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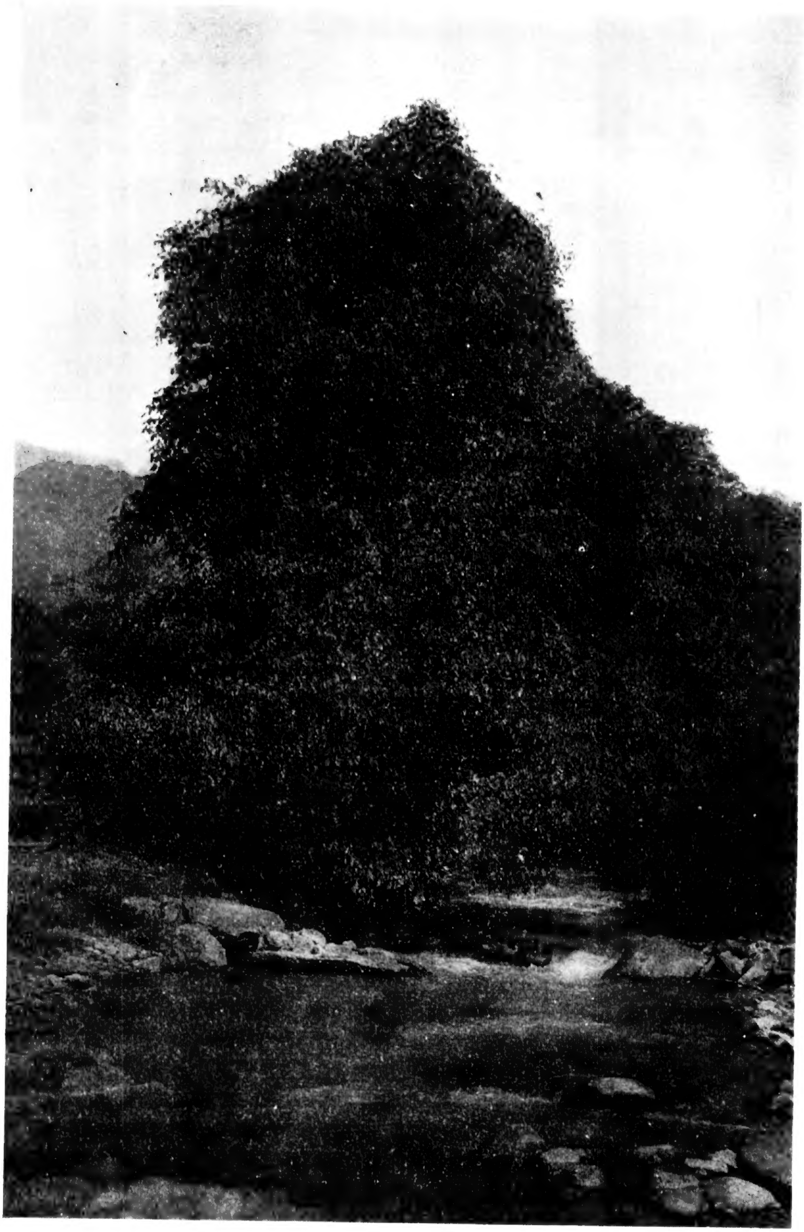

JUGLANS FALLAX Dode spontaneous in the valley of the Khodsha-ata River, western Tianshan.

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REVIEW OF THE JUGLANDACEAE IN THE U. S. S. R.

VERA NEKRASSOWA

Plates 19 and 20

The Juglandaceae in U. S. S. R. are represented by a single species of the small genus *Pterocarya* Kunth and by five of the more recent and much more extensive genus *Juglans* L.

Representatives of this family forming part of the broad-leaved tertiary forests occur wherever remnants of such forests are still found, notably in the Caucasus, on the mountains of Turkestan and in the Far East.

Fossil remains of the Juglandaceae have been found in many parts of the Union,[1] often not only where Walnuts no longer occur but where even no broad-leaved trees and, in some cases, no forests of any kind survive. Thus remains of *Juglans acuminata* A. Br., closely allied to the present *J. regia* L., and *J. nigella* Heer were recorded from Sakhalin; *J. cinerea* L. and other fossils of Juglans were found in Eastern Siberia on the river Aldan; *J. acuminata* A. Br. and *J.* (*Pterocarya*) *densinervis* Schm. in the neighborhood of Tomsk, *J. crenulata* Schm. and *J.* (*Pterocarya*) *densinervis* Schm. jointly with other broad-leaved trees in southern Altai on the river Bukhtarma; *J. acuminata* A. Br. and *Pterocarya castaneaefolia* Goepp. on the Irtysh near Tara; on the source of the same river, in the neighborhood of the mountain Ashutas, remains of *Juglans* have also been discovered among 70 fossil forms of plants belonging to 32 families; near the northern

[1] HEER, Flora Foss. Arct. v (1878).
KRYSTOFOVICH, A. The Butternut (J. cinerea L.) from Fresh-water Deposits of the Province of Jakoutsk. (Mém. Comité geologique, N. S. Livr. 124 [1915]).
JANICHEVSKY, M. Sur la flore du Miocene des environs de la ville de Tomsk. (Mém. Comité géolog. N. S. Livr. 131 [1915]).
SCHMALHAUSEN, J. Ueber tertiäre Pflanzen aus dem Thale des Flusses Buchtarma am Fusse des Altaigebirge. (Palaeontographica, XXXII [1887]).
KRYSTOFOVICH, A. Contribution to the Neogene Flora of the Irtysh Basin, West Siberia. (Bull. Comité Géologique Len. XLVI, No. 7 [1927]).
NEIBURG, M. Sur les matériaux de l'expédition d'Ashutas du Musée Géologique de l'Ac. d. Sc. de l'URSS. (Comptes Rend. Acad. Sci. URSS. 1928).
PALIBIN, J. W. Die fossilen Pflanzenreste der Küsten des Aralsees. (Mitt. Turkest. Abt. Russ. Geogr. Ges. IV. [1907]).
PALIBIN, J. W. Notice sur la flore tertiaire dans la steppe Kirghize. (Bull. Com. Géol. Len. XXIII. [1904]).
KRYSTOFOVICH, A., & J. PALIBIN. Matériaux nouveaux pour la flore tertiaire de Turgay. (Bull. l'Acad. Sci. Petrogr. IX. [1915]).
KRASNOW, A. N. Primitiae florae tertiariae Rossiae meridionalis. (Travaux Soc. natur. Univers. Kharkow, XLIII [1909]).
KRYSTOFOVICH, A. Preliminary note on some new findings of Early Tertiary and Post-tertiary Flora in South. Russia. (Mém. Soc. Natur. Nouvelle Russie, XXXIX. [1914]).

shore of the Aral sea, at the summit of the Kara-Sandyk in a typically steppe country imprints of leaves of *J. acuminata* A. Br. have likewise been encountered. The same species has moreover been found on the river Chegan northwest of the Aral sea and with another species of a genus now absent from the Old World except a limited area in Eastern China and Tonkin, but well represented in the New World—*Carya* (*Hicoria*) *bilinica* Ung.—has been met with on the river Krynka, a tributary of the Mius, near Alexandrovka in the Taganrog district; the same *J. acuminata* A. Br. has been found in Miocene in the vicinity of Tim in the Kursk government. *J.* (*Carya*) *bilinica* Ung. has been further recorded from the Tiraspol district of the Kherson government and, lastly, *Pterocarya Massalongii* G. et Str. or a small leaf of *Carya bilinica* in the northern part (Khotin) of Bessarabia. Remains of the Juglandaceae will most probably be found some day still further north within the territory of the Union as they have even been found to occur in Greenland and Spitsbergen.

It thus appears that the former range of the genera *Pterocarya* and *Juglans* in the U. S. S. R. was much more extensive and reached as far as 61° N. Lat. Now members of the Juglandaceae in the wild state occur exclusively in warmer climates extending, however, as far North as Lat. 51° 13′ N. in the Far East. The most extensively cultivated species is *J. regia* L. which is much grown all over the southern European part of the Union. In the neighborhood of Leningrad, i. e. in Lat. 60° N. the following *Juglans* both thrive and bear fruit: *J. cinerea* L., *J. mandshurica* Maxim., *J. stenocarpa* Maxim., *J. cathayensis* Dode and even the Japanese *Pterocarya rhoifolia* Sieb. & Zucc.; the highly frost resistant Japanese *J. Sieboldiana* Maxim. is likewise met with as well as *Pterocarya caucasica* C. A. M., the latter, however, in the form of a shrub.

Of the four sections of genus *Juglans*[1] but two, *Dioscaryon*, comprising about 7 Asiatic species with *J. regia* L. as the type and *Cardiocaryon* containing about ten, also Asiatic species, are met with in the U. S. S. R. Both these sections are easily distinguished by the sculpture of their nuts and in their geographical range. Section *Dioscaryon* which has a smooth nut ranges over western Europe, Asia Minor, the Caucasus, Persia, Turkestan, Afghanistan, the Himalayas, the mountains of India and Yunnan, while *J. sinensis* Dode even reaches the northern provinces of China, and *J. orientis* Dode the province of Senano in Japan. Section *Cardiocaryon* with sculptured nut extends, on the contrary, throughout the eastern part of Asia occurring in China, Manchuria, the Far East and Japan. In Yunnan both sections have their representatives.

As a consequence of such a distribution of these sections *J. regia* L. and *J. fallax* Dode of section *Dioscaryon* are met with in the Caucasus and in Turkestan, whilst *J. mandshurica* Maxim., *J. stenocarpa* Maxim., and *J. cathayensis* Dode of the section *Cardiocaryon* occur in the Far East.

[1] DODE, L. A. Contributions à l'étude du genre Juglans. (Bull. Soc. Dendr. France, 1906, N 2. 1909. N 11, 13. p. 67–112; 1909, p. 23–50, 165–215, figs.).

In the Caucasus, *Juglans* is represented by the Common Walnut, *J. regia*, occurring throughout Transcaucasia on the mountain slopes in the deciduous forests, sometimes ranging to an altitude of 1500 metres above the sea but only in the form of the cultivated tree reverted to its wild condition.[1] It apparently represents a survival of ancient native cultivation, became acclimatized and disseminated in the forests and although cut without discrimination is still preserved thanks to its high reproductive power. Remains of some kind of dwelling denoting the former presence of man, as a stone wall, broken bits of pottery, may usually be found in the vicinity of Walnut trees. Until quite recently *J. regia* L. has been considered indigenous to Talysh alone on the Persian frontier, but the latest investigations and observations of Prof. A. A. Grossheim, a well known specialist on the Talish flora, show that even in that locality the Walnut was formerly a cultivated tree. In any case, the range of the above mentioned species throughout the Caucasus and the diverse varieties, both wild and cultivated, require a detailed study.

Juglans regia L. is likewise found in the western part of Turkestan,[2] namely in the wooded gorges of the Kopet-Dag mountains. The arboreal vegetation of these gorges is but a scanty remnant of the former Astrabad moist forests. Here *Ficus carica* L., *Punica granatum* L., *Zizyphus vulgaris* L. are met with, as well as certain Caucasian plants, such as *Allium paradoxum* Don, peculiar but to the dense Transcaucasian virgin forests and a special form of *Iris acutiloba* C. A. M. separated as a distinct species. The influence of man having been exerted since a very early period, and several waves of peoples having left traces, it is sometimes difficult to decide whether the huge old Walnuts so often met with near brooks and streams are cultivated or wild trees. In any case, the region mentioned forms the extreme northern limit of *J regia* L. Further East this species is supplanted by a closely related one, *J. fallax* Dode, characterized by small rounded hard-shelled fruit with a small kernel. This species is spread all over the Tian-Shan, namely the Pskem-Ugam mountains, the Chatkal and Fergana chains as likewise the Tadjikistan mountains (Gissar and Darvaz). In all these regions *J. fallax* enters into the composition of the broad-leaved forests forming its first story. In these forests the Walnut is associated with other trees, such as various representatives of the Maple (*Acer Semenowi* Regl. & Herd., *A. turkestanicum* Pax), Ash (*Fraxinus potamophila* Herd. and *F. sogdiana* Bge.), numerous varieties of the Apple-tree, with an underwood of various shrubs, such as: *Prunus cerasifera* Ehrh., *Prunus Mahaleb* L., the endemic shrub *Exochorda Korolkowi* Lavallé, *Evonymus Semenowi* Rgl. & Herd., *Abelia corymbosa* Reg. & Schmalh. and a number of others.

It seems worth noting that among the herbaceous vegetation are commonly found such northern forest plants as *Brachypodium silvaticum*

[1] It should be noted that in western Europe the Walnut ranges to the altitude of 1100–1300 metres, in the Tyrol of 1255 metres, in the Jura of 1070 metres.

[2] Nekrassowa, V. L. The genus Juglans in Turkestan. (Bull. Appl. Bot. xviii. 301 [1928]).

(Huds.) P. B., *Agropyrum caninum* (L.) R. et S., *Poa nemoralis* L., *Geranium silvaticum* L., *Brunella vulgaris* L., *Trifolium pratense* L., *Potentilla reptans* L., *Crepis sibirica* L., *Picris hieracioides* and others. Among the commoner plants is the shade-seeking *Impatiens parviflora* DC., a native of Turkestan, well acclimatized in western Europe and always found near dwellings.

In these forests, spreading over valleys and mountain gorges, Walnuts are always connected with damp and abundantly watered localities in the vicinity of water. The soils under these forests are very interesting: they are of a dark colour with a violet tinge, have a large content of humus and a peculiar structure. Occasionally Walnuts ascend on mountain slopes to a considerable altitude, up to 1850 or even 1915 metres, but always in damp places. In spring during the blossoming of apple- and plum-trees, walnut forests present a lovely sight, while in autumn, when all the trees and bushes are covered with ripe fruit they recall a beautiful garden. The local inhabitants call them "gardens" and during the summer months come to them for a rest-cure from the heat and malaria, while in autumn they are visited for collecting different fruits.

J. fallax Dode in Turkestan and *J. regia* L. in the Caucasus bear edible fruits which are exported in great quantities to the large towns of the Union. The leaves are used for medicinal purposes and the unripe husk yields a brown dye employed by the natives for dying homespun materials. But the greatest value of the Walnut lies in the wood itself and especially in the burl, an overgrown knot or excrescence on the trunk, which is greatly valued for veneer by cabinet-makers. Large quantities of burl are annually taken off the trees and exported to other countries.

Throughout the Caucasus and Turkestan, in every garden trees of *J. regia* L. may be met with, while a closely related species—*J. kumaonia* Dode—with very large fruits highly valued in the trade is sometimes found in the Zeravshan.

Outside the boundaries of the Union of S. S. R. *J. regia* L. extends over the Balkan peninsula, Asia Minor and Persia; *J. fallax* Dode into Persia, Baluchistan and India (according to Dode).

Under somewhat different conditions and in other surroundings occurs in the Far East the section of *Cardiocaryon*[1] consisting of *J. mandshurica* Maxim., *J. stenocarpa* Maxim., and *J. cathayensis* Dode. These three species closely related to each other are often treated as one under the determination of *J. mandshurica* Maxim.[2] And yet, they exhibit certain dissimilarities. Thus, *J. mandshurica* has viscid female flowers covered with glandular hairs, young leaves thickly covered with glands, and mature leaves

[1] Wolf, E. Die mandschurischen Wallnüsse. (Mitt. Leningrad Forstinst. xxxiii. [1926]).
Skvortzow, B. W. Fragmenta Florae Manshuriae. (Bull. Jard. Bot. Princ. U. R. S. S. xxvi. [1927]).
Wolf, E. Die mandschurischen Wallnüsse. (op. cit. xxvii. 349–352. [1928]).
Strogi, A. A. The manchurian walnut. (Bull. Appl. Bot. xviii. no. 2, p. 247–302 [1928]).
Skvortzow, B. W. The Manchurian Walnut. (Manch. Research Soc. ser. A., fasc. 32 [1929]).
[2] Komarov, V. Act. Hort. Petrop. xxii. 9 (Fl. Manshur. ii. [1903]).

with a glabrous upper surface, while the narrow elongated leaflets are acuminate, the fruits being ovate, of a dirty brown dull colour and show numerous uneven cavities. The flowers of *J. stenocarpa* Max. are thickly covered with hairs being destitute of glands; the young leaves are tomentose, the mature leaves covered with stellate hairs, the leaflets being short and acuminate, the fruit elliptical, glossy and brown with 4 large equal and several smaller cavities. The third species, *J. cathayensis* Dode, is related to *J. stenocarpa* Maxim, but differs in having hard thick, less hairy leaves with smaller indentations; the venation of the leaves is more pronounced; the testa of the seed dark brown, the fruit having a more constant form and numerous cavities. All these features are described by E. Wolf from his observations of species grown at the nurseries of the Institute of Forestry and at the Botanical Garden of Leningrad.

In the Far East the Walnut grows in the valleys of rivers and small streams being most frequently found in abundantly watered gullies and narrow gorges and occurs in mixed forests containing *Pinus koraiensis, Abies holophylla, Picea ajanensis, Acer mandshuricum, A. Mono, Fraxinus mandshurica, Ulmus campestris* and others, as well as in purely deciduous forests without any admixture of conifers. The Manchurian Walnut likewise occurs on river banks among a growth of various Willows, *Alnus hirsuta, Ulmus pumila, Prunus padus,* all the trees and shrubs there being entwined by the climbing plants of *Vitis amurensis, Calystegia rosea, Cuscuta japonica* and of other lianas; on the northern confines of its range it affects rocky slopes. It should be noted that in these regions the Walnut does not form pure close stands, but occurs in scattered individuals among the trees of the first story and even in the underbrush. It does not seem to ascend the mountain above an elevation of 300 metres. As it recedes from the centre of its range *J. mandshurica* exhibits a tendency to grow on southern well insulated slopes and gradually ceases to produce ripe fruit. The northern limits of its range appear to be the lower reaches of the rivers Bureja and the Girin, the neighborhood of Sofijsk and Borbi (51° 15′ N. L.), while single specimens may be found on the upper and middle reaches of the river Tumdja which falls in to the Soviet Harbor (49° N. Lat.). Outside the Union of S. S. R. *J. mandshurica* Maxim occurs on the mountains of Manchuria (Chan-Guan-Wai-Lin) and of the Small Khingan, in northern Korea and in Jegol on the Eastern frontier of Mongolia. The geographical range of the two other species is not yet ascertained. Maximovicz[1] has recorded *J. stenocarpa* from the boundaries of Korea and, according to Dode, *J. cathayensis* Dode has an extensive range from the Amur to Szechuan and Hupeh, but as many specimens of *J. mandshurica* Maxim. from the Amur have been relegated by this author to *J. cathayensis* Dode, this indication needs further confirmation. Skvortsov[2] who has studied these trees in Manchuria maintains that they are

[1] Maximowicz in Bull. Acad. Sci. St. Pétersb. xviii. 57–59 and in Mél. Biol. viii. 630–632. (Diagn. Plant. Nov. Jap. Mandsh. Dec. xii.) (1872).

[2] Skvortzow, B. W., l. c.

there represented but by *J. mandshurica* Max. which in that region is distinguished by the form of fruit being subject to much variation.

All three species mentioned yield a very valuable wood for cabinet work as well as for aeroplanes and gunstocks but fail to produce burls similar to those of *J. regia* L. and *J. fallax* Dode. On account of the great strength of the timber the Koreans of Nikolsk-Ussurisk manufacture a special kind of wooden shoes called ni-van-seni from this tree. In consequence of the small size of its kernel and the hardness of the shell the nuts, although containing a high proportion of oil are seldom eaten. As an ornamental tree the Manchurian walnut is of much value on account of the rapidity of its growth, its capacity of developing a fine crown when growing in the open, longevity, freedom from infection and adaptability to different climates. Thus, the Manchurian walnut grows, for instance, in those parts of Manchuria where the mean annual temperature is but 2.6°, the winter being extremely cold, the summer hot and rainy and the period of vegetation only lasting 151 days.

Pterocarya, the other genus of Juglandaceae, consists of 7 species occurring chiefly in Central China (5 species), one species in Japan and *P. caucasica* C. A. Mey in the Caucasus and in Northern Persia. Within the Caucasus, *P. caucasica* is, like the Walnut, met with in the forests of Kolkhida and Lencoran, but while the Walnut is always connected with mountain slopes, this tree, on the other hand, grows but in very damp places chiefly along the river valleys. In western Transcaucasia, *P. caucasica*[1] occurs in the Batum lowlands, in Guria, Mingrelia, Imeretia, Abkhazia and the Chernomorsk government, the northern limit being the lower course of the river Shakhé near Sochi and its eastern near the town of Kutais. Within its range in all these regions this tree never ascending even the nearest foot hills occurs exclusively in swampy or low lying country subject to continuous flooding and it grows among alders—*Alnus glutinosa* Gaertn., various Willows and the Caucasian Blackberry, *Rubus caucasicus*, under whose shade flourish innumerable plants of the fern *Matteucia Struthiopteris*. *Pterocarya caucasica* C. A. Mey likewise grows in Georgia all over the valley of the river Alazan; in Azerbeidjan on all the lowlands adjoining the foot-hills as far as the Nukha and probably occurring in the region of the river Kuba. In Talysh[2] *P. caucasica* C. A. Mey grows along the banks of streams as well as on the sea coast in swampy places overgrown with *Alnus barbata* C. A. M. A number of various lianas and the endemic Lencoran Blackberry, *Rubus Raddeanus* Focke, characterize these forests. *Pterocarya caucasica* C. A. Mey thrives also in the forests of the lower and sometimes middle mountain zones, where the soil at the bottom of the gorges is ever moist, and torrential streams appear after heavy rain. The chief denizens of these forests are the "iron tree," *Parrotia persica* C. A. M., and the majestic Ghirkan, *Acer insigne* Boiss., characteristic of these

[1] MEDWEDJEW. Trees and busches of the Caucasus. (1919).
[2] GROSSHEIM, A. The vegetation and the flora of Talysh. (Tiflis, 1926).

Clumps of Juglans regia L. in the valley of the Abashy River in Mingrelia, Western Caucasus.

Old planted tree of Juglans regia L. in Krasnaya Polyana, western Caucasus.

woods. Among the elements of the mountain forest should also be mentioned *Carpinus Betulus* L. and *Quercus castaneaefolia* C. A. Mey., as well as the Alder, *Alnus subcordata* C. A. Mey., typical of coast region forests. In the herbaceous covering are conspicuous the endemic plant of Ghirkan, *Solanum Kieseritzkii* C. A. Mey., the rare *Myriactis Gmelini* DC., while the most widely diffused are *Ilex aquifolium* L., *Danaë racemosa* (L.) Moench and various ferns which attain a luxuriant growth and frequently predominate over other types.

Beyond the Union of S. S. R. *P. caucasica* C. A. Mey., occurs but in the damp forests of northern Persia.

Pterocarya caucasica grows with great rapidity, lives long and reaches huge dimensions (up to 1 or 1.5 metres in diameter). Its wood is soft and not durable and is therefore used but for the manufacture of domestic articles such as cups, bowls, trays, tubs, troughs, etc. while shoes and cords for fastening boughs of growing vine as also shingles for roofs are made from its bast. The bark yields a very good tanning material. This tree is now being planted in moist places and along canals and ditches.

Botanic Garden, Leningrad, U. S. S. R.
July 1929.

CHROMOSOME NUMBER AND BEHAVIOR IN THE GENUS SYRINGA

Plate 21

Karl Sax

Most of the horticultural varieties of *Syringa* have been obtained from the species *vulgaris*, although *S. persica* and some of the Villosae lilacs are of considerable horticultural importance. The majority of the other species are not commonly grown, although some of them have considerable merit especially from the plant breeders standpoint. *Syringa pubescens* is one of the most fragrant of all lilacs but the flowers are not so attractive as those of the Common Lilac. *Syringa pinnatifolia* is also very desirable because of its unusual foliage and habit of growth, but the flowers are borne in small clusters and are rather inconspicuous. These two species should be especially valuable for breeding work. Combinations of the early blooming *vulgaris* varieties with the late Villosae species would undoubtedly be of value if they could be made. The Persian lilacs also offer interesting possibilities if they could be used in crosses with other species.

Considerable breeding and selection has been done with *S. vulgaris* and hundreds of new varieties have been introduced during the past fifty years. The work of Lemoine in France has been most conspicuous. New varieties have also been developed by John Dunbar in Rochester, New York, and by several nurserymen in Germany and Holland. Crosses have also been made between different species but comparatively few of the horticultural varieties have been originated in this way. *Syringa chinensis*, one of the earliest species hybrids in the genus, is a hybrid between *S. persica* and *S. vulgaris*. Lemoine crossed *S. oblata* and *S. vulgaris* and obtained a number of desirable varieties which are known under the name *hyacinthiflora*. Miss Preston in Canada crossed *S. reflexa* and *S. villosa* and obtained desirable new varieties. The cross between *S. Josikaea* and *S. villosa* is known as *S. Henryi*, after the hybridizer, and some of these hybrids have considerable merit. In all cases the above crosses have been made between closely related species.

Attempts to cross species of the Vulgares group with those of the Villosae group have been made by Lemoine, Miss Preston, Skinner and others but, according to Mrs. McKelvey (4), hybrids have never been obtained between these two groups of lilacs.

According to Rehder (5) there are about 25 cultivated species of Syringa. *Syringa vulgaris* and *S. Josikaea* are native of southeastern Europe, *S. persica* is naturalized in western Asia, and *S. emodi* is indigenous on the western Himalayas. All other species are from eastern Asia.

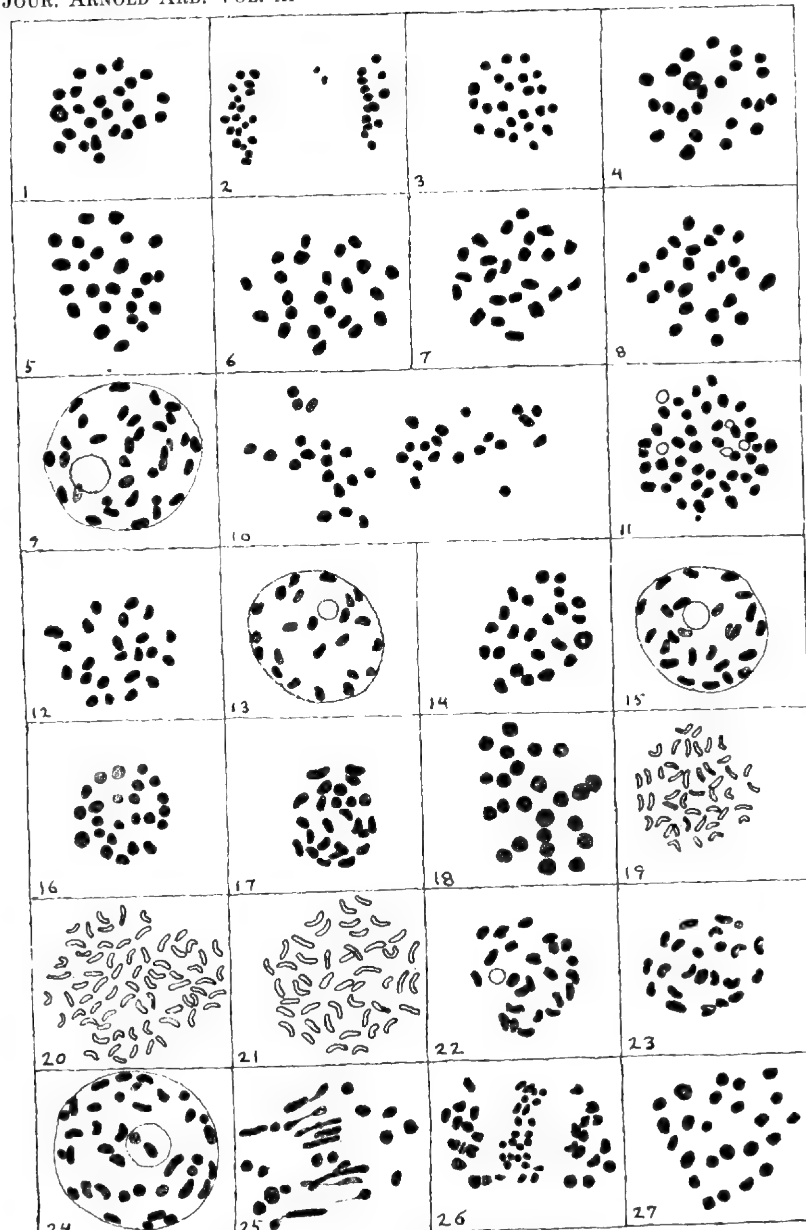
The genus *Syringa* is divided into two subgenera, Eusyringa (K. Koch) and Ligustrina (Rupr.). The first subgenus is further divided into two groups, Villosae (Schneid.) and Vulgares (Schneid.). The Villosae group contains the species *emodi, yunnanensis, Josikaea, Wolfii, Sweginzowii, villosa, tomentella, reflexa*, and *Komarowi*. The Vulgares group includes *Julianae, velutina, microphylla, Palibiniana, pubescens, Meyeri, oblata, vulgaris, chinensis, persica* and *pinnatifolia*. The subgenus Ligustrina contains only three species, *pekinensis, amurensis* and *japonica*.

THE VULGARES GROUP

Syringa vulgaris shows some variation in chromosome number. The variety "Beranger" has 24 pairs of chromosomes which divide regularly in the reduction divisions of the pollen mother cells. The chromosomes at the metaphase of the heterotypic division are shown in figure 1. One pair of chromosomes is consistently larger than the others and can usually be identified in most of the Vulgares species.

In the variety "Dr. Nobbe" there are 23 bivalents and one univalent at reduction. In figure 2 the bivalents are shown at the poles, although they cannot be counted in this figure, and the lagging split univalent is shown. In figure 3 the 23 chromosomes are shown at one pole. In this cell 23 chromosomes could be counted at each pole with the lagging chromosome between. The same type of chromosome behavior was found in the variety "Princess Marie."

There are 24 pairs of chromosomes in *S. pinnatifolia* including a large pair similar to that found in the vulgaris varieties. Chromosome behavior is regular during the reduction divisions. Figure 4 shows the chromosomes at the first metaphase. *Syringa pubescens* also has 24 pairs of chromosomes (fig. 5).



Chromosome number in the genus Syringa.

In *S. oblata Giraldii* there are apparently 24 paired chromosomes at diakinesis but only 23 could be counted at the telophase of the first reduction division (fig. 6). In no case were lagging chromosomes observed. Only 23 pairs of chromosomes were found in *S. Meyeri.* The chromosomes at first telophase are shown in figure 7. There are 24 pairs of chromosomes in *S. Palibiniana* at the first metaphase as shown in figure 8. There are 23 pairs of chromosomes at first metaphase in *S. velutina* (fig. 14) and in *S. Koehneana* (fig. 12). According to Rehder, *Koehneana* should be classed under *velutina.*

No counts were obtained from *S. microphylla* but the size of the pollen grain is the same as the other pure Vulgares species so that it presumably has 23 or 24 chromosomes.

All of the above species have been found growing spontaneously in Asia or southeastern Europe. *Syringa persica,* however, is usually found only as a cultivated plant and these forms are sterile; Meyer found a form of *persica* which is fertile growing wild in Kansu province, China. This spontaneous plant is similar to the cultivated variety *laciniata. Syringa persica* and its varieties *alba* and *laciniata* have sterile pollen and the chromosome behavior is very irregular in the reduction divisions. Unfortunately no chromosome counts were made of the spontaneous form but it has apparently normal pollen and the pollen grain size indicates that the chromosome number is the same as in the species already described.

In *S. persica* there are about 36 chromosomes at diakinesis as shown in figure 9. Similar counts were also obtained in the varieties *alba* and *laciniata.* At the heterotypic division there is usually no pairing of chromosomes and the single chromosomes apparently pass at random to one pole or the other. Such a stage in *S. persica* is shown in figure 10. In a number of cases where the division was almost completed approximately 18 chromosomes could be counted at either pole although in some cases the number varied considerably. In one pollen mother cell there were about 36–39 single chromosomes at metaphase, but occasionally several paired chromosomes could be seen. In *S. persica laciniata* about 44 chromosomes were counted in one cell (fig. 11), but usually the counts were the same as in the other two forms of the species. In the second division there are often from one to three lagging chromosomes but these were usually split. At times all of the chromosomes at the second division seem to be combined in one division figures and diads are found instead of tetrads. When tetrads are formed they usually show some irregularity in the size of the microspores.

Syringa chinensis is supposed to be a hybrid between *S. persica* and *S. vulgaris.* In the variety *Saugeana* there are about 39 chromosomes at diakinesis (figure 24). At metaphase there are usually 24 to 26 chromosomes. In one case there were clearly 24 chromosomes including one large pair typical of the species of the Vulgares group (figure 27). At the heterotypic division it was found that about half of these chromosomes were paired and the other half singles. In figure 25 there are about 13 pairs and 13 singles seen in a side view of the heterotypic division. In the variety *cucullata* typical lagging chromosomes were observed and the number of bivalents and univalents is the same as found in *Saugeana*. In figure 26 the paired chromosomes are shown after they have divided and passed to the poles while the split univalents are just beginning to divide. Only a few lagging chromosomes were observed at the second division but the tetrads usually show a few lost chromosomes in the cytoplasm.

THE VILLOSAE GROUP

Syringa villosa has either 23 or 24 pairs of chromosomes but an exact count could not be obtained. Counts of *S. Josikaea* are available only from root tip material but it is clear that there are 46 somatic chromosomes (fig. 21). *S. Henryi* "*Lutèce*" is a hybrid between *villosa* and *Josikaea*. It has 23 pairs of chromosomes which behave regularly during the reduction division. The chromosomes at the late telophase of the heterotypic division are shown in figure 13.

Syringa Sweginzowii has 23 pairs of chromosomes as indicated by the figure (15) showing the chromosomes at the late telophase of the first reduction division. One plant of *S. yunnanensis* has 24 pairs of chromosomes as shown in figure 16 but in another plant about 68 somatic chromosomes were found in the root tip (fig. 20). The triploid condition of this plant may be due to somatic mutation although the chromosome count was consistent in the roots examined.

There are 23 or 24 chromosomes in *S. tomentella*. A late telophase stage is shown in figure 17. *S. Komarowi* has 23 pairs of chromosomes which are represented at metaphase in figure 18. Only somatic counts are available for *S. Wolfii* but there are apparently 46 somatic chromosomes in this species (fig. 19).

THE LIGUSTRINA GROUP

The species of the subgenus Ligustrina have the same chromosome number as the other pure species of the genus. Both *S. amurensis* and *S. japonica* have 23 or 24 pairs of chromosomes. The chromosomes at late telophase are shown in figures 22 and 23. No counts were obtained of *S. pekinensis*, but they are very probably the same as the other two species in this group of lilacs.

In all of the species examined with the exception of *S. persica* and *S. chinensis* the pollen grains appeared to be perfectly normal. The size of the pollen grains were the same in all of the pure species.

DISCUSSION

So far as chromosome number is concerned there is apparently no reason why crosses can not be made between species in different groups or subgenera of *Syringa*. Although numerous attempts have been made to cross species of the Villosae group with those of the Vulgares group no hybrids have ever been produced. There is no record in Mrs. McKelvey's monograph concerning hybrids between the subgenera of *Syringa*. Crosses were made this year between *S. reflexa* and *S. amurensis* which have produced seeds, but it is too early to know whether the seeds are viable or if a hybrid has been produced. It may also be possible to cross species of the Ligustrina subgenus with species of *Ligustrum*. They are taxonomically very similar except in fruit characters and the chromosome number of all species of *Ligustrum* investigated is the same as found in the pure Lilac species. Crosses have been made between these two genera by Henry but no hybrids were obtained. Crosses between *Syringa* and the related genus *Forsythia* have also been made but did not produce seed. It is very improbable that this cross can be made because all Forsythia species examined have 28 somatic chromosomes.

Syringa pubescens has never been known to set seed in the Arnold Arboretum, although its chromosome behavior is regular and it forms apparently perfect pollen. Only a small amount of seed was set on *S. pinnatifolia*. It is unfortunate that these two species are so unfruitful here since they are among the most valuable for breeding work. Both species were crossed with all other species in the Villosae and Vulgares groups but few seeds were set. These species are not self sterile because single plants set seed in other localities, but the sterility here is probably due to physiological causes. They are both fertile in their native habitat and in cultivation in other localities. All of the other species are fertile and usually set seed in the Arboretum. Most Lilac species seem to be self fertile although *S. oblata* is said to be self sterile.

The chromosome behavior in *S. chinensis*, where there are approximately 12 paired and 12 single chromosomes, suggests that 12 is the fundamental number in the genus. This view is also supported by the fact that there are about 36 chromosomes in *S. persica*. In the Vulgares varieties there may be either 23 or 24 pairs of chromosomes or varieties may have 23 pairs and on univalent. Apparently the species and varieties with 23 bivalents have originated through the loss of a pair of chromosomes in a tetraploid parent. This variation is chromosome number is not limited to any one group in the genus.

Syringa chinensis (also known as *S. rothomagensis*) is believed to be a natural hybrid between *S. persica laciniata* and *S. vulgaris*. It was first obtained in 1777 by Varin, director of the Botanical Garden at Rouen, from seeds of *persica*. These seeds always produced the *chinensis* type. Varin believed that *chinensis* was a variety of *persica* but Henry in 1900 (2) and Lemoine in 1900 (3) described crosses between *persica* and *vulgaris* which produced *chinensis*.

The variety *Saugeana* originated in Varin's cultures. The Arboretum plant was obtained from Spaeth's nursery in 1900. *S. chinensis* is usually completely sterile although seeds have been reported on this species and

30 seeds grown at the Forestry Institute in Italy are reported to have produced plants of the *chinensis* type. This species has never set seed in the Arboretum.

If *S. chinensis* is a hybrid of *persica* and *vulgaris* the *persica* parent must have contributed about 12 chromosomes since there are approximately 12 bivalents and 12 univalents in chinensis.

Syringa persica laciniata in the Arnold Arboretum has 36–39 univalents and produces sterile pollen. According to Mrs. McKelvey this plant (no. 1036–2) has flowers identical in color with those of *S. persica*. She believes that it was grown from a cutting of *persica* with a preponderance of laciniate leaves. It was propagated from cuttings received from Hooper Bros. Pennsylvania in 1905. The cytological work tends to confirm Mrs. McKelvey's opinion.

The spontaneous *S. persica laciata* is represented in the Arnold Arboretum by plant number 18,537 from the U. S. Dept. of Agriculture and originally from seed sent from China. Unfortunately no chromosome counts were obtained from this plant but it has perfect pollen and the pollen grain size suggests that there should be about 24 pairs of chromosomes although judging from the counts in *S. chinensis*, it should have about 12 pairs of chromosomes.

Syringa persica and the variety *alba* are undoubtedly hybrids. They usually have 36 single chromosomes which behave irregularly at reduction and the pollen is sterile. In some cases there are a few paired chromosomes and in these cases the chromosome behavior resembles that found in *chinensis*. Henry (2) believes that *S. persica* is a hybrid between *S. persica laciniata* and *S. vulgaris*. The cytological work supports this opinion since the chromosome number is about the same as in *S. chinensis* and in some cases the behavior at reduction is very similar. Perhaps different forms of the parental species would account for the taxonomic differences found between *chinensis* and *persica*.

The variety *laciniata* is certainly the only pure species in the *persica* group and it is the only one which has been found growing spontaneously. This form was introduced from Persia into southeastern Europe where it apparently crossed spontaneously with the native *vulgaris* and produced the hybrid forms, *persica* and *persica alba*. If the hybrid forms of persica originated in this way they should be classed as varieties of *S. chinensis*. The variety *laciniata* should be considered as the only true type of *persica*.

The chromosome behavior in the *persica* hybrids also indicates that the variety *laciniata* has 12 pairs of chromosomes, although the rare occurrence of pollen mother cells with as many as 44 chromosomes at the first reduction division may call for some other explanation of the chromosome complex.

The cytological work indicates the reason for sterility in *Syringa persica* and *S. chinensis*. The variety of *persica* introduced from China by Meyer is the only one which might be of value for breeding work, since it is the only one with good pollen. However, numerous crosses were made with this form both as the seed and pollen parent but no seeds were obtained. The plant set no seeds in the Arboretum this year. In China it produces seed since it occurs spontaneously and seeds have been collected there, and in some years it produces seed in the Arboretum.

SUMMARY

Most of the pure species of *Syringa* have either 23 or 24 pairs of chromosomes. In several *vulgaris* varieties there are 23 bivalents and 1 univalent. Apparently the species and varieties with 23 bivalents have lost a pair of chromosomes.

Syringa chinensis, which is a hybrid between *S. persica laciniata* and *S. vulgaris,* has about 12 paired and 12 single chromosomes at the first reduction division although the chromosome number and the amount of pairing is somewhat variable.

Syringa persica and the variety *alba* are undoubtedly hybrids. The chromosome number and behavior is similar to that found in *S. chinensis* and it seems probable that these forms of *persica* have also been derived from crosses of *S. persica laciniata* × *S. vulgaris. Syringa persica laciniata* is the only pure species of the *persica* group. The chromosome counts in the hybrids indicate that the *laciniata* parent contributed 12 chromosomes to the F_1 hybrids.

LITERATURE CITED

1. Borgenstam, E. (1922). Zur Zytologie der Gattung Syringa nebst Erörterungen über den Einfluss äusserer Faktoren auf die Kernteilungsvorgänge. (Arkiv. Bot. Bd. **17**: 1–27. 1 taf.)
2. Henry, L. (1900). Crossings made at the Natural History Museum of Paris from 1887 to 1899. (Jour. Roy. Hort. Soc. **24**: 218–236.)
3. Lemoine, E. (1900). Hybrids between the common lilac and the laciniated Persian Lilac. (Jour. Roy. Hort. Soc. **24**: 299–311.)
4. McKelvey, S. D. (1928). The Lilac. McMillan Co., New York. 581 pp. 172 pl.
5. Rehder, A. (1927). Manual of cultivated trees and shrubs. McMillan Co., New York. 930 pp.
6. Tischler, G. (1926). Allgemeine pflanzenkaryologie. Borntraeger, Berlin. 899 pp.

DESCRIPTION OF PLATE

All figures of reduction divisions made from permanent smears except figure 18 which is from an aceto-carmine preparation. Magnification about 2500 ×.

Fig. 1. Syringa vulgaris "Beranger." First metaphase with 24 pairs of chromosomes.

Fig. 2. S. vulgaris "Dr. Nobbe." Telophase with one univalent lagging chromosome.

Fig. 3. Same variety with 23 chromosomes at one pole in early telophase.
Fig. 4. S. pinnatifolia. 24 chromosomes at metaphase.
Fig. 5. S. pubescens. 24 chromosomes at metaphase.
Fig. 6. S. oblata Giraldii. 23 chromosomes at telophase of first division.
Fig. 7. S. Meyeri. 23 chromosomes at telophase.
Fig. 8. S. Palibiniana. 24 chromosomes at metaphase.
Fig. 9. S. persica. Diakinesis.
Fig. 10. S. persica alba. Irregular division of univalents.
Fig. 11. S. persica laciniata?. Metaphase.

Fig. 12. S. Koehneana. 23 chromosomes at metaphase.
Fig. 13. S. Henryi "Lutèce." 23 chromosomes at telophase.
Fig. 14. S. velutina. 23 chromosomes at metaphase.
Fig. 15. S. Sweginzowii. 23 chromosomes at telophase.
Fig. 16. S. yunnanensis. 24 chromosomes at metaphase.
Fig. 17. S. tomentella. 24 chromosomes at metaphase.
Fig. 18. S. Komarowi. 23 chromosomes at metaphase.
Fig. 19. S. Wolfii. 46 somatic chromosomes.
Fig. 20. S. yunnanensis. 68 somatic chromosomes.
Fig. 21. S. Josikaea. 46 somatic chromosomes.
Fig. 22. S. amurensis. 24 chromosomes at telophase.
Fig. 23. S. japonica. 23 chromosomes at diakinesis.
Fig. 24. S. chinensis Saugeana. 39 chromosomes at diakinesis.
Fig. 25. S. chinensis Saugeana. Bivalents and univalents at first reduction.
Fig. 26. S. chinensis cucullata. The 13 bivalents have divided. The univalents are beginning to divide.
Fig. 27. S. chinensis Saugeana. 24 chromosomes at metaphase. Presumably half of these are univalents.

CHROMOSOME NUMBER IN THE GENUS FORSYTHIA

JOSEPH O'MARA

THERE are, according to Rehder (1) six species of *Forsythia*. They are *suspensa*, *intermedia*, *viridissima*, *europaea*, *ovata* and *S. Giraldii* which is not in cultivation. The chromosomes of the five species in cultivation and their varieties were counted to determine if there was any relation between the chromosome number in *Forsythia* and the number in the closely related genera, *Syringa* and *Ligustrum*. It would also be of interest to know if the *Forsythia* species were inter-fertile, since a hybrid with the flowers of *intermedia spectabilis* and the hardiness of *ovata* would be of no little ornamental value.

The chromosomes could be counted satisfactorily by use of the iron-aceto carmine method described by Belling (2). The chromosomes were counted at the heterotypic metaphase and in some cases at the homotypic telophase.

The following counts were obtained:

Forsythia suspensa	14	Forsythia intermedia	14
var. Sieboldii	14	var. vitellina	14
var. Fortunei	14	var. primulina	14
var. decipiens	14	var. spectabilis	14
var. pallida	14	var. densiflora	14
var. atrocaulis	14	Forsythia viridissima	14
var. pubescens	14	var. koreana	14
		Forsythia europaea	14
		Forsythia ovata	14

In *Forsythia intermedia*, a hybrid between *F. suspensa* and *F. viridissima*, each parent contributed fourteen gametic chromosomes. These fourteen chromosomes proved to be perfectly compatible and no lagging was observed at either the heterotypic or homotypic divisions.

Since the gametic chromosome number in *Syringa* and *Ligustrum* is usually twenty-four it is obvious that the relation between the genus *Forsythia* and the genera *Ligustrum* and *Syringa* is a rather distant one.

LITERATURE CITED

1. Rehder, A. (1927). Manual of cultivated trees and shrubs. McMillan Co., New York. pp. 749–750.
2. Belling, J. (1926). The iron aceto carmine method of fixing and staining chromosomes. (Biol. Bull., **50**: 160–161.)
3. Sax, K. (1930). Chromosome number and behavior in the genus Syringa. (Jour. Arnold Arb. **11**: 7–14.)

THE WOODY PLANTS OF SIGUATEPEQUE, HONDURAS

Paul C. Standley

During the winter of 1927–28 I was engaged in botanical exploration of the northern or Atlantic coast of Honduras, as the result of a coöperative agreement between the U. S. National Museum and the Arnold Arboretum, with the assistance of the United Fruit Company. Most of the season was devoted to an investigation of the flora of Lancetilla Valley, near Tela, in the Department of Atlántida, but toward the end of the winter a short collecting trip was made to the interior of Honduras.

Because of the limited time available for the visit, it was necessary to confine collections to a rather thorough exploration of a single locality, the vicinity of Siguatepeque, a small town in the Department of Comayagua, but a trip was made by automobile to the capital, Tegucigalpa, and it was thus possible to obtain a representative cross section of the vegetation of almost the whole extent of Honduras. This cross section does not show the variety that exists in a similar section across Guatemala or Costa Rica, but it does present many points of interest, and is rather typical of the vegetation of any given line drawn across Central America above Nicaragua.

The trip to Siguatepeque, despite the customary difficulties of transportation in this part of Honduras, was made in almost record time. It could have been made by the airplanes operated to the interior by the Tela Railroad Company, but airplane travel does not permit the attention to detail that is desirable in the case of systematic botanists, and it was deemed preferable to pursue the more prosaic but more practical and usual transportation routes. With the coöperation of the courteous officials of the Tela Railroad Company it was possible to make the whole trip to Siguatepeque in one day, a rather prolonged and hurried one, it is true, but still a single day.

Leaving Tela at three on a chilly moonlit February morning, in an already familiar motor car, a Ford which ran on the tracks of the banana railroad, we rode rapidly through the heavy wet tropical forest and banana plantations, the latter, as always, silvered by the moonlight, and past swamps enveloped in fog, above which the Cohune and Royal Palms projected unsubstantially. Through more bananas we passed, then along the broad, sluggish, brown Ulua River, and finally, as day was breaking, reached the inland town of Progreso.

Here our baggage was transferred to an automobile, and we rode with it to the banks of the Ulua. The stream we crossed on a flat-bottomed ferry boat, propelled by ropes and current. On the other bank we took a train, operated by a different banana company, and rode through still more fields of bananas, past plantations of light green sugar cane, and across pasture land whose trees were cut long ago.

The country on the west bank of the Ulua is much drier than the Tela region. There appear here such trees as the Guanacaste or Ear-tree (*Enterolobium cyclocarpum*), Castaño (*Sterculia apetala*), *Cochlospermum vitifolium*, with its brilliant flowers like yellow roses, and the Coyol Palm (*Acrocomia mexicana*).

Soon after leaving the river we neared the high hills, which from here southward are clothed chiefly with Pines. It is probable that the Pines on the hills nearest the coast are Cuban Pine (*Pinus caribaea*), but those farther inland are mostly *P. oocarpa*.

The distribution of Pines in Central America deserves further and careful study. The genus ranges southward into Nicaragua, but does not reach Costa Rica, although Pines often are planted about fincas in the mountains of the latter country. In some places along the Atlantic coast of Central America, as in British Honduras, and in Nicaragua, near Cape Gracias a Dios, Pine trees come to the edge of the sea, and rise high above the rocks which jut into the ocean. In other places, as here in Honduras, they do not approach within fifty miles of salt water. Probably the distribution is explainable by soil conditions, for manifestly Pines will not grow in swamp lands, such as those in which bananas thrive.

As we went farther inland, toward the foothills, the evidently drier country recalled somewhat the plains along the Pacific coast in Guatemala and Salvador. At noon we reached the railroad terminal at Potrerillos, and after a brief lunch we were off again in a *camión*, a truck fitted out as a bus.

I have seen many atrocious roads in Central America, and some of the same sort in the United States, but never have I seen one so bad as this over which it was considered possible to operate automobiles. For mules it was passable, but for motor cars it was a problem. The road was a long succession—about thirty miles—of rock ledges, mud holes of uncertain depth, and streams to be forded, all of which at first were entertaining because of their novelty and variety, but they were repeated so persistently that they soon became merely monotonous and exasperating. I am told that automobiles never fail to make the run from Potrerillos, but that sometimes it requires three days to cover the distance. We were more fortunate, since we had deliberately waited for the driest season of the year. Even at that, the road was all but impassable, and more than once we were brought to a stop by mudholes, or forced to detour through gates and pastures to avoid them. The car careened like a ship in a storm. Piercing shrieks and shrill appeals to heaven for protection, voiced by the women passengers, announced each deeper hole in the road, as we were tossed from side to side, like so many bales of goods.

Botanically speaking, the road is an entertaining one. For some distance beyond Potrerillos there is continued the vegetation that characterizes the lowlands, but the abundance of exposed rock, something almost unknown in Central American lowlands, permits the growth of certain plants which can not prosper in the coastal swamps. In swampy places here in the foothills there are dense thickets of a giant spiny Bamboo, *Guadua aculeata,* which is characteristic of the coasts of Guatemala and Honduras. In general appearance it resembles closely the common cultivated Bamboo (*Bambusa vulgaris*) of Central America, and it is quite as vigorous and majestic in its growth.

When the hills are reached, rapid changes are noticeable in the composition of the vegetation. Although it is still tropical, there begin to appear many species not seen farther coastward. The plant growth, also, is sparser than in the lowlands. The road winds through beautiful valleys and crosses picturesque streams. One of these, the Río Blanco, receives its name from the milky appearance of its current. The road crosses it just at the foot of a long succession of symmetrical cascades, so uniform as to suggest the result of human design. This river is famous for its erratic behavior. Several times in its course it disappears suddenly into the earth, to reappear farther on as a new stream, or to issue forth in a series of springs.

The road climbs rapidly over the rocky slopes as it continues, and soon it is among the Pines. Here the typical mountain vegetation begins to make its appearance, announced by such subtemperate plants as Blackberries, Salvias, Paroselas, and helianthoid Composites. The road runs for a short distance through this thin tall forest, with its dense undergrowth of herbaceous plants and low shrubs, but soon ends on the shore of Lake Yojoa.

This beautiful and isolated body of water, one of the famous scenic features of Honduras, compares favorably with the celebrated lakes of Guatemala and Salvador. Some forty miles long and less than half as wide, it is surrounded on all sides by lofty, heavily forested mountains, whose sides remain untouched by man.

Our crossing of the lake by motor launch was uneventful on this occasion, although more thrilling on the return passage. The aquatic vegetation of this body of water is exceedingly luxuriant, and would well repay any botanist who would brave the mosquitoes to investigate it. In places there are great floating masses, loosely anchored along the shores, composed of a variety of grasses, sedges, and other plants. I am informed on good authority that the American lotus (*Nelumbo lutea*) grows in this lake, but I did not see it, although there was an abundance of *Nymphaea* and *Brasenia*. One of the conspicuous trees of the borders of the marshes is the Pito (*Erythrina glauca*), covered at this season of the year with its gay orange blossoms.

We reached the opposite end of the lake and landed about dusk at a small group of huts called Pito Solo. Immediately we took an automobile for the remainder of our trip, over the mountains to Siguatepeque.

This portion of the day's journey was made in darkness, of course, but on the return trip the plant life was observed closely. On the north side of the mountains, where there is plentiful moisture, there is a curious mixture of Pines and obviously temperate plants with others, such as Aroids, which are essentially tropical. In one place I saw growing for the first time that curious Acanthaceous genus, *Louteridium*.

That night we drove serenely up the mountain side, quite unaware of the spectacular nature of the road we were following. From Lake Yojoa to the Pacific coast there is an excellent gravel highway, constructed by Honduran engineers, and there are in its course many hairpin curves above precipitous slopes that one can pass with greater complacency when they are obscured by darkness than when they are in open view.

It was a beautiful clear starry night, rather too chilly for comfort, as is commonly the case in the Central American highlands. There were few settlements along the road, but now and then we had a flashing glimpse of kitchens lighted by hearth fires, with white-clad people gathered about the smoky flames. From the mountains overhanging Siguatepeque, after passing the divide, we could scarcely make out the town, for its electric light plant was not in operation. About nine o'clock, however, we were jolted over cobblestones, and realized by this universal Central American signal that we had left the countryside and had arrived in a settlement.

I spent two weeks collecting about Siguatepeque, and enjoyed every bit of the time. Enjoyment was heightened by the clean and exceedingly comfortable little hotel, managed so competently by Don José Membreño, the most delightful place of the sort in all Central America in which it has been my privilege to be received as a guest. It stands on one side of the grass-grown plaza which surrounds the dazzlingly white parish church. The patio or courtyard of the hotel is a lovely garden, planted with orange, peach, and pear trees, and fragrant with a profusion of flowers, among which a gardener putters all day long. Its quiet is broken only by the occasional ringing of the church bells, and the quarreling of a couple of red and yellow guaras or macaws, calling to each other in endearing and honeyed terms, while doing their best to peck out each other's eyes, or tearing out the weathered red roof tiles.

Before returning to the north coast, we made the trip by automobile to Tegucigalpa, which lies only 60 miles from the Pacific and the picturesque port of Amapala, where I collected plants seven years earlier. The road to the capital, although too long and tedious, from the standpoint of transportation, and too often disagreeably dusty, is nevertheless fascinating to a botanist. For most of its length it runs through the somewhat monotonous Pine-clad mountains, climbing laboriously to a crest, then descending precipitously down another slope. One of its most impressive vistas is that across the wide valley of Comayagua, shortly beyond Siguatepeque. Never shall I forget that early morning breakfast at Sambrano, high in the Pine forests, just before the valley was reached. How cold it was just after daybreak, and how pure and bracing the air, like that of our own Rocky Mountains.

The Comayagua Valley is perhaps 50 miles across, and shut in by high hazy mountains on every side. These mountains bar the rain clouds, and the valley receives but scant rainfall—none at all, of course, during the winter, or dry season. Its general aspect is parched, and one is reminded inevitably of the famous and larger Zacapa Desert of northern Guatemala, or of the arid areas along the Pacific coast of Guatemala, and Salvador. There is the same scrubby thorn forest, of Leguminosae and other shrubs and small trees, many of which shed their leaves when the rains cease. There is little herbaceous vegetation in evidence during the dry period, although doubtless there is enough when the rains are falling almost daily, in midsummer. There are many steep exposed slopes and rocks, decorated with a stately Agave, one of the handsomest of the genus that I have ever seen. Its compact bluish clusters of neat spiny leaves form a fitting pedestal for the sturdy flower stalks and their ample panicles of yellow flowers. There are Furcraeas, too, and such a profusion of Cactuses as one finds only in Mexico, or about Zacapa in Guatemala. The arborescent forms are not so varied, but there is one columnar *Cereus* of the subgenus *Cephalocereus*, whose few thick branches are topped with straggling masses of long white hair. Still more imposing are the tree Opuntias, some of which are symmetrical trees 20 to 30 feet high, with clean trunks and dense rounded crowns of large pads. Low Opuntias grow over the plains, and there are various other Cactuses, particularly a large *Echinocactus* of the barrel cactus type.

Here and there through the brushland trees were coming into bloom at the time of our visit. Vines of the Bignoniaceae were draped in purple festoons over low trees, and blue *Petrea* supplied a welcome dash of color. The Tabebuias presented vivid masses of blossoms above the withered leaves. The rose and purple of the Macuelizo (*Tabebuia pentaphylla*), one of the finest of all Central American trees, were more conspicuous than anything else, and its relative, the Cortez (*T. chrysantha*), was equally brilliant in yellow. Madre de Cacao (*Gliricidia sepium*) trees, despite their pink flowers, recalled our Black Locust, a very close relative. Bullhorn Acacias grew here and there, with the giant Sandbox (*Hura crepitans*), whose milky sap is one of the local fish poisons. Fantastic Calabash trees (*Crescentia Cujete*) with pumpkin-like fruits were neighbors of most of the dwellings, and a few Lignumvitae (*Guaiacum*) trees were visible beyond the sleepy old town of Comayagua, once the capital of Honduras. Not the least conspicuous tree of the hillsides was the Tree Morning-glory (*Ipomoea arborescens*), with its smooth chalky bark and milk-white trumpets.

Toward Tegucigalpa there were more pine- and oak-forested hills, like those about Siguatepeque, alternating with valleys almost but not quite so arid as the desert of Comayagua. Although the Agave which I mentioned is widely distributed, I did not see any considerable number of Cactuses except about Comayagua.

The vegetation about the capital I could not investigate for lack of time, but from the road it appeared sparse and rather uninteresting. The city itself lies in a picturesque but not very agreeable site, almost in a pit, shut in by bleak mountains.

But to return to Siguatepeque, where I spent but too few days, considering the comfort and the rich collecting to be found there. The list here presented of the woody plants observed about Siguatepeque, now that I have compiled it, seems rather common-place, but the plants did not seem so when I saw them growing. I am sure that the list can be amplified substantially by further exploration extended over a somewhat wider area, especially if carried on during the rainy season. It must be remembered that in the Pine regions the great majority of species are herbaceous plants, especially Grasses and Sedges, and of these I collected a large number, including innumerable interesting forms.

Siguatepeque lies in a wide valley, at an elevation of about 1,100 meters, encircled on every side by fairly or very steep mountains, some of which must rise to 2,700 meters. The highest mountains, unfortunately, I did not have time to explore. They are so difficult of access that more than the two weeks I had available would be necessary to get any comprehensive idea of the nature of their vegetation.

The valley is quite typical of what I saw elsewhere in central Honduras. Its soil is pitifully sterile, a stiff clay which pulverizes into suffocating dust along the more traveled roads. There is a general belief elsewhere in Central America that Honduras is a rich but undeveloped agricultural region, awaiting only colonists to become a center of coffee production. No doubt there are parts of Honduras which have rich agricultural possibilities, but the country which I saw certainly will not produce coffee, and I do not believe that the most of it will ever be useful except for grazing, and not too good for that.

The Siguatepeque basin is watered well enough, by superlatively meandering streams which reappear in such unexpected directions that one can scarcely believe it when told that this is the same stream crossed previously in some distant part of the valley. The valley floor is a wide plain, with a thick growth of grass, on which the neighborhood cattle and horses pasture. Everywhere through the grass there springs up during the rainy season such a bewildering variety of tiny herbaceous plants that it seems impossible to exhaust them. I was reminded of the similar savannas which stretch beyond Panama City, and yield upon every visit some addition to their recorded flora.

Here and there over the plains are low boggy places, which in wet weather must be a true paradise for a patient botanist. Along the streams, some of which run over ledges of white stone, are narrow thickets of shrubbery and small trees, yielding a large number of species, some of them abundant and others represented only by one individual here and another far away. On the grassy plains there are only a few spiny bushes, principally Acacias. All this valley must have been modified greatly by cultivation and settlement, but how much, it is impossible to decide. Probably it was covered once with Pine and Oak trees, but this is by no means certain. In some localities there are low thickets of scrub Oaks, like similar growths in New Mexico, or in the Ozarks.

The mountain sides above Siguatepeque are the most interesting portion of the region. Even the lower slopes are still forested with Pine, for although some trees have been cut, there is only a small local demand for the timber, and no reason for cutting the trees.

The general appearance of these Pine forests is homelike to one who knows the Yellow Pine forests of the southern Rockies, in Colorado and New Mexico. The pines look just the same, also the undergrowth, consisting chiefly of low wiry grasses of the same genera which grow in New Mexico, with a generous admixture of showy-flowered herbaceous plants not very different from those of the Rockies. Salvias and Cupheas, and yellow-flowered composites, similar to Rudbeckias and Sunflowers, are most abundant. The superficial resemblance is heightened still further by colonies of Bracken (*Pteridium*), of a species different from the New Mexican one but still identical in aspect.

Small swift streams run down the slopes, and the dense thickets fringing them resemble the Rocky Mountain Alder thickets, although the genera represented are unknown in the United States, at least for the most part. Along the stream banks there are a few Orchids, of tropical rather than temperate types, and with them Ferns which would certainly be out of place in the United States. One of them is a stemless tree fern whose leaf bases are covered with thick wads of brown scales, like felt. These soft scales, or lana, are used everywhere in the region for stuffing pillows, and they make a satisfactory substitute, as I learned from experience.

The higher one goes in the mountains, the more interesting the vegetation becomes. I rode one day up toward the summit with a man who knew the region well. It was delightful to ride along the easy slopes, over a carpet of grass and pine needles liberally sprinkled with pretty flowers. The country was so open that it was not necessary to follow a road or trail, but only to know the objective of one's excursion.

We arrived about noon at a hut high up in the forest, where the vegetation was quite different from what I had seen lower down about Siguatepeque. Along the way the increasing abundance of Ferns, Orchids, and gaudy Bromeliads on the oak trees had proved that we were approaching an area of greater moisture than prevails about the town in the valley. We received tangible proof of the moisture in a mild rainstorm which overtook us before we reached our goal.

At this high altitude most of the trees were Pines, but another species (*Pinus pseudostrobus*) had made its appearance, a graceful tree with drooping leaves and branches, which did not look at all like the yellow Pine of the Rockies. There was a much denser undergrowth, and almost as many broad-leaved trees as Pines. Here at El Achote I saw for the first time an abundance of Liquidambar, a tree of almost unprecedented distribution among American species. It appeared quite familiar, although perhaps taller and more slender than it usually grows in the United States. With it grew *Ostrya*, and the Central American Elm (*Chaetoptelea mexicana*), but most of the other trees were evidently tropical or subtropical. The temperate element was represented also among the herbaceous plants, for in a small bog near our stopping place grew both the Royal and Cinnamon Ferns. The Royal Fern I had seen previously in Costa Rica, in a similar situation, and here in Honduras was one of its Costa Rican associates, the red-flowered terrestrial *Epidendrum radicans*, the commonest Orchid of Central Costa Rica, which I had never found elsewhere in Central America.

As these high mountains are viewed from Siguatepeque, there appears a wide belt of deep green near their summits, above the more vivid green of the Pines. I am informed that this zone consists of hardwood trees, and if this is true, there is little doubt that a rich harvest of new and rare species will be made by the botanist who visits it first.

The list of woody plants here published is probably typical of the ligneous flora of many similar regions of like altitude through central Honduras, Guatemala, and Nicaragua. Such Pine forests as these do not possess so rich a flora as the wet tropical belts, but they do yield a great deal to reward exploration. They are little known, and they are comfortable and healthful regions in which to work. The climate of Siguatepeque is a delightful one, as pleasant as that of Cartago in Costa Rica, although Cartago's elevation is substantially greater.

The species listed on the following pages are of diverse origin. On the whole, the Siguatepeque flora seems to be related closely to that of the mountains of southern and central Mexico. There is very little to remind one of Costa Rica or Panama, principally because those countries have no Pine trees, and ordinarily but little grassland. The region did not remind me greatly, either, of nearby Salvador, although northern Salvador, along the Honduran border, must have a very similar flora, as indicated by collections made there recently by Dr. Salvador Calderón.

PINACEAE

Pinus oocarpa Schiede. PINO OCOTE. The common Pine of the mountains of central Honduras, covering all the lower slopes of the mountains in the vicinity of Siguatepeque. In the Tela region Pines do not reach the coast, as they do in some parts of Central America, and they are not seen until one travels 50 miles inland. From that point all the way along the automobile road to Tegucigalpa, except for the hot Comayagua Valley, they are the dominating tree.

In their general appearance the forests of *Pinus oocarpa* are almost exactly like the Yellow Pine forests of the Rocky Mountains. But little of the available timber is utilized because of lack of transportation facilities. For local building purposes other materials, especially adobes, are preferred to wooden construction. About Siguatepeque I saw men sawing out pine boards by hand, the logs supported upon a stage and the saw operated by two men, one above and one below the log. Turpentine is sometimes collected in small amounts, but it has not proved to be a profitable industry.

Pinus pseudostrobus Lindl. PINAVETE. A large tree with drooping needles. Abundant at higher altitudes, as about El Achote, associated with numerous hardwood trees.

Cupressus Benthamii Endl. CIPRÉS. This Cypress is planted here for shade, as it is throughout Central America, especially in Guatemala City. It is native in Mexico and perhaps also in Guatemala.

GRAMINEAE

Bambusa vulgaris Schrad., var. BAMBÚ. The form of this Asiatic plant with yellow stems is planted frequently. The trunks are used for poles and for various other purposes.

PALMACEAE

Chamaedorea sp. A small Palm, the slender reedlike stems about 1 m. high; growing in a thicket along a stream near Siguatepeque. The species represented is near *C. pacaya* Oerst., but I have been unable to determine it more accurately.

Cocos nucifera L. COCO. A few coconut palms are planted about Siguatepeque, but although they have attained a fair size, they have never flowered.

Acrocomia mexicana Karw. COYOL. A few trees are planted in the vicinity. The tree grows wild only at lower altitudes than that of the Siguatepeque Valley.

Phoenix dactylifera L. DÁTIL. A few Date Palms are planted, and have grown well. They flower but the fruits do not mature properly. Date Palms are seldom seen in Central America, although they might be expected to thrive in the drier regions.

A fan palm called "Suyate" is planted occasionally about Siguatepeque, but no specimens of it were obtained, and its identity is uncertain.

LILIACEAE

Yucca elephantipes Regel. IZOTE. This handsome arborescent Yucca is planted here, as it is almost throughout Central America. It is not native in the region, but probably was brought long ago from Mexico. The young flowers are cooked and eaten, and form a very palatable vegetable.

Smilax tomentosa HBK. A small unarmed vine, in thickets along streams.

PIPERACEAE

Piper achoteanum Trel. in Jour. Washington Acad. Sci. **19**: 328 (1929). Type collected in a wet thicket in Pine forest at El Achote, no. 56125. A shrub 2–3 m. high, with nearly sessile, narrow, very rough leaves.

Piper alveolatifolium Trel. in Jour. Washington Acad. Sci. **19**: 329 (1929). Type collected in a thicket along a stream near Siguatepeque, no. 56344. A shrub 3 m. high. The very handsome leaves are notable for their closely reticulate veins, and, as Pipers go, the species is an exceptionally well-marked one.

Piper indignum Trel. in Jour. Washington Acad. Sci. **19**: 333 (1929). Type collected in a moist thicket near Siguatepeque, no. 55990. A dense shrub 1.5 m. high with densely pubescent leaves.

Piper nonconformans Trel. in Jour. Washington Acad. Sci. **19**: 334 (1929). Type collected in Pine forest near Siguatepeque, no. 55906. A shrub of 2 m.

Piper umbellatum L. Plants shrubby or almost wholly herbaceous, commonly about a meter high; frequent in thickets.

SALICACEAE

Salix chilensis Mol. SAUCE. A medium-sized tree, frequent along streams. It grows also in the lowlands at sea level. This is the only native American species of *Salix* growing south of Guatemala.

MYRICACEAE

Myrica mexicana Willd. CERA VEGETAL. Common in thickets and along streams. A tree 4.5–6 meters high. This species is common in many of the Central American mountains, and in some regions the wax separated from the fruits by boiling is used for making candles and other articles.

BETULACEAE

Ostrya virginiana var. *guatemalensis* (Winkl.) Macbride. A large or medium-sized tree, growing in the higher mountains, apparently rather common. This is probably about the southern limit of the range of the hop hornbeam.

FAGACEAE

Quercus comayaguana Trelease, sp. nov.[1] (§ *Erythrobalanus, Aristatae*). Twigs moderate (3–4 mm.), fluted, matted-gray-tomentose or lanate, reddish if abraded young; leaves (evergreen?) lanceolate-oblanceolate, acute, subaristate from the midrib, cordulate, moderate (4–5 x 12–15 cm.), slightly glossy; veins about 12 x 2, forking and looped; petiole tomentulose or glabrous; inflorescence and fruit unknown.

HONDURAS: a small tree in thicket along stream, Siguatepeque, Dept. Comayagua, alt. 1,100 m., *Paul C. Standley*, no. 56229, February, 1928 (Herb. Field Mus. No. 581,423, type); also no. 56364, from the same locality.—WM. TRELEASE.

A small tree, seldom more than 9 m. high, common along streams about Siguatepeque. The evergreen leaves are narrow and entire or nearly so.

Quercus hondurensis Trel. ENCINO. A tree 6–12 m. high, common on the pine-clad hills about El Achote. The branches are often heavily covered with Ferns, Bromeliads, Orchids, and other epiphytes. The type of this species was collected in the region of San Pedro Sula.

Quercus segoviensis Liebm. ROBLE. A shrub or tree 2–9 m. high, abundant on the plains and lower hills about Siguatepeque, usually associated with Pines. Often forming large dense thickets on the plains, with most of the plants mere shrubs 1–2 m. high.

Quercus siguatepequeana Trelease, sp. nov.[2] (§ *Erythrobalanus, Aristatae*).

Twigs rather slender (2–4 mm.), fluted, glabrous, quickly dull gray, with inconspicuous concolorous lenticels; buds brown, glabrous, finally glossy, suboblong, obtuse, appressed; leaves persistent, subelliptic to spatulate-oblong, very obtuse, rounded at the base or subcordulate, entire, somewhat crisped, narrowly callous-revolute, moderate (3–4 x 10–16 cm.), rather glossy, glabrous; veins 8–12 x 2, forking and looped; petiole glabrous, reddish, 2 x 5 mm.; inflorescence and fruit unknown.

HONDURAS: in thicket along stream, a tree of 9 m., Siguatepeque, Dept. Comayagua, alt. 1,100 m., *Paul C. Standley*, no. 56393, February, 1928 (Herb. Field Mus. no. 581,663, type); El Achote, at 1,500 m., *Paul C. Standley*, no. 56179.—WM. TRELEASE.

[1] **Quercus comayaguana** Trelease, sp. nov.
Ramuli griseo-tomentosi vel lanati; folia lanceolato-oblanceolata, acuta, basi cordulata, mediocria, sublucida, petiolo tomentuloso vel glabro; inflorescentia ut fructus ignota.

[2] **Quercus siguatepequeana** Trelease, sp. nov.
Ramuli graciles glabri, cito grisei, lenticellis inconspicuis concoloribus; folia persistentia, subelliptica vel spathulato-oblonga, obtusissima, basi rotundata vel subcordulata, integra, subcrispata, anguste calloso-revoluta, sublucida, glabra, petiolo glabro; inflorescentia ut fructus ignota.

A tree about 9 m. high, common about Siguatepeque and El Achote and known as Encino. The bark of this and other Oaks is employed locally for tanning skins.

ULMACEAE

Chaetoptelea mexicana Liebm. MORA. A medium-sized or large tree, growing in the wet zone of the higher mountains. Although *Chaetoptelea* is referred by some writers to *Ulmus*, it seems to me to have fairly good distinctive characters in the fruit. In habit it is not very like our northern Elms, and it occurs well outside the range of the genus *Ulmus* proper. I am somewhat skeptical regarding the vernacular name cited, which usually is given to trees of the Mulberry Family, especially to the Fustic (*Chlorophora tinctoria*).

MORACEAE

Castilla elastica Cerv. ULE, HULE. A few trees are planted about the fincas around Siguatepeque. The tree is native in the forests at lower altitudes, where it is tapped for its rubber.

Morus multicaulis Perr. MORERA. A good many small trees of this Mulberry have been planted about Siguatepeque, with the intention of using the leaves as food for silkworms.

Ficus inamoena Standl. A small tree in pine forest; known previously only from Guatemala. A well-marked species with densely pubescent leaves. A pine forest is a most unusual habit for a Fig, most of the species growing at low altitudes in wet forests.

Ficus involuta (Liebm.) Miq. HIGO. A tree 6–9 m. high, in pine forest. The species is widely distributed in Central America, and grows along the north coast of Honduras at sea level.

Ficus padifolia HBK. A tree 9 m. high, growing along a stream; fruit green, spotted with dark red. Probably the most common and certainly one of the handsomest of the Central American Figs.

Ficus velutina Willd. A tree 9 m. high, not found in fruit; growing at the edge of a stream and spreading over the water.

Ficus radula Willd. HIGO. A tree of 10 m., in moist thickets. One of the common and widely distributed species of Central America, often growing at sea level.

Ficus Carica L. HIGO. The Old World Fig is planted in various places about Siguatepeque, and seems to thrive. It is little grown in most parts of Central America, although it flourishes in the drier regions of Mexico. At Siguatepeque I sampled dried figs of good quality which had been prepared by a local resident.

PROTEACEAE

Grevillea robusta Cunn. GRAVILEA. The Australian Silk-oak is planted here as well as in most of the upland Central American towns. Although it is far from handsome, as it usually grows, it seems to be a great favorite for planting in parks and streets.

AMARANTHACEAE

Iresine Calea (Ibáñez) Standl. A shrub of 1–1.5 m., frequent in moist thickets.

RANUNCULACEAE

Clematis grossa Benth. A large vine, running over shrubs in thickets along the river.

ANNONACEAE

Annona Cherimola Mill. ANONA. A shrub or small tree, rarely exceeding 7.5 m. in height, with greenish flowers. It is planted for its edible fruit, and it also grows wild in thickets about Siguatepeque.

Sapranthus microcarpus (Donn. Smith) R. E. Fries. A tree 6 m. high with small brown-red flowers. The species occurs in Salvador, and extends northward to southern Mexico. In the former country it is known by the names "Palanco" and "Chufle."

MONIMIACEAE

Siparuna nicaraguensis Hemsl. A shrub about 3 m. high, with green flowers, growing in wet thickets. The crushed leaves have a strong and characteristic, somewhat aromatic odor.

LAURACEAE

Persea americana Mill. AGUACATE. The Avocado is grown commonly in the vicinity of Siguatepeque, as it is in nearly all parts of Central America.

Phoebe helicterifolia Mez. A slender tree 4.5–7.5 m. high with softly pubescent leaves; flowers greenish white; fruit black, the cup red. Frequent in thickets about Siguatepeque and at El Achote.

Phoebe mexicana Meissn.? A tree 9 m. high, in thicket along stream. Only sterile material was obtainable, and the specific determination is very uncertain.

HAMAMELIDACEAE

Liquidambar Styraciflua L. LIQUIDÁMBAR. A tree 6–15 m. high, with narrow open crown. Common in Pine forest on the upper slopes above Siguatepeque and about El Achote. It is highly remarkable that this well-known tree, the Red Gum or Sweet Gum of the United States, should occur so abundantly in Honduras, although it occurs in the mountains of Mexico and Guatemala. Probably it reaches the southern limit of its range in the Pine-clad mountains of Honduras, but it may well be that it grows also in the unexplored mountains of Northern Nicaragua.

The tree is well known in Honduras by the name "Liquidámbar," and the balsam obtained from the trunk is highly esteemed for various medicinal purposes. During the European War the balsam was gathered in large amounts for export. For an extended account of its use in Honduras and elsewhere in tropical America see Contr. U. S. Nat. Herb. 23: 317 (1922).

As it grows on the hills above Siguatepeque, the Sweet Gum looks much as it does in the United States, although the Honduran trees seem to be somewhat taller and narrower than is usual in the North. The trees are scattered irregularly among the Pines, especially near the banks of streams. When one has once become acquainted with them, they may be recognized at a long distance because of their vivid green tint, much livelier than that of most other trees of the region.

ROSACEAE

Rubus miser Liebm. MORA. A shrub 1–2 m. high, with white flowers; common in open pine forest. Both this and the next species are frequent on the hills about Siguatepeque, and through central Honduras. The fruit is rather sour, but quite as good as the average of the wild Blackberries of the United States. It is gathered commonly and used for the preparation of jelly and preserves.

Rubus trichomallus Cham. & Schlecht. MORA. A shrub of 2 m., with sour purple-black fruit; usually in thickets along streams.

Spiraea cantoniensis var. *lanceata* Zabel. BUQUET DE NOVIA. Planted commonly for ornament. One of the common ornamental shrubs of Central America.

Rosa spp. Roses thrive at Siguatepeque, as they do everywhere in the mountains of Central America. They are grown abundantly also in the lowlands.

Cydonia oblonga Mill. MEMBRILLO. There are several small plantations of Quinces in the region. The fruit is highly esteemed for making marmalade.

Eriobotrya japonica Lindl. NÍSPERO JAPONÉS. The Loquat is planted occasionally for its well-flavored fruit.

Pyrus communis L. PERA. Several small Pear trees are growing in the patio of the hotel at Siguatepeque. I am informed that trees in the vicinity sometimes mature fruit, but that it is small and of inferior quality.

Licania platypus (Hemsl.) Fritsch. SUNZAPOTE. A fine handsome tall tree, planted occasionally. Native at lower altitudes. The large fruits are edible, but of poor quality.

Prunus Persica (L.) Batsch. DURAZNO. Peaches are planted frequently in the mountains of central Honduras, and fruits of good size sometimes are produced.

KRAMERIACEAE

Krameria cuspidata Presl. A densely branched, small shrub 60 cm. high or less, frequent on the plains about Siguatepeque. Apparently, the species has not been reported previously from Central America, but it is frequent in southern Mexico.

LEGUMINOSAE

Inga edulis Mart. GUAMA. A tree 4.5–7.5 m. high with dense rounded crown; frequent in thickets. The long white stamens make the flower heads showy. The white pulp surrounding the seeds is edible.

Mimosa albida H. & B. ZARZA. A shrub 1–1.5 m. high, armed with sharp prickles. Common in open pine forest.

Mimosa pigra L. A shrub 1–2 m. high, often forming dense thickets about boggy places on the plains.

Mimosa hondurana Britton. A large woody vine armed with closely set, recurved prickles which cling to every passing object and tear the skin painfully; pods dark red. The species was based upon material collected in the Lancetilla Valley, at sea level.

Acacia Farnesiana (L.) Willd. ESPINO. A shrub 1–2.5 m. high with whitish spines. Frequent on the dry plains about Siguatepeque.

Acacia Hindsii Benth. BULLHORN ACACIA. A shrub or tree 2–5.5 m. high, armed with large inflated spines. The spines, as in all the bullhorn Acacias, are inhabited by savage ants, which bite most painfully.

Acacia Milleriana Standley, nom. nov. (*Mimosa campechiana* Miller, Gard. Dict. ed. 8. *Mimosa* no. 20 [1768].—*Poponax campechiana* Britton & Rose in N. Amer. Fl. **23**: 90 [1928].—Not *Acacia campecheana* Schenck, 1913). ESPINO RUCO. A tree 4.5–9 m. high, armed with long stout spines; crown broad and spreading. Abundant on the dry plains about Siguatepeque. The trees are very distinct in their habit and appearance, and they are recognizable at a long distance.

The genus *Poponax* Raf. is recognized as distinct by Britton and Rose in their recent cactusization of the Mimoseae, but there is no apparent reason why this or probably any of the other segregates should be separated from the long-established unit *Acacia*. In all, eleven segregates from *Acacia* are described in the third part of volume 23 of the North American Flora, and many of them stand upon quite as trivial characters as the cactus segregates proposed by the same authors. The genera *Poponax* and *Fishlockia*, for instance, are separated in the key to genera as follows:

Pinnae few to many pairs; leaflets narrow, small, numerous...... *Poponax.*
Pinnae 1 pair; leaflets 1 or 2 pairs, broad, coriaceous.............. *Fishlockia.*

If these are generic characters, there is no reason why each species of plant should not have its own particular genus.

Acacia salvadorensis (Britt. & Rose) Standley, comb. nov. (*Acaciella salvadorensis* Britton & Rose in N. Amer. Fl. **23**: **101** [1928]). A tree 6 m. high, growing in a dry field.

I am transferring this plant to *Acacia*, not because I have any reason to believe that the species is a good one, but merely for convenience. In *Acaciella* Britton and Rose recognize 49 species, mostly forms which a few years ago would have been referred to three or four long-established species. It is certain that some of the segregates represent valid species, but which really deserve nomenclatural recognition can be determined only after a thorough study of the specimens involved. It is to be feared that this group of the genus *Acacia* is approaching the condition hinted in the last edition of Bailey's Cyclopedia of Horticulture: One contributor to that work makes the statement that "the genus consists of 14 specimens," a remark probably truer than he suspected.

Calliandra centralis (Britt. & Rose) Standley, comb. nov. (*Anneslia centralis* Britton & Rose in N. Amer. Fl. **23**: 52 [1928]). A shrub 1 m. high or less, the heads showy because of the abundant bright purple-red stamens. The type was collected at San Pedro Sula, Honduras.

Calliandra lucens (Britton) Standley, comb. nov. (*Anneslia lucens* Britton in N. Am. Fl. **23**: 194 [1928]). A shrub 1-2 m. high, noteworthy for its very thick and shining, small leaflets; stamens purple-red and showy. Frequent in open pine forest. Type, No. 56397, from Siguatepeque. The species is reported also from Guatemala.

Parkinsonia aculeata L. A handsome yellow-flowered shrub, planted in the garden of the church. I noted it as frequent in the Comayagua Valley, and it is naturalized in many parts of Central America.

Cassia grandis L. CARAO. A fine large tree, its dense masses of blossoms strongly suggesting those of apple blossoms, Probably not native in this region, but a few trees were noted about the town.

Parosela psoraleoides (Moric.) Rose. A shrub a meter high with inconspicuous pinkish flowers. Growing in dry thickets.

Parosela vulneraria (Oerst.) Rydb. A shrub 1–2 m. high, very slender and much branched, frequent in dry thickets and open pine forest. Flowers varying from whitish or cream-colored to red-purple, according to the stage of development and withering.

Diphysa robinioides Benth. A tree 6 m. high, in a thicket along a stream. The *Diphysa* species are esteemed in Central America for their bright yellow wood of good quality.

Benthamantha ochroleuca (Jacq.) Alef. A shrub 1 m. high, the greenish white flowers tinged with red. In dry thickets. The leaflets are more numerous than described for this species by Rydberg (in N. Amer. Fl. **24**: 244. 1924), and the form might be regarded as a distinct species, but in this genus of notoriously "weak" species, it does not seem desirable to introduce any additional names.

Desmodium plicatum Cham. & Schlecht. A slender shrub 2 m. high, frequent in pine woods; corolla dark purple.

Erythrina rubrinervia HBK. PITO. A tree 6–9 m. high with few thick branches and soft wood; petals bright red. One of the characteristic small trees of the Pacific slope of Central America, much planted for living fence posts. The young and tender flowers are cooked like string beans, and eaten here as everywhere else in Central America. The tree is a very showy one when in blossom.

Rhynchosia longeracemosa Mart. & Gal. A large vine with greenish yellow flowers; stems usually herbaceous but sometimes somewhat woody. The plant is scarcely to be classed as a shrub.

Piscidia grandifolia (Donn. Smith) I. M. Johnston. A tree 4.5–7.5 m. high, common in thickets about Siguatepeque.

Lonchocarpus atropurpureus Benth. CHAPERNO. A tree 9 m. high; in fruit. In moist thickets.

RUTACEAE

Casimiroa tetrameria Millsp. MATASANO. A tree 6–9 m. high, with dense rounded crown, the leaflets densely soft-pubescent. Growing in thickets along the river. This species bears a sweet watery edible fruit somewhat resembling a green apple.

Citrus sinensis (L.) Osbeck. NARANJA. Oranges of good quality are grown about Siguatepeque. I presume that the other usual citrus fruits of Central America, such as the lime, sour orange, citron, and sweet lime, are planted, but I have no notes regarding their occurrence.

Murraya paniculata (L.) Jack. Planted occasionally for ornament.

SIMAROUBACEAE

Simarouba glauca DC. ACEITUNO, NEGRITO. A large tree with edible black fruits which closely resemble olives. The fruits are of poor flavor and little esteemed. The bark is employed locally as a remedy for affections of the stomach and intestines, especially for dysentery. Oil obtained from the seeds is used in making soap and candles.

MELIACEAE

Trichilia havanensis Jacq. A densely branched tree 9 m. high with glossy leaves and small greenish flowers. Frequent in moist thickets. For the tree I was given the vernacular name "zopilote," but I suspect that this is an erroneous name. In some parts of Honduras it is called "limoncillo," an allusion to its fragrant foliage.

MALPIGHIACEAE

Gaudichaudia Schiedeana Juss. A small inconspicuous woody vine, growing in moist thickets.

Stigmaphyllon ellipticum (HBK.) Juss. A large slender woody vine with sulphur-yellow flowers; in thickets along streams.

Byrsonima crassifolia (L.) DC. NANCE. A large shrub or small tree with showy yellow flowers; frequent in dry thickets. The small fruits, with a flavor somewhat like that of green apples, are eaten chiefly by children.

EUPHORBIACEAE

Croton ciliato-glandulosus Ortega. CIEGA-OJO. A shrub about 1 m. high, frequent in moist thickets. The species occurs also near the coast slightly above sea level. The abundant gland-tipped hairs which fringe the leaves and stipules adhere readily to the hands, and they are said to cause painful and dangerous inflammation of the eyes if in contact with them. So far as known, this distinctive species does not occur south of Honduras.

Croton flavens L. A stiff shrub 1–3 m. high, frequent along streams. There is some uncertainty regarding the specific determination, but the specimens agree well with material from Yucatan which has been referred here. The species is probably new to the Central American flora.

Croton repens Schlecht. A low shrub, seldom more than 40 cm. high, very common in pine forest and in open fields. Easily recognized among the Central American Crotons because of its small, broad, coarsely toothed leaves.

Acalypha leptopoda Muell. Arg., var. *mollis* Muell. Arg. A shrub or small tree 2.5–5.5 m. high, frequent in dry thickets.

Acalypha macrostachya Jacq. A shrub 3 m. high, in dry thickets. The species occurs also at sea level along the north coast.

Acalypha porphyrantha, sp. nov.

Frutex 0.6–1.2 m. altus, ramulis gracilibus, vetustioribus teretibus cinnamomeis rimosis et sparse pallido-lenticellatis, novellis dense pilis albis longis gracilibus patentibus pilosis, internodiis elongatis; stipulae ferrugineae, minutae, lanceolatae, 1–2 mm. longae, deciduae, minute adpresso-pilosulae; petioli graciles, 0.7–3.5 cm. longi, pilosi; lamina ovata vel late ovata, coriacea, 2.5–8 cm. longa, 1.3–4.5 cm. lata, longe acuminata, acumine angusto longe attenuato acuto vel obtuso, basi cordata vel interdum rotundata, supra viridis vel glauco-viridis, pilis longis albidis patentibus dense pilosa, interdum sublucida, costa nervisque prominulis, subtus viridis, prasertim ad nervos albido-hirsuta, basi 5–7-nervia, costa nervisque gracilibus elevatis, costa superne nervos ca. 5 utrinque emittente, nervulis vix prominulis arcte reticulatis, margine grosse serrato, serraturis acutis saepe salientibus. Flores monoici; spicae masculae ex axillis superioribus nascentes, fere sessiles, dense multiflorae, ca. 1.5 cm. longae et 2 mm. crassae; spicae femineae terminales 3–6 cm. longae, breviter pedunculatae, multiflorae, bracteis remotis sessilibus; styli ca. 3 mm. longi, purpureo-rubri, multilacinuligeri.

HONDURAS: in pine forest, Siguatepeque, Dept. Comayagua, alt. 1,100 m., *Paul C. Standley*, no. 56354, February, 1928 (Herb. Field Mus. no. 582,005, type). Also nos. 55841 and 55881 from the same locality.

In all the specimens collected the pistillate inflorescence is so immature that it is impossible to determine the nature of the pistillate bracts, which furnish the most important characters for distinguishing the species. The plant, however, can not be referred to any of the Acalyphas known from Central America. In foliage it suggests *A. leptopoda* Muell. Arg., but the inflorescence is altogether different. The species may be recognized by the small size of the plant and by the very thick, more or less lustrous leaves.

Codiaeum variegatum var. *pictum* Muell. Arg. LAUREL, LAUREL TIRABUZÓN, LAUREL FÚNEBRE, LAUREL COLA DE GALLO. The well-known tropical "crotons," with their gaudy variegated leaves, are planted for ornament in almost all Central American gardens. They seem to thrive quite as well in the mountains as in the lowlands.

Euphorbia pulcherrima Willd. PASCUA. The gorgeous poinsettias are one of the glories of Central American gardens. At Siguatepeque they were in full flower in February, but generally they are at their best about Christmas, hence their usual name of "Pascua," or "Christmas-flower."

Jatropha aconitifolia Mill. Planted frequently in hedges. A shrub or small tree.

ANACARDIACEAE

Mangifera indica L. MANGO. Planted abundantly. The favorite fruit of the Central American people.

Mauria sessiliflora, sp. nov.

Arbor 9–12-metralis, ramulis crassiusculis, novellis pilis minutis fulvis adpressis subdense indutis; folia plerumque 22–30 cm. longa, 6–10 cm. longe petiolata, petiolo gracili subtereti glabro; foliola 5–9, jugis 3–4 cm. distantibus, lateralibus 3–8 mm. longe petiolulatis, terminali 1–2 cm. longe petiolulato, anguste oblonga vel lanceolato-oblonga, 10–15 cm. longa, 3–4.5 cm. lata, coriacea, acuminata, acumine attenuato obtuso, basi acuta vel plerumque sensim attenuata, glabra, supra viridia vel glauco-viridia, sublucida, nervis vix prominulis, subtus pallidiora, costa crassiuscula elevata, nervis lateralibus gracilibus, prominentibus, arcuatis, angulo lato adscendentibus, nervulis prominulis arcte reticulatis. Paniculae axillares 10–12 cm. longae, foliis multo breviores, dense pilis brevibus fulvis subadpressis indutae, ramis infimis 1–1.5 cm. longis, superioribus brevioribus, floribus numerosis sessilibus in fasciculis parvis densis subcapitato-congestis, capitulis sessilibus, bracteis minutis triangularibus acutis; sepala rotundata glabra; petala ovalia, obtusa, 2–2.5 mm. longa, glabra, viridescentia; stamina petalis paullo breviora.

HONDURAS: in thicket along river near Siguatepeque, alt. 1,100 m., *Paul C. Standley*, no. 56062, February, 1928 (Herb. Field Mus. no. 581,919, type). Also no. 56431, from the same locality.

Closely related to *M. birringo* Tul., but in that species the panicles are usually broad and open, the flowers are pedicellate, and the leaflets not long-attenuate at the base.

Rhus terebinthifolia Schlecht. & Cham. A shrub 2 m. high, growing in pine forest near El Achote.

AQUIFOLIACEAE

Ilex panamensis Standl.? A tree 6 m. high, in thickets along streams. It is probable that this tree belongs to an undescribed species. It was possible to obtain only sterile material, and its foliage I can not distinguish from that of the recently described *I. panamensis*. The latter is a coastal plant, and it does not seem likely that it occurs also in the mountain region.

SAPINDACEAE

Paullinia costaricensis Radlk. A large woody vine, in thickets along streams.

Serjania rhachiptera Radlk. In thickets along streams. A large woody vine with handsome, much dissected leaves. The species occurs also in Guatemala and Salvador.

RHAMNACEAE

Sageretia elegans (HBK.) Brongn. A slender shrub 1.5–2.5 m. high, growing in moist thickets.

VITACEAE

Vitis vinifera L. UVA. European grapes are planted occasionally, but they do not thrive in Central America. The leaf-cutting ants seem to be particularly fond of their foliage.

TILIACEAE

Triumfetta speciosa Seem. A shrub 3 m. high; calyx red, shading above into yellowish. A rather handsome plant, in thickets along the river.

MALVACEAE

Robinsonella divergens Baker & Rose. In a thicket along a stream. A tree 6 m. high. Only one tree was found in this vicinity, and it was pointed out to me by the daughters of Don José Membreño, who had been greatly impressed by its beautiful showing of white flowers a week previously, and had recognized it as something unusual. The specimens differ somewhat from the typical form in having three broad, often obtuse or rounded, nearly entire lobes. All the species of *Robinsonella* are closely related, and this Honduran form does not seem sufficiently distinct from *R. divergens* to deserve nomenclatural recognition. These small trees are well worthy of cultivation because of their showy flowers, although, unfortunately, they persist only a short time upon the tree.

Hibiscus mutabilis L. VARIABLE. A shrub cultivated for ornament because of its large showy flowers, which change color rapidly after opening.

Hibiscus Rosa-Sinensis L. MAR PACÍFICO. The Chinese Hibiscus is one of the favorite garden shrubs.

Hibiscus schizopetalus (Mast.) Hook. VIUDA ALEGRE. Planted occasionally for ornament.

STERCULIACEAE

Waltheria americana L. A shrub 30–60 cm. high, or often only an herb, with yellow flowers. Frequent in pine forest. One of the common weeds of Central America.

THEACEAE

Ternstroemia tepezapote Cham. & Schlecht. A scrubby tree about 6 m. high, with dense branches and thick leathery leaves; frequent in thickets along streams. Only sterile specimens were obtainable.

HYPERICACEAE

Hypericum denticulatum HBK.? Plants stiffly erect, 30–90 cm. high, herbaceous or frequently somewhat woody, with fastigiate branches; petals yellow; common in pine forest. The specific determination is very doubtful.

Vismia guianensis (Aubl.) Pers. A shrub 3 m. high, growing in moist thickets.

GUTTIFERAE

Clusia Salvinii Donn. Smith. Oreja de burro ("Donkey's ears"). A shrub or small tree, up to 6 m. high, with very thick, hard leaves and green globose fruit. In wet forest at El Achote.

FLACOURTIACEAE

Casearia sylvestris Sw. A tree of 7.5 m., the small flowers pale green. Common in low thickets.

Xylosma Hemsleyana Standl. A shrub or tree 2.5–6 m. high, in moist thickets. Flowers greenish yellow. The genus is an interesting one because of the fact that the trunks are provided normally with large branched thorns, similar to those appearing on the Honey Locust (*Gleditsia triacanthos*).

LYTHRACEAE

Cuphea Hookeriana Walp. A slender shrub a meter high, or often wholly herbaceous; calyx whitish, the rather showy petals black-purple. Growing about Siguatepeque and as high as El Achote, in open pine forest.

Cuphea utriculosa Koehne. A densely branched shrub about 60 cm. high, growing on rocks at the edges of streams. One of the common species of Central America, and found only along or in streams, with its roots in running water.

Grislea secunda Loefl. A slender bushy shrub about 2 m. high with gland-dotted leaves and axillary, bright red flowers. This shrub was not noted about Siguatepeque, but it was seen on the north coast near Tela, and it was found to be abundant at one place along the road through the mountains above Tegucigalpa. The genus formerly was known only from northern South America, but it was discovered in Honduras three or four years ago by Professor Samuel J. Record. It is remarkable that it has not been found in the intervening countries, and if it does occur there it can scarcely escape attention, because its brilliant flowers make it conspicuous even when seen from a long distance. Its distribution is erratic, it would seem, even in Honduras.

Certainly it would be difficult to find in Central America two regions more unlike than those in which I have seen it; the low hot swamps of the banana country, and the high dry mountains of Central Honduras, where the climate is rather temperate than tropical.

PUNICACEAE

Punica Granatum L. GRANADA. The Pomegranate is planted rather commonly about Siguatepeque. It is seldom seen in most parts of Central America.

MYRTACEAE

Calyptranthes hondurensis, sp. nov.

Frutex vel arbor 3–6-metralis, ramis gracilibus rigidis teretibus cinereis, novellis angulatis glabris, internodiis brevibus vel elongatis; folia breviter petiolata, petiolo crasso 2–4 mm. longo glabro; lamina oblonga vel elliptico-oblonga, rarius oblongo-lanceolata, 4–6 cm. longa, 1–2 cm. lata, apicem versus angustata, obtusa, basi obtusa vel acutiuscula, subcoriacea, utrinque dense minuteque punctata, supra glauco-viridis, costa subimpressa, nervis obsoletis, subtus pallida, glabra, costa gracili elevata, nervis lateralibus utroque latere circiter 9, prominulis, rectis, angulo acuto adscendentibus, prope marginem nervum distinctum collectivum efformantibus, marginibus saepe revolutis. Paniculae terminales fasciculatae, laxe pauciflorae, ca. 3 cm. longe pedunculatae, ramis oppositis vel verticillatis rigidis glabris, floribus sessilibus vel 1–2 mm. longe pedicellatis, plerumque ternis; calyx in alabastro ellipsoideus, 2–2.5 mm. longus, acutus, sparse et minute adpresso-pilosulus; caetera ignota.

HONDURAS: wet thicket, El Achote, near Siguatepeque, Dept. Comayagua, alt. 1,500 meters, *Paul C. Standley*, no. 56164, February 18, 1928, (Herb. Field Mus. no. 581,097, type); Siguatepeque, alt. 1,100 m., *P. C. Standley*, no. 55933.

A relative of *C. pendula* Berg, of southern Mexico, but in that the flowers are sessile and the petioles are longer.

Vernacular name, "Guayabillo."

Eucalyptus spp. Two species of this genus have been planted about Siguatepeque, but specimens of them were not collected. The trees are favorites in some parts of Central America because of their rapid growth.

Eugenia Doubledayi, sp. nov.

Frutex vel arbor 3–6-metralis, ramulis subgracilibus teretibus brunneis plus minusve rimosis minute sericeis vel fere omnino glabris, internodiis elongatis; petioli 10–15 mm. longi, fere glabri, crassiusculi, anguste sulcati; lamina elliptica, 6.5–12 cm. longa, 3.5–5.5 cm. lata, abrupte acuminata, acumine anguste triangulari obtuso, basi acuta, coriacea, opaca sed dense glanduloso-punctata, supra viridis, costa impressa, nervis obscuris, subtus pallida, statu juvenili sericea, cito glabrata, costa valida elevata, nervis lateralibus utroque latere circiter 12 prominulis gracillimis angulo acuto adscendentibus fere rectis prope marginem irregulariter conjunctis, nervulis obsoletis. Inflorescentiae axillares, breviter racemosae, 5–8 mm. longe pedunculatae, plerumque triflorae, pedicellis 5–6 mm. longis minute puberulis; calycis lobi in apice baccae persistentes, rotundati, obtusi, 2.5–3 mm. longi, punctati, extus minute sericei; fructus oblongus vel obovoideo-oblongus, circiter 18 mm. longus et 6–7 mm. latus, 8-costatus, glaucescens et minute albido-sericeus vel glabratus, basin versus paullo angustatus, apice obtusus; semen 1, cylindricum, 12 mm. longum, 4 mm. diam., brunnescens, nigro-puncticulatum.

Honduras: in thicket along river, Siguatepeque, Dept. Comayagua, alt. 1,100 meters, *Paul C. Standley*, no. 56063, February, 1928 (Herb. Field Mus. no. 581,920, type), also no. 56190.

The species is not closely related to any other known from Central America. The leaves resemble those of *E. guatemalensis* Donn. Smith, but in that the fruit is much smaller and oval.

Eugenia Doubledayi is named for Louis Doubleday, who accompanied me on a visit to the interior of Honduras, and to whom I am indebted for a great deal of assistance in making the collections about Siguatepeque.

Eugenia axillaris (Sw.) Willd. A tree 4.5–7.5 m. high, common in thickets along streams.

Eugenia guatemalensis Donn. Smith. A shrub 1.5–3 m. high, in moist thickets. The species grows also along the north coast of Honduras at sea level.

Eugenia Jambos L. Manzana. A large tree with exceptionally handsome foliage and with rather inconspicuous, greenish flowers. The edible fruit has the flavor of rose water, hence the common name of "rose-apple." The tree is planted generally in Central America for its shade and fruit, and about Siguatepeque it is naturalized everywhere, even well up in the mountains along the streams.

Psidium molle Bertol. Guayabilla, Huevo de gato. Common, growing nearly everywhere, on plains, in open pine forest, and in moist thickets along streams. In drier places, where the soil is sterile, the plants are usually only 60–90 cm. high, but in moist places they attain the size of a small tree, about 5 m. high. The fruit is highly esteemed in the interior of Honduras, and it is certainly far superior in flavor to the common guava, being juicy and sweet, but somewhat acidulous. The species is widely distributed in Central America, at least on the Pacific slope.

Psidium Oerstedianum Berg. Arrayana. A low shrub, only 30–60 cm. high, in open pine forest; common. The fruits of this species, also, are considered very good to eat.

MELASTOMACEAE

Clidemia hirta (L.) Don. SIRÍN. A bushy shrub 1 m. high; petals pinkish white. Frequent in open pine forest.

Conostegia xalapensis (Bonpl.) Don. SIRÍN. A frequent shrub 1.5–3 m. high, in pine forest. The most common member of the family in Central America. The species grows also at sea level on the north coast.

Heterotrichum octonum (H. & B.) DC. A shrub 2 m. high, in thickets along streams; petals white.

Miconia albicans Triana. SIRÍN, NEGRITO. A shrub 0.5–2 m. high, very common in open dry pine forest.

Miconia globulifera Naud. SIRÍN. A conspicuous shrub 1.5–2.5 m. high, common in moist thickets and in open pine forest.

Miconia guatemalensis Cogn. SIRINA. A shrub 1–1.5 m. high, in thickets about Siguatepeque and also in bogs at El Achote. Petals white, the fruit red-purple.

Miconia mexicana (H. & B.) Naud. SIRINA. A shrub 2 m. high with handsome white flowers; growing in pine forest about El Achote.

ARALIACEAE

Oreopanax Salvinii Hemsl. MANO DE LEÓN. A tree about 4.5 m. high with large, long-petioled, deeply lobed, coarsely stellate-pubescent leaves. I was told that the tough leaves are used for wrapping soap.

CORNACEAE

Cornus excelsa HBK. A shrub or tree 2.5–5.5 m. high, frequent along streams about Siguatepeque, and collected also in wet thickets at El Achote.

CLETHRACEAE

Clethra hondurensis Britton. A tree 4.5–7.5 m. high, growing in thickets along streams. Found in fruit only.

ERICACEAE

Andromeda mexicana Hemsl. A tree 4.5–7.5 m. high, with rough gray bark. Growing in pine forest; usually very irregular in growth, and often much gnarled, especially in its favorite habitat, exposed rocky hilltops. The species has been collected recently in northern Salvador.

Arbutus xalapensis HBK. INDIO DESNUDO ("naked Indian"). A tree 4.5–6 m. high, in wet thickets high in the mountains. The thin bark peels off in papery sheets, leaving the smooth brown trunk, hence the vernacular name, which is given on the coast to *Bursera Simaruba*, in which the trunk has much the same appearance. The flowers are white and rather handsome.

MYRSINACEAE

Ardisia compressa HBK. CAMACA. A shrub 1.5–2.5 m. high with white flowers. Frequent in moist thickets. The purple-black fruit is edible and of good flavor, but the flesh is very scant. This is one of the common shrubs of the Central American mountains.

Rapanea ferruginea (R. & P.) Mez. A tree 4.5–6 m. high, in pine forest at El Achote.

SAPOTACEAE

Calophyllum mammosum (L.) Pierre. ZAPOTE. A tree about 12 m. high with spreading open crown. Cultivated commonly for its sweet fruit, and also naturalized in thickets along the river. I found the tree wild in primeval forest along the north coast of Honduras.

Chrysophyllum mexicanum Brandeg. CAIMITO. A tree 6 m. high, in thickets along the river. Similar in appearance to the common Star-apple (*C. Cainito*), but with much smaller fruits.

LOGANIACEAE

Buddleia americana L. A shrub 1–2.5 m. high, with small yellow flowers. Frequent in moist thickets. One of the common weedy shrubs of Central America.

APOCYNACEAE

Echites microcalyx A. DC. Common in moist thickets or in pine forest. A small, very slender, herbaceous or somewhat woody vine with handsome, bright yellow blossoms, the corolla having a brown or dark red throat.

Tabernaemontana divaricata (L.) R. Br. MAGNOLIA. A shrub with fragrant white flowers, planted for ornament. It would be interesting to know how the name "Magnolia" happens to be thus misapplied, but, if I remember correctly, it is given to the plant also in Nicaragua. It would be equally interesting to learn how the name "Sassafras," of North American Indian origin, happens to be applied in Central America to species of the genus *Croton*.

Thevetia peruviana (Pers.) K. Schum. CHILCA. A shrub or small tree with large, bright yellow flowers, sometimes planted for ornament.

VERBENACEAE

Lantana involucrata L. PETATILLO. A shrub a meter high, with pink flowers; growing on dry plains.

Lippia Kellermanii Greenm. CUTUFUME. A tree 4.5–6 m. high; corollas pale yellow. In wet thickets high in the mountains.

Lippia myriocephala Schlecht & Cham. A tree about 12 m. high, with a trunk 25 cm. in diameter. Occasional in dry thickets. In Salvador boards are sometimes sawed from the trees.

LABIATAE

Hyptis asperifolia, sp. nov.

Frutex 1–1.5-metralis, ramis gracilibus obtuse quadrangularibus, vetustioribus brunneis vel ochraceis, novellis ferrugineis scabris, internodiis brevibus; folia opposita, fere coriacea, petiolata, petiolo crassiusculo 2–14 mm. longo dense et brevissime villosulo vel scaberulo; lamina oblonga vel oblongo-ovata, pleraque 1–3 cm. longa et 0.8–2 cm. lata, interdum usque ad 8 cm. longa et 4 cm. lata, grosse crenata, apice obtusa vel fere rotundata, basi acuta vel acuminata, supra viridis, scabra, costa manifesta, nervis obsoletis, subtus pallidior, sparse vel dense ochraceo- vel griseo-tomentosa, tomento e pilis stellatis composito, costa gracili elevata, nervis lateralibus utroque latere circiter 6 prominentibus angulo acuto adscendentibus. Flores capitati, capitulis axillaribus dense multifloris plerisque 2–5 mm. longe pedunculatis vix 1 cm. diam., bracteis filiformibus calyce brevioribus; calyx 5–6 mm. longus, scaberulo-hispidulus, laciniis lineari-attenuatis tubo campanulato paullo brevioribus erectis; corolla pallide purpurea, circiter 1 cm. longa, extus sparse puberula, tubo gracili cylindrico, lobis 1.5–2 mm. longis; antherae breviter exsertae.

HONDURAS: in pine forest near Siguatepeque, Dept. Comayagua, alt. 1,200 m., *Paul C. Standley*, no. 56231, February 1928 (Herb. Field Mus. no. 581,425, type); in pine forest, El Achote, near Siguatepeque, 1,500 m., *P. C. Standley*, nos. 56095, 56180.

An isolated species, characterized by its shrubby habit, small thick leaves, stellate pubescence, and small short-peduncled axillary flower heads.

Salvia siguatepequensis, sp. nov.

Frutex 1–1.5-metralis ramosus, ramis crassis obtuse quadrangularibus vel subteretibus densissime brunneo-tomentosis, internodiis elongatis; folia opposita, petiolata, in sicco fere subcoriacea, oblonga vel ovato-oblonga, 9–17 cm. longa, 3–8 cm. lata, acuta vel acuminata, basi obtusa vel acuta, arcte dentibus obtusis serrato-dentata, supra viridis, tenuiter minuteque stellato-tomentella, subtus dense stellato-tomentosa, tomento cinereo vel pallide brunnescente, costa valida elevata, nervis lateralibus utroque latere circiter 8 prominentibus angulo acuto adscendentibus. Flores verticillati, verticillis paucifloris remotis vel approximatis, racemum laxum 4–10 cm. longum efformantibus, pedicellis 2–9 mm. longis ut rhachis pilis interdum viscidis simplicibus vel stellatis hispidulis; bracteae caducae, oblongo-ovatae, circiter 18 mm. longae, apice longe filiformi-subulatae, dense stellato-tomentosae; calyx 1–1.5 cm. longus, anguste campanulatus, prominenter costatus, viridis, sparse glanduloso-pilosulus et ad nervos pilis brevibus basi dilatatis indutus, labiis subaequalibus anguste triangularibus longe filiformi-acuminatis, calyce in statu fructifero inderdum recurvo; corolla coccinea, extus sparse villoso-pilosa, 2.5–2.8 cm. longa, tubo 5 mm. longo et 2 mm. lato, abrupte ampliato, fauce 1.5 cm. longa et 8 mm. lata, labio superiore erecto circiter 8 mm. longo, inferiore breviore intus glabro; stamina inclusa; stylus supra breviter pilosus.

HONDURAS: moist thicket near Siguatepeque, Dept. Comayagua, alt. 1,100 m., *Paul C. Standley*, no. 55917, February, 1928 (Herb. Field Mus. No. 581,177, type); thicket along stream, *P. C. Standley*, no. 56346; pine forest, *P. C. Standley*, no. 55899.

In this plant the corolla and pubescence are much like those of *S. Lindenii* Benth., but in the latter the leaves are cordate or subcordate at the base.

SOLANACEAE

Cestrum lanatum Mart. & Gal. An ill-scented shrub 1.5–3 m. high, with pale green flowers. Frequent in moist thickets.

Solanum diversifolium Schlecht. A prickly shrub 2 m. high with white flowers. Frequent in moist thickets. Probably the most common Solanum of Central America.

Solanum erythrotrichum Fernald. A shrub of 2.5 m. with white flowers, growing in moist thickets. The species ranges rather widely, from Guatemala to Panama. In the Canal Zone it grows in wet thickets at sea level, under very different conditions from those prevailing about Siguatepeque.

Solanum laurifolium Mill. A prickly shrub 1.5 m. high, with unusually large and very showy, violet flowers; in moist thickets.

GESNERIACEAE

Kohleria Deppeana (Schl. & Cham.) Fritsch. A handsome shrub 1.5–2.5 m. high, with bright red, tubular flowers; in wet thickets at El Achote.

The shrubby plants of this family, which constitute perhaps the most brilliantly flowered group of Central American plants, are very rare in the parts of Honduras which I visited. They reach their best development in the mountains of Costa Rica, where the gorgeous Columneas often present vivid masses of color.

ACANTHACEAE

Aphelandra Deppeana Schlecht. & Cham. A shrub 1–2.5 m. high, bearing dense spikes of bright red flowers. Common in thickets along the river.

RUBIACEAE

Cephalanthus salicifolius H. & B. A shrub or small tree, 1–6 m. high, in habit much like the Buttonbush (*C. occidentalis*) of the United States. Abundant along small streams running through the pine forest.

Rondeletia amoena (Planch.) Hemsl. A shrub or small tree with handsome pink flowers, growing in wet thickets at El Achote.

Rondeletia buddleioides Benth. A tree 4.5–7.5 m. high, in thickets along streams.

Bouvardia leiantha Benth. A very slender shrub, a meter high or less, with graceful and brilliant, scarlet flowers. Growing under pine trees.

Gardenia jasminoides Ellis. JAZMÍN DEL CABO. A shrub with fragrant white flowers. Frequently grown for ornament.

Anisomeris protracta (Bartl.) Standl. A shrub or tree 2–6 m. high, in thickets along streams.

Guettarda macrosperma Donn. Smith. A slender shrub or tree 4.5–6 m. high, in thickets along streams.

Coffea arabica L. CAFÉ. Coffee is planted on a small scale about Siguatepeque, but is not grown for export. Substantial amounts of coffee are grown in some parts of Honduras, but in this crop the country is far behind the other Central American states.

Psychotria fruticetorum, sp. nov.

Frutex circiter 1 m. altus, ramulis subteretibus glabris, vetustioribus ferrugineo-brunneis rimosis, novellis viridibus; stipulae ovatae vel lanceolatae, 3.5–4 mm. longae, longe subulato-acuminatae, brunnescentes, caducae, minute scaberulae; folia opposita, glabra, petiolo gracili 3–5 mm. longo supra sulcato; lamina subcoriacea, obovato-oblonga vel oblongo-oblanceolata, 5–6.5 cm. longa, 1.7–2.5 cm. lata, acuta vel obtusa, basin versus longe sensimque cuneato-attenuata, supra glauco-viridis, costa non elevata, venis obscuris vel obsoletis, subtus paullo pallidior, costa prominente gracili, nervis lateralibus utroque latere 7–8 prominulis gracilibus angulo acuto adscendentibus subarcuatis prope marginem obscure conjunctis, margine paullo incrassato et revoluto, nervulis obsoletis. Inflorescentiae terminales cymoso-corymbosae vel umbelliformes, 5–14 mm. longe pedunculatae, pedunculo gracili glabro, pauciflorae, floribus subsessilibus, bracteis minutis; calyx 0.5 mm. longus, 5-lobus, lobis late ovatis obtusis. Fructus ruber, subglobosus, 3–3.5 mm. longus, pyrenis dorso obtuse costatis facie ventrali planis.

HONDURAS: thicket along stream, Siguatepeque, Dept. Comayagua, alt. 1,100 meters, *Paul C. Standley*, no. 56197, February, 1928 (Herb. Field Mus. no. 581,450, type).

Although this plant is not marked by any outstanding characters, it does not agree with any species of *Psychotria* hitherto known from Central America. It grows in thickets along the small streams in the pine-covered hills about Siguatepeque.

Triodon angulatum Benth. A low dense shrub, only 30–60 cm. high; flowers white. Common in the edges of streams.

Borreria fruticosa, sp. nov.

Frutex erectus 30–90 cm. altus, dense ramosus, ramis validis tetragonis ferrugineis glabris, internodiis brevibus vel elongatis; stipulae in vaginam 1.5 mm. longam scaberulam vel glabratam connatae, apice in aristas paucas 3.5–5 mm. longas erectas glabras desinentes; folia opposita, saepe in axillis fasciculis foliorum reductorum onusta, lanceolata vel oblongo-lanceolata, acuta vel acuminata, apice subulato-mucronata, basin versus angustata vel saepe in petiolum brevissimum abrupte contracta, coriacea, glabra, supra luteo-viridia, costa subimpressa, nervis obsoletis, subtus pallida, costa prominula, nervis lateralibus paucis obscuris angulo angustissimo adscendentibus, margine revoluto. Flores subsessiles ad apices ramulorum subcapitati, capitulis paucifloris; hypanthium 2 mm. longum, turbinatum, glabrum; calyx 4-partitus, laciniis 2.5–3 mm. longis lineari-lanceolatis subulato-attenuatis viridibus basi obscure ciliolatis, denticulis minutis alternantibus; corolla viridescenti-alba, 2 mm. longa, extus glabra, fauce pilosula, fere ad basin 4-fida, lobis oblongis obtusis; stamina prope basin tubi inserta, filamentis brevissimis, antheris late oblongis; stylus gracilis, ramis 2 brevibus obtusis. Fructus cylindricus 4.5 mm. longus, 2 mm. crassus, glaber, laciniis calycis persistentibus coronatus, coccis apice tantum longitudinaliter dehiscentibus; semina oblonga, fusca, 2 mm. longa, placentae oblongae 3.5–4 mm. longae pallidae adnata.

HONDURAS: in pine forest, Siguatepeque, Dept. Comayagua, alt. 1,100 m., *Paul C. Standley*, no. 56240, February, 1928 (Herb. Field Mus. no. 581,434, type), no. 56019.

This plant represents a curious and interesting species. By its habit alone it is readily distinguished from all the other species of *Borreria* known from Central America, for it is a true shrub, stiffly erect, with well-developed woody stems. The seed characters are almost distinct enough to furnish generic characters for separating the plant from *Borreria*. They are almost exactly like those of the genus *Emmeorrhiza*, but the style is that of *Borreria*, and the habit is quite unlike that of the former genus, which consists of scandent suffrutescent plants with flowers in umbels. It seems preferable to place the Honduran plant for the present in *Borreria*, since I suspect that similar seeds may be found in some of the numerous species of that genus.

CAPRIFOLIACEAE

Sambucus mexicana Presl. SAUCO. A shrub or small tree, planted frequently about houses, probably because of the fact that it is often used in domestic medicine.

COMPOSITAE

Vernonia canescens HBK. A shrub 1 m. high with pinkish white flowers. Growing in pine forest.

Vernonia Deppeana Less. A shrub or tree of 2–5.5 m., bearing pinkish flowers. In thickets along streams.

Vernonia melanocarpa (Gleason) Blake. HOJA BLANCA. A bushy shrub 1.5–2.5 m. high with white flowers. Common in open pine forest.

Vernonia tortuosa (L.) Blake. A shrub 1.5–3 m. high, the flowers pinkish white, with a strong vanilla odor. In thickets along the river.

Ageratum (§ **Coelestina**) **Standleyi** Robinson, spec. nov., **fruticosum** erectum subgriseo-viride rigidiusculum usque ad 9 dm. altum scabrido-puberulum; caule subtereti supra per abortionem axis principis saepe pseudo-dichotomo; ramis adscendentibus; foliis oppositis breviter petiolatis ovatis obtusis integerrimis margine revolutis textura rigidis supra scabridis puberulis et glandulari-granulosis subtus griseo-pannosis a puncto paullo supra basin 3-nervatis 1–2.2 cm. longis 7–13 mm. latis basi obtusis vel subtruncatis; petiolo 1–3 mm. longo; corymbis terminalibus modice convexis vel hemisphaericis ca. 3 cm. diametro; pedicellis 0–1 cm. longis; involucri campanulati ca. 4 mm. alti ca. 5 mm. diametro squamis subbiseriatim imbricatis angustissime lanceolatis attenuatis apice incurvis 2(–3)-costatis dorso puberulis et cum glandulis sessilibus globosis ornatis; receptaculo leviter conico nudo; corollis lavandulaceis ca. 3 mm. longis extus sparse granulatis; dentibus limbi brevibus vix 0.3 mm. longis deltoideis; styli ramis filiformibus elongatis; achaeniis nigris glabris lucidulis 2.2 mm. longis in summo cum cupula vix 0.2–0.3 mm. alta primo ut videtur infra sed maturitate distincte extra corollam coronatis.

HONDURAS: pine forest, vicinity of Siguatepeque, Dept. Comayagua, alt. 1080–1400 m., Feb. 14–27, 1928, *Paul C. Standley*, no. 56,234 (TYPE in Field Mus.)

The reduction of the pappus to a mere ring or low crown, which at least in its early stages appears morphologically beneath rather than exterior to the corolla, makes this species a somewhat doubtful intermediate between *Ageratum* § *Coelestina* and *Alomia*. In full maturity, however, this shallow and slightly undulate or toothed rim or crown of the achene is pretty clearly external to the base of the insertion of the corolla and may therefore be considered a rudimentary pappus rather than a mere specialized thickening of the receptacle at the articulation of the corolla and summit of the achene.

The small thick rigid entire leaves with dense pale gray indument on the lower surface should make the species easy to recognize among its congeners.—B. L. ROBINSON.

A shrub a meter high, with lavender flowers. Growing in open pine forest.

Eupatorium collinum DC. A shrub of 1–2 m., the flowers white. In pine forest. One of the common species of Central America.

Eupatorium daleoides (DC.) Hemsl. A slender tree of 4.5–7.5 m., growing in thickets along streams.

Eupatorium (§ **Subimbricata**) **hondurense** Robinson, spec. nov., fruticosum erectum 1.2 m. altum; caule subtereti brunnescente puberulo virgato vel sursum paucirameo usque ad 3–4 mm. diametro; foliis oppositis breviter petiolatis ovatis vel ovato-oblongis apice subacutis vel saepius obtusis leviter crenato-serratis basi rotundatis vel subcuneatim angustatis utrinque exserto-reticulatis puncticulatis pinnatim paullo supra basin 3–5-nervatis 4–6.6 cm. longis 2–4 cm. latis textura coriaceis in costa nervisque tomentello-puberulis; petiolo tereti tomentello-puberulo ca. 5 mm. longo; inflorescentia breviter laxeque thyrsoidea 4–9 cm. alta 3–9 cm. diametro apice rotundata; pedicellis 0.5–1.5 mm. longis; capitulis 12–13-floris ca. 6 mm. altis pedicellatis; involucri anguste campanulati squamis ca. 14 subtriserratim imbricatis, exterioribus lanceolatis acutis ca. 3 mm. longis et 1 mm. latis, interioribus oblongis vel anguste obovato-oblongis ad summum versus subdentatis cuspidatis, dorso glandulari-granulatis viridibus; corollis ca. 2–6 mm. longis sursum gradatim ampliatis, dentibus limbi perbrevibus; achaeniis 1.9–2.2 mm. longis sursum brevissime scabratis; pappi setis ca. 20 sublaevibus; styli ramis clavatis nigrescentibus saepe deflexis.

HONDURAS: brushy bank, vicinity of Siguatepeque, Dept. Comayagua, alt. 1080–1400 m., Feb. 14–27, 1928, *Paul C. Standley*, nos. 56,357 (TYPE, in Field Mus.; ISOTYPE in Gray Herb.) and 56,390 (Field Mus.).

This plant, with inflorescence and involucre slightly resembling those of *E. collinum* DC., differs much in its few-flowered heads, short petioles and firm reticulated leaves. Among the Central American Eupatoriums it may be placed near *E. costaricense* Ktze. from which, however, it may at once be distinguished by its shorter, thicker and much more shortly pedicelled heads, denser inflorescence, and more broadly ovate leaves as well as its relatively broader phyllaries.—B. L. ROBINSON.

A shrub a meter high, growing in pine woods and on open brushy banks.

Eupatorium laevigatum Lam. A shrub 2 m. high, in pine forest.

Eupatorium micranthum Less. A tree 4.5 m. high, in pine forest near El Achote.

Eupatorium Oerstedianum Benth. A shrub of 2.5 m., in moist thickets.

Brickellia oliganthes (Less.) Gray. A slender shrub a meter high, in open pine woods.

Brickellia pacayensis Coult. A shrub 1.5–2 m. high with pale yellow flower heads. In dry or moist thickets.

Brickellia paniculata (Mill.) Robinson. A shrub 1–1.5 m. high, characteristic of dry thickets.

Pluchea odorata (L.) Cass. SUACUAMÁN. An unattractive shrub 3–4.5 m. high, with pink flowers. In moist thickets. One of the common and more or less weedy shrubs of Central America, especially on the Pacific slope.

Archibaccharis Standleyi Blake in Jour. Washington Acad. Sci. 19: 271 (1929). On open rocky banks, no. 56193. A shrub a meter high, with white flowers.

Baccharis serraefolia DC. An erect shrub a meter high with greenish white heads. In pine forest.

Baccharis splendens Heering. A shrub 1.5 m. high, in pine forest.

Baccharis trinervis var. *rhexioides* (HBK.) Baker. A shrub 1–2.5 m. high, with recurved branches, the flower heads greenish white. Growing in open pine forest. One of the widely distributed weedy shrubs of Central America.

Nocca helianthifolia var. *suaveolens* (HBK.) Robinson. Plants simple or sparingly branched, suffrutescent or herbaceous, about a meter high; flowers creamy white. Occasional in pine forest.

Calea integrifolia (DC.) Hemsl. A slender shrub a meter high; rays white, the disk yellow. Frequent in open pine woods.

Calea Tejadae Blake. A shrub a meter high, with dirty white heads. Abundant in open pine woods and on dry plains, forming extensive thickets.

Calea urticifolia (Mill.) DC. A shrub of 1–3 m., with yellow heads. Growing in wet thickets, on brushy banks, and in pine forest.

Perymenium Purpusii Brandeg. A low shrub, about a meter high, with yellow-green flower heads. Frequent in pine forest.

Perymenium strigillosum (Rob. & Greenm.) Greenm. A tree about 7.5 m. high, with pale shredded bark; flower heads greenish yellow. Frequent in thickets. This is one of the few Central American Compositae which become true trees. In Salvador its wood is highly esteemed for construction purposes.

Tithonia Pittieri (Greenm.) Blake. Suffrutescent, about a meter high; heads yellow. Growing in pine forest. A narrow-leaved form of this species, according to Blake, who refers here also another specimen, taken from a tall herb. The two plants are so unlike in appearance when growing, as well as in the herbarium, that it scarcely seems possible that they represent the same species.

Verbesina sublobata Benth. A shrub of 3 m. with large pinnatifid leaves and few branches. Occasional in dry thickets.

Zexmenia frutescens var. *villosa* (Polak.) Blake. A shrub of 2 m., the heads yellow. In open pine forest.

Zexmenia melastomacea Blake in Jour. Washington Acad. Sci. **19:** 274 (1929). In pine forest, nos. 56389 and 55826. Suffrutescent or herbaceous, the heads yellow.

Senecio arborescens Steetz. A shrub or tree of 2–6 m., with few thick branches; leaves pinnately lobed. Sometimes forming small groves along streams.

Senecio cobanensis Coulter. A glabrous shrub or small tree 2–4.5 m. high, with yellow flower heads. Growing in thickets along streams.

Trixis Deamii Robinson. FLOR DE CAMPO. A shrub of 1–2 m., bearing numerous small yellow heads. Frequent in open pine woods.

FIELD MUSEUM OF NATURAL HISTORY
CHICAGO.

THREE NEW PLANTS FROM YUCATAN

PAUL C. STANDLEY

DURING the summer of 1929, Dr. J. Bequaert, whose botanical explorations in western tropical Africa yielded such rich returns, collected about 100 numbers of plants in northern Yucatan. The whole collection including the duplicates was kindly presented to the Arnold Arboretum by the collector and a set of his well-prepared specimens was sent to the writer for determination. Although made in a region presumably explored thoroughly by earlier visitors, the collection was found to contain three plants not represented in available herbarium material from Yucatan. It is rather amusing to find that all three of these apparently new species were discovered at Chichen Itzá, the goal of most visitors to Yucatan.

Besides the new species, the Bequaert series contains specimens of many endemic and rare Yucatan plants, some of which, such as *Croton malvaviscifolius* Millsp., have been known heretofore only from the type collection.

Nemastylis Bequaertii, sp. nov.

Herba 30–35 cm. alta, scapis supra medium ramosis subteretibus glabris viridibus spathas 4–6 gerentibus; folia radicalia late linearia, circiter 28 cm. longa et 13 mm. lata, longe sensimque attenuata, glabra 5-nervia, foliis caulinis brevioribus et 6–8 mm. latis; spathae circiter 6-florae, longe pedunculatae, pedunculo 4–8 cm. longo gracillimo glabro erecto vel adscendente; spathae bracteae valde inaequales, interiore duplo breviore vel interdum exteriorem fere aequante, 2–3 cm. longae, longe et angustissime attenuatae, glabrae, multinerviae, erectae; flores longe pedicellati, pedicellis gracillimis usque ad 2.5 cm. longis glabris, inclusis vel breviter exsertis; ovarium oblongum, glabrum, 5 mm. longum, 2 mm. latum; perianthium ut videtur caeruleum circiter 9 mm. longum, segmentis late cuneato-obovatis apice late rotundatis; antherae lineares, 4 mm. longae rectae, connectivo gracili.

YUCATAN: in clearing of woods, Chichen Itzá, *J. Bequaert*, no. 109, June 30, 1929 (Herb. Field Mus. no. 603,516, type; isotype in Gray Herb.).

BRITISH HONDURAS: Honey Camp, *C. L. Lundell*, no. 577, October, 1929.

Erythroxylon Bequaertii, sp. nov.

Frutex vel arbuscula 3.5–4.5 m. alta, ramulis gracilibus subteretibus pallidis vel ferrugineis interdum substriatis glabris lenticellis albidis elevatis conspersis, internodiis brevissimis; stipulae parvae, persistentes, anguste triangulares, attenuatae, integrae, erectae, glabrae; folia petiolata, membranacea, petiolo gracili subtereti glabro circiter 5–6 mm. longo; lamina elliptico-oblonga, prope medium latissima, 2.8–5 cm. longa, 1–2.2 cm. lata, versus apicem obtusum vel anguste rotundatum angustata, apice breviter mucronata, versus basin sensim longeque angustata et ad petiolum longe decurrens, glabra, non areolata, supra viridis, venis prominulis, subtus pallidior, costa gracili elevata, venis nervulisque prominulis et arcte reticulatis; flores ad axillas pauci-fasciculati, pedicellis glabris 4–5 mm. longis validiusculis angulatis; calyx circiter 1.7 mm. longus, 5-fidus, lobis ovatis acutis vel acuminatis crassiusculis; petala oblonga, 3–3.5 mm. longa, glabra, apice obtusa; tubus staminalis calyce paullo longior, filamentis elongatis tubo longioribus, antheris circiter 0.6 mm. longis.

YUCATAN: Chichen Itzá, *J. Bequaert*, no. 102, June 28, 1929 (Herb. Field Mus. no. 603,414, type; isotype in Herb. Arnold Arb.).

The species of *Erythroxylon* are, for the most part, poorly marked, and based upon characters of doubtful value. The present plant, although possessing no outstanding characters, does not agree with any of the species reported from Mexico or the West Indies.

Stenandrium subcordatum, sp. nov.

Herba scaposa perennis, 5.5–11 cm. alta e rhizomate brevi crasso nodoso; folia basalia longe petiolata, petiolo 1.5–2.5 cm. longo dense griseo-piloso; lamina membranacea, oblongo-ovata vel ovali-ovata, 3–4 cm. longa, 1.5–2.5 cm. lata, apice rotundata vel obtusissima, basi inaequali subcordata, utrinque pilis brevibus patentibus albidis densiuscule pilosula, ad nervos longius pilosula; scapus gracilis erectus dense pilis brevibus patentibus albidis pilosus, spica 2–3 cm. longa, dense multiflora, bracteis adpressis anguste linearibus 5–7 mm. longis attenuatis dense puberulis, bracteolis conformibus vel paullo angustioribus brevioribusque; sepala 5 lineari-subulata, 3.5–4.5 mm. longa, subulato-attenuata, nervulosa, scaberula, erecta; corolla purpurascens, glabra, tubo gracili 7–8 mm. longo circiter 0.8 mm. crasso, limbi lobis subaequalibus late obovatis 6–7 mm. longis apice rotundatis; antherae inclusae.

YUCATAN: in bush, Chichen Itzá, *J. Bequaert*, no. 20, June 3, 1929, (Gray Herb., type).

The plant is similar to *S. dulce* (Cav.) Nees, but in that the leaves are narrowed and decurrent at the base, and the bracts are broad and obtuse.

Blake, following Pennell, has used for this genus of the Acanthaceae the name *Gerardia*. In following the International Rules, I do not see that such a course is necessary, and it is surely preferable to retain the name *Gerardia* for the well-known genus of the Scropulariaceae to which it has been applied by most botanists.

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NOTULAE SYSTEMATICAE AD FLORAM SINENSEM

H. H. HU

Schizophragma macrosepalum, sp. nov.

Frutex scandens. Folia papyracea, oblongo-elliptica, circiter 17 cm. longa et 5 cm. lata, acuminata, basi subrotundata vel late cuneata, integra, glabra, supra obscure luteo-viridia, subtus pallidiora et lucida, venis pubescentibus exceptis glabra; petioli 1.5 cm. longi, puberuli. Cymae tomentellae; calycis tubus sparse pilosulus; sepalum floris sterilis late ovatum, 7–11.5 cm. longum et 5–6 cm. latum, acuminatum, basi oblique subrotundatum, venis puberulis exceptis glabrum. Capsula subglobosa, 7 mm. longa et 6 mm. diam.

Climbing shrub. Leaves papery, oblong-elliptic, acuminate, 17 cm. long, 5 cm. broad, nearly rounded to broad-cuneate at base, entire along the margins, glabrous, obscurely yellowish-green above, shining and paler green beneath, glabrous except pubescent along the veins; petiole 1.5 cm. long, puberulous. Cymes tomentulous, calyx-tube sparsely pilosulous; sepal of sterile flower broad-ovate, 7–11.5 cm. long, 5–6 cm. broad, unequally roundish at base, acuminate at apex, glabrous except puberulous along the veins. Capsule subglobose, 7 mm. long and 6 mm. broad.

KWANGSI: Shih wan dar shan, south of Nanning, in woods, 350 m., *R. C. Ching*, no. 7871, Oct. 15, 1928 (type).

A striking species differing from all known species in the exceedingly large sterile flowers. Its entire leaf without the slightest dentation is like *S. hypoglaucum* Rehd., but the sterile flowers readily differentiate this species from the others.

Sloanea Chingiana, sp. nov.

Arbor ad 14 m. alta; truncus 30 cm. diam., cortice cinereo laevi obtectus; ramuli glabri, sparse lenticellati. Folia oblongo-lanceolata vel spathulata, ad 17 cm. longa et 5 cm. lata, longe acuminata, basi cuneata, integra, utrinque glabra, supra intense viridia, subtus pallidiora; petioli ad 5 cm. longi. Fructus 5–7, umbellati, pedunculo 6 cm. longo suffulti; pedicelli ad 3.5 cm. longi, glabri; capsula globosa, 1.5 cm. longa, valvis 3–4 satis tenuibus lignosis velutinis, setis 1 mm. longis viridibus (in sicco fuscis) dense obtectis; semina oblonga, 8 mm. longa et 6 mm. lata, lucide brunnea, arillata.

Tree to 14 m. high; trunk 30 cm. in diameter, with gray smooth bark; branches glabrous with scattered lenticels; leaves oblong-lanceolate to spathulate, long acuminate, cuneate at base, entire along the margins, to 17 cm. long, 5 cm. broad, glabrous on both surfaces, dark green above, lighter below; petiole to 5 cm. long; fruit 5–7, umbellate, on a common peduncle to 6 cm. long, pedicels to 3.5 cm. long, glabrous; capsule globose, 1.5 cm. long, valves 3–4, rather thin, woody, velvety, covered with dense green (brown when dry) bristles 1 mm. long; seeds oblong, shining brown, 8 mm. long, 6 mm. broad, arillate.

KWANGSI: Bako shan, W. Peseh, *R. C. Ching*, Sept. 17, 1928 (type).

Allied to *S. tomentosa*, its capsules being covered with short bristles and not spiny, but differing from it in its branchlets leaves and peduncles and pedicels being all glabrous, and the fruit smaller.

Ostrya Liana, sp. nov.

Arbor 16-metralis; truncus 60 cm. diam., cortice cinereo-nigro longitudinaliter fisso obtectus; rami ramulique glabri. Folia tenuia, membranacea, elliptico-ovata, 4–7.5 cm. longa et 2–4 cm. lata, acuta vel acuminata, basi leviter cordata vel rotundata, dupliciter et irregulariter serrata, supra glabra, subtus secundum venas puberula ceterum glabrescentia, venis utrinque 12–15; petioli graciles, 1 cm. longi, tomentelli. Inflorescentia mascula immatura 6–8 mm. longa, oblonga, bracteis acutis glabris lucidis. Racemi fructiferi circiter 2 cm. longi, fructibus 8–10, pedunculo 2–2.5 cm. longo; fructus 1–1.5 cm. longi et 6 mm. lati, utriculo compresso elliptico-ovato, apice acuto obliquo; nuculae ovatae, compressae, 7 mm. longae, lucide luteo-virides, apice glabrae.

Tree 16 m. high; trunk 60 cm. in diam., bark grayish black, longitudinally fissured; branches and branchlets glabrous; leaves thin, membranaceous, elliptic-ovate, 4–7.5 cm. long, 2–4 cm. broad, acute to acuminate at apex, slightly cordate to rounded at base, doubly and irregularly serrate along the margins, glabrous above, glabrescent except puberulous along the veins beneath, with 12–15 pairs of veins; petiole slender, 1 cm. long, tomentulous; immature staminate inflorescence 6–8 mm. long, oblong, with glabrous shining pointed scales; infrutescence about 2 cm. long, peduncle 2–2.5 cm. long, with 8–10 fruits, fruit 1–1.5 cm. long, 6 mm. broad, utricles laterally compressed, elliptic-ovate, with an oblique pointed apex; nutlets laterally compressed, ovate, 7 mm. long, shining yellowish green, glabrous at the apex.

CHIHLI: Eastern Tomb, *Cheng Fan Li*, No. timber no. 3, Sept. 15, 1929 (type).

Allied to *O. japonica* Sarg., differing in the much smaller fruits and shorter fruit clusters, and nearly glabrous lower surfaces of the leaves.

FAN MEMORIAL INSTITUTE OF BIOLOGY
PEIPING, CHINA

NEW SPECIES AND A NEW GENUS FROM EAST AFRICA

J. MILDBRAED

THE plants collected in Central and East Africa from December, 1926 to April, 1927 by Dr. D. H. Linder who accompanied the Expedition of the Harvard Institute of Tropical Biology and Medicine to Tropical Africa as collector for the Arnold Arboretum had been sent, with the exception of the Orchids, to the Botanical Museum at Berlin-Dahlem for determination.[1] As the expedition after having spent about five months in Liberia traversed rather hurriedly regions of the Belgian Congo and East Africa which were already fairly well explored botanically, the collection comprising about 800 numbers from this part of Africa did

[1] The collections made in Liberia have been sent to Kew where they are being determined in connection with the publication of the Flora of Tropical West Africa by Hutchinson & Dalziell. Descriptions of new species wholly or partly based on Linder's plants have been published in the Kew Bulletin for 1928, p. 380 and 400 and for 1929, p. 20–23.—Ed.

not contain many new plants. Descriptions of five new species of which one represents a new genus follow below.

