bracteatis, plerumque glabris, bracteis circiter 6 mm. longis lineari-filiformibus; floribus subsessilibus, basi bracteolatis, bracteolis minutis, circiter 0.5 mm. longis; calyce 1 mm. longo, 4-lobato, lobis latis obtusiusculis, sinibus latis concavis; corollae tubo 1.5 mm. longo, fauce ± dense pilosulo, lobis 2 mm. longis; filamentis in fauce insertis, 1.5 mm. longis, antheris 1 mm. longis exsertis; stylo 1 mm. longo, stigmatibus 0.5 mm. longis, latiusculis; fructibus oblongis, 6 mm. longis, pyrenis in sicco dorso leviter 1–2-costatis, inter facies ventrales prope medias ± spongiosis, ventre ± costatis.

BRITISH NEW GUINEA: Oroville Camp, Fly River, *Brass 7419* (TYPE), Aug., 1936, in riverbank undergrowth (arborescent shrub; flowers white; fruit soft, red, 6–7 mm. diameter).

According to the description and the plate, this plant seems to be allied with *Amaracarpus heteropus* Val. It differs in the following characters: (*1*) it is not so characteristically short-branched; (*2*) the stipules are glabrous except toward the apex and they do not terminate in the setae characteristic of *A. heteropus* Val., they apparently split down one side and fall off as the bud expands; (3) the leaves are longer-acuminate; (4) the inflorescence is definitely long-pedunculate, and usually branched twice, the two lower branches are mostly terminated by a single flower, the rachis terminating in a single flower or branched again and bearing three flowers; (5) the flowers are about half as large as in Valeton's species.

Amaracarpus brachypus sp. nov.

Arbuscula 2 m. alta; ramulis glabris, internodiis 2–5 cm. longis; stipulis cito caducis, forsitan in una gemma visis, 3 mm. longis, minute pubescentibus; foliis 5.7–13.5 cm. longis, 2–4 cm. latis, valde chartaceis vel tenuiter coriaceis, glabris, elliptico-lanceolatis utrinque angustatis, apice attenuatis obtusis vel leviter acuminatis, basi cuneatis, in sicco margine integris vel subrepandis, nervis lateralibus utrinsecus 8–12 patentibus prope marginem arcuatim confluentibus, utrinque prominulis, venis costalibus inter nervos dispositis, reticulo satis laxo utrinque inconspicuo; petiolo circiter 5 mm. longo; floribus non visis; fructibus solitariis vel in triadibus in apice ramulorum brevium axillorum sessilibus, basi bracteis foliiformibus $\pm$ 6 mm. longis vel foliis valde diminutis (usque ad 3 cm. longis) suffultis, pyriformibus, $\pm$ 8 mm. longis, circiter 5 mm. diametro, in sicco leviter costatis et granulari-rugulosis, apice calyce coronatis (calycis lobis 2 mm. longis, lineari-oblongis, tubo 0.5 mm. longo); pyrenis dorso convexis undulatis, ventre costa media instructis.

British New Guinea: Dieni, Ononge Road, *Brass 3876* (type), April, 1933, alt. 500 m., rain-forest understorey (very small tree 2 m. tall; dark shining leaves; yellow-brown smooth slightly urceolate fruit $\pm$ 8 mm. long, 7 mm. diameter).

The habit of this plant is very much like that of *Amaracarpus grandifolius* Val. but the latter is pubescent, the petiole is shorter, and the calyx-lobes are shorter than the tube and relatively broad like a toothed margin rather than a lobed one.

Amaracarpus solomonensis sp. nov.

Arbor gracilis usque ad 7 m. alta; ramulis glabris, internodiis 2.5–5 cm. longis, superioribus compressis; stipulis $\pm$ 2 cm. longis, lineari-oblongis, $\pm$ pilosis, caducis, in gemmis terminalibus tantum visis; foliis 10–15 cm. longis, 3.5–5.5 cm. latis, tenuiter chartaceis, late lanceolatis vel anguste elliptico-lanceolatis utrinque angustatis, apice attenuatis acuminatis, summo apice obtusiusculis, basi cuneatis, utrinque glabris, nervis lateralibus utrinsecus $\pm$ 10 utrinque subprominulis, patentibus et marginem prope arcuatim confluentibus, reticulo laxo supra obscuro vel utrinque manifesto; petiolo $\pm$ 6 mm. longo, glabro, supra plano; inflorescentiis axillaribus, fasciculatis, brevissime pedunculatis (1–1.5 mm. longis); floribus 1–12 in fasciculo subsessilibus, bracteatis; bracteis membranaceis, glabris; calycis tubo 1.5 mm. longo, lobis vix 1 mm. longis, consperse pilosulis; corollae tubo 4 mm. longo, villosulo, lobis lineari-oblongis, 4 mm. longis; antheris partim exsertis; stylo 8 mm. longo; stigmatibus valde exsertis; fructibus circiter 8 mm. longis (calyce incluso), 4 mm. diametro, levibus; pyrenis dorso convexis, pariete dorsali tenui, ventrali lacunoso.

Solomon Islands: Bougainville: Kieta, *Kajewski 1541*, March, 1930, alt. 15 m., rain-forest creek (plant up to 1.5 m. tall; fruit red when ripe, fleshy);

Guadalcanal: Berande River, *Kajewski 2394,* Dec., 1930, sea level, rain-forest (small tree about 7 m. high; petals cream-colored; fruit red-green when ripe, length including calyx 1 cm., diameter 6 mm.); Ulawa: *Brass 2955* (TYPE), Oct., 1932, alt. 200–300 m., upland rain-forests (slender tree 5 m. tall, with a few short thin spreading branches at the summit; flowers white).

Amaracarpus solomonensis is probably related to *A. brachypus* Merr. & Perry. Both are glabrous plants with large leaves and short petioles. In the latter the fruit appears to be on short axillary shoots and subtended by leaf-like bracts; in the former the flowers seem to be axillary and subtended by membranaceous bracts. Further material of both species is desirable.

Amaracarpus subcaudatus sp. nov.

Arbuscula 3–4 m. alta; ramulis glabris, internodiis ultimis compressis, 5–10 mm. longis; stipulis vix 5 mm. longis, apice bifidis vel lineari-setulosis, setulis pubescentibus; foliis 3.5–6 cm. longis, 1–2.3 cm. latis, lanceolatis vel ellipticis, chartaceis, utrinque angustatis, apice late acuminatis, subcaudatis, basi cuneatis, supra glabris, subtus costa tantum minute patenti-puberula, nervis lateralibus utrinsecus 8–10 valde patentibus prope marginem arcuatim confluentibus, utrinque distincte manifestis, venis costalibus sub lente intermixtis, reticulo conferto indistincto; petiolo 2.5–5 mm. longo, glabro, gracili; inflorescentiis axillaribus, bracteatis, sessilibus; floribus 1–3 in fasciculo, glabris; calyce circiter 1 mm. longo minute 4–5-dentato, margine minute ciliolato; corollae tubo 1.5 mm. longo latoque, fauce sparsim barbato, lobis 1.5 mm. longis; fructibus leviter obovoideis, 6 mm. longis, 4 mm. diametro; pyrenis dorso convexis, ventre planis, minute irregulariter rugulosis.

NETHERLANDS NEW GUINEA: 6 km. southwest of Bernhard Camp, Idenburg River, *Brass 12761* (TYPE), *12801,* Feb., 1939, alt. 1200 m., frequent in rain-forest undergrowth and common on crests of ridges (tree 3–4 m. high; flowers white; fruit red and fleshy).

The size and shape of the leaves of this species suggest *A. Nouhuysii* (Val.) Val. but the latter has a pedunculate inflorescence.

Amaracarpus calcicola sp. nov.

Frutex ± 1 m. altus; ramulis maturis glabratis, cinerascentibus, novellis crispe rufo-pubescentibus, internodiis 1–2 cm. longis, ramulis ultimis valde diminutis ut videtur in axillis foliis aggregatis vel longioribus et axi stipulis subpersistentibus tecto; stipulis novellis puberulis cito glabratis, circiter 2–2.5 mm. longis, subovatis, apice bi-setulosis, subpersistentibus; foliis 1–2.5 cm. longis, 0.5–1 cm. latis, in ambitu valde variabilibus, oblanceolatis vel ellipticis, apice rotundato-obtusis vel acutiusculis, basi angustatis acutis, glabris, valde chartaceis, nervis lateralibus utrinsecus 3–5 supra obscuris, subtus sub lente tantum paulo manifestis, adscendentibus; petiolo ± 1 mm. longo; floribus solitariis in apice ramulis reductis positis, glabris; calycis tubo 1 mm. longo, lobis lineari-lanceolatis, 1.5 mm. longis; corollae tubo 3 mm. longo, intus fauce barbato, lobis 2 mm. longis, reflexis; antheris 1 mm. longis, inclusis; stylo vix 5 mm. longo, stigmatibus exsertis; fructibus (calyce incluso) 5 vel 6 mm. longis, vix 5 mm. diametro, subglobosis; pyrenis dorso leviter bisulcatis inter sulcos obtusis vel rotundatis, ventre subplanis vel leviter undulatis.

NETHERLANDS NEW GUINEA: Tabati, Jautefa Bay, *Brass 8849* (TYPE), June, 1938, abundant in brushes of dry limestone hills of coast (shrub ± 1 m. high; flowers white; fruit red).

Among the species of *Amaracarpus* already described, this is most like *A. Nymannii* Val. It is very close to *Schlechter 16090,* which collection Valeton determined as aff. *A. Nymannii* Val.; however, the Brass specimen differs in the thicker leaves and faint nervation. Here again the pubescence is fairly fine for *Amaracarpus*. On the other hand Valeton described the hairs of *A. Nymannii* as short and broad. This plant from Tabati is very irregularly branched, the shortest branchlets appearing as rosettes of leaves; if the branchlets are longer they are clothed with remnants of stipules. The calyx-teeth are fairly long and sharp in this species.

Amaracarpus trichocarpus sp. nov.

Frutex circiter 1 m. altus; ramulis subvillosis (pilis crispis, rufis), longitudine valde variabilibus, 2.5–20 cm. longis, internodiis ± 1 cm. longis, ramulis ultimis in axillis foliorum valde diminutis; stipulis circiter 3 mm. longis, ± pilosulis, obtuse lanceolatis, caducis; foliis 1.5–2.3 cm. longis, 0.5–0.7 cm. latis, tenuiter chartaceis, elliptico-lanceolatis, apice acutiusculis vel obtusiusculis, basi anguste cuneatis, subsessilibus, utrinque glabris vel subtus costa sparsim pubescente, nervis lateralibus utrinsecus circiter 4, supra obscuris, subtus sub lente manifestis, venulis obscuris; floribus non visis; fructibus in apice ramulorum axillarium valde diminutorum dispositis, sparsim rufo-pubescentibus, subglobosis apice calyce coronatis, circiter 5 mm. longis (calyce 1 mm. longo incluso), calycis lobis 4, lineari-oblongis; pyrenis dorso convexis, ventre medio paulo obtuse costatis, endocarpio crassiusculo.

British New Guinea: Hohoro, Vailala River, *Brass 1039* (type), rain forests (small compact bush about 1 m. tall; branches horizontal; fruit red).

This species has fruit very much like that pictured by Valeton for *Amaracarpus pubescens* Bl., but the leaves here are much smaller and almost sessile.

Amaracarpus Schlechteri Val. Bot. Jahrb. **61**: 116. 1927.

Netherlands New Guinea: Bernhard Camp, Idenburg River, *Brass 13863,* April, 1939, alt. 90 m., common in rain-forest of lower mountain slopes (undergrowth tree 2–3 m. high; branches horizontal; flowers white; fruit red).

This collection has slightly smaller (1.4–1.8 cm. long, 0.6–0.8 cm. broad) leaves more cuneate at the base and somewhat more crowded than those in an isotype of Valeton's species; nevertheless, we believe this is only a variation within the species.

Amaracarpus atrocarpus sp. nov.

Arbuscula usque 3 m. alta; ramis ramulisque ± pilosulis, ramulis brevibus vel longioribus (4–30 cm. longis), internodiis ± 1 cm. longis; stipulis membranaceis 3–4 mm. longis verisimiliter glabris apice setis 2, 2 mm. longis et dense pilosis terminatis, caducis; foliis 1.8–2.3 cm. longis, 0.7–1.3 cm. latis, rhombiformi-ellipticis, utrinque angustatis, apice breviter acuminatis, acumine circiter 3 mm. longo, acutiusculo, basi acutis, sessilibus vel subsessilibus, chartaceis, utrinque glabris, nervis lateralibus utrinsecus 5 adscendentibus deinde arcuatis, supra inconspicuis, subtus sub lente prominulis, venulis conspersis et inconspicuis vel subobscuris; petiolo subnullo; floribus solitariis ut videtur axillaribus et terminalibus, sessilibus vel subsessilibus, basi bracteis stipuliformibus suffultis; calycis tubo 1–1.5 mm. longo, lobis 2 mm. longis obtusiusculis; corollae tubo 3.5–4 mm. longo, 1 mm. diametro, fauce dense villoso, lobis 2–2.5 mm. longis; antheris linearibus vix exsertis; stylo 2 mm. longo; disco fere 1 mm. longo, 0.5 mm. diametro; fructibus subpyriformibus apice calyce coronatis, (calyce incluso) 7–9 mm. longis, 3 mm. diametro; pyrenis 5–6 mm. longis, dorso leviter bisulcatis vel obtuse 3-costatis, ventre subplanis.

BRITISH NEW GUINEA: Fly River, 528 mile Camp, *Brass 6741* (TYPE), May, 1936, alt. 80 m., one of the most common and most striking forest undergrowth species (small near tree attaining 3 m.; branchlets and leaves horizontal on the numerous shortly spreading, drooping branches; small white flowers solitary in axils; fruit black).

At first we were inclined to place this collection in *A. papuanus* Val. but the discrepancies between it and Valeton's species as illustrated, Nova Guin. Bot. **8:** *t. 126.* 1912, have led us to describe it as new. This collection rarely has any short axillary branches as described and illustrated by Valeton, the leaves are much more sharply acuminate than in the plate, the flowers are apparently axillary subtended by stipule-like bracts although the latter may be very reduced branchlets, and occasionally a fruit is terminal also; the corolla in Valeton's species is subrotate-campanulate, while here it is hypocrateriform, the tube being 3.5–4 mm. long and 1 mm. diameter; in the flower of *A. papuanus* Val. the tube of the corolla is pictured as being as broad as long or slightly broader. The stipules of both are very much alike except that in our species they vary in length, the membranaceous part often being twice as long as the setae at the apex.

Amaracarpus papuanus Val. Nova Guin. Bot. 8: 501. 1911; op. cit. 769, *t. 126.* 1912; Bot. Jahrb. **61:** 115 (in key only). 1927.

NORTHEAST NEW GUINEA: Wantoat (Wantot), *Clemens 10977,* Jan. 1940, alt. 1200–1500 m. (small tree; flowers white).

The above cited specimen seems to be more like the plate of this species than anything else which we have at hand. Since the original was collected in Netherlands New Guinea on the other side of the mountains and at a lower altitude, it would seem best, in a group which appears to be as specifically localized as the Psychotrieae, to compare it with the type for confirmation.

Amaracarpus xanthocarpus sp. nov.

Arbuscula 2–4 m. alta; ramis horizontalibus, ramulis pubescentibus (pilis adscendentibus), longitudine diversis 1.5–11 cm. longis, ultimis plerumque brevibus 0.2–2 cm. longis; stipulis in vaginam tubulatam tenuiter membranaceam 1 mm. longam connatis apice setis 4 pubescentibus terminatis, caducis, glabris vel pubescentibus; foliis 0.7–1.5 cm. longis, 0.4–0.7 cm. latis, ellipticis vel rhombiformi-ellipticis utrinque angustatis apice acutiusculis vel obtusiusculis, basi cuneatis vel acutis, tenuiter chartaceis, supra glabris, subtus costa praesertim deorsum ± pubescente excepta glabris, nervis lateralibus utrinsecus 3 vel 4 supra inconspicuis vel subobscuris, subtus manifestis vix prominulis, venis obscuris; petiolo 1–1.5 mm. longo; floribus in apice ramulorum brevium 2–6-fasciculatis, subsessilibus (pedicellis interdum 0.5–1 mm.), bracteatis; bracteis basi pedicelli dispositis; calycis tubo brevi, vix 1 mm. longo, lobis 4 oblongis obtusis, interdum sparsim ciliatis; corollae tubo 3 mm. longo utrinque glabro, latiusculo 1.5–2 mm. lato, lobis 1 mm. longis, ovatis extus apice leviter barbatis; staminibus 1 mm. longis, antheris supra fauce leviter exsertis; stylo brevi; fructibus subglobosis, 4–5 mm. longis calycis lobis coronatis, pyrenis 4 mm. longis, 3 mm. latis, dorso valde 3-costatis, ventre planis.

NETHERLANDS NEW GUINEA: 15 km. southwest of Bernhard Camp, Idenburg River, *Brass 12393*, Jan., 1939, alt. 1500 m., frequent in rain-forest undergrowth (tree 3–4 m. high; branches horizontal; very small white flowers and green fruit); 6 km. southwest of Bernhard Camp, Idenburg River, *Brass 12861* (TYPE), Feb., 1939, alt. 1200 m., occasional in rain-forest undergrowth (slender tree 2–3 m. tall; branches horizontal; flowers white; fruits yellow).

In size and shape of leaves and in the glabrous throat of the corolla, this species suggests *Amaracarpus rhombifolius* Val. However, the leaves are not sessile nor contiguous, the calyx-lobes are very obtuse, and the pyrenes are strongly three-costate on the dorsal surface, the middle costa being considerably larger than the others. The seed does not follow the contour of the putamen as to the ribs, the latter being more like appendages than folds in the crusty cover of the seed.

Amaracarpus compactus sp. nov.

Frutex vix 1 m. altus; ramis ramulisque breviter pilosis vel hirtellis, ramulis longitudine diversis 1–13 cm. longis, ultimis plerumque brevibus 0.5–2 cm. longis; stipulis membranaceis $\pm$ 1 mm. longis, subtruncatis, extus breviter pilosis, $\pm$ caducis; foliis 6–10 mm. longis, 3–5 mm. latis, rhombiformi-obovatis, apice brevissime acuminatis, acumine obtuso, basi elongatis et angustatim cuneatis, tenuiter chartaceis, supra glabris, subtus costa puberula excepta glabris, nervis lateralibus utrinsecus $\pm$ 4 supra obscuris, subtus manifestis, venis obscuris; petiolo 1–1.5 mm. longo, sparsim pilosulo; floribus solitariis terminalibus sessilibus; ovario pubescente 1 mm. longo stipulis tecto; calycis tubo 0.5 mm. longo, glabro, lobis 1 mm. longis; corollae tubo 5 mm. longo, fauce dense piloso, lobis 2.5 mm. longis intus granulari-puberulis; staminibus inclusis; stylo 5 mm. longo, stigmatibus exsertis; fructibus (calyce incluso) 6 mm. longis, 3 mm. latis, obovoideis, levibus.

BRITISH NEW GUINEA: East Mount Tafa, *Brass 4133* (TYPE), May, 1933, alt. 2100 m., common in foothill forest (small compact shrub usually under 1 m. tall; flowers white; fruit smooth, orange-yellow).

The species seems to lie between *Amaracarpus montanus* Val. and *A. cuneifolius* Val. It differs from *A. montanus* Val. in being less hairy, the leaves have shorter petioles and are pubescent along the midrib beneath, and the drupe is obovoid rather than subglobose. It may be distinguished from *A. cuneifolius* Val. by its short branchlets, the stipules are slightly more than half as large as in the latter species and lack the hairy filiform tips characteristic of *A. cuneifolius* Val., and the corolla is more infundibular than hypocrateriform. However, the types of the two should be compared.

Amaracarpus idenburgensis sp. nov.

Arbuscula 2–3 m. alta; ramis ramulisque dense patenti-pubescentibus, ramulis longitudine diversis 1.5–12 cm. longis, ultimis brevibus; stipulis ± 1.5 mm. longis, in vaginam tubulatam connatis, truncatis, pubescentibus, membranaceis, caducis; foliis 6–10 mm. longis, 4–6 mm. latis, ovatis, apice obtusiusculis, basi cuneatis, valde chartaceis (crassiusculis), supra glabris, subtus costa puberula novellis puberulis, nervis lateralibus utrinsecus 2–4 utrinque subobscuris vel tantum leviter manifestis; petiolo circiter 1.5 mm. longo, dorso pubescente; floribus apice ramulorum ultimorum 2–5 dispositis, ± 2 mm. pedicellatis, basi minute bracteolatis, glabris; calyce 1 mm. longo, fere basi 4-fido, lobis ovatis obtusis; corolla campanulata, tubo 1 mm. longo, lobis triangularibus obtusiusculis, 1.5–2 mm. longis; staminibus in fauce insertis, antheris exsertis; stylo ± 1 mm. longo; disco prominente; fructu ovoideo, 7 mm. longo; pyrenis 6 mm. longis, 4.5 mm. latis, dorso convexis, ventre subplanis.

NETHERLANDS NEW GUINEA: 18 km. southwest of Bernhard Camp, Idenburg River, *Brass 12674* (TYPE), Feb., 1939, alt. 2150 m., mossy forest, one of the few undergrowth trees found amongst scrambling bamboo (2–3 m. high; branches horizontal; flowers white; fruit yellow).

This plant seems most like *Amaracarpus montanus* Val. It differs in the larger and not entirely glabrous leaves, the shorter petioles, and the very short spreading hairs on the branchlets.

Amaracarpus belensis sp. nov.

Arbor 3–4 m. alta; ramis ramulisque dense ± adpresse rufo-pubescentibus, ramulis 10–14 cm. longis vel versus apicem 1–4 cm. longis, internodiis ± 1 cm. longis, ramulis ultimis brevissimis plerumque minus quam 1 cm. longis; stipulis 1.5 mm. longis, pubescentibus, in vaginam tubulatam subtruncatam connatis, apice setis 4 pubescentibus; foliis 6–9 mm. longis, 2.5–4 mm. latis, ellipticis vel subrhombiformi-ellipticis, apice obtusis, basi anguste cuneatis, tenuiter chartaceis, supra glabris, subtus praesertim deorsum costa puberula ceterum glabris, nervis lateralibus utrinsecus 2 vel 3 inconspicuis vel subobscuris; petiolo 1–1.5 mm. longo; floribus solitariis in apice ramulorum ultimorum sessilibus vel subsessilibus; calyce cupuliformi 4-dentato, ± 1.5 mm. longo; corollae tubo 2.5 mm. longo, intus glabro, lobis 1 mm. longis, reflexis; antheris parvis, leviter exsertis; fructibus oblongis, (calyce incluso) 5 mm. longis, 3 mm. diametro, levibus.

NETHERLANDS NEW GUINEA: Bele River, 18 km. northeast of Lake Habbema, *Brass 11055* (TYPE), Nov., 1938, alt. 2300 m., common in forest undergrowth (tree 3–4 m. high; branches spreading horizontally and drooping; flowers white; fruit green).

This plant seems most like the description of *A. anomalus* Wernham, but it is a small tree rather than a subrepent subshrub, and the flowers are only about one-third as large as in Wernham's species.

Amaracarpus simulans sp. nov.

Arbuscula 2–4 m. alta; ramulis dense hirtello-pubescentibus, 3–10 cm. longis, ultimis brevioribus, internodiis vix 1 cm., in ramulis ultimis vix 5 mm. longis, nodis plerumque quam ramulis latioribus; stipulis 1 mm. longis, in vaginam tubulatam connatis, apice truncatis, deciduis, novellis apice minute 4-setosis, sparsim puberulis; foliis ellipticis vel rhomboideis, 4–8 mm. longis, 2.5–5 mm. latis, obtusis, basi cuneatis, utrinque glabris, nervis lateralibus utrinsecus circiter 3, supra obscuris, subtus sub lente tantum leviter manifestis; petiolo circiter 1.5 mm. longo, glabro; floribus solitariis in apice ramulorum terminalibus, sessilibus, glabris, parvis; calycis tubo 1 mm. longo, lobis 1.5 mm. longis, lineari-oblongis; corollae tubo 2.5 mm. longo, fauce inter stamina minute piloso-barbato, lobis 1.5 mm. longis; antheris partim exsertis; stylo 2 mm. longo; fructibus ellipsoideis vel paulo obovoideis, 7 mm. longis (calyce incluso), 4 mm. diametro, 6-lineatis, vix costatis; pyrenis dorso rotundatis vel convexis, ventre undulatis.

NETHERLANDS NEW GUINEA: 9 km. northeast of Lake Habbema, *Brass 10522* (TYPE), Oct., 1938, alt. 2800 m., common in tall mossy forest of valley bottoms (undergrowth tree 2–4 m. tall; branches flat-spreading; flowers yellow).

If we had not had at hand a specimen of *A. novo-guineensis* (Warb.) Val., we might have been inclined to assign this specimen to that species, in spite of the vast difference in the altitude; however, although the leaves are much alike, the shape of the fruit is different and the calyx is much larger in our species.

Amaracarpus Brassii sp. nov.

Arbor 3–4 m. alta; ramis 4–5 mm. diametro; ramulis 1–1.5 mm. diametro, ultimis vix 0.5 mm. diametro, plerumque brevibus, subadpresse pubescentibus, pilis rufis; stipulis 1 mm. longis, membranaceis, extus pubescentibus, in vaginam connatis, apice subtruncatis setis pilosis terminatis, caducis; foliis dense confertis apice ramulorum subrosulatis, late ovatis vel subreniformibus, apice obtusis vel interdum subrotundatis, basi subcordatis vel emarginatis vel subtruncatis, 1–2 mm. longis, 1.5–2.8 mm. latis, crassiusculis, utrinque glabris, costa tantum visa, supra plerumque subobscura, subtus deorsum manifesta; petiolo gracili, circiter 0.5–0.8 mm. longo; floribus solitariis in apice ramulorum brevium, sessilibus; calyce campanulato, vix 1 mm. longo, 4–5-dentato, ciliato; corollae tubo 2 mm. longo, glabro, lobis 4 vel 5, recurvatis, apiculatis, 0.6–0.8 mm. longis, antheris ellipticis, leviter exsertis; disco valde convexo; stylo 0.8 mm. longo; stigmatibus 2 brevissimis; fructibus ovoideis vel subglobosis calycis lobis coronatis, 3–4 mm. longis, circiter 3 mm. latis, in sicco nigris.

NETHERLANDS NEW GUINEA: 9 km. northeast of Lake Habbema, *Brass 10823* (TYPE), Oct., 1938, alt. 2700 m., rain-forest of valley bottom, occasional in openings (tree 3–4 m. high; branches horizontal, drooping).

This species is very readily distinguished by the crowded unusually small leaves and short branchlets.

Amaracarpus trichanthus sp. nov.

Frutex usque ad 2 m. altus; ramis ramulisque dense pilosulis vel subvillosulis, ramulis ultimis brevibus, internodiis brevissimis; stipulis ovatis vel subrotundis, 1–2 mm. longis latisque, extus pubescentibus deinde glabratis, subpersistentibus; foliis confertis, chartaceis, 4–6.5 mm. longis, 2–3.5 mm. latis, ellipticis vel leviter obovato-ellipticis, apice paulo angustatis et obtusis vel rotundatis, basi anguste cuneatis vel acutis, utrinque glabris, nervis lateralibus utrinsecus circiter 2 obscuris vel vix manifestis; petiolo 1 mm. longo, glabro; floribus solitariis in ramulorum brevium terminalibus, sessilibus basi bracteis 2 parvis suffultis; ovario et calyce consperse pilosulo; ovario circiter 1 mm. longo; calycis tubo vix 1 mm. longo, lobis 5 oblongis, acutiusculis, sinibus rotundatis; corolla extus dense pubescente, tubo 13 mm. longo, intus prope medio annulo vix 2 mm.

lato pilosulo, sursum minutissime granulari, lobis 2 mm. longis; staminibus in fauce inferiore insertis, filamentis 1.5 mm. longis, antheris 2 mm. longis, linearibus; stylo glabro; fructibus ovoideis calyce coronatis, 5–6 mm. longis, 3.5 mm. diametro.

BRITISH NEW GUINEA: Murray Pass, Wharton Range, *Brass 4615* (TYPE), July, 1933, alt. 2840 m., abundant in undergrowth in forest (horizontally branched shrub or bush up to 2 m. tall; indumentum dark brown; flowers solitary, corolla pale blue).

Amaracarpus bicolor sp. nov.

Frutex usque ad 1 m. altus, glaber; ramulis brunnescentibus, gracilibus, angulatis vel angustissime alatis, internodiis ultimis brevissimis, nodis paulo tumidis; stipulis membranaceis, 1 mm. longis, apice truncatis, deciduis; foliis chartaceis vel tenuiter coriaceis, confertis, spathulatis, 4–8 mm. longis, in parte superiore 2.4–3.5 mm. latis, apice rotundatis, basi in petiolo 1–1.5 mm. longo angustatis, nervis lateralibus utrinsecus 2 vel 3 patenti-adscendentibus, supra obscuris, subtus inconspicuis, venis utrinque obscuris; floribus solitariis, in apice ramulorum ultimorum dispositis, sessilibus; calycis tubo 1 mm. longo, lobis 1.5 mm. longis, oblongis, obtusiusculis, sinibus subrotundatis; corollae tubo 1.2 cm. longo, intus dimidio supero ± pilosulo, lobis 4 mm. longis; staminibus in tertio supero insertis, filamentis brevibus granuloso-puberulis, antheris 2–2.5 mm. longis; stylo 8 mm. longo, in parte supero puberulo, stigmatibus linearibus 1.5 mm. longis; fructibus ellipsoideis, circiter 7 mm. longis, calyce coronatis, levibus.

BRITISH NEW GUINEA: Mount Tafa, *Brass 4019, 5019* (TYPE), May, Sept., 1933, alt. 2310 and 2400 m., fairly common along roadside; also, small undergrowth shrub in damp valley forest (shrub or bush 1 m. or less; branches horizontal; fleshy blue flowers, lobes yellow-tipped).

The flowers of the first collection are not yet open and are described by the collector as blue-green.

Amaracarpus buxifolius (C. H. Wright) comb. nov.

Saprosma buxifolia C. H. Wright, Kew Bull. 1899: 101. 1899.

BRITISH NEW GUINEA: Murray Pass, Wharton Range, *Brass 4766*, Aug., 1933, alt. 2840 m., common as undergrowth in better lighted situations in forests (bush about 2 m. tall; flowers blue); Mt. Albert Edward, southwest slope (Upper Chirima River), *Brass 4379*, June, 1933, alt. 3500 m., a single plant on rocky bank of river (compact low shrub; leaves shining on both sides, the under surface much paler; corolla pale blue with green thick-tipped lobes; fruit compressed, orange-yellow, ± 1 cm. long).

Amaracarpus confertifolius sp. nov.

Frutex gracilis 1–2 m. altus, glaber; ramis teretibus, ramulis quadrangulatis, plerumque brevibus, internodiis 5–7 mm. longis; stipulis in vaginam connatis, circiter 2 mm. longis, rotundatis vel late obtusis, caducis; nodis tumidis; foliis 6–11 mm. longis, 4–7 mm. latis, ellipticis vel leviter obovatis, apice obtusis vel subrotundatis, basi anguste cuneatis, in sicco margine paulo recurvis, nervis lateralibus utrinsecus 3 vel 4, in laminae facie supera ± manifestis, infera deorsum magis prominulis, venulis utrinque ± manifestis; floribus solitariis in ramulis brevibus terminalibus, subsessilibus (pedunculo ± 1 mm. longo), bracteolatis; bracteolis ± 3 mm. longis, basi ovatis deinde abrupte longe acuminatis, ut videtur ± connatis, ovario circumdatis; calycis tubo 1 mm. longo, lobis 2–2.5 mm. longis, sinibus ± rotundatis; corolla infundibulari, tubo 10–12 mm. longo, intus prope medio sursum $\pm$ puberulo, lobis 3 mm. longis; antheris 2.5 mm. longis, partim exsertis; stylo brevi, stigmatibus lineari-oblongis; fructibus ovoideis, 7 mm. longis (calyce incluso), 3.5 mm. latis, levibus; pyrenis dorso convexis, ventre planis.

British New Guinea: Murray Pass, Wharton Range, *Brass 4715* (type), Aug., 1933, alt. 2840 m., common on pathways through bamboo undergrowth in *Dacrydium-Libocedrus* forests (slender shrub 1–2 m. high, with short horizontal branches; flowers pale blue, fleshy).

This plant is more compact than *A. caeruleus* Merr. & Perry but the flowers are somewhat similar, except that the subtending bracteoles differ, and the flowers of the latter species are definitely pedunculate, the fruit of the latter, too, tends to be ribbed, and the leaves are larger and longer-petiolate. In addition to the number above cited we have at hand a single sheet from East Mount Tafa, *Brass 4144,* gathered at 2100 m. altitude in the tall foothill forest, not common (compact shrub with blue flowers). This number has slightly larger leaves than those of the type, and chartaceous; the one flower on the specimen has the corolla-tube within from the middle upward densely puberulous. These are the only differences we note, except possibly the stipules are slightly puberulous; we are inclined to believe all represent one species under different environmental conditions.

Amaracarpus caeruleus sp. nov.

Arbuscula 2–3 m. alta, glabra; ramulis 4-angulatis, nodis tumidis, internodiis ramulorum ultimorum brevibus, 3–10 mm. longis; stipulis 1–3 mm. longis, obtusis, cito caducis; foliis 1–2 cm. longis, 0.5–1.1 cm. latis, ellipticis vel lanceolatis, apice obtusiusculis vel acutiusculis, basi cuneatis vel acutis, tenuiter coriaceis, nervis lateralibus utrinsecus 2 vel 3 adscendentibus vel patenti-adscendentibus utrinque manifestis vix prominulis, reticulo $\pm$ manifesto, laxo; petiolo 3–4 mm. longo; floribus solitariis ut videtur terminalibus et axillaribus, pedunculatis; pedunculo $\pm$ 5 mm. longo; ovario circiter 1 mm. longo bracteolis circumdata; bracteolis 4 decussatis, approximatis, longitudine variabilibus, 2.5–5 mm. longis, ovatis vel lanceolatis, apice elongatis; calycis tubo 1 mm. longo, lobis 1.5–2 mm. longis, lineari-oblongis, acutiusculis; corolla infundibulari, tubo 12 mm. longo, intus medio puberulo sursum granuloso-puberulo, lobis 3 mm. longis, intus granuloso-puberulis; filamentis granuloso-puberulis, antheris 3 mm. longis, lineari-oblongis, basi bilobatis; stylo glabro, stigmatibus linearibus; fructibus ovoideis, (calyce incluso) 7 mm. longis, 3.5 mm. diametro; pyrenis 5 mm. longis, 3 mm. latis, dorso convexis leviter et obtuse 3-costatis, ventre planis.

British New Guinea: Murray Pass, Wharton Range, *Brass 4525* (type), July, 1933, alt. 2840 m., common on forest borders (dark foliaged shapely small tree 2–3 m. tall; corolla pale blue with thick-tipped lobes; ripe fruit yellow, about 5 mm. long, 4 mm. diameter).

Amaracarpus Clemensae sp. nov.

Frutex probabiliter 1–2 m. altus; ramulis dense crispe pubescentibus, deinde glabratis, $\pm$ angulatis, internodiis ultimis brevibus; stipulis glabris membranaceis, 3–4 mm. longis, in parte inferiore in vaginam connatis, apice subrotundatis, caducis, cicatricibus pilosis; foliis lanceolatis vel anguste ellipticis, 1–2 cm. longis, 0.4–0.7 cm. latis, apice acutiusculis, basi anguste cuneatis, tenuiter coriaceis, in sicco margine leviter recurvis, utrinque glabris, nervis lateralibus utrinsecus circiter 4 adscendentibus, supra obscuris, subtus sub lente distincte manifestis, venulis obscuris; petiolo ± 3 mm. longo, glabro; floribus glabris solitariis subterminalibus pedunculatis, bracteolatis; pedunculo 7–11 mm. longo, glabro; bracteolis 4 calycis basi approximatis, persistentibus, paribus decussatis, 7–10 mm. longis, 1–1.5 mm. latis, lineari-oblongis, acutiusculis; ovario et calyce campanulatis; calycis tubo 1.5–2 mm. longo, lobis 1–1.5 mm. longis, lobis et sinibus subrotundatis; corollae tubo 11 mm. longo, intus dimidio supero granuloso-puberulo, lobis circiter 3 mm. longis; filamentis 1 mm. longis, granuloso-puberulis, antheris 3 mm. longis, partim exsertis; stylo 9 mm. longo, stigmatibus 2 mm. longis; fructibus ± 6 mm. longis, oblongis, calyce coronatis, bracteolis suffultis; pyrenis dorso convexis levibus, ventre planis.

NORTHEAST NEW GUINEA: Rawlinson Range, *Clemens 12328* (TYPE), June, 1941, alt. 2100–3600 m. (shrub; fruits tomato-red); same locality, *Clemens 41405, 41943,* May, 1940, June, 1941 (shrub 1–1.5 m. tall; flowers white); Ulap Trail, *Clemens 41168,* April, 1940, alpine or subalpine elevation; Sarawaket, *Clemens 5573,* June, 1937, alt. 2400–2700 m.

Amaracarpus Archboldianus sp. nov.

Arbuscula vel frutex; ramulis glabris cortice longitudinaliter rugulosis, nigrescentibus vel cinereo-nigrescentibus; stipulis oblongis, obtusis, circiter 7 mm. longis, cito caducis, cicatricibus pilosis; foliis 1.5–4 (plerumque 2.5–3) cm. longis, 0.8–2.3 (plerumque 1.2–1.8) cm. latis, ellipticis vel lanceolato-ellipticis, brevissime acuminatis (acumine 2 mm. longo, obtuso) vel acutiusculis, basi cuneatis vel rotundatis deinde breviter cuneatis, in sicco margine leviter recurvis, tenuiter coriaceis, supra glabris, subtus costa praesertim deorsum patenti-pubescente excepta glabris, nervis lateralibus utrinsecus 6 vel 7 supra manifestis, subtus prominulis, oblique patentibus ante marginem abrupte confluentibus, reticulo utrinque distincte manifesto, laxo; petiolo 8–10 mm. longo, novello subtus pubescente, glabrato; floribus glabris, ebracteolatis, subterminalibus, interdum solitariis plerumque 2(–3)-fasciculatis, pedunculatis, pedunculo interdum sparsim pubescente, 1–1.5 cm. longo; calycis tubo campanulato-cupuliformi, 3 mm. longo, lobis 2 mm. longis, oblongis, obtusis, sinibus obtusis vel subrotundatis; corolla infundibulari, tubo 1.5–1.7 cm. longo, intus dimidio supero granuloso-puberulo, lobis 4 mm. longis; filamentis brevibus, granuloso-puberulis, antheris 3 mm. longis, vix exsertis; stylo 1.1 cm. longo; stigmatibus linearibus; fructibus immaturis, oblongis, 1.1 cm. longis (calyce incluso).

BRITISH NEW GUINEA: Murray Pass, Wharton Range, *Brass 4614* (TYPE), July, 1933, alt. 2840 m., very common substage bush or small tree (dark smooth leaves, paler and glossy beneath; flowers in axillary pairs, one maturing long before the other; corolla-tube yellowish, lobes puce-colored and very thick).

Very closely related and perhaps representing the same species is the following collection: Mt. Albert Edward, southwest slope (Upper Chirima River), *Brass 4373,* June, 1933, alt. 3500–3550 m., common as undergrowth in valley forests (small spreading tree or bush 1–2.5 m. tall; leaves very dark and glossy above, midrib whitish; corolla fleshy, greenish white with lavender-colored lobes).

This latter specimen differs from the type as follows: the branchlets are crisply pilose on the younger parts, the older are glabrous, the bark is gray, the leaves are narrower, at most 1.5 cm. broad, and more sharply pointed, the costal veins are more prominent than the reticulations, and in the axils of the primary veins of the lower half of the leaves are minute domatia. The flowers vary greatly in size, but the largest ones could not be distinguished from those in the type-collection. The mode of inflorescence is similar; the fact that the inflorescence is found at the terminal node or the second from the apex leads us to believe this position may be indicative of a sympodial growth of the stem.

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SACCHARUM ROBUSTUM AND OTHER WILD RELATIVES OF "NOBLE" SUGAR CANES

CARL O. GRASSL*

With three plates

SINCE 1928, when an expedition led by Dr. E. W. Brandes of the United States Department of Agriculture explored New Guinea in search of sugar canes (5), an unusually large wild relative of the noble or large tropical sugar canes has been known to sugar cane technologists. Living specimens have been distributed to the major sugar cane stations of the world, and sugar cane breeders have utilized them in the development of new commercial sugar canes. During this period, the wild sugar cane in question has been passing under a nomen nudum (*Saccharum robustum*).

The earliest publication in which the name *Saccharum robustum* occurs was by Brandes in 1929 (5). The name was selected by agreement with Dr. J. Jeswiet, who was the first member of the expedition to see this wild cane. Dr. Jeswiet found the green form on the banks of the Laloki River in the Territory of Papua (British New Guinea) (*Pl. III*), and Dr. Brandes shortly afterward found the striking red form on the Sepik River in the Territory of New Guinea (Northeast New Guinea). It was understood that Dr. Jeswiet was to prepare and publish a description of this new species. Dr. Jeswiet, however, never validated this name so far as can be discovered. Numerous discussions of this species have been published by sugar cane technologists, but no botanical description, constituting technical publication, has as yet appeared. This paper has been prepared in order to correct this situation and to present some data with respect to this interesting wild *Saccharum* and closely related grasses. The name consequently becomes:

Saccharum robustum Brandes and Jeswiet, sp. nov. PL. I, III.

Perenne. Culmi robusti, erecti vel inclinati usque ad 10 m. alti, glabri, plurinodes, cerosi (infra nodos dense cerosi), diam. 2–3 cm. Foliorum vaginae hirsutae usque ad 40 cm. longae. Ligula brevissima (1.5–4 mm.), membranacea, parum ciliata. Laminae lineari-lanceolatae, 1.2–2 m. longae, 3–7 cm. latae, glabrae vel pubescentes, margine serratae. Culmi infra paniculam sparsim appresso-pubescentes. Panicula amplissima, 40–90 cm. longa, effusa; rhachis communis sparsim appresso-sericeo-pubescens. Spiculae sessiles et pedicellatae similes, 3 mm. longae, uniflorae. Prophylletum[1] bicarinatum binerve. Gluma prima 1-nervis. Gluma secunda enervis, hyalina, apice ciliata. Gluma tertia absens vel

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tenuis. Palea parvula, hyalina, enervis, apice ciliata. Lodiculae glabrae. Stamina 3. Stigmata purpurea.

An extremely variable perennial, forming compact tufts to large, dense canebrakes up to 10 m. high (in cultivation, culms that flower the first year are 4–5 m. high). Culms are erect or reclining, unbranched, many-noded, green to yellowish brown sometimes tinged with red, 2–3 cm. in diameter, diameter greatest near the nodes in the growth ring (a pulvinar structure above the root band), solid or with a small pith cavity. Rhizomatous or stoloniferous, with stolons long-jointed, flexuous, 1–1.5 cm. in diameter, sometimes creeping for long distances, up to 20 m. The rind of the culms is very hard and woody with a wax coating that is most prominent in a band below the nodes. The root band has 2–5, sometimes more, rows of root primordia and is surmounted by a swollen growth ring which is colored yellowish to red or reddish brown. The leaf-blades are glabrous to finely pubescent, flat, strongly midribbed, linear-lanceolate, 1.2–2 m. long and 3–7 cm. wide, the greatest width of blade about two-thirds of the distance from the base and the margins finely serrulate. The leaf-sheaths are 25–40 cm. long, coarsely hairy, overlapping about 2 internodes and topped by a ligule which is 1.5–4 mm. long. The inflorescence is a large feathery or plume-like panicle, with the branched portion 40 90 cm. long and sparsely short-pubescent. The branches of the panicle are long, slender, jointed, and somewhat fragile, with the spikelets in alternate pairs, one sessile, the other stalked. Disarticulation of rachis occurs below a ring of silky hairs, up to 1 cm. long, which sparsely surround the spikelets; the pedicellate spikelets become free while the sessile spikelets remain attached to the base of a 4–7 mm. long segment of the rachis. Also attached to the base of such rachis segments is a 2–3 mm. long pedicel of the pedicellate spikelet. Spikelets are similar, perfect, about 3 mm. long, with a flower in the axil of the third glume[1] (very rarely with a second flower in the axil of a fourth glume). The prophylletum is coriaceous, bicarinate with 2 (rarely 4) nerves and a minutely scabrous apex. The first glume is coriaceous, partially enclosed in the wings of the prophylletum, 1(rarely 3-)-nerved, minutely scabrous at apex and with inrolled, hyaline and ciliate margins. The second glume is hyaline, nerveless, with ciliate margins at apex. The third glume (first lemma) is absent or reduced to a slender, hyaline, minutely scabrous-tipped structure, up to 2 mm. long, and almost hair-like in diameter. The palea is hyaline, nerveless, up to 1 mm. long, with ciliate margins. There are 2 lodicules, not ciliate. There are 3 stamens with anthers about 1.5 mm. long. The pistil has purplish stigmas. The seeds are 1.5 mm. long.

New Guinea: S.P.H.[2] nos. 908, 504, 152, 229, 1097, and 222 from clone *28 N.G.*

[1] By third glume is here meant the fourth appendage or first lemma, as the first appendage in the spikelets of Andropogoneae, Tripsaceae, and some Bambuseae is considered homologous with a prophyll and not with the first glume of other grasses. The first appendage in the spikelets of such grasses is here called a "prophylletum" and the second appendage the first glume.

[2] Sugar Plant Herbarium of the United States Department of Agriculture. The different numbers refer to collections made at different times and places from the clone in question. A living collection of more than 1,000 clones of sugar canes and related grasses is now being maintained at Canal Point, Florida, Summit, Canal Zone, and in part at Beltsville, Maryland. Many of the herbarium specimens referred to in this

251, Imp.[3] 496, found by *J. Jeswiet* on the left bank of the Laloki River near Jail Gardens about 27 km. from Port Moresby, Territory of Papua, June 1928 (TYPE: no. *908* deposited in the U. S. Nat. Herb.); S.P.H. nos. 895 and 1093 from clone *28 N.G. 104*, Imp. 653, found on the bank of the Kemp Welsh River near Ni-u-iruka, Territory of Papua; S.P.H. no. 1221, coll. by *J. T. Puxley* from Vailala River, Territory of Papua, 1935; in dense pure stands 7–8 m. high on recent silt deposits of the Idenburg River, Netherlands New Guinea, 50 m. alt., coll. by *L. J. Brass*, no. *13791*, April 1939; colonizing sand and gravel beaches of the Idenburg River, 850 m. alt., 4 km. s. w. of Bernhard Camp, coll. by *Brass*, no. *13264*, March 1939; *C. Boden Kloss*, Camp 1, Nov.-Dec. 1912, 5,000 ft. alt., Utakwa Expedition to Mt. Carstensz, Netherlands New Guinea (Kew Herb.[4]); S.P.H. nos. 904 and 663 from clone *28 N.G. 218*, Imp. 663, found near Ambunti on the Sepik River, Territory of New Guinea; S.P.H. no. 1519 from clone *Molokai 4730*, Imp. 1027, a selection from seed from the Francisco River, Territory of New Guinea, alt. 3 m.; S.P.H. no. 1520 from clone *Molokai 4826*, Imp. 1028, ibid.; S.P.H. no. 1521 from clone *Molokai 5193*, Imp. 1029, a selection from seed collected on the plateau at headwaters of the Ramu River, Territory of New Guinea, alt. 1650 m.

NEW BRITAIN ISLAND: S.P.H. nos. 916, 177, 678, and 1100 from clone *28 N.G. 289*, Imp. 677, coll. by *C. E. Pemberton* from dry, rocky place near Rabaul; S.P.H. nos. 1101, 178, 679, and 917 from clone *28 N.G. 290*, Imp. 622, a selection from seed coll. by *Pemberton* near Rabaul.

NEW HEBRIDES: S.P.H. no. 1351 from clone *N.H. 1*, Imp. 933 (vernacular name: *Nassa-u*) obtained near Imera, Efate, by *E. W. Brandes* in 1935; U. S. Nat. Herb. no. 1539004 from Pentecost I., coll. by *A. Morrison*, May 28, 1896 (also seen in Kew Herb.).

The specimen from Pentecost I. is not quite typical in that the inflorescence is somewhat smaller than normal. This may be a smaller form of this species, the introduction of which into experimental cultivation is desirable, as the discovery of a form with a chromosome number of $2n = 40$ or less would have considerable theoretical interest.

Saccharum robustum Brandes & Jeswiet f. **sanguineum** Grassl, f. nov.

Culmi extus intusque sanguinei.

NEW GUINEA: S.P.H. no. 1525, 1526, and 1527 from clone *28 N.G. 219*, Imp. 975, found along the Sepik River near Ambunti, Territory of New Guinea (TYPE: no. 1525 deposited in the U. S. Nat. Herb.); S.P.H. no. 1538 from clone *28 N.G. 219A*, Imp. 976, found in the same canebrake by *Father Kirschbaum*.

This form differs from the typical form in having a blood red color to the interior of the culms. This color is most intense near the rind and grades off to almost a white in the center of the pith. It is also evident externally in a dark red rind color, deep red buds, dewlaps, and growth rings, and a purplish pink cast to the spikelets.

paper were prepared by Dr. G. B. Sartoris and the late Mr. H. B. Cowgill, while the collection was being maintained in Puerto Rico, and at Arlington Farm, Virginia. Specimens of clones of particular botanical interest can be prepared for exchange.

[3] Imp. = Importation number assigned by Division of Sugar Plant Investigations.

[4] After this paper was submitted for publication an opportunity was had to amend it after examining additional material at the Kew Herbarium and places in England where parts of the herbarium were sent for preservation during the war. The courtesy and assistance extended to me by the Kew Herbarium authorities are gratefully acknowledged.

The types of this form and of the species are specimens from the two largest wild clones of *Saccharum* in cultivation. The importance of this form was immediately recognized by Dr. E. W. Brandes, who found it about 430 km. up the Sepik River in 1928. Special efforts were made to bring it into experimental cultivation at that time, but the original plants died and it was not until almost ten years later, after repeated attempts, that it was established in the living collection of the Division of Sugar Plant Investigations. This was accomplished through the courtesy of the Director of the Department of Agriculture of the Territory of New Guinea, who dispatched a patrol officer to the area on three occasions to get cuttings. A lighter-colored variant of this form was likewise received from who accompanied Dr. Brandes on the Sepik in 1928.
the type locality in 1937 from the late Father Franz Joseph Kirschbaum,

The purplish pink cast to the spikelets of the herbarium specimens collected by Brass from the nearby Idenburg River indicates that these may belong to this form or are closely related. Brass does not indicate the color of the culms of the plants from which these collections were made.

Besides the clones of *Saccharum robustum* listed so far in this paper, there are several in our collection that were recently obtained from the Hawaiian Sugar Planters' Association under Molokai numbers. These clones are not referred to in all cases because the preparation of flowering material of some of them was overlooked during the war emergency. Detailed descriptions of the vegetative characteristics of these and others in our collection have been prepared by Artschwager (2). They represent selections from thousands of seedlings grown in quarantine on Molokai Island from seed collected from wild plants in various parts of the Territory of New Guinea (i.e., Northeast New Guinea: Francisco River, alt. 3 m.; Markham River, alt. 150 m.; Bulolo River, alt. 600 m.; Plateau at headwaters of the Ramu River, alt. 1650 m.; and Plateau at headwaters of the Purari River, alt. 1650 m New Britain: Warangoi and Toriu Rivers, Gazelle Peninsula). A report on the expedition that collected the seed has been published by C. G. Lennox (17).

The presence of *Saccharum robustum* in the Solomon Islands can be expected on the basis of the known distribution. The eastern limit of this species appears to be in the New Hebrides. Plants from Viti Levu, Fiji Islands, which simulate this species will be discussed later in this paper under *Erianthus*.

The distribution of *Saccharum robustum* in Netherlands New Guinea is not well known. What appears to be an illustration of this species is reported by Lam (15, *Fig. 25*), under *S. spontaneum* L., as growing in large patches along the banks of the Mamberamo River. Herbarium specimens were not collected by Lam (16). His reference to this ***gelagah*** (4) (Javanese name for *S. spontaneum*) as often being 9–10 m. high is good evidence that it is *S. robustum*. The collections of *S. robustum* by Brass from the Idenburg River, a headwater stream of the Mamberamo

River, is further evidence that the numerous patches of *Saccharum* noticed by Lam along the Mamberamo River belong to this species. Collectors visiting the Mamberamo River, particularly when in the Meervlakte region, should be sure to collect *Saccharum* from the marshy localities also, as *S. spontaneum* can be expected in such habitats. *Saccharum robustum,* from what is known at present, seems to prefer well-drained river-banks.

The occurrence of *Saccharum robustum* or closely related forms west to the Celebes and Borneo seems possible. Wild grasses which may be *S. robustum* have been reported by Bremer (8, 9, 10) under the vernacular names of *Tanangge* and *Teboe Salah*. *Tanangge* is a vernacular generic name for sugar cane and related wild grasses in the Celebes, while *Teboe Salah* is used for a similar wild grass in Borneo. An attempt to obtain these wild grasses before the Japanese invaded Java was unsuccessful.

Vernacular names have considerable ethnobotanical interest and, consequently, it may not be out of place to note some variations of *Teboe Salah* or false cane. Backer (3, p. 39) refers to *Tebhoe sala* as a vernacular name of *Saccharum spontaneum* in Java, Burkill (12, p. 1924) as *Tebu Salah* under *Erianthus arundinaceus* (Retz.) Jesw. in the Malay Peninsula, and Rumphius (Herb. Amb. 4: 21, *t. 6*) as *Tubu Sala* under *Arundo farcta* II.

Before discussing the relationships of *Saccharum robustum,* a brief account of what is known of the chromosome number of representatives of this species is presented. Chromosome numbers referred to in this report, unless otherwise acknowledged, are based on unpublished studies in the files of the Division of Sugar Plant Investigations by Ruth C. McGuire (formerly R. C. Starret), assistant cytologist. Chromosome numbers of most of the different clones of *S. robustum* in our collection may be found in the report by Artschwager (2). Of particular interest is the fact that all multiples of 10 from $2n = 60$ to $2n = 120$ seem to be represented in this diverse group. The predominant number appears to be $2n = 80$, represented by clones from New Guinea, New Britain, and the New Hebrides. Three clones from New Guinea, including the two under forma *sanguineum,* have $2n = 70$. Only one in the collection, also from New Guinea, has a count of $2n = 60$, which is the same number assigned by Bremer to *Tanangge* and *Teboe Salah*. Two clones, including the type, with $2n = 84$ approximately, are likewise from New Guinea. New Britain Island, besides being represented by two clones with $2n = 80$, has one each with $2n = 90$, 100, 110, and 120, approximately. In spite of the heteroploidy found in this group, there appears to be no good morphological basis on which more than one species can be recognized.

The closest wild relative of *Saccharum robustum* undoubtedly is *S. spontaneum*. *Saccharum robustum* is distinguished readily from *S. spontaneum,* however, on the basis of the reduced or absent third glume (first lemma) and the sparser and shorter nature of the hairs on the main axis of the inflorescence and subtending the spikelets, as well as by the smaller size of the various spikelet structures. The much larger size of the inflorescence and of the vegetative structures also facilitate a ready differentiation.

Hybridization between *Saccharum robustum* and *S. spontaneum* appears to be possible, as Brandes and Jeswiet observed intermediate forms and Lennox (17) reported seeing some natural hybrids where these two species occurred close together. A clone in our collection, *28 N.G. 105*, Imp. 654, with a chromosome count of $2n = 140–148$, from near Ni-u-iruka on the Kemp Welsh River, New Guinea, appears to be somewhat intermediate between these two species. In view of the considerable theoretical interest in the exact nature of hybrids between these species, it seems desirable that artificial hybrids be produced before taxonomic recognition be assigned. Sugar cane breeders who are accustomed to using self- or male-sterile plants as females when making crosses may find it advantageous to try the hot-water emasculation technique, developed by Stephens and Quinby (21) for *Sorghum* hybridization work, when trying to make crosses between self-fertile wild grasses.

In order to clarify the status of *Saccharum spontaneum* in areas in which *S. robustum* has been found, such specimens as are available to me are here cited:

Saccharum spontaneum L.

New Guinea: S.P.H. nos. 894, 1092, 651, and 127 from clone *28 N.G. 101*, Imp. 652, found near Ni-u-iruka on the Kemp Welsh River, Territory of Papua; S.P.H. nos. 1413, 352, and 1354 from clone *28 N.G. 291*, Imp. 875, a selection from seed collected by *P. H. Leigh* in Eriama swamp about 20 km. from Port Moresby on the road to Rona Falls, Territory of Papua; S.P.H. nos. 1414, 353, and 1355 from clone *28 N.G. 292*, Imp. 876, ibid., 13 km. from Port Moresby; S.P.H. no. 223 from along the road between Port Moresby and Rona Falls by *Jeswiet*, Aug. 7, 1928; S.P.H. no. 1529 from near Sapphire Creek by *Brandes & Jeswiet*, June 19, 1928; on roadside in savannahs, Rona, Laloki River, alt. 450 m., *Brass* no. *3528;* abundant on alluvial soil of river-banks in clumps about 2 m. high, Balim River, Netherlands New Guinea, alt. 1600 m., *Brass* no. *11778*, Dec., 1938; very abundant in 2.5–3 m. high thickets on abandoned garden land 18 km. n. e. of Lake Habbema, alt. 2200 m., Bele River, *Brass* no. *11374* Nov., 1938.

Special attention is called to the collection by Brass from near Lake Habbema in Netherlands New Guinea, as it represents an extremely interesting form of this species. It differs from the typical form of *Saccharum spontaneum* in that the hairs on the main axis of the inflorescence and subtending the spikelets are a straw or brownish yellow color instead of silvery or silky white. Clones with this characteristic color should be brought into experimental cultivation, as a better understanding of the factors involved is likely to solve some of the problems with respect to some of the odd color types of native garden sugar canes that are not explainable on the basis of *S. robustum* forma *sanguineum*. Reference is made to native garden sugar canes which have such straw-colored hairs (clone *28 N.G. 287*, Imp. 676, with vernacular name *Huwa*, from Wajake Lo, New Guinea), as well as to others with a brown color to the interior of their culms.

The chromosome numbers of the few clones of *Saccharum spontaneum* in our living collection from New Guinea are not well understood. The three clones in question have $2n = 96$, 114–116, and 84–88, respectively. A fourth clone, *28 N.G. 293*, Imp. 877, from the Vailala River, is not considered here because flowering material is not available and the vegetative characteristics are not quite typical. For the benefit of those not familiar with the complexity of this species, it is interesting to note that clones with $2n = 48$, 50, 56, 60, 64, 72, 80, 90, 94, 96, 98, 112, 120, and 128 supposedly exist (1, 6). The smallest numbers so far discovered are from small plants obtained from the northern extremity of the range of this species along the banks of the Amu Darya in Turkmenistan, the Syr-Darya in Uzbekistan, and near Lahore, India. On the basis of the very small size of some herbarium specimens from China in the U. S. National Herbarium, it is suggested that even lower numbers can be expected when plants of this species from the northern extremity of the range in southern China are examined. Chromosome numbers of forms from the tropics of Africa are not known.

Saccharum spontaneum will not be considered further at this time because none of the numerous elements in this extremely polymorphic group appear to have been involved importantly in the origin of the noble sugar canes. Incidentally, they may have been a modifying influence, but only a few of the many native garden sugar canes of New Guinea have some important characteristics in common with this species. The cultivated sugar canes that are most closely related to *S. spontaneum* are those from China and India that are known to sugar cane technologists under the horticultural species *S. sinense* Roxb. and *S. Barberi* Jesw. respectively (6, 14).

Relationship of *Saccharum robustum* to cultivated species of *Saccharum* will now be considered. Of the two horticultural species of *Saccharum*, *S. edule* Hassk. and *S. officinarum* L., which appear to be related to *S. robustum*, *S. edule* will be considered first. *Saccharum edule* is a relatively small group of plants that has never been very well understood by botanists. A reason for this is the absence of specimens in herbaria and botanical gardens. Only eight clones of this interesting group are in our living collection. Seven of these were obtained by the U. S. Department of Agriculture expedition to New Guinea in 1928, while the other clone, *Teboe Troeboeg*, Imp. 724, had been obtained previously from Java. The latter is of considerable botanical interest because it appears to be very similar to, if not identical with, the *trubu* referred to by Hasskarl and Rumphius. A photograph of the abortive inflorescence of *Teboe Troeboeg*, Imp. 724, in a dried condition and of another clone, *28 N.G. 201*, Imp. 509, from near Lei, on the north coast of the Territory of New Guinea, in a fresh condition gives an idea of the singular appearance of this horticultural species (PL. II, *figs. 1, 2*).

Although the abortive inflorescence of this grass looks somewhat like a banana in the photograph, a resemblance to a mass of small fish eggs apparently led natives to call it *tellor ican*, as listed by Rumphius (Herb.

Amb. 5: 191–192, *t. 75, fig. 1*) under *Ova piscium*. Vernacular names now in use for plants of a similar nature are fairly numerous. *Tebu telur* is a Malay name for this plant according to Burkill (12, p. 1929), while Backer (3, p. 40) lists *Teboe telor* (Malayan), *Teboe endog* (Javanese), and *Tiwoe toeroeboes* (Sundanese). Bremer (10, p. 154) refers to a *Teboe Tigoe Tenggaron* from central east Borneo as having the cauliflower-like panicle. Vernacular names for clones of this species in New Guinea are much more various. Those noted by the U. S. Department of Agriculture expedition under Dr. Brandes include *Urugu* from the village of Medeni (clone *28 N.G. 38*, Imp. 477), *Jahuni* from Jovi (clone *28 N.G. 49*, Imp. 639), *Gauka* from Bodogoru (clone *28 N.G. 82*, Imp. 647), *Ito* from Ututi, Kikori River (clone *28 N.G. 270*, Imp. 669), *Ito Itoika* from Daru (clone *28 N.G. 272*, Imp. 670), *Bogo* from Wajake Lo (clone *28 N.G. 286*, Imp. 497), and *Apia-Baina* from Bodogoru (not established in our collection).

Detailed descriptions of the vegetative structures of the clones of *Saccharum edule* in our collection have been prepared by Artschwager (2). It is interesting to note that the vegetative characteristics of *S. edule* and *S. robustum* are similar except for relatively minor differences. The leaves of *S. edule*, for example, do not have as hairy a sheath. The blades of many of the clones of *S. edule* are much more densely pubescent, almost velvety, while this characteristic is rare or very much suppressed when not completely absent in *S. robustum* as now understood. Some of the wild canes of Borneo which are reported to be densely pubescent (10) may, however, be found to be referable to *S. robustum* when material becomes available for study.

With respect to the distribution of *Saccharum edule*, it is important to remember that only vegetative means of reproduction can be functional. Furthermore, the dry and pithy culms of this horticultural species make it very difficult to establish it in a new location. This is true particularly if more than a short period of days intervenes between the preparation of cuttings and their planting. Hostility and constant warfare between tribes of Melanesians would further bar the distribution of any but the more easily propagated sugar canes. This would indicate that the present distribution would, for the most part, be similar to or only slightly larger than the distribution of the wild species from which it was derived. The distribution of *S. edule* and of *S. robustum* has not been fully or very accurately determined. We do know, however, on negative but fairly conclusive evidence, that *S. edule*, like *S. robustum*, does not occur on islands east of the New Hebrides. A large grass which is utilized in a similar manner in the Fiji Islands appears to belong to another genus and will be described later in this paper under *Erianthus*.

Some of the consequences of dependence on vegetative reproduction are phylogenetically important. Because of obligatory vegetative reproduction, clones of *Saccharum edule* can be considered as truly ancient plants. Except for the possibility of vegetative mutations, they should be the same as when first discovered, possibly thousands, if not tens of thousands, of years ago. Consequently, they may have minor characteristics that have long since disappeared from their contemporary wild relatives.

Dependence on vegetative reproduction would also indicate that no single origin would be sufficient to account for the cultivation of this group in which all of the few clones available to us are considerably different. The morphological differences between our eight clones of *Saccharum edule* consist primarily in the distribution of hairs on the prophylls and leaves and in the color, size, and shape of the vegetative parts. The chromosome numbers, which range from about $2n = 70$ to $2n = 120$, are all different except for two that appear to have $2n = 80$. Opportunities of improving such sterile plants by vegetative selection over reasonable periods of time appear almost nil. Improvement in such groups is more likely accomplished by new discovery of abortive forms and discarding of the inferior ones.

In view of the complete absence of floral parts in *Saccharum edule,* all evidence with respect to the origin of this group is at present based on vegetative characteristics. These indicate that it is more closely related to *S. robustum* than to *S. spontaneum* or any other wild grass now known from the region in question. This statement could be enlarged to include cultivated grasses as well, specifically the noble sugar canes, since the differences between these two cultivated groups is considerable, even though they are very close relatives of *S. robustum.*

The relationship of *Saccharum robustum* to the noble sugar canes, also referred to as *S. officinarum,* is considerably more complicated than the relationship between *S. robustum* and *S. edule*. This is due to the fact that the noble sugar canes comprise a very complex group. As commonly used, the term "noble sugar canes" includes all large thick-stemmed tropical sugar canes that are cultivated by natives in the western Pacific area and southeastern Asia for chewing purposes. Most commercial sugar canes, nearly all of which have been produced by breeding in quite recent times, as well as the smaller Chinese and Indian commercial sugar canes, are not included in this group, although many commercial varieties have a generous admixture of noble "blood." In recent years, the Latin binomial *Saccharum officinarum* has been generally used for this group, as well as for more or less inclusive groups. Many writers, when referring to cultivated sugar canes of any derivation whatsoever, qualify their first reference to sugar canes by this name. In contrast to this broad interpretation, the very careful Dutch sugar cane technologists (8, 10, 14, 19) set up narrower and narrower limits to this group until Bremer (9) concluded that only noble sugar canes with $2n = 80$ chromosomes were *S. officinarum* and all the others were hybrids.

Unfortunately, the group in question is not as simple as this would imply. Many more noble sugar canes have been brought into experimental cultivation since Bremer came to his conclusions. An examination of some of these indicates that a further qualification is necessary if we are to accept his conclusions. This qualification would be that only a part of the noble sugar canes with $2n = 80$ chromosomes are similar to the group he had in mind. This statement is based on observations of some 72 clones of noble sugar canes in the living collection of the Division of Sugar Plant Investigations with $2n = 80$ chromosomes. Some of the clones with this number of chromosomes from Hawaii and New Caledonia do not seem to belong in this group. Reference will be made to them under the discussion with respect to relationships with *Erianthus maximus*.

The importance of the work of Bremer and other Dutch technologists in calling attention to this group lies in the fact that it has brought sharply into focus what undoubtedly is the most important element in the great diversity of forms collectively known as cultivated sugar canes. The group in question — represented by such clones as *Batjan*, *Black Cheribon*, *Crystalina*, *Fiji*, *Gestreept Preanger*, *Otaheite*, and *Simpson* and seedlings of these as *B.H. 10/12*, *D-74*, *E.K. 2*, *S.W. 3*, *D.I. 52*, etc. —, although small in number, has been the backbone of the sugar industry since the last years of the Eighteenth Century, when the historic clone now known as *Creole* began to be displaced in the Western Tropics. Even now, sugar cane breeders still find it necessary to backcross to elements of this group when they wish to obtain high sucrose and low fiber varieties.

In view of the great importance of the group referred to in the above paragraph, it appears desirable to follow the lead of the Dutch workers and at least recognize this group as the basic element of *Saccharum officinarum*, if not necessarily the only element. No type specimen of *S. officinarum* exists (18), and following customary botanical procedure might lead to absurdities, as the only sugar cane extensively grown in southern Europe and the Western Hemisphere at the time of the formation of this binominal and for centuries before was the clone called *Creole*, which appears to be a very odd hybrid type with $2n = 81$ chromosomes. The designation of a lectotype for this horticultural group — *S. officinarum* — might best be delayed until further material becomes available and more detailed studies, particularly cytogenetic, have been undertaken. When reference is made hereafter to *S. officinarum* in this paper, it is to be interpreted as meaning the sugar cane clones mentioned in the preceding paragraph.

A monograph of the cultivated sugar canes is not yet possible because many areas (Easter Island, Marquesas Islands, Solomon Islands, Spice Islands, Borneo, Malay Peninsula, Indo-China, to mention only the most important) have not been adequately searched for representative groups of garden sugar canes, and they represent gaps in our collection of important geographic groups. Furthermore, many of the sugar canes already in experimental cultivation are not represented by flowering material in any herbarium. Only about 200 native garden sugar canes are represented by flowering material in the U. S. Sugar Plant Herbarium. There may have been a more extensive collection, particularly of the Netherlands Indies forms, at the Eastern Java Experiment Station. Coöperation between the various sugar cane stations will again be necessary to advance these studies rapidly on a broad front. The flowering of many sugar cane clones is very erratic, and therefore progress in obtaining flowers is accelerated by teamwork under different environments. An added reason for close collaboration is that a clone under a given name at one station may be totally different from a clone under the same name at a different station. Moreover, identical clones may be carried at two or more stations under different names.

Saccharum officinarum is considerably different from *S. robustum*. The vegetative characteristics of *S. officinarum* will not be considered here because they have been influenced radically by the selective ability of primitive horticulturists and consequently do not help very much in determining relationships. The floral parts of *S. officinarum,* in contrast to those of *S. edule,* have not been utilized by primitive man, and they consequently are not consciously modified but give valuable indications as to relationships. Taken by themselves, the floral parts of the group of noble sugar canes called *S. officinarum* are readily distinguished from similar parts of *S. robustum*. The inflorescence, as a whole, is shorter, broader, and coarser. The rachis segments are stouter and not as long relatively with respect to the size of the spikelets. The spikelets of *S. officinarum* are easily distinguished from those of *S. robustum* in that all the parts are slightly larger. Accompanying this increase in size of the spikelet parts is an increase in the number of vascular bundles in some of the parts. The prophylletum of *S. officinarum* generally has 4 rather than 2 veins as in *S. robustum*. The first glume has 3 veins rather than 1, whereas the second glume has 1 in contrast to none. Only the third glume is similar in that it is absent or greatly reduced in both groups. On the basis of these morphological differences the relationship between *S. robustum* and *S. officinarum* is not very close.

The principal evidence for any relationship whatever between *Saccharum officinarum* and *S. robustum* is based on limited cytogenetic data on hybrids between members of these groups. Hybridization between *S. officinarum* and *S. robustum* is readily accomplished by using *S. officinarum* as the female parent and results in F_1 seedlings that have a larger chromosome number than the sum of the monoploid numbers of the parents (6). The increase in chromosome number beyond the sum of the monoploid numbers of the parents is only about one-half as great as when *S. spontaneum* is used as the male parent and, consequently, it is surmised that *S. officinarum* and *S. robustum* possibly have as many as 20 chromosomes in common. More work in this direction is indicated, using clones of *S. robustum* with $2n = 60$, 80, and 100 chromosomes.

Of considerable interest with respect to relationships between *Saccharum robustum* and noble sugar canes other than *S. officinarum* are the numerous clones obtained in native gardens in New Guinea by the U. S. Department of Agriculture expedition of 1928. Morphologically many of the clones of noble sugar canes from New Guinea are so similar to *S. robustum* in floral characteristics that differentiation on this basis alone is very difficult if not frequently impossible. The same, however, may be said of the hybrids between *S. officinarum* and *S. robustum*. The problems presented by this resemblance are of great interest and importance. What one would like to know is whether these clones are all hybrids between *S. officinarum* and *S. robustum* or if some of them are direct derivatives of *S. robustum*. Clones in which hybridization with *S. spontaneum* may have been involved introduce complicating factors but are more readily differentiated from the others. The complexity of the situation results from the ease with which hybridization takes place between the several groups in question. Answers may be forthcoming when additional material becomes available and further studies are made. Collectors of native sugar canes may help appreciably in the solution of some of these problems by giving special attention to the most inferior types available, as these are most likely to be missing links in the complicated history of sugar cane origins and the first to be discarded by the natives when modern improved varieties become available to them.

A partial clarification of the relationships of *S. officinarum* has resulted from a detailed study of numerous noble sugar canes from Micronesia and Polynesia. These groups are of particular interest because they are so obviously different from the large collection of noble sugar canes from New Guinea. Whereas only a very small percentage of the New Guinea noble sugar canes are similar to the clones of *S. officinarum,* practically all of the noble sugar canes now available from east of the New Hebrides have many morphological characteristics in common with *S. officinarum*. In fact, unpublished notes indicate that the floral characteristics that differentiate *S. officinarum* from *S. robustum* are frequently accentuated in clones of noble sugar canes from this area.

The most significant discovery in the present investigation is that many of the original noble sugar canes from Hawaii have a small awned third glume. The third glume is normally absent from *Saccharum officinarum* and *S. robustum*. Many of the clones in question are also different in that they are morphologically sterile. The prophylletum and glumes, including an awned third glume, are present and apparently normal in every respect, but all the other spikelet structures—palea, lodicules, anthers, and pistil—are absent, except for minute primordia, as in *S. edule* and a species of *Erianthus* (Pl. II, *fig. 3*) described hereunder. The awn, small but very distinct in structure, is important because it verifies to a great extent a conclusion with respect to the origin of *S. officinarum,* which previously had been surmised (7). On page 149 of that paper it was suggested, on the basis of similarity in the morphology of floral structures, that *Erianthus maximus* Brongn. "is in many respects the most likely species of *Erianthus* that may have played a part in the origin of the large cultivated canes."

The evidence points to *Erianthus maximus* as the second important wild relative of the noble sugar canes. Before discussing the relationship of this species to the noble sugar canes, specimens familiar to me are here cited:

Erianthus maximus Brongn. in Duperr. Voy. Coq. Bot. 2(2): 97. 1831.

Saccharum pedicellare Trin. in Mém. Acad. St. Pétersb. Math. Phys. Nat. **2**: 310. 1832.

SOCIETY ISLANDS: Tahiti, *W. A. Setchell & H. E. Parks* no. *535*, July 8, 1922, 18–20 feet high in large clumps in openings on moist slopes on the face of the Diadem, alt. 2500 ft.; S.P.H. nos. 1337 and 1425 from clone *Tahiti-7*, Imp. 852 (in mosaic collection only), vernacular name *Oviri*, from Atimaono, Tahiti, collected by *E. W. Brandes* in 1935; S.P.H. nos. 1353 and 1513 from clone *Raiatea 1*, Imp. 923, from valley, alt. about 600 ft., Raiatea, by *Brandes*.

AUSTRAL ISLANDS: Raivavae, Mt. Muanui, south slope, ravine at edge of forest, alt. 150 m., ascending 2 m. high, sap somewhat sweet, *F. R. Fosberg* no. *11694*, Aug. 8, 1934 (mixture of two kinds — typical *E. maximus* and a noble sugar cane — of which only small fragments were seen at the U. S. Nat. Herb.); Rapa, Hiri Valley, bank, by taro patch, apparently cultivated, alt. 50 m., decumbent, plant 3, *H. St. John & Jean Mairean* no. *15633*, July 20, 1934.

COOK ISLANDS: *T. F. Cheeseman* no. *719*, June 1899, Rarotonga (Kew Herb.).

NEW CALEDONIA: *M. Vieillard* no. *1510*, Mt. Panoin, Gatope (Kew Herb., listed by Balansa and Guillaumin as *Saccharum officinarum*); S.P.H. nos. 1514 and 1518 from clone *N.C. 1*, Imp. 1004, originally from near Noumea, by *Brandes;* S.P.H. nos. 1335, 1515, and 1516 from clone *N.C. 132*, Imp. 921, originally from east coast near Kanala, by *Brandes*.

FIJI ISLANDS: *J. Horne* no. *701*, 1877–78, the wild red and the white *"vico"* (two sheets in Kew Herb. with notes similar to quotation from 13, p. 69, cited below); *B. Seemann* no. *691*, 1860 (as *Eulalia japonica* Trin. in Seem. Fl. Vit. 321, consists of two sheets in Kew Herb., of which one appears to be leaves of *E. maximus* while the other is an immature inflorescence of what appears to be a noble sugar cane); S.P.H. no. 1346 from clone *Fiji 2*, Imp. 861, originally from Nausori, near Suva, Viti Levu, by *J. Matz*, through the courtesy of the Colonial Sugar Refining Co.; S.P.H. nos. 1347 and 1517 from clone *Fiji 3*, Imp. 862, originally from Rarawai, Viti Levu, by *Matz*.

Besides the clones cited, there are six clones in our collection from Viti Levu, Fiji Islands, that are so similar to *Fiji 2* and *Fiji 3* in vegetative characteristics that they must be considered as cultivated derivatives of *Erianthus maximus*. Specimens of the inflorescence of most of these clones are not available as yet and, consequently, they will not be discussed in detail. They are of particular interest because they are the *Duruka* (also *Drauka* and *Daruka*) canes that simulate *S. robustum* so closely in their stem characteristics.

The *Duruka* canes were obtained through the courtesy of the Colonial Sugar Refining Co. The following quotation from a letter with respect to them from Mr. V. Mott is of considerable interest: "The derivation of *"Duruka"* is not known — *"Vico"* by itself means a field of tall grass — *"Duruka Vico"* is a tall cane-like grass that flowers, in contrast with the other varieties of *Duruka* which produce edible heads only . . . The Fijians state that they have never used the *Duruka* juices for sweetening purposes in their cooking, hence apparently the name *"Duruka"* as distinct from the sweeter canes named *"Dovu."*

"There are known to be nine different varieties of native cane, called *Duruka*, growing in Fiji; they are called by the natives *Duruka Kibo, D. Leka, D. Coqecoqe, D. Toci, D. Veirai, D. Mirimanu* — producing "cauliflower" edible heads instead of tassels — and *Duruka Vico Vula* (*Vula* =

white), *D. Vico Damu* (*Damu* = red) and *D. Vico Teiniloka* (*Teiniloka* = bronze) producing flowering tassels."

The abortive types of *Duruka* were referred to by Horne (13) in 1881. On page 91 he gives the following account of this unusual vegetable: "Another gramina, the *drauka,* a plant somewhat resembling the sugar cane, is cultivated largely in some parts of Fiji. As a vegetable it is much relished by the Fijians all over the group. The unexpanded panicle of young flowers is the part eaten. If taken when young and tender, properly cooked, and served with butter as sauce, it is reckoned, by some, not inferior to asparagus. I regret that my specimens of this plant were not in fit condition to be named. They were not sufficiently advanced, and from the demand for the flowering shoots, specimens in full flower could not be obtained. To obtain these in Fiji, a *tabu* or prohibition to touch, would require to be put on a few plants."

Horne apparently did not realize that the flower parts of the kinds that are eaten do not mature. The closely related kinds, such as *Fiji 2* and *Fiji 3,* that flower are extremely tough and fibrous in the boot stage and could not be considered edible except possibly when the inflorescence is in a minute primordial stage. The clones which flower enable us to be fairly certain that this group of grasses is primarily a derivative of *Erianthus maximus*. Hybridization, particularly between diverse forms of *E. maximus* or between such forms and noble sugar canes, undoubtedly was a dominant factor in the origin of the various clones in this group. Inasmuch as there cannot be any certainty about the origin of such a group and because of its unique character, it is desirable that it be given a horticultural name. The name proposed for this group is as follows:

Erianthus maximus Brongn. hort. var. "ABORTIVE." PL. II, FIG. 3.

FIJI ISLANDS: S.P.H. nos. 1522 and 1523 from clone *Fiji 1,* Imp. 860, originally from Nausori, near Suva, Viti Levu.

It is not known if *Fiji 1* is identical with any of the *Duruka* clones not in our collection. The two *Duruka* clones in our collection that belong to this horticultural group — ***Duruka Mirimanu,*** Imp. 1021, and *Duruka Coqecoqe,* Imp. 1020 — are distinct clones. Detailed descriptions of the vegetative characteristics of the clones in our collection belonging to this group have been prepared by Artschwager (2).

The wild and cultivated forms of *Erianthus maximus* have long been mistaken for wild sugar canes. Horne is only one of many who was confused by this species of grass. The following account by Horne (13, p. 69) with respect to this group of plants in the Fiji Islands is of interest: "Sugar canes *dovo* (*Saccharum officinarum*), are common; both wild and cultivated varieties. The wild varieties grow in dense brakes on the rich alluvial flats and along the sides of small rivers and streams. They frequently grow to a height or length of about 20 feet, with a diameter varying from one-fourth of an inch to an inch. They are of various colours, green, white, or red, and some varieties are striped like a ribbon. The juice of some of the varieties has a faint sweet taste, but that of the majority is insipid and watery. Their characters at once suggest them to be the plants from which the cultivated varieties of the sugar cane have descended by improvement on successive sorts from a distant period. Improvement on them will be tried in the Botanical Gardens at Mauritius."

The origin of *Saccharum officinarum*, unfortunately, is not as simple as Horne suggests. *Erianthus maximus* is different from *S. officinarum* in many respects. Besides the differences already mentioned, the differences in floral characteristics are most important. The spikelets of *E. maximus* are in every respect larger than those of *S. officinarum*. This also holds true for all the spikelet parts. The difference in size is considerable in that the parts are almost twice as large as corresponding parts of *S. robustum*. With respect to size of spikelet structures, *S. officinarum* appears to be somewhat intermediate between *E. maximus* and *S. robustum* but closer to *S. robustum*. Besides the difference in size of floral structure, not many differences exist between the floral structures of *Erianthus maximus* and *Saccharum officinarum*. The venation of the spikelet structures of *E. maximus* is fairly similar to that of *S. officinarum*. The veins are generally more distinct and the prophylletum sometimes has one or two additional veins, making a total of 5 or 6 instead of 4. A significant difference is found in the third glume, which is awned in *E. maximus* and generally absent in *S. officinarum*. Awnedness, however, is very likely recessive to absence of third glume. The length of the awn in *E. maximus* varies considerably (11). In the clones from the Fiji Islands and New Caledonia, the awn is greatly reduced and generally does not even extend to the tip of the glumes. Another difference is found in the lodicules, which are very large with numerous cilia along their upper edge in *E. maximus*. In contrast to this, the lodicules in *S. robustum* are very small and not ciliate, while *S. officinarum* may or may not have cilia at each end of the upper edge of this wedge-shaped structure. The fairly frequent occurrence of a second flower in the axil of a fourth glume in the spikelet of *E. maximus* is a character that only rarely occurs in *S. officinarum* or *S. robustum*.

The chromosome number of the various clones of *Erianthus maximus* is of interest. All multiples of 10 from $2n = 60$ to $2n = 100$ are represented. Clone *Raiatea 1*, Imp. 923, from the Society Islands, has a chromosome number of $2n = 60$. *Tahiti 7*, Imp. 852, has about $2n = 70$. *N.C. 132*, Imp. 921, from New Caledonia, as well as *Duruka Vico Vula*, Imp. 1017, and *D. V. Teiniloka*, Imp. 1019, from the Fiji Islands, have $2n = 80$. *Fiji 3*, Imp. 862, has $2n = 90$, while *Duruka Vico Damu*, Imp. 1018, also from Fiji, has $2n = 100$. *N.C. 1*, Imp. 1004, from New Caledonia, may have $2n = 90$ or 100, as this originally was a mixture of two clones of which one part was accidentally discarded and a new count of the remainder has not been completed. The closely related clones of *Erianthus maximus* Brongn. hort. var. "Abortive" have a chromosome number of $2n = 70$ for *Fiji 1*, Imp. 860, and $2n = 80$ for *Duruka Coqecoqe*, Imp. 1020, and *Duruka Mirimanu*, Imp. 1021.

Before discussing further the relationship of *Erianthus maximus* to the noble sugar canes, it should be pointed out that *E. maximus* is not very closely related to *E. arundinaceus* (Retz.) Jesw., *E. sara* (Roxb.) Rumke (20), and the other species of *Erianthus* of the Eastern Hemisphere. The closest wild relative of *E. maximus* appears to be *E. Trinii* (Hack.) Hack. of Colombia, Brazil, and Paraguay. The *Erianthus* on Easter Island has not been seen by the writer of this paper. *Erianthus maximus,* as here interpreted, has been reported from Samoa and the Marquesas, but not from any area in which *S. robustum* is known to occur.

Artificial hybridization of *Erianthus maximus* and *Saccharum officinarum* or *S. robustum* has not been accomplished so far as is known. It may be necessary to import additional clones before such crosses can be made under conditions in southern Florida, where sugar cane breeding of the Division of Sugar Plant Investigations is conducted. The introduction of clones from such places as Samoa, Austral Islands, and the Marquesas is indicated in any event. The absence of artificial hybrids between *E. maximus* and *Saccharum* makes it difficult critically to evaluate the numerous noble sugar canes from Micronesia and Polynesia, as well as from New Caledonia, which are obviously different from *S. officinarum* as here narrowly interpreted.

On a strictly morphological basis it would seem that many of the noble sugar canes from this area are intermediate forms. Evidence for the assumption that many noble sugar canes are intermediate between *Saccharum officinarum* and *Erianthus maximus* is not as definite as is desired. The most convincing evidence is the presence of a small-awned third glume in some of the noble sugar canes in question. Others have larger pistils and a greater number of spikelets with two florets than one normally finds in *S. officinarum*. Six of about 40 Hawaiian original sugar canes have pinkish lavender midribs in their blades, whereas only two of more than 150 from New Guinea, namely, *28 N.G. 13*, Imp. 632 (a reddish purple leaved sugar cane called *Ure* from Abam, Oriomo River, New Guinea, which is very much like *Ireng Malang,* Imp. 1062, *Tomohon Zwart,* Imp. 1090, and *Boetota Bilatoe,* Imp. 1052, in this respect), and *28 N.G. 38,* Imp. 477 (*S. edule*) have this character. Of the few clones of *E. maximus* in our collection, *Fiji 2,* Imp. 861, and *Duruka Vico Teiniloka,* Imp. 1019 — likewise *Duruka Mirimanu,* Imp. 1021 (*Erianthus maximus* Brongn. hort. var. "Abortive") — have pinkish lavender midribs. *Duruka Vico Teiniloka,* Imp. 1019, has, in addition, the reddish purple leaves of *28 N.G. 13,* Imp. 632. The sheaths of the majority of the noble sugar canes from Polynesia, Micronesia, and New Caledonia are surprisingly free of coarse hairs, whereas those from New Guinea are in many cases very hairy. *Erianthus maximus,* from Fiji and New Caledonia, generally has smooth sheaths, or the hairs that develop are immediately deciduous on protrusion of a sheath from the sheaths below. Clones of *E. maximus* from the Marquesas and *Raiatea 1,* Imp. 923, from the Society Islands, have irritating hairs on the sheaths. Other resemblances and differences will undoubtedly be found as progress is made in the understanding of these complex groups.

On the basis of the morphological and geographical evidence presented in this paper, it is suggested that noble sugar canes are most closely related to *Saccharum robustum* and *Erianthus maximus*. There may have been separate origins of sweet forms in both of these groups, but it seems more likely that the main origins were from *S. robustum* and that as these forms were carried eastward beyond the range of wild *Saccharum* they were modified by hybridization with forms of *E. maximus*. The area in which this modification primarily took place appears to be the Fiji Islands and New Caledonia. Some of the modified forms were found to be superior and were carried back to New Guinea and other areas where *S. robustum* occurred and backcrossing took place. Clones that were carried to areas such as Hawaii in Polynesia apparently inbred, and some of the characteristics which appear to have been obtained from *E. maximus* were accentuated.

Comparative observations of a large number of original sugar canes and related wild forms thus far has permitted considerable advance along the road toward elucidation of the origins of sugar canes. It has become apparent in this study that progress is more certain when all available garden canes and related feral types of an island or region are assembled to compare with similarly complete assemblages from other islands or regions. Individual varieties or limited samplings from a given region are not satisfactory. Fortunately, some of the regional collections have been on a generous basis. They prove that there are a number of geographic points of origin and satellite regions of modification shown by distinctly different group compositions in different areas.

The story of sugar cane origins is by no means told. Critical cytogenetic studies of the complex groups involved remain to be made in testing the suggestions advanced in this paper. The high chromosome numbers found in noble sugar canes and related grasses is a very discouraging factor, which may long delay a better understanding of the plants in question. Another hindrance to rapid progress in the theoretical aspects of the problems of origins of sugar canes is the outbreeding normally practiced in the development of garden forms and new commercial sugar canes.

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EXPLANATION OF PLATES

PLATE I

Saccharum robustum Brandes and Jesweit. FIG. 1. *A*. Seeds of forma *sanguineum* Grassl. *B*. Anthers. *C*. Pedicellate spikelet. *D*. Rachis segments with spikelets. *E*. Margin of leaf-blade from a clonotype. *B*, *C*, and *D* are from the type of *S. robustum*. FIG. 2. Type of *S. robustum*, deposited in the U. S. National Herbarium. Note that two herbarium sheets are required to accommodate the 65 cm. long tassel. FIG. 3. *A*. Pistil. *B*. Third glume (first lemma) from a topotype. This structure normally is not as long, 1.5 mm., as this example. The dissection of 20 spikelets from the type specimen of *S. robustum* did not reveal any structure in the position where this third glume should be when present. *C*. Lodicules. *D*. Palea. Paleas of *S. robustum* frequently are shorter and broader with more cilia toward the apex. *A*, *C*, and *D* are from the type of *S. robustum*.

PLATE II

FIG. 1. *Saccharum edule* Hassk., clone *Teboe Troeboeg*, Imp. 724, showing the aborted inflorescence and the flag leaf in a dried condition. The cauliflower-like inflorescence remains enclosed within the sheaths of the upper 3 or 4 leaves. FIG. 2. *Saccharum edule*, clone *28 N.G. 201*, Imp. 509, showing the aborted inflorescence in a fresh but slightly overripe condition, as indicated by the discoloration at the apex. A customary way of preparing this vegetable for consumption is by roasting. FIG. 3. *Erianthus maximus* Brongn. hort. var. "Abortive," clone *Fiji 1*, Imp. 860. Note that the suppression of development of the inflorescence is not quite as complete as in *Saccharum edule*.

All photographs of Plates I and II are by P. St. C. Browne except Fig. 2 of Plate II, which is by J. F. Brewer.

PLATE III

UPPER. Clump of *Saccharum robustum*. Territory of Papua, left bank of Laloki River, the type locality. (Photo by E. W. Brandes.) LOWER. Creeping culms or rhizomes of *Saccharum robustum*, some partly exposed and showing rooted, leafy shoots. The rhizomes sometimes extend 60 feet from the base of an erect stool. Strickland River, Territory of Papua. (Photo by J. Jeswiet.)

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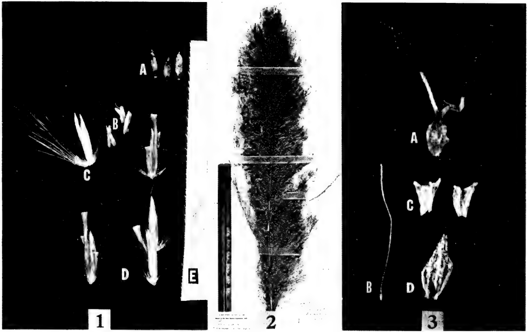
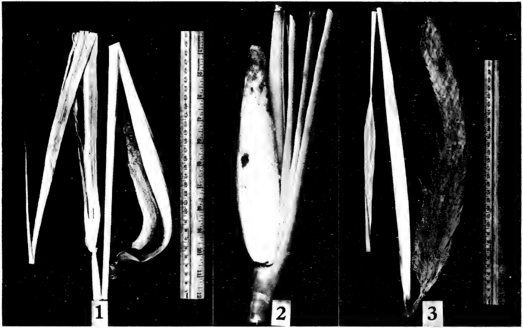


Saccharum robustum



SACCHARUM EDULE AND ERIANTHUS MAXIMUS

Saccharum robustum

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COMPARATIVE MORPHOLOGY OF THE FOLIAR SCLEREIDS IN THE GENUS MOURIRIA AUBL.

ADRIANCE S. FOSTER

With eleven plates

INTRODUCTION

A RECENT intensive study of the foliar sclereids of *Trochodendron aralioides* revealed the remarkable fluctuation in the form and structure of such cells which occur within a single species (10). Because of this polymorphism, one might question the diagnostic value of foliar sclereids in the distinction of species, genera, and tribes within the angiosperms, despite the extensive literature which has accumulated on this subject (cf. the resumé in Solereder, 20). Upon careful examination, much of the early systematic work on foliar sclereids seems inadequate for two reasons. First of all, in many cases the morphological observations are not correlated with specific herbarium collections. Secondly, very little attention is paid to the possibility of variation in sclereid-type between different leaves of one individual and between leaves of different individuals of the same species. As a result, it is hazardous or indeed impossible in many instances to generalize with respect to the major trends in morphological specialization of foliar sclereids within systematic units. Further evidence of the present uncertainty of our knowledge is provided by the investigations of Bailey and Nast (5) on the variable trends of specialization in the foliar sclerenchyma of the species and genera in the Winteraceae.

It is evident, therefore, that intensive and rigorously documented studies on the foliar sclereids of a wide series of genera are highly desirable. In the present article the results of a comparative study of the foliar sclereids of *Mouriria* Aubl. (Melastomataceae) are presented. This genus, according to van Tieghem (21), exhibits a wide range of sclereid-types, each of which is illustrated by a series of species. Moreover, the consistent presence of foliar sclereids in *Mouriria* as well as in the presumably closely related genus *Memecylon* L. was utilized by van Tieghem as the basis for segregating these genera in the subtribe "Mouririées" under the family "Mélastomacées." Unfortunately, however, van Tieghem included neither the author-names of the species of *Mouriria* studied nor citations to specific herbarium specimens. Consequently in the present study a complete re-examination of the foliar sclereids of *Mouriria* has been made, utilizing an extensive series of herbarium collections.

In Cogniaux's (7) monographic treatment of *Mouriria*, 40 species and one "species non satis nota" are recognized. Since the publication of his work many new entities have been described, so that the genus now contains approximately 80 species. The present survey is based upon the examination of 69 species and includes material representing all but 6 of the entities included by Cogniaux as well as all the species discussed by Hoehne (12) and Ducke (8). While it is recognized that some of the entities used may subsequently prove to have been incorrectly determined, the morphological descriptions are based on cited specimens and are thus subject to verification. Furthermore, in the majority of species examined, two or more separate collections were available, thereby permitting some study at least of morphological variations. In the case of 17 species, leaves from the type collection were investigated. Although the importance of type material should not be over-rated in a study of this sort, morphological data on such specimens will need to be considered in any future revision of the genus.

Grateful acknowledgement is made to my wife, Helen Vincent Foster, for her drawings of the sclereids illustrated in *Plate XI*. The writer also thanks Professor I. W. Bailey and Dr. A. C. Smith for many helpful comments during the progress of the investigation.

MATERIALS

The herbarium leaf-specimens forming the material for this investigation were secured through the generous coöperation of the following individuals: Dr. A. C. Smith, of the Arnold Arboretum (A); Dr. Paul C. Standley, of the Chicago Natural History Museum (Ch); Dr. J. M. Greenman, of the Missouri Botanical Garden (M); Dr. H. A. Gleason, of the New York Botanical Garden (NY); Dr. E. P. Killip, of the U.S. National Herbarium (US); Dr. Lyman B. Smith, of the Gray Herbarium (GH); Dr. H. L. Mason, of the University of California (UC); Dr. C. L. Wilson, of Dartmouth College (Dart); and Dr. J. T. Roig, of the Estación Experimental, Santiago de las Vegas, Cuba (Cu). Through the kindness of Dr. F. C. Hoehne of the Institute de Botanica at São Paulo and Dr. J. G. Kuhlmann of the Jardim Botanico at Rio de Janeiro, a separate collection of leaf-specimens of 30 species of *Mouriria* has also been investigated. This material is derived from specimens deposited in the herbarium of the Jardim Botanico (HJBR). The writer is also indebted to the authorities of the Instituto Agronômico do Norte, Belem, Pará, Brazil, for dried and preserved leaves of *M. crassifolia* Sagot. This valuable material was collected "in virgin forest 8 km. from Manaus" by J. P. Murça and was determined by Dr. A. Ducke.

For convenience in reference, the species used in the present study have been arranged below in alphabetical order. At the end of this list are appended a number of undetermined specimens. In all cases, the symbol in parentheses following the citation of each specimen designates one of the herbaria listed above. An asterisk preceding a species name indicates that material from the type collection has been studied.

M. abnormis Naud. French Guiana: *Mélinon* in 1861 (Ch).

**M. acuta* Griseb. Cuba: *Wright 2469* (M, type coll.); *Jack 7955* (Ch); *Britton, Britton & Cowell 9730* (NY, US); *Jack 5741* (A); *Ekman 16384* (US).

M. acutiflora Naud. Brazil: *Ule 7677* (UC); *Kuhlman 4546* (HJBR); *Ducke 18497* (HJBR); HJBR, Rio Madeira, Amazonas; *Krukoff 26653* (HJBR); *Ducke 18500* (HJBR). British Guiana: *A. C. Smith 2573* (A); *A. S. Pinkus 195* (US).

**M. acutiflora* var. *oligantha* Gleason. Surinam: *B. W. 6286* (US, type coll.).

**M. angustifolia* Spruce. Brazil: *Spruce 2987* (GH, type coll.).

M. anomala Pulle. Brazil: *Ducke 14373* (HJBR, US); *Ducke 105* (Ch); *Ducke 25515* (HJBR).

M. Apiranga Spruce. Brazil: *da Costa 124* (Ch); *Ducke 18495* (HJBR); *Ducke 35736* (HJBR). Peru: *Ule 9678* (US).

**M. arborea* Gardn. Brazil: *Gardner 5704* (GH, NY, type coll.).

M. brachyanthera Ducke. Brazil: *Mexia 5964* (UC); *Ducke 35737* (HJBR); *Ducke 10870* (HJBR).

**M. brachypoda* Urban & Ekman. Haiti: *Ekman 6064* (US, type coll.). Santo Domingo: *Ekman H14694* (NY); *Ekman H6257* (A).

M. brevipes Benth. Surinam: *B. W. 1506* (Ch); *Utrecht Herb. 1506* (US); *Plantae Surinamenses 1506* (NY). Brazil: *Ducke 27605* (HJBR).

M. brunneicalyx Standley. Panama: *Seibert 609* (A).

M. buxifolia Urban. Santo Domingo: *Ekman 11295* (A).

M. cauliflora DC. Brazil: *Ducke 25517* (HJBR, US). Peru: *Klug 1374* (Ch).

M. cearensis Huber. Brazil: *Ducke 14378* (HJBR).

M. Chamissoana Cogn. Brazil: *Glaziou 44803* (Ch); *Hoehne 29921* (NY); *Sellow 473* (US); *Porto 10759* (HJBR); *Ducke 6561* (HJBR).

M. Chamissoana var. *paulistana* Hoehne. Brazil: *Hoehne 29921* (Ch); *Hoehne 27704* (A).

M. ciliata Gleason. Brazil: *Krukoff 5478* (UC).

M. collocarpa Ducke. Brazil: *Ducke 299* (US); *Ducke 25516* (HJBR); *Ducke 35740* (HJBR).

M. crassifolia Sagot. French Guiana: *Mélinon* in 1862 (Ch); *Mélinon* in 1864 (A). Surinam: *Utrecht Herb. 3358* (US). Brazil: *Ducke 27624* (HJBR).

M. cyphocarpa Standley. British Honduras: *Schipp 70* (UC); *Gentle 2126* (NY); *Lundell 6945* (US). Mexico: *Williams 9398* (A).

M. densifoliata Ducke. Brazil: *Ducke 801* (M); *Ducke 50951* (HJBR).

M. domingensis Spach. Santo Domingo: *Ricksecker 477* (UC). Haiti: *Ekman H4209* (NY, US); *Ekman H5121* (A).

M. Doriana Saldanha. Brazil: *Brade 11203* (GH); *Saldanha 14418* (HJBR).

M. dumetosa Cogn. Brazil: *Ducke 22518* (HJBR, US).

M. elliptica Mart. Brazil: *Capanema 10620* (HJBR).

**M. emarginata* Griseb. Cuba: *Wright 2467* (M, type coll.); *Ekman 7443* (NY); *Ekman 9280* (US).

M. eugeniaefolia Spruce. Brazil: *Spruce*, Dec.–Mar. 1850 (GH).

M. exilis Gleason. Guatemala: *Wilson 407* (Ch). British Honduras: *Schipp 70* (NY); *Gentle 2927* (A).

M. floribunda Markgraf. Peru: *Mexia 6187* (UC).

M. Gardneri Triana. BRAZIL: *Gardner 2863* (GH); *Gardner 4154* (NY).
**M. Gleasoniana* Standley. MEXICO: *Matuda 3093* (Ch, TYPE COLL.). GUATEMALA: *Steyermark 39525* (Ch).
M. grandiflora DC. PERU: *Williams 8128* (Ch). BRAZIL: *Ducke 18504* (HJBR).
M. guianensis Aubl. BRAZIL: *Drouet 2356* (UC); *Krukoff 11926* (NY); *Krukoff 6613* (A); *Huber 10873* (HJBR); HJBR, Amazonas. FRENCH GUIANA: *Broadway 434* (US). VENEZUELA: *Williams 11600* (US).
M. Helleri Britton. PUERTO RICO: *Heller 1372* (Ch, NY).
**M. hottensis* Urban & Ekman. HAITI: *Ekman 10399* (A, US, TYPE COLL.).
M. Huberi Cogn. BRAZIL: *Mexia 5980* (UC); HJBR, Pará.
**M. lanceolata* Griseb. CUBA: *Wright 1235* (M, TYPE COLL.); *Ekman 15810* (US).
M. Lisboae Huber. BRAZIL: *Lisboa 11462* (HJBR).
**M. maestralis* Urban. CUBA: *Ekman 9350* (NY, US, TYPE COLL.).
M. Marshallii Burtt Davy & Sandwith. TRINIDAD: *Russell 1265–9* (NY).
**M. micradenia* Ducke. BRAZIL: *Ducke 25520* (HJBR, US, TYPE COLL.).
M. monantha Urban. CUBA: *Ekman 4415* (US).
M. Muelleri Cogn. MEXICO: *Matuda 3339* (M); *Matuda 3093* (A); *Reko 3817* (US).
M. myrtifolia Spruce. BRAZIL: *Krukoff 1371* (A, UC); *Krukoff 1407* (A); *Ducke 14379* (HJBR).
M. myrtilloides Poir. CUBA: *Herb. Richard* (Ch). JAMAICA: *Britton 3998* (NY); *Harris & Britton 10629* (US).
M. nervosa Pilger. BRAZIL: *Ducke 205* (A); *Ducke 14388* (HJBR).
M. oligantha Pilger. PERU: *Williams 3904* (Ch).
M. parvifolia Benth. MEXICO: *LeSueur 647* (GH). BRITISH HONDURAS: *Gentle 44* (UC); *Schipp 124* (UC); *Lundell 483* (UC); *Gentle 3712* (NY); *Bartlett 13132* (US). PANAMA: *Pittier 5711* (US); *C. L. Wilson* acc. No. *101* (Dart). ECUADOR: *Rimbach 92* (NY, US). BOLIVIA: *Steinbach 7582* (GH).
M. Petroniana Cogn. & Sald. BRAZIL: *Glaziou 13860* (Ch); *Almeida 48224* (HJBR).
M. Plasschaerti Pulle. BRAZIL: *Ducke 17234* (US); *Ducke 14383* (HJBR).
M. princeps Naud. BRAZIL: *Krukoff 5459* (UC); *Krukoff 8412* (A); *Krukoff 5986* (A); HJBR No. *27622*. PERU: *Killip & Smith 29761* (Ch).
M. pseudo-geminata Pittier. VENEZUELA: *Williams 10182* (Ch).
M. Pusa Gardn. BRAZIL: *Glaziou 19348* (Ch); *Gardner 2596* (NY, US); *Brade & Barreto 45553* (HJBR); *Ducke 14392* (HJBR).
M. rhizophoraefolia Triana. TOBAGO: *Broadway 4622* (Ch, US); *Broadway 3976* (GH).
**M. rostrata* Urban. CUBA: *Ekman 14069* (GH, US, TYPE COLL.); *Collector?* (NY).
M. Sagotiana Triana. SURINAM: *B. W. 5475* (Ch). PERU: *Klug 1501* (US). BRAZIL: *Ducke 10866* (HJBR); HJBR, no locality given.
**M. samanensis* Urban. SANTO DOMINGO: *Abbott 2233* (M, TYPE COLL.); *Ekman 15180* (A); *Ekman 14895* (A).
M. Sideroxylon Sagot. PERU: *Killip & Smith 26845* (Ch, US).
M. spathulata Griseb. CUBA: *Shafer 3254* (US); *Wright 1234* (GH).
M. "aff. *spathulata* Griseb." PUERTO RICO: *Sintensis 6195* (A); *Sintensis 6095* (US).
**M. Steyermarkii* Standley. GUATEMALA: *Steyermark 39446* (Ch, TYPE COLL.).
**M. subumbellata* Triana. BRAZIL: *Spruce 2004* (GH, TYPE COLL.).
**M. trunciflora* Ducke. BRAZIL: *Ducke 16937* (US, TYPE COLL.); *Capucho 456* (Ch); *Ducke 10839* (HJBR).
M. Ulei Pilger. BRAZIL: *Ducke 205* (Ch); *Ule 7677* (US); HJBR, Pará.
**M. Valenzuelana* A. Rich. CUBA: *Wright 2468* (M, TYPE COLL.); *Ekman 13845* (A, Ch, NY, US).
M. vernicosa Naud. FRENCH GUIANA: *Mélinon 189* (Ch); *Martin* s.n. (GH). SURINAM: HJBR, no locality given.
M. Weddellii Naud. BRAZIL: *Gardner 2595* (US); *Lützelberg 5998* (HJBR).
M. sp. BRAZIL: *Krukoff 6565* (A).
M. sp. BRAZIL: *Krukoff 6706* (A).

M. sp. BRAZIL: *Ducke 44* (A).
M. sp. BRAZIL: *Ducke 173* (A).
M. sp. BRAZIL: *Ducke 299* (A).
M. sp. CUBA: *Acuña 12602* (Cu).
M. sp. CUBA: *Acuña 12603* (Cu).
M. sp. CUBA: *Acuña 12604* (Cu).
M. sp. CUBA: *Acuña 7724* (Cu).
M. sp. CUBA: *Bucher 191* (Cu).
M. sp. CUBA: *Roig 61* (NY).

TECHNIQUE

Most of the data presented in this paper are based upon the study of cleared leaves. The technique consists in removing the pigments by treatment with 5% NaOH in an electric oven followed by dehydration in alcohol and clearing in xylene. The preparations were mounted directly in balsam without staining. In the case of large-leaved species, comparable portions of the lamina including the marginal and midrib areas were used. In many of the small-leaved species, the entire cleared lamina could be mounted beneath the cover-glass.

The study of cleared leaves was supplemented, when necessary, by hand-sections and by macerations. In most instances, the sclereids could be readily isolated from the surrounding leaf-tissue by teasing apart small portions of the thoroughly cleared laminae in a drop of water on a slide. The use of acid-alcohol followed by treatment with very dilute ammonium oxalate was particularly helpful where the sclereids are firmly adherent to the mesophyll and epidermal cells. In all cases the isolated sclereids were mounted directly from water into glycerine jelly.

DISTRIBUTION OF SCLEREIDS IN THE LAMINA

One of the most interesting and unexpected results of this study was the discovery that, throughout the species examined, the sclereids tend to be restricted to the ultimate ends of the veinlets (*figs. 1–15, 31–34*). This prevailingly *terminal position* of the foliar sclereids in *Mouriria* contrasts strikingly with the more usual *diffuse* distribution of such cells in the leaves of other dicotyledons (5, 9, 10, 11, 20). Despite the relatively large number of species studied by van Tieghem (21), he overlooked this definitive topographical feature of *Mouriria*, as did Palézieux (15), probably because both investigators made their observations largely on leaf-sections. A more detailed discussion of the morphological and ontogenetic implications of the terminal position of the sclereids will be deferred until the various sclereid-types in *Mouriria* have been described.

In addition to terminal sclereids, a number of species examined develop small unbranched sclereids in the tissues of the midrib and the short petiole. These sclereids occur either as solitary cells or are clustered, and appear to fluctuate in abundance even within the same species. Somewhat similar cells, with numerous pits, were also found lying free in the mesophyll of the leaves of *M. angustifolia*, *M. cauliflora*, *M. cyphocarpa*, *M. exilis*, *M. oligantha*, and *M. trunciflora* (*figs. 10, 21*). In these species, the diffuse sclereids tend to be most numerous in the vicinity of the midrib and the larger veins but their distribution and abundance fluctuate considerably. In *M. oligantha*, for example, small diffuse sclereids were encountered even in the extreme marginal region of the lamina scattered among the large, irregularly branched terminal sclereids.

SCLEREID TYPES

In agreement with the observations of van Tieghem (21), the present survey reveals an extraordinary range in the form of the foliar sclereids in *Mouriria*. The majority of the species develop more or less conspicuously branched sclereids which vary widely in respect to the form of the cell-body and the position and extent of the system of branches. In marked contrast, a relatively few species exhibit remarkable filiform sclereids which resemble slender fibers in their form and unbranched character. These two extremes in sclereid form, however, cannot be sharply demarcated, because of intergradations and because of the strong tendency to fluctuation within many of the entities which have been studied. Under these circumstances, a classification of sclereids based on cell-form must be sufficiently elastic to include not only the outstanding "types" but also the intergradations which exist between them. From this standpoint, a morphological classification of the foliar sclereids of *Mouriria* is now presented. The sequence of arrangement of the four main "types" is mainly one of convenience and is not intended to represent a "phylogenetic series." On the contrary there is no reliable clue at present as to which of these types is "primitive." Therefore such terms as "rudimentary" and "highly developed" are used in a descriptive sense only and carry no evolutionary implications.

TYPE I. The sclereids grouped under this type are characterized by their parenchymatous form and rudimentary branches. Their position is prevailingly terminal at the ends of the veinlets throughout the nineteen species in which they have been encountered. In three species[1], *M. myrtifolia* (all collections except *Ducke 14379*), *M. vernicosa*, and *M. brachyanthera*, occasional sclereids, similar to those at the vein-endings, develop independently within the mesophyll. The sclereids, in the simplest cases observed, are spheroidal cells, unbranched or provided with irregular and short radiating arms. Cells of this kind occur in the leaves of *M. myrtifolia*, *M. Sagotiana*, *M. Valenzuelana*, and *M. vernicosa*. In these species, the secondary wall of the sclereids fluctuates widely in thickness, not only between the different entities but even within the same leaf (*figs. 1, 2*). A more complex and consistently branched kind of spheroidal sclereid was

[1] If no citations to specimens accompany the name of a species in this article it is to be assumed that *all* of the collections of this entity studied exhibit the same morphological type of sclereid.

found in the leaves of *M. angustifolia*, *M. brachyanthera*, *M. Huberi* (*Mexia 5980*), *M. nervosa*, *M. Plasschaerti*, *M. Sideroxylon*, and *M. Ulei* (*Ducke 205*). In these forms, the relatively thick-walled sclereids possess numerous radiating branches which very frequently dichotomize at their tips (*fig. 3*). Sclereids of a fundamentally similar type were also encountered in the leaves of *M. acuta*, *M. marginata*, *M. parvifolia*, and *M. myrtilloides* (*Britton 3998*, *Harris & Britton 10629*). The sclereids in these species tend to develop a more irregular cell-body but they are not sharply distinct from the spheroidal-branched forms described above (*fig. 4*).

TYPE II. Within this category the writer has attempted to segregate a complex series of ramified sclereids which vary considerably in size, form of the cell-body, and degree of development of the branch-system. Among the extremes in specialization within this polymorphic group are the stellate forms typical for example of the leaves of *M. princeps*, *M. micradenia*, and *M. ciliata* (*figs. 6, 7*), the dichotomously lobed sclereids with short acute branches which occur in *M. trunciflora* and *M. Helleri* (*figs. 8–10*), and the bizarre fusiform irregularly branched cells which are found in the leaves of *M. oligantha*, *M. Chamissoana* var. *paulistana*, and *M. Marshallii* (*figs. 13–15*). Many fluctuating and intermediate forms occur between these extremes and preclude any efforts at a rigid system of classification. Indeed it seems entirely possible that the examination of a wider range of leaf material than has been possible in this study would reveal even more extensive variations. For purposes of convenience in discussion, however, two rather well-defined trends of specialization are recognized.

(1) *Stellately branched sclereids*. These remarkable cells are characterized by the possession of relatively long and often dichotomizing arms which radiate in various directions from the irregular cell-body (*figs. 5–7*). In some cases, the tips of the vertical arms may reach the inner walls of one or both epidermal layers, but the major portion of the branch-system is confined within the mesophyll. Sclereids of this kind are prevailingly terminal in position, although in *M. rostrata*, *M. monantha*, *M. domingensis*, and *M. grandiflora* occasional examples of isolated sclereids were seen. When the various species exhibiting stellately branched sclereids are compared, interesting and apparently consistent differences in the size, number, and character of the branches are evident. For example, the branch-system of the sclereids of *M. cyphocarpa* (all collections except *Williams 9398*) consists of a radiating series of dichotomizing arms which seem to represent merely a more vigorous development of the condition described for the sclereids of Type I (cf. *figs. 3* and *5*). A similar trend in development was also encountered in the sclereids of *M. exilis*. In contrast, the stellate sclereids of *M. princeps*, *M. grandiflora*, *M. ciliata*, *M. collocarpa*, and *M. acutiflora* var. *oligantha* develop long slender arms which extend both laterally and vertically through the mesophyll in a most distinctive manner. Often the arms of adjacent sclereids overlap

to varying degrees (*fig. 6*). The sclereids of *M. brunneicalyx*, *M. Weddellii*, and *M. micradenia* closely approach this condition but tend to be somewhat shorter and more irregularly branched (*fig. 7*). In a number of species, the main body of the sclereid, which is somewhat flattened and dichotomously lobed, develops a series of short irregular acute arms which extend toward each epidermal layer. This condition has been observed in *M. trunciflora*, *M. Helleri*, *M. monantha*, *M. buxifolia*, *M. samanensis*, *M. hottensis*, and *M.* "aff. *spathulata*" (*figs. 8–10*). Such sclereids, however, in the material examined tend to fluctuate in form and are not sharply demarcated from the more regular stellate types.

The sclereids of *M. brevipes*, although radiately branched, offer several points of morphological interest. In all the collections of this species examined, the sclereid-branches are unusually slender and often appear bent or twisted in a very distinctive manner. In some cases, small terminal portions of certain of the vertical branches extend between the epidermis and the adjacent mesophyll cells.

In concluding this discussion of stellately branched sclereids, it is necessary to correct the apparently erroneous statements of Palézieux (15, p. 76) that "spicular cells" (i.e. sclereids) are absent from the leaf of *M. domingensis*. His conclusions were based upon Puerto Rican material cited as "*Sintensis 5024*." The present investigation, utilizing one collection from Santo Domingo (*Ricksecker 477*) and two collections from Haiti (*Ekman H4209*, *Ekman H5121*), yields quite a different result. In all cases, small radiately branched terminal sclereids were seen, but they are extremely few in number and the majority of the veinlets terminate in normal tracheary elements. A re-examination of Palézieux's material, using large portions of cleared leaves, would therefore seem very desirable.

(*2*) *Fusiform-branched sclereids.* In a number of species, the sclereids tend to be more or less conspicuously elongated within the mesophyll and the branch-system is correspondingly irregular in character. This trend appears to varying degrees in the sclereids of *M. brachypoda*, *M. Gleasoniana* (*Matuda 3093*), *M. lanceolata* (*Wright 1235*), *M. spathulata* (*Wright 1234*), *M. Lisboae*, *M. sp.* (*Roig 61* from Cuba), and *M. sp.* (*Acuña 12602* from Cuba). Excellent examples are provided by the sclereids of *M. Muelleri*, which vary in form from short irregularly branched elements to cells provided with long fiber-like ends (*fig. 12*). In *M. acutiflora* the sclereids are more profusely branched, with the same tendency, however, to assume an elongated form (*fig. 11*). But the most striking examples of elongated ramified sclereids were observed in *M. Steyermarkii*, *M. oligantha*, *M. Chamissoana*, *M. Chamissoana* var. *paulistana*, and *M. Marshallii*. In each of these species the sclereids are so distinctive in their morphology that separate description is necessary.

In *M. Steyermarkii* the sclereids are extremely variable in form, ranging from irregularly branched cells with the tips of the branches often reaching the lower epidermis to slender and sparingly branched fiber-like elements. In sclereids of the latter type, the vertical branches are often restricted to that portion of the element which is in direct contact with the end of the veinlet.

A very distinctive kind of sclereid was discovered in the leaf of *M. oligantha*. The terminal sclereids of this species are exceptionally large in size, very thick-walled, and provided with a series of relatively short, acute spicule-like branches (*fig. 13*). Although many sclereids are extremely irregular in form, there is a pronounced tendency to the development of a massive fiber-like cell body. When portions of the cleared leaf are observed from both surfaces, it is evident that very short dichotomizing terminations of certain of the branches extend beneath the adaxial epidermis and the mesophyll.

The sclereids of *M. Chamissoana* and *M. Chamissoana* var. *paulistana* are polymorphic to an unusual degree. When even small areas of the cleared leaf are examined it is evident that the range in variation includes (1) short rod-like elements with more or less truncated ends, (2) elongated fusiform cells with few or no branches, and (3) dichotomously branched elements which may appear Y- or X-shaped (*fig. 14*). In both the fusiform and branched types, the ultimate ends of the cell-body or its arms are blunt rather than acute. A careful study of the position of the sclereids in both of the above entities likewise reveals unusual fluctuation. Many of the veinlets terminate in solitary sclereids of varying form, but diffused sclereids of similar morphology are also frequent. In several instances, pairs of ramified interlocked sclereids were observed lying free in the mesophyll.

The situation in the leaf of *M. Marshallii* is one of the most remarkable encountered in this survey. The submarginal regions of the lamina are largely devoid of sclereids, and only rarely were peculiar thin-walled irregularly branched cells observed at the ends of the veinlets. On the contrary, typical sclereids, in the limited material of this species examined, are restricted to the lamina-margin, where they appear as a series of closely packed massive fiber-like cells (*fig. 15*). Branching is sparse and irregular and the secondary wall is thick and apparently conspicuously laminated. Careful examination of cleared material reveals that these sclereids are strictly terminal at the ends of the marginal veinlets.

TYPE III. In sclereids of this type, the greatly elongated axis of the cell extends obliquely or vertically through the entire mesophyll and branches more or less profusely beneath each epidermal layer. The characteristic orientation and distinctive branching of sclereids of this type is vividly illustrated in *M. Pusa*. When a thick transection of the cleared lamina of this species is examined, the sclereids appear as columnar elements with numerous overlapping branches extending beneath the lower and upper epidermis (*fig. 16*). As is evident in this figure, the main axis of these remarkable sclereids frequently dichotomizes, sending out two series of candelabra-like branches toward the upper or lower surface of the lamina. When viewed as isolated cells in macerated material, the sclereids of *M. Pusa* vary widely as to the length of the terminal branches and their relative development at each end of a given cell. Very commonly the sclereid appears I-shaped because of the prominent development of two horizontal branches at each end of the cell (*fig. 37*). But many variants of this condition were noted, including T-shaped cells with short root-like branches at one end and forms with one or two candelabra-like branch-systems. The full extent and complexity of the branch-systems of the sclereids of *M. Pusa* is fully appreciated, however, only by the study of large portions of cleared leaves. When the adaxial surface of the lamina is viewed at a high plane of focus, the subepidermal branches of adjacent sclereids are seen to overlap and to interlock in a most intricate manner (*fig. 17*). In contrast, the branches which develop beneath the abaxial epidermis tend to be somewhat shorter and less crowded in appearance (*fig. 18*).

Sclereids of a similar morphological type are also found in the leaves of *M. rhizophoraefolia* and *M. Gardneri*. In the former the sclereids tend to be less profusely branched but otherwise are very similar to those of *M. Pusa*. But in *M. Gardneri* the subepidermal branch-systems attain a degree of development which is truly remarkable. As viewed from the adaxial surface, the complex radiating and dichotomizing branches of the sclereids collectively form an intricate mesh-work (*fig. 19*). This condition is equally apparent when the abaxial surface of the lamina is examined (*fig. 20*). Here the sclereid-branches are very tightly interlocked and the meshes of the reticulum are occupied by the prominent stomatal crypts which are characteristic of a number of species of *Mouriria* (21, pp. 47–48, *pl. 2, figs. 11–15*).

Columnar branched sclereids were also encountered in the leaves of *M. cauliflora* and *M. abnormis*. In these species, however, the subepidermal branch-systems are somewhat different in character and are much less extensively developed than in *M. Pusa* and *M. Gardneri*. When cleared leaves of *M. cauliflora*, for example, are examined at a high level of focus, it is evident that a considerable portion of the branch-systems of the rather widely spaced sclereids extends in a dendroid manner below the epidermis (*fig. 21*). Instructive views of the distinctive sclereids of this species are furnished by macerations. These reveal that the sclereids are columnar in form with remarkable dendroid branch-systems at each end (*fig. 35*). Often the main axis of the sclereid dichotomizes, thus producing a series of candelabra-like branches (*fig. 36*). The sclereids of *M. abnormis* are rather similar morphologically, differing mainly in the more conspicuous tendency of the main axis to fork.

With respect to position, the branched sclereids of *M. Pusa*, *M. rhizophoraefolia*, and *M. cauliflora* are strictly terminal at the ends of the veinlets. In *M. abnormis*, however, many of the columnar sclereids develop independently of the vascular system within the mesophyll. Unfortunately no decision could be reached with reference to *M. Gardneri*, because clear views of the veinlets are obscured by the profuse subepidermal branch-systems of the sclereids.

TYPE IV. The sclereids included under this type are distinguished by their slender greatly elongated form and by their peculiar orientation within the leaf. They were encountered in only nine of the species investigated and are among the most bizarre of the foliar idioblasts found in *Mouriria*.

The striking features of this type of sclereid are well illustrated in *M. anomala*. As seen in transectional view, the lamina of this species appears to be permeated by a tangled series of thread-like cells which traverse the mesophyll in the most varied directions and extend beneath the epidermal layers (*fig. 22*). The general impression is that of a "diseased leaf" thoroughly penetrated by a fungus mycelium, an impression which is further strengthened when the adaxial surface of cleared leaves is viewed at a high plane of focus (*fig. 23*). As seen from this aspect the sclereids appear as slender intertwined filiform elements, many of which extend horizontally for a considerable distance beneath the epidermis. An essentially similar appearance is presented when the cleared leaf is examined from the abaxial surface, except that the sclereids "avoid" the stomatal crypts. The latter appear singly or in groups bordered by the interlaced and overlapping ends of the sclereids. A careful inspection of *figure 22* will show that a number of the sclereids follow an oblique undulating course through the mesophyll, their opposed ends terminating below the upper and lower epidermis (cf. also 21, *pl. 2, fig. 7*). Whether this is invariably the orientation of every sclereid is impossible to decide because of the great length and tortuous path of many of the cells. The ultimate solution of this question must come from a study of the complete history of development of the sclereids.

Sclereids entirely similar in form to those of *M. anomala* also occur in the leaves of *M. subumbellata*, *M. crassifolia*, *M. Apiranga*, and *M. eugeniaefolia*. In these species the sclereids are extremely long and are well developed beneath the epidermis, where they are arranged in complex intertwined groups (*figs. 24, 28*). This arrangement is also shown in a striking fashion at the extreme marginal region of the lamina, where the filiform sclereids are very closely packed and only occasional free tips are evident (*fig. 25*).

When isolated by maceration, the sclereids of this type appear as long, acuminate fiber-like cells which are bent or twisted to various degrees, as would be expected from their peculiar orientation within the lamina (*fig. 39*). In all of the species mentioned above, occasional sclereids fork at one or both ends and in addition may be provided with a few short spicule-like branches.

The relation of sclereids of this type to the veinlets could only be satisfactorily determined in *M. Apiranga*. In one of the collections of this species (*da Costa 124*) it was possible to find certain areas in the cleared leaf where the attachment of sclereids to the ends of the veinlets was unmistakable. Whether in this and the other four species the sclereids are *prevailingly* terminal in position can be settled only by ontogenetic study.

For convenience, the writer has also included under Type IV the sclereids of *M. densifoliata*, *M. dumetosa*, *M. arborea*, and *M. Petroniana*.

In these species, the sclereids traverse the mesophyll in various directions but tend to branch, more or less profusely, beneath the epidermal layers. On the basis of morphology and orientation, these sclereids thus appear somewhat intermediate between Types III and IV. When the adaxial surface, for example, of the lamina of *M. densifoliata* is examined, the sclereids appear as acuminate unbranched cells which, except for their shorter extension beneath the epidermis, resemble the sclereids of *M. crassifolia* (cf. *figs. 24* and *26*). But when the abaxial surface of the leaf of *M. densifoliata* is studied it is clear that the ends of many of the sclereids are forked or irregularly branched, somewhat like the abaxial ends of the sclereids of *M. Pusa* (cf. *figs. 18* and *27*). This latter resemblance will be clearer by reference to *figure 38*, which depicts an isolated cell of *M. densifoliata*. This element is decidedly fiber-like at one end, while the opposite end is branched very much like that of the sclereid of *M. Pusa* (cf. *figs. 37* and *38*). In *M. dumetosa* a study of cleared leaf-sectors indicates that the sclereids are rather coarse fiber-like cells which branch abundantly under both epidermal layers.

The most striking examples of sclereids which seem to combine the morphological characteristics of Types III and IV were found in the leaves of *M. arborea* and *M. Petroniana*. In these species the terminal sclereids are very long slender cells, branched within the mesophyll and with delicate ramifications beneath each epidermal layer (*figs. 29, 30*). These sclereids appear to be "connecting links" between the extremes in specialization represented on the one hand by the idioblasts of *M. Pusa* and on the other by those of *M. Apiranga* (cf. *figs. 17* and *28* with *figs. 29* and *30*).

DISCUSSION AND SUMMARY

The wide range in sclereid-types which occurs in *Mouriria* and the dominant terminal position of these idioblasts represent problems of considerable morphological and taxonomic interest which will now be examined under two main topics.

(1) TERMINAL POSITION OF THE SCLEREIDS. Throughout the 69 species which have been studied, there is an unmistakable tendency for the sclereids to be restricted in position to the ends of the veinlets, regardless of their form or particular orientation within the leaf (*figs. 1–15, 31–34*). This distinctive topography, which has apparently not been observed in previous studies on angiosperm sclereids,[2] raises the question of the onto-

[2] The relation of the various sclereid-types to the veinlets in *Memecylon* deserves comparative study because of the presumably close systematic relationship of this genus to *Mouriria* (21, pp. 50–51). Although no attempt was made at a comprehensive survey, the writer discovered terminal sclereids in the leaves of the following species: *Memecylon Arnottianum* Wight ex Thwaites (*Thwaites 1589*, US), *M. obtusum* Wall. (*Helfer 126*, A), *M. oligoneuron* Bl. (*Elmer 21308*, *Ramos 1635*, *Yates 1216*, UC), *M. phyllanthifolium* Thwaites ex Clarke (*Thwaites 3901*, isotype US), *M. scutellatum* (Lour.) Naud. (*Ching 9757*, *McClure 20120*, UC; *Clemens 3313*, US), and *M. Spathandra* Bl. (*Linder 1305*, *Dinklage 2971*, *Kennedy 1844*, A; *Grossweiler 9189*, US).

genetic and phylogenetic origin of the sclereids in *Mouriria*. Are these idioblasts "homologous" with the tracheary or sclerenchymatous elements of the veinlets, or is their terminal position a topographical relationship devoid of morphological significance? Unfortunately, material suitable for ontogenetic study has not been secured by the writer and hence it is not clear whether the terminal sclereids originate from "procambial cells" in the developing veinlets or arise from adjacent cells of the "ground meristem."[3] The existence in certain species of both terminal as well as diffuse sclereids has already been mentioned, and developmental studies on the leaves of these plants would doubtless shed important light on the problem. It is of interest, however, that in several of the species investigated indirect evidence is found of the possibly close ontogenetic relationship between terminal sclereids and tracheary elements. The most striking illustration of this was encountered in the leaf of *M. maestralis*. In this Cuban endemic, typical thick-walled ramified sclereids are largely confined to the midrib and marginal regions of the lamina, and the majority of the veinlets terminate in cells intermediate in character between sclereids and tracheary elements. The "hybrid" character of these remarkable cells is shown by their tendency to produce sclereid-like lobes and branches and by the development of helical thickenings closely similar to those of protoxylem elements (*figs. 31–33*). Not infrequently a group of adjacent veinlets exhibits a series of remarkable intergradations between "normal" tracheary cells and thick-walled branched sclereids (*fig. 34*). Because the material available for study was restricted in amount, it is uncertain whether the presence of "transitional cells" represents a reliable diagnostic character of *M. maestralis*. The situation in *M. hottensis* clearly demonstrates the need for a cautious approach to such a problem. In one collection of this species (*Ekman 10399*, A) many of the veinlets terminate in hybrid-like cells similar to those in *M. maestralis*. But in a collection of *M. hottensis* bearing the same number, from the U. S. National Herbarium, the majority of the veinlets end in thick-walled irregularly branched sclereids. Such fluctuations make it plain that the question of the ontogenetic and phylogenetic relationships between sclereids and tracheary elements in *Mouriria* requires intensive as well as extensive study.

(2) Systematic value of the sclereids. The classification of sclereids proposed in this paper is based entirely on morphological characters and was not influenced by the opinions advanced by various writers as to the systematic affinities between the various species of the genus. This standpoint was obviously demanded, because (1) no comprehensive taxonomic revision of *Mouriria* has been attempted since the publication of Cogniaux's (7) monograph, and (2) a number of the entities used in the

[3] *Both* methods of origin occur in the case of the so-called "storage tracheids" found in the leaves of a number of angiosperms (16, pp. 46–50 and 60–62). In "*Capparis religiosa*" the terminal storage tracheids are branched and resemble, to some extent, certain of the sclereids which occur in *Mouriria* (16, *fig. 5*).

present survey may subsequently prove to have been incorrectly determined. For these reasons, the possible diagnostic value of the sclereids can be approached only in a most tentative manner.

First of all, it seems evident that the presence of terminal foliar sclereids is an important *generic character* of *Mouriria* which can be utilized especially in the identification of "sterile" or doubtful material. This was illustrated by the study of a series of unclassified specimens, presumably all belonging to *Mouriria*, obtained from the Arnold Arboretum. In one of these specimens (*Ducke 44*) long filiform sclereids, obviously of the type found in *M. crassifolia* and *M. anomala*, are present. In three specimens (*Krukoff 6565*, *Ducke 173*, *Ducke 299*) typical stellately branched terminal sclereids of a type common in *Mouriria* were encountered. But in *Krukoff 6706* peculiar diffuse sclereids, unrelated to the veinlets, occur. The true affinities of this specimen are obscure, but it does not appear to be a species of *Mouriria*. The generic value of sclereids was also illustrated by the study of a leaf-specimen, presumably of a *Mouriria*, received from the herbarium of the Missouri Botanical Garden under the specific epithet "*Gentlei*" (*Gentle 1684*). When cleared, this leaf proved devoid of sclereids, and a subsequent search in the literature revealed that the same collection was described as *Eugenia Gentlei* (Myrtaceae) by Lundell (13). A further example was provided by the contrast between the two collections of *M. Gleasoniana*. In the leaf of the type collection, from Mexico (*Matuda 3093*), ramified terminal sclereids very similar to those of *M. Muelleri* were found (cf. *fig. 12*). But in the specimen from Guatemala (*Steyermark 39525*) the leaf is entirely devoid of sclereids and, because of the presence of well developed secretory glands in the mesophyll, appears to represent an entity belonging to the Myrtaceae. In two of the species of *Mouriria* included in the present survey, *M. floribunda* (*Mexia 6187*), from Peru, and *M. pseudogeminata* (*Williams 10182*), from Venezuela, sclereids are absent from the lamina and the veinlets terminate in lobed or greatly enlarged helically thickened cells. These elements closely resemble the so-called "storage tracheids" of *Nepenthes* (16, *fig. 8A*). On the basis of the very limited material available, it seems very doubtful to the writer that these specimens were correctly determined.

In any attempt to utilize sclereid-types as an aid in the distinction of species in *Mouriria*, full consideration must be given to the common tendency of sclereids, especially those of Type II, to fluctuate in form within the leaves of the same entity. To determine fully the limits of variation in each case requires the comparison of a much wider range of material than has been possible in the present survey. Nevertheless interesting results emerge when the available morphological data are applied to a discrete and apparently "representative" series of species. The 19 Amazonian species recently discussed from a taxonomic and a phytogeographic standpoint by Ducke (8) furnish very suitable material. In the first place there are included among these species a number of the old and apparently very distinct entities which are treated by Cogniaux (7) in his monograph of *Mouriria*. Secondly, for each of these 19 species, the writer has assembled 2 or more separate leaf-collections, the comparison of which showed excellent general agreement as to sclereid-type. Finally, the specimens of five of the species bear the same number which is cited in Ducke's article. On the basis of sclereid-morphology these Amazonian species can be arranged in four groups as follows:

Group I includes *M. brachyanthera*, *M. Huberi* (*Mexia 5980*), *M. Plasschaerti*, *M. Ulei* (*Ducke 205*), *M. nervosa*, *M. Sagotiana*, *M. vernicosa*, and *M. myrtifolia*. In these species the sclereids are parenchymatous in form and are provided with rudimentary branches (*figs. 1–3*). No significant variations in sclereid-type were encountered except in *M. Ulei* (*HJBR* from Pará), *M. myrtifolia* (*Ducke 14379*), and *M. Huberi* (*HJBR* from Pará), in which the sclereids are more irregularly and profusely branched, resembling those of *M. elliptica* and *M. acutiflora* (*fig. 11*). On this point it is interesting to note that Ducke (8) states that *M. Huberi* is the only species of Amazonia belonging to the subgenus *Olisbea*. The latter was originally defined as one of the two "sections" of *Mouriria* by Cogniaux (7), to include *M. elliptica*, *M. rhizophoraefolia*, *M. arborea*, and *M. Petroniana*.

Group II includes *M. trunciflora*, *M. collocarpa*, *M. micradenia*, *M. grandiflora*, and *M. acutiflora*. The sclereids of all these species are profusely ramified but appear to differ from one another in the form of the cell and the extent of the branch-system (*figs. 7–11*). Because of this, the sclereids may ultimately prove useful in the differentiation of these five species. The presence of numerous small diffuse sclereids appears to be an additional diagnostic feature of *M. trunciflora* (*fig. 10*).

Group III includes *M. cauliflora*, which appears very distinctive because of (1) the columnar terminal sclereids with their subepidermal branch-systems, and (2) the presence of parenchymatous diffuse sclereids (*figs. 21, 35, 36*). *Mouriria guianensis* may also belong in this group, although this species has proved the most variable of all the entities investigated with respect to sclereid-morphology. In some collections (*Drouet 2356*) the terminal sclereids are irregular columnar cells which branch irregularly beneath the upper epidermis of the leaf. In other collections (*Williams 11600*, *Krukoff 6613*) the sclereids closely approach the type found in *M. acutiflora*. Because of such fluctuations it seems possible that the writer's leaf-collections of *M. guianensis* may represent several distinct entities.

Group IV includes *M. anomala*, *M. crassifolia*, *M. Apiranga*, and *M. dumetosa*. In these species the sclereids are greatly elongated fiber-like cells branched to varying degrees beneath the epidermis and oriented in a most distinctive manner in the leaf (*figs. 22–24, 28, 39*).

Whether these "species groups" just defined on the basis of sclereid-morphology are composed of entities which are closely related in other respects is open to question. In this connection it is worthy of note that

Cogniaux's (7) division of *Mouriria* into two sections results in the *separation* of species which exhibit similar morphological types of sclereids. Thus, for example, *M. Gardneri* and *M. Pusa* are classed by Cogniaux under the section *Eumouriria*, while *M. rhizophoraefolia* is placed in the section *Olisbea*. All three species, however, form distinctive columnar sclereids which branch more or less profusely beneath the epidermal layers (*figs. 16–20*). Similarly *M. arborea* and *M. Petroniana* are segregated from *M. crassifolia*, *M. dumetosa*, *M. eugeniaefolia*, *M. subumbellata*, and *M. Apiranga*, although all of these species possess slender fiber-like sclereids which are among the most distinctive idioblasts in the genus (*figs. 22–25, 28–30*). Such apparent discrepancies, however, do not necessarily indicate that sclereid-characters are less reliable than other morphological criteria[4] in judging affinities between species. On the contrary, it is clear that the ideal approach to the systematics of *Mouriria* should involve the comparison and correlation of a wide range of morphological features, including floral structure as well as the histology of the leaf and stem. The important results which emerge from a broad attack of this sort are illustrated by the recent collaborative studies of Smith (17, 18, 19), Bailey and Nast (1, 2, 3, 4, 5, 6), and Nast (14) on the Winteraceae.

[4] Cogniaux (7) used certain characters of the calyx and pollen as the bases for his two sections of *Mouriria*.

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EXPLANATION OF PLATES

PLATE I

Cleared leaves showing terminal sclereids of Type I. Magnification × 140. FIG. 1. *M. myrtifolia* Spruce, *Krukoff 1371*. FIG. 2. *M. Sagotiana* Triana, *Klug 1501*. FIG. 3. *M. brachyanthera* Ducke, *Mexia 5964*. FIG. 4. *M. emarginata* Griseb., *Ekman 9280*.

PLATE II

Cleared leaves showing terminal sclereids of Type II. Magnification × 140. FIG. 5. *M. cyphocarpa* Standley, *Schipp 70*. FIG. 6. *M. princeps* Naud., *Krukoff 5459*. FIG. 7. *M. micradenia* Ducke, *Ducke 25520*. FIG. 8. *M. Helleri* Britton, *Heller 1372*.

PLATE III

Cleared leaves showing terminal sclereids of Type II. Magnification × 140. FIG. 9. *M. trunciflora* Ducke, *Ducke 16937*. FIG. 10. A different region of the same leaf shown in *fig. 9*. Note small diffuse sclereids in mesophyll and along the two veins. FIG. 11. *M. acutiflora* Naud., *Ule 7677*. FIG. 12. *M. Muelleri* Cogn., *Matuda 3093*.

PLATE IV

Cleared leaves showing terminal sclereids of Type II. Magnification × 140. FIG. 13. *M. oligantha* Pilger, *Williams 3904*. The globoid structures in the center and right-hand portions of the figure are masses of crystals. FIG. 14. *M. Chamissoana* var. *paulistana* Hoehne, *Hoehne 29921*. FIG. 15. *M. Marshallii* Burtt Davy & Sandwith, *Russell 1265–9*. Margin of lamina showing large fusiform-branched sclereids. The dark bodies near the sclereids are masses of crystals.

PLATE V

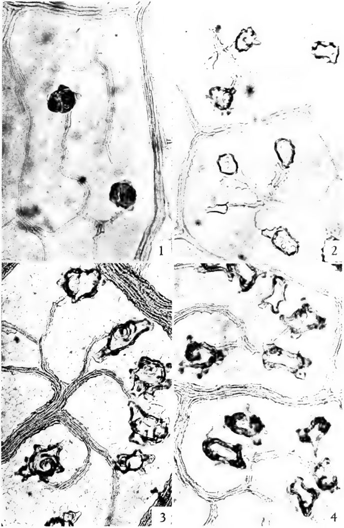
Cleared leaves of *M. Pusa* Gardn., *Gardner 2596*, illustrating form and orientation of Type III sclereids. Magnification × 140. FIG. 16. Thick transection of lamina showing columnar sclereids branched beneath the epidermal layers. Note veinlet in center of figure. FIG. 17. Adaxial surface of lamina showing sclereid-branches under the epidermis. FIG. 18. Abaxial surface of lamina showing sclereid-branches under the epidermis.

PLATE VI

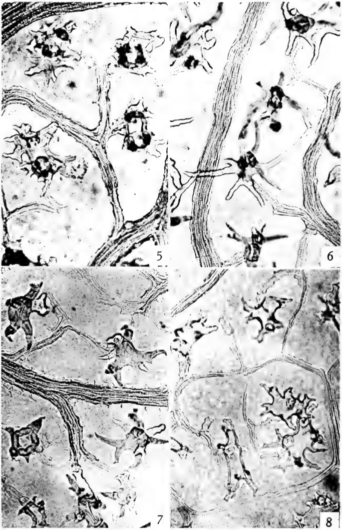
Cleared leaves illustrating sclereids of Type III. Magnification × 140. FIG. 19. *M. Gardneri* Triana, *Gardner 2863*. Adaxial surface of lamina showing the profusely developed subepidermal branch-systems of the sclereids. FIG. 20. Abaxial surface of a portion of the same leaf shown in *fig. 19*. The stomatal crypts, appearing as oval areas, are bordered by the tightly interlocked subepidermal branches of the sclereids. FIG. 21. *M. cauliflora* DC., *Ducke 25517*. Abaxial surface of lamina showing dendroid branching of the terminal sclereids beneath the epidermis. Note the small parenchymatous diffuse sclereids lying in the mesophyll.

PLATE VII

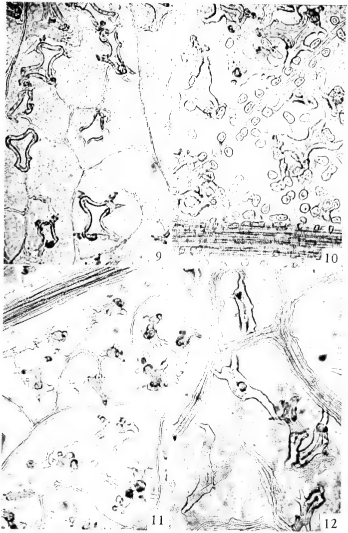
Cleared leaves illustrating sclereids of Type IV. Magnification × 140. FIG. 22. *M. anomala* Pulle, *Ducke 14373*. Thick transection of lamina showing the very numerous intertwined filiform sclereids which traverse the mesophyll region and extend beneath the epidermal layers. FIG. 23. Adaxial surface of a portion of the



Foliar Sclereids in Mouriria

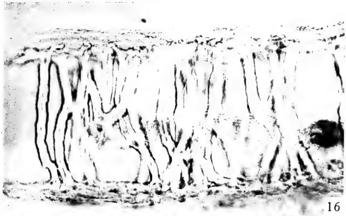


Foliar Sclereids in Mouriria



Foliar Sclereids in Mouriria

Foliar Sclereids in Mouriria



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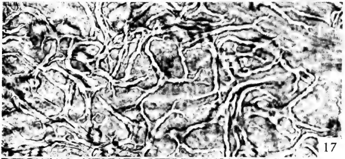

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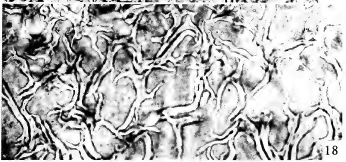

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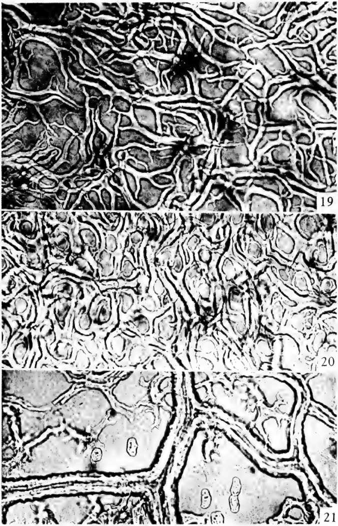
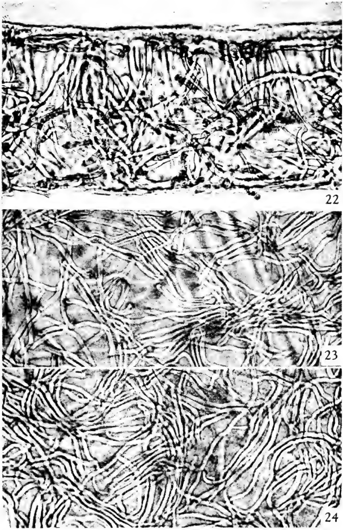
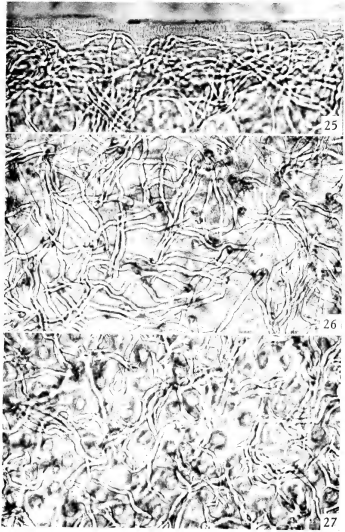
Foliar Sclereids in Mouriria



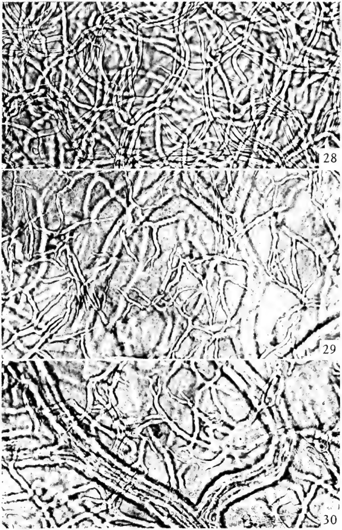
Foliar Sclereids in Mouriria



Foliar Sclereids in Mouriria



Foliar Sclereids in Mouriria



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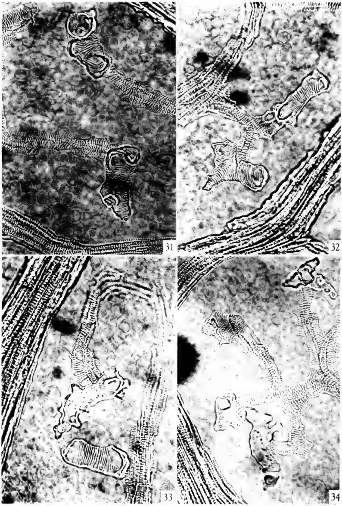

Foliar Sclereids in Mouriria

Foliar Sclereids in Mouriria

same leaf shown in *fig. 22*, illustrating the overlapping of the subepidermal ends of the sclereids. FIG. 24. *M. crassifolia* Sagot, *Utrecht Herb. 3358*. Adaxial surface of the lamina showing the tangled overlapping subepidermal portions of the filiform sclereids.

PLATE VIII

Cleared leaves illustrating sclereids of Type IV. Magnification × 140. FIG. 25. *M. eugeniaefolia* Spruce, *Spruce*, Dec.–Mar. 1850. Margin of lamina showing the tangled arrangement of the filiform sclereids. Note the extremely slender acuminate free tips of certain sclereids. FIG. 26. *M. densifoliata* Ducke, *Ducke 801*. Adaxial surface of the lamina showing the acuminate unbranched subepidermal ends of the sclereids. FIG. 27. Abaxial surface of a portion of the same leaf shown in *fig. 26*. Note the numerous stomatal crypts (circular structures) and the subepidermal crowded branches of the sclereids.

PLATE IX

Cleared leaves illustrating sclereids of Type IV. Magnification × 140. FIG. 28. *M. Apiranga* Spruce, *da Costa 124*. Abaxial surface of lamina showing intertwined subepidermal portions of the very slender filiform sclereids. FIG. 29. *M. arborea* Gardn., *Gardner 5704*. Adaxial surface of lamina showing profuse branching of fiber-like sclereids beneath the epidermis. FIG. 30. *M. Petroniana* Cogn. & Sald., *Glaziou 13860*. Abaxial surface of lamina showing the branching of the fiber-like sclereids within the mesophyll and beneath the epidermis.

PLATE X

Cleared leaves of *M. maestralis* Urban, *Ekman 9350*, illustrating terminal cells intermediate in form and structure between sclereids and tracheary elements. Magnification × 285. FIG. 31. Two irregularly lobed cells with helical thickenings. FIG. 32. Contrasted forms of "hybrid cells" at the dichotomous ends of a veinlet. Note especially the armed, sclereid-like shape of the lower terminal cell. FIG. 33. The curved end of the veinlet in the center of the figure bears a thin-walled irregularly lobed sclereid-like cell provided with numerous small pits. Below this element is seen a cylindrical tracheid-like cell with prominent helical thickenings attached to a short lateral extension of the veinlet. FIG. 34. A series of veinlets illustrating the diversity of terminal cells typical of this collection of *M. maestralis*. Beginning at the top of the figure the veinlets terminate in (1) a thin-walled radiately branched sclereid-like element, (2) a group of short helically thickened tracheary elements, (3) a small lobed "transitional cell" with helical thickenings, and (4) a typical thick-walled ramified sclereid with conspicuous pits and a very narrow lumen.

PLATE XI

Camera-lucida drawings of sclereids isolated by maceration. In order to emphasize the three-dimensional character of these cells, the narrow lumen has been omitted in the drawings. Magnification × 180. FIGS. 35 and 36. Columnar branched sclereids of *M. cauliflora* DC., *Ducke 25517*. FIG. 37. Columnar I-shaped sclereid of *M. Pusa* Gardn., *Gardner 2596*. FIG. 38. Branched, fiber-like sclereid of *M. densifoliata* Ducke, *Ducke 801*. FIG. 39. Long unbranched filiform sclereid of *M. crassifolia* Sagot, *Utrecht Herb. 3358*.

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PAPUODENDRON, A NEW GENUS OF ARBORESCENT MALVACEAE FROM NEW GUINEA

C. T. WHITE

With one plate

IN JULY and August, 1944, accompanied by Dr. H. E. Dadswell, I spent six weeks in the Mandated Territory of New Guinea conducting a school in forest botany and wood technology for the Forest Survey Companies of the 1st Aust. C. R. E. New Guinea Forests. A number of specimens were collected, and after our departure this work was continued by officers of the survey companies. In many cases no collector's name accompanied the specimens, but all bore numbers preceded by the initials N. G. F. (New Guinea Forests).

It is strange that this new genus was discovered in country previously considered to be fairly well worked over. As attention was concentrated on the big trees, however, other novelties will no doubt be found in the collections. This paper is communicated to the Arnold Arboretum, as so much on Papuan botany of recent years has appeared in its Journal. All cited specimens except that of Clemens are deposited in the Queensland Herbarium, Brisbane; duplicates are in the herbarium of the Arnold Arboretum.

Papuodendron gen. nov.

Epicalyx late campanulatus prominenter 5-dentatus, extus uti calyx petala ovariumque dense lepidotus. Calyx campanulatus epicalyce duplo vel triplo longior, initio ut videtur clausus, demum ad medium in lobos 5 ovatos margine saepe incurvos divisus. Petala 5 imbricata mox decidua. Stamina monadelpha; columna annulo pilorum petala aequante cincta; tubus brevis apice in filamenta ca. 20 divisus, filamentis tubo vix breviori-bus, antheris anguste reniformibus rima longitudinali dehiscentibus. Ovarium sessile 5-loculare, loculis pauciovulatis, stylo in ramos 5 stigmatiferos diviso; stigmata majuscula carnosula suborbicularia. Capsula ovoidea, seminibus reniformibus pilis longis densis obsitis.

Arbor. Folia alterna, simplicia, petiolata, penninervia, utrinque lepidota. Flores pro familia parvi, ebracteolati, in paniculos (vel thyrsos) terminales et axillares dispositi.

Species 1 in Papua crescens.

Papuodendron lepidotum sp. nov.

Arbor magna ad 45 m. alta, trunco basin versus anteridifero, cortice griseo, longitudinaliter sulcato, ramulis cortice rubro obtectis, juvenilibus dense lepidotis deinde glabris. Folia elongato-ovata, apice acuta, basi subcordata, utrinque plus vel minus dense lepidota sed lepidibus distinctis margine integris; nervis praecipuis ca. 10 in utroque latere, supra prominulis subtus elevatis; petiolo 1.5 cm. longo, laminis 11–17 cm. longis, 4.5–6.5 cm. latis. Paniculae terminales et in axillis superioribus dispositae. foliis ca. triplo breviores. Epicalyx cum pedicello 2 mm. longo 4 mm. longus. Petala oblonga, 3 mm. longa, intus glabra, extus stellato- vel lepidoto-pubescentia, mox decidua. Annulus pilorum alborum inter petala et tubum stamineum petala aequans. Columna staminea brevis. Capsula dense lepidota, 2 cm. longa. Semina margine pilis albis vel fulvis longis obsita.

NEW GUINEA (North Coast): Narakapoor Road near Yalu, in rain-forest, Forest Survey Company No. 2 *N. G. F. 255* (fl. buds), July 1944 (large tree 120 ft., buttressed up to 6 ft., bark light gray-brown, ½ inch thick, decorticating in small papery flakes); Yalu, in rain-forests on flats, J. Cavanagh *N. G. F. 864* (tree 70 ft., fluted up to 15 ft., crown sparse, leaves insect-eaten, bark fibrous in layers, wood white, light, soft to cut); Aiyura, alt. 6000 ft., L. S. Smith *N. G. F. 1053* (tree 130 ft., buttressed and channelled up to 8 ft., bark ½–⅝ in. thick or slightly more, fibrous, layered, the layers peeling in fibrous strips, wood whitish, fairly soft with conspicuous ripple marks; native name: *Iwo*); Lae, in rain-forest near sea-level, Dadswell, Smith, & White *N. G. F. 1693* (TYPE: flowers and young capsules), July 1944 (tree 140 ft., 90 ft. clear bole, buttressed and channelled up to 10 ft., bark grayish, longitudinally fissured, shed in soft, crumbly flakes, wood whitish, sapwood not defined); Boana,* *Clemens 41728*, May–Nov. 1940, alt. 750–1350 m. (tall tree, ± 65 cm. diameter; flowers dark wine-color).

The nearest affinity with the present genus seems to be *Camptostemon* Masters, but from the description of this given by R. C. Bakhuizen van den Brink in his "Revisio Bombacacearum" (Bull. Jard. Bot. Buitenz. III. 6: 161–232. 1924) the two genera can be distinguished as follows:

Epicalyx irregularly sinuate; calyx irregularly 3-lobed; petals persistent, connate at the base to the staminal tube.................................... *Camptostemon*.
Epicalyx 5-dentate; calyx equally 5-lobed; petals deciduous, free from the staminal tube.. *Papuodendron*.

Bakhuizen, l. c., mentions the doubtful position of *Camptostemon* and suggests that it may belong to the Hibisceae rather than the Bombacaceae, but I think that the staminal column, antheriferous at the top, places it definitely in the latter group. Apart from this character, the differences between the two groups are not very marked, and in my opinion the Bombacaceae is better retained as a tribe of the Malvaceae than accepted as a distinct family.

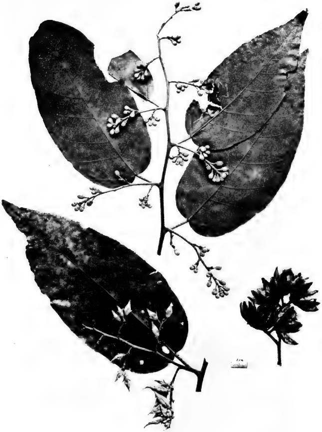
Dr. H. E. Dadswell, who has examined the wood of this new species, states in a letter to me that "*Papuodendron*, from the wood structure point of view, fits the tribe Hibisceae rather than the tribe Durioneae. All the genera listed in the Durioneae in Edlin's classification of the Bombacaceae that we have in our collection or that we can get information on have a special anatomical feature in the medullary rays called 'tile cells.' These tile cells do not occur in the members of the tribe Hibisceae and do not occur in *Papuodendron*. Unfortunately, we do not have specimens of *Camptostemon* to make comparisons. It would be very interesting to see whether tile cells occur in this genus."

* Specimen in the herbarium of the Arnold Arboretum, duplicate in the herbarium of the University of Michigan.

EXPLANATION OF THE PLATE

Papuodendron lepidotum. Top, branchlet bearing inflorescences with flower-buds (from type collection). Bottom left, branchlet with very young fruits (from type collection). Bottom right, dehiscing fruits (from *N. G. F. 1053*, from Aiyura).

QUEENSLAND HERBARIUM,
BOTANIC GARDENS,
BRISBANE, AUSTRALIA.



PAPUODENDRON LEPIDOTUM C. T. WHITE

NOTES ON PAPUASIAN SAXIFRAGACEAE*

JOHN R. REEDER

With one text-figure

THE ONLY comprehensive treatment of the Papuasian Saxifragaceae is that by R. Schlechter (in Bot. Jahrb. **52**: 118–138. 1914), in which he recognized seven genera and 25 species in the group. Only a few new species have been described since 1914. In the present paper 11 new species are described, of which three are in the genus *Carpodetus*, two in *Quintinia*, and six in *Polyosma*. Engler's treatment (in Nat. Pfl. ed. 2. **18a**: 74–226. 1930) may be consulted for the relationships of the Papuasian genera.

In connection with this study, herbarium specimens have been seen from the Arnold Arboretum (A), the Gray Herbarium (GH), the University of Michigan (Mich), the New York Botanical Garden (NY), and the University of California (UC). In the absence of parenthetical letters indicating the place of deposit, cited specimens are to be found only at the Arnold Arboretum. The writer is indebted to the Directors and Curators of institutions from which material has been borrowed, and to staff-members of the Arnold Arboretum, especially to Dr. A. C. Smith, for advice during the progress of this work.

Carpodetus J. R. & G. Forst.

(*Argyrocalymma* K. Schum. & Lauterb.)

Carpodetus amplus sp. nov.

Arbor 6–7 m. alta, ramulis juventute teretibus circiter 4–5 mm. diametro, sparsim puberulis demum glabratis; petiolis supra canaliculatis substrigosis decurrentibus circiter 1 mm. longis; laminis chartaceis in sicco fusco-olivaceis ellipticis vel oblongis, majoribus 10–14 cm. longis 4–10 cm. latis, supra glabris, subtus pilis 0.3–0.5 mm. longis sparsim nervis densius adpresso-strigosis, basi inaequaliter rotundatis, in apicem 1–1.5 cm. longum subabrupte angustatis, margine conspicue serrato-mucronatis, obvie revolutis, costa supra impressa subtus valde prominente, nervis lateralibus utrinsecus circiter 6 vel 7 supra impressis subtus prominentibus, venulis supra leviter subtus valde prominulis; inflorescentia corymboso-paniculata ampla terminali sub fructu circiter 15 cm. longa et 23 cm. lata e basi 3- vel 4-divisa, plerumque 5- vel 6-plo di- vel trichotoma, pedunculis secundariis 3.5–6 cm. longis inferne teretibus superne complanatis, ramis inflorescentiae pedicellisque pallido-puberulis, ramulis ultimis gracillimis; pedicellis teretibus circiter 1.5 mm. longis; fructibus subglobosis submaturis ad 6 mm. diametro rugulosis sparsim puberulis, supra medium calycis lobis

* Botanical Results of the Richard Archbold Expeditions.

4 deltoideo-lanceolatis 0.3–0.5 mm. longis ornatis, apice stylo conico-subulato circiter 1.5 mm. longo coronatis.

SOLOMON ISLANDS: Guadalcanal: Uulolo, Tutuve Mt., alt. 1200 m., *Kajewski 2599* (TYPE), April 29, 1931 (small tree 6–7 m. high, common in rain-forest; fruit on terminal panicles).

Carpodetus amplus is of the alliance of *C. arboreus* (Lauterb. & K. Schum.) Schlechter. These two species are the only ones in the genus which have thus far been described as being 4-merous. From *C. arboreus* the new species differs in having somewhat larger leaves, which are absolutely glabrous on the upper surface, only slightly appressed-strigose beneath, and with a short-attenuate tip. A further difference is that *C. amplus* has a more diffuse inflorescence, which is about one-third larger than that of its ally. Since the Kajewski specimen is in fruit, no comparison can be made with regard to characters of the flowers.

The discovery of this new species extends the range of the genus to the Solomon Islands.

Carpodetus major Schlechter in Bot. Jahrb. 52: 137. *fig. 6.* 1914.

NORTHEAST NEW GUINEA: Finisterre Mountains, alt. 1300 m., *Schlechter 18186* (UC, TYPE COLL.), Sept. 1908 (tree, in misty forest); Morobe District, Kaile to Sarawaket, alt. 1566 m., *Clemens 4791* (small shrub or tree on open trails); Ogeramnang, alt. about 1650 m., *Clemens 5096*, alt. 1500–1800 m., *11211* (A, Mich) (tree 2.5 cm. diam.; flowers white), *11322* (A, Mich) (tree; flower-buds dull, colorless), *41024* (Mich) (small tree on mountain ridge; fruit gray).

The Clemens specimens cited above appear to be identical with the type collection, which apparently has been the only representative of the species thus far cited.

Carpodetus Archboldianus sp. nov.

Frutex vel arbuscula 2–4 m. alta, ramulis juventute subteretibus circiter 2–3 mm. diametro sparsim strigosis, demum glabratis; petiolis supra canaliculatis strigosis decurrentibus circiter 6 mm. longis; laminis chartaceis in sicco viridibus vel fusco-olivaceis ellipticis, (4–) 6–10 cm. longis, (2–) 3–5 cm. latis, utrinque pilis albidis dispersis 0.3–0.5 mm. longis sparsim adpresso-strigosis, basi obtusis, apice plerumque cuspidatis, margine dentibus 8–12 utrinsecus serrato-mucronatis, costa supra impressa subtus valde prominente, nervis lateralibus principalibus utrinsecus circiter 5–7, venulis supra leviter subtus valde prominulis; inflorescentiis corymboso-paniculatis terminalibus multifloris, pedunculo brevi rhachi pedicellisque brunneo-strigosis; pedicellis circiter 2 mm. longis extus sericeis intus glabris; calyce extus breviter sericeo ad 4 mm. longo, tubo cupuliformi 1.5–2.5 mm. longo circiter 2.5 mm. diametro, limbo 5- vel 6-lobato intus glabro, lobis anguste triangularibus 1–1.5 mm. longis; petalis 5 vel 6 patentibus ellipticis circiter 3 × 2 mm., extus sericeis intus basim versus pilosis; staminibus 5 vel 6 circiter 2 mm. longis, filamentis gracilibus distaliter angustatis sparsim pilosis, antheris ovalibus circiter 0.8 mm. diametro; stylo subulato glabro quam staminibus paullo breviore basi circiter 0.4 mm. diametro, stigmate capitato; fructibus subglobosis circiter 8 mm. diametro, calycis lobis et stylo persistente coronatis.

NETHERLANDS NEW GUINEA: 9 km. northeast of Lake Habbema, alt. 2800 m., *Brass 10583* (TYPE), Oct. 1938 (tree 3 m. high, occasional in forest second growths, flowers cream), *10869* (small tree 2–3 m. high, common in early second growth forests on landslips; flowers white); 18 km. northeast of Lake Habbema, Bele River, alt. 2200 m., *Brass 11080* (shrub or tree 2–3 m. high, abundant in undergrowth of pole-wood secondary forest; flowers cream-colored); Balim River, east of Lake Habbema, alt. 1800 m., *Brass 11768* (tree 2–4 m. high, common in sparse secondary forest; flowers white).

Carpodetus Archboldianus is of the alliance of *C. Pullei* Schlechter, but differs in having both sides of the leaves sparsely covered with short appressed strigose hairs. The nerves and petiole are also sparsely strigose. *Carpodetus Pullei* is described as having leaves which are glabrous above and with the nerves below and the petiole puberulent. A further difference is found in the distinctly eglandular disk and the narrowly triangular to subulate calyx-lobes of the new species. Another species to be considered here is *Carpodetus flexuosus* (Ridley) Reeder, but it is too inadequately described to permit critical comparison. From *C. Archboldianus* this latter species differs in having larger, differently shaped leaves and in minor floral characters.

Carpodetus fuscus sp. nov.

Arbor ad 21 m. alta, ramulis juventute teretibus circiter 3–4 mm. diametro dense fusco-hispidulis demum subglabratis; petiolis canaliculatis dense hispidulis circiter 1–1.5 cm. longis; laminis chartaceis ellipticis vel oblongis, 10–17 cm. longis, 4–7.5 cm. latis, in sicco supra pallido-viridibus et sparsim adpresso-strigosis, subtus fuscis et pilos brunneos 0.3–0.5 mm. longos hispidulos dense gerentibus, basi subinaequaliter rotundatis, in apicem 1–1.5 cm. longum subabrupte angustatis, margine dentibus 3 per centimetrum callosis parvis ornatis, costa et nervis lateralibus utrinsecus circiter 8 supra impressis subtus valde prominentibus, venulis supra immersis vel subimpressis subtus valde prominulis; inflorescentia corymboso-paniculata terminali vel axillari sub fructu circiter 8 cm. longa et 10 cm. lata e basi 2–4-divisa, plerumque 3- vel 4-plo di- vel trichotoma, pedunculis secundariis 3–4 cm. longis, ramis inflorescentiae pedicellisque dense fusco-tomentosis, ramulis ultimis rigidis; pedicellis teretibus circiter 2 mm. longis; fructibus subglobosis submaturis ad 7 mm. diametro rugulosis, supra medium calycis lobis 5 lato-deltoideis circiter 0.8 mm. longis et basi 1.2 mm. latis mox caducis ornatis; petalis sub fructu raro persistentibus anguste triangularibus circiter 3 mm. longis et 1.2 mm. latis, extus brunneo-puberulis intus medio albido-pilosis; stylo mox caducis.

NETHERLANDS NEW GUINEA: 9 km. northeast of Lake Habbema, alt. 2800 m., *Brass & Versteegh 10468* (TYPE), Oct. 1938 (tree 21 m. high, common in valley forest substage, the trunk 27 cm. diameter; bark 4 mm. thick, gray, fairly smooth; wood white; young fruits brownish green).

Carpodetus fuscus is easily recognized by the dense stiff brown hairs on the young twigs and on the lower surfaces of the leaves. The upper surfaces of the leaves are only slightly hairy. The size and shape of the leaves suggest *C. grandiflorus* Schlechter, but the pubescence is quite different, and the inflorescence of *C. fuscus* is much larger.

Carpodetus denticulatus (Ridley) comb. nov.

Argyrocalymma denticulata Ridley in Trans. Linn. Soc. II. Bot. 9: 39. 1916.

This species is based on a collection by the Wollaston Expedition from the southern slopes of Mt. Carstensz at an altitude of 1180 m.; it appears distinct from others of the genus, although I have not seen any collections which precisely match Ridley's description. In referring species of *Argyrocalymma* to *Carpodetus* I follow the treatments of Schlechter (in Bot. Jahrb. **52**: 136. 1914) and Engler (in Nat. Pfl. ed. 2. **18a**: 216–217. 1930).

Carpodetus flexuosus (Ridley) comb. nov.

Argyrocalymma flexuosa Ridley in Trans. Linn. Soc. II. Bot. **9**: 39. 1916.

This species is based on a collection from the same locality as the above, *C. denticulatus*, and it also appears distinct in the genus.

Carpodetus montanus (Ridley) comb. nov.

Argyrocalymma montana Ridley in Trans. Linn. Soc. II. Bot. **9**: 39. 1916.

British New Guinea: Central Division, Mt. Albert Edward, alt. 3680 m., *Brass 4282* (tree 3 m. tall, common on forest-fringes and in small isolated forest-patches on grasslands; flowers brownish green; fruit green), *4321* (slender tree 5 m. tall, common in isolated forest-patches and fringes of main forest; leaves yellow-green underneath; flowers greenish brown; fruit tuberculate).

The cited specimens are certainly conspecific and agree in general with Ridley's original description, based on a plant from the southern slopes of Mt. Carstensz at 3200 m. altitude. This description is so inadequate that positive identification is impossible, but a few minor differences are apparent. Ridley described the petioles as being 2 mm. long, whereas the Brass specimens have some petioles up to 5 mm. long. Whereas Ridley described the inflorescences as "dense hirtae," those of the Brass specimens are rather sericeous. Ridley stated that the leaves are 1.5–2 cm. wide, while an occasional leaf on the Brass specimens may be up to 2.8 cm. wide. In all other respects the specimens seem to agree with the original description.

Quintinia A. DC.

(*Dedea* Baill.)

Quintinia Ledermannii Schlechter in Bot. Jahrb. **52**: 125. *fig. 3.* 1914.

Netherlands New Guinea: 4 km. southwest of Bernhard Camp, Idenburg River, alt. 900 m., *Brass & Versteegh 13132* (tree 21 m. high, the trunk 45 cm. diam.; bark 14 mm. thick, gray, shallowly fissured; wood red-brown; flower-buds light green; common in *Agathis* forest, on slope of a ridge), *Brass 13703* (tree 20–25 m. high, abundant in *Agathis* forest as a subsidiary tree; flowers white).

The cited specimens are certainly conspecific and agree very well with the original description, based on *Ledermann 9056* and *10167* from Northeast New Guinea at 850 m. and 1000 m. respectively. Ledermann's specimens were collected on the Etappenberg and Lordberg Mountains near the Sepik River, which is reasonably close to the Netherlands New Guinea locality.

Quintinia lanceolata sp. nov.

Arbor ad 32 m. alta, dense foliata, ramulis infra petiolum leviter angulatis circiter 4–5 mm. diametro; petiolis canaliculatis 1–1.5 cm. longis; laminis subcoriaceis lanceolatis, (4–) 6–9 cm. longis, (1–) 1.5–2.2 cm. latis, in sicco supra fuscis subtus pallidioribus, basi cuneatis et in petiolum angustatis, apice obtusis vel acutis, margine integris et minute revolutis, costa supra impressa subtus valde prominente, nervis lateralibus principalibus utrinsecus circiter 6 vel 7 supra immersis subtus haud prominulis; racemis lateralibus ad 6.5 cm. longis 25–30-floris quam foliis paullo brevioribus, pedicellis 2–2.5 mm. longis; calyce circiter 1.5 mm. longo, tubo obconico circiter 1 mm. longo et 1.5 mm. diametro, limbo 4-dentato, dentibus apiculatis; petalis 4 uninervatis oblongis circiter 2×1 mm. apice obtusis; staminibus 4 circiter 1.2 mm. longis, filamentis ovatis circiter 0.5×0.4 mm., antheris subsagittatis in flore femineo ut videtur sterilibus; stylo quam staminibus paullo longiore circiter 0.5 mm. diametro, stigmate 4-capitato, ovario 4-loculari, placentis axillaribus.

NETHERLANDS NEW GUINEA: 15 km. southwest of Bernhard Camp, Idenburg River, alt. 1770 m., *Brass & Versteegh 11920* (TYPE), Jan. 1939 (tree 32 m. high, occasional in mossy forest; flowers white; young fruits green).

Quintinia lanceolata is of the alliance of *Q. Ledermannii* Schlechter, of Northeast New Guinea, collected at somewhat lower altitudes, from which it differs in having narrower leaves of thicker texture and with very obscure venation, longer racemes, shorter calyx-teeth, and petals with only one nerve.

Quintinia Macgregorii F. v. Muell. in Vict. Nat. 9: 112. 1892. FIG. 1, D–F.

BRITISH NEW GUINEA: Central Division, Murray Pass, Wharton Range, alt. 2840 m., *Brass 4719* (A, NY) (tree 6 m. tall, rare in open low forest, densely branching, leaves lepidote above, the veins conspicuous on the lower surface).

This species was described very superficially. Mueller states merely, "This occurs high up on Mt. Suckling, and is nearest to *Q. Fawkneri*, but

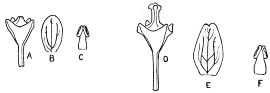


FIG. 1. A–C. *Quintinia Brassii*; A. flower with petals and stamens removed; B. petal; C. stamen. D–F. *Quintinia Macgregorii*; D. flower with petals and stamens removed; E. petal; F. stamen. All approximately $\times$ 5.

the leaves are larger and on much longer stalks, the calyces are less angular, the style is much shorter, and the fruit-valves are more emersed." The Brass specimen cited above was collected at a similar altitude and seems to differ from *Q. Fawkneri* in about the same particulars as are given in the description of *Q. Macgregorii.*

The following material of *Q. Fawkneri* F. v. Muell. is available: AUSTRALIA: Queensland: Rockingham Bay, *Herb. F. v. Mueller* (coll. *Dallachy?*, prob. TYPE COLL., GH); Bellenden Ker, *C. T. White*; Mt. Spurgeon, *C. T. White 10599* (very common climber on trees and over rocks in rain-forest; leaves markedly dimorphic, at first small and rounded, those on flowering branches oblong, cuneate; flowers white); Mt. Bartle Frere, alt. 1500 m., *Kajewski 1275* (small tree up to 10 m. high, sometimes adopting a procumbent habit, rooting and climbing over rocks; petals white and very showy).

Quintinia Brassii sp. nov. FIG. 1, A–C.

Arbor 10–12 m. alta, ramulis infra petiolum leviter angulatis circiter 4 5 mm. diametro; petiolis canaliculatis 1 1.5 cm. longis; laminis subcoriaceis elliptico-oblanceolatis, (4–) 6–9 cm. longis, 1.5–2.5 cm. latis, in sicco supra fusco-viridibus, subtus pallidioribus, basi cuneatis et in petiolum angustatis, apice obtusis vel acutis, margine integris et minute revolutis, costa supra impressa subtus valde prominente, nervis lateralibus principalibus utrinsecus circiter 12 utrinque prominulis vel supra interdum immersis marginem versus anastomosantibus; racemo florifero incompleto solo viso, pedicellis circiter 2 mm. longis; floribus 4- vel 5-meris, calycis tubo obconico circiter 1 mm. longo et 1 mm. diametro, calycis lobis deltoideis circiter 0.7 mm. longis; petalis ellipticis circiter 2.5 × 1.5 mm., nervis principalibus circiter 3 prominentibus; staminibus circiter 1.2 mm. longis, filamentis oblongis circiter 0.5 × 0.4 mm., antheris subsagittatis in flore femineo ut videtur sterilibus; stylo quam staminibus paullo breviore circiter 0.5 mm. diametro, stigmate 4-capitato, ovario 1-loculari, placentis axillaribus; racemis fructiferis ad 9 cm. longis, fructibus circiter 25–30 cupuliformibus, parte basali circiter 2 × 2 mm. conspicue 10-costata, parte distali ovarii quam calycis lobis duplo longiore aperte dehiscente, valvis stigmatibus persistentibus coronatis.

NETHERLANDS NEW GUINEA: 6 km. northeast of Lake Habbema, alt. 3200 m., *Brass 11007* (TYPE), Oct. 1938 (tree 10–12 m. high, abundant in mossy forest on the mountain-slopes; foliage gray).

Quintinia Brassii differs but slightly in foliage from *Q. Macgregorii* F. v. Muell., from Mt. Suckling, British New Guinea, the leaves being slightly longer and narrower. The twigs of the new species are definitely angled and gray, while those of *Q. Macgregorii* are terete and reddish brown. The flowers of *Q. Brassii* are about one-half as large as those of its ally, with extremely short styles and petals with rounded rather than emarginate tips.

Quintinia Schlechteriana O. C. Schmidt in Nova Guin. Bot. **14:** 148. 1924.

NETHERLANDS NEW GUINEA: Bele River, 18 km. northeast of Lake Habbema, alt. 2350 m., *Brass 11453* (shrub 1 m. high, in shrubby regrowth in a forest clearing; leaves pale underneath, the margins recurved; flowers white).

The cited specimen agrees in general with the original description of *Q. Schlechteriana*, based on specimens from the nearby Doormantop at similar elevations. Schmidt describes the petioles as being pubescent. The petioles of the Brass specimen are hardly pubescent, but they are covered with peltate scales; these, however, are not confined to the petioles but cover the young twigs as well. Another difference is that the Brass specimen has pedicels up to 4 mm. long while the description states "± 2 mm." Schmidt describes *Q. Schlechteriana* as having calyx-segments "1.8 mm. long." Those of the Brass specimen are only 0.8 mm. Since the proportions of the flower are essentially the same in other respects, this is probably a misprint. The type specimen not being available for direct comparison, I do not feel justified in proposing a new species on the basis of these minor variations.

Quintinia epiphytica Mattf. in Bot. Jahrb. **70**: 469. 1940.

NORTHEAST NEW GUINEA: Morobe District, Yunzaing, Mt. Aloki forest, alt. 1200–1500 m., *Clemens 2379* (vine; petals and anthers white); A-mieng (A-mien), on Yaneng (Yanem) River, a tributary of the Buso River, above mouth of Tasapik Creek, alt. 1500–1800 m., *Clemens 12368* (flowers white; fruits dull greenish). NETHERLANDS NEW GUINEA: 4 km. southwest of Bernhard Camp, Idenburg River, alt. 850 m., *Brass 13453* (epiphytic shrub 1 m. high; flowers white).

The cited specimens seem certainly to be conspecific and agree very well with the original description, based on *Clemens 7168* and *5845*, from Sambanga and Sarawaket, localities of similar altitude and in the general vicinity of those cited above from Northeast New Guinea. The Brass specimen is from a slightly lower altitude. All of the cited specimens are either epiphytic shrubs or vine-like plants. The original description states: "frutex epiphyticus," but Mattfeld says that a note with the type specimen reads: "common scandent shrub on largest trees in mossy bush." Although the cited specimens have some leaves which are slightly broader, they agree with the original description in most particulars.

Quintinia altigena Schlechter in Bot. Jahrb. **52**: 127. 1914, in Nova Guin. Bot. **12**: 488. 1917.

NETHERLANDS NEW GUINEA: 9 km. northeast of Lake Habbema, alt. 2800 m., *Brass & Versteegh 10449* (tree 24 m. high, rare in mossy forest; crown dark, not wide-spreading; flowers white; young fruits green); 15 km. southwest of Bernhard Camp, Idenburg River, alt. 1800 m., *Brass 11856* (tree 15-20 m. high, one of the commonest subsidiary trees; underside of leaves very pale; flowers white), *Brass & Versteegh 11983* (tree 19 m. high, common on slopes of a ridge; flowers white); 18 km. southwest of Bernhard Camp, Idenburg River, alt. 2100 m., *Brass 12194* (tree 3–5 m. high, abundant in stunted mossy forest on an exposed summit; leaves very pale beneath; flowers white).

The cited specimens appear to be conspecific and probably represent *Q. altigena* Schlechter, the type of which was collected on open terrain of the Hubrecht Mountains, Northeast New Guinea. The Brass specimens may be confidently excluded from all other species of *Quintinia* except *Q. altigena*, the original description of which is too generalized to permit absolute identification. The leaves of Schlechter's species are said to be 7–9.5 cm. long including the petiole, which is described as being 1 cm. long. The Brass specimens have leaves up to 12 cm. long and petioles as much as 2 cm. long. In addition, these leaves may be up to 5 cm. wide, while those of *Q. altigena* are described as being 2–3 cm. wide. On *Brass & Versteegh 10449*, however, which most closely agrees with the description, the leaves average about 9 cm. long and about 2.5–3 cm. broad, the petioles also are only slightly more than 1 cm. long. This last-cited specimen was collected at a comparatively high elevation (2800 m.), which is nearer to that of the type (3100 m.). It seems possible that the other specimens may well represent more robust forms of the same species growing at lower elevations. In spite of variation in leaves and other minor differences among the specimens cited, I am confident that only one species of reasonable variability is represented.

Polyosma Blume

In his discussion of *Polyosma*, Schlechter (in Bot. Jahrb. **52**: 127–136. 1914) includes a key in which the main divisions are based on whether the corolla is tubular or split into separate petals. While these divisions may appear to be rather arbitrary, the present study has shown that the character is reliable. In those species in which the corollas split into separate petals, longitudinal lines are evident early in the bud; in those corollas which remain tubular, however, no lines appear even at maturity.

Polyosma mucronata sp. nov.

Frutex ad 50 cm. altus, ramulis juventute subteretibus circiter 2–3 mm. diametro, dense sericeis, demum glabratis; petiolis supra canaliculatis 1.5–3 cm. longis; laminis coriaceis in sicco fusco-olivaceis obovatis vel elliptico-obovatis, (2–) 3.5–5 cm. longis, (1.5–) 2–2.5 cm. latis, supra nitidis, subtus pallidis, basi acutis vel attenuatis et in petiolum angustatis, apice rotundatis mucronatis, margine minute revolutis, costa supra impressa subtus prominente, nervis lateralibus utrinsecus 6–10 supra inconspicue prominulis subtus leviter elevatis marginem versus anastomosantibus, venulis immersis; racemis terminalibus ad 8 cm. longis 12–16-floris, pedunculo brevi rhachi pedicellisque dense sericeis; pedicellis ad 3 mm. longis, bracteola apicali trifida extus sericea intus glabra, segmento centrali late ovato 2.5–3 mm. longo circiter 1 mm. lato, segmentis lateralibus aequalibus anguste ovatis 2.3–2.5 mm. longis 0.6 mm. latis; calyce extus sericeo circiter 4 mm. longo, tubo obconico-urceolato circiter 2 mm. longo et 1.6 mm. diametro, limbo 4-lobato intus glabro, lobis suberectis deltoideis circiter 1.2 mm. longis; corolla cylindrica maturitate circiter 14 mm. longa et 2.5 mm. diametro extus dense sericea intus glabra 4-lobata, lobis subcarnosis late ovatis circiter 2×1.8 mm. apice obtusis; staminibus 4 circiter 11 mm. longis, filamentis complanatis circiter 0.5 mm. latis copiose pilosis, pilis adscendentibus ad 0.8 mm. longis, antheris circiter 1.8 mm. longis, connectivo latitudine filamentum aequante; stylo tereti quam staminibus paullo longiore 0.5–0.6 mm. diametro dense et breviter hispidulo, stigmate capitato, placentis parietalibus; fructibus ellipsoideis circiter 14×11 mm. (ex. coll.) basi et apice obtusis.