Alchemilla Linderi, n. spec.

Decumbens et adscendens, ramosa, ramis omnino glabris rubescentibus praestantibus ad 30 cm. longis, internodiis 3–0.5 cm. attingentibus. Foliorum petiolus longe sericeo-pilosus vix dimidium laminae aequans; stipulae basi connatae ceterum liberae oblique semi-ovatae vel fere semi-orbiculares, margine crenato-serratae et (imprimis apice dentium) ciliatae, petiolo manifeste longiores; lamina margine ciliato et nervis primariis supra impressis subtus parce adpresse pilosis exceptis glabra, subcoriacea, sub lente dense reticulato-venosa, reniformis, basi sinu late aperto, 1.2–1.6 cm. lata, quinqueloba, lobo mediano ad fere ⅖, laterales ad ⅓ vix ½ radii incisis, omnibus obovatis margine minute crenato-serratis dentibus incurvis. Inflorescentiae elongatae, ramosae ramis glabris; bracteae quasi collare irregulariter (in superioribus saepe 4-) lobatum usque partitum lobi minoribus saepe integris, majoribus pauci-dentatis dentibus plerisque basi latioribus quam longioribus efformantes; flores breviter pedicellati, glabri; calycis dentes late semi-ovati, apice paululo apiculato-acuminati, ca. ⅔ mm. longi; stamina brevissima.

UGANDA: east of Behungi, in meadow, *D. H. Linder*, no. 2576, April 5, 1927. Type in Bot. Mus. Berlin; isotype in Gray Herb.

This new species is most closely related to *A. Mildbraedii* Engl. (cf. figure in Wiss. Ergebn. Deutsch. Zentral Afrika Exp. 1907–08. II. Bot. tab. 21), but it differs in the shorter petioles and particularly in the much broader lobes of the bracts forming a rigid spreading irregularly lobed and cut collar.

Erica Linderi, n. spec.

Frutex ex coll. 3–6 pedalis dense ramosus, ramulis erecto-patentibus novellis bruneo-rubescentibus minutissime albido-puberulis, vetustioribus glabratis atro-violascenti-bruneis. Folia ternato-verticillata cum petiolo vix 1 mm. aequante ca. 4 mm. longa, vix 1 mm. lata, obtusa, dorso sulcata, margine vix ciliato. Flores apice ramulorum plures congesti; pedicelli graciles, ca. 5 mm. longi, prope basin bractea unica lineari obtusa et medio 2 oppositis subadpressis basin calycis haud attingentibus instructi; sepala anguste ovata, 1.8 mm. longa, acuta; corolla ex coll. alba 3 mm. longa vel paulo longior, triente inferiore 2 mm. diam. vix aequans, faucem versus paulo constricta, lobi erecto-patentes 1 mm. longi et basi aequilati, valde obtusi; stamina 8 basin loborum tantum attingentia ideoque semper inclusa; filamenta tenuissima antheris ca. 1 mm. aequantibus subduplo longiora. Ovarium turbinato-globosum, sub anthesi vix 1 mm. altum, stilo 3 mm. longo corollam sat longe superante coronatum.

UGANDA: meadow east of Behungi, in Red-hot Poker Meadow, *D. H. Linder*, no. 2579, April 5, 1927 (shrub 3–6 ft. tall; flowers white). Type in Bot. Mus. Berlin; isotype in Arnold Arb.

Closely related to *E. rugegensis* Engl. which also has the pedicel with two bracts in the middle, but differs in the much slenderer corolla, in *E. rugegensis* nearly 3 mm. in diameter in the lower third. *Erica kingaensis* has still broader flowers and only one bract above the middle of the pedicel.

Buchnera stachytarphetoides Mildbraed & Melchior, n. spec.

Herba ut videtur perennis, caule simplici subcylindrico praeter lineas 2 longitudinales pilis brevissimis horizontaliter patentibus obsitas glabro, in sicco nigra, fere 70 cm. alta. Folia opposita, lanceolata, sessilia, apice obtusa ad 3 cm. longa et 7 mm. lata, inferiora quam internodia duplo longiora, superiora eis subaequilonga, numerosa (ad 30 paria), in bracteas floriferas sensim minores transeuntia, glabra, integra. Spica dimidio inferiore tantum florens jam 25 cm. longa, sublaxa sed bractearum apicibus basin paris sequentis attingentibus; bracteae foliis similes sed margine breviter setose-ciliatae, medio spicae 11 mm. longae et 3 mm. latae; prophylla lanceolato-linearia ca. 6 mm. longa et 0.8 mm. lata, margine parum ciliata. Flores ex coll. colore Lavandulae; calycis tubus anguste cylindricus, 10 mm. longus et vix 1.5 mm. diam., glaber, dentes 6 (semper?) semilineari-lanceolati, parce ciliati, 2 et 3 mm. longi; corollae glabrae tubus fere 2 cm. longus, 1 mm. diam., lobi ovales vel paulo obovato-ovales, basi subcuneato-angustati, apice rotundati, ca. 8 mm. longi et 4 mm. lati, intus faucem versis strigoso-pilosi; stamina paulo supra medium tubi inserta, bina filamentis ca. 2 mm. longitud. aequantibus et antheris apiculatis subaequilongis, bina antheris subsessilibus; ovarium glabrum, ellipsoideum, ca. 2 mm. longum, stilus vix 4 mm., stigma ambitu lanceolatum, obtusum, 3 mm. longum.

BELGIAN CONGO: Kivu Lake, Nyagezi, *D. H. Linder*, no. 2014, Feb. 3, 1927 (flowers lavender, soon blackening). Type in Bot. Mus. Berlin; isotype in Gray Herb.

Apparently most nearly related to *B. usuiensis* Oliv., but differing in the looser spike and chiefly in the corolla tube which is considerably longer in proportion to calyx and bracts. *Buchnera Lastii* Engl. is also similar, but has smaller flowers.

Parastriga, nov. gen.

Calyx late campanulato-cyathiformis dentibus 5 brevibus subaequalibus. Corollae tubus cylindricus fauce galeato-ampliatus et prorsum curvatus, limbus 5-lobatus, lobis subaequalibus e basi lata apicem versus angustioribus reflexis. Stamina 4, subaequalia, vix didynama, filamentis parte superiore tubi insertis, antheris unilocularibus curvatis longitudinaliter deshiscentibus declinatis inclusis. Ovarium placentis crassis ovulis numerosissimis instructis, stilus declinatus, stigma linguiformi-dilatatum et -incrassatum.—Herbae parvae habitu Alectrae vel Euphrasiae.

Parastriga alectroides, n. spec.

Herba exsiccatione nigricans caule tenui simplici (semper?) 10–25 cm. longo, subglabro vel apicem versus pilis curvatis collapsis capitatis hyalinis imprimis ad lineas 2 longitudinales instructo, internodiis infimis ad 7 longis superioribus 3–1 cm. vel etiam brevioribus. Folia opposita glabra, praeter par infimum florifera, sessilia, late triangulari-ovata, basi late truncata et subcordata, apice obtuso interdum apiculata, 1.3 cm. longa et aequilata vel minora. Flores in foliorum axillis solitarii subsessiles; calyx breviter late campanulato-cyathiformis cum dentibus 5 subaequalibus triangularibus basi ca. 3 mm. latis et subaequilongis acutis 8 mm. longus et fere 6 mm. diam., glaber vel margine parce glanduloso-ciliatus, nervis primariis 10 inter sese reticulatim conjunctis; corollae ex coll. roseae tubus circa ovarium magnum parum ampliatus, deinde 3 mm. longe anguste cylindricus, ca. 1.5 mm. diam., fauce galeato-ampliatus et prorsum curvatus, lobi 5 subaequales ca. 4 mm. longi, e basi 2.5 mm. lata semi-oblongi obtusi sed marginibus revolutis saepe pseudo-acuminati, paulo obliqui, reflexi, infimus medianus quam alii paulo longior et angustior; stamina in parte superiore tubi cylindrici inserta, superiora paulo altius, inter sese fere aequalia, filamenta superiorum 2 mm. inferiorum 2.5 mm. longa, antherae uniloculares 1.5 mm. longae, curvato-declinatae inter sese parallelae; ovarium ellipsoideum glabrum, placentis crassis ovulis numerosissimis; stilus glaber declinato-curvatus apice in stigma linguiforme 3–4 mm. longum dilatatus et incrassatus, stamina manifeste superans. Capsula ut videtur nondum perfecte matura (stilo etiam coronata) ovoidea, subacuta, 8 mm. longa, 5 mm. diam., semina 0.5 mm. longa, fusiformi-ellipsoidea, pallide brunea.

Belgian Congo: vulcanic region near Kivu Lake, southwest slope of Mt. Mikeno, alt. 7250 ft., in wet crater meadow, *D. H. Linder*, no. 2428, March 23, 1927 (Flowers pink). Type in Gray Herb.; merotype in Bot. Mus. Berlin.

This new genus closely approaches *Striga* in the structure of the anthers and of the ovary but differs completely in the shape of the corolla.

Justicia kiwuensis, n. spec.

Herba satis ramosa ramis secus lineas 2 longitudinales imprimis apicem internodiorum versus deflexo-hirsuto-pubescentibus. Folia pro rata parva, anguste ovata, basi rotundata vel ex rotundato breviter in petiolum tenuem ad 4 mm. longum angustata, apice obtusa vel late indistincte subacuminata, sicca atro-olivacea, supra subtusque breviter pubescenti-hirsuta, ad 2.5 cm. longa et 1 cm. lata, raro pro longitudine latiora. Flores in foliorum axillis plerumque tantum bini, parvi; bracteae foliaceae petiolo lato ca. 1.5 mm. longo, lamina ovali 2 mm. aequante; prophylla minuta, triangulari-subulata; calycis dentes ad basin fere liberi, lineari-subulati, ca. 3 mm. longi et 0.5 mm. lati, subcarinati, apice longe sensim acuminati et paulo recurvi, pilis nonnullis parce hirsuti; corollae ex coll. albidae fauce pallide roseo-notatae tubus ca. 3 mm. longus; labium superum 3.5 mm. longum, basi 2.5 mm. latum, apice breviter bilobum; labium inferum 4 mm. longum et fere aequilatum, basin versis modo generis bullatum, 3-lobum, lobis subaequalibus vix 1 mm. longis basi ca. 1.5 mm. latis valde obtusis; staminum filamenta 2.5 mm. longa, antherarum thecae inaequales, inferior major et basi calcarata, ovarium glabrum in stilum fere 4 mm. longum glabrum attenuatum. Capsula straminea, glabra 6 mm. longa et paulo supra medium ca. 1.5 mm. diam., valde acuta; semina in visa 3.

BELGIAN CONGO: Ruanda, Kivu Lake, Kissenyi, river bank, *D. H. Linder*, no. 2024, Feb. 10, 1927 (semi-prostrate, spreading; flowers white with pale spinel-pink in throat). Type in Gray Herb.

Similar to *J. melampyrum* S. Moore, but it has broader shorter-petioled leaves; moreover only normal capsules could be found.

Crossandra massaica, n. spec.

Perennis suffrutescens pedalis vel altior, caulibus cylindricis juventute puberulis demum glabratis lignescentibus ad 4 mm. crassis, e vetustioribus ramulos abbreviatos dense foliatos emittens. Folia supra subtusque imprimis ad nervos parce puberula usque subhirta, lamina plerumque ovato-lanceolata vel lanceolato-elliptica, rarius fere ovata vel oblongo-lanceolata, basi breviuscule usque sat longe in petiolum ⅓ ad fere ½ laminae aequantem angustata, apice acuta vel paulo acuminato-acuta vel fere obtusa, in ramis primariis ad 8 cm. longa et 3.5 cm. lata, in lateralibus abbreviatis minora et pro longitud. angustiora. Pedunculi axillares et pseudoterminales, tenues, stricti, 4–12 cm. longi, puberuli; spicae ellipsoideae sine corollis 2–3 cm. longae et ca. 7.3 cm. crassae; bracteae 3–4 infimae, vacuae sensim minores, omnes carinato-cymbiformes scariosae, praeter medianum utrinque nervis 2 crassis percursae, nervis omnibus venis reticulatis sat crasse prominentibus reticulatim conjunctis, margine longe sericeo-ciliatae, ceterum sub lente dense brevissime hirtae, ovato-ellipticae, 15 mm. longae et paulo infra medium 8 mm. latae, apicem haud vel vix reflexum versus sensim acutae, prophylla anguste lanceolato-linearia, apicem versus fere subulata, 9 mm. longa vix 1.5 mm. lata, scariosa, ciliata; sepala hyalina, apicem versis ciliata et nervis excurrentibus subaristata, posticum ellipticum, 6–7 mm. longum, fere 4 mm. latum, apice ad 1.5 mm. bidentatum, 2-nervium, anteriora elliptico-lanceolata aequilonga, uninervia, 2 interiora manifeste minora, vix 4 mm. longa, ceterum anterioribus similia; corollae auranticae tubus 18–20 mm. longus, anguste cylindricus, lobi 2 posteriores 8 mm. longi, medio ad basin separati, latere altero cum lateralibus a fauce 11 mm. longis apice breviter bilobis lobulis rotundatis altius connati, anticus a fauce fere 12 mm. longus, 9 mm. latus, sinu acuto ad 2.5 mm. a margine bilobus, a lateralibus sinubus valde angustis paulo ultra medium radii incisis sejunctus; stamina ca. 4 mm. infra faucem affixa, filamentis brevissimis, antheris 1.5 mm. longis subaequalibus; ovarium glabrum, 3 mm. longum, 1 mm. crassum, acutum, stilus 12 mm. longus, stigma incrassatum apice truncatum, dorso gibbosum. Capsula glabra, 11 mm. longa, compressa, pungenti-acuta; semina 2–3 mm. diam., complanata squamis late cuneatis plus minusve laceratis obtecta.

EAST AFRICA. Kenya Colony: Kikemu, near Lake, *D. H. Linder*, no. 2639 (type), April 21, 1927 (1 ft. high; flowers orange). German East Africa: Ermessa, east of Ikorna, *Jaeger & Oehler*, no. 349, Jan. 3, 1907 ("Ranke zwischen Granitblöcken, Bl. fleischrot"); Marienhof, Ukerewe Island in Victoria Nyanza, *P. Conrads*, no. 509, Dec. 18, 1912 ("Staude oder Strauch auf Termitenhügel; viele Stengel; Bl. rot"). Type and paratypes in Bot. Mus. Berlin; isotype in Gray Herb.

This species is nearest to those forms of *Crossandra nilotica* which in Thiselton-Dyer, Fl. Trop. Afr. v. 115 have been called var. *acuminata* Lindau and particularly to the specimens collected by Schweinfurth in Eritrea. These have the bracts almost as narrow but thinner, more leafy, less rigid, glandular-pubescent and with less prominent veins.

Botanisches Museum
Berlin-Dahlem.

NOTES ON FOREST DISEASES IN NOVA SCOTIA

J. H. FAULL

SOME attention has been given to the insect pests of the forests of Nova Scotia, but almost none to their diseases. Such a large part of the province is adapted solely to productive forest growth that under proper management these lands should yield a handsome perpetual income. The Spruces grow like weeds and tend to overrun areas cleared for agriculture. There are besides these the White Pine, Balsam Fir, Hemlock, Birch, Poplar, Beech, and Hard Maple in abundance, and certain other species of lesser frequency. The province is especially rich in potential pulpwood production. An effective fire protective service is in operation, a public forest conscience is being cultivated, and steps are under way with the end in view of regularized scientific management. It is certain that if this last purpose is to be accomplished most effectively it will be essential to become acquainted with those natural forces that inevitably bring about deterioration in the forest unless intelligently combatted. Standing out prominently among them are the forest diseases.

As a preliminary to their hoped-for study, I was invited by the Department of Lands & Forests to make a pathological reconnaissance. It was possible to devote the latter half of July, 1929, towards this end. I was extremely fortunate to have as companion the Provincial Forester, Mr. Otto Schierbeck, a greater part of the time. Through his unfailing enterprise, abounding energy and intimate knowledge of the forests of Nova Scotia, an opportunity was afforded, otherwise impossible within the limits of such a short period of time, to see representative cross-sections of most of the larger forest areas of the province and to gain a notion of many of their problems. A few notes are offered on some of the diseases seen, several of which have not heretofore been recorded for Nova Scotia. New records are designated by an asterisk (*).

The more common native diseases of White Pine found elsewhere also occur in Nova Scotia, but there is one introduced disease, the blister rust, that calls for comment. That it had found its way into Nova Scotia has been known for several years, but up to the present had been seen on Currant bushes only. Rusted *Ribes oxyacanthoides* (Smooth Gooseberry), *R. prostratum* (Skunk Currant), and *R. nigrum* (Black Currant of gardens) were observed everywhere, but it is important to note that two or three young Pines (eight or ten feet in height), members of a fine, vigorous, even-aged stand near Chester were found in fatal attack.* Blister rust cankers had girdled their stems near the ground. European experience with this rust has been a very unhappy one. It has wiped out or wrecked plantations in many places, and in several countries, as a result, efforts to grow White Pine have been abandoned. (PERLEY SPAULDING, White Pine Blister Rust; A comparison of European with North American conditions. U. S. Dept. of Agriculture, Technical Bull. **87**: 1–58. 1929). This rust is now widely spread throughout the 5-needled Pine belts of North America. In some areas it has severely attacked the White Pine, especially the younger growth, and some attempts here and there, said to be economically successful, have been made to control it by eradication of the associated Currants and Gooseberries. Eventually it may be wise to designate what areas in Nova Scotia are to be conserved for the growing of White Pine and to eradicate the Ribes (Currants and Gooseberries) from them. But for the immediate future it would seem to be the better part of wisdom to place the rust under careful observation. This could be done easily and inexpensively by establishing various plots suitably located and have them checked up annually. If this is to be done, however, there should be no delay in the undertaking.

There are many native rust diseases of Conifers in Nova Scotia. The life histories of several of them were worked out by Professor W. P. Fraser at Pictou and MacDonald College (Cultures of Heteroecious Rusts in Mycologia, **3**: 67–74. 1911; Cultures of Heteroecious Rusts in Mycologia, **4**: 175–193. 1912; Further Cultures of Heteroecious Rusts in Mycologia **5**: 233–239. 1913; Notes on Uredinopsis mirabilis and other Rusts in Mycologia **6**: 25–28. 1914) and Professor H. P. Bell of Dalhousie University. (Fern Rusts of Abies, in Botanical Gazette **77**: 1–31. 1924.) While they are probably mostly interesting from a mycological point of view some are of pathological significance, and reference should be made to a few of them.

The destructive cone rust of the Red, Black and White Spruces was found to be abundant in many places. On one small Black Spruce, observed near Lawrencetown, 279 out of its 500 cones were completely destroyed by the rust. Obviously in harvesting Spruce cones for seed care should be taken not to include the rust-blasted ones and not to gather cones from the smaller trees. An unexpected find, quite frequent on Red and Black Spruces (Beaver Bank, Chester, Lawrencetown, etc.) was the broom rust caused by **Peridermium coloradense*. This broom-forming rust is widespread in North America. "It not only attacks and stunts the twigs and branches of young trees, but also brooms and dwarfs saplings and older trees."

Interesting as a new record in America was the finding of the Vaccinium rust of Hemlocks (**Thecopsora Vacciniorum*) on **Vaccinium Vitis-Idaea* var. *minus* at St. Peter's, Cape Breton.

Of the many Rusts of Balsam Fir those caused by **Milesina Kriegeriana* and **M. polypodophila* may be mentioned as new records for Nova Scotia. The former was found in a very heavy infestation in Guysboro Co., and one unusual feature it manifested was the adherence of the whitened needles of 1928 en masse, killed by it last year. The latter Rust is characterized by its habit of causing malformed, loosely-broomed trees. Another Fern Rust of Balsam found was that caused by **Hyalopsora Aspidiotus*. Two others found in surprisingly large amounts were the Broom-rust of Balsam Fir due to *Melampsorella Caryophyllacearum*, and the Blueberry Rust due to *Calyptospora Goeppertiana*. Stunted trees with hundreds of brooms were seen in Cape Breton, and the latter rust approached economic importance in parts of Guysboro Co.

Turning to other crown diseases of Conifers attention should be called to several. These included various needle cast diseases caused by species of *Lophodermium* and its allies. They have been turned over to Mr. G. D. Darker for identification. A curious *yellowing of the foliage of White Spruce and *Balsam Fir, a chlorosis of unknown cause but of curious interest, was encountered more than once in the western part of the province. A needle blight of Balsam caused by **Acanthostigma parasiticum* was abundant at Beaver Bank. "Red branch" of Balsam is common in places, very striking because of the totally red branches on otherwise green trees. This is generally caused by winter frost following the gnawing of bark by beetles (Monohamus), but a great deal proves to result from a girdling fungus, **Valsa Friesii*. Brooms caused by the dwarf Mistletoe, *Arceuthobium pusillum* are not uncommon on Black and *Red Spruces.

Standing out as perhaps most interesting of all is a widespread condition of Balsam Fir, involving practically all of the trees of entire stands, what I would designate for want of a better term as *"Gout." The trees are stunted, the trunks taper rapidly and never reach normal height, the joints are very much swollen and the twigs in general are thickened and tend to be deflexed. My attention was called to it particularly by Mr. Schierbeck who has been observing it for several years past.

The trunk diseases of Balsam Fir and the Spruces have an important bearing on questions of fire protection, cutting cycles, sanitation, and utilization. Balsam was found to be affected with **Poria subacida*, **Polyporus balsameus*, **Polyporus Schweinitzii*, and **Stereum sanguinolentum*, and Spruce by **Stereum sanguinolentum*, *Trametes Pini*, and others not determined. That a much greater use could be made of the large quantities of wood affected with pecky heart rot (caused by *Trametes Pini*), and red rot (caused by *Stereum sanguinolentum*) is reasonably certain. These and other trunk diseases will also be more and more brought under control with improved methods of management.

Coniferous seedlings in the Provincial Forest Nursery have suffered severely from "heaving" and damping-off. Both of these troubles are amenable to correction, and doubtless steps will be taken to overcome them.

As for the diseases of the hardwoods perhaps the two outstanding ones are the Willow blight, and the bark disease of Beech. An examination of the latter has already been made by the Federal Entomological Branch, and the latter by Drs. G. P. Clinton and F. A. McCormick of the Connecticut Agricultural Experiment Station at New Haven. Dr. Clinton and his associate report that the cause is a fungus, *Fusicladium saliciperdum*, and that it can be effectively controlled by repeated spraying in the spring, four or five times from the period of bud swelling to the final expanding of the leaves, with Bordeaux mixture. They are continuing their investigations, the results of which are awaited with interest.

As a feature apparently not so far noticed is the fact that the *White Poplar (*Populus alba*) seems to be susceptible to the same disease. I saw repeated instances of it in various parts of the province. A similar disease was also noted on *Carolina poplar, but this appears to result from the attacks of an allied species of fungus.

Finally, a yellow spotting of Birch leaves (*Betula populifolia*), by **Exoascus flavus* and a bark canker of the Aspen (*Populus tremuloides*) caused by **Hypoxylon pruinatum* constitute new records. The latter was first noted in some improvement thinnings where it was killing trees outright, but it was subsequently found several times elsewhere. It is important that acquaintance should be made with this disease of the Aspen and the Broad-toothed Poplar, and that care be taken to remove and burn affected trees from areas devoted to improvement operations. "Hypoxylon canker" is an insidious disease, easily overlooked, that works quickly and fatally in trees of all ages. Stands are known in which the mortality from this disease has been as great as seventy per centum.

NOTES

Young. "Botaniste de Pensylvanie."—The library has recently obtained an almost unique copy of "Catalogue d'arbres, arbustes et plantes herbacées d'Amerique. Par M. Yong, botaniste de Pensylvanie. Ce Catalogue est divisé en deux parties; la premiere contient les Plantes que M. Yong peut fournir aux Européens, soit en graines, soit en plantes. La seconde contient celles qu'on ne pourra se procurer, qu'en les demandant dans d'autres Provinces. À Paris, De l'Imprimerie de la V^e. Hérissant, Imprimeur de Cabinet du Roi, Maison & Bâtimens de Sa Majesté. M.DCC.LXXXIII."

It consists of 55 pages, sm.8°, and is unbound, page 55 being supplied in MS. by J. Deniker, Bibliothècaire en chef, Muséum d'Histoire Naturelle de Paris, from a copy in that library.

This is the earliest published book by an American botanist and devoted exclusively to American botany, horticulture and floriculture. It is a curious fact that it has been either purposely ignored or entirely overlooked by scientists, historians and bibliographers. Prior to its discovery by S. N. Rhoads in 1915, it was believed that Humphrey Marshall's "Arbustrum Americanum" was the first treatise on American plants, by a native American and printed in this country. Young's work, though not originally printed in America, is, in other respects in the same category as the "Arbustrum" and antedates it by two years, and it is interesting to note that Marshall refers to it on page 48 of his "Arbustrum," where under *Fothergilla Gardeni* he says: "This, in some late catalogues, has been called *Yuongsonia,* in honour of William Young, botanist of Pennsylvania; but by Dr. Linnæus, *Fothergilla* in honour of the late Dr. Fothergill of London. It was first sent to Europe from Carolina, by John Bartram, to his friend P. Collinson, by the title of Gardenia." This, Mr. Rhoads says, is the only reference to Young's Catalogue which he had been able to find in all literature.

Young, on the other hand, in his Catalogue, under *Yongsonia* declares, "Il a été apporté à Londres dans l'année 1769 & ensuite envoyé au sieur Linnæus par le sieur Fothergill, & j'ai appris que le sieur Linnæus lui a donne le nom de *Yongsonia.*" An interesting contradiction of statement. Dr. Alexander Garden of Charleston, had previously sent it to Linnæus in 1765, as noted by Sir J. E. Smith under Garden's letter to Linnæus, dated May 18th of that year.

The Arboretum copy is that discovered by S. N. Rhoads in Scotland and was originally the property of R. Barclay whose name appears in manuscript on the title-page, together with manuscript notes in the margins. Mr. Rhoads, in 1916, had facsimile copies made of the work, under the title: "Botanica neglecta. William Young, jr. (of Philadelphia) 'Botaniste de Pensylvanie' and his long-forgotten book." In his preface to the facsimile Mr. Rhoads has given a full and interesting account of Young who seems to have been more or less a pretender to his own botanical laurels. "Careful research and correspondence with several of the best libraries and authorities failed to discover any bibliographic allusion to Young's work, and a canvass of the more important American libraries failed to discover a single copy of this work."

Many new names are cited in the "Catalogue" which, lacking descriptions, cannot be identified and as Young is suspected of giving names to aid the sale of his seeds and plants, they cannot be taken seriously.

Though this little book will never "shake the foundations of botanic priority" it lays large claim to bibliographical and historical interest. "Resurrected from a life-long oblivion of 132 years, it now assumes a significant place in the early history of American Botany, and the meteoric career of its obscure author, from an amateur collector of seeds and plants under the guidance of Dr. Garden, to the post of Botanist to Queen Charlotte of England, serves to heighten our interest in his celebrated botanical contemporaries of the golden age of Bartram, Marshall, Collinson, Fothergill, Ellis and Linnæus."—E. M. T.

Index londinensis to illustrations of flowering plants, ferns and fern allies.[1]—The first volume of this revised and enlarged edition of Pritzel's Index to botanical illustrations is now before us and at the first glance one is struck by the vastly greater size of this new work. While Pritzel's Index consists of a single quarto volume with about 107,000 entries, the new Index will comprise six folio volumes with nearly 500,000 entries. Volume I contains references to the genera from Aa to Campanopsis on 547 pages of three columns each. All the citations in Pritzel's Index, with only few citations eliminated, are found in the new Index, which includes the literature published up to 1920. The citations are selected not only from botanical but also from horticultural literature and include also varieties and forms with botanical (i. e., Latin names), while garden forms with names in the vernacular are excluded, thus pictures under names like *Camellia corallina* are cited, while those with names like *Camellia* "Maria Dorothea" are not. This may seem a somewhat arbitrary segregation, but from a practical viewpoint it seems to be the only feasible one.[2] The indication regarding the nature of the illustration cited, whether the illustration is general or represents only flowers, fruits, vegetative parts, habit or a teratological state and whether it is colored or not are very helpful and will save needless looking up illustrations of a character not wanted. Another very helpful feature is the cross-references to synonymous names of genera where additional illustrations may be found, for all illustrations are enumerated under the names they were published under, which is the only procedure feasible in a compilation of

[1] Index londinensis to illustrations of flowering plants, ferns and fern allies being an emended and enlarged edition continued up to the end of the year 1920 of Pritzel's alphabetical register of representations of flowering plants and ferns compiled from botanical and horticultural publications of the XVIII and XIX centuries prepared under the auspices of the Royal Horticultural Society of London at the Royal Botanic Gardens, Kew, by O. Stapf. Vol. I. xx + 547 pp. F. Oxford, Clarendon Press, 1929.

[2] See also note on names of horticultural variations in this Journal, x. 65.

this size and character, but results in many cases in the enumeration of the same plant under different names. One finds, e. g., after *Azalea* a reference to *Rhododendron* and a note that *A. procumbens* is *Loiseleuria;* under *Bignonia* 49 genera are enumerated with a number for each genus; this number appearing after the specific name indicates the genus to which that particular species had been referred and which should be looked up for further references. The great increase in citations as compared with Pritzel's Index will appear from some examples as, *Abelia* with 11 citations in Pritzel and 78 in the new Index, *Abies* with 48 as against about 1,000, and *Acer* with 80 as against more than 1,600 citations, which shows in the last two instances 20 times as many citations in the new Index as in Pritzel's Index, but it is only in horticulturally important genera that the increase is so high. The volume is well printed on good paper in clear type and does credit to the Clarendon Press.

The Royal Horticultural Society is to be congratulated for having sponsored and successfully put through, under the able leadership of Dr. O. Stapf, a work of such magnitude and of such usefulness to the botanical and horticultural world. It is an indispensable reference book and no botanical or horticultural library can be complete without it.—A. R.

Illustrations of Chinese Plants.—Of the Icones plantarum sinicarum[1] of which the first fascicle was noted in this Journal two years ago (Vol. IX. 32), the second fascicle has now appeared. This fascicle is dedicated to Dr. Augustine Henry. The arrangement and general appearance of the work is the same as of the first fascicle, but a great proportion of the plants described and figured are species recently published or at least not yet figured; there is also an improvement noticeable in the drawings. All the species except one represent woody plants of which the following deserve special mention as being comparatively new or still little known: *Ephedra sinica* Stapf, *Ostrya Rehderiana* Chun, *Lithocarpus Fordiana* Chun, *L. Elizabethae* (Tutcher) Rehd., *Quercus Chenii* Nakai, *Magnolia Duclouxii* (Fin. & Gagnep.) Hu, *Deutzia Chunii* Hu, *Rubus Chingii* Hu, *R. Hui* Diels, *Cerdis Chingii* Chun, *Mucuna Birdwoodiana* Tutcher, *Monimopetalum chinense* Rehd., *Vitis fagifolia* Hu, *Elaeocarpus hainanensis brachyphyllus* Merr., *E. yentangensis* Hu, *Schima confertiflora* Merr. and *Sinojackia xylocarpa* Hu. The third fascicle will be published during this year and will contain illustrations of all or almost all known species of Chinese Lindens.—A. R.

[1] Icones plantarum sinicarum. Edited by Hsen-Hsu Hu and Woon-Young Chun under the auspices of the Science Society of China and the Department of Botany, National Central University, Nanking, China. 50 pp. 50 pl. F. Commercial Press, Ltd., Shanghai, China, 1929.

Aeroplane View of the Arnold Arboretum

1. Administration Building.—2. North Woods.—3. Bussey Hill.—4. Central Woods.—5. Hemlock Hill (and South Woods southwest of Hemlock Hill).—6. South Street Tract.—7. Peters Hill.

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THE SPONTANEOUS FLORA OF THE ARNOLD ARBORETUM

ERNEST J. PALMER

Plate 21

WE read in one of the earliest records that has come down to us that the Lord God planted a garden eastward in Eden, and that he gave to the first man, who was obviously the first applicant, the position of gardener; also that the Lord walked in the garden in the cool of the day. All of which furnishes a sufficiently impressive tradition and warrant for the ancient and honorable craft of gardening, as well as for the founders, designers and planters of gardens, and for all such as take pleasure therein.

Groping back along the dim trails of Science, we glimpse man first as a forest dweller, dependent upon the trees for food, protection and shelter. Very early he must have learned to distinguish and esteem some of them above the others for the value of their products as well as for their stateliness and strength, and to have endowed them in his imagination with certain beneficent powers and virtues. Later when he ventured beyond the woodlands and became a hunter of game in the open meadows, the tradition of the forest was not wholly lost to him, and as soon as he attained sufficient culture to have fixed abodes and to build villages and towns he began not only to sow fields of grain for his sustenance but also to plant gardens and groves for the fruit that they yielded, for the comfort and pleasure they afforded, and above all as fitting places for the worship of his gods. Indeed, the worship of trees themselves appears to have been one of the earliest forms of religion amongst many races; and vestiges of these sylvan rites persisted long and are thickly woven into the warp and woof of later cultures, appearing again and again in their traditions, superstitions, folk-lore and forms of artistic expression, some of them having come down to our own times.

As the first crude beginnings of civilization centered about the field and the grove, so through all its later stages there was a steadily increasing development of agriculture and horticulture, which became the foundation for other arts. It would seem that one of the surest gauges of the stage of culture arrived at by the people of any age or land is to be found in a survey of the progress they have made in these arts and in their aesthetic appreciation of nature and of the ornamental garden. This is obviously true of our own times, as we witness with the increase of wealth and culture the constantly growing interest that is being taken and the rapidly increasing effort that is being put into the planning and beautifying of private grounds and public gardens and parks, in the preservation of forest and national monuments, and in the developments of botanical gardens and arboretums for the study as well as for the development of plant life.

The botanical garden is one of the most specialized forms of planting, and naturally it appeared rather late in the history of gardening. The earliest examples were developed about the monasteries of the Old World, and later were attached to the universities that grew out of those religious communities. Like the science of botany itself, the botanical garden owes its origin to the real or supposed virtues of various plants used as simples in the healing art. In later times this interest became subordinated and the scope of the gardens was broadened to include the general scientific study of plants, the testing of newly discovered or recently introduced forms, with a view to determining their adaptability to ornamental use or their economic value in various ways. But the development did not stop here: In the modern botanical garden there is to be noted an ever increasing effort to combine the beautiful with the useful and to furnish demonstrations of what can be done in the harmonious grouping and arrangement of living plants.

The arboretum is a specialized form of the botanical garden, devoted exclusively or mainly to the growth and study of trees and shrubs. In the earlier botanical gardens and arboretums utility was the first consideration, and since the space devoted to them was generally quite limited, the formal arrangement of the plants in beds and rows according to some scheme of classification was usually adopted. This arrangement, while convenient for the study and for the harvesting of the plants, had little to recommend it from the aesthetic standpoint. And as the scheme broadened and better taste prevailed, it gradually gave place to the natural arrangement, in which the trees and other plants are brought together in groups, usually arranged with some regard to taxonomic relationships, but in which a certain semblance to nature is also sought, and consideration is given to the harmony of the various parts with each other and with the surroundings as well as with the contour of the land occupied.

In the most carefully planned artificial parks and gardens something more, as well as something less, than an imitation of nature is attempted: It is an idealization of nature, made up of material drawn from many sources and brought together in an ensemble such as could never be found in a chance growth. In proportion as more or less emphasis is placed upon scientific classification or artistic effect the plan is modified, and it would seem that the ideally developed botanical garden or arboretum is one in which a happy balance has been worked out between convenience of grouping to facilitate scientific study of the plant collections and the pleasing effect of a natural and harmonious arrangement.

To the true lover of trees and flowers and of all nature, who combines an intelligent interest in their scientific study with an artistic appreciation of their beauty, singly or in the broader vistas of group and landscape, the poetry of form and color so differently expressed in the carefully modulated shades and lines of the well-planned garden and in the greater freedom and bolder strokes of untamed nature, each has a strong appeal. But the line between Nature's great wild gardens and those planted and tended by man is not a hard and fast one. The latter are built up of material culled from the former, and Nature herself is the builder if not the designer, guided only by man's selection and aid in planting, pruning and cultivating the things he deems most desirable. There is also a constant effort of Nature to reassert her sway and reclaim for herself the areas that men have planted. Even in the best kept gardens this jealous resistance of Nature is not entirely overcome, if it be expressed only in a few weeds and wild flowers that spring up in beds and borders or in little tracts that are temporarily free from the gardener's attention. If bits of meadow or rugged banks or the borders of brooks and ponds are left at suitable places to the native plants it seldom fails to add to the charm and interest of the garden.

In the Arnold Arboretum this blending of the natural and the artificial has been part of the plan from the beginning, and while the principal object has been the bringing together of a collection of such trees and shrubs, from all parts of the world, as can be grown in the open in the climate of New England, the most careful consideration has also been given to landscape effect. Remnants of the native woods and open spaces of meadow and grassy slopes have been left at intervals as examples of the wild flora, and these bits of the primitive have been so happily blended with the planted groups as to add greatly to the general result. It is thus possible here within the boundaries of a great city not only to enjoy the extensive collections of exotic trees and shrubs, but also for those who are interested in the native trees and wild flowers, either from the standpoint of the scientific student or merely as lovers of them for their beauty and charm, to see a considerable representation of the spontaneous flora.

Here one may wander along cool shaded paths through the Oak and deciduous woods or in the deeper shadows of the stately Hemlocks, where but for the distant hum of the busy city streets the impression of complete seclusion in the primeval forest may be found. Or in the open spaces he may stroll along paths bordered with Violets or Buttercups or with Goldenrods and Asters, according to the season; or pass by banks of ferns or along the margins of ponds and brooks, where Loosestrife and Mallow and Iris bloom, or where rushes and Joe-Pye and Elder toss their heads above the modest Crowfoot and Forget-me-not that cling to the edge of the water. And if his interest and enterprise lead him further he may be rewarded by the discovery of many rarer plants, which should be observed and spared so that they may persist to delight the long line of kindred spirits and nature lovers who will follow in his footsteps as the years and centuries pass.

So while the scientific activities of the Arboretum are devoted to the propagation, display, and study of woody plants, it is recognized that the bits of native woodland and meadow with the wild flowers, ferns, grasses and other spontaneous plants scattered through them add much to its interest and play no small part in the attractiveness of the place.

It is the intention of this paper to briefly describe the spontaneous flora of the Arboretum as it exists today, mentioning also a few of the more conspicuous species that have disappeared in recent years, so far as the meager data now available make it possible. The purpose is two-fold: to serve as a guide to those visitors who are interested in the wild flowers and other spontaneous plants, and also as a record for future reference, since doubtless many of the native plants now growing here are doomed to a more or less speedy extermination, while the element composed of foreign and introduced species will be gradually changed and probably will come to constitute an increasingly large proportion of the flora as the years go by.

Introduced plants seem at present to constitute about thirty per cent of the spontaneous flora. A few of these, such as some of the ferns and more conspicuous wild flowers, were introduced by design through the efforts of the late Director, Professor Charles S. Sargent, of the former Assistant Director, Charles E. Faxon, of Jackson Dawson, the late superintendent, and others. Most of them, however, especially the less conspicuous species, such as would be popularly classed as weeds and grasses, have been accidentally introduced in various ways and from a variety of sources. Most of them are common in the Boston area, but a few unusual things have turned up, which will be mentioned later.

Since it is impossible in many cases to distinguish certainly between those species which were originally planted and the others which have been introduced through natural agencies, all of the herbaceous plants now growing spontaneously in the Arboretum have been included in the list. And although a similar uncertainty also exists in regard to some ligneous species that have run wild or have spread more or less extensively from the planted groups, it seems desirable for obvious reasons to follow a more conservative course in regard to them, and only such species are included as have become so well established that they apparently might be able to maintain themselves indefinitely if left undisturbed.

The Arnold Arboretum contains within its present limits an area of about 260 acres. This tract is roughly oblong in outline with its major axis, which is nearly a mile in length, extending from northeast to southwest. The width varies from less than an eighth to slightly more than a quarter of a mile. The direct distance from the Jamaica Plain gate near the Administration Building to the Roslindale gate is about 4800 feet, or nearly nine tenths of a mile, but in following the roads and paths this is lengthened to more than a mile. The wildest part of the grounds lies a little beyond the center of the Arboretum, as one goes from the Administration Building, and extends from a point about half way between the Center Street and Walter Street gates to the southeast side of Hemlock Hill on South Street.

The surface of the Arboretum is quite varied, ranging from low flat areas, some of which were originally ponds and bogs, through gentle slopes and knolls to rocky outcrops and ridges, culminating in several distinct hills of considerable elevation. The altitude varies from a minimum of about 50 feet above mean tide level in the low ground near the Administration Building and at a few other points, to 150 feet along the rocky crest of Hemlock Hill, 180 feet on Bussey Hill, and 237 feet at the summit of Peters Hill.

Two brooks enter the Arboretum area. The first and smaller of these flows for a short distance just inside the wall near the Jamaica Plain entrance, passing under the road near the Administration Building. Bussey Brook, which is a perennial stream, flows through the central part of the Arboretum, from the Walter Street gate, through a bit of open meadow and along the base of Hemlock Hill, across South Street and through the lower part of the South Street tract, where through a diverted channel it has been led into the pond recently constructed there.

Several more or less permanent springs are found within the Arboretum. The most interesting of these issues from under a rocky ledge, near the Chestnuts. The small stream of pure cool water which flows through the tiny rocky gorge near the edge of the natural Oak woods at this point makes it an attractive spot much frequented by visitors on hot summer days. Along the course of Bussey Brook there are several other small springs, most of which become dry during parts of the year. Springs also issue along the base of Peters Hill, on the southeast side, forming small boggy areas, which will be described later.

There are four small ponds in the Arboretum at present, including the one recently constructed on the South Street tract, which is larger and deeper than any of the others. The other ponds are located near the Shrub Collection and the Forest Hills gate, one of them being on the left of the road, as one enters through that gate, and the other two on the right, amongst the Plums and Cherries planted between the roadway and the formal rows of shrubs.

The rocks and other superficial deposits of the Arboretum show evidence of two geological periods, previous to the recent, which were widely separated in time. All of the outcrops of solid rock are of the Roxbury conglomerate or "pudding stone," which has been referred doubtfully by geologists to the Permian period. Outcrops of this formation occur at several places in the central and southern parts of the Arboretum, and they occupy about three per cent of the surface area. Of much greater extent are the deposits of gravel, sand, clay and other unconsolidated material left by the glaciers of the Quaternary age. The soils and loose gravel found on the surface or at a little depth beneath it, in the more level and lowest parts of the area represent the most recent effect of geologic action, and these have resulted from the working over of the older deposits or from the effects of erosion upon them.

The Roxbury conglomerate is a massive and partially stratified deposit consisting of worn or rounded pebbles and boulders of granite, diorite, quartzite and other rocks, mainly igneous and crystalline, cemented together into a hard and solid mass with a matrix of finer, slate-like material. The beds have been much disturbed since they were originally deposited, resulting in folding, tilting, and in the presence of many faulting planes that cut through the rock at all angles. The stress, which under heavy pressure, caused these movements and the resulting cleavage through the uneven texture of the stone has produced in many places a surface as smooth as if it had been cut with a great knife.

It has recently been suggested[1] that the peculiar shape and character of the pebbles and boulders in this formation, and certain faint striations found upon some of them, indicate that they were of glacial origin, the deposit representing terminal moraines of an ice age that occurred far back towards the close of Paleozoic time.

Ledges and detached masses of this formation come to the surface at several places in the Arboretum. The most extensive outcrops are found to the south of Bussey Brook, extending from the South side of Bussey Street, at the foot of Peters Hill, for about 1500 feet towards the east, terminating in the rugged and almost precipitous crest of Hemlock Hill, where a spendid bit of the primeval Hemlock forest has survived. An old quarry, which was opened up near the south side of this area, and which has been abandoned for some years, exposes perpendicular sections of the conglomerate several yards in thickness. Many weedy plants have appeared amongst the rubble and rubbish of this abandoned quarry, some of which have not been found elsewhere.

Beds and ledges of the conglomerate are also found on the north side of the brook and between the Hickories and the main group of Conifers. At the east end of this outcrop, amongst the Chestnuts and close by the Valley Road, a ledge of this rock is exposed which shows an excellent example of the action of the ice in the last Glacial period, the surface over which the moving ice with its freight of rocky debris passed being polished and striated and clearly showing the direction of the glacier down the valley and towards the bay.

It is on the hills and slopes occupied by the Roxbury conglomerate that most of the remnants of the primitive woods have been preserved, and in such places also many of the native herbaceous plants have persisted.

The unconsolidated deposits of silt, sand, and clay, and of the coarser rock material brought in by the ice in its seaward movement during the

[1] Sayles in Bull. Mus. Comp. Zool., Harvard University, LVI. (Geol. Ser. X.). 141–170, and in Science, XXXII. 723 (1910).

Glacial period in the Quaternery era, and left as it melted and retreated, covers much of the surface of the Arboretum, including nearly all of the higher ground where the old conglomerate does not appear.

Manifest evidence of the action of the ice is also found in the smoothed and striated surfaces of some of the conglomerate ledges, like that mentioned above, near the Chestnut collection, as well as at higher levels near the same locality, on the slopes of Bussey and Hemlock hills, and elsewhere. Detatched boulders of various sizes found at several places in the Arboretum were also transported by the ice and deposited in their present positions. Some of these were derived from the near-by conglomerate beds and others of granite or diorite were brought from greater distances. Good examples of these erratics may be seen along the west and south slopes of Bussey Hill, on the northwest side of Peters Hill, and close beside the path near the Cercidiphyllums, not far from the Administration Building.

The course of the glaciers as they followed the little valleys between the higher elevations, as the ice sheet that had at one time covered the entire area diminished, can be traced clearly in places by observing the present topography, as well as through the more direct evidence of the striations on the rocks.

Peters Hill and Bussey Hill owe their present form largely to the action of the glaciers, the heavy clay and gravel loads carried by the ice having been deposited over and about the rocky peaks or ridges of conglomerate, which were exposed here before they were worn down by the moving ice sheet. A lighter deposit of similar material probably at one time covered all or much of the surface of Hemlock Hill, but most of this was later removed by erosion, again exposing the ancient rocks, which still show evidence of the passage of the ice in their smoothed surfaces on the lower protected slopes, while in the more elevated parts the work of excavation and erosion has gone farther, and the fractured and upturned ledges have been broken down in places and reduced to their present rugged and picturesque form.

Farther down towards the low ground near the Administration Building a series of low hillocks and ridges with typical moraine topography marks the point where a branch of the glacier terminated and as the ice melted, deposited its burden of gravel and other material that now forms the kames and eskers on which a bit of the native deciduous forest has been preserved. The low ground extending unbrokenly from this point through the Fenway to the Back Bay, and on which a large part of Jamaica Plain and other parts of Boston have been built, evidently at the time of the glaciers formed part of the bay, most of it later being occupied by a series of fens and lakes, of which Jamaica Pond and other remnants still exist, although drainage and the other works of civilized man have greatly diminished them in recent historic times. Part of the shore line of the old embayment can be readily traced with the eye in the range of low hills that bound the level plain as one comes down Center Street towards the Arborway and the Arboretum.

Another branch of the glacier within the present limits of the Arboretum passed to the south of Hemlock Hill, leaving its traces in the smooth beveled surface of the conglomerate to be seen just within the Arboretum wall along Bussey Street, and in the gravelly hillocks and ridges where it terminated in the low ground towards Forest Hills.

Looking at these obvious evidences of the former presence of the glacial ice we can trace in imagination something of the strange conditions that once prevailed where we now enjoy the varied beauties of the Arboretum.

Standing on some vantage point along the shore we watch the great slowly moving rivers of ice coming down from the highlands which are almost covered with the glistening mantle, with only a rocky point or the top of some hill showing bare and bleak against the sky-line. At the water front great masses of the ice cliff break off and float away as icebergs into the bay and out to sea, and the load of debris is deposited first in the bay, gradually filling it, and later as the summers begin to grow warmer and the ice to retreat, it is piled up in the kames and eskers of the terminal moraine that we now see along the old shore line. Time goes on and the ice gradually retreats, leaving a desolate scene of bare rocks, barren knolls, and muddy flats, interspersed with innumerable lakes, ponds and fjords. A tundra vegetation of lichens and mosses and an ever increasing number of the hardier herbs and shrubs soon comes to occupy the more favorable situations. A coniferous forest succeeds, with Alders, Willows, and a varied assemblage of other shrubs, ferns, and flowering herbaceous plants in the bogs and depressions. Then the Oaks, Beech, and Maples and their many associates that make up the deciduous woods begin to creep cautiously back from the southern coasts and mountains to which the ice had driven them, and the forest begins to assume the familiar aspect characteristic of our beautiful New England hills and lowlands.

The Indian glided silently through these deep forests, of which now only a few depleted fragments remain. Here he hunted the deer and other wild game and held councils about his camp fires amongst the stately Hemlocks, or from the shores he pushed his canoe across fjords and lakes in quest of seals and fish. Specimens of the stone arrow points that he used in the hunt or in war are still sometimes picked up in the Arboretum.

Then came the white settlers from across the seas, felling the forests and destroying with axe and fire, sometimes recklessly, and sometimes, let us hope, to build a better order and at last to plant a fairer garden.

By rare good fortune a bit of the primeval Hemlock forest was preserved on the rocky slopes and crest of the ridge to the south of Bussey Brook; and this is now one of the most beautiful and interesting features of the Arboretum, and it is also without doubt, taking into consideration the size and typical character of the trees and the romantic and congruous aspect of the surroundings, the finest example of a similar growth to be found in any park or garden near a great city.

The areas of deciduous woods that still remain on the rocky slopes and on the gravelly knolls of the terminal moraines also serve well to illustrate on a small scale this type of forest. And so it has been possible to conserve here without interfering with the wider and more special work of the Arboretum a considerable part of the wild life of New England, both of its native flora and through the protection and encouragement that it affords, a surprisingly large number of native and introduced birds and several mammals and reptiles, besides many of the lower forms of animal life. In the partially swampy meadow opposite the Administration Building and about the margins of the ponds the muskrat still finds a place for his home; the woodchuck has his burrow along the steep wooded slopes of Hemlock and Peters Hills; skunks and chipmunks also find safe retreats and an abundant supply of forage. The gray squirrel is so abundant as sometimes to become a nuisance through his destruction of nuts and seeds in spite of the interest he affords by his sprightly and cunning ways; also the red squirrel has been occasionally observed. Moles, rats and mice are additions, although undesirable ones, to the list of mammals. The gray fox is sometimes found in the Arboretum, and rabbits have been seen in recent years, although none are known at present.

Bird life is a most interesting feature of the Arboretum, and every effort is made to encourage and protect the more desirable species. In the summer and throughout most of the year the shrubs and trees furnish abundant food for them, and this is supplemented in winter by a supply of grain. Water and houses for nesting are also supplied for the birds in various parts of the Arboretum. Unfortunately, however, it is not possible to discriminate between the more timid and desirable of our feathered friends and the agressive starlings, sparrows, and crows. The necessity for frequent spraying of trees and shrubs as a protection against destructive insects has proved detrimental to the birds, and some species that formerly nested in or visited the Arboretum are no longer found here.

Mr. Charles E. Faxon, who was a careful student of bird life and who had an opportunity to study the birds of the Arboretum from the beginning, has fortunately left a record of the species known to visit or nest here, and as some of these have since disappeared it is of considerable interest now.[1] A brief account of the bird life, by the same author, may also be found in the Guide to the Arnold Arboretum.

Before being taken over for its present use, most of the Arboretum area was included in the Bussey Farm, and the flora in some parts had doubtless been considerably changed from its primitive condition. But in spite of over two centuries of occupation by civilized man, several tracts of woodland remained, and much of the flora of bog and meadow was little disturbed. In the process of being adapted to its present use further inroads into the previously undisturbed habitats of the native plants have necessarily been made; but on the other hand, with the cessation of

[1] Garden and Forest, VIII. 292–93 (1895).

grazing and with the attention that has been given to those parts of the woodland and other open spots, better protection has been afforded and there has been an actual recovery and return towards a natural development, so that it is even now possible to recognize in such places certain plant associations and to see their relation to habitat and to ecological conditions.

Opposite and to the south of the Administration Building lies an area of several acres that was occupied by a bog until artificially drained only a few years ago. This is now overgrown with a dense cover of native and introduced plants, many of which are of a weedy character. In seasons of abundant rainfall water stands for some time on the lower parts, giving it still a somewhat marshy aspect. Along the southeast side, where many of the Willows are planted and where some young specimens of the Bald Cypress have recently been set out, water seeping from the bank just inside the Arboretum wall keeps a strip along the margin of the meadow moist for a considerable part of the year. And since the ranker vegetation is kept down here by frequent mowing, a number of small hydrophytic plants are to be found throughout the season. Amongst these are beds of the tall moss, *Polytrichum commune* var. *paragonianum*, the Sensitive Fern (*Onoclea sensibilis*), the Swamp Shield Fern (*Thelypteris palustris*), *Cyperus strigosus*, and several other sedges, besides numerous grasses and species of *Juncus*, *Sagittaria latifolia*, *Viola lanceolata*, *V. papilionacea*, *Hypericum canadense*, *H. mutilum*, *Agalinis tenuis* and *Prunella vulgaris*. Most of the tract is left unmowed during the summer, and the ground is occupied by tall weeds and grass, amongst which a few shrubs, such as the Staghorn Sumach, Elderberry, Meadowsweet and brambles have gained a foothold.

Amongst the more interesting and conspicuous plants found here are the Turk's-cap Lily (*Lilium superbum*), *Iris versicolor*, *I. pseudacorus*, the Great St. John's Wort (*Hypericum Ascyron*), Purple Loosestrife (*Lythrum salicaria*), Skunk Cabbage (*Symplocarpus foetidus*), Spotted Cowbane (*Cicuta maculata*), Tall Meadow Rue (*Thalictrum polygamum*), Water Hoarhound (*Lycopus americanus*), Hemp Nettle (*Galeopsis Tetrahit*), Tall Evening Primrose (*Oenothera biennis*), Mint (*Mentha arvensis*), Vervain (*Verbena hastata*), Tansy (*Tanacetum vulgare*), the tall Wild Lettuce (*Lactuca canadensis*), Cup-plant (*Silphium perfoliatum*), and several species of *Solidago* and *Aster*. Rushes, sedges and grasses are also abundant, such species as *Scirpus cyperinus*, *Carex stipita*, *C. pennsylvanica*, *Glyceria nervata*, and *Calamagrostis canadensis* often being conspicuous. Many other plants besides those enumerated above are to be found in this bit of swampy meadow at different seasons, but the spot is particularly conspicuous in autumn when the New England Aster, the White Panicled Aster, the New York Aster, and the Tall and Rough-leaved Goldenrods, besides other late blooming plants, deck it with a gorgeous variety of color. Tansy and other agressive weeds are at present gradually crowding out many of the more attractive plants, and it is probable that some of the latter would soon disappear even if the tract were left in its present wild state, which, however, is not likely to continue for many years more. The Fringed Gentian is reported to have grown here before the drainage of the tract and up to a few years ago, and doubtless many other plants might have been found at that time which are now gone forever from the Arboretum.

There are several other bits of low and boggy ground in various parts of the Arboretum where marsh-loving and hydrophytic plants find a habitat. These are generally very local and are mostly confined to the borders of the brooks and margins of ponds and to a few places where springs or seepage water issues from banks or hillsides. There is also another rather more extensive area of low ground, at present in an undeveloped state and much of it overgrown with weeds, on the South Street tract, where a pond was constructed about three years ago. Many plants, of which a large proportion are immigrants, have been found here. During the construction of the pond and in the following season a rank growth sprang up on the mud and peet banks resulting from the excavation. A considerable collection was made at this place during two seasons and the plants are included in the list given at the end of this paper, although some of them were perhaps only waifs that cannot be expected to persist or be found again in the Arboretum. Some of the species found here were *Eragrostis caroliniana, Leersia virginica, Setaria verticillata, Stenophyllus capillaris, Polygonum orientale,* and several native species of the same genus, *Polygonella articulata, Celosia argentea, Humulus japonicus, Stellaria graminea, Sisymbrium altissimum, Erysimum cheiranthoides, Penthorum sedoides, Potentilla monspeliensis, Melilotus officinalis, M. alba, Trifolium incarnatum, Dalea alopecuroides, Althea rosea, Epilobium angustifolium, E. coloratum, Oenothera biennis, Scutellaria lateriflora, S. epilobifolia, Galeopsis Tetrahit, Lycopus americanus, Mentha arvensis, Petunia violacea, Bidens cernua, B. vulgata, Arctium minus, Helianthus annuus, Centaurea Cyanus* and *Sonchus oleraceus.* Considerably more than one hundred species of plants were collected at this locality, but the few mentioned here will serve to give an idea of the cosmopolitan character of the flora.

In the bits of boggy meadow along Bussey Brook and elsewhere a considerable number of interesting plants are found, and in these places the flora has been preserved more nearly in its original state than anywhere else in the Arboretum except in the native woods. Here the grass and other forms of rank vegetation are kept down by periodic mowing except along the immediate margins of the brook, and so the smaller plants have had a chance to survive as in the border along the Willow collection mentioned above. On the upper part of the slope between the Conifers and the brook a few, mostly introduced, perennials are conspicuous. Black-eyed Susan (*Rudbeckia hirta*) grows here and is quite showy in the late summer when it gets an opportunity to bloom between mowings of the meadow. The Fall Dandelion (*Leontodon autumnalis*) is also abundant here, as it is in all the open grassland, and Queen Anne's Lace, which is a pretty and not undeserved name for the delicate white unbellate flowers of the humble garden Carrot (*Daucus Carota*), decorates the meadow from mid-summer until the coming of the late autumn frosts. Two species of the curious and dainty little Lady's Tresses (*Spiranthes cernua* and *S. Beckii*), as well as the Ragged Fringed Orchis (*Habenaria lacera*) and the delicate pink-flowered *Gerardia tenuifolia*, spring up amongst the grass. In wetter ground a little lower down are found the Ground Pine (*Lycopodium complanatum* var. *flabelliforme*), the Scouring Rush (*Equisetum arvense*), the Sensitive Fern (*Onoclea sensibilis*), Sweet Vernal Grass (*Anthoxanthum odoratum*), *Carex lurida*, *Juncus effusus*, and several other sedges and rushes, also the Blue-eyed Grass (*Sisyrinchium atlanticum*) and the two Violets *Viola cucullata* and *V. lanceolata*.

A growth of tall herbs and shrubs borders the brook, in which the Elderberry (*Sambucus canadensis*), Joe Pye Weed (*Eupatorium verticillatum*), Thoroughwort (*Eupatorium perfoliatum*), Poison Hemlock, Tall Meadow Rue, the Tickseed (*Bidens frondosa*), *Solidago altissima*, *Aster paniculatus*, *Aster novae-angliae*, and *A. novi-belgii* are most conspicuous. There are also a number of robust grasses and sedges, such as *Phalaris arundinacea*, *Poa palustris*, *Calamagrostis canadensis*, *Scirpus cyperinus*, *Carex crinita* and *C. debilis* var. *Rudgei*. Plants of lower growth along the open margins of the brook, or partially concealed amongst the grasses and taller herbs, are the Hairy Milkweed (*Asclepias incarnata* var. *pulchra*), the Turtlehead (*Chelone glabra*), Mint, Water Hoarhound, *Bidens connata* and many others. The curious little parasitic Love-vine or Dodder (*Cuscuta Gronovii*) twines its amber evanescent stems about some of the upright herbs, and *Polygonum sagittatum* and *P. scandens* climb amongst them in places, forming a tangled mass. Near the rustic bridge across the lower part of the brook another interesting vine, the Climbing Hempweed (*Mikania scandens*) is growing in the protection of a rocky bank. On the immediate margins of the stream the Jewel-weed (*Impatiens biflora*), the Creeping Buttercup (*Ranunculus repens*) and the Forget-me-not (*Myosotis scorpioides*) blossom in modest retirement along the moist shaded banks, and on muddy margins or in the shallow flowing water the Marsh Purselane (*Ludvigia palustris*), and the Water Starwort (*Callitriche heterophylla*) trail or float with their slender prostrate branches.

Near the base of Peters Hill, on the southeast side, a seepage spring issues in a swale or depression which the water follows down the slope to the boundary of the Arboretum near the railway embankment. At the highest point where the water seeps from the bank and again lower down and across Peters Hill Road the ground is kept moist and is quite boggy over small areas. Many of the plants are identical with those mentioned from the other localities, but in addition *Equisetum sylvaticum*, *Carex hirta*, *C. lanuginosa*, *Saxifraga pennsylvanica* and *Hydrocotyle americana* occur. On the nearby grassy slopes but beyond the boggy area Yellow-eyed Grass (*Hypoxis hirsuta*), the Ground Nut (*Amphicarpa monoica*) and the Shin Leaf (*Pyrola elliptica*) are found.

The ponds near the Shrub Collection furnish a habitat for a number of aquatic and hydrophytic plants. The Water Lily (*Nymphaea odorata*) and the Pickerel-weed (*Pontederia cordata*) grow well out in the shallow water and are very attractive when in bloom; the Water Chestnut (*Trapa natans*), the Slender Pond-weed (*Potamogeton filiformis*) and the Feather-foil (*Hottonia inflata*) with its curious inflated stems half floating in the water, are also sometimes found.

The circumstances under which the last named plant appeared here are rather curious. During the season of 1924 a pair of wild ducks nested on the margin of one of the ponds, and in the same summer specimens of the *Hottonia* were observed growing in the pond. The following year the plants persisted and bloomed, but after this they disappeared and have not been found since.

All along the margins of the ponds, from the mud flats submerged during part of the year, but which gradually increase in area as the water becomes low in summer, to the higher banks, there is an abundant and varied growth of herbaceous plants, some of which have doubtless been planted for their natural attractiveness, while others belong to the native flora or have come in as weed immigrants and have established themselves here. Amongst the more conspicuous and interesting species are *Onoclea sensibilis, Marsilea quadrifolia, Equisetum arvense, E. limosum, Sparganium eurycarpum, Sagittaria latifolia, Alisma Plantago-aquatica, Iris versicolor, I. pseudacorus, Acorus Calamus, Cinna arundinacea, Glyceria canadensis, G. acutiflora, G. grandis, G. nervata, Polygonum Muhlenbergii, P. arifolium, P. amphibium, Filipendula ulmaria, Hibiscus Moscheutos, Lythrum Salicaria, Cicuta bulbifera, Sium suave, Decadon verticillatus, Eupatorium verticillatum, Solidago canadensis* and *Bidens cernua.* The slender little Marsh Speedwell (*Veronica scutellata*), the Mad-dog Skullcap (*Scutellaria lateriflora*) and the Jewel-weed grow in places along the wet shaded banks, and as the water recedes from the mud flats many small grasses, sedges, and other weedy plants spring up; amongst these are *Poa annua, Eleocharis obtusa, E. acicularis, E. tenuis, Stenophyllus capillaris* and depauperate specimens of *Bidens cernua.*

The first bit of native deciduous woods found in passing through the Arboretum from the Administration Building occupies the low glacial knolls and ridges just beyond the Aesculus group to the right of the Meadow Road and between the Maples and the Shrub Collection on the left. This may be called the North Woods, and it is so referred to in the list of species at the end of this paper. Oak, Ash and Maple are the commonest trees here, some of the Red Oaks (*Quercus borealis* var. *maxima*) and White Oaks attaining a large size. White Ash is also abundant with some large specimens. Other forest species are the Sugar Maple (*Acer sac-*

charum), Sweet Birch (*Betula lenta*), Hop Hornbeam (*Ostrya virginiana*), Beech (*Fagus grandifolia*) and Black Oak (*Quercus velutina*). The woods are of an open character, having been much thinned, and there is little undergrowth. Single specimens or clumps of Black Haw (*Viburnum Lentago*) and Choke Cherry (*Prunus virginiana*) occur in some places and young growth of Birch, Beech and Maple are in evidence in the more open parts. Elsewhere, and especially along the edge of the woods, various introduced shrubs, such as Loniceras, Barberry and Service Berry, have become established. In such an association it is not always possible to distinguish the spontaneous from the planted trees and shrubs. Occasional specimens of Linden (*Tilia glabra*) and *Amelanchier oblongifolia* probably belong to the native growth, and a large tree of *Ulmus americana* in a bit of low ground at the base of the hills appear to be spontaneous. On the knolls to the left of the road most of the woody growth has been cleared away, leaving only scattered specimens of Oaks and a few other sorts of trees.

The herbaceous flora here is not so varied as in some other sections of the deciduous woods. Typical plants are *Carex pennsylvanica*, *Luzula campestris* var. *multiflora*, *Thalictrum dioicum*, *Lysimachia quadrifolia*, *Desmodium canadense*, *Lobelia inflata*, *Prenanthes alba*, *Solidago caesia* and *Aster cordifolius*. *Apocynum androsaemifolium* and *Helianthus divaricatus* are found on the edge of the woods, and the curious and delicate Indian Pipe (*Monotropa uniflora*) sends up its waxy pink stems and flowers through the carpet of Oak leaves towards the end of the summer. *Houstonia longifolia* was also collected here on one of the gravelly ridges, but it appears to be quite rare. *Hepatica triloba* and *Silene pennsylvanica* are reported to have been growing here after the establishment of the Arboretum, but both have now disappeared.

Several species of ferns grow abundantly towards the bases of some of the knolls and along the paths bordering the lower ground, and they add much to the attractiveness of this part of the Arboretum. In places the banks are covered with a dense growth of the Hay-scented Fern (*Dennstaedtia punctilobula*), the New York Fern (*Thelypteris noveboracensis*), and the Lady Fern (*Athyrium angustum*), interspersed with clumps of *Osmunda Claytoni*, *O. regalis* and *Thelypteris Bootii*. Lower down in the moist swales the Ostrich Fern (*Pteretis nodulosa*) is growing, and in the boggy depression where the Cork-wood (*Leitneria floridana*) has been planted Jack-in-the-pulpit (*Arisaema triphyllum*), Skunk Cabbage and Clearweed (*Pilea pumila*) have persisted, while the Star of Bethlehem (*Ornithogalum umbellatum*) and a wild Garlic (*Allium carinatum*) have become established.

Other areas of deciduous woods through the central portion of the Arboretum are of similar type, but the list of trees and shrubs as well as of herbaceous plants in some of them is much more extensive. On the bank above the Lindens, the Shag-bark Hickory (*Carya ovata*) is growing with the Red Oak and other native trees. Along a steep slope beyond the ponds and adjoining the Bussey grounds a narrow strip of woods has been left. Red and White Oak are abundant, and the American or White Elm and Butternut are also found, with *Prunus virginiana* as an undergrowth. On the dry slopes near this point the little Deptford Pink (*Dianthus Armeria*) and the Wild Garlic (*Allium carinatum*) are abundant, and in moister shaded situations near the base, Enchanter's Nightshade may be found. The Wood Arvens (*Geum canadense*) is also growing in partially shaded situations here.

On the conglomerate outcrops and the slopes to the north of Bussey Brook and between the Hickories and Chestnuts and the main Conifer collection many of the native trees and shrubs remain, and various characteristic herbaceous plants are found amongst them. This is referred to hereafter as the Central Woods. White, Red and Black Oak are all present and a few specimens of the Bear Oak (*Quercus ilicifolia*) remain. *Pinus rigida* and *Juniperus virginiana*, growing amongst the rocks both appear to be native here. Amongst the other spontaneous trees are the Pignut Hickory, Hornbeam and Beech. Poison Ivy and the Dewberry, (*Rubus recurvans*) climb or trail over the rocks, and in more open places the low Blueberries (*Vaccinium pennsylvanicum* and *V. vacillans*) are very abundant. The list of herbaceous plants that are commonly found includes the Bracken (*Pteridium aquilinum* var. *latiusculum*), *Maianthemum canadense, Baptisia tinctoria, Melampyrum lineare, Solidago puberula, Aster patens, A. undulatus, A. divaricatus* and *Antennaria fallax*. Similar conditions prevail and the same type of flora is found in several other small rocky and wooded areas throughout the Arboretum, but in some of them many of the native plants have disappeared as a result of thinning of the woods or other changes from the former natural state. The largest wooded area remaining in the Arboretum lies to the south of Bussey Brook and between the valley of that little stream and the foot of Peters Hill. The Roxbury conglomerate comes to the surface over most of this area, and the ground rises gradually from the western end, culminating in the high narrow ridge of Hemlock Hill. The western portion, on both sides of Bussey Street, is occupied by deciduous woods, but over the higher and more rugged parts, a coniferous forest, mostly of Hemlock (*Tsuga canadensis*) but with a small percentage of White Pine in places, holds sway.

On rocky ledges and on shaded bluffs and steep slopes in the Oak woods are found False Solomon's Seal (*Smilacina racemosa*), Horse Gentian (*Triosteum aurantiacum*), Wild Licorice (*Galium circaezans*) and the pretty pink-flowered Milkweed, *Asclepias quadrifolia*. The Hay-scented Fern and the Marginal Shield Fern grow on the faces of the conglomerate ledges or from clefts and banks along ravines.

At the abandoned quarry just south of Bussey Street and near the crossing to Peters Hill, and in the rubble and waste ground about it, many weedy plants have sprung up, some of which are uncommon in the Boston area. Amongst the species collected here were *Panicum capillare, Echinochloa crus-galli, Setaria glauca, S. italica, Amaranthus hybridus, A. graecizans, Polygonum aviculare, Chenopodium album, C. ambrosioides, C. urbicum, Bassia hyssopifolia, Trifolium arvense, Vicia angustifolia, Lychnis alba, Lepidium campestre, L. virginicum, Brassica oleracea, Erysimum cheiranthoides, Sisymbrium officinale, S. altissimum, Solanum nigrum* and *Physalis heterophylla* var. *ambigua.* This assemblage of plants obviously has no connection with the native flora of the woods, and some of the species will probably disappear when the quarry site is used for other purposes than that of a dumping and incinerating ground, as at present.

Along the steep rocky slopes of Hemlock Hill, and especially on the south side, the native flora has been less disturbed than in any other part of the Arboretum, and for this reason a number of interesting plants found here are restricted to the locality.

Towards the base of the exposure along the south side where the conglomerate was worn down by the action of the glacier it presents a steep bare slope for some distance just within the Arboretum wall and above Bussey Street. Higher up the slope, great blocks and ledges stand out at intervals above the general level, the originally stratified beds having been tilted and faulted in a complex manner. There is a mingling here of the Conifers and the deciduous trees, and the open character of the woods permits the growth of a variety of shrubs and herbaceous species. The Hemlock is found well down the slopes and it becomes the dominant tree over most of the small plateau that occupies the top of the hill, while towards the eastern end and on the steep north exposures it grows as a dense pure stand almost to the exclusion of all other species. There are some large specimens of White Pine in the open woods, and other woody species are *Juniperus virginiana, Carya ovalis, Quercus alba, Q. borealis* var. *maxima, Q. velutina, Fagus grandifolia, Betula letua, B. populifolia, Rhus hirta, R. Toxicodendron, Vaccinium pennsylvanicum, Berberis vulgaris* and *Viburnum acerifolium.* The Columbine (*Aquilegia canadensis*) is growing on some of the rocks, and in more shaded places the common Polypody (*Polypodium virginianum*) is found. There is virtually no undergrowth of shrubs or herbaceous plants in the denser parts of the Hemlock woods. The thick foliage of the closely interlocking branches casts a dense shade, and the ground is thickly carpeted with the small dry leaves. The trees grow in close formation and the gloom and silence and absence of verdure or other evidence of life under the dark canopy supported by the column-like trunks is solemn and impressive.

Towards the east end of the ridge on the south side the rock is more broken and a talus of loose fragment has accumulated in places under the small cliffs formed by the outstanding masses of conglomerate. A number of interesting plants grow here amongst the rocks and at various levels on the slope. Some of the species found in this locality are *Andropogon scoparius* var. *frequens, Sorghastrum nutans, Panicum dichotomiflorum,* *Danthonia compressa, Carex anceps, Baptisia tinctoria, Desmodium rigidum, D. marilandicum, D. rotundifolium, D. nudiflorum, Lespedeza frutescens, Asclepias quadrifolia, Aureolaria pedicularia, A. flava, Eupatorium aromaticum, E. sessilifolium, Helianthus divaricatus, Aster undulatus, A. lateriflorus, A. macrophyllus, Solidago juncea, S. caesia, Hieracium venosum, H. scabrum* and *H. paniculatum.* At the foot of the hill and not far back from the brook *Scutellaria altissima* is growing amongst the rocks, and near the same place the Maidenhair Fern (*Adiantum pedatum*) was found. The last two plants are both quite rare, and the fern may have been planted here. The Lily of the Valley (*Convallaria majalis*) is another introduced plant growing on the shady slopes nearby.

A considerable part if not all of Peters Hill was originally covered with deciduous woods, part of which was probably cleared away at an early day so as to bring the land under cultivation or pasturage. Just within the Arboretum grounds, near Walter Street, is included part of an old burying ground, in which some of the tomb-stones date back to pre-revolutionary days. Stumps of some large Oaks, apparently remnants of the early forest, are to be seen here, some of the trees having been cut down only a few years ago. On the north and east slopes of the hill several large White Oaks were standing amongst the Crataegus plantation within the last few years, but only a single specimen now remains. The only part of the hill on which a fragment of the native woods has been preserved is just below the summit as it slopes off to the east.

There is no outcropping of the conglomerate on Peters Hill, with the possible exception of a few small masses protruding on the north slopes, which may either be detatched fragments or part of a ledge. There can be no doubt, however, that this formation is present and forms the core of the hill below the deposits of glacial clay and gravel.

Although the wooded area on Peters Hill is very limited, it contains quite a variety of trees and shrubs. The following species were noted here, some of the normally arborescent ones, like the Chestnut and Butternut, being represented only by sprouts: *Carya ovalis, Juglans cinerea, Betula papyrifera, B. populifolia, Quercus alba, Q. velutina, Q. borealis* var. *maxima, Castanea dentata, Ulmus americana, Sassafras officinale, Berberis vulgaris, Spiraea latifolia, Rosa virginiana, Rubus argutus, R. occidentalis, Prunus serotina, Rhus glabra, R. Toxicodendron, Celastrus scandens, Acer rubrum, A. saccharum, Rhamnus cathartica, Cornus florida, C. racemosa, Vaccinium vacillans, V. pennsylvanicum, Fraxinus americana, Viburnum Lentago,* and *V. acerifolium.* Amongst herbaceous plants the variety is not very great and only a few species occur that have not been mentioned previously. One of the most interesting of these is the Coral-root Orchid (*Corallorrhiza maculata*), a specimen of which was collected in September, 1925, well up on the slope in a thicket of young Oaks. Lower down towards the edge of the woods the Wild Geranium or Cranesbill (*Geranium maculatum*), the Mountain Mint (*Pycnanthemum flexuosum*) and the Purple Milkweed (*Asclepias purpurascens*) are growing.

The large collection of Crataegus occupies most of the cleared slopes of the hill and in the open spaces between these small trees many herbaceous plants flourish. The flora has doubtless been much changed and many plants have disappeared since the clearing away of the woods, but the prairie-like aspect of parts of the slope and the assemblage of plants growing here strongly suggests that the forest did not at any time completely cover it and that part of it was originally occupied by open glades or meadows. Some of the more characteristic and conspicuous plants of the open slopes are: *Stipa avenacea*, *Andropogon scoparius* var. *frequens*, *Agrostis perennans*, *A. hyemale*, *Arrhenatherum elatus*, *Danthonia spicata*, *Smilacina stellata*, *Rumex acetosella*, *Hypericum perforatum*, *Helianthemum canadense*, *H. Bicknellii*, *Lechea villosa*, *Oenothera biennis*, *Asclepias syriaca*, *Trichostema dichotomum*, *Solidago bicolor*, *S. juncea*, *S. nemoralis*, *S. graminifolia*, *Aster patens*, *A. dumosus*, *A. vimineus*, *A. linearifolius*, *Gnaphalium obtusifolium*, *G. uliginosum*, and *Erigeron ramosus*. Late in the autumn the Asters and Goldenrods often make a brilliant display, *Aster linearifolius*, with its pretty violet rays and yellow discs, being especially abundant and showy.

Besides the plants growing in association at the localities mentioned above, a number of other species worthy of mention have been collected in various parts of the Arboretum. *Cyperus filiculmis* grows rather abundantly on sterile gravelly banks between the Arborway wall and the Shrub Collection; this sedge has also been found in some of the cultivated beds in the Conifer Collection and elsewhere, where it has a more robust appearance. *Plantago aristata* and *Antennaria neodioica* are also growing on the same banks above the shrubs, and the little orange-flowered Hawkweed, or Devil's Paint-brush (*Hieracium aurantiacum*) is found on the grassy paths a little lower down amongst the shrubs. Pinesap (*Monotropa Hypopitys*) is a rarity that has been collected in the Oak Collection, and the Wood Betony (*Pedicularis canadensis*) and the Ground-pine (*Lycopodium obscurum* var. *dendroides*) are known only from one locality above the Laurel along the base of Hemlock Hill. The Beard-tongue (*Pentstemon laevigatus*) is growing sparingly in the lower ground a little farther west and near the Bussey Street wall, where it may have been accidentally introduced or planted. The Ironweed (*Vernonia noveboracensis*) sends up its tall stems to a height of seven or eight feet amongst the shrubs to the west of the Meadow Road, near the Aesculus group, and its panicles of rich purple flowers are quite conspicuous in the late summer. The little Skullcap (*Scutellaria epilobifolia*) is growing in the shade of the Rose bushes along the border between the Meadow Road and the ponds, near the Forest Hills gate, and the Moth Mullen (*Verbascum Blattaria*) has been found amongst the shrubs on the Overlook.

Amongst curious instances of plants unaccountably introduced from distant regions may be mentioned the Chili Tarweed (*Madia sativa* var. *congesta*) a native of the Pacific coast of South America, and now established as a weed along the coast in Oregon and California, and *Bassia hyssopifolia,* from the region of the Caucasus. The Composite first mentioned, came up several years ago in cultivated beds along the meadow Road, not far from the Administration Building, where it bloomed and produced seeds, but it does not seem to have persisted here. The species of *Bassia* was collected at the old quarry near Bussey Street, where it is growing amongst the weeds.

In bits of open meadow and in many of the planted groups where the ground is not cultivated and there is considerable space between the trees, as is the case amongst the Lindens, Elms and Birches, where the grass and other undergrowth is cut at infrequent intervals, an opportunity is afforded for the growth of many spontaneous plants. Common species of such places are the Meadow Buttercup (*Ranunculus acris*), Queen Anne's Lace, Butter and Eggs (*Linaria canadensis*), Self-heal (*Prunella vulgaris*), English Rib-grass, (*Plantago lanceolata*), Ox-eye Daisy, Chickory, Yarrow, Dandelion (*Taraxacum erythrospermum*) and Fall Dandelion (*Leontodon autumnalis*). Local and less frequent are the European Bellwort (*Campanula rapunculoides*), White Campion (*Silene alba*), Cow Vetch (*Vicia Cracca*), Black Knapweed (*Centaurea nigra*) and Canada Thistle (*Cirsium arvense*).

At places amongst the Oaks, Hickories, Walnuts and other groups the grass and other plants are usually allowed to grow undisturbed until late in the season, and some of the native plants as well as other introduced ones have a better chance to survive. In the late summer and fall the bright yellow flowers of the Dyer's Greenwood (*Genista tinctoria*), with several species of Goldenrod, and the purple panicled flowers of the New England Aster and other species make a brilliant display. The tall Milkweed, *Asclepias syriacus,* is also abundant here, and the Hardhack (*Spiraea tomentosa*), Wild Rose (*Rosa carolina*), the pretty purple-flowered *Rubus odoratus,* and several less conspicuous brambles grow amongst the tall grass.

In the beds and borders occupied by planted shrubs the ground is usually cultivated at least once or twice a year, and in such places a variety of annual plants, most of them of a weedy character, spring up. Some of the common species here are *Poa annua, Setaria glauca, Polygonum Persicaria, P. pennsylvanicum, Chenopodium album, Mollugo verticillata, Stellaria media, Cerastium vulgare, C. arvense, Lepidium virginicum, Raphanus Raphanistrum, Barbarea vulgaris, Euphorbia maculata, Linaria canadensis, Plantago Rugelii, Galinsoga parviflora* var. *hispida* and *Senecio vulgaris.* Many other species besides those enumerated are found in the cultivated ground, and the total number that might be collected is perhaps larger than in any other single environment.

The Catalogue of the Spontaneous Plants of the Arboretum given below is largely the result of desultory collecting and observation during the past six years. Collections made by the author are indicated by the serial number attached to them, and those contributed by others are credited to them in the list. Many of the species were collected more than once and were duplicated by different collectors. In such cases the specimen kept for the herbarium is mentioned. The work has been rather unevenly balanced as to seasons, since frequent absence on collecting trips in other parts of the country has made it impossible for the author to find some of the plants in flower or fruit. For this reason the spring flora has been somewhat neglected, and it is perhaps less thoroughly known and represented than that of the later seasons.

Several members of the staff and persons connected with the Arboretum, as well as others, have taken a considerable interest in the work and have made contributions to it, either in the collecting of specimens, the identification of material, or suggestions and aid in preparing the list.

Mr. Frederic W. Grigg, who was at the Arboretum in 1925 and 1926, rendered much aid in preparing the preliminary list and in assisting in the determination of a number of the plants. Because of his careful study and wide knowledge of the local flora, I at one time, invited him to join me in the preparation and authorship of this paper, and the work would doubtless have profited much by his assistance had it been possible for him to have given the time to it.

Miss Caroline K. Allen, while at the Arboretum in 1927, collected a number of specimens of herbaceous plants, some of which are cited in the list. Amongst these are a few that had not been found previously, including the Cardinal flower (*Lobelia cardinalis*), collected along the margin of one of the ponds near the Shrub Collection, and the Wood Lily (*Lilium philadelphicum*), found on the wooded hills near the Maple group.

Amongst others who have aided by the contribution of spontaneous plants or by calling attention to those now growing in the Arboretum, or to species which formerly grew there, are Professor J. G. Jack, Mr. Alfred Rehder, Mr. W. H. Judd, Mr. Geo. M. Merrill and Mr. Percival H. Wardwell.

To Mr. C. A. Weatherby, of the Gray Herbarium, I am under considerable obligation for his valuable aid and expenditure of much time in determining and checking up a number of doubtful species. I also wish to express my thanks to Mr. Alfred Rehder, Curator of this herbarium, for many suggestions and aid in the course of the work.

It is planned to keep the plants of the Spontaneous Flora as a special collection in the Herbarium of the Arnold Arboretum, so that additions to it can be made from time to time, and as additional plants turn up it may be desirable to publish a supplementary list at some time in the future.

The Spontaneous Flora of the Arnold Arboretum, being a part, limited by ecological conditions, of that of eastern Massachusetts, lies in a region well covered by the Manuals. Since most of the area has been under cultivation, grazing, clearing or other artificial disturbances for many years, the native flora had naturally been much modified and depleted even before the establishment of the Arboretum. It is also constantly receiving additions through the introduction of plants from other regions, most of them being common weeds and grasses, but including some unusual species and a few that are new to the local flora.

It would have been most interesting and valuable as a basis for comparison had a list of the spontaneous plants growing in the area been made at the time of the Arboretum was established, more than fifty years ago. No such list is now available, and I am not aware that anything has been written dealing particularly with the flora of the Arboretum, nor that much collecting of the spontaneous plants has been done.

It is fortunate, however, that we can refer at least to a list of the trees and shrubs found in the Arboretum at the time of its establishment. In this catalogue, published as a part of the First Report of the Director, Professor Charles S. Sargent, in 1874, the species not growing spontaneously were indicated by an asterisk (*), and I am appending a copy of the list, excluding these. In some cases where changes have been adopted in the use of names or in a few instances where a species other than the one indicated is known to have been referred to, I have inserted the presently accepted or correct name in parentheses.

SPONTANEOUS SPECIES LISTED IN A CATALOGUE OF THE LIGNEOUS PLANTS GROWING IN THE ARNOLD ARBORETUM, SEPTEMBER 1, 1874, FROM THE REPORT OF THE DIRECTOR, CHARLES S. SARGENT.

Clematis virginiana L. Not now known as a spontaneous plant.
Berberis vulgaris L.
Tilia americana L. (T. glabra Vent.)
Rhus glabra L.
Rhus copallina L. Not now found spontaneous.
Rhus venenata DC. (R. vernix L.). Not now found spontaneous.
Rhus Toxicodendron L.
Rhamnus cathartica L.
Ceanothus americanus L.
Celastrus scandens L.
Acer Saccharinum L. (A. saccharum Marsh).
Acer rubrum L.
Caragana frutescens DC. Probably not spontaneous.
Robinia pseudoacacia L. Not now found spontaneous.
Prunus virginiana L.
Prunus serotina Ehrh.
Spiraea salicifolia L. (S. latifolia Borkh.)
Spiraea tomentosa L.
Rubus strigosus Michx. (R. Idaeus var. strigosus (Michx.) Maxim.)
Rubus occidentalis L.

Rubus canadensis L.
Rubus hispidus L.
Rosa lucida Ehrh. (R. virginiana Mill.)
Rosa carolina L.
Crataegus tomentosa L. (Probably C. Arnoldiana Sarg.)
Amelanchier canadensis var. Botryapium Gray (A. laevis Wieg.)
Pyrus americana DC. (Sorbus americana Marsh. or more probably Sorbus Aucuparia L.) Not now known spontaneous in the Arboretum.
Hamamelis virginica L. (Hamamelis virginiana L.)
Cornus alternifolia L. Not found as a spontaneous plant recently.
Cornus paniculata L'Her. (C. racemosa Lam.)
Cornus florida L.
Sambucus canadensis L.
Viburnum Lentago L.
Viburnum dentatum L.
Viburnum acerifolium L.
Lonicera ciliata Muhl. (L. canadensis Marsh.) Not recently found.
Cephalanthus occidentalis L.
Gaylussacia frondosa Torr. & Gray. Not now found spontaneous.
Gaylussacia resinosa Torr. & Gray. (G. baccata (Wang.) K. Koch.)
Vaccinium pennsylvanicum Lam.
Vaccinium corymbosum L.
Vaccinium macrocarpon Ait. Not recently found.
Gaultheria procumbens L.
Andromeda ligustrina Muhl. (Xolisma ligustrina (L.) Britton). Not recently found.
Azalea viscosa L. (Rhododendron viscosum (L.) Torr.) Not now found spontaneous.
Ilex verticillata Gray. Not now growing spontaneously.
Fraxinus americana L.
Lindera benzoin Meisner (Benzoin aestivale (L.) Nees) Not known to be growing spontaneously now.
Platanus occidentalis L. No spontaneous trees now known.
Juglans cinerea L.
Carya alba Nutt. (C. ovata (Mill.) K. Koch.)
Carya tomentosa Nutt. (C. alba (L.) K. Koch.)
Carya porcina Nutt. (C. ovalis (Wang.) Sarg.)
Carya amara Nutt. (C. cordiformis (Wang.) K. Koch.) Not now found spontaneous.
Quercus alba L.
Quercus bicolor Willd.
Quercus ilicifolia Wang.
Quercus coccinea var. tinctoria Gray (Q. velutina Lam.)
Castanea vesca L. (Doubtless C. dentata (Marsh.) Borkh.)
Fagus ferruginea Ait. (F. grandifolia Ehrh.)

Corylus americana Walt.
Ostrya virginica Willd. (O. virginiana (Mill.) K. Koch.)
Carpinus americana Michx. (C. caroliniana Walt.) Not found native recently.
Myrica cerifera L. (Doubtless M. carolinensis Mill.)
Comptonia asplenifolia Ait.
Betula lenta L.
Betula alba var. populifolia Spach. (B. populifolia Marsh.)
Alnus incana Willd.
Salix—sp.? (Probably S. tristis Ait.)
Salix—sp.? (Perhaps S. discolor Muhl.)
Populus tremuloides Michx. Not now known as a spontaneous plant.
Populus grandidentata Michx.
Pinus rigida Mill.
Pinus Strobus L.
Abies nigra Poir. (Picea mariana (Mill.) B.S.P.) Probably erroneously included in the spontaneous list.
Abies balsamea Marsh. Probably not spontaneous.
Abies canadensis Michx. (Tsuga canadensis (L.) Carr.)
Juniperus virginiana L.
Juniperus Sabina var. procumbens Pursh. (Probably J. communis var. depressa Pursh.) Not now found spontaneous.
Smilax rotundifolia L.
Smilax herbacea L.

ENUMERATION OF PLANTS GROWING SPONTANEOUSLY IN THE ARNOLD ARBORETUM.[1]

Polypodiaceae

Polypodium virginianum L. (*P. vulgare* of authors, not L.). Common Polypody. No. 25617. Found sparingly on conglomerate ledges on Hemlock Hill and in Central Woods.

Adiantum pedatum L. Maidenhair Fern. No. 25716. Collected at base of Hemlock Hill on southeast side. Only one clump was seen and it may have been planted here, although it is probable that the species was once native in the Arboretum.

Pteridium aquilinum (L.) Kuhn var. *latiusculum* (Desv.) Underw. Bracken. No. 23631. Common in open woods and rocky ground.

Athyrium angustum (Willd.) Presl (*Asplenium Filix-femina* (L.) Bernh. in part). Lady Fern. No. 35055. Frequent along brooks and borders of woods. Probably planted in some places but the species is undoubtedly native within the Arboretum.

[1] Introduced species are marked by an asterisk (*), and a few native plants of which we have authentic records but which are now extinct in the Arboretum, have been included in the list and are designated by a dagger (†).
The names adopted in the list are those currently used at the Arnold Arboretum or at the Gray Herbarium, and synonyms are cited only where those adopted are not found in Gray's Manual, 7th edition, either as a valid name or as a synonym.

Athyrium angustum var. *rubellum* (Gilbert) Butters (*Asplenium Filix-femina* (L.) Bernh. in part). No. 25717. This and the next variety grow in similar situations to the typical form.

Athyrium angustum var. *elatius* (L.) Butters (*Asplenium Filix-femina* (L.) Bernh. in part). No. 35051.

Thelypteris noveboracensis (L.) Nieuwland (*Aspidium noveboracense* (L.) Sw.). NEW YORK SHIELD FERN. No. 35053. Low ground and borders of woods at several localities.

Thelypteris Bootii (Tuckerm.) Nieuwland. (*Aspidium Bootii* Tuckerm.). No. 35052. Borders of paths and margins of woods, low ground at foot of hills, North Woods.

Thelypteris palustris (L.) Schott. (*Aspidium Thelypteris* (L.) Sw.) MARSH SHIELD FERN. Nos. 23621, 25866. Common in wet ground in several localities.

Thelypteris marginalis (L.) Nieuwland (*Aspidium marginale* (L.) Sw.). MARGINAL SHIELD FERN. No. 25585; *E. L. Evinger*. On rocky ledges, Hemlock Hill and other localities on conglomerate outcrops.

Dennstaedtia punctilobula (Michx.) Moore. HAY-SCENTED FERN. No. 23608. Dry banks and rocky ledges at several places in Arboretum.

Onoclea sensibilis L. SENSITIVE FERN. No. 35137a. Frequent in wet meadows and about brooks and ponds.

**Pteretis nodulosa* (Michx.) Nieuwland (*Onoclea Struthiopteris* Am. auth., not Hoffm.). OSTRICH FERN. No. 35004. Low ground between North Woods and Meadow Road, and in Rhododendron beds along brook at base of Hemlock Hill.

Osmundaceae

Osmunda regalis L. var. *spectabilis* (Willd.) Gray. ROYAL FERN. No. 28023; *C. K. Allen*. Abundant along brooks and borders of woods throughout Arboretum.

Osmunda Claytoniana L. INTERRUPTED FERN. No. 23513. Rich and moist ground along brooks and borders of woods.

**Osmunda cinnamomea* L. CINNAMON FERN. No. 37743. Banks along Bussey Brook. Not common and probably introduced.

Marsileaceae

Marsilea quadrifolia L. PEPPERWORT. No. 23579. Shallow water and muddy margins of pond, near Forest Hills entrance. Perhaps introduced.

Equisetaceae

Equisetum arvense L. HORSETAIL. Nos. 25594, 35012. Common in low meadows, borders of ponds and sometimes along dry paths.

Equisetum sylvaticum L. No. 27985. Boggy and springy ground, near base of Peters Hill.

Equisetum limosum L. No. 25902. Muddy margins of pond, south side of road near Forest Hills entrance.

Lycopodiaceae

Lycopodium obscurum L. var. *dendroideum* (Michx.) D. C. Eaton. GROUND-PINE. *E. L. Evinger.* Rare and local. Shaded north slopes of Hemlock Hill, above Laurels.

Lycopodium complanatum L. var. *flabelliforme* Fernald. TRAILING GROUND-PINE. No. 35101. Rare and local, in springy meadow along Bussey Brook.

Pinaceae

Pinus Strobus L. WHITE PINE. No. 37700. Native on Hemlock Hill and perhaps elsewhere in the Arboretum.

Pinus rigida Mill. PITCH PINE. No. 36326. On outcrops of Roxbury conglomerate.

Tsuga canadensis (L.) Carr. HEMLOCK. No. 37699. Locally dominant on top and rocky slopes of Hemlock Hill.

Juniperus virginiana L. RED CEDAR. No. 37691. On conglomerate outcrops, Central Woods and Hemlock Hill.

Sparganiaceae

Sparganium eurycarpum Engelm. BUR-REED. Nos. 23611, 25657a. About borders of pond, near Forest Hills entrance.

Najadaceae

Potamogeton foliosus Raf. PONDWEED. Nos. 25643, 36342. In ponds near Forest Hills entrance and on South Street tract.

Alismaceae

Sagittaria latifolia L. ARROW-HEAD. *C. K. Allen.* Wet meadows and borders of ponds.

Sagittaria latifolia f. *obtusa* (Muhl.) Robinson. No. 28096. In similar situations to the typical form and perhaps more common.

Sagittaria latifolia f. *gracilis* (Pursh) Robinson. No. 28202. Wet meadows near Administration Building.

Alisma plantago-aquatica L. WATER PLANTAIN. *C. K. Allen.* Wet meadows and borders of ponds.

Graminae

Andropogon scoparius Michx. var. *frequens* Hubbard. BEAR GRASS. No. 23528. Frequent in dry open ground and in rocky open woods.

Sorghastrum nutans (L.) Nash. INDIAN GRASS. No. 25119. Uncommon and local on rocky slopes, southeast side of Hemlock Hill.

**Digitaria sanguinalis* (L.) Scop. CRAB GRASS. No. 23590. A common weed in cultivated beds and waste ground.

**Digitaria Ischaemum* Schreb. (*D. humifusa* Pers.). Nos. 23636, 28174. Frequent in cultivated and waste ground.

Paspalum pubescens Muhl. Nos. 28167, 28225. Local in meadows southeast of Peters Hill, in Poplar collection.

Panicum capillare L. OLD-WITCH GRASS. No. 25983. A frequent weed in cultivated and waste ground.

**Panicum miliaceum* L. MILLET. No. 28161. Uncommon. Collected in rich ground, South Street tract.

Panicum depauperatum Muhl. Nos. 25627, 37671. Locally common on conglomerate outcrops. This and various other species of the genus are popularly called Panic Grasses, but most of them are not distinguished by common names.

Panicum linearifolium Scribn. var. *Werneri* (Scribn.) Fernald (*P. Werneri* Scribn.). No. 25630, 28046. Dry rocky woods and ledges.

Panicum dichotomum L. Nos. 23529, 25803. Dry open woods and rocky slopes.

Panicum barbulatum Michx. No. 25616. Uncommon in rocky woods, near Hemlock Hill.

Panicum boreale Nash. No. 28153, Rocky open woods, south of Bussey Street.

Panicum Lindheimeri Nash var. *fasciculatum* (Torr.) Fernald (*P. tennesseense* Ashe). Nos. 25682, 27961. Frequent in open woods at various places in the Arboretum.

Panicum Lindheimeri var. *implicatum* (Scribn.) Fernald (*P. implicatum* Scribn.). Nos. 28112a, 34990. Woods and open rocky ground and sometimes also found in cultivated beds.

Panicum sphaerocarpon Ell. Nos. 28013, 35057. Frequent in rocky open woods and also in cultivated beds.

**Echinochloa crus-galli* (L.) Beauv. BARNYARD GRASS. Nos. 23601, 28102a. Frequent in cultivated beds and borders and in waste ground.

**Echinochloa muricata* (Michx.) Fernald var. *microstachya* Wiegand. No. 28113. Uncommon. Collected in cultivated ground near Dawson nursery.

**Setaria lutescens* (Weigel) Hubbard (*P. glauca* (L.) Beauv.). BRISTLY FOXTAIL GRASS. No. 25956. A common weedy grass of borders and waste ground.

**Setaria viridis* (L.) Beauv. No. 25984. In similar places to the last species and about as common.

**Setaria italica* (L.) Beauv. HUNGARIAN GRASS. No. 28104a. Occasionally introduced in cultivated and waste ground.

**Setaria verticillata* (L.) Beauv. FOXTAIL GRASS. No. 28103a. Uncommon in waste ground, South Street tract.

Leersia virginica Willd. WHITE GRASS. No. 28239. Moist or muddy margins of ponds or brooks.

Leersia oryzoides (L.) Sw. RICE CUT-GRASS. No. 23605. Wet meadows and borders of ponds and brooks.

Phalaris arundinacea L. CANARY GRASS. No.2 5729. Locally abundant along margins of brooks.

**Anthoxanthum odoratum* L. SWEET VERNAL GRASS. No. 23430. Common in meadows.

Stipa avenacea L. BLACK OAT GRASS. Nos. 25707, 27959. Locally frequent in open rocky ground along southeast side of Hemlock Hill, and on Peters Hill.

Muhlenbergia mexicana (L.) Trin. SATIN GRASS. Nos. 35154, 36333. Found in meadows and waste ground at several places, but not abundant.

Muhlenbergia Schreberi J. F. Gmel. NIMBLE WILL. No. 35155; *Grigg & Palmer.* Abundant in partially shaded ground and meadows.

**Phleum pratense* L. TIMOTHY. No. 23474. Frequent in meadows and open ground.

**Alopecurus pratensis* L. MEADOW FOXTAIL. Nos. 28108a, 37668. Frequent in wet meadows and along borders of brook.

Agrostis alba L. WHITE BENT GRASS. Nos. 25923, 25960. Common in various situations throughout the Arboretum. It is likely that more than one variety of this species is growing here.

Agrostis hyemalis (Walt.) B. S. P. HAIR GRASS. No. 25764. Occasional in cultivated or dry open ground.

Agrostis perennans (Walt.) Tuckerm. THIN GRASS. Nos. 23572, 28047. Common in dry open ground.

Calamagrostis canadensis (Michx.) Beauv. BLUE-JOINT GRASS. Nos. 25704, 37667a. Low meadows and borders of ponds and streams.

Cinna arundinacea L. WOOD REED GRASS. Nos. 25933, 28187. Moist ground, borders of ponds and brooks.

**Ginnania lanata* (L.) Hubbard (*Holcus lanatus* L.). VELVET GRASS. Nos. 25555, 25721. Abundant in wet meadows.

**Sphenopholis pallens* (Spreng.) Scribn. No. 37667. Rare in borders and waste ground.

Sphenopholis obtusata (Michx.) Scribn. Nos. 28031, 35007. Found in rich open ground at several places. Perhaps introduced.

**Avena sativa* L. OATS. No. 37696. Not uncommon in cultivated and waste ground.

**Arrhenatherum elatius* (L.) Beauv. OAT GRASS. Nos. 25659a, 28039. Local on gravelly slopes of Peters Hill and in rocky open woods, south side of Hemlock Hill.

Danthonia compressa Aust. WILD OAT GRASS. No. 25807. Rocky open woods, Hemlock Hill.

Danthonia spicata (L.) Beauv. Nos. 25708, 35077. Frequent in rocky open ground and woods, and sometimes found in cultivated beds.

**Eragrostis capillaris* (L.) Nees. LOVE GRASS. No. 28105a. Rich open ground, South Street tract. Uncommon.

**Eragrostis caroliniana* (Spreng.) Scribn. (*E. pilosa* (L.) Beauv.) No. 25969. Not rare in cultivated and waste ground.

**Dactylis glomerata* L. ORCHARD GRASS. Nos. 23448, 35164. Abundant in meadows and waste ground.

**Poa annua* L. LOW SPEAR GRASS. Nos. 25703, 28178. Common in cultivated and waste ground. One of the earliest plants to bloom in spring, and specimens may be found in flower or fruit almost throughout the year.

**Poa compressa* L. CANADA BLUE GRASS. Nos. 23617, 28029. Common in meadows and waste ground throughout the Arboretum.

Poa pratensis L. KENTUCKY BLUE GRASS. No. 35156. Frequent in meadows.

Poa palustris L. (*P. triflora* Gilib.). FOWL MEADOW GRASS. Nos. 25751, 28106a. Locally abundant along margins of brook and occasionally found in waste or cultivated ground.

Glyceria canadensis (Michx.) Trin. RATTLESNAKE GRASS. No. 23499. Uncommon in moist ground along brook.

Glyceria laxa Scribn. NORTHERN MANNA GRASS. Nos. 25681a, 27993. Rather frequent about margins of ponds and in wet meadows.

Glyceria stricta (Lam.) Hitchc. (*G. nervata* (Willd.) Trin.). MANNA GRASS. Nos. 25681, 28162. Frequent in wet meadows and on borders of ponds and brook.

Glyceria grandis Wats. REED MEADOW GRASS. Nos. 25008, 28065. Frequent in wet meadows and about ponds.

Glyceria pallida (Torr.) Trin. PALE MANNA GRASS. Nos. 25673, 28155. Uncommon on muddy margins of ponds.

Glyceria acutiflora Torr. No. 25825. Uncommon in wet ground about ponds.

Festuca rubra L. RED FESCUE GRASS. Nos. 27979, 28049. Local in boggy ground about spring, near Peters Hill.

Festuca ovina L. var. *capillata* (Lam.) Hack. SHEEP'S FESCUE. No. 28072. Dry rocky slopes and ledges, southeast side of Hemlock Hill. Rare.

**Festucaelatior* L. TALL MEADOW FESCUE. Nos. 28048, 37670. Not uncommon in waste and cultivated ground.

**Bromus secalinus* L. CHESS. No. 28164. Uncommon in waste and cultivated ground.

**Bromus tectorum* L. DOWNY BROME GRASS. No. 25659. Rather frequent in waste ground and borders.

**Bromus sterilis* L. No. 37711. Not as common as the last species, but growing in similar situations.

**Lolium perenne* L. RYE GRASS. Nos. 28176, 37716. Frequent in waste ground and meadows.

**Lolium multiflorum* Lam. ITALIAN RYE GRASS. No. 25702a. Uncommon in meadows and cultivated ground.

**Agropyron repens* (L.) Beauv. COUCH GRASS. No. 23484, 28107a. Frequent in meadows and waste ground.

**Agropyron tenerum* Vasey. No. 25596. Uncommon in waste ground.

**Hordeum jubatum* L. SQUIRREL-TAIL GRASS. No. 37712. Uncommon in waste ground. Collected at old quarry, near Bussey Street.

***Secale cereale* L. RYE. No. 37697. Not uncommon in waste ground and cultivated beds.

Cyperaceae

Cyperus strigosus L. Nos. 23654, 28214. Abundant in wet meadows and sometimes also found in cultivated beds and borders. The species of Cyperus are popularly called SEDGES, but few of the species have distinctive common names.

Cyperus strigosus var. *compositus* Britton. Nos. 25936, 28185. Growing with the typical form and about as common.

Cyperus filiculmis Vahl. No. 25964. Locally abundant on dry gravelly bank, between Shrub collection and Arborway wall.

Cyperus filiculmis var. *macilentus* Fernald. Nos. 25358, 28009. Rocky and gravelly ground, and sometimes also in cultivated beds.

Eleocharis obtusa (Willd.) Schultes. SPIKE RUSH. Nos. 25865, 35152. Common in wet meadows and on muddy margins of ponds and brooks.

Eleocharis palustris (L.) R. &. S., var. *major* Sonder. No. 25645. Muddy margins of ponds, submerged in wet seasons.

Eleocharis calva Torr. (*E. palustris* var. *glaucescens* (Willd.) Gray). No. 25906. Muddy ground about ponds.

Eleocharis acicularis (L.) R. & S. No. 23585. Muddy margins of ponds, submerged in wet seasons.

Eleocharis capitata (L.) R. Br. (*E. tenuis* (Willd.) Schultes). Nos. 25615, 28042. Wet springy ground and borders of ponds.

Stenophyllus capillaris (L.) Britton. Nos. 25899, 35059. Frequent in moist sandy ground and in cultivated beds.

Scirpus atrovirens Muhl. No. 28244. Frequent in wet meadows. The species of Scirpus are popularly called CLUB RUSHES or BULLRUSHES, but few of them have distinctive names.

Scirpus cyperinus (L.) Kunth. WOOL GRASS. Nos. 23500, 28248. Frequent in wet meadows and along margins of brooks and ponds.

Scirpus atrocinctus Fernald, f. *brachypodus* (Fernald) Blake. No. 25557. Wet meadows along Bussey Brook.

Scirpus polyphyllus Vahl. No. 36108. Low meadow, near Administration Building.

Rynchospora capillata (Michx.) Vahl. Beak Rush. No. 28086a. Rare in wet meadow, between Meadow Road and Arborway wall, in Willow group.

Carex Bicknellii Britton. No. 37751. Meadows and open ground, but apparently not common. The Carices are generally known as SEDGES, but only a few of the more conspicuous species have distinctive common names.

Carex scoparia Schkuhr. Nos. 25547, 25759. Common in dry meadows and open rocky woods.

Carex scoparia var. *condensa* Fernald. No. 23478. Wet meadows and open ground.

Carex tribuloides Wahlenb. No. 28035. Moist rich ground. Not common.

Carex mirabilis Dewey. Nos. 25633, 28002. Frequent in moist meadows and sometimes in dry open ground.

Carex echinata Murr. Nos. 27976, 37723. Boggy ground about spring southeast side of Peters Hill. Local and uncommon.

Carex rosea Schkuhr. Nos. 25549, 25629. Frequent in open woods and dry meadows.

Carex rosea var. *radiata* Dewey. Nos. 28008, 28177. Grows in similar situations to the typical form, and about as common.

**Carex muricata* L. Nos. 25739. Rather frequent in rocky open ground and in dry meadows.

Carex Muhlenbergii Schkuhr. No. 28215. Dry open ground and meadows.

Carex cephalophora Muhl. Nos. 27952, 28006. Abundant in dry open woods and meadows.

Carex vulpinoidea Michx. No. 25654. Wet meadows and margins of ponds.

Carex stipita Muhl. Nos. 25550, 28001. Frequent in wet meadows and along margins of brooks and ponds.

Carex annectens Bicknell. No. 25740. Uncommon along margins of brooks and ponds.

Carex crinita Lam. Nos 25579, 28068. Wet meadows and margins of brook. Locally abundant and conspicuous.

Carex stricta Lam. No. 25548. Wet meadow near Administration Building.

Carex virescens Muhl. var. *Swanii* Fernald. Nos. 25607, 27992. Frequent in meadows and open woods.

Carex pennsylvanica Lam. Nos. 25602, 25632. Frequent in woods and rocky open ground.

Carex panicea L. No. 28075. Boggy ground about spring, southeast side of Peters Hill.

Carex pallescens L. Nos. 25597, 27991. Frequent in wet meadows and along brooks.

Carex anceps Muhl. Nos. 27957, 28005. Local in dry gravelly woods, near Aesculus group, and on rocky ledges and slopes, southeast side of Hemlock Hill.

Carex blanda Dewey. Nos. 2800, 28007. Rather common in meadows and open woods at several localities.

Carex conoidea Schkuhr. No. 25587. Uncommon in wet meadows and springy ground.

Carex debilis Michx. var. *Rudgei* Bailey. Nos. 25685, 28037. Frequent in wet meadows and along borders of brooks and ponds.

Carex lanuginosa Michx. Nos. 28038, 28074. Locally abundant in boggy ground about spring on southeast side of Peters Hill.

**Carex hirta* L. Nos. 28069, 28091; *C. E. Faxon* (1878). Local in boggy ground about spring, southeast side of Peters Hill. The specimen collected by Mr. Faxon is in the Gray Herbarium, and the locality given on label is "Peters Hill, West Roxbury."

Carex lurida Wahlenb. Nos. 23535, 25650. Locally abundant in wet meadows.

Araceae

Arisaema triphyllum (L.) Schott. JACK-IN-THE-PULPIT. No. 25889. Moist shaded ground, along Meadow Road near Aesculus group, and on southeast side of Hemlock Hill.

Peltandra virginica L. ARROW ARUM. No. 25647. Wet margins of ponds near Forest Hills entrance.

Acorus Calamus L. CALAMUS. No. 27997. Occasional along margins of ponds and brooks.

Commelinaceae

Commelina communis L. DAY-FLOWER. No. 25736. Not uncommon in waste and cultivated ground, as a weed.

Pontederiaceae

Pontederia cordata L. PICKEREL-WEED. *C. K. Allen.* Abundant in shallow water and on muddy margins of ponds. Possibly introduced here.

Juncaceae

Juncus bufonis L. No. 25824. Locally abundant in wet meadow, near Administration Building. The species of this genus are generally called RUSHES or BOG RUSHES without distinction.

Juncus tenuis Willd. Nos. 23477, 23522. A very common weed in meadows and waste ground, in almost all sorts of soil.

Juncus effusus L. var. *solutus* Fernald & Wiegand. Nos. 23563, 27978. Common in wet meadows and along margins of brooks and ponds.

Juncus canadensis J. Gay. No. 25836. Uncommon in wet meadows.

Juncus acuminatus Michx. No. 25900. Occasional in moist open ground.

Juncus marginatus Rostk. No. 28175, 37721. Frequent in wet meadows.

Luzula campestris (L.) DC. var. *multiflora* (Ehrh.) Celak. WOOD RUSH. Nos. 23530, 23616. Common in dry rocky woods.

Liliaceae

Oakesia sessilifolia (L.) Wats. SMALL BELLWORT. Nos. 28015, 37746. Local along shaded banks, near Forest Hills entrance, and along Bussey Brook.

**Allium carinatum* L. WILD ONION. Nos. 28234, 37669. Locally abundant on dry banks along Bussey Brook, near Center Street gate, and above Forest Hills Road, and also in boggy ground, along Meadow Road, near Aesculus group.

**Allium vineale* L. GARLIC. Nos. 28060, 37727. Occasionally found in waste ground.

**Hemerocallis fulva* L. DAY LILY. No. 25711. Meadows and open woods.

Lilium philadelphicum L. WOOD LILY. *C. K. Allen.* Rare in open woods and meadows, east of Meadow Road, near Maples, and in Central Woods, near Chestnuts.

Lilium superbum L. TURK'S-CAP LILY. No. 25794, *C. K. Allen.* Locally abundant in low meadow, near Administration Building, and occasionally found in other parts of the Arboretum. It is said to have been planted in the meadow, and perhaps is entirely introduced.

Lilium canadense L. WILD YELLOW LILY. No. 37717. Uncommon in low meadows and thickets.

**Ornithogalum umbellatum* L. STAR OF BETHLEHEM. Well established in boggy ground at foot of hills, near Meadow Road and Aesculus group.

**Asparagus officinalis* L. Common Asparagus. No. 25635. Occasional in meadows and waste ground.

Smilacina racemosa (L.) Desf. FALSE SPIKENARD. No. 35135. Frequent in dry open woods.

Smilacina stellata (L.) Desf. FALSE SOLOMON'S SEAL. No. 25997. Local on gravelly open slopes of Peters Hill, probably formerly covered with woods.

Maianthemum canadense Desf. FALSE LILY OF THE VALLEY. No. 25610. Abundant in dry open woods.

Polygonatum biflorum (Walt.) Ell. SOLOMON'S SEAL. Nos. 23514, 25625. Frequent at several places in woods.

**Convallaria majalis* L. LILY OF THE VALLEY. Moist shaded ground at base of Hemlock Hill, on southeast side.

Smilax rotundifolia L. GREEN BRIAR. No. 36357. Abundant on rocky banks and borders of woods.

Smilax herbacea L. CARRION-FLOWER. No. 34105. Uncommon in rocky woods.

Amaryllidaceae

Hypoxis hirsuta (L.) Coville. STAR GRASS. Nos. 25559, 28044. Found in open woods and meadows at several localities, but nowhere abundant.

Iridaceae

Iris versicolor L. WILD BLUE FLAG. No. 23511. Abundant in wet meadows and about borders of ponds and brooks.

**Iris pseudacorus* L. YELLOW IRIS. Nos. 25562, 25646. Abundant in wet meadows and about ponds.

Sisyrinchium gramineum Curtis. BLUE-EYED GRASS. Nos. 25560, 27982. Dry meadows and gravelly open ground, frequent.

Sisyrinchium atlanticum Bicknell. Nos. 25558, 27995. Locally common in wet meadows and in springy ground at several localities.

Orchidaceae

Habenaria lacera (Michx.) R. Br. RAGGED FRINGED ORCHIS. No. 28057; *C. K. Allen.* In meadows along Bussey brook, near Conifers. Uncommon.

Habenaria psychodes (L.) Sw. PURPLE FRINGED ORCHIS. No. 23531. Rare and local along margin of Bussey Brook.

Spiranthes Beckii Lindl. SMALL LADY'S TRESSES. Nos. 23665, 35037. Rare in meadows.

Spiranthes gracilis (Bigel.) Beck. SLENDER LADY'S TRESSES. Nos. 35048, 35070 In similar places to last species and more abundant.

Spiranthes cernua (L.) Richard. LADY'S TRESSES. Nos. 23671, 35122; *C. K. Allen.* Locally frequent in meadows, especially along Bussey Brook.

Corallorrhiza maculata Raf. CORAL ROOT ORCHIS. No. 28233. Rare in dry woods, near top of Peters Hill.

Salicaceae

**Salix alba* L. WHITE WILLOW. No. 36344. Low ground about pond, South Street tract.

Salix discolor Muhl. GLAUCOUS WILLOW. No. 36115. In low meadow near Administration Building. Possibly introduced or escaped here.

Salix petiolaris J. E. Sm. No. 36116. In low meadow near Administration Building and possibly introduced.

Salix cordata Muhl. HEART-LEAVED WILLOW. No. 36115. Springy ground southeast side of Peters Hill.

Salix Bebbiana Sarg. No. 36345. Moist rich ground, South Street tract.

Salix tristis Ait. DWARF GRAY WILLOW. No. 36115. Rocky open ground and borders of woods, Central Woods and near old stone quarry.

Populus grandidentata Michx. LARGE-TOOTHED ASPEN. *J. G. Jack* (1923). Persisting as sprouts on cleared slopes of Peters Hill.

Myricaceae

Myrica caroliniensis Mill. BAYBERRY. *J. Robinson* (1879). Rocky woods and thickets.

Comptonia asplenifolia (L.) Ait. SWEET FERN. No. 36350. Rocky open woods at several localities.

Juglandaceae

Juglans cinerea L. BUTTERNUT. No. 37733. Uncommon on wooded banks near Forest Hills gate, and as sprouts in woods near top of Peters Hill.

Carya ovata (Mill.) K. Koch. SHAG-BARK HICKORY. No. 37674. Infrequent in woods at several localities.

Carya alba (L.) K. Koch. MOCKER NUT. No. 37731. Uncommon in North Woods and south of Bussey Street.

Carya glabra (Mill.) Spach. PIGNUT. Nos. 37688. Found in deciduous woods, especially on conglomerate outcrops, at several places, but nowhere abundant.

Betulaceae

Ostrya virginiana (Mill.) K. Koch. HOP HORNBEAM. No. 37681. Not rare in deciduous woods throughout the Arboretum.

Corylus americana Walt. HAZELNUT. *E. L. Evinger.* Uncommon on rocky banks and in open woods.

Betula lenta L. SWEET BIRCH. No. 37690. Frequent in woods.

Betula populifolia Marsh. GRAY BIRCH. No. 37756. Borders of woods at several places, but not common.

Alnus rugosa (Du Roi) Spreng. SMOOTH ALDER. No. 36343. Uncommon along borders of brooks.

Alnus incana (L.) Moench. SPECKLED ALDER. *E. L. Evinger.* Along margins of brook. Uncommon.

Fagaceae

Fagus grandifolia Ehrh. BEECH. No. 37676. Frequent in woods at several localities.

Castanea dentata (Marsh.) Borkh. Chestnut. No. 37757. This handsome tree, formerly found in the deciduous woods, is now only represented in the native state by sprouts springing up from old stumps on Peters Hill.

Quercus alba L. WHITE OAK. No. 37687. One of the commonest trees of the deciduous woods, some fine large specimens being found in the North and Central Woods.

Quercus bicolor Willd. SWAMP WHITE OAK. No. 37682. Some large trees of this species are growing in low ground along the Valley Road, near the planted Oak groups.

Quercus coccinea Muench. SCARLET OAK. No. 36101. Uncommon in rocky woods. A few small trees were noted on Hemlock Hill and in the South Woods adjoining, and trees that are probably native occur elsewhere.

Quercus velutina Lam. BLACK OAK. No. 37678. Abundant in deciduous woods.

Quercus borealis Michx., var. *maxima* Ashe (*Q. rubra* Du Roi, not L.). RED OAK. No. 37677. One of the common trees of the deciduous woods, of which some fine specimens remain.

Quercus ilicifolia Wang. BEAR OAK. No. 36323. This shrubby species is still growing spontaneously on outcrops of conglomerate in the Central Woods.

Ulmaceae

Ulmus americana L. WHITE ELM. No. 37734. A few spontaneous specimens are still found. One large tree is growing in low ground at the foot of the hills near the Meadow Road and the Aesculus group, and it was also noted on the wooded slope near the Forest Hill entrance.

Urticaceae

**Cannabis sativa* L. HEMP. No. 36331. Found in rocky waste ground, about the old stone quarry.

**Humulus japonicus* Sieb. & Zucc. JAPANESE HOP. No. 28104. Well established in rich open ground at the South Street tract.

**Urtica dioica* L. STINGING NETTLE. No. 28059. Found as a weed in waste ground, but not abundant.

Pilea pumila (L.) Gray. CLEARWEED. No. 23655. Not rare in rich moist ground at several localities.

Boehmeria cylindrica (L.) Sw. FALSE NETTLE. Nos. 25914, 34993. Uncommon, as a weed in cultivated and open ground.

Santalaceae

Comandra umbellata (L.) Nutt. BASTARD TOAD-FLAX. No. 23571. Not rare on rock outcrops and in rocky open woods.

Aristolochiaceae

**Aristolochia Clematitis* L. BIRTHWORT. In open ground and meadows, just east of Administration Building and elsewhere.

Polygonaceae

**Rumex obtusifolius* L. BITTER DOCK. Nos. 23656, 37745. A common weed in waste ground and meadows.

**Rumex crispus* L. YELLOW DOCK. Nos. 25743, 28109. Common as a weed in waste ground and open situations throughout the Arboretum.

**Rumex acetosella* L. SHEEP SORREL. *C. K. Allen.* Common in dry open ground, especially on sterile gravelly slopes.

Polygonum aviculare L. KNOTWEED. Nos. 23673, 25894. A very common weed of meadows and waste ground and in all sorts of situations.

Polygonum amphibium L. WILLOW-WEED. No. 25963a. In shallow water and along muddy margins of pond, near Forest Hills entrance.

Polygonum coccineum Muhl. (*P. Muhlenbergii* (Meisn.) Wats.). SWAMP SMARTWEED. Nos. 25993, 36321. Common in moist meadows and about borders of ponds and brooks.

Polygonum pennsylvanicum L. SMARTWEED. No. 25926; *Grigg & Palmer.* Common in waste and cultivated ground, and sometimes also found in meadows and elsewhere.

**Polygonum Persicaria* L. LADY'S THUMB. Nos. 23438a, 23564. A common weed in meadows and waste and cultivated ground.

Polygonum Hydropiper L. SMARTWEED. Nos. 23578, 23593. Common as a weed in wet meadows and about ponds and streams.

Polygonum punctatum Ell. WATER SMARTWEED. No. 25996; *Grigg & Palmer*. A common weed, especially in wet open ground.

Polygonum hydropiperoides Michx. WATER PEPPER. No. 28246. Moist meadows and borders of ponds.

**Polygonum orientale* L. PRINCE'S FEATHER. Nos. 25917, 25948. In rich open ground, South Street tract.

Polygonum arifolium L. TEAR-THUMB. No. 23577. Moist meadows and margins of ponds. Uncommon.

Polygonum sagittatum L. TEAR-THUMB. No. 25925; *C. K. Allen*. Common in wet meadows and about ponds.

**Polygonum convolvulus* L. BLACK BINDWEED. No. 23548. A weed in waste and cultivated ground, but not very common.

Polygonum scandens L. CLIMBING FALSE BUCKWHEAT. Nos. 23624a, 23672. A common weedy vine of waste and cultivated ground.

**Polygonella articulata* (L.) Meisn. JOINTWEED. No. 25901. Rare and probably only a transient waif, collected in rich open ground, on South Street tract.

**Fagopyrum esculentum* Moench. BUCKWHEAT. Nos. 25727, 37708. Not rare as a weed in cultivated and waste ground.

Chenopodiaceae

**Chenopodium ambrosioides* L. MEXICAN TEA. No. 35144. A weed in meadows and waste ground, but nowhere very abundant.

**Chenopodium album* L. LAMB'S QUARTER. No. 25873. A common weed of waste and cultivated ground.

**Chenopodium album* var. *integrifolium* F. S. Gray. NARROW-LEAVED LAMB'S QUARTER. Nos. 25937, 35010. Growing as a weed in similar places to the typical form, and about as common.

**Chenopodium album* var. *viridescens* St. Amans. GREEN LAMB'S QUARTER. Nos. 28251, 37736. Growing with the other varieties, and perhaps the commonest form.

**Chenopodium murale* L. SOW-BANE. No. 36328. Uncommon as a weed in waste ground. Collected about old stone quarry.

**Chenopodium urbicum* L. GOOSEFOOT. No. 37714. A weed in waste ground, but not common.

**Bassia hyssopifolia* (Pall.) Volk. No. 36351. This curious little plant, a native of the Caucasus region, was found growing about the old stone quarry, where it had been introduced in some unaccountable manner.

Amaranthaceae

**Amaranthus retroflexus* L. PIGWEED. No. 23542. A weed in waste ground. Not very abundant.

**Amaranthus graecizans* L. TUMBLEWEED. No. 36329. Collected near the old stone quarry. Uncommon.

**Celosio argentea* L. COCK'S-COMB. *Grigg & Palmer*. Growing as a weed in rich open ground, South Street tract. Rare.

Phytolaccaceae

Phytolacca americana L. (*P. decandra* of authors, not L.) POKEWEED. No. 23554; *C. K. Allen.* Frequent as a weed in waste and cultivated ground.

Aizoaceae

**Mollugo verticillata* L. CARPETWEED. No. 23547. Very common in cultivated beds and borders as well as in waste ground.

Caryophyllaceae

Spergularia rubra (L.) J. & C. Presl. SAND SPURRY. Nos. 23634, 23669a. Common in waste and cultivated ground, and often growing in gravelly paths. This plant may be found in bloom almost throughout the year.

Arenaria lateriflora L. SANDWORT. No. 25614. Abundant in meadows and waste ground.

**Stellaria graminea* L. CHICKWEED. Nos. 23550, 25568. Abundant in waste and cultivated ground.

**Stellaria media* (L.) Cyrill. CHICKWEED. No. 23591. A very common weed in waste and cultivated ground. Blooms throughout the year.

**Cerastium arvense* L. FIELD MOUSE-EAR. *F. W. Grigg.* Cultivated and waste ground.

**Cerastium vulgatum* L. MOUSE-EAR. Nos. 25954, 37720. A very common weed of waste and cultivated ground.

**Lychnis alba* Mill. WHITE CAMPION. Nos. 25806, 36106. Not rare in waste ground and cultivated borders.

**Silene noctiflora* L. NIGHT-FLOWERING CATCHFLY. Nos. 28139, 37738. Not uncommon in waste ground and meadows.

**Silene latifolia* (Mill.) Britton & Rendle. BLADDER CAMPION. No. 23549; *C. K. Allen.* Frequent in meadows and waste ground.

**Dianthus Armeria* L. DEPTFORD PINK. Nos. 23450, 28054. Rather abundant in open woods and on dry banks.

Portulacaceae

**Portulaca oleracea* L. PURSLANE. No. 35061. Common in waste and cultivated ground.

Nymphaeaceae

**Nymphaea odorata* Ait. SWEET-SCENTED WATER LILY. No. 25648. In ponds near Forest Hills entrance.

Ranunculaceae

Ranunculus abortivus L. SMALL-FLOWERED CROWFOOT. No. 25619a. Rare in open woods and meadows.

Ranunculus allegheniensis Britton. No. 25619. Rare. Found growing with the last species, which it closely resembles except in the achenes. Probably introduced.

**Ranunculus acris* L. TALL BUTTERCUP. No. 23532; *C. K. Allen.* Common in meadows.

Ranunculus repens L. TRAILING BUTTERCUP. Nos. 25578, 28079. Common in wet meadows and along banks of brooks.

Thalictrum dioicum L. EARLY MEADOW RUE. Nos. 25749a, 34995a. Locally abundant in woods.

Thalictrum polygamum Muhl. TALL MEADOW RUE. No. 23482; *C. K. Allen.* Common in low meadows and along brook.

Aquilegia canadensis L. COLUMBINE. No. 25723. Rather rare in clefts and on ledges of conglomerate, Hemlock Hill and South Woods.

†*Hepatica americana* (DC.) Ker. (*H. triloba* Chaix.). This attractive little early spring plant is reported by Professor J. G. Jack to have been growing until a few years ago on hill slopes in the East Woods, but unfortunately it is now extinct here.

Berberidaceae

**Berberis vulgaris* L. COMMON BARBERRY. No. 37705. Not uncommon as an undershrub in open rocky woods and on ledges.

Lauraceae

Sassafras officinale Nees & Eberm. SASSAFRAS. No. 37752. Found on borders of woods and in thickets at several places. Most abundant on Peters Hill.

Papaveraceae

**Chelidonium majus* L. CELANDINE. *C. K. Allen, P. H. Wardwell.* Frequent on wooded banks and along walls.

**Bocconia cordata* Willd. PLUME POPPY. No. 28170. Amongst shrubs on Overlook, where it may have originally been planted, but apparently well established.

Cruciferae

**Lobularia maritima* (L.) Desv. SWEET ALYSSUM. *Grigg & Palmer.* Collected in rich waste ground about pond, on South Street tract.

**Iberis umbellata* L. CANDYTUFT. No. 28106. Growing as a waif in rich ground, South Street tract.

Lepidium virginicum L. PEPPERGRASS. No. 23558. Uncommon in waste and cultivated ground.

Lepidium apetalum Willd. No. 25609. A common weed in waste and cultivated ground.

**Lepidium campestre* (L.) R. Br. Nos. 27965, 28019. Locally abundant in waste ground, about old stone quarry and on South Street tract.

**Thlaspi arvense* L. PENNY CRESS. No. 27966. In waste ground.

**Capsella Bursa-pastoris* (L.) Medic. SHEPARD'S PURSE. No. 23661; *C. K. Allen.* A common weed in waste and cultivated ground and in meadows.

**Raphanus Raphanastrum* L. RADISH. Nos. 23673a, 26354a. Common in cultivated and waste ground.

**Brassica arvensis* (L.) Ktze. CHARLOCK. Nos. 25804, 27967. Frequent as a weed in waste ground.

**Brassica Napus* L. RAPE. Nos. 28020, 28158. A weed in waste ground.

**Sisymbrium altissimum* L. TUMBLE MUSTARD. Nos. 25903, 27968. Occasionally found as a weed in meadows and waste ground.

**Sisymbrium officinale* (L.) Scop. var. *leiocarpum* DC. HEDGE MUSTARD. No. 23600; *C. K. Allen.* A weed in meadows and waste ground.

**Erysimum cheiranthoides* L. WORM-SEED MUSTARD. Nos. 25763, 28002a. Local in cultivated and waste ground, South Street tract and near Dawson nursery.

**Roripa Nasturtium-aquaticum* (L.) Britten & Rendle. WATER CRESS. Nos. 25649, 28003. Frequent along brooks and about ponds.

Roripa palustris (L.) Bess. MARSH CRESS. Nos. 25799, 25909. Abundant in wet meadows and along muddy banks of ponds.

**Roripa Armoracia* (L.) Robinson. HORSERADISH. No. 28111a. Occasional in meadows and open ground.

Barbarea vulgaris R. Br. YELLOW ROCKET. No. 28078. Frequent in wet ground along brooks, and in wet meadows.

Barbarea vulgaris var. *longisiliquosa* Carion. No. 23504. Wet ground and sometimes in dryer situations in waste places.

Barbarea stricta Andrz. No. 27930. Wet meadows and waste ground.

Arabis laevigata (Muhl.) Poir. SMOOTH ROCK CRESS. No. 25613. Local and uncommon on rocky ledges, near old stone quarry.

Crassulaceae

Penthorum sedoides L. DITCH STONECROP. No. 28206a. Uncommon in wet ground about ponds and along brooks.

**Sedum purpureum* Tausch. LIVE-FOR-EVER. No. 25719; *C. K. Allen.* Dry open ground and waste places at several localities.

Saxifragaceae

Saxifraga pennsylvanica L. SWAMP SAXIFRAGE. No. 27984. Very local in boggy ground about spring, on southeast slope of Peters Hill.

Hamamelidaceae

Hamamelis virginiana L. WITCH-HAZEL. Formerly native in woods, and a few plants that are probably spontaneous still remain. Specimens collected by C. E. Faxon, Jamaica Plain, Oct. 20, 1884, now in this herbarium, may have come from Arboretum.

Rosaceae

Spiraea latifolia Borkh. MEADOW-SWEET. No. 37709; *C. K. Allen.*

Frequent in parts of meadow that are not too frequently mowed and in borders of woods.

Spiraea tomentosa L. HARD-HACK. No. 36104. Not uncommon in rocky open ground and in undisturbed meadows.

Amelanchier oblongifolia (T. & Gr.) Roem. JUNEBERRY. Occasional in woods.

Amelanchier laevis Wiegand. SERVICE BERRY. No. 37740. Uncommon in woods.

Crataegus Arnoldiana Sarg. ARNOLD THORN. No. 37739. The type tree from which this species was described was found spontaneous, on a bank near the Bussey greenhouse, and a small plant, though probably not the original tree, is still growing there.

Sorbaronia fallax Schneider (*Aronia melanocarpa* × *Sorbus Aucuparia*). *A. Rehder* (1902). This interesting hybrid between the Chokeberry and the European Roan Tree was discovered on the border of the Central woods and appears to have originated spontaneously here. *Aronia melanocarpa* is a native plant in the region and probably once occurred in the Arboretum, although we have no positive evidence of it. The other supposed parent is much planted and is a frequent escape, and it is probably the plant referred to on Professor Sargent's list as *Pyrus americana*.

Fragaria virginiana Duchesne var. *illinoensis* (Prince) Gray. WILD STRAWBERRY. No. 35046. Meadows and open woods.

Fragaria vesca L. var. *americana* Porter. Nos. 25583, 28249. Frequent in open woods and meadows.

Potentilla monspeliensis L. Rough Cinquefoil. No. 23483; *C. K. Allen*. Abundant in meadows and open ground.

Potentilla monspeliensis var. *norvegica* (L.) Rydb. Nos. 25753, 25904. Frequent in wet meadows and waste ground.

Potentilla argentea L. SILVERY CINQUEFOIL. Nos. 25792, 28053. Uncommon in dry rocky or gravelly ground.

**Potentilla recta* L. TALL CINQUEFOIL. No. 28053. Uncommon in open or waste ground.

Potentilla pumila Poir. LOW CINQUEFOIL. Nos. 25580, 25624. Abundant in dry rocky woods and on conglomerate outcrops.

Potentilla canadensis L. CINQUEFOIL. Nos. 23510, 25581. Uncommon in meadows and open woods.

**Filipendula Ulmaria* (L.) Maxim. QUEEN OF THE PRAIRIE. No. 35027a. Growing on the margin of a small pond, south side of road, near Forest Hills entrance.

Geum canadense Jacq. AVENS. Nos. 23446, 25745, 34991. Uncommon in dry woods. A form with yellow petals (no. 34991) was collected on a wooded bank, near the South Street gate.

**Rubus Idaeus* L. RED RASPBERRY. Nos. 36118, 36121. Occasional in meadows and thickets. Probably introduced.

Rubus occidentalis L. BLACK RASPBERRY. No. 36120a. Borders of woods and thickets.

**Rubus odoratus* L. PURPLE FLOWERING RASPBERRY. Rather abundant in thickets and undisturbed meadows.

Rubus recurvans Blanchard. DEWBERRY. No. 37689; *C. E. Faxon* (1909). Common on outcrops of conglomerate and in dry open woods.

Rubus setosus Bigel. BRISTLY BLACKBERRY. Nos. 36118, 36121; *J. Dawson* (1884); *C. E. Faxon* (1908). Frequent in low meadows.

Rubus nigricans Rydb. BLACKBERRY. No. 36120. Low meadow near Administration building. Perhaps introduced.

Rubus argutus Link. BLACKBERRY. No. 37747; *C. E. Faxon* (1909). Rocky banks and undisturbed meadows.

Rubus hispidus L. DEWBERRY. *C. E. Faxon* (1909). Locally abundant in wet meadows, especially along Bussey Brook, near Conifers.

**Rubus crataegifolius* Bunge. No. 36102. This Asiatic species has become well established in the open woods near the South Street gate.

Rosa carolina L. (*R. humilis* Marsh.) WILD ROSE. Nos. 37718, 37683. Abundant in open ground and in undisturbed meadows.

Rosa virginiana Mill. WILD ROSE. Found in similar situations to the last species, but less common.

Prunus serotina Ehrh. WILD BLACK CHERRY. No. 37754. Frequent in woods.

Prunus virginiana L. CHOKE CHERRY. No. 37732. Abundant as an undershrub in deciduous woods and in thickets.

Leguminosae

Cassia marilandica L. WILD SENNA. No. 23890a. Rare in borders, and perhaps introduced.

Baptisia tinctoria (L.) R. Br. FALSE INDIGO. Nos. 23630, 25725. Frequent in open woods and on conglomerate outcrops.

**Genista tinctoria* L. DYER'S GREENWOOD. *C. K. Allen.* Common in undisturbed meadows and borders of woods, especially near Central Woods.

**Trifolium arvense* L. RABBIT-FOOT CLOVER. No. 23640. Frequent in rocky waste ground.

**Trifolium incarnatum* L. CRIMSON CLOVER. No. 28186. In waste ground, South Street tract.

**Trifolium pratense* L. RED CLOVER. No. 23658; *C. K. Allen.* Common in meadows.

**Trifolium repens* L. WHITE CLOVER. Common in meadows and waste ground.

**Trifolium hybridum* L. ALSIKE CLOVER. No. 25576; *C. K. Allen.* Frequent in meadows and waste ground.

**Trifolium agrarium* L. HOP CLOVER. Nos. 25634, 27969. Frequent in rocky waste ground.

**Medicago lupulina* L. BLACK MEDIC. No. 23574; *C. K. Allen*. Common in waste ground.

**Melilotus officinalis* (L.) Lam. YELLOW SWEET CLOVER. No. 25878. Occasional in waste ground and meadows.

**Melilotus alba* Desf. WHITE SWEET CLOVER. No. 27970. In waste ground, South Street tract, and about old stone quarry.

**Dalea alopecuroides* Willd. BUSH CLOVER. Nos. 28152, 36335; *Grigg & Palmer*. Locally abundant in rich ground, South Street tract.

Desmodium nudiflorum (L.) DC. Nos. 28143, 35240. Rare in rocky open woods, on southeast side of Hemlock Hill. Plants of this genus are commonly known as BEGGARS TICKS or TICK TRIFOIL, but the different species are scarcely distinguished from each other.

Desmodium rotundifolium (Michx.) DC. No. 27963. Rocky open woods, on southeast side of Hemlock Hill. Local and uncommon.

Desmodium canadense (L.) DC. Nos. 25995, 28211. Locally abundant in open woods at several localities.

Desmodium marilandicum (L.) DC. Nos. 25946, 28141. Local in rocky open woods, south side of Hemlock Hill.

Desmodium rigidum (Ell.) DC. Nos. 25947, 28142. Locally abundant at one locality, rocky slope, south side of Hemlock Hill.

Lespedeza intermedia (Wats.) Britton. BUSH CLOVER. Nos. 25945, 35128. Locally abundant in rocky open woods on south side of Hemlock Hill.

**Lespedeza striata* (Thunb.) H. & A. JAPANESE CLOVER. No. 28195. Rare and probably transient in rich soil, South Street tract.

**Vicia angustifolia* (L.) Reichard. COMMON VETCH. No. 28159. Uncommon in rocky waste ground.

**Vicia angustifolia* var. *segetalis* (Thuillier) Koch. Nos. 25738, 28062. Growing in similar places to the typical form, and apparently more common.

**Vicia tetrasperma* (L.) Moench. SMALL VETCH. No. 25750. Uncommon in meadows and waste ground.

**Vicia Cracca* L. COW VETCH. Nos. 25574, 28160. Common in meadows and waste ground. A native species but probably introduced here.

Amphicarpa monoica (L.) Ell. HOG PEANUT. No. 25951. Local in rocky ground, south side of Hemlock Hill.

Amphicarpa Pitcheri T. & G. No. 28224. Local along spring rivulet, South side of Peters Hill.

Oxalidaceae

**Oxalis europaea* Jordan (*O. stricta* of authors, in part, not L.). Wood Sorrel. Nos. 23490, 28011. Common in meadows and waste ground.

**Oxalis europea* f. *cymosa* (Small) Wiegand (*O. cymosa* Small.). Nos. 28098, 35078. Frequent in meadows and waste and cultivated ground.

Geraniaceae

Geranium maculatum L. CRANESBILL. Nos. 27996, 28229. Uncommon in woods.