BRITISH NEW GUINEA: Central Division, Mt. Albert Edward, alt. 3600 m., *Brass 4310* (A, TYPE, NY), June 23, 1933 (sparsely branched shrub of erect habit, up to 50 cm. high, gregarious on forest-floor, not found above 3600 m.; branches and petioles dark purple; flowers pale purple-gray, very fragrant; fruit smooth, fleshy, dark purple).

Polyosma mucronata is of the alliance of *P. stenosiphon* Schlechter, from the Schraderberg Mountains of Northeast New Guinea, from which it differs in having much longer petioles, somewhat broader leaf-blades, longer calyx-teeth, more copiously pilose filaments, and a conspicuously pubescent style.

Polyosma amygdaloides sp. nov.

Arbor ad 12 m. alta, ramis ramulisque subteretibus, ramulis juvenilibus circiter 2.5 mm. diametro primo leviter puberulis mox subglabratis; petiolis canaliculatis rugulosis 1.3–2.5 cm. longis; laminis coriaceis in sicco viridi-fuscis subtus pallidioribus lanceolatis, (5–) 8–17 cm. longis, (1.6–) 2.5–4.2 cm. latis, utrinque glabris, supra nitidis, basi cuneatis vel attenuatis, apice in acuminem 1–2 cm. longum gradatim attenuatis, margine subintegris vel dentes paucos callosos distanter gerentibus, costa supra impressa subtus prominente, nervis lateralibus utrinsecus 8–13 patentibus obvie anastomosantibus utrinque prominulis, rete venularum utrinque subimmerso; racemis terminalibus vel subterminalibus ad 15 cm. longis multifloris (floribus plerumque 100–150), rhachi pedicellisque sericeis; pedicellis ad 3.5 mm. longis, bracteola apicali trifida extus sericea intus glabra, segmento centrali ovato-attenuato circiter 1 mm. longo et basi 0.5 mm. lato, segmentis lateralibus aequalibus anguste ovatis 0.6–0.7 mm. longis, circiter 0.2 mm. latis; calyce extus sericeo, circiter 2.5 mm. longo, tubo obconico-urceolato 1.75–2 mm. longo 1.2–1.4 mm. diam., limbo 4-dentato, dentibus apiculatis circiter 0.5 mm. longis; corolla cylindrica maturitate circiter 15 mm. longa et 1.5–2 mm. diametro, extus dense sericea, intus copiose farinoso-puberula, lobis subcarnosis oblongo-ovatis circiter 3 × 1 mm. apice obtusis; staminibus circiter 13 mm. longis, filamentis complanatis sparse pilosis, antheris 2–2.5 mm. longis, connectivo latitudine filamentum aequante; stylo tereti quam staminibus paullo longiore 0.4–0.5 mm. diametro strigoso, stigmate capitato, placentis parietalibus; fructibus subglobosis circiter 6 mm. diametro, basi obtusis, apice umbonatis.

NETHERLANDS NEW GUINEA: Bernhard Camp, Idenburg River, alt. 900 m., *Brass 13335* (TYPE), March 1939 (substage tree 12 m. high, occasional in rain-forest on the slopes; flowers yellow, fragrant).

The new species, characterized by lanceolate long-acuminate leaf-blades and very abundant flowers, appears to have no close relatives. In some respects it suggests *P. buxea* Mattf. (of which a type duplicate is available at A), but it differs in its darker differently shaped leaf-blades, obviously pedicellate rather than subsessile flowers, and much longer corollas.

Polyosma cestroides Schlechter in Bot. Jahrb. 52: 129. *fig. 4, A–F.* 1914.

NORTHEAST NEW GUINEA: Morobe District, Yunzaing, alt. about 1650 m., *Clemens 3744* (tree, the trunk 10–13 cm. diameter; flowers flesh-colored to salmon; fruit blue-purple [not seen on our specimen]).

The cited specimen agrees in most particulars with the original description, based on *Ledermann 12566*, from the Sepik region at a similar elevation. The only differences noted are that in the Clemens specimen the inflorescences are about 25–35-flowered, while the original description states that they are 6–12-flowered. Since Schlechter based his description on only one collection, I do not believe this difference to be significant. A further difference is in the bracteoles, which in the Clemens specimen are 1.5–2 mm. long. Schlechter describes them as being 4–5 mm. long, but in his illustration he shows no bracteoles at all. This is probably an error. Since the ovary is only 2 mm. long, and the bracteoles are immediately below it, if these latter structures were 4–5 mm. long they would exceed the ovary and be quite conspicuous. In this case one would expect that special mention of them would be made in the description and that they would be prominently figured in the illustration.

Polyosma tubulosa Schlechter in Bot. Jahrb. 52: 130. *fig. 4, G–L.* 1914.

NETHERLANDS NEW GUINEA: 15 km. southwest of Bernhard Camp, Idenburg River, alt. 1800 m., *Brass 12285* (substage tree 10 m. high, in mossy forest; flowers brownish green).

The cited specimen agrees reasonably well with Schlechter's species, although the leaf-blades are sometimes longer (up to 9 cm.) than those originally described. The Brass specimen has racemes up to 17-flowered, while Schlechter's description states that they are "5–10-floris." His illustration, however, shows a raceme with 17 flowers. In other particulars our specimen agrees well with both the description and illustration.

Polyosma induta sp. nov.

Arbor ad 4 m. alta, ramulis juventute subcomplanatis dense tomentosis, demum glabratis; petiolis supra canaliculatis dense tomentosis 1.3–2.5 cm. longis; laminis in sicco fusco-viridibus ellipticis, 8–15 cm. longis, 2.5–5.5 cm. latis, supra glabris, subtus praecipue nervis tomentosis, basi cuneatis vel attenuatis et in petiolum angustatis, apice acutis vel breviter acuminatis, margine dentibus utrinsecus 5–7 distanter calloso-serratis, costa supra impressa subtus prominente, nervis lateralibus utrinsecus 8–12 supra prominulis subtus valde elevatis marginem versus anastomosantibus, venulis supra immersis subtus elevatis; racemis terminalibus ad 10 cm. longis dense 30–45-floris, pedunculo brevi rhachi pedicellisque dense tomentosis; pedicellis 4–8 mm. longis, bracteola apicali trifida extus tomentosa intus glabra vel sparsim pilosa, segmento centrali lanceolato 3–3.5 mm. longo 0.5–0.8 mm. lato, segmentis lateralibus aequalibus lanceolatis circiter 2.5 mm. longis et 0.4 mm. latis; calyce extus sericeo-tomentello circiter 3 mm. longo, tubo obconico-urceolato circiter 2 mm. longo et 2–2.5 mm. diametro, limbo 4-dentato, dentibus apiculatis; corolla cylindrica maturitate circiter 17–20 mm. longa et 1.5–2 mm. diametro, extus dense sericea intus subglabra, lobis subcarnosis oblongo-ovatis circiter 3×1 mm., apice obtusis; staminibus 4 circiter 15–18 mm. longis, filamentis complanatis circiter 0.5 mm. latis sparsim pilosis, antheris 2.5–3 mm. longis, connectivo latitudine filamentum aequante; stylo tereti quam staminibus paullo longiore 0.5–0.6 mm. diametro sericeo, stigmate capitato, placentis parietalibus; fructibus subglobosis 6–9 mm. diametro, bracteola conspicua persistente subtentis, calycis dentibus minutis persistentibus coronatis.

NETHERLANDS NEW GUINEA: Bele River, 18 km. northeast of Lake Habbema, alt. 2350 m., *Brass 11483* (TYPE), Nov. 1938 (tree 4 m. high, in forest undergrowth; flowers purplish brown).

This species and the following (*P. vochysioides*) are very similar in foliage but differ markedly in characters pertaining to the inflorescence. They appear to have no close relatives, forming an isolated group in the general vicinity of *P. buxea* Mattf., *P. cestroides* Schlechter, etc., from which the copious pubescence separates them. *Polyosma induta* may also be compared to *P. dentata* Schlechter, from which it differs not only in its persistently tubular corolla, but also in its more pronounced indument, much longer petioles, pedicels, and corollas, and more copiously flowered inflorescences.

Polyosma vochysioides sp. nov.

Arbor 8–10 m. alta, ramulis juventute subcomplanatis dense tomentosis, demum glabratis; petiolis subteretibus dense tomentosis 1–2 cm. longis; laminis in sicco viridi-olivaceis ellipticis, (5–) 7–13 cm. longis, (2–) 3–5.5 cm. latis, supra nitidis mox glabratis, subtus praecipue nervis tomentosis, basi cuneatis, apice in acuminem 1–1.5 cm. longum gradatim attenuatis, margine dentibus utrinsecus 4–6 distanter calloso-serratis, costa supra impressa subtus prominente, nervis lateralibus utrinsecus 7–10 supra prominulis subtus elevatis marginem versus anastomosantibus, venulis supra immersis subtus leviter elevatis; racemis axillaribus vel terminalibus ad 15 cm. longis, 35–65-floris, pedunculo brevi rhachi pedicellisque dense tomentosis; pedicellis sub anthesi ad 4 mm. longis, bracteola apicali trifida, lobis aequalibus linearibus ubique tomentosis circiter 3.5 mm. longis; floribus ex apice pedicellorum abrupte obstipis; calyce extus sericeo circiter 3 mm. longo, tubo obconico-urceolato circiter 1.5 mm. longo et diametro, limbo 4-lobato intus glabro, lobis suberectis deltoideis circiter 1 mm. longis; corolla in alabastro cylindrica 1 mm. diametro, extus dense sericea; staminibus 4, filamentis complanatis breviter sericeis; stylo subclavato sericeo, stigmate capitato; fructibus ellipsoideis circiter 7 $\times$ 5 mm., bracteola persistente subtentis, calycis limbo coronatis, pedicellis sub fructu ad 10 mm. longis persistenter tomentosis.

NETHERLANDS NEW GUINEA: Bernhard Camp, Idenburg River, alt. 1800 m., *Brass 12090* (TYPE), Jan. 1939 (tree 8–10 m., frequent in mossy forest substage, with flower-buds and unripe fruits).

From *P. induta*, above described, this species differs but slightly in foliage, its leaf-acumen being more attenuate and longer. In inflorescence, however, there are striking differences between the two species. *Polyosma vochysioides* has the bracteole equally cleft into linear lobes which are uniformly tomentose; the bracteoles of *P. induta* have the central lobe the largest and all the lobes are lanceolate and glabrous within. The flowers of *P. vochysioides* are sharply bent at the apices of the pedicels rather than continuing their direction; the calyx-lobes of *P. vochysioides* are distinctly larger, and it is probable that its corollas are shorter, although mature ones are not available.

Polyosma occulta sp. nov.

Arbor parva dense foliata, ramis ramulisque subteretibus, ramulis juventute circiter 2–3 mm. diametro densissime fusco-velutinis; petiolis canaliculatis subvillosis 0.6–1.5 cm. longis; laminis subcoriaceis undulatis in sicco pallido-viridibus ellipticis vel oblongo-ellipticis, (3–) 3.5–5 cm. longis, (1.5–) 2–2.5 cm. latis, supra subglabris vel sparsim puberulis, subtus densius puberulis, nervis subvillosis, basi cuneatis, apice obtusis vel acutis et calloso-apiculatis, margine dentibus 5 vel 6 distanter calloso-serratis, costa supra impressa subtus prominente, nervis lateralibus utrinsecus 6–10 patentibus supra prominulis subtus prominentibus conspicue anastomosantibus, rete venularum supra subimmerso subtus leviter elevato; racemis subterminalibus immaturis 3–6 cm. longis 8–20-floris, rhachi pedicellisque subvillosis; pedicellis ante anthesin circiter 2 mm. longis, bracteola apicali trilobata foliacea utrinque subsericea supra sparsius, segmento centrali ovato-lanceolato circiter 7 mm. longo et 2.5 mm. lato, segmentis lateralibus subaequalibus lanceolatis circiter 6 mm. longis et 1.8–2 mm. latis; calyce extus dense sericeo circiter 4.5 mm. longo, tubo vasculari circiter 2 mm. longo et 1.5 mm. diametro, limbo 4-lobato, lobis suberectis lato-ovatis 1.3–1.5 mm. longis intus distaliter sparsim sericeis; corolla in alabastro visa cylindrica 2 mm. diametro extus dense sericea; staminibus 4, filamentis complanatis pilosis; stylo subclavato, sericeo, stigmate capitato; fructibus ovoideo-ellipsoideis, circiter 10×7 mm., bracteola conspicua persistente subtentis, calycis limbo coronatis, pedicellis sub fructu ad 6 mm. longis persistenter pilosis.

BRITISH NEW GUINEA: Central Division, Wharton Range, Murray Pass, alt. 2840 m., *Brass 4524* (A, NY, TYPE), June–Sept. 1933 (small tree of forest borders, with smooth undulate leaves; flower-buds brown; fruit green).

This remarkably distinct species is at once recognized by its large persistent foliaceous bracteoles, which conspicuously exceed the calyx in length, and by its ovary, which is definitely bilocular proximally. Further differentiating characters are the compact habit, dense foliage, comparatively small leaf-blades, and few-flowered inflorescences. Another species with a conspicuous bracteole is *P. longebracteolata* O. C. Schmidt, but that species has narrower leaf-blades, shorter petioles, shorter pedicels, and a smaller and differently shaped bracteole. *Polyosma helicioides* F. v. Muell. is too inadequately described to permit comparison, but it apparently differs from the new species in its shorter petioles and pedicels; Mueller does not mention the presence of bracteoles.

The specific epithet refers to the fact that the calyces are concealed by the large bracteoles.

Polyosma oligantha sp. nov.

Arbor 25 m. alta inflorescentiis exceptis ubique glabra, ramulis apicem versus subcomplanatis rugosis crassis circiter 5 mm. diametro, nodis tumefactis; petiolis canaliculatis striatis 1–2.3 cm. longis; laminis crasso-coriaceis in sicco fusco-olivaceis ellipticis, 6–10 cm. longis, 3.5–5.5 cm. latis, basi obtusis vel cuneatis, apice obtusis vel rotundatis interdum leviter emarginatis, costa supra impressa subtus valde prominente, nervis lateralibus utrinsecus circiter 10 erecto-patentibus supra prominentibus conspicue anastomosantibus subtus prominulis, rete venularum supra leviter elevato subtus subimmerso; racemis robustis axillaribus vel terminalibus ad 7 cm. longis 5–8-floris, pedunculo circiter 3 cm. longo, rhachi striata; pedicellis sparsim sericeis 2–3 mm. longis, bracteola apicali trifida extus sparsim sericea intus glabra, segmento centrali ovato 2–3 mm. longo circiter 1 mm. lato, segmentis lateralibus subaequalibus ovatis circiter 1 mm. longis et 0.6 mm. latis; calyce extus sparsim sericeo 5–6 mm. longo et 2.5–3 mm. diametro, lobis erecto-patentibus late ovatis circiter 2 mm. longis et 1.5 mm. latis; corolla cylindrica subcarnosa ad 28 mm. longa et 2.5–3 mm. diametro extus sericea intus glabrata; staminibus quam corolla paullo brevioribus, filamentis complanatis sparsim pilosis, antheris circiter 7 mm. longis, connectivo quam filamentis angustiore; stylo tereti sericeo quam staminibus paullo longiore 0.5–0.75 mm. diametro, stigmate capitato, placentis parietalibus; fructibus ellipsoideis circiter 13 × 11 cm., basi et apice obtusis.

NETHERLANDS NEW GUINEA: Bernhard Camp, Idenburg River, alt. 2000 m., *Brass 12502* (TYPE), Feb. 1939 (tree 25 m. high, rare in rain-forest on slope of a ridge, the trunk 71 cm. diam., the crown fairly wide-spreading, the flowers brown-green, the fruits green, the bark 10 mm. thick, the wood brown).

Polyosma oligantha seems to have no close relatives in New Guinea. It is easily recognized by its thick twigs, thick leaves with entire margins and rounded to emarginate tips, and its very large flowers. Another species with very long corollas is *P. tubulosa* Schlechter, from the Schraderberg Mountains, Northeast New Guinea, but that species has acuminate, narrower leaves and a calyx only about half as long as that of *P. oligantha*.

Polyosma brachyantha Merr. in Philip. Jour. Sci. Bot. **11**: 273. 1916.

BRITISH NEW GUINEA: Central Division, Dieni, Ononge road, alt. 500 m., *Brass 3899* (slender tree 10 m. tall, in rain-forest; upper surface of leaves shining, the midrib brown; green [immature] fruit about 1 cm. long by 8 mm. diameter). SOLOMON ISLANDS: Bougainville: Kupei Gold Field, alt. 950 m., *Kajewski 1647* (small tree up to 15 m. high, common in rain-forest; flowers white on long racemes), *1675* (fruit blue-black when ripe).

The cited specimens seem to be conspecific and appear to be identical with *Polyosma brachyantha* Merr., based on specimens from Amboina. Both the isotype (A) of *P. brachyantha* and the flowering specimen cited above have immature flowers, but these are very similar. Both have stamens with densely pilose filaments and a style which is rather sparsely retrorsely pilose. Although Merrill says that the style is glabrous, a critical re-examination of the isotype shows retrorse hairs.

Polyosma macrobotrys Mattf. in Bot. Jahrb. **69**: 273. 1938.

NORTHEAST NEW GUINEA: Morobe District, Quembung Mission, alt. 360 m., *Clemens 2138* (small tree 8–10 m. tall; fruit green-white). NEW BRITAIN: Kirigo, Maisua, alt. 300 m., *Waterhouse 22688* (small tree 1.5–2 m. tall). SOLOMON ISLANDS: Ysabel: Tiratona, alt. 600 m., *Brass 3211* (slender thin-barked tree; leaves dark dull green; flowers white), *3311* (fruit costate); Guadalcanal: Uulolo, Tutuve Mt., alt. 1200 m., *Kajewski 2556* (tree up to 20 m. high; fruit green when ripe).

The cited specimens appear certainly to be conspecific and to agree in all particulars with Mattfeld's description; furthermore the Clemens specimen is from the type locality. The occurrence of this species in the Solomon Islands extends the range of the genus to the east; otherwise *Polyosma* is known from the Solomons only by *P. brachyantha* Merr., specimens of which are cited in this paper.

It is possible that the New Hanover specimen cited by Lane-Poole (in For. Res. Papua 90. 1925) and White and Frances (in Proc. Roy. Soc. Queensl. 39: 63. 1928) as *P. lagunensis* Merr. actually represents *P. macrobotrys* Mattf.

Polyosma Forbesii Valeton ex Lauterb. in Nova Guin. Bot. **8**: 821. 1912.

BRITISH NEW GUINEA: Central Division, Koitaki, alt. about 485 m., *Carr 12644*

(NY) (tree about 8 m. tall; buds green), alt. about 450 m., *Carr 12780* (NY) (tree about 16 m. tall; flowers dull grayish violet); Western Division, Wuroi, Oriomo River, *Brass 5767* (A, NY) (large shrub, uncommon on tidal mudbanks in river; leaves stiff, the upper side glossy, the nerves deeply impressed above, prominent; flowers whitish).

The cited specimens appear to be conspecific and to agree well with Valeton's original description, which is based on a collection from Sogeri in southeastern New Guinea. The Brass specimen has pedicels up to 1.5 mm. and petals up to 10 mm. long, but it agrees in all other particulars. The Carr specimens agree almost precisely with Valeton's description.

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NOVELTIES IN AMERICAN EUPHORBIACEAE

Leon Croizat

Material recently received from various sources in North and South America renders it desirable to publish the data included in this paper. Unless otherwise stated, the types of the new species are deposited in the herbarium of the Arnold Arboretum of Harvard University.

Acalypha Linnaeus

Acalypha plicata Muell.-Arg. in DC. Prodr. 15(2): 855. 1866; Pax & Hoffm. in Pflanzenr. 85(IV. 147): 124. 1924.

Acalypha cordifolia Griseb. in Abhandl. Gesellsch. Wiss. Göttingen **19**: 60. 1874; op. cit. **24**: 59. 1879. Non Hook. 1847.

Acalypha flabellifera Rusby in Mem. Torrey Bot. Club **6**: 119. 1896; Pax & Hoffm. in Pflanzenr. 85 (IV. 147): 121. 1924; Lourteig & O'Donell in Gen. Sp. Pl. Argent. **1**: 216. *pl. 90*. 1943. Syn. Nov.

In determining *Vargas 1713*, Peru: Depto. Cuzco, I could only conclude that Hoffmann's suggestion that *A. plicata* Muell.-Arg., "Cum *A. flabellifera* comparanda est et verisimiliter eadem," was correct, and accordingly effect the reduction of Rusby's species. It is impossible to separate *Steinbach 8608*, Bolivia: Cochabamba, from the holotype of Mueller-Argoviensis, a photograph of the latter being available. The vigorous juvenile state represented by *Vargas 1713* is likewise fully matched by *Rojas 9221*, Paraguay: Asunción, which indicates that the species extends from Paraguay, northwestern Argentina, and eastern Bolivia to southeastern Peru, this being a normal distribution. *Acalypha lagoensis* Muell.-Arg., a closely related form, is endemic to eastern Brazil, and may be connected with *A. plicata* Muell.-Arg. by intermediates.

In the affinity of *A. plicata* Muell.-Arg. are the northern Peruvian *A. fulva* I. M. Johnst. and *A. cuspidata* Jacq., the latter endemic to the West Indies, Venezuela, Colombia and Ecuador. *Acalypha Sanctae-Martae* Pax & Hoffm. (1924), is identical with the earlier *A. asterifolia* Rusby (1920) from the Atlantic coast of Colombia, but is uncomfortably close to *A. cuspidata* Jacq. The limits of these forms and their inter-relationships are as yet obscure.

Euphorbia Linnaeus

Euphorbia apurimacensis sp. nov.

Arbor parva ad 3–5 m. alta, innovationibus ad lentem puberulis, cicatricosis, cortice pallide brunneo subaurantiaco. Foliis tenuibus ellipticis apice breviter mucronato-acuminatis, basi sensim angustatis in petiololum breve, 5 mm. longum vel minus productis, lamina glabra 3–7 cm. longa, 1–1.5 cm. lata, margine integerrimo ciliolato, venis patentibus gracillimis obscuris. Cyathiis singulis, pedunculo ca. 5 mm. longo fultis.

bracteolis deciduis subtriangularibus ad 4–5 mm. longis, involucro ipso ad lentem puberulo ca. 3 mm. longo, 5 mm. fauce lato, glandulis integris, habitu erectis. Caetera desunt.

PERU: Apurimac: Prov. Abancai, Quebrada de Matara 2000–2800 m., "Xerophytic slopes," *Vargas 2290*.

The nearest ally of this new species is the Ecuadorean and southern Colombian *E. Latazii* H.B.K., from which *E. apurimacensis* is immediately distinguishable because of its very short-petioled leaves, and short peduncled cyathia, the latter being barely half as large as are those of Kunth's species.

Euphorbia refugii sp. nov.

Perennis videtur, cauliculis annuis erectis spithameis totis albo-villosis, radice albicante donatis. Foliis aequa ratione ac caule pubescentibus, infimis alternis paucis, caeterum ad dichotomias oppositis, ovato-rotundatis ad 1 cm. longis, totidemque latis vel minoribus, irregulariter penninerviis, venis utrinque 3–4, petiolulo ca. 1–2 mm. longo, margine subintegris obscureve repandis, stipulis haud obviis. Foliis floralibus vegetativis subsimilibus, minoribus. Cyathio hispido-villoso ca. 1.5 mm. longo latoque, glandulis 4 appendiculatis, appendicibus integris conspicuis, sordide luteis fabrica vix petaloideis, lobis minimis laceratis subtriangularibus, floribus ♂ paucis ad 5, flore ♀ conferte lanoso, stylis 3, quove ad basim partito, semine ovoideo ca. 0.75 mm. longo, testa laete brunnea, grosse foveolato-punctata, arillo pallido, caruncula minima.

TEXAS: Aransas Co., Aransas Refuge, *Cory* (*Tex. Agr. Exp. Sta.*) 49014.

I am much indebted to Dr. Rogers McVaugh of the United States Department of Agriculture for the transmission of this remarkable novelty. Its seed and habit suggest a species of the Subg. *Tithymalus* Boiss. in the vicinity of *E. commutata* Engelm. or *E. peplidion* Engelm., but this impression is immediately dissipated by the pubescence, and the conspicuous, though not truly petaloid appendages to the glands. The cyathium tends to be slightly zygomorphic, the gynophore protruding through a gap in the involucre, which gap appears to take the place of a missing gland. The ♂ flowers are few, and regularly arranged at the base of the gynophore.

This new species apparently belongs in the Sect. *Ipecacuahna* Boiss., but its closest affinities are not yet clear.

Chamaesyce S. F. Gray emend. Croizat

Chamaesyce trancapatae sp. nov.

Repens, caudice ligneo sat robusto descendente, cauliculos plures saepissime habitu rosulatos edente basi lignosos duros, caeterum herbaceos, internodiis pollicaribus vel brevioribus, totis molliter griseo-lanulosis. Foliis basalibus rotundatis subintegris ca. 3 mm. magnis, caeterum obvie anisophyllis rotundato-triangularibus ad 1 cm. longis, 0.5 mm. latis, margine more *C. hirtae* serratis, utraque facie griseo vel albo-lanulosis, petiolulo quam 1 mm. breviore, stipulis interpetiolaribus acutis subintegris, indumenti copia haud obviis. Cyathiis solitariis, ca. 2 mm. longis, 1.5 mm. latis, glandulis 5 plicatis appendice minima integra pallide rosea vel albida, lobis triangularibus plus minusve inciso-sectis, involucro ad lobos viridulo, ad glandulas pallido, ovario pedicellato hispido-lanoso, stylis brevibus bifidis.

PERU: Apurimac-Cuzco boundary, Curahuasi, Trancapata, 2800 m., "Stony slopes," *Vargas 1257* (TYPE in herb. Univ. Cuzco, fragment in herb. Arnold Arboretum).

This species is certainly not the same as **Chamaesyce boliviana** (Rusby) Croiz. comb. nov. (*Euphorbia boliviana* Rusby in Bull. New York Bot. Gard. 4: 442. 1907) which its author erroneously assimilates to *C. serpens* (H.B.K.) Small by referring *Mandon 1064* to it. *Chamaesyce trancapatae* lacks outstanding diagnostic characters, but young vigorous shoots are nevertheless easily identified on account of their heavy whitish or grayish pubescence, the leaf shape suggesting that of small forms of *C. hirta* (L.) Millsp.

ARNOLD ARBORETUM,
HARVARD UNIVERSITY.

PLANT COLLECTING IN THE SOLOMON ISLANDS*

S. F. KAJEWSKI

With two text-figures

TO THE EAST of New Guinea lies a very important chain of Islands, known as the Solomons; this archipelago has great affinities with the Papuan mainland. The people of the two regions are of similar races, having many characteristics in common. The vegetation of the Solomons, although similar in general to that of New Guinea, has certain peculiarities suggestive of the islands farther eastward. There is a political boundary within the Solomons, a portion of the group being under English and a portion under Australian administration. This political boundary, at the time of my visit, was very strictly recognized, as the natives were not allowed to cross it and the whites were required to show passports or permits when crossing it. For biological and geographical discussions the political boundary may be ignored, and all the islands extending from Bougainville to the Santa Cruz group may be considered to make up the Solomons.

The geological formation of the Solomons is of a highly volcanic nature, the soil being remarkably fertile, the rainfall heavy, and the vegetation very luxuriant. For the greater part the islands are exceptionally mountainous and rugged. On Bougainville there is a mountain-chain extending down the center of the island and reaching a height of 10,000 feet, while on Guadalcanal the mountains attain 8,000 feet in height. Most of the smaller islands have mountains up to 5,000 feet in height, and very commonly precipitous hills arise directly from the sea.

The plant life of the Solomons can be divided into two primary groups — that of the lowlands and that of the uplands. As there are very extensive plains on many of the islands, one observes a type of lowland vegetation very different from the usual strand vegetation of the Pacific. The huge plains of southern Bougainville offer an example of lowland inland flora.

* The manuscript of this article has been for some time in the possession of Dr. C. T. White, of the Brisbane Botanic Gardens, by whom it was recently forwarded to the Arnold Arboretum for possible publication. In view of the fact that a complete set of Mr. Kajewski's Solomon Islands plants is deposited at the Arnold Arboretum, where they have been studied and published upon by staff-members, publication of this sketch seems highly desirable. A remarkably high percentage of Mr. Kajewski's specimens have proved to represent new species, as he reached areas and altitudes not visited by the few collectors who preceded him in the Solomons. For an account by the same collector of his work in the New Hebrides and Santa Cruz Islands, see Jour. Arnold Arb. 11: 172–180. 1930. — EDS.

BOUGAINVILLE

The first island of the Solomons which I visited, from April to October, 1930, was Bougainville; this is a large land-mass about 120 miles long and up to 35 miles in breadth. It possesses two active volcanoes, one being the highest point of the island at about 10,000 feet elevation. A very large native population is found on Bougainville, and many areas on the west coast have not yet been brought under control. Labor is plentiful and cheap, in comparison with many other Pacific islands. Because of the large population, much of the rain-forest in the thickly settled areas is regrowth forest and consequently not very high. However, in some of the mountain-gorges, where there has never been any native population, there are stands of rain-forest with an average height of about 150 feet.

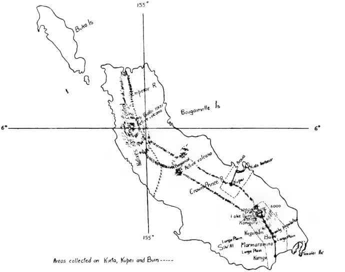

FIG. 1. Sketch map of Bougainville, showing areas visited by the writer.

For a few weeks I collected in the vicinity of Kieta (see map, *fig. 1*), where there is a fairly large population; consequently the majority of my specimens from this area were from regrowth forms of vegetation. Subsequently I extended my operations to Kupei, in the mountains, which is reached by a fairly good native road constructed because of the discovery of a copper lode there. The lode is at an elevation of 3,000 feet, and a house built there for Europeans served as an excellent headquarters.

It is interesting to note that the genus *Casuarina* is found at this altitude, although it is absent from the intervening strip between the sea-coast and 3,000 feet. A *Dacrydium* is also found here, but it is by no means plentiful.

Kupei Goldfield (or perhaps it should be called Copperfield, since the lode is a reef with about 15 percent of copper and a small percentage of gold in it) is about nine miles inland from the northeast coast. Kupei is the name of the last village on the trail, but the lode is approximately 1,500 feet higher. Farther inland the mountains ascend to nearly 6,000 feet, forming the backbone of the island, and consequently precipitation is very heavy. Rain occurs essentially every day, and the region is shrouded in heavy mist for six to eight hours of each day. The sun may be observed shining in the morning, with a few light clouds, when suddenly and without warning banks of clouds come from nowhere and darken the whole atmosphere. The afternoons are invariably misty and foggy. Under these conditions everything in camp is moist and uncomfortable, and the drying of plants is exceedingly difficult. Without the use of artificial heat a collector would find his work impossible. Toward evening the rain ceases and the nights are usually fine. The climate is comparatively cool, perhaps about 15° F. cooler, day and night, than on the coast.

In this vicinity a giant black-stemmed banana is very abundant, the plants being up to 30 feet high; the fibers of this plant should be investigated for commercial possibilities. Several species of *Begonia* are very striking, one species in particular having very showy pistillate flowers and shiny pinkish purple iridescent foliage; it seeds freely in the native state and may prove desirable for greenhouse culture. Tree-ferns, species of *Asplenium*, and various epiphytic plants are abundant in the vicinity of the goldfield, but orchids are scarce. A medium-sized *Casuarina* is peculiar to this level. Moisture-loving plants are naturally common, and mosses and lichens, although not as plentiful as one might suppose, are nevertheless abundant. I have visited other mountains with a lighter rainfall where the rocks and trees are much more heavily covered with cryptogams. The soil near the goldfield is very porous, and one may anticipate that all soluble plant food will soon be leached away if the rain-forest is cleared for cultivation. Consequently it would be necessary to emulate the native agriculture and to clear patches of forest annually, if this region should ever attract a large population.

Turning to the south coast of Bougainville, one finds a very different type of country, due to the fact that the southern end of the island is occupied by a large fertile plain. This plain should have great agricultural possibilities in the future. It is composed of volcanic drift and supports a large native population. The Buin district is very rich in palms, in this respect being the richest locality I have ever encountered. Although the plain is low-lying, it is not swampy, the land rising gradually from sea-level to the foothills. The actual strand-flora, of course, contains the usual pan-Pacific elements. The rainfall of Buin is between two hundred and three hundred inches annually; nevertheless regions away from the coast are reasonably healthy and mosquitoes are not unbearable, since the drainage prevents the accumulation of large amounts of standing water.

On the Buin and Siwai plains (see map, *fig. 1*) one is impressed by the good roads which are maintained by the natives under government supervision. There are about 20,000 natives in this area, and the Patrol Officer can do much of his traveling by bicycle; this seems strange in a region where the only other non-native inhabitants are a few missionaries. A predominating feature is the large number of huge trees left standing by the natives. These are trees of economic value, and they tower above the lower regrowth rain-forest, being 150 to 200 feet high. They have been left undisturbed for centuries, as one can see by their dimensions. Notable examples are specimens of *Canarium*, native mangoes, breadfruit trees, *Syzygium*, *Ficus*, etc.

In the high mountain-ranges around Lake Luralu, one is impressed by the giant timber provided by specimens of *Calophyllum*, *Albizzia*, etc. The lake itself is worthy of mention; it is serpentine in shape and is the sacred place of the natives of the plains. Cremation is practiced in this region, and the dead are supposed to go to the lake and there wash off their ashes, subsequent to which they spend a happy spiritual life in the vicinity. It is difficult to persuade natives to go to Lake Luralu, and I appreciated the assistance of Patrol Officer Ward, who not only accompanied me but also arranged for native carriers. The lake has an elevation of about 5,500 feet and the vegetation in its vicinity is stunted. Species of *Rhododendron* occur there, one of them with large white flowers being suggestive of a garden azalea. Parasitic tree-forms are also in evidence. The whole mountainous area is for the greater part of the time shrouded in fog, and mosses and lichens are abundant; it is certainly one of the most interesting areas of Bougainville from a botanical viewpoint.

MALAITA

From Bougainville I went to the British Solomons, where I received less coöperation than from the authorities on Bougainville. The British Solomons appeared to me to be administered in a comparatively lackadaisical fashion, the hill tribes being encouraged to come and live on the coast. This is a great mistake, as the interior, already difficult of access, is even less approachable after the natives have left. On the island of Malaita the resident government official not only refused to coöperate with me, but he influenced the natives in such a way that I could not obtain carriers. Consequently my work on this island, toward the end of 1930, was very limited (see map, *fig. 2*).

GUADALCANAL

Guadalcanal, where I spent the entire year of 1931, is an extremely interesting island botanically. On the north coast there are extensive stretches of grassy plains which consist of upraised ocean-floor, as shown by recent marine fossils. These fossils are very abundant and are seen in formations more than 100 feet thick, on exposed slopes of foothills. The plains are covered by a species of *Themeda* which grows to a height of about six feet and provides good fodder for cattle. Consequently large numbers of cattle and horses are pastured on the island. The pastures are in belts which are practically treeless, surrounded by patches of lowland

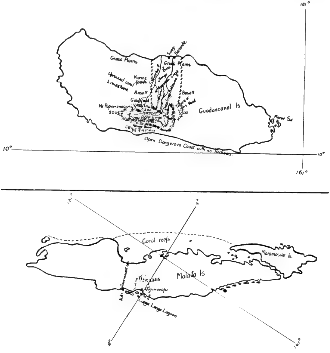

FIG. 2. Sketch maps of Guadalcanal (above) and Malaita (below), showing areas visited by the writer.

rain-forest and extending in a limited manner to the foothills. The only reason I can advance to account for the fact that these plains are not occupied by rain-forest is due to native methods of hunting. The grass has perhaps been fired by the natives for generations in order to drive out the pigs. When a strong wind is blowing the flames can destroy the edges of the bordering rain-forest for a width of a couple of chains. Thus aided, the grass-plains appear to be slowly but surely extending and encroaching on the forest.

The next formation toward the interior is marked by the beds of marine fossils mentioned above, in which many of the present-day forms of sea-life are visible. Here grass and forests mingle on the foothills, gradually merging into the primeval types of rain-forest. In gorges the trees attain very large dimensions, a species of *Calophyllum* being especially noteworthy.

I may mention, in passing, that I once collected on a supposedly sacred mountain, and subsequently was tried by the government for violating a native sanctuary. Although I was freed of the charge, this will illustrate my contention that government officials in the British islands were not exactly coöperative. The "sacred" mountain is a bold upstanding mass named Mt. Tatuve (Tutuve), or the Lion's Head (see map, *fig. 2*). My collections from this region were of unusual interest, although the rainfall is much less than on Bougainville. The only showy flowering plants on the mountain-tops are species of *Rhododendron*. In this vicinity I obtained a great deal of information pertaining to the superstitious usages of plants by the natives, but no plants of outstanding merit for medicinal purposes were discovered. As these natives were living in a stone-age civilization upon the arrival of the white men, it may safely be assumed that they had no systematic methods of treating diseases.

FOOD PLANTS

The inhabitants of the Solomons are skilled in agriculture of a type not much advanced over the stone-age. In this region nature is so provident that food can be grown simply and with a minimum of exertion. In the following paragraphs I shall discuss the principal plants which the natives used in their domestic requirements.

TARO, *Colocasia esculenta* (L.) Schott. Taro is perhaps the most valuable food plant in the entire western Pacific. There are innumerable forms and local varieties, perhaps running into the hundreds. For convenience, the varieties may be divided into two groups, like rice — the upland and the swamp varieties. The upland type is the one universally cultivated, the swamp type being much coarser but yielding larger corms. In the wild state all the forms have a fibrous corm of inferior quality, containing a greater amount of calcium oxalate crystals than the cultivated forms. To obtain a long starchy corm has doubtless taken a very long period of cultivation and selection.

Planting the taro is a simple but effective procedure. A cylindrical hole about eighteen inches deep is made with a large stick, and in the hole the head of a taro plant of which the corm has been eaten is placed, the long leaves protruding from the hole. The heavy rains fill in the hole, and so the native is spared even this slight effort. After about nine months the corm is large enough to be gathered and eaten, usually being either baked or boiled. The top portion, with the leaves attached, is replanted. Reproduction is also effected by allowing the plants to sucker, the new shoots then being planted; these new shoots mature more slowly than the tops of old plants.

On some islands, and especially in mountainous districts, hillside streams are diverted around terraces and large quantities of a water taro are grown. This variety grows with its roots in the water and attains a height of about six feet, with correspondingly large corms. The stream taro is not as popular as the upland forms, and probably only about five percent of the taros used in the Solomons are of this type.

In general, the taro will not thrive in regions of low rainfall. It makes up the bulk of the food of the natives in the interiors of all the large islands. Europeans are not usually fond of this food, as the corms are inclined to be more fibrous than are those of most cultivated vegetables; nevertheless the taro is excellent as a change of diet and is not to be despised in cases of necessity. It must be remembered that all taros must be cooked before being eaten, in order to render innocuous the calcium oxalate crystals. I recall one case in which a District Officer suspected the use of taro juice as a poison. According to the native evidence, the raw juice was put into cooked food, thus causing severe pain in the victim's throat. Although such pain would not be fatal by any means, the native mind is very susceptible to imagination, and it is not impossible that death might be caused by the mere thought of having been poisoned.

YAM, *Dioscorea* spp. Next in importance to taro in the Solomons are yams, which are cultivated in the drier areas, as they will tolerate fairly long periods of drought. Soils near the beaches are usually more sandy than those of the interior, and yams seem to prefer this type of soil. However, they are sometimes grown on wet islands, and I believe that tradition has a great deal to do with whether islanders of certain regions prefer yams or taros. There is an endless variety of yams, from monsters 70 to 80 pounds in weight to small ones the size of carrots. Owing to the fact that their runners need large supports, yams are suitable to newly felled areas of virgin bush, where plenty of large branches are left for the plants to climb over. After the yams have been harvested, bananas are planted in the same area and are left to grow in competition with the tall weeds; in a few years the field becomes jungle-covered and after about ten years it may again be cleared and used for another crop of yams.

Both yams and taros may be cooked in a variety of ways. Often they are boiled and mashed, and to the sticky mass grated coconuts are added, or sometimes the grated kernels of *Canarium* nuts. If the latter nuts are used, they are usually first hung over a fire and smoked and allowed to become rancid; the resultant strong flavor adds piquancy to the dish in the opinion of the natives. There are several species of aromatic herbs which the natives sometimes add to starchy foods. These herbs are in demand at feast times, but usually it is considered too much trouble to gather and prepare them. As long as food is available the natives seldom need any appetizer; they do not like vegetables cooked too soft, even rice, when available, being cooked in a manner almost indigestible to Europeans.

In my observation, the natives of the Solomons are not as highly skilled agriculturists as those of Tanna, in the New Hebrides. The Tannese have raised the cultivation of yams to a very high standard. They sift the soil and make high mounds, rich in humus and bacteria, in which the yam is planted; the vines are trained over well-built supports, and the resultant crop is very large, yams of 70 or 80 pounds being commonplace. The Tannese build yam houses with ventilated sides and store the yams for as long as nine months, until the new crop is ready. In other parts of the western Pacific I have not observed such a high standard of agriculture as on Tanna, the natives of which are quite superior both physically and intellectually.

Wild bananas, *Musa* spp. In one form or another, wild bananas are met with frequently in the rain-forests. In fact, one observes patches of giant bananas, with trunks up to 30 or 40 feet high, growing in dense stands with little or no other vegetation. They prefer wet or damp situations, such as the slopes of the high mountain ranges on Bougainville. All the wild ripe fruits I saw in the Solomons were of an orange color, insipid in taste, the pulp being full of small black seeds.

The banana has a multiplicity of uses, pertaining to food, clothing, fibers, sap used as a dye, etc. As a food it enters largely into the dishes prepared for feasts, as it is always one of the constituents of native puddings. It is noteworthy that the same type of pudding is found throughout the western Pacific and even extending eastward. It is prepared by grating and kneading a starchy material, such as yam or taro, to which is added the flesh of fish or fowl, and bananas. Of course the fruits are also cooked in a variety of other ways, being baked, boiled, or even fried — the latter method being copied from the whites.

The leaves of the banana are used for wrapping meat, fish, or puddings, which are then steamed on glowing coals. Additional banana leaves are heaped on top to keep in the heat, and after about three hours the food is excellently cooked. Skirts are manufactured from the leaves with a minimum of effort. The frond of a large banana, ten feet long or more, is split down the middle of the midrib, and the blades of the two portions are then split like combs and placed on hot sand to dry. The blades shrink to a wispy material, and about half a dozen layers are worn as a skirt, thus solving the clothing problem very easily for the ladies. In the Santa Cruz group the fiber from the stems of bananas is woven into mats and baskets, by means of a loom and shuttle. Considering the crudeness of the apparatus, very beautiful work is done and colored patterns are skillfully introduced.

Sago palm, *Metroxylon salomonense* (Warb.) Becc. Among the most valuable plants of the Solomons, the coconut palm would of course rank very high, but so much has been written about the uses of this species that I can add nothing. Another very valuable palm, the sago palm, however, is also of extreme value to the natives. Its fronds supply one of the most popular and durable thatches; the large pinnae are stripped off and sewn together on a pole, these poles being used in a manner similar to shingles. European houses in isolated places in the Solomons are similarly thatched, as roofs of this material provide very cool houses.

The trunk of the *Metroxylon* supplies huge quantities of sago, which is gathered after the tree has flowered and fruited, usually after about 20 years of growth. When this period arrives, the tree is felled, the trunk split, and the starch grains loosened by beating. The particles are then washed in troughs full of water, and the starch sinks to the bottom, from which it is collected and spread in the sun to dry. The starch has the appearance of arrowroot, as which it is sometimes used by the white settlers. Used by itself it is very constipating, and so a great deal of coconut oil is mixed with it in cooking.

Great quantities of the nuts of the sago palm are collected every year and sold to Japan as ivory nuts of commerce, being used as a substitute for ivory in cheap articles and in the manufacture of buttons. These nuts are said to be not as good as the ivory nuts of South America (*Phytelephas macrocarpa* R. & P. or spp.), but at times there is a considerable demand for them owing to the proximity of the Japanese market.

OTHER PALMS. Buin, in southern Bougainville, is strikingly rich in native palms, which cannot be said of all the islands. However, the Solomons are doubtless richer in palms, on the whole, than the New Hebrides. The uses of palms in the native economy are legion. The trunks of all species have a pithy center and an extremely hard exterior; they are very easily split, after which the soft pith is chopped away and the remaining lathe-like strips used for a very durable flooring in native houses. The outer part of the trunk of the taller species is very hard and takes a good polish, and this wood has been used for centuries in making bows, spears, and other weapons. When making a temporary camp in the bush, the natives use the fronds of any species for shelters. The fronds of the broader cabbage-leaf type are made into light mats on which the natives sleep and which they carry over their heads as a protection against rain.

The crown or undeveloped young fronds of some species can be boiled and eaten as a vegetable. The head of the palm is cut open and the soft immature fronds removed, the coconut palm being especially prized as a source of a salad. Of special interest is the nipa palm, *Nipa fruticans* Thunb. The natives collect the fronds of this species and burn them when they are dry, the resultant ash being used in a manner similar to salt.

BREADFRUIT, *Artocarpus altilis* (Parkinson) Fosberg. Every traveler refers to the breadfruit, one of the principal food plants of the Pacific. In addition to its edible fruit, it possesses a very valuable sap which serves as a strong glue in the manufacture and mending of canoes. The trunks of the trees also make very good canoes, but the fruit is too valuable to permit of many trees being used in this way.

NARLI NUTS, *Canarium* spp. Species of *Canarium* have a wide distribution over the whole of the southwestern Pacific. The trees have very large flanges or buttresses and a tall light-colored trunk, and they are outstanding in the rain-forest. The genus is of great economic value, as its members produce great quantities of nuts, which have an exceptionally high food value, being esteemed by natives and whites alike. As the native is essentially a vegetarian, the oil-ration provided by *Canarium* nuts is a decided addition to his diet. Immense crops of the nuts are produced for four, five, and even six months of the year. They are smoked and preserved in various ways, this being the only food which is stored except for yams and breadfruit, in my observation. The mountain natives make regular pilgrimages down to the coast to barter for the nuts, using them to flavor taro puddings. Wherever the natives destroy the forest for the purpose of making gardens they leave the *Canarium* trees, taking great care that fires do not scorch or damage them. As a result, these trees are very numerous and large, often with a height of 140 feet and a diameter of six feet.

Canarium nuts are known as "garlips" in the Mandated Territory, "sailor" in the Solomons, "narli" in the Santa Cruz group, and "nungi" or "ni" in the New Hebrides. There is a wide range of varieties and species. The largest and oiliest nuts come from the Santa Cruz group, from a tree comparatively small in stature but bearing tremendous crops. One wonders whether this prolific tree could be the result of long cultivation and selection. The timber of *Canarium* might be of value as a cabinet wood, but I do not know of a single instance where a tree has been felled, as this would be sacrilege in the eyes of the natives. In the Mandated Territories it is illegal to cut any of these trees or any other trees which are used for food by the natives.

UPOLU or OOPERU, *Gnetum gnemon* L. This species is a large factor in the supply of green vegetables in the Solomons. Everywhere along the roads in Buin on southern Bougainville one can see the trees growing, as they have been left by the natives when the rain-forest was cleared. The tree has a tall erect pine-like manner of growth; whether this is natural or whether it is caused by the continual stripping off of the smaller branches I am unable to say. The method of collecting the leaves is amusing; a young boy is selected to climb the tree and break off the young branches, which are thrown down to natives under the tree. Only the terminal leaves are removed from these branches, and these young leaves are then boiled and eaten like cabbage. This vegetable has a unique flavor which is entirely pleasing to most Europeans.

In a somewhat similar manner the young leaves of "akamu" (*Polyporandra scandens* Becc.) and "numarrie" (*Rhyticaryum* sp., *Kajewski 2072*), both of the Icacinaceae, are prepared and eaten.

FIGS, *Ficus* spp. The figs of the South Pacific are very difficult to classify botanically, as the species are numerous and variable. Before the arrival of the white men, figs probably had a more important place in the native economy than at present. One species has a strong thick bark which was beaten out to make a cloth resembling tapa (from *Broussonetia papyrifera* Vent.). The thicker portions of this bark were not beaten out but were cut into long strips, being used for thongs in a manner similar to leather.

The large fleshy leaves of some species are cooked and eaten as vegetables; I have tried these and have found them excellent, if only the young and tender leaves from the apices of branchlets were selected. The leaves of other species are very rough and are used as sandpaper, to finish native weapons such as spears and also to polish ornaments, combs, etc. The fruits of most figs are eaten by fruit-loving birds such as pigeons and hornbills.

PIPERS, *Piper* spp. The genus *Piper* is widely distributed throughout the tropics, supplying the pepper of commerce and the "kava" (*Piper methysticum* Forst. f.) of Polynesia. Kava-drinking is not indulged in in the Solomons, but the betel nut is extensively used. There is a sharp dividing line between these two customs, which coincides with the political boundary between the New Hebrides and the Santa Cruz group. Betel nut chewing is unknown in the New Hebrides.

The leaves of some pipers have a very pleasant odor when bruised, and are used by the natives to rub on their bodies. Other species play an important part in native religions, the fruits or roots sometimes being burned to frighten away evil spirits. The leaves of another species (*Kajewski 2185*) are rubbed over the body in order to drive out a poison or to banish a devil. Many species are rich in essential oils, and I have no doubt that the indigenous pipers of Bougainville will be worth chemical investigation.

PANDAN, *Pandanus* spp. In strand floras throughout the Pacific and often found inland up to 5,000 feet elevation are many different species of *Pandanus*. Some species attain a stature of 30 or 40 feet, a notable example of a tall species occurring on the Crown Prince Range of Bougainville, where there are pure stands with little or no forest of other constituents. Pandans have a multiplicity of uses for the islanders. The long leaves are split, after soaking and bleaching in salt-water, and are plaited into mats, baskets, and "grass" skirts. This work is done by the women, and great jealousy is attached to the rights to leaves from certain plants concerning which a sort of priority has been established. In one case I knew of a woman who cut down one of "her" trees because another woman had gathered leaves from it.

Pandan fruits contain small oily kernels which provide a very concentrated food in case of emergency, although to gather the kernels is slow work. The juice of the ripe fleshy fruits is also palatable, and the head has a fine fruity fragrance when ripe.

BARRINGTONIAS, *Barringtonia* spp. Some species of this genus have non-edible fruits which are sometimes considered poisonous, this type being associated with swamps. The nuts of other species are edible and the tree is worth cultivating for this reason as well as for its ornamental value. The fruits have a fibrous outer covering, the kernels having a taste similar to the almond.

General superstitions. The natives of the Solomon Islands have many quaint superstitions which have been handed down for centuries; their whole lives, in fact, are wrapped in superstition. When a native builds a house, the first thing he thinks of is to grow suitable plants to stop the evil spirits from entering his house as he sleeps. Sometimes, in villages, there is a fringe or boundary of these protective plants around the whole village. When a house stands by itself even greater efforts are taken to protect it by the judicious use of plants, since the spirits are more forward where solitary houses are concerned. The plants most widely used for this purpose are wild aromatic gingers, which give off a pungent odor when crushed. Highly decorative plants such as crotons, euphorbias, and hisbiscus are used to please the spirits. This of course is the case in pagan villages; in Christian villages these customs would be distorted, but nevertheless the same plants are still used as ornamentals.

When the pagan native starts to clear the rain-forest, he knows that he is going to offend the spirits by making the forest unsightly, and so he tries to appease them by leaving certain plants standing. These plants vary from island to island, but certain aromatic plants like wild gingers are invariably left undisturbed. Again, when the crops are planted, certain gay decorative and aromatic plants are allowed to grow with the crops, as though the native were reassuring the spirits that he intended to leave the land beautiful. Certain areas or patches of forest are "tambu" and their cutting is forbidden, for which reason one often sees a patch of tall undisturbed forest near a village.

The islanders are very fond of aromatic plants and grow many of them for ornamental purposes and for perfume. One observes the greatest use of these at feast times. Traders exploit this desire for strong perfumes by importing cheap scents which in some districts are replacing the native plants for this purpose.

Methods of gardening. For ages past the natives of the Solomons have been tillers of the soil. A strong tropical sun, a genial climate with no great extremes, bounteous rainfall, and rich soil enable them to produce all the food they require with little effort. The gardens are primitive affairs, with no attempt at serious cultivation. The only great effort is to erect pig-proof fences, for all the pigs, although native-owned, run wild and depend for their livelihood upon their foraging propensities.

The staple of the native diet is taro, and as the native eats but one regular large meal a day he has to plant about 500 taros for a food-supply of six months to one year. He can also, if inclined, set out a few banana suckers, some sweet potatoes, and some tapioca in addition to the plants discussed above. Meanwhile, a single sago palm will provide an enormous quantity of food. The *Areca* nut grows in a semi-wild state, and so his betel nut stimulant costs nothing. Coconuts are grown everywhere up to an altitude of 1,500 feet, while other nuts provide edible oils, and young leaves of various plants provide greens. Tobacco grows almost wild and can be dried and twisted with very little trouble. It is only the desire for trade goods — knives, other tools, mirrors, and calico — that causes the native to condescend to work for the white man.

To prepare a garden the native selects a piece of bush that has not been cultivated for many years, the longer the better. All the trees except the larger ones are felled, allowed to dry, and fired. The unburned logs are piled up against the larger trees, which are sometimes then killed by a second fire. Next the native builds his pig-fence, and his share of the operation is completed. The planting, harvesting, gathering firewood, and cooking are left to the women. One might suggest, in conclusion, that exponents of women's rights would have grounds for a campaign in the Solomons.

THE GENUS ESCHWEILERA IN TRINIDAD AND TOBAGO

A. C. Smith and J. S. Beard

In his Flora of Trinidad and Tobago, R. O. Williams (1: 353. 1934) recognizes two species of *Eschweilera* (Lecythidaceae), one occurring in Trinidad and one in Tobago. The present writers, although agreeing with Williams in referring the common lowland Trinidad form to *E. subglandulosa*, believe that a species occurring in the montane rain-forest of Mt. Tucuche is undescribed. Furthermore, we cannot concur in referring the Tobago plant to *E. decolorans* Sandwith, of British Guiana; this Tobago entity appears to us to be undescribed and below we present a description of it. Although the authors of this paper are jointly responsible for the conclusions expressed, the formal descriptions and the synonymy were prepared by the first author, while the second author assembled the ecological data, largely on the basis of his own field-study.

Herbarium specimens are cited from the Arnold Arboretum (A), Gray Herbarium (GH), Imperial College of Tropical Agriculture, Trinidad (ICTA), New York Botanical Garden (NY), Royal Botanic Garden, Trinidad (Trin), and U. S. National Herbarium (US). We are indebted to the directors and curators of those institutions from which material has been borrowed for the purposes of this study.

Eschweilera subglandulosa (Steud.) Miers in Trans. Linn. Soc. **30**: 266. 1874; Eyma in Pulle, Fl. Surinam **3** (1): 134. 1934; R. O. Williams, Fl. Trin. & Tobago **1**: 253. 1934; Knuth in Pflanzenr. **105** (IV. 219a): 106. 1939.

Lecythis subglandulosa Steud. ex Berg in Linnaea **27**: 459. 1854.

Lecythis laevifolia Griseb. Fl. Brit. W. Ind. 711, nomen. 1864; Urban in Bot. Jahrb. **19**: 670, nomen. 1895.

Eschweilera laevifolia Miers in Trans. Linn. Soc. **30**: 256. *pl. 60, f. 15.* 1874; Knuth in Pflanzenr. **105** (IV. 219a): 99. 1939.

Trinidad: Arena Reserve, alt. 75 m., *Beard 148* (A) (tree 40 m. high, in evergreen seasonal forest; trunk 60 cm. diam.; petals cream-yellow; timber useful; local name: *guatecare*); North Post Road, *Britton, Hazen, & Mendelson 773* (GH, NY, US) (tree 20 m. high, on hillside); St. Anne's Valley, *Broadway 3620* (Trin); without locality, *Fairchild 2857* (A).

On the basis of the cited material and examination of the original and subsequent descriptions, we are inclined to agree with Williams in reducing *E. laevifolia*, presumed to be endemic to Trinidad, to the South American *E. subglandulosa*. No differences are apparent between our specimens and several available from British Guiana. In his recent work, Knuth makes no comparison between the two species, both of which are maintained by him.

Eschweilera subglandulosa ("guatecare"), as it occurs in Trinidad, is a large evergreen tree up to 40 m. in height, with a long cylindric erect trunk up to 75 cm. (or occasionally more) in diameter, branching high up, and with small buttresses. The bark is dark gray to black, somewhat smooth, about 0.5 cm. thick, hard, and slightly fibrous. The wood is white, turning gray when seasoned; it is close-grained and without distinct heartwood. The timber is very hard, heavy, and difficult to work; it is usually hewn rather than sawn into sleepers, posts, and heavy timbers. It is prized for its natural durability in contact with the ground, being resistant to both fungi and termites.

This species is one of the principal dominants of the most widespread forest type of the Trinidad lowlands-evergreen seasonal forest — and has given its name to the *Carapa guianensis–Eschweilera subglandulosa* association of that formation. It is absent from Tobago. In the foothills of the Northern Range of Trinidad (a) it is only of the order of frequent, but it is abundant in the forests of the northern plain (b) and Central Range (c), and it is very abundant on the southern hills and peneplain (d). It becomes abundant also in a drier type of forest in the southern hills, the *Peltogyne porphyrocardia–Mouriria Marshallii* association of semi-evergreen seasonal forest (e). It does not become such a large tree in the semi-evergreen forest, while in other forest types than the five mentioned above the tree is casual and rare.

TABLE 1.

NUMERICAL OCCURRENCE OF ESCHWEILERA SUBGLANDULOSA IN FOREST TYPES IN TRINIDAD; INDIVIDUALS PER 100 ACRES

Locality	Number of trees in girth classes (girth in feet)										
	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	over 10	Totals
a[1]	38	12	4	4	6	2	2	—	—	—	68
b	194	116	54	54	26	12	6	2	—	6	470
c	108	69	35	30	20	2	6	1	1	1	273
d	234	366	201	231	87	48	21	21	6	3	1218
e	100	136	22	24	14	—	—	—	—	—	296

[1] The letters in the left-hand column refer to the localities mentioned in the text above.

The habitat of the plant is characterized by a seasonal rainfall regime with from 1750 to 3000 mm. of rain annually, distributed in a dry season from January to April, with 50 to 80 mm. of rain per month, and a rainy season from May to December, with 100 mm. and upward per month. Mean annual temperature is about 78° F. There is little exposure to strong winds. Topography embraces all types from mountains to plains, and soil types include all except the extremes of excessively freely drained and waterlogged. Apparently the tree occurs in British Guiana in a similar habitat.

Eschweilera subglandulosa is a forest dominant in the sense of physical and numerical superiority, being one of the most abundant trees of the uppermost forest stratum. It is not uniformly distributed, since the *Carapa-Eschweilera* association is divisible into two distinct alternes corresponding to site differences between ridge and flat. *Carapa* is dominant on the badly drained flats with intermittently high water-table — *Eschweilera* on the dry ridges with compact soil and no true water-table. On intermediate sites both dominants occur together. Associate dominants of the *Eschweilera* alterne are *Buchenavia capitata* (Vahl) Eichl., *Terminalia amazonia* (J. F. Gmel.) Exell, *Tabebuia serratifolia* (Vahl) Nichols., *Manilkara bidentata* (A. DC.) Chev., *Vitex divaricata* Sw., *Vitex capitata* Vahl, and *Bravaisia integerrima* (Spreng.) Standley.

Eschweilera trinitensis sp. nov.

Arbor 10–20 m. alta ubique glabra, ramulis subteretibus rugulosis primo purpurascentibus gracilibus 1.5–5 mm. diametro demum cinereis lenticellatis; petiolis canaliculatis valde rugulosis 5–13 mm. longis crassis (2–3 mm. diametro); laminis coriaceis vel valde chartaceis in sicco olivaceis ellipticis vel oblongo-ellipticis, (7–) 10–26 cm. longis, 4–12 cm. latis, basi obtusis vel subrotundatis et in petiolum leviter decurrentibus, in apicem callosum 0.5–1.5 cm. longum cuspidatis, margine cartilagineis integris vel obscure undulatis, costa supra plana vel subprominente subtus valde prominente, nervis secundariis principalibus utrinsecus 7–14 arcuato-adscendentibus marginem versus obscure anastomosantibus supra planis vel prominulis subtus valde elevatis, rete venularum copiose intricato supra immerso vel prominulo subtus valde prominulo; inflorescentia axillari vel subterminali sub anthesi 6–12 cm. longa anguste paniculata ut videtur ad 25-flora, rhachi angulata valde rugulosa 2–4 mm. crassa haud flexuosa, ramulis lateralibus 2–8 adscendentibus ad 3 cm. longis gracilibus; pedicellis teretibus haud bracteolatis 5–8 mm. longis superne 2–3 mm. diametro, basi valde contractis et articulatis, parte inferiore persistente subnulla in pulvino bilobato inconspicuo complanata; calyce sub anthesi ad 12 mm. diametro, sepalis subcoriaceis semiorbiculari-deltoideis circiter 4 × 5 mm. subintegris obtusis; petalis tenuiter carnosis vel in sicco papyraceis ellipticis vel oblongo-obovatis, sub anthesi ad 2 cm. longis et 1.5 cm. latis, obscure nervatis, apice rotundatis, margine obscure denticulatis vel integris; androphoro carnoso explanato circiter 2 cm. longo, super annulo circiter 12 mm. lato, galea spiraliter incurvata circiter 13 mm. lata, parte apicali inflexa extus appendiculis crassis acutis 3–5 mm. longis ornata; staminibus circa annulum et paullo supra numerosissimis, filamentis carnosis subteretibus 0.7–1.2 mm. longis superne incrassatis, antheris oblongis 0.5–0.7 mm. longis; ovario semisupero sub anthesi circiter 3 mm. diametro, in stylum brevem conicum truncatum ad 1 mm. longum umbonato, loculis 4, ovulis in quoque loculo e basi erectis ut videtur 3 (2–4?); inflorescentia sub fructu valde incrassata, pedicellis ad 5 mm. diametro; pyxidio maturo depresso-subgloboso ad 4.5 cm. longo et 5.3 cm. lato, parte infracalycari cupuliformi 2–2.5 cm. alta rugulosa, calycis lobis coriaceis obviis obtusis, vitta interzonali incurvata 3–9 mm. alta, operculo convexo 5–10 mm. alto ad 4 cm. diametro, pericarpio lignoso 3–4 mm. crasso 2–4-loculari, seminibus in quoque loculo 1 vel 2 ad 3 × 2 cm.

TRINIDAD: El Tucuche, in montane rain-forest, alt. 900–1000 m., *J. S. Beard 147* (A, TYPE), Oct. 1, 1943 (tree 15 m. high; trunk 30 cm. diam.; flowers yellow; local name: *mountain guatecare*), *Beard 471* (A, Trin), *472* (A, Trin), April 20, 1945 (trees 10 m. high; trunk 30 cm. diam.; bark soft and stringy).

Of the cited specimens, no. *147* bears flowers and is accompanied by detached immature fruits, no. *471* bears immature fruits, and no. *472* has mature fruits from which the above dimensions are taken. Although there seems no doubt that a single species is represented by these collections, it should be noted that the leaves of no. *472* are on the average considerably larger than those of the other two numbers, although smaller leaves also occur on this specimen. The number of secondary nerves is also greater in the leaves of no. *472*. In general, the maximum dimensions given above pertain to this specimen, the smaller dimensions to nos. *147* and *471*. The variation present seems normal for a species of *Eschweilera* and may be due to conditions of shade or exposure.

The differences between the new species and the common lowland species of Trinidad, *E. subglandulosa*, are obvious, the two even falling into different genera if the classifications of Miers and Knuth are adopted. Among the species of *Eschweilera* with predominantly 4 ovary-locules (*Chytroma* Miers), our plant seems closest to *E. decolorans* Sandwith, of lowland British Guiana, of which we have several specimens for comparison (*Sandwith 348* [type coll., NY, US], *414* [NY], *Jenman 2474* [NY], *Forest Dept. 920* [ICTA], *2563* [NY]). From *E. decolorans, E. trinitensis* differs primarily in having its inflorescence narrowly paniculate rather than usually simply racemose, in having its pedicels shorter, articulate at the base, and ebracteolate rather than articulate above the base and with obvious bracteoles, and in its smaller flowers (this character being obvious in dimensions of the sepals, petals, filaments, staminodes, and ovary). The petals of *E. decolorans* are said to be pure white or creamy white, while those of the new species are distinctly yellow. In foliage the two species are essentially similar, but the leaf-blades of *E. trinitensis* have the secondary nerves more closely approaching the margin and there weakly anastomosing by means of inconspicuous connecting nerves, while the blades of *E. decolorans* have the secondaries more distinctly interconnected somewhat farther from the margin. The proportions of the pyxidia of the two species provide further distinguishing features; for a discussion of the fruits of *E. decolorans* see our note under *E. Sandwithiana*, described below.

The character upon which *Chytroma* is separated from *Eschweilera* (cf. Knuth in Pflanzenr. 105 [IV. 219a]. 1939) — the presence of 4 rather than 2 ovary-locules — often seems to separate closely related species and furthermore is not always dependable, as already pointed out by Eyma (Polygon., Gutt., Lecyth. Surinam 66. 1932).

Eschweilera trinitensis ("mountain guatecare") is a medium-sized evergreen tree up to 20 m. in height, with a trunk up to 75 cm. in diameter. Its trunk is usually short and thick, slightly buttressed, and with heavy and spreading branches. The bark is dark gray to black, smooth, soft and fibrous, and about 1 cm. thick on old trees. The wood is white, close-grained and moderately hard, with no distinct heartwood. As the tree occurs only in fairly inaccessible places, the timber is never worked and nothing is known of its quality.

This species is one of the principal dominants in the montane rain-forest which is localized at the summits of the two highest peaks in the Northern Range of Trinidad — Tucuche and Aripo — above 800 m. elevation. The tree is unknown elsewhere in Trinidad, its distribution being confined to an area of only several hundred acres. The second author believes that he has seen it in forest of a similar type in the mountains of the Paria Peninsula of Venezuela, a range formerly continuous with the Northern Range of Trinidad, but this occurrence is not at present supported by herbarium specimens.

Enumerations show this species to occur at an average rate of 15 trees per acre over 10 cm. in diameter in the montane rain-forest — a figure representing about 16% of the crop. It ranks third in numbers in the association, *Licania biglandulosa* Griseb. and *Richeria grandis* Vahl being each slightly more abundant. The *Eschweilera*, however, grows to be a bigger tree than any of its associates. Other less common members of the association are *Oreopanax capitatus* (Jacq.) Dec. & Planch., *Croton roraimensis* Croizat, *Chimarrhis cymosa* Jacq., *Euterpe Broadwayana* Becc., *Prestoea pubigera* (Griseb. & Wendl.) Nichols., and *Cyathea* spp.

There are no exact data on the habitat of *Eschweilera trinitensis*. It occurs on mountain tops in the cloud belt, where the atmosphere is generally saturated. Annual rainfall is probably about 5000 mm. without any appreciable dry season, and average temperature is about 65° F. The constant wetness is shown by a thick covering of bryophytes on the trees, by luxuriant epiphytes, and by the presence of tree-ferns. The area is exposed to strong winds.

Eschweilera sp.

TRINIDAD: Blanchisseuse Reserve, *R. L. Brooks 12483* (NY); Northern Range Reserve, *Brooks 12687* (NY).

What appears to be a third species of *Eschweilera* from Trinidad is represented by the above-cited specimens. The leaf-blades of this entity are smaller than those of either *E. subglandulosa* or *E. trinitensis*, measuring 7–11 × 3–5 cm., obtuse to acute at base, with the 7–10 secondaries weakly anastomosing and the veinlet-reticulation very intricate. A single fruit accompanying no. *12483* resembles those of *E. trinitensis* but is smaller, with a thinner pericarp and a single 1-seeded locule. Collection of flowers is desired before this form can confidently be placed.

This species of *Eschweilera*, locally known as "guatecare petite feuille," is a large evergreen tree up to 30 m. in height, with a long cylindric erect trunk up to 60 cm. (or occasionally more) in diameter, branching high up, and with very small buttresses. The bark is dark gray, somewhat smooth, about 0.5 cm. thick, soft, and somewhat fibrous. The wood is white, of moderate hardness, and reputedly of poor durability, for which reason it is only very seldom worked for timber. It is occasional in the lower montane rain-forests of the *Byrsonima-Licania* association in the Northern Range of Trinidad, at elevations between 250 and 750 m.

TABLE 2.

NUMERICAL OCCURRENCE OF ESCHWEILERA SP. IN BYRSONIMA-LICANIA ASSOCIATION OF NORTHERN RANGE OF TRINIDAD; INDIVIDUALS PER 100 ACRES

Number of trees in girth classes (girth in feet)										
1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	over 10	Totals
96	78	57	45	36	12	12	4	2	3	345

Eschweilera sp. ("guatecare petite feuille") ranks eighth in number among the dominant trees and represents about 2% of the total crop. The associate dominants are *Licania ternatensis* Hook. f., *Sterculia caribaea* R. Br., *Byrsonima spicata* (Cav.) L. C. Rich., *Licania biglandulosa* Griseb., *Micropholis Cruegeriana* Pierre, *Terminalia amazonia* (J. F. Gmel.) Exell, and *Diospyros ierensis* Britton. The habitat of this *Eschweilera* is essentially the same as that of the next species discussed, *E. Sandwithiana.*

Eschweilera Sandwithiana sp. nov.

Eschweilera decolorans sensu Williams, Fl. Trin. & Tobago **1**: 354. 1934; non Sandwith.

Arbor alta ubique glabra, ramulis subteretibus striatis gracilibus apicem versus 1.5–3 mm. diametro purpurascentibus vel cinereis demum inconspicue lenticellatis; petiolis validis (2–3 mm. diametro) rugulosis supra complanatis 5–20 mm. longis; laminis valde chartaceis in sicco olivaceis vel fuscescentibus ellipticis vel oblongo-ellipticis, (11–) 17–25 cm. longis, (3–) 6–10.5 cm. latis, basi acutis vel obtusis et interdum subrotundatis, in apicem 7–15 mm. longum subito cuspidatis vel acuminatis, margine leviter revolutis et inconspicue undulato-crenulatis vel integris, costa valida utrinque prominente, nervis secundariis utrinsecus 11–15 patentibus leviter curvatis 3–7 mm. e margine regulariter et conspicue anastomosantibus supra leviter subtus valde elevatis, rete venularum intricato copioso utrinque valde prominulo; inflorescentia supra-axillari vel subterminali breviter racemosa sub anthesi 1–2 cm. longa ut videtur 5–8-flora, rhachi angulata striata 1–1.5 mm. diametro, floribus magnis; pedicellis crassis (sub anthesi 1.5–3 mm. diametro) teretibus 6–9 mm. longis superne incrassatis, basim versus articulatis haud bracteolatis, parte inferiore subnulla; sepalis (5 vel) 6 sub anthesi patentibus valde imbricatis coriaceis late ovatis vel suborbicularibus, 5–7 mm. longis, 4.5–8 mm. latis, apice rotundatis, margine interdum scariosis; petalis in sicco papyraceis suborbicularibus vel elliptico-obovatis, sub anthesi 15–20 mm. longis et 13–17 mm. latis, obscure reticulato-nervosis, apice rotundatis; androphoro explanato sub anthesi ad 4 cm. longo, ligula carnosa 2–2.5 cm. longa super annulo 1.5–2 cm. lata, galea spiraliter incurvata compacte subglobosa 15–18 mm.

diametro, parte apicali inflexa extus appendiculis crassis lanceolatis 5–6 mm. longis copiose ornata; staminibus circa annulum carnosum et paullo supra numerosissimis, filamentis carnosis clavatis longitudine diversis (0.5–3 mm. longis, eis basi ligulae longioribus) interdum anantheris, antheris oblongo-ellipsoideis, thecis 0.5–0.7 mm. longis; ovario plus minusve semisupero sub anthesi circiter 3.5 mm. diametro, in stylum crassum subconicum obtusum circiter 1.5 mm. longum producto, pariete crasso, loculis 2 vel 3, ovulis in quoque loculo 4–7 e basi erectis obovoideo-complanatis; inflorescentia sub fructu ut videtur paullo incrassata, pyxidio submaturo depresso-subgloboso ad 3 cm. longo et 3.5 cm. lato, parte infracalycari inconspicua complanata, calycis lobis coriaceis persistentibus, vitta interzonali erecto-patente 5–10 mm. alta, operculo convexo-subconico 10–15 mm. alto ad 35 mm. diametro, pericarpio lignoso 2–5 mm. crasso ruguloso ut videtur plerumque 1- vel 2-loculari, seminibus paucis.

TOBAGO: Roxborough, in the Forest Reserve near the 5-mile post, *I. S. Earle 12899* (Trin, TYPE), May 16, 1933 (*devilwood* or *guatecare*); Roxborough-Bloody Bay Road, Tobago Reserve, alt. about 300 m., *C. Swabey 12941* (Trin) (*devilwood*); King's Bay Estate, *W. E. Broadway 4534* (NY); without definite locality, *R. C. Marshall 12383* (Trin) (big tree).

Although the above specimens are far from satisfactory, taken together they offer enough material to indicate that the Tobago plant is distinctly different from any encountered in Trinidad; furthermore, we are unable to match this with any continental species and therefore we have described it as new. The best flowers accompany the type, while *Swabey 12941* has the best (although broken and not fully mature) fruits. *Broadway 4534* has the only attached inflorescences, but its flowers are immature. This Broadway specimen was cited by Knuth (in Pflanzenr. 105 [IV. 219a] : 99. 1939) as *E. laevifolia*, but it is certainly distinct from that species, discussed above as *E. subglandulosa*.

Eschweilera Sandwithiana is characterized by its large and comparatively narrow acuminate leaf-blades, of which the secondary nerves are united in very regular anastomoses and the veinlet-reticulation is intricate and conspicuous on both surfaces. The fruit of the new species is notable for its small nearly flat infracalycary zone, its spreading interzonal band, and its large operculum. In having a 2- or 3-celled ovary our plant is referable to *Eschweilera* in the limited sense rather than to *Chytroma*, if indeed these two groups are worthy of even sectional recognition.

Obvious characters of leaf-texture and venation distinguish the new species from *E. subglandulosa* (Steud.) Miers. Furthermore, *E. Sandwithiana* has the inflorescence simple and compact rather than divaricately paniculate, the sepals larger, probably the androecial parts also larger at anthesis, and the fruit quite differently shaped.

From *E. decolorans* Sandwith and the above described *E. trinitensis*, the new species differs in its fewer ovary-locules with more numerous ovules, its compact inflorescence, and in minor characters of foliage and flowers. In venation, the leaves of the new species are more suggestive of those of *E. decolorans*, which has a similarly obvious veinlet-reticulation, but our plant has the anastomoses of the secondaries more regular.

Prof. E. E. Cheesman, of the Imperial College of Tropical Agriculture, Trinidad, has kindly loaned us some detached fruits said to be those of *E. decolorans* and presumably from British Guiana. These mature pyxidia, like those of our new species, have a very small flat infracalycary zone (2–3 cm. in diameter), a conspicuous calycary ridge with thickened calyx-lobes, a spreading interzonal band 2-3 cm. high and 5–6.5 cm. in diameter at the much-thickened apex, and a convex operculum 1.5–2 cm. high and up to 6 cm. in diameter. The pericarp is 5–10 mm. thick, and the number of locules varies from 1 to 4, being 3 or 4 in the largest fruits. These pyxidia are essentially similar to those of the new species in proportions, being quite different from those of *E. subglandulosa* and *E. trinitensis*.

It is a pleasure to dedicate this species to Mr. N. Y. Sandwith, of the Royal Botanic Gardens, Kew, in recognition of his valuable work on the flora of Trinidad and Tobago and his interest in the Lecythidaceae.

Eschweilera Sandwithiana is a medium-sized evergreen tree up to 25 m. in height, but usually smaller, with a trunk up to 60 cm. in diameter or occasionally more. The trunk is short, heavily buttressed, and branching low down or with abundant epicormics. The bark is about 1 cm. thick, soft, black, fibrous, and stringy, with a yellowish blaze. The wood is tough, white, of medium hardness, and reputedly of very poor durability. It is never cut for timber owing to its bad reputation.

"Devilwood" is an abundant tree in two of the three types of rain-forest occurring in Tobago (see Beard in Ecol. Monogr. 14: 135–163. 1944; in that paper the Tobago "devilwood" was discussed as *E. decolorans* Sandwith). It is abundant in rain-forest of the *Carapa-Andira* association and in lower montane rain-forest of the *Byrsonima-Licania* association, but it is absent from the xerophytic rain-forest of the *Manilkara-Guettarda* association, which occurs on igneous soil.

TABLE 3.

NUMERICAL OCCURRENCE OF ESCHWEILERA SANDWITHIANA IN FOREST TYPES IN TOBAGO; INDIVIDUALS PER 100 ACRES

Association	Number of trees in girth classes (girth in feet)										
	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	over 10	Totals
Carapa-Andira	100	180	320	140	120	120	40	40	—	—	1060
Byrsonima-Licania	170	230	220	120	40	80	10	20	—	10	900

Eschweilera Sandwithiana ranks fourth in numbers among the dominants in both associations and forms 7% of the total number of trees over 1 ft. in girth in both cases. In the *Carapa-Andira* association its principal associates are *Carapa guianensis* Aubl., *Andira inermis* (Wright) H. B. K., *Hieronyma caribaea* Urban, *Virola surinamensis* (Rol.) Warb., *Euterpe* sp., and *Tresanthera pauciflora* (Solereder) K. Schum. In the *Byrsonima-Licania* association there are *Byrsonima spicata* (Cav.) L. C. Rich., *Licania biglandulosa* Griseb., *Ternstroemia oligostemon* Krug & Urban, *Sloanea trinitensis* Sandwith, *Euterpe* sp., and *Hirtella racemosa* Lam.

The two forest types in which the Tobago *Eschweilera* is found occur on the deep red to yellow clays developed over the schist formation. These are fairly permeable, well-drained, moisture-retentive soils with abundant root-room. The two types are differentiated by altitude, the *Carapa-Andira* association being the taller and more luxuriant, occurring at the lower levels (120–360 m.) and in more sheltered positions. The *Byrsonima-Licania* association ranges from 360 to 580 m. and is more exposed to strong winds. "Devilwood" avoids the shallow gray soil developed over the igneous formation, which lacks root-room and is physiologically dry. Rainfall of the area is probably 2500 to 3700 mm. annually, without any effective dry season.

GENERAL NOTES

Eschweilera subglandulosa is quite distinct from the other three species discussed, all of which are evidently closely related; it is a tree of the lowlands, with a hard brittle bark and heavy durable timber. This species is also known from Guiana and it has probably arrived in Trinidad since the Pleistocene by migration from that direction. The other three species are trees of montane forests; they have a soft stringy bark and timber of poor quality. One (*E. Sandwithiana*) is endemic to Tobago, another (*E.* sp.) to Trinidad, and the third (*E. trinitensis*) probably to Trinidad and the Paria Peninsula of Venezuela. These three are evidently derived from a flora of an ancient Parian land-mass which formerly united all the ranges in the system, now separated by sea. The flora of Tobago indicates continental origin, with isolation for a fairly long period. Probably all three of these *Eschweilerae* are to be considered as derivatives of a single population in the Parian flora.

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PRIORITY OF THE SPECIES PSIDIUM CATTLEIANUM SABINE

C. A. Schroeder

The name *Psidium cattleianum* Sabine (3) has been used for many years for the species. Recently the specific name *P. littorale* Raddi was adopted by Merrill and Perry (1), who gave priority to Raddi's publication (2), based on the following evidence: "In checking the synonymy of *Psidium Cattleianum* Sabine, the name by which this species is best known, we found that *Psidium littorale* Raddi is apparently the earlier specific epithet. The fascicle in which the description and plate of the latter appears was published separately in 1820, although the date of publication is usually cited as 1823. This is the date of the title page of volume 4 complete, but when fascicle-covers are in the volume, these are to be regarded as indicating the actual date of publication rather than the title-page. We have not been so fortunate as to find any record of the publication of Sabine's name before the year 1821." Upon this evidence *P. littorale* Raddi appears as the accepted name in Standardized Plant Names (1942 edition) and thus has been circulated widely.

The priority of Raddi's description is questioned. The following facts are noted:

1. *Psidium cattleianum* Sabine occurs in Transactions of the Royal Horticultural Society 4: 316–317, *pl.,* which, according to Stearn (4), was published in May or June, 1821. The fourth volume of the Transactions has the preface-page dated April, 1822, and the cover-page dated 1823.

2. *Psidium littorale* Raddi appears in Opuscoli Scientifici (Bologna) 4 (fasc. 5): 254. The first five fascicles of the volume are dated 1820, the sixth, 1823. The whole volume is dated 1823. On pages 217–219 is included a letter dated February 8, 1821, which vitiates the 1820 publication date of the whole fifth fascicle. The unreliability of the fascicle-cover dates gives some reason for considering the publication date of fascicle 5 to be possibly as late as 1823. Furthermore, the same fascicle contains another paper (p. 276) which was presented on March 26, 1821. It seems most unlikely that the articles in fascicle 5 could have been set up in type, proofread, printed, and released within the month of April, 1821, which is the only month definitely unaccounted for in the period under consideration.

The conclusion drawn from the above evidence is that Raddi's description is not fully demonstrated to be of earlier date than Sabine's. Since *P. cattleianum* can be dated rather definitely and is probably earlier, it should be used in preference to *P. littorale*. The writer is indebted to staff-members of the Arnold Arboretum, and especially to Dr. L. Croizat, for checking the critical bibliographic references.

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2. Raddi, G. Di alcune species di Pero Indiana (*Psidium* Lin.). Opuscoli Scientifici **4**: 251–255. 1823.
3. Sabine, J. Account of a new *Psidium*. Trans. (Roy.) Hort. Soc. **4**: 316–317. 1822.
4. Stearn, W. T. A supplementary catalogue of papers on the dates of publication of botanical books, p. 4. 1940 (manuscript unpublished).

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NOTES ON SOME CULTIVATED TREES AND SHRUBS, IV

ALFRED REHDER

Salix rigida Mühlenb. f. **purpurascens** (Dieck), comb. nov.

Salix Nicholsonii f. *purpurascens* Dieck, Neuheit. Off. Zöschen, 1899–90: 18 (1889). — [Nicholson in] Kew Hand-list Trees Shrubs, 2: 223 (1896) "var."

Salix cordata var. *rigida* f. *purpurascens* Schneider, Ill. Handb. Laubh. 1: 50 (1904); in Jour. Arnold Arb. 2: 190 (1921). — Rehder, Man. Cult. Trees Shrubs, 116 (1927) "*S. c.* var. *p.*"

Salix cordata × *nigra* var. *purpurascens* Toepffer, Salicet. Exsicc. fasc. v. no. 218 (1910).

In a recent study on American Willows, Fernald has shown (Rhodora, **48**: 28, 31. 1946) that *Salix cordata* Michx. is not the same as *S. cordata* Mühlenb., but is identical with the later *S. adenophylla* Hook., and that the name *S. rigida* Mühlenb. has to be taken up for *S. cordata* Mühlenb., which makes necessary the new combination proposed above. Toepffer considers this form a hybrid of *S. cordata* with *S. nigra*, but there is no indication of any influence of *S. nigra* in this form, and in a pencil note on Toepffer's specimen in the Arnold Arboretum herbarium, Schneider states: "There is no trace of *S. nigra* in it."

Amelanchier stolonifera Wieg. f. **micropetala** (Robins.), comb. nov.

Amelanchier oblongifolia var. *micropetala* Robinson in Rhodora, 10: 33 (1908). — Robinson & Fernald in Gray, Man. Bot. N. U. S., ed. 7, 460 (1908). — Weatherby in Rhodora, 18: 48 (1916). — G. N. Jones, Am. Sp. Amelanchier, 51, 52 (1946), pro syn. sub *A. spicata* (Lam.) K. Koch.

Amelanchier Botryapium var. *micropetala* Farwell in Rep. Michigan Acad. Sci. 17: 176 (1916).

Amelanchier micropetala Ashe in Bull. Torrey Bot. Club, 46: 223 (1919).

Amelanchier canadensis var. *micropetala* Rehder in Jour. Arnold Arb. 26: 71 (1945).

This *Amelanchier*, originally described as *A. oblongifolia* var. *micropetala*, seems most closely related to *A. stolonifera*, with which it agrees in its low stoloniferous habit, shape and pubescence of the leaves, the villous top of the ovary, and in the recurved sepals, but differs chiefly in its narrow small petals. From *A. oblongifolia* (Torr. & Gray) Roemer (= *A. canadensis* (L.) Med.), under which it was originally placed, it differs besides in its narrow petals, in the low stoloniferous habit, the broader leaves, the villous top of the ovary, and the recurved sepals, while *A. oblongifolia* is an upright shrub to 8 m. tall, forming dense clumps, with narrower generally oblong leaves, with the top of the ovary glabrous or nearly so, and with upright sepals. By G. N. Jones *A. oblongifolia* var. *micropetala* was referred to *A. spicata* (Lam.) K. Koch as a synonym, but this was due to a misinterpretation of Lamarck's *Crataegus spicata*, the basonym of *A. spicata* K. Koch. As Fernald has shown in a recent paper, "Amelanchier spicata not an American species" (in Rhodora, **48**: 125–135.

1946), Lamarck's description of *Crataegus spicata* was based on a plant growing in the Paris Botanic Garden and also in other gardens, and supposed to have been introduced from Canada. In its main characters it agrees with the European *A. ovalis* Med., but shows the influence of an American species and is very likely a hybrid of *A. ovalis* with *A. canadensis* (L.) Med. which was at Lamarck's time already established in European gardens, having been introduced before the middle of the seventeenth century.

Pyrus Cossonii, nom. nov.

Pyrus longipes Cosson & Durieu in Bull. Soc. Bot. France, **2**: 310 (1855). — Trabut in Bull. Stat. Recherch. For. N. Afr. **1**: 116, *fig. 1, t. 4* (Poir. Indig. Afr.) (1916) "*Pirus*." — Non Poiteau & Turpin [1808].

Malus longipes Wenzig in Jahrb. Bot. Gard. Mus. Berlin, **2**: 292 (1883).

Pyrus macropoda Rehder in Jour. Arnold Arb. **27**: 170 (1946), non A. Savatier (1882).

In the last number of this Journal (p. 170) I proposed a new name for *Pyrus longipes* Cosson & Durieu, which was invalidated by the earlier homonym *P. longipes* Poiteau & Turpin [1808], and chose the epithet "*macropoda*" for it. Unfortunately I had overlooked the fact that for this binomial there also exists an older homonym, namely *P. macropoda* A. Savatier in Compt. Rend. Assoc. Franc. Avanc. Sci. **11** (Rochelle, 1882): 428, *fig. 87* (1883). Like *P. longipes* Poit. & Turp., the name was based on a pomological variety of *P. communis*, but since it was validly published as a binomial with a description and a figure, it cannot be rejected. Being a name without botanical significance or interest, it has apparently never been mentioned in botanical publications, and though listed in Index Kewensis, it did not appear in the main alphabetical arrangement, but in one of the supplementary additions which are easily overlooked. Among the new names proposed by A. Savatier, I also noticed a homonym which invalidates *P. rufa* Nakai (1935) and two others, namely *P. tomentosa* and *P. canescens*, which are invalidated by earlier homonyms, the former by *P. tomentosa* Moench and the latter by *P. canescens* Spach.

Rosa Harisonii Rivers var. **Vorbergii** (*R. foetida* × *spinosissima*), comb. nov.

Rosa pimpinellifolia × *lutea* Ascherson & Graebner, Syn. Mitteleur. Fl. **6, 1**: 313 (1902).

Rosa Vorbergii Graebner ex Späth, [Kat.] no. **167**: 71 (1915) an prius?; nom. subnud. — Mütze in Gartenschönh. **4**: 102, *fig.* (1923) "*Vorbergi*"; nom. subnud. — Rehder in Man. Cult. Trees Shrubs, ed. 2, 432 (1940), pro syn.

As *Rosa Vorbergii* is a hybrid between the same species as *R. Harisonii* (*R. foetida* × *spinosissima*) it should be classed under the same binomial, but distinguished as a form or variety, since it differs markedly from the original *R. Harisonii* of 1837. It is nearer to *R. spinosissima* than typical *R. Harisonii*; the branchlets are more bristly and with less strong prickles, the sepals and the receptacle are without prickles, and the flowers are single, not double nor semi-double. In the herbarium of the Arnold Arboretum, it is represented by specimens from Spaeth's nursery, from the nursery of Simon-Louis at Plantières near Metz, and by specimens raised at the Arnold Arboretum from seed received in 1926 from the Botanic Garden at Glasnevin.

Prunus dasycarpa f. **persicaefolia** (Loisel.), comb. nov.

Armeniaca persicaefolia Poiteau & Turpin in Duhamel, Traité Arb. Fruit. nouv. éd., 1: *A*. no. 10; p. 19*, *t. 19* [bis], fasc. 4 [1807]. — Poiteau, Pomol. Franc. 1: *A*. no. *9*; p. 160*, *t. 19* [bis], (18 [38–] 46). — K. Koch, Dendr. 1: 89 (1869) "*persicifolia*," pro syn.

Armeniaca atropurpurea β. *Armeniaca persicaefolia* Loiseleur in Duhamel, Traité Arb. Arbust. éd. augm. [Nouv. Duhamel] 5: 172, *t. 52, fig. 1* [1812]. — K. Koch, Dendr. 1: 89 (1869).

Armeniaca dasycarpa β. ? *persicifolia* Seringe in De Candolle, Prodr. 2: 532 (1825), p. p. typ.

Prunus Armenica (f.) *persicifolia* (Loisel.) Zabel in Beissner et al., Handb. Laubh.-Ben. 253 (1903).

This peculiar form with lanceolate, coarsely dentate leaves seems rare in cultivation. In the herbarium of the Arnold Arboretum, it is represented by a single specimen collected by C. K. Schneider in 1903 in the nursery of Simon-Louis at Plantières near Metz. This specimen resembles the plant figured as *Armeniaca persicaefolia* by Poiteau & Turpin (l. c.). The form figured by Loiseleur as *Armeniaca atropurpurea* β. *Armeniaca persicaefolia* (l. c.) has the leaves much more irregular and more or less deeply lobed; the specimen figured has both normal leaves and narrow lobed leaves on different shoots of the same branch.

Laburnum anagyroides Med. f. **serotinum** (Bosse), comb. nov.

Cytisus laburnum var. f. *serotinus* Bosse, Vollst. Handb. Blumengärt. ed. 2, 1: 645 (1840).

Laburnum vulgare autumnale K. Koch in Wochenschr. Ver. Beförd. Gartenb. Preuss. 2: 405 (1859).

Cytisus Laburnum 3b. *auctumnalis* Kuntze, Taschen-Fl. Leipzig, 277 (1867).

Laburnum vulgare var. *bifera* Lavallée, Arb. Segrez. 59 (1877).

Laburnum tardiflorum Hort. ex May in Rev. Hort. 1878: 120 (1878).

Laburnum vulgare f. *autumnale* Voss, Vilmor. Blumengärt. 1: 198 [1894].

Laburnum laburnum B. *serotinum* Ascherson & Graebner, Syn. Mitteleur. Fl. 6, *2*: 273 (1907).

Laburnum vulgare var. *semperflorens* Bean, Trees Shrubs Brit. Isl. 2: 4 (1914).

Laburnum anagyroides var. *autumnale* Rehder in Bailey, Stand. Cycl. Hort. 4: 1763 (1916).

The oldest epithet of this form has apparently been overlooked by later authors who dealt with varieties and forms of this species. Ascherson & Graebner, who published in 1907 the combination *Laburnum laburnum* B. *serotinum*, proposed the varietal epithet as a new name without any synonymy at all.

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STUDIES OF PACIFIC ISLAND PLANTS, V
NEW AND NOTEWORTHY FLOWERING PLANTS FROM FIJI

A. C. Smith

The following notes, based for the most part upon specimens recently collected by Mr. William Greenwood, include descriptions of three new species. The genera *Pterocymbium* and *Amaracarpus*, both represented by new species, are here first reported from Fiji. Cited specimens are deposited at the Arnold Arboretum (A), Gray Herbarium (GH), and New York Botanical Garden (NY).

PIPERACEAE

Piper crispatum A. C. Sm. in Jour. Arnold Arb. **24:** 354. 1943.

Viti Levu: Lautoka: Mt. Evans, alt. about 1050 m., *Greenwood 1145* (A) (climbing on trees in dense forest; leaves pubescent).

This species has otherwise been known only from the type collection, which was without definite locality. The Greenwood specimen, although sterile, agrees precisely in habit and foliage with the type.

URTICACEAE

Elatostema (§ *Euelatostema*) **Greenwoodii** sp. nov.

Frutex vel herba suffruticosa ad 1.5 m. alta, ramulis juventute angulatis strigosis demum subteretibus glabrescentibus; foliis alternatis, petiolis inconspicuis ad 2.5 mm. longis vel subnullis pallide strigosis, laminis papyraceis in sicco viridibus oblongo-lanceolatis, 5–9 cm. longis, 1.2–2.5 cm. latis, basi inaequilateraliter obtusis, apice gradatim acuminatis, margine dentibus obtusis 1 vel 2 per centimetrum grosse serratis, supra cystolithis confertis linearibus 0.2–0.3 mm. longis ornatis et pilis pallidis ad 1 mm. longis disperse strigosis vel glabris, subtus ad nervos hispido-strigosis et interdum cystolithis paucis ornatis, pinnatinerviis, costa supra paullo subtus valde elevata, nervis lateralibus utrinsecus 5–8 adscendentibus supra planis subtus prominulis, venulis immersis; stipulis submembranaceis lanceolatis 5–9 mm. longis acuminatis dorso strigosis mox caducis; receptaculis ♂ solis visis sessilibus 5–8 mm. diametro, bracteis exterioribus plerumque 6 submembranaceis late ovatis, basi connatis, distaliter liberis, apice acumine 1–1.5 mm. longo corniculatis, extus strigoso-puberulis; bracteis interioribus et bracteolis oblongo- vel lineari-obovatis, 1.7–2 mm. longis, latitudine variis (0.5–2.5 mm.), extus minute strigosis, latioribus apice emarginatis; pedicellis sub anthesi circiter 1 mm. longis, perianthii segmentis 4 oblongis circiter 1.5 mm. longis, apicem versus calcare circiter 0.4 mm. longo corniculatis, filamentis sub anthesi subnullis demum ad 0.8 mm. longis, antheris circiter 0.6 mm. longis.

Viti Levu: Lautoka: Mt. Evans, alt. about 900 m., *Greenwood 1083* (A, type), Sept. 24, 1944 (shrub, up to 5 ft. high, in thick forest; flower-heads white).

From *E. fruticosum* Gibbs, with which it agrees in habit and in the conspicuous straight linear cystoliths of its upper leaf-surface, *E. Greenwoodii* differs in its shorter-petiolate and much narrower leaf-blades, smaller staminate receptacles, and smaller bracteoles and stamens. In its leaf-shape, the new species more nearly resembles *E. tenellum* A. C. Sm. and *E. humile* A. C. Sm., from both of which it differs in its shrubby habit, the comparatively long straight cystoliths of its upper leaf-surface, and in details of foliage, bracteoles, and perianths.

MELIACEAE

Aglaia Parksii A. C. Sm. in Bull. Torrey Bot. Club 70: 542. 1943.

VITI LEVU: Naitasiri: Near Nasinu, *Greenwood 1136* (A) (tree 6 m. high, with rusty-pubescent inflorescence).

The cited specimen is the second collection of the species thus far known and was obtained in the vicinity of the type-locality. In vegetative features the two collections agree perfectly; the Greenwood plant has the leaflets 9 or 11 in number. The present collection bears young inflorescences, from which it is apparent that considerable variation in size of inflorescence is to be anticipated. The panicles of our plant are comparatively ample, up to 13 cm. long and 10 cm. broad, freely branched, and many-flowered. The flower-buds are too immature to permit careful observation.

STERCULIACEAE

Pterocymbium oceanicum sp. nov.

Arbor ad 22 m. alta, foliis ante anthesin deciduis, ramulis robustis glabris teretibus superne 4–5 mm. diametro, cortice in sicco pallido valde ruguloso; foliis ad apicem ramulorum confertis ubique glabris vel subtus disperse et minutissime pallido-stellato-pilosis, petiolis subteretibus 5.5–7.5 cm. longis basi et apice leviter incrassatis, laminis siccitate viridibus chartaceis ovatis, 10–15 cm. longis, 7–11 cm. latis, basi valde cordatis, apice obtusis vel obtuse cuspidatis, margine integris, e basi 7(vel inconspicue 9-)-nerviis, costa et nervis principalibus supra elevatis subtus prominentibus, nervis lateralibus e costa utrinsecus 3–5 leviter curvatis, rete venularum intricato utrinque prominulo; floribus delapsis tantum visis, pedicellis glabris teretibus supra articulationem 6–7 mm. longis; calyce tenuiter carnoso obconico-campanulato 20–25 mm. longo, apice ad 15 mm. diametro, extus glabro intus sparse et molliter pallido-piloso, lobis 5 oblongo-deltoideis acutis sub anthesi recurvatis, 8–9 mm. longis, 5–6 mm. latis; columna circiter 25 mm. longa uniformiter et breviter pilosa; staminibus 15 simplici seriei dispositis, filamentis subconnatis circiter 1.5 mm. longis extus sparse pilosis intus glabris, antheris oblongis 2–2.5 mm. longis; carpellis 5 leviter cohaerentibus copiose puberulis, ovario dorso gibboso sub anthesi circiter 1 mm. longo, stylis circiter 1.5 mm. longis superne contractis, stigmatibus pallidis reflexis circiter 0.3 mm. longis; folliculis plerumque 5 immaturis stipite copiose puberulo ad 8 mm. longo incluso ad 5 cm. longis membranaceis ubique puberulis, lobo dorsali rotundato, semine non viso.

VITI LEVU: Lautoka: Mountains near Lautoka, alt. 550–600 m., *Greenwood 1082* (A, TYPE), Sept. 24, 1944, and Aug. 18, 1945 (tree 50–75 ft. high, with wide-spreading branches; leaves clustered at ends of branchlets and light green, deciduous in August; calyx yellow-green without, red-brown within).

This remarkable discovery, which extends the known range of the genus eastward from New Guinea and the Bismarck Archipelago, was first collected by Mr. Greenwood in 1944, at which time fallen flowers and leaves were obtained. The same tree was visited in 1945 and foliage-branchlets were collected. Mature fruits are not yet available.

The new species is characterized by its entire leaves, which are clustered at the ends of branchlets, by its comparatively large calyx, which is pilose within, and by its puberulent follicles. It is perhaps more closely related to *P. viridiflorum* Teijs. & Binn., of Celebes, than to any Papuasian species, but that species is said to have glabrous follicles; other minor characters further distinguish the Fijian entity.

APOCYNACEAE

Alyxia linearifolia A. C. Sm. in Sargentia 1: 107. *fig. 5.* 1942.

VITI LEVU: Lautoka: Mt. Evans, alt. about 950 m., *Greenwood 1065* (A) (shrub 3 m. high, on ridge in thick forest; flowers pale yellow).

The cited specimen is the second collection of the species, the type having been from Ra, Viti Levu, at lower elevation. The Greenwood specimen is from a shrub, whereas the type is said to have been from a liana; furthermore, the leaves of the Greenwood specimen are in twos or threes, whereas those of the type are most often in fours, although some ternate or paired leaves are discernible also on the original specimen. In spite of these differences, the two specimens are fundamentally alike, and the species is instantly recognizable.

RUBIACEAE

Amaracarpus musciferus sp. nov.

Frutex compactus multiramosus dense foliatus 1–2 m. altus, ramulis ultimis purpurascentibus teretibus gracilibus apicem versus 0.5–0.8 mm. diametro pilos pallidos pluricellulares hispidulos circiter 0.2 mm. longos copiose gerentibus, ramulis vestustioribus brunnescentibus glabratis cortice ruguloso; stipulis interpetiolaribus membranaceis purpurascentibus primo lateraliter connatis mox caducis subcalyptratis, oblongo-lanceolatis, circiter 2.5 mm. longis et 1.5 mm. latis, apice obtusis, extus ut ramulis juvenilibus sparse hispidulis; foliis glabris, petiolis minutis ad 1 mm. longis gracilibus teretibus, laminis papyraceis obovato-ellipticis, 5–7 mm. longis, 3–3.7 mm. latis, basi acutis et in petiolum minute decurrentibus, apice obtusis, margine integris et paullo incrassatis, costa supra subplana subtus elevata, nervis secundariis utrinsecus 3–5 patentibus obscuris nervo intramarginali obscure conjunctis supra immersis subtus leviter prominulis; floribus minutis ubique glabris apice ramulorum brevium ultimorum terminalibus, sessilibus, solitariis vel binis; calyce purpurascente obconico 2.5–2.8 mm. longo, tubo gracili, limbo submembranaceo erecto quam tubo paullo longiore apice circiter 1.5 mm. diametro irregulariter 4- vel 5-lobato, lobis deltoideis vel apiculatis 0.2–0.5 mm. longis; disco conspicuo pallido pulvinato circiter 0.7 mm. alto et diametro; corolla infundibuliformi in alabastro 2.5 mm. longa, tubo immaturo 0.8–1 mm. longo, lobis 4 crasso-carnosis erectis oblongis in alabastro incurvatis circiter 1.5 $\times$ 1 mm.; staminibus 4, antheris sessilibus circiter 1 mm. longis crassis circiter 0.5 mm. diametro; stylo in alabastro circiter 1 mm. longo, stigmate minute bilobato; fructibus solitariis ovoideo-ellipsoideis 4-angulatis, ad 6.5 mm. longis (calycis limbo persistente excluso) et 4.3 mm. latis, utrinque angustatis, pyrenis ad 6 $\times$ 4 mm. semi-ovoideis utrinque subacutis, dorso conspicue 1-costatis, ventre plano levi.

VANUA LEVU: Mbua: Navotuvotu, summit of Mt. Seatura, alt. 830 m., *Smith 1646* (GH TYPE, NY, etc.), April 27, 1934 (gnarled shrub 1–2 m. high, in dense forest; fruit red).

In its sessile terminal flowers and fruits, as well as in its microphyllous habit, the entity described above appears definitely to belong in *Amaracarpus* Bl., which otherwise has not been recorded in Melanesia east of the Solomons. The species of *Amaracarpus* thus far known from the Solomons and from Micronesia are not closely related to the Fijian species, which shows a close affinity with certain small-leaved New Guinean species. The simple unawned stipules, the completely glabrous corolla, and the intramarginal nerve of the leaf are noteworthy characters of the Fijian plant. The specific epithet refers to the fact that the type-plant was a host to numerous bryophytes.

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SOME ADDITIONAL RECORDS FOR THE GUAM FLORA

E. D. Merrill and L. M. Perry

In the process of determining some 300 numbers sent for identification by S. F. Glassman, formerly in the Navy Medical Reserve, we have found the following species apparently new for Guam. Of the genera herein recorded, 12 appear for the first time in the flora of the island, eight are introduced, and four are native.

GRAMINEAE

Oplismenus undulatifolius (Ard.) Roem. & Schult. Syst. Veg. **2**: 482. 1817.

Panicum undulatifolium Ard. Animad. Spec. Alt. 14. 1764.

Guam: Mount Lamlam, *Glassman 249*, Jan. 1946, alt. about 300 m., near spring.

Tropical regions of the Eastern Hemisphere.

Pennisetum polystachyum (Linn.) Schult. Mant. **2**: 146. 1824.

Panicum polystachyum (as *polystachyion*) Linn. Syst. Nat. ed. 10, **2**: 870. 1759.

Guam: Outskirts of Barrigada, *Glassman 305*, Nov. 1945, along road shoulder (det. A. Chase).

Probably a native of tropical Africa and India; introduced into Polynesia. According to Mrs. Chase, this plant is an Old World annual, not to be confused with the wholly American perennial plant, *P. setosum* (Sw.) Rich.; the panicles of the latter are characterized by more numerous plumose bristles than those of the Old World species.

Andropogon fragilis R. Br. Prodr. **1**: 202. 1810.

Guam: Mount Tenjo, *Glassman 270*, Jan. 1946, alt. about 240 m., open grassland.

By some workers considered as a variety of *A. brevifolius* Sw., and perhaps previously reported as this species.

Chloris inflata Link, Enum. Hort. Berol. **1**: 105. 1821.

Guam: East of Barrigada, *Glassman 298,* Nov. 1945, open field.

Native of tropical America, now widespread in both hemispheres. Link's name is the oldest valid one for what was long known as *Chloris barbata* Sw.; *C. paraguayensis* Steud. is a synonym. See Hitchcock, Man. Grasses W. I. 133. 1936.

Setaria verticillata (Linn.) Beauv. Agrost. 51. 1812.

Panicum verticillatum Linn. Sp. Pl. ed. 2, **1**: 82. 1762.

Guam: East of Barrigada, *Glassman 297*, Nov. 1945, open field.

Widespread weed.

COMMELINACEAE

Rhoeo discolor (L'Hérit.) Hance in Walpers, Ann. **3**: 660. 1853.

Tradescantia discolor L'Hérit. Sert. Angl. 5. *t. 12.* 1788.

Guam: Alupat Island, *Glassman 230*, May 1945, along strand in sand.

Native in Mexico. Introduced in various Polynesian Islands and the Philippines.

PONTEDERIACEAE

Eichhornia crassipes (Mart. & Zucc.) Solms-Laubach in DC. Monog. Phan. 4: 527. 1883.

Pontederia crassipes Martius & Zuccarini, Nov. Gen. et Sp. Pl. Bras. 1: 9. *t. 4.* 1823.

GUAM: Northeast corner of Agaña marsh, *Glassman 121*, May 1945, in small river.

Native in the subtropics of the Americas. Introduced in the Old World tropics.

ORCHIDACEAE

Eria rostriflora Reichenb. fil. in Seem. Fl. Vit. 301. 1868.

GUAM: Vicinity of Mount Lamlam, *Glassman 234*, January 1946, epiphytic on breadfruit tree (det. C. Schweinfurth).

Society Islands (Tahiti); Fiji.

MORACEAE

Pseudomorus Brunoniana (Endl.) Bur. in Ann. Sci. Nat. V. 11: 372. 1869.

Morus Brunoniana Endl. Atakta Bot. *t. 32.* 1835.

GUAM: Oca Point, *Glassman 204*, April 1945, in woods near cliffs.

Widespread in Polynesia, Australia, and New Guinea. Previously reported from Saipan and Rota in the Marianas.

LEGUMINOSAE

Calopogonium mucunoides Desv. in Ann. Sci. Nat. I. 9: 423. 1826; Amshoff in Pulle, Fl. Suriname 2(2): 196. 1939.

GUAM: Vicinity of Piti, *Glassman 309*, Nov. 1945, ope . field, abundant (det. I. M. Johnston).

Native of tropical America; introduced into tropical Africa and Asia (fide Amshoff).

ICACINACEAE

Merrilliodendron rotense Kanehira, Bot. Mag. Tokyo 48: 920. *f. 7.* 1934.

GUAM: Foot of Mount Tenjo, *Glassman 240*, shrub at edge of woods.

This species has previously been reported from Rota. Sleumer, Notizbl. Bot. Gart. Berlin 15: 243. 1940, has reduced all the known material of the genus to one species, *M. megacarpum* (Hemsley) Sleumer, but until more material is available for examination, we believe the species should be held distinct. The Philippine collection may be identical with the material from San Cristoval, as far as we can tell by comparing Hooker's plate with Elmer's specimen. The leaves are oblong-elliptic and shortly acuminate. Those of the Guam collection are smaller and ovate-elliptic, acute or acuminate, the lateral nerves depart from the costa at a narrower angle, and the style is much more slender.

ELAEOCARPACEAE

Muntingia Calabura Linn. Sp. Pl. 509. 1753.

GUAM: Vicinity of Agaña, *Glassman 115, 285*, in fields.

Native in the region from Mexico to the Amazon; introduced in Siam, Java, the Philippines, and Hawaii.

PASSIFLORACEAE

Passiflora foetida Linn. var. **hispida** (DC.) Killip, Bull. Torr. Bot. Club 58: 408. 1931; A. C. Smith, Sargentia 1: 65. 1942.

GUAM: Oca Point, *Glassman 64*, open field; Soupon Point, *Glassman 105*, open field; Mount Santa Rosa, *Glassman 160*, open field.

A widespread weed, not previously reported from Guam.

LOGANIACEAE

Fagraea Sair Gilg & Benedict, Bot. Jahrb. 56: 555. *f. 3.* 1921; Kanehira, Enum. Micrones. Pl. 391. 1935.

GUAM: Vicinity of Mount Lamlam, *Glassman 233*, Jan. 1946.

Previously reported from Ponape, Kusai, and Truk.

LABIATAE

Hyptis mutabilis (A. Rich.) Briq. Bull. Herb. Boiss. 4: 788. 1896.

Nepeta mutabilis A. Rich. Act. Soc. Hist. Nat. Paris 1: 110. 1792.

GUAM: Oca Point, *Glassman 26*, Feb. 1945, jungle clearing.

Possibly *Glassman 40* also belongs here; the specimen is very immature; the calyx-lobes in the flower-bud do not appear to be quite so long as those of most collections of this species, and the inflorescence is not so open; apart from these differences the plant seems to match *H. mutabilis* (A. Rich.) Briq. very well. Like the four other species of *Hyptis* naturalized in the Old World this is a native of tropical America. Its introduction into Guam undoubtedly was through the medium of the Acapulco-Manila galleons previous to 1815.

COMPOSITAE

Emilia sonchifolia (Linn.) DC. Prodr. 6: 302. 1838.

Cacalia sonchifolia Linn. Sp. Pl. 835. 1753.

GUAM: Vicinity of Agaña, *Glassman 116, 292*, May, Nov. 1945, waste field, flowers scarlet; Mount Tenjo, *Glassman 265*, Jan. 1946, alt. about 240 m., open grassland, flowers red.

Widespread in both the Old and the New World.

Sonchus oleraceus Linn. Sp. Pl. 794. 1753.

GUAM: Foot of Mount Tenjo, *Glassman 239*, Jan. 1946, roadside.

Native in the northern part of the Old World. Apparently here recorded for the first time from Guam.

ARNOLD ARBORETUM,
HARVARD UNIVERSITY.

Elmer Drew Merrill

Dedication

To MARK the seventieth birthday of ELMER DREW MERRILL, Arnold Professor of Botany at Harvard, we, his associates on the editorial board of the Journal of the Arnold Arboretum, dedicate this issue to him.

It gives us much pleasure to be able to bring together for presentation to Dr. MERRILL these articles written by a representative few of his botanical friends, many of whom have been closely associated with him during his years at Washington (1899–1902), Manila (1902–23), California (1924–29), New York (1930–35), and Harvard (1935–). Wherever he has served he is known for his contagious enthusiasm, for his boundless energy, and for his helpful friendliness toward all interested in botany.

Noted for his brilliance as a taxonomist, for his genius as a builder of botanical collections, and for his inspired study of the flora of the Pacific, Dr. MERRILL has made a distinguished contribution to his chosen field.

OCTOBER 15, 1946.

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ON THE DISPERSAL OF THE PLANTS MOST INTIMATE TO BUDDHISM

I. H. Burkill

A faith that forbad digging was ill-equipped to advance horticulture: such was primitive Buddhism. But from among plants which were already dear in cultivation it took a few for its own venerations and exercised an influence in their dispersal. It is with these few that this paper deals. As the subject is near the extreme bounds of horticulture it is well at the outset to remind the reader when and where the possible influence on horticulture by Buddhism originated.

The religious philosopher and founder of Buddhism, Siddhattha, son of a Sakya prince and Māyā, one of the prince's two wives, called from his parentage Sakyamuni or the recluse of the Sakyas, of the clan Gotama (Pali) or Gautama (Sanskrit), enlightened teacher and therefore called buddha, was born about the year 567 B. C. Of the several ways of naming him, the best is by his clan as he would have been addressed in life; he is the Buddha Gautama and when so named cannot be confused with the many hypothetical buddhas of the religion. By that name I shall call him. In his late twenties, as the Pali text expresses it, "going from house to houselessness," he crossed the Gangetic plains from his birthplace under the Himalaya of Nepal to Rājagaha, now Rājgir, where low hills rise that have become honeycombed with hermit cells; then he moved a little farther south to the place now known as Bōdh Gayā, and there, after eight years of meditation, an understanding came to him as he sat in the shade of a tree of *Ficus religiosa*. The assumed date is 528 B. C. Thenceforward he was a missioner crossing and recrossing the plains between Rājagaha and the Himalaya until his death in old age about 487 B. C. (cf. for the establishment of these dates, Vincent Smith, Early Hist. Ind., ed. 4, p. 49, 1924, or other editions). The whole of his preaching had been within the limits of the two kingdoms of Kosala and Magadha, say between the longitude of Lucknow and the breaking up of the Ganges into its delta; and all the plants that the faith associated with him should have been familiar within that area at that time.

The language in use was Pali, which was superseding Vedic, to be superseded itself later by Sanskrit. The upper Gangetic plains were completely aryanized; but where Gautama preached the aryanization was incomplete. It is obvious that the pre-aryan population possessed a considerable agriculture, but of its nature we know nothing save that it cannot have been despicable. Indirect evidence suggests that the land enjoyed a prosperity which aided Gautama in withdrawing from Brahmanism a sect of itinerant missioners entirely dependent on what the land had to spare. These missioners, when the annual Rainy Season immobilized them, as the oldest rules of the Faith show that it did, gathered in groups to edify and teach each other; and in that way they handed down by word of mouth the whole of their beliefs, the philosophy behind them, and the sermons supporting them. They continued to do so until an off-shoot priesthood in far-away Ceylon, in fear that the human chain would be broken, in troublous times in the 3rd century B. C., began piously to commit to palm-leaf books their vast memorized store. Ecstatic minds had spread unevenly over the kernel an inevitable incrustation; and the incredible in the records casts a shadow of suspicion that the background on which one would like to rely may be the background of the time of writing rather than the background of Gautama's day. The Buddhist monuments do not help, for they belong more or less to the time of the writing and are therefore suspect in the same way. Some little light comes from Brahmanistic literature.

Of all plants the Sacred Lotus, *Nelumbium Nelumbo* (L.) Druce, entered deepest into the religion; and it seems good to consider it first. Lotus it should not be called, but Sacred Lotus. This beautiful water-lily grows naturally in a belt across Asia from the delta of the Volga to Japan and, southwards of the belt, through India, China, the Indo-Chinese countries, and Malaysia to New Guinea and northern Australia. It requires still water, the temperature of which rises in summer to 80–95° F.; winter temperatures which freeze the water above it do not hurt it. In fact it is benefited by contrasted seasons. It is intensely light-hungry and therefore shaded waters do not support it, with the consequence that it is absent from wide stretches of the moister tropics, just as it is absent from wide stretches of mountains where there is no still water for it. Man, when he digs hollows for storing water, creates places which may be favourable, but are not necessarily so if the plant cannot get food enough in them. Its several limitations cause its natural distribution to be patchy, but leave it easy to cultivate.

The Aryans must have known it before they pressed south and east, round the mountains of Afghanistan into the Indus plains. This was before 2000 B. C. Their worship included Sun-worship and they seem to have linked *Nelumbium* with sun-rise, just as the Egyptians linked the blue water-lily of their swamps. But the Aryans' dawn-flower was rose-pink like the dawn-flower of the Greeks. *Nelumbium* possesses several appropriate characters in addition to the suggestiveness of its colour; it opens, often very abruptly, at dawn, and like the Egyptian Water-lily it possesses that property most naturally important in Sun-worship of rising into the air from a void of waters. Moreover it is very beautiful: cannot dawn be very beautiful in clear more or less desert skies!

The reason for holding that the Aryans gave the Sacred Lotus a place in their Sun-worship is that their descendants, when they had settled in India and their priestly observances came to be recorded in the Rigveda, showed that they kept the connection, making the flower the eye of a personified Sun and garlanding with it certain horsemen, the Asvins, sons of the Sun, betrothed to the personified Dawn. The connection with the birth of the Day passed into making its pretty cup a birthplace in general, — for the beautiful goddess Lakshmi in Brahmanism and for all good occasions in Buddhism; and today fairies are born in the flowers in the folk tales of more than one country in the East.

The Vedic name "pushkara," which is used in the Rigveda, has a connection by its meaning with the edibility of the rhizome. It yielded place to the Pali "padma"; it is questionable why, but it may have been that the utility expressed in the word "pushkara" brought it about, just as in German "See-rose" has displaced the old High German "Kolerwurtze"; — this is utility displaced by the aesthetic. Furthermore it may be added that in Sanskrit the word "padmaka" appeared by the side of "padma" as a name for the rhizome, having the meaning of "belonging to padma," i. e. the rhizome was put in second place.

At the time of Gautama it cannot have been otherwise than that his compatriots, ready enough to eat the rhizomes and seeds and to use the leaves as platters, loved the plant very particularly for its beautiful flowers. It was honorific to present all pretty flowers in homage but especially its flowers, to seat a ruler on a seat carved as the flower (a "padmasana"), and to place august feet on a stool similarly carved. There is a parable in the Jatakas or Birth stories of Buddha (Jātaka no. 261) indicating that it was cultivated to meet a trade in flowers so established as to feed a flower-bazaar; and as this parable introduces the name of Ananda, Gautama's cousin and most faithful disciple, the existence of the trade is claimed for the time of Gautama. It is evident that they who wrote down the story, and dated it thus 300 years or so before the time of their writing, thought there was no anachronism in attributing the trade in the flowers to that time.

The use the followers of Gautama made of the flowers as an honorific was at first that which others who were not his followers made of it. It was a social custom.

In the year 1898, a planter and skilful surveyor, William Claxton Peppé, carefully opened a reliquary mound at the village of Piprāhwā in the Basti District of northern India, close under the Himalaya of Nepal. He unearthed among other deposits a beautifully shaped steatite vase containing undoubted relics of Gautama, and inscribed as the pious foundation of the Sakya brethren with their sisters, children, and wives. The inscription is held to be of the time of the great buddhist emperor, Asoka, suzerain of three-quarters of India from 272 to about 232 B. C.; and therefore there had been a reburial, so that the date of flowers in gold and silver deposited with the relics is to be taken rather as 247 B. C., which is when Asoka made his recorded pilgrimage to the holy places of his faith, than as near 487 B. C., when Gautama died. That this is right two further considerations suggest, namely (a) with the flowers are trisulas and other emblems likely to have been accretionary in the religion after Gautama's death, and (b) similar flowers have been found in monuments of about Asoka's time. Thus the evidence the deposited flowers afford is to be dated 2½ centuries after Gautama's death. The flowers and other associated objects were drawn, as found, by Mrs. Peppé, and her drawings were reproduced on a plate inserted into the *Journal of the Royal Asiatic Society* (1898, opposite p. 579). Peppé, on p. 576, describes them as "ornaments in gold, gold beads, impression of a woman's figure . . . svastika . . . and quantities of stars or flowers both in silver and gold with six or eight petals each." With the identifications of these two kinds of flowers I am immediately concerned, and in the first place with the six-petalled. They may have the petals rounded or pointed, and if rounded they are very well described as like Forget-me-not flowers with one petal too many. Of Indian flowers they exactly resemble those of the Teak tree. But surely Gautama never saw a Teak tree, as he spent his life to the northward of the area in India which the Teak occupies; and his followers had no reason to connect that tree with him. These flowers in precious metals I determine as conventional representations of Sacred Lotus flowers. As to the improbability of their origin being the Teak tree, Watters' association of this tree (which was in Sanskrit called "Sāka") with the Sakya tribe whence Gautama came (Jour. Roy. As. Soc., 1898, p. 570) sent me hunting for myths that might have led to a connection, but altogether without success.

I have mentioned that the flowers in the Piprāhwā find were illustrated from drawings; a similar find of flowers in gold and silver was made at a village called Bhattiprolu in the Kistna District of the Madras Presidency and was illustrated photographically by Alexander Rea in volume 15 of the *Reports of the Archaeological Survey of India* (1894, *pl. 1*). Three vases were found and their contents are shown on this plate; in the first vase were relatively large eight-petalled flowers, along with smaller six-petalled flowers and a few five-petalled; in the second vase were 164 flowers, two-thirds of them six-petalled, most of the rest eight-petalled, and just a few five-petalled; in the third vase with one exception all the flowers were six-petalled. The reader will note that the eight-petalled flowers are as a rule larger than the others; they must have cost more in the market.

Fully 800 miles separate Bhattiprolu from Piprāhwā.

The image of the six-petalled flower is found cut into the stone in the buddhist monuments of Bōdh Gayā, Bharhut, and Sānchi, which stand wide apart across the centre of India. The representations are so alike that if one is accepted as the flower of the Sacred Lotus, all must be; therefore the distribution of the conventional emblem was wide, fully as wide in any direction as the distance of Bhattiprolu from Piprāhwā suggests. At the Bharhut Stupa the flowers are scattered over altars and are mixed with representations of Sacred Lotus flowers in side view which are not conventional at all nor deceptive (for illustrations of them see Sir Alexander Cunningham's "Stupa of Bharhut," 1879, *plates 13, 14, 15, 17,* and *29*). At Bōdh Gayā the flower is represented on a panel as covering a tree; the tree is fenced round, and the fence serves as an identification mark showing that the tree was the sacred bodhi tree under which Gautama attained enlightenment, his *Ficus religiosa*; therefore the flowers are not its own, but honorific Sacred Lotus flowers put over it as garlandings (see Rajendralala Mitra's "Buddha Gaya," 1878, *plate 38*). The same flower fills niches in the design of one of the gates at Sānchi (see Maisey's "Sanchi and its Remains," 1892, *plate xii* and cf. *plate xxvi*; also Foucher and Marshall, "The Monuments of Sanchi," *plate 51b*).

I have given references enough to show how firmly this conventional representation of the flower must have been established, and I feel assured that the reader will consent that the Bharhut and Bōdh Gayā carvings determine what that flower is.

The eight-petalled flower admits of no mistaking. The natural flower is enclosed in four sepals, and petals follow to an uncertain number; the representation of a flower, should it realistically start with four to indicate the sepals, naturally proceeds with another four and thus eight is reached. The followers of Gautama in time connected the number eight in this flower with "the Noble Eightfold Path" from conversion to enlightenment. The simile did not lead to the device, but the device to the simile.

The flower in gold with five petals, which is present in small numbers in the finds, must also have represented the Sacred Lotus, partly on the argument that the departure from realism by which the six-petalled flower was reached was easy of extension to five, and particularly that five-petalled flowers terminate the arms of composite ornaments made up of six-petalled flowers, being set at the ends as smaller.

From the eight-petalled representation of the flower, Buddhist carving, statuary, and pictures increased the number of petals according to available space, usually by four at a time.

The early Buddhists claimed that Gautama on his death-bed had enjoined four pilgrimages. Whether he did or did not is immaterial, seeing that the pilgrimages came into being. The first was to Kopilavastu, near which he was born, and its symbol was the Sacred Lotus flower; the second to Bōdh Gayā, where he obtained enlightenment, and its symbol was the sanctified *Ficus religiosa* under which it occurred; the third to Benares, where he preached his first sermon, and its symbol was the wheel; and the last to Kusinagara, where he died, and its symbol was a funeral mound (see Foucher in Mem. no. 46, Archaeolog. Survey India, 1934). Though the Sacred Lotus belonged in the greatest measure to Kopilavastu, it is clear that it conveyed to the Buddhists ideas so essential as to be an emblem everywhere; and it is evident that pilgrims offered the flowers not only at Kopilavastu but at the shrines generally, not merely the natural flowers which were more often out of season than in season, but gold and silver representations of them as an alternative or an accompaniment.

Why enshrine the gift in this form? Firstly, it was not coin which the brethren were forbidden to accept, although they did when lax. Secondly, the choice of the flower in gold as a means of honouring was established before Gautama's day. For instance, in the Vedic Satapatha Brāhmana it is directed that a king at his coronation should be garlanded with "pushkara"; and in the later, but still Vedic, Sayana and Katyayana it is suggested that the flowers be of gold and the ceremonies protracted over a whole year, i. e. over months when the natural flower could by no means be procured. Naturally, then, the buddhist priesthood valued the combination of honour and alms that the flowers in gold or silver brought to the altars. And this having been stated, the reader will understand why I have been anxious to make the point that five-petalled, six-petalled, and eight-petalled emblems do not represent rival flowers, but the one only, offered in different sizes. The pilgrim who placed his offering on the altar would of necessity take the smaller flower should his purse be too small to admit of the larger, and the artisans who made the flowers, cramped by the need of getting the price down to meet exhausted pockets, seem to have decided that a reduction to six petals brought the cost down without destroying the similitude of the emblem. I see no reason for seeking another explanation and am fully satisfied that the six-petalled and the eight-petalled are not rivals for honour.

The Sacred Tooth at the Temple in Kandy is placed, when on exhibit, in a golden Sacred Lotus flower.

There are so many figures in buddhist sculpture of flowers in vases that we know they were thus placed on altars. Otherwise in ceremonials they were strewn about.

The buddhist monasteries from very early times made fish-ponds in their grounds, not that they might eat the fish, but that the keeping of the fish might be an act of charity. *Nelumbium* likes plenty of manure; the fish provided it; the plants throve and the altars were well supplied with their flowers. It would be an object to raise freely flowering plants, and, as scent was desired, to choose well scented races; but outside the monasteries greater selection was probable from the luxury of sprinkling the flowers over beds, a luxury expressly forbidden to the priesthood. At times white-flowered races met with favour and were assigned as recognition marks to certain saints. It happens that today the strongest scented flowers in European markets are those of a white-flowered race.

When Buddhism travelled beyond the boundaries of India, it carried the name "padma" as an ecclesiastic name to countries where the plant had its established secular name; and so it is that "padma" or "padema" is known in Ceylon beside "nelun," "nelum," and "nelumbu"; in Burma beside "kya"; in Siam beside "bua"; and in Java beside "tarate." Sometimes the secular name, because it covers species of *Nymphaea* as well as *Nelumbium*, needs for precision a distinguishing adjective.

In China the plant has more than one name, which in an interesting way indicate different parts of it. The chief name is "lien"; it is not ecclesiatic, though "pai lien" or "precious lien" is the Sacred Lotus flower held in the hand of the image of Kuan Yin, the divine source of infinite mercy.

Attention may be drawn in passing to what is apparently an ecclesiatic name used in the northern Shan States, where "poh bo" (that is, "bo" flower, apparently for "poh bo-da" or Buddha's flower) is met with in Palaung (see Mrs. Milne's Palaung-English Dictionary, p. 31).

Nelumbium blossoms in northern India in the months of August, September, and October, after which the buddhist altars would be bare of it. Certain Sanskrit names point to substitutes, chief of all to *Hibiscus mutabilis* Linn., which was called "sthala padma" or "land padma." This name persists in use in Bengal in the form "thalpadma." At the same time this pretty flower was "padmavati" and "padma carini" meaning "like padma." It may be assumed that, as a shrub which could be grown in monastery parks, it had its place, and that its pink flowers served as a substitute.

In Monier-Williams' Sanskrit Dictionary two other plants are said to bear the name "padma." He quotes both from Indian lexicons and therefore the dates of their use are not indicated. The first is the dye-plant *Carthamus tinctorius* Linn.; but it would not be a substitute. Its association arose in the colour which it dyes. The other is *Clerodendron siphonanthus* R. Br., more properly named *C. indicum* Kuntze; and here I suspect an error in identification, for *C. siphonanthus* has not the resemblance to the Sacred Lotus which *C. fragrans* Vent. and in a less measure *C. infortunatum* Gaertn. possess. It would seem reasonable to transfer employment at the altar to these two, but not to the first.

The Chinese associate *Hibiscus mutabilis* with Confucius, calling it "fu jong," a name which extends into Cochin-China and Siam as "fu yong." On the other hand the Chinese give the name "fo sang" or Buddha's mulberry to *Hibiscus rosa-sinensis* Linn. The ideograms for "fu" and "fo" are very unlike; but because of the similarity in modern pronunciation it seems right to ask that some sinologue look into the application of the two names.

India, today, regards the "tulsi," *Ocimum sanctum* Linn., with more affectionate veneration than any other plant, giving the second place to *Ficus religiosa* Linn. Buddhists put the latter into the forefront of their faith because Gautama attained enlightenment when, as already stated, meditating under a tree of this species — his bodhi tree: they gave no place to the *Ocimum*. There is a reason for the Indian villager's preference which is not religious; he can and does grow the *Ocimum* at his house door, but as a rule it is out of the question for him to seek space for a tree so umbrageous as the *Ficus*; it is better to let the village have a communal tree, and so it is arranged. There is also a reason for the Buddhist's disregard of *Ocimum*: namely that the faith forbad digging, and *Ocimum*, by demanding a clean-weeded square foot of soil, asks for it. But to take a small branch of the *Ficus* and to thrust it into the soil as a cutting broke no regulation; and it grows.

The reader will observe in reading this paper that with the exception of *Nelumbium*, all the plants named as intimates are woody: they were all suitable for positions in parks, growing in them without particular attention. Moreover, he will note that *Nelumbium* was raised assuredly without any turning over of soil for it. *Ficus religiosa* readily obtained a place in such parks, and, if by a cutting taken from Gautama's own bodhi tree, so much the more valuable the scion raised. From the founder's tree, according to Jātaka no. 479, a cutting was taken with Gautama's consent to Jetavana in Savatti and planted at one of the town's gates; and it is recorded also that in the 3rd century B. C. the park of Mahamegha, near Anuradhapura in Ceylon, acquired a cutting, and that other cuttings followed until Ceylon had eight. The name "bodhi druma" or tree of enlightenment could scarcely become a distributed vernacular name for this fig until such events began to take place, for it indicated at first an individual tree.

Ficus religiosa is native in the foot-hills of the Himalaya from the Punjab eastward, and of moist country southward as far as the borders of the Madras Presidency, and it is native through Burma almost to Rangoon. Nature spreads it by very minute seeds; and the minute seedling must have plenty of light and moisture. These two needs, acting together, produce restricted limits; but Man can take cuttings, and as the tree is very tolerant of climate when once established, can spread it widely. It is grown from cuttings even in a country so dry as Beluchistan (see the writer's "Working List of the Flowering Plants of Beluchistan," p. 70, 1909). If it be right, and it probably is right, that the Aryans were struggling for lands in the Indus plains when the great town of Mohenjo-daro existed, say in about 2000 B. C., they would have met with the tree on entering India, for Sir John Marshall identifies it with a fair measure of certainty on a seal found there ("Mohenjo-daro and the Indus Civilization," 2, p. 390, 1931). The tree tolerates the climatic conditions of today in the Indus delta (cf. Blatter and Sabnis, "Flora Indus Delta," p. 29, 1929), and there is nothing unreasonable in thinking it could have been carried that far by cuttings. Male plants of *Salix tetrasperma* Roxb. show by their dispersal in southeastern Asia how readily a plant may travel by cuttings.

The *Ficus* is widely seen on roadsides, giving grateful shade; and the Aryans would appreciate this usefulness as well as its yield of fodder. There are, of course, no written records of it at very early dates; but its name "pippala" is met with in the late Vedic Brhadāranyaka Upanishad in a way which MacDonnell and Keith (Vedic Index, 1, p. 531, 1912) regard as a reference to the tree.

The tree marks mid-winter by shedding its leaves and standing bare for a strikingly brief period of two or three days: this and the restlessness of its leaves in any light breeze make it mystic enough to seem a possessor of secrets. Consequently it was prayed to in the Vedic Atharvaveda, and up to our times the Indian villager, especially he of the south, places in its shade the prayer for offspring that he makes when he dedicates a snake stone.

The selection of a seat under it for Gautama's meditation would not be altogether fortuitous.

As the time of its leaf-fall coincides with the anniversary of Gautama's death, the Buddhists decided that it has memorized the event.

Ficus religiosa, of extended dispersal already when Gautama was born, invited buddhist aid for faster travel; and good proof that such aid was given is obtained by the distribution of names derived from the Sanskrit "bodhi druma" or tree of enlightenment. There is "bo gaha" or bo tree in Ceylon; "nyaung bo de" in Burma where "nyaung" is applied to a group of large figs; "cay bodi," "cay budde," and "cay de" in Annam; "bu" or "but" in the Cham language; "po ton" or po tree in Siamese; "d'om p'o" in the Khmer language; "kayu bodi" or bodhi tree in various parts of Malaysia; "p'u t'i shu" or bodhi tree in Chinese; and "bodai ju" in Japanese. But the names are sometimes applied to *Ficus Rumphii* Blume, and sometimes to species of *Tilia*, notably to *T. Miqueliana* Maxim. The two misapplications are of very different degree, for *Ficus Rumphii* is so similar to *F. religiosa* that its appearance justifies the transfer of the name, and in Annam and Malaysia the demand for *F. religiosa* about shrines may be met by *F. Rumphii* in a way which arrests the dispersal of *F. religiosa*. But no similarity justifies the transfer of the name to *Tilia*, which northern Chinese and Japanese, being unable to get the *Ficus* to grow in their climate, made in a kind of desperation. Its interest is chiefly in demonstrating the intensity of a demand that could produce such an unreasoned substitution. Modern Japanese botanical works record the name "bodai ju" as indicating *Ficus religiosa* as well as four or five different species of *Tilia*, most of them favourite trees in their country, with highly scented flowers, and frequently planted.

It was stated at the outset of this paper that Gautama's mother was named Māyā. She, expectant of the birth of her child and wishing it should take place at Devadaha, was travelling thither by palanquin from Kopilavastu and had reached a grove of trees half way when overtaken by labour. Some call the place the Lumbini Garden; but the word garden implies cultivation, whereas the biographic commentary Nidanakatha calls it a wood of variegated climbers, a mass of flowers and fruits, and in it a mighty "sāla" tree. In this grove Gautama was born, his mother clutching a branch of the mighty tree.

"Sāla" is the Pali and Sanskrit name of *Shorea robusta* Gaertn., and shortened to "sāl" persists in Hindi and Bengali. Of the continuity of the application of the name there is not the slightest doubt, particularly as "sāla" was the principal building timber of northeastern India in those days, when all buildings were of wood, and it was in such great use that "sāla" also meant a house. There is an interesting story in the Jatakas (no. 465) of the choice of a great tree for the making of a palace.

As Māyā's journey would bring her among "sāla" trees the story has no geographic incompatibility; but as trees when well grown carry their branches far out of reach, the story had a difficulty to circumvent which it did by making the branch bend miraculously to Māyā's hand.

Gautama's association with the "sāla" did not, however, end with this, for on his last mission he died, lying on his cloak, which Ananda folded and placed for him on the ground between two "sāla" trees; and this solemn event gave a sanctity to the species greater than that of his birth, one which made devout Buddhists anxious to grow the tree about their establishments. But it must have proved intractable. The tree drops its seeds in winged fruits at ripeness and they germinate at once; if they be foiled they die. Foresters in India complain that a layer of dead leaves on the soil is enough to frustrate establishment, as the seed dies while it is delayed in getting anchorage. Its quick death made transport by seed of no avail.

It is remotely possible that Kashmir monasteries, in their inability to raise *Shorea*, substituted *Aesculus indica* Hiern, an Indian Horse Chestnut; but that is not demonstrated. The Chinese, whose pilgrims were certainly familiar with Kashmir, for some unexplained reason took their *Aesculus chinensis* Bunge, which is very like *A. indica*, for "sāla," calling it "so lo" and planting it about their monasteries. There is otherwise no reason for thinking that the Kashmir Buddhists may have taken their tree for the "sāla"; though it would have been, as today, a favourite for planting. No one has as yet found a vernacular name applied to it which could be derived from "sāla." Alternatively the acceptance of *Aesculus chinensis* may have had no more behind it than the acceptance of the ***Tiliae*** already mentioned.

The flower of *Shorea robusta*, cut in gold leaf, was present in the Piprāhwā find.

When in 249 B. C. the great buddhist emperor, Asoka, went on pilgrimage to the holy places of his religion and came near Kopilavastu, his spiritual preceptor, Upagupta, arrested him with the words, "Here, Great King, was the venerable one born." Asoka marked the spot, but the tree grasped by Māyā, according to the records of Asoka's visit, instead of being

Shorea robusta, was that known today through northern India and yet more widely by the very name of the emperor himself — the "asoka," *Saraca indica* Linn., its sanskrit name meaning without sorrow. It is a small tree, branching low, so that Māyā would have had no difficulty in grasping it. When it flowers it is of great beauty, the flowers being from a pale citron to a ruddy orange, and deliciously scented. The poetry of introducing into the story a plant with a name of such meaning and the flattery of doing so in the reign of a ruler of the same name are obvious. Worthiness was preserved: if Māyā's contact was not to be with the greatest tree, it might well be with the most beautiful available flower. There was no geographic incompatibility; for *Saraca indica* is proved to grow by streams in the foothills of that part of the Himalaya. Thence it spreads eastward toward southwestern China and southward in the moister mountains of Peninsular India to Ceylon. It is also in Tenasserim. It is a great garden favourite in parts of India near its natural habitats.

The word "asoka" may have recalled to the reader's mind an English poetic name of the same meaning — "hearts-ease." Names like this are of small valency: they may slide off; and "hearts-ease" did so, for in the sixteenth century it was used for the Wallflower, *Cheiranthus Cheiri* Linn., as well as for the Pansy, *Viola tricolor* Linn., and then slid away from the Wallflower. Similarly "asoka" was not so firmly attached as it is now to the one plant, but denoted also scarlet-flowered species of the genus *Ixora* and apparently other pleasing plants. I have mentioned resort at the altar to *Hibiscus mutabilis* when *Nelumbium* was out of flower; so resort would seem to have been made to *Ixora coccinea* Linn. when *Saraca indica*, after a rather short flowering in the Hot Weather, went into seed; the *Ixora*, whose flowering is very extended, then comes to its best and continues so through the Rainy Season. Prain (Bengal plants, p. 571, 1903) has suggested Chittagong to be the home of this plant. It would seem to have been joined early in Indian gardens by *Ixora stricta* Roxb., from a little further to the east.

To the south of the Vindhya hills "asok" is applied today to the umbrageous tree *Polyalthia longifolia* Benth. & Hook. f., which is unlike *Saraca* and *Ixora* in every respect save that it is cultivated; and Tamils call it "assothi" which is the same name. It is a native of Ceylon and has been brought northward as far as the Gangetic plains by Man's plantings.

There is a curious use of the name "asoka" by the great Chinese pilgrim Hsuan-tsang. He narrates that he was set on by robbers a short distance down stream from Ayudhia in a wood of "asoka" trees (Julien, Hist. Vie de Hiouen-thsang, p. 116, 1853; Watters, On Yuan Chwang, 1, p. 360, 1904; and Beal, Life of Hiuen-tsiang, p. 86, 1911: Julien transliterates the word 'o-chou-kia). I refer to this because it is incredible that *Saraca indica* could have existed as a wood on the sides of a navigable river out in the plains; and Hsuan-tsang could not have meant *Saraca*; nor could he have meant *Polyalthia longifolia*. It is impossible to state what he meant; but the use of the word suggests that to him at least "asoka" was not necessarily *Saraca*.

If "asoka" has been thus loosely applied, it is necessary to take up with the scholars their interpretation of "asoka" in such writings as the Vedic Brihat Samhitā. But Bana, who wrote rather more than a century after Hsuan-tsang had left India, very definitely knew *Saraca indica* as "asoka" and *Ixora coccinea* as "bandhuka."

That the name "asoka" originated in the plains of northern India is certain; it travelled southwards, keeping its form; but across the Bay of Bengal it lost its initial letter, appearing in the Siamese language as "sok" and in the Sundanese as "soka," which are in Siam and Java, respectively, applied to *Ixora*. It is quaint that those who use the name deprived of its first letter go about unknowingly calling it sorrow. In Tenasserim the beautiful *Amherstia nobilis* Wall. has the name "so-ka," apparently of the same origin. Kurz, who first recorded it, does not extend this spelling to *Saraca;* but he makes *Amherstia* and *Saraca* share the name as "thauh-ka." I have improved his transliteration.

The Chinese have translated "asoka" into "wu yu shu" or no sorrow tree.

Whether a four-petalled flower cut into the stone carving at Bharhut be *Saraca* or *Ixora* is impossible to state, but it is probably either the one or the other (for illustration see Rajendralala Mitra's Buddha Gaya, *plate 32*); but the four-petalled flower in the hand of the figure of Gautama and that in the hand of the figure of Padmapani are certainly intended to be *Nelumbium*.

Shorea robusta and *Saraca indica* were not, however, the only trees said to have been grasped by Māyā; in the Lalitavistara, a Buddha epic of the commencement of our era, she is made to grasp a branch of ***Ficus religiosa***. This substitution is late and had its obvious origin in the Indian belief that the foot of this tree is definitely connected with offspring. Then again there is a version of her conception which makes her to be taking a siesta under one of these trees when she dreams the dream which interpreters of dreams explained as marking the moment when she conceived. In other versions her siesta was in the palace.

Watters (On Yuan Chwang, 2, p. 16, 1905) calls attention to a Chinese translation of the Lalitavistara in which Māyā is made to grasp a branch of the "lin-pi" tree. This is not a claim for yet another tree; but "lin-pi" = "lumbi," as he explains, must mean no more than the tree of the Lumbini Grove.

The identical tree which Māyā grasped, the tree which Asoka saw, is said to have been seen in a dying state in A. D. 400 by the pilgrim Fa-hien, and in a dead state over 200 years later by Hsuan-tsang. Now a tree of *Shorea*, if a giant in 567 B. C., had surely died long before A. D. 400, and a tree of *Saraca* had certainly died. Substitutions may have occurred, just as in the case of the *Ficus* at Bōdh Gayā, which substitutions the reader will find recorded by Rajendralala Mitra in his book "Buddha Gaya."

Imaginative disciples during the most accretive years of Buddhism assigned various pleasant trees to hypothetical buddhas, that they might be described as obtaining enlightenment under them or as doing various acts under them. Such trees were *Melia indica* Brandis, *Michelia Champaca* Linn., *Mesua ferrea* Linn., *Terminalia tomentosa* W. & A., *Albizzia Lebbek* Benth., etc. To collect together their names would seem to be a way of knowing what was to be found in the monastery parks; but there were princely courts that laid out parks of the same nature, and the priest did not promote the dispersal of these trees more than the prince, sometimes perhaps less than the prince.

My study of the few that were really intimates began with the collecting of sanskritic names current in Indo-Chinese and Malaysian languages in a wish to know how certain plants of India had come to travel. *Nelumbium* had not needed transport, but obtained from Buddhists some increase in abundance; *Ficus religiosa* had its range extended, but was not always preferred to *Ficus Rumphii*; *Shorea robusta* resisted being taken out of its natural area; *Saraca indica* and *Ixora coccinea* were taken across the Bay of Bengal, not necessarily by Buddhists but by those who laid out parks, whether Buddhists or not. All the trees named, unless the *Terminalia* be excluded, had a definite horticultural value and by that value they are still progressing eastward. Dr. E. D. Merrill indicates, in his "Enumeration of Philippine Flowering Plants," the relatively recent arrival of most of them at the farther end of Malaysia.

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THE CLASSIFICATION OF MALAYAN BAMBOOS

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IN STUDYING the bamboos of the Malay Peninsula, with the help of Gamble's great work (4), I found some difficulty in distinguishing between the genera *Gigantochloa* and *Oxytenanthera*, and I was struck by the resemblance in spikelet-structure between these genera and *Dendrocalamus*, though the latter is placed by Gamble in a different subtribe. This led to a consideration of the basis of Gamble's classification (little modified from the earlier one of Munro), namely fruit-structure, in which again I found agreement between *Gigantochloa* and *Dendrocalamus*; I also found that neither genus differed greatly from *Bambusa* in the gross structure of the fruit. A re-arrangement of Gamble's scheme therefore seemed necessary and was attempted. The result is given below, after discussion of the factors involved. It needs checking by examination of other species, and completing by examining the flowers of *Dinochloa* and the fruits of *Schizostachyum* and *Ochlandra*. I hope however that the scheme, though incomplete, will help others who may have the opportunity of examining bamboo flowers and fruits.

For the sake of convenience, I give here Gamble's conspectus of the subtribes of Indian bamboos:

1. ARUNDINARIEAE (none Malayan).
2. EUBAMBUSEAE. Stamens 6. Palea usually 2-keeled. Pericarp thin, adnate to the seed.
   Genera: *Bambusa, Thyrsostachys, Gigantochloa, Oxytenanthera.*
3. DENDROCALAMEAE. Stamens 6. Palea 2-keeled. Pericarp fleshy or crustaceous, separable from the seed.
   Genera: *Dendrocalamus, Melocalamus, Pseudostachyum, Teinostachyum, Cephalostachyum.*
4. MELOCANNEAE. Stamens 6 or more. Spikelets 1-flowered. Palea more or less similar to the flowering glumes. Pericarp crustaceous or fleshy, separable from the seed.
   Genera: *Dinochloa, Schizostachyum, Melocanna, Ochlandra.*

Fruits of Bambusa, Gigantochloa, and Dendrocalamus.

I found single almost ripe fruits on a plant of *Bambusa Tulda*, and on a *Gigantochloa*, which were flowering in the Botanic Gardens, Singapore, in 1945. These agreed together in essentials of structure, but did not agree with Gamble's statement for the Eubambuseae: "Pericarp thin, adnate to the seed." In both cases the apical part of the pericarp was thick and distinctly separate from the seed; the pericarp was much thinner toward the base of the fruit, but still easily separable from the seed, and the position of the embryo was not observable on the outside of the fruit. The top of the fruit was abruptly narrowed to the style, the base only of which had become somewhat thickened. This structure agrees with that described by Gamble for *Dendrocalamus*, and with a fruit of *D. pendulus* Ridl. which I examined, except that the latter (as in some other species of *Dendrocalamus* described by Gamble) had the pericarp so thin near the base of the fruit that the position of the embryo could be seen. I therefore conclude that *Dendrocalamus* is not separable from *Bambusa* and *Gigantochloa* on fruit-characters.

The stamen-tube as a generic character.

Munro (10) and later authors have used the presence of a tube in place of free stamen-filaments as a character to distinguish genera, and Camus (3) even unites genera with stamen-tubes as a special subtribe. According to Gamble's generic diagnoses, a stamen-tube is present in *Gigantochloa* and *Oxytenanthera* and not in *Bambusa* and *Dendrocalamus*. But some species referred to *Oxytenanthera* have exactly the same spikelet-structure as those species of *Dendrocalamus* which have few florets; and two species included by Gamble in *Gigantochloa* (*G. heterostachya* and *G. latispiculata*) have in other respects the spikelet-structure of *Bambusa*. Further, united filaments occur in *Neohouzeaua* (Camus 3, Gamble 5), which in all other respects agrees with *Schizostachyum*, a genus which nobody considers related to *Gigantochloa*. It thus appears that united filaments have developed on at least three distinct evolutionary lines in the bamboos; therefore the character cannot be regarded as of basic importance in classification, and I doubt if it can be used to distinguish genera. I regard the subtribe Synandrae of Camus as a quite unnatural one.

Spikelet-structure in Bambusa, Gigantochloa, and Dendrocalamus.

It appears to me that the most significant feature of spikelet-structure in these genera is the development of the rachilla. In *Bambusa* the rachilla is elongate and jointed, with several internodes usually 2 mm. or more long, the lemmas of the fertile florets being all of about the same length. In the other genera the rachilla is very short, not jointed, the florets crowded closely upon it, the lower lemmas therefore shorter than the upper when several florets are present. On this basis it is easy to distinguish *Bambusa* on the one hand from *Gigantochloa*, *Oxytenanthera*, and *Dendrocalamus* on the other. A distinction on this basis involves the transfer of *Gigantochloa heterostachya* Munro and *G. latispiculata* Gamble to *Bambusa*, with which (as indeed Gamble realized) they agree in spikelet-structure, and I therefore propose the new binomials **Bambusa heterostachya** (Munro) comb. nov. (*Gigantochloa heterostachya* Munro in Trans. Linn. Soc. **26**: 125. 1868) and **Bambusa latispiculata** (Gamble) comb. nov. (*Gigantochloa latispiculata* Gamble in Ann. Bot. Gard. Calcutta 7: 67. 1896).

We have now to distinguish between *Gigantochloa*, *Oxytenanthera*, and *Dendrocalamus*. Disregarding the stamen-tube (which is in fact sometimes not at all easy to observe) and the fruit, we find that Gamble gives us very few other characters to use. Munro (10, p. 126) originally distinguished *Oxytenanthera* as having 1–3 florets, the palea (upper palea of Munro) of the uppermost or sole floret convex on the back, not keeled, the paleae of the lower florets (if present) 2-keeled; *Gigantochloa* had more florets, and the paleae all alike and 2-keeled. But Munro (and after him Gamble) included in *Oxytenanthera* the species *O. nigrociliata,* which had an imperfect uppermost floret described as unipaleate. The single organ present is called a palea by Gamble, but by its position I think it must truly be a lemma (lower palea of Munro); in any case it is quite unlike the true palea of the upper fertile floret in other species ascribed to *Oxytenanthera,* and is to me indistinguishable from the imperfect uppermost floret of species ascribed by Gamble to *Gigantochloa*. The two genera are in fact neither clearly distinguished nor clearly described by Gamble. As in *Oxytenanthera*, the palea of the uppermost perfect floret in *Dendrocalamus* is keelless, the paleae of the lower florets 2-keeled; Gamble states for some species that there may also be a small imperfect floret above the perfect ones.

I dissected spikelets of several species of *Gigantochloa* and *Dendrocalamus*, and of the Malayan species ascribed to *Oxytenanthera*, and found that Munro's distinguishing character, with slight emendation, is sufficient to separate *Gigantochloa* (including *Oxytenanthera nigrociliata* Munro) from the other two genera. In *Gigantochloa* there are always several fertile florets, all with 2-keeled paleae, and the spikelet is terminated by an imperfect floret consisting of a narrow lemma which is longer than all the other florets and usually projects slightly from the apex of a mature spikelet. In *Gigantochloa* also there is always (in my experience) a well-developed stamen-tube.

The distinction of *Oxytenanthera* from *Dendrocalamus* is not so easy. In both genera the uppermost fertile floret has an unkeeled palea, the lower florets (when present) have all 2-keeled paleae. In *Oxytenanthera* there are only 1–3 florets and there is no rudimentary terminal floret; in most species of *Dendrocalamus* there are more than 3 florets and there is sometimes a small rudimentary terminal floret. In *Oxytenanthera* there is a stamen-tube, in *Dendrocalamus* there is none. But what of *Dendrocalamus pendulus* Ridl. and a few allied species, which have one or two fertile florets, no rudimentary floret, and no stamen-tube? If we include these in *Dendrocalamus*, the distinction from *Oxytenanthera* on number of florets breaks down; if in *Oxytenanthera*, the distinction between the two genera rests only on number of florets, which is not satisfactory.

Vegetatively, all known species of *Oxytenanthera* (and *Dendrocalamus pendulus*) have relatively slender culms, often not strong enough to support their own weight, so that they rely on the support of neighbouring trees and may be described as semi-scandent. *Dendrocalamus*, on the other hand, has usually rather stout culms; but this does not apply to

D. strictus, and I doubt whether the character of slender as against stout culms could be used as a generic distinction. All things considered, I suggest merging *Oxytenanthera* with *Dendrocalamus,* pending further field study of the species.

The ovary of Schizostachyum.

Munro recognized that the ovary of *Schizostachyum* and other genera of his third group of bamboos was a peculiar structure. He wrote (10, p. 4): "The third division consists of berry-bearing Bamboos, in 8 genera. These are all extremely interesting from their peculiar fruit. The pistil generally appears to be contained in an envelope somewhat analogous to the sac, or utricle, or perigynium, which contains the seed of *Carex*. In the young state this is so closely attached to the style that it is almost impossible to separate it; in advancing to maturity it increases in various ways." Gamble was inconsistent in the terminology he used to describe this structure. Thus under *Teinostachyum Wightii* he wrote, "style included in the long beak of the perigynium," and under *T. Griffithii*, "ovary . . . narrowing into a long triquetrous beak forming the style."

I examined living flowers of *Schizostachyum brachycladum* (which flowers continuously in Singapore, but does not normally fruit), and dried flowers of other species, but saw no fruits. The ovary at flowering is slightly swollen, and is continued upward into a stiff angled style, with no sharp distinction between the two, and at the apex of the style are the short divergent stigmas. The style is hollow, with a free central strand of delicate tissue which is continuous below with the inner wall of the ovary, which surrounds the ovule. The annular hollow within the style is due to the breakdown of the thin-walled inner tissues, which do not keep pace in growth with the firm outer tissues. It is true that the stiff hollow style so formed is functionally somewhat similar to the utricle of *Carex*, though in homology and structure it is quite different. This peculiar style is the distinctive feature of all the later genera in Gamble's scheme. In *Dinochloa* the spikelets are very short, and the style also, but its structure appears to be the same; it has not however been well described, and I have seen no material.

Spikelet-structure of Schizostachyum.

In his work of 1896, Gamble does not appear to me to make a clear distinction between *Schizostachyum* and *Teinostachyum* (on p. 77 the spikelets of *Teinostachyum* are said to have one flower, on p. 97 many flowers); but in 1923 (5) he distinguishes the two by stating that *Teinostachyum* has several flowers in each spikelet, *Schizostachyum* only one. Now McClure has described a *Schizostachyum* with two florets in each spikelet (7); and I myself found that spikelets on plants of *S. brachycladum* growing in Singapore may have either one or two flowers. In such cases the palea of the lower floret is loosely convolute and usually distinctly 2-keeled toward the apex; that of the upper floret is tightly convolute and hardly keeled. This not only does away with the distinction between *Schizostachyum* and *Teinostachyum*; it also breaks down their distinction from *Cephalostachyum*, which (according to Gamble's later paper) has a 2-keeled palea, whereas the others are said to have a palea convolute, not keeled. Indeed, Gamble himself was not consistent in this latter distinction, as in 1896 he described the palea of *Schizostachyum tenue* as 2-keeled. I suggest therefore that the genera *Schizostachyum*, *Cephalostachyum*, and *Teinostachyum* should be united; and probably *Pseudostachyum* should go with them.

The spikelets of *Schizostachyum* are articulate at the base of each floret, if there is more than one, as described by McClure (6, 8, 9), and the internodes of the rachilla are always long. Above the uppermost fertile floret the rachilla is extended to bear a more or less imperfect rudimentary terminal floret which is not jointed to it. In this character of articulation of the rachilla, *Schizostachyum* agrees with *Bambusa*, and I suggest that it is more likely to be related to *Bambusa* than to the *Dendrocalamus* group, with its very short unjointed rachilla.

Schizostachyum and Ochlandra.

The lodicules of *Schizostachyum* are relatively large, in the Malayan species usually 3 and sometimes more, often unequal in size, and there are sometimes intermediates between lodicules and stamens. I can see no sharp distinction on characters of lodicules and stamens between the one Malayan species included in *Ochlandra* by Gamble (*O. Ridleyi*) and those he places in *Schizostachyum*, and I would include *O. Ridleyi* in the latter genus; no fruits have been seen. The fruit of other species of *Ochlandra* may be distinctive, but it still lacks a proper description; and it is to be noted that McClure (8) has already united the small-fruited *Dinochloa* with the large-fruited *Melocalamus* (the two genera are placed in separate subtribes by Gamble), so size of fruit alone may not be a sufficient character on which to base generic separation. The only fruit of any of this group of genera which has been fully described is that of *Melocanna*, by Stapf (13).

Neohouzeaua, Dendrochloa, and Klemachloa.

These three genera, from Burma and Indo-China, appear to me redundant. *Neohouzeaua* Camus (2) admittedly differs from *Schizostachyum* only in the presence of a stamen-tube, and as above indicated I do not consider this a valid ground for generic distinction. I think that *Dendrochloa* Parker (11) also should be united to *Schizostachyum*; it has 5–7 florets in a spikelet, the paleae of the lower florets with 2 close keels, and the filaments of the stamens partially united (three together, two together, and one free). In spikelet-structure it shows no essential difference from the Malayan *Schizostachyum grande* Ridl. (of which I have examined type- and other material). *Klemachloa* Parkinson (12) is like *Dendrocalamus pendulus* Ridl. in spikelet-structure, having 1 or 2 florets, an unjointed rachilla, the uppermost or sole palea unkeeled, and free filaments; it has 2 or 3 lodicules, which are not found in *D. pendulus*, but are reported from a few species of *Dendrocalamus*. I would unite *Klemachloa* with *Oxytenanthera*, if that genus is maintained, or with a comprehensive *Dendrocalamus*.

Inter-relationships of bamboo genera.

Several authors have suggested that *Schizostachyum* and its allies, having (where present) large and sometimes numerous lodicules, in some cases quite large fruits and always a well-developed pericarp, and long rachilla-internodes, are the most primitive of existing bamboos. *Bambusa* agrees with these genera in its elongate rachilla-internodes, and in the almost universal presence of lodicules, but it differs in ovary-structure and in never having more than 3 lodicules, of which two are very fleshy like those of a great number of grasses. The short unjointed rachilla of *Dendrocalamus* and its allies seems likely to be derived from a primitive elongate state. In gross characters of ovary and fruit these genera do not differ appreciably from *Bambusa*, but more detailed study may indicate differences. I think it quite likely that *Bambusa* and *Dendrocalamus* represent distinct lines of advance from the primitive bamboo stock, from which *Schizostachyum* has changed less in inflorescence and floral structure.

A suggested re-classification.

Subtribe Melocanneae.

Ovary narrowed gradually into a stiff angled style which is hollow at flowering; fruit large or small, the pericarp free from the seed; spikelets 1- to many-flowered, the rachilla-internodes (if present) long, articulate; paleae of lower fertile florets (if present) more or less distinctly 2-keeled with keels close together; palea of uppermost (or sole) fertile floret tightly convolute; lodicules, if present, often large and flat, sometimes numerous.

Spikelets and style long (genera to be distinguished on fruit-characters?) *Schizostachyum, Ochlandra, Melocanna.*

Spikelets and style short .... *Dinochloa.*

Subtribe Bambuseae.

Ovary abruptly narrowed to a slender style which is not hollow at flowering; fruit small, with pericarp free from seed; spikelets usually many-flowered, with distinct articulate rachilla-internodes; uppermost floret (or florets) usually imperfect; lemmas all about equal; lodicules usually 3, of which 2 are very fleshy and different from the third; stamen-tube rare.

Florets many; palea not bifid...................................... *Bambusa.*

Fertile florets 3; lowest palea deeply bifid.................... *Thyrsostachys.*[1]

Subtribe Dendrocalameae.

Ovary and fruit as in Bambuseae; spikelets 1- to many-flowered, the rachilla very short, not articulate; lemmas in many-flowered spikelets very unequal, gradually longer toward apex of spikelets; uppermost floret perfect or imperfect, if perfect with an unkeeled palea, the other paleae 2-keeled; lodicules usually lacking, if present small; stamen-tube sometimes present.

All fertile florets with 2-keeled paleae; a terminal imperfect floret consisting of a long narrow lemma always present.............................. *Gigantochloa.*

[1] See N. L. Bor (1).

Uppermost or sole fertile floret with unkeeled palea, the paleae of remaining fertile florets 2-keeled; a terminal short imperfect floret present or not. *Dendrocalamus*.

(A possible distinction of *Oxytenanthera* from *Dendrocalamus* as follows:
Fertile florets 1–3, with no imperfect terminal floret; stamen-tube often present .... *Oxytenanthera*.
Fertile florets more than 3, with or without a short terminal rudimentary floret; stamens free.. *Dendrocalamus*.).

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DISTRIBUTION OF THE DIPTEROCARPACEAE

F. W. Foxworthy

There has been a good deal of study of this family during the past quarter century, and it is now possible to give a somewhat more detailed survey of its distribution than that made by Merrill in 1923 (6). Extensive studies of the family have been made in the regions where it is most highly developed. There have been changes in the notions of generic and specific limits, in records of distribution, and in the numbers of species recognized.

What was formerly recognized as the genus *Pachynocarpus* is now relegated to the status of a subgenus of *Vatica*. The genus *Balanocarpus* has been broken up and most of its species placed in *Hopea* or in *Shorea*. The only remaining species is *B. Heimii* King, which will need a new position. Two new genera, *Dioticarpus* and *Upuna*, have been described.

Brandis, in 1895 (2), listed some 325 species in this family, and about 220 of them are still regarded as good species. During the past half century, more than 200 additional species have been described, most of them from Western Malaysia. The principal publications in which the new species have been described are those of van Slooten (8–15), Symington (16–20), and Foxworthy (4, 5). These publications include the descriptions of more than 120 new species from Western Malaysia. Besides these there are scattered publications giving descriptions of new species from other parts of the range of the family, but these are relatively few in number.

I. GEOGRAPHIC DISTRIBUTION.

Six great regions of distribution are recognized, as follows: (1) Africa; (2) Ceylon; (3) India (Western Peninsula); (4) Eastern Peninsula or Further India; (5) Western Malaysia; and (6) Eastern Malaysia. Table I shows the distribution of the genera and species in the different regions. There are, as might be expected, transitional areas, where regions are adjacent or contiguous, and these will be noticed in discussing the different regions.

Region 1. Africa.

This great continent has been considered as outside the range of the typical representatives of the family. The genera *Marquesia*, with three species, and *Monotes*, with 31 species, are the only representatives known from Africa, and they are atypical and sometimes considered improperly placed in this family. However, the finding of fossil material of true

TABLE I.

GEOGRAPHIC DISTRIBUTION OF THE GENERA AND SPECIES OF DIPTEROCARPACEAE

Genus	Total spp.	Africa	Ceylon	India	Further India	Western Malaysia	Eastern Malaysia
Anisoptera	13				2	12	2
Balanocarpus	1					1	
Cotylelobium	5		1			4	
Dioticarpus	1			1			
Dipterocarpus	73		5	2	16	58	1
Doona	12		12				
Dryobalanops	9					9	
Hopea	73		4	8	13	49	4
Marquesia	3	3					
Monoporandra	2		2				
Monotes	31	31					
Parashorea	8				2	7	
Pentacme	3				1	3	
Shorea	131		5	3	20	107	3
Stemonoporus	14		14				
Upuna	1					1	
Vateria	5[1]		2	2			
Vatica	65		3	1	11	52	3
Totals	450	34	48	17	65	303	13

[1] Includes *Vateria Seychellarum,* which does not fit exactly into any of the regions and is not included in the other columns.

dipterocarp wood at Mount Elgon (Kenya-Uganda) and in Italian Somaliland has indicated that the subfamily Dipterocarpoideae was well represented in Africa in *late* Tertiary times. Bancroft (1) and Burtt Davy (3) have recorded the finding of additional material. The following quotation is from Bancroft.

"It is, of course, well known to students of taxonomy and plant distribution that the typical living members of the *Dipterocarpaceae* are confined to Asia, their centre of distribution being most probably the 'Malaysian' area, from which distribution has taken place in a general north-westerly direction; and also that the family is represented in Africa only by an aberrant group, the *Monotoideae,* comprising some thirty species of *Monotes* and three of *Marquesia.* The members of this small group are not rain-forest trees, like the true Dipterocarps, but are scattered inhabitants of the savannah country at high altitudes and of acidic soil type . . . . it is evident that typical Dipterocarps were formerly more widely distributed than at the present day; and the inference is that, having reached Africa from Asia, they subsequently receded, leaving as representative of the family in Africa only the *Monotoideae,* which are well adapted to special conditions of habitat . . . . the former occurrence of true Dipterocarps in Somaliland, and further to the southwest in British East Africa, when considered in relation to the present distribution of those living forms which they seem most closely to resemble, suggests that the extension of the family from Asia into Africa took place *by way of a north-western land-connexion between the two continents*.

"Other African fossil woods are now under consideration, and these, again taken into consideration with the present distribution of related forms, point to a similar conclusion of north-westward migration of Asiatic types. If such migration did in fact take place in Tertiary (or perhaps earlier) times, the climate of the then-existing land-connexion must have been much more humid than that of the corresponding area at the present day.

"Within the past few months, herbarium material has come to hand, from areas as far removed as Nigeria, Gabun, and the Belgian Congo, which indicates that *true* Dipterocarps (the sub-family *Dipterocarpoideae*) are still living in the primitive forests of Africa."

So far as known, the identifications of these recent collections have not yet been published.

The only possible transitional form that has been recorded between this region and the next is *Vateria Seychellarum* Dyer, from the Seychelles. This species seems to be closely related to its congeners in Ceylon and India.

The very distinct character of the hitherto recorded forms from Africa would seem to indicate that the African forms have long been separated from those of the regions to the east.

Region 2. Ceylon.

This island seems to constitute a very compact province of distribution. There are 48 species recorded, in nine genera, and only a single species, *Vatica chinensis* L., is known to have a range extending to India. Three genera, *Doona*, *Monoporandra*, and *Stemonoporus*, are known only from Ceylon. There is a higher proportion of endemism than is found in any of the eastern range of the family.

A few of the species of the larger genera (*Dipterocarpus*, *Hopea*, *Shorea*, and *Vatica*) show close relationship to other species of the same genera in India and Malaya.

All but one of the Ceylon species are found in the moister parts of the island. A single species, *Vatica obscura* Trimen, is recorded as characteristic of the drier part of the island.

Region 3. India (Western Peninsula).

This region, as indicated by Brandis, is bounded on the east by Assam, which is transitional to the next region.

The Indian region, as thus limited, contains but 17 species, 15 of them endemic. The small number of species may be due to the large areas of dry country and to unfavorable soil conditions. There are fairly extensive areas of tropical rain-forest, and all the species but *Shorea robusta* and *S. Tumbuggaia* are restricted to the moist regions.

The monotypic genus *Dioticarpus* is peculiar to a limited area in South India. *Vatica chinensis* L. is found also in Ceylon and *Shorea robusta* Gaertn. f. extends into Assam. *Dipterocarpus indicus* Bedd. is very closely related to *D. turbinatus* Gaertn. f., of the next region, and has sometimes been considered to belong to that species. *Shorea talura* Roxb. is very close to *S. floribunda* Kurz, of Burma, and possibly not distinct.

The transitional area of Assam is separated from India proper by mountainous country. Six species are represented in Assam, two of them endemic; one is Indian, and the others are found in the next region.

Region 4. Eastern Peninsula (Further India).

This includes Burma, Siam down to 10° N. lat., Indo-China, and the tropical portion of China. There is a great deal of mountainous country and the distribution of dipterocarps is limited by elevation and climate.

To the south there is land connection with the Malay Peninsula, which begins at the Isthmus of Kra, at about 10° N. lat. The Malay Peninsula is a part of Western Malaysia. There is a climatic change at about 7° N. lat., and few species cross this line. The area between 7° and 10° N. lat. is transitional between regions 4 and 5. South of 7° the flora is distinctly Malayan and north of 10° it definitely belongs to region 4. In recent geologic time, the Malay Peninsula south of 7° was an island.

Within region 4 are found most of the species that show distinct adaptation to a prolonged and severe dry season. There are also considerable areas of rain-forest, where the conditions approach those of the next region and are most favorable for the development of dipterocarps. Of the 65 species recorded from region 4, 31 are endemic. Most of the species are in the moister parts.

The most striking feature of the distribution of dipterocarps in this region is what has been called the *dry deciduous dipterocarp forests* of Burma, Siam, and Indo-China. These forests are extensive and are most often found on laterite, though sometimes on sandy or gravelly soil. The dominant and strikingly gregarious species are *Dipterocarpus tuberculatus* Roxb., *D. obtusifolius* T. & B., and *Pentacme suavis* A. DC. The last named species occurs in the driest situations and often on other soils than laterite. It has been found on calcareous soil and as far south as 7° N. lat.

The species of the dry deciduous forests usually have a thick bark, which enables them to resist ground fires.

Region 5. Western Malaysia.

This includes the Malay Peninsula, the part of the Malay Archipelago west of Wallace's Line, and the Philippine Islands. The land is generally covered with tropical rain-forest, soil and climate being most favorable to the development of high forest. The most representative species of these forests are members of the family Dipterocarpaceae, which usually provide the largest volume of timber. Fully two-thirds of the species of the family are found in this region. Twenty-four of the species extend into region 4 and only two species into Eastern Malaysia.

The genera *Dryobalanops*, *Balanocarpus*, and *Upuna* are known only from this region; and all of the larger genera of the family also have their greatest development in this region. What was formerly regarded as the genus *Isoptera* is now considered to be a section of the genus *Shorea*.

Table II shows the distribution of species and genera in the different parts of Western Malaysia.

TABLE II.

Genus	Malay Peninsula	Sumatra	Java	Borneo	Philippines	Total spp. W. Malaysia
Anisoptera	7	4		3	4	12
Balanocarpus	1					1
Cotylelobium	2	2		3		4
Dipterocarpus	24	22	5	34	11	58
Dryobalanops	2	2		9		9
Hopea	25	8	1	20	9	49
Parashorea	4	3		2	2	7
Pentacme	1				2	3
Shorea	54	22	1	60	15	107
Upuna				1		1
Vatica	21	10	3	21	8	52
Totals	141	73	10	153	51	303

This region is generally considered to be the centre of distribution of the family. The great island of Borneo has the largest number of species and the Malay Peninsula only slightly less. Considerable parts of Borneo are very imperfectly known botanically, and it is probable that the number of species from the island will be considerably increased. Of the 153 species found in Borneo, 52 are known from the Malay Peninsula, 33 from Sumatra, 15 from the Philippines, three from Java, and two from Eastern Malaysia.

It seems that Sumatra, the Malay Peninsula, and the Philippine Islands have had former land connections with Borneo and that this land was the region where the family originated and from which it spread out.

The most widely distributed species are: *Dipterocarpus grandiflorus* Blanco, from Burma, Siam, the Malay Peninsula, Sumatra, Borneo, and the Philippines; *D. gracilis* Bl., from Assam, the Malay Peninsula, Sumatra, Java, Borneo, and the Philippines; and *Shorea guiso* (Blanco) Bl., from Indo-China, Siam, the Malay Peninsula, Borneo, and the Philippines.

Region 6. Eastern Malaysia.

This includes that part of the Malay Archipelago east of Wallace's

Line, — extending as far to the east and south as the great island of New Guinea. It is an extensive area, but contains very few representatives of this family, — a total of 13 species, as follows:–

Anisoptera — two species. One of these, *A. costata* Korth., is widely distributed in Western Malaysia. The other is restricted to New Guinea.

Hopea — four species in New Guinea, one of them also in Celebes.

Shorea — three species — one in New Guinea, one in the Moluccas, and one in Celebes and the Moluccas.

Vatica — three species — one of wide distribution and two restricted to Celebes. The species of wide distribution, *V. papuana* Dyer, seems to be adapted to distribution by sea-currents. It is found along the coasts of the southern Philippines, East Borneo, the Moluccas (Ternate, Obi, Batjan, Aru Islands), and New Guinea.

Dipterocarpus — a single species, *D. retusus* Bl., as far to the east as Sumbawa.

It would seem that the barrier indicated by Wallace's Line (or its modification by Merrill) has been sufficient to prevent the spread of many species to this region.

Van Slooten (14, p. 434), impressed by the finding of two species of *Dipterocarpus* in Bali and one species in Sumbawa, stated, " . . . it is certain that the distribution of the genus *Dipterocarpus* has nothing to do neither with a line of demarcation through Central Java, nor with the so-called line of Wallace."

Nevertheless, it seems to me that this line is important and marks the limit beyond which few species of dipterocarps have gone.

II. LATITUDINAL RANGE.

The family is, as is well known, a tropical one and has its best development in the equatorial region. A few species extend to the northern limits of the tropics and have an extreme range to a short distance outside the tropics. The known species with such distribution are:–

In India — *Shorea robusta* Gaertn. f. — to 32° N. lat.
In Burma — *Dipterocarpus tuberculatus* Roxb. — to 25° N. lat.
D. obtusifolius T. & B. — to 24° N. lat.
Shorea obtusa Wall. — to 24° N. lat.
Pentacme suavis A. DC. — to 25° N. lat.

III. ALTITUDINAL RANGE AND SOIL CONDITIONS.

Most species are found in lowland forest, usually below 2,000 ft. The highest elevation recorded is a little over 5,000 ft. This has been recorded for *Shorea robusta* and for two species of *Dipterocarpus*.

Certain species are usually found on low ridges, and certain others are usually found at the higher elevations. However, characteristically high hill forms are sometimes found at lower elevations, and the lowland forms may be found up to 2,500 feet or more, apparently depending upon conditions of exposure and drainage.

Soil conditions influencing distribution.

The relatively small numbers of species found in dry or deciduous forests are greatly influenced by the nature or condition of the soil. The most characteristic case is that of *Dipterocarpus tuberculatus* Roxb., which is most often found on lateritic soil. Other species characteristic of the dry deciduous forests have been mentioned. *Shorea robusta* Gaertn. f. thrives on moist deep sandy loam with good subsoil drainage. It may occur on several types of soil, but it needs moist soil and good drainage.

Most species of dipterocarps occur in tropical rain-forest, where there is a good deal of soil moisture and high humidity. Under these conditions, the nature of the soil is of less importance. Drainage is, however, important. Most species, while requiring a good deal of moisture, do not thrive in a water-logged or swampy soil. Nevertheless, there are a number of species which thrive in fresh water swamps. Some of the species found in fresh water swamps, or at the edge of the swamp, and their distribution, are:–

Anisoptera marginata Korth. — Malay Peninsula, Sumatra, Bangka, Borneo.
Dipterocarpus costulatus v. Sl. — Malay Peninsula, Sumatra, Borneo.
Dipterocarpus Dyeri Pierre — Burma, Indo-China, Malay Peninsula.
Dryobalanops Rappa Becc. — Borneo.
Shorea albida Sym. — Borneo.
S. Pinanga Scheff. — Borneo.
S. Teysmanniana Dyer — Malay Peninsula, Sumatra, Borneo.
S. platycarpa Heim — Malay Peninsula, Borneo.
S. rugosa Heim — Borneo.
S. uliginosa Foxw. — Malay Peninsula, Sumatra.
S. inaequilateralis Sym. — Borneo.
Vatica imbricata v. Sl. — Borneo.
V. Wallichii Dyer — Malay Peninsula, Sumatra.

IV. METHODS OF DISTRIBUTION.

1. *By water.*

A few species seem to be adapted to distribution by water. The single species believed to be distributed by sea-currents, *Vatica papuana* Dyer, has already been mentioned.

Several species of river valleys are believed to be distributed by fresh water. Examples are *Shorea seminis* (De Vr.) v. Sl. and *S. sumatrana* (Thor.) Sym.

2. *By wind.*

Most species have fruits that are equipped with wings several times longer than the seed. These wings aid in the dispersal of the fruits by wind action.

The rain-forest, where most of the species grow, is so dense that there is comparatively little action by strong winds within the forest and there is consequently little opportunity for distribution to long distances. Ridley (7, pp. 104–109) has stated that dipterocarp fruits are usually not carried by wind to a distance of more than 30 or 40 yards from the parent tree, and, exceptionally, to only about 100 yards.

This statement may be rather too conservative, in that it does not give sufficient importance to the occasional wind storm. Webber (21) has given an account of a small wind storm, in the Malay Peninsula, that carried large numbers of dipterocarp fruits to a height of several hundred feet and a distance of at least half a mile. Forms represented among the fruits thus carried were: — *Shorea leprosula*, *S. parvifolia*, *S. macroptera*, *S. bracteolata*, *Anisoptera* spp., *Dipterocarpus* spp., and *Hopea* spp.

Similar observations have been made in the Philippine Islands, where fruits of *Parashorea plicata* Brandis were carried to distances in excess of a half-mile by typhoon winds.

Such wind storms as those mentioned are, doubtless, infrequent, but may occur a number of times during the life of a tree. It is evident that wind is an important agency in the distribution of members of this family.

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PARALLEL AND CONVERGENT EVOLUTION IN FERNS

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Whatever the details of its technique, evolution is accepted by the world as the general process by which the countless kinds of living things have been derived from comparatively uniform remote ancestors, and finally perhaps from one single living thing. This has been in general a process of differentiation. It has been so also in detail, as each kind of living thing originated from a more or less different parental kind or species. We are so used to regarding evolution as a process of differentiation that if a botanist or zoologist be asked as to the occurrence of convergent evolution, by which similar or apparently identical creatures are evolved from different ancestors, he is likely to reply that it is theoretically possible, but that he knows of no recognized instance. He may add that if such a procedure did occur in nature, we might not recognize it, but that it would be interesting if we could demonstrate it.

However, as a general proposition, some measure of convergent evolution is not only not rare, but is familiar, if one will but consider what one knows. Dry lands the world over receive immigrants from more humid lands, which undergo similar modification in adaptation to the dry climate. Dry-land plants of the most diverse ancestry thus evolve small, harsh leaves. Many Euphorbiaceae have evolved the form and much of the structure more familiar in the cacti. Dwarf species inevitably lose some of the structures of their larger ancestors, with loss of size. The most universally familiar example of this phenomenon is the loss of structure by parasites, and the resulting resemblance of plants quite regardless of the differences between their ancestors. Plants of many families have undergone in common the loss of leaves and of chlorophyll in becoming parasites. This evolution is convergent or parallel; there is no essential difference. The possibility that present resemblance may blind us to diverse ancestry is shown by the fact that we hold our predecessors of a few years to have been deceived in this way. We recognize more families of parasites than were known some years ago, because we believe that the old families contained unrelated, even if similar, elements.

The ferns are better known, as to their geography and their real affinities, than is any other group of similar size. None is a parasite, and few are dry-country plants. In the light of our present understanding of the relationships of the genera, we now recognize among them numerous instances of parallel and convergent evolution. As recently as the period when the elders among us began to study ferns, their classification by Sir William Hooker was accepted with little question throughout the world.

As Sir William was one of Darwin's influential supporters, this should not have been the expression of a purely pre-Darwinian viewpoint. The Synopsis Filicum of Hooker and Baker recognized 58 genera of Polypodiaceae. One of the greater of these was *Acrostichum*, including almost all ferns with the sporangia spread over the backs of the fronds, — not in discrete clusters, called sori.

Of the 172 species of *Acrostichum* in the 1874 edition of Synopsis Filicum, only (1) *A. aureum* retains to-day that generic name; it is probably a relative of *Pteris*. *Acrostichum pteroides*, now *Neurosoria pteroides* (2), is a little known Australian species related to *Cheilanthes*, perhaps belonging in that genus. *Acrostichum requiniana* is now (3) *Taenitis requiniana*, an imperfectly acrostichoid derivative of the widespread *T. blechnoides*.

Acrostichum apiifolium, endemic in the Philippines, is a descendant of *Dryopteris*,[1] now called (4) *Psomiocarpa apiifolia*, a name given in 1849 but rejected by Hooker and Baker. The Cuban *A. aspidioides* is a very similar independently derived dryopterid fern, now called (5) *Atalopteris aspidioides*. For *A. auritum*, the name (6) *Stenosemia aurita*, given in 1836, has been restored; it is descended from *Dryopteris* through an intermediate genus, *Heterogonium*. Also derived from *Dryopteris*, but from a different part of the genus, is (7) *Quercifilix zeilanica*, called *Acrostichum quercifolium* by Hooker and Baker. Baker later described as *Acrostichum* three species (*A. celebicum*, *A. exsculptum*, and *A. oligodictyum*) now recognized as (8) species of *Dryopteris* (or better, of *Cyclosorus*), all imperfectly acrostichoid in fruit. *Acrostichum Harlandii* and *A. taccaefolium* are species of (9) *Hemigramma*, derived from *Tectaria*, of more remote dryopterid origin.

Acrostichum scandens is now (10) *Stenochlaena palustris*, not clearly related to any other fern here mentioned. *Acrostichum sorbifolium* has been called *Stenochlaena* by some more recent authors, but is better distinguished as (11) *Lomariopsis*. Confused with *A. scandens* in the Synopsis was a very different fern, (12) *Teratophyllum aculeatum*; except that the resemblance is not sufficient to justify Hooker's confusion, we would have here a fine illustration of generically distinct ferns masquerading as specifically identical. *Acrostichum Blumeanum* is now a (13) *Lomagramma*. *Acrostichum articulatum* and *A. Wilkesianum* have also been called *Lomagramma*, but are better distinguished as (14) *Arthrobotrya*. The evolution of these four or five genera has been so convergent that there is to-day no agreement as to their real affinities; but it is agreed that *Stenochlaena*, *Lomariopsis*, *Teratophyllum*, and *Lomagramma* are distinct from one another as well as from *Acrostichum*.