Euphorbiaceae

Acalypha virginica L. THREE-SEEDED MERCURY. Nos. 23521, 23602. Common in moist meadows and waste ground.

Euphorbia maculata L. MILK PURSLANE. Nos. 23546, 25978. Common as a weed in waste and cultivated ground.

**Euphorbia Cyparissias* L. CYPRESS SPURGE. No. 28052. Grassy open ground, about old cemetery, northwest side of Peters Hill.

Callitrichaceae

Callitriche heterophylla Pursh. WATER SPEARWORT. Nos. 23622, 28024. Frequent in shallow water of brooks and on margins of ponds.

Anacardiaceae

**Cotinus coggygria* Scop. EUROPEAN SMOKE-TREE. Observed growing on conglomerate ledges on the western slope of Hemlock Hill by Mr. Rehder, but not seen recently.

Rhus typhina L. STAG-HORN SUMACH. No. 36114. Doubtless originally native and now also adventive in several parts of the Arboretum.

Rhus glabra L. SMOOTH SUMACH. No. 37749. Borders of woods and thickets.

Rhus Toxicodendron L. POISON IVY. No. 37748. Abundant on rocky banks and along walls.

Celastraceae

Celastrus scandens L. BITTER-SWEET. No. 37753. Freely escaping and perhaps native in Peters Hill Woods.

Aceraceae

Acer saccharum Marsh. SUGAR MAPLE. Nos. 35675, 37730. Abundant in woods, especially on the low glacial hills of the North Woods.

Acer rubrum L. RED MAPLE. No. 37758. Not uncommon both in low ground and sometimes in rocky woods.

Balsaminaceae

Impatiens biflora Walt. JEWELWEED. No. 23492; *C. K. Allen*. Abundant in wet meadows and along borders of streams and ponds.

Rhamnaceae

Ceanothus americanus L. NEW JERSEY TEA. No. 37706. Rocky woods, south side of Hemlock Hill.

**Rhamnus cathartica* L. BUCKTHORN. No. 37759. Established in woods on Peters Hill and also in low meadow near Administration Building.

**Rhamnus Frangula* L. No. 36111. In low meadow near Administration Building.

Vitaceae

Vitis Lecontiana House (*V. bicolor* Lam.). SUMMER GRAPE. No. 37704. Rare and local in rocky woods, southwest slope of Hemlock Hill.

Parthenocissus quinquefolia var. *hirsuta* (Donn) Planch. VIRGINIA CREEPER. No. 36103. Occasional in rocky woods.

Tiliaceae

Tilia glabra Vent. (*T. americana* L. in part). BASSWOOD. No. 37729. Rare, in East Woods, though probably formerly more abundant.

Malvaceae

**Althaea rosea* Cav. HOLLYHOCK. In rich waste ground, South Street tract.

**Napaea dioica* L. GLADE MALLOW. No. 25893. Found in rocky open ground near Center Street gate.

Hibiscus Moscheutos L. SWAMP ROSE MALLOW. Nos. 37692, 37725. About borders of ponds. Perhaps introduced.

**Malva rotundifolia* L. CHEESES. No. 25968. A weed in meadows and waste ground. Uncommon.

**Malva moschata* L. MUSK MALLOW. Nos. 37692, 37725. In open ground near Pinetum and near Bussey House.

Guttiferae

**Hypericum Ascyron* L. GREAT ST. JOHN'S-WORT. No. 23486; *C. K. Allen.* Locally abundant in low meadow near Administration Building.

**Hypericum perforatum* L. COMMON ST. JOHN'S-WORT. No. 23432; *C. K. Allen.* Common in meadows and dry open ground throughout the Arboretum.

Hypericum boreale (Britton) Bicknell. *C. K. Allen.* Apparently rare, in moist ground about ponds. This and several of the following species are indiscriminately called St. John's-wort.

Hypericum mutilum L. No. 23487; *Grigg & Palmer.* Common in wet meadows and about ponds and brooks.

Hypericum majus (Gray) Britton. Nos. 25691a, 28173. Uncommon in wet meadows.

Hypericum canadense L. Nos. 25891, 35108. Common in wet meadows and in cultivated beds.

Hypericum gentianoides (L.) B.S.P. PINEWEED. Nos. 23569, 32240. Locally abundant on outcrops of conglomerate and on sterile clay and gravel.

Cistaceae

Helianthemum canadense (L.) Michx. FROSTWEED. Nos. 25590, 35075. Abundant in dry meadows and in dry gravelly ground.

Helianthemum Bicknellii Fernald. Frostweed. No. 25732. Abundant in dry rocky woods and open ground.

Lechea villosa Ell. PINWEED. No. 23561. Locally abundant on dry gravelly open slopes of Peters Hill.

Violaceae

Viola cucullata Ait. MARSH BLUE VIOLET. Nos. 25564, 25971. Frequent in wet meadows and open ground.

Viola papilionacea Pursh. BLUE VIOLET. Nos. 23488, 28113a. Common in meadows throughout the Arboretum.

Viola fimbriatula Sm. OVATE-LEAVED VIOLET. Nos. 25941, 35060. Frequent in meadows and cultivated beds from border of Central Woods to Peters Hill.

Viola lanceolata L. LANCE-LEAVED VIOLET. Nos. 25563, 28170. Locally common in wet meadows, near Administration Building and along Bussey Brook.

Viola pallens (Banks) Brainerd. NORTHERN WHITE VIOLET. Nos. 25620, 28084. Local in wet meadows, near Administration Building, along Bussey Brook and on slope of Peters Hill.

Viola lanceolata × *pallens*. No. 28083a. An apparent hybrid between these two species was collected in the border of the low meadow, between the Meadow Road and the Arborway wall, where it was growing with both of the supposed parent species.

Lythraceae

**Decodon verticillatus* (L.) Ell. var. *laevigatus* T. & G. WATER WILLOW. No. 25936a. Borders of ponds near Forest Hills entrance. Probably originally planted.

**Lythrum salicaria* L. PURPLE LOOSESTRIFE. No. 25801; *C. K. Allen*. Common in low meadows and about ponds, and sometimes in dryer waste ground.

Onagraceae

Ludvigia palustris (L.) Ell. WATER PURSLANE. No. 25928a. In shallow water along Bussey Brook, and on muddy borders of ponds.

Epilobium angustifolium L. GREAT FIREWEED. No. 25898. In rich open ground, South Street tract.

Epilobium coloratum Muhl. WILLOW-HERB. Nos. 23537, 25897. Rich or moist ground, South Street tract, and along brooks.

Oenothera biennis L. COMMON EVENING PRIMROSE. Nos. 23491, 25940. Common in meadows, open woods and waste ground throughout the Arboretum.

Oenothera perennis L. SUNDROPS. No. 28193; *C. K. Allen*. Locally abundant in wet meadows and about borders of ponds.

Oenothera fruticosa L. var. *hirsuta* Nutt. Dry open ground, in Oak groups. Perhaps introduced.

Circaea latifolia Hill (*C. lutetiana* L.). ENCHANTER'S NIGHTSHADE. Nos. 23653, 25748. Local on wooded banks near Forest Hills gate and in South Woods.

**Trapa natans* L. WATER NUT. No. 25831. Uncommon and local in shallow water and along muddy margins of pond south of road, near Forest Hills entrance.

Araliaceae

Aralia racemosa L. SPIKENARD. No. 25789. Local along shaded rocky slopes and ledges, south side of Hemlock Hill.

Aralia nudicaulis L. WILD SARSAPARILLA. Nos. 23572, 25593. Frequent in rocky woods, especially on Hemlock Hill and in South Woods.

Umbeliferae

Hydrocotyle americana L. WATER PENNYWORT. Local in boggy ground about spring, southeast side of Peters Hill and also in wet spots at foot of hills, by North Woods.

Cicuta maculata L. SPOTTED COWBANE. No. 23489; *C. K. Allen*. Frequent in low meadows, along streams and about borders of ponds.

Cicuta bulbifera L. WATER HEMLOCK. No. 36336; *Grigg & Palmer*. Not rare on muddy borders of ponds and brooks.

Sium suave Walt. WATER PARSNIP. Nos. 23560, 25871. Rather uncommon on borders of ponds and along brooks.

Zizia aurea (L.) Koch. GOLDEN ALEXANDERS. No. 25989. Rare, in dry open woods near top of Peters Hill.

**Aethusa Cynapium* L. FOOL'S PARSLEY. No. 36333a. Uncommon, as a weed in beds and waste ground, foot of hills, near North Woods.

**Pastanaca sativa* L. PARSNIP. No. 28026. Uncommon in meadows and waste ground.

**Daucus Carota* L. CARROT, QUEEN ANNE'S LACE. No. 23444; *C. K. Allen*. Common in meadows and waste ground.

Cornaceae

Cornus florida L. FLOWERING DOGWOOD. No. 37702. Occasional in woods, especially on Hemlock Hill and Peters Hill.

Cornus racemosa Lam. (*C. paniculata* L'Her.). SMALL-FLOWERED DOGWOOD. No. 37680. Not rare in woods and thickets at several localities.

Cornus amomum Mill. KINNIKINNIK. Uncommon in wet meadows and along brook.

Pyrolaceae

Chimaphila umbellata (L.) Nutt. var. *cisatlantica* Blake. PRINCE'S PINE. No. 25756; *E. L. Evinger*. Uncommon in woods, Central Woods and near Center Street gate.

Pyrola elliptica Nutt. WINTERGREEN. Nos. 25714, 28041. Local on grassy slopes and borders of woods, Central Woods and near Peters Hill.

Monotropaceae

Monotropa uniflora L. INDIAN PIPE. No. 25883; *C. K. Allen*. Frequent in Oak woods, depressions in glacial hills, also under Hemlocks, south side of Hemlock Hill.

Monotropa Hypopitys L. PINE SAP. No. 35327. Rare and local, under Oak trees, west slope, below Overlook.

Ericaceae

Kalmia angustifolia L. SHEEP'S LAUREL. No. 36354. Rare and local, on gravelly north slopes of Peters Hill, persisting in Hawthorn plantation, and along Bussey Brook.

Gaultheria procumbens L. CHECKERBERRY. No. 36358. Locally abundant on wooded north slopes of Hemlock Hill.

Arctostaphylos uva-ursi (L.) Spreng. BEARBERRY. Rocky banks on south side of Hemlock Hill. Perhaps introduced.

Gaylussacia baccata (Wang.) K. Koch. BLACK HUCKLEBERRY. No. 37686. Not uncommon in dry rocky woods, Central Woods and Hemlock Hill.

**Calluna vulgaris* (L.) Salisb. HEATHER. *C. K. Allen*. Established in gravelly ground of meadow in Linden group.

Vaccinium pennsylvanicum Lam. EARLY SWEET BLUEBERRY. No. 37685, 37719. Common in open rocky woods, especially on conglomerate outcrops.

Vaccinium vacillans Lam. LATE LOW BLUEBERRY. No. 37684. Common with the last species.

Primulaceae

Hottonia inflata L. FEATHERFOIL. No. 25683. Local in shallow water of pond, near Forest Hills gate. Not seen lately and perhaps now extinct in the Arboretum.

Lysimachia terrestris (L.) B.S.P. LOOSESTRIFE. No. 36109; *C. K. Allen*. Common in open woods, especially on gravelly glacial hills, south of Administration Building.

Lysimachia quadrifolia L. WHORLED LOOSESTRIFE. No. 23584; *C. K. Allen*. In similar situations and same localities as last, but less common.

Lysimachia Nummularia L. MONEYWORT. Nos. 25603, 25713. Moist shaded ground at foot of Hemlock Hill, on southeast side.

Steironema lanceolatum (Walt.) Gray. LOOSESTRIFE. No. 28172. Uncommon in wet meadows.

Oleaceae

Fraxinus americana L. WHITE ASH. No. 37679. Frequent in woods throughout the Arboretum.

**Ligustrum vulgare* L. PRIVET. No. 37760. In open woods near top of Hemlock Hill and at a few other localities.

Gentianaceae

†*Gentiana crinita* Froel. FRINGED GENTIAN. Although this pretty plant is now unfortunately extinct in the Arboretum, it was until a few years ago growing in the low meadow, near the Administration Building, where it was known by Mr. Rehder and Professor Jack. A specimen in the Gray Herbarium, collected by Mr. C. E. Faxon, in 1884, and labeled West Roxbury, may have come from the Arboretum, since other Arboretum plants collected by him at that time were so labeled.

Apocynaceae

Apocynum androsaemifolium L. PINK-FLOWERED DOGBANE. Nos. 25761, 34998. Locally abundant in rocky open slopes of South Woods, and also on border of woods, near Dawson nursery.

Asclepidaceae

Asclepias purpurascens L. Purple-flowered Milkweed. No. 25760. Rare, in woods near top of Peters Hill.

Asclepias incarnata L. var. *pulchra* (Ehrh.) Pers. WOOLY MILKWEED. No. 23447; *C. K. Allen.* Abundant in low meadows and about borders of ponds and streams.

Asclepias syriaca L. COMMON MILKWEED. No. 25731: *C. K. Allen.* Common in meadows and thickets.

Asclepias phytolaccoides Pursh. POKE MILKWEED. No. 25879. Uncommon in open woods and amongst shrubs, near Bussey Hill.

Asclepias quadrifolia Jacq. FOUR-LEAVED MILKWEED. No. 25577. Local and uncommon, on rocky wooded slopes of Hemlock Hill.

**Cynanchum nigrum* (L.) Pers. BLACK SWALLOW-WORT. No. 28058. Locally abundant in meadows, near Dawson nursery and at other localities.

Convolvulaceae

**Convolvulus sepium* L. HEDGE BINDWEED. Nos. 25733, 36110. Frequent in low meadows, borders and waste ground.

**Convolvulus arvensis* L. SMALL BINDWEED. No. 28056. Uncommon in meadows and waste ground.

**Cuscuta Coryli* Engelm. DODDER. No. 35129. On *Hieracium paniculatum* and other herbs, rocky ground on south side of Hemlock Hill.

Cuscuta Gronovii Willd. No. 25879a. Frequent on various herbs. Meadows and borders of ponds and brooks.

Boraginaceae

**Myosotis scorpioides* L. FORGET-ME-NOT. Locally abundant along wet margins of Bussey Brook.

Verbenaceae

Verbena urticaefolia L. WHITE VERVAIN. Nos. 23662, 25006. Infrequent in meadows and waste ground.

Verbena hastata L. Blue Vervain. No. 23505; *C. K. Allen.* Frequent in meadows and open ground.

Labiatae

**Ajuga reptans* L. Bugle Weed. No. 28088. Uncommon in meadows and on open banks.

Trichostema dichotomum L. Blue Curls. Nos. 25965, 35071. Locally abundant in sterile soil, gravel, and rock outcrops, and spreading into cultivated beds.

Scutellaria lateriflora L. Mad-dog Skullcap. Nos. 28206, 36322a. Not rare on moist shaded banks and in wet ground.

Scutellaria epilobifolia Hamilton. Skullcap. Nos. 25829, 25896. Locally abundant in rich open ground, South Street tract, and also amongst Rose border and other shrubs along Meadow Road, near Shrub Collection.

**Scutellaria altissima* L. Tall Skullcap. No. 25785; *A. Rehder* (1913). Local in rocky ground at the foot of Hemlock Hill, on the southeast side. The specimen collected by Mr. Rehder is in the Gray Herbarium.

**Nepeta hederacea* (L.) Trevisan. Ground Ivy. Nos. 25735, 27010. Common in meadows and waste ground at several places.

Prunella vulgaris L. Self-heal. *C. K. Allen.* Common in meadows and waste ground, especially in moist places.

**Galeopsis Tetrahit* L. var. *bifida* (Boenn.) Lej. & Court. Hemp Nettle. Nos. 23507, 25796. Abundant in low meadows and waste ground.

**Lamium amplexicaule* L. Henbit. Nos. 32238, 35160. Frequent in meadows and waste ground. Has been found in flower as late as December first.

**Leonurus Cardiaca* L. Motherwort. No. 37707. Uncommon, in waste ground. Collected at old stone quarry, near Bussey Street.

Stachys palustris L. Woundwort. Nos. 25955, 37672. Infrequent in low meadows and waste ground.

Hedeoma pulegioides (L.) Pers. Pennyroyal. Nos. 25830, 35132. Abundant in dry open ground, especially on or near rock outcrops.

Pycnanthemum flexuosum (Walt.) B.S.P. Mountain Mint. No. 25988. Uncommon and local in woods near top of Peters Hill.

Lycopus americanus Muhl. Water Hoarhound. No. 23506; *C. K. Allen.* Frequent in moist meadows and about ponds and brooks.

Lycopus uniflorus Michx. Bugle Weed. Nos. 28228, 28245. Locally abundant in low meadows and about ponds.

Mentha arvensis L. Field Mint. No. 28034. Uncommon in moist open ground.

Mentha arvensis var. *canadensis* (L.) Briquet. Wild Mint. Nos. 25895, 35153. Common in low wet ground, meadows and borders of ponds and brooks.

**Perilla frutescens* (L.) Britton. Beef-steak Plant. No. 25943. Uncommon in waste ground, about old stone quarry.

Solanaceae

**Solanum Dulcamara* L. CLIMBING NIGHTSHADE. No. 36359. Along brooks and in borders at several localities.

**Solanum nigrum* L. COMMON NIGHTSHADE. No. 23672a. Common in cultivated and waste ground.

**Solanum nigrum* var. *villosum* L. No. 37713. Rocky waste ground. Uncommon.

**Physalis heterophylla* Nees. GROUND CHERRY. No. 28149. Rare in rich open ground, South Street tract.

**Physalis hetrophylla* var. *ambigua* (Gray) Rydb. Nos. 25970, 27971. Uncommon in border along Valley Road, near Chestnuts, and in rocky waste ground about old quarry.

**Physalis subglabrata* Mack. & Bush. TALL GROUND CHERRY. No. 37737. Local on bank near Bussey greenhouse.

**Petunia violacea* Lindl. PETUNIA. No. 28017. Growing as a waif in rich waste ground, South Street tract.

**Nicotiana alata* L. var. *grandiflora* Comes. No. 37715. Growing as a waif in waste ground, South Street tract.

Scrophulariaceae

**Verbascum Thapsus* L. MULLEIN. Nos. 25719, 25754. Frequent in open and waste ground.

**Verbascum Blattaria* L. MOTH MULLEIN. Rare in borders near Overlook.

**Linaria vulgaris* Hill. BUTTER AND EGGS. No. 25788; *C. K. Allen.* Common in meadows and waste ground.

Linaria canadensis (L.) Dumont. No. 35002; *C. K. Allen.* Frequent in cultivated ground and in dry open situations.

**Pentstemon laevigatus* Ait. SMOOTH BEARD TONGUE. Nos. 25742, 35400. Rare and local in shaded border along Hemlock Hill Road, near Bussey Street crossing.

Chelone glabra L. TURTLEHEAD. No. 28250; *C. K. Allen.* Locally abundant along borders of brook and ponds.

Ilysanthes dubia (L.) Bernh. FALSE PIMPERNEL. Nos. 25790, 28102. Uncommon in rich moist ground and along muddy borders of ponds.

**Veronica longifolia* L. VERONICA. Nos. 25747, 25864. Not rare locally in borders and on banks near Forest Hills entrance.

Veronica scutellata L. MARSH SPEEDWELL. Nos. 25644, 25838. Local on muddy banks of pond, near Shrub Collection.

Veronica officinalis L. COMMON SPEEDWELL. No. 37744; *C. K. Allen.* Common in meadows in many places.

Veronica serpyllifolia L. THYME-LEAVED SPEEDWELL. Nos. 35065, 35158. Uncommon in cultivated ground near South Street entrance.

Aureolaria pedicularia (L.) Raf. (*Gerardia pedicularia* L.) FALSE FOXGLOVE. Nos. 25920, 28216. Locally abundant in open rocky woods, south side of Hemlock Hill.

Aureolaria flava (L.) Pennell (*Gerardia flava* L.). Smooth False Foxglove. No. 25877. Local and uncommon on rocky open slopes, south side of Hemlock Hill.

Agalinis tenuifolia (Vahl.) Raf. (*Gerardia tenuifolia* Vahl). Slender Gerardia. Nos. 28210, 35068. Locally abundant in wet meadows, near Administration Building and along Bussey Brook. A white-flowered form has been found here.

Agalinis paupercula (Gray) Pennell (*Gerardia paupercula* Britt.). Small-flowered Gerardia. Nos. 25934, 25967. Locally abundant in similar locations to last species.

Melampyrum lineare Lam. Cow Wheat. No. 23527. Locally abundant in dry woods, especially on conglomerate outcrops.

Pedicularis canadensis L. Lousewort. No. 28144. Rare and local on wooded bank, north side of Hemlock Hill.

Orobanchaceae

Orobanche uniflora L. Broom-rape. Uncommon in open woods and meadows, near Conifer groups.

Plantaginaceae

Plantago Rugelii Dcne. Plantain. No. 23589. A common weed in meadows and waste ground.

**Plantago lanceolata* L. English Rib Grass. No. 28108; *C. K. Allen*. Very common in meadows.

**Plantago aristata* Michx. Rib Grass. Nos. 23597, 25791, 25791a. Locally abundant on a gravelly bank between Shrub Collection and Arborway wall, and also as a weed in cultivated beds.

Rubiaceae

Galium circaezans Michx. Wild Licorice. Nos. 25566, 25875. Rocky woods, Peters Hill, Hemlock Hill and South Woods.

Galium tinctorium L. Marsh Bedstraw. Nos. 25653a, 27989. Wet meadows and boggy ground about springs.

Galium Claytoni Michx. Bedstraw. No. 28150; *C. K. Allen*. Frequent in moist meadows and about ponds.

Houstonia longifolia Gaertn. No. 27955. Rare and local in gravelly soil, North Woods.

Mitchella repens L. Partridge Berry. No. 36360. Banks and open slopes, Hemlock Hill, where it may have been introduced.

Cephalanthus occidentalis L. Buttonbush. Apparently spontaneous about small pond on northeast side of Bussey Hill.

Caprifoliaceae

Triosteum aurantiacum Bicknell. Horse Gentian. Nos. 25582, 28097. Local in rocky woods, South Woods, near Malus collection.

**Lonicera tatarica* L. TARTARIAN HONEYSUCKLE. Occasional in thickets and borders of woods.

**Lonicera japonica* Thunb. JAPANESE HONEYSUCKLE. Escaped in borders and thickets.

Viburnum dentatum L. ARROW-WOOD. Probably native along base of hills, North Woods.

Viburnum acerifolium L. ARROW-WOOD. No. 37703. Locally abundant in rocky woods, especially on Hemlock Hill.

Viburnum Lentago L. NANNYBERRY. Probably native in North Woods and on Hemlock Hill.

Sambucus canadensis L. ELDERBERRY. No. 37710; *C. K. Allen.* Frequent along brooks and in meadows.

**Sambucus canadensis* var. *laciniata* Cowell. Adventive on bank between North Meadow and Arborway wall.

Cucurbitaceae

**Echinocystis lobata* (Michx.) T. & G. WILD BALSAM-APPLE. Nos. 25938, 35091. Not uncommon in waste ground at several places.

**Sicyos angulata* L. ONE-SEEDED BUR CUCUMBER. No. 23517. Uncommon in waste ground, South Street tract.

Campanulaceae

Specularia perfoliata (L.) A. DC. VENUS'S LOOKING-GLASS. No. 25758. Uncommon in waste and cultivated ground. Perhaps introduced.

**Campanula rapunculoides* L. EUROPEAN BELLFLOWER. No. 25752. Frequent in meadows.

**Campanula persicifolia* L. No. 37724. In meadows near Bussey Institute.

**Lobelia cardinalis* L. CARDINAL-FLOWER. *P. H. Wardwell.* Local on margin of pond. Probably planted.

**Lobelia siphilitica* L. BLUE LOBELIA. No. 23670. Rare and local along margins of brook, in Magnolia group, near Administration Building. Not seen recently and perhaps now gone from Arboretum.

Lobelia inflata L. INDIAN TOBACCO. Nos. 23582, 32237. Frequent in meadows and cultivated grounds.

Compositae

**Vernonia noveboracensis* Willd. TALL IRONWEED. No. 23462. In border along Meadow Road, near North Woods and Aesculus groups. Probably originally planted.

Eupatorium verticillatum Lam. (*E. purpureum* L., in part). JOE-PYE WEED. No. 23495; *C. K. Allen.* Locally abundant along margins of brooks and about ponds.

Eupatorium sessilifolium L. UPLAND BONESET. Nos. 25944, 28146. Local on rocky ledges, south side of Hemlock Hill.

Eupatorium perfoliatum L. THOROUGHWORT. No. 23627. Frequent in wet meadows and along brooks.

Eupatorium aromaticum L. WHITE SNAKE-ROOT. Nos. 28145, 35117. Local on rocky slopes and ledges, south side of Hemlock Hill.

**Eupatorium urticaefolium* Reichard. WHITE SNAKE-ROOT. No. 34332. Rare, in cultivated ground and meadow, near North Woods.

**Mikania scandens* (L.) Willd. CLIMBING HEMPWEED. No. 35103. Rare along Bussey Brook, near Hemlock Hill.

Solidago caesia L. BLUE-STEMMED GOLDEN-ROD. No. 23667; *C. K. Allen.* Abundant on rocky shaded banks and in open woods.

Solidago caesia var. *paniculata* Gray. *Grigg & Palmer.* Open ground, South Street tract. Not common.

Solidago puberula Nutt. GOLDEN-ROD. Nos. 35149, 35157. Infrequent in open rocky ground, Central Woods.

Solidago arguta Ait. GOLDEN-ROD. No. 35115. Uncommon in rocky open woods, south side of Hemlock Hill.

Solidago juncea Ait. GOLDEN-ROD. Nos. 23437, 35116. Abundant in open woods and on gravelly slopes.

Solidago rugosa Mill. ROUGH-LEAVED GOLDEN-ROD. Nos. 23628, 35130. Common in low meadows and in moist ground about ponds and brooks.

Solidago nemoralis Ait. GRAY GOLDEN-ROD. No. 23438; *C. K. Allen.* Abundant in rocky open woods and on dry gravelly slopes.

Solidago canadensis L. CANADIAN GOLDEN-ROD. Nos. 23439, 35138. Common in meadows and along brooks.

Solidago bicolor L. WHITE GOLDEN-ROD. No. 23609; *C. K. Allen.* Frequent in dry open woods and in rocky or gravelly ground.

Solidago graminifolia (L.) Salisb. BUSHY GOLDEN-ROD. Nos. 23442, 23576. Abundant in dry meadows and in rocky or gravelly ground.

Solidago caesia × *canadensis*. *Grigg & Palmer.* A plant that appears to be a hybrid between these two species was found in the low ground, near the border of the woods, on the South Street tract.

Aster divaricatus L. WHITE WOOD ASTER. Nos. 28243, 35139. Frequent in rocky woods.

Aster macrophyllus L. LARGE-LEAVED ASTER. Nos. 23568, 36105. Locally common in open woods at several localities.

Aster novae-angliae L. NEW ENGLAND ASTER. No. 23646. Common in low ground and in undisturbed meadows.

Aster patens Ait. LATE PURPLE ASTER. Nos. 23663, 35127. Rather infrequent in open woods and in rocky open ground.

Aster undulatus L. Nos. 35106, 35165. Uncommon in dry woods and on rocky slopes of Hemlock Hill.

Aster cordifolius L. BLUE WOOD ASTER. Nos. 23647, 35146a. Abundant in woods.

Aster laevis L. SMOOTH ASTER. *Grigg & Palmer.* Uncommon in meadows and moist ground.

Aster dumosus L. var. *cordifolius* (Michx.) T. & G. Bushy Aster. No. 35066. Uncommon in meadows and open ground.

Aster vimineus Lam. Small White Aster. Nos. 23614, 35146. Common in meadows and along brooks.

Aster lateriflorus (L.) Britton. Calico Aster. No. 28236; *Grigg & Palmer.* Abundant in low meadows and along streams.

Aster lateriflorus var. *pendulus* (Ait.) Burgess. Abundant in meadows and borders of streams.

Aster paniculatus Lam. Tall White Aster. *Grigg & Palmer.* Locally abundant in low meadows and about ponds and streams.

Aster novi-belgii L. New York Aster. No. 35147; *Grigg & Palmer.* Abundant in wet meadows and about brooks and ponds.

Aster puniceus L. Purple-stemmed Aster. Nos. 23663a, 28242. Not common, in low meadows and along brooks.

Aster umbellatus Mill. Flat-topped White Aster. Nos. 26001, 28232. Locally abundant in open woods, especially on glacial hills in North Woods.

Aster linearifolius L. Low Violet Aster. No. 23433. Common on open gravelly slopes and on conglomerate outcrops. Very abundant and conspicuous in late autumn on Peters Hill.

Aster dumosus × *vimineus.* No. 35151. A hybrid apparently between these two species collected in wet ground, near Peters Hill.

Aster lateriflorus × *undulatus.* No. 35079. Found on border of woods near top of Peters Hill.

Erigeron annuus (L.) Pers. Daisy Fleabane. No. 35151; *C. K. Allen.* Common in waste and cultivated ground.

Erigeron ramosus (Walt.) B. S. P. Daisy Fleabane. No. 23434; *C. K. Allen.* Common in meadows and borders of woods.

Erigeron canadensis L. Horse-weed. No. 23613. A common weed in meadows and waste ground.

Seriocarpus asteroides (L.) B. S. P. White-topped Aster. Nos. 23445, 28148. Frequent in dry open woods and in rocky or gravelly open ground.

Antennaria neodioica Greene. Small-leaved Cat's-foot. No. 25657. Locally abundant on gravelly banks between Shrub Collection and Arborway wall.

Antennaria fallax Greene. Indian Tobacco. No. 25626. Frequent in dry rocky woods and on gravelly slopes.

Anaphalis margaritacea (L.) B. & H. Pearly Everlasting. Nos. 23443, 25872. Frequent in dry meadows and on gravelly slopes.

Gnaphalium obtusifolium L. Common Everlasting. No. 23567. Frequent in meadows and waste ground.

Gnaphalium uliginosum L. Low Cudweed. Nos. 23583, 32241. Abundant in waste and cultivated ground.

**Silphium integrifolium* Michx. Rosin-weed. No. 23624. In border near Birch groups. Probably originally planted.

**Silphium perfoliatum* L. CUP-PLANT. Nos. 23623, 35009. A large clump of this is growing in the low meadow south of the Administration Building, and in border near Birches.

Ambrosia artemisiifolia L. RAGWEED. Nos. 23485, 32239. Common in meadows, waste and cultivated ground.

Rudbeckia hirta L. BLACK-EYED SUSAN. Nos. 25572, 25728; *P. H. Wardwell*. Frequent in meadows and in borders.

**Helianthus annuus* L. COMMON SUNFLOWER. No. 25949. In rich open ground, South Street tract.

Helianthus divaricatus L. WOOD SUNFLOWER. Nos. 28140, 34997. On rocky slopes and ledges, south side of Hemlock Hill and in border of North Woods, near Dawson nursery.

**Helianthus decapetalus* L. WILD SUNFLOWER. No. 25911. Occasional in waste ground and borders.

**Helianthus tuberosus* L. JERUSALEM ARTICHOKE. No. 25994. A large bed of this species is growing in the low meadow south of Administration Building.

**Coreopsis major* Walt. WOOD TICKSEED. No. 25885. In borders near Center Street gate.

**Coreopsis grandiflora* Hogg var. *subintegra* T. & G. No. 37726. Open ground near Bussey house, and probably escaped from cultivation in garden of Bussey Institute.[1]

Bidens connata Muhl. PURPLE-STEMMED BEGGAR-TICKS. Nos. 35111, 35089. Not common in wet ground about ponds.

Bidens frondosa L. BEGGAR-TICKS. Nos. 23643, 3665a. Abundant in wet meadows and about borders of ponds and brooks.

Bidens cernua L. NODDING BUR MARIGOLD. Nos. 35088, 35090, 35134. Abundant along brooks and on borders of ponds.

Bidens vulgata Greene. STICK-TIGHT. No. 26003; *Grigg & Palmer*. Abundant in moist open ground about ponds and brooks.

**Madia sativa* Molina var. *congesta* T. & G. CHILE TARWEED. Rare in cultivated beds along meadow Road in Linden and Horse-chestnut groups. Collected in 1924 and not seen since. Perhaps now gone from the Arboretum.

**Galinsoga parviflora* Cav. var. *hispida* DC. No. 28012. Common as a weed in waste and cultivated ground.

Achillea Millefolium L. YARROW. No. 23651; *C. K. Allen*. Common in meadows and waste ground.

**Achillea Ptarmica* L. SNEEZEWEED. No. 27728. Growing as an escape

[1] The typical form of this species, as it grows on the prairies of the southern and southwestern states, has leaves with narrow linear, fleshy segments, and it was thus described in Hogg's mss., and illustrated in Sweet's British Flower Garden, II. t. 175. The plant collected in the Arboretum, which seems to be the common form in cultivation, has membranaceous leaves, with much wider lanceolate or linear-lanceolate segments, up to 1 cm. wide, the lower entire and the upper with small lateral segments. It appears to be a well marked variety, and I am somewhat doubtfully referring it to the form γ *subintegrifolia*, of Torrey & Gray's Flora of North America, II. 345.

in meadows near the Bussey Institute. This is the cultivated variety known under the garden name of "The Pearl."

**Anthemis Cotula* L. DOG-FENNEL. Nos. 23595, 35145. Frequent in borders and waste ground.

**Anthemis arvensis* L. CORN CAMOMILE. No. 27972. Uncommon in waste or open rocky ground.

**Chrysanthemum Leucanthemum* L. OX-EYE DAISY. No. 23657. In meadows and waste ground with the next variety, which is more abundant.

**Chrysanthemum Leucanthemum* var. *pinnatifidum* Lecoq & Lamotte. *C. K. Allen.*

**Tanacetum vulgare* L. TANSY. *C. K. Allen.* A very common weed in undisturbed meadows and waste ground.

**Artemisia vulgaris* L. COMMON MUGWORT. Nos. 28061, 28115. Uncommon in waste ground.

Erechtites hieracifolia (L.) Raf. FIREWEED. No. 35011, 35162. Frequent as a weed in waste and cultivated ground.

Erechtites hieracifolia var. *intermedia* Fernald. No. 23575. Grows in similar places to the typical form, but less abundant.

**Senecio vulgaris* L. COMMON GROUNDSEL. Nos. 23667a, 35104. Abundant in cultivated beds and waste ground.

**Arctium minus* Benth. COMMON BURDOCK. Nos. 23555, 35094. Frequent as a weed in waste and open ground.

**Cirsium lanceolatum* (L.) Hill. BULL THISTLE. Nos. 25912, 28101. Frequent in waste ground and undisturbed meadows.

**Cirsium arvense* (L.) Scop. CANADA THISTLE. Locally abundant in undisturbed meadows and in waste ground at South Street tract.

**Centaurea Cyanus* L. CORN-FLOWER. Nos. 27973, 28105. Uncommon in meadows and waste ground.

**Centaurea nigra* L. KNAPWEED. No. 23668a; *C. K. Allen.* Locally abundant in meadow near Conifers.

**Lapsana communis* L. NIPPLE-WORT. No. 25910. Rich open ground about pond, South Street tract.

**Cichorium Intybus* L. CHICORY. *C. K. Allen.* Common in meadows and open ground.

**Leontodon autumnalis* L. FALL DANDELION. No. 23625; *C. K. Allen.* Very common in meadows.

**Taraxacum officinale* Weber. DANDELION. Common in meadows. Blooming almost throughout the year.

**Taraxacum erythrospermum* Andrz. Nos. 23659, 28040. In meadows with the last species, and perhaps even more common. Blooms from early Spring until well into the winter.

**Sonchus oleraceus* L. SOW THISTLE. Nos. 25710, 25927. Frequent as a weed in waste and cultivated ground.

**Lactuca scariola* L. var. *integrata* Gren. & Godr. PRICKLY WILD LETTUCE.

No. 23666; *C. K. Allen.* Common in waste ground and undisturbed meadows.

Lactuca canadensis L. WILD LETTUCE. Nos. 23626, 28095. Common in meadows and waste ground.

Lactuca spicata (Lam.) Hitchc. TALL WILD LETTUCE. No. 23649; *Grigg & Palmer.* Frequent in low meadows and borders.

Prenanthes alba L. RATTLESNAKE-ROOT. No. 23648; *C. K. Allen.* Abundant in open woods, especially on low glacial hills along Meadow Road.

**Hieracium aurantiacum* L. DEVIL'S PAINT-BRUSH. *C. K. Allen.* Infrequent in meadows and along paths.

**Hieracium Pilosella* L. MOUSE-EAR. No. 25823; *C. K. Allen.* Local along grassy path in Shrub Collection.

**Hieracium pratense* Tausch. KING DEVIL. *F. W. Grigg.* Meadows.

Hieracium venosum L. POOR ROBIN'S PLANTAIN. Nos. 27958, 28183. Locally abundant in rocky woods, south side of Hemlock Hill and in woods along South Street.

Hieracium paniculatum L. TALL HAWK-WEED. Nos. 25959, 28217. Local on rocky slopes, south side of Hemlock Hill.

Hieracium scabrum Michx. ROUGH HAWK-WEED. Nos. 23669, 28218. Not rare locally in rocky woods.

A SECOND SUPPLEMENT TO THE FLORA OF BARRO COLORADO ISLAND, PANAMA

PAUL C. STANDLEY

It is a great source of satisfaction to all scientists interested in the study of the natural history of tropical America in general, and of Central America in particular, to read the entertaining annual reports of the Laboratory for Tropical Research, established on Barro Colorado Island in Gatún Lake in the Panama Canal. Each year shows an increase in the number of investigators who make the laboratory the headquarters for their work. These fortunate students must be envied by the less happy of us, who are forced to spend our winters shut indoors in the cold North.

The increased use being made of this laboratory, so delightfully situated and so comfortably—compared with the quarters usually obtainable in the tropics, one is tempted to say luxuriously—equipped for conducting investigations, is the natural result of the reports brought back by visitors. Sufficient credit will never be given to Dr. Thomas Barbour and Mr. James Zetek for their persistent efforts, in spite of many discouraging obstacles, to make the station a success.

An unusually large number of persons interested in plants visited Barro Colorado in 1929, and several of them made substantial collections of herbarium specimens, which the writer has been privileged to determine. These collections were made by Professor S. W. Frost, of Pennsylvania State College; R. H. Wetmore and R. H. Woodworth, of the Botanical

Museum of Harvard University; and W. N. Bangham and F. M. Salvoza, graduate students of Harvard University. Mr. Bangham's series is one of the finest ever obtained on the island. His specimens are well prepared and complete, and either he visited the locality at an exceptionally favorable season, or else he had a knack of detecting plants overlooked by previous collectors. At any rate, his collection, forwarded to the writer for study from the Arnold Arboretum, contains a surprising number of species new to Barro Colorado, several new to the Canal Zone, and seven which seem to be undescribed.

Mr. Salvoza's collection practically duplicates that made by Mr. Bangham, and the specimens were determined by the collector in comparison with the named set of the latter's plants. Although I have received a list of his numbers, it has not seemed altogether desirable to cite them here, since I have not actually seen the specimens. A few of Mr. Salvoza's specimens which I have examined are listed.

In connection with the descriptions of these new species, it is worth while to list all the additions made in 1929 to the known flora of Barro Colorado Island, which has been recorded by the writer in two published papers.[1] There have been listed heretofore 799 species, chiefly of flowering plants. On the following pages there are reported 63 additional ones, making a very respectable total of 862. It is predicted confidently that this number will be greatly increased by further careful exploration. It is urged particularly upon workers who visit the island that they collect the mosses and other cryptogamic plants.

MOSSES

Determined by Edwin B. Bartram

Philonotis tenella (C. M.) Besch. This and the following, collected by Professor L. A. Kenoyer, were omitted accidentally from the first supplement.

Syrrhopodon incompletus Schwaegr.

POLYPODIACEAE

Determined by C. A. Weatherby

Acrostichum aureum L. *Wetmore & Woodworth*, no. 102. A coarse, widely distributed tropical fern, growing usually in shallow water.

Asplenium auritum Sw. *Wetmore & Woodworth*, no. 132.

Asplenium falcinellum Maxon. *Wetmore & Woodworth*, no. 129.

Asplenium pteropus Kaulf. *Wetmore & Woodworth*, no. 133.

Blechnum serrulatum Rich. *Wetmore & Woodworth*, no. 149.

Dryopteris nicaraguensis (Fourn.) C. Chr. *Wetmore & Woodworth*, no. 128.

[1] Paul C. Standley, The flora of Barro Colorado Island, Panama. (Smithson. Misc. Coll., vol. 78, no. 8, pp. 1–32. 1927.)

Leslie A. Kenoyer and Paul C. Standley, Supplement to the flora of Barro Colorado Island, Panama. (Field Mus. Bot. 4: 143–158, pl. 11–15. 1929.)

MARANTACEAE

Myrosma guapilensis Donn. Smith. Barbour Point to the next point south, *Bangham*, no. 489. A coarse herb 1–2 m. high, with broad canna-like leaves and orange flowers.

MORACEAE

Ficus Oerstediana Miq. Drayton Cabin to the second point north, *Bangham*, no. 509. A small tree with short broad leaves. The fruits are the smallest produced by any Central American species of *Ficus*.

Ficus padifolia HBK. Shores of the lake south of the laboratory, *Bangham*, no. 444. A tree 8 m. high, with small fruits and small narrow leaves. This is the most common wild fig of Mexico and Central America, but, strangely enough, it has not been reported previously from the Canal Zone.

LORANTHACEAE

Oryctanthus spicatus (Jacq.) Eichl. Without data, *Bangham*, no. 421. A parasitic shrub, the small flowers sunken in the rachis of the short spike.

Phthirusa pyrifolia (HBK.) Eichl. Near the lake, *Bangham*, no. 441. A parasitic shrub with oblong obtuse leaves.

POLYGONACEAE

Coccoloba changuinolana Standl. *Bangham*, no. 593. A tree of 12 m., known only from the Atlantic coast of Panama and Costa Rica, and not reported previously from the Canal Zone.

MENISPERMACEAE

Odontocarya truncata, sp. nov.

Frutex scandens, ramulis gracilibus glabris, vetustioribus ochraceis, novellis lenticellis magnis pallidis elongatis conspersis, internodiis elongatis. Folia longe petiolata, alterna, petiolo gracili glabro circa 3.5 cm. longo; lamina subcoriacea, glabra, late ovata vel rotundato-ovata, 9–10.5 cm. longa, 6–7 cm. lata, apice abrupte acuminata, acumine anguste triangulari 1–1.5 cm. longo attenuato obtusiusculo, basi truncata, utrinque glabra, supra viridis, costa nervisque obscuris, subtus paullo pallidior, basi 5-nervia, costa nervisque gracilibus prominentibus, nervulis prominulis laxe reticulatis. Flores feminei racemosi, racemis axillaribus solitariis circa 6 cm. longis, 7 cm. longe pedunculatis, rhachi gracili glabra, pedicellis gracilibus rectis in statu fructifero 9–11 mm. longis. Drupae ovales luteae, circa 1.5 cm. longae et 1 cm. latae; endocarpium dorso rotundatum convexum, facie ventrali valde concavum.

PANAMA: Barro Colorado Island, Canal Zone, Armour house to second bay north, *W. N. Bangham*, no. 541, September 3, 1929 (Herb, Field Mus. No. 604,409, type; duplicate in herb. Arnold Arb.).

Like most of the other Menispermaceae at present recorded from Central America, this plant is known only from incomplete material, and its true generic position is therefore not altogether certain. From the described species of *Odontocarya*, two of which are known from the Isthmus of Panama, the plant here named differs in having truncate rather than cordate leaf blades.

MONIMIACEAE

Siparuna guianensis Aubl. Shore of the lake south of the laboratory, *Bangham*, no. 457. A shrub with red fruits and nearly glabrous leaves. Called "hierba de pasmo" in some parts of Panama.

CAPPARIDACEAE

Cleome Houstoni R. Br. Near the end of Pearson Trail, *Bangham*, no. 576. A spiny herb, the leaves with five leaflets.

ROSACEAE

Hirtella triandra Sw. Along the shore, *Bangham*, no. 398. A small tree of 6 m., the flowers white or pink.

CONNARACEAE

Connarus Turczaninowii Triana & Planch. Along the lake shore, *Bangham*, no. 418; *Wetmore & Woodworth*, no. 26. A large woody vine with yellow flowers; leaves with five leaflets.

LEGUMINOSAE

Entada polystachia (L.) DC. Shore of the lake south of the laboratory, *Bangham*, no. 453. A large woody vine with small greenish flowers in dense panicled spikes; pods large and broad, the compressed seeds 2 cm. broad.

Inga cocleensis Pittier. Between Drayton Cabin and Armour Cabin, *Bangham*, no. 528. A tree of 10 m. Not recorded heretofore from the Canal Zone. No less than 14 species of *Inga* are now known to occur on Barro Colorado Island.

Inga confusa Britt. & Rose. Between Drayton Cabin and Armour Cabin, *Bangham*, no. 516. A tree of 12 m. with white flowers.

Inga gracilipes Standl. Between the Drayton and Armour cabins, *Bangham*, no. 522; Barbour Point to the next point south, *Bangham*, no. 488. A tree of 7 m.; flowers in small umbels. The species is known only from the Canal Zone.

Inga laurina (Sw.) Willd. Armour Cabin to the second bay north, *Bangham*, no. 547. A tree 8 m. high; leaflets only two or three pairs; flowers very small; pods small, thin, glabrous.

Inga pauciflora Duchass. & Walp. On the lake shore, *Bangham*, no. 395a.

BURSERACEAE

Protium Salvozae, sp. nov.

Arbor 4–8-metralis, ramulis gracilibus subteretibus brunnescentibus ubique dense velutino-hirtellis, internodiis elongatis. Folia petiolata, pinnata 5-foliolata, petiolo 2–3 cm. longo gracili subtereti dense hirtello, rhachi 1.8–3 cm. longa, petiolulis 4–8 mm. longis (in foliolo terminali usque ad 2 cm.) dense hirtellis; foliola crasse membranacea, oblonga vel lanceolato-oblonga, 7–12 cm. longa, 2.5–4.5 cm. lata, inferiora paullo minora, subabrupte acuminata, acumine 1 cm. longo et ultra angusto attenuato obtuso, basi acuta et saepe paullo inaequalia, integra, fere concoloria, utrinque ad venas costamque pilis brevibus rigidiusculis patentibus dense hirtella, aliter glabra vel glabrata, costa venisque supra vix prominulis, subtus prominentibus, venis utroque latere c. 12, angulo lato adscendentbus, gracilibus, versus apicem abrupte incurvis, juxta marginem conjunctis, nervulis subtus prominulis laxe reticulatis. Flores sessiles, spicati, spicis axillaribus simplicibus 1–2 cm. longis solitariis, rhachi dense hirtella; fructus ruber, late ovoideus, glabratus, obtusus et apiculatus, 13–15 mm. longus, 10–12 mm. latus, basi obtusus vel subrotundatus.

PANAMA: Barro Colorado Island, Canal Zone, between Drayton and Armour cabins, *W. N. Bangham*, no. 513, September 2, 1929 (Herb. Field Mus., No. 606,248, type; duplicate in herb. Arnold Arb.); near Cabin 2, Barro Colorado Island, *F. M. Salvoza*, no. 948, September 2, 1929 (Herb. Arnold Arb.).

From *P. sessiliflorum* (Rose) Standl. of Panama, which likewise has sessile flowers, the present species differs in its simple flower spikes and pubescent leaflets. *P. asperum* Standl., described from Barro Colorado Island, has very scabrous rather than hirtellous leaflets.

MELIACEAE

Trichilia tuberculata (Triana & Planch.) C. DC. On the lake shore, *Bangham*, no. 434. A tree 7 m. high. Called "alfaje" at Chepo, Panama.

MALPIGHIACEAE

Bunchosia nitida (Jacq.) DC. Between Drayton and Armour cabins, *Bangham*, no. 518. A shrub 2 m. high. The species is new to the Canal Zone.

Spachea elegans Juss. Near Pearson Trail, *Bangham*, no. 579. A tree 8 m. high. The genus is new to Central America, nor has it been found elsewhere on the continent. It occurs in the West Indies.

Stigmaphyllon hypargyreum Triana & Planch. Barbour Point to the next point south, *Bangham*, no. 496. A vine with yellow and red flowers.

VOCHYSIACEAE

Vochysia ferruginea Mart. On the lake shore south of the laboratory, *Bangham*, no. 452. A tree 7 m. high with showy yellow flowers in panicles.

EUPHORBIACEAE

Omphalea diandra L. Drayton Cabin to the second point north, *Bangham*, no. 504; *Wetmore & Woodworth*, no. 58. A large woody vine with a fleshy yellow fruit as large as an orange; petioles with two glands at the apex.

ANACARDIACEAE

Mosquitoxylum jamaicense Krug & Urban. Shore of the lake, *Bangham*, no. 426. A tree 7 m. high with softly pubescent, pinnate leaves, the small fruits red. The genus is new to the Canal Zone.

SAPINDACEAE

Paullinia fimbriata Radlk. East shore, *Salvoza*, no. 908; lake shore south of the laboratory, *Bangham*, no. 446. A large woody vine with white flowers; leaflets 5; leaf rachis not winged. The species has not been recorded previously from the Canal Zone.

Serjania mexicana Willd. *Wetmore & Woodworth*, no. 46.

ELAEOCARPACEAE

Sloanea microcephala Standley in Field Mus. Bot. **4:** 152. 1929. The following additional collection may be reported: Between Drayton and Armour cabins, *Bangham*, no. 515. A tree 10 m. high with yellow flowers.

BOMBACACEAE

Hampea panamensis Standl. Between Drayton and Armour cabins, *Bangham*, no. 520. A tree 12 m. high, with small white flowers. The genus has not been collected previously in the Canal Zone.

Quararibea pterocalyx Hemsl. Near Pearson Trail, *Bangham*, no. 581. A tree with large white flowers, the long calyx bearing 10 narrow vertical wings.

DILLENIACEAE

Doliocarpus brevipedicellatus Garcke. On the lake shore, *Bangham*, no. 400. Fruits red.

Saurauia Zetekiana, sp. nov.

Frutex vel arbor 5-metralis, ramulis crassiusculis glabris lenticellis minutis pallidis elevatis sparse conspersis, internodiis brevibus. Folia sparsa breviter petiolata, petiolo gracili 6–8 mm. longo sparse lepidoto-furfuraceo; lamina crasse membranacea, oblongo-elliptica vel late elliptica, 5.5–11.5 cm. longa, 2.8–6 cm. lata, abrupte breviterque acuminata, acumine anguste triangulari attenuato obtusiusculo, basi obtusa vel acutiuscula, fere ad basin grosse crenato-serrata, utrinque glabra, supra viridis, costa venisque non elevatis, subtus paullo pallidior, costa gracili elevata, nervis lateralibus utroque latere 5–8, angulo acuto adscendentibus, subarcuatis, marginem attingentibus, nervulis obscuris. Flores numerosi paniculati, paniculis densifloris 5 cm. longe pedunculatis ca. 5 cm. longis et aequilatis, ramis subdense minuteque ferrugineo-stellato-furfuraceis, pedicellis gracilibus 3–5 mm. longis; sepala inaequalia late rotundata 1.5–2.5 mm. longa extus sparse stellato-puberula; cetera ignota.

PANAMA: Barro Colorado Island, Canal Zone, near Pearson Trail, *W. N. Bangham*, no. 578, September 8, 1929 (Herb. Field Mus. No. 604, 411, type; duplicate in herb. Arnold Arb.).

The genus is new to the Canal Zone flora, and, indeed, very few Saurauias grow at so low an elevation. The present species is easy of recognition because of its small glabrous leaves. It is named for Mr. James Zetek, whose work in establishing the laboratory on Barro Colorado Island has been so eminently successful.

CLUSIACEAE

Clusia odorata Seem. F. L. Island, *Bangham*, nos. 588, 577. A large shrub with pink flowers. This species probably includes all or most of the material reported from Panama as *C. minor* L.

FLACOURTIACEAE

Casearia javitensis HBK. F. L. Island, *Bangham*, no. 587; lake shore south of the laboratory, *Bangham*, no. 443. A shrub or small tree with small white flowers and red fruits. Called "maúro" in Chiriquí, Panama.

PASSIFLORACEAE

Passiflora ambigua Hemsl. Lake shore south of the laboratory, *Bangham*, no. 466.

RHIZOPHORACEAE

Cassipourea podantha Standl. Lake shore, *Bangham*, nos. 566, 416. A tree 8–10 m. high. The species has not been reported from the Canal Zone, but probably it includes a large part of the material previously referred to *C. elliptica* Poir.

COMBRETACEAE

Combretum coccineum (Aubl.) Engl. & Diels. Between Drayton and Armour cabins, *Bangham*, no. 527. A large woody vine with large dense spikes of fiery red flowers, extremely showy and handsome when in blossom.

MYRTACEAE

Myrcia gatunensis Standley in Field Mus. Bot. 4: 154. 1929. The type was collected on Barro Colorado by Professor L. A. Kenoyer. The following new collections may be reported: Barbour Point to the next point south, *Bangham*, no. 498; lake shore south of the laboratory, *Bangham*, no. 451. A shrub about 3 m. high with white flowers.

Eugenia Banghamii, sp. nov.

Frutex 3-metralis, ramulis gracilibus subteretibus ferrugineo-brunneis glabratis, internodiis 1–2.5 cm. longis. Folia breviter petiolata opposita, petiolo crassiusculo 3–4 mm. longo dense breviterque pilosulo; lamina coriaceo-membranacea, oblongo-elliptica, 8–10 cm. longa, 3–5 cm. lata, abrupte breviterque acuminata, acumine triangulari obtuso, basi obtusa vel acutiuscula, supra viridis, epunctata, ubique dense minuteque velutino-pilosula, costa gracillima prominula, venis obscuris, subtus fere concolor, dense velutino-pilosula et pilis patentibus plus minusve intertextis, costa gracili elevata, nervis lateralibus utroque latere circa 9, angulo acuto adscendentibus, fere rectis, remote a margine conjunctis. Flores pauci ad axillas fasciculati, sessiles vel brevissime pedicellati, pedicellis usque ad 1 mm. longis; calyx 3 mm. latus, sepalis 4 rotundatis ciliolatis; baccae immaturae globosae, 3–4 mm. diam., densissime grosseque punctatae, glabrae, calyce persistente coronatae; cetera ignota.

PANAMA: Barro Colorado Island, Canal Zone, on shores of Gatún Lake south of the laboratory, *W. N. Bangham*, no. 448, August 28, 1929 (Herb. Field Mus. No. 604, 410, type; duplicate in herb. Arnold Arb.).

Although only scanty material is available for study, it seems to represent a clearly distinct species of this genus, notable for the abundant soft spreading pubescence of the leaves, and for the sessile or subsessile flowers.

Eugenia melanosticta, sp. nov.

Arbor 4–6-metralis, omnino glabra, ramulis crassiusculis, vetustioribus teretibus pallide cinnamomeis, novellis subcompressis albidis vel ochraceis undique glandulis magnis ovalibus nigris dense notatis, internodiis plerumque 2–3.5 cm. longis. Folia breviter petiolata, opposita, petiolo crassiusculo 5–7 mm. longo supra sulcato; lamina coriacea, oblonga vel anguste elliptico-oblonga, 8–12 cm. longa, 3.5–4.5 cm. lata, breviter acuteque acuminata, basi acuta vel acutiuscula et brevissime decurrens, fere concolor, supra minutissime impresso-puncticulata, costa profunde impressa, venis obsoletis, subtus dense elevato-puncticulata, costa gracili elevata, venis obscuris. Inflorescentiae axillares solitariae, subracemosae, laxe pauciflorae, 1–2.5 cm. longe pedunculatae, pedicellis crassis 4–7 mm. longis; fructus basi bibracteolatus, bracteolis c. 1 mm. longis rotundatis; bacca globoso-ovalis, 10–12 mm. longa, 8–9 mm. lata, basi et apice rotundata, calyce persistente coronata, densissime tuberculato-glandulosa; calyx 4.5 mm. latus, 5-lobus, lobis late rotundatis brevissimis.

PANAMA: Barro Colorado Island, Canal Zone, Shores of Gatún Lake south of the laboratory, *W. N. Bangham*, no. 445, August 28, 1929 (Herb. Field Mus. No. 606,247, type; duplicate in herb. Arnold Arb.); east shore of Barro Colorado Island, *F. M. Salvoza*, no. 909, August 28, 1929.

The material of this tree available for study is rather unsatisfactory, but it seems better referable to *Eugenia* than to any other group known from Central America, and it is perhaps worth while to give it a name in order to bring it to the attention of future students. The species is noteworthy for the very numerous and conspicuous black glands of the young branchlets.

MELASTOMACEAE

Miconia minutiflora (H. & B.) DC. Barbour Point to the next point south, *Bangham*, no. 486. A shrub or small tree about 5 m. high, with small white flowers.

SAPOTACEAE

Lucuma glabrifolia Pittier? North shore near the end of Pearson Trail, *Salvoza*, no. 999. A tree 10 m. high with milky sap and a large, yellowish green fruit. The determination is very uncertain, because of the absence of flowers, and the tree may well represent an undescribed species.

APOCYNACEAE

Echites microcalyx A. DC. Barbour Point to the next point south, *Bangham*, no. 494. A slender vine; corolla yellow with red throat.

Echites trifida Jacq. On shore at the end of the island, *Bangham*, no. 573. A vine with greenish yellow flowers.

Prestonia macrocarpa Hemsl. Shore of the lake south of the laboratory, *Bangham*, no. 467; shore at the end of the island, *Bangham*, no. 569. A large woody vine.

CONVOLVULACEAE

Aniseia martinicensis (Jacq.) Choisy. F. L. Island, *Bangham*, no. 589. An herbaceous vine with narrow oblong obtuse leaves; corolla white.

VERBENACEAE

Aegiphila cephalophora Standley in Field Mus. Bot. **4**: 156. 1929. Type collected on Barro Colorado by Professor Leslie A. Kenoyer. Another collection may now be reported: Armour Cabin to the second bay north, *Bangham*, no. 543x.

SOLANACEAE

Solanum Hayesii Fernald. Between Drayton and Armour cabins, *Bangham*, no. 514; Drayton Cabin to the second point north, *Bangham*, no. 501. A prickly tree about 7 m. high with white flowers. The species is known only from the Canal Zone.

Markea panamensis, sp. nov.

Frutex scandens, ramulis crassiusculis ochraceis vel brunnescentibus subteretibus, internodiis plerumque elongatis, floriferis vulgo dense foliatis vel cicatricibus foliorum delapsorum dense notatis. Folia breviter petiolata, alterna vel subopposita, petiolo crassiusculo 7–13 mm. longo glabro supra sulcato; lamina pergamentacea, oblanceolato-oblonga vel obovato-oblonga, 8–14 cm. longa, 3–4 cm. lata, acuta et abrupte cuspidato-acuminata, acumine angusto attenuato, versus basin acutam vel acuminatam sensim angustata, utrinque glabra, integra, costa nervisque supra vix elevatis inconspicuis, subtus paullo pallidior, costa gracili elevata, nervis lateralibus utroque latere circa 7, angulo acuto latove adscendentibus, gracillimis, prominulis, margine saepe subrevoluto. Flores ad apices ramulorum fasciculati vel breviter racemosi, pedicellis gracilibus 5–10 mm. longis furfuraceo-puberulis vel glabratis; calyx viridis fere ad basin 5-fidus, laciniis oblongis 5–9 mm. longis acutiusculis vel obtusis sparse minuteque puberulis 3-nerviis; corolla lutea infundibuliformis, 1.5 cm. longa, extus minutissime puberula, 5-nervia, tubo 4 mm. longo 1.2 mm. crasso, fauce 7 mm. longa, ore 6 mm. lata, lobis 5 ovali-ovatis fauce paullo brevioribus obtusis. Bacca immatura ovoidea, 13 mm. longa.

PANAMA: Barro Colorado Island, Canal Zone, Armour House to the second bay north, *W. N. Bangham*, no. 543, September 3, 1929 (Herb. Field Mus. No. 604,412, type; duplicate in herb. Arnold Arb.). Along the Sambú River, southern Darién, at sea level, *H. Pittier*, no. 5566, February, 1912.

The plant is noteworthy in the genus for its very small flowers. It could be referred equally well, probably, to the genus *Merinthopodium* Donn. Smith, whose distinctness from *Markea* is open to question.

BIGNONIACEAE

Anemopaegma punctulatum Pitt. & Standl. Across the bay from Drayton Cabin, *Bangham*, no. 544; also *Wetmore & Woodworth*, no. 40. A large woody vine with showy yellow flowers.

Arrabidaea panamensis Sprague. Shore of the lake south of the laboratory, *Bangham*, no. 449. A woody vine with small, pale lavender flowers.

Petastoma breviflorum, sp. nov.

Frutex scandens, ramis gracilibus teretibus ochraceis striatis lenticellis paucis parvis elevatis conspersis, novellis sparse pilosulis cito glabratis, internodiis elongatis. Folia bifoliolata, opposita, 8–14 mm. longe petiolata, petiolo gracili dense breviterque piloso, petiolulis 8–15 mm. longis gracilibus pilosis; foliola late elliptica, 6.5–9.5 cm. longa, 3–6.5 cm. lata, abrupte acuta vel acuminata, acumine triangulari vel anguste triangulari attenuato acuto vel obtuso, basi obtusa vel rotundata, crasse membranacea, fere concoloria, luteo-viridia, supra glabra, sparse et minutissime pallido-puncticulata, nervis prominulis, subtus ubique sed praesertim ad venas pilis mollibus albidis sparse pilosa, costa nervisque elevatis, nervulis prominulis et reticulatis. Paniculae terminales subdense multiflorae foliis vix longiores, ramulis gracilibus dense breviterque pilosis, floribus graciliter pedicellatis; calyx extus sparse puberulus vel fere glaber, 5 mm. longus et aequilatus, parte inferiore turbinata, limbo patelliformi remote obscureque denticulata; corolla purpurea, tubo 5–6 mm. longo gracili tereti 2 mm. crasso extus glabro, fauce campanulata 6 mm. longa ore circa 8 mm. lata extus glabra, lobis subaequalibus ovalibus 6 mm. longis apice rotundatis extus et intus densissime puberulo-tomentosis; stylus gracilis glaber. Capsula immatura linearis compressa, 26 cm. longa et ultra, 8 mm. lata, glabra, basin versus paullo angustata.

PANAMA: Barro Colorado Island, Shores of Gatún Lake, south of the Laboratory, *W. N. Bangham*, no. 465 in part, August 28, 1929 (Herb. Field Mus. no. 604,413, type); lake shore near the laboratory, *W. N. Bangham*, no. 553, September 3, 1929 (Herb. Arnold Arb.).

Bangham no. 465, as represented in the herbarium of Field Museum, consists of a mixture of two quite distinct plants. The flowering specimens are *Arrabidaea panamensis* Sprague, while the specimens with young fruit belong to the species here described.

Petastoma breviflorum is evidently an ally of *P. patelliferum*, having the same peculiarly distributed pubescence on the corolla, but the flowers of *P. breviflorum* are very much smaller than those of the latter species.

RUBIACEAE

Amaioua corymbosa HBK. Shore of the lake south of the laboratory, *Bangham*, no. 456. A shrub with fleshy red fruits.

Genipa americana L. Near Drayton Cabin, *Bangham*, no. 503. In this species the leaves are glabrous, while in *G. caruto* HBK., which also grows on Barro Colorado, they are densely pubescent beneath. I am now inclined to believe that these two forms represent distinct species.

Hamelia axillaris Sw. Between Wheeler and Shannon trails, *Bangham*, no. 472.

CUCURBITACEAE

Gurania coccinea Cogn. Collected by *S. W. Frost*, no. 229. An herbaceous vine with showy red flowers, Called "bien-te-veo" in some parts of Panama.

COMPOSITAE

Elephantopus mollis HBK. Collected by *S. W. Frost*, no. 286. A low herb with clustered heads of white or purple flowers; leaves mostly basal.

Mikania guaco H. & B. F. L. Island, *Bangham*, no. 597. An herbaceous vine with small heads of white flowers.

FIELD MUSEUM OF NATURAL HISTORY
CHICAGO

RHADINOPUS, A PRESUMED NEW GENUS OF RUBIACEAE FROM NEW GUINEA

S. MOORE

With a figure

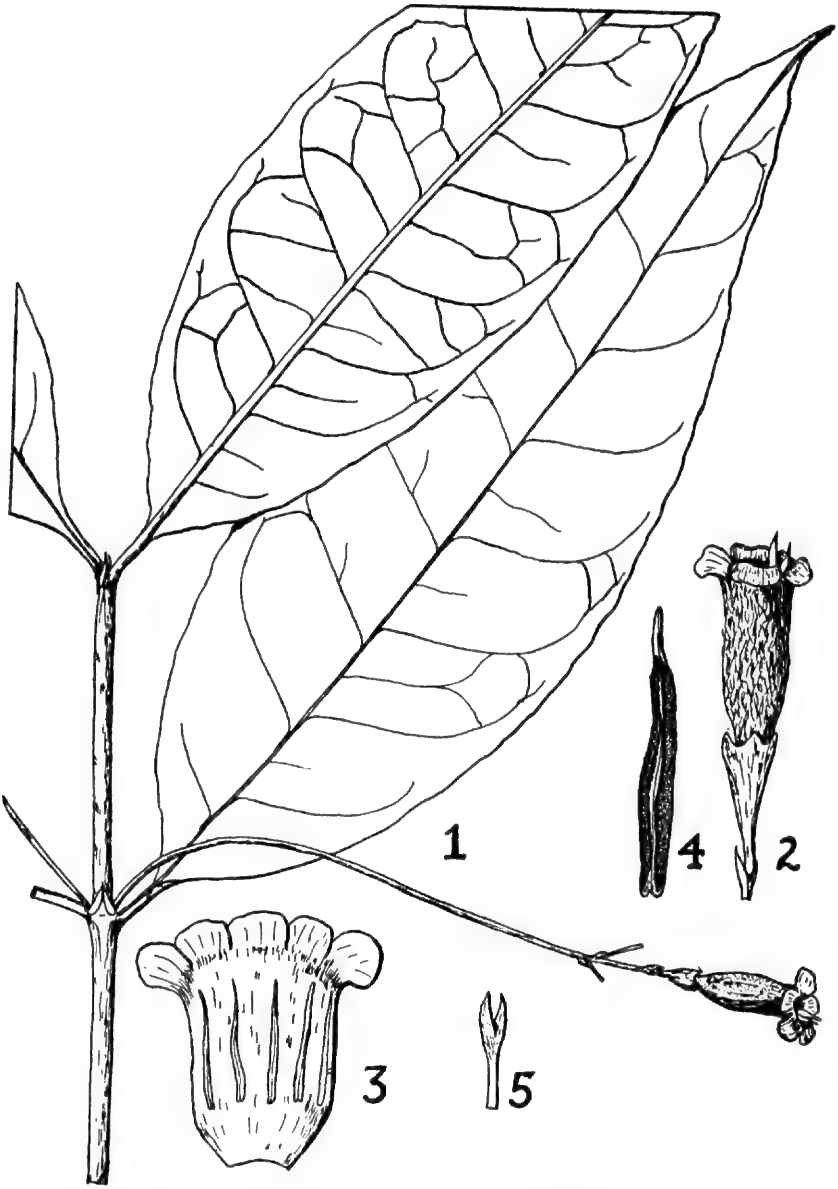
Rhadinopus,[1] gen. nov.

Calycis tubus obconicus; limbus cupularis, 5-denticulatus. Corollae calycem facile superantis tubus ima basi contractus, inde late cylindricus, faucibus glabris; limbus 5-lobus, lobis tubo plane brevioribus, patentibus, aestivatione contortis. Stamina 5, paullo infra medium tubum corollae inserta; antherae dorsifixae, sessiles, inclusae. Discus annularis. Ovarium 1-loculare; stylus crassus, complanatus, sursum biramosus, brevissime exsertus; ovula plura, placentis 2 parietalibus affixa. Bacca globosa, carnosa, verisimiliter oligosperma.—Frutex glaber, fere humanae altitudinis. Folia ampla, opposita, pergamacea. Stipulae basi connatae, diutule persistentes. Flores inter minores, fortasse nonnunquam solitarii, verisimiliter plerumque in cymas perpaucifloras pedunculum elongatum patentem bracteis parvulis raris indutum coronantes digesti.

Rhadinopus papuanus, sp. unica.

Ramulis tetragonis, subdistanter foliosis; foliis oblongo-ovatis, breviter acuminatis, basi obtusis, pagina superiore nitidulis pagina utraque sparsim pustulatis, nervis utrinque circa 8, mediocriter visibilibus, 10–12 × 4–5.5 cm.; petiolis canaliculatis, fere 1 cm. longis; stipulis triangularibus, acutis

[1] ῥαδινὸς, slender, and ποῦς, foot or foot-stalk.



RHADINOPUS PAPUANA S. Moore

1. Flowering branch (nat. size).—2. Flower (× 2).—3. Corolla laid open (× 2).—4. Anther (× 3).—5. Stigma (× 2).

vel caudato-acuminatis, circa 5 mm. longis; pedunculis paullulum supra-axillaribus gracilibus 7–8 cm. longis; calycis tubo tetragono 3.5 mm. longo, limbo 1.5 mm. longo; corollae albae tubo intus sparsim papilloso 13 × 6 mm., lobis late ovatis 5 mm. longis; antheris linearibus, apice lamina lineari-lanceolata acuta terminatis, 8 mm. longis; stylo apice leviter dilatato, glabro, 14 mm. longo, hujus ramis erectis, 2 mm. longis; bacca viva viridi, 12 mm. diametiente.

BRITISH NEW GUINEA: Owen Stanley Range between Mts. Brown and Clarence, alt. 900 m., *L. J. Brass*, no. 1495, May 1926 (bush 5 ft. high; flowers white, on long axillary peduncles; fruit globose, fleshy, pale green). Type in the herbarium of the Arnold Arboretum.

The genus is near *Gardenia* and several of the genera associated with it. From *Gardenia* it differs chiefly in its small flowers, stamens inserted below the middle of the corolla-tube not in its throat, and the 2-armed stigma; from *Nargedia* in the glabrous corolla-mouth, included stamens, 1-celled ovary and in the inflorescence. The glabrous corolla-mouth and the bilobed, not entire and densely hairy stigma separates it from *Villarea*. Among other genera *Hypobathrum* with its short, axillary inflorescences, its densely hairy corolla-throat, 2-celled ovary and hispid style-arms may be mentioned, as also *Petunga* in which we have spicate inflorescences, and a 2-celled ovary with ovules pendulous from the top of the cells.

There being only a single flower on the specimen, great care has been necessary in order to leave the remains after dissection as little damaged as possible. This has made a longitudinal section of the ovary inadvisable, so that some doubt remains as to the precise number and disposition of the ovules. As regards the inflorescence, there are indications of branching at the top of the long and slender peduncles, and this would seem to indicate a few-flowered cyme to be the rule as is indicated in the description.

BRITISH MUSEUM (NATURAL HISTORY)
LONDON

NOTES

Additions to the Library.—Mr. FREDERIC A. DELANO has presented to the Library the most unique gift of recent years, to serve as a memorial to his father Warren Delano, 1809–1898, with the purpose of making it "of real value to students."

It consists of six hundred and eleven paintings of Chinese fruits, flowers and vegetables, natural size, beautifully executed by native artists on sheets 15″ × 19″. Some of them are of well-known plants that have been introduced into this country such as the Rose, Peony, Chrysanthemum, Camellia, etc., but many of them are very rare. In his presentation letter Mr. Delano writes, "My Father, Warren Delano, was one of the early Boston merchants engaged in the China trade—and went there in 1835. He lived in China for more than 20 years, between 1835 and 1866, chiefly in Canton, Macao and Hong Kong connected with the House of Russell & Co. During his stay he endeavored to learn about the products of the country and in the 40's he collected and had drawn by Chinese artists over 500 paintings of 200 or more fruits, flowers and vegetables."

These paintings are replete with interest, botanical, artistic, and historical. They were apparently done by various artists with varying degrees of skill over a period of years. The paper on which they were painted is evidently of English manufacture, the earliest water-marks being "I. Taylor 1794" and "E. & P. 1794", and the latest "Ruse & Turners 1832." Between these are various other dates, many of which bear the name of J. Whatman, and in 1828, "J. Whatman, Turkey Mill" with design resembling a coat-of-arms.

The paintings are exquisitely drawn, in beautiful colors marvelously preserved, with details of fruit and flower, some bearing both on the same plant. Occasionally two plants are figured on the same sheet.

There are 34 paintings of Orchids and a large collection of Camellias.

The names are given in Chinese, with English transliteration and translations which have a quaintness and a flavor of their own, such as:—*Hemerocallis flava* (tah e kwan kin—undressed changed to silk), *Michelia fuscata* (nan seaou hwa—repressed smile flower), *Hovenia dulcis* (wan tsze kwo—fruit like the letter wan), *Dolichos* (kwo shan chun—passing hill stopping), *Thunbergia grandiflora* (shan kien new—hill leading cow), *Nicotiana tabacum* (yen pwa—smoke flower!), *Impatiens chinensis* (kwo tang shay—passing pool snake), *Plumbago rosea* (yen lae hung—wild-goose comes red), *Asclepias curassavica* (ma le kin—horse's tongue string), *Clematis chinensis* (wei ling sien—dreading spirit genii), *Lycoris sanguinea* (kang e tsaou—changing dress herb), *Abrus precatorius* (hung siang sze—red causing thought), *Murraya exotica* (kew le heang—nine mile fragrance), *Rosa Banksiae lutescens* (muh heang hwa—wooden fragrance flower), *Plumbago zeylanica* (che tau po—viscous head old woman) and *Sapindus mukorossi* (woo hwan tsze—without sorrow seeds). In most cases botanical names were also given and to these have been added further identifications.

The paintings were presented in two large mahogany boxes fashioned in the likeness of books, in which the elder Mr. Delano had preserved them.

Mr. Delano's gift is of especial value as it adds a new importance to our already unusual collection of material on Chinese botany and travels, a collection unsurpassed in this country.

Mrs. SUSAN DELANO MCKELVEY has again placed the Library in her debt by the gift of a most unusual collection of beautiful photographs taken by her in Arizona from January to June 1929.

They represent a variety of woody subjects including a large number of photographs of Agaves and of the Cactaceae family of which Mrs. McKelvey has made an intensive study.

The photographs, marvelously clear, showing patience and skill, are enlightening as to the wonderful beauty of the desert plants at their best, and are a priceless addition to the Library's collection.

Miss VIOLET F. EDLMANN has presented a large number of valuable tree photographs taken in Arizona, January to February, 1929.

Mrs. L. A. FROTHINGHAM has presented to the Library the fifth and concluding volume of MARY A. WALCOTT's beautiful colored plates "North American Wild Flowers."

Mr. E. H. WILSON has presented his latest volume of garden classics "Aristocrats of the Trees"[1] published by the Stratford Company, attractively bound and beautifully illustrated with photographs of trees in every land. The book is a fine combining of accurate scientific knowledge and historical and aesthetic treatment in most readable form.

A general introduction to trees, the physiology of root and bark, esthetic beauty, and economic and vital importance to the life of man, with a word on the history and significance of Arbor Day, is followed by chapters on individual trees and groups of trees.

A short chapter is devoted to "Pleached Alleys," rare in this country, and about which little has been written.

Mr. Wilson's intimate knowledge of trees is gained through extensive travel, and for his photographs he has drawn largely upon the Library's collection without which he states the work would have been impossible in its present form.

He has also presented for the photograph collection a copy of the frontispiece of "Aristocrats of the Trees," a remarkably fine reproduction in color of a beautiful painting, "Maple Woods in Autumn, Lake Chuzenji, Japan" by the Japanese artist S. Ishida.

After years of patient effort the Library has acquired by purchase JOSIAH CONDER's "Landscape Gardening in Japan" with its quaint, idealistic Japanese drawings, and text giving an "exposition of the rules and theories of the art of landscape gardening in Japan, as followed from ancient to modern times, so far as they can be gathered from a thorough study of native authorities, added to personal observation of the best remaining examples"; also his "Supplement to Landscape Gardening in Japan," illustrated with photographs of existing gardens, which the author states, "are but imperfect and fragmentary examples of a craft comparatively neglected in recent days."—E. M. T.

Notes from the Herbarium.—During the last months the ligneous plants collected by W. P. Fang in Szechuan for this institution and the Science Society of China amounting to about 1500 numbers have been identified; the collection contained many species not yet recorded from Szechuan and a number of new species and varieties which will be described in this Journal. The herbaceous plants, more than 2000 numbers, are being determined at Edinburgh.

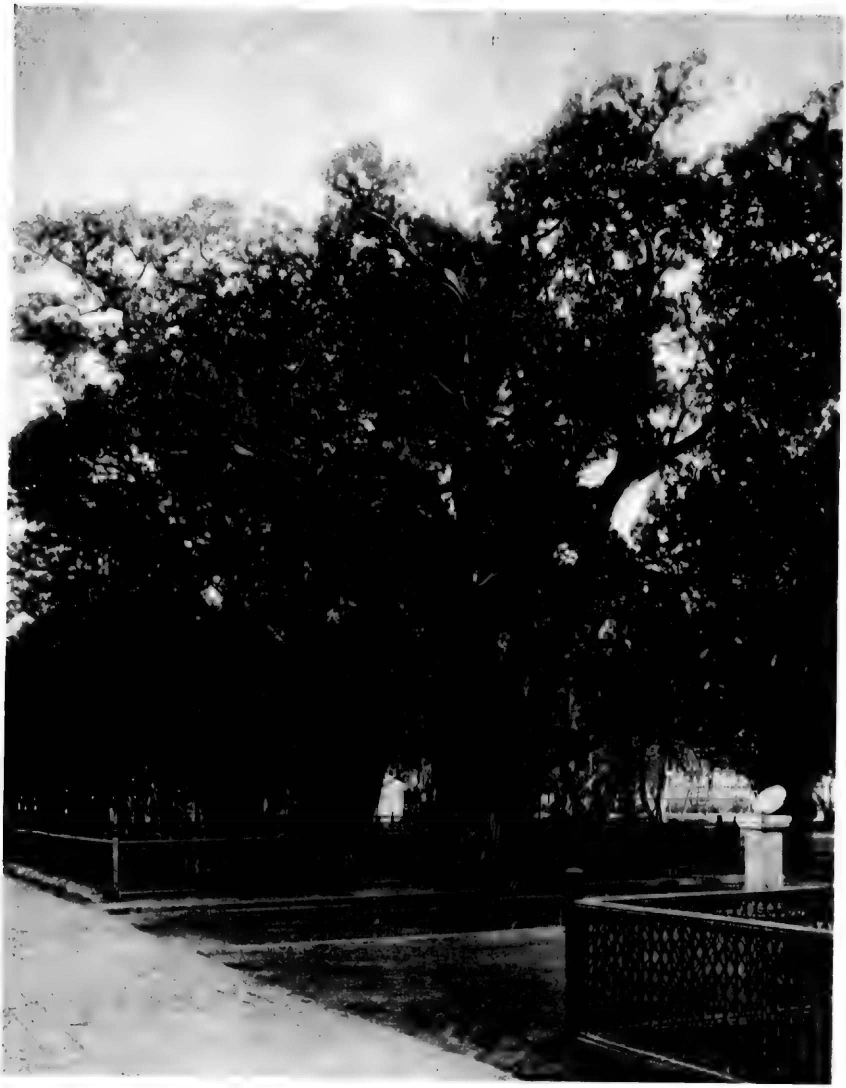
The plants collected by S. F. Kajewski during 1928–1929 in the New Hebrides for this institution and the California Botanic Garden have now been all received and most of them have been sent on to Dr. A. Guillaumin of Paris, who has kindly consented to determine this collection with the exception of some groups which have been sent to specialists.

[1] WILSON, ERNEST H. Aristocrats of the trees. With frontispiece and sixty-six plates. f. (2) + xxi + 279 pp. The Stratford Company, Boston [Cop. 1930].

The whole collection comprises about 900 numbers with many duplicates. Mr. S. F. Kajewski has by this time left Australia for the Solomon Islands where he will collect during the year for this institution and the Bishop Museum in Honolulu.

Mr. F. M. Salvoza of the School of Forestry, University of the Philippines, Los Banos, Laguna, Philippine Islands has nearly finished his monograph of Rhizophora forming his thesis for the Ph.D. degree on which he has been working in the herbarium since last year.

Mr. Chien Pei of Chengtu, Szechuan province, China has spent two weeks in the herbarium in connection with a revision of the Chinese Verbenaceae which he is preparing as his theses for the Ph.D. degree.



Thuja orientalis L.
Tree in Chungsan Park, Peking

JOURNAL

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THUJA ORIENTALIS AND JUNIPERUS CHINENSIS

ERNEST H. WILSON

Plate 23

IN volume VII, page 71, of "The Journal of the Arnold Arboretum" issued in April 1926 an account is given of *Thuja orientalis* Linn. and the article is illustrated by a plate. The text deals faithfully with *T. orientalis* but the plate, unfortunately, represents *Juniperus chinensis* Linn. This picture was one of many supplied to us by an old and esteemed friend of the Arboretum and was published in good faith. On its appearance Mr. J. Hers, another valued correspondent of the Arboretum, wrote pointing out that the picture did not represent the Oriental Arborvitae but the Chinese Juniper. We then got other correspondents in China to take photographs of the real *T. orientalis* and send them to us together with herbarium material from the actual tree of which photographs were made. The correspondence has taken considerable time but at last we are able to publish a picture depicting a magnificent old *Thuja orientalis* and thus correct the error inadvertently made four years ago.

At a glance the two trees look very different but it must be stated that we have pictures showing the Juniper in habit almost identical with the Thuja. The principal difference apparent is the nature of the bark; in the Juniper it is gray and fissured, whereas in the Arborvitae it is dull brownish red, flaking off in thin, fibrous sheets. The branches on old trees of the Arborvitae are ascending and spreading, wheareas in the Juniper the most usual position is for them to spread horizontally. In the grounds of the Temple of Heaven at Peking, in Central Park, and in the grounds of other old temples and palaces both trees have been planted and planted long, long ago. The Juniper is the more common of the two but both are about equally esteemed by the Chinese.

The history given in our note on page 73, volume VII, of the Journal covers both trees but the size of the particular tree mentioned has reference to *J. chinensis*. According to Dr. TenBroeck, trees of *J. chinensis* in Central Park measure 47 feet 4 inches in height with a trunk 18 feet 9½ inches in girth at breast height and a crown spreading 48 feet. One in the Confucian Temple is 41 feet 10 inches in height with a trunk 16 feet 1 inch in girth and a crown spreading 45 feet 6 inches. Another in the grounds of the Temple of Heaven is 46 feet 7 inches in height with a trunk 12 feet 6 inches in girth and a crown spreading 47 feet 8 inches. The tallest tree measured by Dr. TenBroeck is in Central Park and stands 51 feet 6 inches high with a trunk 14 feet 3 inches at breast height. The Thuja would appear to attain larger dimensions. That illustrated measures 57 feet tall with a girth of 21 feet. It is said to be over 600 years old and is growing in the Chungsan Park, Peking.

Both of these Conifers have long been known to cultivation in western lands, where both have given rise to polymorphous offspring much esteemed in horticulture. *J. chinensis* was known to Kaempfer and was also collected in China by J. Cunningham in 1701 as stated in Plukenet's "Amaltheum Botanicum," page 125 (1705). Linnaeus named it in his "Mantissa," page 127 (1767).

Although the Chinese Juniper is widely cultivated in China, being much planted in temple grounds and about graves, not once in my travels did I note a wild specimen. In many parts of Korea and Japan the dwarf growing *J. chinensis Sargentii* is common but the only place in which I have seen old trees of typical *J. chinensis* was on Dagelet Island in the Japan Sea; growing on the cliffs there and facing the full force of the sea were a number of fine old specimens. They were not tall, ranging from 20 to 35 feet in height with trunks 10 to 15 feet in girth and massive wide-spreading branches. They grow in humus filled cracks on the cliffs and must be of extreme age. The columnar habit of this tree is well known but like the Arborvitae when old age approaches its thinner branches are shed and a few of the thicker ones spread horizontally to form an open, widespreading, more or less rounded or flattened crown. Of course, close inspection of the two trees show wide differences not only in bark but especially in foliage and in fruit, but these are not obvious in a photograph.

THE SPREAD AND THE CONTROL OF PHACIDIUM BLIGHT IN SPRUCE PLANTATIONS

J. H. FAULL

IN an earlier paper on Phacidium Blight (J. H. FAULL. A Fungus disease of Conifers related to the snow cover. Jour. Arnold Arb. x. 3–8. 1929) I dealt chiefly with its spread and control in the nurseries. Statistical observations and tests recorded therein showed that the spread of Phacidium Blight in the nursery is rapid if no preventive measures are employed, but that it can be fully controlled in seed beds and transplant lines by spraying with lime sulphur in the late fall. Corresponding data, though not as complete with respect to control, are now in hand relative to the blight in plantations.

1. Spread of the Disease

(a) *Spread in an affected plant*

That the blight invades masses of healthy foliage contiguous to those that are already affected can be convincingly inferred from casual inspections. Also it is quite plain from such that the spread is not continuously progressive in point of time, but that it is periodic; or in other words it is manifest that between successive advances there intervenes long intervals of time during which the blight is to all external appearances static. The regions last infected are characterized by a full foliage of unshrunken needles, bright, glaucous, or ashy brown (the shades and tints varying with the host species), with or without a few intermixed green ones. Those of the immediately preceding infection exhibit a greater or less defoliation and the needles that continue to adhere are whitened and shrivelled; while the needles that may still cling to the branches of regions infected at a yet earlier period are much bedraggled and soiled.

But in order to supplement circumstantial inference with direct demonstration, a large number of blighted Spruce trees in plantations were labelled and measured and the extension of the blight in them accurately noted for two successive years. At the same time data were assembled as to the rate and the times of extension of the disease, and for some of them the height-growth of the hosts. The observations made have shown conclusively that (1) the blight spreads to contiguous foliage, and (2) to the latter without regard to its age or location or orientation so long as the temperature of the air in the snow pockets is sufficiently high; that (3) the spread is under the melting snow in the spring only, with the elsewhere green foliage sharply and permanenly marked off during the succeeding summer from the adjoining browned masses; and that (4) the spread is to those parts only that are under the snow cover. It is not to be doubted that there could be a spread without the concomitancy of snow, provided that the surrounding atmosphere were maintained at the water-saturation point continuously for a sufficient length of time, that the temperature conditions were favorable to the growth of the fungus, and that the state of the host were such as to permit invasion of its leaves.

Complete data covering observations made in the springs of 1927 and 1928 on one group of twenty-two White Spruce trees are assembled in the subjoined table. These show that there was an average upward spread of the blight of almost four inches as against an average height-growth during the intervening summer of three inches. They also reveal the fact that in fifteen out of the twenty-two trees the blight had extended right to the terminal bud of the leader. These trees are marked by an asterisk (*).

Before leaving the subject of the extension of Phacidium Blight in individual trees it isi n place here to state that attempts have been made to find out whether or not there may be some spread through the stem, that is, whether or not the fungus causing the blight ever grows downward

Vertical upward spread of Phacidium Blight, and height growth in 22 White Spruce trees, planted Fall of 1924.

No.	Height; Spring, 1927	Height; Spring, 1928	Increase in Height	Upper Limit of Blight; Spring, 1927	Upper Limit of Blight; Spring, 1928	Increase of Blight
1	16 in.	21 in.	5 in.	9 in.	15 in.	6 in.
2	13	18	5	10	13	3
3	11	15	4	9	*15	6
4	17	19	2	14	*19	5
5	17	22	5	11	13	2
6	14	14	0	9	*14	5
7	10	12	2	10	11	1
8	15	17	2	13	13	0
9	10	13	3	8	*13	5
10	14	19	5	12	*19	7
11	12	15	3	12	*15	3
12	10	13	3	9	*13	4
13	11	13	2	11	*13	2
14	10	12	2	10	*12	2
15	13	15	2	11	*15	4
16	18	22	4	15	19	4
17	8	8	0	7	* 8	1
18	11	14	3	11	*14	3
19	10	14	4	9	*14	5
20	8	10	2	7	*10	3
21	14	19	5	10	18	8
22	12	15	3	9	*15	6
			Average 3.0 inches			Average 3.9 in.

through the bases of infected needles into the tissues of the stem, and thence upward into healthy needles by way of their bases. From what could be determined it would seem that the basal layers of cork prevent invasion by the hyphae through such routes. It is possible that there may be exceptions to this rule to be revealed by more persistent search, but so far none have been found. It is patent to anyone who has the slightest acquaintance with the disease that in general its spread is not by way of the stem; on the contrary it is everywhere apparent that it passes over directly to the green foliage of branches which happen to be pressed into contact with blighted ones by the weight of overlying snow or other means, or that have been inoculated with the reproductive elements of the blight-causing fungus. Moreover, the non-agressiveness of the causal organism after the spring thaws are past, up until the period of sporulation in the fall, affords indirect evidence that it does not invade healthy needles adjacent to diseased ones through the intervening stem.

(b) *Spread from affected plants*

Obviously it is important from the standpoint of control to become acquainted with the phenomena that characterize the dissemination of Phacidium Blight from plant to plant. In the earlier paper referred to above, the subject matter of which was the blight in nurseries, emphasis was rightly placed on the importance of contagion. But there is also a dispersal by means of germs transported through the air; and for plantations, as we shall learn, these agencies are of relatively greater significance than that of contact.

We are now quite familiar with the remarkable contagious habit of the fungus (*Phacidium infestans*) that causes this blight. Its hyphae revive in the spring within the adhering, snow-buried needles that were infected many months previously, and there emerge from them through the stomata countless, most delicately spun, white, cobwebby mycelial threads that grow over, penetrate, and infect such green needles, without regard to the age of the latter, as lie in their path. Moreover, not only are individuals of the same species liable to contagion but also those of other species and genera. Thus the disease spreads by contact from White Spruce to Norway Spruce, Balsam Fir, White Pine, Banksian Pine, etc., and from Balsam Fir to White Spruce, White Pine, Hemlock, etc. In passing it may be stated that not all species of conifers are equally susceptible to blight, and some are apparently immune. Also there are most certainly two or more biological strains of *Phacidium infestans*, and these display a choice of specific hosts; or perhaps it is more accurate to say that a given coniferous species may be susceptible to one biological strain of *P. infestans* and more or less immune to another.

While contagion is of preponderate significance in epidemics of Phacidium Blight within nurseries it can be of secondary importance only in plantations. Naturally, in twice-transplanted or sub-plantation plots, where the little trees soon come into contact, essentially the same conditions favoring contagious spread prevail as in nursery beds or transplant lines. I have seen cases in certain nurseries in which under such circumstances blocks of White Spruce, Norway Spruce, Engelmann Spruce, and Colorado Blue Spruce, comprising numbers up to one hundred trees two to four feet in height, had been virtually ruined by the blight. But in ordinary plantations, whether on forest or park lands, by the time contact is established between neighboring trees their leaders are so well above the snow-level that contagion is restricted to lower branches, the loss of which is not of vital consequence. It need scarcely be pointed out that were there no other common means whereby the blight spreads, its prevention in plantations would follow from the choice of clean stock, always a sensible procedure, and sporadically diseased plants could be pulled by hand and destroyed or left alone in hope that their heads might push above the level of the winter snows ere their vitality had become exhausted.

But a sporulating fungus is the cause of Phacidium Blight, and as its spores germinate readily and abundantly it is certain that they must play some part in the spread of the blight. There are also produced large numbers of tiny, black granules (microsclerotia) of compacted mycelium on the surfaces of blighted needles, easily displaceable by insects or birds or water; and they probably belong to the blight fungus. Though they have not yet been subjected to critical study it may be assumed that they, like other known microsclerotia, function as do spores. They are supplementary means of reproduction, capable of wide transport, and particularly resistant to drought or other unfavorable conditions. Consequently it could scarcely be otherwise than that frequent infections would result from spores and microsclerotia at points quite removed from their sources of origin and far beyond the confines of plants in contact.

While this conclusion is fully warranted, both on inferential and observational grounds, there has been much uncertainty as to the economic importance in plantations of these means of infection. Phacidium Blight is sometimes disastrously abundant in plantations, but our acquaintance with it in America has been so recent that wherever affected trees have been seen in plantations, in numbers no matter how large, one could never be certain whether or not they might have been diseased before leaving the nursery. The same would seem to apply to European experience with *Phacidium infestans* in Scots Pine plantations; widespread plantation losses have been reported from Scandanavia and Russia, but without reference to the subject of dissemination. The question has now been subjected to experimental inquiry, however, and an answer secured in exact, statistical form. One experiment was initiated by controlled inoculations in a blight-free plantation, and others, extending over periods of two and three years, were based on case studies of plantation plots in which some blight was present at the outset. A brief account follows.

I. The first experiment was one of unusual interest. It was located in an isolated plantation of Norway Spruce set out about 1922. The trees were from four to six feet in height and all were free from blight. Twelve trees whose crowns were quite separate from those of their neighbors were tagged, and bundles of Spruce twigs with blighted needles enclosed in mosquito-net bags about six inches in diameter, one to each tree, were tied in among the branches, close to the stem, and below the winter snow-level. This was done November 15, 1927, several weeks after the close of the growing season and just before the beginning of winter.

The following spring by the time the snow had melted away each bag was the center of heavy infection, the brown foliage of which was typically that of Phacidium Blight. The blighted needles were liberally sprinkled with microsclerotia and in the subsequent fall they bore an abundant crop of sporulating ascomata of *Phacidium infestans*.

The experiment was revisited in the spring of 1929, and at that time a remarkable phenomenon was witnessed. An examination showed that not only had the infection extended its limits on each inoculated tree, but that there were now thirty-nine newly infected trees, with browned masses of foliage measuring from three inches to a foot in diameter. Instead of twelve trees with blight as in 1928 there was now a circumscribed colony of fifty-one, and eleven of the former were plainly the centers from which the new infections had originated. The number of readily recognizable blighted trees was four and one-quarter times greater than it was one year previously, or an increase of 325%. The newly blighted trees were not in contact with the original twelve; but they were proximate to them and separated from them by distances of from three to twenty-three feet. In most cases they were within the limits of the eastern quadrants from the latter; evidently conditions for infection were favorable immediately following a transport of spores by wind from a westerly direction. The significance of all of this is enhanced by the fact that no other instances of blight had developed throughout the plantation.

The results of this experiment settle the question as to whether or not Phacidium Blight can be disseminated to an appreciable extent by means other than contagion, and they afford reason to more than suspect that there are strong possibilities of devastating spread in plantations. The data obtained from plantation plots next to be reviewed add strength to this presentation.

II. Six plantation plots were originally staked, but through misplaced zeal of an eradication crew and other causes data secured from four of them are incomplete. Observations on the two remaining plots, however, were continued over a period of three successive years. The results are clearly indicative of the potential seriousness of Phacidium Blight in plantations, though it is not possible to evaluate them with the same degree of exactitude as in Experiment I because of the fact that the disease was undoubtedly brought into the first of the plantations in question, and perhaps the second as well, from the nursery on an unknown number of transplants. At the time these plantations were set out the cause and the infectiousness of the blight were unrecognized, and so some plants were carried forward that otherwise would have been sprayed or destroyed.

Plot 1 measured 100 feet by 200 feet and contained 1020 White Spruce trees from seed of native origin, furrow planted in the fall of 1925.

Number of trees in the plot........................	1020
Blighted trees counted in the fall of 1927............	313 or 30.7%
" " " " " spring of 1928.........	413 or 40.5%
" " " " " " " 1929.........	460 or 45.1%

Plot 2 measured 100 feet by 100 feet and contained 399 White Spruce trees from seed of Dakota origin, planted in 1922. There may or may not have been an inconspicuous amount of blight in the nursery at the time this plantation was set out. No one really knows. If there were any it had not yet attracted notice. This plot, however, was not beyond the reach of spores from other blighted plantations, with no obstacles between to winds blowing from their direction; it is quite possible that the primary infection came from them.

Number of trees in the plot........................	399
Blighted trees counted in the fall of 1927............	110 or 27.6%
" " " " " spring of 1928.........	166 or 41.6%
" " " " " " " 1929.........	237 or 59.4%

Limited as the observations are the conclusion is inescapable that the occurrence of Phacidium Blight in a young plantation is occasion for concern. Unquestionably its control in some plantations at least is imperative.

2. Control of the Disease

We have now had sufficient experience with Phacidium Blight in nurseries to know that control through dormant lime sulphur applied in the late fall is highly effective and entirely practical. We are not quite as far on with the problem in plantations, but some careful experimentation has been carried out, and the point has been about reached where we can speak with reasonable confidence of a successful issue. Attention was centered first on the nurseries, partly because control there was essential to their being, but partly because the elimination and prevention of blight in nurseries are fundamentally important for the plantations dependent on them for their stock.

Towards the solution of the problem European practice has had nothing to offer. Phacidium Blight is common and widespread in Scandinavia, Finland and Russia on Scots Pine (no other hosts are reported from Europe), and it is said to cause considerable losses in natural reproduction and in plantations. But so far European pathologists have made little progress towards effecting its control. On this side, insistence on finding a solution to the problem has largely come from the Forestry Department of the Laurentide Division of the Canada Power and Paper Corporation, and no inconsiderable share of whatever advance may have been made is due to the active backing and co-operation of the staff of that Department and their Chief, Mr. Ellwood Wilson. But before reviewing our experiments and observations brief reference should be made to two factors pertinent in a more general way to the subject of control, but none the less deeply significant, namely, heredity and climate.

The question has been repeatedly raised as to the rôle of heredity in control. The answer is two-sided, with the host on one side and the parasite on the other. It is a fact that species and genera of conifers do exhibit differences in inherent susceptibility towards Phacidium Blight, and some of them are practically immune. It is also true that there are indubitable biological strains or physiological species of *Phacidium infestans*, and these exhibit marked preferences in specific choice of hosts. Manifestly these are matters of great practical interest in dealing with the blight; they will be discussed at another time. There is still another point. On the basis of our general knowledge of infectious diseases it is reasonable to assume that individual plants of White Spruce or other coniferous species are not equally susceptible to the blight fungus, of whatever strain; and there may yet be found some that are immune. But up to the present none of the latter have been recognized, and there are no known exact observations pertaining to the former. The establishment of immunity is an ideal consummation in combating infectious diseases, and presumably in this instance control might be possible by breeding for immunity. But certainly at this stage it would be fantastic to offer such a suggestion as a practical undertaking.

While the incidence of Phacidium Blight is primarily linked with the inherent susceptibility of the host species to the blight fungus, it is also very closely dependent on the environmental factor of climate. This becomes self-evident when it is recalled that the conditions essential to the development of the disease are, in addition to a certain dormancy of the host tissues, a high concentration of moisture in the atmosphere surrounding the foliage and temperatures at which the fungus will grow. These conditions are met in regions in which there is a continuous snow-cover throughout the winter and a prevalence of bright sunshine during the thawing period in the spring. With or without snow, where such conditions do not occur there is little likelihood of trouble from Phacidium Blight. There are still no doubt other factors that have a bearing on the occurrence of Phacidium Blight, and a knowledge of these might be helpful in tree growing or forest management and would throw light on the phenomena of its distribution with reference to the conifers in our native forests. But profitable discussion awaits the gathering of more data; so without further comment we pass directly to the subject of artificial control in plantations.

(a) *Prevention by use of stock from a healthy nursery*

Where Spruce trees are to be planted in regions in which there is a snow-cover throughout the winter it is fundamentally important that they be free from Phacidium Blight when they come from the nursery. The only way to be sure is to know that there is none of the disease in the nursery. Given clean stock to begin with, little or no trouble is likely to be experienced in the plantation.

(b) *Control by excision of branches with blighted needles*

An experiment to discover what control could be attained by the removal of blighted branches from diseased trees was begun in the fall of 1927. Twenty-five suitable trees were numbered and their blighted branches were cut off and burned. They were examined in the spring of 1928, and again in May, 1929. Up to the present nineteen out of the twenty-five have remained free of the disease; six have shown a continuation of it. Either removal of blighted foliage from the latter was not complete, or there had been fresh infection from a spore discharge before the cutting was done. The blight persisted and progressed as it ordinarily does in other blighted trees throughout the plantation not included in the experiment.

Under the circumstances the results are as good as could have been expected. It is conceivable that in special cases, as in certain ornamental plantings, this method might be used. If so, it is essential that the pruning be thorough, and it is desirable to have it done in the spring—certainly at some time prior to the period of sporulation. This method has recently been recommended in Russia for the treatment of Phacidium-blighted plantations; just how economically feasible it might be there I do not know, but in America it would seem to be of very limited applicability.

(c) *Control by hand eradication of blighted trees*

This method was tried out during the summer of 1928 in a preliminary way on a scale involving a comparatively large acreage. On the greater part of the area of eradication the diseased trees were pulled by hand, and deposited at once in canvas bags; these in turn were emptied into a canvas-lined wagon-box, carted away and burned. Elsewhere the trees were older and too deeply rooted to be pulled easily. Their stems were cut off near the ground, and the crowns were hauled away and burned.

I inspected the experiment in May, 1929, and found that the results were fairly satisfactory where the trees had been pulled bodily, but a failure in the other instance. The cost was low and without objection from that point of view. Where the trees were cut off instead of being pulled, low-lying branches remained attached to the stumps and their foliage was almost invariably heavily blighted the following spring. In both cases additional trees developed blight in the spring of 1929. Either these had been overlooked by the eradicators the previous year or they were new outbreaks. Whatever the explanation may be, the necessity for further eradication remained. It so happens that I have some exact information on this point. One of my plantation plots was mistakenly included by the eradication crew in their work. In 1927 there were 373 trees in the plot, of which 77 were blighted. In the spring of 1928 the number of blighted trees had increased to 86. The crew eradicated from the plot in 1928, though how many plants they removed I cannot say. In the spring of 1929 I counted 18 blighted plants in the plot.

Where eradication is by hand it can be done most thoroughly in the spring. The affected plants stand out most prominently at that time, and if removed then they are out of the way before there is any dispersal of spores from them.

Aside from the fact that complete eradication is practically impossible in the operations of a single year, there is a presumptive objection in the to the method that should be considered, namely, the gaps that remain. Whether or not they should be left unfilled would doubtless be contingent on their size, their frequency, and the costs of replanting. Of course if replanting be done the stand is no longer even-aged, but that might be a matter of minor consequence. On rough terrain hand eradication would appear to be one of the most practicable methods.

(d) *Control by spraying with lime sulphur*

Three tests of this method were carried out in 1928 in two widely separated districts, in the Province of Quebec and the State of Maine.

Experiment 1.

There were about 450 White Spruce trees, planted in 1925, in a staked plot. They were sprayed the latter part of October, 1928, with lime sulphur of 50% strength of a standard formula. The plantation all about the plot was heavily blighted, and there was an abundance of new blight in the spring of 1929. Within the sprayed plot there had been 232 blighted trees. Of these, in the spring of 1929, there were 11 plants only in which the blight obviously remained. There were 43 cases in which I could not decide with certainty whether or not the blight had been completely destroyed. In the remaining 178 trees the blight fungus was dead and it had made no further inroads on the foliage.

Experiment 2.

There were about 300 White Spruce trees, planted in 1923, in a staked plot 75 feet by 150 feet. They were sprayed the latter part of October, 1928, with lime sulphur of 50% dormant strength as in Experiment 1. The plantation all about the plot was heavily blighted, and there was an abundance of new blight in the spring of 1929. Within the sprayed plot there had been 105 blighted trees. Of these, in the spring of 1929, there were 3 plants only in which the blight obviously remained. There were 12 cases in which I could not decide with certainty whether or not the blight had been completely destroyed. In the remaining 90 trees the blight fungus was dead and it had made no further inroads on the foliage.

Experiment 3.

This test was carried out on twice-transplanted 8-year old Norway Spruces and 6-year old White Spruces. Lime sulphur of 75% dormant strength was applied in the fall of 1928.

In this experiment there were about 800 trees in all; they were in rows but with the crowns of the trees within each row in light contact. The blighted trees only, 115 in number, were sprayed. Inspection the following spring revealed the fact that in all of these without exception the old blight was killed by the lime sulphur and no new blight had developed. One surprising feature was the extensive development of new blight on the unsprayed trees. Five hundred and ninety-seven of them were now (spring of 1929) more or less conspicuously blighted; it is possible that some of them had been touched with blight in the spring of 1928 but not enough to attract casual notice in the fall of that year.

The outcome of these experiments is very encouraging. In Experiments 1 and 2, where 50% lime sulphur was employed, all of the trees, healthy and diseased, were sprayed. Not a single new case of blight developed, and out of the original 337 blighted Spruces there was an undoubted persistence of the disease in 14 only. It is anticipated that the majority of the former will now establish themselves as permanent members of the plantation; practically all of them would have done so had they been treated before being so severely ravaged. In the third experiment, where 75% lime sulphur was used, blighted trees only were sprayed, 115 in all; the blight was destroyed in every one of them, and with few exceptions they will be merchantable. On the other hand an astonishingly large number of the unsprayed trees in the plot developed blight. All told, 452 blighted trees in the three experiments were sprayed; and living blight continued with certainty in but 3% of them.

Were plantation spraying to be carried out on a large scale, perfection is scarcely to be expected; but if the work is done properly at the proper time the failures are likely to be negligible. One general application, too, would probably be sufficient. It is needless to repeat that late fall is the only season in which spraying can hope to be effective. The 75% formula, dormant strength, is apparently about right for White and Norway Spruce.

(e) *Control by dusting*

Dusts are now being employed quite extensively for the control of various fungus diseases of fruit trees. Some think very highly of their efficacy and use them in preference to sprays; others are not so enthusiastic over them. It is possible that, aside from making the right choice of dust, the nature of the climate plays a part with respect to the quality of the results. If a dust be effective it has in its favor a much lower cost of labor, it can be applied much more quickly, and it is less disagreeable to handle. Dusts can also be used much more easily than sprays where the terrain is rough. Dusting for the control of Phacidium Blight is certainly worthy of careful trial.

(f) *Value of cover in control*

On this point I have nothing more to offer than an account of two casual observations.

One of my plantation plots grew up to a rank growth of coarse grass, so heavy, indeed, that the Spruces on the plot, planted in 1925, were much over-topped by the grass in both 1927 and 1928. It was so difficult finding the markers in the spring of 1929 that hope was abandoned of securing accurate data. But it seemed from what I could observe that the blight had not spread in that plot and that some of the plants had apparently been able to shake it off. If this be true the explanation is to be sought in the shading from the sun in the spring, and the obstruction afforded by the grass to the spread of the spores in the fall.

The second instance that came to notice was that of two adjoining plantations of Spruces separated only by a wagon trail. In the one on the north side of the dividing road no cover was afforded, and blight in that plantation was markedly prevalent. The plantation to the south of the road was covered by a rank growth of weeds and grass, and the trees on it were remarkably free from blight. True, its soil was richer and better prepared, but the explanation for comparative freedom from blight is probably the cover. This is doubtless an important factor governing the distribution of Phacidium Blight in the native forests.

(g) *Constant watchfulness*

In conclusion let me reiterate that maintenance of a blight-free nursery is the first consideration. Then in regions liable to Phacidium Blight the young coniferous plantations should be inspected annually, preferably in the springtime, for the first few years of their existence—until the leaders get well above the snow-cover of winter. If sporadic cases of blight appear in them the diseased plants should be thoroughly sprayed with lime sulphur in the late fall, or pulled out by hand and burned. Just as Phacidium Blight can be economically controlled and prevented in nurseries, so too, I doubt not, can it be in the plantations.

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CHROMOSOMES AND PHYLOGENY IN CAPRIFOLIACEAE

Karl Sax and D. A. Kribs

Plate 24

The family Caprifoliaceae contains thirteen genera, most of which are distributed in the north temperate zone. *Lonicera* is the largest genus with about one hundred and eighty species while *Heptacodium*, *Linnaea* and *Kolkwitzia* are monotypic. The Arnold Arboretum contains representative species of eight genera, and in the larger genera both Asiatic and American forms are represented.

With the possible exception of *Sambucus* the family seems to be a natural one and taxonomists have generally agreed in the grouping of the various genera. There is, however, considerable variation in the degree of specialization of floral parts and in wood structure.

From the standpoint of the geneticist the family is of interest because of the occurrence of natural species hybrids in the genera *Sambucus*, *Viburnum*, *Symphoricarpus*, *Diervilla* and *Lonicera*. The family contains many of our most valuable ornamental shrubs and additional hybrids between certain species should be of considerable horticultural value.

A cytological study of the more important genera of Caprifoliaceae has been made by the senior author to determine the chromosome number and size relationships. A study of wood structure has been made by the junior author in an attempt to determine the phylogenetic changes in structural specialization of these genera. Such studies should throw some light on the relation between chromosome variation and phylogenetic development in this family.

Chromosome counts were obtained from root tips of young plants in the greenhouse and from pollen mother cells of mature plants in the Arboretum. The pollen mother cells were smeared on a dry slide, fixed in Navaschin's solution for about 30 minutes and stained in crystal violet iodine. In some cases the young buds were fixed in absolute alcohol and acetic acid and later used for aceto-carmine preparations.

The taxonomic classification of sections and species of the various genera of Caprifoliaceae is based on Rehder's Manual (1).

The genus Sambucus contains about 20 species which are divided into two sections. Of the seven species described by Rehder three are of Asiatic or European origin while four are natives of North America. Chromosome counts have previously been obtained for *S. nigra* and *S. racemosa* (2). Both species have eighteen pairs of chromosomes. Permanent smears of the pollen mother cells of the American species *S. canadensis* show that this species also has eighteen gametic chromosomes. *Sambucus nigra* and *S. canadensis* belong to the section Eusambucus while *S. racemosa* belongs to the section Botryosambucus. The chromosome number is the same for both European and American species and in all cases the chromosomes are comparatively large. Somatic figures of *S. racemosa* have also been obtained from plants in the Arboretum greenhouses and the size and approximate number of the chromosomes are shown in figure 1. The average length of the chromosomes is about 4 microns.

There are nine sections and about 120 species in the genus *Viburnum*. Most of the species are natives of Asia, but the genus is well represented in North America. Representatives of six of the nine sections have been studied, including both Asiatic and American forms. The section, species, gametic chromosome number and native habitat are given as follows:

VIBURNUM

Section	Species	Chromosome No.	Origin
Lantana	V. Lantana	9	Europe-Asia
Pseudotinus	V. alnifolium	9	N. America
Pseudopulus	V. tomentosum	9	Japan-China
Lentago	V. Lentago	9	N. America
	V. prunifolium	9	N. America
Odontotinus	V. hupehense	9	China
	V. acerifolium	9	N. America
	V. lobophyllum	9	China
Opulus	V. trilobum	9	N. America
	V. Opulus	9	Europe-Asia
	V. Sargenti	9	N. E. Asia

All of the Viburnum species investigated have nine pairs of chromosomes. The chromosomes of this genus are relatively large. The somatic chromosomes of *V. Opulus* are shown in figure 2. The average length of these chromosomes is about five microns.

Only one species of *Symphoricarpus* has been investigated although the genus contains about sixteen species, which with one exception are natives of North America. There are eighteen somatic chromosomes in *S. orbiculatus*. They are relatively small and slender and have an average length of approximately 1.5 microns (Fig. 3). *Symphoricarpus albus* is probably a hexaploid form but exact counts could not be obtained.

Abelia contains two sections and about twenty-eight species, most of which are natives of Asia. Chromosome counts of *A. Engleriana* were obtained from pollen mother cells. The gametic number is sixteen. Somatic chromosomes of *A. Schumannii* were also obtained and although an exact count could not be obtained it is probable that the number is thirty-two. The chromosomes are very small and have an average length of less than one micron (Fig. 4).

Kolkwitzia is a monotypic genus from China. In *K. amabilis* there are sixteen pairs of chromosomes. The somatic chromosomes are similar to those of *Abelia* but are somewhat larger (Fig. 5).

The genus *Diervilla* is divided into three sections and about twelve species. Of the ten species described by Rehder, three are of American origin while seven are natives of Eastern Asia. Species hybrids exist only in the Weigela section.

Chromosome counts have been obtained for three species in the Weigela section and for two species in the Eudiervilla section. There are eighteen pairs of chromosomes in the Asiatic species *D. praecox*, *D. florida* and *D. hortensis* and in the American species *D. sessilifolia* and *D. rivularis*. The somatic chromosomes of *D. hortensis* are shown in figure 6. The chromosomes are quite small and average only a little more than a micron in length.

The genus *Lonicera* is the most important one in the Caprifoliaceae. It contains two subgenera of which one is divided into four sections and about 180 species. Most of the species are natives of North America. Many species hybrids are described by Rehder, but no hybrids are known between species of different subgenera or sections of the genus.

Chromosome counts have been obtained for representative species of the genus. The species investigated include both subgenera, all sections, and both American and Asiatic forms. The subgenera, section, species, number of gametic chromosomes and native habitat of the species follow on page 150.

The chromosomes of *Lonicera* are rather small and have an average length of about 2 microns. The somatic chromosomes of *L. chrysantha* are shown in figure 7. In many cases trabants could be seen but they were not present in all species probably due to difference in fixing and staining.

LONICERA

Section	Species	Chromosome No.	Habitat
Subgenus 1. Chamaecerasus			
1. Isoxylosteum	L. thibetica	9–18	China
2. Isika	L. microphylla	18	E. Asia
	L. coerulea	9–18	Europe, Asia
	L. tenuipes	18	Japan
	L. fragrantissima	9	China
	L. Altmannii	9	Turkestan
	L. Ferdinandi	9	China
	L. orientalis	9	Asia Minor
3. Coeloxylosteum	L. Korolkowii	9	Turkestan
	L. tatarica	9	Russia–E. Asia
	L. chrysantha	9	N. E. Asia
	L. demissa	9	Japan
	L. Maackii	9	China
	L. prostrata	9	China
	L. quinquelocularis	9	Himalayas
4. Nintooa	L. Henryi	27	China
	L. alseuosmoides	18	China
	L. japonica	9	E. Asia
Subgenus 2. Periclymenum			
	L. dioeca	9	N. America
	L. prolifera	9	N. America

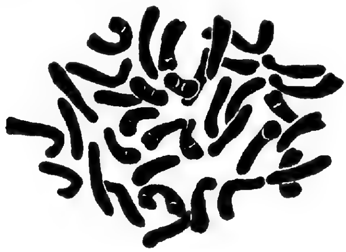
In the hexaploid species *L. Henryi* the chromosomes are about the same size as those of the diploid forms (Fig. 8).

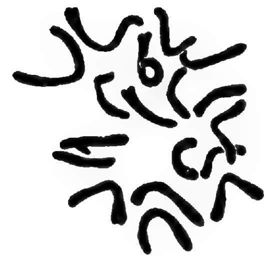
Most of the species of *Lonicera* examined have nine pairs of chromosomes. The tetraploid and hexaploid species have probably originated through chromosome duplication since both diploid and tetraploid forms are occasionally found in the same species, and the hexaploid *L. Henryi* resembles the tetraploid species *L. alseuosmoides*. In no case is there any evidence of species formation by crossing of diploid with tetraploid forms. Polyploidy has apparently been of little importance in species formation in *Lonicera*.

Species with nine (9) gametic chromosomes are found in both subgenera and all sections of *Lonicera* but species hybrids are known only between species of the same section. During the past summer crosses were made between sections and subgenera but no seeds were obtained.

The chromosome numbers found in the genera of Caprifoliaceae suggest that nine is the basic number for the family, although *Abelia* and *Kolkwitzia* with sixteen gametic chromosomes do not agree with this interpretation, unless they are tetraploids which have lost two pairs of chromosomes. *Sambucus* and *Diervilla* have eighteen pairs of chromosomes while *Viburnum*, *Symphoricarpus* and *Lonicera* have nine chromosomes as the basic number. In view of the occurrence of polyploidy in *Lonicera*, and probably also in *Symphoricarpus*, it seems possible that *Sambucus* and *Diervilla* are tetraploid forms with nine chromosomes as the original basic number.

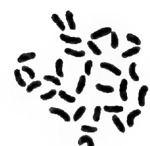
Variation in chromosome size is much more striking than variations in chromosome number. *Sambucus* and *Viburnum* have relatively large


1


2


3


4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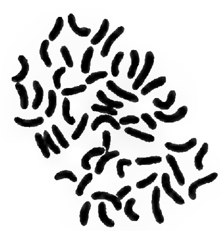
6


7


8

Chromosome number in Caprifoliaceae

chromosomes. The chromosomes of *Lonicera* are about half the length of those of *Sambucus* while the chromosomes of *Diervilla, Kolkwitzia* and *Abelia* are only about one-fourth as long as those of *Sambucus* and *Viburnum.* In volume the chromosomes of *Sambucus* and *Viburnum* are from twenty to forty times as large as those of *Abelia* and *Kolkwitzia.*

In *Lonicera* there is no great difference in the size of chromosomes in different species although those of the hexaploid *Henryi* are somewhat smaller than those of the diploid forms. In some genera, such as *Carex* there is considerable decrease in chromosome size as the numbers increase due apparently to the inability of the nucleus to produce more than a certain amount of chromation. Even where the chromosome number is the same, there may be considerable variation in size of chromosomes of related species.

WOOD STRUCTURE

In the primitive vascular plants, the secondary xylem is composed of tracheary elements of a single general type, the so-called tracheids. This type of wood has persisted in certain Dicotyledonous genera and a remarkably complete record of the evolution and differentiation of more complex types of tracheary tissue is preserved in the xylem of other living representatives of the Dicotyledons. The evidence is so comprehensive that it is possible to arrange the wood of Dicotyledons in a phylogenetic sequence of increasing structural specialization. When this is done it becomes evident that the evolutionary modification of the stem does not usually parallel that of the flower and leaf.

From the standpoint of wood structure the Caprifoliaceae contain primitive, specialized and transitional genera.

The genera with relatively primitive wood structure include *Viburnum, Diervilla,* and *Kolkwitzia. Abelia, Symphoricarpus* and *Lonicera* are intermediate or transitional in structural specialization, while *Sambucus* is highly specialized.

The genus *Lonicera* is a transitional form. The species with more primitive vascular structure include *L. coerula, Maackii, fragrantissima, prolifera* and *tenuipes.* The more specialized species include *L. dioica, Henryi, thibetica, chrysantha, tatarica* and *alseuosmoides.*

It is evident that specialization in wood structure does not parallel floral specialization since *Sambucus* with highly specialized wood structure is the most simple and primitive in floral development.

It is also clear that there is no correlation between either chromosome number or size with the degree of vascular specialization in the Caprifoliaceae. The following table will simplify comparisons.

There is more or less variation in wood specialization in the genus *Lonicera,* but there is little or no relation between degree of specialization and chromosome number of the various species. Since polyploidy is probably of little significance in species formation in *Lonicera* little or no correlation would be expected between chromosome number and morphological characters.

Genus	Chromosome number	Chromosome size[1]	Wood Structure	Number of species
Sambucus	18	2.00	specialized	20
Viburnum	9	1.25	primitive	120
Symphoricarpus	9	.14	intermediate	15
Abelia	16	.05	intermediate	28
Kolkwitzia	16	.09	primitive	1
Diervilla	18	.20	primitive	12
Lonicera	9–18–27	.50	intermediate	180

[1] Approximate volume in cubic microns.

The age and area hypothesis is probably of little value in determining the relationship between the different genera of Caprifoliaceae. *Viburnum* is widely distributed in Europe, Asia and North America and is probably an old genus as indicated by fossil remains and wood structure. *Lonicera*, however, contains more species and is just as widely distributed as *Viburnum*, but is much more specialized in vascular anatomy. *Abelia* might appear to be a relatively young genus since most of the species are found only in Asia, but the presence of two species in Mexico indicated a wide distribution at some time in the past. Since most genera are most abundant in Asia and certain genera are found only in China, it would seem probable that the family is of Asiatic origin. *Symphoricarpus*, however, is represented by only one species of very limited distribution in China; the other species are all natives of North America. Does this mean that the genus is so old that the original Oriental forms have disappeared and only the newer American species remain?

Neither wood structure nor geographic distribution offers any clear indication of the phylogenetic development in the family Caprifoliaceae. It appears that differentiation of genera has been associated with changes in chromosome size, and that changes in chromosome number are probably of minor significance.

SUMMARY

1. The gametic chromosome number in the Caprifoliaceae has been determined as follows: Sambucus 18, Viburnum 9, Symphoricarpus 9, Abelia 16, Kolkwitzia 16, Diervilla 9, and Lonicera 9, 18 and 27.

2. The chromosomes of different genera may vary greatly in size.

3. There is no correlation between either chromosome number or chromosome size and the amount of vascular specialization of the genera in this family.

LITERATURE CITED

1. Rehder, A. (1927). Manual of Cultivated Trees and Shrubs. McMillan Co., New York, 930 pp.
2. Tischler, G. (1926). Pflanzliche Chromosomen-Zahlen. *Tabulae Biologicae* **4**: 1–83.

DESCRIPTION OF PLATE

All figures are from somatic chromosomes obtained in root tips.

Fig. 1. Sambucus racemosa.
Fig. 2. Viburnum Opulus.

Fig. 3. Symphoricarpus orbiculatus.
Fig. 4. Abelia Schumannii.
Fig. 5. Kolkwitzia amabilis.
Fig. 6. Diervilla hortensis
Fig. 7. Lonicera chrysantha.
Fig. 8. Lonicera Henryi.

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NEW SPECIES, VARIETIES AND COMBINATIONS FROM THE HERBARIUM AND THE COLLECTIONS OF THE ARNOLD ARBORETUM[1]

ALFRED REHDER

Rhapis excelsa (Thbg.) Henry in litt., comb. nov.

Chamaerops excelsa Thunberg, Fl. Jap. 130 (1784).—Non Martius.
Rhapis flabelliformis L'Héritier apud Aiton, Hort. Kew. III. 473 (1789).—Willdenow, Spec. Pl. IV. 1093 (1806).—Sims in Bot. Mag. XXXIII. t. 1371 (1811).—Martius, Hist. Nat. Palm. III. 253, t. 144 (1849).
Trachycarpus excelsus H. Wendand in Jour. Soc. Bot. France, VIII. 429 (1861), quoad syn. *Chamaerops excelsa* Thunb., non *C. excelsa* Martius.

Though Martius, when describing a Japanese species of *Chamaerops*, adopted Thunberg's name for that species, he was nevertheless aware, as his citations and remarks show, that Thunberg understood under the name *C. excelsa* the plant published later as *Rhapis flabelliformis* by Aiton. The type specimens in Thunberg's herbarium of which I have photographs before me represent *Rhapis* and his description is clearly based on these specimens. Only Kaempfer's synonyms "Siguro et Sodio" which he cites under α), and "Soo Tsiku, vulgo Sjuro Tsiku" which he cites under β) do not belong here. The former represents *Trachycarpus* and the latter *Rhapis humilis* Bl. Thunberg's *C. excelsa* must obviously be considered as resting on his description and on the type specimens in his herbarium and not on Kaempfer's names cited as synonyms. The name *Chamaerops excelsa* Thunb. was by Aiton and later authors up to 1849 correctly referred to *Rhapis* and cited as a synonym of *Rhapis flabelliformis*, but in 1849 Martius in his Historia Naturalis Palmarum for the reason that the Japanese synonym "Sjuro et Sodio" represented it gave Thunberg's name to a plant later referred by Wendland to *Trachycarpus*. This view, however, can hardly be upheld and, as *Chamaerops excelsa* is the oldest name for the plant described as *Rhapis flabelliformis*, the specific name according to our rules of nomenclature, must be transferred to *Rhapis*.

In publishing the combination *R. excelsa* I am fulfilling a wish of the late Dr. A. Henry, who requested me in his letter of October 31, 1929, to publish this combination in the Journal of the Arnold Arboretum.

The plant described by Martius as *Chamaerops excelsa* and transferred by Wendland to *Trachycarpus* is apparently conspecific with *T. Fortunei*

[1] Continued from vol. x. 136.

Wendl. (*Chamaerops Fortunei* Hook.), though it may be distinguished as a variety. Whether it is identical with *C. Fortunei* var. *surculosa* Henry (in Elwes & Henry, Trees Gr. Brit. & Irel. VII. 1691 [1913]) I am not prepared to say. If considered specifically distinct it should receive a new name.

Carpinus mollis, sp. nov.

Arbor circiter 9-metralis ramulis gracilibus novellis minute tomentellis et sparse pilosis, robustioribus glabratis, annotinis glabris brunneis vel griseo-brunneis; gemmae oblongae, perulis obtusis minute ciliolatis ceterum glabris. Folia ovato-oblonga, 5–8 cm. longa et 3–4.5 cm. lata, basi cordata vel subcordata, acuminata, duplicato-serrata dentibus aristato-mucronatis, supra glabra, subtus tota facie molliter villoso-pilosa, densius ad costam et nervos, nervis utrinsecus 12–16 supra impressis subtus elevatis; petioli 6–14 mm. longi, breviter villoso-pilosi pilis longioribus intermixtis. Inflorescentiae fructiferae densiflorae cylindricae, pedunculo 1.5–2 cm. longo excluso 5–7 cm. longae et circiter 2 cm. diametientes; pedunculus et rhachis dense villoso-pilosa; bracteae stipitatae, oblique ovato-ellipticae vel ovato-oblongae, circiter 2 cm. longae et 8–10 mm. latae, acutae, 3–5-costatae, acute dentatae, latere interiore ad basin lobo suborbiculari inflexo et nuculam obtegente instructo, latere exteriore fere recto inflexo et nuculam et lobum interiorem partim tegente; nuculae cylindrico-ellipsoideae, circiter 5 mm. longae et 2.5 diametientes, glabrae.

CHINA. Szechuan: Sungpan hsien, side of stream, *W. P. Fang*, no. 4245, August 17, 1928 (tree about 9 m.)

This new species is closely related to *C. cordata* Bl. and its var. *chinensis* Fr., but is easily distinguished by smaller leaves with less numerous veins and dense soft pubescence beneath, narrower fruiting catkins and smaller bracts. Besides by this new species the section *Distegocarpus* of *Carpinus* is represented in China by the following species: *C. cordata* Bl. var. *chinensis* Fr., *C. Wilsoniana* Hu and *C. Fangiana* Hu, of which the last two are remarkable for their very long fruiting catkins which measure 20–30 cm. in length, also the leaves are very large attaining 18 cm. in length.

Castanea mollissima Blume, Mus. Bot. Lugd.-Bat. I. 286 (1850).—Schneider, Ill. Handb. Laubholzk. I. 899, fig. 563, c–d (1906).—Seemen in Bot. Jahrb. XXIX. 288 (1900).—Rehder in Bailey, Stand. Cycl. Hort. II. 682 (1914); Man. Cult. Trees Shrubs, 159 (1927).—Nakai in Tokyo Bot. Mag. XXIX. 54 (1915).—Rehder & Wilson in Sargent, Pl. Wilson. III. 192 (1916).

Castanea pumila Blume, Bijdr. 525 (1925).—Non Michaux.

Castanea vesca Bunge in Mém. Div. Sav. Acad. St. Pétersb. II. 137 (Enum. Pl. Chin. Bor. 62) (1833).—Non Gaertner.

Castanea Bungeana Blume, Mus. Bot. Lugd.-Bat. I. 284 (1850).—Nakai in Tokyo Bot. Mag. XXIX. 54 (1915); XL. 585 (1926).—Handel-Mazzetti, Symb. Sin. VII. 27 (1929).

Castanea sativa var. *formosana* Hayata in Jour. Coll. Sci. Tokyo, xxx. art. I. 304 (1911).
Castanea formosana Hayata, Gen. Ind. Fl. Formos. 71 (1917).—Makino & Nemoto, Fl. Jap. 1090 (1925).
For further citation of synonyms and literature see Rehder & Wilson in Sargent, Pl. Wilson. III. 192 (1916).

Though Blume in 1850 recognized the specific difference of the Chinese Chestnut, none of the later botanists followed him, until O. von Seemen in 1900 took up Blume's name *Castanea mollissima* for the Chestnut of Central China. Seemen, however, laying great stress on the very variable pubescence of this species referred some specimens from Northern China to typical *C. sativa* overlooking the much more reliable character of absence or presence of glands on the under side of the leaves. After having examined in 1911 Blume's type specimen in the Rijks Herbarium at Leyden I followed Seemen in accepting Blume's name *C. mollissima* for the common Chinese Chestnut. In 1926, however, Nakai after having examined the type specimens in Leyden of *C. Bungeana* and *C. mollissima* states that the leaves of the latter are tomentose beneath with simple erect hairs. It is true that in the type specimen of *C. mollissima* which I re-examined in 1928 when in Leyden most of the hairs chiefly those borne on the veins and veinlets are simple, but fascicled hairs are present on the parenchyma, scattered on the older lower leaves, more plentifully on the younger leaves. Leaves with similar pubescence can also be found on Chinese specimens as in Meyer's no. 1400a from Ya tze ko, southwest of Sian fu, Shensi, collected Sept. 2, 1914. These simple pilose hairs are characteristic for *C. mollissima*, they are sometimes only sparingly present on the young tips of branchlets, but usually they are more copious and spread often from the branchlets to the petioles, and the midrib, veins and even veinlets of the under side of the leaves. In most specimens of *C. mollissima* the under side of the leaves is densely clothed with a white tomentum of felted fascicled hairs with or without simple hairs on the veins, but sometimes the leaves are glabrescent or quite glabrous. In the absence of simple pilose hairs *C. mollissima* can always be distinguished from the similar *C. sativa* Mill and *C. crenata* Sieb. & Zucc., which both vary with leaves quite glabrous and densely felted beneath, by the absence of glands on the under side of the leaves.

Castanea mollissima and *C. Bungeana* I consider extreme forms of the same species, the first characterized by the presence of copious simple hairs on the branchlets, petioles and under side of the leaves and the second by the absence of simple hairs from the leaves and petioles and a closer and finer white tomentum of felted fascicled hairs which occasionally may disappear entirely and leave the leaves quite glabrous. The branchlets are never quite glabrous, but either more or less villous at least at the apex or bearing scattered pilose hairs or both. I have before me more than 90 specimens from almost all provinces of China, also from Korea and Sikkim, which show all intergradations in pubescence. The most common is the form named *C. Bungeana* by Blume and those botanists who recognize priority of position will have to give precedence to this name which appears two pages ahead of *C. mollissima*, but according to the International Rules of Nomenclature the name *C. mollissima* should be accepted since it was selected by Seemen as the name for that particular species, though he did not cite *C. Bungeana* Bl. as a synonym.

Lithocarpus brunnea, sp. nov.

Arbor 20-metralis, glabra, ramulis gracilibus, annotinis nigro-fuscis; gemmae terminales parvae, globoso-ovoideae, obtusae. Folia coriacea, graciliter petiolata, elliptico-ovata vel ovata, 4.5–9 cm. longa, basi late cuneata, lamina non vel vix decurrente, abrupte breviter acuminata acumine obtuso vel acutiusculo, integra, supra lucidula, subtus paullo pallidiora, primo intuito glabra sed indumento tenui crustaceo obtecta, costa media supra plana subtus elevata, nervis utrinsecus 6–9 supra fere planis vel levissime elevatis subtus elevatis, venulis trabecularibus supra tantum leviter visibilibus subtus totis invisibilibus obsoletis; petioli graciles, 1–2 cm. longi, supra plani vel leviter canaliculati. Inflorescentia fructifera satis gracilis, 9–10 cm. longa, rhachi minute tomentella, cupulis 3–4-ni glomeratis plus minusve confluentibus cupuliformibus circiter 5 mm. altis et 8 mm. latis vel interdum minoribus, bracteis dense imbricatis triangulari-ovatis obtusis vel obtusiusculis leviter vel vix turgidis fusco-tomentellis, glande ovoideo-conica, 7–8 alta et lata, basi circiter terta parte inclusa, fusco-brunnea, nitidula.

CHINA. Szechuan: Loshan hsien, Kiating, alt. 450 m., in thickets, *W. P. Fang*, no. 2290, July 28, 1928 (tree 20 m. high).

This new species is chiefly characterized by the rather small elliptic or elliptic-ovate glabrous leaves with flat midrib above and without reticulation beneath and by the slender fruiting spike, the small brown tomentulose hemispheric cups embracing about ⅓ of the conic-ovoid brown nut. It seems most closely related to *Lithocarpus viridis* (Schottky) Rehd. & Wils., *L. glabra* (Thbg.) Nakai, *L. spicata* (Sm.) Rehd. & Wils. and *L. Henryi* (Seemen) Rehder & Wils. which all differ in their larger and longer leaves with distinctly elevated midrib, larger acorns on a stouter rachis usually only at the base embraced by the nearly patelliform cupula with gray pubescent scales, the leaves except of *L. viridis* being distinctly though slightly reticulate beneath.

Ulmus glaucescens Franchet in Nouv. Arch. Mus. Paris, sér. 2, VII. 76, t. 8, fig. A (Pl. David. I. 267) (1884).—Schneider in Sargent, Pl. Wilson. III. 263 (1916).— Rehder in Jour. Arnold Arb. IV. 168 (1923).

INNER MONGOLIA: "Toumet, Sartchy," *A. David*, no. 2634 (ex Franchet); Wu ye hsien, alt. 1200–1400 m., *R. C. Ching*, no. 15, April 2–13, 1923.

CHINA. Chili: Kalgan, hill slope, *J. C. Liu*, nos. 584 and 585, May 28, 1927. Kansu: Ho lan shan mountains, alt. 1375–2400 m., *R. C.*

Ching, nos. 88, 140, May 10–25, 1923 (National Geog. Soc. Cent. China Exp.) (small tree up to 6 m. high).

This species which has been known so far only from David's collection near Sartchy or Sarchi about 20 miles west of the border of Northern Shansi has now turned up east and west of this locality, namely in northern Chili, at another locality in Mongolia west of Sarchi and in Kansu. It is very similar to *Ulmus pumila* L. and like this it has small glabrous leaves with simple or nearly simple teeth, but the leaves are dull, somewhat bluish green above, comparatively shorter and broader, with fewer, usually 7–9 pairs of veins, while *U. pumila* often has more than 10 pairs of veins. The chief difference is in the fruit, which is broadly elliptic or elliptic-obovate, more or less narrowed at base and 2–2.5 cm. long, while in *U. pumila* the samaras are suborbicular, rounded at base and not more than 15 mm. long.

Ulmus glaucescens var. **lasiocarpa,** var. nov.

A typo recedit samaris tota facie, in centro densius marginem versus sparsius pilosis, orbiculari-ellipticis 2–2.3 cm. longis et 1.8–2 cm. latis, basi fere rotundatis.

CHINA. Kansu: Ho lan shan Mountains, alt. 1375–2400 m., *R. C. Ching*, no. 160, May 10–25, 1923 (small tree).

This interesting variety which differs from the type in its pilose samaras resembles in this character *U. Davidiana* Planch. and *U. macrocarpa* Hance, which however, differ in their much larger doubly serrate and generally obovate leaves pubescent in *U. Davidiana*, scabrid in *U. macrocarpa*. No other species of *Ulmus* is known which varies with pubescent and glabrous fruit, but as this plant agrees in every other character perfectly with typical *U. glaucescens* and grows with it at the same locality, it can hardly be considered anything else but a variety or form of that species.

Litsea cubeba Persoon, Syn. Pl. II. 4 (1807).—Merrill in Philipp. Jour. Sci. XV. 235 (1919).—Rehder in Jour. Arnold Arb. X. 194 (1929).

Laurus cubeba Loureiro, Fl. Cochinch. 252 (1790).
Litsea piperita Jussieu in Ann. Mus. Paris, VI. 213 (1805).
Persea cubeba Sprengel, Syst. II. 269 (1825).
Litsea citrata Blume, Bijdr. 595 (1825).—Gamble in Jour. As. Soc. Beng. XXV. pt. I. 146 (1912).—Lecomte, Fl. Indochine, V. 138 (1914).
Tetranthera polyantha Wallich, Cat. no. 2538 (1830), nom. nudum.—Nees in Wallich, Pl. As. Rar. II. 67 (1831); Syst. Laur. 545 (1836).
Tetranthera citrata Nees, Syst. Laur. 560 (1836).
Daphnidium cubeba Nees, Syst. Laur. 615 (1836).
Tetranthera floribunda Champion in Hooker Kew Jour. Bot. V. 199 (1853).
Tetranthera cubeba Meisner in De Candolle, Prodr. XV. pt. I. 199 (1864).
Tetranthera polyantha β. *citrata* Meisner in De Candolle, Prodr. XV. pt. I. 182 (1864).
Litsea mollis Hemsl. var. *glabrata* Diels in Bot. Jahrb. XXIX. 349 (1900), synon. nov.
Lindera Dielsii Léveillé in Fedde, Rep. Spec. Nov. X. 370 (1912).
Actinodaphne citrata Hayata, Icon. Pl. Formos. III. 164, fig. 21 (1913).—Kanehira, Formos. Trees, 413, fig. (1917).

Litsaea Dielsii Léveillé, Fl. Kouy Tchéou, 220 (1914), nomen.
Litsea citrata var. *citrata* Hochreutiner in Candollea II. 362 (1925).
Litsea citrata var. *polyantha* Hochreutiner, l. c.
Litsea Hui Diels in herb., synon. nov.

I have followed Merrill in referring this very widely distributed species generally known as *Litsea citrata* Bl. to *Litsea cubeba* Pers. which is based on *Laurus cubeba* Lour. Of *Litsea mollis* var. *glabrata* Diels I have before me a duplicate of Bock and Rosthorn's no. 153, a co-type of the variety, and of *Litsea Hui* I have a specimen of Hu's no. 903, the holotype of this species. Both undoubtedly belong to *L. cubeba* (Lour.) Pers., the first specimens bearing young inflorescences and old frutescences with the fruits dropped and the second is a fruiting branch.

Benzoin touyunense (Lévl.) Rehder in Jour. Arnold Arb. x. 194 (1929).
Litsea touyunensis Léveillé in Fedde, Rep. Spec. Nov. XI. 63 (1912); Fl. Kouy-Tchéou, 220 (1914), as *Litsea touyounensis*.