A considerable number of former *Acrostichum* species are now regarded

[1] To avoid a less familiar name, I use *Dryopteris* here in the sense of Christensen's Index Filicum.

as (15) *Bolbitis*, a pantropic genus. An oriental relative of *Bolbitis* is (16) *Egenolfia*, represented in the Synopsis as *A. appendiculata*. Roughly half of the *Acrostichum* species of the Synopsis are now (17) *Elaphoglossum*, a very large genus in all warm countries. Derived from *Elaphoglossum* are (18) *Microstaphyla* and (19) *Rhipidopteris*, each represented by one species of *Acrostichum* in the Synopsis. These five genera have in common a striking spore character, indicating that they are related, mutually and to other ferns recently mistakenly placed in *Dryopteris*.

Acrostichum bicuspe is (20) *Cheiropleuria bicuspis*, a Malayan fern so peculiar that it has been proposed to make it a family by itself. Related to it, however, is (21) *Christiopteris tricuspis*, *A. tricuspe* of the Synopsis. *Acrostichum spicatum* and *A. platyrhynchos*, now called (22) *Belvisia* (or *Hymenolepis*), may be a third surviving branch of the same old group.

Of the polypodioid ferns, *Acrostichum axillare* is (23) *Leptochilus axillaris*, which is so deceptively like *A. lanceolatum*, a (24) *Dendroglossa*, that botanists as keen as Christensen and Ching have been unable to see that they are generically distinct. Under *A. variabile*, Hooker and Baker combined one or more species of *Dendroglossa* with (25) *Leptochilus*[2] *decurrens*, which I am sure is of independent immediate ancestry. *Acrostichum rigidum* is (26) *Photinopteris speciosa*, derived through *Aglaomorpha* from *Microsorium*, which is the immediate parent of *Leptochilus*. *Acrostichum drynarioides* is now (27) *Merinthosorus*, likewise derived from *Aglaomorpha*.

In running through this list, I have overlooked three American genera, (28) *Trachypteris*, (29) *Neurocallis*, and (30) *Polybotrya*.

Platycerium is also perfectly acrostichoid in its fructification, but for other reasons Hooker and Baker held it generically distinct.

It will help to show the diversity of origin of the foregoing list of genera if they be now tabulated in their most recent systematic arrangement.

PTERIDACEAE	
Taenitis requiniana	*Acrostichum requinianum*
Neurocallis praestantissima	*A. praestantissimum*
Acrostichum aureum	*A. aureum*
Neurosoria pteroides	*A. pteroides*
Trachypteris aureo-nitens	*A. aureo-nitens*
ASPIDIACEAE	
Polybotrya osmundacea	*Acrostichum osmundaceum*
Bolbitis serratifolia	*A. serratifolium*
Egenolfia appendiculata	*A. appendiculatum*
Lomariopsis spp.	*A. sorbifolium*
Teratophyllum spp.	*A. sorbifolium*
Arthrobotrya articulata	*A. articulatum*
Lomagramma spp.	*A. Blumeanum*

[2] *Leptochilus decurrens* is the name in present use for this species, but it is improper because the species is of different immediate ancestry from *L. axillaris*, the type of *Leptochilus*. A new generic name is provided for it in my Genera Filicum, now in press.

Elaphoglossum spp.	*Acrostichum* spp.
Microstaphyla furcata	*A. bifurcatum*
Rhipidopteris peltata	*A. peltatum*
Psomiocarpa apiifolia	*A. apiifolium*
Atalopteris aspidioides	*A. aspidioides*
Stenosemia aurita	*A. auritum*
Hemigramma taccaefolia	*A. taccaefolium*
Quercifilix zeilanica	*A. quercifolium*
BLECHNACEAE	
Stenochlaena palustris	*Acrostichum palustre*
POLYPODIACEAE	
Cheiropleuria bicuspis	*Acrostichum bicuspe*
Christiopteris tricuspis	*A. tricuspe*
Belvisia (Hymenolepis) spicata	*A. spicatum*
Platycerium spp.	*Platycerium* spp.
Leptochilus axillaris	*Acrostichum axillare*
Leptochilus decurrens	*A. variabile*, in part
Dendroglossa minor	*A. minus*
Merinthosorus drynarioides	*A. drynarioides*
Photinopteris speciosa	*A. rigidum*

I may not apologize for the length of this list of names, uninteresting to the pteridologically illiterate, even if musical, because the length of the list is the point I emphasize, and have repeated for the sake of emphasis. The list might be made much longer, if, instead of confining myself to Hooker, I went back to Swartz, and to Linnaeus, whose definition of *Acrostichum* was substantially the same as Hooker's. Including their species, the number would have been more nearly fifty of to-day's genera, almost all representing the same kind of convergent evolution.

The acrostichoid fructification is usually associated with the evolution of dimorphic fronds, — different vegetative and fertile fronds, — the fertile ones usually restricted in area, longer-stalked, and shorter-lived. Some degree of dimorphism of fronds, or of parts of fronds, has been evolved independently along a considerably greater number of lines; but dimorphism did not happen to be a primary element in generic definition, and so the ends of the resulting phyletic series escaped combination on this ground.

The Synopsis Filicum maintains a genus *Gymnogramma* of about 100 species, including most ferns with the sporangia in extended lines along the veins and without protective covering, but not on the area between the veins, where their presence would have thrown the plants into *Acrostichum*. These hundred species are now distributed among the following 23 genera:— "*Dryopteris*," *Heterogonium*, *Woodsia*, *Athyrium*, *Ceterach*, *Aspleniopsis*, *Syngramma*, *Craspedodictyum*, *Pterozonium*, *Coniogramme*, *Hecistopteris*, *Gymnopteris*, *Gymnogramma*, *Pleurosorus*, *Eriosorus*, *Bommeria*, *Anogramma*, *Trismeria*, *Pityrogramma*, *Loxogramme*, *Colysis*, *Selliguea*, and *Pleopeltis*. Because some of these genera include more than one independent instance of such evolution, because the Synopsis treats as genera (*Meniscium*, *Hemionitis*) some such series, and because of several such cases unknown to its authors, the actual number of independent evolutionary series converging to the *Gymnogramma* type of fructification is again far more than thirty.

The feature in which parallel evolution has occurred in the largest number of cases is the loss of the indusium. Failure to recognize this by taking account of ancestry was responsible for the monstrous "genus" *Polypodium*; within restricted ranges, for such temporarily respected genera as *Phegopteris*, *Goniopteris*, and *Alsophila*. Presentation of individual cases would involve discussion of species rather than genera, and would require far more space than is available here.

Limiting myself to genera, I will close with two especially interesting cases.

The pair of genera *Cochlidium* and *Scleroglossum* present an exceptional case of convergent evolution. The former has ten named species in tropical America; the latter, seven, from Ceylon to Polynesia. They are tiny ferns with densely clustered thick, linear fronds, with one linear sorus on each side of the midrib in the upper part of the frond. They are so alike that care is required to distinguish the species in the two hemispheres. Their geographical isolation made their generic identity doubtful, but a detailed anatomical study by Goebel made him conclude that there was no sufficient ground for their separation. Before and after his study, I was forced to the same conclusion; the more reluctantly the second time, because Goebel had also established the common descent of the American *Cochlidium* and *Xiphopteris*, and Maxon had previously shown that *Xiphopteris* was too intimately connected with its local neighbors, pinnate ferns called *Polypodium*, or preferably *Ctenopteris*, to require recognition as a genus. This established *Cochlidium* as a genus of American origin, and no other genus of demonstrable American origin was known in the Malay region.

And then, a New Guinea plant named "*Polypodium pleurogrammoides*" came to hand. Let its generic name be what it will (it can be *Nematopteris*, or *Grammitis*), it shares the characteristics of *Scleroglossum* and *Grammitis*, and illustrates the derivation of the former from the latter. The proof is provided by microscopic features of identity, but is sufficient. *Cochlidium* is descended from pinnate ferns; *Scleroglossum* from a genus with simple fronds. But convergent evolution produced genera so identical that neither Goebel nor I could find a satisfactory distinction, though antecedent probability made us expect one. Christensen has later found a second microscopic difference.

Phyllitis Scolopendrium, longer known as *Scolopendrium vulgare*, the "hart's tongue fern," occurs well around the North Temperate zone. Its sorus is "double"; that is, each of two neighboring veins produces a long sorus, on the side facing the other vein, and the indusia are broad enough either to meet, or to come near enough to doing so that the result looks like one sorus. The genus is derived from *Asplenium*. The North American *Asplenium pinnatifidum*, which suggests *Scolopendrium* so strongly that Diels transferred it to that genus, may represent its parentage in *Asplenium*. *Phyllitis* is clearly of northern origin, and is probably not at all ancient.

Scolopendrium Durvillei Bory was described from the New Guinea region. Though misunderstood by Baker and made the basis of another genus, *Diplora*, it has exactly the soral character of *Scolopendrium*. Its approximate ancestor in *Asplenium* is *A. epiphyticum*, not more nearly related to *A. pinnatifidum* than it must be as an *Asplenium*. If not *Asplenium*, *Scolopendrium* and *Diplora* must be two genera, distinguishable by description solely by the base of the lamina, cordate in one, cuneate in the other. This would be unsatisfactory if it were the whole story.

But we know now not merely two, but six instances in which convergent or parallel evolution has produced from *Asplenium* the sorus of *Scolopendrium*:

Asplenium Scolopendrium L.
Scolopendrium Durvillei Bory, the preferable name of which seems to be *Asplenium scolopendropsis* F. v. M.
Scolopendrium Delavayi Franch., preferably *Asplenium Delavayi*.
Scolopendrium cardiophyllum Hance, made a distinct genus, *Boniniella* by Hayata, but better treated as *Asplenium*.
Antigramma Presl, of Brazil, usually called *Scolopendrium*.
Schaffneria nigripes Fée, of Mexico, known also as *Scolopendrium* and *Phyllitis*.

If a summary be desired:

Parallel and convergent evolution are really common phenomena in ferns.

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"NOTHOLAENA" IN BRAZIL

C. A. Weatherby

With two plates

Most American species of the complex traditionally referred to *Notholaena* are Cordilleran. Their aggregate range extends, in a relatively narrow belt limited by the extent of the highlands which offer the dry and rocky habitats congenial to these xerophytes, from the southwestern United States to northern Argentina and Chile. One species, *N. dealbata* (Pursh) Kze., occurs in the western half of the Mississippi Basin in the United States; three are endemic in the West Indies; two, *N. obducta* (Mett.) Baker and *N. Hassleri* Weath., extend to low elevations in the basin of the Paraná; and in the highlands of eastern Brazil, mostly in the states of Minas Geraes, Goyaz, and Piauhy, is found a group of five endemic species (plus a few isolated stations for two varieties of *N. nivea*). Of these outliers, the populations of the Mississippi Basin and of the West Indies are clearly members of otherwise Andean groups. In South America, *N. Hassleri* and *N. obducta* show less close, but still recognizable relationship, the former with *N. sinuata* (Lag.) Kaulf. of wide Andean range, the latter with *N. squamosa* (Gill.) Lowe of Bolivia and northern Argentina. But the five endemics of eastern Brazil are both geographically and morphologically isolated.

Judging from their scanty representation in herbaria, all the east-Brazilian species are rare and local. Although St. Hilaire collected members of the group about 1817, only two species, *N. Pohliana* Kze. (1840) and *N. eriophora* Fée (1850–52), were recognized until 1896, when Taubert added *N. goyazensis*; and nothing resembling a study of the group was made until 1940, when Brade proposed *N. venusta* and gave a key to the whole five.

Brade's knowledge of Brazilian ferns is unsurpassed; that I venture to follow his sketch with discussion of my own is because he goes very little into detail; because I can, I hope, add data inaccessible to him; and because certain points of classification, identity, and nomenclature remain to be considered. They are not all settled here; but it seems worthwhile to set down the information I have, as a step toward better understanding of these still little-known ferns.

Four of the east-Brazilian endemics (*N. venusta*, *N. eriophora*, *N. goyazensis* and *N. geraniifolia*) are closely related and in many ways alike. All have short-repent, often branched rhizomes. The rhizome-scales are narrow, with a weak capillary tip often tortuous in dried material, a more or less developed castaneous, sclerotic central band, and a narrow, brownish, hyaline margin. The fronds are approximate, forming loose tufts. The blades are more or less strongly pedate; under conditions of drought they curl up into tight little balls with only the lower surface, well protected against excessive transpiration by its tomentum, exposed. Unfortunately for the herbarium-worker, most specimens have been collected in this condition. The indument is lanate and, at least on the lower surface, very dense. In three species it is composed of a close felting of very fine hairs next the leaf-surface, overlaid by longer and coarser hairs, quite like a muskrat's fur. The sori are borne on more or less dilated, clavate or somewhat flabellate vein-ends at or near the margin. The sporangia are of the usual cheilanthoid type — short-stalked, with a narrow ring and a broad stomium of laterally much elongated cells.[1] The spores are also of the type commonest in the Cheilantheae, subglobose and smooth or minutely granular.

The four species have their nearest and their only close relative in *N. inaequalis* Kze. of southern Africa (Cape Colony to Natal, Rhodesia, and Angola), as Kunze himself suggested in describing that species. This is, of course, one more example of a geographic relationship often noted in other groups. In indument and position and structure of sori *N. inaequalis* is quite like its Brazilian brethren, but in it the pedate habit is less developed and the rhizome-scales are larger and of different structure.

In the fifth east-Brazilian species, *N. Pohliana*, rhizome, scales, and sori are similar to those of the other four. But the architecture of the lamina and the indument are quite different, and the pinnules have a very narrow, but definite, hyaline marginal band, expanded into small lobes opposite the soriferous vein-ends — an obvious development in the direction of the false indusia of *Cheilanthes*. Band and lobes are ciliate. Like the others, *N. Pohliana* appears to have no close relatives among Andean species. *N. cinnamomea* Baker of Central America resembles it in habit and indument, but has the leaf-margin quite unmodified and the sori somewhat elongate and borne on scarcely dilated vein-ends a little back from the margin. Christensen (Ind. Fil. 462) has suggested that *N. Pohliana* might be better placed in *Adiantopsis*. Very possibly its affinities do lie with a group of species of Brazil, northern Argentina, and areas between, variously referred to *Adiantopsis* and *Cheilanthes*, such as *A. regularis* (Kze.) Moore and *C. Regnelliana* Mett. These species may eventually be brought together as one of the units in the final arrangement of the Cheilantheae.

The taxonomic treatment which follows is based on material in eleven herbaria, the European visited in 1937 and 1939. They are: Berlin (ab-

[1] They are well figured in Mart. Fl. Bras. 1(2): *pl. 66*.

breviated as B); British Museum (BM); Field Museum (F)[2]; Geneva (Gen); Gray Herbarium (G); Kew (K); New York (NY); Paris (P); Philadelphia Academy (Pa); United States National Herbarium (US); Yale University (Y). To the officers of all of them I am greatly indebted for the privilege of examining the specimens under their care — a privilege particularly valuable in a group so inadequately represented in most single herbaria as this.

Characters given in the introduction or in the key are, for the sake of brevity, usually omitted in the descriptions. Many of the place-names, quite unfamiliar to me, were perforce copied, as best I could, from handwritten labels in European herbaria. I have tried to check them with standard atlases (in which they are very often not to be found) and with the recent Millionth Maps of the American Geographical Society (where also I have sometimes failed to find them). If, under these circumstances, I have been guilty of any particularly grotesque mis-spellings or misplacing of localities, I can only beg the indulgence of my South American colleagues.

As in previous papers — Contrib. Gray Herb. **127**: 3–15 (1939); Lilloa 6: 251–275 (1941) — the name *Notholaena* is retained in its traditional broad sense pending a thorough study of all the species concerned.

KEY TO THE BRAZILIAN SPECIES REFERRED TO NOTHOLAENA.

a. Indument of hairs. *b*.
- *b*. Lamina deltoid or pentagonal, pinnate-pedate or pedate, usually much shorter than the stipe; lowest pinnae much the largest, usually strongly inequilateral. *c*.
  - *c*. Stipe thinly villous with straight, distinctly moniliform, often gland-tipped hairs; lamina with 1–3 wholly free pinnae, the rachis between them not winged; only the basal pinnae deeply divided............. 1. *N. venusta*.
  - *c*. Stipe lanate with long, tortuous, matted, slender, non-glandular hairs, or glabrous; all segments of the lamina usually connected at least by a narrow wing along the rachis. *d*.
    - *d*. Indument of both surfaces of lamina of long, slender, tortuous, obscurely articulate hairs; only the basal segment deeply lobed..... 2. *N. eriophora*.
    - *d*. Indument of lower surface of lamina of fine, short, densely felted tomentum overlaid by long, straightish, conspicuously articulate hairs, the cross-walls of their cells dark; median segments, as well as the basal, lobed. *e*.
      - *e*. Indument of upper surface of lamina of fine, whitish, tortuous, more or less matted hairs; median segments simply pinnatifid, with entire lobes; rhizome-scales bright brown in mass................. 3. *N. goyazensis*.
      - *e*. Indument of upper surface of lamina of coarse, straightish, golden to whitish, not much matted hairs; median segments sub-bipinnatifid, their lobes more or less cut; rhizome-scales fuscous in mass. 4. *N. geraniifolia*.
- *b*. Lamina deltoid-lanceolate, bipinnate, equalling or longer than stipe; lowest pinnae not greatly larger than those adjacent, equilateral; indument of lower surface of lamina thin..................................... 5. *N. Pohliana*.

a. Indument ceraceous; lamina at least subtripinnate. *f*.

[2] Now the Chicago Natural History Museum, but known so long under its old title that it seems more convenient and intelligible to retain the abbreviation "F" for the present.

f. Indument white; stipe bright-castaneous; lamina bipinnate above, subtripinnate in lower pinnae.............................6a. *N. nivea* var. *oblongata*.
f. Indument yellow; stipe dark-castaneous; well-developed lamina fully tripinnate. 6b. *N. nivea* var. *flava*.

1. **Notholaena venusta** Brade in Anais Prim. Reun. Sul-Amer. Bot. 2: 7, *t. 4, fig. 1, 2* (1940). PLATE I, FIG. 1.

Notholaena capillus St. Hilaire in herb. and ex Christ in Bull. Herb. Boiss. II. 2: 381 (1902), pro syn.

Rhizome about 2 mm. in diameter, its scales about 2 mm. long, sometimes serrulate toward the apex with narrow, ascending teeth; stipe terete, 0.4–0.5 mm. in diameter, 6.5–9 cm. long, castaneous, shining; lamina pentagonal to somewhat elongate-deltoid, 3–4 cm. long, 2–3 cm. wide, commonly fully pinnate to about the third pair of pinnae from base; basal pair of pinnae deeply pinnatifid and more or less inequilateral by the elongation of the basal segment on the lower side, their divisions oblong, obtuse, entire or the developed basal segment shallowly undulate-lobed; median pinnae oblong or linear-oblong, entire or shallowly lobed, rather distant, decreasing rather gradually to a somewhat prolonged, obtuse, narrow, pinnatifid apex; rachis castaneous; tomentum of the upper surface of lamina grayish, of slender, tortuous and matted long hairs, that of the lower surface rufous, of similar hairs underlaid by a dense felt of shorter and finer hairs; veins immersed, ultimate veinlets 1–2-forked, at least the soriferous with rather abruptly dilated, somewhat flabellate ends at or very near the margin; spores about 65 μ in diameter. — Known to me from Minas Geraes and Piauhy.

TYPE: Ad rupes, Diamantina, Minas Geraes, June, 1934, *Brade 13494* in herb. Jardim Botanico, Rio de Janeiro; not seen.

Specimens seen. MINAS GERAES: Sub rupibus prope pagum Nossa Senhora da Penha, *St. Hilaire B' 1220* (P)[3]; Serra de Ibitipoca, June, 1896, *herb. Magalhães Gomes 1099* (P); Serra do Cipó, June, 1901, *Schwacke 14520* (G, P). PIAUHY: Without definite locality, 1836, *Gardner 2392* in pt. (P).

Both St. Hilaire, who made the first collection of this "especie graciosa," as Brade appropriately calls it, and Christ gave it herbarium names. Christ suppressed his own, but mentioned St. Hilaire's as a synonym of *N. eriophora*. I used *N. capillus* in labelling sheets at Paris; it must now give way to the properly published *N. venusta*.

Both *N. venusta* and *N. eriophora* have had the misfortune to be described from depauperate specimens, as will appear on comparison of the drawing from an average specimen of St. Hilaire's, reproduced here, with

[3] St. Hilaire in his Travels mentions two villages by this name, both in Minas Geraes. One (Voyage dans le District des Diamans, 135) is near what is now Bello Horizonte, about 10 km. north of Caeté and near the Pico da Piedade, of the view of which St. Hilaire writes with appreciation. This village appears on modern maps simply as Penha. The second (Voyages dans les Provinces de Rio de Janeiro et de Minas Geraes 2: 10) is described as near the settlement of Rio Vermelho in the "termo" of Minas Novas. This Nossa Senhora da Penha is not on modern maps; Rio Vermelho appears about 50 km. east of Diamantina. Since St. Hilaire's label reads "in Mina Nova," it is probably the locality from which his no. *B' 1220* came. St. Hilaire says he found no other place in the province with such varied vegetation.

Brade's drawing, and of Fée's original plate of *N. eriophora* with Hooker's later one.

2. **Notholaena eriophora** Fée, Gen. Fil. 159, *t. 13, fig. 3* (1850–52) and Crypt. Vasc. Brésil 55 (1869); Baker in Mart. Fl. Bras. 1(2): 541 (1870), *excl. t. 66.* PLATE I, FIG. 2.

Notholaena palmatifida Kze. Farnkr. 1: 148 (1844), nomen nudum. Based on *Gardner 2390.*

Polypodium eriophorum (Fée) Hook. Ic. Pl. 10: *t. 991* (1854).

Cheilanthes eriophora (Fée) Mett. Cheil. 23 (1859).

Rhizome 2–3 mm. in diameter; stipe terete, 4–11 cm. long, 0.4–0.5 mm. in diameter; lamina pedate-pinnatifid, 2–3.5 cm. long and as broad or somewhat broader, the basal pair of segments usually much produced on the lower side and strongly inequilateral, their basal divisions on the lower side themselves lobed and somewhat inequilateral, all divisions broadly obtuse; upper part of lamina cut to near rachis into 3–4 oblong, obtuse, entire segments, tapering evenly into a broad, short, 3–4-lobed obtuse apex; texture rather thin, the veins, when indument is removed, visible by transmitted light; ultimate veinlets 1–2-forked, their clavate apices a little back from the margin; indument of both surfaces whitish to rufescent; spores about 42 μ in diameter. — Piauhy and probably elsewhere.

TYPE: Shady clifts on the hills near the city of Oeiras, Piauhy, March, 1839, *Gardner 2390*, presumably at Rio de Janeiro; not seen. Isotypes: BM, G, Gen, K, NY, P, US.

Specimens seen. PIAUHY: Felsenritzen, Serra Branca, Jan., 1907, *Ule 7423* (B); Felsen, Serra do S. Ignacio, Feb., 1907, *Ule 46* (B). State uncertain: Rincas das pedras prope Castro, Jan. 8, 1880, *Schwacke 2545* (B). Without definite locality: *Glaziou 14409* (B, K, P, US); *Herb. Kew. 1037* (Y).

The leads for *N. eriophora* in Brade's key read (translated from the Portuguese): "lamina pedate [i. e. without free pinnae] . . . petioles thinly beset with straight hairs perpendicular to it." Exactly the same secondary lead serves for *N. venusta*. He cites, as cotype (I should have supposed it the type) a specimen of *Gardner 2390*, "ex herb. Fée," sheet no. 30,922 in the herbarium of the Jardim Botanico at Rio de Janeiro, which, of course, he must have seen. Yet his statement is difficult to reconcile with any other evidence.

In the first place, Fée described the stipes in his material as "glaberrimi" — a condition which can readily enough be found in old fronds, the tomentum being deciduous — and they are so figured by him, with the lanate tomentum of the lamina correctly delineated. Hooker figures spreading hairs on the stipes, but his own specimens at Kew, from which his drawing must have been made, show no such thing. Since the tomentum of the lamina is also represented by spreading hairs, one must conclude that Hooker's draughtsman, less accurate and less skilful than Fée's, was merely using a conventional means to indicate any kind of pubescence. All of the nine sheets of *Gardner 2390* which I have seen in various herbaria are alike; all show stipes lanate when young, glabrate in age. This does not, of course, preclude the possibility of a mixture in Gardner's collection. But in all the material I have examined, I have seen stipes with sparse, spreading hairs only in *N. venusta*, which, of course, can be recognized by other characters. It would seem, if Brade's statement is correct for the type of *N. eriophora*, that Fée must have had a very depauperate individual of *N. venusta*, not sufficiently developed to show free pinnae, and that he misdescribed the stipe — or that there is a sixth endemic in eastern Brazil unknown to me. In any case, suspecting an error somewhere, I am keeping the name *N. eriophora* for the species represented by the nine sheets of *Gardner 2390*.

Phylogenetic conjecture is very likely quite futile in so small and closely knit a group as this; but if it may be permitted, *N. eriophora*, as here understood, is to be regarded as the most primitive of the four pedate species. In it, the leaf-margin is, as Mettenius described it, "omnino immutatus"; at least two of the others (I have not found it in *N. venusta*) have definite, if rudimentary, hyaline margins. The indument is simple, of one type of hairs only, as against two or three in the other species. The sori are borne on only moderately dilated vein-ends appreciably back from the margin. If Bower's opinion is correct — and his cautious and carefully reasoned conclusions deserve all respect — the more or less elongate sorus, borne on scarcely modified veins somewhat back from the margin, is primitive in the Cheilantheae. It is to be hoped he is correct, for, on this basis, one can trace an unbroken and very pretty developmental series from the elongate sorus and unmodified vein-ends of *Pellaea* and some species of *Notholaena*, through short sori, clavate, flabellate and transversely dilated vein-ends, approaching nearer and nearer to the margin, in *Notholaena* and *Cheilanthes*, to the marginal coenosorus and transverse vein of *Doryopteris*. In this series *N. eriophora* would come somewhat between the pellaeoid and cheilanthoid types, belonging, since the sorus itself is short, to the latter, but preserving something of the former. The other species are purely cheilanthoid. *Notholaena goyazensis* might be considered a derivative of *N. eriophora*, and *N. geraniifolia*, with its more complex venation and specialized indument, a still more advanced member of the same line of descent, with *N. venusta* representing a development in a different direction; but there seems little profit in such speculation.

3. **Notholaena goyazensis** Taubert in Bot. Jahrb. 21: 421 (1896). PLATE I, FIG. 3.
Cheilanthes goyazensis (Taubert) Domin in Bibl. Bot. 20: 133 (1915).

Rhizome about 4 mm. in diameter; scales 3–4 mm. long, 0.1–0.2 mm. wide at base, remotely serrulate toward apex, those of the young growth bright brown and concolorous, the older with castaneous, sclerotic central band; stipe 3–10 cm. long, with the tomentum about 1 mm. in diameter, in age glabrate and blackish castaneous; lamina 4.5–6 cm. long, usually about as wide, pinnate-pinnatifid or, in the basal pinnae only, subbipinnatifid, these usually connected with those above by a narrow wing along the rachis, inequilaterally elongate-deltoid, the basal segments on the lower side much produced and pinnatifid with oblong, obtuse lobes;

median segments of lamina linear-oblong, equilateral, pinnatifid with oblong, obtuse, entire lobes, the basal lobes adnate to the rachis and forming a broad, basally narrowed wing along it; the 2–4 upper segments rather abruptly contracted into an obtusish, short or sometimes produced, pinnatifid apex; tomentum of upper surface whitish or grayish, that of the lower surface at first whitish, in age dull brown or pale ferrugineous; margin of the segments with a very narrow hyaline band, scarcely more than one or two cells wide; ultimate veinlets at an acute angle to the costule, simple or once-forked, the fertile ending at the margin of the leaf-tissue in an abruptly dilated, subflabellate tip; spores about 50μ in diameter. — Minas Geraes and Goyaz.

TYPE: Serra Dourada, Goyaz, Jan., 1893, *Ule 3222*, whereabouts unknown.

Specimens seen. MINAS GERAES: São João d'el Rei (Serra de Lenheira), Oct. 13, 1886, *Glaziou 16643* (B, G, K, P); in locis siccis, Serra do Cipó, April, 1905, *Silveira* (P); on rocks in sandstone area, Serra de Bocaina, Municipio de Serro, 10 km. northwest of Serro, May 4, 1945, *L. O. Williams 6871* (G, US). GOYAZ: Entre le village et la Serra dos Crystaes et Caleceira do Rio Samambaia, dans les fissures des roches, Sept. 18, 1895, *Glaziou 22625* (P); Serra de Caraça, May 28, 1907, *Damazio 1859* (B, NY, P, US); without definite locality, *Glaziou 22625* (B, Gen).

As above noted, I failed to find Taubert's type at Berlin. I here use his name in the sense of Christ and Brade, which agrees well enough with the original description. *Ule 531*, from Serra Dourada, Goyaz (P), which I determined in 1937 as *N. eriophora*, may belong here. Christ, who seems to have understood this species accurately, so places it (Bull. Herb. Boiss. II. **2**: 381). He was, however, thoroughly confused as to *N. eriophora*. He cited under it Fée's and Hooker's plates, which are *N. eriophora*; *plate 66* of the Flora Brasiliensis, which is *N. geraniifolia*; the collections of St. Hilaire, Schwacke, and Magalhäes Gomes here referred to *N. venusta*; and no specimens at all of true *N. eriophora*, as I understand it.

Taubert's name, as here applied, supersedes an unfortunate manuscript name of mine to be found in several herbaria.

4. **Notholaena geraniifolia** St. Hilaire in herb., sp. nov. PLATE I, FIG. 4; PLATE II.

St. Hilarii diagnosis, ipsius manu in schedula scripta, est:

"Stipite gracili, semitereti, subhirsuta: fronde breviuscula profundissime pinnatifida-palmata subtus praecipue hirsutissima: divisionibus angustis pinnatifidis: laciniis breviter linearibus obtusis interdum crenatis — Planta 6–8 pollicaris. Pili paginae inferioris frondis rufi. Stipes atrofuscus."

Quo addendum est sequens. — Rhizoma breviter repens circa 2 mm. diametro, paleis anguste linearibus circa 3–4 mm. longis 0.2 mm. latis medio saturate brunneis subscleroticis, margine angusto hyalino pallido distanter serrulato, apice capillari, dense onustum. Frondes subapproximatae. Stipes quam lamina multo longior (ter vel etiam sexies). Lamina pentagona latitudine longitudinem subaequante; pinnis vel segmentis basalibus inaequaliter deltoideis laciniis basalibus basiscopicis valde elongatis profundeque pinnatifidis, laciniis omnibus plus minusve lobatis; segmentis superioribus laminae circa 4-jugis lineari-oblongis obtusis bipinnatifidis laciniis oblongis vel anguste deltoideis adscendentibus, laciniis basalibus basiscopicis in rhachem decurrentibus lobos sicut e rhachi exeuntes patentes formantibus; apice laminae brevi pinnatifido obtuso. Pagina superior laminae subdense hirsutula pilis ex comparatione crassis aureo-brunneis nitidis subrectis vix intricatis; pagina inferior lanata pilis aliis gracillimis brevibus densissime intricatis ferrugineis aliis longis subrectis articulatis. Laciniae margine hyalino angustissimo instructae. Venulae 2–3-furcatis, soros breves ad apicem dilatatum parenchymatis margine extremo gerentes. Sporangia in soro singulo pauca breviter stipitata. Sporae subglobosae circa 45 μ diametro laeves vel minute granulatae. — Braziliae in provinciis Minas Geraes et Bahia (?) adhuc lecta.

TYPE: In rupibus prope pagum S. Miguel da Tiquitinhonha, *St. Hilaire B' 1489* in Herb. Paris; seen. Illustration: Mart. Fl. Bras. **1**(2): *t. 66* (1870), as *N. eriophora*.

Other specimens seen. MINAS GERAES: Serra de Caraça, Nov. 9, 1913, *A. Maublanc 584* (P); Pantano Agosto, *Glaziou 14408* (B, G, Gen, K, P). BAHIA (?): Auf Felsen bei Calderão, 800 m., Oct., 1906, *Ule 7239* (B).

To this species, clearly distinguishable by the architecture of the blade and the character of the indument, Brade applies the name *N. palmatifida* Kze. This I cannot accept. Kunze mentions the name casually in Farnkr. **1**: 148 as that of a species later to be described, with no word of diagnosis, but with the citation of *Gardner 2390* as its sole basis. This is the type-number of the later *N. eriophora* Fée. Kunze's name had been, until Brade took it up, universally regarded as a direct synonym of *N. eriophora*; this still seems the wisest course.

Kunze in 1845 had been chosen to contribute the treatment of the ferns to the Flora Brasiliensis; he no doubt intended to publish this and some other species, of which he spoke similarly, in that work. At the time of his death in 1851 he had prepared fifteen plates for the Flora which were duly published in 1870 by Baker, who took over the treatment of the ferns. *Plate 66*, which, as Brade points out, represents the present species, is one of the fifteen. Baker remarks (p. 541) that the Kunze specimen figured is more deeply cut than those of Gardner figured by Hooker, but gives no hint as to the name which Kunze had originally attached to his plate and seems by his phrasing to imply that Kunze's specimen was not one of Gardner's. There is no direct evidence that it was. It is possible that there was a mixture in *Gardner 2390*, but, as previously noted, the nine sheets of that number which I have seen are alike, and, though confusion of *N. eriophora* and *N. venusta*, or even *N. goyazensis*, might easily occur, it is much less probable in the case of *N. geraniifolia*.

I have nowhere seen any specimen labelled *N. palmatifida* by Kunze. Until the sheet of *Gardner 2390* which he actually had is discovered, existing evidence should be taken at its face value. It is far better and simpler to suppose that Kunze merely gave a name, which he did not live to publish, to the species later described as *N. eriophora* by Fée, and to take up for the present species the indubitable, though not hitherto published, name of St. Hilaire, than to avoid a new name by applying Kunze's in a sense apparently directly contradicted by his citation of type. This is the easier because *N. palmatifida* was never validly published. It began as a *nomen nudum*; had, so far as I know, been cited only in synonymy until Brade accepted it in 1940; and was then not provided with the necessary Latin diagnosis.

5. **Notholaena Pohliana** Kze. Farnkr. 1: 45 (1840); Hook. Sp. Fil. 5: 118, *t. 286B* (1864); Baker in Mart. Fl. Bras. 1(2): 541, *t. 48, fig. 3* (1870).
Cheilanthes Pohliana (Kze.) Mett. Cheil. *23* (1859).

Stipe slender, terete, blackish, dull, glabrous or beset with short, pale, retrorse, sometimes branched trichomes; lamina tapering regularly from base to long-attenuate apex, 8–12 cm. long, 2.5–4 cm. wide, with up to 18 pairs of pinnae; rachis like stipe; lower pinnae with 3–5 pairs of free, oblong or deltoid-ovate, obtuse, entire or sometimes lobed pinnules 6 mm. or less long, and a 3–5-lobed deltoid, obtuse terminal segment; rachilla of pinnae black; texture of blades herbaceous, opaque, the veins immersed, 3–4-forked; both surfaces loosely beset with long, simple, distinctly articulate, pale brownish hairs; spores subglobose, about 50 μ in diameter, tuberculate. — Rio de Janeiro, Minas Geraes, and (?) Goyaz.

TYPE (fide Mettenius): Brazil, *Pohl*, perhaps at Vienna; not seen. A specimen of *Gardner 3554* at Geneva, determined by Kunze, may be taken as authentic.

Specimens seen: "Environs de Rio de Janeiro et d'Ouro Preto," 1883–84, *Glaziou 15735* (B, K); Serra da Natividade, Oct., 1839, *Gardner 3554* (B, BM, F as *3551*, Gen, det. by Kunze, K, P, US).

Kunze put forward *N. Pohliana* somewhat casually, as he did *N. palmatifida*, as a species later to be described. In this instance, however, he stated that the new species resembled *N. tenera* in habit, was hairy on both surfaces of the lamina, and had a creeping rootstock. There is only one Brazilian species referable to *Notholaena* which fulfills these conditions; Kunze's statement may therefore be taken as indicating the identity of his plant well enough to constitute technical publication. Mettenius provided a detailed description under *Cheilanthes* and Hooker added a good plate. These agree and with the specimen at Geneva determined by Kunze fix the identity of the species beyond doubt.

There is some question as to the correct numbering of the Gardner collection cited. Mettenius, Hooker, and Baker all give the number as *3551*. Hooker also gives the locality "Serra da Natividade." Yet all the sheets from this locality which I have seen, in seven different herbaria, bear the number *3554*, except one at the Chicago Natural History Museum numbered *3551* and one at Kew (where there are two) in which *3551* has been altered to *3554*. Since all the specimens appear to be of the same collection, I am taking *3554* as correct.

6a. **Notholaena nivea** (Poir.) Desv. var. **oblongata** Griseb. Symb. Fl. Argent. 342 (1879).

Rhizome short, erect, its scales linear or linear-lanceolate, brown, concolorous, with elongate, slender-walled cells; pinnae and pinnules petiolate, the ultimate segments small, oblong and entire or subdeltoid and trilobate, often distant, articulate on their pedicels; sori elongate, occupying at least the outer third of the veins; spores rugose. — Peru, northern Argentina, and Santa Catharina.

TYPE not designated, but said to be from Salta; a specimen at Kew labelled "comm. Grisebach, 1878" is taken as authentic.

Specimens seen: SANTA CATHARINA: San Joaquim, 1000 m., *Spannagel 172* (NY, Pa).

6b. **Notholaena nivea** (Poir.) Desv. var. **flava** Hook. Sp. Fil. 5: 112 (1864).
Notholaena flavens (Sw.) Moore, Ind. Fil. LXX (1857).

Distinguished from the preceding by the characters given in the key. — Colombia along the Andes to northern Argentina; Minas Geraes.

TYPE not designated nor any specimens cited in the original description, but identity clear.

Specimens seen: MINAS GERAES: An Felsen des Campos São Julião, *Schwacke 12764* (P); Miguel Burnier, Preto, *Damazio 1728* (NY, US).

For further discussion and full synonymy of these varieties, see Maxon & Weatherby in Contrib. Gray Herb. **127**: 10–15 (1939). Christ, quoting Schwacke, states that var. *flava* is very frequent about São Juliao.

It is not clear whether these isolated Brazilian stations are to be interpreted as the result of migration eastward from the Andes or as relics of once wider ranges. In the Andes all varieties of *N. nivea* are plants of rather high altitudes, descending to lower levels only in the more temperate climate of northern Argentina. The nearest known stations are in eastern Bolivia and in the province of Córdoba in Argentina; they are some 800 miles from the Brazilian locality in Santa Catharina and some 1200 from Minas Geraes.[4] It is possible to postulate a migration-route from eastern Bolivia across the upper Paraná basin, where the gap between the Bolivian and Brazilian highlands narrows to 250 miles, but, pending the discovery of intermediate stations, this must remain pure conjecture.

[4] The two stations in Minas Geraes are close together, perhaps the same.

EXPLANATION OF PLATES

PLATE I

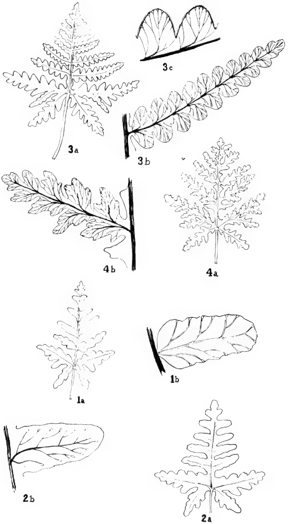
The drawings are intended to show outline of blade and venation; in all cases, indument and sporangia are removed. Blades are approximately $\times$ 1; single pinnae or segments, $\times$ 3; fig. 3c, $\times$ 6.

FIG. 1. *N. venusta:* a, outline of blade from photograph of *St. Hilaire B' 1220*, type of *N. capillus*; b, median pinna from *Schwacke 14520*. FIG. 2. *N. eriophora*: a, outline of blade, from photograph of a sheet of *Gardner 2390* at Kew; b, median segment from sheet of *Gardner 2390* at Herb. Gray. FIG. 3. *N. goyazensis*: a, outline of blade; b, median segment; c, two lobes of the same; all from *L. O. Williams 6871*. FIG. 4. *N. geraniifolia*: a, outline of blade; b, median segment; both from *Glaziou 14408*.

PLATE II

Type of *N. geraniifolia, St. Hilaire B' 1489* in Herb. Paris.

GRAY HERBARIUM,
HARVARD UNIVERSITY.



"NOTHOLAENA" IN BRAZIL

"NOTHOLAENA" IN BRAZIL

MORE PLANT STUDY: FEWER PLANT NAMES

Carleton R. Ball

Nature produces infinite variety. Man (the taxonomist) desires, imagines, and describes uniformity. Therein lies perpetual confusion and conflict. Before obvious differences can be evaluated, we need to understand their nature, extent, and probable causes. The writer can speak definitely only of the genus *Salix* (willows).

FOUR MAJOR CLASSES AND CAUSES OF VARIATION

Four major classes of variation occur normally on shrubby and/or arborescent willows, and to a lesser degree on prostrate and creeping species. A: The same organ, on one part or on different parts of a single plant, normally presents striking variations. The pattern is permanent but the expression is modified by environmental conditions. B: An individual organ usually or often shows great variation during the course of a season or a year. These variations are the direct result of the advance from spring to summer, to autumn, and back to spring again, but their expression will be modified by differing conditions in differing seasons or years. C: Plants of a single species, growing under obviously different conditions of local environment, frequently present large variations from spot to spot. While presumably environmental effects, these variations may include the hereditary differences of Class D also. D: Two or more individuals, growing under apparently identical conditions of local environment, frequently display obvious differences. These should be hereditary variations, if the environments actually are identical, but are influenced somewhat by the age of the plant.

A. Variation of an Organ on a Single Plant

The Individual Leaf. As the leaf emerges from the bud-scale, the outer or apical portion broadens first. This broadening progresses toward the base. If the nutrient supply is reduced by competition farther out, before growth of the leaf is completed, the lower (first developed) leaves may never finish normal basal expansion. Leaf-bases may remain cuneate, acute, or rounded, which should have become acute, rounded, or cordate, respectively. The tip also may fail to elongate, leaving the apex obtuse or acutish when it should have been acute or acuminate.

Different Leaf Forms on a Single Twig. On any given twig, there will be three successive and intergrading sizes and shapes of leaves, occupying basal, central, and apical locations on the twig. The basal leaves in general will be smaller, narrower at base, and broader and blunter at apex than the central leaves. The apical leaves will tend to be larger, broader at base, and more acute or acuminate at apex than the central leaves. The central leaves, therefore, are somewhat intermediate between the basal and apical leaves in size and shape, just as they are intermediate in position and time of development. In general, therefore, there is a steady progression in leaf size and shape from the base (first developed) to the apex (last developed) of the twig. This progression tends to recapitulate the developmental history of the individual leaf. These facts hold, no matter what the normal shape of the leaf may be.

Four Types of Twig Per Plant. Normally there are three, and sometimes four, types of leafy twigs produced successively during each season. Type *a* is represented by the short twigs which develop simultaneously with the fruits, from lateral leaf-buds on the fruiting twigs. Type *b* is represented by the longer and somewhat vigorous twigs which develop, after fruiting is over, from apical buds on the fruiting twigs. Type *c* is represented by the vigorous shoots which develop later from buds on older wood, after the food-drain of fruiting is over. Type *d* is represented by the luxuriant shoots (water sprouts) which sometimes develop on trunks and/or roots in late summer. Schneider (10, p. 9–10)[1] discussed parts of this problem briefly in 1918, but in somewhat vague language; the writer (4) more fully in 1943.

On each of these four successive types and sizes of branchlets, there will tend to be the same progressive shift in size and shape of leaves, from base to apex, as was described above. But in addition to this normal progression, all the leaves on type *a* tend to be shorter and relatively broader, all those on type *b* tend to be intermediate, and all those on type *c* tend to be larger than on the others. These changes, like those on a single twig, probably represent the more abundant food supply and more favorable temperatures as the season advances. Fruiting limits nutrients available to early shoots and rapid elongation of a summer twig may cause food to bypass the basal leaves. Sometimes the apical leaves on late-produced type *c* twigs do not attain full size because of drought or cold in autumn. The leaves of all three groups on the sprouts of type *d* often are enormous in size and more or less different in shape, but there will be the same general progression from base to apex of sprout. Because of the variations just discussed, the writer often takes from three to six or seven sheets from a single plant.

B. Variation of an Individual Organ During the Year

Twig, Bud-scale, and Branchlet Changes. These organs, as well as petioles, may change greatly in color and clothing during the successive seasons of a year, and the twigs during successive years, as they become 1-year and 2-year branchlets. These changes are caused by plant reactions

[1] Numbers in parentheses refer to "Literature Cited" at end of paper.

to sun, temperature, rain, etc. In general, they are greatest in plants in full sun and on those organs in direct sunlight.

In general, colors darken as the season advances. Original yellows, light greens, and light browns become varying shades of darker brown to blackish. As new twigs are produced during the summer, each must pass through these changes. In a few species, as *S. amygdaloides* and *S. lutea*, the yellow is permanent. In parts of Alaska and Yukon, as noted by Dr. Setchell, the abundant *Salix Barclayi* colors the spring landscape with its bright yellow twigs and the very light yellowish green of the unfolding leaves. But in the herbarium, and the manuals, the branchlets are blackish. The occasional bits of still-yellow epidermis are neither large enough nor numerous enough to be conspicuous. The same facts are true of *S. monticola* in the Rocky Mountains, according to the continuing observations of Professor Ernest C. Smith. After going through the press, the twigs, with rare exceptions, are like those of *S. Barclayi*. By extremely careful drying, much of the yellow color may be retained.

Twig, bud-scale, and branchlet hairiness is one of the most variable characters of the vegetative organs of willows, and presumably of other plants as well. It is highly external, being a product of the epidermal cells and therefore greatly influenced by temperature, sun, etc. Its primary function probably is protection of young tissues against sun scald. In many species, the seasonal shoots (hornotini) are more or less densely puberulent, pubescent, or tomentose. This covering may be present in lesser degree as these shoots become 1-year (annotini) and 2-year branchlets in succeeding years. In other species, the seasonal twigs may be completely glabrous and remain so in later years. All this sounds simple, but. . . .

The conspicuous pubescence of a new shoot may wear off gradually during autumn and winter, leaving glabrate to glabrous twigs in spring. Many species shed the epidermis from the branchlets in spring or early summer and, of course, the hairs go with it. In such cases, there usually are "armpit" areas on the twig, behind buds or lateral twigs, where the epidermis was not deciduous and tell-tale remnant pubescence may be found. Hairiness of bud-scales usually parallels that of twigs.

Twig and bud-scale pruinosity occurs on such species as the western *S. irrorata*, *S. Lemmoni*, and *S. subcoerulea*, the northeastern *S. pellita*, and the European *S. daphnoides*. This waxy exudate is more external and less stable than the wax causing glaucousness of leaves, and therefore is more temporary in nature. It may be washed off by rain or snow, gradually removed by slow weathering, or completely discarded with peeling epidermis (5). Many other species, northern and arctic, occasionally show some pruinosity of bud-scales, branchlets, or even capsules, with organ frequency in the order named. This has little diagnostic value, because of infrequent and irregular occurrence, confinement to a small part of the eligible organ surface, or quantity so dilute as to be distinguished only with difficulty.

Leaf Structure. Leaves and stipules may change greatly in degree of gland-presence, serration, and vein-prominence during the season, as they develop from juvenile to full-sized, to mature, and to senescent condition. Glands may drop off and serratures may enlarge. Many species have normally entire leaves but scarcely one of these will fail to show some serration on vigorous apical leaves. Venation often becomes increasingly prominent with age in some species, under conditions little understood. Unusual specimens become varieties or forms under such names as *venulosa, marginata, reticulata,* etc.

Leaf Hairiness. The leaves of many, probably most, species of willows are more or less hairy, on one or both surfaces, while they are unfolding. If densely hairy at first, they become less so through expansion of area, even if no hairs drop off. For those kinds not permanently hairy, the rate of hair fall varies with the kind, the environment, and the individual, just as in the human races. Those which have a natal coating of very long hairs on the under-surface usually lose them quickly (*S. anglorum, S. laevigata*), and persistence is greatest at the tip. Those with shorter hairs are likely to lose them more slowly, first from the leaf-surface, then successively from the larger veins and outer midrib, and finally, if at all, from the lower midrib and petiole. Some arctic species remain ciliate on the margins. Species with permanently hairy leaves are found more commonly in cool and cold climates than in dry and hot areas, but there are exceptions. The hairs normally become thinner with age and some individuals in nearly all species lose most or all of the hairs by autumn. From this, we have varieties and forms named "glabra," "glabrescens," "tonsa," etc. How about naming balding humans?

Leaf Glaucousness. The glaucescence or glaucosity of the lower surface of the leaves of many species of *Salix* are valuable and usable taxonomic characters, if botanists understand the chemistry and physiology of this expression. It is the result of a waxy secretion, and the time of appearance and quantity produced seem to be governed by physiological processes. In species which normally are heavily glaucous, the whitening of the under-surface is apparent when the leaves begin to unfold, as in *S. longipes, S. laevigata, S. discolor,* etc. In species normally less densely glaucous, the color may not become visible until the leaves are half-grown, as in *S. cordata* and some relatives, *S. sericea, S. lasiolepis,* etc. In still others, as in the western *S. lasiandra* and the introduced *S. fragilis,* the under-surface may remain pale green until the leaves are full-sized.

To add to taxonomic troubles, this white waxy substance is destroyed by too rapid or too hot drying of fresh specimens. This occurs often when electric driers are used. The glaucous condition cannot be restored. The blades remain permanently "green on both sides" and cannot be identified by the usual keys.

Floral Organs, such as aments, peduncles with their bracts or leaves, flower-scales, glands, stamens, and capsules with their pedicels and styles and stigmas, likewise change greatly as they develop from the juvenile stage to maturity. Not only this, but the relative lengths of any two organs may change because some start earlier, or elongate faster, or continue growth longer than others. Some of those maturing quickest (glands, styles, and stigmas) may even shrink after maturing and so change relative dimensions. Yet some recent taxonomists still describe floral organs in terms of relative lengths, without regard to the degree of maturity of the two organs compared, as "gland equalling the pedicel," "styles ½ as long as pedicel," or "scale twice as long as the gland," etc. Such statements often are wholly misleading for taxonomic purposes.

There often is 100 percent variation in length of floral organs (except capsules) in a single ament, and it is not regular and progressive from base to apex or the reverse, although pedicels and scales tend to be longest at the base of aments. Scales are especially puzzling, as they usually are relatively short and broad in the opening ament and there is relatively little uniformity at maturity.

Scale Color and Hairiness. Scales in several Sections of *Salix* are pale yellow and deciduous. They may become pale brown in weathering or drying. In two Sections (*Glaucae, Rostratae*) with persistent scales, these are yellowish or light brown and may weather or dry to a medium brown, especially at the normally visible apex. In other Sections, the scales usually are dark brown to black and remain so, although light brown scales occur occasionally.

Flower-scales of most willows normally are hairy, primarily for insulation and protection of the subtended organs. In most species, these hairs tend to drop off gradually, especially from the outer surface. Some scales become glabrate outside, others remain hairy. Some northern and arctic species, however, have scales glabrate or glabrous from the beginning (*S. pyrifolia, S. leiolepis, S. chlorolepis*).

Capsule Hairiness. Many species have permanently hairy capsules and almost never is a plant found whose capsules have become entirely glabrous in age. Only rarely do these species have varieties with normally glabrous capsules. Exceptions are *S. brachycarpa* var. *glabellicarpa*; also the species *S. chlorolepis*. In Sections *Commutatae* and *Chrysanthae*, having some species with permanently hairy capsules and other species with normally glabrous capsules, the latter species are likely to have varieties with more or less hairy capsules (*S. Barclayi* var. *hebecarpa*, *S. commutata* var. *puberula*, *S. Hookeriana* var. *tomentosa*). Hairy-capsuled species in these sections do not have glabrous-capsuled variations. In some Sections (*Nigrae*) with normally glabrous capsules, variations with pubescent capsules may occur (*S. Gooddingii, S. Humboldtiana* var. *Martiana*), but the hairs usually are deciduous before capsule maturity.

C. Plant Variations Caused by Differing Local Environments

Every farmer and farm boy know the difference in height and color of maize plants in different parts of a single rolling clayey field: stunted and yellow plants on the dry and stony hilltops, because of lack of water and food; normal green and healthy plants on the lower slopes because of more water and sufficient fertility; deep green and luxuriant plants on the flat, fertile, well-watered bottoms, through exceptionally favorable conditions; marked differences in the size and color of plants and all of their organs. Yet all grew from the same lot of seed, in the same season. The ear-size of all three groups will be proportional to plant-size, but the hereditary characters, kernel-row number and kernel shape and color, will not be changed by these local influences.

Wild plants respond in the same way to moisture and fertility differences in rich, well-watered alluvium, drier second-bench, sterile sand or gravel bars or sand dunes, and dry and barren hilltops, wherever the same species gains a foothold in several or all of these habitats. In the drier and more sterile locations, the plants will be depauperate and the vegetative and many of the floral organs will be reduced accordingly. In the average or normal habitats, the plants will be normal and their organs will tend to be of average dimensions. Where moisture and fertility are high and temperatures favorable, as on a mid-latitude alluvial flood-plain, the plants will be luxuriant and their organs will respond by tending to reach sizes well beyond the normal. But these differences, however striking the extremes, do not make the different plants into "new" species or varieties. They should be labelled for what they obviously are: "depauperate," "normal," and "luxuriant." If conditions were changed, the plants would change also.

Conditions producing extreme heat locally may result in striking changes in affected plants, such as depauperate growth of plant and parts, extreme hairiness, etc. Such conditions occur on sandy and rocky situations, as bars, blow-outs, dunes, quarries, out-crops, etc., where extreme radiation of heat may occur. In the same way, extreme shade may cause remarkable differences in size, shape, thickness, and color of vegetative organs.

When the leaves of certain species of willows (*Longifoliae*) are eaten off in summer by sawfly larvas, a full new crop of much smaller leaves is likely to appear. They usually will be densely white-hairy, probably a reaction to midsummer temperatures much higher than those prevailing when leaves normally are unfolding. These plants are very deceptive in appearance, looking like something very different from what they really are. Usually, however, some attached fragments of the original and much different leaves may be found and the deception unmasked.

D. Actual Hereditary Differences

We see differences between individuals of the same species, even when growing under apparently identical conditions. If the conditions actually are identical, then these differences should be real and hereditary. The number of such differences, the regularity of their association, the uniformity of their expression, and the degree of their departure from the norm of the species will be factors in determining whether any of the plants warrant recognition as different taxonomic entities.

These basic facts can be verified only by a study of numerous plants in the field, in different geographic areas of the species range. Having in mind, however, the above-presented facts regarding variations, much may be deduced from a study of abundant and widely collected herbarium material. In the case of shrubby and arborescent plants, a herbarium specimen is but a fragment at best. Because, in *Salix* for example, the two sexes are on separate plants, it is a fragment of only one half. A series of specimens, unless specially collected, is only a series of fragments of the halves. And even if an extensive series came from plants which were practically identical, they would have been collected at different times in the season, at different periods of development, and from different portions (expressions) of the plants. And no two plants *are* practically identical. Some will be undeveloped or juvenile, other full-sized, still others mature. Unless the whole series is quite extensive, therefore, no satisfactory large-scale comparison is possible.

Furthermore, the average herbarium labels carry few or none of the data which might enable the taxonomist to determine if local environments (habitats) actually were similar, let alone identical. For these reasons, the student cannot be completely sure whether the differences observed on specimens are actual and hereditary or the effects of local environmental influences, either permanently or temporarily prevailing. To name new species or varieties, therefore, from one or a few fragmentary specimens under such conditions is to shun personal responsibility and to leave the real labor for another to perform later.

COMBINING PRECEPT AND EXAMPLE

Precept is easy and often abundant. Example is difficult and often proportionately rare. Certain important precepts have been set forth above. Summarized, they read: "Know what to expect from plants growing under different conditions, and why."

Below are outlined two quite different methods of studying botanical material for taxonomic purposes. In either case, it is assumed that the material represents, or is supposed to represent, a given species and its varieties, together with closely related species of possibly doubtful validity, and species and/or varieties currently held to be synonyms.

Two Methods of Studying Taxonomic Material

The first method is to obtain the largest possible collection of specimens representing all of these real, supposed, and/or unadmitted entities. Better still, study large numbers of living plants in the field, in different habitats in various geographic areas of the total range. Even better yet, do both. Because adequate field study is difficult or impossible for many students, chief dependence must be put on herbarium material. In any case, the specimens should be sorted out by geographic areas, without regard to the names which have been applied to them previously. Whether living or dead, complete or fragmentary, they are studied critically for similarities and differences, and the differences are analyzed as to nature, causation, and value, on the basis of the previous precepts. All this is without cross-reference to the previously published descriptions of the species and varieties involved.

This is the centripetal method, working from the outside in. It gets to the heart of the matter. It assumes the possibility of specific unity of the material. It challenges the mind to discover if there are differences, and to prove whether discovered differences are inherent or merely the effects of local environment. It says: "Find out what there is, — then what others thought there was." It keeps the mind free from prejudice while this is being done.

The second method is to study, successively, the descriptions and the cited or supposed material of each of the named species and varieties known or suspected to belong within the broad limits set. When one such has been studied and segregated, another is taken up, and so on until all have been covered. This is the centrifugal method, working from the inside out. It flies out from the center in all directions. It assumes differences, consciously or unconsciously, because others have done so. One is following a blazed trail instead of blazing one. Others have applied different names, have emphasized different characters or appearances, and have made comparisons to prove that significant differences exist. There is an internal pressure to verify what others have found or decided. All of this influence is present in addition to the urge to father more entities, new or resurrected, especially just before a new edition of a manual.

Standards for Taxonomic Workers

At present there are no professional standards or requirements for taxonomic workers. Each is a law unto himself, although their products affect tens of thousands of students and teachers, either as a help or as a burden. This lack of standards is responsible in part for the lack of respect in which this profession is held. If embryo taxonomists were required to go out and measure and record the range of variation in organs on a single large living plant or on numerous smaller plants of several species, they would return both tired and amazed. If they were required to follow the progressive variation of all organs on a plant through all of the seasons of even a single year, they would become both enlightened and humbled. Knowledge, with amazement and humility, is an excellent foundation for future taxonomists.

Such procedure would insure fuller and more accurate descriptions of plants, in journals and in manuals. With that, more people would know more about more plants. It also would curb the present tendency to consider every observed variation as a novelty to be named. This would mean reduction in the flood of synonyms, so expensive of time and money. It would keep systematic botany simpler and taxonomists more respected. The end result would be more time and money spent on knowledge of plants and less on knowledge of names. Many years ago, when a great university inaugurated a program of "humanizing instruction at the freshman level," a non-botanist said to the president: "I have seen a miracle on this campus." "What have you seen?" he was asked. "I have seen a class in botany out of doors looking at a plant," was the reply.

Many new species and varieties have been based on these major developmental and environmental variations. This will continue unless there is better teaching. Even a single leaf from each of the three series on a single twig, or three from each of the four twig-types on a single plant, may become the type of supposed new entities. A paleobotanist may do just that because, to him, a leaf is a determinable and usable unit. If two or more leaves are markedly different, they must represent, of course, different entities. Let us use a little common sense in this matter of basing novelties on such variations. Let us not make another 1000 so-called species of *Crataegus,* or of any other genus, with the type specimens of three species taken from one tree.

All are familiar with the often striking differences between the children of the same human parents. All had exactly the same ancestors, but some are short and some tall, some slender and some stout, some fair and some dark, and some quick and some slow. But we do not insist on naming new varieties and forms based on these differences. Nor do we base new species on the differences between the juvenile and the adult human organism.

Example: Exit Salix missouriensis Bebb

Turning now from precept to example, there is set forth an example of the results obtained when variable taxonomic material is studied by the centripetal method. Some may not agree with the conclusions reached. Conclusions in taxonomy always must rest on personal judgments. But it is hoped that there may be agreement as to the value of the method used.

In 1867, Andersson (2, p. 159), the Swedish salicologist, in a monographic discussion of *S. cordata* Muhl., arranged *S. rigida* Muhl. as a subspecies and thereunder created a new variety, *vestita*. This was based on a single juvenile specimen collected by Neuwied at Ft. Osage on the Missouri River (not far from present Kansas City). Of it, Andersson says: ramis crassiusculis, annotinis tomentosis; foliis novellis plus minus dense sericeo-tomentosis, lucidis, integris; amentis ♀ crassis praecocibus omnino nudis, rachi dense villosa, squamis sat longe pilosis, capsulis e basi sat crassa conicis stylo haud elongato apiculatis."

In 1868, Andersson (3, p. 252) presented var. *vestita* again, this time as a seventh variety of subspecies *rigida*. The description is shortened and the reference to thick branchlets omitted. The plant would pass for *S. cordata*, except perhaps for the stout aments and the long-haired scales.

In 1895, Bebb (6, p. 373) decided to raise Andersson's variety to specific rank but, because of the earlier *S. vestita* Pursh, he named it *S. missouriensis* and designated it as "n. sp." Needed parts of his long description will be given in the discussion of plant and organs which follows. He was somewhat doubtful of the validity of his species, however, and said:

"For one of the Cordatae, the extraordinary height and size of trunk attained by this Willow, the repeated [reputed?] durability of the wood for fence-posts, its early period of flowering, together with the technical characters above given, would seem to amply warrant its elevation to the rank of a valid species. At all events, as such, it is more likely to receive that further study and criticism which will determine its true status, than if left as a doubtful variety within the limits of such a polymorphous species as S. cordata."

Several items in Bebb's description and discussion require comment. If the comments appear derogatory of his judgment, let us remember that he always had been careful and conservative, that here he apparently was grossly misled by others on two important points, and that he was aged and failing (he died in 1896).

In the past six years, the writer has studied more than 1000 sheets of *S. cordata* and *S. missouriensis* in his own herbarium, the U. S. National Herbarium, and that of the University of Nebraska. Increasing Nebraska collections by Dr. Walter Kiener soon convinced him that *S. missouriensis* was not a distinct species but at most only a variety (var. *vestita* Anderss.). Since the preparation of the above discussion of the nature and causes of variation, and the appearance of Dr. Fernald's recent discussion (7, p. 27–28) in Rhodora, most of this material has been reviewed for data on the points at issue, with the further conclusion that var. *vestita* is not even a valid variety, for the reasons given below.

Polymorphism. Bebb refers to *S. cordata* Muhl. as polymorphous. It is. All willows (and other plants) are, although perhaps not in just the sense Bebb meant. That polymorphism is the thesis of the present paper. *S. cordata* is an excellent illustration of the principles set forth herein. It has a range (with var. *vestita*) of almost 2000 miles east-west and some 1100 miles north-south, with a corresponding diversity of climate, soils, and local habitats. It is a large enough shrub to permit expression of the maximum variation on a single plant.

Height and Diameter. Bebb describes his species as a tree "thirty or forty, or even fifty, feet in height, trunk ten or twelve, rarely eighteen inches in diameter." Sargent, in 1896 (9, p. 137), repeated these dimensions and later manuals have repeated the height. Where did Bebb get this record of tree-like height for a shrubby or arborescent plant? He had never seen it growing, but refers to collections by Sargent and Bush from Courtney, Jackson Co., Mo. There are three true tree willows which occur along the Missouri in that area, namely, *S. longipes* (var. *Wardii*), *S. amygdaloides,* and *S. nigra*. All three may attain the height, and rarely the trunk diameter, recorded by Bebb. It seems almost certain that, if Sargent or Bush furnished the height data, they included plants of one or more of these tree species when estimating maximum height and diameter. *Salix longipes,* especially, bears a deceptive resemblance to luxuriant *S. cordata* (var. *vestita*).

Most collectors do not record heights of plants collected. In the Bebb Herbarium at the Chicago Natural History Museum are three specimens collected by Bush in 1892 along the Missouri River in Jackson Co., Mo. It may be that Bebb's species was based on these, but no heights are given on the labels. One is said to be a tree 12 inches in diameter and two are called small trees, with 10- and 6-inch diameters, respectively. In 1895 and 1896, Dr. Glatfelter collected at least 31 specimens of var. *vestita* (distributed as *S. cordata* $\times$ *S. sericea*) in and around St. Louis, Mo., the labels giving heights and often diameters. Of these 31, only ten reached 20 ft. or more. Three of these ten reached 25 ft., with diameters of 5.5–7 inches. Only one was 30 ft. high, with 7-inch diameter. These taller plants mostly had single stems, dividing low. Other collectors record heights from 15 to a maximum (Ia.) of 27 feet. It may be that Sargent was responsible for the exaggerated height record. In any case, the Jackson Co. plants were from conditions of moisture, fertility, and climate which make all vegetation remarkably luxuriant. The eastern plant has a general height of 10 to 20 feet, with the maximum somewhat more.

Branchlet Size and Hairiness. In 1867, Andersson (2) described very stout twigs, but in 1868 he dropped the phrase. Bebb said: "one-year-old twigs stout." Actually, twigs show just about the same stoutness from the Great Plains to the Atlantic.

Hairiness varies in exactly the same ways throughout the entire area. It is fixed in many minds that the vegetative parts of *S. cordata* are glabrate or glabrous and those of var. *vestita* are hairy. The study of some 1000 specimens shows hairiness (puberulence, pubescence, and/or tomentum) to be practically universal. The white-pubescent seasonal twigs occur in Lower Canada, New England, the Potomac-Shenandoah Valleys, the Appalachians, and the Lake States, as well as in the Mississippi-Missouri Valleys. The denser the twig pubescence, the more frequently it is associated with pubescence or bud-scales, petioles, midribs, and sometimes stipules and young blades. Glabrate to glabrous yellowish seasonal or 1-year twigs were more common westward in the drier areas, but many 1-year and 2-year twigs glabrous in spring showed tell-tale remnant pubescence behind buds and lateral twigs. The long season and high summer temperatures of the lower Missouri are favorable to denser pubescence of twigs.

Leaves. Andersson's type had only very young leaves. Bebb describes the leaves as:

" . . . lanceolate or oblanceolate, five to six inches long, from one to one and a half inches wide, cuspidate-acuminate, narrowed from above the middle toward the acute or rounded (but not truncate or cordate) base, at first more or less clothed with silky hairs, soon smooth and dark green above, except the downy midrib paler, but not glaucous beneath, margin glandular-serrate; petioles downy, half an inch long, . . ."

These statements regarding leaf-length, leaf-base, and glaucousness are not true for either the western or eastern plants. The leaves of "*S. missouriensis*" by no means average 5–6 inches long. On fruiting twigs and many early seasonal twigs, the leaves are 3–4 inches long and 0.7–1 inch wide. On more vigorous seasonal shoots, they reach 5–6 inches long by 1–1.5 or 1.8 inches wide.

In the eastern area, the leaves average about the same in size, on comparable twigs, as in the western. Relatively large leaves, up to 5.5 inches long and 1.4–1.7 inches wide, are found frequently from Lower Canada and New England southward. Westward, the leaves tend to average narrower. One specimen from Maine has blades 6.5 by 1.4 inches, while specimens from Quebec, Vermont, and New York run to 6 by 1.5–1.7 inches. Petioles on leaves in the Northeast range from 0.5–1 inch long. In Virginia, leaves range up to 6 by 1.75 inches; in West Virginia to 5 by 1.5 inches. None larger have been found in the Missouri River area, on either supposed species. Specimens with shorter but relatively broad leaves occur sparingly throughout and are likely to be associated with densely pubescent shoots, bud-scales, petioles, midribs, and sometimes blades.

In the material assigned to *S. missouriensis*, the bases of the larger leaves commonly are truncate and some are strongly cordate (*Glatfelter 13*), Bebb's note to the contrary notwithstanding. The range for leaf-base shape is exactly that for accepted *S. cordata*. In both eastern and western plants, mature leaves are glaucescent to glaucous beneath, although the color may not develop until the leaves are nearly full-sized. The leaves on autumnal collections of both plants usually are strongly glaucous.

Early Flowering. One of the distinctive characters asserted for *S. missouriensis* was its early flowering. Bebb quotes Bush as follows: "The aments usually open about the first of February and have passed out of bloom by March 1st, whereas those of Salix cordata do not appear till the first week in April." This is a difference of about two months, if true, but it does not happen to be true. Let Bush's own collections speak. In 1896, he collected *S. missouriensis*, nos. *448, 464, 470, 475*, and *480*, at Courtney, Jackson Co., Mo., between April 11 and 19, the first spring after Bebb's publication. These five specimens, in U.S. Nat. Herb., bear just-opening aments, not-yet-flowering aments, flowering aments, and young fruiting aments, all 10 weeks after flowering should have started and 6 weeks after it should have ended, according to Bush. This was not confined to 1896. Number *6552* has 3-inch pistillate aments in flower on April 15, 1912, as delayed as those of 1896. Number *7719* has sessile 2-inch aments in flower on March 24, 1916, seven weeks after it should have begun and 3 weeks after it should have ended. The Glatfelter specimens from St. Louis were in bud from March 25 to April 7; in flower from March 27 to April 12; and in young fruit from April 17 to 24.

Ament Length and Laxity. Bebb described the aments as precocious, sessile, dense-flowered, the staminate oblong, 1.5–2 in. long by 0.5 in. wide, the pistillate lengthening to 3 in. and becoming more or less lax in fruit. Sargent (9, p. 137), in 1896, adds another inch gratuitously ("3–4 inches long"). The maximum (not average) is 3 inches. Abundant material shows that the pistillate, at flowering, are 1–2 in. long, lax, borne on short (0.5 cm.) bracted peduncles. In fruit, the aments become 1.5–2.5 or rarely 3 inches long (*Bush 6552*) and very lax, and the peduncles become up to 1 cm. long, with small leaves. Laxity is a function of rachis and/or pedicel elongation. The pedicels become 1.5–2.5 or rarely 3 (*Bush 475*) mm. long, the capsules 6–7 mm. and the styles 0.5–0.6 mm. long. Eastern material shows aments up to 2.5 inches long from Lower Canada, Massachusetts, and New York, and one Massachusetts specimen (*Forbes 563*) has aments up to 3 in. (7 cm.) long. Pedicels up to 2–2.5 mm. are frequent in the east and 3-mm. pedicels occur in New Hampshire (*Rand & Robinson 652*) and Massachusetts (the Forbes plant with 7-cm. aments).

Scale Length and Hairiness. Both Andersson and Bebb stress the length of the flower-scales and of their densely investing hairs. Both were studying specimens from luxuriant plants whereon most organs were larger than average. Also, the resulting ament laxity enabled the usually partly hidden scales to be easily seen. These facts are true also of luxuriant plants in the eastern area.

Capsule Length. Neither Andersson, in describing var. *vestita,* nor Bebb, in creating *S. missouriensis,* mentions capsule length, so apparently they saw no difference from that of *S. cordata*. *Salix eriocephala* Michx., which Fernald says is the same as *S. missouriensis* Bebb, is staminate. Andersson completely misinterpreted *S. eriocephala* from beginning to end (1, 2, 3), so that his statements about capsules obviously apply to those of other species. Fernald (7, p. 27), however, says: ". . . , the very large precocious aments and long (up to 1 cm.) capsules having deceived those who did not consider the other characters, . . ." Fernald gives no authority for this assertion of unprecedented capsule length, an increase of some 43% over the maximum recorded.

Measuring the capsules on numerous luxuriant specimens from the Missouri flood-plains, the normal length is found to be 5–6.5 mm., with a few reaching a maximum of 7 mm. long. Outside the most favorable habitats, the capsules also average 5–6.5 mm. but never reach 7 mm., so far as seen. The capsules of accepted *S. cordata* normally run to 6 mm. long and occasionally to 6.3 mm.

Summary of "S. missouriensis." The great height and diameter ascribed are not proved and remain extremely doubtful. The tomentum of twigs is shared by many eastern specimens, although Missouri-Mississippi Valley conditions are conducive to extreme hairiness. Long leaves and truncate to cordate bases occur throughout the entire area. The reported extremely early flowering is disproved by the records. Expanded pistillate aments are not sessile and naked. The long aments, scales, scale hairs, and pedicels are matched by those on equally luxuriant eastern specimens. The long capsules asserted by Fernald just cannot be found on any plants. "*Salix missouriensis*" is merely the luxuriant expression of *S. cordata* Muhl. under favorable conditions of temperature, moisture, and fertility.

"Accurate and Cautious Salicologists." Fernald (7, p. 29) designates the Swedish salicologist, N. J. Andersson, as "the most accurate student ever to work on *Salix*, . . ." He further said (7, p. 31) ". . . it is . . . the highest of honors to get near the limited group of most cautious salicologists with Nils Johan Andersson!" Let us consider just what Andersson did with *S. eriocephala* Michx. and *S. cordata* var. *vestita* Andersson, which Fernald states to be one and the same (Section *Cordatae*).

In 1858, Andersson (1, p. 117) placed *S. eriocephala* in a group with *S. lasiolepis* and its relatives (*S. Bigelovii*, *S. irrorata*), all of Section *Lasiolepes* (related to *Cordatae*), and threw in his wholly unrelated *S. Coulteri* (closest to *S. sitchensis*, Section *Sitchenses*) for good measure. *Salix cordata* is not mentioned. In 1867 (2, p. 85) and 1868 (3, p. 225), he arranged *S. eriocephala* as a variety of *S. discolor* (Section *Discolores*), even more distantly related than *S. Coulteri*. In all three papers, his extended discussion contains repeated expressions of uncertainty and repeated comparisons with many and diverse species, but always with *S. discolor* and its relatives, to which it is least related.

In 1867, Andersson (2, p. 159) created his hairy-twigged var. *vestita*, specifically identical with *S. eriocephala* (fide Fernald), and assigned it to *S. cordata*, even noting its glabrous capsules. But he compared it with *S. discolor*, which has glabrous twigs and pubescent capsules with quite different styles and stigmas. This treatment was repeated in 1868 (3, p. 252), without the reference to *S. discolor*.

Andersson, in short, dealt with two specimens of an identical entity, collected in the fertile flood-plain within 400 miles of each other. The pistillate he made a variety of *S. cordata*, where it belonged, but compared it with the unrelated *S. discolor* in spite of its hairy twigs and glabrous capsules, the opposite of *S. discolor*. The staminate plant he first assigned to the *Lasiolepes*, close to *Cordatae*, but then shifted it to *S. discolor*, a completely unrelated species, and invented a pistillate plant to justify that disposition.

Many similar acts by Andersson have been cited by Bebb and others and many more remain uncited. When Fernald assigned to the capsules of *S. eriocephala* a length of 1 cm., he perhaps achieved a certain nearness to Andersson in accuracy and caution.

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TYPES OF SOME AMERICAN TREES

M. L. Fernald

With three plates

Quercus velutina Lam. Dict. **1:** 721(1783) or *Q. tinctoria* Bartr. ex Michx. Hist. Chênes Am. no. 13, *tt. 24* and *25*(1801), at least as to *t. 25*, is, as Sargent said in his Man. Trees N. Am. 239(1905), "more variable in the form of its leaves than the other North American Black Oaks," though its cups, with their grayish-pubescent and thin, free-tipped and acuminate scales, quickly distinguish it, as do the large tomentose winter-buds and the deep yellow or orange inner bark, which gave it the once familiar name, Quercitron. In fact, the foliage, which is remarkably constant on individual adult trees or colonies but discouragingly different on trees of some other colonies, inspired the godfather of the Arnold Arboretum, the late George B. Emerson, to write in his Trees and Shrubs of Mass., ed 2, **1:** 161 (1875), under *Q. tinctoria:* "There are three pretty distinct varieties of the black oak. . . . These trees seem to be as different as the several varieties or species of the chestnut oak group. There are, probably, corresponding differences in the qualities of the wood." Nevertheless, so far as I have noted, most recent descriptions of what is taken as typical or average *Q. velutina* (or *tinctoria*) have studiously avoided the original diagnoses of Lamarck and of Michaux. Furthermore, we find characteristic drawings of leaves which strongly depart from the original illustrations cited by Lamarck or shown by Michaux, for recent drawings (such as those of Emerson, Faxon in Sargent's Silva and Manual, Hough, Dippel, Britton & Brown, Britton's North American Trees, Gray's Manual, the popular books of Mathews and others) all show a pinnatifid leaf with deep sinuses and elongate sharply toothed lobes. The characteristic leaves of the types of *Q. velutina* and *Q. tinctoria*, if mentioned at all, are usually treated as something quite atypical. Probably they are unusual on adult fruiting trees and to a great extent they seem to be juvenile or reversionary foliage, found on seedlings or saplings too young to fruit, and very generally on late sprouts coming out in August or September on the branches of trees from which the usual adult and pinnatifid leaves were stripped by caterpillars earlier in the summer.

To begin at the beginning, Lamarck's *Quercus velutina* was briefly but clearly described:

11. Chêne velouté, *Quercus velutina*. *Quercus foliis obovatis angulatis subtus brevissimè lanatis, angulis setá terminatis.* N. *An quercus humilis Virginiensis, castaneae folio.* Pluk. Alm. 309

[*i. e.* *Q. prinoides* Willd.].

β. Eadem foliis inciso-lobatis. N. ex Hort. D. Cels. Conf. *Quercus nigra.* du Roi. Harbk. p. 272. t. 6. f. I.

Ce *Chêne,* qui semble tenir le milieu par ses charactères entre l'espèce précédente [all-inclusive *Q. rubra* L.] & celle qui suit [*Q. nigra* L.], nous paroît ne devoir former qu'un arbrisseau. Il s'éloigne des *Chênes rouges* par ses feuilles ovales-obtuses, & veloutées ou comme drapées en dessous. Ces feuilles sont pétiolées & rétrécies en coin à leur base. Les pointes sétacées qui terminant leurs angles, ne permettent point de confondre ce *Chêne* avec l'espèce qui suit [i. e. *Q. nigra* L., including *Q. marilandica* Muench.].

Then, as an important item, Lamarck stated that he knew his *Quercus velutina* only imperfectly, having seen only a *very young* individual, said to have come from North America (Au reste, nous ne le connoissons qu'imperfaitement, ne l'ayant vu que fort jeune).

Lamarck's query as to whether his *Quercus velutina* might be what Plukenet had called "Quercus humilis Castaneae folio *Virginiensis* **The Chinquapin Oake**" at once suggests that the leaf of the type of *Q. velutina* could not have been the deeply pinnatifid one commonly illustrated under that name. Furthermore, his suggestion under *Q. velutina β*, "Conf. *Quercus nigra.* duRoi," not L., leads at once to DuRoi's figure (our PLATE I, *fig. 3*), which is certainly not deeply pinnatifid. Finally, the TYPE, preserved at Paris (our *figs. 1* and *2*), shows conclusively that Lamarck's species was indeed based on foliage of an "arbrisseau . . . fort jeune." This leaf is very closely matched by those of many specimens of saplings, such as shown on a "young tree in woods" from Fountain County, Indiana, *G. N. Jones* no. *15550*. Such a leaf is comparatively rare on fruiting branches but on sprouts coming out in August, on the branches of adult trees which have earlier been stripped, it is common. Incidentally, however, the leaf of the type of *Q. velutina* could almost as well have come from a sapling of Red Oak, *Q. rubra* L. (*Q. rubra maxima* Marsh. [1785]; *Q. ambigua* Michx. f. [1812], not Humb. & Bonpl. [1809]; *Q. borealis* Michx. f. [1817]; *Q. maxima* (Marsh.) Ashe [1916]). In fact, on reconsideration, Lamarck thought so himself, for after the publication by the younger Michaux of his *Q. ambigua* in 1812, Lamarck wrote on the original label of his *Q. velutina* "*Q. ambigua.* Mich."!

Leaving for a moment the question of *Q. rubra* L., we turn to *Q. tinctoria* Bartr. ex Michx. Hist. Chênes Am. no. 13 (1801), the name validated for the scarcely described *Q. tinctoria* of Bartram, Trav. 37 (1791), Bartram having simply "Gigantic Black Oak. Querc. tinctoria; the bark of this species of oak is found to afford a valuable yellow dye. The tree is known by the name of Black Oak in Pennsylvania, New-Jersey, New-York, and New-England." Whether a species is acceptably described merely by stating its colloquial name and its economic use without a single morphological character is very questionable. If that is all that is required the possibility of various upsets may well be considered. At any rate, Michaux validated *Q. tinctoria* Bartram, and after Michaux's fuller description and illustration the name was almost universally used in the United States for the northern Black or Yellow-barked Oak or Quercitron, this general usage lasting for nearly a century—until the doubtful *Q. velutina* was picked up in 1892 by Sudworth and accepted by Sargent in his Silva in 1897.

Michaux's *Quercus tinctoria*, "foliis petiolatis, subtus pubescentibus, lato-obovalibus, leviter et subrotunde lobatis, basi obtusis," etc., consisted of two named varieties, each accompanied by a life-sized illustration of foliage and fruit, partly shown in our PLATE II, *figs. 1* and *4*. The foliage in both plates of Michaux is so similar that that of only one is here reproduced, but the cups were so distinct that they are reproduced as in the originals (*figs. 1* and *4*). The leaves, as will be seen, are not at all deeply lobed but are suggestive of the leaf of the type of the problematic *Q. velutina* Lam. The first of Michaux's two varieties, *Q. tinctoria angulosa*, the CHÊNE QUERCITRON *à feuilles anguleuses* (*fig. 1*), was assigned a synonymy including "*Q. Americana rubris venis*," etc. of Plukenet, this being one of the basic synonyms, and possible source of the trivial name, cited by Linnaeus for his *Q. rubra* (1753); *Q. nigra* Marsh., not L., which had the leaves "irregularly and sometimes pretty deeply sinuated"; and *Q. velutina* Lam. In the first ("α") variety, *Q. tinctoria angulosa*, the cups were somewhat platter-like or saucer-shaped ("Cupula subscutellata . . . Cupule presque'en soucoupe") and their short scales appressed ("écailles peu adhérentes"), the cup and its scales (*fig. 1*) thus somewhat similar to those of *Q. ambigua* Michx. f. (1812), not Humb. & Bonpl., our *fig. 2*, or *Q. borealis* Michx. f. (1817), as well as of *Q. rubra* L., as shown by Sargent, Silva, 8: *t. ccccx, figs. 1* and *3* (our *fig. 3*)!

Under his second ("β") variety, *Quercus tinctoria* (*sinuosa*), shown in our PLATE II, *fig. 4*, Michaux cited the figure of *Q. nigra* sensu DuRoi, not L., our PLATE I, *fig. 3*, which Lamarck had earlier noted under his *Q. velutina*. *Quercus tinctoria sinuosa*, with "FOLIIS profundius sinuosis," although the profundity, as shown in his plate, was not very profound, otherwise differed from the first variety in its "Cupula turbinata" (our PLATE II, *fig. 4*), with the thin, lanceolate scales less tightly appressed, Redouté's (or Michaux's) figure well matching Faxon's in Sargent, l. c., *t. ccccxv, fig. 1*, of the fruits of *Q. velutina* (our PLATE II, *fig. 5*). The second half of *Q. tinctoria* was, then, referable to *Q. velutina* as interpreted by recent authors, the first half to *Q. rubra* L.

If it be urged that *Quercus velutina*, as described by Lamarck and as shown by the single leaf preserved, is not clearly definable exclusively as one species, and if it be admitted that Michaux's first variety of his *Q. tinctoria* was *Q. rubra* L., which is not generally used in dyeing, it might become necessary to face *Q. discolor* Ait. Hort. Kew. 3: 358(1789). In fact, *Q. discolor* antedated by two years Bartram's doubtfully acceptable description and by 12 years the validation by Michaux of his *Q. tinctoria*, under which supposedly preferable name it rested as a synonym throughout that long period when neglect of strict priority was not a sin. Sargent, Trelease, and others regularly cited *Q. discolor* as a synonym of *Q. velutina* (or *tinctoria*), but Aiton's description was so discouragingly brief and inconclusive that it could have applied to any one of several species; and when Aiton stated that it was *Q. rubra* β. of Linnaeus he projected grave doubt into the situation, for, according to Sargent, Silva, l. c. 125, *Q. rubra* β. is not separable from *Q. rubra* (α), the species which some authors delight to call *Q. borealis* Michx. f. N. Am. Sylv. **1**: 98, *t.26*(1817), the younger Michaux not wholly clarifying his very clear plate by retaining for it the earlier designation *Q. ambigua*! I do not know just what Aiton's type of *Q. discolor* was; if he were indeed correct in identifying it with *Q. rubra* β. of Linnaeus (1753), then those who would throw out the name *Q. rubra* L. as a *nomen confusum* should prayerfully consider the priority by 28 years of *Q. discolor* Ait. over *Q. borealis* Michx. f. Personally I am not now doing so, because of inadequate knowledge of what Aiton had. Nor am I throwing out *Q. rubra* L., the significance of that name having been sufficiently established by a century of good usage. As showing that the situation is not an absolutely simple one it is worth noting that *Q. discolor* had been introduced into cultivation in England as early as 1763 (Ait. l. c.). Lamarck's final comment after his description of *Q. velutina* twenty years later (in 1783) therefore becomes illuminating, but with a somewhat blinding light: "On le dit originaire de l'Amérique septentrionale: nous l'avons entendu nommer *Quercus desgulor anglorum*." Professor Arthur Stanley Pease informs me that, whereas *"Quercus"* and *"anglorum"* are perfectly evident, *"desgulor"* is not Latin. "Could that by any chance be a mistake, due to someone's faulty hearing of *discolor?* Is there any oak which the English botanists had called *Q. discolor?*" In view of the fact that the Lamarck specimen was a sapling raised at Paris, it is not at all improbable that it was derived from the tree cultivated in England and later published as *Q. discolor* Ait. I do not know on what evidence *Q. discolor* was placed by Sargent and by Trelease in the synonymy of *Q. velutina*.

Coming down to Earth, we have the situation which recurs in case of very many of the earlier American species described in Europe, without any clear understanding of our plants. When Linnaeus, Aiton, or Lamarck based a species on a single cited specimen all was well; when they cited two, confusion was probable; when they based species on several citations and quite uncoördinated specimens, confusion became confounded. Nevertheless, if we should start in to reject all the Linnean names of this sort as *nomina confusa* the wreckage would be enormous. What real good would be accomplished, except the satisfaction of a mechanical theory? No theory (not even attempts to "standardize" colloquial usage) ever established a language or its use. The well known and common ***Asplenium platyneuron*** (L.)Oakes would be rejected, for the basic *Acrostichum* *platyneuron* L. would have to go because Linnaeus included under his binomial not only an *Asplenium* but members of *Polypodium*. *Scirpus capillaris* L. (nomenclatural basis of *Fimbristylis capillaris* (L.)Gray, *Stenophyllus capillaris* (L.)Britton, and of *Bulbostylis capillaris* (L.)C. B. Clarke — *Bulbostylis* a conserved name), "*Habitat* in Virginia, Aethiopia, Zeylona," was a mixture of several species and at least two genera; yet the trivial name has been fixed by usage ("established custom") ever since it was restricted by Roemer & Schultes in 1817, and no good would result from now suddenly declaring it a *nomen confusum*. Surely *Quercus velutina*, as described by Lamarck and as shown by his preserved specimen, is pretty vague. *Quercus tinctoria* of Michaux consisted of two specific elements, the first not belonging to *Q. tinctoria* as interpreted for a century.

Or take a very simple case, that of *Fraxinus americana* L. Sp. Pl. 1057(1753):

3. FRAXINUS foliolis integerrimis, petiolis teretibus. *Gron. virg.* 122. *Roy. lugdb.* 533.

Fraxinus caroliniensis, foliis angustioribus utrinque acuminatis pendulis. *Catesb. car.* I.*p*.80.*t*.80.

Habitat in Carolina, Virginia.♄

That is a relatively uncomplicated account but it has its entanglements. The Catesby plate (a portion shown in our PLATE III, *fig. 1*) of his *Fraxinus caroliniensis*, etc. of "low moist places" in Carolina, shows a characteristic fruiting branch with the small oblong leaflets acuminate at both ends, and the very distinct fruit of the southern Water- or Swamp-Ash, the characteristic small tree of southeastern swamps and very abundant in both Carolinas and eastern Virginia, "with," to quote Sargent's Silva, "elongated stout terete pale petioles"; whereas the White Ash, the *Fraxinus americana* of all recent authors, has, as Sargent correctly says, "stout grooved petioles," etc. Gronovius gave nothing not covered later by Linnaeus, and he, likewise, cited Catesby's description and plate. Royen simply abbreviated the Gronovian account but included the Catesby reference. In view of the "petiolis teretibus" of the Linnean diagnosis, the citation by him of a single plate, and his citation first of Carolina, a perfectly rational case could be made out for using the name *Fraxinus americana* L. (1753) for the southern Water-Ash which we all call *F. caroliniana* Mill. (1768). We should then be forced to call the common northern White Ash either *F. nova-anglia* Mill. (1768), *F. acuminata* Lam. (1786), or *F. caroliniensis* Wangenheim (1787), according to which of these, on careful comparison of the types, proved to have right of way; it would be ironical if Wangenheim's name won the competition!

My point is just this: the evidence of the Linnean account and the one plate which he cited lead directly to *Fraxinus americana* as the name for the southern Water-Ash; but one final point, often neglected by those who invoke the principle of *nomina confusa*, saves the day. Linnaeus had in his herbarium, when he prepared the *Species Plantarum* of 1753, a specimen which he marked as no. "3. *americana*" (our PLATE III, *fig. 2*). Only by taking as the TYPE this badly defoliolated specimen, showing dentate round-based leaflets (a characteristic leaf of a species with "grooved petioles") can we save the name *F. americana* in its familiar sense. Yet this is exactly what we have to do in a great number of cases, or else abandon some of the most familiar names or, most unfortunately, reverse their significance.

When the unquestioned type has been hopelessly misinterpreted and there is no way out we must make the change, but when a Linnean species was a confusion of several elements, as in *Quercus Prinus* and *Q. rubra,* the case approaches that of *Fraxinus americana,* just discussed. Sargent, Silva, 8: 53, using the name *Quercus Prinus* L. in its long-restricted sense of *Q. Prinus* (*monticola*) Michx. or *Q. montana* Willd., said in a footnote (footnotes have a way of being given the principal weight!): "The early description of the Chestnut Oak might apply as well to the Swamp Chestnut Oak (*Quercus Michauxii*) as to this species, which does not grow near the coast of Virginia, where, however, the Swamp Chestnut Oak is common." That was the entering wedge; forthwith the name *Q. Prinus* was transferred by the credulous to the latter. However, as Svenson pointedly says in Rhodora, 47: 365(1945), "To this may be replied that Banister, who collected much of the early material described by Plukenet, did not lose his life by falling off a mountain on the coastal plain," Banister living "on the coast" of Virginia, only about 10 miles from Clayton's home. Furthermore, the Rock Chestnut Oak (*Q. montana*) occurs in the right situations (dry rocky slopes) not only near Clayton's home but in a number of counties to the south and southwest, where, if there are any disbelievers, I shall be glad (if they pay the bills) to show it within sight of transatlantic freighters steaming up the lower James! Since, as Svenson shows, Linnaeus himself marked specimens of this oak as *Q. Prinus,* what but confusion results in a change in the application of the name, especially when the new interpretation is based upon wholly erroneous and theoretical assumption?