CHINA. Kweichou: Tou-yun, *J. Cavalerie*, no. 1, Nov. 10, 1902 (type). Hupeh: Changyang hsien, *E. H. Wilson*, no. 302, in part, Nov. 1907; Ichang, *E. H. Wilson*, no. 302, in part, March 20, 1909. Kwangtung: way to Sie-kun, Lokchong hsien, North River Region, *Tsiang Ying*, no. 1436, Oct. 23, 1928 (tree 40 ft. high, with lenticellate bark and brittle branches).

FORMOSA: Karenko to So-o, prov. Karenko, *E. H. Wilson*, no. 11087, Nov. 24, 1918.

When I first identified *Benzoin grandifolium* Rehd. with *Litsea touyunensis* I pointed out the difference in the pubescence of the two specifically identical forms, but did not distinguish the glabrous plant by a distinct name. Now, however, as a well marked strongly pubescent form has come to light, it seems advisable to distinguish and name the two extremes of this species.

The type of *B. touyunense* has the under side of the leaves fairly densely villous-pubescent with the midrib glabrescent, the upper surface is perfectly glabrous, as are the branchlets and petioles, the two outer bracts of the inflorescence are glabrate and the peduncles minutely pubescent. The specimens from Hupeh and from Formosa are somewhat less densely pubescent on the under side of the leaves, while the Kwangtung specimen shows a slight and minute pubescence also on the petioles of the leaves, besides it has broader leaves up to 7 cm. wide and to 16 cm. long and larger fruits fully 2 cm. long.

Benzoin touyunense f. megaphyllum (Hemsl.), f. nov.
Lindera megaphylla Hemsley in Jour. Linn. Soc. XXVI. 389 (1891).—Gamble in Sargent, Pl. Wilson. II. 80 (1914).—Non *Benzoin megaphyllum* Ktze.
Benzoin grandifolium Rehder in Jour. Arnold Arb. I. 145 (1919).
Benzoin touyounense (Lévl.) Rehder in Jour. Arnold Arb. x. 194 (1929), in part.

A typo recedit foliis glaberrimis.

CHINA. Kiangsi: Kiukiang Mts., *E. Faber* (ex Henry). Hupeh: Ichang, *A. Henry*, nos. 1112, 1284, 2195, 3010, 3010a; Patung, *A. Henry*, nos. 3151, 3345, 3345a and 3345b; Chienshi, *A. Henry*, no. 4508; Nanto and mts. to the northward, *A. Henry*, nos. 6609, 7525, 7618, 7848a. Ichang, alt. 300–900 m., *E. H. Wilson*, Veitch Exped. no. 59, April and Oct. 1900; same locality, *E. H. Wilson*, Arnold Arb. Exped. no. 302, in part, March 15 and Oct. 1907; Chang-lo hsien, alt. 300–900 m., *E. H. Wilson*, no. 302, in part, April and May 1907; Chanyang hsien, alt. 600 m., *E. H. Wilson*, no. 302, in part, July 1907; Hsing shan hsien, alt. 750 m., *E. H. Wilson*, no. 302, in part, October 1907; "Ou-pan-chan," alt. 600 m., *C. Silvestri*, no. 2985, March 23, 1910; Da yu tze, alt. 750 m., *W. Y. Chun*, no. 3567, July 27, 1922; Siu yeh see, *W. Y. Chun*, no. 4391, Oct. 30, 1922. Hunan: in silva infra vicum Tungdjiapi prope minas Hsikwangschan distr. Hsin wha, alt. 550 m., *Handel-Mazzetti*, no. 11888, May 20, 1918. Anhwei: Chemen, alt. 225 m., *R. C. Ching*, no. 3129, Aug. 5, 1925. Szechuan: distr. "Tchen-kéou-tin," *P. Farges*, no. 1211; Mt. Omei, alt. 300–1200 m., *E. H. Wilson*, no. 3706, in part, June 1908; Wênchuan hsien, Min Valley, alt. 600–1200 m., *E. H. Wilson*, no. 3706, in part, Oct. 1908. Yunnan: Yuan-chiang, alt. 1500–1800 m., *A. Henry*, nos. 13275 & 13275a.

FORMOSA. Taihoku, prov. Sekitei, *E. H. Wilson*, no. 10168, March 17, 1918.

As the above enumeration of the specimens shows the glabrous form is by far the most common and most widely distributed, its range extending from Formosa and Kwangtung to northwestern Szechuan and southern Yunnan, while the type, though of similar range, but apparently much less common, has not yet been collected in Kwangtung, Hunan, Szechuan and Yunnan, and the following form is known only from Szechuan.

Benzoin touyunense f. trichocladum, f. nova.

A typo recedit ramulis, petiolis et costa folii subtus tomentoso-villosis, costa supra breviter minute villosa, facie inferiore praecipue ad nervos et venulos villosis.

CHINA. Szechuan: Nanchuan hsien, *W. P. Fang*, no. 5843, Nov. 9, 1928.

This form on account of the dense grayish yellow pubescence of the branchlets, petioles and the under side of the midrib looks at the first glance very distinct from typical *B. touyunense* and its glabrous form and one might be inclined to rate it higher than a mere form, if not Ying's no. 1436 from Kwangtung enumerated under typical *B. touyunense* showed a slight pubescence on the young branchlets and on the petioles and thus forms a transition to the form described above.

Philadelphus paniculata, sp. nov.

Frutex 3-metralis, ramulis maturi rubro-fusci, annotini cortice lamellis tenuibus solubili. Folia elliptico-ovato vel oblongo-ovata, 6–11 cm. longa et 2.5–6 cm. lata, acuminata, basi late cuneata, integra vel minute et distanter denticulati denticulis ad glandulam reductis (in ramulis floriferis qui tantum adsunt), supra intense viridia, pilis adpressis laxis conspersa, subtus pallide viridia, ad nervos et venulas primarias sparse strigoso-pilosa, ceterum glabra, nervorum paria basalia satis distantia plerumque 2, in axillis non barbata; petioli glabri, circiter 5 mm. longi. Ramuli floriferi glabri, plerique foliorum paribus tribus, paribus duobus superioribus flores in axillis gerentibus; inflorescentia fructifera paniculata capsulas 20 vel plura gerens, 12–16 cm. longa; axes glabri; axium lateralium paria 3 inferiora 2–4-, pleraque 3-flora, 3 vel 4 superiora uniflora; pedunculi circiter 1 cm. longi; pedicelli 6–10 mm. longi, sparse pilosi; calycis tubus et sepala extus adpresse pilosa; sepala ovata, acuminulata, cira 4 mm. longa, intus tomentosula; stylus basi pilosus, circa 6 mm. longus, apice tantum divisus, stigmatibus ut videtur satis latis; capsula non perfecte matura circa 1 cm. longa.

CHINA. Szechuan: Kuan hsien, alt. 900–1050 m., in thickets, *W. P. Fang*, no. 2237, July 15, 1928.

This new species differs from all other Chinese species in its paniculate inflorescence, a character found so far only in a few Californian species; it seems nearest related to *Philadelphus sericanthus* Koehne which is easily distinguished by the simple 7–11-flowered raceme and the distinctly dentate leaves nearly glabrous beneath even on the veins and bearded in the axils. It is also related to *P. subcanus* Koehne, but that species has 5–9-flowered simple racemes and the leaves more or less pubescent beneath. In *P. paniculatus* the 3 or 4 upper lateral axes of the inflorescence are one-flowered, while the 3 or rarely 4 lower axes bear a cyme of usually 3 flowers sometimes augmented by a fourth flower springing from one of the lateral pedicels, or occasionally an additional flower on a solitary pedicel appears below the peduncle in a vertical plane, while the normal cyme branches in a horizontal plane. I have never observed these accessory basal pedicels oriented in a vertical plane in *P. california* Benth.

Hydrangea strigosa Rehd. f. **sterilis,** f. nov.

Hydrangea aspera ε. *sinica fl. sterilibus* Diels in Bot. Jahrb. XXIX. 375 (1900).

A typo recedit floribus omnibus sterilibus inflorescentiam plus minusve hemisphaericam formantibus.

CHINA. Szechuan: Nanchuan, Ma fu lin po, *A. v. Rosthorn*, no. 629, Aug. 1891 (shrub 2 m.; type); Mt. Omei, *E. H. Wilson*, Veitch Exped. no. 4902a, Sept. 1904; same locality, alt. 450–600 m., in thickets, *W. P. Fang*, no. 2313, Aug. 1, 1928, (shrub 2 m.). Hupeh: Fang hsien, alt. 1200–1800 m., thickets, *E. H. Wilson*, no. 2390, Aug. 1907 (shrub 1–1.5 m., flower pink).

In the four specimens enumerated above all the flowers have assumed the shape of the sterile marginal flowers with enlarged sepals, but the specimens differ more or less in the shape of the leaves and the size of the sepals. The specimen from Nanchuan is according to the shape of the leaves referable to var. *sinica* (Diels) Rehd., and Fang's no. 2313 from

Mt. Omei to var. *angustifolia* (Hemsl.) Rehd., while Wilson's no. 4902 from Mt. Omei and no. 2390 from Hupeh are intermediate between var. *angustifolia* and var. *macrophylla* (Hemsl.) Rehd. They also differ in the size of the flowers which are only 12–15 mm. across in Fang's no. 2313, about 2 cm. in Rosthorn's no. 629, and about 3 cm. in Wilson's nos. 4902a and 2390, and in the margin of the sepals which is entire in Fang's specimen and in Wilson's no. 2390, somewhat toothed in Wilson's no. 4902a and very sparingly so in Rosthorn's specimen.

All the specimens seem to have been collected from plants growing wild and not as one might assume from cultivated plants. We also know that the sterile forms of the American *H. arborescens* L. and *H. cinerea* Small now much cultivated have been found originally wild in the woods, while the sterile forms of *H. macrophylla* (Thbg.) DC. and of *H. paniculata* Sieb. have been introduced from the gardens of the Far East into western gardens.

Hydrangea villosa Rehd. f. **sterilis,** f. nov.

A typo recedit floribus omnibus sterilibus inflorescentiam hemisphaericam formantibus.

China. Hupeh: Mts. near Ichang, *E. H. Wilson*, Veitch Exp. no. 1473a, August, 1900 (bush 2–3.5 m.; flowers pinkish).

This is another form with all the flowers sterile of which now quite a number are known belonging including this form, to four Asiatic and to two American species. Like the preceding form it has been apparently collected in a wild state. According to the character of its pubescence it does not belong to typical *H. villosa* but to its var. *strigosior* (Diels) Rehd.

Cotoneaster rotundifolia Wall. var. **tongolensis,** comb. nov.

Cotoneaster disticha var. *tongolensis* Schneider, Ill. Handl. Laubholzk. I. 745, fig. 419d (1906).—Rehder & Wilson in Sargent, Pl. Wilson. I. 154 (1912).

China. Szechuan: Tongolo, *J. E. Soulié* (ex Schneider); uplands around Tachienlu, alt. 2600–3000 m., June 1908, *E. H. Wilson*, no. 2186, June 1908 (decumbent bush, 1 m. tall); Baurong to Tachienlu, via Hadjaha, alt. 2750–4650 m., *Herbert Stevens*, no. 338, May–June, 1929.

This variety differs from typical *C. rotundifolia* in the usually more acute or acutish broad-oval or oval leaves pubescent beneath, in the usually slightly pubescent, rarely nearly glabrous calyx-tube, in the flowers being borne often in twos or threes at the end of the branchlets. It may possibly be a distinct species.

Rosa Soulieana Crép. var. **sungpanensis,** var. nov.

A typo recedit foliolis multo majoribus ad 3.5 cm. longis et 2.2 cm. latis, obovatis vel elliptico-obovatis apice saepius fere rotundatis et acuminulatis, crenato-serrulatis vel serrulatis, corymbis multifloris 10–15 cm. diam. sepalis ovato-lanceolatis 12–15 mm. longis, columna stylari in stylos distinctos dissoluta, disco in annulum 1.5 mm. altum producto stylos basi cingente.

CHINA. Szechuan: Sungpan hsien, on side of river, *W. P. Fang*, no. 1525, Aug. 2, 1928 (shrub 2–3 m.; flowers whitish.)

This variety looks at the first glance very different from *Rosa Soulieana*, but agrees in all essential characters with that species except that the leaflets are much larger and the flowers are borne in broad many-flowered corymbs at the end of long vigorous shoots. Dissolved stylar columns are also found occasionally in specimens of otherwise typical *R. Soulieana* as in Wilson's no. 4164 collected between Maochou and Sungpan which also has leaves similar in shape but only 1–1.5 cm. long; the inflorescence is usually only 3-flowered and the disk only little produced above the mouth.

Rosa Stevensii, spec. nov.

Frutex robustus ut videtur; rami robusti ut ramuli glabri, aculeis sparsis rectis 5–10 mm. longis basi dilatatis partim infrastipularibus muniti. Folia pleraque 9-, interdum 11-foliolata, cum petiolo 1.5–3.5 cm. longo 11–13 cm. longa; foliola breviter, terminale longius petiolulata, elliptica, 2–3 cm. longa et 1–2 cm. lata, basi late cuneata, apice acutiuscula vel obtusiuscula et mucronulata, argute simpliciter serrata, supra glabra, subtus pallide viridia ad costam mediam satis dense et molliter, ad nervos laterales sparsius pubescentia, ceterum glabra vel fere glabra, nervis utrinsecus circa 8–10 leviter elevatis, reticulo venularum denso impresso; stipulae conspicuae, 2–2.5 cm. longae et 5–8 mm. latae, auriculis late ovatis, dense stipitato-glanduloso-ciliatae, subtus praesertim ad nervos et venulas glandulosae, ceterum glabrae; petioli et rhachis laxe pubescentia et satis dense stipitato-glandulosa. Inflorescentiae pleraequae 3-florae, basi pauci-bracteatae; flores circa 4.5 cm. lata, purpurea; pedicelli graciles, 2–3 cm. longi, ut hypanthium infra medium aculeolato-setosi setis glanduligeris; hypanthium oblongum apice attenuatum; sepala ovata in acumen longum foliaceum attenuata, integra, petalis plerumque paullo longiora, extus glandulis stipitatis praesertim ad margines exteriores ornata, marginibus interioribus tomentellis exceptis extus glabra intus dense tomentella; petala suborbicularia, extus tomentella; stamina numerosa, filamentis ut videtur purpurascentibus et antheris fuscesentibus (in sicco) 2 mm. longis; capitulum stigmaticum subsessile.

CHINA. Szechuan: Baurong to Tachienlu, via Hadjaha, alt. 2750–4650 m., *Herbert Stevens*, no. 215, May–June 1929 (Kelley-Roosevelt Exped.).

This handsome Rose seems to be most closely related to *R. caudata* Bak., but is easily distinguished by the pubescent leaves, the very large stipules and the petals being tomentulous outside; from *R. Sweginzowii* Koehne and *R. Moyesii* Hemsl. & Wils., to which it seems also related, it differs in the entire sepals, the slender pedicels and the tomentulous petals. The latter character is rather unusual in the genus.

Prunus phaeosticta Maxim. f. **dentigera,** forma nov.

A typo recedit foliis supra medium remote spinuloso-denticulatis denticulis utrinque 2–6 minus longe caudatis, leviter bullatis, nervis subtus magis elevatis.

CHINA. Szechuan: Kikiang hsien, alt. 1050–1375 m., in thickets, *W. P. Fang*, no. 1314, June 11, 1928 (tree 10 m.).

This form looks at the first glance on account of its toothed somewhat bullate leaves rather distinct from the type which has quite entire flat leaves, and is found in southeastern China and in Japan. In western China *P. phaeosticta* seem to be represented only by this and the following form.

Prunus phaeosticta Maxim. f. **lasioclada,** forma nov.

A typo recedit ramulis fulvo-villosulis foliis integris vel partim sparse et minutissime denticulatis.

CHINA. Yunnan: Szemao forest, alt. 1500, *A. Henry*, no. 11666 (tree 6 m.; flowers white) (type); without precise locality, *G. Forrest*, nos. 15750, 15802, 17489, 17710, 17721, 17760, 17888, 18112.

UPPER BURMA: hills around Stawgaw, Lat. 26° N., Long. 98° 25′ E., in mixed thickets, *G. Forrest*, no. 26500, in 1924–1925 (shrub 30 ft.; flowers white).

This form differs from the type in its short-villous young branchlets and in the leaves being on the same branch either entire or toward the apex minutely and remotely denticulate; in Henry's specimen and in every one of the Forrest numbers from Yunnan minute teeth can be found at least on a few leaves of every specimen which seems to show that the presence of teeth is a character of the western forms of *P. phaeosticta*, for in every one of the many specimens before me from southeastern China and from Formosa the leaves are quite entire and the branchlets lack the villous pubescence. Forrest's specimen from Burma, however, agrees in its entire leaves with the type and the pubescence of the branchlets is not quite as conspicuous as in the Yunnan specimens.

Ilex latifolia Thbg. var. **Fangii,** var. nov.

A typo recedit folius angustioribus oblongis vel oblongo-lanceolatis vel oblongo-oblanceolatis 9–13 cm. longis et 2.8–4.8 cm. latis utrinque attenuatis apice magis acuminatis minus crasse coriaceis, ramis et ramulis fuscis gracilioribus.

CHINA. Szechuan: Mt. Omei, alt. 1375–1675 m., in thickets. *W. P. Fang*, nos. 3098 and 3144, Aug. 17 and 18, 1928 (shrub 5 m.).

The two specimens cited above which are in young fruit seem to agree in all essential characters with typical *I. latifolia* except that the leaves are smaller and narrower, longer-acuminate and somewhat less thickly coriaceous; also the branchlets are less stout measuring toward the apex only about 2 mm. in diameter. To my knowledge the species has not been found west of Chekiang and Kiangsu, and the Omei plant may therefore be considered a geographical variety and not a mere narrow-leaved form.

Evonymus centidens Léveillé in Fedde, Rep. Spec. Nov. XIII. 262 (1914); Cat. Pl. Yun-Nan, 34, fig. (1915).

Frutex 2-metralis glaber, sempervirens, ramulis glabris gracilibus acute quadrangulatis, annotinis plus minusve verruculosis demum fuscis subteretibus; gemmae terminales parvae, perulis paucis lanceolatis glabris interdum sparsisime fimbriato-lobulatis. Folia opposita, chartacea, brevissime petiolata petiolo canaliculato circa 2 mm. longo, oblonga vel oblongo-lanceolata vel oblongo-oblanceolata, 3–8 cm. longa et 1.1–2.5 cm. lata, argute et dense serrulata dentibus erecto-patentibus glandula parva fusca terminatis, luteo-viridia, subtus pallidiora, costa media supra et subtus elevata, nervis utrinsecus 5–7 supra fere obsoletis subtus prominulis nervis secundariis leviter prominulis conjunctis, venulis obsoletis. Inflorescentiae in parte aphylla inferiore ramulorum hornotinorum vel in apice ramulorum brevium vel e gemmis perulatis axillaribus ramulorum annotinorum, pleraeque triflorae vel 1–2-florae, pedunculo gracili 2–7 mm. longo, pedicellis 2–4 mm. longis; flores 4-meri, circa 7 mm. diam., sepalis semi-orbicularibus, petalis suborbicularibus 2–5 mm. longis et 3 mm. latis leviter vel vix crenulatis, filamentis brevissimis, antheris subglobosis luteis, ovario breviter conico; capsulae solitariae (semper?) lobis fere ad basin partitis ellipsoideis 6–7 mm. longis obtusis, plerumque tantum uno vel duobus rarius tribus evolutis, monospermis; arillus scarlatinus, apertus, semen fere nigrum dimidium tantum vel paullo ultra tegens.

CHINA. Yunnan: "collines broussailleuses à Long-ky," alt. 700 m., *E. E. Maire*, June 1912 ("grand arbuste à feuilles caduques") (type). Szechuan: Nanchuan hsien, in thickets, *W. P. Fang*, no. 5819, Nov. 8, 1928 (shrub 2 m.).

Though the type of *E. centidens* is based on a flowering specimen and Fang's plant from Szechuan is in fruit, I have no doubt that the two specimens are identical, since they agree well in their vegetative characters and in the inflorescence except that the leaves in Maire's specimen are generally larger attaining up to 8 cm. in length, and 2.8 cm. in width, while those of Fang's specimen are not larger than 6 × 2 cm. The leaves are not membranous as described by Léveillé, but distinctly chartaceous or subcoriaceous and at least partly persistent. The species seems to be most closely related to *E. Dielsiana* Loes. from which it differs chiefly in the closely and sharply serrulate leaves, the shorter petioles and the shorter peduncles. It also agrees with *E. Dielsiana* Loes. in its fruit which is very similar to that of *E. alata* (Thbg.) Reg. and of *E. Euscaphis* Hand.-Mazz.; in all these species the fruit is deeply lobed nearly to the base and of the four carpels usually only 1–3 develop, so that the mature fruit is usually 1–3- instead of 4-lobed.

As Léveillé's description is very meagre and based only on flowering material I have given above a full description of the species, based on Maire's flowering and Fang's fruiting specimens.

Microtropis fokienensis Dunn in Jour. Linn, Soc. XXXVIII. 357 (1908).— Dunn & Tutcher, Fl. Kwangtung (Kew Bull. Add. Ser. x. 61 [1912]).

CHINA. Fukien: Yenping, alt. 1500 m. *S. T. Dunn*, April to Nov. 1905, (Hongkong Herb. 2394; isotype). Kwangtung: Swatow district (ex Dunn & Tutcher). Chekiang: Tientai shan, Huating, *C. Y. Chiao*, July 23, 1927 (Herb. of Univ. Nanking no. 14480). Szechuan: Nanchuan hsien, in thickets, *W. P. Fang*, no. 5756, Nov. 5, 1926 (shrub 4 m.).

This species had been known before only from southeastern China, where it has been collected in Fukien, Kwangtung and Chekiang. The Szechuan plant differs only slightly from the type in the longer peduncles and pedicels, the former being 5–7 mm. long and the pedicels of the lateral flowers of the 3-flowered cyme being up to 3 mm. long, while the terminal one is subsessile; also the leaves are longer and narrower being up to 7 cm. long and 1.6–2 cm. wide, while in the type they are up to 6 cm. long and 2–2.8 cm. wide. The Chekiang specimens resembles the Szechuan plant in its leaves, but has the short peduncles and pedicels of the type.

Eurya Fangii, sp. nov.

Frutex metralis, ramis suberectis ramulis hornotinis satis dense strigoso-pilosis vel setoso-pilosis tertio anno glabrescentibus. Folia persistentia, subcoriacea, brevissime petiolata petiolo 1–2 mm. longo glabro, elliptica vel oblongo-elliptica, 2.5–3.5 cm. longa et 10–14 mm. lata, basi cuneata, apice breviter obtuse acuminata, minute serrulata dentibus mucrone acuto incurvo terminatis, supra atroviridia, subtus flavo-viridia, glabra, costa supra incisa subtus elevata, nervis utrinque 6–8 supra leviter impressis subtus prominulis, venulis supra obsoletis vel levissime impressis subtus leviter elevatis. Flores (alabastra tantum visa) in axillis foliorum solitarii; pedicelli glabri, 1–2 mm. longi; bracteae 2, suborbicularia, 0.5–1 mm. longae, majore minute ciliolata; sepala late ovata, 2 mm. longa, obtusa, minute ciliolata. Baccae subglobosae, circiter 5 mm. longae; semina numerosa, suborbicularia, circa 1.25 mm. diam., leviter compressa, rubro-brunnea.

CHINA. Szechuan: Omei hsien, Mt. Omei, in thickets, alt. 2600–2750 m., *W. P. Fang*, no. 2917, Aug. 13, 1928 (shrub 1 m.).

This new species seems to be most closely related to *E. japonica*, but differs chiefly in the hirsute branchlets, the smaller leaves with impressed veins above and the ciliolate sepals.

Stachyurus yunnanensis Fr. var. **obovata,** var. nov.

A typo recedit foliis tenuioribus, obovatis, infra medium basin versus sensim in petiolum attenuatis apice subito in acumen 1–1.5 cm. longum productis, 5.5–7.5 cm. longis et supra medium 2–3 cm. latis.

CHINA. Szechuan: Kuan hsien, alt. 1075 m., in woods, *W. P. Fang*, no. 2000, July 4, 1928 (tree 4 m.).

This plant looks at the first glance very distinct on account of its obovate almost lyrate caudate-acuminate leaves, but the leaves of some specimens of *S. yunnanensis* before me show a tendency toward an obovate shape and the serration agrees with that of *S. yunnanensis*. As the flowers are unknown, the specimen bearing young fruits, it does not seem wise to describe it as a new species.

Schefflera Bodinieri, comb. nov.

Heptapleurum Bodinieri Léveillé in Bull. Acad. Intern. Geog. Bot. XXIV. 144 (1914); Fl. Kouy-Tchéou, 35 (1914).

Frutex; ramuli initio farinaceo-puberuli mox glabrescentes, annotini pallide rubro-brunnei. Folia longe petiolata petiolo gracili terete 8–15 cm. longo glabro, digitata; foliola membranacea, plerumque 7–9, interdum 5–6, inaequaliter petiolulata petiolulis glabris infimis brevissimis 1–2 mm. longis, terminali 1.5–5 cm. longo, ceteris intermediis, inferiora ovata-lanceolata vel lanceolata, 4–7 cm. longa et 1–1.6 cm. lata, terminale lineari-lanceolata, 10–16 cm. longum, 1–2.5 cm. latum, cetera intermedia, basi late cuneata vel interdum fere rotundata, sensim longe acuminata, remote sparseque denticulata denticulis utrinque 1–8, rarius integra, supra atroviridia, subtus glauca et initio sparsissime farinaceo-puberula, mox fere glabra, costa media supra prominula, subtus elevata, nervis utrinsecus 8–16 fere obsoletis. Inflorescentia pedunculo circa 1 cm. longo incluso 7–11 cm. longa, umbellulis 6–7 multifloris globosis circiter 2 m. diam., racemosa vel axi laterali inferiore iterum racemoso paniculata, farinaceo-puberula; pedunculi umbellularum 1–2 cm. longi, bi-bracteolati bracteolis parvis plerumque infra medium pedunculi insertis et saepe gemmam abortivam in axilla gerentibus; pedicelli 2–5 mm. longi, graciles, farinacei; calycis margo 5-denticulatus denticulis discum superantibus; petala 5, oblongo-ovata, 3–3.5 mm. longa, acutiuscula, reflexa, extus sparse farinacea; stamina 5, petalis paullo longiora; discus annularis crassus; stylus 1–2 mm. longus, striatus, stigmate punctiformi indiviso coronatus; ovarium 5-loculare, extus farinaceo-puberulum. Fructus non visi.

CHINA. Kweichou: "district de Tsin-gay, vallée de Kia-la-tchong," *J. Laborde* in herb. Bodinier, no. 2459, Dec. 21, 1897 ("grand arbuste") (syntype); "environs de Kouy-yang, mont du Collège," *E. Bodinier*, Sept. 1898 (flowers), Feb. 17, 1898 (fruit) (ex Léveillé) (syntype); "route de Pin-fa à Kouy-tin," *J. Cavalerie*, nos. 747, 3098 (syntype), Oct. 1 and Dec. 4, 1902 (ex Léveillé); Long-ly, *J. Cavalerie*, no. 1567, Sept. 1897. Szechuan: Nanchuan hsien, woods, *W. P. Fang*, no. 5740, Nov. 4, 1920 (shrub 1–2 m.).

This species is apparently related to *Schefflera octophylla* (Hance) Harms and *S. hypoleucoides* Harms but is easily distinguished by the smaller and narrowly linear-lanceolate remotely serrulate membranous leaflets and the much smaller inflorescence. It also resembles *Brassaiopsis speciosa* Dcne. & Pl. from which it differs in the same characters and in the 5-celled ovary. As Léveillé's description is very brief and incomplete, I have given above a detailed description based on Laborde's no.

2459 which may be considered the type, on Cavalerie's no. 1567 and Fang's no. 5740.

Vaccinium conchophyllum, sp. nov.

Frutex sempervirens, ut videtur semiprostratus, 20–30 cm. altus, ramis crassiusculis; ramuli angulati, breviter patenti-pilosi, brunnescentes, vetustiores glabrescentes, grisei. Folia crasse coriacea, satis congesta apicem versus fere imbricata, brevissime petiolata petiolo 1–2 mm. longo glabro, late ovalia vel late obovato-ovalia, 8–14 mm. longa et 6–9 mm. lata, apice rotundata basi late cuneata vel rotundata, margine initio ciliato hyalino integro recurvo, ideo folia subtus plus minusve concava, supra initio laxe villosa mox costa media villosula excepta glabrescentia, reticulato-rugosa, subtus laevia, pallide viridia, ab initio glabra, costa media supra impressa sed basin versus prominula subtus levissime vel vix elevata, nervis utrinque 3–4 supra impressis subtus obsoletis. Flores rubri, in racemis 4–6-floris axillaribus solitariis vel paucis in apice ramulorum brevibus; rhachis glabra; bracteae oblongae, glabrae, pedicellis 1–2 mm. longis glabris longiores, caducae; sepala triangulari-ovata, 1.5 mm. longa, acuta, ovario paullo breviora, glabra; corolla ovoideo-urceolata, 5 mm. longo, lobis triangularibus brevissimis reflexis; stamina 10, filamentis latis pilosis 2 mm. longis, antheris 2-tubulosis glabris, in dorso ad apicem filamenti 2-aristatis aristis dimidios tubulos aequantibus; stylus glaber, staminibus subaequilongus. Fructus deest.

CHINA. Szechuan: Nanchuan, alt. 2450–2750 m., in thickets, *W. P. Fang*, no. 849, (type) May 20, 1928 (bush 1 foot; flowers red).

This new species is apparently most closely related to *Vaccinium Nummularia* Hook. f. & Thoms. from Sikkim which is easily distinguished by the dense hispid pubescence of the branchlets, the hairs partly exceeding the diameter of the branchlets, by the pubescent rhachis of the usually larger inflorescence, and by the serrulate broadly ovate rather than broadly oval-obovate leaves with rounded or even slightly subcordate base; Hooker describes the leaves as subentire, but on Griffith's and his own specimens and on Schlagintweit's no. 14755 they are distinctly though minutely serrulate with mucronulate teeth.

Styrax Huanus, spec. nov.

Arbor 6–15-metralis; ramuli juniores pilis stellatis vestiti; annotini glabri, fusco-brunnei, cortice in lamellas tenues soluta. Folia alterna vel inferiora subopposita, petiolata petiolo 4–10 mm. longo stellato-piloso, elliptica vel elliptico-oblonga, interdum obovato-elliptica, 7–11 cm. longa et 3–5.5 cm. lata, basi cuneata, acuminata, minute denticulata supra obscure viridia, costa nervisque stellato-tomentosulis exceptis glabra vel fere glabra, interdum leviter rugulosa, subtus dense albido-stellato-tomentosa, utrinque nervis 6–8 angulo acuto divergentibus supra leviter vel vix impressis subtus elevatis ante marginem anastomosantibus. Inflorescentia fulvido-tomentosa, racemosa, terminalis, plerumque basi

1 vel 2 racemis ex axillis foliorum ortis aucta; racemi 7–12 cm. longi, 8–16-flori vel laterales minores; rhachis stellato-tomentosula; bracteae subulatae, pedicello breviores vel paullo longiores, rarius infima foliacea; pedicelli circa 5 mm. longi; calyx campanulatus, circa 5 mm. longus, extus dense fulvido-tomentosus, intus minute stellato-pubescens, basin versus glaber lobis late triangularibus 1–2 mm. altis acuminulatis; corolla 5-partita, tubo circa 5 mm. longo, lobis aestivatione imbricatis, elliptico-oblongis vel spathulato-oblongis, 12–14 mm. longis, 5–6 mm. latis, acutiusculis extus dense stellato-tomentosis intus sparsius pilis stellatis obtectis; stamina 10, tubo medio adnato, lobis paullo breviora, parte libera plana glabra circiter 8 mm. longa, antheris 4 mm. longis ad marginem sparsissime stellato-pilosis; stylus staminibus longior, lobos fere aequans, glaber; ovarium globoso-ovoideum, villosum semi-inferum, multi-ovulatum.

CHINA. Szechuan: Nanchuan hsien, alt. 1200–2700 m., in thickets and woods, *W. P. Fang*, no. 1376, June 3, 1928 (type), no. 1133 and 1401, May 29 and June 4, 1928 (tree 6–15 m. high).

This new species seems closely related to *S. Hemsleyanus* Diels with which it agrees in general appearance, size and shape of the leaves, inflorescence and size of flowers, but from which it is easily distinguished by the dense white stellate tomentum of the under side of the leaves and also in the longer and glabrous filaments. It also resembles *S. rugosus* Kurz from Burma which differs chiefly in its more rugose leaves, much longer calyx-teeth, 6-parted corolla and superior ovary, and the North American *S. grandifolius* Ait. which has broader usually entire leaves, white-tomentose calyx nearly glabrous inside, and the filaments pubescent below.

I take pleasure in associating this handsome shrub with the name of Dr. H. H. Hu, Professor of Botany at the Fan Memorial Institute, Peiping.

Lonicera saccata Rehd. **f. calva,** forma nov.

A typo foliis utrinque glabris recedit.

CHINA. Szechuan: Nanchuan hsien, alt. 2500–2750 m., in thickets, *W. P. Fang*, no. 845 (type), May 20, 1928 (shrub 4 m. tall; flowers white); summit of Nin tou shan, west of Kuan hsien, alt. 2750 m., *E. H. Wilson*, no. 1862 (in part), June 20, 1908.

Fang's no. 845 agrees in all its characters except in the lack of pubescence with the type. The corolla is distinctly saccate and the leaves are obovate-oblong with the veins yellowish beneath. Wilson's no. 1862, in this herbarium, consists of two branches, one with glabrous leaves and one with the leaves thinly pubescent beneath; the corollas on both branches are gibbous rather than saccate. The new form also approaches *L. aemulans* Rehd. which differs chiefly in its smaller obovate leaves, shorter pedicels and smaller flowers with gibbous, not saccate corolla.

THE PHYTOPHTHORA DISEASE OF THE CALLA IN AMERICA

KENNETH S. CHESTER

IN the early part of January of this year, my attention was called to a diseased condition of the cultivated Calla Lily, *Zantedeschia aethiopica* Spreng. (*Richardia aethiopica* Hort.), in a greenhouse in Martha's Vineyard, Mass. About one hundred plants were being reared for cut-flower purposes, and all showed to a pronounced degree the effects of a severe blight. The plants were stunted, none of the blossom stalks was over two feet in length, and some were less. Many of the leaves were completely dead, and others were dying from the margins inward. A few of the blossoms were of perfect appearance though small, but most of them showed a browning of the distal portion of the spathe, ruining the commercial value. The symptoms pointed to a root or nutritional derangement. On knocking out the earth ball, a few excellent young roots were seen, but the great majority were either partly or completely rotted with only the papery root-sheath remaining, or were entirely absent with the impression of the root left in the soil. Both new and dead roots came from the same region of the corm. The partly-affected roots showed a glassy, translucent, water-soaked appearance between the normal portion and that completely rotted. Associated with the glassy appearance of the roots was a slight red discoloration in spots. The corms themselves showed various degrees of rot. In some only the lower end of the corm was decayed, in others half or more than half was brown and mushy. In the worst cases the whole corm was completely rotted away within the outer shell, and the base of the stalk could be pushed into the mushy mass. Even in these last cases, however, the top was partly green, and a few good roots were attached to the base of the stalk.

The course of the disease is a slow wasting one. The plants do not die immediately, but continue in a state of reduced vitality to produce sickly, non-marketable blossoms.

Believing that this trouble might be due to unfavorable physical or chemical soil conditions, the propagator carried out a set of experiments in an attempt to ameliorate the blighted condition. Thirty pots, each of three plants, were treated with varying amounts of water, lime, liquid hen manure, soot, and bone meal, in addition to the usual "liquid feed." But no improvement resulted, for all, including the control plants, showed the effects of the disease to the same extent when examined several months later. It was at this stage that the diseased Callas came under my observation.

The general symptoms indicated that the disease was of a biotic rather than abiotic cause, and microscopic investigation at once revealed the presence of a fungus. The next step was the isolation and identification of the fungus. The glassy roots of several plants were washed and placed in a little water in moist chambers. *Phytophthora* sporangia developed in abundance from cortical ruptures in the glassy region after 24 hours, and after 48 hours had proliferated and liberated zoospores in abundance. Four months later the same technique was repeated with the same plants and the same results obtained. Examination of the sporangia showed them to be the centrally proliferating type described by Buisman (2) for *Phytophthora Richardiae* Buis., a virulent parasite of the Calla in Europe. In appearance and size the sporangia and zoospores were in conformity with Buisman's description, while the symptoms corresponded precisely to those seen in Europe. It so happened that Dr. Buisman was working in the Arnold Arboretum at the time, and when shown the diseased plants and the cultures of the fungus she expressed no doubt that the disease is identical with the European disease caused by *Phytophthora Richardiae*.

The Calla disease was first observed by Buisman in Holland in the few years prior to 1927. It was noted for the first time in England in 1927 by Salmon and Ware (3) and found to be identical with the Dutch disease. Incidentally it may be mentioned that Ashby (1), after a study of the fungus that causes the disease in Europe, has expressed the opinion that it is a variety of *Phytophthora cryptogaea* Pethyb. & Lafferty (var. *Richardiae* Buis.) since the differences between the Calla fungus and *Ph. cryptogaea* are mainly quantitative with respect to size of sporangia and oogonia and since recent work on *Phytophthora* has shown wide variation in size of these organs within the same species. It is of more than passing interest to record that this disease has just been reported (since this manuscript was prepared) by Weiss from America (4). Weiss notes its occurrence in New York, New Jersey, and probably in California.

Turning to the question of control, it is very satisfying to note that Buisman found that formalin treatment was effective in control, and her method was essentially followed with satisfactory results by Salmon and Ware. This method was recommended to the propagator at Martha's Vineyard and the developments fulfilled expectations. The technique is as follows: The corms are taken from the soil and all rotted parts are excised. It is essential to cut back the roots rather severely, as the fungus is present in some cases in apparently healthy roots. The corms are washed thoroughly in running water and then soaked for one hour in a weak solution of formalin (one part commercial formalin to fifty parts water). Fresh pots and uncontaminated soil are employed in repottimg the corms, and effective disposition is made of all contaminated soil and other waste from the plants. The pots formerly containing the diseased plants may be rendered safe for use by washing in a 1:20 formalin solution or by baking in an oven.

In January of this year every one of the one hundred plants in the greenhouse mentioned above was found to be affected, and they showed hardly a single marketable blossom. At this time the diseased parts were excised and the corms treated with formalin as indicated above. In spite of the setback attendant on cutting back the roots and repotting at the height of the blossoming period, four months later the disease had been materially reduced and the plants bore numerous healthy blossoms. The propagator, who in January was at the point of discontinuing the rearing of the Calla, was entirely optimistic regarding their culture at the end of the four month period following the formalin treatment.

Weiss does not give specific data with regard to the use of formalin as a disinfective measure, but his experiments with chemical agents, particularly soaking the corms in 1:1000 mercuric chloride solutions, were followed by indifferent results thus far. However his experiments are being continued.

The *Phytophthora* disease of the Calla, as far as is known, has not been reported in America previous to this year, and it is important to discover the possible source of the disease. As to the infection reported here from Massachusetts, it is known that the diseased corms were purchased from a large wholesale importing firm. Since many of our corms are brought in from Europe, it is reasonable to suspect that the disease was brought to America in shipments from Europe. Weiss' observations and those reported above show that the disease is already distributed in the East. I have had occasion to be in contact with the Boston flower market for a number of years, and during that time no indication of the disease as manifested through scarcity of good blossoms has come to my attention. With the knowledge of the strong possibility of the epidemic spread of diseases caused by *Phytophthora* of whatever species, the recognition and the eradication of the Calla disease are earnestly recommended before it increases to unwieldy proportions.

LITERATURE CITED

1. Ashby, S. F. (1929). Further note on the production of sexual organs in paired cultures of species and strains of Phytophthora. *Trans. Brit. Mycol. Soc.* **14**: 254.
2. Buisman, C. (1927). Root rots caused by Phycomycetes. *Meded. Phytopath. Lab. Baarn, Holland,* **12**: 13.
3. Salmon, E. S. & W. M. Ware (1927). Root rot of Richardia. *Gard. Chron.* (England) **81**: 234.
4. Weiss, F. (1930). Root rot of the white Calla new to the United States. *Flor. Exch.* **73, 16**: 11.

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May 2, 1930.

A PLANT COLLECTOR'S NOTES ON THE NEW HEBRIDES AND SANTA CRUZ ISLANDS[1]

S. FRANK KAJEWSKI

I left Sydney on the 1st February, arriving at Vila on the 11th, calling at Lord Howe Island and Norfolk Island en route. The first glimpse I got of Vila Harbour was very pretty and I was struck by the fresh vivid green of the foliage flanking the different colored coral waters of the harbor. To this the little town of Vila presents a strong contrast, as it consists of a row of squalid buildings in the main street which does not look very pleasing. There is no sanitation, water, electric light or other conveniences. Mosquitoes are bred plentifully in the empty tins lying around, the food of the inhabitants like in most tropical towns consisting largely of canned goods.

There is no decent hotel, as the one existing before was sold to the Condominion Government to be made into a lands office. The only other hotel is a small French one, which caters for all classes and colors. Plenty of bars, little evil places, built after the style of a small kiosk, many of them unregistered, sell alcoholic drinks to all classes and colors. The liquor is amazingly cheap, as there is a very small custom duty on it.

The Government is a joint dual control of England and France, which is not satisfactory to either party. Earthquake shocks or tremors are often felt, but as a rule do very little damage. There are three active volcanoes in the group, on the islands of Tanna, Ambrim and Lopevi.

From Vila the first island visited southwards was Erromanga, which is a remarkable island in many respects. This island has an elevated grassed plateau about 900 to 1200 feet above sea level and on this plateau an Australian gentleman, Mr. Martin, has a sheep station. It is a wonderful thing to see sheep doing so well in the tropics. On this plateau can be seen old coral formations everywhere on the surface. The coral is in a wonderful state of preservation, many different types being recognizable, also coral boulders, referred to throughout the islands as niggers heads. This proves conclusively, that a shelf of the sea was upraised by a volcanic disturbance.

The area of the grassed plateau is not very large and only occupies a small part of the island. The natives on this island in the early days were very savage and treacherous, having the reputation of being the fiercest of the whole of the natives of the New Hebrides. Altogether they killed four missionaries, but I think it was through their mistrust

[1] Mr. S. F. Kajewski collected for the Arnold Arboretum from Feb. 11, 1928, to March 20, 1929, in the New Hebrides and on Vanikoro of the Santa Cruz Islands. The following summer and autumn he spent in North Queensland collecting, and after regaining there his health which had been impaired by fever while in the New Hebrides, he went to the Solomon Islands where he is now continuing his work for the Arboretum. The plants collected in the New Hebrides are being determined by Dr. A. Guillaumin of Paris and partly by specialists; of this collection we expect to publish an enumeration in this Journal some time next year.—Eds.

of all white men at that time, as the sandalwood traders and blackbirders were cruel and inhuman in their treatment to the natives.

Erromanga has no harbors and the only anchorages are bays on the leeward side of the prevailing wind. The anchorage where I stayed at Dillons Bay is very pretty. The Williams River flows through a gorge over 700 feet deep, with a luxuriant rain forest growth down the sides and in the bottom. This coupled with the very clear waters of the river makes a beautiful sight indeed. Mr. Rae, the Presbyterian missionary there, was very kind, supplying me with boys and giving me every possible assistance.

Although a small island it has four distinct classes of soil distribution. The first is the tropical rain forest which is the same throughout all the islands, since close to the sea the strand flora is much the same. This type of rain forest is usually never very high, as cyclones, strong trade winds and its continual destruction by the natives in the past for gardens, have spoiled the conditions necessary for a tall rain forest.

The next formation on Erromanga is at 700 to 800 feet above sea level, which is of coral formation with coral boulders projecting everywhere. This is beautifully grassed and is open pasture country, with numerous ravines and well grassed steep hills. Clumps of Wattle (Mori) are growing everywhere, the Wattle being closely allied to *Acacia Cunninghamii.* The only drawback is that on account of the good soil and high rainfall, the grass tends to grow too rank and a growth of from 60 to 80 centimetres is quite common with sheep grazing over it all the time. Where sheep have no access the height is much greater running well over a metre. The sheep keep in excellent condition, many being sold locally in the islands for mutton, while the wool realizes good prices. The annual rainfall of the Island is over 70 inches.

The next formation is a little higher, 800 to 1500 feet, and consist of poor red clay soil, which marks the end of the coral formation. This formation is undoubtedly much older than the coral formation and like on all poor soil, bracken is very plentiful. The soil seems to be very porous and the leaves of the smaller trees and shrubs are thick, tough and have a dull color, evidently an adaptation of the plants to hold their own against the dry porous nature of the soil.

The last formation is the elevated rain forest on the slopes of mountains and small elevated plateaus. This contains many forms common in the coastal rain forests, but also has many trees peculiar to its elevation, which are quite large and of good proportions. In fact, the tallest trees are found on this area, the soil being very rich, mainly red or chocolate colored. Kauri Pine trees occur in this belt in ones and twos, but they are not common.

Seeing that the natives have a number of plants that they use for poisoning fish, I was determined to test the efficiency of these poisons. Taking my boys with me, we crossed to a place where some holes in the reef had been left full of salt water after the tide had gone out. They went into the bush and cut bundles of a vine that was growing close by and brought them to the edge of the pool. I found out that they use a number of plants for this purpose and I have marked on the label every plant that I know is used for this purpose. With a stone each man beat the pieces of vines into shreds, and kept beating and soaking them alternately. When a bundle of crushed vine is put in the water, it quickly changes the color of the water in the vicinity to a milky color.

As the pool was of a large size about 56 lbs. of vine was used, some of it as thick as a man's wrist, others being much smaller. A small leguminous plant was also used in a similar manner.

After a quantity of the vines had been added the water became very cloudy and the fish came to the surface and darted aimlessly about. I saw several fish swim and leap right out of the water to get away from the substance that was poisoning them and lie struggling on the coral, being easily picked up by hand. Others sink to the bottom without coming to the surface as is popularly supposed. Some float and swim aimlessly about and are easily speared or shot with bow and arrow. The natives tell me that a good many die and remain hidden in the coral ledges under the water. When I asked them why they did not dive into the water for the fishes, they said it was bad for the eyes. I could not persuade any of them to jump into the pool, so I cannot say whether the water has any bad effect on human beings.

Erromanga has been noted for the quality and quantity of the sandalwood exported from its shores. Many lives were lost by both white and black and much suffering and misery caused through it. The natives have for generations used the sandalwood along with any other wood for firewood and had no idea of its value until the foreigners came and asked for the wood. The only price at first given for a big boat load of wood was a small piece of hoop iron three to four inches long, which was greatly prized by the natives since they only had stone axes.

Very often a rascally sandalwood trader would get his ship filled by showing all kinds of articles for barter and when his ship was filled with wood, would clap on all sail and go away laughing, giving the natives nothing. It is no wonder that the natives were so ferocious and bitter against the white man. Many innocents suffered including two missionaries, one missionary and his wife and one assistant missionary. Many other white men, rough diamonds of that period, no doubt also perished, besides numerous natives, often shot for little reason.

From 1820 to 1870 $875,000 worth of sandalwood was gathered, and that figure would be tremendously increased at present prices. There is very little sandalwood left on the island and that is inaccessible. The natives are now carrying the wood on their backs 15 miles to the nearest trader. The reason why any sandalwood is left at all, is that the wood must be very old to be of any value, as the older the wood the higher the content of oil. As the trees flower when they are about seven years old, a small quantity have survived. The seeds do not seem to carry well and fail to germinate away from their own island.

From Erromanga the next island south is Tanna and I was there the guest of Mr. Nicol, the district agent. The native population is fairly large being about six thousand and Mr. Nicol takes a genuine interest in the natives, and this is one of the few islands where the population is increasing. Mr. Nicol rules with a fearless hand, suppressing grog and silly customs that are against the principles of civilization. Tanna has an active volcano which erupts regularly every three minutes and you can look for a cloud of smoke after these intervals. Of course sometimes it is much quieter than at others, but the periods remain the same. Captain Cook noted this particularity when voyaging down the coast and it has remained so to this day. Such an island is naturally very fertile, as it is continually getting a rich dressing of volcanic ashes, and marvelous crops are grown with very little cultivation.

The rain forest is thick but not very tall, one peculiarity I noticed was the absence of Lawyer vines, *Calamus sp.* The most conspicuous fact in the flora of Tanna is the marvelous number of different kinds of Figs growing there, from noble Banyans, that cover upwards to an acre, to a small one that does not grow more than three metres high.

I must say a little here about native superstition, which fifty years of missionaring has not stamped out. Quite recently after an epidemic of measles and dysentery, which caused many deaths, the natives were suspicious of some one causing all the mischief and accordingly set to work to trace the author. Consequently every day they held meetings and heard what witnesses had to say, and like a chain they kept dragging fresh persons into it, in a manner similar to a political scandal. All the happenings of the island for a number of years were recalled and memories had to work overtime to deny or assert facts. Practically the whole male population was represented as I saw many bushmen or heathen, with long plaits of bushy hair and almost nude. They were very fine men physically, most of them being six feet in height.

It is a very fine sight to see a crowd of eight hiundred natives, all men, seated on the grass and one man at a time talking. As there are four different languages on Tanna there are some men translating all the time. When one man has finished, one man of the opposing side gets up to contradict what he said and so the proceedings go on for days. Personally I think the men enjoy it as it is a welcome break in their lives, since they have not too much to do, making their wives do all the work. It must be interesting how they record the evidence as there are no shorthand writers, but the decision of the chiefs is final.

The next place we passed on to was Aneityum, the most southerly island of the group and having the distinction of being the first one of the group to be settled by missionaries. The first glimpse one gets of

Aneityum is very pretty and the wonderful harbor flanked by the coral and different colored waters is indeed beautiful. One does not get a good impression of the timber wealth of the island as the Kauri tops are not silhouetted against the skyline like at Vanikoro. Instead one sees a succession of poor red soil ridges, that lead up to the higher rain-forest hills and mountains, where the Kauri pine is found.

These red soil ridges are covered with Bracken and stunted shrubs, the soil being very poor. It seems to have been red mud spouted out of geysers and assumed a gravel-like texture, being very porous. It covers quite a large area of the island which differs in this respect from Vanikoro, where there is only a small proportion of waste land not covered by Kauri.

The climate of Aneityum is decidedly cool compared with the other islands, the temperature in the hot season staying between 75 and 90 degrees all the time, going down to 75 only at night.

There is a striking similarity of the vegetation of Vanikoro and Aneityum in regards to ferns and small trees. Both islands in addition to the flora of the tropical coral formation islands have a flora much older and distinctly different, growing on the red volcanic soil hills, including the wonder trees of the Pacific, the Kauri. In addition a *Podocarpus* found in the Eastern Malay Archipelago is also found there. Aneityum has not as many Orchids as Vanikoro, owing to the lower rainfall and cooler climate.

The Kauri on Aneityum (*Agathis obtusa* Mast.) seems to be very similar to that on Vanikoro (*Agathis macrophylla* Mast.). On Aneityum I think there are more species of commercial timbers than on Vanikoro.

The native population is fast decreasing owing to a variety of causes. The Aneityumese are a much lighter skinned race than the rest of the natives of the New Hebrides and are a pleasure loving crowd always laughing. Only 250 natives remain today out of an estimated former population of six thousand people. The remains of a church is still standing on one side of the Island, that would accomodate two thousand people and even that, it is said, had been far too small.

The decrease had set in before the missionaries came, as there was a whaling station there and other traders visited the island in search of sandalwood. These men brought all kinds of diseases and the native had not the constitution to stand against them, consequently they melted away before their inroads. Happy Aneityumese, they bear no malice against the white man, who has been responsible for nearly wiping them out. The birthrate is lower than the death rate and has been so since records were kept by missionaries. The men are twice as numerous as the women and infantile mortality is very high, yet an orphan finds a number of people always willing to adopt it.

THE NORTHERN GROUP OF THE NEW HEBRIDES

The whole of the New Hebrides group lies between 10 degrees and 22 degrees and consequently within the tropics. The rain forest formation is the same throughout the group, a species of Cottonwood (*Hibiscus*) being prominent everywhere. In fact, one can find the same trees common throughout the group.

The majority of the islands are very rugged, the mountains coming right down to the sea, consequently the area suitable for plantations is not great. Pockets of fertile soil have here and there been cleared and planted. Quite a lot of wild cocoanuts are gathered and made into copra by the natives and this is picked up by cutters and small schooners. The islands are very hot and humid and there is only an appreciable difference when the trade winds blow and the sun is on the other side of the equator.

I went to the most northern islands of the whole group, the Banks Group and stayed at the largest island Vanua Lava. The Banks are the wettest islands in the whole group, the annual rainfall being over 200 inches. One of the flowering plants was a pretty *Begonia* which climbed well up the trees and was one of the prettiest there.

There is a good lot of Mangrove on the eastern side of the islands and nowhere have I seen mosquitoes so bad. The anopheles are in droves and when walking along the beach and an empty or hollow log is tapped, the mosquitoes come out in a cloud. It was on this island that I had the misfortune to contract fever very badly and I would have been sent to a hospital only there was no means of getting me there.

I must tell of the sulphur desposits of Vanua Lava which I visited before I was sick. These deposits on Vanua Lava are a splendid spectacle of volcanic formation and are well worth the trouble of getting to them. You leave a small bay at Langnetack and walk through about five miles of tropical scrub, crossing a river of sulphurous water aptly named Sulphur River, in which the water has a decidedly yellow tinge. The water is steaming all the time, giving off the familiar but strong smell of the sulphur compounds. The water is so hot that all the human skin can bear is to place the arms in it.

To get to the sulphur deposits you leave the river and take a short cut through the scrub, which consists of a luxurious vegetation, being in no way affected by the sulphur. After about three miles, without any warning, you come across a big cleft in between two hills, with a stream of hot blue water running through the bottom. On one side the scrub comes right down to the water's edge without any loss in luxuriance, while on the other side the ground is of a gray ashy color all smoking with sulphur fumes. Here and there are bright yellow patches of pure sulphur, while further up on the crest of the hill are numerous stunted trees of a *Eugenia* which seems to be found throughout the islands in a stunted form under adverse conditions. The same tree in the rain forest assumes mighty dimensions. There are also *Pandanus* trees and it seems very strange that these two members of the plant world should grow in soil that is exceptionally hot. I went through the crust of the soil at the base of one stunted *Eugenia*, burning my feet in the hot molten soil and the tree was still alive although it showed signs of not having much life ahead of it.

The traveler has to be very wary where he places his feet as in many places there is only a thin crust on the molten lava and if this is broken the foot sinks into it and one could be very severely burnt before being able to extricate the foot.

The golden yellow deposits of sulphur is what takes the eye, as they are there in yellow pinnacles of all shapes and sizes, with the sulphur fumes rising thickly around, sometimes obscuring them and causing an uncanny mystic sensation. Under such conditions one is loth to break the top off of one of these pinnacles but when this is done, a slight report followed by a cloud of sulphurous steam gives a great shock to the breaker as he imagines he is letting off the pent up gases of the interior to wreck havoc and destruction.

Further on is a circular pool where the water is boiling with tremendous energy, the steaming blue sulphurous water being dashed round and round.

By this time the traveler has had enough of the dense sulphurous fumes, having a very severe headache and after breaking off a few pieces of sulphur is glad to set off for home watching his step as he does so.

VANIKORO, SANTA CRUZ ISLANDS

Vanikoro is the southern port of the Solomon Islands and is unique in respect of the stand of Kauri Pine there. The rainfall is exceedingly heavy, the gorge at the port being a very fine example of tropical luxuriance, which surpasses anything seen in the New Hebrides. The trees are draped with epiphytes comprising climbers, Ferns, Lycopods and the common long trailing Orchids of the tropics. The soil is brownish red and seems to be of a very great age. The absence of coral formations on the hills confirms this theory.

The Vanikoro Timber Company have carried out great improvements for the transport of timber to the sea. The rainfall is so heavy that the use of mechanical transport is impossible, except where there are railroad lines laid down. The Company have a tramline about one mile long into the foothills and use steam haulers with long wire ropes to haul the logs to the head of the tramline. The logs make deep furrows and on account of the heavy rainfall, a greasy surface is always present, which makes the hauling much easier than on dry soil.

The Kauri Pine has a very large head of branches and an exceedingly short trunk in comparison. On account of this a lot of timber is wasted as there are numerous branches on otherwise good logs. Sapwood is very considerable and proves that the Kauri is a fairly quick growing timber.

The trees bear large crops of cones and I have seen the heads white with large crops of cones in all stages, from the flowering stage to the cones that are bursting. A plentiful supply of seed is always available but only one in a hundred thousand germinates according to a rough calculation made by me. Out of that one, only a fraction comes to maturity. The darkness caused by the overhead canopy of vines and leaves of the rain forest, together with the excessive dampness destroys the seeds and it is only when a seed lands on a well lighted piece of ground and gets favorable conditions that it germinates. In places it is very difficult to find small trees although there are numerous large trees about. This is one of the outstanding features of the islands.

The Lycopods of Vanikoro are very interesting. Nowhere else have I seen such a variety growing on the trees. These beautiful draping plants in my opinion give the trees a curtain effect. The number of varieties found here are astonishing being the richest island I have come across in this respect. The same applies to Orchids and other epiphytic plants.

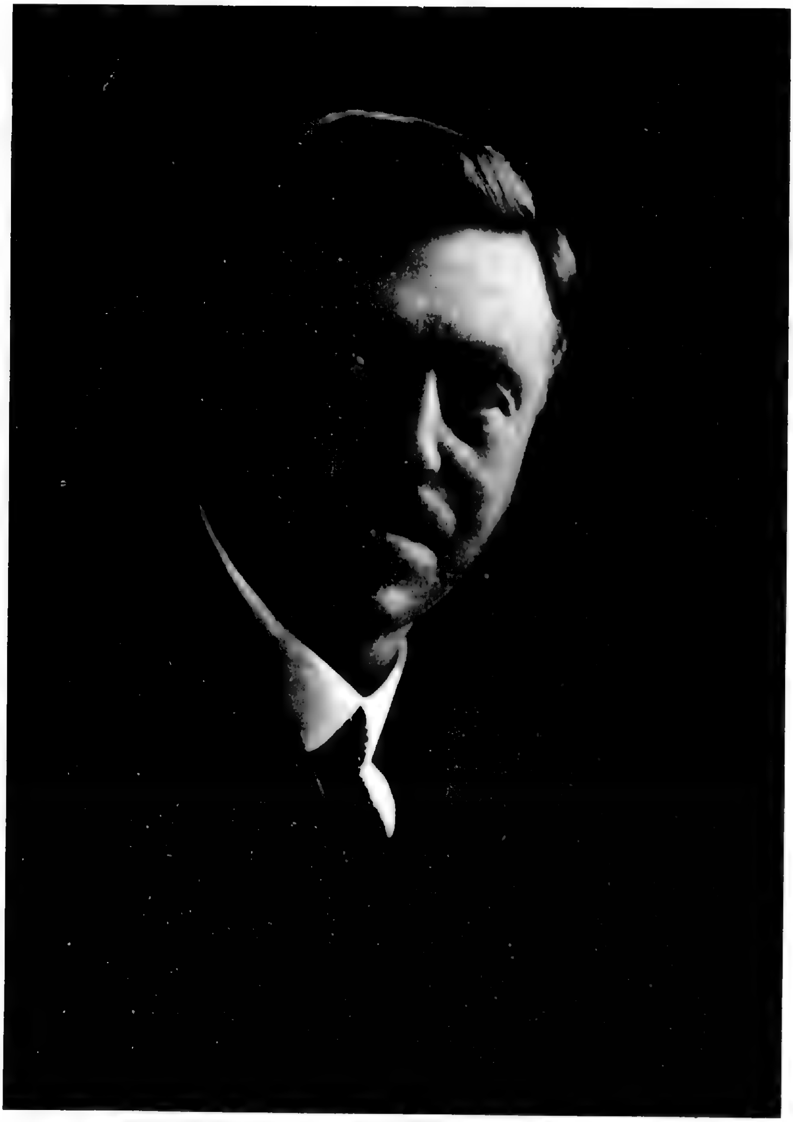
The flora of Vanikoro is the richest I have seen on a single island and the great variety of all classes of plants is amazing. The mosses on the tops of mountains are very grand making the trunks of the small trees look like gigantic pillars. These mosses all grow one length, about 7 inches long, and radiating out from the tree all around, give a wonderful pillar effect, like the ruins of an old Roman temple. A very pretty Orchid with a flower as large as the rest of the plant, was found growing out of the moss. It was found in two colors, white and pink.

Before finishing I must mention the Narli Nut or Ni, as this valuable nut is found right through the islands and is a valuable source of food supply for the natives. Nowhere are the trees as prolific as at Vanikoro, nor do they have the same long fruiting period. The nut is from 6 to 8 cm. long and 3.5 to 4.5 wide and about 3 cm. across, flattened on one side, with a slight round curve and going to an angle on the other side. An average kernel is about 5 cm. long, 3 cm. wide and 1.5 cm. across, but a good many are much larger. The cotyledons are well formed and constitute almost the entire kernel. These nuts have a flavor of their own, but one has to get used to them as they are very rich in oil. It is noticeable how fat the natives are, where this food forms one of their chief diets.

The trees bear exceedingly heavy crops of nuts up to ten being counted on a single fruiting stem, in fact so heavy are the crops that the branches are well bent down with the weight. They are covered with a purple black husk when ripe. The trees are exceedingly handsome and the bark exudes a high turpentine smelling gum. For economic and ornamental reasons, the trees should be planted in tropical and warm temperate climates.

There is a very interesting plant that grows right through the New Hebrides, being the native Arrowroot. This is typical of the large variety of plants that grow wild with very little attention. The tubers are not very large, being of the same size as the English potato, but they grow much larger in cultivation. One or two bulbs are found growing on a single plant, never more. This plant seeds very freely, one plant producing large quantities of seed.

The arrowroot is prepared in the same manner as that from *Canna edulis* and has a good reputation, being of excellent quality. The missions have raised sums of money by getting the natives to collect and manufacture it. The natives did not use it in any way before the white men came and even now do not manufacture arrowroot unless under white supervision. They can get plenty of other food without going to so much trouble. I sent seeds of this plant to the California Botanic Gardens.



E. H. Wilson

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ERNEST HENRY WILSON

ALFRED REHDER

With portrait

THE sudden death on October 15 of Ernest Henry Wilson, Keeper of the Arnold Arboretum, in an automobile accident, was a great shock to his associates and friends, taking him in the prime of his life from the work he loved so well and in which he was interested with all his heart.

Ernest Henry Wilson was born at Chipping Campden in Gloucestershire, England, on February 15, 1876, the eldest son of Henry and Annie (Curtis) Wilson. After leaving school he entered the nurseries of Messrs. Hewill at Solihull, Warwickshire, and in 1892 was recommended to the Curator of the Birmingham Botanical Gardens as a promising young gardener. He accepted a position in these gardens and notwithstanding the long hours of work he studied at the same time in the Technical School in Birmingham which offered excellent facilities for the study of botany, and did so well that he won the Queen's prize in this subject at the examination held by the Board of Education. In January 1897 he entered the Royal Botanic Garden at Kew where he soon succeeded in winning recognition for his work in the garden as in the lecture room. On the advice of his friends and induced by his love of botany he left Kew and entered in October 1898 the Royal College of Science at South Kensington with the intention of becoming a teacher of botany.

About this time the nursery firm of Veitch & Sons asked the director of Kew Gardens to recommend a suitable man to send to China to collect seeds and living plants. The choice fell on Wilson and he left England in April 1899 for China by the way of Boston and San Francisco. This was his first visit to Boston and to the Arnold Arboretum. One of the chief objects of his journey was the introduction of *Davidia involucrata* and he had instructions to see Dr. A. Henry who was at that time in Szemao, Yunnan, and obtain information where to find this tree which Dr. Henry had seen in Hupeh nearly 20 years before. Arrived at Hongkong he had to sail to Haiphong in Tonkin as the best way to reach Szemao. After much delay and with great difficulties owing to political disturbances[1] Wilson finally succeeded in reaching Szemao. After Dr.

[1] A vivid description of this episode is found in Wilson's Aristocrats of the Garden, pp. 275–294.

Henry had given him the desired information and all possible advice and assistance, he returned to Hongkong and went from there early in 1900 to Shanghai and up the Yangtze River to Ichang. There he found some of Dr. Henry's men who guided him to the place where Dr. Henry had seen the *Davidia* tree, but to Wilson's dismay all he found was the stump of the tree which had been cut down a few years previously. Wilson then decided to collect all the interesting plants of the region he could and in traveling around for this purpose he found in another locality trees of *Davidia* in full bloom, from which he collected in autumn a rich harvest of seed. With Ichang as his headquarters he collected in Hupeh, during 1900 and 1901, seeds and living plants of a great number of new ornamental plants and also a large amount of herbarium material.

In April 1902 he returned to England and on June 8 married Ellen Ganderston of Edgbaston, Warwickshire. Mrs. Wilson, quiet and unassuming, found her highest pleasure in making the happy atmosphere of the home in which he loved to write of his adventures in far away lands. They had one daughter, Muriel Primrose, who, was married last year to Mr. George Slate, a member of the staff of the New York Agricultural Experiment Station at Geneva, N. Y.

He had been so successful in his work that Messrs. Veitch & Sons decided to send him again to China, and in January 1903 he started on a second expedition. He arrived in Shanghai on March 22, and started at once for northern Szechuan. He made Kiatingfu his headquarters and first went to Tachienlu and later north to Sungpan where he found among other things *Meconopsis punicea*. The year 1904 also he spent in the exploration of western Szechuan and returned in March 1905 to England, where he attended for some time to his introductions in the Veitchian nurseries at Coombe Wood and later went as temporary assistant to the Herbarium at Kew to assist in the sorting and identification of his herbarium collections. He had sent in during the expeditions about 2000 numbers of seeds and plants and about 5000 numbers of herbarium specimens of which many proved new to science. In January 1906 he accepted a position as botanical assistant at the Imperial Institute in London.

The success of Wilson as a collector of seeds and living plants and of herbarium specimens attracted the attention of Professor C. S. Sargent and he secured Wilson's services for another exploring expedition to China this time in behalf of the Arnold Arboretum. In December 1906 Wilson came to the Arnold Arboretum and left on the last of the month for China via San Francisco. He arrived in Shanghai on Feb. 4th and proceeded at once to Ichang. He made an excursion in April to the southwest, where at an altitude of 7000 ft. the trees were still bare and snow was lying in the crevices. On this trip he discovered *Pinus Bungeana* wild in Central China. During the rest of the year he explored western Hupeh in different directions with Ichang as the base where he also spent the winter. In May of 1908 he traveled west and using Kiating as the base, explored western Szechuan in different directions finding the Min valley, Mt. Wa and Mt. Omei particularly interesting and profitable. At the end of the year he left Szechuan and went east again and leaving China towards the end of April 1909 arrived in England on May 15. He stayed in London until September when he returned to the Arnold Arboretum.

As the Conifers in western China did not bear cones in the autumn of 1908 and as it seemed important to secure cones and seeds of these trees, Wilson went to China for the fourth time in April 1910. He traveled by the Trans-Siberian railway via Moscow and Peking and arrived at Ichang by the end of May. As the men who had traveled with him on his former expeditions had been already notified, he was able to start without delay for western Szechuan and reached Chengtu on July 27. At the beginning of August he set out for Sungpan and after having collected there and having made arrangements for digging the bulbs of the Regal Lily in October, he started on his return trip to Chengtu. When following a narrow trail along a steep slope Wilson's party was surprised by a rock slide and Wilson was hit by a rock which broke his right leg in two places below the knee. He was still three days from Chengtu and with his leg temporarily bandaged with splints improvised from the legs of his camera tripod he had to be carried to Chengtu where he was cared for by doctors of the Friends' Presbyterian Mission, but infection had set in and at the end of six weeks as there were no signs of the bones uniting the question of the amputation of the leg was raised. The doctors, however, finally succeeded in staying the infection and after three months Wilson was able to walk on crutches.[1] Soon after he started on his return voyage to America where he arrived in March 1911. After spending a few weeks in a Boston hospital, where he had his right leg, which was nearly an inch shorter reset and fitted with a special boot, he was able to walk freely again. In 1910 the Conifers in western Szechuan had fruited freely and were collected as were the Lily bulbs by Wilson's trained collectors, so that notwithstanding the unfortunate accident the object of the expedition was realized.

During the two Arboretum expeditions Wilson collected about 65,000 specimens representing 4700 numbers and secured 1593 lots of seed and 168 lots of plants and cuttings, also about 850 excellent photographs of plants, general views of vegetation, and of other objects of interest.

From March 1911 to the end of 1913 he remained at the Arnold Arboretum sorting and classifying his collections and preparing jointly with the writer an account of his collections in China edited in three volumes by C. S. Sargent under the title "Plantae Wilsonianae."

In 1914 he went to Japan and spent February and March in southern Japan paying special attention to Cherries; in one garden, where 80

[1] See Wilson, Plant hunting II. 150–153.

garden forms were grown, he collected herbarium material of 63 named forms. From April to June he collected in Central Japan and in July and August in Hondo and Saghalin. In autumn he returned to central Japan and the last two months of the year he spent on the island of Shikoku. After having collected about 2000 numbers with many duplicates, taken about 600 photographs and sent home a large collection of Japanese cherries and seeds he returned to the Arnold Arboretum in January 1915.

From January 1915 to the end of 1916 he assisted again, after having worked and arranged his Japanese collections, in the preparation of the "Plantae Wilsonianae," the last part of which was issued in January 1917.

In January 1917 he started on his sixth voyage to the Far East and explored first in February and March the Liukiu and in April the Bonin Islands. In May he left for Korea and made several excursions with Dr. Nakai, the government botanist of Korea, and during 1917 visited almost all the provinces and also the southern island of Quelpaert and the small Dagelet Island whose flora is closely related to that of Japan. After having spent the last months of the year in the southern provinces he returned in January 1918 to Japan to proceed at once to Formosa where he arrived on January 22; he visited Mt. Arisan where *Taiwania cryptomerioides* the tallest tree of Eastern Asia grows and also ascended Mt. Morrison the highest peak of Formosa (13072 ft.). In April he left the island and returned to Japan where he visited the city of Kurume on Kyushu Island to see a collection of 250 named kinds of Kurume Azaleas; this collection was started by Motozo Sakamoto about 100 years ago and is now in the hands of K. Akashi; the parent stock came from Mt. Kirishima.[1] In June he made a second trip to Korea where he stayed until September 28, when he returned to Japan to visit Formosa once more. About the middle of December he left Formosa and after a short sojourn in Japan returned to the United States arriving in Boston on March 17, 1919. From this last expedition he brought back about 30,000 specimens representing 3268 numbers and 700 photographs, also many seeds and living plants. Some of the most interesting plants he introduced during this expedition are *Taiwania cryptomerioides*, *Pinus luchuensis*, *Juniperus taxifolia* and *Cunninghamia Konishii.*

In April 1919 Wilson was appointed Assistant Director of the Arnold Arboretum and in July 1920 started on a tour to Australia, New Zealand, India and Central and South Africa. He first went to England whence he embarked in September for Australia where he visited the Botanic Gardens at Perth, Adelaide, Melbourne, Sydney and Brisbane and made collecting tours into the native forests. February and March of 1921 he spent in New Zealand and Tasmania, then returned to Australia which country he left in June for Singapore. From Singapore he went to Penang, Rangoon and Calcutta and during August made a tour through the northern and north-western forests, visiting the botanic gardens at

[1] See Wilson, Plant hunting, II. 232–244.

Lucknow, Saharampur, Lahore, Simla and the Forestry College at Dehra Dun. In September he made a tour to Sikkim and Assam and in October went to Bombay and from there to Ceylon and later to the Nilghiri Hills visiting Ootacamund and Coimbatore. On Nov. 4 he sailed from Bombay for Mombasa in East Africa whence he proceeded at once to Nairobe in British East Africa; from there he visited Kenya and the forest where *Juniperus procera* grows. In the beginning of 1922 he went to Portuguese East Africa and thence to Victoria Falls in Rhodesia. On February 2 he reached Pretoria and from there traveled to Durban and Capetown. From Capetown he sailed on April 7 for London in June he paid a visit to Edinburgh and in July made a trip to France. On August 15 he sailed from Liverpool for the United States to take up again his duties as Assistant Director of the Arnold Arboretum. During this last tour he took 522 photographs and collected a large number of herbarium specimens in all the countries he visited. He fully realized the chief object of this tour which was to bring about closer relations between the Arboretum and other botanical institutions all over the world and to establish friendly relations with individuals interested in botany, horticulture and forestry. In April 1927 after the death of the Director, Professor C. S. Sargent, he was appointed Keeper of the Arnold Arboretum.

On October 15, 1930, Dr. and Mrs. Wilson were returning from a visit to their daughter. When near Worcester, Mass., the automobile which Dr. Wilson was driving skidded on a road made slippery by fallen leaves and swerving across the side walk crashed through a wooden fence and dropped over a steep embankment to a field 40 ft. below the level of the road. Mrs. Wilson was dead when extricated and Dr. Wilson died on the way to the hospital without regaining consciousness.

Wilson's chief contribution to horticulture and botany lies in his exploration of China where he spent most of his time between 1899 and 1911. His long sojourn in this country and his familiarity with it earned for him the epithet "Chinese" Wilson. He made four journeys to China and in all six to the Far East, the last two to the different countries of the Japanese Empire. He was a born plant collector; endowed with a strong physique, robust health, indomitable will power and a deep love of plants he succeeded in collecting and introducing into cultivation a greater number of plants than any other collector. He knew how to handle his men and never had any serious trouble in all his expeditions in the Far East. He introduced more than a thousand species previously unknown to cultivation and collected about 16,000 numbers of herbarium specimens, with numerous duplicates, so that now his specimens are found in all important herbaria throughout the world and his plants have spread to all the gardens of temperate and subtropical regions. It is not feasible to enumerate here all his introductions and only a few of the more important can be mentioned, as: *Abelia Schumannii* Rehd., *Abies Fargesii* Franch., *Acer Davidii* Franch., *Actinidia chinensis* Planch., *Aesculus Wilsonii* Rehd., *Ampelopsis megalophylla* Diels & Gilg, *Berberis Sargentiana* Schneid., *B. triacanthophora* Fedde, *Buddleia Davidii* var. *magnifica* Rehd. & Wils., *Buxus microphylla* var. *koreana* Rehd. & Wils., *Catalpa Fargesii* Bur., *Celastrus angulata* Maxim., *Cercis racemosa* Oliv., *Citrus ichangensis* Swingle, *Cladrastis Wilsonii* Takeda, *Clematis montana* var. *rubens* Ktze., *Corylopsis Veitchiana* Bean, *Cotoneaster apiculata* Rehd. & Wils., *Cunninghamia Konishii* Hay., *Deutzia longifolia* var. *Veitchii* Rehd., *Dipteronia sinensis* Oliv., *Evonymus Aquifolium* Loes. & Rehd., *Forsythia ovata* Nakai, *Fagus lucida* Rehd. & Wils., *Fortunearia sinensis* Rehd. & Wils., *Gaultheria Veitchiana* Craib, *Hamamelis mollis* Oliv., *Hydrangea Sargentiana* Rehd., *Ilex Pernyi* Franch., *Jasminum primulinum* Hemsl., *Kolkwitzia amabilis* Graebn., *Liquidambar formosana* Hance, *Liriodendron chinense* Sarg., *Lonicera tragophylla* Hemsl., *Magnolia Delavayi* Franch., *Malus theifera* Rehd., *Neillia sinensis* Oliv., *Photinia Davidsoniae* Rehd. & Wils., *Picea asperata* Mast., *Pieris taiwanensis* Hay., *Populus lasiocarpa* Oliv., *Prunus Dielsiana* Koehne and many varieties of *P. serrulata* Lindl. and *P. Lannesiana* Carr., *Pyrus Calleryana* Dcne., *Rubus lasiostylus* Focke, *Rosa Moyesii* Hemsl. & Wils., *Salix magnifica* Hemsl., *Sargentodoxa cuneata* Rehd. & Wils., *Schizophragma integrifolium* Oliv., *Sinofranchetia chinensis* Hemsl., *Sinowilsonia Henryi* Hemsl., *Sorbaria arborea* Schneid., *Sorbus Sargentiana* Koehne, *Spiraea Veitchii* Hemsl., *Staphylea holocarpa* Hemsl., *Stewartia koreana* Nakai, *Styrax Wilsonii* Rehd., *Sycopsis sinensis* Oliv., *Syringa reflexa* Schneid., *Taiwania cryptomerioides* Hay., *Thea cuspidata* Kochs, *Tilia Oliveri* Szysz., *Tsuga yunnanensis* Mast., *Vaccinium praestans* Lamb., *Viburnum rhytidophyllum* Hemsl., *Vitis Davidii* Foëx, *Aconitum Wilsoni* Stapf, *Astilbe Davidii* Henry, *Corydalis thalictrifolia* Franch., *Lilium regale* Wils., *Meconopsis integrifolia* Franch., *Primula Veitchii* Duthie, *Rodgersia aesculifolia* Batal., *Senecio tanguticus* Maxim., *Thalictrum dipterocarpum* Franch., *Rehmannia angulata* Hemsl., and others.

During his travels in different parts of the world Wilson paid much attention to forest conditions and published valuable contributions and suggestions relating to the forest problems of several countries, as Korea (A summary report forestry and afforestation of Chosen. 1919), East Africa (Indigenous forest trees of Kenya. 1922), South Africa and Australia (Northern trees in southern lands. 1923). He also rendered a great service to silviculture through the introduction of important forest trees into cultivation.

In his position as Keeper of the Arnold Arboretum he carried on the work of Professor Sargent and succeeded well in maintaining its steady progress and development. Besides this work he took an active interest in the Massachusetts Horticultural Society of which he was trustee and member of several important committees, and was advisory editor of the Society's publication "Horticulture." He also was much sought for as a lecturer by horticultural societies in different parts of the country and particularly he liked to lecture on the Arnold Arboretum, the subject closest to his heart. Notwithstanding all these activities he found time for literary work. He was a frequent contributor to horticultural and botanical periodicals and published a number of important horticultural and botanical books; he wrote of his experiences in China in "A Naturalist in Western China," "Plant Hunting" and "China, Mother of Gardens"; he dealt with ornamental plants, chiefly trees and shrubs, in "Aristocrats of the Garden," "More Aristocrats of the Garden," "Aristocrats of the Trees," and "America's Greatest Garden" which is a description of the Arnold Arboretum. More strictly botanical are "Cherries of Japan," "The Conifers and Taxads of Japan," "A monograph of Azaleas (with A. Rehder)" and "The Lilies of Eastern Asia." Wilson's books are well written. In his botanical publications he covers his ground completely with painstaking accuracy, knowing the plants he is dealing with not only from the study of ample herbarium material but also as they grow in their native habitat; in his more popular books he writes in a vivid and entertaining style imparting his masterly knowledge of the plants in a way that keeps the interest of the reader alive from cover to cover. Not the least valuable part of his books are the reproductions of the excellent photographs he took in all parts of the world.

Many honors were bestowed upon Wilson. On November 6, 1906 he received the Veitchian medal in recognition of his services in horticulture and in 1913 the Victoria medal of honor in horticulture. He also received the Geoffroy St. Hilaire Gold Medal, the George Robert White Medal, the Medal of the Horticultural Society of New York and the Centennial Gold Medal of the Massachusetts Horticultural Society. In 1916 the honorary degree of A.M. was conferred on him by Harvard University and in 1930 the honorary degree of Sc.D. by Trinity College of Hartford, Conn. He was elected fellow of the American Academy of Arts and Sciences, was an honorary member of the Rhododendron Society, the American Horticultural Society and also was a member of other scientific and horticultural societies. In recognition of his services to Chinese botany a new genus of Hamamelidaceae from China, *Sinowilsonia*, was named in his honor. Besides this, about 60 species and varieties of Chinese plants bear his name of which some may be cited here: *Aconitum Wilsonii* Stapf, *Aesculus Wilsonii* Rehd., *Aralia Wilsonii* Harms, *Cladrastis Wilsonii* Takeda, *Corydalis Wilsonii* N. E. Br., *Daphne Wilsonii* Rehd., *Deutzia Wilsonii* Rehd., *Evonymus Wilsonii* Sprague, *Ilex Wilsonii* Loes., *Iris Wilsonii* C. H. Wright, *Magnolia Wilsonii* Rehd., *Populus Wilsonii* Schneid., *Rubus Wilsonii* Duthie, *Salix Wilsonii* Schneid., *Sophora Wilsonii* Craib, *Sorbus Wilsoniana* Koehne, *Spiraea Wilsonii* Rehd., *Styrax Wilsonii* Rehd., *Ulmus Wilsoniana* Schneid., *Viburnum Wilsonii* Rehd.

Although Wilson was taken from us in the full vigor of his life, he had already accomplished so much that his memory cannot die with us who knew him both personally and as a friend. His name will live through generations to come in the new plants he discovered many of them commemorating his name and in the plants he brought from foreign lands to enrich and embellish our gardens.

LIST OF PUBLICATIONS OF ERNEST HENRY WILSON

Western China, a field for the sportsman. (In Field 1905, cvi, 109.)

Rubus innominatus. [London. 1905.]
"From the *Gard. chron.*," 1905, 3d ser., xxxviii, 290–291.

Leaves from my Chinese note-book. (In Gardeners' chronicle, ser. 3, 1905–06, xxxvii–xxxix.)

Vegetables. Illustr. (In Freeman, W. G., and Chandler, S. E. The world's commercial products, 1907, pp. 254–263.)

Fruits. Illustr. (Ibid, 1907, pp. 263–278.)

[Arnold arboretum expedition to China, 1907–1909; a series of 720 photographs.]

Gardeners' chronicle (contributions in). 1907–24, ser. 3, xli–lxxv. 30 articles.

Chinese Rhodendrons. [In collaboration with W. B. Hemsley.] (Kew bulletin of miscellaneous information, 1910, pp. 101–120.)

Plant novelties from China. (in Horticulture, 1910, xi, 5, 37, 69, 105, 145, 181, 221, 257, 293, 329, 367, 433, 473.)

Field notes relating to plants collected on the Arnold arboretum second expedition to Western China, 1910. London, *etc.* [1911].

[Arnold arboretum second expedition to China, 1910–1911; a series of 384 photographs.]

The kingdom of flowers. Illustr. (in National geographic magazine, 1911, xxii, 1003–1035.)

Sargent, C. S., editor. Plantae Wilsonianae (contributions in). 1911–17. 12 articles by E. H. Wilson; 47 articles in collaboration with Alfred Rehder.

Vegetation of western China. Introduction by C. S. Sargent. London. 1912. (Arnold arboretum. Publications, 2.)
An index to accompany a selection of 500 photographs from his "Arnold arboretum expedition to China, 1907–1909."

A naturalist in western China; being some account of eleven years' travel. With introduction by C. S. Sargent. 2 vol. London, Methuen & Co. [1913.] Plates.

The same. 2 vol. New York, Doubleday, Page & Co. 1913. Plates.

The "wood-oil" trees of China and Japan. [London. 1913.]
Bulletin of the Imperial institute, 1913, xi, 441–461.

[The Arnold arboretum expedition to Japan, 1914; a series of 619 photographs.]

The family tree of the modern rose. Done into graphic form by F. A. Wilson. [Boston.] 1915. Chart 24⅛ x 18½ in.

The Cherries of Japan. Cambridge, University Press. 1916. (Arnold arboretum. Publications, 7.)

The Conifers and Taxads of Japan. Cambridge, University Press. 1916. (Arnold arboretum. Publications, 8.)

A century of certified plants introduced from China. (In Journal of the Royal horticultural society, 1916, xlii, 35.)

The history and botanical relationships of the modern rose. [In collaboration with F. A. Wilson.] N. P. cop. 1916. Chart 32⅝ x 25⅛ in.

The American Rose annual (contributions in).
[i.] 1916. Some new Roses introduced by the Arnold arboretum during the past decade, pp. 37–41
[viii.] 1923. Roses in Australia, pp. 118–120.
[ix.] 1924. What Roses does America need? pp. 23–25.

Aristocrats of the garden. Garden City; New York, Doubleday, Page & Co. 1917. Plates.

The same. [2d ed.] Boston, The Stratford Company. 1926. Plates.
This edition has an entirely new set of plates.

The vegetation of Korea. [Seoul. 1918.]
Reprinted from the *Transactions of the Korea branch of the Royal Asiatic society*, 1918, ix, 1–16.

A summary report on the forests, forest trees, and afforestation in Chosen (Korea). [Edinburgh. 1919.]
Reprinted from *Transactions of the Royal Scottish arboricultural society*, 1919, xxxiii, 44–51.

Work of Arnold arboretum. Broadside. Illustr.
Reprinted from *Christian science monitor*, June 2–4, 1919.

The romance of our trees. Garden City; New York, Doubleday, Page & Company. 1920. Plates.
Enlarged from articles in *Garden magazine*, 1919–20.

Kurume Azaleas. (In Bulletin of the Massachusetts horticultural society, 1920, no. 3.)

Journal of the Arnold arboretum (contributions in).
i. 1920 ['19–20]. A phytogeographical sketch of the ligneous flora of Korea, pp. 32–43; The Bonin Islands and their ligneous vegetation, pp. 97–115; New woody plants from the Bonin Islands [in collaboration with Alfred Rehder], pp. 115–121; The Liukiu Islands and their ligneous vegetation, pp. 171–186; Four new Conifers from Korea, pp. 186–190; Camphor, Cinnamomum camphora Nees & Ebermaier, pp. 239–242.
ii. 1922 ['20–22]. A phytogeographical sketch of the ligneous flora of Formosa, pp. 25–41; The "Indian Azaleas" at Magnolia gardens, pp. 159–160; Notes from Australasia, i, ii, pp. 160–163, 232–236.
iii. 1922. Notes from Australasia, iii, pp. 51–55.
iv. 1923. The Rhododendrons of northeastern Asia exclusive of those belonging to the subgenus Anthodendron, pp. 33–56; Northern trees in southern lands, pp. 61–90; The Hortensias, Hydrangea macrophylla DC. and Hydrangea serrata DC., pp. 233–246.
v. 1924. The Rhododendrons of Hupeh, pp. 84–107; A new species of Reevesia, pp. 233–235.
vi. 1925. The Rhododendrons of eastern China, the Bonin and Liukiu Islands and of Formosa, pp. 156–186; Rhododendron chrysocalyx *Lév. & Vaniot*, pp. 200–201.
vii. 1926. The Taxads and Conifers of Yunnan, pp. 37–68; Thuja orientalis Linnaeus, pp. 71–74; Gymnospermae [of New Caledonia], pp. 76–85.
viii. 1927. Juniperus procera Hochst., pp. 1–2; An enumeration of the ligneous plants of Anhwei, by Alfred Rehder and Ernest H. Wilson, pp. 150–199; 238–240.
ix. 1928. Enumeration of the ligneous plants collected by J. F. Rock on the Arnold Arboretum expedition to northwestern China and northeastern Tibet, by Alfred Rehder and Ernest H. Wilson, pp. 4–27; 37–125; Podocarpus falcata R. Br., pp. 143–144.
x. 1929. Widdringtonia juniperoides, pp. 1–2.
xi. 1930. Thuya orientalis and Juniperus chinensis, pp. 135–136.

A monograph of Azaleas [in collaboration with A. Rehder]. Cambridge, University Press. 1921 (Arnold arboretum. Publications, 9)

The Azaleas of the Old World; by E. H. Wilson.—The Azaleas of North America; by Alfred Rehder.

Indigenous forest trees of Kenya. 2 pt. (in The Farmers journal of East Africa 1922, iv, no. 8, pp. 17–20; no. 10, pp. 17–20.)

Rhododendron society notes (contributions in).
ii. 1922–24. The Rhododendrons of northeastern Asia, pp. 93–106; The Rhododendrons of Hupeh, Central China, pp. 160–174; The Rhododendrons of the Bonin and Liukiu Islands and of Formosa, pp. 228–240.
iii. 1925 ['26]. The Rhododendrons of eastern China, pp. 18–28.

Acacias. (In Bulletin of the Massachusetts horticultural society, 1923, no. 11.)

Autumn landscapes.
Christian science monitor, Oct. 8, 1923.

Garden magazine (contributions in). Illustr.
xxxvi–xxxviii. 1923–24. Travel tales of a plant collector, xxxvi, 264–268, 309–311; xxxvii, 35–38, 127–130, 185–189, 247–252, 326–330, 384–387; xxxviii, 35–39, 101–105; Indian Azaleas at Magnolia, p. 159; Travel tales of a plant collector, pp. 170–173, 285–287, 355–359.
xxxix. 1924. Where Orchids are at home, pp. 215–219.
30 shorter articles contributed to vol. xix–xxxii, 1914–1921.

Northern trees in southern lands. [Lancaster, Pa., 1923.]
"Reprinted from *Journal of the Arnold arboretum*," 1923, iv, 61–90.

The same. New issue. 1929.

Country life (contributions in). Illustr.
liii. 1923. Oriental Cherries, pp. 511–514.
liv. 1923. Oriental Crabapples, pp. 9–12; Hawthorns, pp. 681–683.
lv. 1924. American Crabapples, pp. 26–28; The Magnolias, 2 pts., pp. 214–216, 252–253.
lvi. 1924. The modern Rose, 2 pt., pp. 648–650, 679–681; Wild Roses, pp. 848–850.
lvii. 1925. Hardy Azaleas, 2 pts., pp. 339–340, 444–445; Viburnums, pt. 1, pp. 1038–1040.
lviii. 1925. Viburnums, pt. 2, pp. 25–27.

Horticulture (contributions in), 1923–1930, n. s. I–VIII. 99 articles. Illustr.

Harvard's tree museum.
Museum work, 1924, vi, 147–152.

Garden (contributions in), 1924–1926, lxxxviii–xc. 26 articles.

House and garden (contributions in), 1924–1930. Illustr.
xlv. 1924. The royalty of spring, no. 3, pp. 61, 62, 63, 116, 118; Early flowering trees and shrubs, no. 4, pp. 62, 63, 114, 118, 122; Hardy climbers for the garden, no. 5, pp. 70, 71, 120, 122, 124; Wild Roses for the garden, no. 6, pp. 66, 67, 130, 132, 134.
xlvi. 1924. The brilliant gaiety of Azaleas, no. 1, pp. 56, 57, 100, 102, 104; The best hardy Conifers, no. 2, pp. 50, 51, 102, 104, 106, 108; Hawthorns for ornamental planting, no. 3, pp. 70, 71, 124, 126, 130, 132; Green carpets for various grounds, no. 4, pp. 66, 67, 106, 108, 110; Mid-season flowering trees and shrubs, no. 5, pp. 64, 65, 138, 140, 142; Fruiting trees and shrubs, no. 6, pp. 60, 61, 114, 120, 122.
xlvii. 1925. The beauty of the Barberries, no. 1, pp. 76, 77, 110, 114, 116; Winter beauty in the woody plants, no. 2, pp. 80, 81, 106, 108, 110, 114; The Cherries of Japan, no. 3, pp. 92, 93, 114, 116, 122; The Dogwoods and their great variety, no. 4, pp. 78, 79, 100, 102, 104; Honeysuckles in bush and vine, no. 5, pp. 90, 91, 114, 116; The glory of the Lilies, no. 6, pp. 66, 67, 116, 118, 124.

xlviii. 1925. The excellent family of Viburnums, no. 1, pp. 66, 67, 108, 110, 114, 116; The architecture of trees, no. 2, pp. 72, 73, 74, 75, 108, 110, 112; The family of Evonymus, no. 3, pp. 90, 91, 148, 154; Good bulbs from South Africa, no. 4, pp. 72, 73, 136, 138, 140; From Australia come Acacias, no. 5, pp. 92, 93, 120, 122; Curious fruits from many plants, no. 6, pp. 66, 67, 120, 122, 124.

xlix. 1926. Pecans and other Nut trees, no. 1, pp. 74, 75, 118, 122; Some Yews and low-growing Conifers, no. 2, pp. 82, 83, 150, 154; The best street trees for town betterment, no. 3, pp. 112, 182, 186, 188; Twelve best shrubs for ten regions, no. 3, pp. 101, 166; The coming of Kurume Azaleas, no. 4, pp. 112–113, 142, 146, 148; Spring beauty in the garden, no. 5, pp. 116, 117, 150, 154, 156, 170.

51 shorter articles contributed to vol. L–LVIII, July 1926–1930.

America's greatest garden. Boston, The Stratford Company. 1925. Plates.

The same. [2d issue.] Boston, The Stratford Company. 1925. Plates.

The same. Autographed de luxe ed. Boston, The Stratford Company. 1925. Plates.

The same. 3d ed. Boston, The Stratford Company. 1926. Plates.

The Lilies of eastern Asia. London, Dulau & Co. 1925. Plates.

Among the head-hunters of Formosa. (In The Country gentleman, 1925, xc, no. 7, pp. 7, 34.)

New plants from China. (In American forests and forest life, 1925, xxxi, 85–86, 91.) Illustr.

Price of the Regal Lily. (In The Country gentleman, 1925, xc, no. 36, pp. 11, 145.)

Wildrosen (in Gartenschönheit, 1925, vi, 106–109.)

Azaleas in the Arnold arboretum. (In Rhododendron society notes, 1926, iii, 73–76.)

Plant hunting. 2 vol. The Stratford Company, Boston, 1927. Plates.

Charles Sprague Sargent. (In Harvard graduates' magazine, 1927, xxxv, 605–615.)

Identification of the rhododendrons collected by J. F. Rock on the Arnold Arboretum expedition to northwestern China, 1924–27. (In Rhododendron society notes, 1927, iii, 160.)

Arnold Arboretum Bulletin of Popular information, 1927–1930; 3d ser., vol. 1–3.

More Aristocrats of the garden. The Stratford Company, Boston, 1928. Plates.

Plant crabapples for beauty in flower and fruit. (In Garden club of America Bulletin, 1928, no. 23, pp. 14–17.)

Garden cinderellas by Helen Morgenthau Fox. Foreword, pp. vii–ix, 1928.

Korean plants in gardens. (In New flora and silva, 1928, i, 9–21.) Illustr.

History and distribution of the Lilac. (Chapter in Susan D. McKelvey's "The Lilac," pp. 1–6. 1928.)

China, mother of gardens. The Stratford Company, Boston, 1929. Plates.

Broad-leaved evergreens. (In Ladies' home journal, 1929, xlvi, 13.) Illustr.

Good shrubs for every garden. (In Ladies' home journal, 1929, xlvi, 203.) Illustr.

Shrubs to beautify the garden, spring, summer and autumn. (In Yearbook of the Garden Club federation of Massachusetts, 1929, i, 28–32.) Illustr.

Thomas Roland, 1863–1929. (In Yearbook of the Massachusetts horticultural society, 1930, p. 71.)

Aristocrats of the trees. The Stratford Company, Boston, 1930, Plates.

The island of Formosa and its flora. (In New flora and silva, 1930, ii, 92–103.)

Report on a journey around Gaspé Peninsula in search of the ragweed or hay fever plant. (Not yet published.)

The ragweed or hay fever plant. (Not yet published.)

A NEW ARUNDINARIA FROM CHINA

AIMÉE CAMUS

Arundinaria Fangiana, nov. subsp.

Culmi 0.30 m. alti, fistulosi, ramulis ad nodos fasciculatis. Folia chartacea, lanceolata, basi rotundata, in petiolum brevem attenuata, apice longe acuminata, 3–5 cm. longa, 0.4–0.7 cm. lata, glabra, margine scabra, nervis secundariis utrinque 3, venulis transversis conspicuis; vaginae elongatae, striatae, glabrae, superne truncatae, fimbriatae; ligulae truncatae. Panicula foliata, paucispiculata; pedicelli 1–1.7 cm. longi, glabri, tenues; spiculae 2–2.5 cm. longae, 6-florae, subglabra; glumae steriles contiguae, prima 0.5–2 mm. longa, ovata, acuminata; secunda 3–7 mm. longa, subulata, margine scabra; rachillae internodium 1 mm. longum, sericeum; gluma fertilis inferior ovato-lanceolata, apice cuspidata, 1.2–1.4 cm. longa, superne pilosula, 7-nervia nervis conspicuis, scabris. Palea 7–8 mm. longa, apice bicuspidata, subenervia, carinis ciliatis; rachillae internodia 4–6 mm. longa, sericea, superne dilatata; stamina 3; stylus longus; stigmata 2, elongata, plumosa. Caryopsis oblonga, superne attenuata, 6 mm. longa, sulcata, glabra.

SZECHUAN: Mt. Omei, alt. 3000–3300 m., *W. P. Fang*, no. 3002, August 15, 1920.

The leaves here described are those of flowering branches; those of sterile branches are probably much larger.

In the lower flower the fertile glume is 1.2–1.4 cm. long, in the second flower 0.8–1 cm.; the length decreases gradually toward the upper part of the spikelet.

In its general characters *A. Fangiana* approaches closely *A. racemosa* Munro to which, I believe, it should be attached as a subspecies. *Arundinaria racemosa* grows in the Northeast Himalayas, Nepal and Sikkim, at about the same altitude and differs from the Szechuan plant in the two glumes being very distant from each other and much smaller (2–3.5 cm. long), often less long cuspidate, in the internode of the rhachilla being much longer between the upper sterile glume and the first flower, often exceeding 2 mm., and finally in the often less long-cuspidate fertile glumes exceeding the palea not so much.

In *A. racemosa* the shape and size of the sterile glumes are very variable, but in all specimens which I have seen in the Paris Herbarium and in those of the Kew Herbarium the empty glumes are more distant and the upper glume is farther removed from the lower flower than in *A. Fangiana.* This character of the lengthening of the lower internodes of the rachilla seems constant.

I wish to thank Dr. Hill, Director of the Royal Botanic Gardens at Kew, for his kindness in having had compared the Chinese plant collected by Fang with the numerous specimens of *A. racemosa* in the Kew Herbarium.

Muséum d'histoire naturelle,
Paris.

CHROMOSOME STRUCTURE AND THE MECHANISM OF CROSSING OVER

Karl Sax

Plates 25 and 26

The correlation between the chromosome mechanism and the genetic behavior of hybrids is now so completely established that the chromosome theory of heredity is no longer questioned. There are, however, several important genetic facts which have no adequate cytological explanation. The cytological problems of greatest importance in connection with the chromosome theory of heredity are the maintenance of the linear order of the genes and the mechanism of crossing over.

The present study of meiotic chromosomes was undertaken primarily to determine the significance of spiral chromonemata. It was found that the coiling of the chromonemata is not a mechanism essential for the preservation of the linear order of the genes, as has been suggested by several investigators, but is due to a difference in the rate of contraction of the chromosome and the chromonema at certain stages of meiosis.

The organization of the chromatids in the chromosomes of *Secale* and *Lilium* was so different from that commonly found in Orthopteran chromosomes that a comparative study was made of the chromatids in certain plants and animals. The chromosome behavior is fundamentally the same in the plant and animal species, but in the plant chromosomes there is a much closer association of the paired chromatids, which at metaphase appear as a single coiled chromonema.

This work has lead to a cytological interpretation of crossing over which seems to be in accord with all genetic requirements.

MATERIALS AND METHODS

The figures on which the present study is based were from smear preparations of *Secale cereale* and *Lilium regale.* Pollen mother cells were smeared on a dry slide, fixed in Navaschin's solution, and stained with crystal violet iodine. Smears of the spermatocytes of the grasshopper, *Melanoplus femur rubrum,* were also studied.

In *Secale* it was difficult to get satisfactory figures of diplotene and early diakinesis stages. If the pollen mother cells were smeared thin enough for critical study, the cell walls were usually ruptured and the chromatin was irregularly distributed among neighboring cells. Even in late diakinesis and metaphase the chromosomes may pass from one p. m. c. to another or be lost entirely, where the cells are subjected to too much pressure.

Throughout this paper the term chiasma will be used to mean the point where an exchange of partners occurs between the paired chromatids, and does not mean that a break has occurred as the original use of the term by Janssens would imply (Diagram 2).

Sister chromatids are those derived from a longitudinal splitting of one of the parental chromosomes. The association of homologous chromatids means that one chromatid from one parental chromosome is associated with a chromatid from the other homologous chromosome.

CHROMOSOME STRUCTURE IN SECALE

In the smear preparations it was not easy to get intact cells smeared sufficiently thin at the earlier stages of meiosis. The occasional critical figures obtained show that at pachytene there is an apparently split thread with pairs of chromomeres much like those pictured in *Lilium* by Belling (1928). Since the chromosomes appear to be double throughout most of their length at this stage, it is probable that they are longitudinally four-parted as Belling has described in *Lilium.*

At early diplotene the chromatids open out at various points forming the nodes and internodes so commonly seen in Orthopteran chromosomes. In *Secale* it was not possible to see the individual chromatids, but it is probable that the nodes and internodes represent exchange of partners among the chromatids. Possibly some of the apparent association between chromosomes may be due to twisting, but if so the twisting is slight as there is little evidence of it at later stages. There may be as many as four or five possible points of contact in a single chromosome at early diplotene as shown in figure 1.

The chromosomes shorten and thicken until at early diakinesis they appear as shown in figure 2, which represents three chromosomes from a single cell showing the typical structure at this stage. The loops have opened more fully and there are three or four points of contact which probably represent points where the chromatids exchange partners, although the relations of the chromatids at the chiasmas cannot be observed. There is no evidence of twisting of the chromosomes around each other in smear preparations, but in sectioned material such figures often show an apparent strepsinema condition. No internal structure of the chromosomes could be seen at this stage.

At late diakinesis the chromosomes have shortened and thickened further and the association between members of a bivalent is approximately the same as it is at metaphase. A typical chromosome at diakinesis is shown in figure 3. At this stage the chromosomes are usually attached only at the ends, although occasionally an additional median attachment is evident. Occasionally there is an apparent separation of chromatids for a short distance at one end of the chromosome.

The seven haploid chromosomes of *Secale* vary somewhat in the location of spindle fiber attachment which results in various types of metaphase associations. The points of fiber attachment range from subterminal to median and are apparently constant for each chromosome. At early metaphase most, or often all, of the chromosomes are ring shaped, but at slightly later stages there may be as many as four pairs of chromosomes which are in contact at only one end. The seven pairs of chromosomes at metaphase are shown in figure 7, and are so arranged that the details of each one can be shown, which would not be possible if drawn in their natural positions. In all chromosomes there is a coiled chromonema, but no evidence of its dual nature except at the ends of certain chromosomes. Often one end appears to be in contact with no indication of a chiasma or exchange of partners among chromatids, while the other end shows the association between the homologous chromatids. In most cases where the spiral chromonemata could be followed, they appear to coil in opposite directions in the two homologues at metaphase, which means that when the homologues are side by side the coiling is in the same direction. Each homologue also has approximately the same number of coils. In some cases the chromonema seems to reverse its direction of coiling near one end.

The chromosome with the subterminal attachment is easiest to follow in respect to chromonema coiling. This chromosome at early metaphase is shown in figure 4. The coiling here is more uniform than is usual. At this stage the chromonema is finer and more coiled than at the later stages. In this figure, there are about six coils in each homologue. The points of attachment show no evidence of a previous chiasma or exchange of partners among chromatids.

More typical examples are shown in figures 5 and 6. In these chromosomes the coiling is not so uniform and apparent breaks occur in the chromonemata at about the points of the spindle fiber attachment.

In the early metaphase it is often difficult to differentiate the chromonema from the less chromatic portion of the chromosome. In these figures only the chromonemata are pictured, except in figure 16 where they are shown surrounded by the lighter staining constituent of the chromosomes. The less chromatic material extends to, but not beyond, the coiled chromonema which suggests that the coiled chromonema is limited by a definite sheath or pellicle. At the lower end of the chromosome represented in figure 6, the chromonema appears extended and free from any matrix as if the pellicle had broken at the end and released part of the coiled chromonema. Outside of the chromosome, whether it shows coiled chromonema or is homogeneous, there is a hyaline area which gives the impression that there is a limiting membrane at some distance from the chromatic material, but this appearance may be an optical illusion.

Only occasionally is there evidence of an unterminalized chiasma at metaphase. Figures 8 and 9 show exchanges of partners among the chromatids but there is no evidence that there is any fundamental difference between these chromosomes and those shown in figure 10, or in the last chromosome of figure 7. In figure 10 the exchange of partners simply forms a cross as the chromatids are pulled apart and there is no apparent crossing of chromatids.

At the later stages when some of the chromosomes are about to divide, the chromonemata become less coiled and appear more or less corrugated rather than spiral. In figures 10 and 12 the number of turns is reduced to two or three compared with five or six at the early stages. Meanwhile the length of the chromosomes is about the same, although the chromonemata appear to be somewhat thicker.

The separation of the chromatids in each chromonema appears to occur very rapidly and appears only after the chromonema is straightened out. The chromosome represented in figure 13 shows a separation of chromatids through about half the length of each homologue. Occasionally one homologue is split while the other is still slightly coiled and apparently undivided (Figure 14). The point of the spindle fiber attachment is especially clear in this figure. When the chromatids are entirely split in both homologues the chromosome appears much like those frequently found in most Orthoptera. A typical tetrad is shown in figure 15. The homologous chromatids are parallel and show no evidence of coiling at this stage.

When the chromosomes divide and pass to the poles, most of them are in the form of double V's held together only at the point of the spindle fiber attachment. These anaphase chromosomes seldom showed any internal structure in my preparations although occasionally some indication of a spiral chromonema could be observed (Figure 16). In this figure only one chromatid of each daughter chromosome is shown.

As the homologues reach the poles the split chromosomes elongate and the two members of each daughter chromosome separate widely except at the point of fiber attachment (Figure 17). When the nuclear wall is formed the chromosomes appear as long, more or less twisted, chromonemata held together by a still thinner constriction. The fiber constriction involves an appreciable portion of the two chromonemata. There is no true resting stage between the first and second meiotic division. Often the nuclei appear to contain an indefinite spireme stage, but it is always possible to identify some of the chromosomes and doubtless all of them retain their earlier association throughout this stage.

At the second division the chromosomes are shortened and the pairs of chromosomes lie parallel and more or less at right angles to the axis of the spindle fibers. No spiral chromonemata were observed during the second divisions, but it is quite possible that they exist. Although in the interphase the chromosomes are held together only at the point of spindle fiber attachment, they show evidence of an attraction throughout their length at second metaphase and various degrees of association as the chromosomes are pulled apart (Figure 19). It is evident that at the second reduction division the chromosomes are not held together by the fiber attachment alone.

CHROMOSOME STRUCTURE IN LILIUM

The behavior of the chromosomes in the meiotic divisions of *Lilium* has been described by many investigators and only the more critical stages will be considered here.

As the four-parted chromosome reaches the diplotene stage and the chromatids open out, the chromonemata can be seen to be associated at a number of points. Most of these points probably represent points of exchange of partners among chromatids, although the individual chromatids could not be identified in my preparations at this stage (Figure 20). As the chromosomes shorten and are oriented on the first metaphase plate they show a reduction in the number of points of attachment. At this time there is an average of about two points of attachment for each chromosome. The orientation of the nodes and internodes is much like that found in the multiple ring chromosomes of certain Orthoptera. The looped internodes are usually more or less at right angles to each other. Such a chromosome with three nodes is shown in figure 21. The chromonemata are not clearly differentiated from the less chromatic substance in the chromosome at this stage, but do show evidence of a coiled structure. This coiled chromonema appears to be single at the earlier stages, but its double nature is indicated by the separation of the chromatids during the division of the chromosomes.

The chromosome represented by figure 22 has only two nodes and a comparatively long section of the chromonema between the fiber attachment end and the first node. If a chiasma has been partially terminalized prior to this stage, there should be some evidence of the dual nature of the chromonema at some point, which is not the case.

The nodes in *Lilium* are apparently points of exchange of partners among the four chromatids. The relation of the chromatids is shown in figure 23 where the chromatids are pulled out showing the chiasma. One of the paired chromosomes shows the separation of the chromatids. The other may be split, but in most cases the two daughter chromosomes lie in different planes more or less at right angles to each other so that the double nature of both chromosomes is not evident until the chromatids are widely separated.

The chromatids often vary in their rate of separation. One pair of chromatids may be completely pulled apart while the other is still coiled at the distal end (Figure 24). In these cases, one chromatid may be almost straight between the point of fiber attachment and the point where the chromatids are coiled together at their ends. The other chromatids, which are separated at the distal ends and are not under tension, begin to form spirals or corrugations. This behavior is especially clear in figure 25, where two chromatids have separated and contracted into a more or less coiled structure while the other two chromatids are still associated and are relatively straight. Often all four chromatids are straightened out forming a distorted diamond-shaped tetrad. When the division is completed the chromatids of the daughter chromosomes contract and show more or less coiling as shown in figure 26. They are associated only at the point of spindle fiber attachment. Only chromosomes with a terminal fiber attachment are shown, although two of the twelve *Lilium* chromosomes have a sub-terminal attachment.

CHROMOSOME STRUCTURE IN MELANOPLUS

The spermatocyte chromosomes of *Melanoplus* are so similar to those described in other Orthoptera that a detailed description of them is unnecessary. The individual chromatids can be followed at all stages from diplotene to the end of the meiotic division. The chromatids are seldom so closely paired that they appear as a single chromonema. The chromatids shorten as the chromosome shortens between diplotene and metaphase so that during this period there is no coiling of the chromonema.

DISCUSSION

COILED CHROMONEMATA

The spiral structure of the chromonema was first described in 1880 by Baranetzky in *Tradescantia*. Since that time the spiral chromonemata of meiotic chromosomes have received little attention until recent years, although they were described in *Ascaris* and *Lilium* by Bonnevie (1908), and Vejdovsky (1912).

Coiled chromonemata in meiotic chromosomes have been described in *Tradescantia* by Sands (1923), Kaufmann (1926), Kuwada and Sugimoto (1926), Kuwada and Sakamura (1927), Sakamura (1927), and Clausen (1929). They have also been described in *Podophyllum* by Kaufmann (1926), in *Secale, Vicia, Fritillaria,* and *Lilium* by Sakamura (1927), in *Lathyrus* by Maeda (1928), in *Hosta* by Inariyana (1928), in *Lilium* by Belling (1928), in *Crepis* by Babcock and Clausen (1929), and in *Matthiola, Polemonium, Allium* and *Lathyrus* by Clausen (1929). The writer has also observed spiral chromonemata in *Pinus, Sambucus,* and *Triticum.*

According to Kuwada (1927), the coiled chromonemata in *Tradescantia* chromosomes at meiosis are double with the two chromatids so arranged that the two spirals can be easily separated without uncoiling. In most genera there is little evidence of the double nature of the chromonemata until late metaphase or early anaphase.

Spiral chromonemata have been described in a considerable number of representative genera and as the smear technique and proper differential staining comes into more general use, it is probable that most plant genera will be found to have spiral chromonemata, at least in certain stages of meiosis. The fact that these structures are found in living cells and are so consistent in their form in a given genus, indicates that they are not artifacts produced by fixation. No doubt they are coagulated by fixation and may be greatly altered by certain reagents, but their definite organization and behavior must mean that the spiral chromonemata actually exist in the living chromosomes.

The behavior of the chromonemata, especially in *Lilium*, suggests that they possess the properties of a stiff elastic gel. When the coiled chromonema is stretched out at anaphase, it appears to contract and coil as soon as the tension is released when the chromatids finally separate (Figure 25). The contraction is not rapid since all stages of contraction can be observed in pollen mother cells from a single anther, but the behavior does suggest some elasticity of the chromonema.

In the earlier stages in both *Secale* and *Lilium*, the chromonemata lie in a matrix of lighter staining chromatic material, but when the chromatids are separated and elongated only the chromatids are differentiated from the cytoplasm. When the chromosomes shorten as they pass to the poles the less chromatic matrix is again visible (Figures 16 and 26). At a later stage when the daughter nuclei are organized, the *Secale* chromosomes again seem to consist of only the paired chromonemata (Figure 18). Bridges (Alexander 1928) suggests that the chromosome consists of a pellicle containing a chromonema of stiff gel coiled in a more fluid matrix. Such a chromosome sheath is described by Clausen (1929). A sheath, or limiting membrane, seems essential to account for the structures observed in the chromosomes.

THE SIGNIFICANCE OF SPIRAL CHROMONEMATA

According to Belling (1928), the chromonema of *Lilium* can contract to one-third of its original length before the chromomeres come in contact with each other. But the metaphase chromosome is only about one-tenth as long as the original chromonema at pachytene. Thus, in order to maintain the linear arrangement of the chromomeres a coiling or "zig-zagging" is necessary at the later stages of contraction. The approximation of the chromomeres and the corrugation of the chromosomes are sufficient to account for all of the contraction observed according to Belling.

A similar explanation of chromosome coiling has been presented by Bridges (Alexander 1928) based on the description of chromosomes of *Ascaris* by Bonnevie (1908) and Vejdovsky (1912, 1926). Bridges assumes that the genes are in contact at all stages and that the gene string does not change its actual length by stretching or contraction except to a subordinate degree. The contraction of the chromosome would of course necessitate a coiling or looping of the chromonema which contains the gene string, if the linear arrangement of the genes is to be maintained. Bridges accepts Kuwada's (1927) interpretation of the method of coiling. According to this interpretation the two chromatids of the chromonema coil in such a manner that for each turn of the spiral there is a twist of the two threads about each other in the reverse direction. Such a relation of the chromatids is essentially the same as a corrugation of two threads in only one plane. Such an arrangement of the chromatids permits free separation even though they may appear to be united in a single coil. This type of coiling would occur if the two chromatids are held fixed at the ends as the coiling occurs. Bridges assumes that coiling is caused by the contraction of the pellicle forcing the more or less elastic chromonema into a coil within the pellicle. The coiled condition is supposed to persist through metaphase and subsequent stages as pictured by Kuwada (1927) and Vejdovsky (1926).

In *Secale* there is evidence that coiling of the chromonema is caused by the contraction of the chromosome without any shortening of the chromonema. The chromosomes at metaphase are about one-third as long as they are at early diplotene while the chromonemata are about the same length at both stages (Compare Figures 1 and 4). At later stages, however, there is a shortening of the chromonemata while the chromosome length remains essentially unchanged. The spirals become fewer (Figures 12, 13, 14) and finally the chromatids appear as parallel rods (Figure 15). During the period from early metaphase to the stage where the chromosome shows its tetrad structure, the chromonema contract until they are about one-third as long as they were at early metaphase or early diplotene. Obviously, the coiling of the chromonemata is not a mechanism essential for the preservation of the linear arrangement of the genes.

In *Lilium*, the chromosomes at metaphase are about one-half as long as they are at diplotene. This shortening is associated with a coiling of the chromonemata which probably do not change their length to any great extent during this period. The length of the chromonemata at metaphase is about three times the length of the chromosomes which would mean that coiling begins when the chromonemata have decreased to about one-third of their original length, as Belling has found.

In *Lilium* the coiled chromonemata are found at all stages of the first meiotic division except for a short time when the chromatids are stretched out just before the final separation of the chromosomes. During metaphase the chromatids do contract somewhat but not more than one-half of their original length at diakinesis. When free from tension the chromatids are always coiled or corrugated at the first meiotic division.

The chromosomes of grasshoppers show approximately the same amount of contraction as found in *Secale* between diplotene and metaphase. There is, however, no coiling of the chromonema and the chromatids are easily identified as separate units through the various stages. At diakinesis and at metaphase of the meiotic divisions the chromatids are so oriented in most cases that they are as free to separate as if they were parallel rods. In early prophase there is some evidence of a coiled structure but in the later stages the shortening of the chromosomes is accompanied by a corresponding shortening of the chromonemata.

A comparison of the behavior of the chromosomes in *Secale*, *Lilium* and Orthopteran species indicates that the coiling of the chromonema is due to the difference between the rate of contraction of the chromosome and the chromonema. In grasshoppers the chromonema shortens as the chromosome contracts; in *Secale* the chromosome shortens rapidly in the prophase while the chromonema is practically unchanged in length, but at metaphase the chromosome is unchanged while the chromonema shortens; and in *Lilium* the chromonema shortens somewhat, but is always longer than the chromosome except when it is stretched out at early anaphase. Possibly the rate of division has something to do with these differences. In the two species of plants the stages from diplotene to late diakinesis are not easily obtained but in grasshoppers these stages are the most common. A rapid contraction of the chromosome might prevent the corresponding change in the chromonema while a relatively slow change in chromosome length and organization would permit the chromonema to accommodate itself to this change.

If the spiral chromonema is the result of a contraction of the chromatids held in a relatively fixed position, then they would be free to separate while still coiled as Kuwada describes for *Tradescantia*. In *Secale*, however, the paired chromatids do not separate while coiled and in *Lilium* the paired chromatids separate only when pulled apart at time of division of homologous chromosomes. In *Lilium* the chromonema between the spindle fibre attachments and the first chiasma, is usually straightened out before any split appears. Occasionally the distal ends of the chromonema separate while still coiled, but in most cases the chromatids appear to be closely associated and pull apart only under considerable tension. However, the coiling must be primarily of the type described by Kuwada, which is essentially the same as a corrugation in one plane, or the chromatids would be so entangled that they could not be pulled apart at metaphase. It is probable, however, that some twisting of the chromatids occurs so that they are not easily separated while coiled.

CHROMATID ASSOCIATION

In both plants and animals the most critical studies indicate that the meiotic chromosomes consist of four chromatids at diplotene. In some animals the four chromatids can be followed through the prophase stages and "tetrads" are commonly observed at diakinesis and at metaphase. Even in the more complicated ring formations in the Orthoptera the four chromatids can be identified.

In most plants, however, the tetrad nature of the chromosome cannot be seen until late metaphase when the homologous chromosomes are practically separated. The failure to recognize the tetrad structure of plant chromosomes until the late stages of the first meiotic division is evidently due to the close association and coiling of the paired chromatids.

According to Darlington (1929), homologous chromosomes at diakinesis and metaphase are held together only through the exchange of partners between pairs of chromatids. The chiasmas formed by exchange of chromatids evidently do hold the paired chromosomes together at the earlier stages, but at diakinesis and metaphase the homologous chromosomes are often associated where no chiasmas are present. In *Datura* there are no chiasmas at the late stages of the first meiotic division and the chromosomes are associated only at the ends (Belling 1927). In *Secale* many metaphase chromosomes are attached at one end with no apparent chiasma formation (Figures 4, 5 and 6). In many cases the chromosomes are in contact at their ends with no evidence of the existence of earlier chiasmas. Apparently the chromonemata can be attached at their ends without exchange of partners between pairs of chromatids. In *Lilium* the chromosomes at metaphase are apparently held together only by their chiasmas. The difficulty of separation of homologues seems to be dependent on the number of chiasmas present at metaphase. In *Secale* there is no evidence of unusual tension in the separation of homologues but in *Lilium* the paired chromosomes are pulled apart with some difficulty. Darlington finds that the short chromosomes with a single chiasma separate earlier than long chromosomes with several chiasmas.

Darlington's study of polyploid Tulips and Hyacinths does show that the degree of pairing of homologous chromosomes is dependent on the number of chiasmas formed at diplotene. Only two chromosomes can be associated at any one point at pachytene so that in triploids the homologous chromosomes always change partners. At diplotene only two chromatids are associated at any one point and the exchange of partners among chromatids forms the only connection between two or more homologous chromosomes. Darlington's explanation of the method of chromosome and chromatid association is of considerable value in interpreting the mechanism of crossing over and the chromosome behavior in polyploid species.

In triploids the bivalents are apparently separated with some difficulty at the first meiotic division while univalents appear to divide readily in most cases. Newton and Darlington (1929) suggest that the difference in the behavior of bivalents and univalents in triploids may be due to the differences in the constitution of the chromatids. In a bivalent the chromatids in each homologue may be from different parents, due to crossing over, while in a chromosome which has not been paired they are of the same origin. Occasionally a univalent appears to divide like a bivalent, but such a univalent may have been associated with the bivalents at an earlier stage so that it might consist of chromatids from different chromosomes.

According to Newton and Darlington (1929) the difficulty of separation of bivalent, and the ease of separation of univalent chromosomes must be due to a greater attraction between homologous chromatids than between sister chromatids. On purely *a priori* grounds there is no reason for supposing that such differences should exist. The fact that the chromatids are from different parents is no reason for supposing that they have a greater attraction for each other than chromatids from the same parent. In Orthopteran chromosomes, where the chromatids can be clearly observed, there is no indication that the association of sister chromatids is any different than the association of homologous chromatids. A stronger attraction between homologous chromatids than between sister chromatids would mean that only homologous chromatids would pair and as a result of such pairing no detectable crossing over could occur. Such an association is not in accord with genetic results in other genera.

The apparent difficulty of separation of bivalents compared with univalents is probably due to differences in the mechanical association of the chromatids. In *Lilium* the homologous chromonemata are coiled during metaphase and are connected by chiasmas. A single coiled chromonema would divide readily if the chromatids were associated according to Kuwada's interpretation, but the chromatids could not separate readily except in one plane. If these planes do not coincide in the bivalent then one pair of chromatids would separate only under considerable tension. There is evidence in *Lilium* that such differences between the two pairs of chromatids do exist (Figure 24). If there is any twisting of the homologues about each other, or if crossing over occurs, the difficulties in separation of coiled chromatids would be increased. In *Secale* the chromonemata are not coiled at the time of chromatid separation and the chiasmas are usually single and terminal. In these chromosomes there is no evidence that unusual tension is required to separate the chromosomes. The rare occurrence of univalents which behave like bivalents in the triploid Tulips and Hyacinths is probably due to some twisting of the chromatids about each other which would prevent easy separation.

PARASYNAPSIS AND TELOSYNAPSIS

In *Secale* and *Lilium* side by side pairing is essential to account for the relation of the homologues at diplotene and early diakinesis. The parasynaptic interpretation is the only one which is supported by cytological evidence in all genera which have been critically studied. The association of chromosomes in triploids described by Newton and Darlington (1929), and Belling's (1927) description of segmental interchange applied in more detail to the *Oenothera* problem of ring formation by Darlington (1929) has removed all remaining arguments for telosynapsis.

Recently telosynapsis has been described in *Secale* by Melburn (1929), but it is obvious from an examination of the figures presented that any conclusions drawn from such material are worthless.

PRE-REDUCTION OR POST-REDUCTION

The first meiotic division is generally considered to be the one at which the homologous chromosomes are usually separated (Wilson 1925, Robertson 1916), but there is good evidence that post-reduction also occurs (Wenrich 1916, Carothers 1926). When crossing over occurs there is little significance in these two terms because either meiotic division would be both reductional and equational for different segments of the same chromosome.

The invariable occurrence of pre-reduction must mean that sister chromatids are already bound together by the spindle fiber attachment at the leptotene or pachytene stage, or that the formation of nodes and internodes at diplotene is not a random process. The first suggestion is the more probable.

Where pre- and post-reduction occur in equal proportions in a particular chromosome (Wenrich, 1916) we must conclude that internode formation at diplotene depends on random association of chromatids and that the spindle fiber attachment does not unite associated chromatids until diplotene or later.

Invariable post-reduction will occur if homologous chromatids are bound together at the point of spindle fiber attachment at pachytene, or if internode formation is not a random process, but always occurs so that homologous chromatids are always associated at the point of fiber attachment. Post-reduction would also invariably occur if only homologous chromatids were paired, but in such a case crossing over could not be detected by genetic tests.

The fact that the chromosome segments are seldom, if ever, of the same genetic constitution at the point of the spindle fiber attachment in the "equational exceptions" described by Bridges and Anderson (1925) and by Redfield (1930) proves that in *Drosophila* the first meiotic division is invariably reductional. Both the cytological and the genetic evidence leads to the conclusion that regular post-reduction is exceptional.

THE MECHANISM OF CROSSING OVER

Janssens' earlier theory of crossing over has been discussed by Wilson and Morgan (1920) and his latest modification of the chiasmatype theory (Janssens 1924) has been considered in detail by McClung (1927). In his earlier discussion of crossing over Janssens assumed that the homologous chromosomes were twisted and broke at certain points of contact to reunite forming new associations which combined segments from each homologous chromosome. In his more recent paper he assumed that breaks might occur in the chromatids at any point where they were in contact. As the paired chromatids open out, the "chiasmas" represent points of segmental interchange between two homologous chromatids. Crossing over was described at various stages of meiosis including metaphase.

As Janssens' critics have pointed out, the chiasmatype theory of crossing over is not in accord with the cytological facts. The "chiasmas" are only optical phenomena and are formed by the alternate separation of different pairs of chromatids (Diagram 2). Since a detailed criticism of the chiasmatype theory of Janssens has already been presented by McClung it will be unnecessary to discuss it further at this time.

Belling (1929) has offered another explanation of crossing over, although it is presented only as a working hypothesis. He assumes that breaks occur in the chromatids at leptotene. When two breaks in different chromatids coincide at pachytene they may reunite to form a chiasma or point of segmental interchange between homologous chromatids. The chiasmas found at metaphase represent points at which crossing over occurs when the chromosomes divide.

As Newton and Darlington (1929) have pointed out Belling's theory of crossing over is based on the unproved assumption that the occurrence of one break will interfere with the occurrence of a second break in the adjacent sections of the chromatid. The theory can not be reconciled with the differences in chiasma formation in triploid and tetraploid Hyacinths (Darlington 1929). There is no explanation of the cause of numerous breaks in the chromatids, or if they do break, why they should reunite.

Morgan (1919) has suggested that the twisting of the chromosomes about each other in the early prophases might cause breaks in the chromatids so that sections of different chromatids would reunite. According to this theory crossing over is dependent on the twisting of chromonemata about each other at a number of points. This theory has little cytological support and does not meet all genetic requirements.

Several other theories have been presented to account for crossing over, but since they have such an inadequate cytological basis they need not be considered here.

In none of the theories presented is there an adequate explanation for the remarkable precision of crossing over so that duplication and deficiency of chromatid sections rarely occur. Nor is there any adequate reason why the chromatids should be recombined after they break.

No satisfactory interpretation of crossing over can be based entirely on the spermatocyte chromosomes of the Orthoptera, because in this group there is little cytological or genetic evidence that crossing over occurs in the males (McClung 1927, Nabours 1925). But if we assume, as seems probable, that chromosome behavior in plants and amimals is fundamentally the same, differing only in details, then our knowledge of Orthopteran chromosomes, combined with recent information concerning chromosome structure and behavior in plants, should serve as a basis for a logical interpretation of crossing over which is in accord with all genetic requirements.

The cytological interpretation of crossing over will be outlined, followed by the cytological evidence and a discussion of the genetic evidence.

THE CYTOLOGICAL INTERPRETATION OF CROSSING OVER

The homologous chromosomes become associated side by side at pachytene and are often more or less twisted about each other (Diagram 1). The chromonema of each chromosome is two-parted at leptotene although the sister chromatids may not be differentiated until pachytene or later. The pairs of chromatids may also be twisted about each other to some extent.

At diplotene the paired chromatids open out forming nodes and internodes. There is usually an alternate association of sister and homologous chromatids. The nodes represent points at which the chromatids change partners and are referred to as chiasmas. The maternal chromatids are pictured as black threads and the paternal chromatids as white threads (Diagram 2).

Between diplotene and metaphase the chromosomes contract about two-thirds of their length. In many species the paired chromatids do not contract during this period but form an apparently single spiral chromonema in each homologue. The relation of the chromatids during the earlier stages of chromosome contractions are shown in Diagram 3.

Due to the partial twisting of the chromosomes about each other at pachytene some of the internodes will be oriented so that two of the chromatids will come in contact where they cross each other at the chiasmas. Contact of chromatids at chiasmas will also occur due to the coiling of the chromonemata as shown in diagram 6. In this case the internodes open out at right angles to each other although only the sections of the chromonemata adjacent to the chiasma are represented. Beginning at the right end of this chromosome segment the coiling of both chromonemata is to the right, and at the chiasma the two crossed chromatids lie in one plane and are in contact with each other. Whether the chromatids come in contact due to twisting of the homologues or to coiling of the chromonemata, their subsequent behavior is the same. The paired chromatids on either side of the chiasma are closely associated and pairing of the chromatids, gene by gene, extends up to the point where the chromatids cross each other. The close association and coiling of the paired chromatids prevents any movement of the chiasmas and any strain imposed on the chiasma will cause the crossed chromatids to break at the point of contact. This strain on the chiasma could be induced by a further opening of the internodes, by unequal contraction of the two chromonemata, or by a slight amount of twisting of the chromonema as it coiled.

Breaks in the two chromatids occur at the same locus in most cases due to the close association of the paired chromatids. The free ends of the broken chromatids then pair, gene by gene, with the intact chromatids until the broken segments of the different chromatids are brought in contact. In this way segments from different chromatids are combined.

Between early diplotene and metaphase the number of chiasmas is reduced, due to crossing over between different chromatids. In the chromosome represented by diagram 2, there are four chiasmas. Let us assume that crossing over occurs at chiasmas B and C. The relation of the chromatids at metaphase will then appear as shown in diagram 4. At this time, and probably at the earlier stages, the chromatids are so closely associated that they appear as a single coiled chromonema. In this diagram the association of maternal and paternal chromatids is indicated by cross lines.

The chiasmas which persist until metaphase are pulled apart as the chromosomes divide and at anaphase the four chromatids are completely separated except at the point of the spindle fiber attachment. The composition of the four chromatids resulting from this double crossover is shown in diagram 5. In the second division the chromatids, now the daughter chromosomes, are finally separated.

Crossing over between sister chromatids is not shown in the diagrams, but it could occur if there were preferential pairing between homologous chromatids, which is improbable. It could also occur if there were a twisting of the chromatids and pairing of homologous chromatids on either side of the twisted strands. Random association of chromatids, so that there is pairing between diagonal as well as adjacent chromatids, will result in crossing over between sister strands. With random associations of chromatids one-third of the crossovers should be between sister strands in diploids and one-fifth in triploids. Such a random association of chromatids is also improbable.

The present theory of crossing over is based on the fact that at diplotene there is an exchange of partners between paired chromatids at the chiasmas and that between diplotene and late diakinesis there is a reduction in the number of chiasmas. When extensive movement of the chiasmas is prevented by the close association or coiling of the paired chromatids, any reduction in the number of chiasmas must be due to breaks in the chromatids at the chiasmas so that segmental interchange occurs between two chromatids. This segmental interchange between two homologous chromatids is the cytological mechanism responsible for genetic crossing over.

THE CYTOLOGICAL EVIDENCE

The cytological evidence for this interpretation of crossing over is based on the work of McClung and his students with the Orthoptera, and on the recent work of Belling and Darlington, as well as the results of the present study of chromosome structure in *Secale* and *Lilium*.

In both plants and animals the homologous chromosomes pair side by side at the early prophase of the first meiotic division. The individual chromosomes may be longitudinally split before pairing as shown by the work of Robertson (1916) and McClung (1928) and as indicated by the work on somatic chromosomes by Kaufmann (1926) and Sharp (1929). If the chromonema appears as a single thread at pachytene, which is often the case, the dual nature of the chromonema appears at later stages.

According to the cytological interpretation of crossing over two homologous chromatids must come in close contact with each other at chiasmas. This association of chromatids may be due to some twisting of the homologous chromatids about each other before or shortly after the diplotene stage, or to coiling of the chromonemata which would frequently cause the crossed chromatids to come in contact with each other at the chiasma. There is some evidence that a strepsinema stage occurs before or during early diplotene (Wenrich 1916, 1917, Robertson 1916, Janssens 1924). This twisting of the chromosomes occasionally persists to some extent to the later stages, but as a rule this torsion is undone as meiosis proceeds so that at metaphase the chromonemata on either side of a chiasma are in planes at right angles to each other. Strepsinema stages have also been described in many species of plants at both early and late prophase, but critical preparations show that twisting of synaptic chromosomes occurs only to a limited extent, if at all, at early and late diakinesis. Very little twisting of the chromosomes is necessary, however, to bring the crossed chromatids in contact at one or more chiasmas. Some such torsion seems necessary to produce apparently parallel chromosomes connected by a median chiasma as has been pictured at diakinesis in *Crepis* by Babcock and Clausen (1929).

There is no direct evidence that coiling of the chromonemata brings chromatids in contact at chiasmas, but there is adequate evidence that coiling of the chromonemata occurs in many plants and some animals. By means of wire models it can be demonstrated that such coiling will often bring the crossed chromatids into close contact at the chiasmas (Diagram 6).

In the Orthopteran chromosomes the associated chromatids change partners so that at diplotene different chromatids are paired in alternate internodes. The relation of the chromatids at diplotene is not so clear in plant chromosomes, but there is some evidence that the nodes are really chiasmas at this stage, and at metaphase when the chromosomes are pulled apart the chiasmas are frequently observed. It seems very probable that the relation of the chromatids at diplotene is the same in most plant and animal species.

There is no coiling of the chromonemata in the Orthopteran chromosomes at diplotene or later stages and the chromatids appear to be free to divide in a single plane. As the chromosome contracts and the diplotene loops open out, the chiasmas are free to move along the chromosome and are easily terminalized. In these chromosomes there is little chance for crossing over to occur.

In many plants and apparently in some animals the chromatids are closely associated and are coiled. In such chromosomes there can be no extensive movement or terminalization of the chiasmas before late metaphase. But there is a reduction of the number of chiasmas between diplotene and metaphase. In *Lilium* the total number of nodes or chiasmas is reduced from about thirty-nine at diplotene to about twenty-three at late diakinesis and metaphase (Belling 1928). A similar reduction of the number of chiasmas is also shown in *Tulipa* by Newton (1927). In *Secale* the average number of chiasmas in typical chromosomes is reduced from about four at diplotene to one or two at metaphase. The subterminal chiasmas in *Secale* are often terminalized but the median ones must break at the point of intersection of the crossed chromatids. If terminalization had occurred the dual nature of the chromonemata should be evident in the median sections of the chromosomes as it is occasionally at the ends.

The reduction in the number of chiasmas in these species must mean that in most cases the chiasmas which disappear between diplotene and diakinesis are due to breaks in the crossed chromatids. According to Belling (1928) "the nodes which disappear between diplophase and late diakinesis do not seem to be all or mainly twists. Nor do these vanishing nodes seem to be chiasmas which open out; for if so, this process should have been visible as it is at early anaphase." As has been shown in the diagrams such breaks would result in crossing over between two chromatids.

In some chromosomes as many as three or four crossovers are possible, although it is improbable that so many chiasmas would break at one division of a single chromosome. The average number of crossovers per chromosome appears to be about two in *Secale* and somewhat more than one in *Lilium* and *Tulipa*. Some of these crossovers may be between sister chromatids and could not be detected by genetic tests.

The cytological evidence for crossing over is not complete in all details and the actual breaks in the chromatids at chiasmas have not yet been observed. It seems very probable, however, that crossing over between homologous chromatids is associated with the reduction in the number of chiasmas between diplotene and diakinesis as Darlington (1929) has suggested.

THE GENETIC EVIDENCE

The genetic evidence for crossing over, especially in *Drosophila*, is now so complete that any theory regarding the mechanism involved can be thoroughly tested. The cytological interpretation presented in the preceding section seems to be in accord with the genetic results.

Time of Crossing Over

According to the genetic evidence crossing over must occur shortly after the pairing of homologous chromosomes. The cytological evidence presented in the preceding section indicates that it occurs between diplotene and diakinesis. The effect of temperature on crossing over would seem to show that the segmental interchange between chromatids occurs at an early prophase stage (Plough, 1917). The potential amount of crossing over is determined to some extent by the number of chiasmas formed at early diplotene so that any treatment which would affect chiasma formation at this time might be correlated with the amount of crossing over, even though the actual breaks at the chiasmas do not occur until late diplotene or early diakinesis.

Crossing over occurs at the four-strand stage as was shown by Bridges (1916). Several cases of equational non-disjunction were found where one of the X chromosomes was a crossover and the other was not. Later this interpretation was more fully confirmed by an analysis of equational exceptions obtained from triploid females of *Drosophila* (Bridges and Anderson 1925). These results clearly indicate that crossing over occurs when the chromosomes are split into two strands or chromatids. This work also proves that crossing over occurs only between two chromatids at any one point. The present cytological interpretation is in accord with these genetic results, but the previous theories are not.

Gene Duplication and Deficiency

Crossover levels between the two chromatids seem to be remarkably uniform, but Sturtevant (1925) has found a case of unequal crossing over at the bar locus of the X chromosome in *Drosophila*. If the paired chromatids are not closely associated on either side of a chiasma it is possible for the crossed chromatids to come in contact so that a break will result in unequal crossing over. Such a relation of the chromatids and the results of unequal crossing over are shown in diagrams 7 and 8.

Sturtevant found that the order of the different genes was unchanged in duplicated and deficient sections of the chromosomes but the order of the two alellomorphs, bar and infrabar, may be BB′ or B′B. The order of alellomorphic genes will depend on the point at which unequal crossing over occurs.

Sturtevant's data indicate that the length of the chromosome is increased by duplication because the percentage of crossovers between forked and fused in normal bar stock is 2.5, but when the bar locus is double in each chromosome the percentage of crossing over between forked and fused is increased to 3.5. Apparently the unequal crossing over in this case involves an average length of one genetic unit.

Subsequent pairing between duplicated and deficient chromosomes will involve difficulties in the pairing of similar genes, although the elasticity of the chromonemata might permit pairing of similar genes in cases where only a very short section is involved.

The most remarkable fact concerning crossing over is the accuracy of chromatid exchange at the same level. The unequal crossing over at the bar locus described by Sturtevant is exceptional, and is the only case recorded. Equal crossing over would be expected to occur if the associated chromatids are paired, gene by gene, up to the point of crossing of chromatids. This close association of the paired chromatids on either side of the chiasma would result in very short sections of the chromatids where crossing over is free to occur. In fact the pairing of similar genes in the associated chromatids would be expected to bring the point of crossing over to a region between the same two consecutive genes in each of the two chromatids involved in crossing over. The fact that the chromatid can contract about two-thirds of its length between diplotene and late metaphase suggests that at the time of crossing over, the gene elements may be separated by genetically inactive segments of the gene string.

Crossing over between Sister Chromatids

Crossing over between sister chromatids can only be detected by genetic tests in case of unequal crossing over, or perhaps by comparing the amount of crossing over in diploids and in triploids. Sturtevant (1928) has found no case of unequal crossing over at the bar locus of the X chromosome which is not accompanied by crossing over between forked and fused, so he concludes that in this region of the X chromosomes crossing over between sister chromatids does not occur. If pairing occurs between chromatids at random at the prophase of the meiotic division, then one-third of the crossovers in diploids and one-fifth of the crossovers in triploids will be between sister chromatids. A comparison of crossing over frequency in diploids and triploids should show whether or not crossovers occur between sister strands, but as Anderson and Bridges (1925) and Redfield (1930) have found, the differences between diploids and triploids show so much variation in different regions of the chromosome that any differential effect on crossing over, which might be caused by crossing over between sister chromatids, is completely masked.

There is no genetic evidence that crossing over occurs between sister chromatids, and the cytological evidence indicates that such crossing over must be exceptional. Crossing over between sister chromatids posits preferential pairing of homologous chromatids which is unlikely, and if such pairing is exclusive no genetic crossovers would occur. An occasional crossover between sister chromatids might be expected, due to the association of different homologous chromatids in two successive internodes, but such crossovers must be considered exceptional.

Interference

The phenomenon of interference was first observed by Sturtevant in 1913 and since that time it has been extensively studied by a number of investigators (Morgan, Bridges, and Sturtevant, 1925). In *Drosophila* chromosomes there is a modal interval between crossovers so that a break in one region interferes with a second break. Zero coincidence is found for a certain distance, followed by an increase and then a second decrease, due to a second point of crossing over. The amount of coincidence is different for the three long chromosomes and varies in different sections of the same chromosome. The relation of the chiasmas and internodes seems to provide an adequate cytological explanation of interference. The genetic evidence indicates that the distance between crossovers is variable and Bellings (1928) description of *Lilium* chromosomes shows that the internode length is variable. The high coincidence in the middle of the third chromosome of *Drosophila* indicates that breaks in chiasmas are more likely to occur in two consecutive chiasmas where the internode length is comparatively long.

Variations in Crossing over

The amount of crossing over varies in different chromosomes and in different sections of the same chromosome (Morgan, Bridges, and Sturtevant, 1925). Crossing over would be expected to be a variable process if chiasmas are formed more or less at random and break only as the result of accidental twisting, unequal chromonema contraction, or other irregularities. Both the genetic and the cytological evidence is in accord with Morgan's (1925) conclusion that crossing over is an accidental by-product of the reduction division.

In *Drosophila* crossing over does not occur in the male and may be partially or completely inhibited in the female. There are several possible explanations to account for the lack of crossing over in the male. If only sister chromatids are associated at diplotene, there would be no chiasma formation and no opportunity for crossing over to occur. But due to absence of chiasma formation the association of homologues would be loose and considerable irregularity would be expected in the first meiotic division. There is adequate genetic and cytological evidence that such irregularity does not occur. Random pairing between only homologous chromatids would also prevent any detectable crossing over, but there is no reason to suppose that such pairing occurs, or if it occurs, why it should not occur in the female as well as the male. The only alternative seems to be that the association of the chromatids in the male is the same as in the female, but that in the male the chromatids can adjust themselves to changes in the chromosome during meiosis without breaking at the chiasmas as appears to be the case in the Orthoptera[1].

The Y chromosome of *Drosophila* is a special case because it shows no crossing over with the X even when it is present in the female (Bridges 1916). In secondary non-disjunction of an XXY female Bridges finds that pairing between XX occurs about four times as often as between XY. This difference in pairing of the X and Y chromosomes indicates that there is less attraction between the X and Y than between the X chromo-

[1]Huettner's description of the spermatocyte chromosomes of *Drosophila* which appears in a recent issue of the Zeit. f. Zellforschung indicates that there is a loose association of homologous chromosomes, but that a few chiasmas are formed and the first meiotic division is regular.

somes. Such a difference may be due to the absence of genetic factors, or it would occur if chromatid pairing in the Y is always between the sister chromatids. If only sister chromatids pair the X and Y could be associated only at the ends, which would result in loose pairing of the X and Y in normal males so that these chromosomes should divide before the division of the autosomes or tend to lag behind as univalents. Metz (1926) has found in several species of *Drosophila* that there is a loose association of the X and Y chromosomes at meiosis. According to Huettner (1930) the X and Y lag behind in the first spermatocyte division of *Drosophila melanogaster*, although apparently not as univalents.

Where crossing over is suppressed in all chromosomes of the female (Gowen and Gowen 1922), it is possible that pairing occurs only between sister chromatids. As has previously been pointed out, such pairing would result in a loose association of homologous chromosomes with the frequent occurrence of univalents at the first meiotic division and considerable irregularity in chromosome distribution. Gowen (1928) does find a relatively high proportion of chromosome duplication in the progeny of non-crossover flies.

This interpretation of the cause of no crossing over is supported by the work of Beadle (1930). He found that a single recessive factor caused asynapsis, or lack of chromosome pairing at meiosis, in *Zea*. The pollen of such plants is sterile, but some of the ovules are functional. When these asynaptic plants are pollinated with normal pollen about half of the progeny were triploids. Asynapsis leads to triploid production in *Zea* and is probably the cause of triploid flies in Gowen's non-crossover stock.

Asynapsis would occur if there is a differential rate of development between chromosome pairing and chromatid organization. If at leptotene the sister chromatids have already reached a stage of separation and development commonly found at diplotene then there can be no chiasma formation at later stages because the sister chromatids are already organized in pairs. The pairing between homologous chromosomes would be very loose, if it occurred at all. As a result no crossovers would occur, univalents would usually be found at diakinesis and metaphase, and irregular distribution of univalents would produce gametes with the haploid, intermediate, and diploid chromosome numbers. Asynaptic females crossed with normal males would produce aneuploid and triploid progeny. Apparently the pairing of sister chromatids in non-crossover stocks of *Drosophila* is not exclusive because rare crossovers are obtained (Gowen, 1929). In Beadle's asynaptic strain of *Zea* a few bivalents are often found.

A considerable number of crossover modifiers have been found in *Drosophila* which decrease or eliminate crossing over in certain chromosome segments (Morgan, Bridges, and Sturtevant, 1925). These variations in crossing over may also be due to preferential pairing of sister chromatids in these regions. If preferential pairing of sister chromatids occurs over a considerable portion of the chromosome there should be a loose association of the homologues, and crossing over should be reduced or eliminated from a relatively long section of the chromosome. Bridges' (1916) work on high non-disjunction stocks of *Drosophila* seems to be of value in solving this problem. According to Bridges a high percentage of non-disjunction exceptions from XXY females means that the percentage of XY pairing is increased while pairing between XX is decreased. This change in the relations of the X and Y chromosomes would be expected if a genetic factor caused preferential pairing of sister chromatids for a considerable length of the X chromosome. The association between X chromosomes would be decreased because few chiasmas would be formed. The loose association between the two X chromosomes would result in an increase of XY pairing, which normally is very low. But such an association of sister chromatids would also decrease the amount of crossovers between the X chromosomes which do pair. It is perhaps significant that Bridges found crossover reducers in high non-disjunction stocks which decreased the amount of crossing over in the X chromosomes (Morgan, Sturtevant, and Bridges, 1925).

Crossing over would also be eliminated in chromosome segments if a chromosome with an inverted segment paired with a normal chromosome as Sturtevant (1926) has found. The cytological explanation is obvious.

Crossing over in Triploids

If the present cytological interpretation of crossing over is correct it must also be in accord with the crossover relations found in triploids. In triploid females of Drosophila crossing over has been found to occur between all three of the X chromosomes (Bridges and Anderson 1925) and between the three third chromosomes (Redfield 1930). In both cases two types of double crossovers were found; recurrent crossovers where the second crossover involves the same two chromosomes as the first, and a progressive type in which the second crossover takes place between different chromosomes from the first. These two types of crossovers occur with equal frequency. Appropriate genetic tests have permitted an analysis of the two chromosomes which pass to the same egg cell.

The behavior of the chromosomes in triploid Hyacinths described by Darlington (1929) seems to offer an explanation of triploid crossing over. When three homologous chromosomes pair at pachytene only two of them are associated at any one point so that an alternation of partners occurs. The association of three such homologous chromosomes at pachytene is represented by diagram 9. At diplotene chiasmas are formed between any two of the three chromosomes as shown in diagram 10. At the first reduction division two of the three chromosomes pass to one pole. The equational division separates paired chromatids.

In the hypothetical trivalent, shown in diagram 10, let us assume that crossovers occur at chiasmas 1, 3, and 5. The spindle fiber attachment is at the left end. We will assume that chromosomes A and B pass to the same pole at the first meiotic division. The chromatid constitution for the different segments of these two chromosomes will be $\frac{\text{AAAA}}{\text{ABBB}}$ and $\frac{\text{BAAC}}{\text{BBCA}}$. The second reduction division will then separate paired chromatids so that the two chromatids received by the egg cell will be $\frac{\text{AAAA}}{\text{BAAC}}$, or $\frac{\text{AAAA}}{\text{BBCA}}$ or $\frac{\text{ABBB}}{\text{BAAC}}$ or $\frac{\text{ABBB}}{\text{BBCA}}$. Three of these associations of chromatids would result in "equational exceptions" since for part of their length the two chromatids are alike. Crossing over between three chromosomes may be progressive or recurrent. In the above case only progressive crossovers occur, but if chromosome C paired with A instead of B, which would be equally probable, then recurrent crossovers would be obtained. With random association of the three homologous chromosomes, recurrent and progressive crossovers should occur in equal numbers.

In both the X and the third chromosome of *Drosophila*, regions in which the genes are closely spaced on the diploid map are lengthened on the triploid map, and regions in which the genes are far apart in the diploid are shortened in the triploid. The work of Muller and Painter (1929) and of Dobzhansky (1930) seems to throw some light on the possible cause of these differences in crossing over. These investigators found, that in the third chromosome the regions where the genes are closely spaced on the genetical map are far apart on the cytological map and *vice versa*. Such a relationship suggests that in regions where the genes are closely spaced on the genetical map, the average internode length between chiasmas is relatively long. The occurrence of long internodes would indicate that there is preferential pairing of chromatids in such regions. Such preferential pairing is probably caused by the physical relations of the chromosomes at the time of pairing rather than any preferential attraction between different chromatids.

When three chromosomes pair there may be preferential pairing of two chromosomes in the region where long internodes occur in diploids or the chromosomes may change partners in this region. In either case the number of chiasmas will be increased in this region in the triploid. In the trivalent shown in diagram 10, let us assume that in the diploid the internode length frequently extends from chiasma 1 to chiasma 4. In the triploid two additional chiasmas are formed in this region. Thus crossing over in triploids would be increased in regions where genes are closely spaced in the diploid.

In regions where the internode lengths are short in the diploid the intercalation of the third chromosome between two chiasmas would not be expected to occur, so that for regions where the genes are widely spaced on the diploid map crossing over in the triploid would be reduced one-third.

SUMMARY

In *Secale cereale* each of the homologous chromosomes at metaphase of the first meiotic division contains a single coiled chromonema. The direction of coiling of the chromonema, in respect to the point of spindle fiber attachment, seems to be the same for any two homologous chromosomes.

During metaphase the chromonemata contract and become uncoiled. The chromonemata do not divide into separate chromatids until the chromonemata are uncoiled, although doubtless the two chromatids retain their identity from early prophase.

Between diplotene and metaphase the chromosomes shorten about one-third, but the chromonemata retain their original length by coiling. During metaphase the length of the chromonema is reduced about one-third while the length of the chromosome remains essentially the same.

In *Lilium regale* coiled chromonemata are also found at metaphase. The first meiotic division begins while the chromonemata are coiled. As the chromosomes are pulled apart the spindle fiber ends of the chromonemata are straightened out. The chromosomes are apparently separated with difficulty. When the division is nearly completed the chromonemata are pulled out into more or less straight rods. At this time the two chromatids of each chromonema can be identified. When the division is complete the chromatids contract and become more or less coiled. At early telophase each daughter chromosome appears as two coiled chromatids held together only at the point of the spindle fiber attachment. During metaphase and anaphase there is some shortening of the chromonemata but it is always longer than the chromosome when free from tension.

The coiling of the chromonemata, in *Secale* at least, is not a mechanism essential for the preservation of the linear order of the genes.

A comparison of *Secale* and Orthopteran chromosomes indicates that coiling of the chromonema is due to a differential rate of contraction between the chromosome and the chromonema.

The relations of the chromatids during the meiotic divisions are fundamentally the same in both plant and animal chromosomes. The nodes, or chiasmas, represent points where the chromatids exchange partners.

In plants the individual chromatids are closely associated in an apparently single chromonema and the tetrad nature of the bivalent chromosome is not clearly evident until late metaphase or anaphase.

Between early diplotene and late diakinesis the number of chiasmas is reduced, due primarily to breaks in the chiasmas. Such breaks would result in crossing over between the two chromatids involved.

A cytological interpretation of crossing over has been presented, based on the reduction in numbers of chiasmas between diplotene and late diakinesis. This interpretation of crossing over seems to be in accord with all of the genetic requirements.

The genetic phenomena of interference, gene duplication and deficiency, variations in crossing over, and crossing over in triploids, have been discussed in their relation to the cytological mechanism of crossing over.

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LITERATURE CITED

Alexander, J. (1928). Colloid Chemistry. Vol. ii. p. 1029. The Chemical Catalogue Co. New York.

Belling, J. (1927). The attachments of chromosomes at the reduction division in flowering plants. (Journ. Gen. **18**: 177–205.)

Belling, J. (1928). The ultimate chromomeres of *Lilium* and *Aloe* with regard to the number of genes. (Univ. Calif. Pub. Bot. **14**: 307–318.)

Belling, J. (1928). Contraction of chromosomes during maturation divisions in *Lilium* and other plants. (Univ. Calif. Pub. Bot. **14**: 335–343.)

Belling, J. (1928). A working hypothesis for segmental interchange between homologous chromosomes in flowering plants. (Univ. Calif. Pub. Bot. **14**: 283–291.)

Belling, J. (1928). Nodes and chiasmas in the bivalents of *Lilium* with regard to segmental interchange. (Biol. Bull. **54**: 465–470.)

Babcock, E. B. and Clausen, J. (1929). Meiosis in two species and three hybrids of *Crepis* and its bearing on taxonomic relationship. (Univ. Calif. Pub. Agr. Sci. **2**: 401–432.)

Baranetzky, J. (1880). Die Kerntheilung in der Pollenmutterzellen einiger *Tradescantien*. (Bot. Zeit. **38**: 241–247, 265–274, 281–295.)

Beadle, G. W. (1930). Genetical and cytological studies of Mendelian asynapsis in *Zea mays*. (Cornell Univ. Mem. **129**: 3–23.)

Bonnevie, K. (1908). Chromosomenstudien, 1. Chromosomen von *Ascaris, Allium* und *Amphiuma*. (Arch. Zellforsch. **2**: 201–278.)

Bridges, C. B. (1916). Non-disjunction as proof of the chromosome theory of heredity. (Genetics, **1**: 1–52, 107–163.)

Bridges, C. B. and Anderson, E. G. (1925). Crossing over in the X chromosomes of triploid females of *Drosophila melanogaster*. (Genetics **10**: 418–441.)

Carothers, E. E. (1926). The maturation divisions in relation to the segregation of homologous chromosomes. (Quart. Rev. Biol. **1**: 419–435.)

Clausen, J. (1929). Exchange between chromatids of homologous chromosomes. (Reviewed in Res. Genetica **4**: 252.)

Darlington, C. D. (1929). Meiosis in polyploids. II Aneuploid Hyacinths. Journ. Gen. **21**: 17–56.)

Darlingtion, C. D. (1929). Ring formation in *Oenothera* and other genera. (Journ. Gen. **20**: 345–363.)

Darlington, C. B. (1929). Chromosome behavior and structural hybridity in Tradescantiae. (Journ. Gen. **21**: 207–286.)

Dobzhansky, T. (1930). Translocations involving the third and the fourth chromosomes of *Drosophila melanogaster*. (Genetics, **15**: 347–399.)

Gowen, J. W. (1919). A biometrical study of crossing over. (Genetics, **4**: 205–250.)

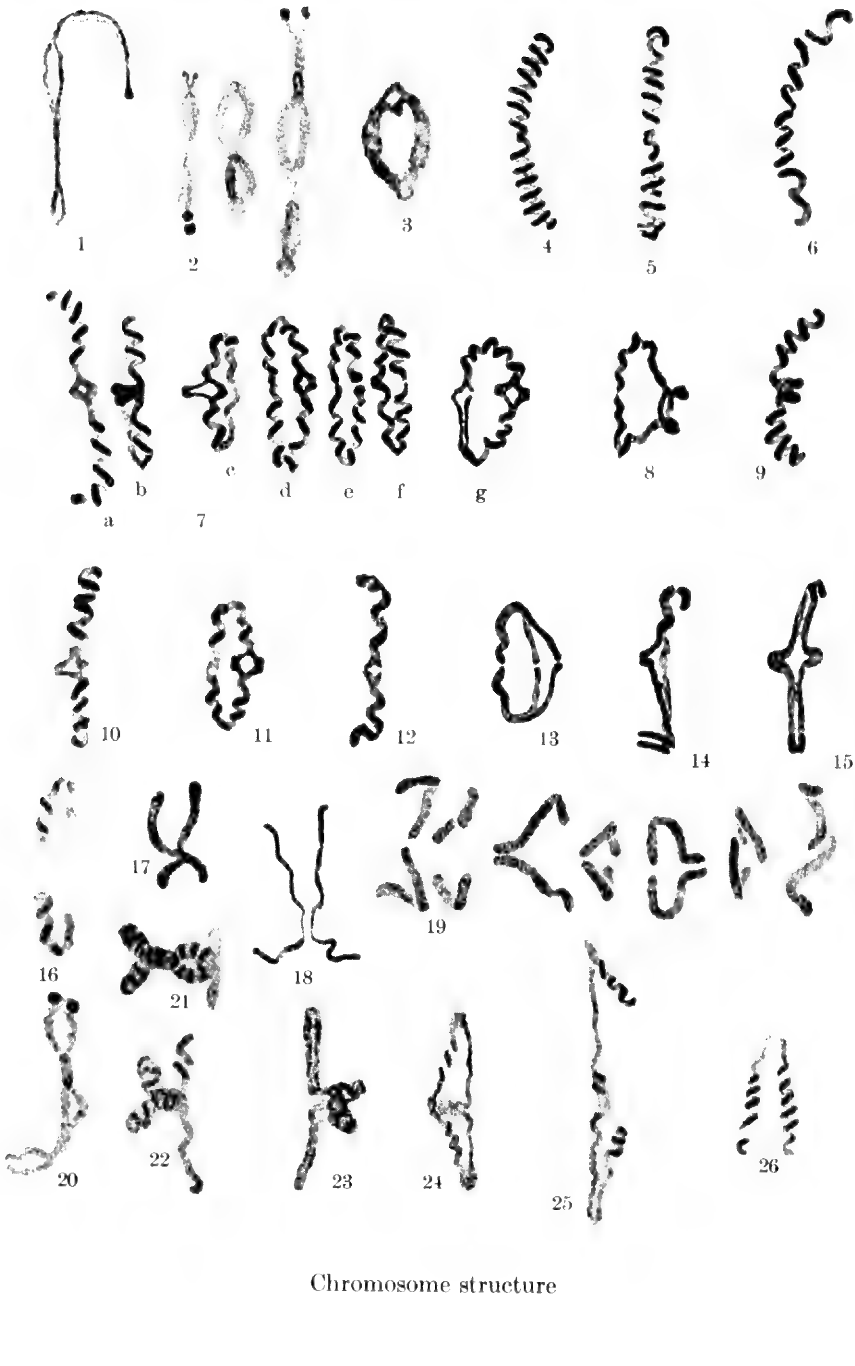
Gowen, M. S. and Gowen, J. W. (1922). Complete linkage in *Drosophila melanogaster*. (Amer. Nat. **56**: 286–288.)

Gowen, J. W. (1928). Mutation, chromosome non-disjunction and the gene. (Science, N. S. **68**: 211–212.)

Gowen, J. W. (1929). The cell division at which crossing over takes place. (Proc. Nat. Acad. Sci. Wash. **15**: 266–268.)

Huettner, A. F. (1930). Recent criticisms concerning meiosis in *Drosophila melanogaster*. (Science, **71**: 241–243.)

INARIYAMA, S. (1928). On the spiral structure of chromosomes in *Hosta Sieboldiana* Engl. (Bot. Mag. Tokyo, **42**: 486–489.)
JANSSENS, F. A. (1924). La chiasmatypie dans les insects. (La Cellule, **34**: 135–359.)
KAUFMANN, B. P. (1926). Chromosome structure and its relation to the chromosome cycle. 1. Somatic mitoses in *Tradescantia pilosa*. (Amer. Journ. Bot. **13**: 59–80.)
KAUFMANN, B. P. (1926). Chromosome structure in its relation to the chromosome cycle. II. *Podophyllum peltatum*. (Amer. Journ. Bot. **13**:355–63.)
KUWADA, Y. AND SUGIMOTO, T. (1926). On the structure of the chromosomes in *Tradescantia virginica*. (Bot. Mag. Tokyo, **40**: 19–20.)
KUWADA, Y. AND SAKAMURA, T. (1927). A contribution to the colloid chemical and morphological study of chromosomes. (Protoplasma **1**: 239–254.)
KUWADA, Y. (1927). On the spiral structure of chromosomes. (Bot. Mag. Tokyo, **41**: 100–109.)
MAEDA, T. (1928). The spiral structure of chromosomes in the Sweetpea (*Lathyrus odoratus*, L.). (Bot. Mag. Tokyo, **42**: 191–195.)
McCLUNG, C. E. (1927). The chiasmatype theory of Janssens. (Quart. Rev. Biol. **2**: 344–366.)
McCLUNG, C. E. (1928). Differential chromosomes of *Mecostethus gracilis*. (Zeit. Zell. v. m. Anat. **7**: 756–778.)
MELBURN, M. C. (1929). Heterotypic prophases in the absence of chromosome pairing. (Nat. Res. Council Canada **1**: 512–527.)
METZ, C. W., (1926). Observations on spermatogenesis in *Drosophila*. (Zeit. f. Zell. u. Mik. Anat. **4**: 1–28.)
MORGAN, T. H. (1919). The physical basis of heredity. 305 pp. I. B. Lippincott Co., Philadelphia.
MORGAN, T. H., BRIDGES, C. B. AND STURTEVANT, A. H. (1925). The genetics of *Drosophila*. (Biblio. Gen. **2**: 1–262.)
MORGAN, T. H. (1925). The bearing of genetics on cytological evidence for crossing over. (La Cellule, **36**: 113–123.)
MULLER, H. J. AND PAINTER, T. S. (1929). The cytological expression of changes in gene alignment produced by X-rays in *Drosophila*. (Amer. Nat. **63**: 193–200.)
NABOURS, R. K. (1925). Studies of inheritance and evolution in Orthoptera. V. The grouse Locust, *Apotettix Eurycephalus* Hancock. (Kan. Agr. Exp. Sta. Tech. Bull. **17**: 3–231.)
NEWTON, W. C. F. (1927). Chromosome studies in *Tulipa* and some related genera. (Journ. Linn. Soc. **47**: 339–354.)
NEWTON, W. C. F. AND DARLINGTON, C. D. (1929). Meiosis in polyploids. (Journ. Gen. **21**: 1–55.)
REDFIELD, HELEN, (1930). Crossing over in the third chromosome of triploids of *Drosophila melanogaster*. (Genetics, **15**: 205–252.)
ROBERTSON, W. R. B. (1916). Chromosome studies. 1. (Jour. Morph. **27**: 179–332.)
PLOUGH, H. H. (1917). The effect of temperature on crossing over in *Drosophila*. (Jour. Exp. Zool. **24**: 147–209.)
SAKAMURA, T. (1927). Fixierung von Chromosomen mit siedenden Wasser. (Bot. Mag. Tokyo, **41**: 59–64.)
SAKAMURA, T. (1927). Chromosomenforschung an frischen material. (Protoplasma **1**: 537–565.)
SANDS, H. (1923). The structure of the chromosomes in *Tradescantia virginica* L. (Amer. Journ. Bot. 10: 343–360.)
SHARP, L. W. (1929). Structure of large somatic chromosomes. (Bot. Gaz. **88**: 349–382.)
STURTEVANT, A. H. (1925). The effects of unequal crossing over at the bar locus in *Drosophila*. (Genetics, **10**: 117–147.)
STURTEVANT, A. H. (1926). A cross-over reducer in *Drosophila melanogaster* due to inversion of a section of the third chromosome. (Biol. Zbl. **46**: 697–702.)
STURTEVANT, A. H. (1928). A further study of the so-called mutation at the bar locus of *Drosophila*. (Genetics, **13**: 401–409.)



Chromosome structure

VEDJOVSKY, F. (1912). Zum Problem der Vererbungsträger. (Böhm. Ges. Wiss. Prag, p. 1–184.)

VEJDOVSKY, F. (1926). Structure and development of the "Living Matter." p. 360. Royal Bohemian Soc. Sci. Prague.

WENRICH, D. H. (1916). The spermatogenesis of *Phrynotettix magnus* with special reference to synapsis and the individuality of chromosomes. (Bull. Mus. Comp. Zool. **60**: 57–133.)

WENRICH, D. H. (1917). Synapsis and chromosome organization in *Chorthippus* (*Stenobthrus*) *curtipennis* and *Trimerotropis suffusa* (Orthoptera). (Jour. Morph. **29**: 471–516.)

WILSON, E. B. AND MORGAN, T. H. (1920). Chiasmatype and crossing over. (Amer. Nat. **54**: 193–219.)

WILSON, E. B. (1925). The cell in development and heredity, p. 1232. The Mac Millan Co., New York.

DESCRIPTION OF PLATE 25

All figures were drawn from smear preparations of pollen mother cells. Figures 1 to 19 inclusive are magnified 2700 times; figures 20 to 26 inclusive are magnified 1600 times.

SECALE CEREALE

Fig. 1. A typical chromosome at diplotene showing nodes and internodes.
Fig. 2. Three chromosomes at early diakinesis showing the number and distribution of nodes and internodes.
Fig. 3. A typical association of homologues at late diakinesis.
Figs. 4–6, Metaphase chromosome with coiled chromonemata.
Fig. 7. All seven chromosomes at metaphase showing the different types of chromosome pairing.
Fig. 8. A vertical ring chromosome with a chiasma at one end.
Figs. 9–12. Chromosomes at late metaphase showing less coiling of the chromonemata and the dual nature of the chromonemata.
Fig. 13–15. Chromosomes at late metaphase showing the straightening of the chromonemata and the separation of the chromatids.
Fig. 16. Two chromatids at late anaphase.
Fig. 17. A daughter chromosome at telophase.
Fig. 18. A chromosome at interphase. The two chromatids are held together only by the spindle fiber attachment.
Fig. 19. The seven chromosomes at the second meiotic division.

LILIUM REGALE

Fig. 20. A chromosome with nodes and internodes at diplotene.
Figs. 20–22. Metaphase chromosome with coiled chromonema. Alternate internodes at right angles to each other.
Fig. 21. Early anaphase as the chromosome begins to divide. No separation of chromatids.
Fig. 22. Later stage of first meiotic division showing dual nature of chromonemata and the relations of the chromatids at the chiasma.
Fig. 23. Unequal separation of chromatids.
Fig. 24. Late anaphase with one pair of chromatids in contact while the other pair have separated and contracted.
Fig. 25. A typical daughter chromosome at early telophase showing contraction and coiling of the chromonema.

DESCRIPTION OF PLATE 26

Diagrams illustrating the cytological mechanism of crossing over.

Diagram 1. Pairing of chromosomes at pachytene. The chromosomes are slightly twisted about each other and are separated into their respective chromatids. The maternal chromatids are pictured in black, the paternal chromatids in white.

Diagram 2. Diplotene looping and the formation of nodes and internodes. The exchange of partners between paired chromatids constitutes a chiasma.

Diagram 3. Later diplotene stage as the chromatids become closely paired and form a coiled chromonema. Due to a partial twisting of the chromonemata, about each other or to the coiling of the chromonemata, the chromatids which appear to cross each other at the chiasmas will often be brought in contact with each other.

Diagram 4. Early metaphase. Chiasmas B and C have broken between early diplotene and late diakinesis. Since the close association and coiling of chromatids prevents appreciable movement of chiasmas any stress imposed on the chiasmas, due to unequal contraction of chromonemata, to opening of diplotene loops, or torsion caused by chromonema coiling, will cause breaks in some of the chiasmas. The association of two independent chromatids, one from each parent, into an apparently single chromonema, is indicated by cross lines.

Diagram 5. The four chromatids at late anaphase showing the results of the double crossover. The associated chromatids separate at the second meiotic division.

Diagram 6. Due to coiling of the chromonemata two chromatids may be brought in contact with each other even though the adjacent internodes lie in planes at right angles to each other as shown in this diagram. Gene by gene association in the paired chromatids will cause pairing of the associated chromatids up to the point of exchange of partners, so that breaks in the chromatids are confined to a very small segment of the crossed chromatids, and will result in precise crossover levels between the two chromatids.

Diagrams 7–8. These diagrams show the relations of the chromatids which would result in unequal crossing over. The order of the two alellomorphic genes B and B′ in the duplicated section will depend on the point where crossing over occurs.

Diagrams 9–10. The relations of the three homologous chromosomes at pachytene and at diplotene in triploids. These relations of the chromosomes and chromatids are based on Darlington's description of the chromosomes in triploid Hyacinths and seems to be in accord with genetic results obtained from *Drosophila* triploids.

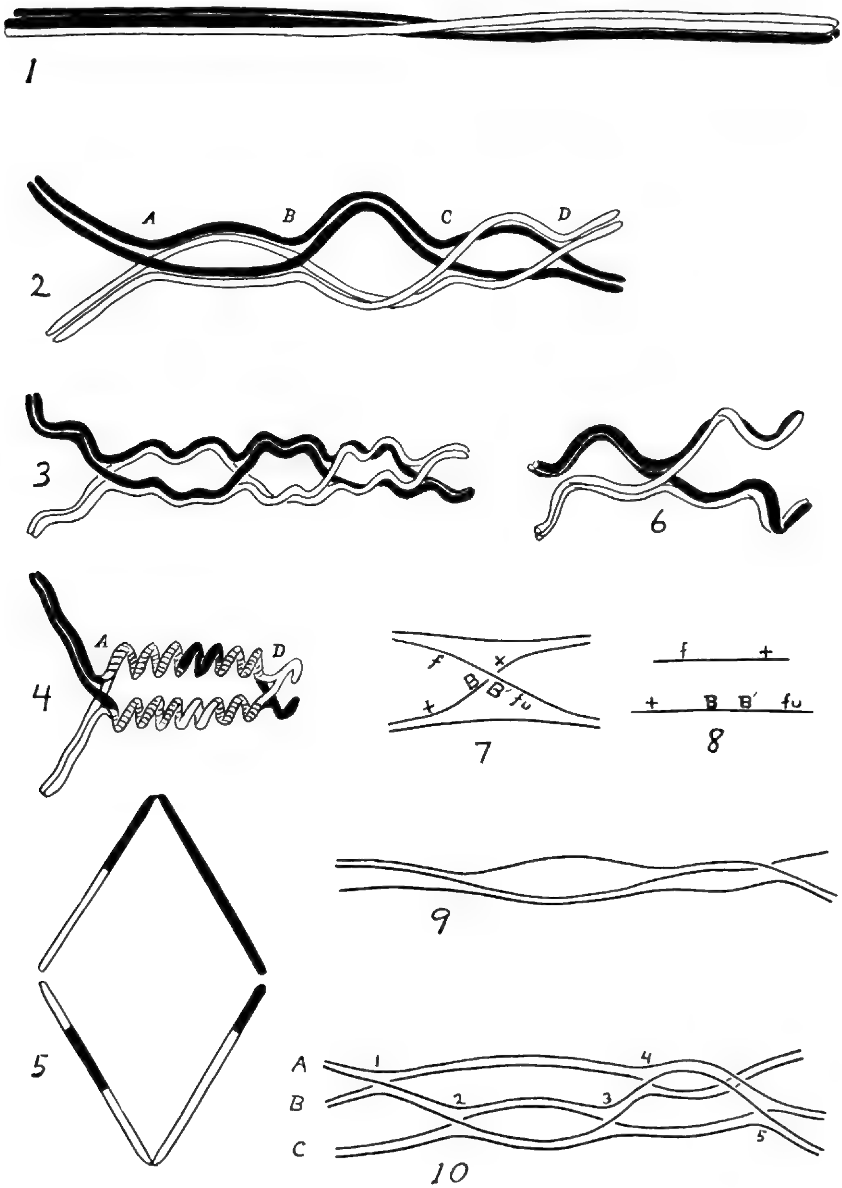
CHROMOSOME NUMBERS IN QUERCUS

HALLY JOLIVETTE SAX

THE genus *Quercus* is divided into three subgenera, *Cyclobalanopsis Erythrobalanus* and *Lepidobalanus*. These subgenera include more than three hundred species of Oaks. They are found in the temperate regions of the northern hemisphere and in the tropics at high altitudes. They range south to Colombia in America and to the Malay Archipelago in Asia.

There are many hybrids known among the Oaks. Trelease says "So far as my knowledge goes, no hybrids have been detected except between parents of a single subgenus though supposed crosses of the aberrant red oak, *Q. Emoryi*, with the white oaks, *Q. grisea* and *Q. pungens* are reported." Crossing is usually found between very closely related species within the subgenus. Trelease reports fifty-one hybrids in the United States.

The Arnold Arboretum includes among its collections many pure



THE MECHANISM OF CROSSING OVER

species and hybrids of *Quercus*. A number of these were studied to determine the number of chromosomes, the size of pollen grains, and the amount of pollen grain sterility.

The first report on chromosome number in *Quercus* was given by Cosens in 1912. He reported eight chromosomes as the somatic number in *Q. coccinea* Muench.

Wetzel, in 1928, reports eleven as the reduced number for the following species: *Q. coccinea* Wangh., *Q. Dalechampii* Tenore, *Q. glandulifera* Blume, *Q. Koehnei* Ambrozy (*Q. Ilex* × *sessiliflora ?*), *Q. libani* Oliv., *Q. macranthera* Fisch. & Mey., *Q. pontica* K. Koch, *Q. robur* L., *Q. sessiliflora* Salisb. (*Q. sessilis* Ehrh.). The chromosome numbers in the above species were obtained by studying the divisions in the pollen mother cell. The number of somatic chromosomes, determined by studying nuclear divisions in the root-tips, was found to be twenty-two in *Quercus Cerris* L. and *Quercus nigra* L.

In 1929 Grimpu reported the number of chromosomes found in the following species: *Q. suber*, *Q. Ilex*, *Q. coccifera*, *Q. palustris*. He found twelve to be the reduced number. He studied the somatic chromosomes in *Q. cerris* and found twenty-four chromosomes.

Friesner, in 1930, published the chromosome number in ten species of Quercus: *Q. alba*, *Q. macrocarpa*, *Q. Prinus*, *Q. Michauxii*, *Q. Muhlenbergii*, *Q. borealis* var. *maxima*, *Q. velutina*, *Q. coccinea*, *Q. marilandica*, and *Q. prinoides*. He reports twelve as the diploid number of chromosomes in the roots of each of the ten species.

The species of *Quercus* studied in the present work belong to the subgenera *Erythrobalanus* (the Red and Black Oaks) and *Lepidobalanus* (the White Oaks). All the hybrids are from crosses between species of the same subgenus.

The chromosome number was determined from the divisions in the pollen mother cells. Very good figures were obtained from acetocarmine smears. Although the chromosomes were very small, it was possible to get clear figures by this method.

The counts are given in the table included below which gives the species, the place of origin, the number of chromosomes, the average size of the pollen grains and the percentage of sterility found in each species.

In most species the number of chromosomes was very distinctly twelve. In some cases, there were apparent only eleven chromosomes; in others thirteen chromosomes could be counted. As reported by Grimpu, there seems to be some irregularity in the meiotic division due to the loose association of the chromosomes. In all cases the number was 12 or 12 $\pm$ 1. The hybrids show the same number. From the table there appears to be a remarkable uniformity in number when the species are of the same or of different subgenera or when they are pure species or hybrids.

Since pollen grain size is usually considered an index to relationship of chromosome number within a genus, measurements of the pollen grains in the above and additional species were made. Mature pollen grains were mounted in aceto-carmine. They were then measured by means of an ocular micrometer. In order to avoid differences due to swelling on applying aceto-carmine, the spores were measured at the same intervals of time in the different species after fixing. A large number of pollen grains were measured. From these the average size of the grain was computed. The data are given in Table I.

The size of the pollen grains in the different species ranges from 6.8 to 8.7 units with the exception of *Q. dentata*. In this species pollen was taken from two trees, one having pollen grains of 8.7 units in diameter, the other 11.2. It is noteworthy that there is the same range of variation in size of pollen grains in the species where the chromosomes have been counted and have been found to be 12 or 12 $\pm$ 1 as there is where no counts were made, excepting the one unusual case of *Q. dentata*. It would be interesting to determine the chromosome number in both specimens of *Q. dentata* to see if there is any cytological variation connected with the morphological differences.

The amount of pollen grain sterility in the different species was determined by counting the number of poorly developed pollen grains in a field as well as the total number. Several counts were made and the percentages of sterility calculated for each species.

Table I includes the data on sterility. The sterility ranges from three to ten percent with the exception of one of the two trees of *Q. dentata*. This tree, which also had the exceptionally large pollen grains, showed eighty percent sterility. The other specimen of *Q. dentata* had eight percent pollen sterility. This does differ significantly from that of other species. With one exception, there is really no significant difference in sterility between the different species and the hybrids studied. There is a striking uniformity in fertility both in pure species and in hybrids. *Q. ludoviciana*, *Q. Leana*, *Q. exacta*, *Q. Bebbiana*, and *Q. Sargentii*, all hybrids, show no significant difference in sterility from that found in pure species.

The uniformity in chromosome number, in the pollen grain size and pollen grain fertility among both pure species and the hybrids is remarkable. There is a large number of natural hybrids with apparently fertile pollen within the subgenus. Thus in the Oaks we find great variability in morphological characters and a wide geographical distribution with uniformity in chromosome number.

Much of the variability in the morphological characters of *Quercus* is doubtless due to hybridization but it is not associated with any irregularity in chromosome distribution.

DATA ON QUERCUS

Quercus	Chromosome number	Pollen size	Pollen St. %	Habitat
Erythrobalanus				
Q. ludoviciana ×	12 ± 1			N. America
Q. imbricaria	12	7.5	4	N. America
Q. Leana ×	12 ± 1	7.4	8	N. America
Q. exacta ×	12	7.4	7	N. America
Q. ilicifolia		7.9	6	N. America
Q. velutina	12 ± 1	7.0	7	N. America
Q. coccinea		7.7	4	N. America
Q. palustris	12	6.9	6	N. America
Lepidobalanus				
Q. serrata		7.3	6	Asia
Q. Cerris		8.0	3	Asia
Q. macranthera		7.9	6	Eurasia
Q. robur		6.8	10	Europe, N. Africa, West Asia
Q. haas		7.8	7	Asia Minor
Q. alba	12	7.5	3	N. America
Q. Bebbiana ×		7.6	7	N. America
Q. Gambelii		6.9	9	N. America
Q. macrocarpa	12 ± 1	6.9	6	N. America
Q. bicolor	12	7.4	3	N. America
Q. montana	12	7.3	3	N. America
Q. Sargentii ×		7.1	7	
Q. prinoides		6.9	3	N. America
Q. Muhlenbergii	12	6.8	7	N. America
Q. aliena		7.0	4	Asia
Q. glandulifera		7.1	9	Asia
Q. mongolica	12 ± 1			Asia
Q. dentata		11.2	80	Asia
Q. dentata		8.7	8	Asia

Q. ludoviciana = Q. phellos × rubra.
Q. Leana = Q. imbricaria × velutina.
Q. exacta = Q. imbricaria × palustris.
Q. Bebbiana = Q. alba × macrocarpa.
Q. Sargentii = Q. montana × robur.

LITERATURE CITED

Cosens, A. A contribution to the morphology and biology of insect galls. *Trans. Cand. Inst.* **9**: 297–381 (1912).

Friesner, R. C. Chromosome numbers in ten species of Quercus. With some remarks on the contributions of Cytology to Taxonomy. *Butler University Botanical Studies.* Vol. II. paper 7 (Jan. 1930).

Grimpu, V. Sur les chromosomes de quelque Chênes. *Rev. de Bot. Appl. et d'Agric. Colon.* 1929. pp. 176–179.

Rehder, A. Manual of cultivated trees and shrubs. 930 pp. Macmillan and Co. New York, 1927.

Trelease, W. The American Oaks. National Academy of Science XX.

Wetzel, G. Chromosomen studien bei den Fagales. *Bot. Archiv.* **25**: 257–283. 1929.

NOTULAE SYSTEMATICAE AD FLORAM SINENSEM, II[1]

H. H. Hu

Acer Chingii, sp. nov.

Arbor ad 11 m. alta, trunco 60 cm. diam. ,coma ampla patente, cortice calcareo-albido, ramulis glabris. Folia 5-loba, circa 10 cm. diam., basi profunde angusteque cordata, lobis acuminatis integris vel apicem versus sparse adpresseque serratis, lobo medio anguste oblongo marginibus fere parallelis ad 5.5 cm. longo et 2 cm. lato, lobis lateralibus ad 4.5 cm. longis, basalibus ovatis 1–1.2 cm. longis, saepe deorsum curvatis lateribus inferioribus fere contiguis, utrinque reticulata, supra laete viridia et glabra, subtus nervis primariis basin versus satis dense villosis exceptis glabra; petioli ad 3 cm. longi, pubescentes. Corymbi fructiferi circa 5 cm. diam., ut videtur breviter paniculati et multiflori, sed in specimine viso fructus immaturos 4 vel 5 gerentes; flores ignoti; samara alis angulo recto divergentibus nuculo leviter compresso 4 mm. longo incluso ad 18 mm. longis et 7 mm. latis rubro-purpureis extus rectis intus leviter falcatis basin versus angustatis.

Tree to 11 m. high, trunk 60 cm. in diam., with large spreading crown, bark chalky white, branchlets glabrous. Leaves 5-lobed, deeply cordate at base, 10 cm. in diameter, lobes acuminate, entire or sparsely and appressedly serrate toward the apex, midlobe to 5.5 cm. long, 2 cm. broad, lateral lobes to 4.5 cm. long, basal lobes often bending abruptly downward, approximately 10–12 mm. long, reticulate, light green and glabrous above, glabrous except densely pubescent along the midribs beneath; petiole to 3 cm. long, pubescent; corymbs about 5 cm. in diameter, apparently many-flowered, in the specimen at hand with 4 or 5 fruits; flowers unknown; samara with wings spreading at right angle, 1.8 mm. long including the nutlet, wings reddish-purple, straight at back, slightly falcate on the inner side, narrowed at base, to 14 mm. long, 7 mm. broad; nutlet slightly compressed, smooth, 4 mm. long.

KWANGSI: Bin Long, Miu Shan, north of Luchen Hsien, on border of Kweichow, alt. 1220 m., common in woods, *R. C. Ching*, Kwangsi Expedition, Academia Sinica, no. 5980 (type), June 14, 1928.

A species of the section Platanoidea, distinct from other Asiatic species chiefly in the deeply cordate base of the leaf and approximate basal lobes.

Schima bambusifolia, sp. nov.

Arbor ad 15 m. alta, trunco 30 cm. diam.; ramuli glabri. Folia coriacea, elliptica vel elliptico-lanceolata, 5.5–9 cm. longa et 2–2.5 cm. lata, acuta vel longe acuminata, basi cuneata vel fere rotundata, integra vel obscure crispata ad marginem, supra levia, glabra, lucida et intense viridia, subtus glabra et obscure coeruleo-viridia; petioli crassi, 13 mm. longi, glabri. Fructus racemosi, globosi, 1 cm. diam., brunnescentes, albido-punctati; pedicellis crassiusculi, 12 mm. longi; semina reniformia, 5 mm. longa et 4 mm. lata, uno latere leviter conçava, anguste alata.

[1] Continued from p. 48.

Tree to 15 m. high, trunk 30 cm. in diam.; branchlets glabrous. Leaves coriaceous, elliptic to elliptic-lanceolate, acute to long acuminate at apex, cuneate to subrounded at base, entire to obscurely crisped along the margins, smooth, glabrous and dark shining green above, glabrous and dull bluish-green beneath, 5.5–9 cm. long, 2–2.5 cm. broad; petiole thick, 13 mm. long, glabrous. Fruits racemose, globose, 1 cm. in diam., brownish, punctate with whitish dots; pedicels thickish, 12 mm. long; seeds reniform, slightly concave on one side, narowly winged, 5 mm. long, 4 mm. broad.

A species differing from all others in much smaller entire leaves, smaller fruits and seeds.

KWANGSI: Shih wan dar Shan, south of Nanning, alt. 1300 m., common in woods, *R. C. Ching*, no 8020, Oct. 19, 1928 (type), no. 8523, Oct. 27, 1928.

Vatica cordata, sp. nov.

Planta lignosa scandens (fide coll.), ad 4 m. alta; ramuli glabri longitudinaliter striati, lenticellis sparsis elevatis breviter ovalibus instructi, ut inflorescentia luteo-griseo-pubescentes. Folia subcoriacea, oblongo-ovata, 12–14 cm. longa et 7–9.5 cm. lata, basi cordata et 5-nervia, supra glabra et pallide viridia, subtus pallidiora et dense pilis flavo-fuscis sericeo-strigosis; petioli 5–6 cm. longi, glabrescentes. Inflorescentia axillaris, racemosa, folia excedens; alabastra conica, obtusa, 4.5 cm. longa, puberula; bracteolae ovato-lanceolatae, acutae, 1.5 mm. longae; calycis lobi deltoidei, acuti, 1 mm. longi. Fructus calyx tubo brevi sparse puberulo; calycis lobi longiores 2, lineari-oblongi, 7.5 cm. longi et circa 1–2 cm. lati, obtusi vel subacuti, basin versus leviter sensim angustati, minute pilosuli, nervis 3 conspicuis et 2 lateralibus levioribus dimidios lobos tantum percurrentibus; lobi breviores 3, oblongi, 1.5 cm. longi et 4 mm. lati, acuminati et apicum versus dentibus 1 vel 2 instructi; fructus obovoidei, apice rostrati, circa 1.8 cm. longi et 6 mm. diametientes.

Woody climber (fide collector) to 4 m. high, branchlets glabrous, longitudinally striated, with scattered elevated short oval lenticels, branchlets and inflorescence yellowish-gray pubescent, leaves subcoriaceous, oblong-ovate, cordate and 5-veined at base, glabrous and light green above, paler and densely yellowish-brown sericeous-strigose beneath, 12–14 cm. long, 7–9.5 cm. broad, petiole glabrescent, 5–6 cm. long; inflorescence axillary, racemose, longer than leaves; flower buds conical, obtuse, 4.5 mm. long, puberulous; bracteoles ovate-lanceolate, acute, 1.5 mm. long; calyx-teeth deltoid, acute, 1 mm. long; pedicels to 12 mm. long, puberulous; fruiting calyx with short tube sparingly puberulous, large calyx-lobes 2, linear-oblong, obtusish or subacute at apex, slightly narrowed gradually downward, minutely pilosulous, with three strong veins in the middle portion and 2 fainter lateral veins reaching about half of the length of the wings, 7.5 cm. long, about 12 mm. broad, smaller lobes 3, oblong, acuminate and 1- or 2-auricled near the apex, 1.5 cm. long, 4 mm. broad; fruit obovoid, beaked at apex, about 1.8 cm. long, 6 mm. in diameter.

KWANGSI: Bako Shan, west of Poseh Hsien, alt. 900 m. in thicket on cliff, *R. C. Ching*, Kwangsi Expedition, Academia Sinica, no. 7426 (type), Sept. 14, 1928.

A species of the section Synaptea distinct from other species chiefly in the ovate-oblong leaves cordate at base and densely yellowish green sericeous-strigose beneath. That this species is recorded by the collector as a woody climber is exceedingly interesting. If correct, then it may prove to be the first known species of this family to be climbing, and the slightly bending branches certainly look like those of climbers.

This is the second species of the genus *Vatica* discovered in China. The other species, *V. astrotricha* Hance, endemic in Cochin-China but lately discovered in Hainan, also belongs to this section. With the discovery of this species, there are now discovered in China three species of the family Dipterocarpaceae. The third species of this family is *Shorea chinensis* which Merrill discovered in Kwangtung.

Gilibertia angustiloba, sp. nov.

Frutex ad 1.5 m. altus (fide coll.), ramulis glabris. Folia omnia (?) profunde trilobata, ad 16 cm. longa, basi cuneata vel sub-rotundata, glabra, supra laete viridia, subtus pallidiora, lobis lanceolatis, medio ad 15 cm. longo, lateralibus ad 12 longis, omnibus circa 18 mm. latis et apicem versus angustatis acutis, leviter et sparsissime denticulatis denticulis mucronulatis vel integris, nervo medio supra elevato et angusto, subtus minus elevato sed latiore, venulis exilibus, non reticulatis; petioli ad 6.5 cm. longi. Fructus (immaturi) globosi, 4 mm. diam., glabri, calyce obsolete denticulato, disco conspicuo, stylis in columnam 1 cm. longam connatis; pedicelli circa 1 cm. longi.

Shrub to 1.5 m. high (fide collector), branchlets glabrous; leaves all (?) deeply 3-lobed, cuneate to rounded-cuneate at base, to 16 cm. long, glabrous, bright green above, paler beneath, lobes lanceolate, mid-lobe slightly longer than the lateral lobes, all tapering toward the apex, acute, obscurely and very remotely denticulate or entire, teeth mucronate, midrib elevated and narrow above, less elevated but broader beneath, veinlets faint, not reticulate, mid-lobe to 15 cm. long, lateral ones to 12 cm. long, about 18 mm. broad; petiole to 6.5 cm. long; fruit (immature) globose, glabrous, 4 mm. in diameter, crowned with a prominent disk, calyx-teeth obsolete, style connate, 1 mm. long; pedicels about 1 cm. long.

KWANGSI: Shih Wan Dar Shan, south of Nanning, alt. 900 m., under growth in forest, *R. C. Ching*, Kwangsi Expedition, Academia Sinica, no. 8019 (type), Oct. 19, 1928.

A species distinct in its leaves being all (?) deeply 3-lobed with long narrow remotely denticulate lobes which have a prominent midrib and faint veinlets.

Sinojackia Rehderiana, sp. nov.

Frutex ad 5 m. altus; ramuli juveniles stellato-pubescentes. Folia membranacea, subsessilia vel breviter petiolata, obovato-elliptica ad elliptico-oblanceolata vel oblonga ad ovata, ad 9 cm. longa et 4 cm. lata, sed plerumque multo minora (2–3 cm. longa et 1.2–1.5 in ramis florentibus), acuta vel obtusiuscula, basi cuneata vel rotundata vel subcordata, laete viridia, utrinque ad venas et laminae basin versus stellato-pubescentia, ceterum glabra, reticulata; petioli breves, 1–4 mm. longi, stellato-pubescentes. Flores albi, penduli, laxe cymoso-paniculati, pedicellis ad 2 cm. longis et pedunculis gracillimis dense stellato-pilosis, calyx cinereo-stellato-pubescens; 5–6-dentatus dentibus triangularibus acutis 1 mm. longis; corolla profunde 5–6-partita segmentis oblongo-ellipticis, 12 mm. longis et 4 mm. latis, acutiusculis, extus stellato-puberulis; stamina 8 mm. longa, filamentis basi in tubum brevem connatis stellato-puberulis; ovarium 3-loculare, stellato-puberulum, sensim in stylum 6 mm. longum, glabrum, attenuatum, stigmate obsolete 3-lobulato; ovula 8 in quoque loculo, biseriata. Fructus ligneus, indehiscens, apice conico longe rostrato ad 1 cm. longo; pars inferior obovoidens, leviter compressus, in stipitem attenuatus et cum stipite 1.5 cm. longum et 5.5 mm. diam., exocarpio suberosa non fisso, endocarpio ligneo, semen solitarium.

Shrub to 5 m. high; young branchlets stellate-pubescent. Leaves membranaceous, subsessile to short-petioled, obovate-elliptic, elliptic-oblanceolate, oblong to ovate, acuminate, acute or obtusish at apex, cuneate, rounded or slightly cordate at base, serrulate, green and glabrous except sparsely stellate-pubescent along the main veins or at the base of leaves on both surfaces, veins reticulate, to 9 cm. long, 4 cm. broad, usually much smaller (2–3 cm. long, 1.2–1.5 cm. broad at flowering time); petiole short, 1–4 mm. long, stellate-pubescent. Flowers white, pendulous, loosely cymose-paniculate, peduncles and pedicels very slender, densely stellate-pilose, pedicels to 2 cm. long; calyx grayish stellate-pubescent, 5–6-dentate, teeth triangular, acute, 1 mm. long; corolla deeply 5–6-cleft, segments oblong-elliptic, acutish at apex, stellate-puberulous outside, 12 mm. long, 4 mm. broad; stamens 8 mm. long, filaments connate at base into a short tube, stellate-puberulous; ovary lanceolate, stellate-puberulous, 3-celled, style subulate, 6 mm. long, stigma obscurely 3-lobed; ovules 2-seriate in each cell, 4 in each series. Fruit woody, indehiscent, apex conical, long-beaked, to 1 cm. long, lower half of the fruit obovoid, slightly compressed, tapering into a stalk at base, grayish brown, punctate with whitish dots, 15 mm. long with the stalk, 5.5 mm. broad; exocarp corky, not fissured; endocarp woody; seed solitary.

Allied to *S. xylocarpa* Hu, differing in shrubby habit, in thinner leaves, in looser flowers and much more slender and elongated fruits.

KIANGSI: Nanchang, common on low hills, *H. H. Hsiung*, no. 578, in 1929 (fruiting specimen); no. 578b, April 20, 1930 (flowering specimen; type).

I take great pleasure in naming the second species of this interesting genus in honor of Mr. Alfred Rehder, Curator of the Herbarium of the Arnold Arboretum of Harvard University, whose profound knowledge of the ligneous flora of China is unsurpassed by any living botanist.

A SUPPLEMENT TO J. T. P. BYHOUWER, "AN ENUMERATION OF THE ROSES OF YUNNAN."

C. E. KOBUSKI.

IN a former number of the Journal of the Arnold Arboretum[1] Dr. J. T. P. Byhouwer presented a paper dealing with the Roses of the Chinese province Yunnan. This year he planned a second visit to the Arboretum and intended while here to study additional material of Roses from Yunnan recently sent by Professor W. Wright Smith of the Royal Botanic Garden at Edinburgh. We are very grateful to Professor Smith for the loan of this material. Unfortunately Dr. Byhouwer found it inconvenient to visit the United States this year and to make the supplementary study. Since I was actively engaged in the study and writing of the former paper, it was desired that I should complete this study in order that the borrowed material could be determined and returned to the Edinburgh Herbarium without great delay.

The specimens for study were those of a later collection by George Forrest, along with material collected by F. Ducloux, Monbeig, C. Schneider and others.

Sect. SYNSTYLAE DeCandolle, Hort. Monsp. 137 (1813).

Rosa multiflora var. **cathayensis** Rehder & Wilson in Sargent, Pl. Wils. II. 304 (1915), where full citation of literature and synonyms is given.—Byhouwer in Jour. Arnold Arb. x. 85 (1929).

Près de la ville, Yunnan-sen, *F. Ducloux*, no. 637, April 24, 1904.

Rosa multiflora var. **carnea** Thory in Redouté, Roses, II. 67, t. (1821).—Rehder & Wilson in Sargent, Pl. Wils. II. 305, (1915), where full citation of literature and synonyms is given.—Byhouwer in Jour. Arnold Arb. x. 86 (1929).

On the margins of thickets and by streams, Chienchuan-Mekong divide, lat. 26° 30′ N., long. 99° 20′ E., alt. 2440 m., *G. Forrest*, no. 23535, June 1923 (spinous, scandent shrub, 3–6 m.; fls. white to pale rose, fragrant); margins of thickets and by streams, Chienchuan-Mekong divide, lat. 26° 30′ N., long. 99° 20′ E., alt. 2135–2440 m., *G. Forrest*, no. 23573, July 1923 (spinous, clambering shrub, 3–4.5 m.; fls. white, fragrant); margins of thickets and by streams, hills around Wei-Hsi, lat. 27° 12′ N., long. 99° 12′ E., alt. 2135–2740 m., *G. Forrest*, no. 25724, July 1924 (spinous, semi-scandent shrub with arched branches, 2–3 m.: fls. pure white, fragrant).

[1] See vol. x. 84–107 (1929).

The three Forrest specimens cited above present a deviation from typical var. *carnea* in that they all possess white flowers. Also the leaves of no. 25724 are distinctly glabrous while the other two specimens (nos. 23535 and 23573) are densely puberulent on the rhachis, petiole and lower surface of the leaves.

Besides these three cited specimens two other numbers may be mentioned under this variety. These all vary from typical *R. multiflora* var. *carnea* in having smaller, glabrous leaves measuring only 1–2 cm. in length and being distinctly obtuse or rounded at the apex. All together the variation seemed so great that on the first superficial examination one would hardly class them as belonging to the same species. The data of these two specimens are as follows:—Amongst scrub by streams near habitations, Chienchuan-Mekong divide, lat. 26° 20′ N., long. 99° 20′ E., alt. 2440 m., *G. Forrest*, no. 23487, June, 1923 (spinous shrub, 1–3.5 m.; fls. pale yellow); amongst scrub by streams, Chienchuan-Mekong divide, lat. 26° 20′ N., long. 99° 20′ E., alt. 2440 m., *G. Forrest*, no. 23518, July 1923 (spinous, semi-scandent shrub, 3–4.5 m.; fls. fragrant, deep rose). One observes in examining the annotation on the labels of these two specimens that the color variation is very great; the former specimen (no. 23487) with its yellow flowers agreeing with the numbers cited in the paragraphs above while the latter (no. 23518) having rose colored flowers agrees with typical *R. multiflora* var. *carnea* as it is generally known.

Rosa Brunonii Lindley, Ros. Monog. 120, t. 14 (1820).—Rehder & Wilson in Sargent, Pl. Wils. II. 306 (1915), where full citation of literature and synonyms is given.—Byhouwer in Jour. Arnold Arb. x. 306 (1915).

Exact locality and date lacking, northwest Yunnan, *T. Monbeig*, nos. 93 and 94, in 1907.

Rosa Helenae Rehder & Wilson in Sargent, Pl. Wils. II. 310 (1915).—Byhouwer in Jour. Arnold Arb. x. 88 (1929).

Rosa floribunda Rolfe in Gard. Chron. ser. 3, LVIII. 210 (1915), pro parte. —Non Steven, nec Baker.

On trees and scrub in thickets, Chienchuan-Mekong divide, lat. 26° 30′ N., long. 99° 20′ E., alt. 2440–2740 m., *G. Forrest*, no. 23534, June 1923 (scandent, spinous shrub 3–9 m.; fls. white, fragrant).

Rosa longicuspis A. Bertoloni in Mem. Acad. Sci. Bologna, XI. 201, t. 13, (1861); Misc. Bot. XXI. 15, t. 3 (1861).—Rehder & Wilson in Sargent, Pl. Wils. II. 313 (1915).—Byhouwer in Jour. Arnold Arb. x. 88 (1929), where full citation of literature and synonyms is given.

Vallons du Tchong chan, Yunnan-sen, *F. Ducloux*, no. 1210, April 28, 1909; Ko [?]-tsou region de Kiao Kia, *F. Ducloux*, no. 1211, Mai 11, 1909 (plante cueillie par le père S. Ten); Tchen fong chan dans la prefecture de Tchao tong, *F. Ducloux*, no. 635, Mai 11, 1901; open thickets and by streams along ascent of the Li-ti-puie from the Yangtze, lat. 27° 12′ N., alt. 2740–3050 m., *G. Forrest*, no. 13875, June 1917 (spinous shrub, 2–4 m.; fls. fragrant, white, flushed and margined rose); date and exact locality lacking, *E. B. Howell*, nos. 209 and 210.

Rosa glomerata Rehder & Wilson in Sargent, Pl. Wils. II. 309 (1915).— Byhouwer in Jour. Arnold Arb. x. 91 (1929).

Amongst scrub by streams, Chienchuan-Mekong divide, lat. 26° 30′ N., long. 99° 20′ E., alt. 2740 m., *G. Forrest*, no. 23491, July 1923 (spinous, semi-scandent shrub, 3–4.5 m.; fls. fragrant, white).

Sect. BANKSIAE Crépin in Jour. Hort. Soc. XI. 3 (1889).

Rosa Banksiae Ait. **f. lutea** Lindley in Bot. Reg. XIII. t. 1105 (1827).— Byhouwer in Jour. Arnold Arb. x. 92 (1929).

Rosa Banksiae f. *luteiflora* Léveillé, Cat. Pl. Yun-Nan, 234 (1917), nomen.
Rosa Banksiae f. *luteo-plena* Rehder in Bailey, Cycl. Amer. Hort. IV. 1552 (1902).

In thickets and hedges and by streams around villages, Chienchuan-Mekong divide, lat. 26° 30′ N., long. 99° 20′ E., alt. 2440 m., *G. Forrest*, no. 23516, July 1923 (non-spinous? shrub, 2–3 m. with arched branches; fls. bright, soft yellow).

Sect. INDICAE Thory, Prodr. Gen. Rosae, 128 (1820).

Rosa odorata Sweet var. **gigantea** Rehder & Wilson in Sargent, Pl. Wils. II. 338 (1915), where full citation of literature and synonyms is given.—Byhouwer in Jour. Arnold Arb. x. 94 (1929).

Vallons du Tchong chan, Yunnan-sen, *F. Ducloux*, no. 634, April 13, 1904; Eul long Keou region de Kiao Kia, *F. Ducloux*, no. 1209 April 1909 (Plante cueillie par le père S. Ten); by streams around habitations, Chienchuan-Mekong divide, lat. 26° 20′ N., long. 99° 20′ E., alt. 2440 m., *G. Forrest*, no. 23575, June 1923 (erect shrub 2–3 m. with arched branches; fls. fragrant, rose-pink).

Rosa chinensis Jacquin, Obs. Bot. III. 7, t. 55 (1768).— Rehder & Wilson in Sargent, Pl. Wils. II. 320 (1915), where full citation of literature and synonyms is given.—Byhouwer in Jour. Arnold Arb. x. 96 (1929).

Village dans les vallons au N. E. de la villa, Yunnan-sen, *F. Ducloux*, no. 620, April 11, 1906.

Sect. CINNAMOMEAE De Candolle apud Seringe, Mus. Helv. I. 2 (1818).

Rosa multibracteata Hemsley & Wilson in Kew Bull. Misc. Inform. 1906, p. 156.—Rehder & Wilson in Sargent, Pl. Wils. II. 328 (1915), where full citation of literature and synonyms is given.— Byhouwer in Jour. Arnold Arb. x. 101 (1929).

Without exact locality, Père Monbeig, no. 95, in 1907.

Rosa sertata Rolfe in Bot. Mag. CXXXIX. t. 8473 (1913).—Rehder & Wilson in Sargent, Pl. Wils. II. 327 (1915), where full citation of literature and synonyms is given.—Byhouwer in Jour. Arnold Arb. x. 100 (1929).

Ad vias, regione prope Yung ning, *C. Schneider*, no. 1169, June 19, 1914 (frut. erect. circiter 2 m. alt.)

Sect. SERICEAE Crépin in Jour. des Roses XV. (Nouv. Class Ros. 25) (1891).

Rosa omeiensis Rolfe in Bot. Mag. CXXXVIII. t. 8471 (1912).—Rehder & Wilson in Sargent, Pl. Wils. II. 331 (1915), where full citation of literature and synonyms is given.—Byhouwer in Jour. Arnold Arb. x. 102 (1929).

Djou kou la près Pin tchouan, *F. Ducloux*, no. 627, 1907 (plante cueillie par Jean Ty); without exact locality, *Père Monbeig*, nos. 89 and 90, in 1907.

NOTE ON DARLINGIA SPECTATISSIMA F. V. MUELL. WITH DESCRIPTION OF A NEW VARIETY

C. T. White

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One of the commonest trees in the rain-forests of Northeast Queensland is *Darlingia spectatissima* F. v. Muell. In October 1899 J. F. Bailey named a second species from leaves only as *D. ferruginea*, suggesting at the same time it might when better known prove only to be a more ferrugineous form of *D. spectatissima* F. v. Muell. From flowering specimens recently sent to me by Mr. W. J. Ross and some collected on behalf of the Arnold Arboretum by Mr. S. F. Kajewski I have no hesitation in referring *D. ferruginea* J. F. Bailey as a variety to *D. spectatissima* F. v. Muell. This note is published before a general account of S. F. Kajewski's North Queensland collection as he collected a number of sheets and a distribution of his number as *D. spectatissima* F. v. M. has been made.

Darlingia spectatissima F. v. Mueller, Fragm. Phytogr. Austr. v. 152 (1886).

North Queensland: Rockingham Bay, *J. Dallachy;* Upper Barron River, *J. F. Bailey;* Atherton, *J. F. Bailey, H. W. Mocatta;* Evelyn, *J. F. Bailey;* Yarrabah near Cairns, *N. Michael;* Yungaburra, *J. L. Tardent;* Johnstone River, *T. L. Bancroft, N. Michael.* (See also Domin in Bibl. Bot. XXII (89^1) 593 [1921]).

Darlingia spectatissima F. v. Muell. var. **ferruginea,** var. nov.

D. ferruginea J. F. Bailey in Queensl. Agric. Jour. v. 402 (1899).

This variety differs from the normal form in young leaves being densely red-ferrugineous tomentose on the lower side, the hairs never totally disappearing even from the older leaves.

North Queensland: Evelyn (local name Brown Oak), *J. F. Bailey* (leaves only), *W. J. Ross* (type of the variety); Atherton, *C. T. White* (leaves only); Malanda, *C. T. White* (leaves only); Gadgarrah Reserve, Atherton Tableland, alt. 800 m., *S. F. Kajewski*, no. 1127.

Common in the rain-forest; medium sized tree up to 25 m.; flowers cream with a delightful perfume.

GRAFT-BLIGHT OF LILAC

KENNETH S. CHESTER

SINCE 1928 I have been engaged in a study of the diseases of Lilacs. Among these there is a destructive and widespread disease of the common Lilac, *Syringa vulgaris*, which is a sequent to a prevailing method of nursery practice and to which I have given the name GRAFT-BLIGHT. It is a disease of exceptional interest and importance and one to which I have given special attention. The investigation of this particular disease has been carried to such a point that I can now give preliminary notice of my findings. A more extended account of this research will be published in the near future.

This disease I have found prevailing in destructive measure in many widely separated places. I have observed it in various nurseries in New England, New York, and New Jersey, as well as in numerous private plantings, while reports have been received of its occurrence in various states as far west as Oregon, in Ontario, Canada, and in Germany.

Plants affected with graft-blight exhibit symptoms of general nutritional deficiency, characterized by a progressive yellowing of the leaf margins and intervenous spaces, reduction in the size and number of the leaves, brittleness and curling of the leaves, premature or abnormally late leaf fall, and the resultant stunting of growth of the plant as a whole. It is limited, for the most part, to plants one to three feet in height and three to seven years of age. Since the symptoms are not usually ameliorated as the plants grow older, the cumulative effects of the disease are shown by those which linger on in a state of depauperate dwarfism; such plants are finally discarded or because of their lowered resistance fall a prey to some secondary disease. A relatively small proportion of blighted plants recovers.

Although the disease gives all appearance of being of abiotic origin, care was taken to demonstrate that it was not of a contagious nature. Attempts were made to transmit it by recognized methods of inoculation such as are used in the case of diseases caused by fungi, bacteria, or viruses. The results of these experiments have proved definitely that the disease is not accompanied by the presence of any pathogenic organism or contagious principle. Likewise the distribution of the disease indicates that it is not of a biotic type.

Although of abiotic origin, the disease shows no consistent relation to the external environment. It occurs under widely varying conditions of temperature and rainfall, on various kinds of soil, and in plants adjacent to absolutely healthy ones.

By a process of elimination the search for the cause was narrowed down to an investigation of the relation of the disease to the grafting method so commonly employed by propagators. It was soon found that the disease characteristically manifests itself solely in Lilacs that were started by grafting or budding on Privet stocks. The trouble was found to lie in this practice of grafting the Lilac onto Privet.

The main burden of proof of this conclusion has rested on a set of grafting experiments repeated during two successive years under controlled conditions with identical results. Scions, all taken from the same Lilac plant, were grafted onto various species of Privet. These were observed in conjunction with control scions from the same source grafted onto Lilac stocks, as well as with cuttings from the same source rooted in the soil. This set of experiments was repeated a second season in a more extensive way. The disease manifested itself in a typical manner in every instance in the Privet-grafted plants, while the controls in all cases remained absolutely free from it. These experiments have been supplemented in other ways, all of which have yielded corroborative evidence.

The results of these investigations have demonstrated unquestionably that the trouble lies in the Privet method of propagation. Incidentally it may be noted that the symptoms vary according to the species of Privet used, but no species of Privet stock tested is satisfactory. In brief it has been demonstrated that an incompatibility exists between Lilac scions and Privet stocks, and that this is expressed by a pathological condition of the Lilac crown. This incompatibility is so pronounced in its severity that large numbers of Lilacs so propagated and sent out by the nurseries for planting fail or languish in the hands of the buyer.

Control of this Lilac blight is obviously to be accomplished by some modification of or by the abandonment of the Privet budding or grafting method and the adoption of some other method of Lilac propagation. Without question budding or grafting on Privet, Ash, *Chionanthus*, *Forsythia*, or other members of the *Oleaceae* is objectionable as usually employed. The Lilac can readily be propagated by the various "own-root" methods of layering, use of suckers, and by hard- and green-wood cuttings. It can also be propagated on Lilac understocks, but this is undesirable because of the suckering of the Lilac stock. Propagation by "own-root" methods has been found to be the most desirable course. It is slower at first, but eliminates all danger of incompatibility, produces a high percentage of successful plants, and is commercially practical.

Pathological Laboratory, Arnold Arboretum,
Harvard University,
September 24, 1930.

NOTES

The Arnold Arboretum during the Fiscal year ended June 30, 1930.

The Arboretum.—The year 1929–30 was unusually dry and very ununfavorable to plant growth in general; little or no rain fell during the months of July, August and September and the winter snowfall was extremely light. Good rains happened in the spring but were insufficient to make good the general shortage; unless heavy rain falls during the summer months the trees and shrubs are likely to suffer. The vicinity of

Boston enjoyed a mild winter, being more fortunate in this respect than many districts in New England, not to mention more distant parts of the country. The frost at no time penetrated deeply into the ground which is fortunate since the snowfall was light. In general, plants in the Arboretum suffered little winter injury, evergreens in particular coming through unscathed. Rhodendrons and other broad leaved plants never wintered better. In January and February some freak weather was experienced, the temperature rising to an abnormal height which was not without its ill effects; on January 8th the thermometer rose to 64° F. and from February 20th to the 25th inclusive a daily average of 65° F. was maintained. This excited the flower buds on a number of plants, especially in those of the Prunus tribe, and subsequent cold weather killed them. The flower buds on the trees of *Prunus yedoensis* and *P. mandshurica* were all blasted; so, too, were the majority on the Siberian Apricot (*P. sibirica*) and related species. The Peach trees in many parts of Massachusetts suffered badly; these early flowering northern trees are readily excited by warm weather in February and the result, as a rule, is disastrous. The advantage of planting them on high ground is well exemplified by trees of *P. yedoensis* on Bussey Hill and on Peters Hill, where the display of blossom was never finer, so the lesson is not to choose low land or supposedly warm corners in which to plant these northern spring flowering trees.

During the autumn the work of extending and spreading out the collections continued; on Hemlock Hill a new group of about one hundred and fifty Hybrid Rhodendrons was made and in the spring a majority flowered. Under the grove of Pines on the right entering South Street Gate a plantation of some five hundred Kalmias was carried out. These two plantations should in the future be among the most attractive features of the Arboretum. The most important gift of plant material the Arboretum received during the year was twelve thousand Narcissi bulbs from Mr. T. A. Havemeyer, of Glen Head, Long Island. These were planted on the land immediately beyond the Administration Building and flowering freely in the spring were a pleasing sight among the grass.

On the whole the plants in the collections flowered well but the drought interfered with the display of fruit and autumn foliage. Among the more interesting plants that blossomed was the new *Stewartia koreana*, an Arboretum introduction from Korea; it promises to be the hardiest and best of its family. For the first time in cultivation blossomed *Platyosprion platycarpum*, a rare Japanese tree related to the American Yellowwood; this plant was introduced by the Arboretum in 1919 and so far as is known is the only one in cultivation either in this country or in Europe. The Lilacs, now thoroughly rehabilitated, bloomed with great freedom. The collections are beginning to show the good effects of fertilizing, although the application of fertilizers will have to be continued over a period of years to produce any really marked results.

The drought made the fire hazards greater than usual and at times gave cause for much anxiety. The Arboretum proper escaped with one or two minor fires that were put out without any serious damage. On the land adjoining the branch line of the New York, New Haven and Hartford Railway a fire caused either by sparks or live ashes established itself in the peat bog and burned intermittently for more than two months. The railway company behaved very well, paying two hundred and fifty dollars damages. The Park Commission continue to keep the roads in good condition and carry out their part of the contract with Harvard University in an admirable manner. The police protection, however, remains most inadequate, indeed, it may be truthfully said that the Arboretum is unprotected.

During the year 3,222 plants, including grafts and cuttings, were distributed in the United States, Canada, Great Britain, Holland, Germany, Poland and Hawaii and 1,627 packets of seed in the United States, Canada, Great Britain, Ireland, Finland, United Soviet Socialistic Republics, China and New Zealand. There have been received 22,912 plants, including grafts and cuttings and about 15,000 bulbs, from the United States, Canada, Great Britain, Cuba and Japan and 754 packets of seed from the United States, Canada, Cuba, Navassa, Great Britain, Ireland, France, Germany, Poland, United Soviet Socialistic Republics, China, Japan, India, Australia, and New Zealand.

The "Bulletin of Popular Information" was issued as usual and its circulation has enlarged. The regular four numbers of the "Journal of the Arnold Arboretum" were issued; the circulation has increased and it continues to be a valued medium of exchange.

Visitors to the Arboretum were more numerous than in any previous year. Some 1,114 visitors registered at the Administration Building; they came from nearly every state in the union and from several countries of Europe, from South Africa, New Zealand, China, Japan and Java. Among the most distinguished visitors was General J. Smuts, an ardent botanist and one time Prime Minister of South Africa. Another was Mr. Arthur Osborn, who has charge of the arboretum at the Royal Botanic Gardens, Kew, England. Mr. Osborn spent a couple of weeks in the Arboretum and made a list of four hundred plants in cultivation in this Arboretum not growing in Kew Gardens. In July The American Association of Nurserymen held their convention in Boston and some five hundred of them spent a day among the Arboretum collections. Letters seeking information on dendrological and horticultural subjects increased and so, too, did the number of plant specimens sent in for identification. That the Arboretum is doing useful work, is best emphasized by the fact that the response to its annual appeal was more generous than ever before and included several hundred new supporters.—E. H. W.

Pathological Laboratory.—The second year in the history of the Arboretum's research laboratory in Plant Pathology has been marked by an enlargement of equipment, a growing list of inquiries for help, and an active program of investigation.

Early in the year an experimental greenhouse was erected contiguous to the laboratory. This supplied an imperative need; it has been occupied almost to capacity from the outset with experimental work for which provision elsewhere would have been impossible. A second item of interest has been the inauguration of a pathological herbarium. The private collection of the staff afforded a nucleus as a beginning. To this have been added many hundreds of specimens obtained from the western United States, collected during the summer of 1929 by Mr. G. D. Darker, who was sent out by the Arboretum for that purpose. The object in view is the accumulation of a working and reference collection, as complete as possible, of preserved materials illustrating the many diseases of trees and shrubs. Provision for the care and the housing of such a collection remains to be made.

Inquiries for advice relative to specific diseases of trees, shrubs and forests have been received from about twenty States and Provinces. They have come from nurseries, forest operators, institutions and private owners.

The investigational activities have been varied, and substantial progress has been made on several problems undertaken. A summary follows.

1. A RECONNAISSANCE OF THE FOREST DISEASES OF NOVA SCOTIA. In July, 1929, Nova Scotia was visited at the request of the Provincial Forester, to examine cross sections of its forests from a pathological point of view (J. H. FAULL. Notes on Forest Diseases in Nova Scotia. Jour. Arnold Arb. XI. 55–58. 1930). One immediate outcome has been the starting of an investigation of a disease which has ravished the Beeches there—a disease knowledge of which is of commanding interest because of the imminent threat to this highly valued tree species beyond the limits of that Province.

2. PHACIDIUM BLIGHT OF CONIFERS. The Report of the Arboretum for 1928–29 made reference to the success that had attended our efforts in a study of the cause of this disease and its control in nurseries. Observation and experimentation continued in the nursery of the Brown Company at Oquossoc, Maine, have shown that many species of Conifers other than Spruces are susceptible to Phacidium blight, that the disease is perfectly controllable in all of them, and that without control their culture in areas characterized by certain climatic features is liable to failure. Similar studies have been extended to Phacidium blight in plantations (J. H. FAULL. The Spread and the Control of Phacidium Blight in Spruce Plantations. Jour. Arnold Arb. XI. 136–147. 1930).

3. TRUNK AND ROOT DISEASES OF SPRUCE. A good deal of attention has been devoted during the year to a complex of problems comprised under this designation, and at present they constitute one of our major undertakings.

4. Elm diseases. We have been fortunate to have had with us throughout 1929–30 Dr. C. J. Buisman of the Phytopathologisch Laboratorium "Willie Commelin Scholten," Baarn, Holland. Miss Buisman, who had already made notable researches on the European Elm disease, occupied herself with studies on the diseases of our native Elms, with special attention to those of the American Elm. Towards the end of her sojourn here a finding of great potential importance was made in some diseased Elm specimens sent from Ohio, namely, the presence of an organism that appears to be identical with the causal agent of the feared European Elm disease. As a result the Federal Bureau of Plant Industry was enabled to reach decisions of moment in this connection.

5. Needle Cast Fungi. Studies on this group of fungi have been materially advanced by Mr. G. D. Darker.

6. Lilac diseases. Most important among the diseases of Lilacs is one which is shown to follow a prevalent, but ill-advised practice among propagators. Studies nearing completion, made by Mr. K. S. Chester, have demonstrated the cause and point the way to avoidance of the same. A preliminary account appears in the present issue of this Journal.

7. Various minor topics have been taken up. Mention may be made of one, namely, on a rot of Calla Lily, since the brief paper published on it constitutes one of the the first records of this destructive, imported disease in America, and at the same time has something constructive to offer with respect to its control (K. S. Chester. The Phytophthora Disease of the Calla in America. Jour. Arnold Arb. xi. 169–171. 1930). —J. H. F.

Cytological Laboratory.—The investigation of the chromosome numbers of the species of the more important genera has been continued and several lines of work have been completed. The results obtained throw some light on relationships of different species and in some cases are of considerable interest to the plant breeder.

All of the pure species of *Syringa* were found to have the same chromosome number, but crosses can be made only between species in the same taxonomic groups. The chromosome relationships in certain hybrids indicate that all of the existing species are tetraploids. These results have been published in the Journal of the Arnold Arboretum Vol. xi, 1930.

The chromosome relationships in the genus *Rhodendron* have been found to be most interesting. This polymorphic genus contains nearly 500 species, but representative species of different sections of the genus have the same chromosome numbers or are tetraploids. Hybrids between American and Oriental species show that there is complete compatibility between the parental chromosomes, although the two species may have been separated for millions of years. An account of this work has been published in the American Journal of Botany, Vol. xvii, 1930.

Chromosome counts in *Vitis* show that the species of the subgenus

Euvitis have 19 pairs of chromosomes, while the Muscadinia species has 20 pairs of chromosomes. This difference in chromosome number seems to be associated with fundamental differences in the two subgenera so that no fertile hybrids can be obtained between these two groups. This work has been published in the Proceedings of the American Society for Horticultural Science, 1930.

A cytological study of the *Caprifoliaceae* shows that in most genera the basic chromosome number is the same. There is, however, a great deal of difference in the size of chromosomes of the different genera. No correlation was found between chromosome number or size and the degree of specialization of wood structure. These results were published in the Journal of the Arnold Arboretum Vol. XI, 1930.

The chromosome number and behavior in hybrids between different genera of the Pomoideae of the family Rosaceae have been studied. The fact that the chromosomes of different genera of this group may function together indicates that they are more closely related than the taxonomic classification would imply. Part of this study has been published in the Proceedings of the National Academy of Sciences Vol. 15, 1929. A more complete cytological analysis of the Pomoideae will appear in the next issue of this Journal.

A study of chromosome structure and the nature of chromosome association at the meiotic divisions is of considerable value in the determination of the cause of variations in chromosome numbers in various genera and in species hybrids. A study of chromosome structure in *Secale* and *Lilium* has shown the nature of chromosome association at meiosis and has served as a basis for a cytological interpretation of crossing over. This work appears in the present issue of this Journal.

An investigation of chromosome structure is also being carried on with material which was collected at the Harvard Biological Laboratory, Soledad, Cuba.

Breeding work has been continued, especially with the more important horticultural genera. Seedlings from the crosses made last year are now growing in the new greenhouse.—K. S.

The Herbarium.—The Herbarium now contains 333369 sheets, 18313 having been added during the time from July 1, 1929 to June 30, 1930. Of these accessions approximately 5700 were native of the United States and Canada, 2700 of Central and South America including Mexico and the West Indies, 1615 of Europe and Western and Central Asia, 4800 of China, 1000 of Southern Asia and Malaysia, 400 of Africa, 600 of Australasia and 1000 were cultivated plants. Among the more important collections received during the year the following may be mentioned: from expeditions wholly or partly supported by the Arnold Arboretum were received about 2000 numbers with numerous duplicates collected mostly in the southern and southwestern States by E. J. Palmer, about 850 numbers with many duplicates collected by J. G. Jack in Cuba, about

1000 numbers with many duplicates collected by S. F. Kajewski in the New Hebrides and Santa Cruz Islands, more than 3500 numbers with duplicates collected by W. P. Fang in the Chinese province of Szechuan, nearly 600 numbers with duplicates collected by C. T. White and S. F. Kajewski in North Queensland, about 250 numbers with duplicates collected by J. Mattfeld in Bulgaria. As gifts were received about 360 numbers with duplicates collected by W. Bangham in Central America and the West Indies, and about the same number collected by F. M. Salvoza in Panama and Cuba, about 120 numbers with duplicates collected by Dr. J. Becquaert in Yucatan, and about 540 specimens of cultivated plants from Vilmorin-Andrieux in Paris. By exchange were received from the Sun Yatsen University about 1700 Kwangtung plants, from the Edinburgh Botanic Garden about 500 Yunnan plants collected by G. Forrest, from the Metropolitan Museum at Nanking about 360 plants from Kwangsi collected by R. C. Ching, from the Riks Museum at Stockholm about 330 plants of Tropical America, from the Berlin Botanic Garden about 200 Kamerun plants, from the Yale Forestry School about 350 Liberian plants collected by G. P. Cooper; from the New York Botanic Garden about 1250 plants from E. Asia and the Philippines. Through purchase were acquired about 300 specimens from Argentina collected by Venturi and about 300 specimens from Mexico collected by C. A. Purpus.

Besides the constant use of the herbarium by the staff in the determinations of plants sent in for identification and in the determination of large collections, chiefly from North America and Eastern Asia, the facilities of the herbarium have been used by students of other departments of the University and from abroad as by Mr. Chien P'ei of Chengtu, China, who is working on a revision of the Chinese Verbenaceae and by Mr. F. P. Metcalf of the Canton Christian College who is preparing a flora of Fukien. For study outside of the Arboretum 803 specimens have been sent out on loan to 18 institutions and individuals in this country and Europe.

There have been distributed from the herbarium 17430 specimens to 41 institutions in the United States and Canada and in Europe, Australia and Africa; also 350 wood specimens to two institutions.

To the fruit collection 137 specimens have been added which brings the number of fruit specimens up to 7037. The fluid in which fleshy fruits are preserved has been changed from a formalin solution to an alcohol-formalin solution.

The arrangement and labeling of the wood collection has been finished and the general wood collection now contains 2186 specimens arranged in systematic order, 686 having been added during the year.

Botanical explorations partly or wholly financed by this institution have been carried on in different parts of the world. Dr. H. Humbert who has collected during the second half of 1928 in Madagascar, has spent the greater part of 1929 in East Africa where he visited chiefly the region of the Great Lakes, Tanganyika, Kivu and Lake Edward, ascended many high mountains, as Kanuzi (3250 m.), Karisimbi (4506 m.), Muhavura and Mikeno (over 4000 m.), Niragongo and Niamlagira (over 3000 m.) and Mt. Runenzori to the foot of the glaciers (4500 m.); he also visited the tropical forests of the upper Congo basin and the Kenya Colony. He returned in the autumn of 1929 to Algiers after having collected more than 5000 numbers with duplicates and he is now working on his collections of which we have received recently the first shipment. Mr. S. F. Kajewski spent the winter 1929–30 collecting in North Queensland and after regaining his health impaired by attacks of fever while in the New Hebrides the preceding summer set out at the end of February for the Solomon Islands and went first to Bougainville Island, the largest island of the group. Professor C. Y. Chiao of the University of Nanking has started at the end of May 1930 for Shantung on a collecting tour for the Arnold Arboretum and Nanking University; he will visit chiefly the central and western part of the province which is yet botanically little known. Professor J. Bornmüller has collected from the end of April to the end of July 1929 in Asia Minor chiefly Anatolia and Paphlagonia. Assistant Professor J. G. Jack has spent again several months, July and August 1929 and January to April 1930 in Cuba continuing the botanical exploration of the region near the Harvard Tropical Garden at Soledad, Cienfuegos. Mr. E. J. Palmer made from the middle of August to the middle of September a collecting trip to southeastern Canada returning through New York and Pennsylvania; he paid particular attention to the species of Crataegus in view of the revision of the American species of the genus in which he is now engaged.—A. R.

The Library.—During the year the Library has added 760 volumes, 252 pamphlets and 1280 photographs, giving a total of 39,195 bound volumes, 9,466 pamphlets and 16,124 photographs. The number of photographs as given covers only the cards upon which they are mounted, sometimes as many as 6 small pictures being placed on one mount, bringing the actual number to nearly 17,000; besides these, 100 photographs taken by Mr. E. J. Palmer in the middle and south western states, 1924–1929, and 144 taken by Mr. Frank N. Meyer in China from 1905 to 1916 have been mounted in albums. In addition to the bound volumes there are over 200 works which were issued in parts, a large number of which are still publishing but many have been discontinued.

Four hundred periodicals are received currently and represent nearly every country, among these there are several new ones from China strengthening our contacts with that part of the world. One hundred and ninety-three come as exchanges for the *Journal of the Arnold Arboretum* and a few for the *Bulletin of Popular Information.*

About 1200 cards have been filed in the catalogue of books and more than 2400 slips for the supplement to the printed catalogue; 1000 cards were filed in the catalogue of photographs and 4559 in the "Card-index of new genera, species and varieties published by the Gray Herbarium." To the manuscript "Index of illustrations and of new genera, species and varieties of ligneous plants since 1915," prepared at the Arboretum, 3754 cards have been added making the present total 86,851.

Five hundred books have been bound, including periodicals and 1000 titles, and 1280 photographs catalogued.

During the past few years all nursery catalogues offering woody plants for sale have been preserved and they form an interesting and valuable group, representing 152 foreign and 198 American firms with total number of 1750 catalogues and lists.

The rapid growth of the periodical section necessitated more room and 66 new shelves have been added to accommodate it.

Among the more important acessions of the year, some of which have been previously noted in the April issue of this Journal are:—

WALCOTT, Mary V. North American wild flowers. Vol. 5. 1925. Gift of Mrs. L. A. Frothingham.

CONDER, Josiah. Landscape gardening in Japan. 1893.

SCHWEIGGER, A. F. Flora Erlangensis. 1811.

SATOW, Sir E. M. The voyage of Captain John Saris to Japan, 1613. 1900.

DEERING, Charles. Catalogus stirpium, &c.; or, A catalogue of plants naturally growing and commonly cultivated in divers parts of England more especially about Nottingham. 1738.

CHAMBERS, William. A dissertation on Oriental gardening. [With] an explanatory discourse by Tan Chet-qua. 2d ed. 1773.

MARATTI, G. F. Plantarum Romuleæ et Sàturniæ in agro romano existentium specificas notas describit inventor. 1772.

RENAULT, P. A. Flore du departement de l'Orne, ouvrage élémentaire de botanique, composé de la réunion des systèmes de Tournefort, de Linné et de Jussieu. [1804].

Höss, Franz. Monographie der schwarzföhre, Pinus austriaca, in botanischer und forstlicher beziehung. 1831.

ZAWADZKI, Alexander. Flora der stadt Lemberg. 1836.

MALY, J. K. Enumeratio plantarum phanerogamicarum imperii austriaci universi. 2 teile. 1848.

M'LEOD, John. Voyage of His Majesty's ship Alceste to China, Corea, and the island of Lewchew with an account of her shipwreck. 3d ed. 1820.

GMELIN, K. C. Hortus magni ducis Badensis Carlsruhanus. 1811.

ROSCOE, William. An address delivered before the Botanic gardens in Liverpool. 1802.

MOTT, F. T. Flora odorata. 1843.

MAKINO, Tomitarô. A manual of the flora of Nippon. 1927.

STAPF, Otto. Index londinensis. Vol. 2, 3. 1930.

WILSON, E. H. Aristocrats of the trees. 1930.

The original drawings by Mr. C. E. Faxon for the revised edition of Professor Sargent's Manual of the Trees of North America have been arranged and suitably bound.

Through the courtesy of its author, Alfred Carl HOTTES, the Library has received "The Gardener's Pronouncing Dictionary," compiled for *Better Homes & Gardens*, 1930.

The names used are principally those in "Standardized Plant Names." The "Manual of Cultivated Trees and Shrubs," by Alfred Rehder, and the "Manual of Cultivated Plants," by L. H. Bailey have been frequently consulted, as has T. S. Lindsay's "Plant Names," and English books which may not be available to American readers.

The botanical names are followed by a clear indication of pronunciation, the common name and a short description of the plant. The list also includes references under the common names and explanations of descriptive terms. Two plates show types of leaves, of flowers, and of fruits.

A book of 88 pages, in paper cover, this little Dictionary meets a long felt need and is bound to prove useful in the questions so perplexing to the student and to the amateur flower lover, the pronunciation of plant names.

From the AMERICAN SOCIETY OF MECHANICAL ENGINEERS, has come their publication "A Bibliography on Woods of the World, exclusive of the Temperate region of North America, and with emphasis on tropical woods," 1928.

It is printed in clear type and consists of 77 pages double column. The entries are numbered from 1 to 1530 and are arranged under the headings General, Tropical America, Europe, Asia and Oceania, Africa. A full subject index ends the volume.

The work was undertaken on the recommendation of the Wood Industries Division of the American Society of Mechanical Engineers in co-operation with the Tropical Plant Research Foundation, Washington, D. C. to investigate the possibilities of applying tropical woods to the wood industries in this country, Professor Samuel J. Record's "Bibliography of the Woods of the World with Emphasis on Tropical Woods" forming the starting point. "The references cover tropical forestry, lumbering, marketing, wood uses, and characteristics, as well as botanical information of an extensive nature on the woods of the world."

Due to our rapidly disappearing forests, the study of the world's forest trees becomes a crying necessity, and a bibliography so complete is a valuable aid in its pursuit.

Mr. F. M. SALVOZA of the School of Forestry, University of the Philippines, has presented to the Library his "Monograph of the Genus Rhizophora, an investigation carried out at the Arnold Arboretum, and submitted as a thesis in partial fulfilment of the requirements for the degree of Doctor of Science in the Bussey Institution of Harvard University." It comprises 123 type-written sheets and 13 photographic plates and maps.

New serials include:—

FAN memorial institute of biology. Bulletin. Peiping, China. 1929.

FORESTRY. Published by the Japanese forestry association, Tokyo. No. 558. 1929.

FORSTLICHE zeitschrift für das grossherzogthum Baden. Bd. i; ii, heft 1, 2. 1838–42.

BEITRÄGE zur kenntnis des forstwesens in Deutschland. Heft i–iv. 1819-21.

MALAYA—Rubber research institute.
Quarterly journal. 1 → Kuala Lumpur. 1929 →
Bulletin. 1 → Kuala Lumpur. 1929 →

MIYAZAKI. College of agriculture and forestry. Bulletin. 1. Miyazaki. 1929.

NIKITA, Russia. Botanical garden.
Bulletin. 1. Yalta. 1929.
Zapiski. 8. Mockba. 1925.

SINENSIA; contributions from the Metropolitan museum of natural history, National research institute, Nanking. Nanking. Aug. 1929. 1.

MEXICO—Universidad nacional autonoma—Instituto de biologia. Anales. 1. Mexico. 1930.

SUBTROPIKI. Published by Abhâsian scientific society, Agricultural section. No. 1. Suchum, V. R. R. S. 1929.

Among the photographs presented to the Library are over 400 of plants of Arizona taken by Mrs. Susan D. McKelvey in 1929 and 75 by Miss Violet F. Edlmann; 120 views of trees and forests taken in Japan and northern China by Professor J. G. Jack in 1905; 143 photographs, chiefly of flowering and fruiting branches of plants in the Arboretum, taken by Mr. H. A. Gleason, 1927–1929; and 35 of flowers and fruits in the Arboretum by Mr. J. H. Lovell. Mr. E. J. Palmer has added 150 to his photographs of western vegetation and Mr. E. H. Wilson 46 of the Arboretum. The Rochester Park Department has added 95 photographs to its already generous gifts.

The most unique gift of recent years is that of Mr. Frederic A. Delano, consisting of 611 paintings of Chinese fruits, flowers and vegetables by native artists.[1]

In view of the fact that the British Museum Catalogue, Pritzel, Kew Catalogue, and all other sources consulted quote "The Botany of the Voyage of H. M. S. Sulphur, under the command of Captain Sir Edward Belcher, 1836–42, by George Bentham," as 1844, the date on the title-page, it is interesting to note that the copy in the Library of the Arnold

[1] See the April issue, pp. 131–132, of this Journal.

Arboretum is in its original buff paper covers, in which the work was issued in 6 parts, and from which it is evident that the later parts appeared in later years:—

No. 1 comprises pages	1– 16,	and plates 1–10.	1844.
No. 2 comprises pages	17– 48,	and plates 11–20.	1844.
No. 3 comprises pages	49– 72,	and plates 21–30.	1844.
No. 4 comprises pages	73– 96,	and plates 31–40.	1844.
No. 5 comprises pages	97–144,	and plates 41–50.	1845.
No. 6 comprises pages	145–195,	and plates 51–60.	1846.
	(index pp. 183–195)		

A notice on the cover of part 1 reads:—"On the 1st of January, 1844, will be published Part 1. of 'The Botany of the Voyage of H. M. S. Sulphur.' By George Bentham. As little benefit can accrue to science by the publication of mere catalogues of all the species collected, the descriptive matter will be confined to those hitherto unknown, or to the elucidation of such obscure points, as the specimens assist in clearing up; whilst in selecting the species for illustration, those will be preferred which are more particularly distinguished for the peculiarity of their organization, or with which a fuller acquaintance is desirable in the present state of botanical knowledge. The parts will appear quarterly." —E. D. M. T.

Staff of the Arnold Arboretum, 1930–31

OAKES AMES, A.M., Professor of Botany, Supervisor.
JOHN GEORGE JACK, Assistant Professor of Dendrology.
ALFRED REHDER, A.M., Curator of the Herbarium.
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Synonyms are printed in *italics*, new names in **bold-face** type.

ERRATA

Page 101 line 1 *for* Raphanastrum *read* Raphanistrum
" 108 line 17 from below *for* Pastanaca *read* Pastinaca
" 137 line 5 *for* intervenes *read* intervene
" 144 line 1 from below *omit* in the
" 154 line 11, from below after (1906) *add* as synon. of *C. hupehensis*

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JOSEPH HORACE FAULL AND KARL SAX
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Japanese Damascene Ware

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JOURNAL

OF THE

ARNOLD ARBORETUM

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RHUS VERNICIFLUA AND JAPANESE DAMASCENE WARE

OAKES AMES

Plate 27

IN CHINA AND JAPAN where the resin of *Rhus verniciflua* is used in the manufacture of lacquer ware, Rhus dermatitis or lacquer poisoning, is recognized as an industrial disease. Usually this disease is confined to workmen who gather the fresh resin or apply it, but from time to time, not only in China and Japan, but in countries to which lacquer ware is exported, well marked cases of Rhus poisoning occur among people who handle lacquered articles.

In April 1930 a rather extraordinary outbreak of lacquer poisoning occurred among passengers returning from Japan to the United States on the S. S. Columbus of the North German Lloyd Line. One woman experienced a severe case of poisoning after wearing a necklace of Japanese damascene ware purchased in Kyoto. Her neck, where the necklace had rested, was encircled by the papular eruptions characteristic of Rhus dermatitis. It was supposed that the necklace had been purchased from a salesman whose hands had been in contact with fresh lacquer, but this supposition was rendered doubtful when other women on the steamer exhibited well marked cases of Rhus dermatitis as a result of wearing necklaces and bracelets of damascened metal purchased in Japan.

Japanese damascene ware resembles very closely the product of Damascus from which it takes its name, and appears to be wholly composed of metal, that is, of gold or silver inlaid on oxidized steel. Assuming that the Japanese product is wholly metallic, it is difficult to understand how the symptoms of poisoning were stimulated that occurred among the passengers of the S. S. Columbus. There would be nothing to fear from any polishing substance or protective coating necessitated by the classic methods of manufacture.

Investigations indicated that the damascened articles,—such as necklaces, bracelets, cuff-links, cigarette cases and boxes,—purchased in Japan by the passengers on the S. S. Columbus, differed materially from genuine damascene, not only in the methods of manufacture, but in composition. The black background employed to bring out the delicate designs executed in gold and silver, proved in every case to be non-metallic and to consist of a resinous substance which yielded readily to a cutting instrument.

The common type of modern Japanese damascene ware that one finds in the shops to-day, is made by incising numerous lines on a polished surface of steel and pounding in a design of gold or silver or both, in low relief. Then black lacquer, prepared from the resin of *Rhus verniciflua* is applied and brought up level with the surface of the design. Unless actually disturbed with cutting instruments the lacquer is extraordinarily durable and will withstand drastic solvents without being materially damaged. Even when boiled for a short time with such solvents as carbon tetrachloride, toluene and butyl acetate, specimens of Japanese damascene that are in part composed of lacquer exhibit only slight injury. Indeed, lacquer made from *Rhus verniciflua* is one of the few materials of botanical origin that will come through the ordeal of this treatment and retain its original aspect. It is well known that Japanese lacquer resists the solvent effects of alcohol and is often used in the manufacture of cocktail cups.

Technically the term damascene should be confined to articles made of iron or steel inlaid with more precious metals. Tourists who purchase the supposedly damascened articles carry away the impression that only metals are used. It is true that some of the manufacturers of Japanese damascene admit that lacquer constitutes a part of the design. One of the large manufacturers in Kyoto describes the process as follows: "Lines are cut double hatchway on a polished surface of steel, and gold and silver are pounded down, a design being worked out in this way. Either lacquering or oxidizing process is given next, which is followed by the finishing work of polishing or engraving." The use of lacquer to imitate oxidized steel, while permissible as a form of artistic expression, is indefensible if deception is being practiced and the substitution of black lacquer for oxidized steel is made with fraudulent intentions. There must be a considerable difference in the cost of manufacture between lacquer-damascene and damascene of the original type, and it is evident that the profit is great when what may be termed lacquer-damascene is sold for the same price that would have to be established for true damascene.

When lacquer is comparatively fresh it is still capable of causing the characteristic symptoms of Rhus poisoning and when dry may be toxic to people who are especially susceptible to the poisonous effects of Poison Ivy (*Rhus toxicodendron*) and Poison Dogwood (*Rhus vernix*). If bracelets and necklaces are worn for prolonged periods, symptoms of poisoning will begin to appear, redness of the skin being in evidence in susceptible people, in about two days. Undoubtedly the season of the year will have a direct influence on the degree of toxicity, and if in hot weather lacquer-damascene of comparatively recent origin is worn against the skin by one who is extraordinarily sensitive to Rhus poisoning, well marked symptoms of dermatitis may develop rapidly and cause serious trouble. The necklace which caused the most severe case of Rhus dermatitis on the S. S. Columbus (cf. Pl. 29) is in large part made of gold, the lacquered parts being of comparatively negligible area. Furthermore only the metallic part of the necklace was worn in direct contact with the skin, yet the symptoms of poisoning encircled the neck of the wearer.

SUMMARY

The cases of Rhus dermatitis or lacquer poisoning caused by wearing or handling Japanese damascene are attributable to lacquer, the prepared latex of *Rhus verniciflua* Stokes, dyed black. The Japanese product in which lacquer is used should be called lacquer-damascene to avoid confusion and to warn those who are susceptible to Rhus or lacquer poisoning.

Laboratory of Economic Botany,
Harvard University.

EXPLANATION OF PLATE 27

The bracelet at the top of the plate has one of the designs (executed on a metal tablet) removed to show the method of construction. (Bot. Mus. Harvard U. no. 4485.) The cigarette case is lacquered where black is shown. (Bot. Mus. Harvard U. no. 4486.) The necklace is reproduced from the one which caused the first case of Rhus dermatitis on the S. S. Columbus. (Bot. Mus. Harvard U. no. 4463.)

THE ORIGIN AND RELATIONSHIPS OF THE POMOIDEAE

Karl Sax

Plate 28

Cytological studies of the more polymorphic genera of the Rosaceae have shown the probable origin and relationship of many species. The larger genera such as *Rosa*, *Rubus*, and *Prunus* each contain a number of species with the same basic chromosome number, and a large series of polyploids. The Pomoideae on the other hand consists of genera which are usually diploid, with a few tetraploids and triploids.

The basic chromosome number is 7 for the larger genera of the Rosoideae and 8 for the Prunoideae, but is 17 for all of the genera in the Pomoideae. Nebel (1929) and Darlington and Moffett (1930) have suggested that the Pomoideae are aneuploids derived from a 7 chromosome ancestor by chromosome duplication. Nebel suggests that the present *Malus* species are halved pentaploids derived from an ancestor with 35 somatic chromosomes. Darlington and Moffett also believe that the basic chromosome number of *Malus* is 7, but that the present forms are secondary polyploids with a basic number of 7 pairs of chromosomes, of which 4 are represented twice and 3 are represented three times. These authors go even further and suggest that the morphological characteristics of the Pomoideae are due to the establishment of a secondary basic chromosome number. These conclusions are based on the fact that the more important genera of the Rosoideae have 7 chromosomes as the basic number and that in species of *Malus* quadrivalents and sexivalents are found at the first meiotic divisions. Such an unbalanced secondary number of chromosomes must be considered remarkable in view of the fact that all of the species and varieties in the Pomoideae are orthoploid, with chromosome numbers of 17 or multiples of 17.

The present investigation was made in order to obtain chromosome counts of most of the genera of the Pomoideae. In view of the theory that this sub-family originated from a 7 chromosome form, a further survey of chromosome numbers was made in other genera of the Rosaceae. Most of the chromosome counts were obtained from acetocarmine smears of pollen mother cells. Mr. Dermen has made the counts of the *Prunus* species and most of the Spiraeoideae recorded, while Mrs. Sax is responsible for the counts in the *Amelanchier* species. The taxonomic grouping is based on Rehder's Manual (1926).

The chromosome numbers of representative genera are given in the following table. Counts obtained by previous investigators are indicated. In genera with polyploid species only the basic and highest polyploid numbers are given.

CHROMOSOME NUMBERS IN THE ROSACEAE

Sub-family	Genus	Chromosome No.	Native habitat
Spiraeoideae	*Physocarpus*	9	N. Am., Asia
	Spiraea	8 +	N. Am., Asia
	Pentactina	9	Korea
	Sibiraea	9	Eu., Asia
	Exochorda	8	Asia

Pomoideae	*Cotoneaster*	17–34	Eu., Afr., Asia
	Mespilus	17	Eu.
	Crataegus	16–32 L.[1]	
		17–34	N. Am., Eu., Asia
	Sorbus	17	N. Am., Eu., Asia
	Aronia	17	N. Am.
	Photinia	17	Asia
	Eriobotrya	17 M.	Asia
	Chaenomeles	17 K. M.	Asia
	Cydonia	17 R. K.	Asia
	Malus	17–34[2] R. K. N. D.	N. Am., Eu., Asia
	Pyrus	17–[illegible][2] R. K.	Eu., Asia
	Amelanchier	17–34	N. Am., Eu., Asia
Rosoideae	*Neviusia*	8	N. Am.
	Rhodotypus	8	Asia
	Rubus	7–28 L. C.	N. Hemisphere
	Potentilla	7–14 Ti. S.	N. Hemisphere
	Rosa	7–28 T. B. H. E.	N. Hemisphere
	Fragaria	7–28 L. I.	Am., Eu.
Prunoideae	*Maddenia*	16	Asia
	Prunus	8–88[2] K. O. D. Me.	N. Hemisphere
	Prinsepia	16	Asia
	Osmaronia	6 K.	N. Am.

[1] L.—Longley, M.—Morinaga, K.—Kobel, R.—Rybin, N.—Nebel, D.—Darlington, T.—Tackholm, B.—Blackburn and Harrison, H.—Hurst, E.—Erlanson, I.—Ichijima, Me.—Meurman, C.—Crane, Ti.—Tischler, S.—Shimotomai.

[2] Triploids also found especially among the cultivated varieties of *Malus* and *Pyrus*.

The chromosome counts in the Spiraeoideae were obtained from the following species:—*Physocarpus monogynus, P. intermedius, P. stellatus,* and *P. capitatus; Spiraea pubescens* and the hybrid *S. oxyodon; Pentactina rupicola; Sibiraea laevigata;* and *Exochorda Giraldii Wilsonii.*

Most of these genera contain few species and *Pentactina* is monotypic. There are about 80 species of *Spiraea,* however, and a considerable number of species hybrids. This genus undoubtedly contains some polyploid species although exact counts of the higher chromosome numbers could not be obtained. The basic numbers for this sub-family are 8 and 9.

In the Rosoideae chromosome counts were obtained for the following species:—*Neviusia alabamensis, Rhodotypus scandens, Potentilla fruticosa* (7) and *P. tridentata* (14). *Neviusia* and *Rhodotypus* are monotypic genera. *Potentilla* is a large genus with more than 300 species of which only a few are woody. Both the woody and herbaceous species of *Potentilla* have 7 pairs of chromosomes as the basic number (Tischler 1929, Shimotomai 1929) instead of 8 as earlier investigators reported. The haploid chromosome number is 8 for the two monotypic genera, but is 7 for the polymorphic and polyploid genera *Rubus, Rosa, Potentilla* and *Fragaria.*

In the subfamily Prunoideae, chromosome counts have been obtained for *Maddenia hypoxantha*, and *Prinsepia uniflora*. According to Kobel the monotypic genus *Osmaronia* has only six pairs of chromosomes. The large genus *Prunus* has eight chromosomes as the basic number. Chromosome counts of the following species have also been made. Species with eight pairs of chromosomes include *Prunus incana*, *P. avium*, *P. serrulata sachalinensis*, *P. incisa serrata*, *P. subhirtella*, *P. glandulosa*, *P. pennsylvanica*, *P. allegheniensis*, *P. pumila susquehanae*, *P. angustifolia*, *P. americana*, *P. japonica Nakaii*, *P. orthosepala*, *P. hortulana*, *P. Munsoniana*, *P. maritima*, and *P. lanata*. Two species were found to be tetraploids; *Prunus Padus* and *P. virginiana*. Previous investigators have found diploids, triploids, tetraploids, hexaploids and aneuploids in the genus *Prunus* (Kobel 1927, Okabe 1928, Darlington 1928–30) and in one species Meurman (1929) found about 88 pairs of chromosomes. The two genera *Maddenia* and *Prinsepia* are apparently tetraploids but *Osmaronia* does not seem to have the typical basic number of 8.

CHROMOSOME NUMBERS IN THE POMOIDEAE

All of the genera of the Pomoideae have 17 pairs of chromosomes or polyploids with a basic number of 17. In some genera, especially *Cotoneaster* and *Crataegus*, it was difficult to obtain clear division figures with the acetocarmine technique. In some cases there appeared to be only 16 pairs of chromosomes in *Crataegus* as Longley (1924) has reported. In most genera there is more or less association between the chromosomes at the first meiotic division, as previous investigators have found, so that it is often difficult to determine the exact number of bivalent chromosomes. The following chromosome counts were determined from acetocarmine smears of pollen mother cells.

Cotoneaster moupinensis and *C. salicifolia* are diploids with 17 pairs of chromosomes while *C. horizontalis* is a tetraploid. The 17 bivalent chromosomes of *C. moupinensis* at diakinesis are shown in figure 4. The chromosomes of the tetraploid species are shown in figure 3. Other species were also found to have more than 17 pairs of chromosomes although exact counts were not obtained. It seems probable that a relatively large proportion of the *Cotoneaster* species are polyploids.

Mespilus germanica has 17 pairs of chromosomes and not 16 pairs as reported by Meyer (1915). The meiotic chromosomes at 1 M are shown in figure 2.

Only a few species of *Crataegus* were examined because this genus was thoroughly studied by Longley (1924). Longley reports that 16 is the basic chromosome number in *Crataegus* and he finds numerous triploid and a few tetraploid species. The great variation in morphological characters in this genus is attributed to hybridization between species.

In several species of *Crataegus* the acetocarmine preparation showed only 16 pairs of chromosomes but other species undoubtedly have 17 chromosomes as the basic number. The 16 groups of chromosomes in the hybrid *C. Lavallei* are shown in figure 1. In *C. Deweyana* there are clearly 17 pairs of chromosomes at late diakinesis (figure 8). In this species, as well as most other species in the Pomoideae, there is a tendency for bivalents to be associated in groups of two or even three. At the first metaphase *C. lawrencensis* appears to have 17 or 18 pairs of chromosomes (figure 7), but at the telophase of the division there are about 33 chromosomes at one pole (figure 6) and 32 at the other, with one lagging chromosome still at the metaphase plate. The chromosomes in this pollen mother cell were especially clear. It is possible that *Crataegus* is a transitional genus with both 16 and 17 chromosome forms, and that such species as *C. lawrencensis* with apparently 32 bivalents and 2 univalents could produce segregates with either 16 or 17 chromosomes as the basic number. The association of chromosomes into tetravalents is the result of duplication of the primary basic number of chromosomes.

In the *Sorbus* species there is much less tendency for the bivalents to form a secondary association and exact chromosome counts were easily made. *Sorbus Aucuparia, S. americana, S. discolor, S. alnifolia,* and *S. Aria* are all diploids with 17 pairs of chromosomes. The meiotic chromosomes of *S. aucuparia* and *S. alnifolia* are shown in figures 5 and 12.

The closely related genus *Aronia* also has 17 pairs of chromosomes. Two of the three species were studied and both *A. melanocarpa* and *A. arbutifolia* were found to be diploids (figure 11).

Only one species of *Photinia* was available for study in the Arnold Arboretum. It was found to be diploid with 17 pairs of chromosomes which are shown in figure 10.

The chromosome number of *Eriobotyra* was determined from root tip counts from seedlings grown in the greenhouse. The somatic chromosome number is 34 which is in accord with the count obtained by Morinaga (1929) for the same species, *E. japonica.*

The 17 chromosomes of *Chaenomeles sinensis* are shown in figure 9. This count agrees with the number previously reported by Morinaga (1929). Rybin (1926) and Kobel (1927) also find 17 pairs of chromosomes in the closely related genus *Cydonia.*

Rybin (1926) found 34 somatic chromosomes in several species of *Pyrus* and Kobel (1927) found 17 bivalents in certain species and varieties, but a variable number of chromosomes in many of the cultivated forms. It is probable that these forms with irregular chromosome behavior are triploids with 51 somatic chromosomes.

The genus *Malus* has been investigated by a number of cytologists (Rybin 1926, Kobel 1927, Nebel 1929, and Darlington and Moffett 1930). Most of the species are diploids with 17 pairs of chromosomes, but several tetraploid species have also been described. In two cases triploids were found but other forms of the same species were found to be diploid. Triploid species could not reproduce themselves by sexual reproduction and would be expected to occur only occasionally. Among the cultivated varieties of apples, however, triploid forms are frequently found, and although they are partially sterile, enough flowers develop to produce a commercial crop of fruit. About 75 horticultural varieties of apples have been investigated and of these about one-third are triploids. No tetraploid horticultural varieties have been described.

Counts of somatic chromosomes were obtained from root tips of seedlings several years ago, but since so many species have been studied recently, it was considered unnecessary to carry this phase of the work further. The following species were found to be diploid: *Malus baccata, M. prunifolia, M. micromalus,* and *M. brevipes. Malus angustifolia, M. coronaria,* and *M. glaucescens* are tetraploids. In general these results are in accord with those of previous investigators. *Malus adstringens, M. Scheideckeri, M. Soulardi, M. robusta, M. zumi,* and *M. Dawsoniana,* are all recognized as species hybrids by Rehder (1926) and all of them are diploids and have 34 somatic chromosomes. It is possible, of course, that chromosome counts from seedlings do not indicate the chromosome number of a parental tree because a triploid might produce a diploid seedling, but the fertility of the parental trees and the uniformity in chromosome counts in the seedlings indicated that the counts obtained from seedlings also represent the parental chromosome numbers in these species.

All of the pure species of *Amelanchier* which have been studied are diploids, but two natural species hybrids are tetraploids. The diploid species are *Amelanchier asiatica, A. humilis, A. stolonifera, A. sanguinea* and *A. oblongifolia.* The chromosomes of *A. oblongifolia* are shown in figure 16. In *Amelanchier,* as in *Sorbus,* there is little tendency for the bivalents to form secondary associations.

The tetraploid hybrid *A. grandiflora* is a cross between *A. canadensis* and *laevis*, while *A. spicata* is a cross between *A. oblongifolia* and *stolonifera* (?) according to Rehder. In these tetraploids the chromosomes usually pair as bivalents at meiosis.

Generic Hybrids in the Pomoideae

A relatively large number of natural generic hybrids have been found in the Pomoideae. Among the hybrids recognized by Rehder are *Crataegomespilus* (*Crataegus* × *Mespilus*), *Sorbaronia* (*Sorbus* × *Aronia*), *Sorbopyrus* (*Pyrus* × *Sorbus*), *Amelasorbus* (*Amelanchier* × *Sorbus*), and *Pyronia* (*Pyrus* × *Cydonia*).

Representatives of three of these generic hybrids are growing in the Arnold Arboretum and the chromosome behavior of two of the hybrids has already been described (Sax 1927).

Two types of *Crataegomespilus* have been studied. *Crataegomespilus Dardari* is a graft hybrid which developed from the graft union of *Mespilus germanica* on *Crataegus monogyna*. Meyer's (1915) study of this graft hybrid shows that the outer layers of tissue are those of *Mespilus* although the fruit shape is like that of *Crataegus*. It is probable that the gametes are derived from *Mespilus* tissue. The number of chromosomes at the first reduction division is 17 as shown in figure 15 and are probably from *Mespilus* cells.

The generic hybrid *Crataegomespilus grandiflora* is supposed to be a cross between *Crataegus Oxyacantha* and *Mespilus germanica*. *Mespilus germanica* is a diploid species and according to Longley *C. Oxyacantha* is also a diploid form, but the F_1 hybrid seems to have more than 17 pairs of chromosomes. There are 17 groups of chromosomes at the first metaphase shown in figure 14, but at late diakinesis (figure 13) there are about 17 bivalents and 6 univalents. It is possible that there are only 34 somatic chromosomes in this hybrid and that there is incomplete pairing of chromosomes, but the presence of so many apparently bivalent chromosomes makes it seem more probable that one of the parental gametes was diploid. About 75 per cent of the pollen is obviously sterile.

Sorbaronia Dippelii is a cross between *Sorbus Aria* and *Aronia melanocarpa*. Both of these parental species are diploids. In the F_1 hybrid there is apparently complete compatability of the two sets of chromosomes and 17 chromosomes are found at the first meiotic division of the pollen mother cells (figure 21). Several other generic hybrids between *Sorbus* and *Aronia* are also described by Rehder (1926). Prof. J. G. Jack has found several such hybrids and Mr. F. Hyland has recently found a hybrid between *S. Aucuparia* and *A. floribunda* growing near Orono, Maine. These hybrids all seem to be completely fertile and set fruit abundantly.

A hybrid between *Sorbus* and *Pyrus* is known as *Sorbopyrus auricularis* and is supposed to be a cross between *P. communis* and *S. Aria*. The variety *bulbiformis* is a seedling of *S. auricularis* and is more like *Pyrus* than the F_1 hybrid. A cytological examination of the pollen mother cells of this variety shows that there are 34 chromosomes at metaphase of which about half are univalents (figure 18). The first meiotic division is somewhat irregular but usually the bivalents seem to pass to the poles first and most of the univalents lag behind. A typical division figure is shown in figures 17–19 where there are 17 chromosomes at one pole, 19 at the other and about 14 lagging univalents.

The variety *bulbiformis* evidently has two sets of *Pyrus* chromosomes and one set of *Sorbus* chromosomes, and probably originated by the union of a diploid F_1 egg cell with a haploid *Pyrus* male gamete. The fact that the chromosomes in the triploid segregate, and do not form trivalent chromosomes does not necessarily mean that the *Pyrus* and *Sorbus* chromosomes are incompatible, but since the F_1 hybrid is relatively sterile this interpretation is probably correct. The parental genera must be closely related, however, since the two sets of chromosomes function normally in somatic development.

Pyronia Veitchii is a hybrid between *Cydonia oblonga* and *Pyrus communis*. The F_1 plant sets fruit but no seeds are formed. Apparently these genera are closely related but pairing between the two sets of chromosomes does not occur.

Another generic hybrid discovered by Prof. Jack is *Amelasorbus Jackii*, which is a cross between *Amelanchier florida* and *Sorbus sitchensis*. Plants of this hybrid in the Arboretum are not large enough to produce flowers so that nothing is known about its cytological behavior. It sets seed freely in its native habitat which would indicate that the two parental sets of chromosomes are compatible with each other, although it is possible that it is a teptraploid, as are the *Amelanchier* species hybrids. If so, the F_1 might be fertile even if the parental chromosomes did not pair with each other.

Species Formation in the Rosaceae

Cytological and genetic studies in several genera of the Rosaceae have shown the relationship and origin of many species. A brief survey of this work will be presented here as a basis for the discussion of the origin and relationships of the genera of the Pomoideae.

The polymorphic genus *Rosa* has been found to contain an extensive series of polyploid types with diploid, triploid, tetraploid, pentaploid, hexaploid, and octoploid forms. (Tackholm 1922, Blackburn and Harrison 1921, Hurst 1927 and Erlanson 1929.) More than 1000 species and forms of *Rosa* have been examined and these include all of the sections of the genus distributed over the northern hemisphere. Of these forms studied 377 are diploids with 7 pairs of chromosomes, while over 600 are polyploids. A few aneuploid forms have been found by Tackholm and Erlanson, but practically all of the species have a chromosome number of 7 or a multiple of 7.

According to Hurst there are five fundamental diploid types, each with a different set of 7 chromosomes. These five fundamental diploid sets of chromosomes have been identified by genetic and cytological tests. The chromosomes of one set will not pair with those of another set, and each set is responsible for certain morphological differences. The species containing set AA is represented by *R. sempervirens*, BB by *R. sericea*, CC by *R. rugosa*, DD by *R. carolina* and EE by *R. macrophylla*. A duplication of the same set of chromosomes results in what Hurst calls duplicational polyploid varieties which have the same characteristics as their basic species. Differential polyploids, however, contain two or more different sets of chromosomes, such as AABB, and are distinct species. Twenty-six regular polyploid species are possible of which 18 have been identified. Irregular polyploids are those containing at least one set of bivalent chromosomes and from one to four sets of univalents. Of the 180 different possible combinations which would result in irregular polyploid species, only 25 have been identified in the wild state. According to Hurst there are 211 possible species of *Rosa*, if the 180 irregular polyploids are included, of which about 50 have been identified. Some taxonomists have recognized nearly 5000 species of *Rosa* although Rehder states that there are only one to two hundred good species.

The irregular polyploids are best represented by the species of the Caninae section. These species have 7 bivalents and either 14, 21 or, in a few species, 28 univalents. Tackholm found that the reduction was irregular in these forms. The bivalents divide normally but the univalents lag behind and are irregularly distributed in the first and second meiotic divisions of the pollen mother cells. Micronuclei are often formed, pollen sterility is high, and the few functional pollen grains have 7 chromosomes derived from the division of the bivalents. In the reduction division of the megaspore mother cells, however, 7 chromosomes from the bivalents and all of the univalents pass to one pole. From this cell the female gamete is formed with 21, 28 or 35 chromosomes. It may be fertilized with a 7 chromosome male gamete and reproduce the parental type, or due to apomictical reproduction the parental type is reproduced asexually. Thus these types of unbalanced polyploids of undoubted hybrid origin breed true due to the peculiar chromosome distribution and apomixis.

The cytological and genetic work on *Rosa* clearly indicates that most of the numerous species and forms of the genus have originated from a few basic types by hybridity and polyploidy or by hybridity followed by apomixis.

The genus *Rubus* also contains a series of polyploid forms. Longley (1924) has found diploid, triploid, tetraploid, pentaploid, hexaploid, and octoploid species in this genus. Crane and Darlington (1927) have presented cytological and genetic evidence which seems to show that there are at least three different basic sets of 7 chromosomes each, in this genus. The genetic evidence seems to show that the chromosomes of two different basic septets may also pair with each other (Crane and Darlington). Apparently in this genus chromosome differentiation is not complete so that pairing occurs between different sets of chromosomes. According to Crane and Darlington unreduced egg cells frequently function in *Rubus* hybrids and apogamy also occurs. According to Longley there are about 10 bivalents at the first meiotic division of triploids and about 17 in pentaploids which would indicate that there is pairing between non-homologous chromosomes.

Fragaria is another polyploid genus containing diploid, tetraploid, hexaploid and octoploid species (Longley 1926, Ichijima 1926). The tetraploid form has not been found in natural species, but was obtained from a cross between two 7 chromosome species followed by somatic doubling in F_1 (Ichijima). Ichijima found that *Duchesnea indica* has 42 gametic chromosomes and since it can be crossed with *Fragaria* it is possibly a dodecaploid form of *Fragaria*.

The chromosomes of all 7 chromosome species seem to be compatible and pair in species hybrids. In crosses between 7×28 chromosome species there are 7 bivalent and about 21 univalents at meiosis in the F_1 which would indicate that there are at least three and possibly four different sets of 7 chromosomes each (Ichijima 1926).

Yarnell (1929) found that Ichijima's tetraploid bred true. When back crossed with one of the 7 chromosome parents a triploid was produced. In this triploid 7 bivalents and 7 univalents were occasionally found at the first meiotic division of the pollen mother cells but usually there were 10 bivalents and 1 univalent. At the second reduction division 10 or 11 chromosomes were most frequent at metaphase. The triploid plants were partially fertile. In *Fragaria,* as in *Rubus,* there is evidently pairing of the non-homologous chromosomes.

The genus *Prunus* contains diploid, triploid, tetraploid, hexaploid and aneuploid species (Kobel 1927, Okabe 1928, Darlington 1928, 1930), and in one species Meurman (1929) has found a remarkable case of polyploidy where the basic somatic chromosome number is reduplicated eleven times. The basic somatic chromosome number is 8, and many species, even those belonging to different subgenera, seem to have similar sets of chromosomes so that chromosome pairing occurs in many species hybrids. Darlington (1930) finds chromosome pairing in a series of hybrids: *P. domestica* (6n) × *P. cerasifera* (2n), *P. triflora* (2n) × *P. cerasifera* (2n), *P. triflora* (2n) × *P. Persica* (2n) and *P. Persica* (2n) × *P. Amygdalus* (2n). *Prunus Persica* (Peach) and *P. Amygdalus* (Almond) belong to the subgenus *Amygdalus* while the species of Plums belong to the subgenus *Prunophora.* In the cross between *P. domestica* and *P. cerasifera* the F_1 behaves like a tetraploid which indicates that there are at least two similar sets of chromosomes in the hexaploid parent. In the cross between the Peach and the Almond some chromosomes frequently fail to pair, but fruit production is not seriously impaired. Rehder (1926) also describes a number of hybrids between species of different subgenera. The hybrid *P. dasycarpa* is probably a cross between *P. Armeniaca* (Apricot) and *P. cerasifera* (Plum) and rarely sets fruit. Only in one case is there any record of a cross between cherry and plum species. *Prunus pumila* (Sand Cherry) × *P. cerasifera* (Plum) produced a hybrid which sets fruit. In general the first two subgenera of this genus seem to be genetically similar in many cases, although it is improbable that all crosses between species of these two groups would produce fertile hybrids. Subgenera 4 and 5, *Padus* and *Laurocerasus,* are somewhat similar, but are probably well differentiated from the other groups. Thus in the genus *Prunus* there are at least several different basic sets of chromosomes and in addition there is some evidence that chromosome differentiation is now in progress.

Okabe finds that the flowering Cherries are triploids which accounts for their sterility. The Sweet Cherries (*P. avium*) are usually aneuploid with from 17 to 19 somatic chromosomes (Darlington 1928). The occurrence of autosyndesis and secondary chromosome association in hybrids and species of *Prunus* indicate that polyploidy in this genus is often due to duplication of a single basic set of chromosomes. Species differentiation seems to be due largely to differences in basic sets of chromosomes.

The larger genera of Rosaceae have many similar characteristics in chromosome behavior. They all contain a series of polyploid species which may be caused by a duplication of the same basic set of chromosomes, or may be due to the combination of different basic sets of chromosomes. Most of the species are orthoploid and aneuploid forms are rarely found in nature. Species formation is due to genetic differentiation of basic sets of chromosomes so that the chromosomes often fail to pair in species hybrids, and to hybridization of distinct species followed by polyploidy. The production of diploid gametes is relatively frequent in this family and apogamy often permits the reproduction of unbalanced polyploid types which could not be maintained by sexual reproduction.

The chromosomes in autopolyploid species usually form bivalents instead of tetravalents at the first meiotic division due to the lack of sufficient chiasmata to bind more than two chromosomes together. In *Rubus*, *Fragaria* and *Crataegus* non-homologous chromosomes seem to pair in triploids although it seems improbable that there is an intimate association of chromatids in such an association of chromosomes. The association of non-homologous chromosomes does suggest, however, that chromosome pairing is not always a reliable indication of genetic homology.

The Origin and Relationships of the Genera of Pomoideae

The genera of Pomoideae form a distinct and closely related group. All of the genera investigated have 17 pairs of chromosomes as the basic number. This subfamily is undoubtedly of Asiatic origin since all but three of the 18 genera enumerated by Rehder are represented by Asiatic species. The monotypic genus *Mespilus* is found in south-eastern Europe and Persia, while the monotypic genus *Peraphyllum* and the genus *Aronia* are natives of North America. *Mespilus*, however, is very closely related to *Crataegus; Aronia* is simply a form of *Sorbus* as indicated by genetic and cytological relationships; and *Peraphyllum* may be only an abberrant type of Amelanchier. Twelve of the genera of Pomoideae are not found in America while 7 are found only in Asia.

We may conclude then that the Pomoideae originated in Asia and that before the migration of the various species over the northern hemisphere, a period of perhaps millions of years, this group of plants had 17 chromosomes as the basic number. It would be most remarkable if each genus developed the same unbalanced polyploid number independently.

The chromosome behavior of any genus of this subfamily should, therefore, indicate the chromosome relationships of the entire group. According to Nebel the genus *Malus* is a halved pentaploid with 7 as the basic chromosome number. There is little evidence for this conclusion except that there is a tendency for the meiotic chromosomes to form secondary associations. Darlington and Moffett believe that *Malus* has developed from a 7 chromosome type, of which four chromosomes are represented twice and 3 chromosomes represented three times, or in other words, the present *Malus* species are of the gametic constitution of $2n + 3$.

The evidence presented by Darlington and Moffett to support this theory is very weak. Multiple association of chromosomes occurs at the first meiotic division so that in extreme cases four quadrivalents and three sexivalents are seen in polar views instead of 17 bivalents. This clumping of chromosomes, especially in sectioned material, may have little significance, however, and in side views of the metaphase of the first meiotic division no such general association of bivalents is shown. In the eight figures of "diploids" shown on page 136 (Darlington and Moffett 1930) there is usually only one quadrivalent shown in each figure and in only one case is there any indication of a sexivalent group of chromosomes. In triploid apple varieties these investigators find bivalents and trivalents most frequently but also a few quadrivalents, and only one group of 9 chromosomes. As Darlington has shown earlier, the larger multiple associations might not be expected to occur frequently because of limitations in chiasma formation.

The chromosome numbers in seedlings from triploids is also presented to support the theory that *Malus* is a secondary polyploid with 7 chromosomes as the basic number. The progeny from a triploid pollinated with a diploid should have from 34 to 51 somatic chromosomes. Darlington and Moffett find that in 13 seedlings the lowest somatic count is 38 and the highest 47. Three seedlings have 40 somatic chromosomes and four have 41. The authors conclude that since the greatest chromosome frequency is 41 there is a tendency for the chromosomes to form segregates with the secondary diploid number 34, plus the primary haploid number 7. But it could equally well be argued that the basic number is 8. However, a frequency distribution of this type based on only 13 individuals shows nothing except that gametes with intermediate chromosome number are functional, and is of no significance in determining the basic chromosome number.

The work of Crane and Lawrence (1930) shows that the progeny of triploid Apple varieties are usually weak, presumably due to their aneuploid condition. If the basic chromosome number of *Malus* is 7 and the basic sets are not sufficiently differentiated to prevent occasional pairing, as Darlington and Moffett believe, then one might expect new polyploid forms with 41 or 48 chromosomes to function as well as triploids, but such types have never been found.

If secondary chromosome association in the Pomoideae indicates polyploidy, it would seem much more probable that 8 is the original basic number and that the present genera are tetraploids plus one bivalent, as Tischler (1929) has assumed. Such an association of chromosomes would account for the occasional quadrivalents and sexivalents observed by Darlington and Moffett. It would also account for the 16 and 24 bivalent types of *Crataegus* found by Longley, although the 24 chromosomes in triploids may be due to pairing of non-homologous chromosomes as occurs in *Rubus* and *Fragaria*. Species and varieties which have an additional pair of chromosome are found in many genera whereas diploids or tetraploids plus several bivalents are rare in natural species. For instance most of the genera of Ericaceae have a chromosome number of 12 or a multiple of 12 (Hagerup 1928) but several genera, including the polymorphic genus *Rhododendron*, have 13 chromosomes as the basic number. The fact that one genus has 6 haploid chromosomes and another 18 would suggest that 6 is the primary basic chromosome number for this family and that *Rhododendron* is really a tetraploid plus one bivalent. It would seem improbable, however, that *Rhododendron* has been differentiated from other genera of Ericaceae simply by tetraploidy plus a bivalent chromosome. Darlington and Moffett suggest, however, that the establishment of the secondary basic chromosome number as described in *Malus* may be responsible for the differentiation of the Pomoideae from the other Rosaceae. The chromosome numbers in other Rosaceae do not support this suggestion. The aneuploid types of *Fragaria*, *Rosa*, and *Prunus*, are all very similar to the orthoploid species.

Many of the genera of Pomoideae are closely related and the subfamily as a whole includes a distinct group of genera. The fact that intergeneric hybrids can be made between *Pyrus* and *Sorbus*, *Cydonia* and *Pyrus*, *Amelanchier* and *Sorbus*, and between *Aronia* and *Sorbus* indicates that these genera are closely related. In fact *Aronia* must be considered simply as a form of *Sorbus* since crosses between these two genera produce fertile hybrids in which there is complete compatibility between parental chromosomes. It is possible that such genera as *Aronia* and *Mespilus* are now in the process of differentiation and that ultimately they might become genetically distinct from their closely related forms so that chromosome pairing could not occur in intergeneric hybrids.

Many of the genera have never been crossed with each other although in many cases there has been ample opportunity for such hybrids to occur. There are no known hybrids between *Malus* and *Pyrus* although these genera are morphologically very similar.

In the larger genera of Pomoideae there are a few triploid or tetraploid species. In *Malus* there is good evidence that triploids and tetraploids are autopolyploids. The fact that about a third of the cultivated Apples are triploids and that no tetraploid varieties have been found indicates that chromosome duplication is caused by the occasional production of a diploid gamete. Similar evidence of autopolyploidy is also found in *Crataegus* and *Pyrus*. In *Amelanchier* the only known tetraploids are natural species hybrids, but it seems improbable that there are two different basic sets of chromosomes in these closely related parental species.

Polyploidy seems to have played a minor part in genus and species differentiation in the Pomoideae, although it is possible that the present diploid forms are polyploids with a basic chromosome number of 8. The genetic similarity of so many genera, and the morphological similarity of genetically differentiated genera, would indicate, however, that not more than one basic set of chromosomes was involved in the origin of the present genera. It seems probable that the genera of *Pomoideae* all originated by genetic changes in the basic set of 17 chromosomes and that various degrees of chromosome differentiation now exist in the different genera.

Within the genera further changes have occurred, but in many or perhaps in most cases they are not great enough to prevent chromosome pairing in species hybrids. The species of *Malus*, *Crataegus*, *Sorbus*, and *Amelanchier* hybridize rather freely in nature and many more species hybrids could undoubtedly be made. It is probable, however, that certain species in the larger genera are completely differentiated from each other. With the exception of *Crataegus* most of the genera of Pomoideae contain relatively few species.

According to Sargent (1922) there are more than 1000 species of *Crataegus*. In most cases species differentiation is based on minor morphological differences. Palmer (1925) in his introduction to the "Synopsis of North American *Crataegi*" states that "in these tables the color of the anthers, number of stamens, glabrous or pubescent character of corymbs at flowering time and general shape of the leaves were adopted for most groups, in the order named. . . . . The taxonomic value of characters varies in different groups, but generally there appears to be considerable variability even within the species in such particulars as the size of the flowers, the number in the corymbs and the compactness or laxity of the latter. The shape of the leaves is even less stable and dependable, many types often being found on a single branch. . . . The fruit is often one of the best guides to group distinctions, but there is quite too much variation in such particulars as shape, size and color for them to be depended upon rigidly as specific criteria. . . Even the presence or absence of pubescence on the corymbs, often one of the best specific distinctions, cannot always be relied upon." The number of stamens and color of anthers are considered one of the most definite criteria for distinguishing species, but stamen number is also variable and anther color is often correlated with the color of the fruit.

Seedlings of the more ornamental types have been grown in considerable numbers at Rochester Park and at the Arnold Arboretum. My colleague, Mr. E. J. Palmer, informs me that in most cases the species of *Crataegus* breed true from seed, even to the most minute characters. Many species have a wide geographic range while others are of very local geographic distribution.

Longley has investigated about 80 species of *Crataegus* and found that about three-fourths of these species are triploids. Standish (1916) found that pollen sterility was prevalent in about 80 per cent of the species studied and in many cases pollen sterility was complete. It seems probable then that about 75 per cent of the *Crataegi* are triploids and form partially or completely sterile pollen. In view of the prevalence of triploids and pollen sterility in this genus it is remarkable that almost all species of *Crataegus* produce fruits abundantly. And still more remarkable some of these triploid forms with partially sterile pollen are known to breed true from seed. The only explanation of these phenomena seems to be that the triploid species are apogamous, or that seeds develop, from unreduced egg cells, so that the progeny receive the maternal set of somatic chromosomes and would of course breed true.

This explanation of seed production in the triploid *Crataegi* will account for the numerous species found in this genus. It is quite probable that there are at least several distinct types of *Crataegi* whose chromosomes are completely differentiated, but for the most part the different forms have similar basic sets of chromosomes. Variations caused by mutation and by hybridization between similar types which differed in such characters as size and color of fruit, pubescent or glabrous corymbs, color and number of anthers and leaf shape would produce many different types of segregates differing only in these minor characters. The occasional production of diploid gametes, which seems to be characteristic of many genera of the Rosaceae, would frequently result in the production of triploids. These triploids seem to have developed a type of apogamous reproduction so that they breed true for both morphological characters and chromosome number. The older triploid types would be expected to have as great a geographic range as the diploids but the more recent ones would have only a local range.

Triploids could also be derived from homozygous diploids and from crosses between diploids and tetraploids. The production of triploid forms from diploid species will cause chromosome irregularity and pollen sterility, so that these phenomena are not necessarily associated with hybridity. Chromosome irregularity can also be caused by genetic factors, grafting, X-rays, segmental interchange between non-homologous chromosomes, and to some extent by environmental conditions.

There is also some evidence for apogamy in the genus *Malus* (Kobel 1927). Mr. W. H. Judd of the Arnold Arboretum tells me that some of the *Malus* species breed true from seed. In the Arboretum a number of species are grouped together and in many cases a species is represented by a single tree. In view of the fact that all horticultural varieties of Malus are cross pollinated, it is remarkable that any of the species grown in the Arboretum should breed true, unless they develop seed by apogamy or from unreduced egg cells. Certainly the cultivated varieties do not breed true from seed. In connection with some breeding experiments a number of flowers of *Malus theifera* were emasculated while the anthers were green and before the buds opened. The stigmas were also cut off at the same time and yet most of the fruits developed to maturity and seeds were obtained. Thus there are several lines of evidence that some species of *Malus* are apogamous or parthenogenetic, but further work should be done with both *Crataegus* and *Malus*.

In view of the close relationships of many genera of the Pomoideae and the frequency of fertile species hybrids in most genera the validity of the taxonomic grouping must be questioned. Of course the differentiation of species limits is a matter of personal opinion as best indicated perhaps by the recognition of about 5000 species of *Rosa* by some taxonomists as compared with 100 to 200 recognized by Rehder.