Similarly with *Quercus rubra* L. That name covered many (if not most) of the eastern species of subgenus *Erythrobalanus* as now understood, but the northern Red Oak was just as much among them as any of the others. In 1916, however, Sargent in Rhodora, 18: 46, suddenly reversed the long-established usage by stating his opinion that "the name *Quercus rubra* Linnaeus must be transferred to the tree which later was called *Quercus falcata* by Michaux, the Red Oak of the southern states." If typification is to rest primarily on colloquial names it is important to check the facts.

In his original publication of *Quercus falcata* Michx. Hist. Chênes Am. no. 16(1801), the elder Michaux called it "DOWNY RED OAK." Michaux filius, who knew vastly more than any predecessor (or most successors) from first-hand experience with eastern North American trees, called it in his Hist. Arb. Forest. Am. Sept. 2: 104(1812) only "SPANISH OAK," and he then explained, as he did again, in English, in his No. Am. Sylva, 1: 87

(1817), under "SPANISH OAK," that "In Delaware, Maryland and Virginia, it is known only by the name of Spanish Oak, and in the Carolinas and Georgia by that or Red Oak." Now checking on the names used in the period following Michaux but before the colloquial names were factory-made, we get interesting results. Stephen Elliott, Sketch Bot. S. C. and Ga. **2**: 605(1824), under the very strikingly different *Q. falcata* var. *triloba* (Michx.)Nutt., said of colloquial usage in South Carolina and Georgia: "These two trees are called by the inhabitants Red Oak or Spanish Oak. Where I have seen any distinction made, Red Oak was applied to the Q. Triloba — Spanish Oak to the Q. falcata." Croom, Cat. Pl. New Bern, N. C. 30(1837) has *Q. falcata* simply as *"Black oak,"* thus entering a new competitor! Darby, Man. Bot. So. States, 316(1841), gave for *Q. falcata* only "Spanish Oak." M. A. Curtis, Geol. Nat. Hist. Surv. N. C. pt. III.35 (1860), enumerating the oaks of the state, had "Spanish Oak (Q. falcata.)" and "Red Oak (Q. rubra.)," but on p. 39, under "SPANISH OAK. (Q. falcata, Michx.)" he said: "This is generally known in this state, I think, by the name of *Red Oak,* though sometimes called as above. It is also, in some parts, denominated *Turkey Oak,* from a vague resemblance between the form of the leaf (when it has but three divisions) and the track of a Turkey." Porcher, writing of the practical uses of plants among the people of South Carolina, in his Resources of So. Fields and Forests, 256(1863), called *Q. falcata* "Spanish Oak," Porcher stating that "In domestic practice, where an easily obtained and efficient astringent is required, this, and the more common species, the *Q. rubra* [in the long-established sense], are of no little value. They are used to a large extent on the plantations in South Carolina." If anyone knew about such uses in South Carolina, certainly Porcher did. His statement gives support to the much earlier one of Brickell in 1737, Nat. Hist. N. C. [repr. without date, by the Trustees of Public Libraries of N. C.], 60, Brickell saying: "The *Spanish Oak* has a whitish smooth Bark [Sargent, Silva, **8**: 147, says "sometimes pale"] . . .; the Bark of this Tree is used for the Cure of the *Yaws.*" Not quite so early was John Clayton's "Quercus rubra seu Hispanica hic dicta, foliis amplis varie profundeque incisis," in Gronovius, Fl. Virg. ed. 2. 149(1762), for when, in 1839, Asa Gray examined these Clayton plants, he wrote against this no. (785) in his copy of Gronovius "*Q. falcata.*" It is not necessary to draw in Clayton's further comment, "Cortex ad corium depsendum utilissimus" and to argue that he referred to the "Cure of the *Yaws.*" "Could be!" The early use of the name "Spanish Oak" for typical *Quercus falcata* must be apparent, although from Virginia southward the name Red Oak was also sometimes used.

Sudworth, in his Nomencl. Arb. Fl. U. S. 171(1896), enumerating the states where the colloquial names are used, but using the name *Q. digitata* for *Q. falcata, Q. triloba* and *falcata,* var. *pagodaefolia* Ell., gave "Spanish Oak" preference, this name for *Q. falcata* (*digitata*) being used in 12 states, including "South Carolina, North Carolina, Virginia, Delaware and

Pennsylvania"; while "Red Oak" had been found in use for this species in 8 states, the northeasternmost being North Carolina and Virginia. Later, however, in his Check List For. Trees U. S. (1927), Sudworth, following Sargent's lead, wrote of the "tree we have been calling Spanish Oak" which "must, therefore, be called *Quercus rubra* Linnaeus. Notwithstanding the fact that this oak has long been known . . . as Spanish Oak. . . It seems advisable, therefore, to discard the name 'Spanish Oak' and to take up Southern Red Oak," just as if this edict from Washington would change the actual usage of such unschooled woodsmen as have always called it "Spanish Oak," "Turkey-Oak" or even "Black Oak." In this volume, however, Sudworth gives a reenumeration of states in which the various colloquial names are used: "Spanish Oak" in 12, including "Del., Md., Va., N. C., S. C.," etc.; "Red Oak" in 10, the northeasternmost being "N. C., Va."; "Southern Red Oak" in none. Therefore, by his strange method of counting the ballots, the "NAME IN USE" is "Southern Red Oak." *Standardized Plant Names* has no monopoly in deciding what names are in actual use among "the people."

My point in all this is as follows: since the sum-total of evidence from those who early wrote of southern trees from first-hand knowledge of them is that the name "Spanish Oak" was, before modern dictatorial days, more generally used for *Q. falcata* than the name "Red Oak" (used more generally in the South for the traditional *Quercus rubra*), the argument that by *Q. rubra* of "Virginia, Carolina" Linnaeus really meant *Q. falcata* seems to me a forced one. Sudworth, in 1897, had enumerated 27 states (all in which it occurs) where "Red Oak" was used for *Q. rubra* of practically all botanists down to Sargent in 1916. Since the name of this species suddenly and quite unjustifiably has been changed to *Q. borealis* its "NAME IN USE" suddenly changes to "Canadian Red Oak" or "Northern Red Oak." *C'est à rire!*

Nothing but confusion arises from shifting the name *Quercus rubra* to the very different southern *Q. falcata,* which has honorably borne that name for nearly a century-and-a-half, especially since *Q. rubra* in its traditional sense was among the specimens so marked by Linnaeus. If the argument is pressed that *Q. rubra* L. was a *"nomen confusum,"* we shall have to face the same argument regarding hundreds of other names which had a tangled beginning. It seems to me that in these cases, as in those of *Quercus velutina* and *Fraxinus americana,* the cause of real understanding and progress is best served by following the *spirit* more definitely than some imagined *"letter"* of the International Rules; and in holding such names as were based demonstrably in part on the plant long accepted as typical. Naturally, there are left many names which have from the first been misapplied. In these cases change is unavoidable. When, however, long-established and universally understood names can legitimately be preserved, why seek reasons to change them? One of the Guiding Principles of our International Rules (Art. 5) reads: " . . . where the consequences of rules are doubtful, established custom must be followed." The earlier wording was better: "established custom becomes law."

EXPLANATION OF PLATES

PLATE I

FIGS. 1 and 2. The TYPE and labels of *Quercus velutina* Lam. (after *Cintract*), FIG. 2 showing Lamarck's reference to DuRoi's illustration of *Q. nigra* sensu DuRoi, not L., with which Lamarck thought *Q. velutina* might be identical, and his later identification of *Q. velutina* with *Q. ambigua* Michx. f. FIG. 3. DuRoi's illustration of his *Q. nigra*.

PLATE II

FIG. 1. Portion of the original illustration of *Quercus tinctoria angulosa* Michx. FIG. 2. Fruit of *Q. borealis* Michx. f., 1817 (*Q. ambigua* Michx. f., 1812, not Humb. & Bonpl. [1809]), from the original plate. FIG. 3. Fruit of *Q. rubra* L., after *Faxon* in Sargent's Silva. FIG. 4. Fruit of *Q. tinctoria* (*sinuosa*) Michx. from the original plate. FIG. 5. Fruits of *Q. velutina*, after *Faxon* in Sargent's Silva.

PLATE III

FIG. 1. *Fraxinus caroliniensis, foliis angustioribus utrinque acuminatis pendulis* of Catesby, the illustration cited by Linnaeus as his *Fraxinus americana*. FIG. 2. The specimen (courtesy of Mr. *S. Savage*) marked by Linnaeus "3 americana" in his own herbarium prior to 1753, this specimen accepted as the TYPE of the species.

GRAY HERBARIUM,
HARVARD UNIVERSITY.

TYPES OF SOME AMERICAN TREES

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FOOD PLANTS OF THE INDIANS OF THE GUATEMALAN HIGHLANDS

Paul C. Standley

Four hundred and twenty-five years ago Pedro de Alvarado led a little band of Spanish soldiers and a host of Mexican mercenaries out of Mexico across the Río Suchiate into Guatemala. When they reached the highlands of Quezaltenango, they entered a densely inhabited region that extended all the way across the mountains (Los Altos) as far as the present site of Guatemala City. The density of the population is attested by contemporary writers like Bernal Díaz de Castillo, by extensive ruins of such magnificently located cities as Utatlán and Zaculeu, and by reports of other towns of which no visible trace remains.

Just outside Xelajuj, now Quezaltenango, the Spaniards fought a great battle that resulted in slaughter of myriads of Indian warriors. The Río Samalá, a tranquil mountain stream, is said to have run red with blood, causing the horror-struck Indian survivors to name it the "River of Blood," a name it still bears. In that battle and in ensuing ones, perished the flower of Indian aristocracy. Thus today there are few descendants of the upper classes, who according to all testimony were a group much superior to the rude hunters and tillers of the fields.

The highland plains and valleys were densely populated in preconquest times and may well have had more inhabitants than now. Their people, although less advanced than those of the Valley of Mexico and Yucatán, had achieved a relatively high degree of culture. There is ground for belief that they lived under conditions little if at all inferior to those of rural Iberians of 1500 or perhaps even of 1946.

The Guatemalan Indians are among the most conservative peoples of the earth. After four centuries of exposure to Iberian culture they have changed their customs but little. Their clothing is different because of the introduction of sheep and imitation of early Spanish costumes. They have adjusted their pagan rites comfortably to the forms of Christian religion. Many of their dwellings scarcely are of aboriginal type but are copied from those of the Spaniards. They now have pigs and lard to improve their former food, although any meat they get from these or other imported animals is no important element of their diet. Otherwise the highland Indians subsist much as did their remote ancestors.

Their diet is probably no better and no worse. They eat little meat now since they have few domestic animals except sheep, whose chief product is not meat but wool. In preconquest days their only edible domestic animals were turkeys and perhaps a few ducks, and except in homes of the upper classes meat must have been a rarity. Wild animals large enough for food are scarce in Guatemala now, and probably they never were much more plentiful after the land had been settled.

Guatemala has climates suitable for growth of any plant of the earth. Many exotic ones have been introduced since the Conquest, and in the markets of the larger cities are displayed most of the important fruits and vegetables of all tropical and temperate climes. The only vegetable I never have found there is the parsnip. There have been introduced other vegetable crops such as coffee and sugar, but these, produced in vast quantities in Guatemala, are little known to the highland Indians and used less.

Coffee and sugar are not grown in the highlands, and the Indians know them only as luxuries. As for Old World vegetables, I suspect the Indians simply do not care for them. They do cultivate them for the *ladino* markets of Guatemala and Quezaltenango, and make a good living by doing so. It would be hard to discover finer vegetables than those of the irrigated valleys of Almolonga and Zunil, near Quezaltenango, but those Indians are rather sophisticated, and long ago devised the best methods of cultivating them for the *ladino* trade.

Despite very liberal and successful introduction of fruits, vegetables, and cereals into Guatemala from abroad, highland people subsist upon the same vegetables and cereals, cooked in the same ways, as they did 500 years ago. The single important exception is the potato, brought probably soon after the Conquest from Peru or Chile, and now planted throughout Los Altos. It is grown at higher elevations than any other crop, unless it be maize.

What were the food plants of the early Guatemalans? There were only two really important ones, maize and beans, or *frijoles*. Maize in the form of tortillas and *frijoles* constitute practically the whole diet of the highland Indians, and anything else they may eat is mere lagnappe. This was the diet of their ancestors. The antiquity of maize and beans in Guatemala can be deduced from the great variation that both exhibit. Their varieties often are very local and carefully guarded, but not because they are believed superior to varieties grown by neighbors. The Indians cherish a firm belief that it is best to plant seeds grown on the premises. Otherwise the plants never would be happy; they would become homesick, as it were, pine away, and the crop would fail.

It is fortunate that maize and beans together form a moderately nutritious and balanced diet, for it is practically all that the Indians, or the *ladinos* for that matter, have to eat. One used to the fare of North America or continental Europe will find this diet heavy, difficult of digestion, and flavorless. Even the Indians find it so, and long ago they learned to flavor it with the native chile (*Capsicum*). Guatemalans, unlike Mexicans, seldom use chile to excess, but they use it enough and sometimes fortify it with a little imported garlic.

Another ancient vegetable used primarily for flavoring is the tomato, which may have been brought by the Spaniards from Peru. It does not behave here as a native plant, never is found truly wild, and is attacked by many pests. It is said that if a Guatemalan cook goes into a kitchen and does not find tomatoes there, she walks out, refusing to start a meal. The highland Indians are less temperamental. An excellent substitute for tomato is the ground-cherry (*Physalis*), used not like a fruit as in the United States, but in cooking exactly like the tomato. Great quantities of *tomatillos* are traded in the markets, some of them as much as two inches in diameter and looking like small, green or yellow tomatoes.

An aboriginal vegetable of Central America is the pumpkin. It has no close wild relative in North America, although there are native wild species of *Cucurbita* that are inedible. It should be emphasized that the "foods" of the Guatemalan Indians were originally and still are maize and beans. Other edible plants, of scant nutriment, are merely *verduras* or "greens," which serve principally like the roughage fed to cattle, or as appetizers. Fruits, likewise, are not considered real food but are eaten because they taste good. The poorer people of Guatemala, and especially the Indians, seldom place fruits on the table but merely eat or "suck" them between meals.

As for pumpkins, most Guatemalan varieties have little resemblance to common pumpkins of the United States. Their long cultivation has established many well-marked forms, almost unlimited in number as one sees them in the markets, yet certain common varieties of other Central American countries, like the little *pipián* of Salvador, which is eaten only when very immature, are lacking in Guatemala.

Tomatoes and pumpkins were by no means the only secondary vegetables grown by the ancient Guatemalans, nor the only ones cultivated today by the Indians. An important one, known only in cultivation, is the chayote, the *güisquil* or *huisquil* of Guatemala. Although the chayote is grown throughout southern Mexico and Central America, there seem to be many more varieties in Guatemala than elsewhere. They are large or small, green or white, spiny or unarmed. In the Department of Huehuetenango there are fantastic forms, large fruits so densely armed with long, flexible but still rather stiff spines that it is unpleasant to handle them. The chayote plant is almost unique because every part can be eaten except when old and tough. The fruits are an excellent vegetable that can be cooked in many ways. The tender immature seed or *lengua* is a delicacy pressed upon guests; the young shoots, inflorescences, and fresh leaves are a common *verdura*. The huge roots, which may be removed without killing the plant, are a good vegetable, and also are the basis of a tasty dessert that has a strange consistency almost like wood shavings.

One vegetable that is Guatemalan *par excellence* is the pacaya, the staminate inflorescence of a low slender palm of the genus *Chamaedorea*. Pacayas are not confined to Guatemala, as some ill-informed or disingenuous persons would have us believe, nor are they the product of a single species of *Chamaedorea*, even within Guatemala. Those of Guatemala are so much more abundant than those of other countries and so much better in quality that Guatemala has some justification for claiming a monopoly of them. The finest are those grown about Cobán in Alta Verapaz, most of which are cultivated in regular plantations, and transported by truck-load to Guatemala and other cities. Their cultivation upon a small scale is probably ancient, the palms having been planted about dwellings because their natural home was in distant mountain forests, where it was not always easy to get them when wanted.

The pacaya is one of the most delicious of Central American vegetables. The plants are dioecious, and only the staminate spadices are eaten. With their enveloping spathes, these resemble roasting ears with their husks and sometimes are quite as large. When "husked" or opened, there is exposed an intricate mass that suggests a cluster of white worms. This part of the pacaya is dipped in egg and fried, or cooked in other ways. It may be boiled and seasoned with oil and vinegar, and eaten raw it makes a savory salad. Pacayas always have a slightly bitter flavor that is agreeable, and no matter how prepared for eating, they always are good.

Another vegetable that is planted, or at least never grows really wild, is the local Yucca or *izote*, *Yucca elephantipes*. This may have been brought to Guatemala from Mexico by the mercenaries hired by the Spanish conquerors, but it may have reached Central America earlier on the backs of the traders that wandered, as they do today, hundreds of miles north and south trading in products of different regions of Mexico and Central America. Yucca flowers are so liked that it is unusual to find one of the treelike plants with a full-blown inflorescence. While still in bud, the flowers are gathered, cooked, and eaten. They afford a good vegetable when dipped in egg and fried, and probably they would make a good salad. They are abundant and substantial enough to make a filling food.

The *chaya*, *Cnidoscolus aconitifolius*, is rather scarce in Guatemala and may be a recent introduction from Yucatán. It is a large shrub or small bushy-topped tree with an abundance of deep green, rather succulent foliage that is cooked and eaten. Introduced experimentally into southern Florida, it has been found that the leaves are particularly rich in certain vitamins; thus the *chaya* may enjoy a brief popularity among food faddists.

The Guatemalan vegetables brought under cultivation by the Indians presumably were those of greatest food value and easiest adaptation to cultivation, or ones that could not always be found wild when wanted. The aboriginal people, like their descendants, used as food a substantial number of plants that were edible, more or less agreeable in taste, but grew so generally about settlements that cultivation was unnecessary. These plants never have been "improved" like beans, pumpkins, and tomatoes, and they seem to vary little, no matter how varied their natural habitats. These esculent plants are rather numerous, but only a few can be noted here.

Purslane or pusley (*Portulaca oleracea*) sometimes is eaten as a pot herb in the United States, but in Guatemala its use is common and doubtless of great antiquity. Its good quality and abundance make it unnecessary to plant spinach in Central America. Another plant of the same family, *Calandrinia micrantha*, often is eaten like spinach. Much more popular are several native species of *Crotalaria,* known locally as *chipilín* (an Aztec name), whose young shoots, leaves, and flowers are cooked and eaten. They, like many edible wild plants, are sold in huge amounts in the Indian and *ladino* markets.

A favorite pot herb of the Guatemalan Indians is our common black nightshade, *Solanum nigrum*. Large quantities of the tender foliage with the flowers and young fruits are gathered and either consumed at home or sold in nearby markets. This plant, known in Guatemala as *yerba mora* or *mucuy*, is cooked like spinach, or used to fill tartlike *empanadas*, small turnovers filled with every conceivable mixture of greens, vegetables, meats, raisins, fruits, and other articles that it is best not to investigate too closely.

Blossoms of red-flowered Erythrinas are cooked like string beans and eaten, and made into a sort of fritter. The immature and still tender seed pods of *Gonolobus* are cooked and eaten as a vegetable. One of the favorite "greens" of Guatemala is the young shoots and flowers of *Fernaldia*, a genus of Apocynaceae, known in Guatemala and Salvador as *loroco*. Young sprouts of the Bromelias are much used as food, especially in arid parts of eastern Guatemala. One scarcely would expect that their usually stiff and spine-edged leaves could be eaten, but of course only the tenderest ones are gathered. It is hard to believe that even those can be a delectable vegetable. I have not had an opportunity to sample them.

A most unusual vegetable, fairly common, consists of the tender young flower heads of the Calatheas, which are dipped in egg or batter and fried or broiled. Equally strange are the young inflorescences of the aroid genus *Spathiphyllum*, which are treated in the same manner. The spadices in this genus look much like embryonic ears of corn. Some years ago, it is related, a North American, possibly a tourist, reported to the U. S. Department of Agriculture that in Guatemala he had been served soup of which miniature ears of corn were an ingredient. One may imagine the thrill with which this news was received, and the disgust of the men sent by the Department to investigate the matter. The credulity of scientists knows no bounds, and marvels still are expected from other continents besides Africa.

This year the world has heard a great deal about famine. In Guatemala famine is nothing new. When the maize crop fails, the result is catastrophic in a region where the diet at best is scant. In recent years the government has found temporary means of alleviating such disasters, but only a few years ago the highland Indians often suffered severely, and the results were quite as bad when clouds of locusts invaded the corn fields of the Pacific lowlands. In such cases the people had to resort to any vegetable matter that would sustain life. One of the plants used at such times was one or more wild species of *Dioscorea*, called *madre de maíz*, whose large hard roots were made into a kind of tortilla or tamal. Even more use was made of the large seeds of *Brosimum*, which were boiled, ground, and made into coarse tortillas. Only a few years ago a scientist of the U. S. Department of Agriculture soberly suggested in print the planting of a large part of the Florida Peninsula with forests of *Brosimum Alicastrum*. Whether the trees would grow there is dubious, but if they did, one suspects that the good people of Florida, for whose welfare so much solicitude was expressed, would care less for cakes of *Brosimum* seeds than for fried chicken, ice cream, or even grits. It is only when starving that Guatemalan Indians condescend to eat them.

The leaves of *Eryngium foetidum* and *Chenopodium ambrosioides*, both plants of incomparably vile odor, give a pleasing or even delicious flavor to soups and meat stews. It must have been in time of famine that the Indians discovered the comestible value of plants so unpromising.

These are only a few random notes on edible plants of Guatemala, presented in no orderly fashion. One plant not yet mentioned, but one for which Guatemala is famous, is the avocado. No region of the earth produces better avocados; few regions ones of comparable quality. Their food value is high because of the large amount of oil in the flesh, and the mountain Indians enjoy eating their hard-skinned avocados for both their food value and their delicious flavor.

Although from a botanical standpoint indubitably a fruit, the avocado is regarded by Guatemalans as something else, as is the tomato in the United States. At a hotel table in the town of Jutiapa one day, some regular patrons who formed a sort of lunch club demanded the usual "fruit" that should accompany the noonday meal. The French housekeeper explained tactfully that fruit was scarce in the market now, in the middle of the dry season; however she *could* give them some avocados. Uproarious shouts greeted this hopeful offer. For the rest of the meal every new guest to enter the dining room was greeted with the story, which ended: "Figúrese! We asked Madame for fruit, and she offered us *avocados*!"

CHICAGO NATURAL HISTORY MUSEUM.

A CRITICAL STUDY OF PHILIPPINE SPECIES OF THE TRIBE AQUILARIEAE, FAMILY THYMELAEACEAE*

EDUARDO QUISUMBING

THE TRIBE AQUILARIEAE (R. Br.) Baill. (1877); Gilg (1894) is represented by five genera: *Aquilaria* Lam., *Gyrinopsis* Decne., *Brachythalamus* Gilg, *Gyrinops* Gaertn., and *Lachnolepis* Miq. These genera have been much confused and no two authors can agree on their status. Even the well known genus *Aquilaria* is badly defined and the species, in general, are inadequately known. Hallier[1] reduced the four small genera *Gyrinops, Gyrinopsis, Brachythalamus,* and *Lachnolepis* to *Aquilaria.* Hallier grouped the species of *Aquilaria* under six sections: *Agallochum, Gyrinopsis, Amphinoma, Brachythalamus, Gyrinops,* and *Lachnolepis.* His third section seems ill-founded. *Aquilaria khasiana* Hallier, the only species under this section, appears to be but a mere form of the more familiar *A. Agallochoa* Roxb. On the other hand, on account of the presence of five stamens, I agree with Domke[2] that *Brachythalamus* is similar to *Gyrinops.* The shape of the perianth-tube is more like that of *Gyrinopsis,* which is slender and tubular. The presence of five stamens places *Lachnolepis* under *Gyrinops.* As to *Gyrinopsis* I concur with Merrill[3] that it is distinct from *Aquilaria.* In addition, I feel that the form of perianth-tube is a major distinguishing feature between the two genera, as well as the relative position of the nectarial scales, and the filaments. The development of the fruit is a distinguishing character in *Aquilaria* (*A. sinensis* and *A. malaccensis*), the fruit developing at the summit of the receptacle over the perianth. In *Gyrinopsis* (*G. Cumingana* et al.), the fruit develops and breaks at the side of the perianth-tube. As to *Gyrinops,* typified by *Gyrinops Walla,* I am convinced that it is distinct from the two genera. *Aquilaria* and *Gyrinopsis* are characterized by having ten stamens; *Gyrinops* has five or six stamens, normally five. Hallier discounts the value of the number of stamens as a distinguishing feature of the genera *Aquilaria* and *Gyrinops.* In this connection Hallier[4] expresses his views thus:

* The study upon which this treatment is based was essentially completed before the recent war, during which the herbarium and library of the Bureau of Science, Manila, were destroyed. Of the two new species of *Gyrinopsis* here proposed, isotypes were sent to the herbaria at Singapore and Buitenzorg and are also to be found in some American and European herbaria.

[1] H. Hallier in Med. Rijks Herb. Leiden, 44: 1–31. 1922.

[2] Domke in Notizbl. Bot. Gart. Berlin, 11: 349. 1932.

[3] Merrill in Philip. Jour. Sci. Bot. 7: 313. 1912.

[4] H. Hallier in Med. Rijks Herb. Leiden, 44: 5. 1922.

"So hätten wir denn nur noch zwei Gattungen, nämlich *Aquilaria* (mit Einschluss von *Gyrinopsis*) und *Gyrinops* (mit Einschluss von *Lachnolepis* und *Brachythalamus*), die widerum durch die einander sehr ähnlichen Kapseln der *A. khasiana* m. und der *Gyrinops Walla* auf's engste mit einander verknüpft werden, sich im übrigen aber nur durch das Vorhandensein oder Fehlen der fünf Kronstaubblätter von einander unterschieden. Auch auf letzteres Verhältnis darf jedoch nicht allzuviel Gewicht gelegt werden, da auch bei den vermütlichen Stammeltern der Thymelaeaseen, sowie der ganzen Myrtinen, der Polygalinen. . ."

Apparently the genus *Gyrinopsis* was not known to Hooker.[5] He recognized but two genera (*Gyrinops* and *Aquilaria*) under the tribe AQUILARIEAE. Of note is the way he differentiates the two genera, on the basis of the form of the perianth and the number of stamens.

While in some genera the number of stamens varies, in others this feature is important and of a major character. I consider, in this particular case, this feature a distinguishing one.

This paper includes descriptions of two apparently new species of *Gyrinopsis* (*G. parvifolia* and *G. pubifolia*). Because of a critical study of the group a few nomenclatural changes are in order.

In conclusion, it seems best to recognize three genera (*Aquilaria, Gyrinopsis,* and *Gyrinops*) in this group of allied plants. They may be separated on technical characters as follows:

1. Stamens 10.
   2. Perianth-tube campanulate or infundibuliform; stamens stalked; fruit developing on the summit of the perianth; seeds with umbilical cord. ....1. *Aquilaria*.
   2. Perianth slender, cylindric; stamens sessile; fruit developing from the side of the perianth-tube; seeds without umbilical cord. ....2. *Gyrinopsis*.
1. Stamens 5; perianth cylindric. ....3. *Gyrinops*.

Aquilaria Lamarck

Aquilaria Lam. Encycl. **1**: 49. 1783, **2**: 610. 1788, Illus. **2**: *t. 356*. 1799; Cav. Diss. 377, *t. 224*. 1790; Meisn. in DC. Prodr. **2**: 59. 1825, **14**: 601. 1857; Royle, Illus. Himal. Bot. **1**: 173. 1835, **2**: *t. 36*. 1839; Meisn. Pl. Vasc. Gen. 73. 1836; Arnott in Lindl. Nat. Syst. ed. 2, 442. 1836; Hook. Ic. **1**: *t. 6*. 1837; Endl. Gen. 333. 1837; Roxb. & Colebrooke in Trans. Linn. Soc. **21**: 199, *t. 21*. 1854.

Agallochum Rumph. Herb. Amb. **2**: 34, *t. 10*. 1741; Lam. Encycl. **1**: 47. 1783.

Ophiospermum Reichb. Consp. 82. 1828.

Ophiospermum Lour. Fl. Cochinch. 280. 1790; Meisn. in DC. Prodr. **2**: 59. 1825.

Decaisnella O. Kuntze, Rev. Gen. Pl. **2**: 584. 1891.

According to Roxburgh and Colebrooke, the flowers are incomplete; calyx campanulate, 5-cleft; corolla none; nectary (scales) 10-leaved, alternate with stamens; capsules superior, 2-celled, 2-valved; seed solitary; embryo inversed, without perisperm.

Distribution of the genus: Northeastern India, southern China, Hongkong, Malaysia to New Guinea.

[5] J. D. Hooker, Fl. Brit. Ind. **5**: 192. 1890.

PHILIPPINE SPECIES

Aquilaria acuminata (Merr.) comb. nov.

Gyrinopsis acuminata Merr. in Philip. Jour. Sci. Bot. **17**: 294. 1920, Enum. Philip. Fl. Pl. **3**: 130. 1923.

DINAGAT ISLAND: Surigao Province, *Bur. Sci. 35158 Ramos and Pascasio* (TYPE — flowering), May 13, 1919, at low altitude. BUCAS GRANDE ISLAND: Surigao Province, *Bur. Sci. 35055 Ramos and Pascasio* (fruiting), June 11, 1919, at low altitude.

Aquilaria apiculata Merr. in Philip. Jour. Sci. **20**: 411. 1922, Enum. Philip. Fl. Pl. **3**: 130. 1923.

MINDANAO: Bukidnon Province, *Bur. Sci. 38601 Ramos and Edaño* (TYPE), in dry forests, altitude 1100 m.

Aquilaria brachyantha (Merr.) H. Hallier in Med. Rijks Herb. **44**: 16. 1922.

Gyrinopsis brachyantha Merr. in Philip. Jour. Sci. Bot. **7**: 313. 1912, Interpret. Herb. Amb. 380. 1917, Enum. Philip. Fl. Pl. **3**: 130. 1923; Elmer, Leafl. Philip. Bot. **5**: 1629. 1913.

Cortex filarius Rumph. Herb. Amb. **Auct.**: 13. 1755.

LUZON: Cagayan Province, Abulug River, *Bur. Sci. 13862 Ramos* (TYPE), Jan. 28, 1912, *For. Bur. 17220, 19562 Convocar*, Jan. 25, 1912. ALABAT: Tayabas Province, *Bur. Sci. 48136 Ramos and Edaño*, Oct. 8, 1926, *Bur. Sci. 48220 Ramos and Edaño*, Sept. 21, 1926. Borneo, Amboina.

The calyx is campanulate.

Aquilaria malaccensis Lam. Encycl. **1**: 49. 1783; Gamble in Jour. As. Soc. Beng. 75²: 264. 1912; Merr. in Philip. Jour. Sci. Bot. **10**: 44. 1915, Enum. Philip. Fl. Pl. **3**: 130. 1923.

Aquilaria secundaria Meisn. in DC. Prodr. **2**: 59. 1825.

Aquilaria ovata Cav. Diss. 377, *t. 224*. 1790.

Agallochum secundarium (*coinamense* et *malaccense*) Rumph. Herb. Amb. **2**: 34, 35, *t. 10*. 1741.

LUZON: Camarines Prov., Salauigan, *For. Bur. 21452 Alvarez*, May 21, 1914. Malay Peninsula, Sumatra, Siam.

Excluded Species

Aquilaria pentandra Blanco, Fl. Filip., ed. 1, 373. 1837. Philippines.

EXTRA-PHILIPPINE SPECIES

Aquilaria Agallocha Roxb. Hort. Beng. 33. 1814, Fl. Ind. ed. 2. **2**: 422. 1832.

Agallochum secundarium Calambac Rumph. Herb. Amb. **2**: 34. 1741.

Bengal, Assam.

Aquilaria Baillonii Pierre ex Lecomte, Fl. Gén. Indo-Chine, **5**: 179. 1915. Indo-China: Cambodia.

Aquilaria Crassna Pierre ex Lecomte in Bull. Soc. Bot. France, **61**: 411. 1915. Indo-China: Cambodia.

Aquilaria hirta Ridley in Jour. Roy. As. Soc. S. Br. **35**: 78. 1901. Malay Peninsula.

Aquilaria khasiana H. Hallier in Med. Rijks Herb. **44**: 18. 1922. India.

Aquilaria microcarpa Baill. in Adansonia **11**: 304. 1875. Sarawak, West Borneo.

Aquilaria Moszkowskii Gilg in Notizbl. Bot. Gart. Berlin, **5**: 84. 1908. Sumatra.

Aquilaria Ophispermum Poir. in Dict. Sci. Nat. **18**: 161. 1820.

Aquilaria chinensis Spreng. Syst. **2**: 356. 1825.

China.

Aquilaria rostrata Ridley, Fl. Malay Penin. **3**: 148. 1924. Malay Peninsula.

Aquilaria sinensis (Lour.) Merr. in Philip. Jour. Sci. 15: 248. 1919.
Ophispermum sinense Lour. Fl. Cochinch. 280. 1790.
Aquilaria grandiflora Benth. Fl. Hongk. 297. 1861.
China.

Gyrinops Gaertner

Gyrinops Gaertn. Fruct. 2: 276, *t. 140.* 1791; Meisn. in DC. Prodr. 2: 60. 1825, 14: 602. 1857; Arnott in Lindl. Nat. Syst. ed. 2, 442. 1836; Meisn. Pl. Vasc. Gen. 73. 1836; Hook. Ic. 1: *t. 5.* 1837; Endl. Gen. 333. 1837.

Perianth tubular, cylindric, slender; stamens 5, arranged in a row; nectarial scales inserted above the stamens, connate in a ring; other features resembling *Aquilaria*.

The genus *Gyrinops* is based on the type of *Gyrinops Walla* Gaertn. Five species are known today under this genus. Domke[6] reduced three species of *Brachythalamus* to *Gyrinops*. The latter genus is distinct from *Aquilaria* and *Gyrinopsis* in having only five stamens. Domke described another species, *G. Ledermannii,* from New Guinea. Hallier[7] reduced all the species of *Gyrinops* to *Aquilaria,* with which I do not agree.

Extra-Philippine Species[8]

Gyrinops caudatus (Gilg) Domke in Notizbl. Bot. Gart. Berlin, 11: 349. 1932.
Brachythalamus caudatus Gilg in Bot. Jahrb. 28: 146. 1900.
New Guinea.

Gyrinops Ledermannii Domke in Notizbl. Bot. Gart. Berlin, 11: 349. 1932.
New Guinea.

Gyrinops moluccana (Miq.) comb. nov.
Lachnolepis moluccana Miq. in Ann. Mus. Bot. Lugd.-Bat. 1: 132. 1863.
Aquilaria moluccana (Miq.) H. Hallier in Med. Rijks Herb. 44: 19. 1922.
Moluccas.

Gyrinops podocarpus (Gilg) Domke in Notizbl. Bot. Gart. Berlin, 11: 349. 1932.
Brachythalamus podocarpus Gilg in Bot. Jahrb. 28: 146. 1900.
Aquilaria podocarpa H. Hallier in Med. Rijks Herb. 44: 19. 1922.
New Guinea.

Gyrinops Versteegii (Gilg) Domke in Notizbl. Bot. Gart. Berlin, 11: 349. 1932.
Brachythalamus Versteegii Gilg in Nova Guinea, 8: 410. 1910.
Aquilaria Versteegii H. Hallier in Med. Rijks Herb. 44: 19. 1922.
New Guinea.

Brachythalamus Versteegii Gilg is the type of the genus *Brachythalamus.*

Gyrinops Walla Gaertn. Fruct. 2: 276, *t. 140.* 1791; Meisn. in DC. Prodr. 2: 60. 1825, 14: 603. 1857; Hook. Ic. 1: *t. 5.* 1837.
Ceylon.

Gyrinopsis Decaisne

Gyrinopsis Decaisne in Ann. Sci. Nat. Bot. II. 19: 41, *t. 1, fig. B.* 1843, Bot. Zeit.

6 Domke in Notizbl. Bot. Gart. Berlin, 11: 349. 1932.

7 H. Hallier in Med. Rijks Herb. 44: 15–20. 1922.

8 All species of *Gyrinops* herein included are extra-Philippine. The genus is not represented in the Philippines.

2: 599. 1844; Endl. Gen. Pl. Suppl. III, 65. 1843; Walp. Repert. 5: 410. 1845; Meisn. in DC. Prodr. 14: 602. 1857; Lemée, Dict. Desc. Syn. Gen. Pl. Phan. 3: 404. 1931.

The genus *Gyrinopsis* is based on *G. Cumingiana,* described from a Philippine specimen, *Cuming 1617*. The genus has previously been reported only from the Philippines, but apparently it occurs also in Borneo and Amboina.

The perianth is slender and cylindric. There are 10 sessile stamens arranged in two rows, one below the other, unequal, the five alternating smaller. There are 10 scales, alternating with the stamens or below the stamens. The fruit develops from the side of the perianth-tube. The seeds are without umbilical cord.

PHILIPPINE SPECIES

Gyrinopsis citrinaecarpa Elmer, Leafl. Philip. Bot. 5: 1631. 1913; Merr. Enum. Philip. Fl. Pl. 3: 130. 1923.

Aquilaria citrinaecarpa (Elmer) H. Hallier in Med. Rijks Herb. 44: 18. 1922.

MINDANAO: Agusan Province, Cabadbaran (Mt. Urdaneta), *Elmer 13566*, Aug., 1912, on forested ridges, altitude about 1200 m.

Gyrinopsis Cumingiana Decne. in Ann. Sci. Nat. Bot. II. 19: 41, *t. 1, fig. B.* 1843, Bot. Zeit. 2: 599. 1844; Walp. Repert. 5: 410. 1845; Miq. Fl. Ind. Bat. 1[1]: 883. 1857; Meisn. in DC. Prodr. 14: 603. 1857; F.-Vill. Novis. App. 183. 1880; Vidal, Phan. Cuming. Philip. 140. 1885, Rev. Pl. Vasc. Filip. 230. 1886; Merr. in Philip. Bur. For. Bull. 1: 41. 1903, Enum. Philip. Fl. Pl. 3: 131. 1923; Elmer, Leafl. Philip. Bot. 5: 1629. 1913.

Gyrinopsis Cumingiana Decne. var. *pubescens* Elmer, Leafl. Philip. Bot. 5: 1629. 1913; Merr. Enum. Philip. Fl. Pl. 3: 131. 1923.

Aquilaria Cumingiana (Decne.) H. Hallier in Med. Rijks Herb. 44: 17. 1922.

Aquilaria decemcostata H. Hallier in Med. Rijks Herb. 44: 17. 1922.

PHILIPPINES: *Cuming 1617* (TYPE). LUZON (Nueva Ecija, Bulacan, Tayabas, Laguna, Camarines, Albay), CATANDUANES, SAMAR, SIBUYAN, LEYTE, PANAY, MINDANAO, JOLO. In primary forests at low and medium altitudes. Celebes.

Local names: *Alahan* (Tag.); *bago* (Mbo.); *binukat* (Ak., Bis.); *butlo* (Neg.); *dalakit* (S. L. Bis.); *Maga-an* (Tag.); *palisan* (Tag.); *pamaluian* (Bag.).

Gyrinopsis urdanetensis Elmer, Leafl. Philip. Bot. 5: 1630. 1913.

Aquilaria urdanetensis (Elmer) H. Hallier in Med. Rijks Herb. 44: 16. 1922.

MINDANAO: Agusan Province, *Elmer 14195, 13742*, in the mossy forest on exposed ridges, altitude about 1700 m.

Local names: *Makolan* (Mbo.); *mañgod* (Mbo.).

Gyrinopsis parvifolia sp. nov.

Frutex circiter 1 m. altus, partibus junioribus subtus foliis fructibusque exceptis glabris; foliis lanceolatis vel anguste lanceolatis, utrinque attenuatis, acutis vel apice leviter acuminatis, ad 8.7 cm. longis et 2.5 cm. latis, supra glabris, subtus parce pubescentibus, nervis primariis utrinque 7–10, leviter prominentibus, petiolo ad 5 mm. longo; capsulis parce pubescentibus, ad 1.2 cm. longis, obovoideis, in siccitate rugosis; pedunculis dense pubescentibus.

Shrub about 1 m. tall (Edaño), glabrous except the growing tips, young leaves, petioles, peduncles, and capsules. Leaves small, subcoriaceous, lanceolate or narrowly lanceolate, narrowed to an acute apex and base, the apex in some cases somewhat acutely acuminate, 4.5–8.7 cm. long, 1–2.5 cm. wide, greenish or olivaceous when dry, glabrous above, the lower surface slightly pubescent, in young unopened leaves very densely pubescent, the primary lateral nerves somewhat distinct, 7–10 on each side of the midrib, the secondary ones exceedingly numerous, very slender, densely arranged, the petioles slender, glabrous with age, otherwise pubescent, 4–5 mm. long. Perianth (in fruit) slightly pubescent, 5–6 mm. long including the lobes, the lobes 5, broadly ovate, rounded, about 1.5 mm. long. Capsules yellowish, rugose when dry, slightly pubescent, obovoid, 10–12 mm. long, 2-valved, 2-seeded (sometimes 1-seeded), more or less compressed, the seed broadly ovoid, apiculate, dark brown, glabrous, shining, smooth, 8–9 mm. long, 6.5–7 mm. wide, flat on the ventral side, the peduncles densely pubescent, very short, 1–2 mm. long.

LUZON: Camarines Sur Province, Her-it River, *Bur. Sci. 76441 Edaño* (TYPE), December 10, 1928, on forested slopes, altitude about 1000 m.

This species is closely allied to *G. urdanetensis* Elmer, from which it is distinguished by its differently shaped leaves with somewhat prominent primary lateral nerves, and its pubescent capsules.

Gyrinopsis pubifolia sp. nov.

Frutex circiter 1 m. altus, ramis et foliis supra exceptis pubescens; foliis lanceolatis, ad 18 cm. longis et 5 cm. latis, graciliter acuminatis, basi cuneatis; nervis lateralibus primariis utrinque 12–16, secundariis numerosis, dense dispositis; floribus parvis, circiter 1 cm. longis, axillaribus, fasciculatis.

Shrub about 1 m. high (fide Edaño), pubescent except the branches and older branchlets and upper surface of the leaves, the branchlets terete, brownish. Leaves lanceolate, 10–18 cm. long, 3–5 cm. wide, slenderly acuminate at apex, narrowed to the cuneate base, greenish and shining on both surfaces when dry, chartaceous, glabrous above, soft pubescent beneath, the primary lateral nerves distinguishable, 12–16 on each side of the midrib, the secondary ones numerous, very slender, somewhat obscure, the petioles pubescent, 4–7 mm. long. Inflorescence in few-flowered fascicles, sessile or very shortly peduncled (peduncles 1–1.5 mm. long). Flowers 10–15 mm. long, the pedicels very slender, pubescent, 2–3 mm. long, the tube slender, slightly pubescent; stamens 10 arranged in a single row near the throat, the filaments nearly sessile, ciliate, the anthers about 1.5 mm. long, the scales 10, densely ciliate; ovary densely pubescent, oblong-obovoid, narrowed downward, the style sessile, the stigma capitate.

CATANDUANES: Mt. Abucay, *Bur. Sci. 75314 Edaño* (TYPE), September 11, 1928, on summit, altitude about 1600 m.

A species doubtless allied to *G. Cumingiana* Decne., differing conspicuously in its pubescent leaves and smaller flowers. It differs from *Elmer 10981* (*G. Cumingiana* Decne. var. *pubescens* Elmer) in the color, shape, and size of the leaves.

EXTRA-PHILIPPINE SPECIES

Gyrinopsis grandifolia (Domke) comb. nov.

Aquilaria grandifolia Domke in Notizbl. Bot. Gart. Berlin **11**: 348. 1932.

I have not seen the type, which is from Sumatra. But based on the description (calyx-tube more or less cylindrical, about 7 mm. long and 2 mm. in diameter; scales 10; stamens 10, subsessile or the filaments 0.2–0.8 mm. long), there seems no doubt that it is a *Gyrinopsis*. The leaves are unduly large (17–27 cm. long, 6–7.5 cm. wide). The lateral nerves on both sides of the midrib are prominent, 15–25. The species, therefore, by its description, is apparently allied to *Gyrinopsis Cumingiana* Decne.

Gyrinopsis salicifolia (Ridley) comb. nov.
Gyrinops salicifolia Ridley in Trans. Linn. Soc. Bot. II. **9**: 145. 1916.
New Guinea.

NATURAL HISTORY MUSEUM,
MANILA.

THE LICHEN FLORA OF THE PHILIPPINES

ALBERT W. HERRE

THE LICHEN flora of the Philippines is one of great interest. This, however, is only to be expected from the geographical position of that marvellous archipelago, which is really a northern spur of the East Indies. While the Philippines lie entirely in the monsoon area of the rainy tropics, there is a great variety of ecological conditions within their limits. From the rocky and storm-swept Batanes Islands at the extreme north not far from Formosa, to the Sibutu Islands well down on the east coast of Borneo, there is a range of climates and habitats that ensures a lichen flora that is relatively as large and diversified as that of the flowering plants. The altitudinal range of the many high peaks, reaching up to almost ten thousand feet, adds greatly to the variety and ensures a well represented boreal element in the lichen flora.

The Philippine lichen flora long remained almost unknown. The lichens of Indo-China, Java, Labuan, New Caledonia, and other regions not too remote from the Philippines were more or less well known before 1890.

So far as can be ascertained, the only lichens known from the Philippines before 1909 were those discussed in the following few paragraphs. *Sticta tomentosa* Ach. was collected in 1830 by the distinguished German botanist Meyen; on his trip around the world Meyen was the guest for a month of the noted Paul de la Gironnière at his great estate, Jala Jala, on the north shore of Laguna de Bay. Charles Gaudichaud, a celebrated French botanist, visited Manila on the Bonite in 1836 and collected five lichens: *Ramalina furcellata* (Montagne) A. Zahlbr. var. *torulosa* (Nyl.); *Physcidia callopis* (Meyen & Flot.) Müll. Arg.; *Ocellularia concolor* Meyen & Flot. (these three are not mentioned by Wainio and the two following have not been taken since Gaudichaud collected them); *Graphis persicina* Meyen & Flot.; *Opegrapha prosodea* Ach. var. *sclerocarpa* (Meyen & Flot.) Wainio.

The unrivalled English collector, Hugh Cuming, was in the Philippines from 1836 to 1839 and traveled over a large part of the islands. Although his real interest was in conchology, he collected in several other lines of natural history and secured 30 sets of botanical specimens. Among these were 25 species of lichens, as follows:

Trypethelium anomalum Ach.; *Trypethelium areolatum* Montagne; *Laurera Cumingi* Mont.; *Phylloporina rufula* (Krempelh.) Müll. Arg. var. *rhodoplaca* Müll. Arg.; *Graphis tenella* Ach.; *Graphina Achari* (Fée) Müll. Arg.; *Graphina Babingtoni* (Mont.) A. Zahlbr.; *Phaeographis chrysenteron* (Mont.) Müll. Arg.; *Phaeo-*

graphis flexuosa (Nyl.) Müll. Arg.; *Sarcographa Leprieuri* (Mont.) Müll. Arg.; *Ocellularia Berkeleyana* (Mont.) A. Zahlbr.; *Pannaria lurida* (Mont.) Nyl.; *Pannaria mariana* (E. Fr.) Müll. Arg.; *Coccocarpia pellita* (Lam.) Müll. Arg. var. *incisa* (Pers.) Müll. Arg.; *Physma bursinum* (Ach.) Müll. Arg.; *Leptogium phyllocarpum* (Pers.) Mont.; *Leptogium tremelloides* (Linn. fil.) S. F. Gray, var. *azureum* (Swartz) Nyl.; *Sticta argyracea* Del. var. *aspera* (Laur.) Krempelh.; *Sticta sinuosa* Persoon; *Lecidea piperis* (Spreng.) Nyl.; *Stereocaulon ramulosum* Ach.; *Parmelia relicina* (E. Fries); *Ramalina vittata* Nyl.; *Pyxine sorediata* E. Fries; *Physcia applanata* (Fée) A. Zahlbr.

Of the 25 listed above, ten are not mentioned by Wainio, and a number have never been taken since Cuming obtained them. Apparently the Spanish botanists never collected a Philippine lichen. The 31 species named above were all that were known from the islands until after the Americans came. In talking to Dr. Alexander Zahlbruckner, in 1907, I was urged almost every day to go to the Philippines to collect and study lichens. Always he would say "Aber, es ist eine ganze neue Welt." He believed it was the last considerable area left with a large and diversified lichen flora which was quite unknown.

With the beginning of scientific work by Americans in 1902, the botanists of the Bureau of Science and Bureau of Forestry and their native assistants began to take an active interest in collecting lichens as well as ferns and flowering plants. The botanists most ardent in collecting lichens were E. D. Merrill, C. F. Baker, Mrs. Mary Strong Clemens, E. B. Copeland, H. M. Curran, A. D. E. Elmer, F. W. Foxworthy, and C. B. Robinson. Equally keen in obtaining lichens was the ornithologist R. C. McGregor, while C. M. Weber also collected many. Native assistants who paid special attention to lichens were G. Edaño, Eugenio Fénix, L. Mangubat, and above all M. Ramos. Besides these, other Americans and Filipinos contributed lichens to the herbarium of the Bureau of Science.

The large amount of material collected by them was sent by Dr. E. D. Merrill to the noted lichenologist, Dr. E. A. Wainio, of Helsingfors, Finland. His results were published in four papers, from 1909 to 1923 (2–5). With the appearance of this work of nearly 500 pages of descriptive text, the broad outlines of the Philippines lichen flora were at last set forth. Wainio listed 92 genera and 680 species, besides many varieties, some of them really worthy of specific rank. Adding eleven species collected between 1830 and 1840 and not mentioned by Wainio, as he lacked material for study, 691 species are thus far recorded from the Philippines. Of the 680 species given by Wainio, 441 or 64.85% are new. This is an amazing proportion and well supports Zahlbruckner's statement.

This great ratio of endemism is actually more apparent than real. There is no question but that, when intensive lichen collecting is done in other parts of the oriental tropics from the mainland and Sumatra to New Guinea and the Solomons, the proportion will change. Wainio's new species will be found in these other regions, just as many supposedly endemic California lichens are now known to occur in adjoining states and even in regions far away.

It is well to note that Wainio's publications are far from presenting a complete conspectus of the Philippine lichen flora. On sea cliffs occur unrecorded species of *Roccella* and other fruticose and crustaceous lichens, while the tablelands of Mindanao show earth-dwelling *Lecideae* and other undescribed lichens. Strange Graphidaceae occur on mossy rocks in the mountain gorges above Dumaguete, and on trees in various regions. Critical examination of rocks would make possible large additions to the lichen flora. In the past rock lichens have either escaped observation or else collectors have not been prepared to remove them from the substratum. It is safe to assume that over 800 species of lichens will ultimately be known from the Philippines. Intensive collecting in the Batanes Islands and on the limestone cliffs and peaks of Palawan should raise the list nearly to that figure. However, optimism must be tempered by a recognition of the destruction by man and its impact on the lichen flora. The rarities obtained by Gaudichaud and Cuming at Manila may be extinct, so great have been the changes during the past century. The conversion of forests to cogonales, and the terrific erosion following caiñgan culture on steep hillsides, may well have brought other lichens to extinction.

The composition of the Philippine lichen flora is in marked contrast to that of the United States or Europe. Naturally it is much like that of the rest of the oriental rainy tropics. But it also has species previously known only from Brazil, Colombia, Peru, the West Indies, and other American localities. Such instances merely indicate how little collecting has been done in the intervening regions. The family best represented is the Graphidaceae. *Graphis* has 39 species, of which 19 are new in Wainio's work, *Graphina* has 33 with 25 new, *Phaeographis* has 26 of which 19 are new, and *Phaeographina* 12 species and eight new. This is a total of 110 species in *Graphis* and its very close allies, which Wainio considered but subgenera.

A botanist new to the Philippines is usually disappointed in the lichen flora. The cities, like those elsewhere, are poor places for lichens, and the interminable rice paddies and sugar cane fields are no better for lichens than the corn and wheat fields of the middle west. Coconut groves are better, but collecting is very poor in the mountain rain forests or the vast jungles of the upper Agusan valley. The pale spots which often cover the trunks of trees in such places are lichens, but their thallus is defective and they never fruit, owing to the excessive moisture and twilight shades of the forest. Mosses, liverworts and ferns thrive much better in such locations. If one is able to leave the gloom below and gain access to the tree tops far above he will find lichens abundant. On the edge of the forest beside clearings, especially where jakfruit occurs, crustaceous and foliaceous bark lichens are profuse and in great variety. An examination of the leaves of shrubs and trees reveals a wealth of epiphyllous species, often in bewildering variety to the North American or European. No doubt there are numerous unknown leaf lichens awaiting discovery in Philippine forests.

At the same time the islands have lichens well known in Europe and the United States, and when one is encountered it is like meeting an old friend in a place where all is strange. Most of them occur in the mountains or on plateaus, at elevations from 2,000 to over 9,000 feet. Among them are the following: *Microphiale diluta* (Pers.) A. Zahlbr.; *Microphiale lutea* (Dicks.) A. Zahlbr.; *Leptogium azureum* (Sw.) Nyl.; *Pannaria leucosticta* Tuck.; *Pannaria rubiginosa* (Thunb.) Del.; *Sticta aurata* (Ach.); *Sticta crocata* (L.) Ach.; *Peltigera polydactyla* (Neck.) Hoffm.; *Cladonia sylvatica* (L.) Rabenh.; *Cladonia Floerkeana* (E. Fr.) Sommerf.; *Cladonia bacillaris* Nyl.; *Cladonia coccifera* (L.) Willd.; *Cladonia didyma* (Fée) Wainio; *Cladonia furcata* (Huds.) Schrader; *Cladonia squamosa* (Scop.) Hoffm.; *Cladonia gracilis* (L.) Willd; *Cladonia pityrea* (Floerke) E. Fr.; *Cladonia verticillata* Hoffm.; *Pertusaria velata* (Turn.) Nyl.; *Lecanora subfusca* (L.) Ach.; *Haematomma puniceum* (Ach.) Mass.; *Parmelia perlata* (L.) Ach.; *Parmelia cetrata* Ach.; *Usnea florida* (L.) Web.; *Usnea longissima* Ach.; *Usnea trichodea* Ach.; *Physcia picta* (Swartz) Nyl.; *Anaptychia hypoleuca* (Mühlb.) Mass.; *Anaptychia leucomelaena* (L.) Wainio; *Anaptychia speciosa* (Wulf.) Mass. This does not complete the list, and we may expect it to be much extended when the Batanes Islands and the rocks of the high mountains have been thoroughly explored.

The extensive lichen collections of the Bureau of Science, largely named by Wainio but with many named by G. K. Merrill and myself, along with the rare and valuable works on lichens which I selected for the great library, have been maliciously destroyed by Japanese soldiers. The loss to scientific workers in the Philippines is well-nigh irreparable. There is nothing left in the islands of the authoritative material on which Wainio worked so long and painstakingly, nothing with which future collections may be compared. At the request of Dr. E. D. Merrill I prepared sets of Philippine lichens from material examined and named by Dr. Wainio or G. K. Merrill. These sets were distributed by Dr. Merrill to the principal herbaria of the world. Some of these herbaria, as at Berlin, were destroyed during the war, but most of them are intact. These sets contained duplicates, often many, wherever the material permitted. I suggest that it would be a graceful act and an exemplar of true scientific spirit for the curators of the various herbaria to go through these sets of Philippine lichens. From them they can undoubtedly select duplicates of well represented species which can be spared for the purpose of helping rebuild botanical activities in the Philippines.

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NATURAL HISTORY MUSEUM,
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OBSERVATIONS ON SOME SHRUBBY ADESMIAE OF CENTRAL CHILE

C. Skottsberg

With two text-figures

In the dry chaparral country south of Coquimbo a tall *Adesmia* is one of the predominant shrubs; nevertheless I found some difficulty in naming it, because it did not seem to fit *A. arborea* Bert. ex Colla or *A. microphylla* Hook. & Arn., the shrubby species supposed to occur in this region. A study of the literature and of herbarium specimens showed that there has been and still is some confusion about *A. arborea* and its relatives, which made me look a little closer into the matter. The result is communicated below.

Adesmia arborea of Bertero and of Colla

I quote Colla's description in full (4, p. 58):

"*A. arborea* (Berter. in Merc. Chil. 12. p. 557 sine descriptione); caule frutescente ramisque glanduloso-scabris, foliis fasciculatis 7–10-iugis, foliolis subsessilibus ovato-oblongis ciliatis, pedunculis axillaribus 1-floris folio brevioribus, leguminis longe barbatis (flores flavi)" Nob. Habitat in fruticetis collium apric. *Quillota*, cult. in h. ripul. e seminibus missis ab Auctore; stamina in hac stirpe 5–10, setae leguminum barbato-plumosae versicolores; ergo in sect. I (*Chaetotricha* DC. l. c.) collocanda."

Walpers (11, p. 729) quotes "Mercurio chilense" XII. 559 and Colla's paper. I have not had access to Bertero's original paper, but only to Dr. Ruschenberger's English translation (1), where we find, on p. 67 under *Adesmia*: "The *Palhuen* which I have named *A. arborea*, a pretty shrub which is found in the stony and arid situations about hills approaches the *Zuccagnia punctata*. Cavanilles. Its foliage, the number and color of its flowers, and above all its pods, clothed with very long and different colored hairs, make it interesting in English gardens. The other species are all herbaceous. . . ." From this we may conclude that Bertero recognized only *one* arborescent species. According to Clos (3, p. 196), *Palhuen* is the common name for *A. microphylla* Hook. & Arn., but it is also used for what he describes as *A. arborea*, together with *Espinillo*, which, as we shall see presently, is the name given by Bertero for *A. microphylla*, distributed by him as *A. arborea*.

Whether Colla drew his description from specimens he received or only from those he raised from seeds, I do not know. In Herb. Stockholm is a specimen of Bertero with two labels: (a) testified as written by Bertero:

"761[1] *Adesmia arborea Bertero vulgo espinillo. In fruticetis lapidosis collium Quillota (Chile) 1819 8 $^{br.}$ 9 $^{mbr.}$*"; (b) *Adesmia arborea. microphylla Hook.* (added later). This specimen, which forms part of the type material of *A. arborea* Bert., is *eglandulose,* has 4–6 pairs of obovate-orbicular, very small leaflets, and racemose flowers supported by minute bracts. It cannot have anything to do with Colla's *A. arborea* but it is identical with *A. microphylla* of Hooker & Arnott. To judge from a note (5, p. 55), these authors came to the same result: "Our *Adesmia microphylla* we have received from Mr. Mathews as the *arborea* of Bertero's MSS. But this plant of Bertero M. Guillemin is disposed to refer to *Zuccagnia punctata* of Cavanilles." This, as far as I can see, is an impossible suggestion. Bertero was familiar with Cavanilles' work, and could not very well have mistaken *Zuccagnia punctata,* well described and figured by Cavanilles (*2,* p. *2, pl. 403*) for an *Adesmia.* On the other hand, it is easy to show that Bertero's *A. arborea* was a mixture.

Ademsia arborea of Clos and Reiche

Clos (3, p. 192) divides *Adesmia* § V, Plantas frutescentes y espinosas, into two groups: 1. Flores no arracimadas, and 2. Flores dispuestas en rácimos. In group 1 the branches carry numerous more or less semi-globular dwarf shoots with fasciculate leaves surrounding a few axillary flowers; in the second group these shoots, after a few very short internodes, become prolonged, forming a raceme as a rule terminated by a spine. To the first group *A. arborea* Bert. is referred, to the second *A. microphylla*. Clos gives a detailed description of the former, which is a tree, 6–7 feet high, eglandulose in all parts; the branches, which end in 2- or 3-furcate spines, are provided with dwarf shoots in the shape of tubercles carrying leaves and flowers; leaves canescent, with 3 or 4 pairs of small oval leaflets; calyx-teeth narrow, acute, of the same length as the tube. It grows in the provinces of Colchagua and Santiago, north to Coquimbo. Clos adds (p. 195): "Creemos que la *A. arborea* de Colla deberia mas bien unirse á la *A. glutinosa,* puesto que está descrita como glandulosa y nada se dice de sus espinas, que son muy raras en esta última especie." This is, however, not very probable, because *A. glutinosa* belongs to the second group of Clos, while Colla's *A. arborea* falls within the first. Clos continues: "Nuestra planta es por cierto la *A. arborea* de Bertero, de la que tenemos á la vista los ejemplares recojidos y marcados por el mismo." Consequently, Bertero must have distributed two different species under the name of *A. arborea,* one of which is equal to *A. microphylla* Hook. & Arn., the other differing from Colla's *A. arborea* in lacking all glands and in having 3 or 4 pairs of leaflets instead of 7–10. Unfortunately, I have not had an opportunity to examine Colla's type. That *A. arborea* Bert. is a mixture was pointed out by Steudel (10, p. 27). Under *A. microphylla* we find as a synonym "A. arborea. *Bert.* hrb. (ex parte nr. 763 non nr. 5)," whereas no. 5 is

[1] Or *763?*; the last figure is indistinct.

called "A. Berteroniana. *Steud.* A. arborea *Berter* (ex parte nr. 5. non 763)," and under *A. arborea* Bert. we find "A. Berteroniana, microphylla." Colla is not mentioned by Steudel. Index Kewensis retains *A. arborea* Bert. and refers *A. arborea* Colla to *A. glutinosa* Hook. & Arn. without a query.

Philippi (6, p. 48) lists *A. arborea* Bert. Mem. Tor. XXXVII. 59, where, as we have seen, Colla is the author; besides, he idenitifies an "arborea Colla ubi?" with *A. viscosa* Gill., a very different plant.

Reiche's *Patagonium arboreum* (Bert.) (8, p. 120), "Adesmia arborea Bert. Gay II páj. 194", is identical with Clos' and the description is an abbreviated translation of his. He does not quote Colla, but under *Patagonium glutinosum* (Hook. & Arn.) we find as a synonym "*Medicago arborea* Colla." As far as I am aware, Colla never described such a species. Probably Reiche has copied Philippi (6, p. 49), who puts "Medicago arborea Colla" as a synonym of *A. glutinosa*. The distribution of *A. arborea* is according to Reiche from Coquimbo to Linares, in sterile hills, but not in the littoral zone, but he also lists it from Valparaiso (4, p. 196), rather a doubtful record.

I have seen two collections clearly belonging to *A. arborea* of Clos and Reiche:

(1) "*Adesmia arborea* Bert. Chile centralis, Prov. Colchagua, ad Baños de Cauquenes, 28. VIII. 1896. *P. Dusén*" (S). Figs. 1, 2.

Morphology as described. Leaves 15–20 mm. long, including the petiolar half of the rachis, rather densely canescent, with 3 or 4 (very rarely 5) pairs of leaflets $2–3 \times 1–1.5$ mm., these elliptic-obovate, in some cases minutely apiculate. Calyx densely canescent, 4.5–5 mm. long, including teeth of 2–2.5 mm.; standard with a glabrous limb $5–6 \times 7–8$ mm. and a boat-shaped claw 1.7–2.1 mm. long; wings with limb $5.7–6.1 \times 3.5–3.8$ mm. and claw 2.4–2.7 mm. long; keel with limb $5–5.2 \times 2.8–3.7$ mm. and a claw of 2.5–2.7 mm. Stamens apparently anomalous in most flowers. Ovary 5-jointed, densely hirsute along edges, the sides of joints with numerous glandular appendices, becoming greatly lengthened and plumose in the developed pod. Flowers yellow with veins marked with reddish brown.

(2) "*Adesmia arborea* Bert. Nom. vulg. *Palhuén*. Prov. Santiago, alt. 1450 m. X. 1931. *C. Grandjot.*" (S). Figs. 3, 4, 25.

Very like the former. Leaves to 20 mm. long, generally 3- but sometimes 4-jugate, the leaflets linear to linear-spatulate, obtuse and more or less distinctly apiculate, $3–5 \times 0.7–1.7$ mm., puberulous. Calyx 5–5.5 mm. long including the 2–3 mm. long linear-subulate teeth. Standard as in the former, the limb $4.5–5 \times 7.8$ mm., the claw 1.7–2 mm. long; limb of wings 4.7×3.7 mm., the claw 3.5 mm. long; keel with limb 4.5×4 mm., the claw 3 mm. long. Longer stamens 8–8.5 mm. long, the shorter ones 7–7.5 mm. long. Ovary 4- or 5-jointed, as before, the style 6 mm. long. In an envelope is an almost ripe pod, but whether or not it belongs to the specimen I cannot tell. It measures 16 mm. long, with three fertile joints, their flat sides adorned by plumose setae 7–8 mm. long. They are less numerous than in *A. glutinosa,* so that the pubescent wall of the pod, which is completely hidden in this, is visible.

Adesmia arborea Bert. is a ***nomen nudum***. It does not include *A. arborea* Colla, which is a dubious species, but two other species, *A.* ***microphylla*** Hook. & Arn. and *A.* ***arborea*** in the sense of Clos and Reiche. For the latter we may better take up the name *A.* ***Berteroniana*** Steud.

Adesmia microphylla Hook. & Arn. (5, p. 19, *pl. IX*)

A well-defined species, of which I have seen numerous specimens.

Described as a decumbent, intricately branched shrub; the long shoots carry much reduced, tuber-like dwarf shoots with a fascicle of leaves surrounded by the old persistent stipules. Leaves pubescent, as much as 6-jugate, the leaflets very small, orbicular. The dwarf shoots are not represented in the plate, which does not give a good idea of the morphology; the leaves are drawn as 3- or 4-jugate with mostly alternate leaflets, and in many cases they show a terminal leaflet, which I believe never develops. The flowers are borne in terminal racemes ending in a needle-pointed spine, but the plate gives no idea of the complex system of vegetative-floral branches. The short calyx-teeth are quite characteristic of *A.* ***microphylla***. The pod is said to be 3-jointed, but all the pods figured are 4-jointed, and this seems to be the rule.

The type was collected by Menzies at Valparaiso, where *A.* ***microphylla*** seems to be common. I have examined the following specimens from the vicinity of Valparaiso:

R. A. Philippi, Pl. chil. no. *390,* Dec. 1851 (S, U); *N. J. Andersson* in 1852 (S); *W. H. Harvey* in 1856 (S); *E. Asplund* no. *3,* July 21, 1921 (S); Zapallar, n. of Valparaiso, *C. Skottsberg,* Sept. 16, 1908 (U); El Salto, n. of Valparaiso, *C. & I. Skottsberg* no. *945,* Aug. 26, 1917; Quillota, e. of Valparaiso, *Bertero* no. *761* (*763?*), in 1819 (S).

According to Reiche (8, p. 131), *A.* ***microphylla*** is distributed from Coquimbo province to Santiago and Valparaiso, and (9, p. 184) it is quoted from Frai Jorge in Coquimbo, but the frutescent *Adesmia* growing there belongs to a different species, and the records from Santiago are rather dubious.

The length of the leaves, the size and shape of the leaflets and flower-parts, etc., show a certain variation. A summary of my observations is given below.

Bertero no. *761* (*763?*). Leaves mostly 5-jugate, about 20 mm. long, the leaflets obovate, rarely suborbicular, (0.8–) 1–2 × 0.8–1.1 mm., thinner than in most cases. Calyx 3 mm. long, including teeth of 1 mm. I did not feel justified in sacrificing one of the very few flowers; they look exactly like those of *A. microphylla*.

Philippi no. *390*. Leaves 3- or 4-jugate, 10 mm. long, the leaflets orbicular, 1.2 × 1.2 mm. Calyx 2.5–3 mm. long, the teeth 1–1.3 × 0.8–1 mm. Standard-limb 5.3 × 8, the claw 2.9 mm. long; wing-limb 4.8 × 2.9, the claw 3 mm. long; keel-limb 4.5 × 3.2, the claw 2.5 mm. long; longer stamens 8.2, the shorter ones 5.5 mm. long.

Harvey. Leaves as in the preceding. Calyx 2.8–3 mm., the teeth 0.5–1 mm. long; standard-limb 5.5 × 7, the claw 2.8 mm. long; wing-limb 4.2 × 2.7, the claw 3 mm. long; keel-limb 4 × 3, the claw 3 mm. long; longer stamens 8.5, the shorter ones 6.2 mm. long.

N. J. Andersson. Leaves as above, the leaflets mostly shed, leaving rachis standing. Calyx 3 mm., the teeth 0.5–0.9 mm. long; standard-limb 4 × 6, the claw 2 mm. long; wing-limb 3.5 × 2, the claw 2.5 mm. long; keel-limb 4 × 2.6, the claw 2.5 mm. long; longer stamens 6.5–7, the shorter ones 5.5 mm. long.

Skottsberg, Zapallar. Leaves 10–20 mm. long, 2–5-, generally 3- or 4-jugate, the leaflets suborbicular to orbicular, very obtuse, sometimes slightly emarginate, 1.6–3.2 × 1.8–2.7 mm. Calyx 3–3.5 mm., the teeth 0.7–1 mm. long; standard-limb 9.5 × 10.5–11, the claw 3.5 mm. long; wing-limb 7.5 × 3.4, the claw 4 mm. long; keel-limb 7 × 4.6, the claw 4 mm. long; longer stamens 11, the shorter ones 9.5 mm. long. FIGS. 9, 10, 27.

Skottsberg no. *945*. Leaves 3- or 4-jugate, about 10 mm. long, the leaflets broadly ovate to orbicular, 0.9–2 × 0.9–1.5 mm., distinctly (0.2–0.4 mm.) petiolulate. Calyx 2.5–3 mm., the teeth 0.5–0.7 mm. long; standard-limb 5–6 × 7.8–9.5, the claw 2.7 mm. long; wing-limb 4.5–5 × 2.6–2.7, the claw 3–3.5 mm. long; keel-limb 4.2–4.4 × 3.3–3.5, the claw 2.7–3 mm. long; longer stamens 7.3–8.2, the shorter ones 6.3–6.5 mm. long. FIGS. 5, 6, 26.

Asplund no. *3* represents exactly the same form as *Skottsberg* no. *945*. FIGS. 7, 8.

The specimens from Zapallar differ conspicuously from the rest by their larger leaflets and flowers; leaflets of the same size are also observed in a specimen without locality, date, or name of collector (misit A. de Jussieu, 1834, S): 3- or 4-jugate, the leaflets 1.5–3.2 × 0.9–2 mm.

The ovary is, as a rule, 4-jointed, but it happens that only two or three (in some cases only one) of the joints produce seed. The setae are as much as 9 or 10 mm. long, plumose with a naked base, and the pericarp is clearly visible.

Adesmia glutinosa Hook. & Arn. (5, p. 19)

"Caule fruticoso ramoso, ramulis patentibus glanduloso-hirsutis, glutinosis spinescentibus, foliolis subtrijugis ellipticis hirsutis, racemis elongatis terminalibus simplicibus spinescentibus bracteisque linearibus glanduloso-hirsutis, leguminibus triarticulatis longissime setoso-plumosis.

"HAB. Coquimbo. — This differs from the preceding [*A. microphylla*] in its larger leaflets, longer racemes, narrower bracteae, longer pedicels, and in the viscid glands and patent hairs which clothe all the younger parts of the plant except the corolla."

Through the kindness of the Director at Kew I had occasion to see the type sheet. Framed-in is the top of a branch with a terminal inflorescence in advanced bud stage. There are very few leaves left, 10–12 mm. long, with 3 or 4 pairs of leaflets 2–2.6 × 1–1.5 mm., thick, hirsute especially beneath, and with numerous bottle-shaped glands. Stem and inflorescence, including pedicels and calyx, are covered with the same coarse pubescence and glands. The specimen is labeled "*Beechey's Voy. Adesmia glutinosa Hook. & Arn.*" in W. J. Hooker's hand, and Dr. I. M. Johnston has added

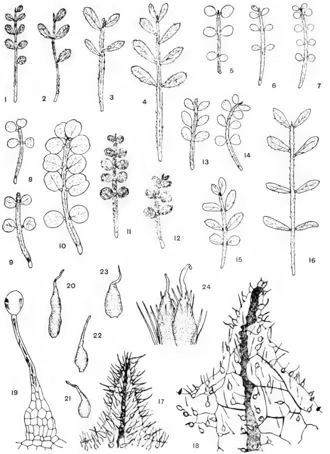

FIG. 1. 1–16. Leaves of *Adesmia* species. *1, 2. A. Berteroniana*, leg. *Dusén*; *3, 4.* id., leg. *Grandjot. 5, 6. A. microphylla, Skottsberg* no. *945*; *7, 8.* id., *Asplund* no. *3*; *9, 10.* id., leg. *Skottsberg*, Zapallar. *11, 12. A. glutinosa, Werdermann* no. *214*; *13, 14.* id., leg. *Grandjot. 15, 16. A. Bedwellii, Skottsberg* no. *801. 17.* Calyx-tooth of *A. glutinosa, Werdermann* no. *214; 18.* id., leg. *Grandjot. 19.* Secretory gland from calyx of *Werdermann* no. *214. 20–23.* Very young setae from pod of *A. Bedwellii, Skottsberg* no. *801. 24.* Slightly older setae from pod of *A. microphylla, Skottsberg* no. *945*. — 1–16 × 2; 17, 18 × 20; 19–24 × 200.

"Type." The collectors are Lay and Collie. Obviously this is not the entire type material, as it lacks pods. The stump is glued to the paper, making a closer examination of the flower impossible. The calyx is about 4.5 mm. long, with acute teeth of about 2 mm.

On the same sheet are samples collected by C. Gay. The label bears in print "Herb. Mus. Paris" and "Amériq. mérid[le]. Chili," and written "Rec[d]. 1864–65. *Adesmia glutinosa Hook. Clos in Gay Fl. Chil. II, 195.*" There are numerous well developed leaves, flowers, and pods, some mature, but this material has not been used for the original description. The cortex of the old branch is dark cinnamon-colored. The leaves are 20–25 mm. long, 4- or 5- or even 6-jugate, hirsute and glandular when young, later glabrescent, with elliptic to slightly obovate, acute to very blunt leaflets averaging 3 mm. in length and 2 mm. in width (2.5–3.5 × 1.3–2.5 mm.). The pubescence and glandulosity of the stem and inflorescence are exactly as in the type, and there can be no doubt that Gay's specimen represents true *A. glutinosa;* Clos' description differs, however, in two points: the leaflets are said to be in 8–6 pairs (in the Spanish description he says 6 or 7) and only 0.5–1 mm. large; otherwise the specimens match the description perfectly. That Hooker and Arnott call the pods 3-jointed and Clos 2–7-jointed is of no importance; they are 4- or 5-jointed in Gay's specimen. It is noteworthy that in certain pods the lowermost joint is naked, whereas in others all are beset with the long, densely hairy setae which form a much thicker cover than in *A. microphylla,* so that the pericarp is completely hidden. Clos himself did not feel quite sure that his *A. glutinosa* was identical with Hooker's. The differences in the number of leaflets and pod-joints seem, however, to disappear on comparison. Another difference would be that the racemes end in a spine according to Hooker's description and type (a short and weak needle barely visible between the buds), being unarmed in Clos' plant. Whether or not the main axis terminates in a spine can not be found out without damaging the specimen, but in an undeveloped vegetative-floral branch the tip of a needle is seen.

Clos suggests that Colla's *A. arborea* is identical with *A. glutinosa,* but this is hardly possible, especially on account of "pedunculis axillaribus 1-floris folio brevioribus"; in *A. glutinosa* all the supporting leaves are reduced to bracts. Colla's plant came from the lowlands, while Clos' *A. glutinosa* is a montane species, found "en los llanos de Gantua, á 6000 pies de altura, y en otros puntos." Reiche (8, p. 126) quotes it from the Cordillera of Coquimbo at 2000 m. I suppose that the plains of Gantua are in the same range. His description is a combination of the original diagnosis and the description in Gay's Flora.

Clos mentions that he had seen specimens of *A. glutinosa* with leaves white with a dense tomentum. This form is matched by *Werdermann* no. *214,* collected in the cordillera of Río Turbio (Coquimbo) at 3000 m., Dec. 1929 (S), which may be described as follows:

It is a very spiny shrub with the cortex of the older branches deep cinnamon-colored, and all the younger parts, including the inflorescence, very glutinous. Leaves 15–20 mm. long, densely tomentose on both faces, grayish green, generally 4- or 5-jugate, orbicular or broadly obovate, obtuse, thick and firm, 1.5–2.2 × 1.4–2.2 mm. Calyx 4.5–5 mm. long, with teeth 1.5–2 mm. long, densely glandular and glutinous; standard-limb 7 × 9, the claw 2.5 mm. long; wing-limb 5.5 × 3.6, the claw 3.5 mm. long; keel-limb 5.5–6 × 3.7 mm.; longer stamens 9–10, the shorter ones 7.5–8 mm. long; style 6.5 mm. long. This may be regarded as an alpine, more tomentose form. The pods are as in Gay's plant. FIGS. 11, 12, 17, 28.

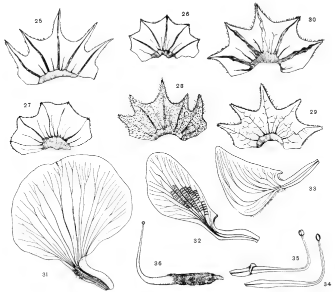

FIG. 2. 25–30. Calyces. *25. A. Berteroniana,* leg. *Grandjot. 26. A. microphylla, Skottsberg* no. *945; 27.* id., leg. *Skottsberg,* Zapallar. *28. A. glutinosa, Werdermann* no. *214; 29.* id., leg. *Grandjot. 30. A. Bedwellii, Skottsberg* no. *801.* 31–36. *A. Bedwellii: 31.* standard, *32.* wing, *33.* keel, *34.* longer stamen, *35.* shorter stamen, *36.* pistil. — All × 4.

More doubtful is another plant, collected by C. Grandjot in Sept. 1933 at Las Palmas de Pedegua, Prov. Aconcagua, alt. 650 m., and determined as *A. glutinosa*:

In general habit it resembles *A. microphylla;* the racemes and pedicels are shorter and the leaflets smaller than in *A. glutinosa,* but the glutinous pubescence, long calyx-teeth, and pod are as in the latter. Cortex dark violet-brown, more or less glossy. Leaves 10–15 mm. long, 3- or 4-, rarely

5-jugate, puberulous, dull green, the leaflets suborbicular to obovate or obcordate, 1–2 (–2.5) × 0.7–1.4 (–1.8) mm. Calyx 5–5.5 mm., the teeth 1.5–2.5 mm. long; standard-limb 7–7.3 × 9–9.5, the claw 2.7–3 mm. long; wing-limb 5.5–5.9 × 3.2–3.3, the claw 3.7–4 mm. long; keel-limb 6.7–6.9 × 4.2–4.3, the claw 3.5 mm. long; longer stamens 11, the shorter ones 9.5 mm. long; style 7.5 mm. With the material at hand I can find no good reason to separate this from *A. glutinosa*. FIGS. 13, 14, 18, 29.

Adesmia Bedwellii sp. nov.

Frutex spinescens ramosissimus usque bimetralis, cortice cinereo. Rami nodulosi, nodulis (ramis valde abbreviatis) fasciculatim foliosis, superioribus elongatis foliosis et racemigeris. Folia 15–25 mm. longa, puberula, 3–5-, vulgo 4-juga; foliola distantia, lineari-spathulata vel anguste obovata, obtusa, subsessilia, sat tenuia nervis plus minusve conspicuis, 2.5–6.5 (vulgo 3–5) mm. longa et 1–2 (vulgo 1.5) mm. lata. Racemi 2–4 cm. longi, inferne foliiferi, dein bracteiferi, apice spinescentes, rhachide parce puberula sed non glandulosa, circ. 12-flori. Bracteae triangulares, 1 mm. longae, fuscae. Flores lutei rufo-striati. Pedicellus gracillimus, puberulus et plerumque glanduloso-scaber, glandulis lageniformibus glutinosus. Calyx late campanulatus, breviter pubescens, dentibus acutis 1.5–2 mm. longis. Vexillum limbo extus pubescente, 9–10 mm. longo et 10.3–12 mm. lato, ungue 3.5–4 mm. longo superne lanato; alae limbo 7.5–8.5 mm. longo et 4–4.5 mm. lato, ungue 4.2–4.5 mm. longo; carina limbo 6.5 mm. longo et 4.3–4.5 mm. lato, margine inferiore parce lanato, ungue 3.5–3.7 mm. longo. Stamina longiora 11.5–12 mm. longa, duo breviora nectarifera 9.5–10 mm. longa, anthera 0.5 mm. longa; ovarium 5 mm. longum, stylus 6.5 mm. longus. Legumen 20–25 mm. longum 4- vel 5-articulatum, dorso tomentoso-glandulosum, latere dense setigerum, setis 8–9 mm. longis ferrugineis albo-pilosis.

CHILE: Prov. Coquimbo: Frai Jorge, alt. 200–300 m., frequens, *C. & I. Skottsberg* no. *801*, July 14, 1917 (Göteb., TYPE; S). FIGS. 15, 16, 30–36.

In his account of a visit to Frai Jorge, F. Philippi (7, p. 206) speaks of a spiny Adesmia, 1.5–2 m. high and very abundant, and adds that "although it is similar to *Adesmia arborea* Bert., the commonest kind of this vast genus near Santiago, its habit is quite different, and it may easily be a distinct species." Reiche, in his description of the vegetation of the landward slope of the Frai Jorge ridge, the same locality where no. *801* was collected, refers the shrubby *Adesmia* — and there is, as far as I know, only one kind in this district — to *A. microphylla* (9, p. 184). *Adesmia Bedwellii,* named in honor of the late Mr. F. Bedwell, owner of the Frai Jorge farm at the time of our visit, is closely related to *A. microphylla,* but differs in the much longer and narrower leaflets, glutinous pedicels, longer calyx-teeth, and larger corolla (this is, however, almost as large in the form of *A. microphylla* collected at Zapallar). From *A. glutinosa* it differs in the leaves, the lack of glands on the rachis of the raceme and calyx, and in the shorter bracts, which in *A. glutinosa* are from 1.5 to 3.5 mm. long and very narrow.

The glutinous glands in *A. glutinosa* and *A. Bedwellii* are bottle-shaped, many-celled secretory organs with a long, slender neck; in the herbarium specimens a yellow, glistening drop of the hardened resin is frequently seen (FIG. 19). Morphologically, the setae on the pod are homologous with secretory organs, and in their young state rather like these, as seen from FIGS. 20–24.

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BOTANICAL GARDEN,
GÖTEBORG.

CENTRIFUGAL STAMENS

E. J. H. Corner

With seven text-figures

An unexpected difference among the families of dicotyledons arises from the direction in which the stamens develop. In 1857, Payer showed that, in contrast to the usual centripetal or acropetal order, there were a few families in which it was centrifugal — "l'éruption staminale est donc centrifuge," (4, p. 4). In modern works this remarkable contrast seems to have been almost entirely forgotten, yet clearly we cannot hope to understand the variations of the androecium in ignorance of it. So far as I have discovered in general reading, the following thirteen families have stamens developed centrifugally (I have placed the name of the authority in brackets):—

Actinidiaceae (Brown), Aizoaceae (Payer), Bixaceae (Corner), Cactaceae (Payer), Capparidaceae (Payer), Dilleniaceae (Payer), Hypericaceae (Payer), Loasaceae (Payer), Lecythidaceae (Mclean Thompson), Malvaceae (Payer), Paeoniaceae (Schöffel), Theaceae (Payer, Warming), Tiliaceae (Payer).

In contrast, the chief families with many centripetal stamens are:—

Annonaceae, Lauraceae, Leguminosae, Lythraceae, Magnoliaceae, Myrtaceae, Nymphaeaceae, Papaveraceae, Punicaceae, Ranunculaceae, Rosaceae.

In these, the andrœcium follows the perianth in normal sequence, whether spirally or by alternating whorls. In the centrifugal families, there is a break between the perianth and the andrœcium which is caused by the intercalation of the new stamens. Accordingly, they are not packed in parastichies but as closely as possible in centrifugal order to give the short, irregular, non-seriate rows which one finds also in the arrangement of the pores of the Polyporaceae and the spines of the Hydnaceae. We have, in fact, a new construction in which stamens arise, not in the logarithmic spirals of acropetal phyllotaxis, but on a peripherally expanding disc. In the more regular flowers of this kind, as will be mentioned, the stamens may be arranged in centrifugal whorls with a regular doubling of the number of stamens in each.

I propose to describe briefly the typical centrifugal andrœcium in the relatively massive flowers of *Wormia, Tetracera,* and *Bixa* — massive in the sense of having a large bud and wide receptacle. I will then indicate what seem to be derivative states caused by diminution in the size of the

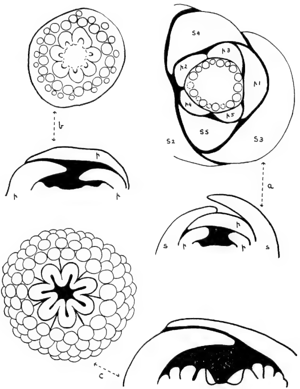

FIG. 1. *Wormia suffruticosa*: three stages in the development of the androecium, in surface-view (with the perianth cut off) and in section; *a* corresponds with *c* in *Fig. 2*, *b* with *d*, and *c* with *e*; s = sepals, p = petals; × ca. 45.

flower; and, finally, I will discuss the systematic or phyletic value of the feature and how a more precise notation for the andrœcium must be introduced into the floral formula. Needless to say, much more research must be done on multistaminate tropical genera before we can hope for satisfactory understanding. A mathematical theory and geometrical construction must also be worked out for centrifugal development from detailed measures of series of enlarging flower-buds: for the order of development is the opposite of that of the classical Composite-inflorescence.

THE MASSIVE CENTRIFUGAL ANDROECIUM

The massive flowers of *Dillenia, Wormia, Bixa, Gordonia, Thea, Opuntia, Saurauja,* and, probably, the Lecythidaceae show the typical features of the centrifugal, multistaminate andrœcium, thus: —

1. After the initiation of the corolla, or even before it is complete, the floral apex becomes a wide, low disc with vague angles, and its apical growth gives place abruptly to radial growth.

2. The first stamens arise in a ring of 15–21, commonly 17–18, primordia, without obvious relation to the perianth, and practically simultaneously. They may precede the carpels (*Dillenia, Wormia*) or develop just after the carpels (*Tetracera, Bixa*), in which case the first stamens alternate, more or less, with the carpels and the gynœcium and andrœcium form one centrifugal system.

3. The floral disc expands basipetally, or peripherally, between the initial staminal ring and the corolla and, on this andrœcial annulus, the other stamens (numbering 50 to several hundred) develop centrifugally in closest apposition to the preceding stamens. A tendency to develop in alternating whorls of increasing members is generally obscured by asymmetry of the floral disc.

4. The mature flower is usually perigynous with the stamens united, more or less, in a short tube developed from the basipetal enlargement of the andrœcial annulus. (In *Tetracera* the flower is secondarily hypogynous.)

Figures 1–7 will illustrate the manner of development in *Wormia, Tetracera,* and *Bixa*. The later stages, in surface-view and longitudinal section, supplement Payer's solid views of *Opuntia, Thea,* and *Gordonia*.

In *Wormia suffruticosa* there are 16–20 initial stamens around the floral apex, and the outermost, or youngest, stamens are sterile and form short ligulate staminodes (homologous with the petals of *Mesembryanthemum*); the staminodes have neither the space, nor the time, nor the food-supply (probably) to become fertile and, though there are all transitions to fertile stamens, there are no transitions to the petals as there are in the centripetally developed flowers of the Nymphaeaceae. It must be noted that the variations of the dilleniaceous andrœcium, particularly in *Hibbertia,* can be understood only by reference to its centrifugal development and the sterilization of the later stamens; it is, thus, fundamentally different from the ranalian andrœcium.

Tetracera Assa (Dilleniaceae) differs from *Wormia* in the precocity and incipient oligomery of the gynœcium. The carpels are initiated before the stamens and follow the tetramery of the perianth so that there are 7 or 8 stamens developed slightly before the others in the initial ring; the gynœcium thus induces a slight centrifugal alternation of whorls in the andrœcium, but it is soon lost as more members are inserted. The outer stamens are fertile and identical in length and appearance with the innermost in the open flower. The receptacle elongates shortly during the expansion of the bud and renders the flower secondarily, or indirectly, hypogynous.

In *Bixa* the gynœcium is even more precocious and appears before the

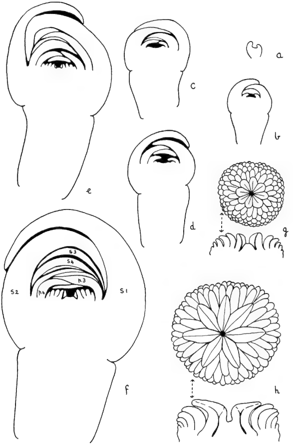

FIG. 2. *Wormia suffruticosa:* six stages (a — f) in the development of the massive flower-bud; two later stages (g — h) in the development of the androecium and gynoecium; f corresponds with a in *Fig. 3*; s = sepals, p = petals; × ca. 15.

4th and 5th petals. The floral apex is very massive when the initial ring of 17 or 18 stamens arises practically at once round the subcircular gynœcium; the ring bears no obvious geometrical relation to the perianth. In this respect, *Bixa* has the most independent andrœcium governed, apparently, merely by the spacing-relations (or bulk-ratio) between the staminal primordia and the area of the "andrœcial disc" and by the centrifugal order. All the stamens are fertile and equally long in the open flower and the only indication of its unusual development is the slight perigynous disc on the outer slope of which the stamens are inserted.

In *Saurauja subspinosa* (Actinidiaceae, 2) the andrœcium of about 50 stamens starts from a ring of 15–21. When there are only 15, five are opposite the sepals and five pairs oppose the petals, but they arise practically simultaneously. This precision in number and position, conforming with the perianth, coincides with reduction in size of the floral apex and leads to the derivative and specialised conditions in the smaller flowers which will be considered next.

The obvious interpretation of the massive centrifugal andrœcium is that the order of development has been reversed through the abrupt cessation of the apical growth of the floral bud while its radial growth continues between the gynœcium and the perianth. The generating field of the andrœcium is transformed from an acropetal cone to a centrifugal disc on which the primordia develop as enations packed as closely as their minimal initial areas admit without interference. The state is clearly derived from the massive multistaminate flower with normal acropetal sequence of stamens of modern form, for in acropetal flowers radial growth of the floral apex is regularly co-ordinated with apical growth, and both decline together; in the centrifugal flower the two are, as it were, dissociated in a curious way which should help us to analyse more clearly the growth of the stem-apex.