There should be a specific genetic test to determine species relationships. The use of the term species as used by most taxonomists seems to be almost as indefinite as it was in Darwin's time. From the standpoint of genetics and cytology a species might be defined as a group of individuals of common descent which possess genetically similar sets of chromosomes. Such a definition will have to be modified at times in view of occasional genetic factors which may inhibit hybridization and affect the fertility of hybrids even in varietal crosses, but it is fundamentally sound. Of course such a test of genetics and cytological relationships can be applied only to a limited extent, but it should provide a more precise and natural system of classification for many groups of plants.

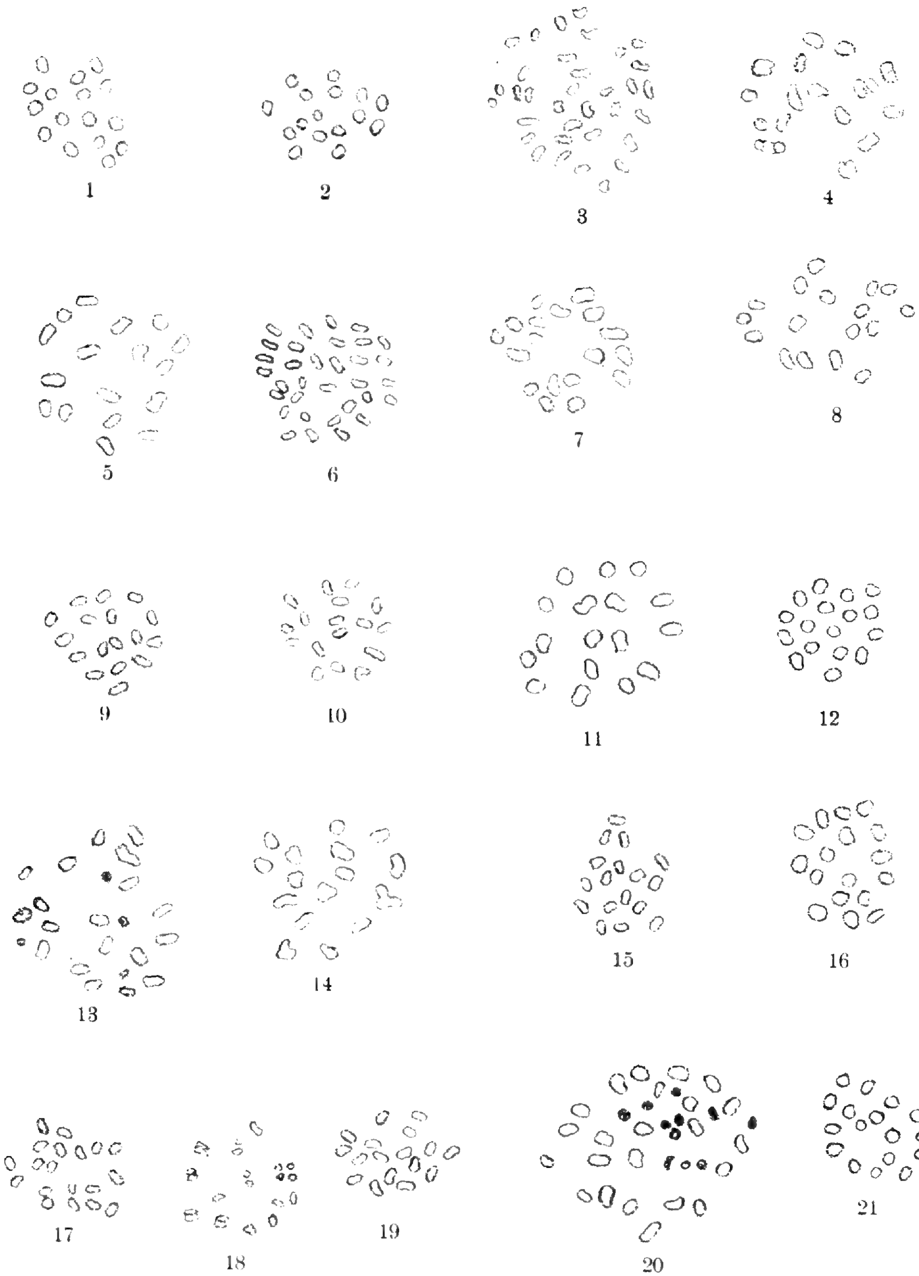
According to the genetic system of classification perhaps all of the Pomoideae could be classed as one genus and most of the present genera could be regarded as genetic species. In some cases two different genera, such as *Sorbus* and *Aronia*, should be combined in one genetic species. In the larger genera it is quite probable that there are a number of good genetic species so that the number of genetic species would exceed the present number of genera. This reversion to the older system of classification of the Pomoideae seems to be more in accord with genetic relationships than the present system, although a considerable amount of work must be done to determine the relationships of all of the genera and species.

SUMMARY.

In the Rosaceae the basic chromosome number is 8 and 9 for the Spiraeoideae, 7 and 8 for the Rosoideae, 8 for the Prunoideae, but is 17 for the Pomoideae. In the Rosoideae and Prunoideae, and probably in the Spiraeoideae, the larger genera include a series of polyploid species. In several genera which have been extensively studied it has been shown that species differentiation is caused by genetic differentiation of basic sets of chromosomes and by hybridization associated with polyploidy.

In the Pomoideae a few of the larger genera contain many triploids and a few tetraploids, but these forms are probably autopolyploids. The genera of Pomoideae have apparently had a common origin and have developed by genetic differentiation within the basic set of 17 chromosomes.

Many of the genera of Pomoideae are very closely related. *Sorbus* and *Aronia* have similar sets of chromosomes which pair in F_1 hybrids. Generic hybrids are also known to occur between *Crataegus* and *Mespilus*, *Sorbus* and *Amelanchier*, *Sorbus* and *Pyrus*, and *Pyrus* and *Cydonia*. Other genera are morphologically very similar although no generic hybrids are known to exist. The species in the larger genera are often closely related and natural species hybrids are commonly found.



Origin of Pomoideae

On a genetic and cytological basis of classification all of the present genera of the Pomoideae might be classed as genetic species under one genus. In at least one case two genera should be combined in one species.

Most of the numerous species of *Crataegi* are triploids and are fruitful and breed true apparently due to apogamy or parthenogenesis. Most of these triploid forms are probably the result of polyploidy within a genetic species and should be classed as varieties which breed true by asexual reproduction.

There is some evidence of secondary chromosome association at meiosis which may indicate that the present diploid genera are polyploids with an original basic chromosome number of 7 or 8.

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DESCRIPTION OF PLATE 28

From acetocarmine preparations of pollen mother cells.

Figure 1. *Crataegus Lavallei.* First metaphase.
2. *Mespilus germanica.* First metaphase.
3. *Cotoneaster horizontalis.* Second metaphase.
4. *Cotoneaster moupinensis.* Diakinesis.
5. *Sorbus Aucuparia.* First metaphase.
6. *Crataegus lawrencensis.* Telophase.
7. *Crataegus lawrencensis.* First metaphase.
8. *Crataegus Deweyana.* Late diakinesis.
9. *Chaenomeles sinensis.* Second metaphase.
10. *Photinia villosa.* Second metaphase.
11. *Aronia melanocarpa.* First metaphase.
12. *Sorbus alnifolia.* First metaphase.
13. *Crataegomespilus grandiflora.* Late diakinesis.
14. *Crataegomespilus grandiflora.* First metaphase.
15. *Crataegomespilus Dardari.* First metaphase.
16. *Amelanchier oblongifolia.* First metaphase.
17–19. *Sorbopyrus auricularis bulbiformis.* Telophase.
20. *Sorbopyrus auricularis bulbiformis.* First metaphase.
21. *Sorbaronia Dippelii.* First telophase.

The bivalents have divided and are shown at each pole in figures 17 and 19, while the lagging univalents are shown in figure 18.

LITERATURE CITED

BLACKBURN, K. B. (1925). Chromosomes and classification in the genus *Rosa.* (Amer. Nat. **49**: 200–208.)

BLACKMAN, K. B., and HARRISON, J. W. H. (1921). The status of the British rose forms as determined by their cytological behavior. (Ann. Bot. **35**: 159–188.)

CRANE, M. B. (1927). Studies in relation to sterility in plums, cherries, apples and raspberries. (Mem. Hort. Soc. N. Y. **3**: 119–134.)

CRANE, M. B., and DARLINGTON, C. D. (1927). The origin of new forms in Rubus. 1. (Genetics **9**: 241–276.)

CRANE, M. B., and LAWRENCE, W. J. C. (1930). Fertility and vigour of apples in relation to chromosome number. (Jour. Gen. **22**: 153–163.)

DARLINGTON, C. D. (1928). Studies in Prunus. I and II. (Jour. Gen. **19**: 213–256.)

DARLINGTON, C. D. (1930). Studies in Prunus. III. (Jour. Gen. **22**: 65–93.).

DARLINGTON, C. D. and MOFFETT, A. A. (1930). Primary and secondary chromosome balance in Pyrus. (Jour. Gen. **22**: 129–151.)

ERLANSON, E. W. (1929). Cytological conditions and evidences for hybridization in North American wild Roses. (Bot. Gaz. **87**: 443–506.)

HAGERUP, O. (1928). Morphological and cytological studies of Bicornes. (Dansk. Bot. Ark. **6**: 1–26.)

HURST, C. C. (1927). Differential polyploidy in the genus Rosa, L. (Verhand, Cl. V. Int. Kon. F. Vererb. 866–906.)

ICHIJIMA, K. (1926). Cytological and genetic studies on Fragaria. (Genetics **11**: 590–604.)

KOBEL, F. (1927). Zytologische Untersuchungen an Prunoideen und Pomoideen. (Archiv. d. J. Klaus-Stiftung **3**: 1–84.)

LONGLEY, A. E. (1924). Cytological studies in the genus Crataegus. (Amer. Jour. Bot. **11**: 295–317.)

LONGLEY, A. E. (1924). Cytological studies in the genus Rubus. (Amer. Jour. Bot. **11**: 249–282.)

LONGLEY, A. E. (1926). Chromosomes and their significance in strawberry classification. (Jour. Agr. Res. **32**: 559–568.)

MEURMAN, O. (1929). Prunus laurocerasus L., a species showing high polyploidy. (Jour. of Gen. **21**: 85–94.)

MEYER, J. VON. (1915). Die Crataegomespili von Bronvaux. (Zeitschr. Ind. Abst. Vererb. **13**: 293–333.)

MORINAGA, T. et. al. (1929). Chromosome numbers of cultivated plants. II. (Bot. Mag. Tokyo **43**: 589–592.)

NEBEL, B. (1929). Zur Cytologie von Malus und Vitis. (Die Gartenbauwissenschaft **1**: 549–592.)

OKABE, S. (1928). Zur Cytologie der Gattung Prunus. (Sci. Rept. Tohoku Imp. Univ. Ser. III, **4**: 733–743.)

PALMER, E. J. (1925). Synopsis of North American Crataegi. (Jour. Arn. Arb. **6**: 5–128.)

REHDER, A. (1927). Manual of cultivated trees and shrubs. p. 930. Macmillan Co., New York.

RYBIN, V. A. (1926). Cytological investigations of the genus Malus (Bull. Appl. Bot. **17**: 101–119.)

SARGENT, C. S. (1922). Manual of trees of North America. Houghton.

SAX, K. (1929). Chromosome behavior in Sorbopyrus and Sorbaronia. (Proc. Nat. Acad. Sci. **15**: 844–845.)

SHIMOTOMAI, N. (1929). Ueber die Chromosomenzahlen bei einigen Potentillen. (Sci. Rep. Tohoku Imp. Univ. Ser. III, **4**: 369–372.)

TÄCKHOLM, G. (1922). Zytologische Studien über die Gattung Rosa. (Acta Hort. Bergiani, **7**: 97–381.)

TISCHLER, G. (1929). Verknüpfungsversuche von Zytologie und Systematik bei den Blütenpflanzen. (Deutsch Bot. Ges. **47**: 30–49.)

TISCHLER, G. (1929). Revisionen früherer Chromosomenzählungen und anschliessende Untersuchungen. (Planta **8**: 685–697.)

YARNELL, S. H. (1929). Meiosis in a triploid Fragaria. (Nat. Acad. Sci. **15**: 843–844.)

CYTOMYXIS

Robert H. Woodworth

While making a study of pollen development in *Oenothera gigas* and *O. biennis*, Gates (3) frequently noted an extrusion of chromatin from the nucleus of one pollen mother-cell across plasma strands into the cytoplasm of an adjacent mother-cell. He considered this to be a normal process and called it cytomyxis. Since that time thirty or more cytologists have observed and reported these cytoplasmic strands and chromatic extrusions. A few of the early students considered the process to be normal.

Rosenberg working with *Drosera* (5), Sakamura with *Vicia* (6), Sinoto on *Iris* (7), Yasui with *Papaver* (10), Tischler with *Phragmites* (8), and Erlanson on *Rosa* (2) all think of this nuclear behavior as extremely abnormal and variously suggest that it is due to faulty technique in handling living material, to the action of the fixing fluids or even to pathological conditions. The present tendency has been to agree with the one or other explanation.

Several recent workers (Hicks 4, Church 1, Woodworth 9) who have been studying plant groups mainly from the standpoint of chromosome numbers and abnormalities of the reduction division with a view to detecting plants of hybrid origin, have paid some attention to cytomyxis especially when it involves chromosomes, chromosome groups, and even whole spindles. If such a transposition of chromosomes be normal and the cells in question could function in fertilization, the chromosome number in the gamete would be other than haploid. This would be of some genetic significance. It was thought to be important enough to stimulate further consideration of the normality or abnormality of cytomyxis.

Professor K. Sax has obtained some pertinent data concerning the nature of cytomyxis from a study of smear preparations of pollen mother-cells of *Secale* and other plants. Rye is especially good for such studies because if the end of the anther is cut off the pollen mother-cells may be squeezed out with little change in the normal arrangement of the cells. When such preparations are fixed and stained with aceto-carmine, or fixed in the usual fixatives and stained with crystal violet and iodine, there is little evidence of cytomyxis except at the late spireme stage. The spireme stages do show as high as ten per cent of the cells with chromatin connections but these cases are usually confined to the ends of the string of pollen mother-cells where the anther was cut or where it was pressed in removing the contents. At diakinesis one may occasionally find one or more bivalents which have passed into adjacent cells. At metaphase and later stages there is no evidence of chromosome migration and the normal chromosome number and arrangement is found in practically all cells.

When the pollen mother-cells are squeezed out of the anther with enough pressure, or smeared with a flat needle after their removal from the anther so that the string of cells is flattened on the slide, "cytomyxis" is found very frequently. In fact under such conditions it is often difficult to find normal spireme stages. Most of the pollen mother-cells have distorted nuclei and chromatic strands between adjacent cells. This may also obtain at diakinesis when chromosomes are extruded into the cytoplasm, into adjacent cells, or into the fixing fluid where they are lost.

Some three hundred slides of the betulaceous catkins which were prepared and studied for chromosome numbers and peculiar behavior (Woodworth 9) were reëxamined for cytomyxis. The anthers which showed this protoplasmic continuity were usually in groups while the surrounding stamens, by far the majority in the catkins, showed no cytomyxis whatever. These aggregations of cytomyctic anthers appeared to be located either where the catkins were held between the thumb and forefinger when their sides were sliced off preparatory to dropping them into the fixing fluid or at a region where the razor blade passed through. The catkins were certainly not handled roughly but it seems that roughness of handling is a relative matter and that the pressure of holding and cutting the catkins must have caused the delicate mother-cells to expel some of their contents. The action of the fixative might contribute to these abnormalities initiated by pressure.

The above conclusion is substantiated by the fact that many species of *Betula* which showed cytomyxis have quite normal meiosis producing perfect pollen, If extrusion of chromatin, especially chromosomes, from one cell into another were a normal process it might reasonably be expected that the pollen grains would be varisized or even sterile in part.

As a check to the foregoing conclusion catkins of some of the species which showed cytomyxis were collected with great care to avoid pressure. These were imbedded and when sectioned showed almost no cytomyxis.

Hybrid plants which have considerable irregularity in the reduction division show the most extreme cases of cytomyxis wherein chromosomes and sometimes even spindles are transposed into adjacent cells. It would seem that some innate unbalance in the heterozygous protoplasm makes it much more susceptible to even slight pressures which would cause the extrusion of chromosomes.

Those students who have seen cytomyxis in the mother-cells of species of plants have not noted the subsequent phases of meiosis to have a deficiency or excess in the chromosome number of any of the cells as an effect of chromosome migration. The evidence now at hand strongly indicates that cytomyxis is not a natural process. Injury to the cells by pressure at the time of preservation seems to account for these cytoplasmic connections and chromatic extrusions.

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LITERATURE CITED

1. CHURCH, G. L., Meiotic phenomena in certain Gramineae. (Bot. Gaz. **88**: 63–84. 1929.)
2. ERLANSON, E. W., Cytological conditions and evidences for hybridity in North American wild Roses. (Bot. Gaz. **87**: 443–506. 1929.)
3. GATES, R. R., Pollen formation in Oenothera gigas. (Ann. Bot. **25**: 909–940. 1911.)
4. HICKS, G. C., Chromosome studies in the Cyperaceae, with special reference to Scirpus. (Bot. Gaz. **86**: 295–316. 1928.)
5. ROSENBERG, O., Cytolog. u. morpholog. Studien an Drosera longifolia u. D. rotundifolia. (Kgl. Svensk. Vet. Handl. **43**: 3–64. 1909.)
6. SAKAMURA, T. Studien über die kernteilung bei Vicia cracca L. (Bot. Mag. Tokyo **28**: 131–147. 1914.)
7. SINOTO, Y., On the extrusion of the nuclear substance in Iris japonica Thunb. (Bot. Mag. Tokyo **36**: 99–110. 1922.)
8. TISCHLER, G., Untersuchungen über den Riesenwuchs von Phragmites communis var. Pseudodonax. (Ber. Deutsch. Bot. Gesell. **36**: 549–558. 1918.)
9. WOODWORTH, R. H., Cytological studies in the Betulaceae. (Bot. Gaz. **87**: 331–362. **88**: 383–399. 1929.)
10. YASUI, K., On the behavior of chromosomes in the meiotic phase of some artificially raised Papaver hybrids. (Bot. Mag. Tokyo **35**: 154–167. 1921.)

STUDIES IN GANODERMA

W. R. HADDOW

Plates 29 and 30 and Text figure

INTRODUCTION

AMONG my field collections made in the summer of 1929 is a specimen of a *Ganoderma* from a fallen Spruce on an island in Remi Lake, northern Ontario. It is a normal fructification, annual, heavily laccate or varnished above, smooth and shining, rich reddish brown in color, laterally and rather stoutly stipitate. The stipe broadens at its apex, without demarcation, into the pileus; and both are alike in the characters just noted. The context is punky and rather tough, creamy white throughout, except close to the pores, where it darkens to chocolate brown. The pore layer is uniformly brown. The spores are abundant, and have the wall structure which is characteristic of *Ganoderma*, that is, a smooth and comparatively light epispore, and a dark, thick-walled, echinulate endospore. Apart from the fact that the fungus was growing on Spruce, it would seem to be *Ganoderma lucidum* according to Karsten, or *G. Tsugae* according to Murrill, but which, if either?

Having access to Professor J. H. Faull's collection at the Arnold Arboretum, I found almost identical specimens on Hemlock, Birches, and Oaks from America, and on *Abies* from Europe. I also found there others of curious interest, stalked and sessile Ganodermas, annuals and a few perennials, and some taken from the bases of living trees in which the fungus was evidently the cause of a butt rot. My aroused curiosity led me also to examine the copious American collections largely assembled by Dr. W. A. Murrill in the herbarium of the New York Botanical Garden, and the collections especially rich in old world material in the Farlow Herbarium of Harvard University.

One would naturally expect substantial agreement among authorities on the Polyporaceae as to the diagnostic criteria on which the definitions of the commoner north temperate zone species of *Ganoderma* are based. Representative specimens are frequent, they are conspicuous, they carry prolific crops of spores which are available at all times, and they are among the first to find a place in almost every mycological herbarium. One would expect to be able to determine quickly and unerringly the name of such a specimen as the Remi Lake plant from any good manual or paper dealing with the group to which it belongs, but such is not the case.

According to the European manuals this specimen would be referred to *Ganoderma lucidum*. There is not, however, the same unanimity among American authorities. Murrill in his presentation in the North American Flora (12) does not recognize *G. lucidum* as occurring in North America. What appears to be the same thing as the Remi Lake plant is described there under the name *G. Tsugae*, and no other description is applicable. But he affirms that *G. Tsugae* is restricted to Hemlock; while this plant was on Spruce, two hundred miles north of the range of Hemlock. If we consult Atkinson's paper on *Polyporus lucidus* (2) we find closer agreement with the European mycologists; to him it would be *G. lucidum*, though in the matter of nomenclature he prefers the name *G. pseudoboletum*. To Atkinson *G. Tsugae* is not a distinct species. Overholts, in his "Comparative Studies in the Polyporaceae" (15) agrees with neither Atkinson nor Murrill. He does accept *G. Tsugae* as a good species, under the name *Polyporus Tsugae*, extending the host range to include Pine; but he also recognizes *G. lucidum* under the name *P. lucidus*, in our flora. The latter, however, he finds on hardwoods only. He appears to take no cognizance of the fact that *G. lucidum* in Europe is not so restricted; and *G. lucidum*, as he sees it, is made to include an entirely different plant described by Murrill as *G. sessile*. If we follow Overholts, the decision between *G. Tsugae* and *G. lucidum* rests predominantly on the host, that is, whether it be a conifer or a hardwood.

This instance serves as an example of the confusion that exists with respect to conceptions of species of *Ganoderma*, especially in the American flora. Moreover, confusion exists with respect to not only the species, but also the genus itself. A short excursion into the literature soon reveals the fact that the *Ganoderma* of one author is not the *Ganoderma* of another. Interest, therefore, naturally expanded from a diagnosis of the Remi Lake specimen, to the making of a broader survey of the subject, and to the undertaking of more intimate studies. The results are presented in this paper; they include a review of the taxonomic history of the genus *Ganoderma*, a presentation of definitions of what are believed to be some of the valid species in our flora, and an account of the studies on which these definitions are based.

HISTORICAL

1. The Genus Ganoderma.

The genus *Ganoderma* was established by Karsten in 1881. In an earlier (1876) systematic work (8), following the Friesian classification of the Polyporaceae, Karsten treated the form which was later to be *Ganoderma lucidum* as *Polyporus lucidus*, the species coming within the Friesian sub-genus Pleuropus, which included forms laterally or eccentrically stipitate. The characteristic varnishing was noted in the specific description. In his (9) "Enumerratio Boletinearum et Polyporearum Fennicum Systemate novo dispositarum" (1881) the new genus, *Ganoderma*, was instituted. The author's conception of it was conveyed rather briefly in a key to the Polypores, and was essentially as follows, translated from the original Latin: "Context white, at times golden yellow, or rarely rose or clay colored. Spores white. [Sporae (omnium?) albae]. Pileus flexible, corky, leathery, or woody. Pileus stipitate. *Ganoderma* n. gen. Pileus and stipe laccate." Only one species, namely *G. lucidum*, was described. Later, in his "Critical Review of the Basidiomycetes of Finland," (1889), Karsten continued to recognize *Ganoderma*, and for the first time gave as synonyms the

"*Polyporus* of other authors in part" and "*Placodes* of Quélet, in part."

It should be explained that *Placodes* as defined by Quélet, (18) comprised woody, persistent forms, with encrusted, sulcate pilei, which in the main are sessile but not infrequently resupinate, or rarely with a tuberculate stipe. Quélet placed *P. lucidus* in an apparently more or less aberrant section of the genus, comprising corky forms with a thinly encrusted surface, colored context, and dark spores. The species was described as having the pileus and stipe "varnished." Quélet's *Placodes* was made by him to include such diverse species as *Polyporus betulinus*, *Fomes applanatus*, and *F. fomentarius*.

It seems probable that Karsten, referring to "*Placodes* in part" as synonymous with *Ganoderma*, had in mind Quélet's section "Suberosi," and in particular that part of it reserved for species with colored spores, in which, to be sure, only *P. lucidus* is found. We must also conclude that subsequent to the time of his earlier work in 1881 when the genus was established, Karsten had become impressed with the peculiar character of the spores of *G. lucidum*, with the result that in his work of 1889, to which reference is made above, he based his description of the genus on spore characters, and did not refer to the varnishing of the pileus and stipe which earlier had been the generic criterion. Hence we are in some doubt as to the essential criteria of *Ganoderma* as conceived by Karsten, and this uncertainty has at least contributed to the difficulties in interpreting the genus which others have experienced in working with forms representative of a much wider geographical range.

This leads us naturally to a consideration of the work of Patouillard, whose collections were representative of a much wider field. Karsten confined himself solely to temperate Europe, while Patouillard gave his attention to tropical collections as well. In his study "Le Genre Ganoderma" (17), which appeared the same year as Karsten's later studies of the Polyporaceae of Finland, Patouillard emphasized the importance of spore characters in the study of the taxonomy of the Polypores. He referred to Karsten's original definition of the genus *Ganoderma*, but considered that there were many forms other than *G. lucidum*, which, chiefly on the evidence of similar spore structure, properly belonged in the same group. Patouillard included in the genus those forms characterized by a more or less colored context, and a rigid brittle crust which is more or less shiny, either smooth or rimose and formed of thickened hyphal elements. The spores of the included species are brown or yellowish, ovoid to globose, either smooth or asperulate, and sometimes with thickened or cuticularized walls. He also stated that some of the forms are annual, while others are persistent, and that they may be sessile or stipitate. Patouillard described about 50 species, which were sub-divided into two groups—the first, sub-genus *Ganoderma* vrai, having ovoid spores, and sporophores with a shiny, well varnished crust; and the second, which is composed of tropical and sub-tropical species, sub-genus *Amauroderma*, having globular to subglobular spores, and sporophores with little if any surface varnishing. Thus through his desire to include in the genus *Ganoderma* all those species which have one, or both of the characters of varnishing and "rough" spores, Patouillard was led to extend its bounds much beyond what we must consider to have been the original conception of the genus.

Turning to American authorities, we find that Murrill gives the essential character of *Ganoderma* simply as a reddish brown varnishing of the surface of the sporophore, thus holding rather closely to Karsten's original description. In his treatment in North American Flora, he makes a new genus of Patouillard's sub-genus *Amauroderma*, to include epixylous, stipitate, encrusted, but not varnished forms, with ovoid to globular brown spores. The species in North America are confined to the tropics or sub-tropics.

Miss Ames (1) follows somewhat the treatment of Patouillard. Her conception of the genus is broad. Its essential characters are a fruit body with a heavily encrusted upper surface, which might be either of the "palisade" type noted by Patouillard, as in *G. lucidum*, or of the "interwoven" type as in *Fomes applanatus*. Varnishing is not considered an essential character. The spores must be smooth, pale to dark brown, with a "wall perforated with darker lines"—a description which was derived from Atkinson's account, based on his careful observations, of the structure of the spore. Inconsistently, Miss Ames includes such species as *Fomes fomentarius*, which we now know possess spores with simple, smooth walls. Presumably, with regard to such, she had not seen their spores, and mistakenly assumed that they were of the Ganoderma type.

For the sake of easier comparison of the criteria of *Ganoderma* as conceived by the several authors who have treated the genus, the essentials of their descriptions are arranged in tabular form on page 30:

DESCRIPTIONS OF GANODERMA

Author	Habit	Persistence	Context	Crust		Spores
				Surface	Structure	
Karsten*	stipitate	———	———	varnished	———	———
†	———	———	———	———	———	ovoid, warty, yellow-brown
Patouillard	stipitate or sessile	annual or perennial	———	brittle, shiny, smooth or rimose	formed of thickened hyphal elements	ovoid to globose, yellow or brown, smooth or asperulate
Murrill	stipitate or sessile	annual or perennial	brown or pallid	varnished red or brown	———	ovoid, brown
Ames	stipitate or sessile	annual or perennial	fibrous to corky or woody; pale to dark brown	hard, sometimes varnished	———	smooth, wall perforated with darker lines; pale to dark brown

* Karsten 1881. †Karsten 1889.

2. Taxonomic History of Certain Species

(a) Ganoderma lucidum (Leys.) Karst.

The synonomy of *Ganoderma lucidum* (Leys.) Karst. is recorded by Atkinson (2) under *G. pseudoboletus* (Jacq.) Murrill quoted incorrectly by him as *G. pseudoboletum* as follows:

Agaricus pseudoboletus Jacquin, Flor. Aust. **1**: 26–27. pl. 41 (1773).
Boletus rugosus Jacquin, Flor. Aust. **2**: 44. pl. 169 (1774).
Boletus obliquatus Bulliard, Herb. France, pl. 7 (1780).
Boletus lucidus Leysser, Flor. Halensis. 300 (1783).
Polyporus lucidus Fries, Syst. Myc. **1**: 353 (1821).
Polyporus laccatus Persoon, Myc. Eur. **2**: 54 (1825).
Ganoderma lucidum (Leys.) Karsten, Rev. Myc. **3**: no. 9, p. 17 (1881).
Ganoderma Tsugae Murrill in Torr. Bot. Club, **29**: 601 (1902).

It was on a specimen of this form that Karsten based the genus. The distinctive fructifications had long been recognized throughout Europe and occur there commonly. All the European descriptions allow for considerable variation in habit, shape, color, and also host range. Thus Fries (6) describes *Polyporus lucidus* as with or without stipe, the position being central, eccentric, or lateral,—in which case the pileus is reniform. The color is light yellow when young, chestnut or almost black when mature. The occurrence is on the trunks of Oaks and other trees in Europe, Asia, Japan, and North America. In the Exsicc. Karst. Fung. Fenn. 1865, no. 239, *Polyporus lucidus* Leys. is reported as occurring on *Quercus, Alnus* *glutinosa*, and *Abies excelsa*. In Krieger's collection there is a specimen from Birch. Others have collected it from Willow, and as Karsten himself reports, specimens have been collected from conifers.

While European taxonomists are substantially in agreement on *Ganoderma lucidum* in Europe, American authorities on the other hand hold very diverse views of the species, both as to host relationships and morphological characters. There are three prevailing American conceptions as represented by Atkinson, Murrill, and Overholts.

Considering host relationships first, Atkinson holds that *Ganoderma lucidum* occurs in the American flora, but he surmises that there are various strains of the species both here and in Europe. From first hand observations, he holds that there are two distinct strains in Europe. He calls attention to a very dark form on Firs in the Jura mountains, and to a lighter form on the other hosts. The latter he designates as *G. pseudoboletum typicum*, and the former as *G. pseudoboletum* var. *montanum* Atk. He likewise recognizes two forms in America, one growing on Hemlock (Murrill's *G. Tsugae*), which he designates *G. pseudoboletum* var. *Tsugae* Atk., and a second one found on other hosts, but especially hardwoods, which he calls *G. pseudoboletum typicum*, though probably not the typical *G. lucidum* of Europe. Murrill at first considered *G. lucidum*, the typical European form, which he preferred to call *G. pseudoboletus*, to be represented in America (11) and reported it as occurring on Oak, Alder, Hazel, Maple, Willow, Honey Locust, Sweet Gum, and Beech, throughout Europe, and in England, Australia, and America. In his later work (12) (13) reference to the species is omitted, and although we do not know what disposition was made of the numerous American collections previously reported by him, we must believe that Murrill came to the conclusion that the American forms were distinct, and that *G. lucidum* does not occur in America. Overholts (15), voicing a third viewpoint, believes that *G. lucidum*, which he calls *Polyporus lucidus*, is an American as well as a European species, and that it is found generally throughout the eastern part of the United States on the trunks and roots of deciduous trees. He does not recognize it, however, as occurring on conifers; for such he adopts Murrill's name *G. Tsugae* (*Polyporus Tsugae*), though with wider significance (15).

The American authorities are likewise almost as far apart in their notions of habit, shape, and color, as in the matters of name and hosts. This has naturally followed from the circumstance that there has been no agreement as to the limitation of the species, and also because there has been so often no clear differentiation between variable and constant characters.

(b) Ganoderma sessile Murr.

This species was originally described by Murrill (11) as a sessile form occurring on deciduous trees. It was stated to differ from *G. lucidum* in having an acute margin, a more rugose surface and in being always without a stipe. This first description was subsequently much modified, so that in "Northern Polypores" (13) we find *G. sessile* described as either sessile or laterally stipitate, and as occurring on conifers or hardwoods. From the later descriptions of this species we gather that the characteristic features of the fruit body are its reddish chestnut color, more or less zoned surface, an acute margin and a fibrous context. The author states that it resembles *Polyporus lucidus* of Europe, but considers that *G. sessile* is an indigenous American plant. Overholts (14) considers it synonymous with *G. lucidum*, and Atkinson makes no mention of it. It is appropriate to refer here to *Ganoderma subperforatum* Atk., which was described by Atkinson in 1908 on the basis of a single specimen collected in Ohio. Having become impressed with the peculiar structure of the spore in Ganoderma, it was noticed that in this specimen the walls were relatively thin and the echinulations of the endospore reduced. This feature, and also the fact that although stipitate the occurrence was on Oak led Atkinson to consider it a hitherto undescribed species. When Murrill revised *G. sessile* so as to include stipitate forms, he considered *G. subperforatum* as probably identical. Overholts, on the other hand, considers it identical with *Polyporus lucidus*. After studying the type specimen, a privilege extended through the courtesy of the custodian of the Atkinson Herbarium, I have no hesitation in expressing agreement with Murrill's disposition of it. It is a *Ganoderma sessile.*

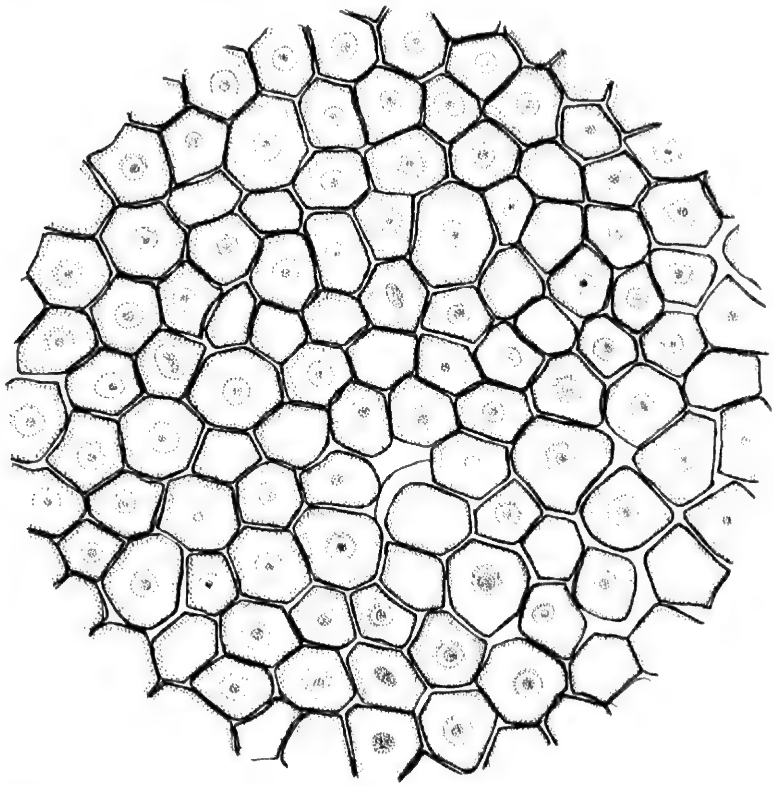
(c) Murrill's Ganoderma Tsugae

The chief characteristic of *Ganoderma Tsugae* Murr. that sets it apart from other species of *Ganoderma*, according to its author, is its host specificity for Hemlock. There are other characters noted, to be sure, but they are not of the same determinative value. In comparison with the later descriptions of *G. sessile*, the significant features seem to be a darker colored, non-zonate top, a softer context, perhaps a less acute margin, and a concave rather than a convex lower surface. Atkinson recognizes *G. Tsugae* simply as a form of *G. lucidum*. He states that in color and other characters it differs but slightly if any from the typical form, and only its host specificity distinguishes it. According to Overholts (15) on the other hand, *G. Tsugae* cannot be differentiated by host affiliation alone, as it is found growing on and about the stumps of Pine as well as Hemlock. Overholts considers this a good species, however, recognizing in the context a distinctive structure and color and manner of branching of the hyphae, all of which, it is held, are characteristic of this form only, and serve to distinguish it from its close allies. The present writer can confirm this only in part. All the specimens which he has examined from Hemlock do display a context which in macroscopic and microscopic features answers to the description by Overholts, but many of the European collections of *G. lucidum* have these same characters, and cannot be distinguished on this basis. Similarly among Professor Faull's collections is a specimen from an oak stump which has the typical context of *G. Tsugae*, and in the herbarium of the New York Botanical Garden there is a collection from a maple log which cannot be distinguished from *G. Tsugae*, and which in fact is labelled such. Although as far as is known the specimens on Hemlock have always the same kind of context, this by no means serves to separate them from all other species.

In view of the obvious confusion which exists in regard to these species, one is led to seek an explanation. The writer believes that it is due at least in part to the assumption of host specificity, and the recognition of species on this basis. This assumption is not supported by proof. It is of course true that in the case of many of the Polypores certain hosts are favored, but in this group one is hardly justified in characterizing a species as host specific. Whether in certain species there are biological strains in which strict host specificity is developed is a possibility which in this group still remains to be demonstrated. One must, therefore, rely as yet on morphological characters alone as the basis on which species are to be recognized, and these possibilities are by no means exhausted in the case of the species under discussion. Important morphological differences are to be found in the crust and in the spores. They will probably also be found in the mycelial mats of pure cultures grown on artificial media.

CRITICAL STUDIES OF THE CRUST

In order to study the structure of the crusts of the sporophores, it was found necessary to prepare vertical and transverse sections. Since the varnish which covers the mature fruit body as a thin fragile pellicule dissolves rapidly in alcohol and xylol, the usual embedding methods could not be employed. The best sections showing the varnish were prepared by infiltrating with a soap solution small blocks of the crust capped context under a reduced pressure. The material was embedded in soap, the water being evaporated off as rapidly as possible. Soap solution will gradually dissolve the varnish, but if the infiltration and embedding are done rapidly good sections can be secured. The temperature must not be high, otherwise the varnish will be melted.



Transverse section through the palisade elements of the crust of G. oregonense (× 800).

Though showing considerable specific differences, the crusts of all our Ganodermas have certain features in common. They are seen to be composed of the enlarged and somewhat bulbous ends of hyphae growing out from the context. These are arranged very compactly together in the vertical position; and they form a sort of palisade layer, over the surface of which is the hardened varnish, resembling a thick fragile cuticle. The hyphal elements which together compose the crusts are typically very thick walled, and appear to be impregnated with the dark orange varnishing substance which they have secreted. In cross section they are angular, frequently pentagonal or hexagonal, and are surprisingly uniform in shape and size. They are without surface pores, and it is only with difficulty that a central canal or lumen can be made out. The walls appear to be thickened concentrically, until the elements are practically solid. Their color is a rich orange yellow, which penetrates uniformly to a depth somewhat below that of the base of the palisade layer into the thick-walled threads of the context. In very thin sections the color is faint yellow.

(a) **Ganoderma oregonense** Murrill

This species has a crust which is darker in color, thicker, and of more regular structure than the crust of any other species studied The club-shaped elements of which it is composed are from 50 to 60 μ in length and from 6 to 10 μ in diameter. In thin sections the color, which is orange yellow, is seen to penetrate from the surface to a depth of as much as 275 μ. In specimens which have developed favorably the varnish may be 15 μ thick. See Fig. 16.

(b) **Ganoderma lucidum** (Leys.) Karst.

In the case of this species, which is taken to include *G. Tsugae* Murr., the crust differs from that of *G. oregonense* only in being composed of slightly shorter bulbous elements, which are sometimes not as regularly arranged, and in having a thinner coat of varnish. In *G. oregonense* the hyphae approaching the crustal layer are rather straight and uniform, while in *G. lucidum* they are usually crooked, tangled, and of varying diameter. This feature in *G. lucidum*, however, is by no means constant. The character of the crust is doubtless determined to some considerable extent by the nature of the conditions under which the sporophore comes to maturity. In *G. lucidum* the bulbous elements of the crust are about 40 μ long, and from 6 to 8 μ in diameter. The varnish is commonly about 12 μ thick. The crust of a typical *G. lucidum* is illustrated in vertical section in Fig. 8.

(c) **Ganoderma Curtisii** Berk.

This species is usually described as partially varnished or with varnish coming off in flakes. An examination of the crust reveals the interesting fact that the whole of the palisade layer exfoliates leaving the sporophore with a chamois-like surface of densely woven fine hyphal ends. The crust of this species is comparatively thin. The palisade elements are bulbous and commonly from 15 to 25 μ long. They arise from a stratum of densely woven fine hyphae, which constitutes a plane of weakness along which the separation of the crust from the sporophore takes place whenever the former is shed in irregular flakes. Not infrequently there are thin-walled elements, such as are observed at the growing margin of all species, interspersed among those with thickened walls. This feature is one never observed in other species. Spores may be found embedded in the crust. In *G. Curtisii* the total thickness of the crust including the varnish is about 30 μ. See Fig. 18.

(d) **Ganoderma sessile** Murrill

In *G. sessile* the crust is distinctly different from that of other species. The palisade elements are bulbous rather than club shaped and, although forming a dense compact stratum, are not as closely and uniformly fitted together as in the case of *G. lucidum* or *G. oregonense*. The crust is thinner than in those species, the bulbous elements being from 15 to 30 μ in length. The coating of varnish is distinctly thinner, being about 8 μ in depth. See Fig. 12.

CRITICAL STUDIES OF THE SPORES

The spores of *Ganoderma* differ from those of most of the other Polypores not only in being brown in color, but in appearing to be rough or warty superficially. Actually, they are smooth, but the peculiar structure of the walls lends an appearance of roughness, so that in the early descriptions they were described as warty, rough, echinulate, or spiny. Patouillard was the first to draw attention to the double wall of the spore, the inner of which was described as being echinulate and comparatively thick, the outer as thin, and "moulded exactly on the points of the endospore." More careful observations have shown this description to be not entirely correct. It was Atkinson (2) who first pointed out that the exterior surface of the spore wall is perfectly smooth. His deductions, however, as to the structure and development of the walls, although not stated in positive terms, were erroneous in that, not conceiving of the wall as essentially duplex, he considered the spines or echinulations of the endospore to be extensions of the brownish spore content. White (21), referring to the similar spores of *Fomes applanatus*, observed that Atkinson's interpretation was incorrect, and stated that within an original hyaline wall a "rough coated, thick, and yellow walled endospore is formed." While the nature of the outer wall of the mature spore was not clearly described, subsequent work has shown White's interpretation to be essentially correct. It remained for Coleman (4) to describe in detail the development of the duplex wall. He found that the endospore wall originates from granules laid down on the inner margin of the epispore, that these increase in size and fuse to form a membrane which thickens and develops spines, and that the latter penetrate the thick, softer epispore while it is still plastic. Coleman also demonstrated chemical differences in the epispore and the endospore by means of staining and microchemical tests.

The phylogenetic significance of the Ganoderma type of spore is a subject beyond the scope of this paper. It is surprising, however, that more attention has not been devoted to it, and that more use has not been made of spore characters in classification.

Believing that there might be significant differences in the spores which would be of value in specific diagnosis, the writer examined spores from many American and European specimens. It soon became apparent that within the Ganoderma type, two distinct sub-types could be readily identified, which are distinguished by the thickness of the walls, particularly of the endospore wall, and the length and the number of spines projecting from it. Thus the superficial appearance of the spore of one is distinctly thick-walled and very rough, while that of the other is comparatively smooth, the double wall and the spines being made out only with difficulty under high magnification. These differences in the spores of *Ganoderma* have already been noted by others, but little importance has been attached to them. Patouillard, in describing the spores of his new species *G. carnosum*, says that they are a little larger and rougher that those of *G. lucidum*. Atkinson, likewise, for his species *Ganoderma subperforatum*, stated that its spores are distinctly smoother than those of *G. lucidum;* he embodied this observation in the specific appelation *subperforatum*. The writer's observations on the spores of various species of *Ganoderma* are summarized below.

(a) **Ganoderma oregonense** Murrill

The spores of *G. oregonense* are larger than those of any eastern North American species. They range in size from 7.4 by 11.9 to 8.4 by 14.0 μ. They are thick-walled and heavily echinulate on the endospore surface, the echinulations, however, being spaced rather far apart. Thus the spores appear exceedingly rough. See Fig. 17.

(b) **Ganoderma Curtisii** Berk.

A striking feature of the spores of *G. Curtisii* is their great variability in size and shape. Those measured by the writer ranged in size from 4.8 by 9.5 to 6.3 by 11.2 μ. The shape is from almost symmetrically ovate to sub-allantoid. Even from the same specimen spores differing considerably in size and shape are found. They are of the thick-walled "rough" type. See Figs. 19 and 20.

(c) **Ganoderma lucidum** (Leys.) Karst.

The spores of typical specimens of this species are also of the thick-walled, heavily echinulate type. They range in size from 6.3 by 7.7 to 9.8 by 11.9 μ. Included here are those forms commonly found on Hemlock (Murrill's *G. Tsugae*), the spores of which are indistinguishable from those of *G. lucidum* on hardwoods. The Remi Lake specimen, to which reference has frequently been made in this paper, proves also to be representative of this species in spore characters as in others. See Figs. 9, 10 and 11.

As for the so-called *G. Tsugae*, it is apparent that the Hemlock is a particularly suitable host for this form, but there seems to be no reason for regarding it as a distinct species. Identical forms are known to grow on Birch, Maple, Spruce and other hosts. In this connection it is interesting to note that although not found in Europe at the present time, the Hemlock occurs there in Eocene deposits (7) (20), and that it probably persisted in Europe and in northern latitudes between Europe and America until the Pleistocene.

(d) **Ganoderma sessile** Murrill

In *G. sessile* the spores differ from those of the species enumerated above in being relatively thin-walled. The endospore has numerous short delicate spines, which can be observed only with difficulty under high magnification. This character at once distinguishes *G. sessile* from its close allies. The spores are of approximately the same size as in *G. lucidum*. See Figs. 13, 14 and 15.

Ganoderma subperforatum Atk. is identical with *G. sessile* Murr. Had Atkinson been familiar with the spore characters of Murrill's *G. sessile*, he would probably have placed his specimen there instead of creating a new species, because it shows the same spore characters as those possessed by the spores of *G. sessile*.

Continuing the subject of spore characters, it was with considerable interest that the writer examined the European collections labelled *G. lucidum* in the Farlow Herbarium. It was found that these specimens could be readily separated into two groups on the basis of the character of the spore wall, and that those with relatively thin walls and with numerous fine echinulations on the endospore (the "smooth" type) resembled closely in gross features the American *G. sessile*, while the "rough" spored specimens resembled the American *G. lucidum* (including *G. Tsugae*). To which group the type specimen of *G. lucidum* belonged it has been impossible for the writer to determine, since type material was not available. It is to the point, however, to state that Karsten's specimen number

239, which he quoted as the type of the new genus Ganoderma, is represented in the Farlow Herbarium by a duplicate collection bearing the same number, and that this specimen has spores which are thick-walled and coarsely echinulate on the endospore surface. Moreover, going back to Jacquin's original description of *Agaricus pseudoboletus* (in Flor. austr. 1: 26–27. pl. 41. 1773; and 2: 44. pl. 169. 1774), and Leysser's account of *Boletus lucidus* (in Flora Halensis, 300. 1783; and figured in Curtis, Flora Londinensis 4. pl. 224, original edition), we find that the sporophores before these authors were stalked. The resemblance was to that of the sporophores so common in America on Hemlock, and not to Murrill's *G. sessile.* I may also add that in order to get an idea as to whether or not this is a form frequent in Austria, I have examined the specimens of Ganoderma found in the von Höhnel collections, now stored in the Farlow Herbarium. All of the plants collected by von Höhnel around Vienna as represented in this herbarium are rough spored, and the stalked form would seem to be the prevailing type. On the other hand it is clear that in Europe there also exists a form similar to or identical with *G. sessile* Murrill, and that it differs essentially from what we consider to be *G. lucidum.* The writer, therefore, unhesitatingly concludes that *G. lucidum* and *G. sessile* are distinct species, each of which is found both in Europe and America, and that they answer to the descriptions given below.

DESCRIPTION OF SPECIES

By way of summary, I have ventured to re-define the species studied in this paper as follows:

Ganoderma lucidum (Leys.) Karst.

Sporophore stipitate, stipe lateral, ascending, or short-tuberculate, rarely sessile, annual, rarely perennial; pileus dimidiate or reniform, convex above, plane or concave below; margin plane to broadly lobed, sometimes wavy when dry, surface smooth becoming wrinkled and furrowed when dry, heavily laccate, lustrous, cherry red to deep mahogany or almost black; stipe as in pileus; context felty to corky, or rarely radiate fibrous, light in color except close to tubes; hyphae of context hyaline, frequently branched, rather crooked; tubes cinnamon brown to umber, 3–5 per mm.; crust of vertical solid palisade hyphae, dense and compact, about 40 μ long; varnish 10 to 12 μ thick; spores ovoid, slightly asymmetrical on vertical axis, light brown, smooth, but appearing rough, walls thick; endospore coarsely echinulate with relatively few spines; spores 6.3 by 9.8 to 7.7 by 11.9 μ.

On hardwoods and conifers. In America most commonly on Hemlock. *G. Tsugae* is a synonym. See Figs. 1, 2, 3, 8, 9, 10, and 11.

Ganoderma sessile Murrill.

Sporophore sessile, rarely stipitate, annual (rarely perennial?); pileus dimidiate to semi-circular, plane to slightly convex above, usually plane to convex below, usually thick behind; margin acute; surface smooth or irregular, frequently zonate, thinly laccate, lustrous to dull when dry, light brick red to brownish red; margin often lighter tending to yellowish; context radiate fibrous, of two distinct layers, the upper light brown, the lower cinnamon to chocolate brown; hyphae hyaline to brownish, uniform, usually branching infrequently; tubes cinnamon brown to umber; mouths whitish to umber, glaucous where not bruised, 3–5 per mm.; crust of vertical palisade hyphae, compact, but not as dense as in *G. lucidum*, about 30 μ long; varnish 6 to 8 μ thick; spores ovoid, slightly asymmetrical on vertical axis, light brown, smooth, walls thin, endospore finely echinulate with numerous delicate spines seen with difficulty; spores 6.3 by 10.5 to 7.0 by 11.6 μ.

In North America and Europe on deciduous leaved trees (rarely on conifers?). *Ganoderma subperforatum* Atkinson is a synonym. See Figs. 4, 5, 12, 13, 14, and 15.

Ganoderma Curtisii (Berk.) Murrill.

Sporophore stipitate, stipe lateral, eccentric or central, annual (or perennial?); pileus reniform to circular, convex or depressed; margin usually thick and abrupt when mature; surface smooth, thinly laccate, often zonate, yellowish brown or orange, with olive tinge when scratched; stipe with persistent varnish, yellowish brown to brick red; context of two layers, the upper light, the lower dark chocolate brown, felty to radiate fibrous; tubes cinnamon brown to umber, mouths whitish; crust of vertical bulbous hyphae, some solid, others empty, of irregular size and height, about 20–25 μ long; crust frequently peeling off, leaving surface dull cream or yellowish; varnish 6 to 8 μ thick; spores variable in size and shape, mostly long ovoid, sometimes distinctly curved; light brown, smooth, appearing rough, walls thick, the endospore being coarsely echinulate with few spines; spores 4.8 by 9.5 to 6.3 by 11.2 μ.

In southeastern North America. Reported only on hardwoods. See Figs. 6, 18, 19, and 20.

Ganoderma oregonense Murrill.

Sporophore stipitate with short thick lateral stipe or almost sessile; annual; pileus convex above, usually concave below, relatively thick; margin regular or wavy, rather acute, often with a furrow close to the edge and paralleling it; surface smooth, heavily encrusted and laccate, dark bay to black; context thick, soft, felty, light buff, deepening in color near the tubes, often with tissue of white mycelium irregularly disposed in lower part near stipe; tubes long, 3 to 5 per mm.; crust of vertical solid palisade hyphae, dense and compact, 50 to 60 μ long; varnish heavy, 15 to 20 μ deep; spores ovoid, slightly asymmetrical, light brown, smooth, with echinulate thick walled endospore; spines coarse and relatively few; spores 7.4 by 11.9 to 8.4 by 14.0 μ.

On conifers in western North America. See Figs. 7, 16 and 17.

This species was first described by Murrill in North American Flora, at which time it was known only from the type locality in Oregon. It is now known to occur generally on the Pacific slope, and has been collected on a number of conifers besides *Picea sitchensis*, on a log of which it was first found. It bears a close resemblance to Atkinson's *G. pseudoboletum* var. *montanum* but has definitely larger spores.

SPECIMENS STUDIED

(a) *Ganoderma oregonense.*

HERBARIUM J. H. FAULL: specimen 3691 on *Tsuga heterophylla*, Sonora Island, British Columbia; spec. 6706 on Douglas Fir, Royston, B. C.; spec. 9355 on conifer, Vancouver, B. C.

HERBARIUM NEW YORK BOT. GARD.: spec. 6 (*type*) on old log of *Picea sitchensis*, near Seaside, Oregon; spec. coll. by H. D. House, Martha's Lake, near Everett, Wash.

(b) *Ganoderma Curtisii.*

HERBARIUM J. H. FAULL: spec. 3568 on Oak, Thomasville, Ga.; spec. 3682 on dead hardwood, Pinehurst, N. C.; spec. 175.

HERBARIUM NEW YORK BOT. GARD.: spec. 4389 on dead wood; spec. on dead Oak, Biloxi, Aug. 31, 1904. E. G. E.; spec. on *Quercus rubra* stump, Alliston, Mo.; spec. coll. by B. B. Higgins, Experiment, Ga.; spec. 545 ex. Herb. A. Commons; spec. coll. by W. A. Murrill, Biltmore, N. C., Oct. 1907; spec. coll. by Edwin Fowler, on root of Maple, Trenton, N. J., labelled *G. sessile.*

(c) *Ganoderma lucidum.*

HERBARIUM J. H. FAULL: spec. 181 *G. lucidum*, on *Betula alba*, Toronto, Ont.; spec. 183 *G. lucidum* on Oak stump, Toronto; spec. 182 *G. lucidum*, on *Betula lutea*, Wilcox Lake, Ont.; spec. 179 *G. lucidum* forma *montanum*, Vosges, France, ex Herb. G. F. Atkinson, 21077; spec. 9718 *G. lucidum*, on fallen Spruce, Remi Lake, Ont.; spec. 185 *G. Tsugae*, on *Tsuga canadensis*, Toronto, Ont.; spec. 3470 *G. Tsugae* on *Tsuga canadensis*, East Angus, Prov. Qebec; spec. 5422 *G. Tsugae* on *Tsuga canadensis*, Algonquin Park, Ont.; spec. 1579 *G. Tsugae* on *Tsuga canadensis*, Toronto, Ont.

HERBARIUM NEW YORK BOT. GARD.: spec. 645 *G. Tsugae* coll. by W. A. Murrill, Aug. 7–10, 1904; spec. 1157 *G. Tsugae* on Maple log, Cadillac, Michigan; spec. on decaying stumps of Hemlock; spec. 2529 *G. Tsugae;* spec. 11 *G. Tsugae* coll. by A. H. Mackey, Nova Scotia; spec. 3281 *G. Tsugae* on *Tsuga canadensis*, Sturgisson, W. Va.; spec. 536 on old log in Rhododendron Valley coll. by W. A. Murrill, labelled *G. sessile*.

FARLOW HERBARIUM (all labelled *G. lucidum*): Fung. Fenn. 239 (Karsten); Fung. Gall. 180 (Roumerguère); Fung. Brit. 2nd. Ed. 101 (Cooke); Fung. Brit. 1st. Ed. 603 (Cooke); Myc. March. 2106 (Sydow); Fung. Sax. 1116 (Krieger).

(d) *Ganoderma sessile.*

HERBARIUM J. H. FAULL: spec. 9335 *G. sessile* on *Acer saccharinum*, Cambridge, Mass.; spec. 1221 *G. sessile* on living *Ulmus americana*, Port Credit, Ont.; spec. 1551 *G. sessile* on living *Ulmus americana* Port Credit, Ont.; spec. 180 *G. sessile* on Elm stump, Ithaca, N. Y.; spec. 9525 *G. sessile* on living *Fraxinus americana*, Cambridge, Mass.

ATKINSON HERBARIUM in the New York State College of Agriculture: spec. 19560 *G. subperforatum* Atk. (type).

HERBARIUM NEW YORK BOT. GARD.: spec. 734 *G. sessile* ex Herb. G. Commons; spec. 2575 by stump of *Acer rubrum*, Gold Station, Md.; spec. 1430 *G. sessile;* spec. 1435 *G. sessile;* spec. 1 ex. Herb. L. O. Overholts; spec. 446 ex Herb. N. M. Glatfelter on Black Oak, St. Louis; spec. from Miss Sadie F. Price, Bowling Green, Ky.; spec. 2323 ex Herb. A. P. Morgan; spec. 32 *P. lucidus* Leys., Cincinnati, Ohio; spec. marked *G. sessile type*, from old Oak stump, Bedford Park; spec. *G. sessile* on Red Maple stump, N. Y. Bot. Gard. autumn, '08; spec. 25 *G. sessile* typical; spec. *G. sessile* on partly dead trunk *Acer rubrum*, on road from Clason's Point to Unionport, New York City; spec. 2507 Flora Ludoviciana legit A. B. Langlois, St. Martin's Ville, La.; spec. *G. sessile* on Norway Spruce stump, coll. W. A. Murrill and P. Wilson, Williams Bridge, New York City.

HERBARIUM RUSH P. MARSHALL: spec. on *Tilia americana*, Washington, D. C.; spec. on *Ulmus americana*, Andover, Mass.; spec. on *Acer saccharum*, Glastonbury, Conn.

FARLOW HERBARIUM (the following are labelled *G. lucidum*): Myc. Univ. 104 (de Thümen); Erb. Critt. Ital. series I 769; Fung. Europ. 1213 (Rabenhorst); Myc. Venet. 9 (Saccardo).

ADDENDUM

The following table shows the dimensions of spores of most of the species of *Ganoderma* recorded in the North American Flora, other than those studied in this paper, as determined by the writer from specimens in the Herbarium of the New York Botanical Garden:

Species	*Dimensions*	*Dimensions given in the North American Flora*
G. Sequoiae	6.7–7.4 x 11.9–14.2 μ	none
G. nevadense	7.4 x 11.9–13.4 μ	none
G. oregonense	7.4–8.4 x 11.9–14.0 μ	none
G. sulcatum	5.9 x 11.9–12.6 μ	4–4 x 8–10 μ
G. nitens	7.4–8.2 x 10.4–11.9 μ	none
G. tuberculosum	7.4–8.2 x 9.7–11.2 μ	6 x 8 μ
G. zonatum	5.2–5.9 x 10.4–11.2 μ	4–6 x 8–10 μ
G. subincrustatum	6.7–7.4 x 9.7–11.2 μ	4 x 8 μ
G. sessiliforme	5.9–6.7 x 8.9– 9.7 μ	none
G. argillaceum	5.2–6.3 x 8.9–10.4 μ	7 x 12 μ
G. subfornicatum	5.2–5.9 x 9.7–10.4 μ	4 (globose) μ
G. stipitatum	5.2–5.8 x 7.4– 8.2 μ	3.5 x 5 μ

Many of the foregoing are represented by specimens from the type locality only. The species can be grouped according to the character of their spores, whether resembling those of *G. sessile* ("smooth" type) or those of *G. lucidum* ("rough" type), as follow:

Species having thin-walled spores; the echinulations of the endospore fine	*Species having thick-walled spores; the echinulations of the endospore coarse*
G. argillaceum	*G. Sequoiae*
G. sessileforme	*G. nevadense*
G. sulcatum	*G. nitens*
G. subincrustatum	*G. tuberculosum*
G. zonatum	
G. stipitatum	
G. subfornicatum	

The writer is indebted to Professor J. H. Faull for suggesting the subject and for direction throughout this research. He is also under obligations to the curators of the Herbarium of the New York Botanical Garden, and of the Farlow Herbarium for affording free use of their collections.

SUMMARY

1. The history of the genus *Ganoderma* is briefly reviewed and attention drawn to the diversity of opinion in regard to the limitations of the genus, a situation due to the inadequacy of the original description and various subsequent modifications. Based on the distinctive organization of the crustal layer of the sporophore, and the remarkable structure of the spores, the genus is a well defined one.

2. The distinctive features of the crust are a peculiar "palisade" layer composed of modified hyphae, and a resinous cuticle which is secreted superficially.

3. The spores are smooth externally, though appearing rough from the numerous echinulations of the endospore.

4. Two sub-types of spores are recognized, (1) those with thick walls and relatively few, coarse echinulations on the endospore, and (2) those with thinner walls, and many finer echinulations on the endospore. The spores of any given species are of one type only.

5. The morphological characters of the sporophores, particularly of the crust and spores, are of paramount importance in the determination of species. According to our present knowledge there is no justification for assuming strict host specificity in this group; such an assumption in the past has led to erroneous specific determinations.

6. These studies have been confined to four temperate zone species as follows:

(a) *G. lucidum* (Leys.) Karst., a polypore found in Europe and America on hardwoods and conifers. It is especially common on Hemlock in America. The sporophore is distinguished by its heavy varnishing, and well developed "palisade" layer, its uniform context, and its thick-walled spores with coarsely echinulate endospore surface. *G. Tsugae* Murrill is a synonym.

(b) *G. sessile* Murrill, a polypore found in North America and in Europe on hardwoods (rarely conifers ?). It is distinguished by comparatively lightly varnished, distinctively colored and marked sporophores. The sporophore has a duplex context, a somewhat thinner and more irregular palisade layer than *G. lucidum*, and thin-walled spores with very finely echinulate endospore surface. *G. subperforatum* Atk. is a synonym.

(c) *G. Curtisii* Berk., a polypore reported only from the eastern half of the United States. The sporophore is distinguished by its exfoliating crust, its duplex and darkly colored context, and its

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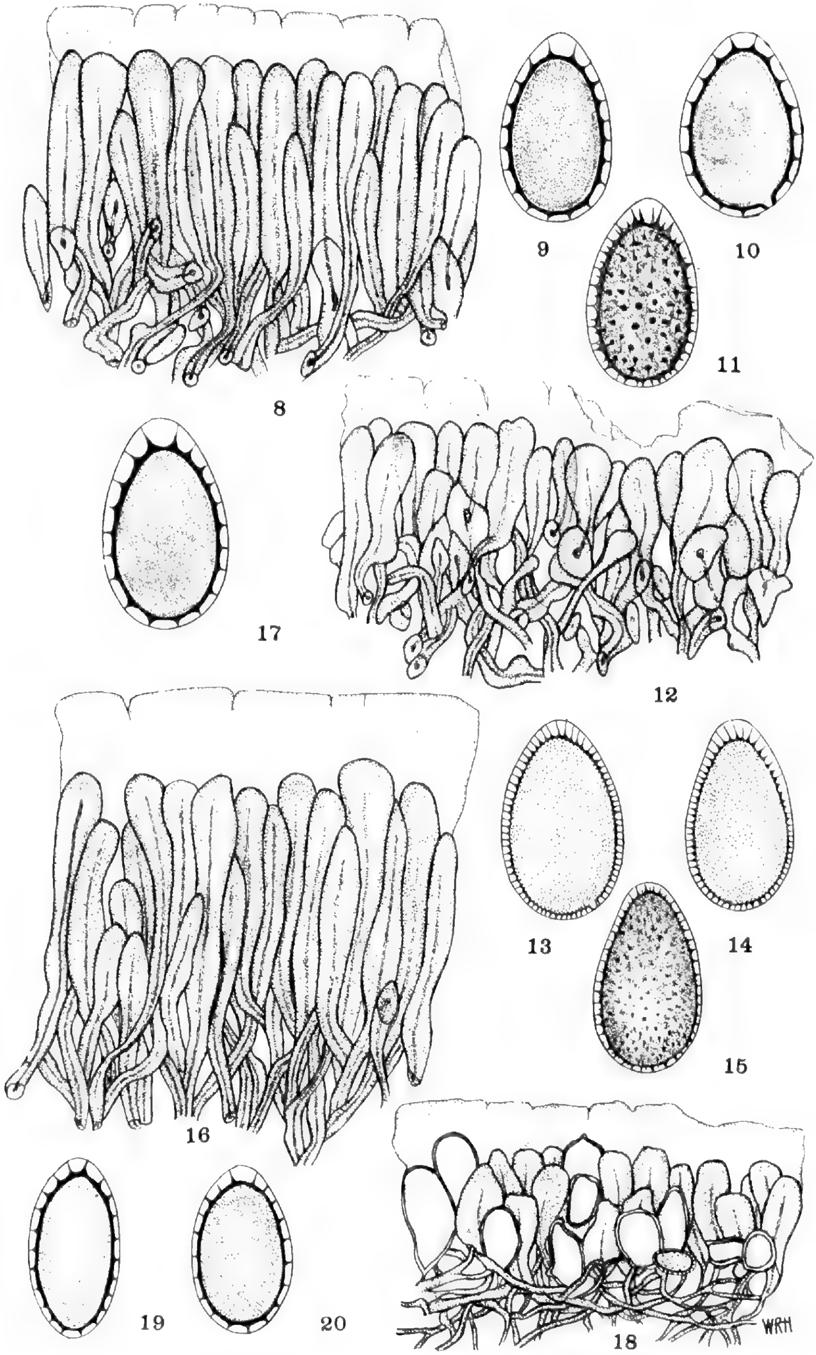

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spores of variable size, which are coarsely echinulate on the endospore surface.

(d) *G. oregonense* Murrill, a species found in western North America on conifers. The sporophore is distinguished by its dark color, its very heavily varnished surface and deep crustal layer, its thick soft uniform context, and its relatively large spores which have coarse echinulations on the endospore surface.

7. A list of the specimens studied is recorded, and also a record of measurements of the spores of most of the species described in the North American Flora.

PATHOLOGICAL LABORATORY, ARNOLD ARBORETUM
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EXPLANATION OF FIGURES OF PLATES 29 AND 30

Fig. 1. Photograph of the upper surface of a sporophore of *G. lucidum* (the Remi Lake specimen, on Spruce. Herb. J. H. Faull, spec. 9718); × .3.
Fig. 2. Photograph of a sporophore of *G. lucidum* showing three years' growth and that of the current fourth. (Herb. J. H. Faull, spec. 185); × .5.
Fig. 3. Photograph of sporophore of Fig. 1 in vertical section; × .5.
Fig. 4. Photograph of sporophore of *G. sessile* in vertical section (Herb. J. H. Faull, spec. 180); × .5.
Fig. 5. Photograph of same sporophore, upper surface view; × .5.
Fig. 6. Photograph of sporophores of *G. Curtisii* (Herb. J. H. Faull, spec. 3568); × .4.
Fig. 7. Photograph of sporophore of *G. oregonense* (Herb. J. H. Faull, spec. 9355); × .3.
Fig. 8. Vertical section through crust of *G. lucidum* (Herb. J. H. Faull, spec. 9718); × 550.
Fig. 9. Sectional view of a spore of *G. lucidum;* × 1575.
Fig. 10. Sectional view of a spore of *G. lucidum*. This spore is rather larger than the average; × 1575.
Fig. 11. Surface view of a spore of *G. lucidum;* × 1575.
Fig. 12. Vertical section through crust of *G. sessile* (Herb. J. H. Faull, spec. 180); × 550.
Fig. 13. Sectional view of a spore of *G. sessile*. This spore is rather larger than the average; × 1575.
Fig. 14. Sectional view of a spore of *G. sessile;* × 1575.
Fig. 15. Surface view of a spore of *G. sessile;* × 1575.
Fig. 16. Vertical section through crust of *G. oregonense* (Herb. J. H. Faull, spec. 9355); × 550.
Fig. 17. Sectional view of spore of *G. oregonense;* × 1575.
Fig. 18. Sectional view through crust of *G. Curtisii* (Herb. J. H. Faull, spec. 3604); × 550.
Fig. 19. Sectional view of spore of *G. Curtisii;* × 1575.
Fig. 20. Sectional view of spore of *G. Curtisii;* × 1575.

BIBLIOGRAPHY

1. AMES, ADELINE. A consideration of structure in relation to genera of the Polyporaceae. (Ann. Myc. **11**: 3. 211–253. 1913.)
2. ATKINSON, G. F. Observations on Polyporus lucidus Leys. and some of its allies from Europe and North America. (Bot. Gaz. **46**: 321–338. 1908.)

3. Bose, S. R. Artificial culture of Ganoderma lucidus Leys. from spore to spore. (Bot. Gaz. **87**: 665–667. 1929.)
4. Coleman, L. C. Structure of spore wall in Ganoderma. (Bot. Gaz. **83**: 1–48. 1927.)
5. Edgerton, C. W. The rate and period of growth of Polyporus lucidus. (Bull. Torr. Bot. Club, **7**: 89. 1907.)
6. Fries, E. Systema Mycologicum, vol. 1. 1821.
7. Gardner & Ettinghausen. British Eocene Flora. 1884.
8. Karsten, P. A. Myc. Fenn. Pars tertia. Basidiomycetes. (Bidrag till kännedom af Finlands natur och folk. **25**: 254. 1876.)
9. ——— Enumeratio Boletinearum et Polyporearum Fennicum systemati novo dispositorum. (Rev. Myc. **3**: 9. 17. 1881.)
10. ——— Kritisk Öfversigt af Finlands Basidsvampar. (Bidrag till kännedom af Finlands natur och folk. **48**: 327. 1889.)
11. Murrill, W. A. The Polyporaceae of North America. (Bull. Torr. Bot. Club, **29**: 601. 1902.)
12. ——— North American Flora, **9**: 2. 118–123. 1908.
13. ——— Northern Polypores. 1914.
14. Overholts, L. O. The Polyporaceae of Ohio. (Ann. Missouri Bot. Gard. **1**: 81–155. 1914.)
15. ——— Comparative studies in the Polyporaceae. (Ann. Missouri Bot. Gard. **7**: 667–730. 1915.)
16. ——— The Polyporaceae of the Middle-western United States, **3**: 44–46. 1915.
17. Patouillard, N. Le genre Ganoderma. (Bull. Soc. Myc. France, **5**: 64. 1889.)
18. Quélet, L. Enchiridion fungorum in Europa media et praesertim in Gallia vigentium. 1886.
19. Saccardo, P. A. Sylloge fungorum, **6**: 157 (1888).
20. Saporta, Marquis de. Origine paléontologique des arbres cultivés ou utilisés par l'homme. 1888.
21. White, J. H. On the biology of Fomes applanatus. (Trans. Roy. Can. Inst. **12**: 133–174. 1919.)

PTERIDOPHYTES COLLECTED FOR THE ARNOLD ARBORETUM ON VANIKORO, SANTA CRUZ ISLANDS, BY S. F. KAJEWSKI

E. B. Copeland

In 1928 while collecting for the Arnold Arboretum in the New Hebrides Mr. S. F. Kajewski paid a visit to the Santa Cruz Islands and collected on Vanikoro Island from October 17 to December 15 188 numbers of plants of which 32 were Pteridophytes. Descriptions of the new species and notes on species already known follow. A list of all the species of Pteridophytes collected will be published later with the general enumeration of the Vanikoro plants.

Cyathea Veitchii (Baker), comb. nova.

Alsophila Veitchii Baker, Syn. Fil. ed. II. 41 (1873).

Santa Cruz Islands: Vanikoro, common in rain-forest, alt. 50 m., no. **545**, Oct. 28, 1928 (trunk up to 15 m. tall; fronds three to four meters long).

Baker's description is very brief, but fits this fern as far as it goes. It is clearly one of the group of *C. lunularis*, the type-group of *Alsophila*. Costae and costules are rather densely squamulose beneath; pinnules conspicuously caudate; sori small and very numerous.

Tectaria grandifolia (Presl) Copeland in Philip. Jour. Sci. Bot. II. 413 (1907).

SANTA CRUZ ISLANDS: Vanikoro, rain-forest, no. **507,** Oct. 18, 1928 (Fern with large fronds up to 1.5 m. high; sterile fronds much smaller, about ¾ m. high).

A species of uncertain status, based on a Cuming collection which was probably a mixture; apparently intermediate between *T. crenata* and *T. decurrens*. The rachis and the upper end of the stipe may be broadly winged, or the lower pinnae may be free. Described from the Philippines, and not positively known elsewhere.

Oleandra angusta, sp. nova.

Rhizomate scandente, paleis appressis lanceolatis castaneis pallide marginatis ciliatis vestito, 3 mm. crasso; pedicellis 2 mm. longis, approximatis non verticillatis, paleis similibus minoribus vestitis; stipitibus 2 cm. longis, gracilibus; fronde 25–30 cm. longa, 10–14 mm. lata, utrinque longe attenuata, subcoriacea, costa paleis angustis 1 mm. longis horizontaliter distantibus ornata, lamina inferiore pilis nonnullis deciduis adspersa, aliter glabra, non ciliata et vix marginata; venis furcatis, tenuibus, arcte approximatis; soris 1.5–3 mm. a costa remotis, parvis, indusio nudo, firmo, oblique acroscopice aperto.

SANTA CRUZ ISLANDS: Vanikoro, rain-forest, alt. 50 m., no. **537,** Oct. 25, 1928 (a branching fern found on giant Kauris).

A species well distinguished by its long, slender fronds with attenuate base, long stipe and short pedicel, paleate costa, and remote lines of sori. The veins are very fine and close; as they reach the margin, they are spaced about twenty to the centimeter.

Lindsaya Kajewskii, sp. nova.

L. Lapeyrousii affinis, pinnis acroscopice bipinnatifidis distincta; rhizomate terrestri, brevirepente, intricato; stipitibus subcaespitosis, 2–3 cm. longis; fronde usque ad 30 cm. longa, media longitudine 4–5 cm. lata, utrinque angustata; pinnis medialibus 2.5 cm. longis, 1 cm. latis, basiscopice usque ad alam angustissimam costae excisis, recurvis, acroscopice in pinnulas ca. 4 unilateraliter subpinnatas et ca. 2 simplices ad alam aequi-angustam pinnatis; segmentis pinnulae quaeque majoris ca. 3, lineari-cuneiformibus; vena in segmento quoque aut simplice aut furcato; soro solitario, infra-apicale.

SANTA CRUZ ISLANDS: Vanikoro, common in rain-forest, alt. 50 m. no. **523,** Oct. 20, 1928 (growing on large rain-forest trees).

This species and *L. Lapeyrousii* constitute a group, of which *L. Blumeana* may be a representative with pinnate rachises, the affinity of the group as a whole being to that of *L. decomposita*, all anastomosis of veins of course disappearing with the fine dissection of the frond. *L. hymenophylloides* is not a member of this group; it and *L. fissa* are correspondingly finely cut relatives of *L. macraeana.*

Lycopodium Kajewskii, sp. nova.

Phlegmaria, caulibus pendentibus usque ad 75 cm. longis, repetiter dichotomis, foliis inclusis 15–18 mm. crassis; foliis confertissimis, patentibus, subcoriaceis, 7–8 mm. longis, basi 2 mm. latis, acuminatis; spicis plerisque simplicibus, usque ad 10 cm. longis, 1.2–1.5 mm. crassis, sporophyllis deltoideis sporangiis aut aequantibus aut paullo longioribus.

SANTA CRUZ ISLANDS: Vanikoro, rain-forest, alt. 100 m., no. **573** (type), Nov. 6, 1928 (a common parasite on rain forest trees); same locality, alt. 50 m., no. **520,** Oct. 20, 1928 (common, growing on large forest trees); same locality, alt. 100 m., no. **624,** Nov. 12, 1928 (a parasitic plant, common on the great Kauri).

Well marked in its group by the small and exceedingly numerous leaves, and slender spikes.

Herter in Beiblatt zu den botanischen Jahrbüchern, nr. 98, p. 22, (1909), has reported *L. Phlegmaria* and *L. phlegmarioides* from Vanikoro; also *L. serratum*, *L. phyllanthum* and *L. oceanianum* from the New Hebrides. Kajewski has collected what I suppose is *L. oceanianum* on Efate island. From Vanikoro, he sends 9 sheets,—3 of *L. Kajewskii*, 2 of *L. Phlegmaria*, and one each of *L. cernuum*, a related species (sterile), *L. vanikorense*, and *L. nummulariifolium*.

Lycopodium vanikorense, sp. nova.

L. setaceo affine gracilius, de arboribus pendente, caulibus repetiter dichotomis, deorsum foliis inclusis 5 mm. crassis; foliis subappressis, rectis, 8 mm. longis, vix 1 mm. latis, acutis, plerisque trifariis, saepe angustissime pallide-marginatis, sursum decrescentibus et fertilibus, ramis fertilibus 3–4 mm. crassis foliis 5 mm. longis.

SANTA CRUZ ISLANDS: Vanikoro, rain-forest, common, alt. 50 m., no. **521,** Oct. 20, 1928 (found growing on large rain forest trees).

Distinguished from *L. bolanicum* by less spreading leaves and consequently more slender shoots, and particularly by the more slender apices; from *L. Parksii* by the straight (not inflexed) and less acuminate leaves. *L. proliferum* Blume, ascribed by Herter to this group and by Baker to that of *L. squarrosum*, is unknown to me.

A SYNOPSIS OF ROBINSONELLA

EVA M. FLING ROUSH

With seven text figures

A SYNOPTICAL treatment of this group was thought advisable because of the difficulty of specific determination due to the scattered literature, the inadequacy of the original descriptions, the lack of a key to the species, the extreme variation in the form of leaf, the degree of pubescence and the small number or fragmentary nature of the specimens upon which some of the species were founded.

Robinsonella, a genus of tree mallows of the American tropics, named in honor of Dr. B. L. Robinson of the Gray Herbarium of Harvard, was established by Rose and Baker in 1897 with three species of which two, *R. cordata*, type of the genus, and *R. divergens*, were new, the third, *R. Lindeniana*, having formerly been referred to *Sida* and *Abutilon*. Only seven species are known at present and all are worthy of cultivation because of their showy flowers; they are, however, suited for subtropical and tropical regions only.

The author is indebted to those in charge of the following herbaria for the privilege of examining their material: the Arnold Arboretum and the Gray Herbarium of Harvard University, the New York Botanical Garden, the United States National Herbarium, the Missouri Botanical Garden and the Field Museum of Natural History.[1] Appreciation is due Mr. Alfred Rehder of the Arnold Arboretum for assistance and suggestions in the preparation of this paper.

Robinsonella Rose & Baker in Gard. & For. x. 244 (1897).—K. Schumann in Engler & Prantl, Nat. Pflanzenfam. Nachtr. II. 42 (1900).—Standley in Contrib. U. S. Nat. Herb. XXIII. pt. 3, 760 (Trees & Shrubs Mex.) (1923).

Shrubs or small trees up to 9 m. high, much branched, the younger and more herbaceous parts more or less stellate-pubescent (rarely pilose). Leaves alternate, petiolate, mostly ovate or orbicular in

[1] AA, Arnold Arboretum; F, Field Museum of Natural History; G, Gray Herbarium of Harvard University; M, Missouri Botanical Garden; NY, New York Botanical Garden; US, United States National Herbarium.

outline, palmately 5–7-veined, up to 25 cm. long, cordate, subcordate or rounded at base, acute, acuminate or obtuse at apex, entire, dentate or more or less lobed; the lobes vary much in shape, size, number and dentation; petioles vary in length and pubescence; stipules if present, caducous. Flowers large, showy, in ample panicles or in small clusters on short lateral branchlets; bracts small, lance-linear; pedicels articulated near the middle or toward the apex, pubescent or puberulous; calyx cup-shaped, ebracteolate, deeply 5-parted, open or reflexed in fruit, externally densely stellate-pubescent or tomentose (rarely pilose), on the inner upper part arachnoid-pilose in the young stage; nectaries if present forming a pubescent 5-angled ring at the base of the calyx within; petals obovate, unguiculate, with a tuft of hairs on each side of the claw forming the so-called "weel," rarely pubescent dorsally toward the base; staminal column conic, varying in length with the size of the flower, glabrous or stellate-pubescent, dividing into numerous filaments; cells of the ovary 9–13, uni-ovulate; the ovule pendulous, becoming apparently basal by the rapid growth and inflation of the upper portion of the ovary; style-branches as many as the cells of the ovary, exceeding the stamens; stigmas capitate, papillose. Carpels 9–13, compact or spreading, obtuse at apex, thin, membranous, slightly veined, much inflated at maturity, perhaps tardily dehiscent from the base up along the back, the seed often hanging by a slender thread which runs dorsally along the full length of the carpel; seed very small, dark, glabrous or sparsely stellate-scurfy.

TYPE SPECIES: *R. cordata* Rose & Baker in Gard. & For. x. 244 (1897).

DISTRIBUTION: From the State of Durango in Mexico south to Costa Rica in Central America.

Robinsonella belongs in the tribe Malveae because the carpels are of the same number as the style-branches and the staminal column is antheriferous at the summit; to the subtribe Sidinae because of the capitate stigmas. It is most closely related to *Sida* and *Gaya* by the uni-ovulate cells of the ovary in which the seed is pendulous. It is distinguished from *Sida* by the more tree-like habit, by the thin, membranous, non-reticulated and much inflated carpels which are obtuse (erostrate) and more or less divergent and separable, by the seed which occupies only a small space in the base of the carpel, by the sepals being smaller than the petals and open or reflexed at maturity. The species of *Gaya*, on the other hand, are herbaceous or suffruticose with undivided leaves, and chiefly yellow, sometimes purplish flowers which are pedunculate and solitary in the axils, often racemose; the apices of the mature carpels are connivent, but separate from the persistent axis and are dorsally dehiscent into two valves at maturity.

Key to the Species

Inflorescence cymose-paniculate, terminal or axillary; leaves more or less lobed.
- Leaves 3–5-lobed.
  - Leaves deeply 3- or 5-lobed, lobes ovate-oblong, constricted at base....................................1. R. *Lindeniana*
  - Leaves more or less 3-lobed, lobes blunt or obtuse..2. *R. divergens*
- Leaves only slightly and irregularly lobed, often unequally-sided 3. *R. edentula*

Inflorescence not paniculate, flowers solitary or in 2's or 3's on short lateral branchlets; leaves obscurely or not at all lobed.
- Leaves discolorous, with a fine, dense, appressed silvery tomentum beneath, more or less coarsely dentate..............4. *R. discolor*
- Leaves green on both sides.
  - Leaves furfuraceous-tomentose beneath, ferrugineous on the veins, shortly acuminate...........................5. *R. subcordata*
  - Leaves loosely stellate-pubescent beneath.
    - Leaves pilose on the veins and petioles........6. *R. cordata*
    - Leaves not pilose on the veins or petioles, glabrescent. 7. *R. pilosa*

1. **Robinsonella Lindeniana** (Turcz.) Rose & Baker in Gard. & For. x. 245 (1897).—Standley in Contrib. U. S. Nat. Herb. xxiii. pt. 3, 760 (Trees & Shrubs Mex.) (1923).—Fig. 1.

Sida Lindeniana Turczaninow in Bull. Soc. Nat. Moscou, xxxi. pt. 1, 200 (1858).—Hemsley, Diag. Pl. Nov. ii. 24 (July 1879); Biol. Cent. Am. i. t. 9, 105 (Nov. 1879).—Gray in Proc. Am. Acad. Arts Sci. xxiii. 295 (1888).—Baker in Jour. Bot. xxx. 139 (1892); Syn. Malveae, 53 (1894).

Sida Ghisbreghtiana Turczaninow in Bull. Soc. Nat. Moscou, xxxi. pt. 1, 200 (1858).

Abutilon ? ambiguum Turczaninow in Bull. Soc. Nat. Moscou, xxxi. pt. 1, 205 (1858).

Shrub 2.5–3 m. high or larger, branchlets stellate-pubescent, often furfuraceous. Leaves large, up to 27 cm. long, dark green, sparsely stellate-pubescent or scabrous above, paler, densely and softly stellate-pubescent beneath; lower leaves deeply 5-lobed, the uppermost usually 3-lobed, the lobes ovate-oblong, constricted at the base, acute or shortly acuminate, entire or dentate; petiole up to 15 cm. long, stellate-pubescent, often furfuraceous or merely puberulous. Flowers in ample, open cymose panicles up to 3 dm. long and 2–3 dm. broad, branches and pedicels slender, usually furfuraceous-pubescent or puberulous; pedicels 2–4 cm. long, articulated a little below the flower; sepals broadly ovate-oblong, acute or slightly obtuse, pubescent or puberulous, nectaries present; petals white, 1–1.4 cm. long; staminal column short (4 mm.), conic, glabrous. Carpels 11–13, small, compact, about 1 cm. long, coarsely stellate-pubescent.

MEXICO. Vera Cruz: Orizaba, *M. Botteri*, no. 1134 (G, US); Barranca of Metlac near Orizaba, alt. 900 m., *C. G. Pringle*, no. 5906, Jan. 29, 1895 (G, US); Mirador, Orizaba, *F. M. Liebmann*, no. 430, March 1842 (AA, NY, US); Valley of Cordova, *M. Bourgeau*, no. 1501, Dec. 15, 1867 (G, US); Cordova, *J. M. Greenman*, no. 166, Jan. 25, 1906 (F); Canton de Huatusco, alt. 1200 m., *C. Conzatti*, no. 833, Dec. 1898 (G, US); Barranca de Tenampa, Zacuapan and vicinity, *C. A. Purpus*, no. 2210, Nov. 1906 (F, G, M, NY, US).

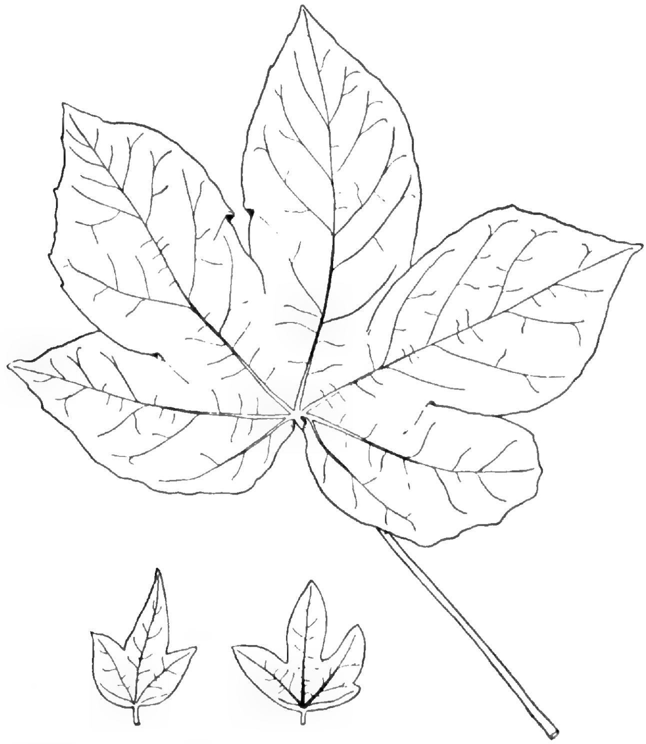


FIG. 1. ROBINSONELLA LINDENIANA (Turcz.) Rose & Baker.—Typical leaf, and smaller leaves from the upper part of flowering branches (× ½).

Robinsonella Lindeniana was first described by Turczaninow in 1858 in the same paper as three different species, the two flowering specimens were referred to *Sida* and the fruiting one questionably to *Abutilon*. This species resembles *Sida* only in the solitary pendulous seed in each carpel. Superficially the fruits resemble those of *Abutilon*, section *Gayoides* A. Gray (*S. crispum* Sweet), but differ in being uni-ovulate. Dr. Asa Gray created a separate section for this species in *Sida* and called it *Abutilastrum*. E. G.

Baker retained this section in his Synopsis Malveae and added other species of *Sida*. Later Rose and Baker removed this species from *Sida* and placed it in their new genus *Robinsonella*, which they had established upon *R. cordata*.

Robinsonella Lindeniana may be confused with *R. divergens*, but it has larger palmately 5-parted lower leaves with ovate-oblong constricted lobes, and slenderer and less furfuraceous branches and pedicels in the inflorescence. The sepals of *R. Lindeniana* are ovate-oblong and not reflexed in fruit.

2. **Robinsonella divergens** Rose & Baker in Gard. & For. x. 245 fig. 32 (1897).—Standley in Jour. Arnold Arb. xi. 34 (1930).—Fig. 2.

Small tree up to to 6 m. high, branchlets with coarse, furfuraceous stellate pubescence (rarely more or less puberulous). Leaves orbicular, cordate, up to 15 cm. long, slightly scabrous above, with dense short stellate pubescence beneath; the lower leaves 3-lobed,

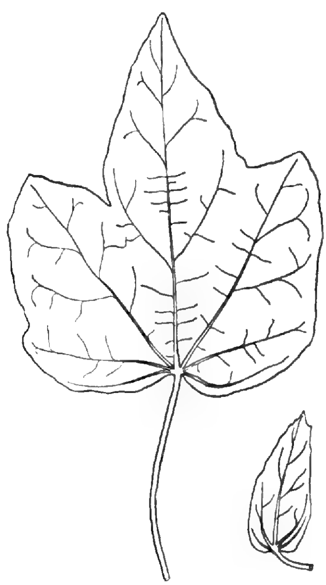


Fig. 2. Robinsonella divergens Rose & Baker.—Typical leaf, and small leaf from upper part of flowering branches (× ½).

the lobes acute or obtuse (in extreme forms very large, ovate-oblong, constricted at the base), entire or dentate; the uppermost leaves lanceolate, petioles up to 10 cm. long, coarsely stellate-pubescent (often furfuraceous). Flowers in large cymose-panicles up to 4 dm. long, branches and pedicels stout (if slender more or less puberulous) covered with a furfuraceous stellate pubescence; pedicels up to 2 cm. long, articulated just below the flower; sepals lanceolate, acute, reflexed in fruit, stellate-pubescent, nectaries prominent; petals white, rarely striped with reddish purple, 0.5–1.5 cm. long; staminal column short (4 mm.), very slender, conic, glabrous. Carpels 9–10, large, spreading and widely separated at apex, strikingly stellate-pubescent or merely puberulous.

CENTRAL AMERICA. Guatemala: Santa Rosa, Dept. of Santa Rosa, alt. 900 m., *Heyde & Lux*, no. 4326, Jan. 1893 (F, G, NY); Cuajiniquilapa, Dept. of Santa Rosa, alt. 750 m., *Heyde & Lux*, no. 6299, Nov. 1893 (F, G). Honduras: vicinity of Siguatepeque, Dept. of Comayagua, alt. 1080–1400 m., *P. C. Standley*, no. 55975, Feb. 14–27, 1928 (AA, F, US); El Salvador: Santa Tecla, *S. Calderon*, no. 1515, March 1923 (G); vicinity of Santa Tecla, Dept. de La Libertad in Cafetal, alt. 790–950 m., *P. C. Standley*, no. 23021, April 10, 1922 (F, G, NY). Nicaragua: between Jinotega and Pantasmo, *A. S. Oersted*, Jan. 1848 (F). Costa Rica: environs de San José, alt. 1200 m., *H. Pittier*, no. 2186, Dec. 1902 (US); San José, bords du rio Torres près San Francisco de Guadalupe, alt. 1135 m., *H. Pittier* (also *Ad. Tonduz*), no. 8471, Dec. 1892–93 (F, US; *syntype*); San José, bord d'un ruisseau, *Ad. Tonduz*, no. 1425, Nov. 28, 1880 (US; *syntype*); San José, alt. 1135 m., *Ad. Tonduz*, no. 7311, Jan. 1893 (F, G, US; *syntype*); San José, alt. 1080 m., *J. D. Smith*, no. 4751, April 1894 (G); vicinity of La Verbena, Prov. of San José, alt. about 1200 m., *P. C. Standley*, no. 32216, Jan. 29, 1924 (F); foothills south of San José, *J. M. & M. T. Greenman*, no. 5500, Feb. 8, 1922 (M); vicinity of San José, alt. about 1130 m., *P. C. Standley*, no. 47333, Dec. 4, 1925–Feb. 10, 1926 (F); mole de San Rafael (plaine du San Carlos), *H. Pittier*, no. 2600, June 1890 (US; *syntype*); environs of San Rafael, *Ad. Tonduz*, no. 1977, Feb. 13, 1890 (US; *syntype*).

Honduran forms of *Robinsonella divergens* resemble *R. Lindeniana* in having very large leaves with ovate-oblong lobes, more open panicles, more slender and less furfuraceous-pubescent branches and pedicels of the inflorescence, but the always three-lobed leaves, lanceolate and reflexed sepals and the larger, more widely separated carpels place them specifically with *R. divergens*.

3. **Robinsonella edentula** Rose & J. Donnell Smith in Bot. Gaz. XXXVII. 417 (1904).—Rose in Contrib. U. S. Nat. Herb. VIII. 519 (1905).—Fig. 3.

Shrub or small tree, branchlets stellate-pubescent. Leaves suborbicular in outline, 3–9 cm. long, cordate at base with a deep sinus, irregularly lobed and somewhat unequally-sided, shortly and sparsely stellate-pubescent above, densely and coarsely pubescent beneath, the lobes acute, obtuse or rounded, entire, undulate or slightly dentate, petioles 0.5–3 cm. long, coarsely stellate-pubescent. Flowers very abundant, in short axillary panicles up to 8 cm. long, pedicels slender 8–16 mm. long, stellate-pubescent, articulated near the apex; bracts when present lance-linear; sepals ovate-

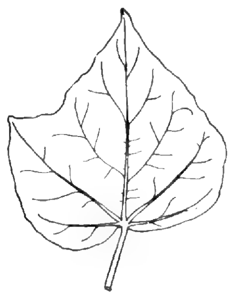


FIG. 3. ROBINSONELLA EDENTULA Rose & Donn. Sm.—Leaf (× ½).

lanceolate, acute, stellate-pubescent, nectaries present; petals violaceous (pale lilac), 1 cm. long; staminal column very short (6 mm.), slender, glabrous. Carpels about 10, small, delicately veined, sparsely pubescent.

CENTRAL AMERICA. Guatemala: Cobán, Dept. Alta Verapaz, alt. 1300 m., *H. von Tuerckheim* no. 665 (Donn. Smith, Pl. Guatem. etc., no. 8382), Nov. 1902 (F, G, NY, US; *holotype*).

4. Robinsonella discolor Rose & Baker in Contrib. U. S. Nat. Herb. v. 181 (1899).—Standley in Contrib. U. S. Nat. Herb. xxiii. pt. 3, 370 (Trees & Shrubs Mex.) (1923).—Fig. 4.

Slender tree 6–9 m. high, branchlets glabrous with yellowish-gray bark. Leaves broadly ovate, up to 12 cm. long, cordate or subcordate at base, often unequally-sided, entire, coarsely dentate or obscurely lobed toward the acute or acuminate apex, discolorous, green above, covered with a fine, densely appressed, silvery tomentum beneath, with a tuft of long soft hairs at the base of the main veins; petioles up to 10 cm. long, puberulous. Flowers borne toward the apex of short lateral branchlets, solitary or in pairs on puberulous pedicels about 2 cm. long, pedicels articulated near the middle; sepals ovate, acute, covered with a fine tomentum, nectaries not evident; petals white, 6–10 mm. long; staminal column short (5 mm.), conic, glabrous. Carpels about 12, more or less compact, minutely stellate-tomentose.

MEXICO. San Luis Potosi: Las Palmas, Limestone hills, alt. 90–120 m., *C. G. Pringle*, no. 5767 (F, G, US; *syntype*) and no. 8007 (AA, F, G, M, NY, US; *syntype*), April 27, 1894 and March 2, 1899.

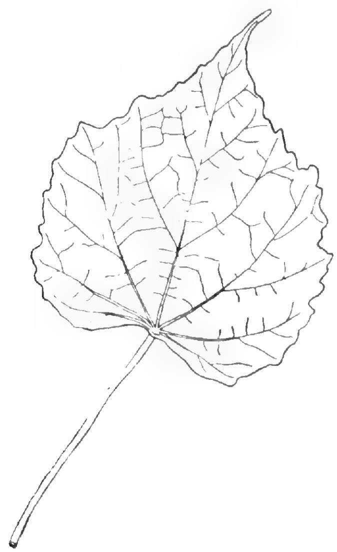


FIG. 4. ROBINSONELLA DISCOLOR Rose & Baker.—Leaf (× ½).

5. **Robinsonella subcordata** Hochreutiner in Ann. Conserv. Jard. Bot. Genève, XXI. 449 (1920).—Standley in Contrib. U. S. Nat. Herb. XXIII. pt. 5, 1674 (Trees & Shrubs Mex.) (1926).—Fig. 5.

Tree, branchlets with ferrugineous and furfuraceous tomentum. Leaves thick, ovate, 2–2.7 cm. long (young?), subcordate or rotund at base, almost entire, shortly acuminate, slightly tomentose above,

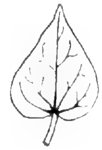


FIG. 5. ROBINSONELLA SUBCORDATA Hochreut.—Leaf (× ½).

densely furfuraceous-tomentose beneath, more or less ferrugineous on the veins; petioles 0.5–1.5 cm. long, densely tomentose, more or less furfuraceous and ferrugineous. Flowers many, congested on short lateral branchlets, pedicels up to 3 cm. long, tomentose, articulated near the middle; sepals ovate, 8 mm. long, acute, prominently one-nerved, gray-tomentose; nectaries evident; petals pale lilac [?], 2.5 cm. long; staminal column attenuate-conic (8 mm.), stellate-pubescent. Carpels about 13, appressed tomentose when young (mature carpels not seen).

MEXICO. Oaxaca: Jayacatlan, *H. H. Rusby*, without no. (NY, *holotype*).

6. **Robinsonella cordata** Rose & Baker in Gard & For. x. 244, fig. 31 (1897).—Hochreutiner in Ann. Conserv. Jard. Bot. Genève, XXI. 450 (1920).—Standley in Contrib. U. S. Nat. Herb. XXIII. pt. 3, 761 (Trees & Shrubs Mex.) (1923); pt. 5, 1674 (Trees & Shrubs Mex.) (1926).—Fig. 6.

Tree 4–9 m. high, much branched, branchlets pilose or glabrescent. Leaves up to 15 cm. long, cordate or subcordate at base, long acuminate, dentate or slightly lobed toward the apex, softly

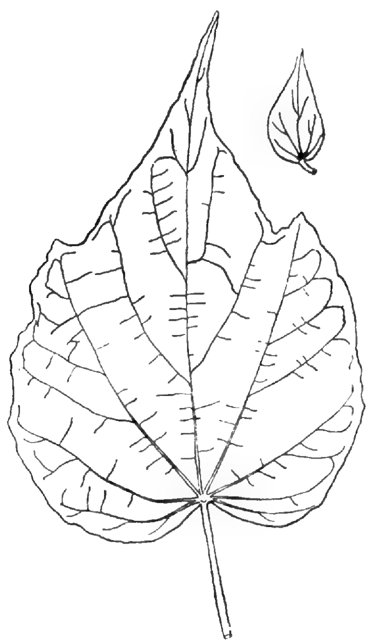


FIG. 6. ROBINSONELLA CORDATA Rose & Baker.—Typical leaf, and small leaf from the upper part of flowering branches (× ½).

pilose or glabrescent above, loosely stellate-pubescent beneath, pilose on the veins, petioles up to 5 cm. long, pilose. Flowers in 2's or 3's on short lateral branchlets; pedicels 1.5–2.5 cm. long, mostly densely pilose or rarely short stellate-pubescent, articulated near the middle; sepals large, ovate-lanceolate, gray-tomentose, not conspicuously nerved, nectaries evident; petals pale lilac (sometimes white), about 1.5–2.5 cm. long, stellate-pubescent externally near the base; staminal column 5–8 mm. long, minutely and densely stellate-tomentose. Carpels 12–13, distinct nearly to the base, stellate-pubescent or rarely pilose.

MEXICO. Durango: San Ramon, *Edw. Palmer*, no. 54, April 21–May 18, 1906 (G, M, NY, US). Oaxaca: Hacienda de Guadalupe, alt. 1600 m., *C. Conzatti*, no. 2322, Dec. 6, 1908 (F, G, M); Cerro San Felipe, alt. 2000–3000 m., *Gonzales & Conzatti*, no. 881, Aug. 7, 1898 (G, US); alt. 2100 m., *Gonzales & Conzatti*, no. 671, March 7, 1898 (G, US); Tamazulpam, alt. 2000–2135 m., *E. W. Nelson*, no. 1955, Nov. 16, 1894 (US; *syntype*); San Luis Tultitlanapa, Puebla near Oaxaca, *C. A. Purpus*, no. 3251, April–May 1908 (F, G, M, NY, US); Sierra de San Felipe, alt. 2300 m., *C. G. Pringle*, no. 6244, Dec. 11, 1895 (AA, G, F, NY, US; *syntype*) (distributed as *Malva subtriflora* or *Malvastrum subtriflorum*); S. J. del Estado, Rancho de Calderon, alt. 1830 m. *L. C. Smith*, no. 529, Feb. 11, 1895 (G, US); without definite locality: *F. M. Liebmann*, no. 1090, 1841–43 (US); Hacienda de Riego, Tehue (?), cultivated, *C. Patini*, no. 7204a, March 13, 1917 (US).

Considerable variation in this species is shown in the kind and degree of pubescence, dentation and acumination of the leaves, in the size and color of the petals, and in the shape of the sepals. The presence of pilose hairs on veins, petioles, pedicels, calyx and branchlets, with the absence of furfuraceous or ferrugineous pubescence anywhere, are the most distinctive characters which separate this species from *R. subcordata*.

7. **Robinsonella pilosa** Rose in Contrib. U. S. Nat. Herb. VIII. 320 (1905).—Fig. 7.

Shrub or small tree, branchlets grayish-yellow, glabrous. Leaves ovate, up to 10 cm. long, cordate at base, not lobed, glabrescent above, loosely stellate-pubescent beneath, petioles up to 5 cm. long,

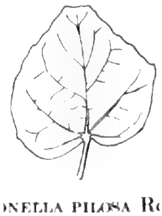


FIG. 7. ROBINSONELLA PILOSA Rose.—Leaf (× ½).

glabrescent. Flowers clustered on short lateral branchlets, pedicels pilose; sepals ovate, obtuse, long pilose in the bud. Carpels 13 (?) fairly long stellate-pubescent, obscurely pilose in the younger stage.

CENTRAL AMERICA. Honduras: Valle de Comayagua, entre Villa de Flores y Comayagua, alt. 690 m., *G. Niederlein*, Feb. 22, 1898 (US, *holotype*).

The material upon which this species was founded is so fragmentary that it is difficult to give its relationship except tentatively as being much closer to *R. cordata* than to *R. edentula* as given in the original description. The pedicels and young flower-buds are as pilose if not more so than in some specimens of *R. cordata*. There is, however, no indication of lobing and no pilose hairs on the fragments of the leaves. A detailed description is not possible from the material available.

NEW SPECIES, VARIETIES AND COMBINATIONS FROM THE HERBARIUM AND THE COLLECTIONS OF THE ARNOLD ARBORETUM[1]

ALFRED REHDER

With a text figure

Taxus cuspidata Sieb. & Zucc. f. **Thayerae** Wilson in Horticulture, VIII. 424, fig. (1930).

A typo recedit praecipue habitu humili depresso ramis gracilibus fere horizontalibus vel patentibus apice ascendentibus.

Plants and specimens examined: plants received in 1924 from the Bayard Thayer estate and now growing in the Arnold Arboretum under no. 17653; herbarium specimens collected in fruit, October 14, 1930.

A very handsome form of the Japanese Yew of low wide-spreading habit with nearly horizontally spreading or somewhat ascending branches. It is much more graceful than the other dwarf forms of *T. cuspidata*, as f. *nana* Rehd. (var. *brevifolia* Hort.) with rather stiff irregularly arranged branches reaching ultimately a height of 2 m., and f. *densa* Rehd. which is a very low and dense cushion-like shrub.

This Yew was raised from seed of *T. cuspidata* by Mr. William Anderson, superintendent of the Bayard estate at Lancaster, Mass. and the largest plants are now about 1.25 m. high and 4 m. in diameter.

Populus cathayana, sp. nov.

Populus suaveolens Schneider in Sargent, Pl. Wilson. III. 18, 28 (1916), quoad specimina sinensia citata.—Rehder in Jour. Arnold Arb. IV. 133 (1923), pro parte; Man. Cult. Trees & Shrubs, 88 (1927), pro parte.—Henry in Gard. Chron. ser. 3, LIII. 198, fig. 88 (1913), quoad icon.; in Elwes & Henry, Trees Gr. Brit. & Irel. VII. 1841, t. 410, fig. 25 (1913), quoad icon.—Non Fischer.

[1] Continued from vol. XI. 168.

Populus szechuanica Schneider in Sargent, Pl. Wilson. III. 21 (1916), quoad specimina Wilsoniana citata, nos. 1413, 2165, 4346, 4348, 4361.
?*Populus balsamifera* var. *suaveolens* Burkill in Jour. Linn. Soc. XXVI. 536 (1899), pro parte.
?*Populus balsaminifera* (*sic*) Kanitz in Szechenyi, Keletasz. Utján. Tudom. Eret. II. 842 (Pl. Enum. 58) (1891); in Szechenyi, Wissenschaft. Ergeb. Reise Ostas. II. 732 (1898).

Arbor ad 30 m. alta, trunco circuitu ad 4 m., omnino glabra; ramuli teretes, hornotini maturi aurantiaci vel fusco-aurantiaci vel griseo-lutei, annotini et vetustiores griseo-lutei, turiones teretes vel leviter obtuse angulati; gemmae purpurascentes elongatae, viscidae. Folia ramulorum fructiferorum ovata vel anguste ovata, 6–10 cm. longa et 3.5–7 cm. lata, papyracea, distincte acuminata, basi rotundata, rarius leviter subcordata, minora interdum latissime cuneata, satis dense crenato-serrulata denticulis adpressis incurvis glanduligeris, ima basi integra vel remote denticulata, supra laete vel intense viridia, subtus albescentia, nervis utrinque 5–7 curvatis ut costa supra leviter subtus magis elevatis, rete venulorum subtus conspicuo et prominulo supra minus conspicuo vel fere obsoleto; petioli subteretes, graciles, 2–6 cm. longi; folia turionum pleraque oblongo-ovata, 12–20 cm. longa et 5.5–10 cm. lata, vel interdum majora basi saepe subcordata, dense glandulosa-denticulata, petiolis 1.2–3 cm. longis. Amenta mascula 5–6 cm. longa, bracteolae fimbriatae, glabrae; stamina 30–35, antheris circiter 2 mm. longis lineari-oblongis quam filamenta longioribus; amenta feminea visa tantum 4–5 cm. longa (vel longiora ?), glabra; bracteolae fimbriatae; pedicelli brevissimi circ. 0–5 mm. longi, apicem versus fere 0; perigonii discus patelliformis, basin ovarii tantum cingens, circiter 2.5 mm. diam., margine integro; ovarium glabrum, ovoideum, 2–3 mm. longum, stigmatibus 2–4 dilatatis breviter stipitatis coronatum; amenta fructifera 10–20 cm. longa, fructibus satis distantibus brevissime pedicellatis vel subsessilibus; capsula ovoidea, acuta, 7–9 mm. longa, valvis plerumque 3 vel 4, rarius 2, acuminatis apice recurvis.

CHINA. Szechuan: Fei yueh ling, Ching chi hsien, alt. 2100–2750 ft., *E. H. Wilson*, no. 1432, May 1908 (tree 12 m. tall, girth 1.25 m.; fruiting; type); same locality, *E. H. Wilson*, no. 1431, Oct. 1908 (bark); near Mongkong ting, ascent of Hsao chin ho, alt. 2100–2500 m., *E. H. Wilson*, no. 2164, June 29, 1908 (tree 12–24 m. tall, girth 1.5–2.5 m.; fruiting); west of Kuan hsien, Pan lan shan, alt. 2500–3000 m., *E. H. Wilson*, no. 4348, Oct. 1910 (tree 21–24 m. tall; fruiting); same locality, *E. H. Wilson*, no. 4346, Oct. 1910 (tree 18–24 m. tall; vigorous shoots); northeast of Tachienlu, forests of Ta pao shan, alt. 1600–4200 m., *E. H. Wilson*, nos. 1413, 2165, July 3 and 6, 1908 (tree 15–30 m., girth 1.5–3.5 m.; fruiting branches and bark); same locality, planted around temples, *E. H. Wilson*, Veitch Exp. no. 4529, July 1903 (tree 18–24 m.); Mupin, alt. 2400–2700 m., *E. H. Wilson*, no. 4361, Oct. 1910 (tree 15–18 m., tall, girth 2–2.5 m.; vigorous shoots); between Hui li chou and Pai koa wan, *C. Schneider*, no. 532, March 31, 1914 (tree 8 m. tall, girth 0.3 m.; staminate flowers). Kansu: Ho lan shan Mountains, rocky slopes, alt. 1375–2400 m., *R. C. Ching*, no. 75 (Wulsin Exp.), May 10–25, 1923 (tree 10 m. high; pistillate flowers); near Ping fan in gorge, alt. 2350–2800 m., *R. C. Ching*, no. 482 (Wulsin Exp.), July 12–20, 1923 (tree to 24 m.). Shansi: Lin hsien, Nan yang shan, alt. 2000–3000 m., *Tchuang Kieh*, Hers. no. 2067, Sept. 11, 1922 (tree up to 2 m. in girth); Fang shan hsien, Nan yang shan, alt. 1500–2500 m., *J. Hers*, no. 2700, Sept. 22, 1923 (leafy branches and vigorous shoots); Wu chai hsien, To nan kow, alt. 2000–3000 m., *Tchuang Kieh*, Hers no. 2021, Sept. 7, 1922 (tree up to 3 m. in girth; vigorous shoot); Great Wall pass, alt. 1400 m., *J. Hers*, no. 2608, July 27, 1923; Wu tai shan, 1600 m., *J. Hers*, no. 2641, July 31, 1923; Tung Tsa, alt. 1500–1800 m., *C. O. Lee*, Herb. Univ. Nanking nos. 5512, 5543, 6027, July 1924; Lin kon shan, *K. Ling*, Herb. Univ. Nanking no. 9301 (tree 15 m. tall). Chili: Jehol, *W. Purdom*, no. 2, in 1909; Nankow, *J. Hers*, no. 1597, Aug. 14, 1921 (vigorous shoot); Po hua shan, *J. Hers*, no. 1654 (shoot); Hsiao Wu tai shan, alt. 1500 m., *F. N. Meyer*, no. 1311, Aug. 23, 1913 (leafy branches and detached fruit); same locality, *J. Hers*, no. 1488, July 1921 (fruiting branches); Huai lai hsien, Liu shu chwang, alt. 800 m., *J. Hers*, nos. 2079, 2080, Oct. 3, 1922; Ta hung men, *J. Hers*, no. 2217, Oct. 10, 1922; Huai lai hsien, Yang kia ping, alt. 900 m., *J. Hers*, no. 2091, Oct. 4, 1922; Peking Plain, *C. S. Sargent*, Sept. 17, 1903 (small tree); Peking, *J. Hers*, no. 2476, April 8, 1923 (staminate flowers); Miao feng shan, hills west of Peking, Shantung Univ. Coll. no. 69, Sept. 29, 1921; same locality, alt. 1000 m., *J. Hers*, no. 2538, June 12, 1923.

SOUTHERN MONGOLIA: Mont. Muniula, *N. M. Przewalski*, in 1872.

MANCHURIA: Jala tun, in park, *P. H. Dorsett*, no. 3480, June 27, 1925; Harbin, *C. S. Sargent*, Aug. 16, 1903 (tree with smooth pale bark deeply furrowed near base).

KOREA: Ping yang, *J. G. Jack*, Sept. 18, 1905 (sterile).

For some time I have suspected that the Chinese Poplar referred by most authors to *P. suaveolens* Fisch. does not represent typical *P. suaveolens*, judging from the figure given by Pallas in his Flora Rossica of the Davurian *P. balsamifera* upon which Fischer based his *P. suaveolens*. When in Leningrad in 1928 I took the opportunity to examine Fischer's type specimen which came from Herb. Pallas and probably served for Pallas' drawing. At the same time I looked over all the material of *P. suaveolens* in the herbaria of the Botanic Garden and of the Academy of Sciences and came to the conclusion, that the two plants are quite different and that typical *P. suaveolens* does not occur in China at all, but is restricted to the region north of the Mongolian desert, while the Chinese plant is a new species described above as *P. cathayana.* This species occurs throughout northern China and ranges from western Szechuan and Kansu to Chili and Manchuria and possibly to Korea, if Jack's specimen from Ping yang belong here which is somewhat doubtful. *Populus cathayana* is more closely related to *P. Simonii* Carr., *P. Purdomii* Rehd. and *P. szechuanica* Schneid. than to *P. suaveolens* Fisch. which is easily distinguished by its oval or elliptic to elliptic-oblong leaves, generally broadest about the middle, abruptly acuminulate at the apex with a very short often twisted acumen, with often slightly impressed veinlets above and usually slightly pilose beneath near base, and by its shorter petioles 0.5–3 cm. long, generally not longer than ¼ the length of the blade, and often slightly pilose. *Populus Purdomii* differs in its larger leaves, with somewhat coarser and not appressed serration usually short-pilose chiefly on the veins beneath and in the 2-valved capsules. In the size and shape of its leaves *P. cathayana* holds about the middle between *P. Simonii* which occupies nearly the same range and *P. szechuanica* which is known only from Szechuan and seems of restricted distribution. The latter differs from *P. cathayana* chiefly in the much larger broadly ovate leaves measuring on fruiting branches 10–20 cm. in length and 8–15 cm. in width with broad rounded or subcordate base and in the sharply angled vegetative shoots, while *P. Simonii* differs in its smaller leaves, usually 4–8 cm. long and broadest near the middle with broadly cuneate base, in the shorter 1–2.5 cm. long petioles, in the more or less angled vegetative shoots with short-petioled usually obovate leaves and in the slenderer catkins with smaller mostly 2-valved fruit. Of the specimens cited above Wilson's nos. 1413 and 2165 and Ching's no. 482 resemble somewhat *P. szechuanica* to which these Wilson numbers had been referred by Schneider besides nos. 4346, 4348 and 4361. I now restrict *P. szechuanica* to Wilson's nos. 2163 (type), 1434 and 4355. Wilson's Veitch Exped. no. 4529, Schneider's no. 843 and Sargent's specimen from Harbin approach *P. Simonii.*

One of the reasons why this Chinese species has been confused by many recent authors with *P. suaveolens* Fisch., is probably the absence or scarcity of material of the true species in the herbaria of western Europe and of America; also in the herbarium of this institution the true *P. suaveolens* was not represented until I brought several duplicates from Leningrad two years ago. To which species the specimens from Songaria and Turkestan referred by several authors to *P. suaveolens* belong, I am not prepared to say, as I have not studied the Poplars of those regions.

Populus cathayana var. **Schneideri,** var. nov.

A typo recedit folii venis supra et subtus minute puberulis, petioles et ramulis gemmisque densius et minute puberulis, rhachi amenti fructiferi et capsulis breviter pilosis.—Folia ovata, 6–9 cm. longa et 4–6.5 cm. lata, basi rotundata, serraturis parvis adpressis interdum fera obsoletis, supra opace flavo-viridia, venis et petiolis flavescentibus; amenta fructifera circiter 8 cm. longa.

CHINA. Yunnan: Yung ning, *C. Schneider*, no. 1611, June 20, 1914 (large tree, bark as in *P. tremula*).

In all its other characters except in the fine pubescence of the branchlets, winter-buds and veins of the leaves and in the pilose capsules this specimen agrees well with typical *P. cathayana* as represented by Wilson's nos. 1432, 2164 and 4348, but the leaves show not the slightest tendency toward a subcordate base and the serration is less distinct. It is the most southern specimen of *P. cathayana* I have seen, but though Yung ning is in Yunnan it is situated close to the Szechuan border.

Populus Simonii Carrière in Rev. Hort. 1867, p. 360—Wesmael in De Candolle, Prodr. XVI. pt. II. 330 (1868); in Mém. Soc. Sci. Hainaut, III. 247 (Monog. Peupliers, 67) (1869).—Maximowicz in Bull. Soc. Nat. Moscou, LIV. 52 (1879).—Kanitz in Szechenyi, Keletazs. Utján. Tudom. Eret. II. 841 (Pl. Enum. 58) (1891); in Szechenyi, Wissensch. Ergeb. Reise Ostas. II. 732 (1898).—Dippel, Handb. Laubholzk. II. 211, fig. 105 (1892).—Komarov in Act. Hort. Petrop. XXII. 746 (1904).—Schneider, Ill. Handb. Laubholzk. I. 16, fig. 6, o–q (1904); in Sargent, Pl. Wilson. III. 21 (1917).—Dode in Mém. Soc. Hist. Nat. Autun, XVIII. (Extr. Monog. Inéd. Populus, 58, t. 12, fig. 90) (1905).—Gombocz in Math. Termesz. Közl. XXX. 105 (Monog. Gen. Populi) (1908).—Henry in Elwes & Henry, Trees Gr. Brit. & Irel. VII. 1839, t. 410, fig. 28 (1913).—Rehder in Jour. Arnold Arb. IV. 134 (1923); Man. Cult. Trees & Shrubs, 88 (1927).—Handel-Mazzetti, Symb. Sin. VII. 58 (1930).

Populus suaveolens var. a. Maximowicz in Bull. Soc. Nat. Moscou, LIV. 51 (1879).

Populus Przewalskii Maximowicz in Mél. Biol. XI. 321 (1881); in Bull. Acad. St. Pétersb. XXVII. 540 (1882).—Gombocz in Math. Termesz. Közl. XXX. 101 (Monog. Gen. Populi) (1908).—**Synon. nov.**

Populus laurifolia γ. *Simoni* Regel, Russ. Dendr. ed. 2, 152 (1883).

Populus balsamifera μ. *Simonii* Wesmael in Bull. Soc. Bot. Belg. XXVI. 378 (1887).—Burkill in Jour. Linn. Soc. XXVI. 536 (1899).

Populus balsamifera var. *laurifolia* Burkill, l. c. 535 (1899), pro parte.—Non Wesmael.

Populus balsamifera var. *suaveolens* Burkill in Jour. Linn. Soc. XXVI. 535 (1899).—Non Loudon.

Populus brevifolia Carrière ex Schneider, Ill. Handb. Laubholzk I. 16 (1904), pro synon.

Populus suaveolens var. a. *angustifolia* Gomboez in Math. Termesz. K"zl. XXX. 110 (Monog. Gen. Populi) (1908); vix Regel.

Populus Przewalskii f. *microphylla* Gombocz in Math. Termesz. Közl XXX. 105 (Monog. Gen. Populi) (1908).

Populus suaveolens Schneider in Sargent, Pl. Wilson III. 18 (1916) pro parte, quoad specimina citata, Tibet, Kansu, Chili et Wilson nos. 2162 and 4577 e Szechuan bor.—Rehder in Jour. Arnold Arb. IV. 135 (1923).—Non Fisch.

Populus suaveolens var. *Przewalskii* Schneider in Sargent, Pl. Wilson. III. 32 (1916), specimine e Mongolia citato et descriptione exceptis.—Rehder in Jour. Arnold Arb. IV. 133 (1923).

EASTERN TIBET: K o k o n o r : *N. M. Przewalski*, 2/14 July 1880 (syntype in herb. Petrop); ad fl. Tchurmyn, 9–9500 ft., *N. M. Przewalski*, 2/14 May (1880) (herb. Petrop.); Kuen-luen "nördliche Vorberge von Nanshan, Da-tschouan," 5000 ft., *W. J. Roborowski*, May 10, 1894 (herb. Petrop.).

MONGOLIA. Alashan, Van-usin-uin, *S. S. Tchetyrkin*, no. 444, July 16, 1908 (herb. Petrop.); northern Mongolia, *E. Klementz*, in 189.?; Ordos, Baga-gol, *G. N. Potanin*, Sept. 12, 1884 (herb. Petrop.); Ordos, *N. M. Przewalski*, Aug. 1871 (herb. Petrop.).

CHINA. K a n s u : ad Hoangho superiorem, *N. M. Przewalski*, 2/14 April 1880 (syntype in herb. Petrop.); without precise locality, *N. M. Przewalski*, 22 Aug./3 Sept. 1872 (syntype in herb. Petrop.); Shan-dan-siang, *P. J. Piasezki*, 22 July/4 Aug. 1875 (syntype in herb. Petrop.), Han-tschou-fu, *P. J. Piasezki* 17/29 July, 1875 (syntype in herb. Petrop.); without precise locality, *P. J. Piasezki*, 26 May/7 June 1875 (herb. Petrop.); oppidum Talachi, 26 Oct. 1884, *G. N. Potanin* (herb. Petrop.); ad fl. Bardun, *G. N. Potanin*, 18 May, 1884 (herb. Petrop.); Hoang-ho, *L. de Loczy*, no. 219, Aug. 1879 (herb. Budapest); Pin-fan, *S. S. Tchetyrkin*, no. 559, July 22, 1909; vicinity of Ningsia, alt. 1750–1850 m., *R. C. Ching*, no. 225, June 4–10, 1923; near Pingfan, alt. 2350–2800 m., *R. C. Ching*, no. 505, July 12/20, 1923; inter Kansu et Thianshan, ante Anssitschou, *P. J. Piasezki*, 8/20 Aug. 1875 (herb. Petrop.). S z e c h-u a n : Min valley, Wen chuan hsien, 4–7000 ft., *E. H. Wilson*, no. 1420, Oct. 1908; Min Valley, Sungpan to Mao chow, alt. 2–3000 m., *E. H. Wilson*, no. 4577, Aug. 27, 1910; Monkong Ting, alt. 2400–3000 m., *E. H. Wilson*, no. 2162, June 28, 1908. Y u n n a n : ad fluv. Landsang-djiang (Mekong) near Wei-hsi, alt. 2300 m., *H. Handel-Mazzetti*, no. 10034, Sept. 17, 1916. H u p e h : Hing shan hsien, alt. 4000 ft., *E. H. Wilson*, no. 1454, Aug. 5, 1907. Shensi: Yenan-fu, *Wm. Purdom*, no. 351, in 1910; Lungshow, Kuan shan, alt. 2000 m., *J. Hers*, no. 2333, July 3, 1922; Lintung, alt. 350 m., *J. Hers*, no. 3018, Oct. 28, 1924; Tsing Ling, 60 km. south of Sianfu, alt. 1000–1500 m., *J. Hers*, no. 3015, Oct. 20, 1924. Shansi: in valle fl. Shaho, *G. N. Potanin*, June 3, 1884 (herb. Petrop.); Taiyuan-fu plain, Fen ho valley, alt., 800 m., *J. Hers*, no. 2702, Oct. 4, 1923; Wu chai hsien, 2000–3000 m., *Tchuang Kieh*, Hers no. 2022, Sept. 7, 1922. Chili: Peking, *J. Hers*, nos. 2255, 2256, 2257 and 2259, Oct. 18, 1922; Peking, *W. Y. Hsia*, May 3, 1926; Peking, western hills, *J. Hers*, nos. 2219 and 2227, Oct. 11, 1922; Po hua shan, *J. Hers*, no. 1651, Sept. 9, 1921; near Sun tun ying, *F. N. Meyer*, nos. 974 and 975, May 31, 1913; Huai Lai hsien, Lin shu chwang and Yang kia ping, *J. Hers*, nos. 2073 and 2080, Oct. 3 and 4, 1922; Ta han ling, *J. Hers*, no. 1642, Sept. 7, 1921; Nankow, *J. G. Jack*, Oct. 6, 1905; Kalgar, Methodist compound, *N. H. Cowdry*, no. 1441, June 6, 1921. Honan: Neihwang, alt. 100 m., *J. Hers*, no. 2457, Oct. 31, 1922; Min chih, alt. 580 m., *J. Hers*, no. 2523. Kiangsu: Yas wan (on the Great Canal), *J. Hers*, nos. 624 and 625, May 2, 1921; Nanking, *K. Ling*, no. 7946, May 1925, (tree 50 ft. high, in open places).

MANCHURIA: common north of Harbin, *C. S. Sargent*, Aug. 29, 1903; Harbin, *P. V. Suizev*, Aug. 1905 (herb. Petrop.); near Harbin, *B. Skvortzov*, July 1927.

KOREA. North Heian prov.: Wijyu, *T. Nakai*, no. 1952, June 3, 1914; abundant on Yalu river around Shingishu, *E. H. Wilson*, no. 8784, July 16, 1917. South Kankyo: Hensan to On-senri, *E. H. Wilson*, no. 9343, Oct. 5, 1917.

Populus Simonii and *P. Przewalski* have been regarded up to the present by all authors as two distinct species, but an examination of the type material in the herbarium of the Botanic Garden at Leningrad convinced me that there is no specific difference between the two. The very characteristic short-petioled, obovate leaves of vegetative shoots of *P. Simonii* are also present on vegetative branches of Piasezki's specimen from Kansu collected May 26/June 7, 1875, and the leaves of mature trees of the Kansu specimens are not different from those of specimens collected near Peking which is the region from which *P. Simonii* was introduced. Fruiting specimens from both regions agree in their slender catkins and small mostly two-valved fruits. Maximowicz knew *P. Simonii* only from the description (see Bull. Soc. Nat. Moscou, LIV. 52) and one can readily understand that he did not identify this species described as having strongly angled branches and short petioled leaves 14–18 cm. long with his material from mature trees which showed terete branches and slender-petioled small leaves. These differences which are really differences between young and mature plants were emphasized by later authors as Dode and Gombocz who probably had seen little if any typical material of *P. Przewalskii*, but were well acquainted with *P. Simonii*. Also Schneider when describing his *P. suaveolens* var. *Przewalskii* had seen no material of typical *P. Przewalskii* and based his description on Potanin's specimen from "circa lacus Ubsa" which he had received from Kew under the name *P. Przewalskii*, though it is not enumerated by Maximowicz. Potanin's specimen, however, which I saw in Leningrad, is entirely different from typical *P. Przewalskii* and belongs to *P. pilosa* Rehd., though the specimen is not so distinctly and densely pilose as the type from Baga Bogdo, Altai Mountains. Also *Populus suaveolens* var. *macrocarpa* Schrenk seems nearer to *P. pilosa* than to any other species, but its fruits are glabrous.

Populus Simonii has a wide distribution; it ranges from the Kokonor region of eastern Tibet through northern China and southern Mongolia to Manchuria and northern Korea. It is chiefly characterized by normally rather small leaves, those of mature trees generally rhombic-ovate, 4–8 cm. long, acuminate, broadly cuneate at the base and borne on slender petioles 1–2.5 cm. long; the leaves of vigorous vegetative shoots and young plants are rhombic-obovate to elliptic and usually 4–8 cm. long, abruptly short-acuminate, narrowed toward the base and borne on short petioles usually 0.5–1.5 cm. long, but occasionally the leaves may be up to 15 cm. long and the petioles correspondingly longer. The shoots are more or less angled, but the branches of mature trees are terete. The fruits are rather small and 2- or partly 3-valved; they are either pubescent as described by Maximowicz or glabrous as in Piasezki's specimen from Shan dan siang (syntype); also the only fruiting specimen I have seen from near Peking has glabrous fruit. It may be assumed therefore that typical *P. Simonii* has glabrous fruit. The form with pubescent fruit may be distinguished as f. **Przewalskii** (Maxim.), f. nov., with Przewalski's specimen from Kokonor as the type.

Populus Simonii is related to *P. suaveolens* Fisch. and *P. cathayana*. The former which is geographically well separated by the Mongolian desert, is easily distinguished by somewhat larger elliptic or elliptic-ovate to elliptic-oblong or occasionally elliptic-obovate leaves, abruptly short-acuminate at the apex and more or less rounded at the base and borne on petioles generally not longer than ¼ the length of the leaf; the branches are always terete. *Populus* *cathayana*, whose range is similar, differs chiefly in the larger, distinctly ovate leaves broadest below the middle, more gradually acuminate at the apex and rounded or subcordate at the base, in the petioles being up to 6 cm. long and usually about ½ as long as the blade, or even longer and in the always terete branches.

Two forms differing in habit have been introduced into cultivation: *P. Simonii* f. *pendula* Schneider (in Sargent, Pl. Wilson. III. 22, 1916) with pendulous strongly angled branches, and *P. Simonii* f. *fastigiata* Schneider (l. c.) with ascending slightly or scarcely angled branches forming a pyramidal head.

Populus suaveolens Fischer in Allg. Gartenzeit. IX. 404 (1841); in Bull. Acad. Sci. St. Pétersb. IX. 348 (1842).—Ledebour, Fl. Ross. III. 629 (1850).—Maximowicz in Bull. Soc. Nat. Moscou, LIV. 51 (1879), quoad var. b.—Koehne, Dendr. 84 (1893), pro parte.—Schneider, Ill. Handb. Laubholzk. I. 14 (1904), pro parte.—Dode in Mém. Soc. Nat. Hist. Autun, XVIII. (Extr. Monog. Populus, 61) (1905), pro parte.—Ascherson & Graebner, Syn. Mitteleur. Fl. I. 48 (1908), pro parte.—Elwes & Henry, Trees Gr. Brit. & Irel. VII. 1841 (1913), pro parte et excl. icon.—Schneider in Sargent, Pl. Wilson. III. 18 (1916), pro parte.—Rehder, Man. Cult. Trees & Shrubs, 88 (1927), pro parte.

Populus balsamifera Pallas, Fl. Ross. I. pt. I, 67, t. 41 (1784), excl. fig. B.—Non Linnaeus.

Populus pseudo-balsamifera Turczaninow in Bull. Soc. Nat. Moscou, I. 101 (1838), nom. nudum; secundum specimen orig. in Herb. Petrop.

Populus balsamifera var. 4. *intermedia* Loudon, Arb. Brit. III. 1674 (1838).

Populus balsamifera var. 5. *suaveolens* Loudon, l. c. (1838).—Wesmael in De Candolle, Prodr. XVI. pt. II. 330 (1868); in Mém. Soc. Sci. Hainaut, III. 246 (Monog. Peupliers, 66) (1869).—Dippel, Handb. Lauholzk. II. 206, fig. 100 (1892).

Populus suaveolens var. β. *latifolia* Gombocz in Math. Termesz. Közl. XXX. 111 (Monog. Gen. Populi) (1908); vix Regel.

EASTERN SIBERIA. Gov. Irkutsk: *V. Komarov*, June 14, 1902 (herb. Petrop.); near Kirenga river, *M. Tomin*, Iter ad fl. Lena et Kirenga, no. 282, July 26, 1909; locality not identified, *N. I. Kusnezov*, no. 1364, July 25, 1910 (herb. Acad. Petrop.). Transbaicalia: "Dahuria" Hb. Pallas ex Herb. Fischer (Herb. Petrop.); ad ostium torrentis Utulik, *N. S. Turczaninow*, in 1835 (herb. Petrop.); Bargusina, *I. F. Krynkov*, nos. 189, 1608, July 30, 1905 (herb. Petrop.); Schilka river, *C. Maximowicz*, June 7, 1859 (herb. Petrop.); Nerchinsk, *I. M. Krascheninnikov*, nos. 1265, 1271, June 4 and 7, 1909 (herb. Petrop.); Zabaik, *V. I. Syrjanov*, nos. 3, 40, in 1908, *I. W. Nowopokrowsky*, in 1908, *I. F. Krynkov*, nos. 50, 54, June 15 and July 18, 1909, *V. N. Lipsky*, July 2, 1901, *B. Fedt-*

schenko, nos. 172, 294, in 1909, *E. F. Trofimova* & *V. E. Rudzinsky*, no. 411, in 1911, *Stukow*, Pl. Transbaical. (all in herb. Petrop.); locality not identified, *I. I. Yarygin*, no. 199, in 1908. Gov. Yakutsk: inter fl. Wilui (640 N. L.) et fl. Olenek (68° N. L.) *R. Maak*, in 1854 (herb. Acad. Petrop.); Burchan, Nitschatka, *G. Maydell*, June 20, 1872; localities not identified, *F. V. Sokolov*, nos. 181, 311 and 312 in 1909; "ad fl. Maja," *W. Drobow*, no. 499, July 21, 1912 (all in herb. Petrop.).

This species which by recent authors has been confused with the two Chinese Poplars discussed above from which it is well separated by morphological characters and removed geographically. It is the most northern of the Asiatic Poplars occurring as it does between 50° N. Long. and the Arctic Circle. According to the specimens seen it ranges from the former Gov. Irkutsk through Transbaicalia to the Gov. Yakutsk; farther east it is replaced by *P. Maximowiczii* Henry which is a closely related species and occurs in Kamtschatka, Saghalin, the Maritime Province, Mandschuria, Korea and Japan; it is chiefly distinguished by pubescent branchlets, larger leaves pubescent beneath, and pubescent petioles. There are, however, glabrescent forms and the two species are not always readily separated. Another closely related species *P. koreana* Rehd. occurs in northern Korea, and is chiefly distinguished by its viscid-glandular young shoots.

Populus suaveolens var. *β*. **pyramidalis** Regel, Russk. Dendr. 96 (1870); ed. 2, p. 151 (1883).

Forest Institute at Leningrad, planted, *E. Wolf*, without date and Sept. 1928.)

This form differs from the type in its ascending branches forming a pyramidal head. The leaves on mature branches are oval or elliptic-ovate, 6–7 cm. long and 4–5 cm. broad, rounded at base and abruptly acuminate, short-pilose on the midrib above and beneath and sparingly so on the veins; the petioles are 1.5–2 cm. long and pilose. The leaves of the perfectly terete vegetative shoots are ovate-oblong up to 10 cm. long, rounded at base or elliptic-oblong and short-petioled and glabrous on both sides. The tree is staminate and the catkins are 4 cm. long; bracteoles cuneate-obovate, deeply laciniate, strigose-pilose on the back and with ciliate lobes; anthers ellipsoid, 1–1.5 mm. long, on slender filaments longer than the anthers.

Corylus Fargesii Schneider, Ill. Handb. Laubholzk. II. 896, fig. 561 d (1912); in Sargent, Pl. Wilson. II. 444 (1916).

Corylus rostrata Ait. var. *Fargesii* Franchet in Jour. de Bot. XIII. 199 (1899).—H. Winkler in Engler, Pflanzenr. IV–61, p. 53, fig. 14 F (1904).

Corylus mandshurica Maxim. var. *Fargesii* Burkill in Jour. Linn. Soc. XXVI. 505 (1899).—Diels in Bot. Jahrb. XXIX. 281 (1900).

CHINA. Szechuan: Tchen-keou-tin, *P. Farges*, no. 1307 (holotype); Sungpan hsien, woods, *W. P. Fang*, no. 4251, Aug. 17, 1928 (tree 10 m. high.)

An examination of the type specimen of *Corylus rostrata* var. *Fargesii* convinced me that the plant, as already pointed out by Schneider (in Pl. Wilson, l. c.), is not closely related to *C. rostrata* Ait. or *C. Sieboldiana* var. *mandschurica* (Maxim.) Schneid. but more nearly to *C. chinensis* and that it possibly might be considered a variety of the latter species, from which it differs chiefly in the oblong, thin, nearly glabrous leaves, rounded to truncate or even broadly cuneate at the unequal base. The fruit in its husk and nut agrees very well with that of *C. chinensis*, while in *C. rostrata* and in *C. Sieboldiana* and its varieties the husk is more gradually contracted above the nut which is ovoid, higher than broad and has a much smaller hilum and thinner walls. The staminate catkins are arranged 3–6 in a more or less elongated raceme and the bracts of the catkins are closely and finely pubescent with a glabrescent mucro, while in *C. rostrata* and in *C. Sieboldii* var. *mandschurica* the catkins are produced in sessile clusters of 2–3 or solitary and the bracts are rather densely hairy with a long-ciliate mucro. Also the serration of the leaves of *C. Fargesii* resembles more that of *C. chinensis* with shorter and blunter teeth than that of *C. Sieboldiana* which has longer acuminate teeth. The specimens collected by Fang near Sungpan agrees exactly with Franchet's type, but the fruits had induced me to consider it, before I had seen Franchet's type, an extreme form of *C. chinensis* with much narrower leaves.

Hydrangea Chungii, sp. nov. (§. EUHYDRANGEA, ser. Petalanthae).

Frutex; rami hornotini fuscescentes dense pilis strigoso-villosis brevibus et patentibus ad 3 mm. longis vestiti, annotini epidermide soluto glabri, albido-cinerei. Folia membranacea, elliptico-oblonga, 12–20 cm. longa et 4.5–8.5 cm. lata, acuminata, basi cuneata, imo basi excepto serrato-dentata dentibus leviter vel vix sursum curvatis, supra laete viridia, satis dense pilis brevibus et longis subaccumbentibus conspersa, subtus pallidiora tota facie satis dense breviter villoso-pilosa et praesertim ad costam, nervos et venulas conspicue hirsuta pilis hyalinis ad 3 mm. longis, nervis utrinque 8–12 curvato-ascendentibus supra inconspicuis subtus leviter elevatis; petioli 1–4 cm. longi, hirsuti et breviter pubescentes. Cyma plana, floribus sterilibus exclusis 7–9 cm. diam., breviter pedunculata pedunculo 1–2.5 cm. longo pilis breviter et longioribus hirsutis vestita, floribus sterilibus paucis (4–7) praedita; flores steriles quadrisepali, sepalis obovato-rotundatis in fructu 1.5–2.2 cm. longis utrinque pubescentibus integris, pedicello gracili pubescente sub fructu ad 3 cm. longo suffulta; flores fertiles (alabastra tantum visa) cyaneo-purpurascentes, 5-meri; pedicelli 1–2 mm. longi ut calyx dense strigosi; calycis lobi triangulares, acuti, circiter 1 mm. longi; petala (non plane evoluta) elliptica, circ. 2 mm. longa; stamina 10; styli 3, rarius 2; ovarium semi-inferum sub anthesi tantum paullo e tubo calycis exsertum; capsula matura globosa-ovoidea, stylis erecto-patentibus exclusis circ. 2 mm. longa, ovario tubum calycis triente superans; semina ovoidea, exalata, 0.5 mm. longa.

CHINA. Fukien: Yenping, Fort north of Steps 3800, on slopes, alt. 230 m., *H. H. Chung*, Aug. 21, 1924 (type); Yenping, Buong Kang, in thickets, *H. H. Chung*, June 8, 1925.