DERIVED CENTRIFUGAL ANDROECIA

The following four constructions seem to show how diminution in the growth of the floral bud, recognizable from the sharper angles of the floral disc after initiation of the perianth, introduces greater precision in the number and position of the stamens. For illustration, I must refer to Payer's figures.

1. *Initial whorls. Saurauja subspinosa,* just mentioned, is an instance. The floral disc, after the initiation of the perianth, becomes more or less sharply angled because it does not undergo such rapid radial expansion. On the points, or shoulders, of the disc arise five antisepalous stamens, alternating with the petals, and then ten antipetalous stamens in five pairs, slightly external to the antisepalous; after this other stamens develop as in the more massive flowers. In *Cistus* and *Helianthus* it seems that only five antipetalous stamens develop, giving an initial, regular phase of A5 + 5. In the tetramerous *Capparis spinosa* the andrœcium appears to be wholly

whorled in the centrifugal order 4 + 4 + 8 + 16 + 32 (? + 64. . . . .) so that the stamens in the mature flower appear to be arranged according to the normal centripetal, but falling, whorled phyllotaxis of the Papaveraceae.

2. *Centrifugal fascicles.* In the dilleniaceous genera *Candollea* and *Hibbertia,* after the initiation of the five petals, the pentagonal floral disc forms five antisepalous humps on each of which the stamens develop cen-

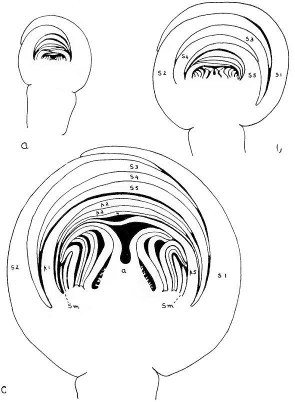

FIG. 3. *Wormia suffruticosa*: three stages in the later development of the flower, *a* corresponding with *f* in *Fig. 2*, *c* about half-grown; s = sepals, p = petals, sm = staminodes; × ca. 7.

trifugally. If the stamens are very numerous, the five groups coalesce centrifugally, but if they are relatively few (? in smaller flowers), they remain in five antisepalous clusters in the open flower. In the Hypericaceae, *Bathys prolifica* has five slight *antipetalous* humps on which the stamens develop centrifugally, but they coalesce to give a homogeneous andrœcium; in *Hypericum* the humps are more pronounced and give five bundles of stamens (or three in the case of smaller flowers with rapidly falling phyllotaxis). In the Tiliaceae and Malvaceae the stamens also tend to be in *antipetalous* fascicles developed centrifugally on antipetalous humps of the young floral disc; in *Sparmannia* (Tiliaceae), however, they are antisepalous.

Fasciculation of this kind, resulting from prominent humping, or radial lobing, of the floral disc in its early stages seems very clearly to be connected with the diminution in size of the floral bud, and the humping, itself, seems to be caused both by the pressure of the perianth segments on the floral disc as they develop, and by their very close proximity with the incipient andrœcium. More detailed studies of floral development, by section and dissection, will doubtless explain the peculiar ridging of the young andrœcium. The basipetal elongation of the receptacular tissue of the humps, corresponding with the basipetal (or centrifugal) growth of the andrœcium, elevates each bundle of stamens on a common stalk, exactly as in the development of floral tubes.

Payer and many botanists after him have regarded fasciculate stamens as branched systems, or compound microsporophylls, derived from the repeated branching of the initial hump, as pinnae are produced on the compound leaf. When there is no visible stalk or axis to the hump, the staminal primordia which appear on it are supposed to have arisen by "congenital" branching in the solid mass of tissue. This is clearly a *reductio ad absurdum*. There are all transitions from the massive centrifugal andrœcium to the fasciculate state, e. g. Dilleniaceae, and one cannot conceive the evenly centrifugal and ring-like andrœcium of *Wormia* or *Bixa* either as compounded of congenital initials or as representing one amplexicaul sporophyll, not even from the point of view of the vascular bundles, as recently maintained (2, 9).[1] The centrifugal andrœcium is merely a reversal of the normal state, for the explanation of which we must consider what disturbance of the growth-processes can produce a reversal; fasciculation is an added complication which does not involve abstract morphology. That bilobed staminal primordia sometimes form on the floral disc does not indicate branching of a compound sporophyll but the manner of interference of unit-primordia on origin, exactly as bilobed and trilobed pores in Polyporaceae or spines in Hydnaceae indicate con-

[1] In the centrifugal flowers the initial androecial vascular bundles develop in spiral sequence after those of the perianth, thus indicating the normal acropetal organization of the interior of the floral apex; they then break up into a plexus immediately below the surface of the androecial disc, to supply its new departures.

genital fusion, from uneven spacing, of normally discrete primordia. Centrifugal enation in an asymmetric or confined space is far more likely to produce irregularities than the normal acropetal and centripetal process.

3. *Zonation.* In the Theaceae, the reduced andrœcium of *Visnea* develops five, initial, antisepalous stamens, then two more stamens beside

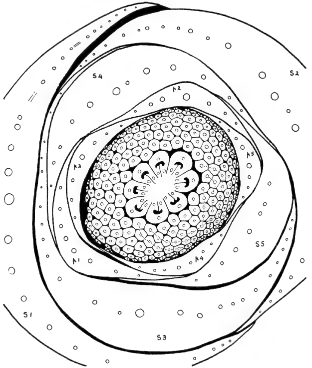

FIG. 4. *Wormia suffruticosa:* transverse section of a flower-bud about one-third grown (between stages *b* and *c* in *Fig. 3*), the stamens irregularly centrifugally whorled (20 + 20), the v. b. shown; × ca. 15.

each, first one on one side and then one on the other of each of the original five. Thus a single ring of 15 stamens is produced and it appears as the natural reduction of the massive, centrifugal andrœcium of *Thea* and *Gordonia* to the initial ring of 15; centrifugal growth of the andrœcial disc is so limited that only 10 slightly external stamens arise after the first five and all appear inserted at the same level in the open flower. The andrœcia of *Portulaca, Philadelphus,* and *Citrus* seem to develop in the same way, but in *Citrus* there is prolonged tangential enlargement of the andrœcial disc which allows many more stamens to be intercalated in the same zone.

4. *Centrifugal obdiplostemony.* The andrœcium of *Visnea* is obdiplostemonous with an outer, though later, whorl of five pairs of antipetalous stamens. If one imagines the centrifugal growth of the andrœcium so

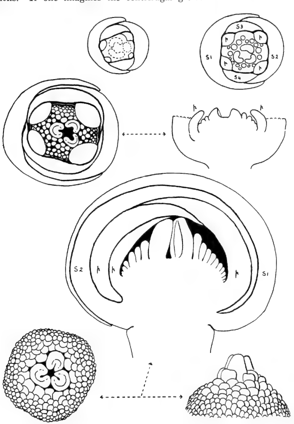

FIG. 5. *Tetracera Assa:* early stages in the development of the flower-bud (these buds with only 3 carpels); s = sepals (4), p = petals (4); × ca. 27.

limited that only one stamen can be inserted in each of the gaps between the initial five, then the 5 + 5 obdiplostemonous andrœcium will be formed, c. f. *Cistus* and *Helianthemum*. Such appears to have been the case in the Geraniaceae, for *Monsunia* has 15 stamens in two whorls, the outer (and later in development) consisting of five antipetalous pairs, while *Geranium* has only five stamens in the outer, and later, whorl. Similarly in the Zygophyllaceae, *Peganum* and *Nitraria* have 15 stamens as in *Monsunia*. Indeed, both families agree with the Rutaceae in showing traces of descent from the massive centrifugal andrœcium. The obdiplostemony of the Caryophyllaceae, Ericaceae, and Epacridaceae seems explicable in the same manner.

In the Capparidaceae, the reduction of the multistaminate state in *Capparis* has produced the 6-staminate condition of *Cleome,* in the slender little flowers of which the stamens develop centrifugally in 2 whorls, 2 + 4, to give the same tetradynamous arrangement as in the Cruciferae. Thus the cruciferous andrœcium appears to be another limiting state of the centrifugal gynoecium in the tetramerous flower.

According to Eichler, this was the interpretation of obdiplostemony given by Chatin, Pax, and Hofmeister; he affirms that in obdiplostemonous flowers the antipetalous stamens develop after the antisepalous (3, p. 336). It is noteworthy, as corroborative, that in monocotyledons staminal development is always centripetal and obdiplostemony seems not to occur (5, p. 297). In centrifugal obdiplostemony there is no interruption in the alternating whorls of the flower but a reversal in the direction of development of new stamens after the first whorl, and this reversal, in the limiting case of two whorls of n + n or n + 2n members, gives a false appearance in the mature flower. Nevertheless, in the Tiliaceae, Malvaceae, and Hypericaceae there is a form of obdiplostemony which does interrupt the sequence of alternating floral whorls, for the initial andrœcial humps in the floral bud are *antipetalous* and the reduction of their centrifugal andrœcia to two whorls would give apparent *diplostemony*. It is clear that our macroscopic interpretations of andrœcia will remain confused or uncertain until there is much more precise knowledge of the developmental sequence of the stamens and of the spacing factors in the floral bud.

PHYLETIC VALUE

The systematic importance of the centrifugal andrœcium is shown by the two instances of *Paeonia* and *Saurauja*.

Paeonia is usually placed in the Ranunculaceae, where its persistent sepals and distinct, if rudimentary, aril are anomalous. In 1908, Worsdell wrote (10):—

> "From a consideration of the character of the vascular anatomy alone I am sure that no one would ever dream of classing *Paeonia* with the *Ranunculaceae;* on the other hand, a very fair case could be made out for classing the genus with the *Magnoliaceae.*"

Worsdell proposed the family Paeoniaceae as a link between the Ranunculaceae, Magnoliaceae, and Calycanthaceae. Yet, the two anomalies of persistent sepals and aril still remain, and the comparison with the Magnoliaceae introduces three or more anomalies in the pinnate leaves, the acyclic calyx and corolla, and the flat receptacle of *Paeonia*.

In 1932, Schöffel discovered that the andrœcium of *Paeonia*, consisting of 200 or more stamens, developed centrifugally on a slightly raised staminal disc (evidently as in *Wormia*), and that this feature was unique among the Ranunculaceae (6).

If, now, we follow this clue and compare *Paeonia* with the Dilleniaceae,

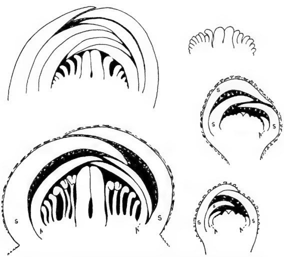

FIG. 6. *Bixa Orellana*: early stages in the development of the flower-bud; s = sepals, p = petals; × ca. 27.

we find that the vascular character emphasized by Worsdell, the persistent sepals, the aril, the hard testa, the woody tendency and, even, the pinnate, exstipulate leaves are as much dilleniaceous as the centrifugal andrœcium. Dilleniaceous leaves are typically simple, but the large, acropetally developing, toothed leaves of *Dillenia* give every appearance of a webbed pinnate leaf, and in the dwarf shrubs, or woody herbs, of *Acrotrema* there are species with doubly or simply pinnatifid leaves and simple leaves. Indeed, there are no obvious features to separate the Paeoniaceae from the Dilleniaceae, particularly if *Actinidia* is included among them. *Paeonia*, thus, appears naturally as a temperate derivative of the Indo-Malaysian

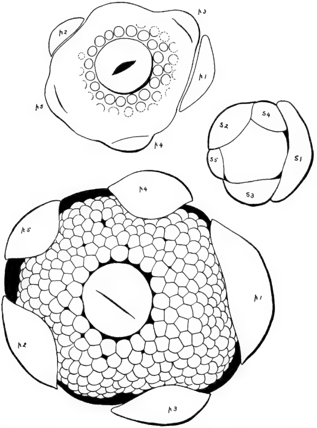

FIG. 7. *Bixa Orellana*: early stages in the development of the flower-bud in surface-view, × ca. 45.

Dilleniaceae closely comparable with *Actinidia*. It is not at all odd that they should be typically oriental, for the great land-mass of southern China has been the only part of the world where the tropical flora has been able for ages to invade over a vast front the north temperate region. It is worth noting, too, that another anomalous genus, *Crossosoma*, which has been put in the Dilleniaceae, was classed by Baillon with *Paeonia* (1, p. 66).

Saurauja is another problematic genus which has been placed in the Dilleniaceae, the Theaceae, and, with *Actinidia*, in the Actinidiaceae. Brown has shown that its andrœcium is centrifugal, exactly as in the Dilleniaceae and Theaceae. This agreement clinches the close affinity between the two families; and, again, the Theaceae appear naturally as an oriental and temperate off-shoot of the older, Indo-Malaysian Dilleniaceae.

A third instance, far less certain, through lack of knowledge, may be found in the Parietales as a whole. The series appears to be a very vague group of diverse families without any character in common, not even the placentation. It is a natural group by "concatenation." Yet, so far as known, the andrœcium is centrifugal in six families—Hypericaceae, Cistaceae, Dilleniaceae, Theaceae, Bixaceae, and Loasaceae; it may well be centrifugal also in the Ochnaceae, Caryocaraceae, Guttiferae, and Flacourtiaceae. It is centrifugal in the allied Opuntiales.

From these considerations I am compelled to regard the centrifugal andrœcium as a most important systematic character which defines, as a natural phylum, a large number of dicotyledonous families at present confused with other series of families possessing the centripetal andrœcium. On the one hand there are the primary ranalian, rosalian, myrtalian series and, on the other hand, there is the centrifugal series derivative from one or other of the primary series, or their ancestors. It is likely that, beside the Parietales and Opuntiales, most of the Geraniales, Malvales, Centrospermae, and Ericales belong to the centrifugal series.

Dogmatic and biased as this may seem at first sight, yet a clear standpoint is to be preferred when a new idea emerges. Morphologically I would expect so profound a disturbance in floral development as the reversal of the andrœcium to be highly peculiar and, therefore, phyletic. On the other hand, particularly in flowering plants, we know that homoplasy is general, that such floral features as sympetaly, synandry, syncarpy, epigyny, and so on, have arisen independently in many different series, for which reason we might consider the centrifugal andrœcium as merely another instance of this confusing phenomenon. Yet, one must remark that, whereas all such homoplastic features occur in many different dicotyledonous *and* monocotyledonous series, the centrifugal andrœcium does not occur among the monocotyledons, and among the dicotyledons it is centered around the Parietales. Therefore, I think one must regard as anomalous the association of the centrifugal Capparidaceae *cum* Cruciferae with the centripetal Papaveraceae in the Rhoeadales and that of the centrifugal Lecythidaceae with the centripetal Myrtaceae and Lythraceae in the Myrtales. One must ask whether they have not been as mistakenly classified as *Paeonia* with the Ranunculaceae. And the position of all obdiplostemonous families must come under review.

NOTATION

The symbols A ∞ and An + n . . . must be resolved into

A $\overrightarrow{\infty}$ and A $\overleftarrow{\infty}$ for centripetal and centrifugal stamens, respectively; and

A $\overrightarrow{n}$ + n . . . and A . . . n + $\overleftarrow{n}$.

Thus, a major difference between the Ranunculaceae and the Dilleniaceae can now be shown in their floral formulae.

For the Lauraceae, we may write A $\overrightarrow{3}$ + 3 + 3 + 3, but for *Capparis* A . . . 32 + 16 + 8 + 4 + $\overleftarrow{4}$.

Monsunia becomes A 10 + $\overleftarrow{5}$, and *Geranium* A 5 + $\overleftarrow{5}$, while *Brownea* may be A $\overrightarrow{5}$ + 5 + 5 and *Caesalpinia* A $\overrightarrow{5}$ + 5.

In the case of the fasciculate stamens, we may write An($\overleftarrow{\infty}$), as in *Hypericum* A 5($\overrightarrow{\infty}$).

For zonate stamens, the notation is more difficult, but it may suffice to write A $\overleftrightarrow{n}$ or A n + $\overleftrightarrow{m}$, where n is the number of initials and m the number of stamens intercalated between them. The symbol A $\overleftrightarrow{\infty}$ would imply amphipetal development of the androecium, which is not known.

Obdiplostemony appears to be represented better by

Kn Cn A n + $\overleftarrow{n}$ Gn

than by the usual formula

Kn Cn A $\overrightarrow{n}$ + n Gn.

SUMMARY

1. A list of 13 families of dicotyledons is given in which the stamens develop centrifugally. The mechanism is explained in detail for *Wormia, Tetracera,* and *Bixa*.

2. The centrifugal andrœcium appears to be a feature of considerable systematic importance which indicates a common origin for the families in which it occurs. Thus the Paeoníaceae, with centrifugal andrœcium, are referred to the Dilleniaceae rather than to the Ranales.

3. The primitively massive, centrifugal andrœcium must have been derived from the usual centripetal state. Reduction-specialization, leading to fasciculate, zonate, and diplostemonous andrœcia, seems to have occurred in both kinds of flower, resulting in a confusion in classification which takes no account of manner of development. Particularly is this so in obdiplostemonous families, e. g. Geraniales, Centrospermae, and Cruciferae, which seem referable to the centrifugal series.

4. There is no evidence that centrifugal fasciculate stamens (Hypericaceae, Tiliaceae, Malvaceae, Dilleniaceae) are branched sporophylls.

5. More critical notation for the andrœcium in the floral formula is suggested.

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NEW CYATHEACEAE FROM COLOMBIA

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With one plate

RECENT exploration in Colombia gives indication of a far richer fern flora than has previously been known from that country. This is true especially of the tree-ferns (Cyatheaceae), in which perhaps not more than half the specimens of several large collections can be identified with reasonable certainty. To me the more interesting members of the family are those species — mostly small plants — with pinnate-pinnatifid fronds, in habit and general appearance most resembling various species of *Dryopteris* (Polypodiaceae), and I have previously published descriptions of nearly a dozen from tropical America as new. Of the four additional species here described three are of the sort mentioned, with pinnate-pinnatifid fronds. The fourth, *Alsophila mollicula,* is quite unlike these in having the blades fully bipinnate, the secondary pinnae deeply pinnatifid; it is not approached by any of the diminutive tropical American species thus far known.

Cyathea rupestris sp. nov.

Caudex erectus, fortasse 10–12 cm. longus (pars 6 cm. longa adest), 1.5–2 cm. diam., apice et inter cicatrices rotundas ca. 5 mm. diam. appresso-paleaceus, basi crasse radicosus; paleae subdeltoideae, 2–3 mm. longae, 1–1.7 mm. latae, apice obtusae vel subacutae, basi subcordata affixae, parte media castaneae, densae nitidaeque, marginibus latis cinnamomeis teneris laxe et varie fimbriatis. Folia plura, patentia, 40 cm. longa; stipites ca. 5 cm. longi, 3–4 mm. diam., atropurpurei, inermes, basi appresso-paleacei; laminae lanceolatae, ca. 35 cm. longae, 10–11 cm. latae, acuminatae, pinnato-pinnatifidae, rhachi atropurpurea, infra nuda et glabrescente, supra crebre brunneo-hispida et paleis linearibus laxis pallidis tenuibus instructa; pinnae majores ca. 20-jugae, sessiles, inferiores oppositae et plus minusve deflexae, mediales suboppositae, patentes, anguste oblongae, acuminatae, 5–6 cm. longae, 11–14 mm. latae, profunde pinnatifidae (pleraeque basi pinnatisectae), subcoriaceae, supra costa hispida excepta glabrae, infra costis et costulis pilis brunneis rigidis paucis praeditae; segmenta ca. 12-juga, oblonga, subfalcata, 5–7 mm. longa, medio 3–3.5 mm. lata, obtusa vel antice subacuta, marginibus subintegris leviter revolutis, plerumque anguste conjuncta, ala costali utroque latere ca. 1 mm. lata; venae 7- vel 8-jugae, plerumque furcatae, obliquae, infra modice elevatae, cum parenchymate glabrae; sori 3-jugi, basales, contigui, indusiis hemisphaericis, brunnescentibus, membranaceis; sporangia numerosa; paraphyses ut videtur nullae.

TYPE in the U. S. National Herbarium, No. 1,852,149, collected along the Río Margua, between Junin and Córdoba, region of Sarare, in the Cordillera Oriental, Departmento Norte de Santander, at 920 to 1240 meters elevation, among rocks, November 22, 1941, by J. Cuatrecasas (No. *13396*).

In general appearance only *Cyathea rupestris* somewhat recalls *C. Nockii* of Jamaica. That species differs markedly, however, in its heavier caudex and much larger fronds, these fully bipinnate, the vascular parts pale and conspicuously paleaceous throughout.

Hemitelia decorata sp. nov. PLATE I.

Caudex erectus, usque ad 3 m. altus, ca. 3 cm. diam., inermis, inter cicatrices remotas fusco-vernicosus, dense imbricato-paleaceus, paleis lanceolatis, acuminatis, 7–9 mm. longis, 1.5–2 mm. latis, fusco-castaneis, opacis, marginibus anguste ochroleucis subintegris, paleis apice ipso majoribus, usque ad 14 mm. longis, marginibus pallidis multo latioribus. Folia 6–8, rigide adscendentia, 100–110 cm. longa; stipites 10–20 cm. longi, 5–7 mm. diam., ochracei, verrucosi, crebre hispidi (pilis pallide ferrugineis 6–9 mm. longis), ubique dense paleacei, paleis basalibus anguste triangularibus, usque ad 15 mm. longis, medio castaneis, marginibus pallidis latis, paleis sursum laminam versus numerosis, conspicuis, oblongo-lanceolatis, acutis, usque ad 2 cm. longis et 6 mm. latis, flavo-brunneis, lucidis, late imbricatis, subintegris, persistentibus; laminae anguste lineari-oblanceolatae, abrupte acuminatae, 85–100 cm. longae, 24–30 cm. latae, pinnato-pinnatifidae, rhachi ubique dense hispida sed basi excepta paleis carente; pinnae 35–40-jugae, proximae, patentes (jugae inferiores deflexae), ligulatae, acute vel abrupte acuminatae, 11–15 cm. longae, 2.2–3.2 cm. latae, pinnatifidae, herbaceae, costis supra hirsutis, infra longe hispidis; segmenta 15–20-juga, patentia, proxima, late oblonga, rotundato-obtusa, 9–14 mm. longa, 5–6 mm. lata, leviter (raro profunde) crenata, costulis venisque utrinque laxe hispidis vel hirsutis, parenchymate glabro; venae 6- vel 7(8)-jugae, medio furcatae; sori 4–6-jugi, mediales, rotundi, ca. 1.3 mm. diam.; indusia ampla, profunde saccata, integra, demum 2- vel 3-lobata, brunnescentia; receptaculum magnum, globosum; paraphyses nullae.

TYPE in the U. S. National Herbarium, Nos. 1,852,571–573, collected in forest along the Río Yurumangui, Department of El Valle, altitude 5 to 50 meters, January 28 to February 10, 1944, by J. Cuatrecasas (No. *15737*).

The following additional specimens, all in the National Herbarium, have been studied: Córdoba, Dept. El Valle, alt. 80–100 m., in forest, ***Killip** 5257*; Río Cajambre, Dept. El Valle, alt. 5–80 m., in forest, ***Cuatrecasas** 17429*; Agua Clara, along highway from Buenaventura to Cali, Dept. El Valle, alt. 100 m., in dense forest, ***Killip & Cuatrecasas** 38914*; dense forest south of Río Condoto, between Quebrada Guarapo and Mandinga, Intendencia del Chocó, alt. 120–180 m., ***Killip** 35192*; ridge along Yeracüí Valley, Corcovada Region, upper San Juan, Intendencia del Chocó, alt. 200–275 m., ***Killip** 35334*.

Hemitelia decorata is apparently not uncommon in the Pacific lowland region of Colombia, having first been brought out by Killip in 1922. The excellent series of specimens cited shows remarkably little variation, although the plants are of various ages, with stems ranging from 30 centimeters to 3 meters tall. The widely imbricate, persistent covering of large, fawn-colored scales upon the stipes is a notable feature, suggesting the desirability of introducing this beautiful plant into cultivation.

Hemitelia pumila sp. nov.

Rhizoma adscendens, 5 cm. longum, 1.5 cm. diam., parte apicali copiose imbricato-paleaceum, deorsum radicosum; paleae lineari-attenuatae, apice subfiliformes, 5–7 mm. longae, 0.5–0.7 mm. latae, albidulae, concolores, tenerae, subintegrae. Folia plura, adscendentia, ca. 50 cm. longa; stipites 15–18 cm. longi, 1–1.5 mm. diam., sulcati, inermes, brunneo-olivacei, glabri, paleis patentibus albidulis linearibus laxis tenuiter praediti; laminae oblongae, acuminatae, ca. 35 cm. longae, 12–14 cm. latae, pinnato-pinnatifidae, rhachi supra hispidula, subtus glabra; pinnae majores ca. 10-jugae, subremotae, patentes, lineari-oblongae, acutae, 6–7.5 cm. longae, 1.5–2 cm. latae, conspicue petiolulatae (usque ad 7 mm.), grosse pinnatifidae vel inferiores basi superiore pinnatisectae, subtus omnino glabrae, supra costis tenuiter hirtellis; segmenta membranaceo-herbacea, 9- vel 10-juga, pleraque late oblonga, apice rotundata, maxima 6–8 mm. longa, sinu acuto 5–6 mm. lata, et ala costali utroque latere 2–3 mm. lata conjuncta, solum segmentum basale anticum pinnarum inferiorum nonnullarum sessile vel subsessile, ovale, marginibus undulatis vel leviter dentato-crenatis; venae 6-jugae, apicales exceptae ad vel ultra medium furcatae, obliquae, tenues; sori 1–3-jugi, inter se remoti, mediales vel supramediales, plerumque furca venarum siti; indusium parvum, brunnescens, obdeltoideum, modice concavum, subintegrum; receptaculum parvum, globosum, paraphysibus numerosissimis elongatis diffuse et irregulariter ramosis onustum.

TYPE in the U. S. National Herbarium, Nos. 1,875,038–9, a unicate collected on the Cerro del Castillo, Upper Apaporis Basin, near confluence of the Ajuju and Macaya, Territorio del Caquetá, at about 540 meters altitude, in wet shady forest, on sandstone, July 27, 1943, by R. E. Schultes (No. *5664*).

Although the present species is almost certainly distinct, its proper generic reference is doubtful, if one chooses to maintain the traditional genera of Cyatheae. It might, in fact, almost as well be placed in *Alsophila* as in *Hemitelia,* since the indusium is reduced to a triangular, slightly concave structure scarcely typical of *Hemitelia* and, except for its greater breadth, not very different from the minute vestigial scale that may be observed in several species of *Alsophila*. So far as I know, it is without any very near relatives.

Alsophila mollicula sp. nov.

Rhizoma deest. Folia plura, laxe adscendentia, 55 cm. longa; stipites 15 cm. longi, 2–3 mm. diam., spinis ad 1.5 mm. longis castaneis cylindricis gracilibus instructi, basi comoso-paleacei, paleis filiformibus, leviter flexuosis, 10–15 mm. longis, 0.2–0.3 mm. latis, basi castanea minuta excepta pallide ferrugineis, sursum copiose hispidi, pilis plerumque 5–6 mm. longis, pallide ferrugineis; laminae ovatae, acuminatae, 40 cm. longae, 25 cm. latae, bipinnato-pinnatifidae, rhachi sicut stipite longe hispida, paleis nullis; pinnae ca. 14-jugae, patentes, inferiores (2 jugae) suboppositae, remotae, breviter petiolulatae, alterae alternae, plerumque triangulari-oblongae, acuminato-caudatae, basi valde acroscopicae, maximae 13 cm. longae, basi inaequilaterali 2.5–3.5 cm. latae, tenuiter herbaceae, plane pinnatae; pinnulae proximae, oblongae, apice rotundato-obtusae, basales superiores maximae, sessiles, 15–20 mm. longae, 6–8 mm. latae, pinnatifidae, lobis obtusis costulae latere utroque ala ca. 1 mm. lata conjunctis, costulis et venis utrinque abunde laxe hirsutis; venae 2- vel 3(4)-jugae, obliquae, tenerae, simplices vel infimae rarissime furcatae; sori 1- vel 2-jugi, pusilli, mediales, sporangiis paucis; receptaculum minutum; paraphyses simplices, tenues, moniliformes, griseae, sporangia saltem aequantes.

Hemitelia decorata Maxon

TYPE in the U. S. National Herbarium, No. 1,804,961, collected between Santa Marta and Marsella, Territorio del Caquetá, August 4, 1926, by G. Woronov and S. Juzepczuk (No. *6415*). Two fronds of this number in the herbarium of the Komarov Botanical Institute of the U. S. S. R., Leningrad, are nearly identical with the type. The rhizome, unfortunately wanting, was presumably a slender erect caudex.

As mentioned above, the bipinnate-pinnatifid fronds of *A. mollicula* are wholly distinctive for so small a plant in this genus. In a general way the leaf dissection suggests several of the smaller species of *Dryopteris*, subgenus *Ctenitis*, particularly *D. nemorosa* (Willd.) C. Chr., of Puerto Rico and Hispaniola.

EXPLANATION OF THE PLATE

Hemitelia decorata Maxon: photograph of one sheet of the type specimen, about two-fifths natural size.

UNITED STATES NATIONAL MUSEUM,
WASHINGTON.

PRELIMINARY REVISION OF THE GENUS LONICERA IN MALAYSIA

C. G. G. J. VAN STEENIS

With two text-figures

IN MY yet unpublished "Javanese Mountain Plants in Colours" I recognize two indigenous species of *Lonicera*, as did Blume in his "Bijdragen," p. 653, 1825. Topotypes are abundant in the Buitenzorg Herbarium. The question arose which were the appropriate names for the Javanese species, as the naming of the herbarium material was in some disorder. The latest suggestion was (in herb.) that of C. A. Backer and W. M. Docters van Leeuwen, who assumed that *L. Loureiri* represented only an extreme "alpine" form of *L. javanica*; hence, they recognized only one variable species in Java. Since I could not agree to this, I made a study of all Malaysian *Lonicerae* present in our herbarium. As I have not seen types of several extra-Javanese "species," my conclusions are provisional.

The genus is by no means a difficult one but, on the other hand, there is a rather large variability in characters supposed to be important for specific distinction, extreme forms from isolated populations along the borders of the generic area being described as separate species. In dried material dimensions are often misleading; immature buds open slightly during drying and appear to be mature. *Lonicera sumatrana*, for example, described by Miquel, was based on bud material and thus misplaced in Rehder's monograph. For this reason it was not identified with *L. leiantha* Kurz and later was redescribed by Merrill as *L. jasminifolia*.

I am of the impression that in *Lonicera* too much stress has been laid on density of pubescence. To me the colour of the indumentum is more important. Of the four Javanese species recognized I am familiar with three in the living state, and I feel that it is of importance to know whether the upper lip is straight or whether both lips are recurved, the latter a character which probably goes parallel with the texture of the corolla. This difference is very striking in the Javanese species, but is not always readily distinguishable in herbarium material.

In the Javanese species, of which I have studied abundant material, the shape of the calyx-lobes, bracts, and bracteoles and their pubescence are rather variable, as are the shape and dimensions of the leaves and their pubescence. It seems urgent to me to obtain a clear idea of characters fit for specific distinction in the section NINTOOA and both of its subsections. The reduction of 13 names to only four species suggests a further reduction in the section.

I wish to draw attention to the possibility of polygamy as studied by Docters van Leeuwen, another testimony that geographical and ecological studies of plants cannot be carried on without an exact taxonomic knowledge. Docters van Leeuwen described *L. javanica* in his work on the "Biology of Plants and Animals Occurring in the Higher Parts of Mount Pangrango-Gedeh in West Java" (Verh. Kon. Akad. Wet. A'dam sect. II, 31: 235–239. 1933) and remarked that according to him only one species occurred in Java. His material belongs to *L. acuminata* (= *L. Loureiri*), as true *L. javanica* does not occur on the summit of Mt. Pangrango, where the altitude ranges from 2400 to over 3000 m. *Figure 60* in his study suggests *L. javanica*, while *fig. 61* is doubtless

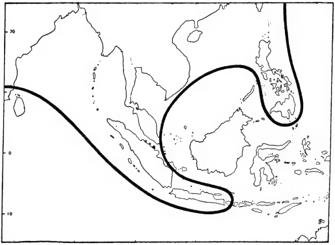

FIG. 1. Geographical distribution of the genus *Lonicera* in Malaysia, showing the two migrational routes.

L. acuminata. The first he calls the "bisexual" form. However, the dimensions of the flower, the two recurved lips, and the protruding anthers and style suggest identity with *L. javanica*.

In the "female" form which, according to his description, is certainly *L. acuminata* (= *L. Loureiri*), he describes the erect upper lip as forming a hood which covers most of the stamens and states: "the anthers which remain closed do not contain pollen." Yet, of so-called galled inflorescences with small flowers which hardly open he remarks: "the stamens which still may produce pollen remain hidden." Whether female forms of *L. acuminata* with sterile stamens occur I do not know; this must be further studied in the field.

All Malaysian species have the normal colour of the flower, i. e. creamy in buds and freshly opened flowers, yellow or orange in old flowers. Each is reported to be fragrant. Sometimes, the twigs of *Lonicera* are claimed to be used as a substitute for binding purposes (probably in emergency cases).

When dealing with Malaysian mountain plants which have originated on the southeastern Asiatic continent, one always must be extremely cautious in separating them from the Asiatic alliance and in classifying them as distinct species which are endemic in Malaysia. In addition to the great probability that the isolation has induced the Malaysian representatives to gain subspecific or racial value, the study of Indian and Malaysian species by various authors in different herbaria must be carefully considered; often these authors have limited themselves to the material in their country in order to avoid enlarging their study for which they needed material from other herbaria. Monographers sometimes follow the "current opinion" of earlier works and of botanists who confine themselves to administration rather than critical unbiased study. And local botanists often consider it outside their realm of work to combine their species with others of neighbouring countries, though they often hint at the possibility. This mutual disinclination to join forces leaves the identity and status of the plants often unsolved. Sumatran, Javanese, and Malay Peninsular mountain plants cannot be studied without consulting the southeastern Asiatic species. *Lonicera sumatrana,* in my opinion, occurs in Burma and Siam (under the name *L. leiantha*), and I expect *L. pulcherrima* and *L. javanica* also occur (under other names) on the Asiatic continent: *L. acuminata*, which I accept in the Hookerian sense, has the widest range.

For the sake of convenience I have made a key for the two cultivated and the four wild Malaysian species and I have added remarks under the latter. To facilitate naming duplicates in other herbaria I have mentioned the collector's numbers under each of them.

My provisional enumeration of the Malaysian species, in Bull. Jard. Bot. Buitenz. III, 13: 179. 1934, is herewith corrected.

KEY TO THE WILD AND CULTIVATED SPECIES OF LONICERA IN MALAYSIA

1. Each cyme of 2 flowers sustained by 4 bracteoles and 2 *leafy* bracts; filament and style glabrous; cultivated. ....1. *L. japonica* Thunb.
1. Bracts not leafy .... 2.
2. Ovary hairy all over; cultivated, but rather rare (Medan, Singapore) .... 2. *L. confusa* DC.
2. Ovary glabrous (except the apex in *L. pulcherrima*). .... 3.
3. Plant entirely glabrous (except few hairs on stamens and style and small negligible ciliae on the edge of the calyx and the bracts); inflorescence loose, few-flowered; flowers 4–5 cm. long, the 2-flowered peduncles slender; nerves few, slightly prominent, the reticulations indistinct or hardly visible. ....3. *L. sumatrana* Miq.
3. Hairy, at least the petiole; nerves and reticulations distinct, prominent. .... 4.
4. *Corolla short but relatively thick, 13–20 mm. long* (s. s.), the *tube 1.5–3 mm. diam.*, the *upper lip* straight in opened flowers, the lower lip recurved; corolla of thick texture, not with glandular hairs; inflorescence *dense*, *short*, mostly not

exceeding the upper foliage; thickened part of the bud about as long as the tube; stamens, at least 3 of them, included under the upper lip; pubescence rather rough, *yellow*, its density variable; leaves *mostly rugose*, sometimes subbullate, the midrib *always* hairy on the upper surface nearly to the apex, the leaves not glaucous beneath. ....4. *L. acuminata* Wall.

4. *Corolla 18–50 mm. long, the tube slender, 1–2 mm. diam.*, when mature *both lips recurved*; texture of the corolla thin; inflorescence *not contracted*, often foliaged, paniculate, with glandular hairs, mostly exceeding the leaves; pubescence not rough, often not yellow; midrib often glabrous above; leaves *glaucous* beneath. ...... 5.

5. Style slightly hairy; flowers long, mostly in dense rich-flowered *Ixora*-like, globose terminal inflorescences exceeding the leaves, in subumbelliform clusters at the ends of the upper axillary stalks; peduncles contracted with a conspicuous yellow tomentum which continues on the internodes of the twigs and is interspersed by dot-like, red glands; twigs not wiry and not glossy red-brown, but stiff; pubescence of the calyx-teeth often descending on the upper portion of the ovary. ....5. *L. pulcherrima* Ridl.

5. Style glabrous; flowers medium-sized, in less rich-flowered inflorescences, the stalks mostly with a grey tomentum, the red sessile glands absent; twigs ± wiry, soon conspicuously shiny red-brown, slender; ovary glabrous. ....6. *L. javanica* DC.

3. **Lonicera sumatrana** Miq. (*L. leiantha* Kurz, *L. jasminifolia* Merr.).

By its glabrousness, subtriplinervous leaves without distinct reticulations, and poor-flowered lax inflorescences this species is clearly distinct from all other Malaysian representatives. The ovary also offers distinction: it is constricted at the apex, with the part of the calyx which is free from the ovary splitting halfway down so as to form a short tube, which, in turn, is much shorter than the ovary. The bracts are about half as long as the ovary, and the bracteoles are still smaller. In the other Malaysian species the free part of the calyx consists of five separate triangular to subulate lobes.

SUMATRA: *Yates 2534; Teysmann 1039 HB; Lörzing 6602; Kleinhoonte 558;* all from the Toba-region and Sumatra Westcoast; and *Ajoeb* (exp. *Jacobson*) *181* from Rimbo Pangadang in the Res. Benkoelen.

The species occurs in Burma, Siam, North and Central Sumatra, between 1000 and 1250 metres altitude. Lörzing mentions the flower as white, later yellow; Kleinhoonte claims the colour to be "rosa-like beige." It is a submontane plant occurring in forest borders.

Rehder placed this species incorrectly in the subsection BREVIFLORAE because of the fact that Miquel described the flowers from the immature bud state.

I have seen type specimens of *L. sumatrana* (*Teysmann 1039 HB* from Alahan Pandjang, Sumatra Westcoast) and *L. jasminifolia* (*Yates 2534* from Tapanoeli). These are quite identical. Of *L. leiantha* I have seen only the description. With Rehder's key one determines directly to *L. leiantha*. Kurz' description is also wholly fit for Sumatran plants. Because of these facts, I feel that all these names represent a single species, at which Merrill has already hinted.

4. **Lonicera acuminata** Wall. ex Roxb. (*Caprifolium Loureiri* Bl., *Lonicera Loureiri* DC., *L. oxylepis* Miq., *L. Leschenaultii* Miq. non Wall., *L. philippinensis* Merr., *L. Rehderi* Merr., *L. Giraldii* Rehder).

Ultimate twigs thick, *1.5–3 mm. diam.*, ruddy, *not* conspicuously shining brown, the inflorescences, leaves, etc., with *yellow rather hirsute* hairs, or glabrate. Petiole *hairy*. Leaves mostly *rugose*, sometimes subbullate, the lower surface *not glaucous*, the hairs on the lower surface scattered or nearly absent, the glandular-tipped hairs *absent*, the margin of the blade often *recurved*, sometimes entirely flat, the upper side of the blade often rather glabrous, but *the midrib pubescent nearly to the apex*. Inflorescences terminal and lateral in only few (2) axils, moderately or very *dense* as the upper internodes are short, *never* a loose panicle; inflorescence *seldom exceeding the foliage*, more or less embedded in it (also in fruit). Calyx-lobes ciliate, with few stiff hairs on the back. Buds rather *short and thick*, the *enlarged upper portion about as long as the lower part*, which is relatively thick, *2–3 mm. diam*. Opened flowers about 13–20 mm. long (s. s.). Corolla-lobes 3–4 mm. broad, the *upper lip straight*, the lower lip *recurved*. Style about as long as the corolla. Stamens about *as long as or shorter than the* (*expanded*) *corolla*, pubescent or glabrous. Anthers large, *2.5–5 × 0.5–1 mm*. Style pubescent or glabrous.

SUMATRA: *Bünnemeijer 891, 9453, 9811.*

JAVA: *Backer 478, 3293, 3301, 5054, 5081, 9727, 13530, 22345; Bakhuizen van den Brink 35; Bruggeman 79; Docters van Leeuwen 123, 1159, 2516, 8207, 8352, 8353, 8739, 8942, 12262, 21709; Hallier f. 478, 480; Koorders 15632, 25975, 32215, 32217, 37359, 38271, 40367, 40920, 43538; van Slooten 2627; van Steenis 1990, 4056, 4870, 7428, 10917.*

BALI: *Sarip (R. Maier) 376.*

PHILIPPINES: Bureau of Science *31886, 40232* (*L. philippinensis*).

The species is interpreted in the current sense of Blume (we possess a number of topotypes), Hasskarl, Hooker, Rehder, and Koorders. There is no question about its identity. Backer (in herb. Bogoriensis) expresses as his opinion that *L. Loureiri* and *L. javanica* represent the same species. Blume already mentioned the different altitude at which both species occur in Java, *L. Loureiri* thriving especially on summits and *L. javanica* in forests. If we study the altitudinal zone for all specimens together we have 1000–3300 m. If we separate *L. Loureiri* and *L. javanica* we find *L. Loureiri* at 1600–3300 m. and *L. javanica* at 1000–2000 m. This would indicate that the altitudinal ranges overlap. However, the altitudinal range is more intricate than it appears if we arrange separately the specimens found on each mountain. Then we obtain the distribution shown in FIG. 2.

From this table it appears that the altitudinal ranges do not overlap. Only on Mts. Patoeha and Gedeh in West Java do the ranges touch one another. No intermediate specimens have been found; both species show a "healthy" variability. However, it is not actually known whether they can grow together at the same location without intermingling. They might represent altitudinal exotypes (altecotypes versus planecotypes), the more so as both species occur in Java and Bali and "accompany" one another. The chance is small, as the differential characters are numerous and distinct. I shall study this later in the field.

As to the altitudinal occurrence, it is to be noticed that the general aspect of "Massenerhebung" is also here represented. If we examine FIG. 2, it appears that *L. acuminata* occurs between 1600 and 3300 m. but

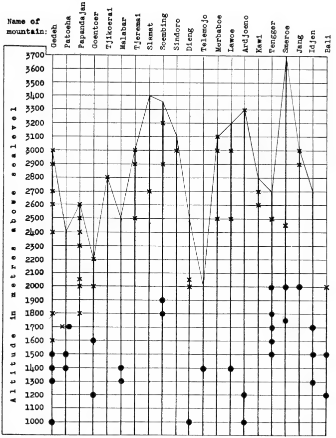

FIG. 2. Occurrence of *Lonicera acuminata* (crosses) and *L. javanica* (solid spots) in Java and Bali. The names of the mountains have been arranged, from left to right, in a west-to-east direction. The crosses and spots represent the altitude of the localities, while the thickened lines represent the altitudes of the summits of the various mountains.

only on mountains which themselves reach at least 2200 m. alt.; on these mountains it descends as low as 1600 m. In E. Java the lower limit is situated higher (at about 2500 m.), and *L. javanica* also reaches its highest stations there at about 2000 m., whereas in W. Java it is collected only up to 1700 m. On most mountains scarcely attaining 2200 m., such as Mts. Boerangrang, Tangkoeban Prahoe, Wajang, Windoe, Boekit Toenggoel, Galoenggoeng, Telagabodas, Oengaran, and Telemojo, *L. acuminata* has not been found.

On account of the occurrence of *L. Loureiri* in Sumatra, SE. Asia, and the Philippines, one would suspect *L. javanica* also to occur throughout that range, but as far as our material goes *L. javanica* has not yet been collected in Sumatra. On the other hand I suspect that *L. javanica* represents a race or subspecies of some SE. Asiatic species, in a widened specific concept, a concept which I think is badly needed in *Lonicera*.

My conclusion is that the status and distribution of *L. Loureiri* are sound but those of *L. javanica* are less satisfactory.

In some specimens I have found 3-verticillate leaves. The flowers occur sometimes in threes instead of twos. It is peculiar that the hairs on the corolla in *L. Loureiri* and *L. javanica* are directed toward the base of the corolla.

Lonicera Rehderi Merr. (1905) is described from the Philippines. On account of the fact that it is described with hairy midrib, the flowers about 2 cm. long, setosely pilose, in a crowded terminal inflorescence, the corolla-limb as long as the tube, I believe it to represent *L. acuminata*. As such it was identified at first according to Merrill's publication. Merrill says that, according to Rehder, *L. Rehderi* should differ from both *L. Loureiri* and *L. acuminata* in its yellow, not *red,* corolla, etc. But the flower of *L. Loureiri* is of the same general colour as are the other Malaysian species: at first creamy or light yellow, later yellow. The other differential characters I think are of hardly any value for distinction. Specimens referred to this species are not present at Buitenzorg, but I do not hesitate in regard to its identity.

Lonicera philippinensis is represented at Buitenzorg by the two cited duplicates, which fit in clearly with the Javanese material. The small corolla, the tube as long as the limb, the dense umbelliform sessile inflorescences, the ciliate calyx, the short style, and the yellow pubescence point certainly to *L. Loureiri*, to which it should be reduced, in my opinion. Merrill says that it is quite distinct from *L. Rehderi*, but I cannot find any important difference after comparison of both descriptions.

Lonicera oxylepis Miq. is partly based on Blume's type. Miquel is of the opinion that the name *L. Loureiri* ought to be reserved for Loureiro's plant. This is not proper, since Blume's description was based wholly on Javanese specimens without any reference to Loureiro's plant, as was done by De Candolle.

Lonicera Leschenaultii Miq. non Wall. is clearly the same as *L. oxylepis*, as may be inferred from Miquel's publication.

Of *Lonicera acuminata* I have seen only the description and a sheet (*Smith & Cave 2633*) named *L. acuminata,* and two Sikkim sheets, coll. *T. Thomson,* named *L. Loureiri,* all of which are matched by several Javanese specimens (*Koens 444, Backer 3293, 3301, 21709*). Unfortunately, the specific name *L. acuminata* has priority over *L. Loureiri* by one year. On the other hand, Clarke also pointed to the identity and says that the Javanese species differs in the glabrous corolla-tube and style. I have found that these characters vary, the corolla is pubescent or glabrous, and the style is also sometimes pubescent on the middle portion (*Backer 25975*) or glabrous (*Backer 478*). Also the stamens are sometimes glabrous (*Backer 478*) or pubescent (*Bünnemeijer 891*). One must be very cautious in dissecting the stamens, otherwise their always hairy elongation which is coalescent with the corolla-tube is interpreted as "stamens with hairy base." If one is still convinced of the distinctive specificity of the Javanese specimens, the alternative is that *L. acuminata* also occurs in Java, the specimens from Java being identical with those from SE. Asia. The leaf-shape and size of the Javanese specimens vary from ovate to lanceolate.

Lonicera Giraldii Rehder is distinguished by Rehder from *L. acuminata* by a slight difference in the relation between the length of the tube and the limb, the size of the leaves, and the spreading hairs, characters which are rather variable. The only character of importance could be the spreading, not reflexed hairs of the corolla in *L. Giraldii,* but even this can hardly serve as a specific character.

Lonicera acuminata occurs in SE. Asia (Himalayas to China), the Philippines, and Sumatra-Java-Bali; it was dispersed in two invasions into Malaysia (FIG. 1).

5. **Lonicera pulcherrima** Ridl. (?*L. malayana* Henderson).

A species which can be easily distinguished in the subsection LONGIFLORAE by its pubescent style, the other species possessing this character being *L. sumatrana* (= *L. leiantha*), *L. Hildebrandiana, L. Braceana,* and *L. dasystyla.* From the first three it is totally different in its pubescence. From *L. dasystyla* it differs in numerous characters: the bracts as long as the ovary, the larger leaves yellow-tomentose (usually densely) beneath, the rich-flowered globose terminal inflorescence with flowers in subumbelliform clusters at the ends of the upper axillary stalks, and the hairy calyx-teeth which are as long as the ovary.

SUMATRA: Only in Atjeh, Tapanoeli, and the Eastcoast. Plant not tall, climbing mostly in open rocky places, between 850 and 1400 m. alt. — *Hagen s. n.*; *Huitema 50; F. R. I. b. b. 9842; Jochems 66; v. d. Koppel 8; Lörzing 4565, 4973, 6222, 6603, 7155, 7920, 8297, 9967*; *v. d. Meer Mohr 135*; *Ouwehand 66*; *van Steenis 5853*; *Symington 24690*; *Yates 1282, 1402, 2202.*

I can place *Lonicera malayana* here only provisionally until I have studied the type specimen; it is antedated by *L. pulcherrima* by one year. The large flowers (by corolla-tube 6 cm. long is probably meant the whole corolla statu vivo?) and the yellow pubescence remove it from

L. javanica and *L. acuminata*. Most characters, along with its geographical distribution and altitudinal range, point to its identity with *L. pulcherrima* Ridl. However, there are three points of difference: firstly the corolla is said to be *sparsely* yellow-pubescent on the outside (in *L. pulcherrima* it is densely or rather densely hairy), secondly, the style is mentioned as *glabrous* (Henderson may have overlooked the few hairs which are always present in *L. pulcherrima*), thirdly, the inflorescence is described "Peduncles axillary, 3 1/2 cm. long, . . . two-flowered." This hardly seems to match *L. pulcherrima*. A further decision is to be postponed.

Ridley correctly pointed out the difference between *L. macrantha* and *L. pulcherrima*.

6. **Lonicera javanica** (Bl.) DC. (*Caprifolium javanicum* Bl., ?*L. mindanaensis* Merr.) (Description after Javanese specimens).

Ultimate twigs *grey-short-hairy*, mixed with *glandular-tipped* hairs, the internodes soon *shiny brown, slender, 1.5–2 mm. diam.* Petiole *hairy, also in glabrate forms*. Underside of the blade *glaucous* (also s. s.), glabrate or more or less densely *grey-hairy* to thinly subtomentose. Margin of the blade flat or nearly flat. Upper surface of the blade *not or slightly rugose*, glabrous or the base of the midrib hairy. Inflorescences short *grey-hairy*, terminal and in the upper axils so as to form a rather *lax panicle exceeding the leaves*; lower branches up to 6 cm. long, provided with reduced leaves, the upper internodes not abbreviated, the flowers and stalks provided with numerous or few *glandular-tipped* hairs. Calyx-lobes *mostly* rather densely grey-hairy. Bud club-shaped, the thickened end about $\frac{1}{3}$–$\frac{1}{4}$ of the length of the mature bud, often acute. Corolla about *18–30 mm. long*. Corolla-tube *slender, about 1 mm. diam. or thinner*. Corolla-lobes *narrow*, about *1–2.5 mm. broad, both lips eventually recurved*, the lobes as long as the tube or *shorter*. Anthers thin, *2–4 × 0.3–0.5 mm.*, the stamens protruding. Style often *longer* than the corolla.

JAVA: *Backer 3700, 3702, 5215, 9861, 15710, 22496, 25087*; *Bakhuizen van den Brink 34, 1411, 1412, 2241*; *Danser 6737*; *Denker 48*; *Docters van Leeuwen 341*; *Kobus 141*; *Koorders 14939, 26033, 26300, 27917, 28647, 31617, 32270, 32891, 37356 — 37358*; *Lörzing 136*; *Mousset 641, 863*; *Sapiin 2561*; *Soegandiredja 185, 213*; *Smith & Rant 425*; *Winckel 775, 1857*.

BALI: *de Voogd 1680*.

Known only from Java, Bali, and the Philippines; closely allied to *L. glabrata* DC. and *L. affinis* Hook. & Arn.; in forests and forest borders between 1000 and 2000 m.; sometimes (in Java) cultivated.

On young shoots 3-lobed leaves sometimes occur (*Bakh. v. d. Br. 2241*). The leaf-parenchyma is very finely white-dotted in the herbarium under the lens. Sometimes 4-flowered clusters occur in the same plant along with 2-flowered cymes.

On the inflorescences, the leaves, and the internodes glandular-tipped hairs occur next to normal hairs. Sometimes the corolla is clad only with sparse glandular hairs. I have never seen sessile, red dot-like glands in *L. javanica* as in *L. pulcherrima*.

The pubescence is very variable. There is a series of intermediates between very hairy forms like *Koorders 14939* and almost glabrous forms as collected by Rant above Prigeu and Ultée above Poenten. However, the petiole always remains hairy. Leaf-shape and leaf-size are also rather variable, with ovate and obovate leaves occurring on the same twig. The pubescence of the calyx-teeth varies from ciliation on the margin to entirely tomentose. The pubescence of the twigs and underside of the leaves may even approach a yellowish colour, e. g., in *Koorders 14939*, *26300*, *32891*. The hairs of the corolla are pointed downward, while the glandular hairs stand off at a right angle.

The length of the flower is variable, the tube 10–19 mm., the limb 8–14 mm. in the dried state (in living specimens the flower measures 30–35 mm.).

From *L. acuminata* it is easily distinguished by its slender, glandular corolla, the two recurving lips causing the stamens to protrude, and in the absence of rather stiff yellow hairs. Since in fresh specimens the corolla of *L. acuminata* measures from 15–30 mm., there is no reason to insert *L. javanica* in the subsection Longiflorae and *L. acuminata* (= *L. Loureiri*) in the subsection Breviflorae. The distinction of these subsections is in my opinion rather artificial, *L. javanica*, *L. affinis*, and *L. glabrata* being so closely allied that there is a chance that they will appear to belong to one species after an extensive study of more material.

Lonicera javanica has not been found as yet in Sumatra. To a certain degree it is replaced there by *L. pulcherrima*, but although *L. pulcherrima* grows at the same altitude, it prefers more open places and is, therefore, not such a tall climber as is usually the habit of *L. javanica*. I doubt whether the species really exclude each other.

Lonicera mindanaensis is a glabrate form (such as also occur in Java, though I have not found in Java entirely glabrous mature foliage as is described in *L. mindanaensis*), and the reddish brown branches, the small flowers, the hairy petiole, the narrow corolla-lobes, and the inflorescence point together to *L. javanica*. Merrill says that it is distinguished from *L. Rehderi* and *L. philippinensis* by its larger flowers. However, this difference hardly concurs with Merrill's description (*L. mindanaensis*: 22 mm. corolla; *L. Rehderi*: 20–22 mm.). *Lonicera mindanaensis* is described with filaments and style villous in their lower part, the bracteoles orbicular-reniform.

Doubtful records

Lonicera chinensis was mentioned as occurring in New Guinea by Miquel (Fl. Ind. Bat. 2: 128. 1856) on the basis of a specimen collected by Zippel to which the latter apparently had attached the manuscript name *L. repens* Zipp.

As *Lonicera* is not likely to occur in New Guinea, Zippel's specimen may represent a cultivated plant of *L. japonica*, but 1856 would seem a very early date for this ornamental. *Lonicera repens* is mentioned by Hasskarl as cultivated in the Botanic Gardens at Buitenzorg in his Cat. Hort. Bog., p. 116. 1844. According to Index Kewensis and Rehder this is *L. japonica*.

Though there is no reason for me to doubt Miquel's identification, an examination of the original specimen in the Leyden Herbarium is necessary. There is also a probability that Zippel's plant came from Java, as several of his labels appear to be incorrect or mislaid at Leyden; this was certainly not caused by that gentleman himself, as he was very accurate and of wide knowledge.

EXCLUDED RECORDS

Lonicera Gaertn. = Loranth.

Lonicera chinensis Wats., *L. confusa* DC., *L. javanica* DC., and *L. macrantha* DC. were mentioned to occur in the Philippines by F.-Villar, Nov. App. 104. 1880; these records are excluded by E. D. Merrill, Enum. Philip. Fl. Pl. 3: 578.

Lonicera Symphoricarpus Blanco, non L. = *Scurrula philippinensis* (Cham. & Schltd.) G. Don, cf. Danser in Philip. Jour. Sci. 58: 121. 1935.

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MEIOTIC PROPHASE PHENOMENA IN SPECIES AND INTERSPECIFIC HYBRIDS OF NICOTIANA

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With three plates and one text-figure

INTRODUCTION

INVESTIGATIONS bearing upon problems of species origins and relationships in the genus *Nicotiana* have been carried on in this laboratory at the University of California for many years. With increasing accumulation of evidence it appears that, in this genus at least, extent of chromosome pairing at MI in F_1 interspecific hybrids in general reflects the degree of relationship of the species involved. Recent articles (Goodspeed, 12, 13, 14) expose the extent and character of the data in this and other cytological connections and reveal the close correspondence between morphological, taxonomic, and cytogenetic evidence of relationships within the genus.

Chromosome behavior at MI has been studied in a total of 213 F_1 interspecific hybrids of *Nicotiana*. Information in the case of 135 of these hybrids, which involve as parents 53 of the 58 valid species (Goodspeed, 12, 14; Wheeler, 49), has been obtained in this laboratory, and Kostoff (27) has contributed much of the remainder. Of the 135, 69 are intrasectional, 25 intersectional, and 41 are intersubgeneric hybrids. Our evidence shows that 29 hybrids exhibit at MI complete or almost complete pairing, 35 lack of pairing or approximations thereof, 22 low but variable pairing, 16 high but variable pairing and 35 "Drosera scheme" pairing. Examples of these various categories of pairing are discussed in what follows.

The correlation of extent of MI pairing in hybrids with the taxonomic relationships of the species involved is as follows: in approximately 90% of intrasectional hybrids pairing is complete or nearly so; 90% of intersectional and all intersubgeneric hybrids fall into the lack of pairing category; all hybrids involving amphidiploid species (cf. Goodspeed and Bradley, 16) and the descendants of their putative ancestors show "Drosera scheme" pairing, while 85% of hybrids involving these amphidiploid species and species other than those postulated to have entered into their parentage show almost complete lack of pairing. The information concerning meiotic phenomena in the additional 78 hybrids studied by others enforces almost without exception the significance of the above evidence.

The proposition that amount and character of MI pairing reflects the extent to which in the parental genoms the genes and their arrangement are the same or similar is obviously basic to all cytotaxonomic conclusions to which studies of first meiotic metaphase chromosome behavior contribute (Stebbins, 44). A considerable to a high degree of MI pairing is characteristic of many interspecific hybrids in most genera other than *Nicotiana* (cf. Stebbins, l. c.). The apparent conclusion that *Nicotiana* is unique in the sense that many interspecific hybrids exhibit a negligible amount of MI pairing is, however, difficult to document. Taxonomic criteria from genus to genus are variable, and thus what is said to constitute an interspecific hybrid in one may correspond to a varietal hybrid in another. Again, in no other genus is comparable cytological evidence available for such a high proportion of the possible interspecific combinations, and there is here the suggestion that more extensive data for other genera might reveal the occurrence of pairing categories comparable to those in *Nicotiana*. This discrepancy in evidence may be, in part at least, a product of inability to obtain interspecific hybrids in other genera, a possibility which suggests that the ability to obtain numerous hybrids between species of *Nicotiana* which are taxonomically remotely related may be due to evolution of factors inhibiting crossibility having occurred at a slower rate than evolution of those responsible for species differentiation. In any case, interspecific hybridization — frequently leading to amphidiploidy with its polyploid and aneuploid byproducts — apparently represents a major evolutionary mechanism in *Nicotiana*, and disappearance of many of the contributory ancestors leaves the modern genus small in terms of species and restricted in terms of distribution. In such a relic genus with such an evolutionary background species distinctions, morphological and thus genic, may be expected to be considerable with the result that lack of pairing and "Drosera scheme" pairing are of relatively frequent occurrence among its F_1 interspecific hybrids. In other words, it is probable that *Nicotiana* may actually be unique among genera which have been cytotaxonomically treated.

Important for the interpretation of the character and significance of MI pairing in F_1 interspecific hybrids is the question of the extent to which pairing observed at MI is a reflection of meiotic prophase association. This is particularly true, for example, in the considerable number of *Nicotiana* hybrids where the pairing mode at MI is zero or approximately zero. It may be contended in such cases that MI evidence is not reliable because genic effects are known to produce desynapsis and thus a complete or considerable zygotene-pachytene association might not necessarily be followed by the appearance of a corresponding amount of MI pairing. Therefore, without evidence concerning early meiotic prophase phenomena in hybrids, the amount of MI pairing is doubtfully applicable to interpretation of the relationships of the parental species involved. In the present article the results of comparative studies of meiotic prophases of species and F_1 interspecific hybrids of *Nicotiana* are described and commented upon.

There are few reports of meiotic prophase phenomena in species or F_1

interspecific hybrids of *Nicotiana*. For triploids of *N. tabacum* Olmo (35) and for haploids of that species, Lammerts (28) described the extent and something of the character of pachytene associations. In a normal haploid plant the average number of bivalents per PMC at MI ranged from .17 to .43, while in a "Coral" *N. tabacum* haploid in which the F chromosome was genetically altered the average was 1.44. At pachytene the correspondingly greater amount of association observed in the "Coral" as contrasted with the normal haploid was assigned primarily to non-homologous pairing. In an asynaptic haploid of *N. sylvestris* (Goodspeed and Avery, 15), approximately 50% of the PMC contained a bivalent at MI with some instances of 2 to 4 bivalents. Some pachytene pairing was seen, primarily between segments of two strands which apparently were structurally alike as a result of duplication. The rare occurrence of more than one bivalent at MI was assigned to non-homologous association and "fold backs" at prophase. In the above citations emphasis at pachytene was laid upon correspondence in chromomere pattern or its absence as indicative of the presence or lack of homology in the paired chromosomes. Some reference to meiotic prophase in haploids of *N. rustica, N. Langsdorffii,* and *N. sylvestris* is made by Kostoff (27), who found that the negligible amount of pairing observed at MI was preceded by a minimum amount of pachytene association. Elvers (9) made a preliminary examination of pachytene in F_1 *N. glutinosa* $\times$ *N. wigandioides*.[1] At MI this hybrid shows a range of 2 to 9 pairs. At pachytene paired threads appeared to be much more numerous than unpaired ones. In some cases Elvers considered the paired threads homologous in terms of matching chromomeres, while others appeared to be instances of non-homologous association.

Relatively little information is available concerning the relation between prophase and MI chromosome behavior in hybrids in other genera in which pairing at the latter stage of meiosis is lacking or reduced. In most such cases a typical pachytene stage was not seen (cf. Federley, 10; Harrison and Doncaster, 17; Ramanujam, 37) or only short paired segments were observed (Meurman, 32). However, Karpechenko (21) found in hybrids of *Raphanus sativa* $\times$ *Brassica oleracea* that synapsis did not differ from that in the parents, although there was no pairing at MI. In an interspecific hybrid in *Crepis* (Tobgy, 48), marked differences in length at MI of the parental chromosomes apparently did not reduce the extent of pachytene association.

The reduced amount of MI pairing in asynaptic and desynaptic plants makes them in that sense comparable to F_1 interspecific hybrids of *Nicotiana* which show lack of or low variable pairing. In desynapsis more or less normal zygotene association is observed or indicated (cf. Koller, 23) to have occurred and is followed by lack of chiasma formation (cf. Beadle,

[1] Not F_1 *N. glutinosa* $\times$ *N. tomentosa* as originally reported by Elvers.

2; Catcheside, 5; Levan, 29), while in asynapsis zygotene association is found to be lacking or at a minimum (cf. Huskins and Hearne, 19; Ramaer, 36; Yamomoto, 51). Both phenomena are taken to be genically controlled. The falling apart of chromosomes was seen to occur in late pachytene or between diakinesis and MI (cf. Richardson, 39; Levan, 29; Li, Pao, and Li, 30).

TECHNIQUE

Variations of the conventional paraffin technique did not give adequate pictures of meiotic prophase conditions in PMC of species or F_1 interspecific hybrids of *Nicotiana,* although certain paraffin preparations were useful for comparative purposes. Smears were satisfactory when prepared according to the following techniques:

A. After fixation in 3 parts absolute alcohol to 1 part glacial acetic acid for 20 to 24 hours, the anthers were removed to 70% alcohol, two or three changes of alcohol being made within a period of a few hours. A shorter (12 hour) fixation did not prove to be so satisfactory.

B. Fixation in 1 part chloroform to 1 part of the solution used in fixation A was continued for 24 hours to several days. Anthers transferred to alcohol after a 24 hour fixation showed darker cytoplasm than those left in the fixative for a considerably longer period.

After fixation anthers were smeared in strong iron aceto-carmine. Additional iron from dissecting needles was added to the drop of carmine in which anthers were to be smeared until the stain began to appear purplish. Preparations were alternately heated and pressed until the desired degree of spreading and staining of the chromosomes was achieved. Technique B proved to be superior to technique A for detailed studies of spiralization in loops and segments of chromosomes. The less delicate quality of the staining in technique A, however, made its use more appropriate for investigation of the entire contents of nuclei. Therefore, all drawings except PLATE I, *fig. 6* were made from material prepared according to technique A. Swanson (46) has had success in demonstrating finer structure of early prophase chromosomes in *Tradescantia* after pretreatment with heat. One set of cut inflorescences of several *Nicotiana* species was, therefore, kept in jars of water at approximately 40°C. for 24 hours and another at 32°–35°C. for the same period. In neither case did the results of such pretreatment improve the definition of prophase in our material.

OBSERVATIONS

(a) SPECIES. — Over a period of years information has accumulated in this laboratory concerning diplotene-diakinesis sequences in *Nicotiana* and has been applied to interpretation of chromosome behavior at MI in species and F_1 interspecific hybrids. Until the techniques above described were available, pre-diplotene stages proved difficult to study and little significant evidence on those early meiotic phenomena was secured.

The four species referred to in what follows were selected for description of the leptotene-diakinesis progression because they are distinguished from one another in chromosome number or karyotype or because they represent parents of F_1 hybrids in which meiotic prophases have been studied. Members of Subgenus *Petunioides,* Section *Alatae, N. Langsdorffii* (n = 9) has a $2\ m + 4^1\ s\ m + 3^1\ st$ karyotype and *N. longiflora* a $10^2\ st$; *N. glauca* (Subgenus *Rustica,* Section *Paniculatae*) has a $1m + 1\ s\ m + 10^1\ st$ karyotype, while in *N. otophora* (Subgenus *Tabacum,* Section *Tomentosae*) the karyotype is $7^1\ m + 5^1\ st$ (Goodspeed, 13). In a number of instances marked distinctions in somatic chromosome morphology make possible the identification of individual chromosomes in early meiotic prophases and thereby assist in interpretation of the results obtained.

Pre-leptotene chromosomes show relic coils which are eliminated by mid-leptotene along with parallel enlargement of the nucleus and lengthening of individual strands. Adequate evidence of duality and of the relational coiling of sister chromatids resulting from a gradual resolution of relic coiling is not yet available. Optically, therefore, mid-leptotene chromosomes appear as much attenuated, slender chromonemata evenly distributed in the nucleus. With technique A these chromosomes have a distinctly beaded appearance which for certain of them at least seems to correspond to a pattern in terms of size and linear position of chromomeres. With technique B, however, equivalent material shows the establishment at mid-leptotene of the meiotic spiralization cycle. Thus it appears that the beaded appearance of the chromosomes (chromomeres) is largely a product of fixation which obscures the presence of the major spiral without altering spiralization patterns. The "spiralization pattern" of a meiotic prophase chromosome is here assumed to be established by genically controlled distinctions in size and pitch of gyres, in their linear relations, and in amount and/or character of nucleic acids of consecutive segments. In other words, our evidence supports the conclusion that a pattern of chromomeres represents a heritable spiralization pattern. From this point of view the spiralization pattern is the same in sister chromatids and homologous chromosomes. Certainly at zygotene conspicuous linear correspondence of spiralization patterns is often seen, and obviously complete and intimate association between two chromosomes in which the major coils have been developed can occur only where both possess identical spiralization patterns.

At early zygotene conjugating segments are seen at ends of chromosomes and/or in intercalary regions which may represent position of centromeres (PLATE I, *fig. 6a, b*). Free ends extending from paired segments frequently can be seen to possess identical spiralization patterns. By late zygotene intermeshing of the two spiralized chromosomes is complete and only at ends (particularly at satellites) can the dual nature of the strands be demonstrated. Some relational coiling occurs at pachytene and appears to represent random twisting of the long paired threads. During pachytene appreciable condensation is seen. This is a product of the onset of despiralization which begins to be conspicuous at late pachytene, where in chromosomes undergoing repulsion the number of gyres is reduced, the diameter of the gyres is increased, and the gyres are closer together (PLATE I, *fig. 6 c, d*).

At mid-pachytene distinctions in somatic chromosome morphology within the genoms of the species of *Nicotiana* under discussion permit identification of entire paired lengths or large segments of such lengths. Thus, in a number of PMC of *N. Langsdorffii* four of the nine pairs can be individually distinguished (cf. PLATE I, *fig. 2*). For example, the entire extent of one submedian pair characterized by possession of an extremely large satellite, and of one very short subterminal pair with distal satellites, could be studied and were found consistently associated with the nucleolus. In this species at pachytene centromeric as well as satellite constrictions are pronounced and usually reflect the duality obtaining. In *N. longiflora* (PLATE I, *fig. 3*) the two chromosomes which bear satellites, one a small proximal and the other a large distal satellite, and the nucleolus were always associated. Even at this stage these two chromosomes were distinguishable from each other by reason of size and position of satellites. Another somatic chromosome of this species characterized by a large distal knob is readily identifiable at pachytene by the presence of a conspicuous terminal heterochromatic area. Although during mitosis the knob never appears as a typical satellite it is at pachytene frequently, though not consistently, found near the nucleolus. In *N. longiflora* centromeric constrictions at pachytene, unlike those of *N. Langsdorffii,* are not pronounced in the majority of the chromosomes. As in *N. Langsdorffii* and *N. longiflora,* so also in *N. glauca* (PLATE I, *fig. 1*) and *N. otophora* certain chromosomes at pachytene can be identified by distinctions in centromere position and/or by number and size of satellites, and in the latter species certain chromosomes of both length classes of the strikingly dimorphic genom can be followed over their entire extent.

In early diplotene condensation has reached the point where, in such species of low chromosome number as *N. Langsdorffii* and *N. longiflora* (PLATE I, *fig. 4*), the majority of the paired lengths can be studied in their entirety. However, relational coiling due to twisting of homologues makes impossible a determination of all points at which crossing-over has occurred. As diplotene advances, further despiralization, accompanied by maximum attraction and repulsion of homologues and chromatids, is apparent with consequent decrease in relational coiling. As a result chiasmata in the now optically quadripartite units become readily distinguishable from twists which did not involve crossing-over (PLATE I, *fig. 4*). Often chromatids can be traced through chiasmata and the independent coils of sister chromatids identified (PLATE I, *fig. 6 g*). At diakinesis (PLATE I, *fig. 5*) the tetrads, distributed about the periphery of the nucleus, become exceedingly compact and are characterized by outlines the distinctly uneven quality of which indicates the presence of spiralization which is obscured by accumulation of matrical material.

(b) HYBRIDS. — In all F_1 interspecific hybrids of *Nicotiana* except those characterized by approximately complete MI pairing the meiotic prophase sequence, particularly mid to later stages, shows marked departures from that of the parental species, the extent of the distinctions being in general directly proportional to the extent to which the chromosomes fail to pair at MI.

As in other genera, the leptotene-diakinesis sequence in species of *Nicotiana* exhibits stages which become points of reference. Thus, zygotene with its tendency toward parallel orientation of homologues and its evidence of the beginning of synaptic unions, mid-pachytene where all chromosomes exhibit an approximately uniform degree of condensation and are completely paired with duality apparent only at ends or where repulsion is already under way, and diplotene with its conspicuous configurations can all be identified with confidence. By contrast, in F_1 interspecific hybrids such points of reference may be much less pronounced or entirely lacking. For example, in hybrids of the lowest pairing category there is nothing comparable to zygotene, pachytene is identifiable only in PMC where certain chromosomes show intimate association over relatively short segments, and typical diplotene does not occur.

In hybrids, as in species, pre-leptotene chromosomes exhibit relic coiling. As leptotene strands take form, this coiling is wholly or largely lost and by mid-leptotene appears to be replaced by the initiation of the new major coiling cycle. As in species, the leptotene material of hybrids prepared according to technique A showed bead-like chromomeres which after technique B was applied to equivalent material were seen as gyres of a specific spiralization pattern. Although not yet adequately demonstrated, it appears that in hybrids, particularly of the low pairing category, there is a somewhat stronger suggestion than in species of duality of early to mid-leptotene chromosomes. Assuming leptotene duality, relational coiling of sister chromatids resulting from straightening of relic coiling must have been eliminated, probably, in part, by rotation of ends in the enlarging nucleus and in part by the initiation independently in the closely appressed sister chromatids of the major coiling cycle. In general, except for absence of typical zygotene, pre-pachytene conditions in hybrids correspond to those in species.

At pachytene, however, striking contrasts appear. Whether pachytene pairing in a given nucleus of a hybrid is approximately complete or is limited to a few short segments or is entirely lacking, the unpaired chromosomes (whole chromosomes or segments) are strikingly atypical as a result of the occurrence of alternating thick and thin areas of varying length. This phenomenon continues until diakinesis which, apart from differences in the valencies of the chromosomes involved, is entirely comparable in appearance to the same stage in species. The presence of spiralization patterns in the chromosomes throughout the meiotic prophase is more readily demonstrated in hybrids than in species, at least in the sense that it is revealed after technique A as well as after B.

As a typical representative of a *Nicotiana* hybrid exhibiting lack of pairing at MI, the meiotic prophases of F_1 *N. glauca* ($n = 12$) $\times$ *N. plumbaginifolia* ($n = 10$) were extensively studied (PLATES II, III). Apart from the report of Kostoff (27), more than 4 pairs at MI have not been seen in this hybrid. Some 750 PMC analyzed by Ramanujam and Joshi (38) gave a pairing range of 0 to 4, well over 75% showing zero pairs, and our unpublished data involving over 100 PMC correspond (*Text fig. 1, a*). On the other hand, Kostoff (l. c., p. 396) reports a pairing range of 3 to 9 and elsewhere (l. c., p. 632) one of 6 to 10. It should be noted that the occurrence of numerous "off-spindle attachments" and the tendency of the univalents to form an equatorial plate rather than lying scattered in the PMC produces a misleading impression of the amount of pairing obtaining.

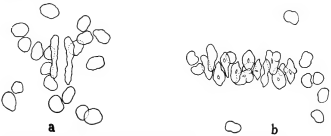

FIG. 1. MI conditions in F_1 interspecific hybrids: *a*, F_1 *Nicotiana glauca* ($n = 12$) $\times$ *N. plumbaginifolia* ($n = 10$), showing 2 bivalents and 18 univalents, off-spindle attachments, and secondary association; *b*, F_1 *N. tabacum* ($n = 24$) $\times$ *N. otophora* ($n = 12$), showing 12 bivalents and 12 univalents.

In this hybrid some PMC at a stage taken to correspond to pachytene showed only unpaired chromosomes, but in the majority of PMC from one to several paired segments, frequently but not exclusively terminal, occurred (PLATE II, *figs. 2, 3*). Usually such paired segments were short, but in most favorable material a relatively long paired segment was sometimes seen.[2] In terms of identity of spiralization patterns of the segments paired at pachytene and of distinctions of such patterns in unpaired segments of the same chromosomes, conjugation appears to occur only between structurally homologous segments of otherwise non-homologous chromosomes (PLATE II, *fig. 3*). This conclusion is borne out by the occasional presence of heteromorphic pairs at MI in this hybrid.

[2] Undoubtedly this pairing is of sufficient length to permit chiasma formation, a fact which probably accounts for the relatively frequent occurrence of one pair at MI.

At diplotene (cf. PLATE II, *figs. 4, 5, 6*) the duality of each chromosome is rather strikingly visible, particularly in terminal areas (PLATE II, *fig. 5*), sister strands showing as independently coiled elements capable of lateral separation from each other. At early diakinesis (PLATE III, *fig. 1*) evidence of duality and spiralization is unmistakable, whereas in species at an equivalent stage both are somewhat difficult to demonstrate. In the hybrid centromeric constrictions are conspicuous. Frequently the initiation of off-spindle attachments and of secondary association characteristic of some univalents at MI can be seen (PLATE III, *fig. 2*), reflecting perhaps an earlier association of segments too short to permit chiasma formation.

In the case of F_1 *N. tabacum* (n = 24) × *N. otophora* (n = 12), a hybrid which combines the genoms of the former species and of a modern descendant of one of its putative ancestors, MI shows a close approximation of the "Drosera scheme" pairing which is characteristic of other hybrids which, like it, involve amphidiploid species and those related to their parentage. The pairing mode in some 150 PMC analyzed is $12_{II} + 12_{I}$ although a range of 10 to 13 pairs occurs, with a trivalent frequently seen (*text fig.* 1, b). As in F_1 *N. glauca* × *N. plumbaginifolia*, a lack of pairing hybrid, detailed prophase studies of this "Drosera scheme" one reveal a complete correspondence between the amount of pachytene and MI conjugation (PLATE III, *figs. 3, 4, 5*). Thus at the former stage paired and unpaired chromosomes appear in approximately a 1:1 ratio (PLATE III, *fig. 3*), although it cannot be determined as accurately as can the MI ratio of bivalents to univalents because of the difficulty of following any one of the pachytene chromosomes throughout its entire length. However, complete pairing is clearly visible over the entire extent of large pachytene loops which, in some instances at least, represent the major portions of the chromosomes involved, and the occurrence of long unpaired lengths is equally conspicuous. Unpaired segments in otherwise completely paired strands are seen at times. In them the spiralization patterns are not the same, whereas paired chromosomes consistently appear to be structurally homologous. Some relational coiling of homologues was observed.

As will be noted in PLATE III, *fig. 3*, satellited chromosomes — two paired and one unpaired — are attached to the nucleolus, and there are not too sharply defined heterochromatic regions, the latter doubtless contributing the chromocenters which are peculiarly conspicuous in somatic nuclei of *N. otophora* at the metabolic stage.

Pairing at MI in F_1 *N. paniculata* (n = 12) × *N. Benavidesii* (n = 12) is approximately as complete as it is in the parental species with a mode of 12_{II} in 85 of the 100 PMC analyzed. At pachytene, in the many cells examined, no unpaired chromosomes or segments were found. Another hybrid of the complete pairing category, F_1 *N. Raimondii* (n = 12) × *N. cordifolia* (n = 12), is important as indicating the degree of reflection of MI conjugation at pachytene, since at MI the pairing mode is $11_{II} + 2_{I}$ and in pachytene, although completely paired lengths are the rule, unpaired segments can at times be seen. Throughout the meiotic prophase sequence of the complete pairing hybrids all stages appeared to correspond in detail to equivalent stages in the parental species.

For the hybrid F_1 *N. tabacum* (n = 24) × *N. glauca* (n = 12) the extent of MI pairing has been variously reported. Sarana (41) mentions "up to 12 pairs," Kostoff (27) gives a pairing range of 9 to 12, while in approximately 100 PMC analyzed here the range was 0 to 8 with 4 and 5 pairs occurring with equal frequency. This hybrid has therefore been placed in the low variable pairing category and prophase investigation makes it clear that association at pachytene is similarly low but variable in amount. Although unpaired chromosomes predominate in the majority of the PMC there is considerable variation from one cell to the next, but no instance of "Drosera scheme" or even approximately "Drosera scheme" pairing occurs.

Prophase conditions in an asynaptic individual of *N. tomentosa* (n = 12) were studied, since under the influence of environmental conditions variability in extent of MI pairing was comparable to that of such a hybrid as has just been described. When pachytene and MI material were taken simultaneously from this plant the latter stage was a reflection of the former in terms of the amount of pairing which occurred. It should be noted, however, that even when MI pairing was minimum the majority of PMC at pachytene showed, by contrast with F_1 interspecific hybrids of *Nicotiana* of the lack of pairing category, a considerable number of paired segments and even what were taken to be one or more completely paired chromosomes (cf. PLATE III, *fig. 6*).

COMMENT AND SUMMARY

Comparative studies of meitoic prophase phenomena in species and F_1 interspecific hybrids of *Nicotiana* above described show that in both cases the extent and quality of MI pairing is a reflection of the amount of early prophase association. Thus, in a hybrid showing approximately as complete pairing at MI as occurs in the parental species, zygo-pachytene conjugation is also complete. In a hybrid exhibiting a variable amount of pairing from one PMC to the next at MI, an equivalent range in ratio of paired to unpaired chromosomes appears throughout the zygotene-diakinesis sequence. Similarly, where "Drosera scheme" behavior is shown at MI in a hybrid where the chromosome number of one parent is twice that of the other, the ratio at pachytene between paired and unpaired units is approximately 1:1. The extensive studies of prophase phenomena in hybrids showing complete or almost complete lack of pairing in all PMC analyzed at MI confirm the evidence just summarized that univalents at MI reflect absence of prophase association or that such association is commonly confined to short segments.

There is no evidence that genically conditioned desynapsis is responsible for the univalents present at MI in F_1 interspecific hybrids[3] nor that their occurrence can be assigned to the presence of an inherited asynaptic state. If a genic alteration causing asynapsis is recessive, its effects would not be manifest in the hybrids under discussion. It is, of course, possible that dominant gene mutations leading to asynapsis might offer an explanation for a few of the many instances of complete lack of pairing or variable pairing at MI, but "Drosera scheme" behavior obviously could not be assigned to the operation of such heritable influences. Furthermore, the fact that distinctions in relationship based upon morphology and distribution are almost uniformly in accord with cytogenetic evidence is significant in this entire connection.

Chromomeres have been variously described and interpreted. For example, they have been referred to as discrete chromatic disks of varying thickness (Heilborn, 18), as a series of enlargements of the genonema (Koltzoff, 25), condensation centers of chromatin (Ellenhorn, 8), localization centers of nucleic acids (Caspersson, 4), products of close intertwining of sister chromatids (cf. Kaufmann, 22), and as misinterpretations of coiled structures (Ris and Crouse, 40). In *Nicotiana* interpretation of chromomeres and their disposition as evidence of the presence of specific spiralization patterns appears justified. As already indicated a spiralization pattern is here taken to represent the product of genically controlled distinction in size and pitch of gyres, in their linear relations, and in the quantity and character of nucleic acids in consecutive segments.

In the species of *Nicotiana* examined leptotene duality is not demonstrable. However, at lepto-zygotene each chromosome is here assumed to represent a double strand the sister chromatids of which have been freed from relational coiling by rotation as they earlier straightened and lengthened and by initiation of the major coil independently in each chromatid. Onset of spiralization at leptotene is suggested by the evidence of Taylor (47), Shinke (43), Koshy (26), Naithani (34), and Swanson (46), whereas Darlington (7) and Huskins and Smith (20) see leptotene as unspiralized.

Following zygotene intermeshing of chromosomes, the homology of which determines an identity of their spiralization patterns, the pachytene-diakinesis sequence becomes a product of despiralization, the operation of forces of repulsion and attraction and the addition of nucleic acids, each of these phenomena characterized by its specific timing relation to the complete progression. Despiralization beginning in pachytene is visible at late pachytene in the greater diameter, as compared with zygotene, of the separating chromosomes and continues through diplotene (PLATE I, *fig. 6e, f*) and diakinesis to effect a progressive decrease in number of gyres and increase in their diameter. This evidence for *Nicotiana* agrees with Swanson's (46) conclusion for *Tradescantia* but is in contrast to that of

[3] Such "desynapsis" as occurs corresponds only to the falling apart of short segments associated at pachytene in which the homology does not extend over a sufficient distance to favor chiasma formation.

certain investigators who see indication of comparable despiralization only at a considerably later stage. The assumption that despiralization is beginning independently in each chromatid of the tetrad during pachytene, concurrently with the occurrence of crossing-over and chiasma formation between chromatids of homologues, suggests that the breaks which condition the latter phenomenon may be in part a result of the tensions set up by the former process. This same assumption provides an explanation of the observed reduction in relational coiling of homologues, decrease in chiasma frequency, and increase in terminalization coefficient characteristic of diakinesis as contrasted with diplotene (Swanson, 45). It appears that the degree of despiralization observed is sufficient to account for the amount of reduction in length of strands which is seen between pachytene and diakinesis without employing axial contraction of the chromosomes as a contributing factor. In *Nicotiana* there is during prophase no evidence of the minor coil which is referred to elsewhere and considered (cf. Sax, 42) as a third factor in effecting reduction in chromosome length.

To analysis of the factors involved in the progress from leptotene to diakinesis, the study of prophases of hybrids, particularly those of the lack of pairing category, makes contributions. As shown above such material where the parental chromosome numbers are low is peculiarly valuable for interpretation of spiralization phenomena. The unpaired chromosomes of both the hybrids and the asynaptic under discussion consistently exhibit striking distinctions in the width of alternating segments (of varying length), a condition undoubtedly proceeding from a disruption of the timed progression of the spiralization-despiralization cycle characteristic of normal species. Investigations of similar material in other genera reveal prophase irregularities. For example, in asynaptics Huskins and Hearne (19) refer to a "confused irregularly contracted zygotene-diakinesis condition," Beadle (1) refers to "local regions of greater condensation," and Ramaer (36) to "a mass of threads partly contracted . . . . " Similarly for F_1 hybrid prophases reference is made to "many fine threads with thickenings at some places . . . [perhaps] the result of differential contraction of threads" (Ramanujam, 37), "general thickening of threads with irregularly alternating regions becoming attenuated and strained in appearance" (Melburn, 31), to the fact that in some loops very thin regions connect thick ones (Cretschmar, 6), and that "the chromosomes undergo successive changes at different rates" (Meurman, 32). Lack of uniform timing of despiralization appears, in large part, to account for the presence in *Nicotiana* hybrids and in an asynaptic of alternating thick and thin segments of varying length in the unpaired chromonemata. Thus, precocious despiralization produces increased width in one segment while segments of the same chromosome retain their relatively attenuated pre-pachytene appearance. In PLATE II, *fig. 4* the presence of a coil with gyres varying in diameter and degree of relaxation can be seen.

There is probably a relation between the timing of the spiralization-despiralization cycle and the progression of nucleic acid condensation during prophase. For example Callan (3) concludes that nucleic acid is always present during spiralization, White (50) suggests that since chromatids are regarded as more tightly coiled at metaphase when the nucleic acid concentration is taken to be at a maximum, spiralization may be a consequence of nucleic acid synthesis, and Goldschmidt and Kodani (11) refer to coiling or molecular folding of the chromonemata forming the core of the disks of salivary gland chromosomes and to the presence of nucleic acid in the disks and its probable absence between them. It is, therefore, possible that disruption of normal spiralization-despiralization in hybrids might fundamentally represent a disruption of the normal nucleic acid cycle. In this connection it is to be noted that the nucleolus may be concerned in nucleic acid metabolism (cf. Koller, 24), and presumably the balance between the rôles played by nucleoli, chromosomes, and plasma is a specific character. If this is the case, the presence of nucleoli of unrelated origins, and thus presumably of distinctions in amount and activity of nucleolar material, in the nucleus of an interspecific hybrid might directly influence the nucleic acid cycle. Indeed, the physiological condition of the hybrid protoplast as a whole, which is the product of interaction of often large distinctions in the genic constitution of the parental genoms, might affect nucleic acid synthesis. Since in species of *Nicotiana* at pachytene, areas known to be heterochromatic because of connection with centromeres show only a slight differential reaction to staining, the distribution of heterochromatin may not be limited to centromeric regions and satellites (cf. Morgan, Schultz, and Curry, 33). Thus, the thicker and denser portions of the chromosomes above referred to as characteristic of prophases of lack of pairing hybrids might be related to distinctions or transitions between eu- and heterochromatin or, at least, the presence of such chromatic distinctions might intensify the appearance of disruption of the normal pachytene-diakinesis sequence.

The above interpretation of prophase phenomena in F_1 interspecific hybrids of *Nicotiana* has introduced a series of problems which require for solution more evidence than is at present available. Irrespective of the significance which may attach to these phenomena in terms of spiralization-despiralization, nucleic acid and heterochromatin cycles or states, the importance of the results of the comparative prophase studies above described lies in their application to the relation between MI pairing and prophase association. As already stated, the significance of MI association in terms of its indication of fundamental relationships between the parents of F_1 interspecific hybrids cannot be fully accepted without evidence from preceding prophases that such pairing or its lack reflects synapsis or its absence. The investigations discussed above supply such evidence. Therefore, on the basic assumptions concerning the factors responsible for synapsis, it appears that the amount of MI pairing in interspecific hybrids, of *Nicotiana* at least, may be taken as a measure of the degree to which the genes of the parental genoms united in those hybrids are equivalent or similar in character and arrangement. In other words, in *Nicotiana* the extent and quality of MI association represents a reliable cyto-taxonomic criterion suggestive of phylogenetic relationships.

ACKNOWLEDGEMENTS

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EXPLANATION OF PLATES

All figures drawn with camera-lucida and reduced to × 1360.

PLATE I

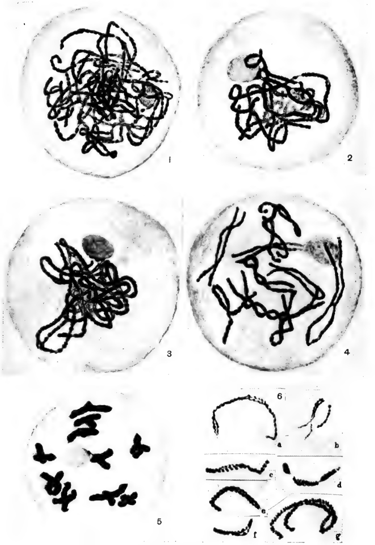
Meiotic prophases of species of *Nicotiana*.

FIG. 1. Pachytene, *Nicotiana glauca* (n = 12): paired chromosomes exhibiting duality at ends and centromeres. FIG. 2. Pachytene, *N. Langsdorffii* (n = 9): four pairs distinguishable in their entirety — two satellited, one long ***m*** (above), and one *st* (near nucleolus). FIG. 3. Pachytene, *N. longiflora* (n = 10): two satellited pairs associated with nucleolus, another with distal knobs near nucleolus. FIG. 4. Diplotene, *N. longiflora*: all pairs distinguishable throughout their lengths; structure of some chiasmata visible. FIG. 5. Diakinesis, *N. longiflora*. FIG. 6. Zygotene to late diplotene (segments), *N. Langsdorffii*. (*a*), (*b*) zygotene: (*a*) pairing practically complete; (*b*) pairing in centromere area. (*c*), (*d*) pachytene showing onset of despiralization: (*c*) in homologues; (*d*) in segment (including centromere) of pair with large satellite. (*e*), (*f*) early diplotene: identity of spiralization patterns (*f*) in repulsed segment. (*g*) later diplotene: structure of chiasmata and character of spiralization in an entire chromosome pair.