This new species is apparently related to *H. Moellendorffii* Hance with which the specimens cited above have been confused. The latter species which is known only from the type specimen in the British Museum differs chiefly in the strigillose appressed pubescence of leaves and stem, the smaller shorter-petioled leaves, the smaller long- and slender-stalked inflorescence with few disepalous sterile flowers. The two species are apparently very local, *H. Moellendorffii* being known only from near Kiukiang, Kiangsi, and *H. Chungii* only from near Yenping, Fukien.

Liquidambar Styraciflua L. f. **rotundiloba,** forma nova.

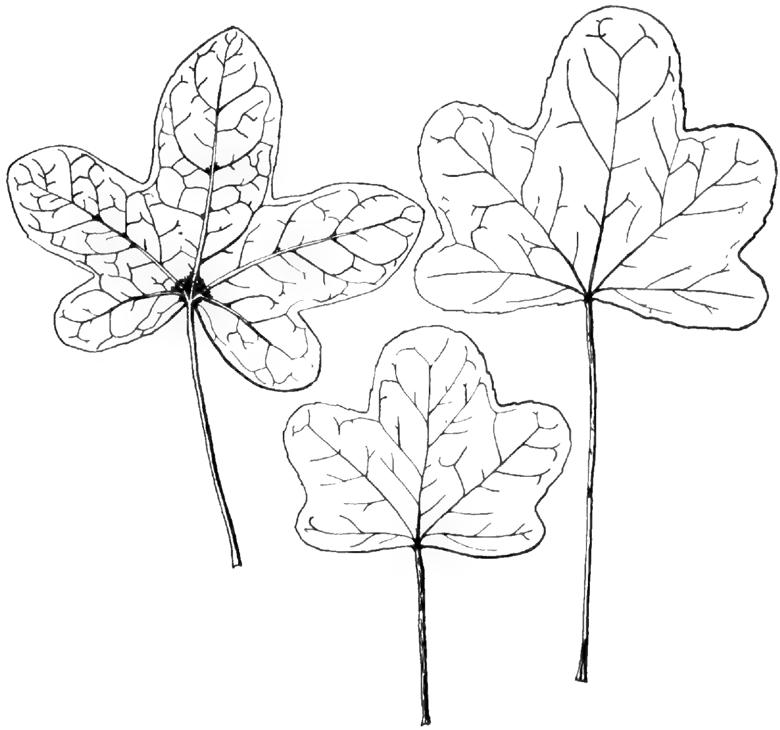
A typo recedit foliis obtusilobatis lobis rotundatis plerumque latioribus quam longis remote et saepe indistincte serrulatis.

NORTH CAROLINA: near Pinehurst, *R. E. Wicker*, September 15, 1930.

This form differs so much in its leaves from typical Sweetgum that at the first glance one would hardly recognize it as belonging to *Liquidambar*. The leaves with their broad rounded indistinctly serrulate lobes usually broader than long, rarely somewhat longer than broad, resemble more those of a Maple, than those of Sweet-gum which have acuminate sharply and rather closely serrulate lobes. The leaf variations so far known and discussed and figured by Theo. Holm[1] always show acuminate or acute lobes or on unlobed leaves an acute apex and occur either on seedlings and juvenile plants or on mature trees at the base or apex of the branchlets. They are thus of ontogenetic nature and not distinct forms of individual trees. The majority of leaves on mature trees show little variation and all the numerous specimens in this her-

[1] HOLM, THEO. Leaf-variations in Liquidambar Styraciflua L. (Rhodora, XXXII. 95–100, pl. 200, 201. 1930).

barium representing its whole range of distribution show uniformly leaves with triangular-ovate to triangular-oblong acuminate sharply serrulate lobes without any transitions to this new form with short and broad rounded lobes.



LIQUIDAMBAR STYRACIFLUA f. ROTUNDILOBA Rehd.—Leaves (× ½).

We owe the discovery of this interesting form to Mr. R. E. Wicker of Pinehurst, North Carolina, who kindly sent us branches from the single tree he found of this form. He states in his letter that he examined the whole tree and the shoots around it for reversion to the type, but found all the leaves uniformly of the shape described above; he also mentions that in bark and limb formation the tree differs somewhat from the typical form. He promised to send to this Arboretum branches for grafting, so that we may hope to have this interesting new form soon growing here.

Crataegus scabrifolia, comb. nov.

Pyrus scabrifolia Franchet, Pl. Delavay. 229 (1889).—Léveillé, Cat. Pl. Yun-Nan, 231 (1917).

Crataegus Henryi Dunn in Jour. Linn. Soc. XXXV. 494 (1903).—Schneider, Ill. Handb. Laubholzk I. 770, f. 435, 1–6 (1906).—Diels in Notes Bot. Gard. Edinb. VII. 236 (1912).—Sargent, Pl. Wilson, I. 181 (1913).—Léveillé, Cat. Pl. Yun-Nan, 229 (1917).—**Synon. nov.**

CHINA. Yunnan: Tali (an culta?) *J. M. Delavay*, no. 3731, June 1882 (type in herb. Paris); Tali range, alt. 8–10000 ft., *G. Forrest*, nos. 4430 and 4432, May and August 1906; Mengtze, 5000–5500 ft., *A. Henry*, nos. 9426, 9426a and 9426b (tree 10–20 ft., flowers white; type of *C. Henryi*); "commun dans les vallées et coteaux á Tong-tchouan, alt. 2550 m.," *E. E. Maire*, Arnold Arb. nos. 455 and 456, about 1912 ("fl. blanches—fruits rouges utilisés pour les confitures"); Teng Yueh, versus flum. Salween, *C. Schneider*, no. 3183, Oct. 1914; openings in dense mixed and conifer forest on the hills between Sha-yang and Chu-tong, alt. 8–9000 ft., *G. Forrest*, no. 21143, April 1922 (shrub 20–30 ft.; flowers creamy white); watershed of the Black River or Papien ho between Mohei and Maokai (Mopo and Manpieh), *J. F. Rock*, no. 2927, March 21, 1922; without precise locality, *G. Forrest*, nos. 7668, 9853, 11831, 17922, 18585.

Having examined Franchet's type of *Pyrus scabrifolia* (labeled by Franchet *Pirus scabrida*) in the herbarium at Paris I find that the specimen is not a *Pyrus* of the section Aria as stated by Franchet, but that it is a *Crataegus* and without doubt identical with *C. Henryi* Dunn, a species apparently common in Yunnan. Franchet's specific name being the older has to replace Dunn's name.

Pyracantha crenato-serrata, comb. nov.

Photinia crenato-serrata Hance in Jour. Bot. XVIII. 261 (1880).—Hemsley in Jour. Bot. XXIII. 262 (1887).

Cotoneaster Pyracantha Pritzel in Bot. Jahrb. XXIX. 386 (1900), in part.—Pampanini in Giorn. Nuov. Bot. XVII. 288 (1910).—Non Spach.

Pyracantha crenulata C. Schneider, Ill. Handb. Laubholzk. I. 761 (1906); II. 1004 (1912), in part.—Wilson in Sargent, Pl. Wilson. I. 177 (1912), in part.—Non Roemer.

Pyracantha crenulata var. *yunnanensis*, M. Vilmorin apud Mottet in Rev. Hort. 1913, p. 204, t.—Meunissier in Rev. Hort. 1925, p. 572, fig. 203, pl., fig. 5.

Pyracantha Gibbsii var. *yunnanensis* A. Osborn in Garden, LXXXIII. 138, fig. (March 1919); LXXXVII. 52, fig. (1923).—A. B. Jackson in Gard. Chron. LXV. 266, fig. 132 A (May 1919).

Pyracantha yunnanensis Chittenden in Gard. Chron. LXX. 325 (1921).—Stapf in Bot. Mag. CLI. t. 9099 (1926).—**Synon. nov.**

Pyracantha Gibbsii Rehder in Jour. Arnold Arb. V. 178 (1924); Man. Cult. Trees Shrubs, 362 (1927).—Non A. B. Jackson.

CHINA. Hupeh: Ichang, *Watters*, Herb. Hance, no. 20988 (type) in herb. Brit. Mus.; Hing shan hsien, alt. 3–4000 ft., *E. H. Wilson*, Arnold Arb. Exp. no. 2984, June 1907; Fang, *E. H. Wilson*, Veitch Exped. no. 349, July 1901; Monte Triora, alt. 1950 m., *C. Silvestri*, no. 898, Sept. 1907. Shensi: (ex Stapf). Kansu: near Hui hsien, *F. N. Meyer*, no. 1742, Sept. 26, 1914. Szechuan: valley of Min river, Wen chuan hsien, alt. 4–6000 ft., *E. H. Wilson*, no. 2985, June and Nov. 1908; Kiang tsin district, *C. Y. Hwang*, no. 233, May 26, 1926; Mt. Omei, *E. H. Wilson*, nos. 4871 and 4871a; Nanchuan hsien, 5–6000 ft., *W. P. Fang*, no. 1356, June 1, 1928. Y u n n a n : Yunnan fu, *C. Schneider*, nos. 44 and 85, Feb. 14 and 19, 1914; north of Yunnan fu, Shi shui tang, *C. Schneider*, no. 297, March 9, 1914; Yunnan fu, alt. 2000–2100 m., *O. Schoch*, no. 20, April 24, 1916.

Among the types which I examined in London last year was *Photinia crenato-serrata* Hance. The type specimen consists of a small flowering branch with obovate, crenate-serrulate leaves. The structure of the flowers which have 5 free styles, as already stated by Hance in the original description, excludes the species from *Photinia* and there can be no doubt that it belongs to *Pyracantha* and is identical with *P. yunnanensis* Chittenden (*P. Gibbsii* Rehd., non A. B. Jackson) which is chiefly characterized by obovate crenate-serrate leaves. This species belongs to a group of very closely related species which, though readily distinguished in their extreme forms, are more or less connected by intermediate forms. These species are *P. crenato-serrata*, *P. atalantioides* (Hance) Stapf (*P. discolor* Rehd.) and *P. crenulata* Roem. and especially its var. *Rogersiana* A. B. Jacks. (*P. Rogersiana* Bean). The geographical and taxonomic relations of these plants are treated in detail by Dr. Stapf (l. c.). I had formerly identified *P. Gibbsii* A. B. Jacks. with the form called originally *P. crenata* var. *yunnanensis*, judging from a figure of a leaf published with the original description and showing a distinct serration. This caused me to redescribe *P. Gibbsii* under the name *P. discolor* which I based on wild specimens with quite or almost entire leaves glaucescent beneath, while *P. Gibbsii* was based on cultivated specimens of which I had seen at that time no material. The difference in the serration is easily explained by the fact that Mr. Jackson's plants were young, vigorously growing, cultivated plants which are apt to produce in a species with a tendency toward serration leaves with a distinct serration, while old mature plants growing under less favorable conditions, as were probably the wild plants which yielded the specimens, are inclined to have entire leaves and at the same time are likely to be more distinctly glaucescent beneath than those of young vigorous plants, which explains why Mr. Jackson did not put stress on the latter character.

Ilex crenata Thbg. f. **bullata,** f. nov.

A typo recedit foliis bullatis i. e. supra convexis et subtus concavis.—Frutex erectus ramis gracilibus erecto-patentibus initio minute puberulis. Folia ovalia vel obovato-ovalia ad oblongo-ovalia, 1.2–2.2 mm. longa et 6–10 mm. lata, apice obtusa et mucronulata, supra lucida. Fructus 5–8 mm. diam., interdum in cymis 3-floris, pedunculis 2–4 mm., pedicellis circiter 3 mm. longis.

Cultivated in the Arnold Arboretum under no. 20069 (plant sent from Japan in 1919 by E. H. Wilson as *I. Mariesii*); specimens in Herb.: *A. Rehder*, Oct. 4, 1921 (sterile); *W. H. Judd*, Dec. 23, 1930 (fruiting; type).

This form agrees with typical *I. crenata* Thbg. in its habit forming an upright shrub with spreading branches, but differs in its bullate leaves. It was sent as *I. Mariesii* from Japan in 1919 by *E. H. Wilson* who probably found it in some Japanese nursery. It was subsequently distributed by the Arnold Arboretum under *I. Mariesii* and later as *I. crenata nummularia*, but it is not *I. crenata* var. *nummularia* Yatabe (*I. crenata* var. *Mariesii* Dallim.) which is a dwarf, very slow growing shrub with crowded suborbicular small leaves. At the Arnold Arboretum var. *bullata* has proved hardier than typical *I. crenata* and even hardier than *I. crenata* var. *microphylla* Maxim. It therefore may be recommended for trial in regions where the typical form has not proved quite hardy.

Paliurus Hemsleyanus, nom. nov.

Paliurus australis Franchet in Nouv. Arch. Mus. Paris, ser. 2., v. 223, (Pl. David. I. 71) (1883).—Non Gaertn.

Paliurus orientalis Hemsley in Kew Bull. Misc. Inform. 1894, p. 387, excl. of the name-bringing synonym and Delavay's specimen cited.—Pritzel in Bot. Jahrb. XXIX. 457 (1900).—Schneider, Ill. Handb. Laubholzk. II. 260, fig. 182 c. (1909).—Pampanini in Nuov. Giorn. Bot. Ital. n. ser. XVII. 425 (1910).—Schneider in Sargent, Pl. Wilson. II. 209 (1914).—Chun, Chin. Econ. Trees, 242 (1922).—Rehder & Wilson in Jour. Arnold Arb. VIII. 165 (1927).

CHINA. Eastern Szechuan: South Wushan, *A. Henry*, no. 7205 (type); same locality *E. H. Wilson*, Veitch. Exp. no. 634, June 1900; Taning hsien, *E. H. Wilson*, no. 4630, June 1910; Cheng kou ting, *P. Farges.* Shensi: "Tciuz sien," *G. Giraldi*, 1903. Hupeh: Fang hsien, *E. H. Wilson*, Veitch Exp. without no., June 1901; Ichang, *E. H. Wilson*, Veitch Exp. no. 105, June and Sept. 1901; without locality, *A. Henry*, no. 6379, and *E. H. Wilson*, Veitch Exp. no. 2103, May 1901. Kiangsu: Shien chuan tze, *Ching & Tso*, no. 454, May 13, 1926; Hai wei, south Tshing, *Ching & Tso*, no. 596, May 1926; Taiping men, *Tso*, no. 1116, May 1926. Anhwei: Chuchou, Herb. Univ. Nanking, no. 1701, June 26, 1920; same locality, *A. N. Steward*, Herb. Univ. Nanking no. 2310, June 14, 1922; Lishan, Chemen, *R. C. Ching*, no. 3123, Aug. 5, 1925. Kwangtung: *C. Ford*, no. 325 (ex Hemsley). Kwangsi: without locality, *R. C. Ching*, no. 7303, Sept. 3, 1928.

Hemsley when describing his *P. orientalis* basing the description chiefly on Henry's no. 7205 considered this number identical with

Paliurus australis var. *orientalis* of Franchet and raised this variety to specific rank conserving the varietal name and citing as the first specimen Delavay's plant from Yunnan, upon which Franchet based his variety. Henry's and Delavay's specimens, however, are not identical, but belong to two geographically clearly separated species with well marked characters. Hemsley's name being based on Franchet's varietal name has to remain with Delavay's specimen and the species represented by Henry's no. 7205 will have to receive a new name for which I here propose *P. Hemsleyanus*.

Paliurus lucidus Carrière in Rev. Hort. 1866, p. 380 referred by Schneider, l. c., doubtfully to this species, probably does not belong here. The name is based on a cultivated plant sent from China by E. Simon and described as a shrub less spiny than *P. aculeatus* and "surtout remarquable par ses feuilles qui sont d'un vert très luisant, comme vernies." The latter character scarcely fits *P. Hemsleyanus*, but applies to *Zizyphus jujuba* Mill. which is common around Peking from where most of the plants came which Simon introduced. No species of *Paliurus* has been found so far in Chihli.

Paliurus orientalis Hemsley in Kew Bull. Misc. Inform. 1894, p. 387, excl. of description and Henry's and Ford's specimen cited.

Paliurus australis var. *orientalis* Franchet, Pl. Delavay, 132 (1889), excl. specimine e Shensi.

Paliurus sinicus Schneider in Sargent, Pl. Wilson, II. 211 (1914); **synon. nov.**

CHINA. Yunnan: Ta pin tze near Tali, *L. M. Delavay*, no. 239, June 1883 (syntype of var. *orientalis*); Mengtze, alt. 4500–4600 ft., *A. Henry*, no. 9427 (holotype of *P. sinicus*) and 9427 B (paratype).

When in Paris last summer I had an opportunity to examine Franchet's *P. australis* var. *orientalis* and found that Schneider was right in saying (l. c.) that this variety is possibly identical with his *P. sinicus*. It is unfortunate that this makes it necessary to transfer to *P. sinicus* Schneid. Hemsley's combination from the species for which it has been used by all writers until now. The nomenclature of these two species would be much clearer, if we could preserve the name *P. sinicus* for this species, but *P. orientalis* Hemsl. can hardly be classed as a nomen confusum or ambiguum, since with the facts known the application of the name according to our rules of nomenclature is perfectly clear.

Tilia chinensis Maxim. f. **investita** (V. Engl.), comb. nov.

Tilia Baroniana var. *investita* V. Engler, Monog. Tilia, 132 (1909).

A typo recedit foliis subtus sparse vel sparsissime piloso-stellatis cinereo-viridibus, petiolis ut ramuli leviter pruinosi glabris.

CHINA. Shensi: Huan-tou-san, *G. Giraldi*, no. 7142 (holotype).

This form which has the leaves sparingly stellate-pilose beneath and not glabrous as described by V. Engler is connected with the type by the form described as *T. Baroniana* Diels which differs from the type chiefly in the glabrous petioles and branchlets and the less densely pubescent under side of the leaves which are often somewhat more distinctly and sharply serrate. The form described as *T. Baroniana* seems to be the most widely distributed, while typical *T. chinensis* with pubescent branchlets and petioles is a rarer extreme form and looks very distinct from the other extreme represented by f. *investita* which also seems rare, but they are closely connected by intermediate forms which may be distinguished as f. **Baroniana** (Diels.), f. nova. Engler cites under his var. *investita* as a synonym *T. cordata* Diels in Bot. Jahrb. XXXIX. 468 (1901) not Miller, but enumerates under *T. Baroniana* Giraldi's no. 1313, the only specimen quoted by Diels for *T. cordata*. As I have not seen Giraldi's no. 1313, I am not able to say whether *T. cordata* Diels should be referred to *T. Baroniana* as a synonym or whether Giraldi's no. 1313 should be quoted under var. *investita*.

Osmanthus fragrans Loureiro, Fl. Cochinch. I. 29 (1790).—De Candolle, Prodr. VIII. 291 (1844).—Rehder in Sargent, Pl. Wilson. II. 609 (1916).

Olea Thunbergii Thunberg, Fl. Jap. 18, t. 2 (1784).
Olea acuminata Wallich, Cat. no. 2809 (1828), nom. nudum.—De Candolle, Prodr. 291 (1844).
Olea ovalis Miquel in Jour. Bot. Neerl. I. 111 (1861).
Pittosporum yunnanense Franchet in Bull. Soc. Bot. France XXXIII. 413 (1886); **synon. nov.**

When in Paris last summer I examined among other types of Franchet's species also his *Pittosporum yunnanense* based on Delavay's no. 780, from Yunnan and found that it is not a *Pittosporum* at all, but *Osmanthus fragrans* Lour. Franchet overlooked entirely the opposite leaves and his description of the fruit as "bivalvis" was apparently based on a few fruits in which the exocarp had split at the apex through pressure. The specimen had apparently been examined critically before, for there was a note on a little pocket containing some fruits stating "n'est pas un Pittosporum."

Clerodendron cyrtophyllum Turczaninow in Bull. Soc. Nat. Moscou, XXXVI. pt. III. 222 (1863).—Rehder in Sargent, Pl. Wilson. III. 377 (1916).

Clerodendron amplius Hance in Ann. Sci. Nat. ser. 5, v. 233 (1866).—Franchet in Nouv. Arch. Mus. Paris, ser. 2, VI. 111 (Pl. David. I. 231) (1883).

Clerodendron formosanum Maximowicz in Bull. Acad. Sci. St. Petersb. XXXI. 85 (1886); in Mel. Biol. XII. 519 (1886).

Cordia venosa Hemsley in Jour. Linn. Soc. Bot. XXVI. 143 (1890); **synon. nov.**

On examination of the type of *Cordia venosa* Hemsl. at Kew I found that this species is identical with *Clerodendron cyrtophyllum* Turcz. The type specimen was collected by E. Faber in 1887 on the Ningpo Mountains and distributed as Faber, no. 183. The specimen consists of a small branch with two rather sparingly branched inflorescences only 6–10 cm. in diameter bearing a small number of mature fruits with enlarged calyces and young calyces without corollas. On account of its small inflorescences the specimen looks quite unlike the usual specimens with inflorescences 15–30 cm. in diameter, but on closer examination the specimen agrees in all its parts perfectly with *C. cyrtophyllum*. Flowering material of this species from the same locality collected by E. Faber in 1888 under no. 645 is represented in this herbarium.

Viburnum setigerum Hance in Jour. Bot. XX. 261 (1882).—Hemsley in Jour Linn. Soc. XXIII. 356 (1888).—Rehder in Sargent, Trees & Shrubs, II. 112 (1908).

Viburnum phlebotrichum Hemsley in Jour. Linn. Soc. XXIII. 354 (1888).—Graebner in Bot. Jahrb. XXIX. 589 (1901).—Mottet in Rev. Hort. 1919, p. 264, tab. col. (1919).—Non Siebold & Zuccarini.

Viburnum theiferum Rehder in Sargent, Trees & Shrubs, II. 45, t. 121 (1907), 114 (1908); in Fedde Rep. Spec. Nov. IX. 183 (1911); in Sargent, Pl. Wilson, I. 112 (1911); Man. Cult. Trees & Shrubs, 806 (1927); in Jour. Arnold Arb. VIII. 197 (1927).—Schneider, Ill. Handb. Laubholzk. II. 645, fig. 413 e–f. (1911).—Bean, Trees Shrubs Brit. Isles, II. 657 (1914); ed. 4, p 657 (1925).—McFarland in Gard. Mag. XXXIV. 42, fig. (1921).—**Synon. nov.**

Viburnum Bodinieri Léveillé in Fedde, Rep. Spec. Nov. IX. 442 (1911); Fl. Kouy-Tchéou, 65 (1914); **synon. nov.**

CHINA. Eastern Szechuan: "in monte Ko-lo-shan, ab aestivo occasu oppidi Chun-king, alt. 2000 ped.," *W. Mesny* (Herb. Hance no. 21739), July 1880 (type in Herb. Brit. Mus.); South Wushan, *A. Henry*, no. 5586 (paratype of *V. theiferum*); Nanchuan hsien, *W. T. Fang*, no. 1107, May 27, 1928; Kikiang hsien, *W. P. Fang*, no. 1330, June 11, 1928; without precise locality, *W. P. Fang*, no. 433. Kweichou: "Kouy-Yang, bois de Kin-Lin-Chan," *E. Bodinier*, no. 2193, April 14, 1898 (syntype of *V. Bodinieri*, in Herb. Edinb.; merotype in Herb. Arnold Arb.); Pin fa, *J. Cavalerie*, no. 1285, May 1903 (syntype of *V. Bodinieri* in Herb. Edinb.). Hupeh: Kui, *E. H. Wilson*, Veitch Exped. no. 579, April and Autumn 1901 (holotype of *V. theiferum*); Chang yang, *E. H. Wilson*, Veitch Exped. no. 644 (paratype of *V. theiferum*); Chang lo hsien, *E. H. Wilson*, no. 236, June & Sept. 1907; Ichang, *E. H. Wilson*, no.

218, 218 bis, May & Sept. 1907; Giu gia swan, *W. Y. Chun*, no. 3814, Aug. 9, 1922; He ya tze, *W. Y. Chun*, no. 3983, Aug. 20, 1922. Hunan: Chang cha, Yolu shan, *Handel-Mazzetti*, no. 11615, April 4, 13, 1918. Kiangsi: Kuling, *E. H. Wilson*, no. 1711, July 31, 1907; Mt. Yun touling, *Wang Te Hui*, Pl. Sin. Cur. Handel-Mazzetti no. 269, April 1921; An fu wu kung shan, *H. H. Hu*, no. 708, 122, April 21 and 22, 1921; Yung shing hsien, Ih shan, *H. H. Hu*, no. 802, May 5, 1921. Anhwei: Kimen, *N. K. Ip*, no. 36 (Herb. Univ. Nanking, no. 5249), April 23, 1924; also no. 5266, April 24, 1924; same locality, *R. C. Ching*, no. 2644 (University Nanking no. 7572 and 2780), May 1, and June 27, 1925. Chekiang: Dong si, near Han chow, *F. N. Meyer*, no. 446, in 1907; East Tien mu, *H. H. Hu*, no. 1619, June 20, 1927; Yu tsien hsien, *Y. L. Keng*, no. 518, June 26, 1927; Sui an hsien, *Y. L. Keng*, no. 780, July 14, 1927; without precise locality, *R. C. Ching*, no. 4784.

When in London last summer I examined the type of *Viburnum setigerum* Hance which never had been identified with any of the more recently collected Viburnums and found that it is identical with my *V. theiferum*. Also *V. Bodinieri* Léveillé which I had an opportunity to see two years ago in Edinburgh belongs here.

The species was first introduced into cultivation by E. H. Wilson in 1901 from Kui, Hupeh, and distributed by the Veitchian Nurseries. Seeds were again sent in 1907 by him from Chang lo hsien to the Arnold Arboretum. Among the plants raised from the seed of his later introduction one was found which bore fruits of a bright orange color and may be distinguished as a color form under the following name:

Viburnum setigerum f. **aurantiacum,** f. nov.

A typo recedit fructibus aurantiacis.

Cultivated at the Arnold Arboretum under no. 20189 (raised from seed of Wilson's no. 236); type specimen in Herb. Arnold Arboretum, *A. Rehder*, Oct. 13, 1926.

This handsome form differing from the type with scarlet fruit in its bright orange-red fruits was raised from seed collected by E. H. Wilson in Chang-lo hsien, Hupeh, under no. 236; from the same number also the typical red-fruited form was raised.

(*To be continued*)

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GRAFT-BLIGHT: A DISEASE OF LILAC RELATED TO THE EMPLOYMENT OF CERTAIN UNDERSTOCKS IN PROPAGATION

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I. INTRODUCTION

DURING recent years many growers, commercial and private, have become cognizant of puzzling and unsatisfactory results that have attended their efforts at propagating or rearing Lilacs. These experiences are widespread throughout the United States and are practically coincident with the geographic distribution of lilac culture in America. They apply to the Arnold Arboretum and in addition have been observed in large nurseries in Springfield, Mass., Long Island, N. Y., New Jersey, Ontario, and elsewhere. They have also been reported to me by correspondents in Oregon, Pennsylvania, Ohio, Colorado, from several stations each in Massachusetts, New York, and New Jersey, and in Germany. A large proportion of the plants in question have manifested a trouble characterized by yellowing and rolling of the leaves, inhibition of growth, and ultimate death. Various explanations, some more or less plausible, others quite wide of the mark, have been offered; but none of these has been supported by experimental evidence. The trouble is, in reality, a disease sequent to a prevalent method of propagation, namely, to the practice of the grafting or budding of scions of *Syringa* upon understocks of species of *Ligustrum*. It is in short an expression of incompatibility of two plant systems foreign to one another when brought into intimate graft contact. Hence the disease may quite appropriately be named "Graft-blight of the Lilac."

The present paper, which is an outgrowth of studies during the past three years, presents in detail the results of my research on this subject. My purposes in this paper are to describe the graft-blight of Lilac, to outline the proof of its causal relation to the method of privet grafting, to consider the ultimate nature of the incompatibility in the lilac-privet graft, to analyze the present status of lilac propagation in the United States and Europe, and finally, from a consideration of all assembled data, to point out effective and practical methods for the elimination of the disease.

Preliminary to the main exposition, however, it will be helpful to review, briefly, the immediately pertinent literature and to recount the experiences and opinions of a few of the many important American and European growers with whom I have been carrying on a correspondence.

Symptoms similar to those due to graft-blight of Lilac have been reported in a few cases in the scientific literature, although in no instance is it possible from the data given, to determine with certainty that they refer to precisely the same disease. The difficulty has been that the papers in question give no information relative to the histories of the plants observed, nor are the accounts sufficiently precise to enable one to determine whether or not they are dealing with somewhat similar troubles resulting from environmental disturbances quite apart from grafting. Incidentally it may be observed that none give indication of any attempt at experimental demonstration of the explanations proposed. Thus Laubert (19) described a leaf-roll and yellowing of lilac plants accompanied (as in graft-blight) by excessive starch accumulation in the leaves. He attributed the condition tentatively to detrimental pruning of the Lilac, combined with excessive growth of the roots, and complicated by numerous other possible environmental influences. Neger (26), referring to the same disease, compared it with the leaf-roll of Potato, and believed low nocturnal temperatures to be responsible. Similar symptoms were observed on Lilacs by Peicker (28), who also found dead roots on his plants, and believed that the cause of the disease was to be sought in this root trouble. Klebahn (16), who examined Peicker's materials, confirmed the latter in finding no pathogen present, but attributed the disease to the cold, damp climate of the area in which these plants grew. Although in none of these instances is it possible definitely to ascribe the disease to graft-incompatibility, it is significant to note that in every case, as is true of lilac graft-blight, unfavorable root conditions were found. Aside from these there appear to be no other direct references in the purely scientific publications which might conceivably deal with lilac graft-blight other than my own recent preliminary note in the Journal of the Arnold Arboretum (8).

Turning to the horticultural literature, I discovered that many lilac propagators and connoisseurs have suspected a pernicious effect in the practice of grafting the Lilac upon privet understocks, though none of them has subjected his opinions to experimental proof. Thus a correspondent of the Gardeners' Chronicle (35) wrote that "my experience with the Lilac when grafted on privet stock is that the plants are apt to die suddenly without any apparent cause." Another correspondent of the same journal likewise stated that Lilacs grafted on the common form (*Syringa vulgaris*) live longer than those grafted on Privet (2). Dunbar (11) found that Lilacs budded on the California Privet "grow with tremendous vigor for a few years, but according to our experience are short-lived."

In my correspondence with the commercial lilac growers of this country and Europe during the past two years, several of them have reported to me the symptoms of the lilac disease under consideration. It is only fair to say that there is not universal agreement among them with respect to methods of propagation, for while many explicitly disfavor the privet-grafting method of lilac propagation, a few, perhaps more often from supposedly economic considerations, express themselves in favor of it, and others, not knowing, are non-commital. The opinions of the first group, however, are the only ones which interest us at this immediate point. R. M. Cooley in Oregon writes that "the leaf-buds often fail to mature on 'budded-on-privet' lilac plants, and the new growth presents a half-dead condition at the tips." L. W. Needham of the Farr Nursery Company in Pennsylvania states that "the leaves lose their deep green color (in privet-grafted Lilacs) and tend to curl and have brown spots. We think this is due to undernourishment, as the lilac scion grows faster than the privet stock." The Jackson-Perkins Company of New York State announce that they are discontinuing the use of Privet as an understock for Lilacs, as, in their opinion, the union seems to be uncongenial. They report that "in the case of the California privet understock there seems to be a checking influence which causes the leaves to cup and turn yellow, and stunts the growth. Privet-grafted plants show this influence unless they have become own-rooted." Mr. Henry Kohankie in Ohio finds that "plants budded on any privet shoot above the ground will grow vigorously for perhaps two years, more vigorously in fact than under any other method of propagation. They then make very little progress, however, and are short-lived." Again he states that "it has been our experience that Lilacs grafted on Privet or any other foreign stock sooner or later become anaemic, so to speak, and in a short time perish." From Colorado Mr. D. M. Andrews writes: "I have come to the belief that a sort of anaemia results from malnutrition if the Lilac is not soon established on own-roots, the direct result of an incompatible root system. The effect is a stunting of the growth from which the bush seldom recovers. The wood hardens and becomes inactive, simulating extreme age. No focus of disease appears, but the roots seem to share the general appearance of inactivity." The experience of the Bay State Nursery in Massachusetts is that "in later years plants on privet stock have done very poorly, with a large percent of culls and few really good plants. We consider a Lilac on privet stock almost worthless." Many other correspondents remark on the limited duration of life of the privet-grafted Lilacs, and the relative weakness of such plants.

Such is a fair picture of what is known and believed regarding graft-blight of the Lilac. Naturally the question now arises as to whether or not a similar trouble is known in other graft combinations among the many that occur in horticultural practice. The answer is in the affirmative, though when the literature is scanned, one is rather surprised to find how comparatively seldom the phenomenon has received special attention, either as a topic of research or of discussion. The more important and definite of such references bear passing comment in this introduction, leaving to a later part of the paper a fuller consideration of such instances as may shed light on one phase or another of my own investigation.

Under the heading "Yellowing due to the grafting stock," Sorauer (33) found that "On good soils Pears grafted on quince stocks often turn yellow, while trees on wild stock thrive well. In dry summers I found with such dwarf trunks that well grown scions inserted later in the bark formed strong but yellowish shoots, while the older top was green." This was attributed to the inability of the stock to cope with the water demands of the scion. A. S. Rhoads (31) described a disease of Citrus under the title "Devitalization of trees on lemon rootstock" which is of the same general type. In trees of Grapefruit, Orange, and Tangerine, grafted upon rough Lemon or overbearing Lemon, there is evident in trees ten to fifteen years of age or sometimes younger, a chlorotic condition. "In the flush of growth subsequently developed, the foliage is characterized by being abnormally small, and by a dull, dingy, hard appearance. On the growth developed following this symptom of tree decline, the leaves become even smaller and conspicuously frenched at the ends of the branches. The more seriously affected twigs and branches die back rapidly." It is apparent that in both cases cited we are dealing with troubles similar to that of the lilac graft-blight, particularly in the latter case, where the chlorosis, the frenching, and the age of the trees showing the symptoms are in accordance with the situation in the Lilac.

II. MATERIALS

My studies with the Lilac thus far have been concentrated upon graft-blight as it appears on varieties of *Syringa vulgaris* and on the closely related *S. oblata* and *S. hyacinthiflora*. That various degrees of graft incompatibility exist between other species of *Syringa* and *Ligustrum* understocks is evident from the isolated cases that have been observed, but since the majority of the other species of *Syringa* are propagated by own-root methods, the graft problem is not practically involved in connection with them. Because the overwhelming majority of Lilacs in culture are varieties of *Syringa* *vulgaris*, the application of this study is bound to refer almost exclusively to this species.

Among the many recognized varieties of *Syringa vulgaris* it is doubtful if any are immune to graft-blight; at all events no immune varieties have come to my attention. It has been my good fortune to have had the opportunity to examine and to study at first hand a wealth of lilac plants, both grafted and own-rooted, such, for example, as in the rich collections in the Arnold Arboretum, the Rochester Park Department of Rochester, N. Y., and in three of the largest commercial nurseries in Eastern America. The most extensive field observations, naturally, have been possible on the many hundreds in the Arnold Arboretum, a collection that comprises twenty-six of the known thirty species of *Syringa* and more than two hundred varieties of *Syringa vulgaris*. The locations of all the plants in this latter collection were charted and notes were periodically taken throughout each of three successive summers on all these plants, healthy as well as blighted. These latter, that is, the plants showing graft-blight, in almost all instances were known to have been privet-grafted. Fortunately, too, their complete histories were known as to propagation, age, source, time of planting, culture, etc., since it is the practice of the Arnold Arboretum to keep a file of such data on all the plants in its collection. Because of this last fact, an enormous amount of time was saved in this work, as the data obtainable from these files were precisely what was wanted for my purposes.

In order to record in graphical form the varieties of *Syringa vulgaris* in which graft-blight is known to occur, Table I (p. 85) compiled from my field data gives a list of the varieties most intensively studied, together with the ages of the plants under consideration and their root constitution.

The great majority of these Lilacs, as has been noted, were known to have been grafted upon Privet, there being only relatively few cases in which there was no exact information as to the understock. In practically all instances the Privet indicated is *Ligustrum ovalifolium*. A few of the Lilacs may have been grafted upon *Ligustrum vulgare*, but since the symptoms of graft-blight involving these two stocks are essentially identical, the use of either in place of the other is immaterial to the point in question.

Beside these cases of lilac graft-blight which have been observed in commercial plants, the disease was experimentally reproduced by the grafting of scions of *Syringa vulgaris* and its varieties upon a number of species as understocks. Two series of grafted plants were kept under observation during two successive years, numbering in

TABLE I. SCION VARIETIES, AGES, AND ROOT CONSTITUTION OF 110 AUTHENTIC CASES OF LILAC GRAFT-BLIGHT STUDIED IN DETAIL

Variety	Age in years	Under-stock	Variety	Age in years	Under-stock
SYRINGA VULGARIS VAR.					
A. B. Lamberton	4	Privet	Mme. Antoine Buchner	4	Privet
Alexander Hamilton	8	"	Mme. Auguste Gouchault	4	"
Archevêque	4	"	Mme. Casimir Périer	3	"
Arthur W. Paul	7	"	Mme. Florent Stepman (Five plants)	5	"
" " "	5	"			
Azurea plena	8	"	Mme. Florent Stepman (Five plants)	3	"
Belle de Nancy	8	"			
Boule azurée	7	"	Mme. Florent Stepman (Ten plants)	2	"
Capitaine Baltet	4	"			
Carmen	4	"	Mme. Lemoine	4	"
Caroli X	8	"	" "	5	"
Charles Sargent	4	"	Magellan	4	"
Corinne	6	"	Marie Finon	4	"
Crampel	9	"	Masséna	6	"
Danton	4	"	"	4	"
De Jussieu	8	"	Maurice Barrès	8	"
De Saussure	4	"	" "	4	"
Eckenholm	8	"	Maximowicz	3	"
Bicolor	8	"	Mons. van Aerschot (Two plants)	4	"
Gen. Haig	8	"			
Gen. Kitchener	4	"	Miss Ellen Willmott	4	"
Gen. Pershing	4	"	Montaigne	8	"
Gloire de Croncels	?	?	Monument Carnot	5	"
Henri Martin	4	Privet	Mr. R. W. Mills	3	?
Henry Ward Beecher	8	"	Mrs. R. W. Mills	3	?
Herman Eilers	4	"	My Favorite Double	3	?
Hippolyte Maringer	7	"	Othello	5	Privet
" "	5	"	Pasteur	3	"
Hugo Koster	7	"	Paul Deschanel	8	"
" "	5	"	Perle von Teltow	8	"
" "	5	"	" " "	5	"
" "	4	"	Président Grévy	3	"
Hyazinthenflieder	7	"	Prof. E. H. Wilson	4	"
"	5	"	Reine Elisabeth	4	"
Jacques Callot	8	"	Roi Albert	8	"
Jan Van Tol	7	"	Rubra de Marly	8	"
J. de Messemaker	7	"	Souv. de Henry Simon	11	"
Jules Simon	4	"	Souv. de Rothpletz	4	"
Katherine Havemeyer	7	"	Triomphe de Moulins	8	"
Klager's:			Victor Lemoine	7	"
Dark Dense Truss	3	?	Ville de Troyes	5	"
Dark Navy Blue	3	?	Violacea	8	"
Dark Purple	3	?	Waldeck-Rousseau	4	"
Large Dark Double	3	?	William C. Barry	4	"
Lavoisier	4	Privet	William S. Riley	8	"
Le Nôtre	4	"	SYRINGA HYACINTHIFLORA VAR.		
Leopold II	4	"			
"	4	"	Catinat	7	"
Longview	3	?	Necker	4	"
Mme. Antoine Buchner	8	Privet	Louvois	4	"

all more than three hundred plants. The grafted plants were grown under the controlled conditions of the Arnold Arboretum research greenhouse. In these grafting experiments the scions used were almost exclusively of the variety *Syringa vulgaris* "Andenken an Ludwig Spaeth." As understocks the following oleaceous species were employed: *Chionanthus virginica, Forsythia suspensa, Fraxinus americana, Ligustrum amurense, L. ibolium, L. ibota, L. obtusifolium* var. *Regelianum, L. ovalifolium, L. vulgare* and its horticultural form "Lodense," *Syringa japonica, S. villosa,* and *S. vulgaris.*

III. SYMPTOMS OF THE DISEASE

The symptoms of lilac plants suffering from typical graft-blight are striking and characteristic. For purposes of convenience they may be described according to their manifestation in gross appearance, microscopic structure, and physiological behavior of diseased plants.

Throughout the first year following the grafting procedure in late winter growth is excellent as regards size. The privet-grafted plants attain a size equal to that of control plants grafted upon Lilac. In some cases growth may appear to be even better on the privet understock than in the lilac-on-lilac grafts, which is in accordance with findings in the grafting of other trees and shrubs that the combination of two plants somewhat separated taxonomically may have a stimulating effect, at least temporarily.

In an experiment to determine this point, fifty scions of *Syringa vulgaris* var. "Andenken an Ludwig Spaeth" were grafted upon *Ligustrum ovalifolium* stocks, while an equal number of scions from the same parent plant were grafted upon common lilac understocks. The rate and amount of growth of the scion buds as determined by increased twig length were measured at intervals during the growing season. A study of the data thus obtained showed that during this season and under uniform greenhouse conditions the lilac-on-privet grafts had increased their total twig length by an average of 18.8 cm., while the lilac-on-lilac grafts showed under the same conditions a growth increment of only 14.6 cm.

In the spring of the first year there is evident, however, in the privet-grafted Lilacs a slight curl of the leaves, together with a tendency to pallor of the leaf margins and the larger intervenous spaces. This becomes more striking as the summer progresses, but by far the most characteristic symptom at this stage is the appearance of small pale spots, 2–5 mm. in diameter, over the leaf surface and especially along the leaf margins. The spots soon die and become silvery or brown, giving the leaf a flecked appearance. The margins of the leaves become torn and ragged with the greater growth of the central region of the leaf, and there is a marked thickening and brittleness of the whole leaf. These symptoms become somewhat aggravated as the summer progresses, but are rarely so severe as to attract attention. The symptoms of this incipient stage of graft-blight are faithfully reproduced in Figure 4, (Pl. 33) and an inspection of this photograph will show precisely the flecking, the leaf-curl, the torn margins, and the general picture of graft-blight during the first year after the grafting of Lilac upon *Ligustrum ovalifolium,* the understock commonly used in commerce.

During the next few years these same symptoms are present in varying degree, but usually it is not until the third to fifth year after grafting that the extreme symptoms of graft-blight appear. Frequently there is little or no production of blossoms during this time and for some years later. Meanwhile some of the grafted plants will have recovered and the symptoms will not be evident further, though many will begin to show the more acute symptoms described below.

The extreme stage is marked by a striking yellowness and dwarfing of the Lilac scion. The leaves appear well formed in the early spring, but by the first of May it is noticed that there is a general pallor of the plants. The leaves are small, often few, and clustered at the tips of the twigs as in the symptom known as "frenching" of certain other plants. The margins of the leaves and the intervenous spaces are markedly yellowed and the leaves are variously wrinkled and curled, distorted by the unequal tension of the more rapidly growing venous areas and the pale intervenous and marginal areas. One is impressed by the distinct pattern of green and yellow in the leaves, the yellow margins and intervenous areas standing out in bold contrast to the green areas along the veins. As the summer progresses, the yellowed portions lose all their chlorophyll and encroach farther and farther on the still green areas, the dividing line often being very distinct. The leaves become thicker and very brittle. Meta-anthocyanoplasia (Whetzel), that is, the morbid production of anthocyanin, sometimes results in a reddening of the yellowed portions. Actual browning of the leaf tissue is late, and sometimes does not occur before the leaves fall, although in other cases the margins of the leaves are brown by midsummer. Leaf cast is very marked by the middle of the summer and sometimes the plants are devoid of leaves by this time. In other cases the abscission layer fails to develop, and the leaves remain attached long into the winter. In those cases in which the leaves continue green throughout the summer, they are very small and "frenched" in tufts at the tips of the twigs, and may be dark, thick, and brittle. The twigs and winter buds are poorly developed, weak, often dying back, and hence the following season there is an inadequate amount of fundamental tissue for development, resulting in a cumulative effect from year to year. This is particularly evident in the condition of the new wood, the twigs generally being weak and thin and the wood "hard" rather than active.

The yellowing and diminution in size and number of the leaves bring about a reduction of the normal photosynthetic activity of the crown, an indirect effect of which is seen in the poor development of the root-system. The latter is usually very weak, meagre, exhibiting secondarily the same starved condition as the crown.

The essential features of the extreme stage of graft-blight are illustrated in Figs. 1–3 (Pl. 31 and 32). Figures 1 and 2 were taken on the same day and show two adjacent lilac plants of the same age, one perfectly healthy, the other suffering from typical and extreme graft-blight. Fig. 3 represents the condition of a plant suffering from extreme graft-blight, although with one healthy sucker which has been able to free itself from dependence on the privet stock by sending out its own root system.

When a lilac plant is suffering from the extreme stage of graft-blight, practically no increase in size is shown from year to year. The stunted size is a characteristic symptom. Curve "A" in Text figure VII (p. 140) represents normal growth for Lilac; thus a healthy six-year-old plant should be approximately 4.5 feet in height. The actual heights of one lot of thirty-five typically blighted plants of this age ranged from 1′ 9″ to 4′ with half of them less than 3′ in height, and an average height of 3′ 2″. The average height of a similar lot of fifteen plants one year older was 3′ 3″, individual heights of this lot ranging from 2′ to 4′ 6″, an average gain per plant of only one inch during a year.

The yellowed areas just noted as occurring in the extreme stage of graft-blight are heavily loaded with starch. This may be tested by boiling leaves for five minutes in water, decoloring in 95% alcohol for 24–48 hours, and then immersing them in a moderately strong solution of iodine in potassium iodide for a few minutes. The formerly yellow areas of the leaves appear a vivid purple-black against the now yellow, formerly green, venous areas of the leaves, that is we have, so to speak, a photographic negative of the leaf in its former state. The figure is sufficiently precise that if a tested leaf be laid on a sheet of sensitized paper and exposed to light, a faithful photograph of the original leaf may be obtained. Normal lilac leaves collected at the same time and tested in the same way give no positive starch reactions.

An increase in thickness of the blighted leaves has been mentioned. An approximately quantitative demonstration of the increased weight per unit of leaf surface was made by cutting out isodiametric discs of healthy and blighted leaves with a 12.5 mm.

cork-borer, and weighing. The average weight as computed from 1300 such cylinders was for blighted leaves .280 mg. per sq. cm. of leaf surface; for healthy leaves under the same conditions the corresponding average was .211 mg. per sq. cm.

Other causes may produce local symptoms on plants very closely resembling those so far described. Among these may be mentioned the boring of the canes by the lilac borer, *Podosesia syringae*, and the leopard moth larva, *Zeuzera pyrina*, the depredations of the oyster-shell scale, *Lepidosaphes ulmi*, and the effects of girdling the canes as by insects or mechanically. In all these cases, however, only certain branches of the shrub are attacked, others remaining healthy. The yellowing due to poor soil, drought, and other unfavorable environmental conditions (19), is less definitely localized in its occupation of the leaf-surface. Leaves yellowed by these causes more often become wholly paler and paler until they are completely yellowed. The wrinkling and curl due to unequal growth in the graft-blighted leaf is hence less evident in the drought- and soil-blighted leaf. Moreover, since the Lilac is very tolerant of an unfavorable external environment, there is little danger of confusing blight due to external environment with that due to incompatibility of stock.

Turning now to the microscopic examination of healthy and blighted leaves, we find that it reveals several striking differences. In the first place, a blighted leaf in either the incipient or the extreme stage is generally much thicker than a healthy leaf of the same size. Measurements show the blighted leaves to be approximately 1.5 times as thick as healthy leaves. This increase in thickness was found to be the result of hyperplasy in the palisade layer. The palisade cells become much elongated vertically and proportionally narrower. The yellowing was found to be due to degenerative processes within the chloroplasts and not to failure of development of the chlorophyll in the chlorophyllous organs, a phenomenon technically designated as chloroanaemia (Whetzel). The vacuoles are large. Brownian movement is very striking in the degenerating cells. The chloroplasts lose their form, degenerate into a brown amorphous mass at the side of the cell, and the walls tend to collapse. There is a great accumulation of starch granules in the cells. By flushing a section with iodine these are brought out vividly. The cells of the palisade layer and often the cells surrounding the veins are glutted with them. Many starch granules are likewise found in the cells of the spongy layer, but not so many, for the most part, as in the palisade layer. Individual cells of the spongy layer, however, may be crammed with them. Even epidermal cells are sometimes filled with them, though this is less frequently the case. This phenomenon has received the technical name of meta-amyloplasia (Whetzel). Stratification of the starch grains is not apparent. Frequently the epidermal cells are filled with a clear golden deposit.

These symptoms as revealed under the microscope are most striking in leaves showing the extreme blight. But even in leaves in the incipient stage there is an abnormal development of the palisade layer and an accumulation of starch. In the case of extreme graft-blight starch grains are found only in the sections of the yellow parts of the leaves, the green parts even in severely blighted leaves being free from them, while in incipient graft-blight the starch accumulation is less definitely localized in the leaf tissue.

As with the gross symptoms, so too the microscopic symptoms of graft-blight are closely approximated by those in the leaves of plants suffering from other causes of deficiency. Indeed no one characteristic can be designated as being wholly diagnostic of graft-blight other than what is shown by the graft connection and the root system. But to the experienced observer the complex of symptoms as has thus far been outlined will not be readily confused with that of any other lilac trouble.

Finally, by way of completing the account of the symptoms, reference should be made to one which has solely to do with the physiological behavior of the diseased plants, namely, to the property possessed by extracts of blighted plants, of precipitating in the presence of extracts from healthy representatives of the various species of the Oleaceae. Since this phenomenon will be considered in detail in Section V it will suffice to state that it is a characteristic element of the symptom complex of lilac graft-blight.

IV. CAUSE OF LILAC GRAFT-BLIGHT

The search for the cause of lilac graft-blight followed along four main lines of investigation, namely, the determination of whether the disease is biotic or abiotic in nature, the consideration of the possibility of its being due to external environment, the elimination of the hypothesis that it might be due to the "constitutional weakness" of certain varieties of Lilacs, and the proof that the privet-grafting method of propagation is the determining factor in the causation of graft-blight.

A. ABIOTIC NATURE OF THE DISEASE

In determining the causal agency of the lilac disease it was first necessary to explore the possibility of its being due to a pathogenic organism or contagious principle. The outcome of my research with lilac graft-blight has shown with certainty that the disease is not of biotic origin.

On a priori grounds the details of the distribution of graft-blight in plots of healthy and diseased plants might well lead one to the conclusion that the disease is abiotic in nature. A careful survey of such plots shows that the diseased plants are grouped within the plots with no indication of sources of infection. Graft-blight does not spread outwardly from foci in larger and larger concentric areas. Rather, single plants which are diseased may be found constantly, year after year, surrounded by healthy plants. There is no spread to those adjoining. Incidence of the disease is apparently conditioned by the individual constitution of each plant, entirely irrespective of the distance from or condition of any other plant in the plot. This fact in itself is strong evidence of the abiotic nature of graft-blight, but the matter merits a more direct attack towards its solution.

The nature of the symptoms is instructive in determining the causal agency of a disease. In the case of lilac graft-blight it is observed that the symptoms, both macroscopic and microscopic, are not those customarily associated with biotic disease. They are not localized in the plant but general. All the leaves of the crown are ordinarily affected simultaneously, to the same degree of severity, and in the same manner. Only when some complicating factor is involved does it happen that one part of a plant is more severely affected than other parts. Moreover the leaves themselves show no localization of lesions. Thus the yellowing begins at the tips and margins and in the broader intervenous spaces, and gradually spreads nearer to the larger veins, all of which is quite in contrast to what happens in a contagious disease, where there is either no relation to the venation, or if there be any it is one quite different to that which characterizes this disease. That the disease is systemic is also shown by the fact that the symptoms are extreme in one plant, moderate in another, nearly lacking in a third; this is not the case ordinarily with diseases of pathogenic origin, but is the situation where a disease is systemic and abiotic in nature.

With a knowledge that in certain systemic contagious diseases the entire crown is more or less involved, it might be urged that the symptoms of graft-blight of Lilac could result from the activity of organisms of a pathogenic nature attacking the conducting tissues or the root-system, or that graft-blight is a virus disease. But these possibilities were not overlooked, and so materials were subjected to macroscopic, microscopic, and cultural examinations as well as to the techniques commonly employed in the detection of plant viruses.

Repeated macroscopic examinations were made in a search for any signs of bacterial or fungus infections, but none were consistently found. Moreover there were no stem or twig lesions such as are caused by bark or wood inhabiting pathogens. Nor were fructifications, sclerotia, or mycelia of fungi to be found. To be sure I did occasionally meet with species of *Fusarium* and *Cytospora* in the dead wood of lilac plants, especially around the graft union, and with occasional colonies of *Bacterium Syringae* in the soft new tissues, but none of these was constantly associated with the trouble; they were the exception rather than the rule. As for the bacterial disease, it is manifested by symptoms entirely different from those of graft-blight; and infection experiments with the kinds of fungi named, which were obtained in pure culture and subsequently inoculated into healthy plants, were negative. *Polyporus versicolor*, abundant on older Lilacs, was never found on plants of the age of those showing the blight.

So, too, many microscopic sections of leaves, twigs, wood and roots of blighted plants were examined; but they were ordinarily found to contain neither bacteria nor fungus mycelia. Typically the living tissues were perfectly free from visible pathogens.

Of course it sometimes happens that a pathogenic fungus or bacterium may be present in plants suffering from disease, but in such limited amount that the respective individuals or hyphae are passed by in microscopic examination. In order to eliminate the possibility that they were overlooked in this case, small fragments of leaves, bark, and wood were surface sterilized and placed in tubes of sterile agar. Where blighted but living tissues were so used, there was no appearance of fungus mycelium or bacterial colonies. Where dead tissues were used in these inoculations, there was found only a growth of saprophytic organisms.

Finally the hypothesis was entertained that lilac graft-blight might be caused by an ultramicroscopic contagious principle of the type such as causes the so-called virus diseases of plants. In order to investigate this possibility, the recognized techniques of investigation of virus diseases were employed in an extensive series of experiments which will be described at this point.

For the purpose of determining whether graft-blight is communicable by grafting, as is true of many virus diseases, an experiment was set up in 1928 in which buds from severely blighted lilac plants were inserted into healthy, own-root Lilacs. This experiment showed that transmission of graft-blight by this method is not accomplished, since the buds so inserted developed into healthy shoots showing no sign of blight, and since there was no detrimental effect on the stock plant, the leaves of the latter remaining green and healthy throughout the season.

The scope of this experiment was extended the following year in a second series of grafts for the purpose of determining whether there were present in the scions from the diseased plants any contagious principle which might be communicated to healthy stock plants of susceptible varieties by the act of grafting, and incidentally of observing whether the blight were not due to a root deficiency which would be eliminated by the act of substituting in the grafting process a healthy, unquestionably lilac root-system for the root-systems of the blighted plants. The experiment consisted in grafting twenty-five healthy lilac stocks of different varieties, as in 1928, with scions from severely blighted plants. As controls, another set of twenty-five of the same stocks were grafted with scions from healthy lilac plants. Besides these twenty-five controls, the experimental grafts were checked against ungrafted stocks of the same lot as was used in the experiment, against the healthy plants which had supplied the control scions, and against the graft-blighted plants which had supplied the blighted scions. The results of this experiment were clear and decisive. Although the scions from the graft-blighted plants were so weak from the cumulative effects of the blight on the parent plants that a few died without uniting at all, the twenty-two which did unite with the stocks developed extraordinarily well. There was no sign of the typical graft-blight on any of the formerly blighted scions, and the shoots which were permitted to develop from the stocks were strong and healthy. Meanwhile the parent plants which had supplied the blighted scions proceeded through the usual extreme symptoms of graft-blight as the summer wore on. In spite of the weakness of the wood and buds of the experimental scions, some of which were but a few millimeters in thickness, the new wood totalled an average length of 13.0 cm. per plant, as compared with the average increment of 15.8 cm. of the healthy control scions, a difference quite insignificant in view of the state of health of the tissues of the former. Fig. 6 (Pl. 33) shows a typical specimen from this experiment. The stock illustrated was a healthy Lilac of the variety "Andenken an Ludwig Spaeth," and the scion was taken from a lilac of the variety "Rubra de Marly" which was slowly dying from graft-blight. At the time that this photograph was taken the parent plant was of poor appearance and suffering from severe, typical graft-blight. Plainly the act of grafting, that is, of substituting for the privet root-system of the parent plant a lilac root-system, has resulted in perfect recovery of the scion. To be sure, the twigs are frail because of the slow starvation of the parent plant, but as will be observed, the leaves are in excellent health, and the plant exhibits no sign of any diseased condition. Up to the time of writing the parent plant has shown no improvement in health.

There follow from these two experiments two important conclusions: (a) that the disease is not transmitted to a healthy, susceptible plant through the graft-association of a season, and (b) that recovery of removed portions of the crowns of blighted plants is assured if for the parent roots there be substituted a healthy lilac root-system. In the light of the second conclusion it at once follows that a systemic pathogenic organism or contagious principle cannot be present, for if it were, even though such an organism or principle failed to be transmitted through the graft-union to the stock, it would certainly have shown its presence in the scion.

Lest the objection be raised to these conclusions that lilac graft-blight may be of the type of a "masked mosaic," that is one in which certain species or varieties of host may be infested with a virus but not show any outward symptoms of disease, a series of grafts was made in which both healthy and blighted scions were used in grafts in conjunction with various other oleaceous stocks, in the same manner as in the experiments just reported. The stocks employed were, in addition to the varieties of *Syringa vulgaris* mentioned above, *Ligustrum ovalifolium*, *L. amurense*, the horticultural form "Lodense" of *L. vulgare*, *L. obtusifolium* var. *Regelianum*, *Syringa villosa*, *S. japonica*, *Fraxinus americana*, *Forsythia suspensa*, and *Chionanthus virginica*. In all these grafts there was never observed throughout the year following the grafting any difference in the development of the blighted and healthy scions respectively on each species of understock, and in no case was there apparent any transmission of a diseased condition from the blighted scions to the healthy variety of understock. As some of these graft combinations are incompatible (see subsection "D," below) symptoms of graft-blight do occur during the season, but these symptoms were never more pronounced on the originally blighted scions than on the originally healthy scions, while the stock plants remained healthy in every case. Hence these experiments corroborate the experiments in grafting healthy and blighted scions upon stocks of *Syringa vulgaris*.

By way of obtaining further evidence that lilac graft-blight is not a virus disease, I macerated blighted leaves in distilled water and directly applied the resulting liquid to fifteen healthy plants of varieties of Lilac susceptible to graft-blight. Under such circumstances if a virus were present it might be so transmitted. Inoculation was made by brushing the uninjured leaves with the liquid, by scratching the leaves with a needle wetted in the liquid, and by injecting the liquid hypodermically into the leaves, new stem growth, and older stems. Control plants were similarly treated but using sterile water in place of the liquid obtained from the crushed leaves. The experimental plants were all periodically examined throughout the whole of the growing season. In all this time there were no observable indications of the symptoms of graft-blight. This failure to transmit the blight is further evidence of its abiotic nature.

With the same purpose in mind still another experiment was undertaken, one which would make sure that the disease could not be referred to a virus disease in the privet understock. It is known that there is a virus disease of the California Privet in the southern United States. So a number of privet plants were obtained from a Georgia nursery in the heart of the region of this disease. Healthy scions of Lilac grafted upon these stocks developed the symptoms of graft-blight which are usually associated with the use of California Privet of whatever source as an understock. As a second part to the experiment with this same lot of Privet, some of their buds were inserted into healthy lilac shoots. They grew satisfactorily but neither was there any transmission of visible blight to the lilac stocks, nor did the grafted buds at any stage of their subsequent development show any signs of disease. Were there present in these Privets a virus disease communicable by grafting, it is to be expected that it would likewise be transmitted by budding in this fashion.

There still remains to be described a set of experiments of the same general import but dealing with the phenomenon of variegation as it occurs in certain varieties of Lilacs. It is known that a number of chloroses and variegations in plants are contagious, and presumably due to the activity of some ultramicroscopic principle. This situation has been found to obtain in some of the Oleaceae, as in *Fraxinus* and *Ligustrum* (3, 4), and so might very well be true of some of the Syringas. Three variegated varieties of Lilac, namely, *Syringa vulgaris* var. *aurea*, *S. vulgaris* var. *aucubaefolia*, and *S. emodi* var. *aurea*, were examined. While all of them showed a yellowing of the foliage, in no case was it at all comparable to the yellowing of graft-blight. Five scions each of these three varieties were grafted upon healthy lilac plants of varieties susceptible to graft-blight. Thirteen of the fifteen grafts were successful; in the other two (*S. emodi aurea*) the scions failed to unite with the stocks. In no case was there evident throughout the season after grafting any symptom of yellowing in the shoots from the stocks. All the plants remained perfectly healthy. The evidence from this experiment shows that the chlorosis in these variegated varieties is not communicable to *Syringa vulgaris* by grafting, and that it is entirely distinct from graft-blight.

From the abundant evidence presented it is concluded that graft-blight is not caused by any pathogenic or contagious principle.

B. RELATION OF GRAFT-BLIGHT TO EXTERNAL ENVIRONMENT

Since graft-blight has been shown to be abiotic in nature, it is next necessary to consider whether the disease might not be due to some unfavorable influence in the external environment. It is apparent that factors of the external environment which might conceivably bring about a diseased condition in Lilacs of the type of graft-blight are the climate, the physical and chemical constitution of the soil, and the conditions of soil and atmospheric moisture. With regard to the first, it will at once be seen that since the distribution of graft-blight coincides with the range of climatic conditions most suitable for lilac culture, it is inconceivable that graft-blight could be attributed to unfavorable climate.

That the disease might be due to unfavorable soil conditions or constitution was next investigated. It must be borne in mind at the outset that the Lilac in general is extremely tolerant of adverse soil conditions, its popularity to a considerable extent depending upon this adaptive capacity. The last vestige of cultivation in many deserted New England homesteads is the hundred-year-old lilac thicket, which has persisted, even thrived, in spite of the impoverished condition of the soil.

The lilac blight was observed in a wide variety of soil conditions and on soils which showed that the disease could bear no relation to soil fertility or soil acidity. It can be seen in its greatest severity in nurseries where every other species of shrub appears perfectly healthy. Healthy and blighted plants of Lilac frequently grow in essentially the same soil, side by side. The blight was found in nursery plots of a high degree of fertility no less severe than in the field. It was experimentally reproduced in plants growing in well fertilized loam in a greenhouse beside healthy control plants in the same soil. That the disease is independent of the degree of soil acidity was established by pH determinations of soils in which healthy and blighted plants were growing. Severe blight was found in soils ranging in pH from 5.3 to 8.1 with no difference in degree or nature of symptoms in any of these soils. It is entirely improbable that a disease which could occur over a range of pH of this breadth could have been caused by degree of soil acidity or alkalinity.

Since an iron deficiency of the soil is known to bring about a cholorosis of the leaves, a number of plants in the field were treated with varying amounts of iron sulphate. Commercial copperas was used in dosages of 100 to 500 grams per three foot plant, well mixed in the soil. In no case was there any amelioration of the symptoms seen in the subsequent examinations which extended over a period of eighteen months. Control plants similarly treated remained perfectly healthy. Hence it may be concluded from all the foregoing observations that the nature of the soil is not the causative agent of lilac graft-blight. The disease bears no consistent relation to the physical or chemical properties of the soil.

If one considers the possible relation of graft-blight to the water supply, the evidence is more suggestive. The disease was observed during three summers. The summer of 1928 was rather wet in New England. The disease that year was present in destructive measure. The following summer was one of the driest experienced in the same vicinity. The disease was if anything more severe than during the preceding year. During the summer of 1930 there was a subnormal rainfall, but sufficient for most vegetation. There was some alleviation of the symptoms during that summer. But that rainfall is not the determining factor is evidenced by the fact that in both very wet and very dry years the disease still occurs to destructive extent. It should be noted that the water requirements of the Lilac are not extreme. It requires a reasonable amount of moisture, though the soil must be well drained. The blight was found on well drained hillsides under conditions in which the water supply for Lilacs is near an optimum. It was found to an equal extent in moist, shady, lowland nurseries and in the dry soil of hilltops. In experimentally reproduced graft-blight, the plants were in a greenhouse with a somewhat humid atmosphere, and were well watered. Nevertheless the disease was of significant severity under all these conditions. From the foregoing, while it may be concluded that the disease is increased in severity by abnormal dryness and diminished in severity by moderate moisture, yet one cannot attribute to moisture more than a minor contributory significance in the causation of the disease.

As a final check on the influence of external environment on lilac graft-blight, a number of healthy and blighted plants were transplanted into locations somewhat different in soil fertility, water relations, and exposure. Blighted Lilacs were transplanted to the sites of successful plants, and healthy plants were moved to sites where severe blight was prevalent. Typically blighted plants with histories of at least two years of acute symptoms were transferred from their former location, on a well-drained, fertile hillside to: (a) a low, moist, well fertilized nursery bed; (b) an exposed hilltop where the water supply was limited but where there was a healthy old hedge of Lilac over a hundred years of age; (c) a lowland, well-drained nursery bed with light, loamy soil; (d) a greenhouse where they were potted in rich soil and well watered; (e) an upland nursery bed adjacent to healthy, thrifty Lilacs. In addition (f) two blighted plants from a nursery bed with well-drained fertile soil were transplanted to a hillside location surrounded on all sides by excellent healthy lilac plants. The crowns of all these plants were cut back severely at the time of transplanting and the plants well watered for the remainder of the summer. These plants were observed periodically for eighteen months. At the time of writing none has shown its symptoms to be ameliorated to any appreciable extent. Meanwhile six healthy lilac suckers with histories of excellent development were placed in the identical spots vacated by six of the severely blighted plants. These were given the same care as the other transplanted Lilacs. During the eighteen months following the transplantation, these six plants have doubled their former size, and at the time of writing are in excellent health.

These transplantation experiments show even more vividly the independence of the disease on the immediate external environment, and offer a final demonstration that the disease is related directly to the properties of the plants themselves, and only to an inconsequential degree to any external environmental factor.

C. CONSTITUTIONAL WEAKNESS OF CERTAIN LILAC VARIETIES NOT THE BASIS OF THE DISEASE

As a third projected explanation of graft-blight it was suggested that the disease is simply a manifestation of the constitutional weakness of certain newer varieties of *Syringa vulgaris*. During the past two or three decades an increasing number of new horticultural varieties of Lilacs have been originated; these newer varieties have collectively received the somewhat inaccurate name "French Hybrids." The French hybrids are the outcome of selection, the basis of which has been to enhance the beauty and the quantity of bloom. Little attention has been paid in this process of selection to hardihood and vigor in the selected varieties. Hence it is conceivable that these new varieties might be inherently weak in constitution, and that their inability to prosper under conditions usually suitable for Lilacs might result in the symptoms of the disease under consideration. However, the question can be answered by a study of the varieties in which graft-blight is known to occur.

If the disease were found exclusively in the newer French hybrids, then one would have grounds for assuming that their weakness might be responsible for the symptoms. If, on the other hand, the disease could be shown to occur in numerous old, well established, time proven varieties, then one might eliminate the constitutional weakness of the newer varieties as an explanation for graft-blight. A careful study of the distribution of graft-blight among the varieties of *Syringa vulgaris* has brought out clearly that the disease is not restricted to the newer varieties, but that it occurs with destructive frequency in the old, long-established varieties of Lilac which are distinguished by their strength and vigor. A few examples of the occurrence of graft-blight in such vigorous old varieties will serve to illustrate the point.

Lilac graft-blight was observed in 79 of the 238 accepted horticultural and natural varieties of *Syringa vulgaris*. These 79 varieties include the varieties "Perle von Teltow" and "Rubra de Marly" which have been recommended for use in forcing because of their resistance and vigor. The variety "Andenken an Ludwig Spaeth," in which the blight was experimentally reproduced scores of times, is generally conceded to be one of the strongest varieties known. The list of varieties in which graft-blight occurs includes "Azurea plena," "Bicolor," "De Croncels," and "Violacea" (*S. vulgaris* var. *purpurea*), all of which are old horticultural forms which have proved successful for the last eighty years or more. The lists of the best lilac varieties, chosen for strength and vigor as well as for beauty by the lilac connoisseurs Wilson (38), Havemeyer (15), Molyneux (25), and Wister (39) include a number of forms in which graft-blight has been found to occur. Among these varieties are: Archevêque, Belle de Nancy, Capitaine Baltet, Carmen, De Croncels, Henri Martin, Hippolyte Maringer, Jacques Callot, Jules Simon, Mme. Antoine Buchner, Mme. Lemoine, Masséna, Maurice Barrés, Miss Ellen Wilmott, Montaigne, Othello, Rubra de Marly, Victor Lemoine, Ville de Troyes, and Waldeck-Rousseau as well as the variety Necker of *Syringa hyacinthiflora*. In all these varieties graft-blight was seen occurring naturally in Lilacs obtained from commercial nurseries.

The conclusion is obvious. Lilac graft-blight shows no restriction to variety in all the cases that have thus far been investigated, and in particular it may be definitely said that the disease has nothing to do with the alleged constitutional weakness of the newer French hybrid varieties.

To be sure it was observed that some varieties show the effects of graft-blight more than the others. Some nurseries from their experience have already become aware of this fact. By way of example the varieties "Mme. Lemoine" and "Mme. Florent Stepman" show the effects of incompatible grafting to a greater extent than other varieties, as "Diderot." But I am convinced that no variety of *Syringa vulgaris* is immune to the detrimental effects of privet grafting.

D. INCOMPATIBILITY BETWEEN LILAC SCIONS AND PRIVET STOCKS AS THE CAUSE OF LILAC GRAFT-BLIGHT

It was stated in the introduction of this paper that lilac graft-blight is due to an incompatibility between lilac scions and privet stocks when associated in the graft-union. Before considering the proof of the relation of the disease to such an incompatibility, it was first necessary to visualize all the other possible factors which might cause graft-blight and to show in turn that each of these could not stand in causal relation to the disease. This having been done in the preceding subsections, the way is now clear for a detailed statement of the grounds on which the decision is based that graft-blight is caused by such an incompatibility.

The proof of the relation of graft-blight to a lilac-privet incompatibility rests on two main bodies of evidence. In the first place, the correlation between privet grafting of Lilacs and graft-blight was established by an extensive series of experimental lilac grafts in the greenhouse; in the second place, the results obtained from these experimental grafts were confirmed by numerous observations in the field. But before proceeding to a detailed exposition of these experiments and observations, it is fitting to introduce as a preface the circumstances which originally led to a consideration of the relation between graft-blight and the practice of grafting Lilacs upon privet roots.

Lilac graft-blight first came to my attention in the ornamental lilac planting of the Arnold Arboretum. In the year 1928, there were in this collection about 350 lilac plants, 75 of which were showing the typical symptoms of graft-blight. The histories of these 75 Lilacs were studied in detail in conjunction with those of the 275 healthy plants. It was at once apparent that although the diseased plants varied extensively as regarded age, variety, situation, exposure, and soil conditions, they all agreed in one respect, namely, that they had all been propagated by grafting upon Privet. Such was not the case with the healthy plants. The fact that the blighted plants had been grafted upon Privet, as stated in the records, was confirmed in most cases by a direct examination of the root systems.

The sources of these diseased plants were investigated and the results of this investigation are incorporated into Table II.

TABLE II. SOURCES OF 75 LILAC PLANTS, ALL AUTHENTIC CASES OF GRAFT-BLIGHT

Source	Year of Acquisition									
	1929	1928	1927	1926	1925	1924	1923	1922	1921	Total
Nursery "A"...	2	32		1	4	1			1	41
Nursery "B"...			3	1		19	1			24
Nursery "C"...			4		5	1				10
Total.........	2	32	7	2	9	21	1		1	75

Thus all of the diseased Lilacs came from three nurseries, and it was later ascertained that each of these three nurseries uses the privet method of lilac propagation almost exclusively. It is seen from the table that the majority of these Lilacs came in two shipments, one in 1924, the other in 1928. The shipment from nursery "B" in 1924 originally numbered 74 plants. Nineteen of these are now in the ornamental planting of the Arnold Arboretum and are displaying various degrees of typical graft-blight. Ten more are perfectly healthy. Of the remaining forty-four many were culled out in the years 1924–1928 while a few are still in the nursery beds, too small to be planted out in the ornamental collection. The shipment in 1928 from nursery "A" originally numbered thirty-three plants. At present thirty-two of these are numbered among the authentic cases of graft-blight in this collection. Three of the plants are already dead; others are of miserable appearance. A few will probably ultimately recover.

Working from these observations as a starting point, the problem of graft-incompatibility was put to a test under controlled experimental conditions. A set of experiments was undertaken in 1928 to compare the condition of grafts of the same variety of Lilac grafted upon various understocks as compared with those propagated by cuttings, the plants being all grown side by side under the controlled environmental conditions of a greenhouse. The results were so striking that the experiments were repeated in 1929 on a larger scale, and below will be considered the results of these experimental grafts, which demonstrate beyond question the causal relation of the privet grafting method to lilac graft-blight.

In carrying out these experiments "splice" grafts were used for the most part, although a few of the grafts were of the "whip" type. The appearance of the junction in splice grafts is shown in Figures 4–6. The differences in technique brought about no effect on the success of the union. The grafts were so made that each scion would have two pairs of good buds for development. The unions were bound with raffia and waxed. In no case was the union permitted to be below the soil level. Technically the process of grafting showed a high degree of success; union was accomplished in nearly all cases. The grafted plants were grown in a greenhouse under suitable conditions. Table III presents the results of these experiments. The scions employed were of the variety *Syringa vulgaris*

TABLE III. EXPERIMENTAL OLEACEOUS GRAFTS 1929–1930

Stock:	Number of grafts:	Number of ungrafted controls:	Date of grafting:	Success of graft:
Syringa vulgaris	6 65	6 2	1–25–29 1–21–30	INCOMPATIBILITY NONE. All remaining in excellent health throughout the experiment. Controls healthy. Fig. 4 (Pl. 33) shows a representative specimen.
Syringa japonica	5 14	1 2	1–25–29 1–21–30	INCOMPATIBILITY SLIGHT. Excellent growth but evidence of a mild degree of incompatibility, manifested by a slight flecking of the leaves during the summer. Controls healthy. Illustrated in Fig. 5 (Pl. 33).
Syringa villosa	15	2	1–21–31	INCOMPATIBILITY MODERATE. The growth is weak on this stock, the twigs small, leaves few. Browning of the leaf margins, brittleness of the leaves, and early defoliation mark the graft. Controls healthy.
Ligustrum ovalifolium (This is the stock generally used in commercial lilac propagation where "privet" is indicated. Throughout this paper the term "privet" refers to this species, the California privet.)	6 50	2 3	2–27–29 1–21–30	INCOMPATIBILITY MARKED. During the course of the summer the leaves become wrinkled, thicker, brittle, and spotted with tiny dead areas which mark the early stage of development of incompatibility. The margins of the leaves become dead and torn. However, the growth and general appearance are not usually very bad. All survive the winter. The following year these same symptoms are present and somewhat more marked than the preceding year. These are the typical symptoms as are seen in the field, marking a plant as grafted on Privet and in an early stage of incompatibility. These symptoms have never been seen on an own-rooted Lilac. Controls healthy. This important stage of incompatibility is well indicated in Fig. 4 (Pl. 33), which is a faithful reproduction of one of the plants of this experimental set.
Ligustrum ibota	6	2	1–25–29	INCOMPATIBILITY MARKED. The symptoms here are almost identical with those of the grafts on *L. ovalifolium*. The course of the disease is the same. The remarks applying to one apply to the other equally. Controls healthy.

Stock:	Number of grafts:	Number of ungrafted controls:	Date of grafting:	Success of graft:
Ligustrum ibolium	6	2	1–25–29	INCOMPATIBILITY MARKED. Symptoms identical with those of the two preceding with the exception that here the blight is slightly less apparent. The condition the second year is somewhat better. However, none of these stocks is to be considered as a desirable understock for Lilac. Controls healthy.
Ligustrum vulgare	6	2	1–25–29	INCOMPATIBILITY MARKED. Symptoms similar or identical to those of the other species of Privet above. Controls healthy.
Ligustrum vulgare var. "Lodense" (Horticultural variety)	9	2	1–21–30	INCOMPATIBILITY MARKED. Symptoms similar to those of *L. ovalifolium* but incompatibility more pronounced. This stock is intermediate in its incompatibility between the species immediately preceding and following. Controls healthy.
Ligustrum obtusifolium var. *Regelianum*	11	2	1–21–30	INCOMPATIBILITY MARKED. Symptoms as in all the preceding species of privet but more severe than any other yet considered. Controls healthy.
Ligustrum amurense	6 45	2 9	1–25–29 1–21–30	INCOMPATIBILITY EXTREME. This is by far the most incompatible of the privet series. In April the leaves become yellow in the same way as the extreme cases of commercial grafts in the field. The yellowing progresses in typical fashion involving first the leaf margins and the intervenous areas. Curl, brittleness, and thickening of the leaves are very marked. By fall all the leaves have fallen. The plants do not survive the winter. The especial significance of this stock is that it duplicates in a single season the course of typical incompatibility in the *L. ovalifolium* grafts in three to seven years or more. Controls healthy. This type of incompatibility is shown in Fig. 4 (Pl. 33) which illustrates a plant of this original experiment.
Fraxinus americana	5 3	2 1	1–25–29 1–21–30	INCOMPATIBILITY COMPLETE. Of the type of the following two species but somewhat less severe. Leaves large and well developed at first (Fig. 5 of Pl. 33) but later on the summer becoming very yellow and falling. *Plants nearly dead by fall. Do not survive the winter.* Controls healthy.

Stock:	Number of grafts:	Number of ungrafted controls:	Date of grafting:	Success of graft:
Chionanthus virginica	6 3	2 1	1-25-29 1-21-30	INCOMPATIBILITY COMPLETE. Leaves very small, in little tufts at the ends of the branches, becoming yellow during the summer. *All scions dead by fall.* The symptoms, due to the greater degree of incompatibility differ somewhat from those of the privet grafts, as the leaves are never well enough developed in the beginning to exhibit the symptoms described as for *L. amurense.* Controls healthy. These symptoms are shown typically in Fig. 5 (Pl. 33).
Forsythia suspensa	5 3	2 1	1-25-29 1-21-30	INCOMPATIBILITY COMPLETE. Leaves very small, tufted at the ends of the branches, not becoming yellow but falling during the summer. *All scions dead by fall.* Incompatibility of the same type as in *Chionanthus virginica* above. Illustrated in Fig. 5 (Pl. 33). Controls healthy.

"Andenken an Ludwig Spaeth" in nearly all cases, and they were all obtained from the same parent plant.

A consideration of Table III reveals a number of interesting conclusions:

a. In the first place, it reveals a graded series of degrees of incompatibility beginning with the species *Syringa japonica* and *S. villosa*, and passing through the various species of *Ligustrum* to *L. amurense*.

b. It is further plain that the employment of *S. japonica* and *S. villosa* as understocks for varieties of *Syringa vulgaris* is questionable, while in no case is the employment of any species of *Ligustrum* justified as a lilac understock.

c. All the species of *Ligustrum* exhibit approximately the same degree of incompatibility with the exception of *L. amurense*.

d. As for *Ligustrum amurense*, the symptoms of lilac graft-blight are very striking where this species is employed as an understock. It will be remembered that in ordinary field experience the symptoms of graft-blight in Lilacs grafted upon *Ligustrum ovalifolium* do not become extreme until several years after grafting. The grafts of Lilac on *L. amurense* present a condition as though the experience with *L. ovalifolium* in six years were concentrated into a single season. The symptoms are identical with those in the field in old, very incompatible Lilacs.

e. The grafts on *L. ovalifolium* show precisely the same symptoms as distinguish privet-grafted Lilacs from own-root Lilacs in the field, the symptoms which have been watched gradually increasing to the extreme stage in incompatible grafts of Lilac.

f. The extreme incompatibility manifested by Lilac when grafted upon *Fraxinus americana*, *Forsythia suspensa*, and *Chionanthus virginica* demonstrates that the use of these species as lilac understocks is highly impractical.

It is well in this connection to compare the photographs of the lilac-on-*L. ovalifolium* graft and the lilac-on-*L. amurense* with that of the control Lilac grafted on lilac roots as indicated in Fig. 4 (Pl. 33). This brings out characteristically the differences in size of the plants, the typical symptoms of these two types of privet graft, and the striking likeness between the experimental symptoms and the symptoms in the field.

In these experiments four types of controls were employed. (a) A certain number of the stock plants of each species were permitted to grow ungrafted. These in every case remained healthy. (b) Each year there were a number of lilac-on-lilac grafts made, the number corresponding to the greatest number of grafts on any one stock species during that year. These remained healthy, and since the scions were of the same origin in both the privet grafts and the controls, the latter served as desirable checks on the development of the incompatible grafts. (c) A number of cuttings of the same parent plant as supplied the scions were rooted in the soil, and the condition of these was found to correspond in health precisely to the lilac-on-lilac grafts. (d) The parent plant of the scions served as the fourth type of control. Hence these various grafted scions were checked against sister scions grafted upon lilac roots, against the sister scions rooted directly, and against the parent tree itself. The foliage of all the controls remained identical in appearance and perfectly healthy throughout the experiments. Because of the comparative uniformity of conditions throughout these experiments and because of the employment of control plants, the appearance of the developing scions in all the grafts is taken to be directly indicative of the degree of compatibility between stock and scion.

In order to confirm the results of the grafting experiments just reported, and to compare the observations made in the Arnold Arboretum with the actual situation in nurseries, an investigation was made in 1929 of the condition of lilac plants in a number of nurseries in New England, New York, and New Jersey. The evidence forthcoming was entirely confirmatory. In the first place, it was seen that in nurseries which do not use Privet as a lilac understock there were to be found none of the symptoms of lilac graft-blight. On the other hand, in nurseries which do use Privet as a lilac understock the disease invariably occurred, and it was limited to the plants which had been propagated on Privet, even though plants propagated by other methods were in the same plots and rows as the blighted plants.

To give a still clearer conception of the correlation between privet grafting of Lilacs and graft-blight, reference should be made to my observations of graft-blight as it occurred in a typical large eastern nursery. This nursery offered a situation not unlike a well ordered experimental plot on a large scale. There were 37,000 Lilacs of all ages, and they were so grouped that each block contained plants of the same variety and age but propagated according to the different methods. The plants propagated by grafting could be distinguished from those which were not grafted by the fact that the graft unions were above the soil and so plainly in sight, while the plants grafted on lilac roots could be separated from those on privet by the fact that sufficient quantities of suckers were developed from the stock root-systems to identify the species of the stock with accuracy. In no case did a plant propagated on lilac roots show the symptoms of graft-blight. Of the plants propagated on Privet, those two years old were generally healthy, but here and there was a typically blighted plant. The three-year-old plants showed the effects of grafting to a more marked degree, which increased with the age of the plants. The effects of grafting were even more striking in those cases in which the privet-grafted plants were grown in "standard" form, that is, with a long, unbranched main stem surmounted by a compact, dense system of branches.

The type of evidence yielded by this nursery in question is best illustrated by the following descriptions of two typical plots, as transcribed directly from my field notes. Plot 1 consisted of three-year-old plants, plot 2 of five-year-old ones.

PLOT 1

"3500 Lilacs budded on Privet, 3500 budded on Lilac, side by side, under the same conditions. The two kinds of plants could be distinguished at a glance in most cases, the blighted plants being invariably on Privet and the lilac-on-lilac combinations invariably good, and in every case the word of the propagator as to stock and the occurrence of stock suckers confirmed the truth of the observation. Towards the end of the investigation, as we looked at block after block it became possible for me to distinguish immediately the stock of the plant by the appearance of the crown, and with perfect accuracy, no matter how the two kinds were intermingled."

PLOT 2

"2000 budded on Lilac, 1000 budded on Privet. Neither lot was on scion roots whatsoever, the unions all being above the ground. A very distinct line could be drawn between those on lilac roots and those on privet roots. The former looked healthy, the latter distinctly yellowed, though growing side by side in the same block."

Thus it is seen that the preliminary observations made at the Arnold Arboretum, tested out under the more exacting conditions of controlled experiments, and substantiated by direct observations of graft-blight in numerous nurseries and other outdoor plantings, offer at once an explanation and the only explanation of the cause of lilac graft-blight. The mutually confirmatory evidence from all these sources leaves one no alternative but the conclusion that lilac graft-blight is due to an incompatibility which exists between lilac scions and privet stocks when united in the graft association.

E. RELATION OF GRAFT-BLIGHT TO THE DEVELOPMENT OF ADVENTITIOUS ROOTS FROM PRIVET-GRAFTED LILAC SCIONS.

As corollaries to the fact that graft-blight is due to the privet grafting method of lilac propagation, it was soon discovered (a) that there is an intimate relation between the degree of severity of graft-blight in Lilacs and the degree of development of adventitious roots from the scions of grafted plants, and (b) that this degree of development of scion roots is influenced by the technique of privet-grafting as employed in the nursery. It is pertinent at this juncture to point out in detail the reasons which have led me to these two conclusions.

As regards the relation between scion-root development and degree of incompatibility, a large number of observations were mutually confirmatory in pointing out that there is a great diversity in the amount of scion-root development in lilac-privet grafts. In some cases the scion begins to throw out adventitious roots within a year of the time of grafting. In such cases the scion soon becomes independent of the privet stock and supported by its own system of lilac roots. In other cases the scion apparently is never successful in the production of a lilac root-system. Moreover there are all degrees of scion-root development between these extremes. Figures 7, 8, and 9 illustrate cases in which there was no production of adventitious scion roots up to the time of photographing. In Fig. 3 is shown a scion-root-system of comparatively high degree of development, but still not great enough to prevent the appearance of severe graft-blight.

It is very significant that the degree of severity of graft-blight varies inversely with the ability of the scions to form their own roots soon after grafting. When scion-roots are few or wanting the symptoms of graft-blight are most severe; when, on the other hand, the lilac scions become independent of the privet root-systems soon after grafting, the symptoms are slight and the lilac scions are seen to recover from the disease. These conclusions were the outcome of numerous observations of which two examples are here given to illustrate the two important types of evidence involved.

In the first place, it was observed in the field that plants of the same age, variety, method of propagation, and external environment, differed somewhat in degree of severity of graft-blight. When such Lilacs were examined closely, it was seen that the plants displaying severest symptoms had developed fewest scion roots. Thus in one nursery a plot of plants which had been grafted on Privet in 1928 and were examined in 1929 varied in their symptoms. Those which showed marked symptoms of graft-blight had developed no lilac roots whatsoever. There were three apparently healthy plants in this plot, and on digging these up each was found to have at least fifty percent of its roots belonging to the lilac scion. A plot of Lilacs propagated in 1927 was examined, and among these, as I looked down the rows, here and there were plants which looked strong and vigorous with only slight symptoms of blight. Mingled with these in the same rows were occasional plants showing extreme blight. When the comparatively healthy plants were examined, each was found to have at least one strong lilac root, while the badly blighted plants, often growing no more than a foot away, had developed no lilac roots whatever.

A second type of evidence was obtained from a consideration of suckers from privet-grafted Lilacs. It frequently happens that a severely blighted Lilac will have attached to its root-system one or more lilac suckers which show no signs whatever of graft-blight. On dissecting the root-systems it is seen that the healthy suckers develop from adventitious buds at the base of the lilac scion, and that they draw their water and mineral salts almost exclusively from lilac roots, and not from the privet stocks of the mother plants. Hence they are economically independent of the privet stocks, and the absence of graft-blight symptoms readily yields to interpretation on this basis. A typical example of such a healthy sucker growing from the base of a severely blighted Lilac is illustrated in Fig. 3 (Pl. 32). In this figure the severe symptoms of the mother plant are strongly contrasted with the healthy condition of the sucker.

From such observations as the preceding, it was concluded that there is an inverse relation between the development of adventitious roots from privet-grafted lilac scions and the severity of graft-blight. It is essential to consider next the relation between the technique of grafting and the production of adventitious scion roots.

There are a great many variations in technique employed by lilac propagators in grafting lilac scions upon privet stocks. However, these fall into essentially three groups: topgrafting, budding, and piece-root-grafting. All three methods are extensively employed. In the case of *topgrafting* a lilac cutting is grafted above the ground upon a privet stem. This is the type of grafting illustrated in Figs. 4–6 (Pl. 33). *Budding* is similar except that instead of using a cutting of lilac as the scion, a single lilac bud is inserted into the privet stem. *Piece-root-grafting* consists in grafting a lilac cutting onto a piece of privet root and burying the union below the soil.

Almost all lilac propagators are agreed that the desideratum is a lilac upon its own roots eventually. This is claimed to follow naturally when the piece-root method is employed, and is induced in the cases of topgrafting and budding by sinking the grafted or budded plant into the soil so that the graft- or bud-union is covered by 2–12 inches of earth. The sinking of the union into the earth may follow soon upon the grafting process or may be delayed for several years. Production of adventitious roots from the scion is sometimes facilitated by scarification of the lilac scion just above the graft union.

It would be expected that such a diversity of methods would be followed by an equal diversity of degree of development of adventitious roots. Such was found to be the case. The piece-root grafting method was found to be least pernicious, the employment of this method being most favorable for scion-root development. The production of scion-roots is still further aided by planting the grafted plants so that the unions are well below the surface of the soil. With either budding or topgrafting the results are less favorable. The greatest opportunity for scion-root development is afforded if the unions are immediately buried and if the scions are scarified by a few knife cuts, just above the unions. The practice of some nurseries of so propagating their Lilacs that the unions are above the soil line when the plants are sold (two to three years after grafting) is most undesirable, because in such cases the wood of the scions is already so hard that the possibility of production of adventitious roots is greatly lessened.

Thus it is seen that although some techniques of lilac propagation by the employment of privet stocks are less pernicious than others, no method fully escapes the penalty of graft-blight, because no method assures the production of numerous adventitious roots from the scion in every case. The statements made by nurserymen who use the privet method that their Lilacs are on their own roots within a short time after grafting were found to be erroneous when such Lilacs were examined. And as a natural conclusion it follows that until a privet method of lilac propagation can be shown to produce own-root Lilacs with a high degree of success, all methods of lilac propagation which involve the use of privet stocks are to be condemned.

The foregoing concludes the discussion of the appearance and causal relation of graft-blight to the use of privet stocks. It is maintained that because of the nature of the symptoms, because of the fact that the disease could not be the result of any factor considered but the use of privet stocks in propagation, and because the disease in the field and in experimental plants shows a perfect parallel to the use of privet stocks in propagation, that the disease is the direct result of such grafting, and that its elimination can be accomplished only from the standpoint of such a conclusion. Having established this conclusion, it is of value at this point to consider the ultimate nature of the incompatibility in grafts of this type with a view to shedding light on the factors which make one graft association successful while another is incompatible.

V. NATURE OF THE LILAC-PRIVET INCOMPATIBILITY

I have spent considerable effort on inquiries into the characteristics of successful and unsuccessful graft unions and into the precise differences between lilac scions and privet stocks in an attempt to reach an explanation of the ultimate basis for the incompatibility in the lilac-privet graft. The literature on the subject of grafting yields a number of theories as to the failure of certain graft combinations. Those theories which could conceivably apply to the lilac-privet graft association are here discussed according to their merits in shedding light upon the nature of the lilac-privet incompatibility. It is manifest that the nature of graft incompatibility must in the end be referred to some fundamental difference between the protoplasms of stock and scion. Such a fundamental difference underlies the manifestation of various symptoms of uncongeniality, whether in the crown, in the root-system, or at the graft union. Hence a considerable part of this section is devoted to a report of investigations bearing on the fundamental protoplasmic differences between lilac scions and privet stocks, the problem being attacked from the standpoint of immunological experimentation.

A. ANATOMICAL UNION OF STOCK AND SCION

In a number of instances as reported in the literature, it has been found that in incompatible graft combinations the stock and scion fail to establish sufficient continuity of the conducting elements to maintain the food and water requirements of the graft components. To be sure this phenomenon is probably a manifestation of some more fundamental protoplasmic difference between stock and scion, at least in those cases in which there appear to be no anatomical differences in the wood structure of stock and scion; but as the subject has always been treated in a descriptive rather than in an experimental manner, it is of value at this point to note whether in the lilac-privet graft, as in certain other graft combinations, the symptoms developing in the crown bear any relation to an anatomical failure of stock and scion to unite.

As examples of such failures in anatomical union there may be cited several instances from the literature. Bradford and Sitton (5) found that in the incompatible grafts of Pear on Apple, and Pear on Quince the cambium continuity became broken at the end of each growing season until finally the transpiration channels and the phloem became so discontinuous that the scion failed. Waugh (36) held that failure in the incompatible unions studied was a result of the deposition of a certain amount of scar tissue between stock and scion. Proebsting (29) confirmed Waugh in finding the weakness in interspecific Pyrus grafts due to the laying down of parenchyma at the point of union, and also found that in some incompatible grafts bark tissue was present in place of this separating parenchyma. In a later paper (30) the same author added that the xylem at the line of union may degenerate into a gummy mass which might check water movement.

None of these conditions has been found to obtain in the lilac-privet graft, however. The graft failure which occurs even in ordinarily compatible graft combinations due to carelessness in the original setting of the graft (5, 6, 13, 14) was never observed in the lilac-privet graft, even though the technique was varied during the course of my experiments. Many compatible and incompatible graft unions of Lilac were examined macroscopically and microscopically. In all cases the union of the conductive and meristematic tissues was excellent after the first year. Since there is no observable anatomical difference between the woods of *Syringa* and *Ligustrum*, and since the union was perfect in practically all cases, it was impossible to distinguish under the microscope where one graft component ended and the other began. The microscopic examination failed to reveal any indication of abnormality in structure which could cause failure of the graft association. This point is illustrated in Fig. 10 (Pl. 34) which shows the microscopic anatomy of a typical incompatible lilac-privet graft union in transverse section. The original junction of the two woods shows as a line of crushed cells and a certain deposit of scar tissue. But subsequent growth was so perfect that it is quite impossible, except in a general way, to trace the dividing line between the two woods beyond the original junction.

B. RELATIVE DIFFERENCES IN THE PERIOD OF GREATEST METABOLIC ACTIVITY OF STOCK AND SCION

If the times of activity (leafing-out, blossoming, fruiting, dormancy) of stock and scion differed markedly, it might be expected that the success of the union would be jeopardized. However, there are numerous observations to show that the root systems of the plants in consideration are always potentially active and that dormancy is localized in the buds. Thus Denny and Stanton (10) have shown by forcing with chemicals that a single bud can be forced while the root is in the "dormant season," although the remainder of the lilac buds remain dormant. Likewise, observation shows that exceptionally in nature a single bud will develop in the same way. Further, if lilac plants are moved at the beginning of the dormant season, the roots begin activity, the top remaining dormant. In addition I was able to keep the crowns of lilac plants continuously in leaf throughout the whole of the dormant season by the use of chemicals and heat in forcing the dormant buds before the leaves of the current year had fallen. Moreover, in grafts made in late January of *Syringa vulgaris* on *S. villosa* (which is very late in coming into leaf) the common lilac scions had developed crowns of mature leaves and completed their season's growth a full month before the opening of the buds of the ungrafted *S. villosa* stocks. Finally, in a graft of common Lilac upon *S. villosa* in which the scion was accidentally broken off soon after it had commenced growth, the buds of the *S. villosa* stock commenced development, due to the stimulus of the abortive grafting process, a month before the buds of the other ungrafted *S. villosa* stocks began to develop. All these observations point to one fact: Dormancy is localized in and conditioned by the buds. The absorbing and conducting systems are potentially active twelve months of the year. Hence, if these facts be applied to the graft union, it will be seen that it is immaterial whether the root-system belongs to a plant which is normally "early" or "late." If the root-system is capable of activity at all times, the scion will determine and control the absorption and conduction of the raw materials of the soil.

C. RELATIVE RESISTANCE OF THE VARIOUS STOCKS TO DISEASE

In a number of instances the Privet has shown itself susceptible to certain diseases and insects which may exert an unfavorable influence on the graft union. Among these may be mentioned the privet borer, the crown gall disease caused by *Bacterium tumefaciens*, which I have found on the privet roots of a number of grafted commercial Lilacs, and possibly the privet anthracnose caused by *Glomerella cingulata*. A typical crown gall from the privet roots of a commercial Lilac is illustrated in Fig. 7 (Pl. 34). None of these diseases bears sufficiently consistent relation to the lilac disease, however, to merit consideration as the cause of the lilac graft-blight, serving rather merely as complicating features.

D. RELATIVE HARDINESS OF THE LILAC SCION AND THE PRIVET STOCK

California Privet has been anathematized as an understock for Lilac by northern growers (9) since it is not reliably hardy much north of New York City. Doubtless such growers are justified in their opinion, but south of New York I have observed the customary symptoms of graft-blight, and even in Boston it is only exceptionally that California Privet is root-killed in the winter, in spite of the fact that graft-blight occurs in mild years. The northern growers have an additional reason, but not an exclusive one for condemning the practice of grafting Lilac on Privet.

E. RELATIVE VIGOR OF THE LILAC SCION AND THE PRIVET STOCK

A number of observations seem to point to the fact that an imporant factor in the ultimate failure of lilac grafts on Privet is the inability of the privet roots to cope with the water requirements of the growing lilac scion. From the facts that the symptoms are those of chronic water deficiency, that the privet grafts thrive at first and do not show the disease in its extreme form for several years, and that actual examination of the root-systems of blighted plants shows obvious gross insufficiency in root development for the size of the crown, it is concluded that herein lies an important factor in the failure of the lilac-on-privet grafts.

That this insufficiency of the privet system is related to the inability of certain substances to cross the graft union is seen in the large swelling due to accumulated food just above the graft union, not only in the lilac graft but in numerous grafts of other plants, as for example the grafts of Navel or Valencia Oranges or Eureka or Lisbon Lemons upon *Citrus aurantium*. Webber (37) considered this characteristic of certain graft unions of considerable importance in determining the congeniality of graft unions; and that this is a constant character in the lilac grafts is seen from an examination of the figures of lilac root-systems at the end of this paper.

F. SPECIFIC PHYSICO-CHEMICAL OR IMMUNOLOGICAL DIFFERENCES BETWEEN STOCK AND SCION

This is a province which I approach with a considerable degree of hesitation, as it is not strictly within the field of the pathologist, and is, moreover, most controversial and obscure. We are profoundly ignorant of the ultimate physiology and physical chemistry of the interreactions of living protoplasms. That the relative vigor of stock and scion is not the only factor involved in the failure of lilac-on-privet grafts is shown by the early symptoms and death of the grafts of *Syringa vulgaris* on *Ligustrum amurense*, as well as by the incompatibility of Lilac and *Chionanthus*, *Forsythia*, and *Fraxinus*. In the precise nature of the physiological basis for this incompatibility we have a question which cannot yet be answered by the biological sciences. But in an attempt to draw a little nearer to an understanding of a possible immunological basis for graft incompatibility, I have attempted a number of experiments with the Lilac, and should mention them, although it is impossible, before a great deal of fundamental investigation has been accomplished, to draw many definite conclusions.

Plant immunology is nearly a virgin field in striking contrast to the high degree of development of animal immunology. The first real impetus to the science came as a sequent to Osborne's monumental work in isolating plant proteins (27). Such pure plant proteins, as well as crude plant-protein-containing mixtures were used in inoculating animals, a line of work which has been carried out in a number of laboratories in America and Europe. Mez and his followers using this technique have built up a complicated phylogenetic system based on this reaction (22, 23, 24). The fact that Mez's results are deemed somewhat questionable by other European and American workers has led to a bitter controversy on the continent, with the result that the subject of plant immunology is held to be rather fruitless by many present day investigators. In all this work, however, the *plant* was secondary in consideration. It was an animal which furnished the reactions observed, and it is essential to distinguish here the difference between immunological reactions in which plant proteins are the stimulus to induced immunization in an animal, and the reactions in which the plant itself is the organism developing the power of protection against foreign proteins by means of precipitation, cleavage, or other method of removal from activity of the foreign protein. The former reactions belong properly to the domain of animal immunology, the latter constitute plant immunology in its proper sense.

When one considers the essential similarity in vital processes between animal and plant protoplasms it is a natural corollary to expect a like relation with regard to the ability of the organism to protect itself by means of immunological mechanisms. The more conservative of the animal immunologists are inclined to doubt the practical possibility of demonstrating such a similarity, giving as their reasons the absence in the plant of a conductive system comparable to the blood system of the higher animals, the difficulty of obtaining plant proteins in pure condition, and the relatively great dilution of plant protein in extracts made by the customary procedures in comparison to the high concentration of animal protein in blood serum. Granting all these difficulties, it is nevertheless entirely possible to obtain comparable reactions by choice of suitable techniques, and since the plant does possess certain advantages in comparison to animals, such as ease of cytological investigation, the field of plant immunology in its restricted sense is worthy of serious consideration in the light of possible explanations of heretofore obscure biological processes within the plants.

The pioneer work in plant immunology consisted in an attempted application of the techniques and theories of animal immunology directly to plants without essential modification. For example, plants were infected with pathogenic bacteria and the extracts subsequently made were tested for their agglutinative and lytic properties against the bacteria in question. The outcome of these endeavors has not been very satisfactory because of the limited application of the animal methods. Most of this work was done in the laboratories of southern Europe, and although it is beyond the scope of this paper to deal with this phase of immunology in plants, an excellent account of the whole subject and literature is to be found in the "Immunità nelle piante" of Carbone and Arnaudi in 1930 (7). To the literature should be added mention of a paper by East and Weston (12) in 1925 in which the hypothesis is advanced that in Sugar-cane the plants "may gain a temporary immunity after an experience with mosaic similar to that a human being attains after recovering from a virulent typhoid infection." All of these experiments, observations, and hypotheses are based on the conception that in plants there may be a display of immunological phenomena analogous to that due to the mechanisms of immunity in animals.

A most valuable forward step in plant immunology was the elaboration of this conception of immunological mechanisms in plants by Kostoff working in East's laboratory in 1928 and 1929 (17, 18).

A new technique was developed, that of grafting species of Solanaceae and investigating the possibility of acquired immunity as a result of such graft unions. From one point of view, the graft union is a case of parasitism of scion on stock, this parasitism being somewhat reciprocal, however, as each biont provides something to the economy of the complex. But the essential feature here is that in the graft union we have a most intimate association of plants of distinctly different species in which the opportunities for mutual sensitization and immunization are far in excess of those in the other methods of plant immunology heretofore investigated. Kostoff tested leaf extracts of stock and scion before grafting and periodically after grafting. Not only were normal antibodies found in the Solanaceae, but it was found that after grafting in many cases there was an acquirement or increase of immunity as demonstrated by precipitin and lysin reactions. These antibodies were sometimes specific, sometimes not so. One of the most striking bits of evidence offered was that after grafting the reaction of leaves just above the graft union was greater than that of leaves farther removed from the place of union, that is, the precipitating potency spread outward from the graft union to the more distant parts of the plant.

Using this work as a starting point, I performed more than a thousand precipitin and lysin reactions in the Oleaceae with especial reference to the grafts of Lilac on Privet. The results of these experiments are introduced here, not because they offer a final answer to the question of graft incompatibility of the type under consideration, as the whole field is yet too young to permit of dogmatism, but rather in order that they may shed some light upon the matter of plant immunology and serve, in conjunction with other data which shall be forthcoming in the future, to help in laying the foundations of plant immunology as an experimental science.

Since I was dealing with woody plants in distinction to the herbaceous Solanaceae, and since the term of life, rapidity of growth, age of flowering, and annual cycle of foliation and defoliation are so different in the Oleaceae, it was necessary to modify somewhat the technique previously employed. Briefly my procedure was as follows. From five to twenty-five grams of leaves were collected from each of the plants to be investigated. The leaves were cut from the plants, when turgid, with a sterile razor. (*Note:* Chemical sterility rather than biological sterility is indicated throughout this section wherever the word "sterile" is employed.) The leaves of each plant were washed in tap water, rinsed in sterile water, dried between sterile cotton, and weighed immediately. They were then cut up in small pieces with sterile scissors and ground in a sterile unglazed porcelain mortar until in a thick paste with no fragment more than one millimeter in diameter. The paste was then placed in a sterile test-tube of suitable size and with it was mixed twice the weight of the leaves of distilled water which was first used to rinse out the mortar and pestle. The test-tube was immediately stoppered with sterile cotton and placed in a refrigerator for 24 hours at 2° C. At the expiration of this time, the mixture in the tube was filtered until the filtrate was crystal clear. Even slight opalescence was eliminated by repeated filtration. For filtering it was sometimes possible to attain the results desired by means of one or two passages through ordinary, fairly fine filter papers. (The finer, hard, thin, Schleicher & Schüll papers proved most satisfactory.) In more refractory cases it was necessary to use other means, as the quantity of extract was necessarily so small as to cause absorption of the liquid by the paper to detract seriously from the quantity of liquid. Hence, where it was necessary to filter more than twice, an apparatus was used which reduced the absorption to .1 cc. per filtration. This apparatus consisted of a sterile Gooch crucible with a filtering disc of finely divided Jena glass. (The No. 4 of Arthur Thomas Co. proved most serviceable.) This crucible fitted into a sterile thistle-tube and was rendered air-tight by a thick rubber collar. The lower end of the thistle-tube extended through a 1-hole rubber stopper into a filter-flask, and was so arranged that the filtrate dropped into a sterile three-inch test-tube within the filter-flask. The filter-flask was attached to a suction pump. The material to be filtered was placed in the Gooch crucible and the filter-flask evacuated. Even under these circumstances filtration was sometimes very slow, but a clear liquid usually resulted after one or sometimes two or three passages through the filter. After filtration the liquids were clear, varying in color from lemon-yellow to dark amber, and strongly acid. The tubes were immediately placed in a beaker of water surrounded by a bath of melting ice, and used in testing.

In the testing, from .2 to .4 cc. of the liquid of greater specific gravity was introduced into specially made sterile test-tubes measuring 30 mm. in length and with an internal diameter of 2–3 mm. by means of a pipette of exceedingly fine bore at the tip. The second liquid (of lower specific gravity) was so pipetted into the same tube as to form a clear layer over the first, separated from the first by a very thin refractive plane. This required a good deal of care in order to avoid mixing the two. The specific gravity was determined by trial and error each time, as the appearance of an extract gave no clue to its density. In a negative test this layering remained unchanged for one hour or longer. In a positive precipitin test, after one minute to fifteen minutes (usually about three to five minutes), the refractive zone became a very thin cloudy zone (Uhlenhuth's ring). This cloudiness increased in intensity and the zone became thicker and thicker until it was milk-white and about 2–3 mm. thick. Then from its lower margin little white rootlike projections would begin to penetrate the clear lower extract in tortuous paths. More of these would form and grow longer, until finally the whole of the lower two thirds of the contents of the tube became milk-white and all signs of layering were lost. The whole process generally took about forty minutes. The test-tubes were held in a rack devised by riveting little bent strips of brass to a brass rod in such a way that the spring of the brass clips would hold the tubes firmly in place. Observation was made in doubtful cases by viewing through a large lens with obliquely transmitted light against a black background. The refraction of the walls of the test-tubes was eliminated where necessary by immersing the test-tubes in a small plane-sided vessel of cedar oil. But in good reactions (indicated by "2" to "4" in the tables below) the Uhlenhuth ring was so plain, even in these small test-tubes, as to be visible at a distance of several yards. Notes on each reaction were taken at intervals of 1, 5, 10, 20, 30, and 40 minutes and longer where there was any doubt, while full details of the origin and constitution of the plants and extracts were kept in every case.

The small tubes and pipettes were cleaned by boiling for two hours in .5% sodium carbonate solution and then for four hours in four changes of distilled water. This was followed by washing in two changes of alcohol and one of ether. The larger glassware was washed in water and then in alcohol and ether. The Gooch crucibles were cleaned by flushing through with alcohol and ether and then burning to whiteness over a Bunsen flame.

The various features of this technique were tested out in detail during the course of these investigations. Extracts were preserved by placing in the refrigerator at 2° C and covering with a fairly thick layer of toluene. In such cases they were found to retain their potency for at least several days as a rule. But for the most part the experiments reported below were performed with fresh extracts. The results are indicated under the heads of NORMAL REACTIONS and REACTIONS OF BLIGHTED PLANTS. By the former is meant reactions in which the extracts were made from healthy, ungrafted plants.

Normal Reactions

The precipitin tests made in the Oleaceae show that there are no normal precipitins present in the genera of the Oleaceae studied that are demonstrable by the technique employed. A table of these tests follows (Table IV). The proper names in all cases refer to the horticultural varieties of *Syringa vulgaris*. "*Ligustrum vulgare*" here includes both the species and the variety *foliosum*. "*L. obtusifolium*" includes the variety *Regelianum*. Otherwise no varieties were employed except as specified. In this and the other data given below, the following symbols are used:

– : No reaction. t : Trace or doubtful reaction.
1 : Weak but definite reaction. 2 : Moderate reaction.
3 : Strong reaction. 4 : Maximum reaction.
0 : Lytic reaction. (Formation of a clearer zone separating the two extracts. Of doubtful significance at present.)

TABLE IV. NORMAL PRECIPITIN REACTIONS IN THE OLEACEAE.

	Chionanthus virginica	Fraxinus americana	Forsythia suspensa	Ligustrum acuminatum	L.amurense	L.ibolium	L.ibota	L.macrocarpum	L.obtusifolium	L.ovalifolium	L.vulgare	Syringa japonica	S.vulgaris	" Aline Mocqueris	" Amethyst	" Arthur W. Paul	" Edmond Boissier	" Gigantea	" Languis	" Ludwig Spàth	" Marie Legraye	" Maurice de Vilmorin	" Michel Buchner	" Mireille	" Mme.Casimir Périer	" Mme.Lemoine	" Près.Carnot	" Princesse Marie	" Spectabilis	" Verschaffeltii
Chionanthus virginica	-	-			-					-										-										
Fraxinus americana	-				-					-										-										
Forsythia suspensa																				-										
Ligustrum acuminatum					-	-		-	-	-	o		-	-				-			-		-		-	o	-	o		
L.amurense	-	-		-		-	-	-	-	-	-	-	-					-			-		-		-					
L.ibolium				-	-		-	-	-	-	-		-				-			-			-		-	-		o		
L.ibota				-	-				-	-	-				-	-	-		-	-		-		-					-	-
L.macrocarpum			-	-	-			-	-	-		-	-	-							-		-		-					
L.obtusifolium				-	-	-	-	-		-	-		-	-	-	-	-	t	-	-	-	-	-	-	-	-	-	o	-	-
L.ovalifolium	-	-		-	-	-	-	-	-		-	-	-				-			-										
L.vulgare				o	-	-	-		-	-					-	-	-	t	-	-		-		-	-	1	-	o	-	-
Syringa japonica					-					-										-										
S.vulgaris				-	-	-		-	-	-																				
" Aline Mocqueris				-				-	-												-									
" Amethyst							-		-		-																			
" Arthur W. Paul							-		-		-						-													
" Edmond Boissier					-	-	-		-	-	-					-				-										
" Gigantea				-					t		t																-	o		
" Languis							-		-		-																			
" Ludwig Spàth	-	-	-		-	-	-		-	-	-	-					-			-										
" Marie Legraye				-				-	-					-																
" Maurice de Vilmorin							-		-		-																			
" Michel Buchner				-	-	-		-	-																					
" Mireille							-		-		-																			
" Mme.Casimir Périer				-	-	-		-	-		-																			
" Mme.Lemoine				o		-			-		t																	-		
" Près.Carnot				-					-		-						-											o		
" Princesse Marie				o		o			o		o							o								-	o			
" Spectabilis							-		-		-																			
" Verschaffeltii							-		-		-																			

An examination of the data presented above reveals at once the striking difference between the Solanaceae and the Oleaceae. In the former family Kostoff found many examples of normal immunity. Here, on the other hand, is a manifest absence of such immunity. This lack of positive reactions cannot be attributed to the technique as the tests indicated were performed with the same extracts as gave the positive reactions to be seen in the next table. In no case, in the combinations of species and varieties considered, was there even a moderate reaction; in one case we find a weak reaction; and there are a few borderline cases. In a few instances there appears to be a lytic zone formed at the junction of the two extracts; but this is not consistent, is weak, and is apparently of no great significance. A number of these reactions were repeated several times, the rest once. This absence of positive reactions with normal extracts is all the more striking in view of the high precipitin potency of extracts from diseased Lilacs.

Reactions of Blighted Plants

In contrast to the above normal reactions, a similar series of tests of grafted lilac scions against the various stocks was made simultaneously. The results are seen in Table V below. In no case was the "blighted" extract taken from any but a plant suffering from graft-blight. Experiments with Lilacs suffering from blights due to other causes will be considered subsequently. In every case the following scheme of controls was employed:

Immune lilac extract	+	normal privet.	Normal lilac		+	normal	privet.
"	+	" lilac.	"	"	+	"	lilac.
"	+	other immune lilac extracts	"	privet	+	"	privet.
"	+	distilled water.	"	"	+	distilled water.	
			"	lilac	+	"	"

In conjunction with Table IV, the data in Table V are very suggestive. It will be seen that in the first place, in every one of the plants suffering from graft-blight there is a strong acquired precipitin potency. This varies in intensity from plant to plant as would be expected where some of the plants are suffering from the disease to a greater extent than others. But in every case there is a marked development of this property. The precipitin potency is, moreover, not specifically directed against one species of *Ligustrum* or against all Privet species, since a definite, although weaker, reaction exists between the privet-grafted Lilac and the normal Lilac as well as between two specimens of privet-grafted Lilac. In addition it is seen that the reactions are appreciably stronger in general against some of the Privet species, weaker against others. Thus the lilac

TABLE V. PRECIPITIN REACTIONS OF GRAFT-BLIGHTED LILACS.

Lilac grafted on privet, showing the blight:

		Archeveque	Arthur W. Paul	Belle de Nancy	Caroli X	de Jussieu	Gen.Haig	Gen.Kitchener	Henri Simon	Hermann Eilers	Hugo Koster	Hyazinthenflieder	Jules Simon	Lavoisier	Leopold II	Mme.Lemoine	Messemaker	Michel Buchner	Roi Albert	Rubra de Marly	Souv.de Rothpletz	Violacea
Normal privet	Ligustrum acuminatum							1	3		1	4	3	2				4			-	4
	L. amurense							-	2		-	1	2					1			t	3
	L. ibolium								3		-	2	1			1		3		1		
	L. ibota		4	4		4				4						4	4		4	2		
	L. macrocarpum								3			4	2					3				4
	L. obtusifolium		3	4		4		4	4	4	4	4	3	4		3	3	3	4	1	-	4
	L. ovalifolium	3					-				-				-	t				-		
	L. vulgare	-	4	4	t	4	3	4	4	4	4		4	4	3	4	4		4	-	t	
Normal lilac	Aline Mocqueris																	2				
	Amethyst																-					
	Andenken an L. Spath		2								-											
	Arthur W. Paul		2	2													1					
	Edmond Boissier		3													4				t		
	Languis																t					
	Marie Legraye																	3				
	Maurice de Vilmorin																		2			
	Mireille																1					
	Mme. Casimir Perier												3									
	Mme. Lemoine							1			-			1							-	
	Princesse Marie							1			-			t							-	
	Spectabilis																		2			
	Verschaffeltii																		3			
Graft-blighted lilac	Belle de Nancy					2				3												
	Caroli X																o					
	de Jussieu			2						2												
	Gen. Kitchener										-			1							1	
	Henri Simon												1									
	Hermann Eilers			3		2																
	Hugo Koster							-			t			1			1				2	
	Jules Simon								1													
	Lavoisier							1			1										3	
	Messemaker				o						1											
	Rubra de Marly															-						
	Souv. de Rothpletz							1			2			3								

extract is strongly precipitated by *Ligustrum vulgare*, *L. obtusifolium*, and *L. ibota*, while the weakest reaction is against *L. amurense* and *L. ovalifolium*. The difference in reaction against *L. amurense* is in accordance with the fact that *L. amurense* is manifestly different from the other *Ligustrum* species in its graft reactions. But *L. ovalifolium* is the understock generally used throughout these lilac grafts, and if the precipitin reaction were a specific antibody-antigen reaction in the graft of *Syringa vulgaris* on *Ligustrum ovalifolium* it would be expected that the greatest reaction would be obtained against this species of Privet.

It is significant in this same connection that the acquired precipitins in the grafted Lilac are potent against ungrafted healthy Lilac, although this potency is somewhat weaker than against Privet. The reactions of grafted Lilac against ungrafted Lilac are typical and indistinguishable from those of grafted Lilac plus Privet, with the only exception that they are somewhat weaker in general. The reactions of grafted Lilac against grafted Lilac seem to bear some relation to degree of severity of the blight. That is, a severely blighted Lilac tests strongly against a mildly blighted Lilac, less strongly against a severely blighted plant in general.

The reaction was consistently uniform if repeated from beginning to end. The variations found in such repetitions were insignificant. This fact not only served as a valuable check on minor variations in technique, but likewise strengthened the whole significance of the reactions. For example, the following tables give examples of five

TABLE VI. NORMAL PRECIPITINS

Normal precipitin reaction of *Syringa vulgaris* v. "E. Boissier"—Normal
Tested against *Ligustrum vulgare*—Normal

	Potency of reaction after:					
Date:	1 min.	5 min.	10 min.	20 min.	30 min.	40 min.
8-30-29......	—	—	—		—	—
9-1-29......						
9-3-29......						
9-5-29......	—	—	—			
9-7-29......			—	—	—	

TABLE VII. ACQUIRED PRECIPITINS

Acquired precipitin reaction of *Syringa vulgaris* v. "E. Boissier"—Blighted
Tested against *Ligustrum vulgare*—Normal

	Potency of reaction after:					
Date:	1 min.	5 min.	10 min.	20 min.	30 min.	40 min.
8-30-29......	—	1	2	3	4	4
9-1-29......	—	1	2	3	4	4
9-3-29......	t	1	2	3	4	4
9-5-29......	t	1	2	3	4	4
9-7-29......	t	1	2	3	4	4

repetitions of the same experiment, each separately performed from beginning to end on successive days. The test was a healthy Lilac and a typically blighted Lilac of the same variety and clon against the *same* extracts of *Ligustrum vulgare*. The data show only slight fluctuations in the readings at the end of the first minute, and this is due to the rapidity of appearance of the reaction and the relative difficulty in deciding between no reaction (–) and a trace of a reaction (t).

It is to be noted that in the preceding discussion I have frequently used the word "blighted" rather than "grafted" when referring to Lilacs suffering from graft-blight. The reason for this is that in the first place no positive test was ever forthcoming from a grafted Lilac unless it showed moderate to extreme symptoms of graft-blight (yellowing, leaf-curl, leaf-thickening, etc.). During the course of development of the graft-blight symptoms of my experimental grafts of Lilac on *Ligustrum amurense* and *L. ovalifolium* I performed weekly precipitin tests from the time the leaves appeared until the time the symptoms were extreme. The positive precipitin test appeared only when the leaves began to show the acute symptoms mentioned above (136 days after grafting). In the second place the term "blighted" is used because it was found during these studies that the positive test is obtained when the precipitating extract comes from a plant showing symptoms similar to graft-blight, even though the plant has never been grafted. For example, certain types of soil and root deficiency, boring of the canes by Lepidopterous larvae, drought, and various types of local injury produce symptoms sometimes resembling those of graft-blight. And in some of these cases strong positive precipitin tests were obtained, differing in no wise from the tests of Lilacs suffering from acute graft-blight. A few such tests are indicated below:

1. The Lilac "Edmond Boissier," in the preceding table (Table VII) had a history of having been propagated by cuttings in 1921. It was, however, suffering from an unfavorable environment. During the very dry summer of 1929 the leaves became yellow (although the plant recovered the following, moister summer) and the plant resembled in some measure plants suffering from graft-blight. The tests were positive as is seen from the above table. Further tests with the same plant were:

		Tested against normal:
S. vulg. "E. Boissier" (Blighted)	4	*Ligustrum vulgare*
" " "	3	*L. obtusifolium*
" " "	4	*L. ibota*
" " "	3	*Syringa vulg.* "E. Boissier"
" " "	1–3	" " (other varieties)

2. *Syringa vulgaris* "Michel Buchner." This plant was claimed by the propagator to have been propagated from cuttings. It was suffering from acute drought, there having been no rainfall whatever

for nearly six months in the locality from which it had been obtained, as in the Lilac "Edmond Boissier" above. Its reactions were all "4" against *Ligustrum vulgare, L. obtusifolium*, and *L. ibota.*

3. *Syringa vulgaris* "Ranunculiflora" from the same source as No. 2 above and suffering from drought with similar though milder symptoms was negative to the same three Privet species. This was also true of a wild seedling of *Syringa vulgaris* from the same nursery.

4. Another plant, *Syringa vulgaris* "Deuil d'Émile Gallé," similar in symptoms and environment to No. 1 above although suffering from the drought to less extent, gave the following reactions:

		Tested against:
S. vulgaris "Emile Gallé" (Blighted)	t	*Ligustrum amurense*
" " "	2	*L. acuminatum*
" " "	—	*L. ibolium*
" " "	t	*L. macrocarpum*
" " "	2	*L. obtusifolium*
" " "	3	*L. vulgare*
" " "	— to 1	Normal Lilac
" " "	—	Blighted Lilac

5. *Syringa vulgaris* "Mme. Casimir Périer." The plant was in perfect health except for one branch which was notably chlorotic from the depredations of a cane borer. The blighted branch and a healthy branch *of the same plant* were tested with the following results:

(a)		Tested against normal:		(b)
Lilac "Périer"	—	*L. vulgare* (Leaves)	3	Lilac "Périer"
(Healthy branch)	—	*L. vulgare* (Fruit)	2	(Blighted branch)
" "		*L. obtusifolium*	3	" "
" "		*L. macrocarpum*	t	" "
" "		*L. ibolium*	t	" "
" "	-	*L. acuminatum*	3	" "
" "		*L. amurense*	1	" "

6. *Syringa vulgaris* "Louis Henry" was similarly blighted from a root-rotting disease, although according to the records it had not been grafted. Its reactions were:

		Tested against normal:
S. vulgaris "Louis Henry" (Blighted)	4	*L. vulgare* (Leaves)
" " "	3	*L. vulgare* (Fruit)
" " "	4	*L. obtusifolium*
" " "	t	*L. macrocarpum*
" " "	1	*L. ibolium*
" " "	2	*L. acuminatum*
" " "	t	*L. amurense*

7. The reactions of three own-root plants suffering from local root injury and displaying chlorotic symptoms were tested by using both healthy and chlorotic branches from the same plants respectively, with the following results:

		Tested against normal:		
(a)	—	*L. vulgare*	t	(a′)
Lilac "Gigantea"	—	*L. obtusifolium*	t	Lilac "Gigantea"
Local injury	—	*L. acuminatum*	—	Healthy
				Same plant as (a)
(b)	4	*L. vulgare*	—	(b′)
Lilac "Prés. Carnot"	4	*L. obtusifolium*	—	Lilac "Prés. Carnot"
Local injury	2	*L. acuminatum*	—	Healthy
				Same plant as (b)
(c)	1	*L. vulgare*	0	(c′)
Lilac "Prin. Marie"	—	*L. obtusifolium*	0	Lilac "Prin. Marie"
Local injury	—	*L. acuminatum*	0	Healthy
				Same plant as (c)

Thus it is seen from all these examples that the precipitin potency is not an inseparable sequel to the ill effects of grafting, since it may be brought about by purely abiotic factors. In this respect its specificity is seriously thrown open to question. This is all the more striking in contrast to the precise specificity of animal immunology. Apparently the degeneration in the leaf tissue is of such a nature as to alter the precipitating power of the extract derived therefrom, but attractive as is the hypothesis that this is a direct and inseparable reaction of the lilac protein and the privet protein analogous to the reactions of mammalian blood to foreign proteins, one can hardly hold to such an hypothesis in view of the results seen above.

The physical and chemical properties of the extracts were investigated to a limited extent with the following results:

1. The precipitating power of the extracts is independent of the pH of the extracts within very wide limits. This is in conformity with Kostoffs' findings (l. c.) as well as those of animal immunologists (20).

2. Heating of the antigenic extract (normal Privet) momentarily to any temperature between 0° C and 90° C does not destroy the precipitating power if the extract be used immediately. Heating of the antibody extract (blighted Lilac) momentarily to any temperature between 0° C and 100° C does not destroy the power of the extract of being precipitated if the extract be used immediately. This is not in accordance with the situation in animal immunology where the sera are relatively sensitive to heating and where the precipitating powers are usually destroyed long before 90° or 100° C is reached.

3. The reaction is similar, though a little weaker, if 10% NaCl solution is used as a solvent of the antigen rather than distilled water.

4. In one experiment, boiling, acidification, and filtration of the resulting precipitate did not lessen the precipitating potency of the antibody extract of graft-blighted Lilac.

5. The extracts automatically precipitate themselves if kept at room temperature in from a few hours to several days. The antibody extracts autoprecipitate very easily, the antigenic extracts less easily. This proved to be one of the greatest technical difficulties in the work.

6. The proteins of the leaf extracts differ from animal proteins in a number of ways as was first pointed out by Osborne (27). Thus they are hydrolized by .3% NaOH, are densely precipitated by the addition of 20% alcohol, and do not precipitate strongly when treated with weak acids.

7. It may be remarked parenthetically that as a by-product of this work with extracts it was found that oospores of the lilac fungus *Phytophthora Syringae* are produced abundantly in sterile lilac leaf extracts, although their production is difficult in many cases by the use of the ordinary techniques.

In addition to the precipitin experiments outlined above, I also performed a series of lytic tests, working on the theory that even though the mixture of two protein extracts did not result in visible precipitates, yet there might be a disruption of the foreign protein molecule into various cleavage products which might be demonstrated by a suitable technique. This type of defensive reaction is found in animals, and it would not be extraordinary to find its homologue in plants.

As a reagent I used Ninhydrin (Triketohydrindene hydrate) (1, 32) in a 1% aquatic solution. This is a test for a number of protein cleavage products. Its delicacy is so great that in my preliminary tests I was able to get a positive test with peptone in a dilution of 1:50,000. However, as far as I went with the use of this reagent, my results were negative. This does not necessarily mean either that the technique is not applicable here or that there is no lytic disintegration of the foreign protein molecule, as the scope of my work on this head was not sufficiently extensive to warrant such conclusions.

A consideration of the foregoing data leads one to a choice of two interpretations. Either (a) the reactions manifested by the extracts of the Oleaceae represent purely physical phenomena and are independent of any specific immunological property, or (b) we have here true immunological phenomena but differing markedly from the phenomena of animal immunology. The facts that the reactions are non-specific and that the precipitin reaction may be reproduced in all detail by purely physical means are evidence for a physical interpretation of the reactions. On the other hand, they are independent of both pH and concentration of extracts, which would not be expected if they were purely physical. Alternately, the reactions may be truly immunological. The protein molecule of the healthy plant has undergone a certain decomposition in the degenerative processes exhibited in the blighted plants considered, and it is conceivable that under such conditions the resulting cleavage products might possess immunological properties different from those of the original protein molecule from which they have been derived. Yet if the reactions are truly immunological they are certainly radically different from the phenomena of animal immunology, as witness the reactions of plants blighted because of external environmental factors.

It is not possible at present to decide definitely which of the two alternatives is applicable here, nor to dogmatize upon the subject. However, this much may be said. The great differences in the circumstances attending the reactions from those in animal reactions (as impurity of the extracts, different types of proteins, relatively great dilution of proteins, greater sensitivity of the animal as made possible by the circulation of the blood) are sufficient to cause one to expect a somewhat different display of immunological phenomena. As yet the technique is crude. One deals with an extract of varying concentration and chemical constitution, an extract which is a conglomeration of many substances, probably of constantly fluctuating composition. It is rather surprising that one does obtain consistent results under these conditions.

From the evidence with regard to immunological phenomena in the Oleaceae as outlined in the preceding pages, a number of conclusions may be drawn:

1. The technique of plant immunology, with certain modifications, is shown to be applicable to a study of the lilac-privet graft.

2. Normal precipitins are not demonstrable within the species of Oleaceae considered and according to the technique employed.

3. Strong acquired precipitins are found in the leaves of Lilacs suffering from severe typical graft-blight.

4. The acquired precipitins show little specificity within the limits of these experiments.

5. Analogous or identical reactions may be obtained from the leaves of Lilacs suffering from blight due to other causes. This fact offers an hitherto uncontrolled source of error in plant immunology as investigated along these lines.

6. Neither normal nor acquired lysins were demonstrated in the Oleaceae, although the possibilities in this field have by no means been exhausted.

7. The grafting of Lilac upon Privet results in symptoms of disease in the crown and also results in pronounced changes in the immunological properties of the leaf-extracts. The precise nature of the relation between these phenomena is not yet understood, because of a lack of fundamental knowledge of the exact limits and nature of the precipitin reaction.

8. The immunological technique is not diagnostic of graft-blight, but it is diagnostic of a type of crown disease which may be due to a number of causes, including incompatible grafting.

9. The application of plant immunological technique to a study of the normal and morbid physiology of plant tissues would probably be fruitful in the light of these experiments.

VI. PRESENT STATUS OF LILAC PROPAGATION

Having determined the cause of graft-blight it was next desirable to take up the subject of the control of the disease. However, in order to accomplish this end most effectively, it was of value first to make a brief survey of the present status of the lilac industry in America and Europe. The purposes of the survey were to determine how Lilacs are being propagated, why they are so propagated, the state of mind of the growers with regard to lilac propagation, and the economic situation with regard to the lilac industry.

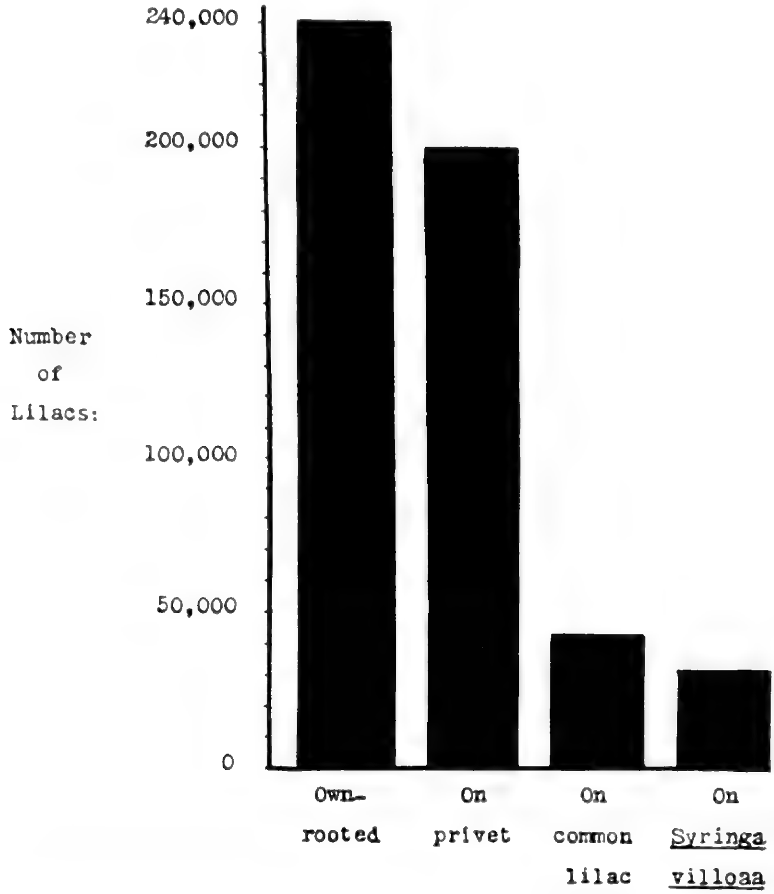
With these purposes in mind, a questionnaire was sent to all the important lilac propagators and experts in the United States, as well as to a number of the leading, representative growers in Canada and Europe. The results exceeded all expectations. Complete replies were received from fifty-two of them. These fifty-two propagators are at present engaged in the growing of nearly a million lilac plants. That they comprise a representative cross section of the lilac industry in America and Europe is seen from their distribution, which is as follows:

United States: Cal. 1; Col. 1; Conn. 1; D. C. 1; Ga. 1; Ill. 3; Mass. 6; Mich. 2; Minn. 1; N. J. 4; N. Y. 6; Ohio 2; Ore. 1; Pa. 4; Tenn. 1; Vt. 1; Wash. 1	37
Canada	2
England	5
France	1
Germany	2
Holland	4
Switzerland	1
	52

The most significant questions proposed in the questionnaire were: (1) What are the methods of propagation practiced by you in growing Lilacs? (2) What success has been attained in the various methods practiced? (3) How much time is required to produce a two-foot plant by the methods employed? (4) What is the retail price at which a two-foot plant must be sold to afford a reasonable profit? (5) What methods of propagation have you found undesirable and why? (6) What is your opinion with regard to own-rooted versus privet-rooted Lilacs? (7) If you use Privet as an understock, how long does it take for the plants to get on their own roots, in general? (8) Have you observed any weakness or diseased condition in Lilacs which you think might be traceable to the method of propagation? (9) If cost were not a factor, how would you propagate lilacs? (10) Approximately how many Lilacs have you in all stages of cultivation? The answers to these questions brought out several striking and hitherto unknown facts with regard to the lilac industry.

It is to be borne in mind that in this, as in all similar collections of data, one must appreciatively weigh the opinions of the correspondents on unproved matters. However, with regard to some details, the data can be accepted without reserve, as for example those matters of actual practice in vogue, and of cost of production. The replies to the questions asked of the nurserymen are considered at this point.

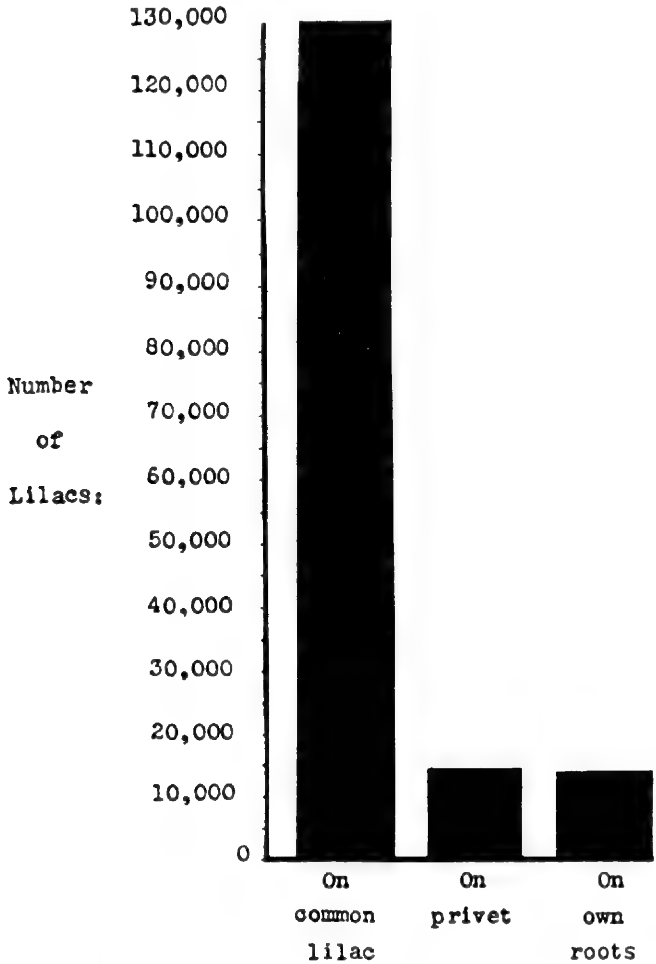
It was necessary to know at the outset what methods of lilac propagation are actually being employed today. It was found that in the United States Lilacs are being propagated commercially by a large number of methods with each method capable of numerous modifications. Lilacs are being propagated by various own-root methods comprising rearing from seed, suckers, layers, hard-wood cuttings, and soft-wood or green-wood cuttings, and in contrast to these methods by budding, piece-root grafting, and top-grafting on the various stocks: *Syringa vulgaris*, *S. villosa*, *Ligustrum ovalifolium*, *L. ibota*, *L. sinense*, *L. vulgare*, and *L. ibolium*. Growing Lilacs from seed is limited for the most part to the "pure" species of Lilacs, as the named varieties do not come true from seed. Propagation by suckers and layering is very limited, being employed only on a very small scale because of the large number of parent plants required. The use of hard- and green-wood cuttings is very extensive, the details of the practice differing, however, with individual propagators. All these methods give own-root plants in which the questions of incompatibility and the suckering of the foreign rootstock do not enter. Nurserymen are divided in their opinion as to the desirability of joining a lilac crown with a foreign root. Budding is economical of the wood of the named variety; top-grafting is easily done at a time when the nurseryman is relatively free of other duties and rapidly produces good-sized plants; root-grafting gives the minimum assistance from the foreign root-system, and hence is least pernicious from the standpoint of incompatibility. As is seen, the stocks employed vary widely. Of all these methods, however, the three outstanding types of lilac propagation are: (1) propagation by own-root methods (which involves almost entirely



TEXT FIGURE 1. Graph showing the ratio of Lilacs propagated by the various methods in actual practice in the nurseries of America. Compiled from questionnaire data.

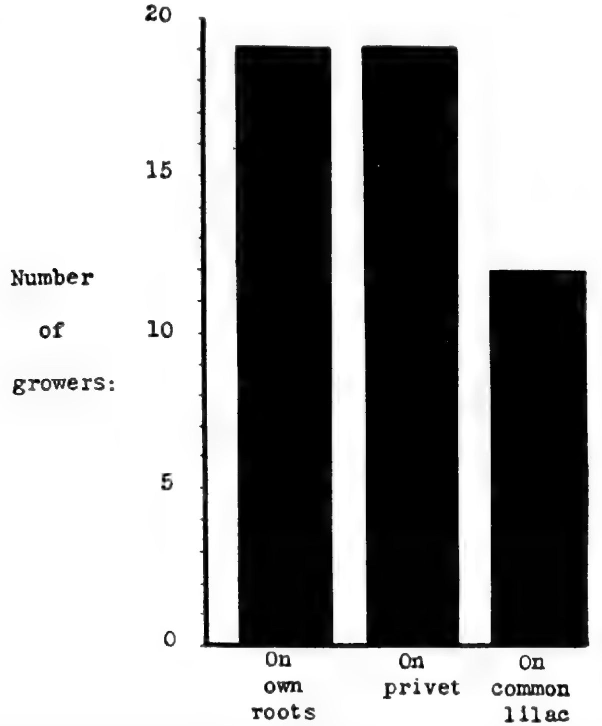
the use of cuttings), (2) propagation by budding, top-grafting, or root-grafting onto some species of Privet, generally *Ligustrum ovalifolium*, and (3) propagation by budding, top-grafting, or root-grafting onto the common Lilac, *Syringa vulgaris*.