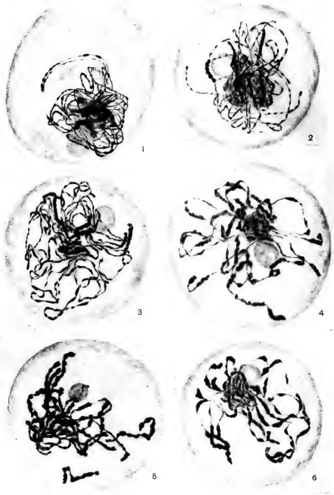
PLATE II

Meiotic prophase of F_1 *Nicotiana glauca* (n = 12) × *N. plumbaginifolia* (n = 10).

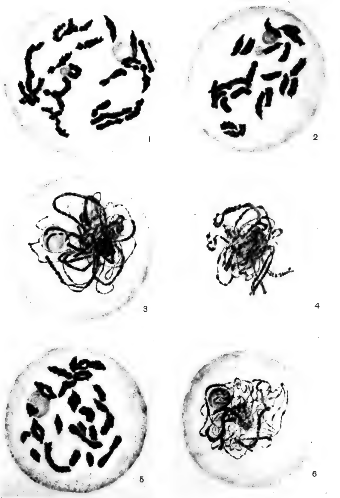
FIG. 1. Pre-pachytene. FIG. 2. Pachytene: several short segments associated, unpaired chromosomes exhibiting thick and thin areas. FIG. 3. Later pachytene: distinctions between thick and thin areas more striking; note spiralization in paired segment on extreme right. FIG. 4. Late "pachytene" or early "diplotene": thick and thin areas and spiralization conspicuous. FIG. 5. "Diplotene": chromatid separation apparent. FIG. 6. Diplotene: one paired segment (lower right) possibly with chiasma.



Meiotic Prophase Phenomena in Nicotiana



Meiotic Prophase Phenomena in Nicotiana



Meiotic Prophase Phenomena in Nicotiana

PLATE III

Meiotic prophase of F_1 interspecific hybrids: Figs. 1 and 2 F_1 *N. glauca* × *N. plumbaginifolia*, figs. 3 to 5 F_1 *N. tabacum* ($n = 24$) × *N. otophora* ($n = 12$), fig. 6 asynaptic *N. tomentosa* ($n = 12$).

FIG. 1. Early diakinesis: duality, spiralization, and centromeric position conspicuous. FIG. 2. Diakinesis: secondary association. FIG. 3. Pachytene: paired segments or whole chromosomes and unpaired chromosomes in approximately equal numbers; note thick and thin areas in unpaired lengths. FIG. 4. Diplotene: chiasmata shown in segments of at least three pairs; note identity of spiralization patterns at lower right. FIG. 5. Diakinesis: $12_{II} + 12_{I}$; note evidence of spiralization. FIG. 6. Pachytene: paired segments or whole chromosomes, unpaired segments showing thick and thin areas.

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LA PROTECTION DE LA NATURE A MADAGASCAR

HENRI HUMBERT

Avec cinq planches et une carte

MADAGASCAR est l'une des parties du monde où se révèlent le mieux l'importance des questions relatives à la Protection de la Nature, l'ampleur des problèmes que celle-ci soulève, et les difficultés auxquelles elle se heurte. C'est en même temps, dans l'ensemble des territoires de la France d'Outremer, celui où l'effort le plus actif a été entrepris pour la sauvegarde de la flore et de la faune, dont la richesse en espèces endémiques est extraordinaire. Cette richesse, la grande île, fragment du vieux continent de Gondwana, la doit à un long passé géologique au cours duquel des connexions territoriales ont permis, à plusieurs reprises, au cours de l'ère secondaire et de l'ère tertiaire, des migrations floristiques et faunistiques à la faveur desquelles se sont superposés des éléments d'origines diverses, conservés ensuite grâce à l'isolement de cette vaste terre qui couvre environ 600,000 km.^{2} Un ensemble de preuves d'ordre principalement biogéographique conduit à placer au Miocène supérieur la dernière de ces connexions.

D'autre part, l'île offre toute une gamme de climats, conditionnés principalement par la disposition des reliefs qui font obstacle aux vents chargés d'humidité soufflant de l'Océan Indien pendant toute la saison fraîche (alizé de S-E.). Le versant oriental ne comporte pas de saison sèche bien marquée et le total annuel de pluies y est élevé (3 mètres et plus dans le N-E.). Sur les hauts plateaux et les montagnes qui les surmontent, parmi lesquelles plusieurs massifs dépassent largement 2,000 m. d'altitude (Tsaratanana, dans le Nord, culminant à 2,886 m.; Ankaratra, dans le Centre, 2,644 m.; Andringitra, dans le Sud-Est, 2,650 m.), la saison fraîche est entrecoupée de fines pluies et le degré hygrométrique est habituellement élevé. L'Ouest au contraire offre deux saisons fortement contrastées: la saison sèche y dure les six mois pendant lesquels l'alizé de S-E., s'étant déchargé de son humidité sur les hauts reliefs, s'échauffe en descendant vers les plaines occidentales; celles-ci reçoivent, par contre, en saison chaude, comme les hauts plateaux et les montagnes du Centre, des pluies orageuses abondantes dans leur partie Nord, de moins en moins copieuses en descendant vers le Sud. Dans le Nord-Ouest, le petit bassin du Sambirano jouit d'un climat spécial, très régulier, chaud et humide, sans saison sèche accusée, comme celui de l'Est, grâce aux reliefs élevés qui relaient en saison fraîche les vents humides de S-E. jusque sur la côte du canal de Mozambique et la petite île de Nossi-be. Le Sud-Ouest et l'extrême Sud sont des pays semi-arides (0 m. 40 à 0 m. 50 de pluies annuelles, sous forme d'averses irrégulières).

Les sols sont eux-mêmes variés, en raison à la fois de la structure géologique et de l'influence des climats sur la décomposition des roches-mères. Ces dernières sont principalement des roches cristallines, éruptives, métamorphiques ou volcaniques, se décomposant sous les climats humides (Est, Centre et Sambirano) en argiles latéritiques d'autant plus épaisses (plusieurs mètres, parfois 10 à 30 mètres) que le climat local est plus constamment pluvieux. Dans la plus grande partie de l'Ouest et dans une partie importante du Sud, se présentent des roches sédimentaires d'origine marine (du Permien au Tertiaire): schistes, grès, sables, calcaires, marnes, argiles, etc.

Les grandes aires de végétation se répartissent, comme toujours, en fonction des caractéristiques climatiques, et, à cet égard, l'île se subdivise en deux Régions. La *Région orientale* comprend l'ensemble des territoires soumis en saison fraîche à l'influence directe de l'alizé humide; elle se subdivise en trois Domaines: *Domaine de l'Est*, depuis le littoral oriental jusqu'aux environs de 800 m. d'altitude; *Domaine du Centre*, au-dessus de 800 m.; *Domaine du Sambirano*, au-dessous de 800 m. dans le bassin du fleuve de ce nom. La *Région occidentale* se subdivise en deux Domaines: *Domaine de l'Ouest et de l'extrême Nord*, au-dessous de 800 m. d'alt. jusqu'au littoral; *Domaine du Sud-Ouest*, suivant une bande de territoire peu profonde le long du littoral Sud-Ouest et Sud.

La composition de la flore et les aspects de la végétation diffèrent considérablement de l'une à l'autre de ces aires, si l'on considère la flore et la végétation *autochtones*. Celles-ci ont été détruites sur d'immenses surfaces par les indigènes, comme nous l'expliquons plus loin, et la végétation secondaire substituée à la végétation primitive contraste violemment avec celle-ci par la pauvreté de sa flore et la monotonie de ses aspects.

La végétation primitive, dans le *Domaine de l'Est et dans celui du Sambirano*, est essentiellement constituée par une haute forêt dense à feuillage persistant, forêt ombrophile (rain-forest) d'une extrême complexité, où les essences sont tellement intriquées qu'il n'y a pas d'espèces nettement dominantes. Les indigènes, d'origine mélanésienne, dont la présence à Madagascar ne remonte pas loin dans le passé (quelques millénaires) se sont attaqués à la forêt orientale par la hache et par le feu (abatage suivi d'incinération) en important la culture du "riz de montagne" et de quelques autres plantes vivrières (manioc, patate douce, bananier, etc.) suivant la méthode dite des "tavy" (semblable à celle des "rây" en Indochine), culture sans irrigation et par suite nécessairement extensive, en raison de l'épuisement rapide du sol. Ils ont déforesté à partir de la côte et, de proche en proche, le long des vallées et vallons les plus accessibles des pentes orientales qui s'élèvent à peu de distance de celle-ci, de sorte que c'est généralement vers le haut des mamelons et sur les versants escarpés que subsistent encore des restes de forêts plus ou moins étendues, dans ce domaine. Sous le climat habituellement humide qui le caractérise, une végétation secondaire envahissante se développe après la destruction de la forêt; les indigènes lui donnent le nom de "savoka" qui s'applique à divers types de peuplements, composés d'arbustes ou petits arbres ou encore de grandes monocotylédones herbacées, essences de lumière occupant solidement le terrain et formant une sorte de jungle qui pourrait, dans les conditions les plus favorables, faire retour à la forêt si l'homme n'intervenait pas de nouveau et s'il restait des parcelles boisées au voisinage. Mais, en fait, les savoka, dont le sol se dégrade facilement sur les pentes, sont à leur tour attaqués de temps en temps par les incendies et en règle générale c'est une évolution régressive que l'on constate: le savoka cède peu à peu le pas à des formations graminéennes et celles-ci transmettent aisément les incendies quand les chaumes sont secs; même sous le climat habituellement humide de l'Est, la prairie secondaire occupe une grande partie du terrain abandonné par la forêt d'abord et par les savoka ensuite. Il en est de même dans le domaine du Sambirano.

Dans le *Domaine du Centre*, les savoka occupent de bien moindres étendues; ils se présentent le plus souvent sous forme de peuplements buissonnants constitués en majeure partie d'Ericacées du genre *Philippia* accompagnées d'autres espèces héliophiles qui vivent normalement dans la végétation primitive sur les crètes et les escarpements ou dans les ravins interrompant le couvert continu de la forêt dense; ils se rencontrent surtout dans la partie orientale plus humide de ce domaine, ceinturant les lisières forestières en régression ou occupant l'emplacement de forêts récemment détruites. Les savoka de ce type brûlent facilement et à leur tour sont remplacés par la prairie secondaire d'herbes dures (*Aristida*, etc.) qui s'étend maintenant sur la presque totalité de ce domaine, où il devient très difficile de trouver encore des témoins de la forêt native, sauf sur quelques montagnes ou plateaux protégés par des escarpements ayant fait pare-feux. L'immense étendue de cette prairie du Centre a fait croire autrefois que c'était une steppe climatique. C'est là une grosse erreur aujourd'hui reconnue par tous les botanistes et les forestiers qui ont suivi son évolution: ce n'est qu'un "fire-climax"; les incendies y sont allumés chaque année par les indigènes pour provoquer le départ des jeunes feuilles de graminées en vue de la nourriture du bétail en saison sèche; mais ce procédé élimine peu à peu les espèces bonnes fourragères au profit des espèces les plus xérophiles et finit par ruiner les pâturages, dont le sol se décape et se durcit de plus en plus: l'argile latéritique mise à nu apparaît et donne au paysage cette teinte rouge ou ocre devenue caractéristique de ces contrées aujourd'hui presque entièrement dépouillées de leur couvert végétal primitif.

Celui-ci était constitué par une forêt toujours verte, moins puissante que celle de l'Est, très riche en épiphytes, à sous-bois formé d'espèces mésophiles à feuillage tendre avec une abondance remarquable de Muscinées, le passage de l'une à l'autre étant d'ailleurs trés ménagé. Mais sur les pentes occidentales de ce Domaine, plus sèches et plus lumineuses, où règne un climat de transition vers le climat de l'Ouest, c'était une forêt basse et claire très différente, formée de petits arbres sclérophylles, avec un riche sous-bois relativement xérophile et héliophile; facilement inflammable, elle a presque entièrement disparu. D'autre part, en altitude, à partir de

2,000 m. environ, la forêt du Centre passait à une végétation dense d'arbres tortueux et bas surchargés de Lichens épiphytes pendant aux branches et de Muscinées garnissant les troncs: cet étage forestier supérieur correspond au niveau le plus nébuleux et le plus humide des montagnes. Plus haut, il passe à des formations buissonnantes très riches en espéces spéciales, formant une sorte de maquis dense, difficilement pénétrable sauf sur les rochers escarpés où habitent de très nombreuses plantes basses particulières à ce genre de station. Chaque massif de montagnes possède des espèces qui lui sont propres, à aire par conséquent très réduite, en même temps que des espèces à aire fragmentée communes à l'ensemble ou à une portion des hauts reliefs.

Cette végétation des sommets ne craint pas la foudre, qui coïncide avec les grandes pluies, mais elle est très sensible aux incendies venus de la nappe graminéenne secondaire, lorsque celle-ci arrive à son contact après la fragmentation de la ceinture forestière de l'étage immédiatement inférieur. Aussi voit-on souvent des restes de cette dernière dans les vallonnements plus frais, où ils se maintiennent plus longtemps, ou au flanc des pentes, alors que les croupes des contreforts et les crêtes supérieures sont déjà dénudées et occupées par la prairie, si des obstacles rocheux n'ont pas arrêté les feux: l'aspect de ces juxtapositions est bien différent de celui qui s'offre dans l'Est. La prairie se substitue presque immédiatement à la forêt, sauf dans la partie orientale de ce domaine: les feux atteignent directement ses lisières et les font régresser lentement mais inexorablement; les formations éricoïdes des sommets peuvent même brûler en masse, par temps sec, lorsque le vent y pousse les flammes.

La végétation autochtone du *Domaine de l'Ouest et de l'extrême Nord* était constituée par des forêts variées composées d'essences à feuillage généralement caduc. Il en reste encore d'importantes étendues, principalement sur les plateaux calcaires et les sols sablonneux. Certaines d'entre elles, à basse altitude, offrent de splendides exemples de forêt tropophile (deciduous forest) de haute futaie. Dans ce Domaine, où les affleurements géologiques sont très variés, on peut constater de grandes différences de composition floristique et d'aspect dans les formations forestières primitives, en rapport avec la nature du sol: il y a là, sous un même climat, des "climax édaphiques" nettement différents.

La destruction de ces forêts, par "tavy" ou par "feux de brousse" venus de l'extérieur, amène l'extension de formations secondaires graminéennes souvent piquetées d'arbres ou d'arbustes appartenant à quelques espèces résistant aux feux, à racines profondes ou drageonnantes; parmi ces espèces, certaines ont un port caractéristique, tels quelques Palmiers des genres *Medemia, Hyphaene* et *Borassus*. Aussi ce domaine offre-t-il divers aspects de savanes, arborées ou non, que les feux parcourent annuellement; ceux-ci pénètrent parfois assez profondément dans l'intérieur du complexe forestier et en provoquent le recul. Sur les sols argileux ou marneux, et en général sur ceux où la prairie secondaire, haute et dense, alimente les incendies les plus violents, les végétaux ligneux sont souvent totalement éliminés.

Le *Domaine du Sud-Ouest,* le plus sec de l'île, est celui qui a conservé les plus grandes étendues de végétation intacte, parceque celle-ci, formée de petits arbres et arbustes en partie succulents (notamment de nombreuses Euphorbes arborescentes), brûle difficilement, à moins d'être abattue; mais comme, sous ce climat, les cultures ne sont guère possibles que sur des sols alluviaux riches, les "tavy" ne sont que rarement pratiqués. Les formations graminéennes, sur sols habituellement rocailleux ou sablonneux, sont maigres, les feux sont par conséquent peu puissants et s'arrêtent aux lisières du complexe végétal primitif.

La destruction généralisée du couvert végétal à Madagascar a eu d'immenses conséquences: décapage des terres meubles, qui entraînées par les grandes pluies de la saison chaude viennent finalement se perdre en grande partie à la mer qu'elles rougissent jusqu'à plusieurs milles de l'embouchure des fleuves; ravinement des pentes, instauration d'un nouveau cycle d'érosion aux contours heurtés, aggravation du régime torrentiel avec ses suites désastreuses. Tels sont les résultats des méthodes pratiquées par l'indigène pour étendre sans effort cultures et pâturages par l'usage généralisé des incendies qui parcourent la majeure partie de l'île pendant la saison sèche.

On conçoit dès lors quelles difficultés se présentent aux promoteurs d'une oeuvre de protection de la nature destinée à sauver pendant qu'il en est encore temps des surfaces aussi importantes et diverses que possible de la merveilleuse végétation native, tant dans un but scientifique de conservation des innombrables espèces végétales et animales constituant les "biocénoses" primitives, que dans un but économique.

Le but scientifique a été plus spécialement visé par l'adoption de la formule des "Réserves naturelles intégrales" dont la définition a été proposée par les délégués français à la conférence internationale pour la Protection de la Faune et de la Flore en Afrique réunie à Londres en 1933. Cette définition, différente de celle des "Parcs Nationaux" adoptée à la même Conférence, est la suivante:

Réserves naturelles intégrales. — "L'expression *Réserve Naturelle intégrale* désignera une aire placée sous le contrôle public et sur toute l'étendue de laquelle toute espèce de chasse ou de pêche, toute exploitation forestière, agricole ou minière, toutes fouilles ou prospections, sondages, terrassements ou constructions, tous travaux tendant à modifier l'aspect du terrain ou de la végétation, tout acte de nature à nuire ou à apporter des perturbations à la faune ou à la flore, toute introduction d'espèces zoologiques ou botaniques, soit indigènes, soit importées, sauvages ou domestiquées, seront strictement interdits; où il sera défendu de pénétrer, de circuler, ou de camper sans autorisation spéciale écrite des autorités compétentes; et dans laquelle les recherches scientifiques ne pourront être effectuées qu'avec la permission de ces autorités."[1]

[1] Voici, à titre de comparaison, la définition des Parcs Nationaux telle que l'a établie cette même Conférence.

Parcs Nationaux. — "L'expression *Parc National* désignera une aire placée sous le

Dès 1927, un décret du 31 décembre paru au Journal Officiel de la République Française avait institué à Madagascar 10 Réserves naturelles intégrales distribuées dans chacun des Domaines définis plus haut et aux divers étages altitudinaux; une onzième fut créée par décret du 11 juin 1939. En voici l'énumération avec le no. de la réserve, la province où elle est située, la surface, et le type de végétation qu'elle représente:

RÉSERVES NATURELLES INTÉGRALES DE MADAGASCAR

R.N.No. 1 — Betampona (province de Tamatave), 1,632 hectares. — Forêt ombrophile.

R.N.No. 2 — Cap Masoala (province de Maroantsetsa), 29,977 hect. — Forêt ombrophile.

R.N.No. 3 — Zakamena (province de Moramanga), 66,410 hect. — Forêt ombrophile.

R.N.No. 4 — Tsaratanana (province de Nossi-bé), 59,280 hect. — Forêt ombrophile et étages supérieurs de végétation.

R.N.No. 5 — Andringitra (province de Fianarantsoa), 30,100 hect. — Forêt ombrophile et étages supérieurs de végétation.

R.N.No. 6 — Lokobe (province de Nossi-bé), 1,160 hect. — Forêt ombrophile à basse altitude.

R.N.No. 7 — Ankarafantsy (province de Majunga), 67,000 hect. — Forêt tropophile sur sables siliceux.

R.N.No. 8 — Tsingy de Namoroka (province de Majunga), 5,900 hect. — Forêt tropophile sur calcaire.

R.N.No. 9 — Tsingy de Bemaraha ou Antsingy (province de Maintirano), 83,600 hect. — Forêt tropophile sur calcaire.

R.N.No. 10 — Bush du plateau Mahafaly et lac Manampetsa (province de Tuléar), 17,520 hect. — Bush xérophile sur calcaire et sables.

R.N.No. 11 — Massif d'Andohahela ou Rocher Carré (province de Fort-Dauphin), 30,000 hect. — Divers étages de végétation, de 300 à 1,975 m. alt.; versant oriental et versant occidental très contrastés: forêts ombrophiles, végétation buissonnante des crêtes, forêts tropophiles, bush xérophile, etc.

contrôle public, dont les limites ne seront pas changées et dont aucune partie ne sera capable d'être transférée sauf par l'autorité législative compétente, mise à part pour la propagation, la protection et la conservation de la vie animale sauvage et de la végétation sauvage, et pour la conservation d'objets d'intérêt esthétique, géologique, préhistorique, historique, archéologique, et d'autres intérêts scientifiques, au profit, à l'avantage et pour la récréation du public général, dans laquelle la chasse, l'abatage ou la capture de la faune et la destruction ou la collection de la flore est interdite sauf par l'entreprise ou sous la direction ou le contrôle des autorités du parc."

Il est à noter que ces deux définitions ne s'excluent pas l'une l'autre, une ou plusieurs Réserves naturelles intégrales pouvant être incluses dans un Parc National.

Les divers types de végétation sont représentés de la façon suivante:

Domaine de l'Est: Réserves naturelles intégrales nos. 1, 2, 3 (partie), 11 (partie).

Domaine de Sambirano: R.N.I. no. 6.

Domaine du Centre: R.N.I. no. 3 (partie), 4, 5, 11 (partie).

Domaine de l'Ouest: R.N.I. nos. 7, 8, 9, 11 (partie).

Domaine du Sud-Ouest: R.N.I. nos. 10, 11 (partie).

Ces Réserves sont gérées et surveillées par un service spécial rattaché à celui des Forêts et à la tête duquel se trouve un Officier forestier, conservateur des Réserves naturelles. Elles ont été délimitées et immatriculées au nom de l'Etat français. Leurs limites ont été choisies autant que possible en suivant des lignes de protection naturelle (cours d'eau, escarpements,

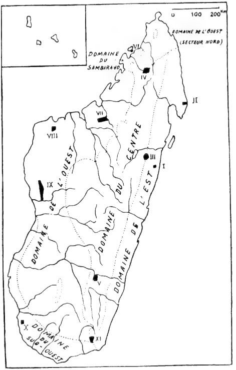

Fig. 1. Réserves naturelles intégrales de Madagascar. Les limites des Domaines de Végétation sont indiquées par le pointillé.

etc.) et, partout où il est nécessaire, des lignes de protection artificielle contre les feux de brousse (pare-feux, etc.) ont été prévues, et établies par ordre d'urgence. Des zones intermédiaires de protection (périmètres de reboisement, etc.) ont été ménagées sur certaines parties de leurs pourtours. Leur bornage, jalonnant des pistes qui matérialisent leurs limites, a été également entrepris, mais la guerre a interrompu ces travaux. Ces Réserves naturelles intégrales, choisies dans des territoires inhabités, représentent la nature primitive intacte.

Il est à peine besoin d'indiquer ici que la prééminence donnée au but scientifique dans la conception de ces Réserves naturelles intégrales n'exclut aucunement l'intérêt d'ordre économique, bien au contraire. Elles sont en effet destinées à la conservation, dans leur milieu naturel, des milliers d'espèces propres à Madagascar, et il n'est pas douteux qu'un grand nombre de ces espèces est susceptible d'utilisations de tout ordre. Elles constituent donc les plus précieuses réserves de porte-graines qu'il soit possible de conserver en vue de futures cultures, ou de reboisements, etc. Mais, et c'est là une différence capitale avec les Réserves forestières ordinaires, elles ne sont pas des Réserves d'exploitation. Par ailleurs, elles permettront les observations les plus fructueuses sur l'évolution naturelle des peuplements végétaux autochtones. Enfin elles protègent contre l'érosion et ses conséquences des surfaces importantes de territoires dont plusieurs sont des massifs montagneux dont la déforestation totale serait désastreuse par les répercussions qu'elle aurait sur le régime des eaux et même sur le climat des contrées environnantes.

Récemment, deux décrets parus au Journal Officiel de la République Française (1945, no. 143) fixent les conditions de réglementation de la protection de la nature dans les territoires relevant du Ministère des Colonies (décret no. 45–1344 du 18 juin 1945) et instituent un Conseil Supérieur de la Protection de la Nature aux Colonies (décret no. 45–1347, même date), qui remplace un Comité préexistant.

D'autre part, un grand nombre de stations naturelles est soumis également à une protection spéciale instaurée par le décret du 25 août 1937 relatif à la Protection des monuments naturels et des sites de caractère historique, scientifique, légendaire ou pittoresque des colonies, pays de protectorat et territoires sous mandat relevant du Ministère des Colonies. Sous cette désignation sont compris notamment d'intéressants témoins de végétation native, qui pour diverses raisons (généralement leur faible étendue) ne pouvaient constituer des Réserves naturelles intégrales. Des grottes, des gisements fossilifères, etc. sont aussi visés par ce texte.

Il n' a pas été créé jusqu'ici à Madagascar de Parcs nationaux ouverts au tourisme, mais cette création n'est nullement exclue: par exemple, la belle forêt de la montagne d'Ambre près de Diégo-Suarez, déjà pourvue de routes, offrant de très beaux sites (cratères-lacs), s'y prête parfaitement.

Quant à l'ensemble du domaine forestier, au sens le plus large, en dehors des territoires spécialement protégés suivant les formules précédentes, il est soumis au contrôle du service des Forêts. Le régime des "tavy" et les exploitations abusives sont interdits, mais, en fait, les tavy sont encore trop souvent pratiqués clandestinement dans les territoires d'accès difficile où la surveillance est sporadique.

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EXPLICATION DES PLANCHES

PLANCHE I

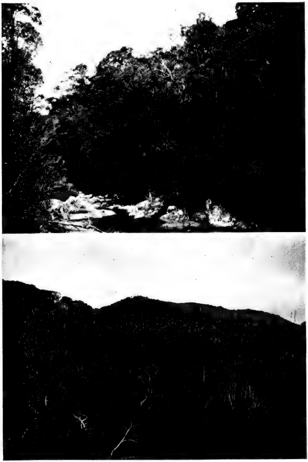
En haut: Forêt ombrophile. Vallée de la Rienana, vers 1,000 m. alt. (H. H., 1924).
En bas: Forêt ombrophile. Massif du Beampingaratra, vers 1,000–1,400 m. alt. (H. H., 1928).

PLANCHE II

En haut: Forêt des crêtes. Massif du Kalambatitra, sommet de Beanjavidy, vers 1,700 m. alt. (H. H., 1933).
En bas: Végétation éricoïde des sommets: *Philippia* arborescents couverts d'épiphytes. Massif du Tsaratanana, vers 2,750 m. alt. (H. H., 1937).

PLANCHE III

En haut: Forêt basse sclérophylle des pentes occidentales, vers 1,000 m. alt. Vallée de la Manambolo, affluent du Mandrare. (H. H., 1934).
En bas: Forêt tropophile de haute futaie à basse altitude, dans l'Ouest. Environs de Morondava. En avant *Adansonia Za* Baill. (en saison sèche) (H. H., 1933).



LA PROTECTION DE LA NATURE À MADAGASCAR

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PLANCHE IV

En haut: Forêt xérophile, faciès de transition entre la forêt de l'Ouest et le bush de l'extrême Sud, vers 200 m. alt. Vallée moyenne du Mandrare, *Adansonia Za* Baill. (en saison des pluies), *Alluaudia procera* Drake (arbre céréiforme) (H. H., 1933).

En bas: Bush xérophile sur le plateau calcaire Mahafaly, vers 150 m. alt. Euphorbes arborescents de la section *Tirucalli*, etc. (H. H., 1928).

PLANCHE V

En haut: Prairie secondaire du Centre substituée par le régime des feux à la forêt du type représenté pl. 1, en bas. Haut Itomampy. (H. H., 1928).

En bas: Savane secondaire à *Hyphaene Schatan* Boj. substituée par le régime des feux à la forêt tropophile de l'Ouest. Environs d'Ambilobé (secteur Nord) (H. H., 1937).

MUSÉUM NATIONAL D'HISTOIRE NATURELLE,
PARIS.

A REPORT ON THE GROWTH OF EXCISED TOMATO ROOTS

WILLIAM J. ROBBINS

With one plate

IT WAS found by Robbins and Schmidt (5, 6, 7) that a solution of mineral salts, cane sugar and thiamine (or the vitamin thiazole, 4-methyl-5β-hydroxyethyl thiazole) appeared adequate for the unlimited growth of excised tomato roots. The first report (5, 7) covered 12 successive passages extending over a period of one year in a solution of mineral salts, cane sugar and synthetic thiamine and seven successive passages in a period of seven months in the same solution with thiazole substituted for thiamine. The second report (10) was made at the end of 29 passages in the thiamine solutions and 23 in those containing thiazole. We have now maintained this strain of roots through 125 passages for a period of ten years and ten months since the roots were severed from the original seedlings on September 29, 1935. The clones have been grown for 112 successive passages in a solution of mineral salts, cane sugar and thiamine and for 105 successive passages in a solution of mineral salts, cane sugar and thiazole.

These experiments are of interest because of the extended period of culture. Some additional observations have been made on this strain of roots, which are also recorded here.

CONDITIONS OF CULTURE

The excised roots were grown individually in 50 ml. of solution in 125 ml. Erlenmeyer flasks of Pyrex glass. The mineral salts were of C. P. grade; the cane sugar, Pfanstiehl's C. P. sucrose; the thiamine, Merck's synthetic. The 4-methyl-5β-hydroxyethyl thiazole was obtained through the courtesy of Merck & Co. It was free from vitamin pyrimidine as determined by tests with *Phycomyces blakesleeanus*. This is an important consideration, as we have had samples of thiazole contaminated with pyrimidine and others have reported to us similar difficulties. All glassware was cleaned with sulfuric-chromic acid cleaning mixture and thoroughly rinsed with tap and distilled water. A comparison of the growth of excised tomato roots in glassware cleaned with sulfuric-chromic acid cleaning mixture and in glassware cleaned with concentrated hydrochloric acid showed no differences. We concluded that the residual effects of chromium (3) were not important in these experiments.

For the last several years the roots have been cultivated in a modified Pfeffer's solution plus one per cent cane sugar and 10 mμ moles of thiamine or of thiazole per flask. The modified Pfeffer's solution was prepared by diluting stock solutions of the various salts. Our procedure was as follows: The stock solutions consisted of

I.	$Ca(NO_3)_2.4\ H_2O$	83.25 g.
	$Fe_2(SO_4)_3$	0.565 g.
	Distilled water	500 ml.
II.	KCl	20.8 g.
	KNO_3	41.6 g.
	KH_2PO_4	41.6 g.
	$MgSO_4.7H_2O$	41.6 g.
	Distilled water	500 ml.
III.	H_3BO_3	2.86 g.
	$MnSO_4.4H_2O$	2.04 g.
	or	
	$MnCl_2.4H_2O$	1.81 g.
	$ZnSO_4.7H_2O$	0.22 g.
	$CuSO_4.5H_2O$	0.08 g.
	$H_2MoO_4.H_2O$	0.09 g.
	Distilled water	1000 ml.

Two ml. of stock solution I, 1 ml. of II and 0.1 ml. of III were added to 1000 ml. of distilled water.

The final solution contained per liter 333 mg. $Ca(NO_3)_2 \cdot 4H_2O$, 41.6 mg. KCl, 83.2 mg. KNO_3, 83.2 mg. KH_2PO_4, 83.2 mg. $MgSO_4 \cdot 7H_2O$, 2.26 mg. $Fe_2(SO_4)_3$, 0.286 mg. H_3BO_3, 0.181 mg. $MnCl_2 \cdot 4H_2O$, 0.022 mg. $ZnSO_4 \cdot 7H_2O$, 0.008 mg. $CuSO_4 \cdot 5H_2O$, 0.009 mg. $H_2MoO_4 \cdot H_2O$. The approximate amounts of the supplemental mineral elements in parts per million in this solution were 0.32 Fe, 0.05 B, 0.05 Mn, 0.005 Zn, 0.002 Cu and 0.005 Mo.

The iron precipitated in stock solution I but by shaking satisfactory aliquots could be obtained. The other stock solutions remained clear and without precipitate.

The amount of sugar was found to be quite important. One per cent sugar was much superior to the two per cent used in the early passages (Pl. I, upper). The growth of replicate cultures was more uniform; the individual roots were more normal in appearance and showed less browning.

The modified Pfeffer's solution containing cane sugar can be autoclaved at 12 pounds pressure for 20 minutes with no deleterious effects as far as the growth of the tomato roots is concerned and with minor inversion of the cane sugar.

Transfers to fresh culture media were made at approximately monthly intervals. A portion, about 0.5 cm. square of a safety razor blade spot-welded on an iron wire held in a Rosenberger and Greenman needle holder was used to cut the roots into pieces. The pieces of root were one or two cm. long and included the primary root tip or one or more branch tips. The pieces were transferred to fresh culture media by a platinum wire bent into an L at the tip. This was found to be more convenient than a straight wire or one with a loop on the end.

For some years the roots were incubated in faint diffuse light at 25°C. Since the incubator was not equipped to run at temperatures below room temperature there were periods during the summer months when the incubator temperature exceeded 25°, rising to as much as 30° for part of some days. Some difficulty was experienced at times in maintaining the thiazole cultures. This we suspect may have been caused by the higher temperatures of the summer months. Our cultures are now being maintained at 20° in the dark. They are exposed to light occasionally for short periods when observations are made.

Growth has been measured by dry weights usually at the end of two months' growth. The roots were washed with distilled water, placed in weighed aluminum pans, dried at 100°C., cooled and weighed. The results for passages 84 to 96 inclusive are given in TABLE 1. The average

TABLE 1.

Growth of excised tomato roots in modified Pfeffer's solution, 1 per cent cane sugar and 10 $m\mu$ moles of thiamine or thiazole through 13 successive passages.

Date	Passage	Supplement	No. Roots Weighed	Dry Wt. per root mg.	Range Dry Wt. mg.
10/7/42 to	84	Thiamine	20	6.5	4.9– 9.8
12/10/42		Thiazole	5	7.8	5.1–10.0
11/9/42 to	85	Thiamine	18	9.5	6.2–15.2
1/8/43		Thiazole	23	5.7	1.5–10.4
....	86	No weights taken			
1/12/43 to	87	Thiamine	49	10.5	5.0–16.1
3/24/43		Thiazole	31	6.0	1.0–11.7
2/11/43 to	88	Thiamine	3	8.6	6.0–13.4
4/16/43		Thiazole	12	5.6	2.3– 8.7
3/12/43 to	89	Thiamine	6	9.8	8.1–12.3
5/13/43		Thiazole	23	7.7	4.6–10.7
4/13/43 to	90	Thiamine	19	9.4	6.8–12.0
6/12/43		Thiazole	25	9.9	0.9–15.1
5/11/43 to	91	Thiamine	2	9.8	....
7/19/43		Thiazole	23	12.0	....
6/10/43 to	92	Thiamine	24	7.8	....
8/10/43		Thiazole	24	12.9	....
7/6/43 to	93	Thiamine	3	8.8	....
9/9/43		Thiazole	22	13.8	....
8/4/43 to	94	Thiamine	14	13.8	....
10/11/43		Thiazole	25	13.2	....
9/6/43 to	95	Thiamine	21	9.2	....
11/9/43		Thiazole	12	16.2	....
10/6/43 to	96	Thiamine	23	13.4	....
12/10/43		Thiazole	24	8.8	....

dry weights of the roots varied somewhat from passage to passage. In the 12 passages given the lowest average dry weight in the thiamine solutions was 6.5 mg. and the highest 13.3 mg.; for the thiazole solutions these figures were 5.6 mg. and 16.2 mg.

RELATION TO VITAMINS

Robbins and Schmidt demonstrated by the use of *Phycomyces blakesleeanus* that this strain of tomato roots synthesizes the pyrimidine portion of thiamine or a substitute therefor. This accounts for the ability of these roots to grow indefinitely in a medium supplemented with the vitamin thiazole only.

Reid and Robbins (2) found the excised roots grown in a thiamine solution produced ascorbic acid.

I have found the roots to synthesize biotin and pyridoxine in solutions supplemented with thiamine or thiazole. This was demonstrated as follows:

Roots which had grown 57 days in the thiamine solution in passage 73 were immersed in a medium containing per liter 1.5 g. KH_2PO_4, 0.5 g. $MgSO_4 \cdot 7H_2O$, 50 g. dextrose, 2.0 g. asparagine and 1.5 per cent purified agar. Zero, one or three roots were added per tube containing 8 ml. of the agar medium. The average dry weight per root was 6.8 mg. After sterilization one set of tubes was inoculated with *Ceratostomella ulmi* and another with *Ceratostomella ips* #438; *C. ulmi* has a complete deficiency for pyridoxine and *C. ips* #438 for biotin (4). The only source of vitamins in the medium was the tomato roots. The growth of *C. ulmi* demonstrated the presence of pyridoxine or a substitute for it and that of *C. ips* #438 the presence of biotin (Pl. I, lower).

A similar experiment performed with roots grown in a thiazole solution showed the synthesis of biotin and pyridoxine in that medium also.

The demonstration that these tomato roots synthesize pyridoxine in a solution of mineral salts, cane sugar and thiamine or thiazole explains their ability to grow in a solution containing no pyridoxine. They require pyridoxine and in its absence from the medium synthesize enough for some growth though not enough for maximum growth.

Our determinations of pyridoxine in excised tomato roots were not quantitative. However, it is reasonable to suppose that the marked improvement in growth noted (8, 9) when pyridoxine is added to the thiamine medium is because the amount of pyridoxine synthesized by the roots is inadequate. In the thiamine solution growth is limited by the amount of pyridoxine synthesized and the addition of the latter vitamin to the medium permits more growth to occur.

Pyridoxine, Pyridoxal and Pyridoxamine. Snell (11) found that pyridoxal and pyridoxamine were as effective for some organisms as pyridoxine and in some instances were considerably more so. For the strain of tomato roots discussed in this paper pyridoxal and pyridoxine were equally effective under the conditions of our experiments. Pyridoxamine may be somewhat less active since as much dry weight was found with 10 mμ moles of the first two compounds as with 50 mμ moles of pyridoxamine. The difference, however, is not great and is not of the same order of magnitude as found by Snell (11) for some organisms, for example, *Lactobacillus casei* and

Streptococcus lactis R. Our excised tomato roots are apparently able to convert these compounds into the functional one whatever that may be.

In the experiments summarized in TABLE 2 the pyridoxal and pyridoxamine were filtered sterile and added to the balance of the solution after it

TABLE 2.

Dry weights of excised tomato roots grown two months in 50 ml. of modified Pfeffer's solution containing one per cent cane sugar, 10 mμ moles of thiamine and the amounts of pyridoxine, pyridoxamine or pyridoxal given in the table.

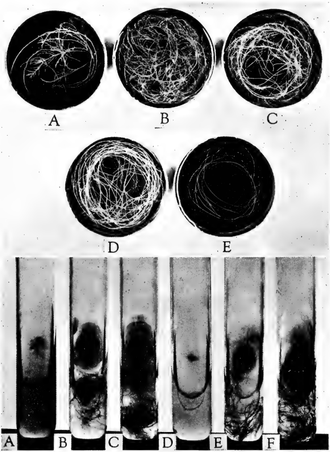
Supplement in mμ moles	Pyridoxine			Pyridoxamine			Pyridoxal		
	No. Roots	Av. dry wt. mg.	Range mg.	No. Roots	Av. dry wt. mg.	Range mg.	No. Roots	Av. dry wt. mg.	Range mg.
100	9	27.2	22.2–29.3	9	27.9	24.9–30.9	10	28.5	26.1–29.8
50	10	24.8	18.4–28.5	9	24.3	19.7–27.3	10	26.0	22.6–29.4
10	9	25.5	21.3–29.7	10	17.1	15.1–19.9	7	24.2	22.6–28.3
1	10	14.5	11.2–20.4	7	12.7	10.7–14.6	9	14.7	12.0–17.1
0.1	8	13.0	11.1–14.5	10	13.5	10.6–16.1	9	15.2	8.4–18.3
0.0	9	14.3	12.4–17.7	9	14.3	12.4–17.7	9	14.3	12.4–17.7

had been autoclaved. The inoculum came from roots grown 24 days in a thiamine solution in passage 107. The roots were incubated in faint diffuse light.

We might expect considerable destruction of these compounds in diffuse light in a period of two months on the basis of the findings of Cunningham and Snell (1). Although it would be desirable to repeat our experiments with roots grown in the dark, we doubt whether our conclusions on the relative effectiveness of the three compounds would be changed. We have been unable to detect a difference in the dry weights of excised tomato roots grown two months side by side in the dark and in the light in solutions containing thiamine or thiamine and pyridoxine.

During this extended period of culture (more than 100 passages) we have observed no evidence that the roots have changed genetically. They appear to be growing now about as they did in 1939 or earlier. Neither has there been any sign of the production of shoots, although we would expect shoot production to be within their genetic potentialities.

We have produced individual roots with dry weights of 200 mg. or more. These were grown 106 days at room temperature in diffuse light in liter flasks containing 100 ml. of the modified Pfeffer's solution and one per cent cane sugar plus 30 mμ moles of thiamine and 166 mμ moles of pyridoxine. In a period of two months in 50 ml. of solution supplemented with 10 mμ moles of thiamine and 50 mμ moles of pyridoxine the maximum



Growth of excised tomato roots

weights range between 35.0 and 40.0 mg. In thiamine-pyridoxine solutions increases in length averaging 2 cm. per day for a period of two months have been observed, resulting in roots with a total length of 120 cm.

SUMMARY

A report is made on the cultivation of excised tomato roots in a synthetic solution of mineral salts, cane sugar and thiamine or thiazole through more than 100 passages extending over nearly eleven years. The cultural conditions are detailed and the relation of the roots to vitamins is discussed.

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EXPLANATION OF THE PLATE

(Upper) Excised roots grown 60 days in diffuse light at 25° in 50 ml. of modified Pfeffer's solution containing 10 mμ moles of thiamine and 50 mμ moles of pyridoxine plus A, 2 per cent cane sugar; B, 1.5 per cent; C, 1.0 per cent; D, 0.5 per cent and E, 0.1 per cent.

(Lower) Growth of *Ceratostomella ulmi* (A, B, C) and *Ceratostomella ips* #438 (D, E, F) in media containing tomato roots. A, no root; B, one tomato root; C, 3 tomato roots; D, no root; E, one root; F, 3 roots.

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THE ARNOLD ARBORETUM DURING THE FISCAL YEAR ENDED JUNE 30, 1946

1935 — 1946

THIS is my final report as Director of the Arnold Arboretum. My resignation was presented in June, but too late to be acted upon before the end of the fiscal year.* While I retain my academic title as Arnold Professor of Botany, Harvard University, for the next two years, and will continue to work at the Arboretum, I will have no further administrative responsibilities. As a matter of record I attain the age of 70 in October of the present year, and will become *emeritus* at the end of June, 1948.

Under the reorganization plans as outlined in the Bailey report which was officially approved March 1, 1946, the position of Administrator of Botanical Collections was officially terminated, and I was relieved of all responsibilities effective at the end of June, 1946. The projected reorganization of the very complex botanical situation at Harvard University involves a much closer affiliation of the nine separately endowed units in botany with the Department of Biology of the University, and a closer coördination of their work with that of the Department, both in teaching and in research. The new plan provides for a Biological Council under which will function two chairmen, one in charge of the Institute for Research in General Plant Morphology, the other in charge of the Institute for Research in Experimental and Applied Botany.

Thus in the case of the Arnold Arboretum, the largest and most complex of the nine separately endowed institutions concerned, all of its inside activities, such as the herbarium, library, and certain types of laboratory work, will fall under the purview of one chairman, while all matters appertaining to the maintenance of its grounds and plantings, and those phases of research that deal with the living plants, will fall under another chairman; and its general policies, research, publications, and teaching program will be developed and supervised by the chairmen and the Council. An executive officer will be designated to handle normal current affairs of the institution. This is indeed a very radical change.

Furthermore, the approved plan involves the construction of a major building in Cambridge designed to house all of the library and herbarium activities of the Gray Herbarium, the Farlow Herbarium, and the Arnold Arboretum, which means within the course of a few years the transfer of practically all of the inside staff of the Arboretum to Cambridge, and a corresponding reduction in the amount of work now prosecuted in Jamaica Plain. This move will clearly very greatly simplify what is a very complex situation, greatly reduce duplication and even triplication of effort and expense in certain fields, and will make the unique library-herbarium facili-

* On July 15, 1946, my resignation was accepted effective July 31, 1946.

ties of Harvard University much more accessible to all staff members and to graduate students than is now the case with three geographically separated units in the same general field. This matter has been discussed in previous reports. It will, however, very greatly reduce the Arnold Arboretum operations in Jamaica Plain, for there, in the future, will be prosecuted only those phases of its activities that appertain to living plants. These activities may, of course, be amplified in the course of time.

In my term of service as Director of the Arnold Arboretum since the latter part of 1935, an attempt has been made to maintain and to increase its prestige, not only as a local institution catering to the general public, but also as a national and international one in the research and publication fields. As funds became available there was no hesitation in amplifying its field of operations both at home and abroad. Thus its field work in China was greatly extended, and activities were initiated in India, Indo-China, Burma, Siam, Malay Peninsula, Philippines, Java, other parts of the Malayan region, Papuasia, Australia, New Caledonia, various parts of Mexico, Central America, South America, the West Indies, and even parts of Africa. In selecting areas outside of China, careful attention was given to those regions from which it was clearly evident that the institutional reference collections should be increased. These extensive operations were for the most part financed by grants made to competent and dependable residents of the regions involved, and the results have been outstandingly successful. Field work on the part of staff members of the institution has been financed from regular institutional funds, or through special grants secured from this or that foundation, in Canada, various parts of the United States, Mexico, Central America, and the West Indies. Thus in a decade the herbarium has been increased, in part by exchange of duplicates, in part through actual purchase of material, but largely through its own field efforts by more than 220,000 mounted sheets. Very extensive exchange credits have been established with botanical institutions in all parts of the world through the actual distribution of sets of duplicate specimens acquired through these various field operations. Within Harvard University, because of the vast accessions of material received through its sponsored field work, in excess of 130,000 specimens have been transferred to: the Gray Herbarium (123,000), Farlow Herbarium (2,470), and the Ames Orchid Herbarium, Botanical Museum (4,800), while in excess of 6,400 illustrations of plants with accompanying descriptions have been transferred to the three units mentioned. All of this was from currently received material outside of the field covered by the Arboretum, namely herbaceous plants, ferns and cellular cryptograms.

Efforts were made also to increase the already extraordinary library holdings of the institution, and by certain staff additions, more extensively to utilize the vast amount of published data therein available. Furthermore, the publication field was amplified, the technical Journal increased in size, and various and sometimes very extensive special publications were sponsored, even when it became necessary to seek financial aid outside of the regular budgetary income of the institution. Two of the older serial titles were dropped in favor of shorter and more concise ones in Arnoldia, to replace the Bulletin of Popular Information, and Sargentia, to replace the Contributions from the Arnold Arboretum; the new names, incidentally, commemorate James Arnold (1781–1868), whose initial modest bequest made the establishment of the institution possible, and Charles Sprague Sargent (1841–1927), who actually developed it and initiated its policies on a broad base.

In maintaining the Arnold Arboretum, as to its grounds and plantings, Harvard University is most efficiently serving the public of the Boston Metropolitan area. This is proved by the enormous number of casual visitors that inspect its grounds and plantings each year. While we do not have even an approximation of the total number of annual visitors, close estimates made on certain days in the spring flowering season, from late April to early June, indicate that on occasion there may be in excess of 50,000 visitors in a single day. This is free service to the public and incidentally a very greatly appreciated service. This is, however, but a part of its local service, for as an institution it operates as a free source of information to the interested public on matters associated with plants, plant problems, and plant names. In addition to this local service a continuous effort has been made to make the institution not only more and more a national one, but also more and more international as well, in line with the general policies of Harvard University.

From a national standpoint the Arboretum not only attracts visitors from all over the country, but also from foreign lands as well. Its information service extends to all parts of the country to professional horticulturists and botanists, and to amateurs. For many decades it has served the extensive nursery interests of this and of foreign countries as well, by making available living plants, cuttings, and seeds from its more striking or interesting introductions. Throughout its history it has maintained a very high place among botanical institutions both at home and abroad, in financing its own exploring expeditions to various parts of the world with a view to introducing into cultivation new plants of potential economic or horticultural interest; and in this field it has been outstandingly successful. It has been one of our objectives during the past decade to maintain and to increase this service.

From an international standpoint the position of the Arboretum has always been clear. It has greatly increased the store of cultivated woody plants in Europe and in Great Britain, as it has within the United States. It has coöperated with foreign institutions very fully in the interchange of reference material, living plants, seeds, publications, and general information. In the past decade many of these activities have been increased, some rather radically. At the same time it has played its part in the training of graduate students, both citizens of the United States and of foreign countries, who have elected to major in this or that field covered by the Arboretum.

The material resources of the institution have been very considerably increased in the past decade. This applies not only to its library holdings and its collections of reference material, photographs, and records, but also to the financial field as well. Its chief source of support is the income from its own restricted endowment, and in the past decade this endowment has been increased by approximately $321,500.00, in spite of the 10% write-down of its capital in 1936 to offset the 10% write-up in 1930. As a matter of record the actual additions to capital received in the year just closed approximate $365,000.00, with considerable additions to be received in the coming year under the provisions of certain wills now in probate. In addition to this increase in its endowment funds, a total of about $112,000.00 has been received within the decade in the form of gifts for immediate expenditure, mostly unrestricted, but in some cases restricted, to use for such purposes as fellowships, scholarships, special-travel, exploration, or publication. This amount does not include certain special grants, the total a distinctly considerable sum, that were received from such sources as the Milton-Clark fund and various other endowments for the support of this or that research project carried on by various staff members; nor does it include special grants made to support field work, such as the two seasons operations on the Alaska Military Highway.

When one considers that the decade 1935–46 covered the last half of a long continued financial depression which actually ceased only after the most destructive war of modern times was initiated, the financial record must be considered as at least satisfactory. It was from the gifts for immediate expenditure that much of the expansion activities were financed in the past decade, for the normal income in general sufficed only to take care of obligated charges.

As this report coincides with the end of an era it has been deemed pertinent to include here the following summary of the present endowment of the Arboretum, showing how it has been built up by gifts and by bequests from the modest initial sum of $99,223.21 in 1872 to its present impressive total of $3,215,983.69.

Arnold Arboretum Endowment Funds

Arboretum Construction Gifts (balance)	$91,223.21
Arnold Arboretum (1899)	125,650.00
Arnold Arboretum Endowment (1917)	431,661.64
Arnold, James (1872)	176,945.34[a]
Billings, Robert Charles (1904)	13,500.00
Bradley, William L. (1897)	21,040.00
Burr, Lucy Williams (1925)	47,051.78
Bussey Fund for the Arboretum (1903)	2,308.06

[a] The initial fund in 1872 was $99,335.48, but under the terms of indenture 5% of the income is added to capital each year.

Case, James Brown (1942)	50,000.00[b]
Case, Laura Lucretia (1925)	24,999.96
Case, Marian Roby (1945–46)	365,137.09[b]
Collamore, Helen (1916)	2,525.00
Cowell, Helen E. (1932)	50,000.00
Cowell, Mr. & Mrs. Henry (1932)	50,000.00
Crocker, Annie Bliss (1930)	5,000.00
Edwards, Grace M. (1939)	25,355.56
Estabrook, Arthur F. (1923)	5,000.00
Estabrook, Ida F. (1925)	5,285.00
Evans, Maria Antoinette (1919)	22,240.76
Hutchinson, C. L. (1932)	29,518.60
Jewett, James R. (1940)	5,000.00
Judd, William H. (1946)	2,832.50
Loring, William Caleb (1930)	25,000.00
Mass. Soc. Promoting Agriculture (1911)	13,375.00
Phillips, Anna T. (1925)	5,000.00
Pratt, Harriet B.	5,000.00
Richards, Anna M. (1931)	423,057.22
Sargent, Charles Sprague (1928)	21,613.47[c]
Sargent, Charles Sprague (1928)	20,083.17
Sargent, Charles Sprague Memorial (1926)	1,048,489.26
Sargent, Mary Robeson (1919)	8,309.37
Shaw, Isabella P. (1925)	8,644.55
Skinner, Francis (1906)	20,000.00
Skinner, Francis, Jr. (1915)	10,000.00
Thayer, Bayard and Ruth S. (1911)	25,042.75
Weld, Stephen M. (1917)	25,000.00
Whitney, Edward (1912)	2,881.97
Williams, Adelia C. (1927)	1,000.00
TOTAL	$3,215,983.69

[b] Does not include the value of extensive real estate holdings in Weston.

[c] The original fund was $10,000.00, income to be added to capital for 100 years before any part of it can be used.

One may legitimately express the hope that the institution will continue to expand within its field, and that it may increase its contributions to the enjoyment of the public, to education, to research, to the services of amateur and professional horticulturists, locally and all over the country, to professional botanists, to its sister institutions everywhere, and to plant science in general within the fields that it covers, and thus justify its continuance and support. Too often in the case of biological institutions, more particularly those within the botanical garden area, when expansion ceases, stagnation or decline sets in.

Were I asked to indicate what I consider to be the greatest immediate need of the institution at this, the close of the seventy-fourth year of its existence, my response would be a restricted publication fund; i.e., one the income of which would be restricted for use in financing the cost of publishing popular and technical information within the arboretum field. Too often when necessary retrenchments in institutional budgets are made the publication funds are among the very first items to be reduced, or even eliminated, such funds apparently being looked upon more in the nature of a luxury than as a necessity. It is rather curious to note that for the support of research, provided one has a legitimate project, one may literally approach dozens of sources of funds and actually receive grants — frequently very generous ones — to support research; but not a cent, usually, for publication expenses. Unless the results of research be published they do not, in general, become widely available. The initial capital of such a fund need not be large, for it would be possible judiciously to increase it over a term of years by adding to capital annually the receipts from sales of subsidized publications. Here it is pertinent to remark that for a high percentage of research publications subsidization is essential to publication, for the demand for much of the output comes not from individuals so much as it does from institutional libraries. Thus the sales field is limited. In plant science the actual value of a research paper cannot be gauged by the number of copies sold. I merely observe here that the Arnold Arboretum needs no further publicity; but the knowledge of its activities in the world at large — and it is one of the most widely and most favorably known units of Harvard University — comes very largely from its widely distributed official technical and popular publications.

In 1947 the Arnold Arboretum will attain the age of 75 years. It has been my pleasure, privilege, and honor to direct its activities over the past decade, ten years charged with many difficulties due to a variety of causes, including the most destructive hurricane ever experienced locally since 1620, two recent winters with unusually heavy ice damage, an unusually large number of destructive grass fires in abnormally dry seasons, financial difficulties of one type or another, the extraordinary restrictions of the war years, with the concomitant labor shortages, radically increased cost of labor, and difficulties in relation to supplies and equipment. While I shall have no administrative responsibilities on the occasion of the institution attaining its 75th anniversary, it can only be assumed that continued success will be in store for what is, in its field, the pioneer institution, for it is actually the oldest Arboretum in the world. It is also the outstanding institution of its kind and the progenitor of between fifty and sixty arboreta in the United States alone. Some of these are small and largely built on hope and enthusiasm, but others are large and well-endowed. Thus it is that from its modest beginnings in 1872 with an initial endowment of slightly less than \$100,000.00 the Arnold Arboretum has developed into an outstanding cultural, educational, and research institution as its material resources have increased; for its modest initial endowment has been increased by gifts and by bequests by more than thirty fold to the impressive total of $3,215,983.69, to be further increased within the coming year by additional impressive sums.

1945 — 1946

Financial. — Normally the institution has been operated within the limits of its annual income, but in certain years, especially during the war when the labor staff was at low ebb and we could not purchase desired equipment, the departmental balance was fortunately increased. In 1935 this balance was $16,058.19, and at the end of 1945 it had been increased to $40,507.06. The year just closed was exceptional in that the actual overdraft or deficit was $12,108.29, which was charged to this reasonably ample departmental balance. Authorization was granted in advance for this overdraft. The causes were several, chiefly two blanket increases in labor rates, and a ten percent increase in all salaries for individuals receiving $3,000.00 or less per year, and for which no budgetary provisions had been made in advance. The badly depleted labor staff was increased, this being imperative because of the deplorable condition of many of the plantings due to lack of care in the war years. There was, of course, an increased cost for supplies and equipment, and further an unavoidable delay in the settlement of the Marian Roby Case estate. Thus it was that the maintenance costs of the Weston real estate that came to the Arboretum as a part of her bequest, assumed April 1, 1945, had to be continued as a charge against the regular Arboretum income for the year 1945–46. With the payment of a large part of the Case bequest in June, 1946, this matter is now adjusting itself.

The endowment funds of the institution were increased during the past year by a total of $365,137.09, very largely from the Marian Roby Case bequest. Toward the end of the year the modest William H. Judd Memorial Fund was established through certain voluntary gifts, now amounting to $2,833.50. Additions to capital under the terms of gift of two items amounted to $1,253.72. Still to be received is the final balance of the Marian Roby Case bequest and all of the Katherine Balch bequest mentioned last year.

In addition to income from endowment and from miscellaneous sources on which the actual budget is based, the extra-budgetary Cultural Purposes Fund was increased by $5,704.00 from 172 individuals, and the special Publication Fund was further increased by gifts from 33 individuals in the amount of $5,275.00, this fund now being apparently sufficient for the immediate publication needs of the institution. One grant of $600.00 was received from the Penrose Fund, American Philosophical Society, for use in support of a bibliographic research project. Two grants have been made to support Dr. A. C. Smith's projected botanical exploration of Fiji, from the Guggenheim Foundation and from the Penrose Fund of the American Philosophical Society. The total of all gifts for immediate expenditures was $15,679.00.

Staff. — There have been few staff changes. The institution suffered a very severe loss, on May 23, in the sudden and unexpected death of William H. Judd, for 33 years a member of its staff. Mr. Judd was in charge of plant propagation, and of the accessions and distribution records. He was a veritable one-man bureau of information on plants, plant problems and plant names, being actually one of those irreplaceable persons. See Arnoldia **6**: 25–28, *portr.* 1946. Dr. H. M. Raup was promoted from an Assistant to an Associate Professorship, and under the reorganization plan he has been designated as Director of the Harvard Forest. Dr. C. E. Kobuski, after three years in the military service, reported for duty in August, 1945. In May, through arrangements made by the new chairmen, Mrs. Beatrix Farrand was added to the staff, on a retainer basis, as Consulting Landscape Gardener. The other changes have chiefly been in the labor field, where significant and very badly needed addition to the labor staff has been made.

Instruction. — The graduate student situation remained about as it was during the war years. With the close of the war the number of inquiries radically increased. The present prospects are for a distinctly increased number of graduate students in 1946–47 who wish to specialize in the general field covered by the Arboretum. The Bailey report, briefly mentioned last year, was finished and submitted during the year. It was officially approved by action of the Corporation March 1, 1946, and as the new plan goes into effect it will apparently have far reaching effects on the future program of the Arnold Arboretum, and particularly in reference to the relationship of its staff members to Harvard University through the Division of Biology. In general it should greatly strengthen the advanced instruction in botany through a closer association of staff members of the separately endowed units, of which the Arnold Arboretum is one of nine, with the botanical staff of the Division of Biology of Harvard University.

Buildings, grounds, and horticulture. — The normal amount of attention has been given to all buildings to maintain them in good condition, and certain work has been done on the newly acquired residences and other buildings on the Case Estate in Weston. A survey of maintenance costs was made during the year to see if certain savings might not be made were all building repair services turned over to the Maintenance Department of Harvard University. However, the estimates submitted showed an increased cost of several thousand dollars, and so no change was made.

We are indebted to a group of lady members of the Board of Overseers Committee to Visit the Arnold Arboretum, all personal friends of the first director of the institution, for their initiative in having prepared a special memorial to Dr. Sargent. This took the form of a beautifully designed and executed bronze plaque, 30 by 21½ inches, which was installed May 12, 1946, on the right hand pillar of the Jamaica Plain gate. The inscription reads:

CHARLES SPRAGUE SARGENT
1841–1927
ARNOLD PROFESSOR OF BOTANY
IN HARVARD UNIVERSITY

FIRST DIRECTOR OF
THE ARNOLD ARBORETUM
1872–1927
THE ARNOLD ARBORETUM, HIS CREATION,
IS A LIVING AND ENDURING MEMORIAL

We are under very special obligations to Mr. William P. Long, Chairman of the Boston Park Department, for his continued interest in the Arboretum and its problems, as evidenced by the entire renovation of the road surfaces in May by the Park Department. Very extensive repairs were made as needed and the entire road, except that in the Peters Hill section, was re-tarred.

The attractiveness of the grounds decreased during the war years due to circumstances beyond our control, chiefly labor shortages and our inability to acquire needed equipment. Some of the plantings actually approached a deplorable condition. There has been some criticism of the conditions of the plantings, but this has come largely from individuals who maintain no estates and who hence were not in a position to judge fairly. Estate owners, subject to perhaps even greater restrictions than was the Arboretum during the war years, very generally understood the situation.

Following the close of the war this matter was critically considered. Two staff members returned to service following their honorable discharge from the Army, Mr. Heman Howard as Assistant Horticulturist and Mr. Alfred Fordham as Assistant Propagator. We were fortunate in securing the services of a well trained and skilled tree specialist who has the pruning program well under control. Because of the really vast amount of work that needs to be done, it is estimated that it will take him a year or two to go over all of the plantings. In the meantime, however, special attention is being given to those trees that are most conspicuous or in most need of attention, the results of his work being already evident. In any event the trees and shrubs are now receiving the care that could not be extended to them during the war years. Three ex-service men have been added to the labor force, bringing its total up to fourteen. The services of four high-school boys were secured for the summer months. With this additional labor we can, even within the present open season, go far in repairing the ravages due to neglect of plantings, damage by snow and ice, and that by storm and fire. As a simple example, over fifty truck loads of dead or superfluous stems and branches were removed from the lilac collection alone, and several other collections have been dealt with proportionally.

We have acquired certain new equipment, this being necessary to keep labor costs within bounds. Included are two sickle-knife mowers for use in those areas where the tractor cannot be utilized to advantage. The most useful item is a Worthington "Grass Blitzer" mower, the five reel type. Its use in the extensive linden, maple, elm, and beech areas eliminates all work of raking and hauling hay. The areas are maintained in much more presentable condition, and the grass clippings left on the ground materially benefit the soil. The Ford-Ferguson tractor has increasingly proved its worth, being in almost continuous use. The radically increased cost of labor forces us not only to become more and more mechanized, but also to keep the machines working continually. We are constantly looking for specialized machines, by the use of which hand labor can be eliminated, for it is only by the utilization of such labor-saving devices that we can hope to cover the amount of work that must or should be done and at the same time keep within the budget allotment. An outstanding example of reduced labor costs is that shown by the maintenance of the shrub collection. This large tract was formerly cultivated entirely by hand. With a judicious rearrangement of the beds, elimination of alternate grass walks, and other improvements permitting the use of mechanical equipment and weed killers, most of the hand work has been eliminated and the actual cost of maintenance reduced to about one-fifth of what it was before the new system was installed. In conjunction with labor costs Mr. Williams has installed a simple daily record, so that we can now determine the exact number of man-days and boy-days involved for thirty-five different classifications.

On the Case Estates in Weston, a considerable amount of work was required in eliminating certain plantings, thinning of others, and general work in cleaning up of certain buildings, with essential repairs as necessary. The nursery space was enlarged and some large seed beds established. Several thousand cuttings were rooted in connection with certain projected horticultural investigations. The large fields were again cover cropped, in preparation for planting in the spring of 1947. At times when the necessary work at Weston is under control the men report at the Arboretum for work on its grounds.

The town of Weston, seeking a site for a new elementary school, studied three possible tracts, two of them on land already owned by the Arboretum and another on adjacent land. Since it seemed possible that the more desirable tract, from our standpoint, might be taken under the right of eminent domain, the University offered about forty-one acres, including the buildings thereon, to the town for the very modest sum of $10,000.00. This was from the Louisa W. Case gift of 1942, and the arrangement was made with her full knowledge and consent. As this was practically a gift to the town of Weston, the local authorities were greatly pleased, and this augurs well for our future relationships in Weston with the local residents and town officials.

Through an agreement made with the Department of Landscape Architecture, Graduate School of Design, Harvard University, that unit has been granted the use of several acres on the Marion Robey Case estate for the possible development of demonstration plantings. The Arnold Arboretum is free of any financial obligation in reference to this project. The use of the land, which is not adapted to anything we may wish to do in Weston on behalf of the Arboretum, was granted to the Landscape Architecture Department as a courtesy.

It became necessary to remove the remaining material in the nursery adjacent to the State Serum Laboratory building in the spring. Some of the plants not needed for Arboretum purposes were presented to the University and to Radcliffe College. The valuable plants needed by the Arboretum were moved to Weston and planted in a special nursery there. The large nursery on South Street will be continued for another year, after which some of the plants will be placed in the collections and others will be transferred to Weston.

During the year 59 living plants, 72 lots of cuttings and scions, and 25 packages of seeds were received from various sources in the United States and a few packages of seeds from foreign countries. To various institutions and individuals in the United States and Canada 261 living plants were distributed as well as 163 lots of cuttings and scions and 60 packages of seeds, and a few packages of seeds were sent to institutions abroad.

With the close of the war, interest in the Arboretum has become evident in the greatly increased number of visitors. Very many of these have the interest of the institution at heart and their very presence assists materially in protecting the place against vandalism on the part of irresponsible boys. On May 15 the institution was honored by acting as host to more than five hundred delegates to the National Convention of the Garden Club of America, this large group being escorted through the grounds by staff members of the institution. Arrangements have been completed to stage certain important demonstrations in the Arboretum for the meeting of the National Arborists Association in the late summer.

Perhaps as one result of reductions of controls during the war years, it is becoming increasingly evident that vandalism in the Arboretum is approaching an all-time high. One evidence of this is the extraordinary number of grass fires during the drier parts of the spring and fall seasons. In one recent season we experienced more than seventy fires, more than half of which were so serious that the fire department services were required. During the last year when the spring and fall seasons were fortunately not so dry, there were about forty fires. These are obviously set by boys. Since the Arboretum is open to the public from sunrise to sunset every day in the year, these young vandals cannot be excluded; neither can the Arboretum maintain guards at all times, before and after working hours, Sundays and holidays.

However, when the weather is such that the fire menace is acute, practically the entire maintenance force is distributed to strategic points and assigned the task of watching all groups of boys. When holidays and after office hours are involved this increases our labor costs, as we must pay the men one-half more per hour than the regular scale. Naturally time devoted to watching for fires distinctly reduces the labor efficiency, for while so assigned the men can do little or no regular work. Police protection has been meager during the war years for the simple reason that the Police Department has been undermanned and overworked. Courteous treatment is always extended to the Arboretum by members of both the Police and the Fire Departments; and yet these constantly recurring fires constitute a distinct burden of expense on the Boston Fire Department. We have attempted to reduce the fire hazards as far as this could be done with our limited force. In the Peters Hill area strips were plowed and harrowed to form fire lanes, thus materially reducing the number of fires there and limiting their extent.

Two years ago the greater part of our magnificent collection of dwarf evergreens was destroyed by fire, and what remains is in a precarious position. Last year saw the destruction of a fine collection of Chinese firs near South Street; this past season our juniper collection was seriously damaged — and so it goes. What the institution needs and needs very badly is a uniformed guard supplied with proper transportation who shall be on duty at those times when the fire menace is great. Possibly satisfactory arrangements could be made with the Police Department, whereby the Department would be reimbursed on a per diem basis to cover services rendered. The situation is indeed a most serious one.

My personal opinion is that we should plan to protect what we have before we further expand staff activities by the creation of new positions in this or that field; and certainly a guard can be provided for from the additional income that will become available when certain bequests are paid in. We must keep in mind that the development of open spaces with closely cut grass attracts the baseball players among the youth in the spring and summer, the football players in the fall, and the amateur golf players at all seasons; and when a strip is opened down a slope this becomes an attraction for coasting and skiing in the winter. True it is that such activities are prohibited within its grounds, but the prohibition is not now and cannot be enforced without a properly authorized guard.

The appointment of Mrs. Beatrix Farrand as Consulting Landscape Gardener consummated in May should materially assist in the solution of certain outside problems. Her objective will be to initiate plans that will bring the living collections of the Arboretum to the highest possible degree of usefulness and attractiveness to the general public. Mrs. Farrand, once a student under Charles Sprague Sargent at the Arboretum, has been Consulting Landscape Gardener to Princeton University, Yale University, Dumbarton Oaks, and other important institutions in the country.

Plant Breeding. — Many of the ornamental apple hybrids bloomed last spring and the better types have been selected for propagation. The new varieties are budded on *Malus toringoides* root stocks and are grown to flowering age before final selections are made. Consequently about ten years must elapse before final selections are made and the new varieties are released to growers.

Several promising new varieties of cherries, forsythias, and lilacs flowered for the first time. One of the most spectacular new hybrids is a dwarf azalea which last winter behaved as an evergreen. The evergreen segregates of *Berberis mentorensis* have not proved to be outstanding, but a few plants have been retained for further tests. Some variation was obtained in the F_2 generation of X-rayed *Berberis Thunbergi,* but the segregates are not of much value. Hybrids of red $\times$ silver maple have been set in permanent location and are making very rapid growth.

Root stock experiments have been continued in an attempt to obtain dwarfing stocks for ornamental trees and shrubs and to determine graft relationships. As is well known, certain combinations do well the first year but graft union is incomplete, and the scion dies the second year. In the Pomoideae, however, there is considerable compatibility between certain genera. The tree lilac has been used as a root stock for the common and Persian lilac with promising results. A Chinese lilac seedling budded on *Syringa amurensis japonica* made more growth in one season than it had made in six years on its own roots. Budding or grafting of hybrid seedlings may avoid the high mortality of seedlings of certain species crosses.

A cytological study has been made of bigeneric hybrids of which *Sorbus* was one of the parents, including *Sorbaronia, Amelasorbus,* and *Sorbopyrus*. All of these hybrids show considerable cytological irregularity, although all are partially fertile. Work has been continued on the effect of temperature variations on X-ray induced chromosomal aberrations.

Wood Anatomy. — Professor Bailey and his co-workers, in continuation of their investigations of the comparative morphology of the dicotyledonous families, concentrated on an intensive investigation of the foliar morphology of *Illicium*. This work was carried on in coöperation with Dr. A. C. Smith as to the taxonomic phases of the subject. The accumulated morphological evidence indicates that this genus belongs in an independent family closely related to the Schisandraceae. It indicates no close relationships to either the Magnoliaceae (sensu stricto) or the Winteraceae. While *Illicium* as a genus is sharply characterized by a number of salient, relatively stable, diagnostic, and phylogenetically significant structures, the problem of differentiative taxonomic entities within the genus is a difficult one, the morphological boundaries between species commonly being vague and indefinite. Miss Lillian Nagle is completing a morphological study of the Monimiaceae for the doctorate, and Mr. W. Spackman, Jr., is initiating an extensive survey of the salient trends of specialization in the wood parenchyma of the dicotyledons.

The Herbarium. — The total number of specimens mounted during the year was 13,248, of which number 6,178 were herbaceous specimens subsequently transferred to the Gray Herbarium as noted below. However, we removed from among material mounted and incorporated in previous years a total of 5,755 specimens (5,740 of which were herbaceous plants and 15 of which were duplicates); as a result the actual growth of the herbarium was only 1,315 specimens. The total number of mounted specimens now in the herbarium is 631,452. In a way it is fortunate that the present rate of growth is slow, since all expansion space has been filled and further distribution of material into the collections cannot be made under existing conditions. The mounting staff spent a considerable proportion of their time mounting the photographs from the Linnaean Herbarium, mentioned elsewhere in this report, and in addition some time was devoted to repair work. A limited number of clippings and mounted illustrations was inserted into the herbarium.

Although accessions during the war years have necessarily been below normal, a greater influx of material is to be expected in the near future. Certain institutions in China and other parts of the Old World have been accumulating substantial amounts of material on behalf of the Arboretum, and shipment of this may be expected as soon as transportation conditions permit. These forthcoming acquisitions will increase the strain upon our storage facilities; at present the available space for storage of unmounted duplicates, like the herbarium, is crowded to capacity.

During the fiscal year the Arboretum received approximately 54,999 specimens, acquired in the following manner: gifts, 1,673; for identification, 2,705; subsidy, purchase, or on salary basis, 18,405; and exchange, 32,216. The largest single acquisitions were 25,533 Argentine specimens received from the Instituto Miguel Lillo, Tucumán, in exchange, and about 5,000 specimens from the same institution received on a subsidy basis. Other important collections were about 3,000 specimens collected on San José Island, Panama, by Dr. Johnston; 8,769 specimens collected in Minas Geraes, Brazil, by Dr. Louis O. Williams on behalf of the Arboretum (the material subsequently transferred to the Gray Herbarium for study and distribution); and 612 specimens received in exchange from the Naturhistoriska Riksmuseet, Stockholm. A geographical breakdown of incoming material shows the following: South and Central America, 46,463; United States and Mexico, 3,157; West Indies, 1,112; Canada, 984; Pacific Islands, 1,285; Australia, 255; Europe, Africa, and Asia, 1,061; miscellaneous (mostly cultivated), 682.

The Arboretum sent to other institutions a total of 29,558 specimens; as usual in recent years the bulk of this material was transferred to other departments of Harvard University as inter-institutional transfers, as follows: to the Gray Herbarium 23,467 specimens (17 for identification, 12,107 mounted specimens transferred, 10,588 unmounted specimens transferred, and 755 mounted illustrations transferred); to the Ames Orchid Herbarium at the Botanical Museum 439 specimens (81 for identification, 90 specimens and 268 mounted illustrations transferred); and to the Farlow Herbarium 327. To other American institutions we sent 4,453 specimens in exchange, 281 specimens for identification, and 18 specimens as gifts; to non-American institutions went 186 specimens in exchange, 380 specimens for identification, and 7 specimens as gifts. Microfilms, photostats, and publications to the value of 861 specimens were sent out on an exchange basis. The total number of specimens or their equivalent distributed by the Arboretum, therefore, was 30,419.

To 18 institutions (14 American and four foreign) the Arboretum made 33 loans totalling 1,301 specimens; members of our own staff received 49 loans from 17 institutions (11 American and six foreign), totalling 2,303 specimens.

To the catalogue of references to new species and other important literature pertaining to woody plants 2,511 cards were added, bringing the total number of cards in this catalogue to 141,161. Only 28 negatives were added to the collection representing types and other critical species; this collection of negatives now totals 4,239.

In addition to carrying on the usual amount of routine work, staff-members continued their special researches. Professor Rehder brought to completion the major project which has occupied him in recent years, namely the preparation of a Bibliography of Cultivated Trees and Shrubs. This extensive work is now in press, and its appearance will be welcomed by the numerous individuals who make frequent use of Prof. Rehder's Manual of Cultivated Trees and Shrubs, of which the Bibliography will be in some respects a supplement. Dr. Smith, continuing his collaborative studies of the Ranales with Prof. Bailey and Dr. Nast, worked on the genera *Illicium, Schisandra,* and *Kadsura;* a revision of these important genera is now approaching completion. In order to make possible a projected exploration of the Fiji Islands, Dr. Smith applied for and was awarded a John Simon Guggenheim Memorial Fellowship, for use in 1947. He also received a grant from the Penrose Fund of the American Philosophical Society, for application toward the same project. Dr. Smith plans to leave in February, 1947, to spend about nine months in Fiji in continuation of his field work undertaken there in 1933–34, with the intention of obtaining sufficient material to make feasible the preparation of a modern descriptive Flora of Fiji.

Dr. I. M. Johnston continued his collaboration with the Chemical Warfare Service in relation to the San José Project. From December, 1945, to February, 1946, on army orders, he made his third trip to San José Island, Gulf of Panama. As a result of his association with this project he had exceptional opportunities for the study of tropical vegetation and for assembling reference material. In recognition of his work during the tests at San José he was awarded a citation in August, 1945, by the Chief of the Chemical Warfare Service. Much of the detailed data that he assembled regarding San José Island and its vegetation can now be published. His detailed report, the preparation of which is now well advanced, will appear in Sargentia.

Dr. H. M. Raup devoted most of his time to the completion of two papers, one published, one in press, the former being his phytogeographic consideration of the Athabaska–Great Slave Lake region, published in our Journal in 1946, and the latter his Botany of Southwestern Mackenzie, which is now in press as a number of Sargentia.

Dr. Kobuski, after an absence of three years in military service, returned to his position at the Arboretum in August; resuming his work on the family Theaceae, he is undertaking a revision of the genus *Adinandra*. Mr. Palmer completed his revision of the genus *Crataegus* in the northeastern United States and adjacent Canada, and he is continuing his investigations of the taxonomy of hybrid oaks. Dr. Allen, after completing her manuscript revising the Lauraceae of Panama for inclusion in Woodson & Schery's Flora of that country, has begun assembling material and data for a study of the South American representatives of the Lauraceae. Dr. Perry continued her studies of Papuasian plants, with special reference to the large collections of the Richard Archbold Expeditions; she also prepared for publication translations of several scientific articles originally published in Dutch (for reference to these, see the bibliography appended to this report). Dr. Croizat continued his studies of the Euphorbiaceae, particularly of tropical America, while devoting much time to identifications of cultivated material.

My own activities, in the limited time that was available because of the pressure of administrative work, have been devoted largely to bibliographic matters and to identifying and reporting on various collections from the Old World tropics. Completed and published was the consideration of the technical names of plants proposed by William Bartram (1791), and completed and presented for publication a somewhat similar treatment of the Amos Eaton names (1817–1840). Progress has been made on a similar treatment of Muhlenberg's names (1813–1819), and the long continued Rafinesque project, the Index Rafinesquianus mentioned in previous reports, approaches completion and will be finished during the coming year. My Botanical Bibliography of the Islands of the Pacific, mentioned elsewhere in this report, was completed during the year.

Bibliography. — Dr. Frans Verdoorn edited volume three of the Annales Cryptogamici et Phytopathologici, and volumes seventeen and eighteen of A NEW SERIES OF PLANT SCIENCE BOOKS. Chronica Botanica was published in installments, being chiefly devoted to historical subjects. He also continued to act as advisor to the Board for the Netherlands Indies, Surinam and Curaçao in New York City, and to supervise the Central Depository Library for the Netherlands Indies, which he established in 1942. With Dr. Pieter Honig he edited *Science and Scientists in the Netherlands Indies,* which includes a detailed directory of scientists resident in the Netherlands Indies at the time of the Japanese invasion. For the Board he is now preparing a plan for an international visitors' research station to be established in the East Indies.

Much attention has been given to the basic Index Botanicorum project, about seven thousand sheets having been added to the file during the year. The services of numerous new collaborators have been secured, notably in Finland, France, the Netherlands, Sweden, and Switzerland. Much of the work has been done by Mr. Walter Baron, formerly of the Berlin Institute for the History of Medicine, with the part time assistance of several other persons. In connection with the development of this project the following files are being developed: — a collection of portraits of plant scientists; one of illustrations of botanical gardens and botanical museums; and one of autographs of plant scientists; a card catalogue index to the literature of the history of the plant sciences; and a similar index to the literature and other data on the history of botanical institutions.

For the first time since work on the Index Botanicorum project was initiated in 1942 it was possible for Dr. Verdoorn to assign to it personal funds. His present rate of expenditure is about twice the amount of the modest subsidy provided by the Arnold Arboretum.

Other important bibliographical projects include Prof. Alfred Rehder's Bibliography of Cultivated Trees and Shrubs, the printing contract having been consummated in May. It will probably take the better part of a year to see this major work through the press. The long continued work on the Index Rafinesquianus is practically finished, remaining to be completed being only the introduction, and this is well advanced. The Bartram project mentioned in last report was finished and published, while the Eaton manuscript was completed and is now being printed.

Because of expressed desires of officials of the Smithsonian Institution, work was reinitiated on a thorough revision of my Polynesian Botanical Bibliography 1773–1935, which was published in 1937, bringing it up to date and increasing the author-entries from about 2,600 to approximately 3,900. This covers the entire Pacific basin from Juan Fernandez and Hawaii to the Marianas, Caroline, and Palau Islands, and southward to New Caledonia. The revision was completed during the year and this extensive contribution is now in press as one of the official publications of the Smithsonian Institution under the title: — A Botanical Bibliography of the Islands of the Pacific.

Because of its remarkable library facilities the Arnold Arboretum has been strong in the bibliographic field, as witnessed by the Bradley Bibliography (1911–1918), the Bibliography of the Botany of Eastern Asia (1938), and its comprehensive library catalogue (1914–1923). It is fitting that extensive work in this field be accomplished here where it is possible to gain access to most of the published literature, even including numerous exceedingly rare volumes. It may be argued that such intensive work does not benefit the individual or the institution to any great degree, but this is actually a false argument. Good bibliographic work can be done in only a relatively few centers in the world, and this happens to be one of them. It should not be forgotten that the published output in the bibliographic field is very widely used by productive botanists and by librarians all over the world, and that service rendered in this special field is very greatly appreciated elsewhere. In this sense the Arnold Arboretum is a world institution, not merely a local or national one.

Lithoprint reproductions of rare works. — Because of the very successful outcome of the lithoprint facsimile reproduction of the very rare "Sylva Telluriana" and "Autikon Botanikon" of Rafinesque in 1943, it was decided to extend this service more particularly for the benefit of the younger botanical research institutions in the United States and elsewhere. It is now practically impossible to acquire copies of certain basic works, and even when they are rarely offered the asking price is exorbitant. The newly reproduced works, all issued in 1946, are Rafinesque's "Flora Telluriana" (1836–1838), about 450 pages, "New Flora and Botany of North America" (1836–1838), about 404 pages, "Atlantic Journal" (1832–1833), 212 pages, Blume's "Catalogus," 112 pages, Gronovius' "Flora Virginica" (1739), 206 pages and its edition two (1762), 176 pages, and Walter's "Flora Caroliniana" (1788), 252 pages. The modest unit prices for these modern reproductions vary from $2.00 to $5.00, depending on the number of pages involved.

It may legitimately be pointed out that here is a field in which older institutions with very ample library facilities can be of distinct service to more recently established ones. Of one of the above titles the only known copy in all of the botanical libraries of North America is the one on the shelves of the Arnold Arboretum library; because of the nature of the work it ought to be available in the libraries of all institutions where botanical research is prosecuted. It may further be pointed out that in another case where the lithoprint reproduction can be had for the very modest price of $3.00, a dealer has recently demanded $375.00 for a copy of the rare original; and it is a curious fact that the modern reproduction is not only easier to consult, but is actually clearer than is the rare original. As another case of recent exorbitant asking prices may be cited two items, which the Arboretum fortunately already possessed, where copies were offered in 1946 at $4000.00 each; and yet one of these was offered only two or three years ago for about one-third of the price now asked. Unfortunately, with these inflated prices the items, if sold, pass into the possession of wealthy bibliophiles, and so become lost to working botanists who need access to them.

The cost of reproducing all of these lithoprint reproductions has been covered by private funds supplied by the director, but the institution receives the credit, for each bears the Arnold Arboretum imprint. There are so many rare volumes that are in relatively great demand, and the asking prices are so exorbitant that they are quite beyond the financial limitation of the average botanist, or, for that matter, the average botanical institution, that any institution that might elect to exploit this field could not only reimburse itself for the expenditures involved, but could actually make this field a source of revenue, where additional income is needed.

The Library. — Two hundred and ninety bound volumes were added to the library and 147 pamphlets were catalogued, bringing the totals to 46,131 and 13,753 respectively. Five hundred and seventy author and subject cards were filed in the main catalogue and 4,930 cards were distributed into the Gray Herbarium card index.

Inter-library loans were many and varied, the total number handled, including incoming and outgoing loans, reaching the impressive figure of 686, the number increasing year by year. Our own borrowings are very largely limited to other Harvard libraries, it being only occasionally that we have to go outside of the Boston area for a needed book. This service is one that is very greatly appreciated by staff-members of other institutions where the library facilities are much more limited than is the case here. This is another field where the institution can be of very great service to others in actual loans of needed volumes, or in having microfilm or photostat reproductions made where the high value or extreme variety of a volume renders its loan undesirable. During the year many orders for microfilm and photostat work were filled, in some cases covering entire volumes.

The large photograph collection fills a distinct need, it being much consulted by students, by nurserymen who are planning new catalogues, and by authors seeking illustrations for their about-to-be-published books.

Much time is devoted each year to scanning second-hand book catalogues. Although it is relatively rare that we thus locate a needed work that we do not have, occasionally an item well worth while is located. This year perhaps the most noteworthy case was a nearly complete set of the very rare Rafinesque "Speccio delle scienze" (1814), with, most surprisingly, its original fascicle covers. In this case we realized what we were purchasing even if the dealer did not realize what he was selling, as the price paid was a very modest one.

Much attention has been given to the matter of reinitiating our exchanges of technical publications with foreign institutions in former enemy or enemy-occupied countries. Contacts have been reinitiated so far with forty institutions in eleven countries. It is interesting to note that in each case, each institution had reserved a set of its technical publications to be sent in exchange for ours, immediately this became possible following the close of hostilities.

It is realized that we shall have difficulties in filling the *lacunae* in certain sets of technical periodicals due to the loss of reserve stocks of current issues in certain publishing centers, such as Berlin, Leipzig, Tokyo, and other cities devastated by war. Doubtless in some cases we shall have to be content with microfilm or photostat records. However, every effort will be made to complete the files in the case of essential publications.

Linnaean microfilms. — The acquisition by the Arboretum of a complete microfilm record of the Linnaean Herbarium was mentioned in previous annual reports. A complete set of 5×7 prints has now been made from this microfilm, and these prints are filed in the Arboretum Library in two steel 5-drawer cabinets. Each print is mounted on a stiff card measuring $7\frac{1}{2}$ by $9\frac{3}{4}$ inches, occupying about half of the card. On the other half is a printed label bearing such pertinent information as the name of the plant in the Linnaean Herbarium, the number under which it is described in Mr. S. Savage's "A Catalogue of the Linnaean Herbarium" (1945), etc. There is ample room on each card for annotations pertaining to the proper modern name of the species, original place of description, references to critical discussions, etc. It is believed that the collection will be more useful maintained as a unit in the sequence of the Linnaean Herbarium than if the prints were scattered in the general herbarium. Each mounted photograph may be removed from the files for examination and comparison with specimens. Such a collection will increase in value as it is used, as annotations by competent authorities are added to the cards. The total number of entities is 14,207, but on about 462 cards there are two or even three photographs, due to the fact that certain specimens were photographed more than once to show details, important annotations, etc. The collection, therefore, contains approximately 14,669 photographs.

These prints, while scarcely sharp enough to make good half-tone reproductions, do generally supply a fairly graphic representation of what Linnaeus had before him. From a critical examination of these photographic records in association with the printed Linnaean record and in association with actual specimens collected in the various historical localities, one can generally gain a very definite idea as to what a Linnaean binomial, that was based on an actual specimen, actually applies. The Arboretum is very fortunate in having this photographic record, for here again it is now in a position to assist botanists elsewhere by loaning individual prints that may be required for examination.

Atkins Institution of the Arnold Arboretum. — With the initiation of an active campaign toward the end of the preceding year to remedy the overgrown conditions of the plantings, very excellent progress has been made and practically all signs of neglect have been removed under the vigorous campaign initiated by Mr. Walsingham. Even the coarse grass was removed from the stream-beds, which were cleaned during the dry season, as well as that in the boundary fences. The year incidentally was more favorable than the preceding one, with a much more ample and better distributed rainfall (56 inches). There were no severe storms, nor were low temperatures recorded during the winter months. Taking advantage of favorable conditions, additional plantings were made in the *Albizzia, Bauhinia, Cassia, Ficus,* and other sections, and over 300 small palms that had been grown in pots were planted in the garden.

Work was initiated in June on the regeneration of a native forested area in Belmonte. Several hundred seedlings of teak, lemon wood, and mahogany were planted, and about 500 seeds of both teak and mahogany were planted *in situ*. If the resulting young plants withstand the dry season this interplanting will be extended next year. Eight of the new cement beds were used for sowing teak seeds, four in April and four in May. Excellent germination resulted and there may be available between two and three thousand seedlings by next year for transplanting.

Essential repairs were made to the watchman's house, and the new cement water cover on the nursery site, which had cracked at the corners, was repaired and is again in service. In the renovation program from October onward, after the planting was finished, most of the labor force was assigned to a general clean-up of the entire garden area. The results are very striking.

While, as in the preceding war years, no students were actually in residence, many more individuals visited the institution than in recent years, some spending from a week or two to as many as eight or ten weeks. Various Cuban government officials continue their interest in the institution by visiting it at intervals.

In June over 600 packages of seed were received from the New York Botanical Garden from the Mexican collections of Mr. E. J. Alexander. From other sources 82 packages were received, and 97 lots were collected from plants growing in the garden for local use. During the year the distribution comprised 323 packages of seeds, 263 living plants, and 27 lots of cuttings for propagation. It is becoming more and more evident that in the mature plants now being grown at Soledad, both native and exotic species, an exceedingly valuable asset is now actually available in Cuba for the benefit of that country.

Under the reorganization plan which has been approved and is now actually in effect the Atkins Institution has been divorced from the Arnold Arboretum, and henceforth will be known as the Atkins Garden and Research Laboratory, under the direction of Dr. Arthur G. Kevorkian, who will spend a part of each year in Cambridge and a part at Soledad.

Publications. — As usual, four numbers of the Journal were published; these included 16 papers by 12 authors, a number smaller than average because of the length of important contributions by Dr. Allen (in volume 26, numbers 3 and 4) and by Dr. Raup (in volume 27, number 1). No numbers of Sargentia were published, but one issue, containing an account of the botany of southwestern Mackenzie by Dr. Raup, is in press, and the manuscripts of one or two additional numbers are well advanced. The usual numbers of Arnoldia, our bulletin of popular information, a service that is highly considered in both professional and amateur horticultural circles, were published.

In addition to the periodical publications mentioned above, two major works by staff-members are now in press. The first of these, Prof. Rehder's Bibliography of Cultivated Trees and Shrubs, is an extensive work giving the synonymy and full bibliography of all the entities in his much consulted Manual of Cultivated Trees and Shrubs. The other is the second part of Mrs. McKelvey's Yuccas of the United States, an extensive treatment which will complement the first part, published in 1938. The second part of this very important study will be published in the same format as the first part and will similarly be elaborately illustrated by the author's striking photographs.

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E. D. Merrill,
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Synonyms are printed in *italics;* new names in **bold-face** type.