These three main types of propagation indicated are employed in the United States according to the proportions represented in the graph in Text figure I. The proportions will appear very surprising to many who are acquainted with the lilac industry, since it is a common belief among lilac fanciers that the majority of Lilacs in this country are grown on privet roots. But since the questionnaire



TEXT FIGURE II. Methods of lilac propagation employed in Europe. The striking difference between this and the preceding figure is explained in the text. Compiled from questionnaire data.

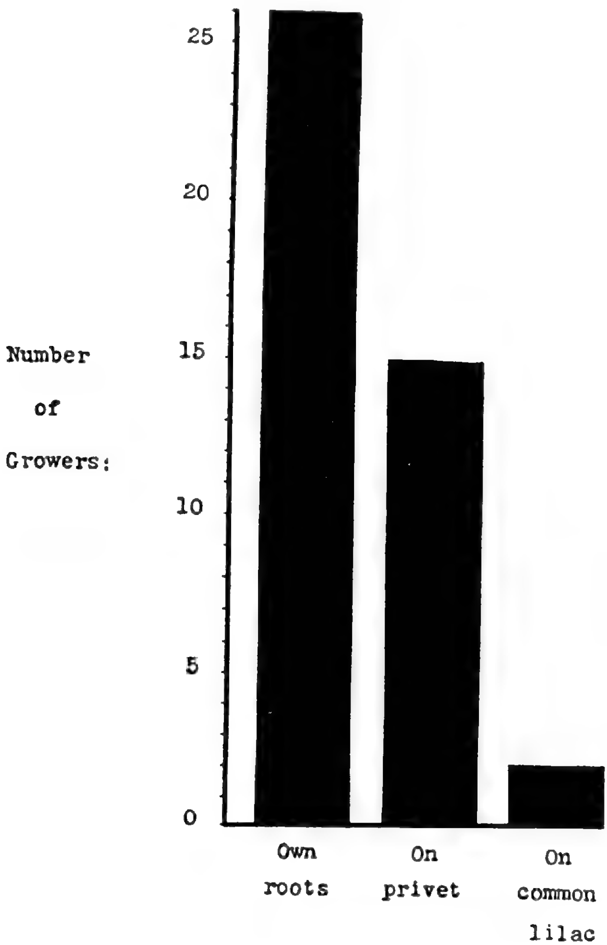
is of such scope as to be representative of the lilac industry in America, the results are incontestable. The essential point to be drawn from the graph is that there are at least as many Lilacs grown in America by own-root methods as on Privet. This fact stands in distinct opposition to statements found in the horticultural literature, such as, "American nurserymen are now almost universally using California Privet (as a lilac understock)" (39, p. 34), and "growing Lilacs from cuttings has been almost discontinued except in a very few nurseries" (39, p. 33). The data presented likewise show incontrovertibly that lilac propagation by own-root methods (that is, by the use of cuttings) is commercially practicable, since it is already employed on a large scale under existing conditions.



TEXT FIGURE III. Methods of lilac propagation actually employed in America and Europe today. Compare with the following graph. The difference in the graphs of Text figures III and IV represents a body of nurserymen who recognize the superiority of own-root Lilacs but are unable to produce them because of the competition with those growers who insist on using the cheaper privet method.

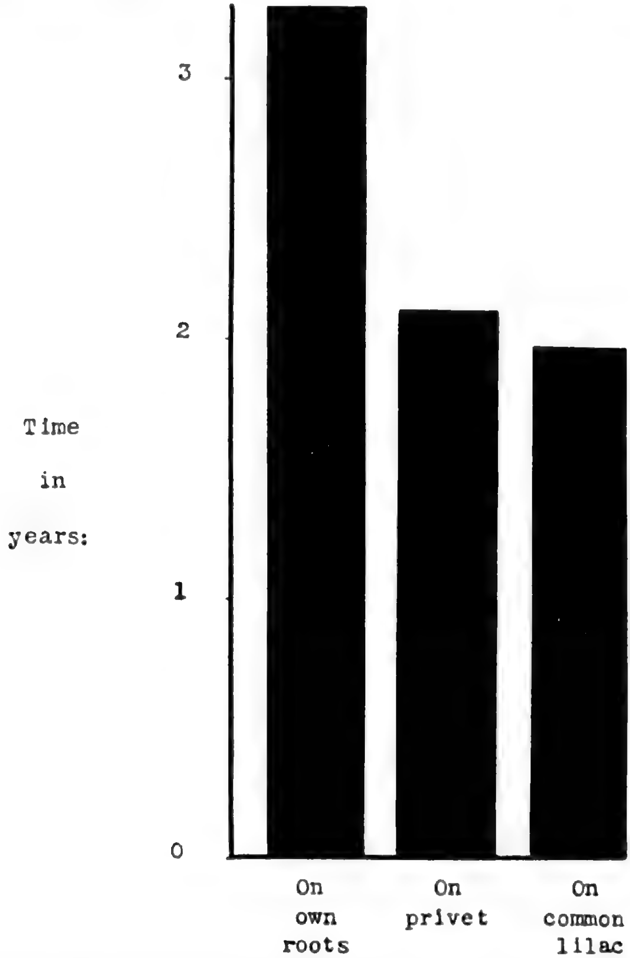
In Europe the situation is somewhat different, since the commerce in cut blossoms assumes greater proportions and the requisite is speed in production of blossoms, and not necessarily long-lived plants. Forcing the Lilac by heat, chemicals, etc., is extensively employed, and hence it has been found that propagation by means of grafting or budding onto the common Lilac fulfills the requirements in the majority of cases. The actual situation in Europe is shown in Text figure II.

The reason for the employment of Privet as a lilac understock is an economic one, as is quite apparent from a study of the data presented in Text figures III and IV. Text figure III represents the actual prevailing situation with regard to the number of propagators using the various methods of propagation considered. Text figure



TEXT FIGURE IV. Methods of lilac propagation which would be employed by the propagators of America if it were not for the additional expense of propagation on own roots.

IV, on the other hand, represents the relative number of propagators who would use the respective methods were it not presumably impossible for them to leave out of consideration the fact that own-root propagation is slower and more expensive. It will be seen from a comparison of the two graphs that there is a considerable number of propagators who are using Privet as a lilac understock because they are forced to by the economic stress of competing with producers who use the cheaper privet method. These propagators would turn to own-root methods if they could afford it, since they recognize the superiority of the own-root plant. On the other hand,

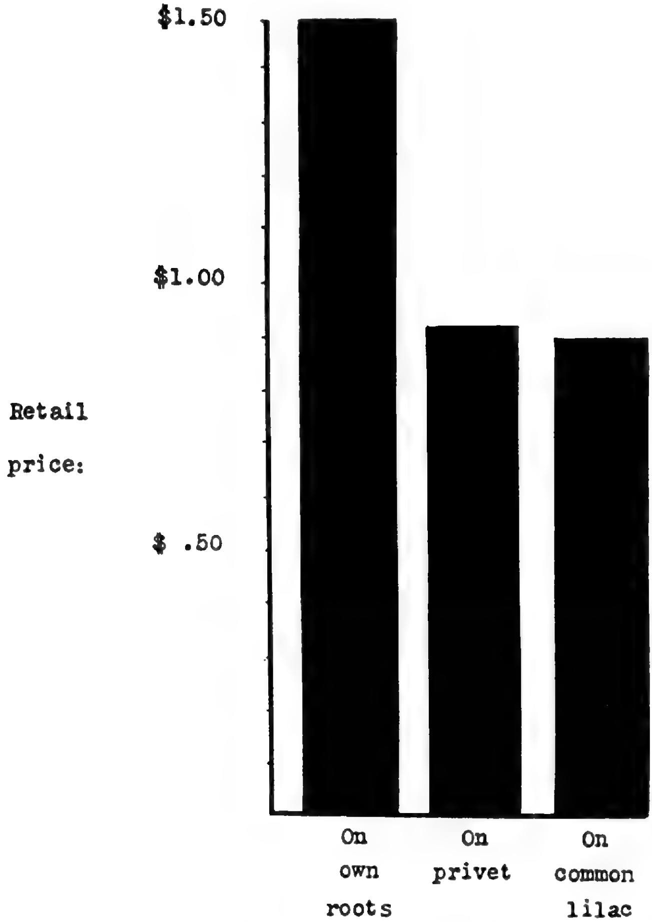


TEXT FIGURE V. Relative time required to produce a two-foot lilac plant by the methods of propagation indicated. Compiled from questionnaire data. Discussion in the text.

there is a certain body of nurserymen who fail to perceive the superiority of the own-root Lilac, and are content with the privet method.

A measure of the greater cost of growing Lilacs by own-root methods is afforded by a consideration of Text figures V and VI.

Text figure V gives the actual ages of marketable Lilacs as grown by the various methods of propagation. It will be seen that the own-root Lilac is in the nursery about a year longer than the grafted Lilac. If this be translated into dollars and cents (Text figure VI) it will be seen that the own-root Lilac costs about sixty cents per plant more than the grafted Lilac, the sixty cents representing the



Text figure VI. Relative cost of production of a two-foot lilac plant propagated according to the methods indicated. Compiled from questionnaire data. Discussion in the text.

additional year of care in the nursery. It will be noted that Text-figures V and VI are almost superposable, which indicates the intimate relation between speed of production and cost of production.

Turning now to the question of the percentage of success of Lilacs as propagated by the various methods, we find the experience of the nurserymen rather at variance. In budding or grafting, whether on lilac roots or on Privet, most propagators obtain from 80% to 100% of saleable plants from the original number of plants budded or grafted, the percentage being fairly uniform. But with respect to the use of cuttings, the results are hardly so consistent. In general those nurseries which propagate by cuttings on a large scale show creditable percentages of plants from the number of cuttings planted in the soil. Those which use the method as an alternative or in a small way often report rather low percentages. Some of these percentages are given to illustrate this point.

Reported percentages of saleable plants:

Softwood cuttings:—0–75; 20–40; 25; 49; 50; 50; 60–75; 65; 72; 75; 75; 75–100; 80; 80; 89; 90; 100; 100.
Hardwood cuttings:—15; 15; 25; 40; 75; 90; 100.

Some propagators find that one type of cuttings is desirable, the other wholly undesirable. In part this is due to equipment, because bottom heat in the greenhouse bench is an almost necessary adjunct to the rooting of lilac cuttings. But it is sufficient to say that the rooting of cuttings by one means or another can be accomplished with a high degree of success, and is being done by a number of large nurseries. Since this is so, failure in the rooting of cuttings is due to faulty technique on the part of the operator and does not justify condemnation of own-root methods of lilac propagation.

It is very apparent to one who has dealt with this question that the method of propagation of Lilacs is an open and live problem to nurserymen. Opinions are at variance, and accordingly it was to be expected that in a survey such as was carried out in connection with this study a great many contradictory statements should be obtained. Such was the case. It would be interesting to include here some of the various remarks on both sides of this question which have been received in correspondence; but space forbids such an inclusion. In lieu of this I can only state that many of the nurserymen are cognizant of a weakness in lilac plants resulting from the privet-grafting procedure. Many others feel that the lilac-privet graft is a desirable method of lilac propagation if and only if the Lilac is able to produce a scion root-system. Almost no propagator will argue that a Lilac is satisfactory unless it does produce scion roots, although many experienced nurserymen contend that the grafted plant does get on its own roots, and adhere to the privet method because of its relative apparent economy in comparison with own-root methods. Bearing this in mind, the following section will deal with an analysis of the desirable and the undesirable points of the various methods of lilac propagation in order to give a background for the recommendations for the control of lilac graft-blight.

VII. CONTROL OF LILAC GRAFT-BLIGHT

The legitimate evidence for and against the various ways of propagating Lilacs as gleaned from the questionnaire as well as from my own observations and experiments is here briefly stated:

A. PROPAGATION BY BUDDING OR GRAFTING ON COMMON LILAC

For the production of ornamental shrubs, the practice of grafting or budding upon common Lilac is undesirable. Opinion is nearly unanimous among nurserymen that under such conditions the danger of suckers from the grafted rootstock is so great as to eliminate this method from consideration. To the amateur these suckers are indistinguishable from the named variety. They soon devitalize the scion and completely choke out the named variety. This method does have the advantages of being rapid, cheap, and offering perfect compatibility, and is practical in those cases in which the Lilacs do not leave the hands of trained nurserymen, as in the forcing industry of Europe, but under American conditions the sucker nuisance is sufficient to outweigh any of the advantages of the method.

B. BUDDING OR GRAFTING ON SPECIES OF SYRINGA OTHER THAN S. VULGARIS

In some cases it is evident from my grafting experiments indicated in section IV, that a relatively moderate incompatibility exists between the common Lilac and the other Lilac species. Until a Syringa stock is proven to be compatible and at the same time shown to be either free from the sucker habit or producing suckers which can be easily recognized as such, until such a stock is found and is obtainable in sufficient quantity, the species of Syringa may be eliminated from consideration as understocks for Lilacs. *Syringa villosa* is claimed to have been used successfully for this purpose; but according to my experience with this stock it is rather questionable whether its use is justified in view of the moderate degree of incompatibility manifested by grafts of *S. vulgaris* on *S. villosa*. *Syringa japonica* falls into the same category.

C. BUDDING OR GRAFTING ON FRAXINUS, CHIONANTHUS, AND FORSYTHIA

Fraxinus, *Chionanthus*, and *Forsythia* have proven to be so completely incompatible with Lilac as to eliminate them from consideration as lilac understocks.

D. BUDDING OR GRAFTING ON LIGUSTRUM SPECIES

No species of *Ligustrum* has been shown to be more compatible with Lilac than *L. ovalifolium*. Hence the elimination of *L. ovalifolium* on the grounds of incompatibility automatically eliminates all the other species of Privet considered in this paper. The use of Privet has the advantages of being very rapid, hence cheaper, of requiring less skill than propagation by the use of cuttings, and of being more conservative of the wood of the plant supplying the scions. It has a number of disadvantages as compared with own-root methods, which more than offset the advantages. Chief among these is a greater or less incompatibility, resulting in shorter life of the scion, weaker growth, and unsuitability for forcing. In addition to this there are the disadvantages of the tendency on the part of the privet stock to sucker, its relative susceptibility to cold, and its susceptibility to certain parasites, such as the crown-gall bacterium and the privet borer. Finally, in some cases at least, it has been found that the union of Lilac and Privet results in a graft association which is mechanically weak and easily broken by accident.

If the lilac scion rapidly threw out roots after it had been grafted on Privet, it would soon become independent of the privet stock. Such does happen in some cases, but very frequently no attempt is made by the scion to root itself, at least until years after the grafting procedure. The statements that Lilac grafted on Privet are on their own roots within two or three years are erroneous, being founded on untested opinion. This question was included in the lilac questionnaire and the replies were far from uniform. Individual estimates ranged from "one year" to "never," and almost no two propagators agreed as to the length of time consumed before the grafted Lilac is independent of the privet stock.

Many lilac root-systems were examined in the course of this study. These showed that only in exceptional cases is the lilac root-system well developed soon after grafting. An examination of the root-systems of one shipment of thirty-three typical Lilacs from a nursery which claims that its Lilacs are on their own roots within two years after grafting on Privet, showed well over half still almost completely dependent on the privet stock at the end of this time. Compare Figures 7 and 8 (Pl. 34) in this respect, which illustrate two representative Lilacs from this particular shipment.

As a matter of fact there are great differences in the technique of grafting and the method employed exerts a definite influence on the matter of scion-root formation. Thus one nursery which buds Lilac onto Privet never brings the scions nearer than two inches above the soil before the Lilacs are sold. The consumer is instructed to bury the Lilacs considerably deeper than they stood formerly. Such Lilacs are very slow in forming scion roots and exhibit a high incidence of graft-blight. In other cases the budding or grafting is above ground but the Lilacs are progressively buried deeper until the scions lie well below the surface. Chances for own-rooting are greater here, although there is still a high incidence of graft-blight. Finally some propagators merely graft a small piece of a privet root to the scion and plunge the whole into the soil. This method is least pernicious of all, but does not completely eliminate the blight.

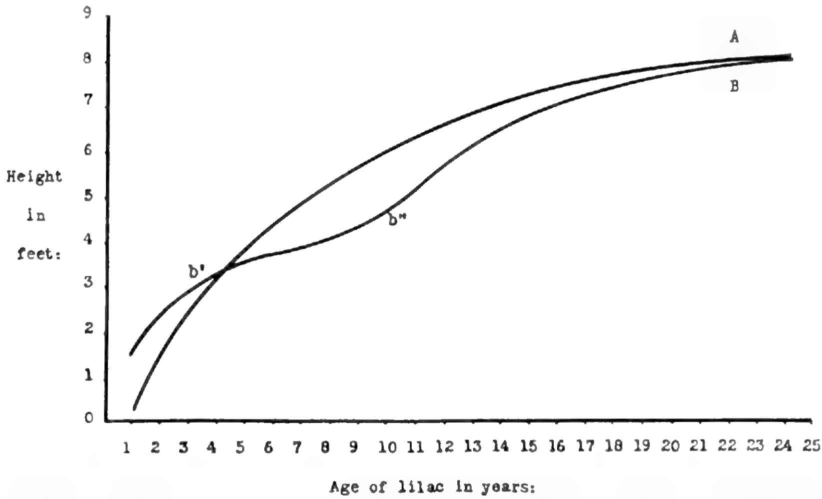
The essential point is that no matter what care be taken to induce the scions to form their own roots, they do not always do so, and *even in the most carefully handled privet-grafted plants, the incidence of graft-blight is sufficiently high to prohibit the use of Privet in lilac propagation in any form hitherto employed.*

I say "in any form hitherto employed" because it is conceivable that the privet method might be so modified as to be safe, although this would involve a little care on the parts of both the propagator and the consumer. This could be accomplished by some method which would eliminate the privet root bodily after it had served its purpose of carrying the Lilac over to the point where it had started to form its own roots. Two methods of doing this are suggested: (a) The propagator could feel sure of the future health of his plants, as far as graft-blight is concerned, if he would clip away the old privet rootstocks completely before the plants are sold. The crowns would have to be cut back proportionally, and this method could only be used when the scions had started root-formation. Since the own-rooted plant from cuttings is not much slower in getting started than the privet-rooted plant if the latter must be cut back severely, this plan might not show much advantage over the own-root methods. (b) The other method suggested is as yet theoretical but worthy of trial. If at the time of propagation the graft union be bound with wire, firmly but not too tightly, then as the plant grew the privet root would become automatically cut off. The Lilac would be forced either to form scion roots or to perish. This is an alternative worthy of serious consideration by those who insist on using Privet in lilac propagation, but it has not been proven as yet.

E. PROPAGATION BY THE USE OF HARD- AND SOFT-WOOD CUTTINGS

This method has the disadvantages of being slower and hence more expensive, of requiring greater skill, and of taking more "mother wood" for the production of a given number of plants. It has the advantages of absolute freedom from incompatibility, resulting in longer life and better, stronger plants. There is never danger of suckers from a foreign rootstock choking out the plant or of confusing the named variety with the rootstock variety. It is practical. With care a high percentage of plants can be obtained. In the Arnold Arboretum during the past few years successful propagation by cuttings has been employed with fifteen species of *Syringa* and more than one hundred varieties of *S. vulgaris*. Of all the varieties of *S. vulgaris* in which the method was employed, 95.2% were rooted successfully from cuttings. Hence there is no justification for the omission of the use of cuttings in lilac propagation on the grounds that it is impractical or unsuccessful.

In answer to the chief argument advanced against the use of own-root methods, namely that the growth of own-root plants is rela-



TEXT FIGURE VII. Growth curves of Lilac propagated by own-root methods (A) and by budding or grafting on Privet (B). Curves constructed from measurements of more than 500 Lilacs of all ages during the years 1928–1930. Curve B does not represent the growth of individual plants but rather the totality of growth of many grafted plants. Discussion in the text.

tively very slow as compared with that of grafted plants, it is desirable at this point to take up the matter of comparative rapidity of growth of grafted and own-root Lilacs in some detail.

It is self evident that Lilacs grown from cuttings are slower in getting a start than budded or grafted plants. Wister (39) represents this same situation in graphical form. But it has been pointed out earlier in this paper that sooner or later there is a checking effect in many of the privet-grafted plants. This fact has occasioned the question: Do the own-root Lilacs ever equal or surpass the privet-rooted Lilacs? The answer to this question is found in Text figure VII, which represents the normal growth curve of Lilac plants propagated on own roots as compared with the growth curve of privet-rooted Lilacs. It is seen that at the age of two or three years, the normal selling time for lilac plants, the grafted plant is about a foot taller than the own-root plant. But as the privet-rooted plant reaches the age of three or four years the graft-blight begins to manifest itself. Numerous plants fail to make any growth at all. And the result as shown by the figure is that the own-rooted Lilacs attain the same size as the grafted plants in approximately four to five years on the average. From this time forth until maturity the own-root plants are larger and in every way superior to plants which have been propagated on Privet. From the fifth to the tenth years many of the privet-rooted plants die out, many others are culled out as being unworthy of further care, while some recover from the blight. The result of all these factors is to cause the privet-graft curve to rise again, till at maturity the two kinds of plants are indistinguishable, although there has been a heavy mortality in the privet-grafted plants. It must always be borne in mind that isolated plants may not follow this curve. Some grafted plants soon form scion-root systems and follow the normal curve. Many others never reach maturity. The technique of grafting or budding has an effect which has already been considered. But the significant fact to gain from these data is that *in general the own-root plant does overtake the privet-rooted plant, and surpasses it in size and desirability.* The time at which the own-root Lilac overtakes the privet-rooted plant is not until after the plants have left the hands of the producer and are in the garden of the consumer. This fact in no way lessens the responsibility of the nurseryman, whose interest ideally lies in his plants throughout their entire life, yet it tends to obscure the importance of the root-constitution of his Lilacs since the extreme symptoms are not seen in the nursery by the propagator but in the private planting by the purchaser.

F. RECOMMENDATIONS

Having analyzed the various methods of lilac propagation, it seems fitting to close this paper with the following recommendations for the control of the lilac graft-blight:

1. Own-root methods of lilac propagation are unhesitatingly recommended as being unquestionably sound, practical, and in the long run economical.

2. Propagation on *Syringa vulgaris* rootstocks is not considered justified because of the sucker difficulty, at least under American conditions.

3. The use of Privet as a lilac understock should be abandoned unless a method is adopted, such as has been suggested, which will eliminate the privet root-system before the plant is sold.

4. If the consumer can be led to see the desirability of own-root plants, and if the producer will look beyond the immediate present and have regard for the welfare of his Lilacs after they leave his hands, then the consumer will be willing to pay the slightly higher price for his own-root plants, and the producer will not tolerate the production of any but permanent plants. Hence an important feature of any program of elimination of the lilac graft-blight is the education of the consumer to demand permanent plants and of the nurseryman to produce them.

VIII. SUMMARY

1. The present paper describes an unrecorded and destructive disease of the common Lilac, *Syringa vulgaris*, to which I have given the name "Graft-blight" of Lilac.

2. The disease is found to be widespread throughout the United States and of sufficient severity to occasion the loss of many thousands of prized Lilacs every year.

3. The symptoms are those of general nutritional deficiency, characterized by a progressive yellowing of the leaf margins and intervenous spaces, reduction in the size and number of the leaves, brittleness and curling of the leaves, premature or abnormally late leaf fall, and the resulting stunting of the growth of the plant as a whole. Since the effects are cumulative from year to year, the possibility of recovery is very limited.

4. The disease is proved to be independent in its causation of any parasitic organism or contagious principle. It is likewise shown to be relatively independent of the external environment.

5. The use of Privet (*Ligustrum* species) as a grafting understock is demonstrated to be the cause of the symptoms indicated. This conclusion is reached through an extensive observation of Lilacs in the field as well as through the reproduction of the disease in carefully controlled experiments. The symptoms are found to be precisely correlated with the use of certain species of privet understocks in propagation.

6. The chief undesirable factor in the lilac-privet graft is considered to be a discrepancy in the vigor of growth of the two graft symbionts which is caused or aided by the interruption of elaborated substances in their passage from the crown to the root-system, although that there are other physiological factors involved is apparent from a consideration of the experimental results.

7. In an attempt to shed some light on the problem of graft incompatibility in the Lilac, the precipitin technique was applied to the lilac-privet graft. The methods and experimental results are described in detail. A total absence of normal precipitins was found in the Oleaceae. Graft-blighted plants exhibited a high precipitin potency which, however, was non-specific within the limits of this study. A possible explanation of this lack of specificity is advanced. Although the subject of plant immunology is still so problematical as to render definite conclusions difficult, these experiments serve their purposes of extending the field of plant immunology by focussing attention on a hitherto unconsidered variable—the state of health of the tissues involved, and of the development of the precipitin reaction as related to morbidity of the plant cell.

8. By means of a questionnaire submitted to most of the leading lilac growers in America and some in Europe, it was possible to determine with accuracy the present status of lilac propagation with regard to such points as present methods of propagation, their relative desirability, and relative cost of production of Lilacs according to the various methods of propagation employed.

9. On the basis of a comparative analysis of the possible methods of lilac propagation, a number of recommendations for the elimination of lilac graft-blight have been made. These recommendations include the abolishment of the use of Lilac as understock, the discontinuance or modification of the use of Privet in this capacity, the encouragement of the use of own-root methods, and the education of the consumer and the producer as to the greater desirability of own-root Lilacs.

IX. ACKNOWLEDGMENTS

The investigation reported in this paper centered in the laboratory, greenhouses, and outdoor plantings of the Arnold Arboretum. I am grateful to Professor J. H. Faull for direction and encouragement throughout the entire investigation. I am also under obligation to Dr. E. H. Wilson, late Keeper of the Arnold Arboretum, for numerous suggestions, to Professor E. M. East for suggestions with respect to the immunological experimentation, to Mr. Wm. Judd for technical assistance in lilac propagation, and to the lilac propagators who made possible the compilation of data regarding the present status of the lilac industry.

X. LITERATURE CITED

1. ABDERHALDEN, E. & H. SCHMIDT (1911). Über die Verwend. von Triketohydrindene hydrate, usw. (Zeit. Phys. Chem. **72**: 37.)
2. ANONYMOUS (1909). The grafting or budding of the lilac. (Gard. Chron. ser. 3, **45**: 250.)

3. BAUR, E. (1906). Weitere Mitteilungen über die infectiose Chlorose der Malvaceen und einige analoge Erscheinungen bei Ligustrum und Laburnum. (Ber. Deutsch. Bot. Gesell. **24**: 416.)
4. ——— (1907). Ueber infectiose Chlorose bei Ligustrum, Laburnum, Fraxinus, Sorbus, und Ptelea. (Ber. Deut. Bot. Gesell. **25**: 410.)
5. BRADFORD, F. C. & B. G. SITTON (1929). Defective graft unions in the apple and pear. (Mich. Agr. Exp. Sta. Tech. Bull. 99.)
6. ——— (1929). Errors in methods cause faulty graft unions. (Quart. Bull. Mich. Agr. Exp. Sta. **12**: 58.)
7. CARBONE, D. & C. ARNAUDI (1930). L'immunità nelle piante. (Monogr. dell'Inst. Sieroterap. Milanese.)
8. CHESTER, K. S. (1930). Graft-blight of lilac. (Jour. Arnold Arb. **11**: 232.)
9. CRAIG, J. (1897). Lilac on privet stock. (Gard. & For. **10**: 208.)
10. DENNY, F. E. & E. N. STANTON (1928). Localization of response of woody tissues to chemical treatments that break the rest period. (Am. Jour. Bot. **15**: 337.)
11. DUNBAR, J. (1915). History, development, and propagation of the lilac. (Ann. Rept. Hort. Socs. Ont. **10**: 75.)
12. EAST, E. M. and W. H. WESTON (1925). Report on the sugar cane mosaic situation in Feb. 1924 at Soledad, Cuba. (Harvard Univ. Press, Boston. (Ref. page 15.)
13. GLEISBERG, W. (1927). Anatomische Vorgänge und krankhafte Erscheinungen an Veredlungen. (Der Obst und Gemüsebau **5**: 6.)
14. ——— (1930). Die wichtigsten Umpfropfkrankheiten. (Flugbl. Reichsverb. deutsch. Gartenb. 15.)
15. HAVEMEYER, T. A. (1928). *In* McKelvey: The lilac. (see below): 519.
16. KLEBAHN, H. (1909). Die Krankheiten des Flieders. (Geb. Borntraeger, Berlin.)
17. KOSTOFF, D. (1928). Induced immunity in plants. (Proc. Natl. Acad. Sci. **14**: 236.)
18. ——— (1929). Acquired immunity in plants. (Genetics, **14**: 34.)
19. LAUBERT, R. (1914). Über die Blattrollkrankheit der Syringen und die dabei auftretende abnorme Stärkeanhäufung in den Blättern der kranken Pflanzen. (Gartenflora, **63**: 9.)
20. MASON, V. P. (1922). Relation of pH to specific precipitation. (Johns Hopkins Hosp. Bull. **33**: 116.)
21. MCKELVEY, S. D. (1928). The lilac. (McMillan Co., Boston.)
22. MEZ, C. (1922–). Anleitung zu sero-diagnostischen Untersuchungen für Botaniker. (Bot. Arch. **1**: 177–200 and following issues.)
23. ——— (1924). Serum-reactionen zur Feststellung von Verwandschaftsverhältnissen im Pflanzenreich. (Abderhalden, Handb. der Biol. Arbeitsmethoden. Abt. XI, Teil 1: 1059–1094.)
24. ——— und H. ZIEGENSPECK (1926). Der Königsberger sero-diagnostische Stammbaum. (Bot. Arch. **13**: 482.)
25. MOLYNEUX, E. (1909). Lilacs. (Gard. Chron. Ser. 3, **46**: 16.)
26. NEGER, F. W. (1924). Krankheiten unserer Waldbäume: 46.
27. OSBORNE, T. B. (1924). The vegetable proteins. Ed. 2. New York.
28. PEICKER, W. (1903). Meine Wahrnehmungen über eine eigentümliche Krankheitserscheinung an *Syringa vulgaris*. (Mitt. deut. dendrol. Gesell. **12**: 107.
29. PROEBSTING, E. L. (1926). Structural weaknesses in interspecific grafts of Pyrus. (Bot. Gaz. **82**: 336.)
30. ——— (1928). Further observations on structural defects of the graft union. (Bot. Gaz. **86**: 82.)
31. RHOADS, A. S. (1930). Devitalization of trees on lemon rootstocks. (Pl. Dis. Reporter **14**: 169.)

32. RUHEMANN, S. (1910). Triketohydrindene hydrate (Ninhydrin). (Trans. Chem. Soc. **97**: 2025.)

33. SORAUER, P. (1914). Manual of plant diseases. Ed. 3, Vol. I: Nonparasitic diseases. Dorrance translation. p. 284.

34. TAKENOUCHI, Y. (1929). Physiologisch-anatomische Untersuchungen über die Pfropfversuche von Tee und einige andere Pflanzen. (Jour. Soc. Trop. Agr. Japan, **1**: 253.)

35. "W" (1909). Grafting or budding the lilac. (Gard. Chron. ser. 3, **45**: 267.)

36. WAUGH, F. A. (1904). The graft union. (Mass. Agr. Exp. Sta. Tech. Bull. 2.)

37. WEBBER, H. J. (1926). Rootstock reactions as indicating the degree of congeniality. (Proc. Am. Soc. Hort. Sci. **23**: 30.)

38. WILSON, E. H. (1928). *Syringa vulgaris*, etc. (Arn. Arb. Bull. Pop. Info. (Ser. 3) **2**: 32.)

39. WISTER, J. C. (1930). Lilac culture. (Orange Judd Publ. Co. New York.)

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January 8, 1931.

EXPLANATION OF PLATES 31 TO 34

Fig. 1. Healthy Lilac, variety "Leon Matthieu," seven years of age. An own-rooted plant for comparison with Fig. 2.

Fig. 2. Lilac of the variety "Arthur William Paul," aged seven years. A typical and severe case of graft-blight. In contrast with Fig. 1, this plant is grafted on privet roots. In every other respect the plant has received similar treatment to the plant shown in the preceding figure.

Fig. 3. *Syringa vulgaris* variety "Hugo Koster." This plant was grafted on privet in 1925. The photograph shows it suffering from severe, typical graft-blight in 1930. The line through the root-system approximately divides the privet stock roots from the lilac scion roots. The one healthy shoot is a sucker from the lilac root-system. This sucker shows no sign of the blight, since it is practically independent of the privet root for support.

Fig. 4. Left to right: *Syringa vulgaris* grafted upon *S. vulgaris;* the same grafted upon *Ligustrum ovalifolium;* the same grafted upon *Ligustrum amurense*. These are typical plants from the grafting experiments reported in Section IV. The photograph was taken five months after grafting and shows the normal condition of the lilac-on-lilac graft, the moderate symptoms of the graft of Lilac upon California Privet, and the extreme symptoms of the graft of Lilac upon Amur Privet.

Fig. 5. Left to right: *Syringa vulgaris* grafted upon *S. japonica* (control); the same grafted upon *Forsythia suspensa;* the same grafted upon *Fraxinus americana;* the same grafted upon *Chionanthus virginica*. Typical appearance of these graft combinations four months after grafting. Further explanation in the text.

Fig. 6. *Syringa vulgaris* variety "Rubra de Marly" grafted upon *S. vulgaris*. The scion was taken from a plant showing extreme graft-blight as in Fig. 3. Illustrating the complete recovery of the scion due to the substitution of a lilac root-system for the privet root-system of the parent plant.

Fig. 7. *Syringa vulgaris* variety "Boule Azurée," root-system. A commercial plant at selling time, two years after grafting upon Privet. The scion has formed no lilac roots, and the plant is in addition handicapped by the presence of a crown gall in the privet root system.

Fig. 8. Another plant of the same source as that shown in the preceding figure. The crown was just beginning to manifest the extreme symptoms of graft-blight. Note the swelling at the graft union, the absence of scion roots, and the obvious inadequacy of the privet root-system.

Fig. 9. Root-systems of two lilac plants which died from graft-blight. Neither had made any attempt at scion-root formation. These were commercial plants which had been retained in a private collection for several years after purchase and given ample opportunity for establishment on own roots.

Fig. 10. Photomicrograph of a typical graft union of Lilac and Privet. The broken line abc represents the original junction of the cut surfaces and is marked by crushed and irregular cell structure. At c the cambiums of stock and scion fused completely, so that thenceforward, approximately to d, it is impossible to trace the line of demarkation.

NOTES

Species of Rhododendron.[1]—Under this title the Rhododendron Society has issued a volume containing descriptions of all the known species of the genus with the exception of those from New Guinea, Malaya and Indo-China. About 700 species of which 33 are new are described, arranged under more than 40 series, some of them divided into subseries. The arrangement of the series and of the species under each series and subseries is alphabetical, but under each series a key to the species is given, so that it will be possible to identify an unknown species, if one recognizes the series. A representative species of each series and subseries is illustrated usually by a full page text figure of a flowering branch with analyses. The descriptions are as complete as possible and each is printed on a separate page which will make it feasible to arrange the species and series in any desired order if one secures an edition of the book with only one side of each leaf printed. The descriptions and keys are the work of three authors: the elepidote species have been worked out by H. T. Tagg of the Royal Botanic Garden, Edinburgh, the lepidote Rhododendrons by J. Hutchinson of the Royal Botanic Gardens, Kew, and the Azaleas and their allies by A. Rehder of the Arnold Arboretum. A considerable number of species are published here for the first time, most of them from

[1] The species of Rhododendron. Published by the Rhododendron Society. pp. 8 + 861. Ill. O. Edinburgh, 1930.—Price £1.10.

1 2

Graft-blight of Lilac

Graft-blight of Lilac

4

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Graft-blight of Lilac

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Graft-blight of Lilac

Yunnan and some from Tibet, Burma or Assam; the names of the new species are the following: *Rhododendron Balfourianum* Forr. & Tagg, *R. glischroides* Forr. & Tagg, *R. hirtipes* Tagg, *R. rude* Forr. & Tagg, *R. vesiculiferum* Tagg, *R. chrysolepis* Hutch. & Ward, *R. deleiense* Hutch. & Ward, *R. mishmiense* Hutch. & Ward, *R. crebreflorum* Hutch. & Ward, *R. pruniflorum* Hutch. & Ward, *R. tsangpoense* Hutch. & Ward, *R. peregrinum* Tagg, *R. Hardingii* Forr., *R. paludosum* Hutch. & Ward, *R. imperator* Hutch. & Ward, *R. uniflorum* Hutch. & Ward, *R. ciliipes* Hutch., *R. notatum* Hutch., *R. scopulorum* Hutch., *R. taronense* Hutch., *R. Taggianum* Hutch., *R. dumicola* Tagg & Forr., *R. vellereum* Hutch., *R. eurysiphon* Tagg & Forr., *R. docimum* Balf. f., *R. vestitum* Tagg & Forr., *R. cerasinum* Tagg, *R. concinnoides* Hutch. & Ward, *R. bauhiniiflorum* Watt, *R. flavantherum* Hutch. & Ward, *R. pleistanthum* Balf. f., *R. asperulum* Hutch. & Ward, *R. insculptum* Hutch. & Ward and *R. exasperatum* Tagg. Besides these new species two new names are proposed: *Rhododendron Makinoi* Tagg for *R. stenophyllum* Makino, not Hook. f., and *R. hongkongense* Hutch. for *Azalea myrtifolia* Champ.

The chief value of the work lies in the fact that here for the first time the large number of Rhododendrons discovered and described chiefly from western China during the last 50 years have been brought together in one volume and made readily available for the botanist and for the lover of these highly ornamental plants. The fact that the descriptions are drawn up according to a uniform scheme makes comparisons of the descriptions of the different species easy and thus facilitates identification.—A. R.

Illustrations of Eucalyptus.—Under the title "An anthography of the Eucalyptus" Russell Grimwade[1] has published an attractive volume containing descriptions and monochrome plates of 103 species of Eucalyptus. The plates are reproductions of characteristic photographs of flowering and fruiting branches and the monochrome print brings out beautifully the color of the flowers which vary from white to yellow and pink or red. The text accompanying the plates contains notes on the discovery of the species, their distribution, economic importance and other points of interest and in the non-technical description the characters not apparent or clearly seen on the plate are emphasized. In an introductory chapter the history of the genus is dealt with and its distribution, botanical characters, vernacular names and economic properties. The work is primarily intended for the horticulturist, nature lover, forester and grower of Eucalyptus, but also the botanist will find

[1] GRIMWADE, RUSSELL. An anthography of the Eucalyptus [Ed. 2] 22 + 8, 103 pl. O. Angus & Robertson, Ltd., Sydney, 1930.—Price £2.2.

much of value and interest in the volume and particularly will he find the plates often helpful in the identification of species, though for detailed description and classification he will have to turn to J. H. Maiden's voluminous Critical revision of the genus Eucalyptus. The first edition of the Anthography appeared in 1920; it had only 80 plates and less full descriptions.—A. R.

PANDOREA NERVOSA VAN STEENIS, n. sp.
A. Habit (1/2 nat. size). B. Cross section of the ovary (magnified).

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A PREVIOUSLY UNDESCRIBED PANDOREA FROM NORTHEAST QUEENSLAND, AUSTRALIA

C. G. G. VAN STEENIS

Plate 35

Pandorea nervosa Van Steenis, n. sp.

Pandoreae jasminoidi similis sed foliis utrinque reticulato-venosis, nervis venisque utrinque prominentibus, calyce in alabastro clauso deinde irregulariter in lobis rumpente, corolla infundibuliforme, albida, tubus intus secus basin pallide flavescente, lobis minoribus differt.

Vine with slender, ribbed, purple stems minutely puberulous towards the top. Leaves with 5 leaflets, those immediately below the thyrse reduced to 3 leaflets; petioles 1.5–3.5 cm. long, slightly sulcate towards the tip as the rhachis, the bases of each pair connected with a prominent rim; rhachis ca. 2 cm. long; petioles of the lateral leaflets sulcate and winged by the decurrent margin of the blade, 2–5 mm. long, articulated at the insertion, those of the terminal leaflet (in the 2-jugate leaves) 1–1.5 cm. long, those in the 1-jugate leaves nearly sessile on and articulated with a stalk (rhachis) 1 cm. long. Leaflets dark green, ovate to ovate-oblong, the base rounded or rather cuneate, decurrent along the petiole, the tip rather abruptly acutely acuminate or even shortly caudate (acumen up to 1 cm. long), blade mostly oblique, 2.5–6 cm. long and 1.5–4 cm. broad; margin entire or with 1–2 crenate teeth on each side below the acumen; midrib sulcate above, rather strongly prominent below; primary nerves 5–7 pairs and a few smaller ones in the acumen, curved upwards towards and along the margin and united in a looped line, when dry prominent on both sides as are the numerous reticulations; glands impressed on the upper surface, dark-colored and not immersed below. Peduncle terminal, protruding ca. 2 cm. above the reduced upper leaves, as long as the rhachis. Thyrse minutely puberulous throughout, dense-flowered; lateral stalks opposite, the lower ones ca. 5 mm. long, 3-flowered, the upper ones (sometimes all in the poorer specimens) 1-flowered. Bracts acute-triangular, 1–1.5 mm. long, the bracteoles smaller.

Pedicels 3–6 mm. long, articulated below the thickened obconical hypanthium supporting the calyx. Flowers odorless, showy. Calyx glabrous, closed in bud with indistinctly indicated lobes, later on irregularly split into lobes up to 2.5 mm. high, campanulate, 6–7.5 mm. high (measured from the articulation). Corolla white, the tube with yellow inside near the base, infundibuliform, slightly curved, ca. 3.5 cm. long (excluding the lobes), puberulous-papillose outside, the slightly inflated broad base glabrous, the lower half of the tube inside long-pubescent at the side of the fertile stamens, glabrous at the opposite side near the staminodium; lobes 5, slightly unequal, broadly rounded, suborbicular, 7–9 mm. high, 7–11 mm. diameter, papillose-puberulous on both surfaces. Stamens 4, the smaller ones on filaments about 7 mm. long, inserted about 6 mm. above the base of the tube, the filaments of the longer ones 12–13 mm. long, inserted at about 9–10 mm. height, all glabrous except at their glandular-hairy insertion. Anthers divergent, linear-oblong, rather blunt, 3.5 mm. long, the connective indistinctly protruding above the cells. Staminodium small, curved, linear. Disk entire, annular-cupular, surrounding the base of the ovary. Ovary oblong, 6 mm. high, more or less terete, 2-celled, each cell with several rows of ovules, each row with 10–15 ovules; style linear, ± 1.5 cm. long, stigma with 2 blunt spathulate lobes. Dissepiment bearing 2 prominent placentas in each cell. Fruit unknown.

NORTH QUEENSLAND: Ghurka Pocket, Boonjie, Atherton Tableland; common in rain-forest, 700 m. alt., *S. F. Kajewski*, no. 1227 (Arnold Arb. Exped.), Sept. 24, 1929 (vine growing over small trees, leaves dark green, stems purple, flower white with light yellow inside near the base, very showy but no perfume).

This is the fourth Australian species of *Pandorea*. It is allied to *P. jasminoides* K. Schum. and can be inserted into the key given in my monograph of the Australian Bignoniaceae (Proc. Roy. Soc. Queensland, XLI. 39–58. 1928) as follows:

1a. Corolla large, 4–5 cm. long, outside papillose-puberulous............1b.
Corolla 1–1.5 cm. long, glabrous outside............................2.

1b. Corolla white with light yellow inside near the base of the infundibuliformous tube, the lobes suborbicular, ca. 1 cm. in diameter. Calyx 6–7.5 mm. long, closed in bud, later on split irregularly into lobes up to 2.5 mm. long. Leaflets ovate to ovate-oblong, distinctly and mostly abruptly acute-acuminate, the nerves and reticulations distinctly prominent..................................*P. nervosa*.
Corolla creamy or pale rose, streaked with carmine in the throat, the tube hypocraterimorphous, the lobes suborbicular, ± 2 cm. in diameter. Calyx 5–6 mm. high, open in bud, remaining truncate. Leaflets oblong to lanceolate, rarely some ovate, with a blunt, gradually tapering tip, the nerves and reticulations not or slightly visible. *P. jasminoides*.

A prominent nervature is known in *Pandorea* only in the entirely different *P. stenantha* Diels from New Guinea and *P. Baileyana* Van Steenis from New South Wales. The form of the corolla is the same as in *Tecomanthe* and the lobed, large calyx is aberrant in *Pandorea;* the corolla-tube, however, being long-pubescent on the anterior side and the inflorescence being a thyrse (not a raceme as in *Tecomanthe*) I found it advisable to refer it to *Pandorea.* For the rest I have already pointed out elsewhere (Bull. Jard. Bot. Buitenzorg, sér. 3, x. 202. 1928) that there seems to be no important difference between *Pandorea, Tecomanthe* and *Campsis* but I feel not competent to unite these genera as I had no opportunity to make a closer study of *Campsis*, this being the oldest genus described.

As appears from the key *P. nervosa* is related to *P. jasminoides* K. Schum., the latter species having no large range of variability as contrasted with *P. pandorana* Van Steenis which is exceedingly variable.

I do not know the description of *Tecoma doratoxylon* J. M. Black (Transact. & Proc. Roy. Soc. S. Austral. LI. 383. 1927) because this periodical is not accessible to me but I suspect that it will be another species of *Pandorea* or *Tecomanthe.*

HERBARIUM, BUITENZORG
JAVA

NOTULAE SYSTEMATICAE AD FLORAM SINENSEM, III

H. H. HU

Fagus lucida Rehder & Wilson in Sargent, Pl. Wilson. III. 191 (1916).

Descriptioni adde: Involucrum 6–9 mm. longum, fulvo-tomentulosum, extus squamis adpressis deltoideis brevissimis acutis munitum, nuculis exsertis fulvo-sericeo-pubescentibus 9 mm. longis, pedunculo gracili 1 cm. longo glabro suffultum.

Involucre 6–9 mm. long, tawny-brown-tomentulose, with very short appressed acute deltoid scales on the outside, nut exserted, tawny-sericeous-pubescent, 9 mm. long; stalk slender, 1 cm. long, glabrous.

KWANGSI: Dar Young Kiang, Luchen, border of Kweichow, 1300 m., *R. C. Ching*, Kwangsi Exped. Metrop. Mus. Nat. Hist. Acad. Sin. no. 6272, June 27, 1928.

The specimen collected in Kwangsi agrees exactly with the type from Hupeh in the leaves having sinuate margins with secondary veins projecting from the bases of the sinus forming triangular teeth, but differs in the midribs and secondary veins beneath being glabrous, while the midribs above are pilose.

It is very satisfactory to have been able to collect the fruits and to publish a supplementary description of this interesting species which Rehder & Wilson first published fourteen years ago based on sterile specimens. This species is striking also in the involucre being covered not with recurved prickles but with very short appressed deltoid scales, a character very rare in the genus *Fagus*, which easily differentiates this from all other eastern Asiatic species. It is very common in the woods on the top of Dar hills above Dar Young Kiang.

Hydrangea kwangsiensis, sp. nov.

Frutex 1 m. altus, ramulis gracilibus teretibus glabris. Folia membranacea, oblanceolata vel lanceolata, 7–10 cm. longa et 1.8–2.8 cm. lata, acuminata, basi cuneata et decurrentia, margine leviter revoluta et satis remote minuteque callosa-denticulata, glabra, supra laete viridia et costa leviter elevata, subtus pallide viridia, costa magis elevata et venis lateralibus curvatis vix distinctis; petioli 8–10 mm. longi, glabri. Cymae planae, satis multiflorae, ad 14 cm. longae et 8–9 cm. latae, longe pedunculatae pedunculo circiter 5 cm. longo gracili, radiis 3–5 oppositis, basi bracteis parvis foliaceis suffultis, axibus pedicellisque minute crispulo-villosis; pedicelli graciles, 1.5–2 mm. longi; flores steriles pauci, sepalis 4 albis rhombico-ovatis vel suborbicularibus 11 mm. longis latisque ad marginem crispatis; flores fertiles coerulescentes, tubo calycis turbinato minute hispidulo, dentibus triangularibus, petalis late ovatis apice rotundatis 2 mm. longis, staminibus 10 subaequalibus quam petala brevioribus; ovarium semi-superum; styli 3 recurvi. Fructus ignotus.

Shrub to 1 m. high; branchlets slender, terete, glabrous. Leaves membranaceous, oblanceolate to lanceolate, acuminate, cuneate and decurrent at base, slightly revolute and rather remotely and minutely callose-denticulate, glabrous, light green and with slightly elevated midrib above, pale green and with more prominently elevated midrib and very faint lateral arching veins beneath, 7–10 cm. long, 1.8–2.8 cm. broad; petiole glabrous, 8–10 mm. long. Cymes flat, many-flowered, to 14 cm. long, about 8–9 cm. broad, composed of 3–5 opposite radii with small leafy bracts at the base, long-peduncled with the peduncle about 5 cm. long, rachis of the cyme and pedicels minutely crisp-villose; pedicels slender, 1.5–2 mm. long; sterile flowers few, sepals 4, white, rhombic-ovate to suborbicular, crisp along the margins, 11 mm. long and broad; fertile flowers bluish; calyx turbinate, minutely hispidulous, teeth triangular; petals broadly ovate, rounded at apex, 2 mm. long; stamens 10, subequal, shorter than the petals; ovary half-superior, style 3, recurved. Capsule unknown.

KWANGSI: Chu-feng Shan, north of Luchen Hsien, on border of Kweichow, alt. 800 m., very common in woods or in open thickets, *R. C. Ching*, Kwangsi Exped. Metrop. Mus. of Nat. Hist. Acad. Sin. no. 5386 (type), June 8, 1928.

A species of the section Euhydrangea, allied to *H. yunnanensis*, Rehd. differing in the leaves being minutely callose-denticulate and with very faint lateral veins, in the long-peduncled cyme and in the smaller sterile flowers.

Citrus kwangsiensis, sp. nov.

Arbor ad 10 m. alta, trunco 25 cm. diam., cortice viridi-cinereo; ramuli longi, irregulariter angulati, striati, lenticellis sparsis ovalibus muniti, sparse pilosuli, virides; spinae validae, pungentes, 8–12 mm. longae. Folia coriacea, elliptico-oblonga, 9–15 cm. longa et 4–6.5 cm. lata, apice obtusiuscula, basi late cuneata vel rotundata, irregulariter dupliciter adpresseque crenulato-serrulata, glabra, supra intense viridia et venis non prominentibus, subtus pallide viridia, et venis elevatis reticulata; petioli articulati, anguste alati, 12–15 mm. longi, sparse pilosuli. Flores ignoti. Fructus immaturus ovoideus, leviter obtuse apiculatus, 3–5 cm. diam., 13-locularis, cortice 11 mm. crasso glabro, pulpa exigua 1.5 cm. diam.; fructus maturus 7 cm. diam., luteus (fide collectoris).

Tree to 10 m. high, 25 cm. in diam.; bark greenish-grey; branches long, irregularly angular, striate, with scattered oval lenticels, sparsely pilosulous, green; spines stout, sharp, 8–12 mm. long. Leaves coriaceous, elliptic-oblong, obtusish at apex, broadly cuneate to rounded at base, irregularly doubly and appressed-crenulate-serrulate along the margins, glabrous, intensely green and with non-prominent veins above, paler green and with elevated and reticulate veins beneath, 9–15 cm. long, 4–6.5 cm. broad; petiole articulate to the blade and the twig, narrowly winged, 12–15 mm. long, sparsely pilosulous at base. Flowers unknown. Young fruit ovoid, slightly obtusely apiculate at apex, 3.5 cm. in diam., rind 11 mm. thick, glabrous, pulp scanty, 1.5 cm. in diam., 13-segmented; mature fruit 7 cm. in diam., yellow (fide collector).

NORTH KWANGSI: Hoo-chi, alt. 900 m., cultivated in garden, *R. C. Ching*, Kwangsi Exped. Metrop. Mus. Nat. Hist. Acad. Sin. no. 6456 (type), June 14, 1928.

A very distinct species apparently related to *C. medica* L. and *C. maxima* Merr. by its fruits having very thick rind, but differing from the former in the articulated and narrowly winged petioles and from the latter in narrowly winged petioles and much smaller fruits.

Acer angustilobum, sp. nov.

Arbor ad 14 m. alta, trunco 30 cm. diam., cortice cretaceo-albo; ramuli graciles, glabri. Folia chartacea, 3-5-lobata, ad 15 cm. longa et 13 cm. lata, basi cuneata vel subrotundata, lobis lanceolatis longe caudatis apicem versus remote serrulatis, lobo medio ad 6.5 cm. longo et 2.2 cm. lato, lateralibus paullo brevioribus et angustioribus, basalibus parvis ad 1.5 cm. longis, sinubus acutis, lamina utrinque clare et lucide viridi, axillis subtus albido-barbatis exceptis glabra, utrinque reticulato-venulosa; petioli graciles, ad 4 cm. longi, glabri. Inflorescentia paniculata, ad 11 cm. longa; samarae virescentes, alis horizontaliter patentibus, nuculis inclusis 3 cm. longae et 1 cm. latae, basi distincte angustatae, dorso curvatae, nuculis ellipsoideis leviter compressis sublaevibus leviter tantum venulosis, 6 mm. longis et 3.5 mm. latis.

Tree to 14 m. high, 30 cm. in diam.; bark chalky white; branchlets slender, glabrous. Leaves chartaceous, 3–5-lobed, cuneate or subrounded at base, to 15 cm. long, 13 cm. broad, lobes lanceolate, long-caudate at apex, with acute sinuses, remotely serrulate toward the apex, midlobe to 6.5 cm. long, 2.2 cm. broad, lateral lobes slightly shorter and narrower, basal lobes small, to 1.5 cm. long, 7 mm. broad; pale shining green on both surfaces, glabrous except with axillary tufts of whitish hairs beneath, reticulate-venulose on both surfaces; petiole slender, to 4 cm. long, glabrous. Panicles elongated, to 11 cm. long; samaras greenish, with wings horizontally spreading, including the nutlets about 3 cm. long, 1 cm. broad, distinctly narrowed at base and arching at back, nutlets ellipsoid, slightly compressed, rather smooth, only slightly venulose, 6 mm. long, 3.5 mm. broad.

KWANGSI: Chu-feng Shan, north of Luchen Hsien, alt. 630 m., common in woods, *R. C. Ching*, Kwangsi Exped. Metrop. Mus. Nat. Hist. Acad. Sin. no. 5802 (type), June 8, 1928.

A species of the section Spicata, allied to *A. sinense* Pax and *A. Wilsonii* Rehd., differing from the former in the 3–5 narrow ascending lobes remotely serrulate toward the apex and in the blade being narrowed toward the rounded base and from the latter in the leaves often 5-lobed with two small basal lobes.

Acer oblongum Wall. var. **macrocarpum,** var. nov.

A typo recedit folius subtus minute tomentulosis, corymbo fructibus 4–5, pedunculo permanenter floccoso, samarae ad 4 cm. longae, alis semiorbicularibus 3.2 cm. longis et 1.4 cm. latis, basi abrupte contractis ad marginem irregulariter erosis, nuculis ad 7 mm. longis.

Differing from the type in leaves being minutely tomentulose beneath, cymes with 4–5 fruits, peduncle persistently flocoose, samara to 4 cm. long with semi-orbicular wings 3.2 cm. long, 1.4 cm. broad, irregularly erose along the margins and abruptly contracted on the lower part, and nutlets to 7 mm. long.

KWANGSI: Tang-Chia-Fu, east of Luchen Hsien, alt. 300 m., rare in woods, *R. C. Ching*, Kwangsi Exped. Metrop. Mus. Nat. Hist. Acad. Sin. no. 5220 (type), May 23, 1928.

Rhododendron minutiflorum, sp. nov. (§ Tsutsuti)

Frutex erectus ad 2.25 m. altus, ramosissimus; ramuli verticillati, ascendentes, tenues tortuosi, vestigiis fuscis setarum scabridi, juniores strigoso-setosi setis applanatis rubro-fuscis appressis. Folia persistentia, 4 vel 5 in apice ramulorum congesta, crasse chartacea, late obovata vel oblonga, 7–11 mm. longa et 4.5–5.5 cm. lata, basi cuneata, apice breviter acuminate, margine revoluta et minute crenulata, supra obscure viridia et strigoso-setosa, subtus pallide viridia et glabra costa margineque strigoso-setosis exceptis; petiolo strigoso-setosi; ad 2 mm. longi. Flores simul cum foliis novellis, in umbellis terminalibus 3-floris; bracteae minutae, triangulares, acutae; pedicelli strigoso-setosi, ad 2 mm. longi; calyx dense pilis strigosis obtectus et ciliatus, lobis subrotundatis circa 1 mm. longis et 1.5 mm. latis; corolla 7 mm. diam., rotato-infundibuliformis, tubo extus pilis rubescentibus pilosulo intus glabro 2.5 mm. longo, lobis patentibus tubum subaequantibus ovato-oblongis breviter acuminatis 3 mm. longis basi 2.5 mm. latis utrinque glabris non maculatis; stamina 5, subaequalia, exserta, filamentis circa 7 mm. longis triente superiore excepto minute puberulis, antheris oblongis 1 mm. longis; ovarium dense setosum, 2.5 mm. longum; stylus declinatus, 8 mm. longus, rubido-pubescens, stigmate capitato. Capsula ignota.

Erect shrub to 2.25 m. high; branchlets dense, verticillate, slender, tortuous and arching, scabrid with blackened remains of old appressed bristly hairs, young growth strigose-setose with reddish-brown flattened bristly hairs. Leaves persistent, those of this year's growth 4 or 5 crowded at the apex of the branchlets just above those of last year, thickly chartaceous, broadly obovate to oblong, cuneate at base, shortly acuminate at apex, revolute and minutely crenulate and the margins, dark green above and strigose-setose above, paler green and glabrous except densely strigose-setose along the midrib and the margins beneath, 7–11 mm. long, 4.5–5.5 mm. broad; petiole strigose-setose, to 2 mm. long. Flowers appearing with the leaves, in terminal 3-flowered umbels; bracts minute, triangular, acute; pedicels strigose-setose, 3–4 mm. long; calyx completely covered by and fimbriate along the margins with dense bristly hairs, lobes distinct, roundish, rounded at apex, about 1 mm. long and 1.5 mm. broad; corolla 7 mm. in diameter, rotate-funnel-shaped, tube pilosulous with reddish hairs outside, glabrous inside, 2.5 mm. long, lobes spreading, about as long as the tube, ovate-oblong, shortly acuminate, 3 mm. long, 2.5 mm. broad at base, glabrous on both surfaces, not spotted; stamens 5, subequal, exserted, about 7 mm. long, minutely puberulous on the lower 2/3 of their whole length; anthers oblong, 1 mm. long; ovary completely concealed by dense bristly hairs, 2.5 mm. long; style declinate, pubescent with reddish hairs, 8 mm. long; stigma capitate. Capsule unknown.

This is a very distinct species of the section Tsutsutsi; in its flowers it resembles *R. Seniavinii* Maxim., except that they are much smaller, but the leaves are very different and by their size recall those of *R. serpyllifolium* A. Gray which, however, has entirely different flowers.

KWANGSI: Chu-feng shan, north of Huchen hsien, alt. 1120 m., *R. C. Ching*, Kwangsi Exp. Metrop. Mus. Nat. Hist. Acad. Sin. no. 5860 (type). June 9, 1928.

Porana sinensis Hemsley in Jour. Linn. Soc. XXVI. 167 (1890).
Vatica cordata Hu in Jour. Arnold Arb. XI. 225 (1930).

In describing this species I had overlooked that the genus *Porana* has a fruit very similar to that of the section Synaptea of the genus *Vatica*. The presence of only fruiting specimen caused this error.

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CONSPECTUS OF THE GENUS AMORPHA

Ernest J. Palmer

Plate 36 and text figures

Amorpha, a genus of leguminous plants of the tribe Psoraleae, is so far as known confined to the temperate and semi-tropical parts of North America, ranging from the Connecticut valley and Saskatchewan to Florida and northern Mexico. One little known species has also been described from further south in Mexico. All of the known species are shrubs of rather uniform habit and characters. About 60 names for species have been proposed of which 20, including one new one, are recognized as valid in the present treatment. There are also several varieties and forms, some of which have previously been described as species by other authors, and a few that are here described for the first time.

Amorpha is rather closely related to the cosmopolitan genus *Psoralea* and to the genera *Dalea* (*Parosela*) and *Eysenhardtia*, the second of which ranges over most of western North America and the last is represented by a few species in the arid southwestern states and in Mexico and Central America.

The genus *Amorpha* was established by Linnaeus in 1753, Species Plantarum ii. 743, based upon a plate published in Hortus Cliffortianus in 1737, showing a flowering branch of *Amorpha fruticosa* which thus becomes the type species of the genus. In 1788 a second species *A. herbacea*, was described by Walter, and in 1804 Desfontaines published the name *Amorpha glabra*, which was briefly described three years later by Persoon. Willdenow and Michaux, in 1796 and 1803, added two more names, which proved to be synonyms of Walter's species. The names of several other species were added to the list by Nuttall, Pursh, and Rafinesque from 1813 to 1817, one of which, by the last named author, is unrecognizable. In the meantime Schkuhr had in 1796 published the names *Amorpha perforata* and *A. nonperforata*, which have generally been regarded as applying to mere forms of *A. fruticosa*, and treated as synonyms. When Torrey and Gray issued the first volume of the Flora of North America in 1838 they recognized eight species, descriptions of three of which were published for the first time. Dr. Gray does not seem, however, to have made much progress in understanding the genus, for in 1845 he wrote in Plantae Lindheimerianae: "I know of no constant characters for distinguishing *A. glabra, Desf.*, A. Caroliniana, *Croome*, A. nana, *Nutt., Bot. Mag.*, and A. laevigata,

Amorpha brachycarpa E. J. Palmer, sp. nov.
Photograph of the type specimen

Nutt. from A. fruticosa. The A. Roemeriana, *Scheele in Linnaea*, 21, p. 461, is doubtless a form of A. fruticosa or of A. paniculata."

The principal recent treatments of the genus are by C. Schneider, Illustriertes Handbuch der Laubholzkunde, vol. II. 68–74 (1907), and by Dr. P. A. Rydberg in the North American Flora, vol. XXIV, pt. 1, pp. 26–34 (1919). Schneider's Handbook contains helpful figures bringing out the distinctions in leaf, flower, and fruit characters of several species; and the key, descriptions and synonomy given in the North American Flora are quite full. Four new species were described by Rydberg, three of which are retained as species in this paper, although the material that I have seen of them is not very full. The fact that the plan of the North American Flora does not admit of the description of varieties has led, as it seems to me, to the acceptance there of some species that cannot always be clearly distinguished and are better treated as forms or varieties, which is the plan followed here.

The principal morphological characters in *Amorpha* on which species can be distinguished are the shape and size of the fruit, the form of the calyx-lobes, and the pubescence. A few species show well marked distinctions in the texture and veining of the leaves, the number and length of the flowering racemes, and in the presence or absence of glands on the calyx and petiolules. In other species, however, these characters are variable.

Amorpha fruticosa and several closely allied forms constitute a group in which it is extremely difficult to find constant characters, and consequently there has been considerable difference of opinion amongst authors in the treatment of these species, and many names have been proposed that must be regarded as synonyms, forms or varieties. *Amorpha tennesseensis* Shuttlew. and *A. fragrans* Sweet are considered varieties of *A. fruticosa* in the present treatment, while *A. occidentalis* Abrams and *A. croceolanata* Wats., for reasons stated in connection with the descriptions, are retained as species. It has also seemed best on the strength of the specimens examined to regard *A. hispidula* Greene as a variety of *A. californica* and *A. arizonica* Rydberg as a variety of *A. occidentalis.*

One of the difficulties in describing species in this genus and especially in constructing a key is the fact that many of the species have both a pubescent and a glabrous form or similar slight differences in a single character. For this reason it has been found necessary to include the varieties in the key and in a few instances to have the same variety or species appear twice.

Most of the species of *Amorpha* occur in the Southern States, and particularly in the coastal plain and piedmont regions. *Amorpha* *fruticosa* with its varieties and forms, is the most widely distributed, ranging over most of the United States east of the Rocky Mountains, from Canada to Florida and beyond the Rio Grande into northern Mexico. *Amorpha canescens* is another species of wide range, occurring from Michigan and Indiana and southward through the Mississippi valley and the Great Plains to New Mexico and northern Texas. Most of the other species are much more local. An interesting and surprising fact is the reappearance or the continuance of the range of several of the species originally discovered and most common in the southern Appalachian region in the southwestern part of the Ozark region of central and western Arkansas and eastern Oklahoma. One species, *Amorpha nana*, is found only in the Western plains region, and two or three well marked endemic species are found in Texas.

The significance of the present distribution of *Amorpha* would seem to be that the genus was established at a rather early period, perhaps as early as the middle or late Tertiary, and that it then gave rise to several distinct species which became widely distributed before the uplifting of the western mountains and the incursion of the northern ice sheet isolated them in different regions, where under changed conditions they gave rise to the number of more or less closely related forms of these primitive species which are now found. Outstanding and probably early developed species are *Amorpha nana, A. canescens, A. herbacea, A. paniculata, A. glabra, A. fruticosa* and *A. texana*. Some of the other species are also well marked but can in most cases at least be accounted for as probably being offshoots of one of the above. My interest in the genus and the present treatment arose from the study and collection of most of the forms in the field for a number of years, the problems suggested by their somewhat puzzling geographic distribution, and the fact that it was often difficult to decide to which species some of the specimens should be referred and to find clear and constant characters separating them.

In addition to the material in the herbarium of the Arnold Arboretum, I have had for study all of the specimens of the Gray Herbarium, the Philadelphia Academy of Natural Sciences, and a number, representing obscure or recently described species, from the New York Botanical Garden collections. I wish to express my thanks to the authorities of all of these institutions for their courtesies. I am also under obligations to my colleagues, Mr. Alfred Rehder, Curator of this herbarium, for aid and suggestions, Dr. C. E. Kobuski, Assistant Curator, for his careful drawings of the fruits and leaflets. In the enumeration of specimens examined the herbarium in which the specimens are found is indicated by the following parenthetical letters: (A) Arnold Arboretum, (G) Gray Herbarium, (P) herbarium of the Philadelphia Academy of Natural Sciences, (N) herbarium of the New York Botanical Garden.

KEY TO THE SPECIES

Branches, petioles, and rachises of leaves beset with spine-like glands.
  Plants distinctly pubescent; calyx-lobes about as long as the tube. 1. *A. californica*
  Plants nearly glabrous; calyx-lobes shorter than the tube. 1-b. *A. californica* var. *hispidula*
Branches, petioles, and rachises of leaves without spine-like glands.
  Low shrubs, usually less than 1 m. high (rarely higher); leaves nearly sessile, the petioles usually shorter than the width of lowest leaflets.
    Plants pubescent or canescent.
      Plants densely canescent throughout.
        Calyx-lobes as long as the tube, all of nearly equal length. 2. *A. canescens*
        Calyx-lobes about half as long as the tube, the upper two shorter than the lower three. . . . . 3. *A. herbacea*
      Plants villous or thinly pubescent or becoming glabrous in age.
        Calyx-lobes as long as the tube; leaflets not conspicuously punctate. 2-a. *A. canescens* var. *glabrescens*
        Calyx-lobes much shorter than the tube; leaflets conspicuously punctate. . . . . 5. *A. floridana*
    Plants glabrous or essentially so at all times.
      Leaflets conspicuously punctate, thick or firm and with revolute margins at maturity.
        Leaflets 15–25, oblong, less than twice as long as wide; flowering racemes usually single or few. . . . . 4. *A. cyanostachya*
        Leaflets 21–41, narrow-oblong, about twice as long as wide; flowering racemes clustered, usually several. 5. *A. floridana* (mature state)
      Leaflets not conspicuously punctate, thin and without revolute margins at maturity.
        Calyx-lobes as long as the tube; flowering racemes several, paniculate. . . . . 6. *A. brachycarpa*
        Calyx-lobes about half as long as the tube; flowering racemes usually single, short. . . . . 7. *A. nana*
  Tall shrubs, usually 1–3 m. high; leaves distinctly petioled, petioles longer than width of lowest leaflets.
    Branches and foliage glabrous or essentially so.
      Leaflets few (7–17) remote or at least not crowded.
        Calyx-lobes all very short or nearly obsolete. . . . . . 8. *A. glabra*
        Calyx-lobes longer, at least some of them acute.
          Leaflets broad-oblong, often as broad as long, rounded at both ends or emarginate; calyx glandular, pubescent. 15-a. *A. texana* var. *glabrescens*
          Leaflets narrower, oblong, ovate or obovate, rarely emarginate; calyx glabrous except ciliate margins of lobes.
            Calyx and petiolules conspicuously glandular; flowering racemes usually elongated (1–2.5 dm. long). . 9. *A. laevigata*
            Calyx and petiolules not conspicuously glandular; flowering racemes shorter (0.5–1.5 dm. long).
              Young leaflets sparingly short pilose, slightly paler on lower than on upper surface; bark gray. . . . . . 10. *A. nitens*

Young leaflets essentially glabrous, glaucous or conspicuously paler on lower than on upper surface; bark very pale. 10-a. *A. nitens* var. *leucodermis*

Leaflets more numerous (15–35), remote or crowded.

Mature leaflets firm or subcoriaceous, margins revolute and usually crenulate; flowers white or pale blue........11. *A. crenulata*

Mature leaves thin, without revolute margins; flowers purple or indigo.

Flowering racemes usually sessile or closely flowered to the base; pod straight or nearly so..................12. *A. Curtissii*

Flowering racemes usually pedicelled; pod curved.

Leaflets obtuse or emarginate at apex; flowering racemes usually solitary........20-a. *A. occidentalis* var. *emarginata*

Leaflets rounded or acute at apex; flowering racemes usually several.

Leaflets 11-25, narrowed at base, 1.5–2.5 cm. long. 21-a. *A. fruticosa* var. *angustifolia* f. *glabrata*

Leaflets 19-39, obtuse or rounded at base, 2.5–4 cm. long. 21-c. *A. fruticosa* var. *oblongifolia*

Branches and foliage noticeably pubescent (branches glabrous in *A. nitens*), at least on young growth.

Calyx-lobes from half to fully as long as the tube, all acute or acuminate.

Calyx-lobes fully as long as tube; flowering racemes usually single, 0.5–1 dm. long...........................13. *A. Schwerini*

Calyx-lobes about half as long as the tube; flowering racemes usually several, 3–5 dm. long.....................14. *A. paniculata*

Calyx-lobes much shorter than the tube, the two upper obtuse or rounded; flowering racemes 1–2.5 dm. long.

Leaflets 7–15, broad-oblong, often as broad as long, usually emarginate; petiolules conspicuously glandular......15. *A. texana*

Leaflets 11–35, obovate or oblong, 1.5–2 times as long as broad.

Leaflets oblong or ovate, firm and with revolute margins at maturity; petiolules somewhat glandular....16. *A. virgata*

Leaflets mainly oblong or elliptic, varying to ovate or obovate, thin at maturity and rarely with revolute margins; petiolules glabrous or pubescent but not glandular.

Branches, foliage and calyx copiously pubescent.

Pubescence gray; leaflets obovate or oblong, 1.5–2.5 cm. long; flowering racemes usually single. 20-b. *A. occidentalis* var. *arizonica*

Pubescence tawny or rufous; leaflets oblong or ovate, 2.5–6 cm. long; flowering racemes usually several. 17. *A. croceolanata*

Branches and foliage pilose or sparingly pubescent; calyx slightly pubescent or glabrate.

Pubescence sparse, loosely attached; calyx glabrous or nearly so except ciliate margins; pod not conspicuously glandular-dotted.

Mature leaves glabrous and shining above; pod curved (plants turning black in drying)......10. *A. nitens*

Mature leaves dull above; pod straight or nearly so; calyx-lobes almost obsolete (plants not turning black in drying).........................18. *A. Bushii*

Pubescence firmly attached, spreading or appressed; pods conspicuously glandular-dotted.

Flowering racemes usually single, 1–2.5 dm. long, sometimes with a second shorter one at base. 19. *A. occidentalis*

Flowering racemes usually several, seldom over one dm. long.
Leaflets mostly ovate or oblong, obtuse or rounded at base; pubescence spreading, usually copious, at least on young growth.
Leaflets 13–25, averaging 1.5–2 times as long as broad, not crowded on rachis.
Leaflets ovate or oblong, rounded or acute at apex. averaging about twice as long as broad.
20. *A. fruticosa*
Leaflets broad-oblong, rounded or emarginate at apex, averaging 1.5 times as long as broad.
20-b. *A. fruticosa* var. *emarginata*
Leaflets 21–35 (rarely more) narrow-oblong or lance-oblong, averaging 2–3 times as long as broad, often crowded on rachis.
Leaflets usually 1–2 cm. long, noticeably pubescent at least on young growth; pod straight or nearly straight.
20-d. *A. fruticosa* var. *tennesseensis.*
Leaflets 2–5 cm. long; pubescence sparse (or glabrate at maturity); pod slightly curved.
20-c. *A. fruticosa* var. *oblongifolia*
Leaflets usually elliptic or obovate, narrowed at base; pubescence short, appressed.
20-a. *A. fruticosa* var. *angustifolia*

1. **Amorpha californica** Nuttall in Torrey & Gray, Fl. N. Am. I. 306 (1838).—Fig. 1.

A shrub 1–3 m. high; foliage and branches more or less pilose and beset with scattered spine-like glands. Leaflets 11–25, ovate or oblong, 1–3 cm. long, 0.8–2 cm. wide, usually rounded or subcordate at base, obtuse or slightly emarginate and mucronate at apex, thin but firm at maturity, and then scabrate or nearly glabrous above, pilose and conspicuously punctate-dotted beneath; petioles about as long as the breadth of the lowest pair of leaflets. Racemes single or few, erect, 1–2 dm. long, rather loosely flowered; calyx 5–6 mm. long, densely pubescent, the lobes lanceolate, about as long as the tube or a little shorter; standard purple. Pod 6–8 mm. long, curved on back, pubescent and conspicuously glandular-dotted.

Southern California and western Arizona.—Type locality: Santa Barbara, California.

CALIFORNIA: Banning Cañon, Riverside County, *A. R. Seitz*, July 16, 1915 (A); between Pozo and La Panza, San Luis Obispo County, *Alice Eastwood*, June 15, 1902 (A); road from San Luis Obispo to Pozo, *Alice Eastwood*, no. 15147, May 17, 1928 (A); Mt. Wilson, Los Angeles County, *Alice Eastwood*, no. 9046, June 20, 1919 (A); Mt. Wilson, *Alfred Rehder*, no. 199, Aug. 1, 1914 (A); Little Santa Anita Cañon, Los Angeles County, *LeRoy Abrams*, no. 2622, July 1, 1902 (A, P); Pitt to Baird, Shasta County, *Alice East-*

wood, no. 1449, July 25, 1912 (A); hills west of Pomona, *I. M. Johnston*, no. 1348, June 14, 1917 (A); San Bernardino Mts., *G. Engelmann & C. S. Sargent*, Sept. 21, 1880 (A); San Bernardino Mts., *S. B. Parish*, nos. 10903, 10958, June 16, June 22, 1916 (A); Monterey County, *T. S. Brandegee*, 1885 (A); Jolono, *C. S. Sargent*, Sept. 12, 1896 (A); Red Reef Cañon, Ventura County, *Leroy Abrams & E. A. McGregor*, no. 130, June 8, 1908 (A); Santiago Peak trail, Orange County, *LeRoy Abrams*, no. 1828, June, 1901 (A); Montgomery Creek, Shasta County, *Alice Eastwood*, no. 632, June 27, 1912 (A); Mt. Wilson, *J. F. McBride & E. Payson*, no. 896, July 25, 1915 (G); Griffins, Mt. Alamo, Ventura County, *A. D. E. Elmer*, no. 3950, July, 1902 (G); Anisal Creek, Santa Cruz Mts., *L. R. Abrams*, no. 3037, July 19, 1913 (G); San Bernadino, *S. B. Parish*, no. 4185, June 26, 1896 (G); Heroult, Shasta County, *L. E. Smith*, no. 402, June 25, 1913 (A, G); San Bernardino Mts., *Philip A. Munz & I. M. Johnston*, no. 8559, July 14, 1924 (G); 4 mls. s. of Oak Glen, San Bernardino County, *Philip A. Munz & I. M. Johnston*, no. 8699, July 17, 1924 (G); Mupa Cañon, near Ojai, *C. E. Peckham*, 1866 (G); *D. Douglas* (without locality or date) (G); Elysian Park, Los Angeles, *E. Brouton*, no. 424, June 1, 1902 (G); Los Angeles, *J. C. Nevin*, 1880 (G); Mt. Wilson, *Geo. B. Grant*, no. 39, May 19, 1904 (G, P); Suey Creek, near Santa Maria, *Alice Eastwood*, no. 400, June 13, July 3, 1906 (A, G); Pit River Ferry, Shasta County, *H. E. Brown*, no. 232½, May 5–28, 1897 (P); San Bernardino, *R. J. Smith*, July 1, 1904 (P).

ARIZONA: Prescott, *Susan D. McKelvey*, nos. 396, 1222, Nov. 8, 1928, June 2, 1929 (A); Copper basin, *J. W. Toomey*, no. 529, June 25, 1892 (A).

1a. **Amorpha californica** var. **napensis** Jepson, Man. Fl. Pl. Calif., 556 (1925).

California.—Type locality: Howell Mt., Napa Range.

I have not seen specimens of this variety. Jepson's description is as follows: Subglabrous; sessile; glands on rachis none; racemes 1–1½ in. long; calyx nearly glabrous and glandless, its teeth minute.

1b. **Amorpha californica** var. **hispidula** (Greene), comb. nov.

Amorpha hispidula Greene, Fl. Francisc. 14 (1891).

Differs from the type in being nearly or quite glabrous throughout, and in the somewhat shorter calyx lobes.

Central and southern California.—Type locality: Monterey County.

CALIFORNIA: Laguinetas, Marin County, *Alice Eastwood*, May, 1895 (G); hills near Pipe Valley, *Berlandier*, no. 2548, in 1863 (G);

Calistoga, *Alice Eastwood*, no. 11743, May 9, 1923 (A); between Cazadero and Sea View, Sonoma County, *Rimo Bacigalupi*, no. 1799, Sept. 3, 1927 (A); Cazadero, *T. S. Brandegee*, July 1, 1923 (A); Nunn's Cañon, Sonoma County, *Michener & Bioletti*, no. 1724/2, May, 1893 (P); near Burke's Sanatarium, Sonoma County, *A. A. Heller*, no. 5757, June 24, 1902 (G, P); Moore Creek, Howell Mt., *W. L. Jepson*, no. 6834, Aug. 6, 1916 (A); Marin Co., *H. N. Bolander*, May, 1873 (G).

2. **Amorpha canescens** Pursh, Fl. Am. Sept. 467 (1814).—Fig. 2.
Amorpha canescens Nuttall, Fraser Cat. (1813), nomen nudum; reprinted in Pittonia, II. 116 (1890).
Amorpha canescens var. a. *typica* C. Schneider, Ill. Handb. Laubholzk. II. 70 (1907).

A low shrub 3–10 dm. high, more or less densely gray-canescent throughout. Leaves nearly sessile; petioles usually shorter than the width of the lowest pair of leaflets; leaflets 15–45 or rarely more, crowded or overlapping, elliptic, oblong or ovate, usually rounded at base, rounded or obtusely pointed at the mucronate apex, 7–20 mm. long, 4–10 mm. wide. Inflorescence terminal, usually with numerous, slender, 8–25 cm. long racemes; calyx villous-canescent, its lobes lanceolate and all of nearly equal length, about as long as tube; standard blue-purple. Pod densely villous-canescent, glandular-dotted, 4–5 mm. long, nearly straight dorsally, with long, ascending beak.

Indiana and Michigan to Manitoba and Saskatchewan and south through the Mississippi valley and plains to Arkansas, New Mexico and northwest Texas.—Type locality: Banks of the Missouri River.

MANITOBA: Killarney, *W. Scott*, Sept. 1892 (G).

SASKATCHEWAN: Winnepeg valley, *E. Bourgeau*, 1857–8–9 (G).

MICHIGAN: Mottville, *Geo. L. Fisher*, no. 27, June 30, 1923 (A, G).

WISCONSIN: St. Croix Falls, *C. F. Baker*, July 8, 1900 (G); Madison, *J. R. Churchill*, Aug. 22, 1893 (G); Kilburn, *C. H. Morss*, July 8, 1884 (G); Prairieville, *I. A. Lapham*, Aug. 14 (G); Lake Wingra (near Madison), *Gilbreth, Jack & Seymour*, Aug. 23, 1893 (A); Wild Rose, *W. L. McAtee*, no. 3050, Aug. 8, 1919 (A); Mauston, Juneau County, *E. J. Palmer*, no. 28429, Sept. 8, 1925 (A); Kilburn, Sauk County, *E. J. Palmer*, no. 27675, June 7, 1925 (A); Falls of St. Croix, *Houghton* (G); Veroqua, Vernon County, *Huron H. Smith*, no. 7239, July 12, 1922 (A); Prairie du Chien, *Huron H. Smith*, no. 7577, July 24, 1922 (A); Sugar Loaf, Columbia County, *Huron H. Smith*, no. 8065, Aug. 5, 1922 (A); Black River Falls, Jackson County, *Huron H. Smith*, no. 6809, June 27, 1922 (A); Milwaukee, *I. A. Lapham* (P).

MINNESOTA: St. Anthony Falls, *J. H. Schuette*, July 14, 1888 (G); Courtland, Nicolette County, *C. A. Ballard*, July, 1892 (G); Bald Eagle, Ramley County, *S. F. Blake*, no. 170, July 4, 1910 (A); Cass Lake, *L. H. Pammel*, no. 50, July 24–26, 1925 (A); Lake Pepin, 75 mls. below St. Paul, ex Herbarium Jno. R. and Jas. Rhodes, no. 875, July 11, 1862 (P).

INDIANA: Miller's, *J. M. Greenman*, Aug. 20, 1908 (G); Howe, LaGrange County, *C. C. Deam*, nos. 14949, 20670, Aug. 29, 1914, July 9, 1916 (A); Ciecott, Cass County, *C. C. Deam*, no. 17843, July 22, 1915 (A); Lakeville, Newton County, *C. C. Deam*, no. 18105, Aug. 24, 1915 (A).

ILLINOIS: Port Byron, *E. T. & S. A. Harper*, June, 1898 (A); Lisle, *A. J. Prisc*, no. 131, Aug. 4, 1925 (A); Utica, *Mrs. Joseph Clemens*, Aug. 7, 1900 (A); East Dubuque, Jo. Daviess County, *E. J. Palmer*, nos. 27877, 27878, June 12, 1925 (A); Oquawka, *Harry N. Patterson*, May–June (G); Macon, Forsythe County, *Allan Gleason*, no. 211, June 10, 1896 (G); Winnebago County, *M. S. Bebb*, 1867 (G, P); Augusta, *S. B. Mead*, July, 1846 (G); Champaigne, *A. S. Peace*, no. 12804, Sept. 11, 1909 (G); Peoria, *F. E. McDonald*, July, 1904 (G); Stony Island, Cook County, *Huron H. Smith*, no. 5961, June 30, 1914 (G); Normal, *B. L. Robinson*, July, 1887 (G); Illinois, *Buckley* (without locality or date) (G); Rockford, Winnebago County, *M. E. Holmes*, 1874 (P); Chicago, *S. C. Williamson*, 1893 (P); Rock Island, *Dr. Sargent*, Oct., 1859 (P); Peoria, *A. J. Stewart* (P); Chicago, *H. W. Clark*, no. 977, July 12, 1902 (P); Delavan, *J. J. Carter*, July, 1879 (P); Beardstown, *Chas. A. Geyer*, July, 1842 (P); between Galena and Chicago, *Mrs. Blandine* (P); Prairies of Illinois, *Lapham*, Sept. 1837 (P); Prairies of Illinois, *C. W. Short*, 1860 (P); Augusta, *S. B. Meade*, Aug. 1852, June 25, 1860 (P); Prairies of Illinois, *Jane Bettle* (P); Waukegan, *T. Meehan* (P).

IOWA: Dennison, Jefferson County, *T. A. Allen*, July 26, 1867 (G); Grinnell, *M. E. Jones*, 1876, July 17, 1877 (G, A); Hamberg, *L. H. Pammel & H. Clark*, no. 19, July 4, 1914 (A); Ames, *Robt. Combs*, no. 572, July 2, 1897 (G); Crawford County, *T. A. Allen*, July 14, 1867 (G); Bentonsport, *E. W. Graves*, no. 1697, July, 1920 (A); Charleston, Lucas County, *E. J. Palmer*, no. 35807, May 18, 1929 (A); *S. C. Williams*, July, 1893 (P).

MISSOURI: *O. E. Lansing, Jr.*, nos. 3109, 3177, June 5–12, 1911 (G); Allenton, *G. W. Letterman*, May 25, 1887 (G); Dumas, *B. F. Bush*, nos. 5890, 9546, 10131, July 7, 1909, Aug. 29, 1921, July 27, 1923 (A); Dumas, *E. J. Palmer*, no. 21879, Sept. 7, 1922 (A); Jerome, *J. H. Kellogg*, no. 366, June 18, 1913 (A); Odessa, *B. F.*

Bush, nos. 11361, 11362, 11363, July 7, 1927 (A); Monteer, *B. F. Bush*, no. 11429, Aug. 4, 1927 (A); Carthage, *B. F. Bush*, no. 10393, Oct. 6, 1925 (A); Knox City, Knox County, *E. J. Palmer*, no. 35922, May 21, 1929 (A); Cole Camp, Benton County, *E. J. Palmer*, nos. 26363 (in part), 30083, Oct. 1, 1924, May 12, 1926 (A); Howe's Mill, Dent County, *E. J. Palmer*, no. 34937, July 3, 1928 (A); Watson, Atchison County, *E. J. Palmer*, no. 18937, Sept. 3, 1920 (A); Maryville, Nodaway County, *E. J. Palmer*, no. 25439, June 13, 1924 (A); Forest City, Holt County, *E. J. Palmer*, nos. 25395, 26004, June 12, Sept. 2, 1924 (A); Swope Park (Jackson County), *B. F. Bush*, no. 10358, Oct. 10, 1924 (A); Montieth Junction, Bates County, *E. J. Palmer*, no. 26076, Sept. 10, 1924 (A); Webb City, Jasper County, *E. J. Palmer*, June 16, 1901, no. 22319, Oct. 17, 1922 (A); along James River, Stone County, *E. J. Palmer*, no. 5840, June 2, 1914 (A); Mansfield, Wright County, *E. J. Palmer*, no. 34691, June 25, 1928 (A); St. Louis, *Nuttall* (P); Hannibal, *J. Davis*, June 19, 1917 (P); Meramec Highlands (St. Louis County), *E. B. Bartram*, no. 1507, May 27, 1911 (P).

North Dakota: Bismarck, *Esther L. Larsen*, no. 170, Aug. 12, 1929 (G); Fargo, *H. L. Bolly*, no. 120, July, 1892 (G, P); Buckhouse slough, Hankinson, *F. P. Metcalf*, no. 170, July 23, 1917 (A); Dakota (without locality or date) *Dr. Gladfelter* (P).

South Dakota: White Rock, *Mrs. H. O. Powell*, July, 1903 (G); Brookings, *John J. Thurberer*, July 17, 1894 (G); Big Stone, *T. A. Williams*, no. 160, Aug. 14, 1894 (A); Pine Ridge Indian Reservation, Washabaugh County, *E. J. Palmer*, no. 37641, June 29, 1929 (A); Piedmont, Lawrence County, *E. J. Palmer*, no. 37024, June 8, 1929 (A).

Nebraska: Plummer's Ford, Dismal River, Thomas County, *P. A. Rydberg*, no. 1417, July 8, 1893 (G); Kearney, *J. H. Holmes*, 1889 (A); Whitman, *J. M. Bates*, no. 6011, July 22, 1914 (A); Omaha, *C. Williamson*, Aug., 1889 (P).

Kansas: Riley County, *J. B. S. Norton*, nos. 88, 88a, 1895, 1896 (G); Wichita, *S. F. Poole*, May, 1905 (G); Osborne City, *C. L. Shear*, no. 105, June 11, 1894 (G); Neodesha, Wilson County, *E. J. Palmer*, no. 22017, Sept. 19, 1922 (A); Ellsworth, Ellsworth County, *E. J. Palmer*, no. 21269, May 13, 1922 (A); Lyons, Rice County, *E. J. Palmer*, no. 21224, May 10, 1922 (A); Hays, Hays County, *E. J. Palmer*, no. 21310, May 15, 1922 (A).

Oklahoma: Cora, Woods County, *G. W. Stevens*, no. 748, May 28, 1913 (A); Cache, Comanche County, *G. W. Stevens*, no. 1338½, June 25, 1913 (A); Miami, Ottawa County, *G. W. Stevens*, no. 2457, Aug. 27, 1913 (A); Fonts, Lincoln County, *Clara Means*, June 13, 1895 (G); Huntsville, Kingfisher County, *Laura A. Blankenship*, May 30, 1896 (G); Witchita Mts., Marcey Expedition, 1852 (G); Kenton, Cimarron County, *G. W. Stevens*, no. 492, May 15, 1913 (G); Elk City, Beckham County, *E. J. Palmer*, no. 12567, June 16, 1917 (A); Seiling, *D. M. Andrews*, no. 67, Aug. 17, 1915 (A); Sapulpa, *C. B. Williams*, July 2, 1924 (P).

ARKANSAS: *Dr. Pitcher* (without locality or date) (P).

WYOMING: Sundance, Crook County, *Aven Nelson*, no. 5919, July 24, 1910 (G).

NEW MEXICO: Las Vegas, San Miguel County, *Bro. Anect*, no. 136, June 1920 (G); Vermejo Park, *Mrs. O. S. St. John*, no. 184, July–Aug., 1894 (G); La Cueva, Mora County, *Bros. G. Arsène & A. Benedict*, no. 17104, July 2, 1926 (A); Las Vegas Hot Springs, *Alfred Rehder*, no. 643, Sept. 21, 1916 (A).

TEXAS: Gamble's Ranch, Armstrong County, *E. J. Palmer*, no. 13980, June 6, 1918 (A).

Frequently cultivated in American and European Parks and gardens.

2a. **Amorpha canescens** var. **glabrata** Gray, Pl. Wright. I. 49 (1852).

Amorpha canescens β. leptostachya Engelmann apud Gray, Mem. Am. Acad. Sci. II. 4, 31 (1849), nomen nudum.

Differs from the typical form in the branches and foliage being only sparsely pubescent or glabrate and in the greener color of the leaves. The amount of pubescence is extremely variable and a complete series of gradations may be found between this variety and the typical form. In depauperate specimens the leaflets are often very small and the inflorescence is reduced to a single short spike. These variants perhaps deserve only to be regarded as forms, but to avoid making a new combination I am retaining Dr. Gray's varietal name.

Illinois and Missouri to Texas and New Mexico.—Type locality: eastern Texas.

MISSOURI: Medill, Clark County, *B. F. Bush*, no. 9162, Aug. 23, 1920 (A); Forest Mill, Jasper County, *E. J. Palmer*, no. 21673, June 2, 1922 (A); Neck City, Jasper County, *E. J. Palmer*, no. 20523, Sept. 19, 1921 (A); Melugin, Jasper County, *E. J. Palmer*, no. 25305, June 4, 1924 (A); Galena, Stone County, *E. J. Palmer*, no. 26150, Sept. 16, 1924 (A); Pontiac, Ozark County, *E. J. Palmer*, no. 33126, Oct. 12, 1927 (A); Columbia, cliffs of Grindstone, *Francis P. Daniels*, July, 1903 (University of Missouri Herbarium); Cole Camp, Benton County, *E. J. Palmer*, no. 26362, Oct. 1, 1924 (in part) (A).

OKLAHOMA: Kenton, Cimarron County, *G. W. Stevens*, no. 492, May 15, 1913 (in part) (G).[1]

TEXAS (?): *F. Lindheimer*, no. 37, 1843 (G).[2]

Sometimes cultivated in America and Europe.

3. **Amorpha herbacea** Walter, Fl. Car. 179 (1788).—Fig. 3.

Amorpha pubescens Willdenow, Berlin. Baumz. 17 (1796).

Amorpha pumila Michaux, Fl. Bor. Am. II. 64 (1803).

Amorpha herbacea var. a. *typica* C. Schneider, Ill. Handb. Laubholzk. II. 67 (1907).

Amorpha herbacea var. b. *Boyntoni* C. Schneider, l. c.

A low suffruticose shrub, usually less than one m. high, finely canescent throughout. Leaves very short-petioled; leaflets 11–41, elliptic, oblong, or slightly oval, 1–2 cm. long, 0.6–1 cm. wide, rounded at both ends or abruptly pointed at the apiculate apex, with the veins, except the mid-rib, inconspicuous. Inflorescence of numerous slender, rather loosely flowered racemes, 1–3 dm. long; calyx villous, the two upper lobes broadly triangular and shorter than the lanceolate, acuminate lower ones, which are fully half as long as the tube; standard white or pale violet. Pod nearly straight dorsally, 4–5 mm. long, pubescent, with conspicuous dark glandular dots.

North Carolina to Florida and Georgia.—Type locality: Carolina.

NORTH CAROLINA: Kingston, Lenoir County, *L. F. & Fanny R. Randolph*, no. 560, July 9, 1922 (G); *Curtiss* (without locality or date) (G); Bladen County, ex Biltmore Herbarium, no. 35b, June 20, 1897 (A, G, P); Wilmington, *T. G. Harbison*, no. 3, June 21, 1915 (A); Wilmington, *C. S. Williamson*, July, 1895 (P); Wilmington, *M. A. Curtis* (without date) (P); eastern North Carolina, *Gerald McCarthy*, no. 51, July, 1885 (P); Carolina, *Pinkney* (without locality or date) (P);

SOUTH CAROLINA: Santee Canal, *H. W. Ravenel*, (G); Calhoun Falls, *T. G. Harbison*, no. 9, May 20, 1918 (A); *M. A. Curtis* (without locality or date) (G).

GEORGIA: Rabun County, *T. G. Harbison*, no. 187, Oct. 1, 1910 (A); Augusta, *C. S. Sargent*, April 29, 1914 (A); Pulaski, Bulloch County, *R. M. Harper*, no. 9421, June 24, 1921 (A); Georgia, *Nuttall* (without locality or date) (P); Baldwin?, ex Herbarium

[1] The sheet of this number in the Gray Herbarium seems to belong to this variety, while that of the same number in the Arnold Arboretum Herbarium is of the typical form.

[2] This interesting specimen has the small, green, glabrate leaves of this variety, and the slender loosely flowered racemes are 13–26 cm. long. The sheet is labelled: "Flora Texana exsiccata. 37. A. paniculata Torr. & Gray. Fasc. I, leg. F. Lindheimer, 1843." The sheet also bears the notation: "N. B.—There has evidently been a confusion of labels and plants on this sheet. This is certainly not Lindheimer's 37." The specimens seem to agree best with Engelmann's var. *leptostachya*.

Schweinitz (without date) (P); Milledgeville, *Samuel Boykin* (without date) (P).

FLORIDA: Tampa Bay, *Otto Visterland*, no. 3, May, 1887 (A); Brookville, Hernando County, *E. J. Palmer*, no. 27352, May 18, 1925 (A); Florida, *Leavenworth* (without locality or date) (G); New Market, ex Herbarium A. C. Hexamer and F. W. Maier, June, 1855 (G); Richland, Pasco County, *A. H. Curtiss*, no. 6664, June 15, 1900 (G, P); St. Johns River, between Palatka and St. Augustine, *Rugel*, July, 1848 (G); near Manatee River, *Rugel*, no. 165, June, 1845 (G); Sumpter County, *A. H. Curtiss*, no. 573, June (P); Eustis, Lake County, *Geo. V. Nash*, no. 1976, June 16–30, 1895 (P); Florida, *A. W. Chapman* (without locality or date) (P); John's Pass, *S. M. Tracy*, no. 7794, May 26, 1901 (G).

Sometimes cultivated in American and European gardens.

4. **Amorpha cyanostachya** M. A. Curtis in Boston Jour. Nat. Hist. I. 140 (1835).—Fig. 3.

?*Amorpha pumila* Schlechtendahl, Ind. Sem. Hort. Hal. 8 (1848).
Amorpha caroliniana Rydberg in N. Am. Fl. XXIV. 29 (1919).—Not *A. caroliniana* Croom.

A shrub 1–2 m. high; branches glabrous or sparingly pilose. Leaves 1–1.5 dm. long; petioles short, 8–12 mm. long; leaflets oblong or elliptic, 15–25 mm. long, 8–12 mm. wide, rounded at both ends or acute at the mucronate apex, glabrous or nearly so, dark green and glossy above, paler and conspicuously punctate-dotted beneath, of firm texture and with revolute margins at maturity. Flowering racemes single or few in cluster, slender, 0.5–1 dm. long; calyx glandular, glabrous, except the ciliate margins of the teeth, the upper two of which are obtuse or broadly triangular and the lower three acute and subulate-pointed; standard bright blue. Pod about 5 mm. long, conspicuously glandular-dotted, straight or nearly so on back.

North Carolina to Florida and Alabama, near the coast.—Type locality: Wilmington, N. C.

NORTH CAROLINA: Wilmington, *T. G. Harbison*, no. 16, June 11, 1917 (A); Wilmington, *Edward A. Bartram*, Oct. 6, 1908 (P); Wilmington, ex Biltmore Herb. no. 1381L, July 1, 1904 (P); Swain County, *H. C. Beardslee & C. A. Kofoid*, July 17, 1891 (P); Hamlet, *C. S. Williamson*, May 20, 1895 (P).

FLORIDA: West Florida, *Chapman*, ex Biltmore Herb., no. 5767, June, 1890 (G); East Florida, *Chapman* (without locality or date) (G); Florida, ex Torrey Herb. (without locality or date) (G).

ALABAMA: Banks of Alabama River, *S. B. Buckley*, Aug. 1840 (G).

By comparing the original descriptions of *A. caroliniana*[1] and of *A. cyanostachya*[2] with that given by Rydberg in N. Am. Fl. it will be seen that Croom's plant cannot have been the glabrous species there referred to it. His insistence on the short solitary spike and characterization of a plant with pubescent branches and leaves covered on both surfaces with minute shining hairs is somewhat suggestive of *A. Schwerini*, which is so distinct that it would have been likely to have attracted the attention of earlier botanists. I hesitate, however, to refer that species to it as a synonym, as the pubescence on Schneider's plant is soft and copious, and I do not know of any specimens from the vicinity of Newbern. In fact I have seen no specimens that in all respects agree with the original description. Curtis describes the leaves of *A. cyanostachya* as glabrous, and in their number and other characters as well as those of the calyx and flowers it agrees with the specimens here referred to it. The author's note comparing it with *A. fruticosa*, from which it is distinguished by its shorter, more pubescent spikes, throws some doubt upon it. However, the plant which he called *A. fruticosa* about Wilmington probably was not that species and may have been *A. glabra*.

Since the description given of *A. caroliniana* appears to be too indefinite to be applied to any plant known in the region, it seems advisable to abandon it, and I am taking up Curtis' name for this plant, which is a common species in the neighborhood of Wilmington, to avoid adding another name, since it agrees with it more fully, although not clear in all particulars.

5. **Amorpha floridana** Rydberg in N. Am. Fl. XXIV. 31 (1919).—Fig. 5.

A shrub 1–1.5 m. high; branches sparingly villous. Leaves 1–1.5 dm. long, petioles short (0.5–1 cm. long), equalling or shorter than the lowest leaflets; leaflets 21–41, narrow-oblong, rounded at both ends, glabrous or nearly so above, paler and conspicuously glandu-

[1] Amorpha * caroliniana.
Plant shrubby, four to five feet high; branches pubescent, striate; leaves pinnate; leaflets oblong, obtuse, mucronate, petiolate, covered on both surfaces with minute, shining hairs, and thickly studded with diaphanous glands; spike *solitary, short;* flowers very small, dark purple, approaching to indigo; calyx sprinkled with minute hairs. Found by Dr. Loomis in 1832, near Newbern, flowering in July.

[2] *Amorpha cyanostachya.* Leaflets oblong, emarginate, obtuse at each end, smooth; Rachis pubescent; Flowers subsessile; Calyx with the margins villous, two of the teeth short, obtuse, and three acuminate, subaristate, nearly equal; Vexillum obcordate, more than twice the length of the calyx.

Obs. Leaflets 10–15 pairs, 6–9 lines long, 3–4 wide, glandular, occupying the petiole nearly to the stem. Flowers blue, darker at the summit of the vexillum, and becoming lighter towards the base. This species is distinguished from *A. fruticosa* by its different colored flowers; shorter pedicels; spikes shorter, more pubescent, and less attenuated; a calyx at base; shorter stamens; and smaller and more numerous leaflets.

lar-dotted beneath, more or less pubescent when young, becoming glabrous at maturity and then firm in texture and with slightly revolute margins. Racemes numerous, clustered, 5–15 cm. long; rachis villous; calyx 3–4 mm. long, slightly puberulent or glabrous, glandular-dotted; calyx-lobes short with ciliate margins, the upper two broadly triangular, obtuse, the lower three lance-triangular; standard purple. Pod 4–5 mm. long, conspicuously glandular-dotted, slightly curved dorsally.

Florida.—Type collected by Chapman (without definite locality).

FLORIDA: *Chapman* (without locality or date) (Type) (N); *Chapman*, west Florida, June, 1890, ex Biltmore Herb., no. 5767 (A, N); *Chapman* (without locality or date), ex Torrey Herb. (N); Apalachicola, *B. F. Saurman*, 1867 (P).

6. **Amorpha brachycarpa**, sp. nov.—Plate 36 and Fig. 6.

Frutex erectus gracilis 6–9 dm. altus, ramis paucis, glabris vel parce pubescentibus. Folia numerosa subsessilia, rachibus gracilibus canaliculatis; foliola densa vel imbricata, 21–45, oblonga, 8–15 mm. longa et 4–8 mm. lata, apice rotunda vel emarginata, mucronata, basi rotundata vel subcordata, matura papyracea, glabra vel parce ciliata, marginibus revolutis, costis nervisque prominentibus, reticulata. Inflorescentia paniculata, 1–2.5 dm. longa, ramis multis gracilibus dense floriferis; pedicelli glabri, 1–1.5 mm. longi; calyx turbinatus, angulatus, glaber vel fere glaber; sepala lanceolata, ciliata, superiores tubo triente breviores, inferiores tubum aequantes vel longiores; vexillum obovatum, apice truncatum vel leviter emarginatum, purpureo-caeruleum; stamina et stylus glaber exserta. Legumen obliquo-obovatum, 4–5 mm. longum, 3–3.5 mm. latum, dorso recto, calycis dentes vix excedens, atrobrunneum, manifeste glanduloso-punctatum, monospermum, rostro incurvo.

A slender shrub 6–9 dm. tall, with few, erect, glabrous or sparsely pubescent, grooved branches. Leaves numerous, 7–12 cm. long, sessile or nearly so, with 21–45 oblong leaflets, rachis slender, glabrous or nearly so, channeled above; stipules inconspicuous, linear-subulate, 1–1.5 mm. long; leaflets approximate, crowded or imbricately overlapping, oblong, symmetrical or slightly oblique, 8–15 mm. long, 4–8 mm. wide, rounded or subcordate at base, rounded or slightly emarginate and mucronate at apex, the terminal one reduced and often nearly orbicular and deeply emarginate, thin but firm, glabrous or with a few ciliate hairs on the margins and on the veins beneath, margins slightly revolute, the mid-vein prominent and the secondary veins rather conspicuous on the slightly reticulate lower surface; petioles glabrous, about 1 mm. long. Inflorescence paniculately branched, 1–2.5 dm. long, of many, erect, slender, closely-flowered branches; flowers on very short (1–1.5 mm.) pedicels; calyx turbinate, 4–5 mm. long, the tube angled, glabrous or nearly so, except the lanceolate, acuminate, calyx-lobes, the upper two of which are about two-thirds the length of the tube and the lower ones fully as long or longer than tube, ciliate on the margins; standard obovate, truncate or slightly emarginate at apex, bright violet-blue; stamens and glabrous style exserted. Fruit obliquely obovate, 4–5 mm. long, 3–3.5 mm. wide, much flattened, nearly straight on the back, terminated by curved beak and persistent style, dark brown, with conspicuous resinous dots, margins slightly thickened, one-seeded, the pod scarcely exceeding the calyx-lobes.

Barrens and glades of the Ozark region, Missouri.—Type locality: Galena, Stone County.

MISSOURI: Galena, Stone County, *E. J. Palmer*, no. 19197 (type), Sept. 27, 1920 (A); nos. 20649, 22853 (paratypes), Oct. 1, 1921, May 24, 1923 (A).—Cultivated specimens: Arnold Arboretum, under numbers 15781, 20002, collected Sept. 19, 1923, Aug. 4, Sept. 23, 1924, Sept. 23, 1929 (paratypes) (A).

This little species of *Amorpha* resembles *A. nana* in size, habit and foliage. However, it is well distinguished from that species by the large, many-branched panicle, and by the relatively short tube and long teeth of the calyx, the latter about equalling the broad pod with its strongly reflexed beak. From *A. canescens*, to which it is perhaps most closely related, it is distinguished both by its glabrous character and by the relatively broader, much flattened, straight-backed pod, with strongly reflexed beak. The leaflets are also relatively shorter and broader than in typical forms of *A. canescens*.

The type locality where *Amorpha brachycarpa* was discovered is typically Ozarkean in topography and flora. It was growing in limestone glades, in openings of deciduous woods, where it was locally abundant. It should be looked for in similar situations at other localities in the Ozarks.

Plants grown at the Arnold Arboretum, both from seeds and roots collected at the type locality, have produced flowers and fruit, retaining all of the distinguishing characters of the parent plants, and since specimens collected from these, especially at flowering time, were in even better condition than the native material, both have been drawn upon for the description and figures.

7. **Amorpha nana** Nuttall in Fraser, Cat. (1813); reprinted in Pittonia, II. 116 (1890).—Fig. 7.

Amorpha microphylla Pursh, Fl. Am. Sept. 466 (1814).
Amorpha punctata Rafinesque, New Fl. III. 14 (1838).

A low, erect shrub 3–9 dm. high, glabrous or nearly so throughout. Leaves numerous, 3–10 cm. long, with very short petioles; leaflets 15–31, oblong, oval, or slightly obovate, rounded or abruptly narrowed at base, rounded or emarginate and mucronate at apex, 8–14 mm. long, 4–8 mm. wide, firm and slightly reticulate, green on both sides. Inflorescence of single or few erect, densely-flowered racemes, 3–8 cm. long; calyx-lobes lanceolate, acuminate, about half as long as the tube; standard purple. Pod about 5 mm. long, straight dorsally, with short, erect, or slightly oblique beak, densely punctate-dotted.

Iowa and Kansas to Saskatchewan and south to New Mexico.—Type locality: near Mandan, North Dakota.

IOWA: Armstrong, *R. I. Crotty*, June–July, 1892 (A, G); Prairies, Emmet County, *R. I. Crotty*, Sept. 26, 1882 (P).

KANSAS: Ellis County, *E. N. Plank*, no. 18, 1884 (G).

MINNESOTA: Blue Earth River, *Dr. Parry*, 1848 (G, P); New Ulm, *Lesquereaux*, June, 1856 (G); Wheaton, Travers County, *E. P. Sheldon*, Sept., 1893 (G); Minnesota, *E. V. Campbell*, 1882 (without locality or date) (G); Upper Mississippi, ex herbarium J. Torrey (without exact locality or date) (G); Stevens Expedition, *Dr. Buckley*, (without locality or date).

NORTH DAKOTA: Pembia, *E. Coms*, 1873 (G); Upper Missouri, Stevens Expedition, *Dr. Buckley* (without definite locality or date) (G); Northwest Territory, *I. N. Nicolette*, no. 175 (without exact locality or date (P); Missouri (River), *Nuttall* (without definite locality or date, but marked with *, used by Nuttall to indicate new species).

SOUTH DAKOTA: White Rock, *Mrs. H. O. Powell*, June, 1903 (G); bluffs of the Missouri, Ft. Pierre, *T. A. Williams*, Aug. 4, 1891 (A); White River, *E. C. Sterns* (A); Lymon County, opposite Chamberlain, *E. J. Palmer*, no. 36091, June 7, 1929 (A); Creston, Pennington County, *E. J. Palmer*, no. 37239, June 14, 1929 (A).

MANITOBA: Winkler, *John Macoun*, no. 12530, Aug. 6, 1896 (G); 6 mls. east of Forest, *John Macoun & William Herriot*, June 19, 1906 (G); Winnepeg Valley, *E. Bourgeau*, 1859 (G).

SASKATCHEWAN: Assiniboine River, *J. Macoun*, no. 103, June 14, 1879 (G).

Cultivated for many years in American and European gardens.

Some doubt as to the identity of Nuttall's plant of Fraser's Catalogue has existed as a result of the note in Torrey & Gray, Flora of North America, I. 690. But the brief description accompanying the name, and the locality given by Nuttall, as well as the fact that Pursh in proposing his later name, *Amorpha microphylla*, cites

Amorpha nana, Fraser, Catal. as a synonym, seems to be sufficient ground for using the name *A. nana* rather than the later one of Pursh. The confusion apparently arose merely from the fact that a form of *Amorpha fruticosa*, obtained under the name *A. nana* from the Fraser nursery was cultivated in England. Nuttall's note in the Fraser catalogue is as follows:

"This is a very elegant dwarf shrub, with highly odorous purple flowers. Collected near the Mandan towns, 1600 miles up the Missourie. It is perfectly glabrous, dentures of the calyx all acuminate, and the legume one seeded. It appears intermediate between *A. fruticosa* and *A. pubescens*, from both of which it is evidently distinct."

8. **Amorpha glabra** Desfontaines, Tabl. École Bot. Paris, 192 (1804), nomen nudum.—Persoon, Syn. Pl. II. 295 (1807), nom. seminudum.—Poiret in Lamarck, Encycl. Méth. Suppl. I. 330 (1810).—Fig. 8.

Amorpha montana Boynton in Biltmore Bot. Studies, I. 138 (1902).
?*Amorpha fruticosa* var. *glabra* Bean, Trees & Shrubs Brit. Isles, I. 193 (1914).

Stout shrubs, 1–1.5 m. high, glabrous or essentially so throughout. Leaves 1–2 dm. long; petioles 1.5–3 cm. long; leaflets 9–21, oblong, oval or slightly obovate, 1.5–4 cm. long, 1–2.5 cm. wide, rounded at both ends or somewhat emarginate at apex, and rarely narrowed at base, thin, dark green above, paler beneath, with inconspicuous veins. Flowering racemes usually single, 1–2 dm. long, rather loosely flowered, sometimes with one or two shorter ones at base; calyx campanulate, 3–4 mm. long, the lobes very short and broad, or the upper sometimes nearly obsolete; standard bright purple. Pod obliquely ovate in outline, straight dorsally, 7–8 mm. long, with short, erect or slightly deflexed beak, covered with numerous small glandular dots on upper part.

North Carolina and Georgia to Tennessee, and in the Ozark region of southern Arkansas and eastern Oklahoma. Found on rocky mountain slopes of the Piedmont regions.

NORTH CAROLINA: Chimney Rock, Rutherford County, ex Biltmore Herbarium, no. 14f, May 10, 1898 (G); Asheville, *B. L. Robinson*, no. 47, Aug. 1, 1893 (G); Cedar Cliff, Buncombe County, *T. G. Harbison*, no. 20, Oct. 14, 1905 (A); Highlands, *T. G. Harbison*, no. 24, May 22, 1918 (A); Tuckaslegee River, Jackson County, *T. G. Harbison*, no. 1595, May 19, 1914 (A); Macon County, *T. G. Harbison*, no. 133, Sept. 6, 1914 (A); Weldon, *C. S. Williamson*, July (P); Hot Springs, ex Herb. Charles E. Smith, May, 1889 (P); Hog-back Mountain, *C. S. Sargent*, Sept. 22, 1885 (A); Biltmore, ex

Biltmore Herb., no. 14, May 13, 1896 (A); White Oak Mountain, Polk County, ex Biltmore Herb., no. 14d, May 31, 1897 (A); Swain County, *T. G. Harbison*, no. 1594, May 18, 1914 (A); Swain County, *H. C. Beardslee & C. A. Kofoid*, July 7, 1891 (G, P).

ALABAMA: Huntsville, *C. S. Sargent*, Oct. 9, 1898 (A).

OKLAHOMA: Page, Le Flore County, *E. J. Palmer*, nos. 9038, 20572, 20913, 21645, Oct. 27, 1915, Sept. 23, 1921, April 25, 1922 (A).

CULTIVATED: Arnold Arboretum; Hort. Vilmorin, Verrières, France.

9. **Amorpha laevigata** Nuttall apud Torrey & Gray, Fl. N. Am. I. 306 (1838).—Fig. 9.

Amorpha laevigata var. *typica* C. Schneider, Ill. Handb. Laubholzk. II. 74 (1907).

A glabrous shrub 1–2.5 m. high. Leaves 1–2 dm. long; petioles slender, 2–3 cm. long; leaflets 7–21, oblong or obovate, 2–3 cm. long, 1–2 cm. wide, rounded at both ends or cuneate at base and sometimes slightly emarginate at apex, thin, conspicuously punctate beneath; petiolules conspicuously glandular. Flowering racemes usually 2 or 3 (sometimes more), slender, 1.5–3 dm. long; calyx glabrous, glandular-dotted; calyx-lobes short, the upper two rounded, the lower three lanceolate, acute; standard indigo or purple. Pod about 5 mm. long, conspicuously glandular dotted, nearly straight dorsally.

Oklahoma to Texas.—Type locality: Banks of Arkansas River near Salt River (Oklahoma).

TEXAS: Houston, Elihu Hall, no. 128, June 10, 1872 (G, N); *Lindheimer* (without locality or date) (P); *Lindheimer*, no. 38, April 1842 (G, P).[1]

I have been in some doubt as to the wisdom of maintaining the name, *A. laevigata*, Nutt., since there seems to be considerable uncertainty as to just what the plant is that was collected by Nuttall on the banks of the Arkansas River, in what is now Oklahoma. The description given in Torrey and Gray's Flora, based on his notes, seems to indicate a very distinct plant and I do not know of any from the region that quite agrees with it in all particulars. Torrey and Gray state that they had seen no specimen of it and I have been unable to find any so named by Nuttall. Since its publication the name has been applied to various glabrous or nearly glabrous

[1] A specimen in the Gray Herbarium, J. Reverchon, no. 814, on the label of which has been written in another hand: "Collected by Ball on the Neches, Van Zant County, July, 1877," and another branch on the sheet, which looks like the same collection, labelled: "Reverchon, N. W. Texas," have small, cuneate leaves, truncate to deeply emarginate at apex. It is a very curious form of *A. laevigata*, but without better material or more definite data I hesitate to describe it as a distinct variety.

forms of *Amorpha* by collectors, and the expanded descriptions of later authors seem to be based on a composite description of these.

In 1862 Buckley described *Amorpha texana* from west-central Texas, giving a clear and definite description of his type specimen, which is now preserved in the herbarium of the Philadelphia Academy of Natural Sciences. The form described by Buckley differs widely from the description of *A. laevigata*, being a plant with pubescent branches, short, few-spiked inflorescence, and broad-oblong leaflets, pubescent on under surface, rounded or emarginate at the apex and not at all narrowed at base. However, *A. texana* proved to be quite a variable species, and there is a form with leaflets glabrous or nearly so, although with pubescent calyx, which Dr. Gray identified with Nuttall's species, making it a synonym and calling the pubescent (typical) form var. *pubescens*. Specimens have also been collected in Texas which agree with *A. texana* in having the conspicuously punctate leaves and glandular calyx and petiolules which characterize the entire group, but in which the flowers are smaller, the calyx is essentially glabrous, the flowering racemes slender and elongated and the leaves sometimes narrowed at the base. This agrees fairly well with the description of *A. laevigata* as given by Torrey and Gray,[1] and it seems best to distinguish it by the older name, and to maintain Buckley's name for the commoner Texan plant, since the extreme forms differ so widely and scarcely can be brought under one specific description, although probably closely allied genetically and perhaps passing into each other.

10. **Amorpha nitens** Boynton in Biltmore Bot. Studies, I. 139 (1902).—Fig. 10.

A shrub 1–3 m. high; branches glabrous, angled. Leaves 1–2.5 dm. long, ascending; petioles 1–3 cm. long; leaflets 9–19, oblong or oblong-ovate, rounded at both ends or rarely abruptly pointed or slightly emarginate at apex, 2–6 cm. long, 1–2 cm. broad, thin, glabrous and at maturity shining above, usually thinly pubescent on the under surface, inconspicuously feather-veined (often turning black in drying). Racemes usually solitary, 0.5–2.5 dm. long, rarely with one or more additional short ones at base; rachis glabrous or

[1] *Amorpha laevigata* (Nutt. mss.): "glabrous and very smooth; leaves large; leaflets distant, elliptical oblong, attenuate below: the common petiole short; stipules minute; bracts rather long and subulate, caducous; calyx very glandular; the teeth acute, the three lower ones longer and accuminate; vexillum deep blue, about the length of the calyx; legume 1-seeded.

"Banks of the Arkansas, near Salt River,—A very distinct large shrubby remarkably smooth species, with large, distant and very obtuse leaflets, and long (8–10 inches) clustered terminal spikes. Calyx nearly glabrous except the margin, covered with elevated glands." *Nuttall.*—This species we have not seen. It is apparently allied to A. paniculata.

nearly so; calyx narrowly conic, about 3 mm. long, striate, glabrous except the ciliate margins of the lobes; calyx-lobes much shorter than the tube, the two upper ones very obtuse or rounded, the lower ones ovate, acute; standard blue-purple. Pod about 7 mm. long, curved, nearly glandless.

Georgia and Alabama to southern Illinois and in the Ozark region of Western Arkansas.—Type locality: Waynesboro, Georgia.

GEORGIA: Augusta, *T. G. Harbison*, nos. 1531, 1536, May 5, 1914 (A); Milledgeville, *Samuel Boykin* (P).

ALABAMA: Valleyhead, *T. G. Harbison*, no. 533, May 2 (A).

ILLINOIS: Golconda, Pope County, *E. J. Palmer*, nos. 15371, 23778, June 5, 1919, Sept. 17, 1923 (A).

ARKANSAS: Little Rock, Pulaski County, *E. J. Palmer*, no. 22967, May 31, 1923 (A); Gulpha, Garland County, *E. J. Palmer*, no. 24555, April 25, 1924 (A); Magnet Cove, Hot Springs County, *E. J. Palmer*, nos. 26915, 29724, April 24, 1925, April 19, 1926 (A); Hot Springs, Garland County, *E. J. Palmer*, nos. 23027, 23148, 24485, 24888, 24908, 26862, June 3, 7, 1923, April 22, May 14, 1924, April 22, 1925 (A); Wynne, Cross County, *E. J. Palmer*, no. 31662, Sept. 9, 1926 (A).

10-a. **Amorpha nitens** var. **leucodermis,** var. nov.
Amorpha leucodermis Boynton in Herb.

A typo recedit foliolis subtus pallidis vel leviter glaucescentibus et cortice pallidiore.

GEORGIA: Augusta, *F. E. Boynton*, nos. 666, 7035 (type), April 30, Sept. 3, 1902 (G).

11. **Amorpha crenulata** Rydberg in N. Am. Fl. XXIV. 30 (1919).—Fig. 11.

A shrub 1–1.5 m. high, nearly glabrous throughout. Leaves 1–2.5 dm. long, with rather remote leaflets and short (1–1.5 cm.) petioles; leaflets relatively narrow, oblong, linear-oblong or sometimes narrowly ovate or obovate in outline, 1.5–4 cm. long and 0.5–1.2 cm. wide, acute or rounded at base, obtusely pointed, truncate or slightly emarginate at apex, margins often obscurely crenulate, bright green above, paler and finely punctate-dotted beneath, firm and slightly reticulate at maturity; petiolules more or less glandular. Flowering racemes slender, one to several, rather loosely flowered below; calyx 3–4 mm. long, usually glandular, glabrous except the short ciliolate margins of the acute lobes, the lower three of which are lanceolate and about half as long as the tube; standard white. Pod 6–7 mm. long, nearly straight on the back, conspicuously glandular-dotted above the middle.

Southern Florida.—Type locality: hammocks between Cocoanut Grove and Cutler.

FLORIDA: Fort Dallas, *Dr. Cooper* (G); Miami Road, Cocoanut Grove, *Miss O. Rodham*, 1910 (A, P); near Little River, *Alfred Rehder*, no. 738, April 25, 1920 (A); near Miami, Dade County, *E. J. Palmer*, no. 27476, May 21, 1925 (A); Ft. Myer, *T. G. Harbison*, no. 12, Sept. 17, 1914 (A); between Cocoanut Grove and Cutler, *J. K. Small & J. J. Carter*, no. 718 (isotype?), Nov. 1903 (P); Miami, *H. B. Meredith*, March 14, 1917 (P); Miami, *A. P. Garber*, June-July, 1877 (G. P); Miami, *J. K. Small*, *J. J. Carter & G. K. Small*, no. 17, Feb. 1911 (P); Florida, *A. W. Chapman* (without locality or date) (P); East Florida, *Dr. Leavenworth* (P).

12. **Amorpha Curtissii** Rydberg in N. Am. Fl. XXIV. 30 (1919).—Fig. 12.

A shrub 1–3 m. high; glabrous or essentially so throughout. Leaves 1–2 dm. long; petioles 1–2 cm. long; leaflets 11–20, oblong or elliptic, 2–4 cm. long, 1–1.5 cm. wide, rounded at both ends or slightly acute at base, and sometimes at apex, dark green above, paler and punctate beneath, firm but thin at maturity. Racemes single or clustered, .5–1.5 dm. long, usually sessile or closely flowered to base; calyx glabrous except the ciliate margins of the lobes, sometimes with a few glands on upper part; calyx-lobes short, the upper two rounded, the lower three triangular and acute; standard dark bluish-purple. Pod 7–8 mm. long, 4 mm. wide, nearly straight dorsally, conspicuously glandular punctate.

North Carolina (?) to Florida.—Type locality: Jacksonville, Florida.

FLORIDA: Jacksonville, *A. H. Curtiss*, no. 4703, May 6, Aug. 21, 1894 (type) (N); Jacksonville, *A. H. Curtiss*, no. 6410, May 20, 1898 (G); vicinity of Mayport and Jacksonville, *Henry D. Keller*, 1870–76 (N); Port Orange, *F. C. Straub*, no. 166, May 2, 1895 (G, N).

SOUTH CAROLINA: Andersonville, *Louis R. Gibbes*, 1885 (N).

NORTH CAROLINA: Wilmington, ex Biltmore Herb., no. 1381L, July 1, 1904 (G).[1]

13. **Amorpha Schwerini** C. Schneider, Ill. Handb. Laubholzk. II. 69, 71 (1907).—Fig. 13.

Amorpha densiflora Boynton in Small, Fl. SE. U. S., ed. 2, 1342 (1913).

A branching shrub 1–2 m. high; branches finely pubescent. Leaves 0.5–1.5 dm. long; petioles about 1 cm. long; leaflets 11–25, oblong or ovate-oblong, 1–4 cm. long, 0.5–1.5 cm. broad, rounded at both ends, slightly emarginate at apex, dark green and short-

[1] The fruit in this specimen is 9–10 mm. long and distinctly curved. In other characters it appears to agree with description of this species.

pilose above, paler and densely soft-pubescent beneath. Calyx 4–6 mm. long, pilose, the lobes all lanceolate, subulate, as long or longer than the tube; standard purple. Pod about 5 mm. long, straight dorsally, punctate and puberulent.

North Carolina and Georgia.—Type locality: Dunn's Mountain, Roan County.

NORTH CAROLINA: Dunn's Mountain, *J. K. Small*, Aug. 18–27, 1894 (isotype) (N); Crowder's Mountain, ex Biltmore Herb., nos. 14764, 14765b, Sept. 26, 1902, May 14, 1904 (N).

GEORGIA: Augusta, *C. S. Sargent*, April 29, 1914 (A).

14. **Amorpha paniculata** Torrey & Gray, Fl. N. Am. I. 306 (1838). —Fig. 14.

Amorpha Roemeriana Scheele in Linnaea, XXI. 461 (1848).

A stout shrub 2–3 m. tall, growing in sandy bogs or wet ground; branchlets sulcate, tomentose. Leaves 2–3.5 dm. long; petioles 4–5 cm. long; leaflets 15–19, oval or oblong, 3–8 cm. long, 1.5–3 cm. wide, rounded at both ends or rarely emarginate at apex, when young finely short-pilose above and densely tomentose beneath, at maturity glabrous and glossy above and still tomentose on lower surface, prominently feather-veined. Calyx oblique, narrow-campanulate, pubescent, the lobes lanceolate, about half as long as the tube; standard purple. Pod 6–8 mm. long, more or less curved dorsally, pubescent and with large resinous glandular dots.

Louisiana and southwestern Arkansas to southern Oklahoma and eastern Texas.—Type locality: Arkansas.

ARKANSAS: Fulton, *B. F. Bush*, no. 5818, June 10, 1909 (A); McNab, Hempstead County, *E. J. Palmer*, no. 22310, Oct. 12, 1922 (A).

LOUISIANA: Lecompte, *R. S. Cocks*, no. 116, April, 1901 (A).

TEXAS: *F. Lindheimer*, no. 37, 1843 (without locality) (G, P); *Drummond expedition*, no. 461 (without locality or date) (A, P); neighborhood Zavala, *Dr. Leavenworth*, July (P); *Wright*, (without locality or date) (G); *Lindheimer*, Brazos, July, 1843 (P); Headwater, *J. Reverchon*, no. 2665, June 18, 1901 (A); Marshall, *B. F. Bush*, no. 991, Oct. 8, 1901 (A); Marshall, Harrison County, *E. J. Palmer*, no. 8635, Sept. 24, 1915 (A); Big Sandy, Upshur County, *E. J. Palmer*, no. 31728, Sept. 27, 1926 (A); Grapeland, Houston County, *E. J. Palmer*, nos. 12829, 14414, Sept. 22, 1917, Sept. 16, 1918 (A).

CULTIVATED: Arnold Arboretum.

15. **Amorpha texana** Buckley in Proc. Acad. Nat. Sci. Phila. 1861, p. 452 (1862).[1]—Fig. 15.

[1] The original description of this species is as follows:
Amorpha T e x a n a, s. nov.—Fruticosa, foliis magnis, foliolis 4–6-jugis, elliptico-

Amorpha laevigata var. *pubescens* Gray, Pl. Wright. I. 49 (1852).
Amorpha texana var. *mollis* Boynton in Biltmore Bot. Studies, I. 149 (1902).
Amorpha subglabra Heller, Bot. Exped. to Texas, 48 (1925).[1]

A shrub 1–3 m. high, with spreading branches; branches, foliage and inflorescence more or less pubescent. Leaves 1–1.5 dm. long; petioles 1–2 cm. long; leaflets 7–15, broad-oblong or oval, 1.5–4 cm. long, 1.5–3 cm. wide, rounded at both ends or emarginate at apex, sometimes deeply so, firm, dark green and glossy above, paler and pubescent at least along the veins beneath; petiolules 3–5 mm. long, usually pubescent and conspicuously glandular. Flowering racemes single or few, 0.5–1.5 dm. long, rather loosely flowered, at least near the base; rachis pubescent; calyx narrow-campanulate, 4–5 mm. long, more or less pilose-pubescent, glandular; calyx-lobes all much shorter than the tube, the two upper blunt or round, the three lower short-lanceolate, acute; standard blue or violet. Pod 6–7 mm. long, nearly straight dorsally, conspicuously glandular-dotted.

Central and southwestern Texas.—Type locality: on the Pedernales River. Usually found on banks and along beds or rocky streams in the limestone regions.

TEXAS: Dead Man's Hole, on the Pedernales River, *S. B. Buckley* (type), June, 1861 (P); Kerr County, *A. A. Heller*, no. 1772, May 14–21, June 19–26, 1894 (A, G, P); Kerrville, Kerr County, *E. J. Palmer*, nos. 13623, 33826, May 16, 1918, May 7, 1928 (A); Lacey's Ranch, Kerr County, *E. J. Palmer*, no. 10028, June 2, 1918 (A); Spanish Pass, Kendall County, *E. J. Palmer*, no. 9862, May 23, 1916 (A); Fischer's Store, Comal County, *E. J. Palmer*, no. 12193, June 6, 1917 (A); Texas, *Charles Wright*, 1849 (G); Fredericksburg, *F. Lindheimer*, no. 16, June, 1847 (G).

15a. **Amorpha texana** var. **glabrescens**, var. nov.

Amorpha fruticosa var. (1) Gray in Boston Jour. Nat. Hist. VI. (1850).

A typo recedit foliolis glabris vel subglabris.

Central and southwestern Texas.

oblongatis emarginatis mucronatis basi obtusis, breve petiolatis, subtus glanduloso-pubescentibus supra glabris, spicis axillaribus vel capitatis glanduloso-tomentosis, folio parum longioribus, sublaxifloris, floribus breve pedicellatis, calycis dentibus, subaequalibus, ovatis, acutis, stylo exserto villoso, leguminibus subovatis, arcuatis, acutis.
On the Pierdenalis [*sic*] River. June.
Shrub 4–5 ft. high. Racemes and flowers brownish-red; filaments and style long, exserted; leaflets 1–2 inches long and ¾–1¼ wide, the pairs at intervals of about an inch from each other; corolla more than twice the length of the calyx; flowers large in comparison with other species.

[1] Heller's plant, judging by the sheets I have seen of it, appears to be typical *Amorpha texana*, and not the subglabrous plant referred to as a variety of *A. fruticosa* by Gray in Plantae Lindheimerianae, with which he seems to have identified it. For this reason I am using another name for the form of *A. texana* with glabrous leaflets.

TEXAS: New Braunfels, *F. Lindheimer*, no. 743 (type), May, 1850 (A); *Lindheimer*, ex G. W. Short Herb., no. 296, 1849–50 (G, P); Bandera, *J. Reverchon*, no. 1513, June, 1885 (A); Headwaters of the Medina, *J. Reverchon*, no. 42, 1885 (G); Medina Lake, Bandera County, *E. J. Palmer*, no. 12259, June 14, 1917 (A).

16. **Amorpha virgata** Small in Bull. Torrey Bot. Club, XXI. 17 (1894).—Fig. 16.

An erect shrub 1–2 m. high, with single or several stems, usually branching at the summit; branches finely canescent or short pilose when young, becoming glabrous. Leaves 1–2 dm. long; petioles 1.5–2.5 cm. long; leaflets 9–19, oblong or oblong-ovate, often twice as long as wide, 2–5 cm. long, 1–2.5 cm. wide, rounded at both ends or sometimes slightly emarginate at the scarcely mucronate apex; petiolules slender, 3–4 mm. long. Inflorescence usually of several clustered, erect spikes, 1–2 dm. long; standard blue or blue-purple; calyx sparingly villous or canescent at flowering time, glabrous at maturity except the ciliate margins of the lobes; calyx-lobes all much shorter than tube, the two upper obtuse or rounded, the lower triangular and acute. Pod 6–7 mm. long, slightly curved or nearly straight dorsally, usually distinctly keeled, much flattened, glabrous and with rather remote glandular dots.

Florida to Alabama, northward in the Mississippi Valley to southern Illinois, and in the Ozark region of western Arkansas and eastern Oklahoma.—Type locality: Stone Mountain, De Kalb County, Georgia.

FLORIDA: Eustis, *Geo. V. Nash*, no. 261, March 12–31, 1894 (A, G) and no. 1137, July 1–15, 1894 (G, P); Eustis, *T. G. Harbison*, no. 10, June 22, 1919 (A); Sumner, *T. G. Harbison*, no. 8, June 12, 1915 (A); Lake Bersford, Volusia County, *A. H. Curtiss*, no. 6684, July 11, 1900 (G, P); Myers, *A. S. Hitchcock*, no. 52, July-Aug., 1900 (G).

GEORGIA: Stone Mountain, DeKalb County, *J. K. Small*, July 3, 17, 1893 (isotypes) (A, G, P); Stone Mountain, ex Biltmore Herb., no. 14c, May 12, Sept. 8, 1897 (A, G); Stone Mountain, *C. R. Pollard & Wm. R. Maxon*, no. 464, Aug. 10, 1900 (G); McGuire Mill, Gwinnett County, *J. K. Small*, July 17, 1893 (G); "in montibus carolinae et Georgiae," *S. B. Buckley* (P).

ALABAMA: summit of Cheawhan Mountains, Clay County, *Chas. Mohr*, July 31, 1896 (A).

MISSISSIPPI: Byram, *T. G. Harbison*, no. 6, May 24, 1915 (A); West Point, *T. G. Harbison*, no. 7, May 4, 1914 (A); Jackson, *T. G. Harbison*, nos. 59, 61, April 17, 1915 (A).

ARKANSAS: top of Magazine Mountain, Logan County, *E. J. Palmer*, no. 24187, Oct. 17, 1923 (A); Magnet Cove, Hot Springs County, *E. J. Palmer*, no. 26591, Oct. 15, 1924 (A); Hot Springs, Garland County, *E. J. Palmer*, no. 24252, Oct. 20, 1923 (A).

OKLAHOMA: Beachton, McCurtain County, *E. L. Little, Jr. & C. E. Olmstead*, no. 510, July 3, 1930 (A).

CULTIVATED: Arnold Arboretum.

17. **Amorpha croceolanata** Watson, Dendr. II. pl. 139 (1825).—Fig. 17.

Amorpha fruticosa var. b. *croceolanata* C. Schneider, Ill. Handb. Laubholzk. II. 73 (1907).

A stout shrub 2–3 m. high; branchlets furrowed or striate, more or less villous-pubescent, usually copiously so on young growth. Leaves 1.5–2.5 dm. long; petioles 1.5–3 cm. long; leaflets 13–23, oblong or ovate-oblong, 2.5–6 cm. long, 1.5–2.5 cm. broad, rounded at both ends or sometimes slightly cordate at base or emarginate at apex, conduplicate as they unfold and then densely covered with tawny, matted, tomentum, firm but thin at maturity, sparsely villous above and copiously so on lower surface, at least along the veins and on the petiolules. Inflorescence of from one to several erect spikes 1–1.5 dm. long; calyx more or less villous-pubescent, usually copiously so, the lobes all much shorter than the tube, the upper two broadly triangular or rounded, the lower slightly longer and more acute; standard purple blue. Pod 6–7 mm. long, curved dorsally, punctate-dotted and usually pubescent, at least when young.

Florida to Louisiana and northward in the Mississippi valley to southern Illinois and Missouri, and in the southern part of the Ozark region of southern and western Arkansas. Swamps and rocky banks of streams in the coastal plain or piedmont regions.

FLORIDA: Duval County, *A. Fredholm*, no. 5165, May 5, 1902 (A, G); South Jacksonville, Duval County, *J. R. Churchill*, April 13, 1897 (G); Lake County, *Thomas Holm*, March 12, 1893 (G); Duval County, *A. H. Curtiss*, no. 572, April (G, P); St. Marks, *T. G. Harbison*, no. 1505, April 29, 1914 (A); Old Town, Lafayette County, *E. J. Palmer*, no. 27311, May 16, 1925 (A); Bradford, Suwannee County, *R. M. Harper*, no. 155, April 17, 1910 (A, P); Hastings, *Alfred Rehder*, no. 702, April 19, 1920 (A); Florida, *A. W. Chapman* (without locality or date) (G, P).

GEORGIA: Augusta, *C. S. Sargent*, April 6, 1914 (A); Augusta, *T. G. Harbison*, no. 1522, May 4, 1914 (A); Milledgeville, *T. G. Harbison*, no. 1556, May 6, 1914 (A).

ALABAMA: Mobile (without name of collector), Oct. 25, 1839 (G);

Mobile, *Bigelow* (G); Alabama, *Buckley* (without locality or date) (G); Alabama (without name of collector or locality), 1849 (G); Selma, *T. G. Harbison*, no. 577, May 11 (A); Sardis, *T. G. Harbison*, no. 1465, April 23, 1914 (A); Tuscaloosa County, *E. J. Palmer*, no. 35380, April 15, 1929 (A); Demopolis, Marengo County, *E. J. Palmer*, no. 27200, May 14, 1925 (A).

MISSISSIPPI: Ocean Springs, *Josephine Skehan*, no. 42, April 1892 (G), and May 8, 1895 (A, G); Tishomingo County, *T. G. Harbison*, no. 21, May 5, 1913 (A).

LOUISIANA: Chopin, Natchitoches Parish, *E. J. Palmer*, no. 7548, May 6, 1915 (A).

KENTUCKY: Paducah, McCracken County, *E. J. Palmer*, nos. 17929, 22498, 27341, June 17, 1920, May 3, Sept. 15, 1923 (A).

MISSOURI: Malden, Dunklin County, *E. J. Palmer*, no. 30317, May 25, 1926 (A).

ARKANSAS: Faulkner County, *J. T. Buchholz*, no. 948, May 30, 1924 (A); Magnet Cove, Hot Springs County, *E. J. Palmer*, no. 26918, April 24, 1925 (A); Hot Springs, Garland County, *E. J. Palmer*, nos. 23051, 24517, 24909, 26863, June 4, 1923, April 24, May 14, 1924, April 22, 1925 (A): High Point, Garland County, *E. J. Palmer*, no. 24943, May 15, 1924 (A).

CULTIVATED: Arnold Arboretum and in other American and European gardens.

18. **Amorpha Bushii** Rydberg in N. Am. Fl. XXIV. 31 (1919).—Fig. 18.

A shrub 1–2 m. high; branches sparsely pilose when young, becoming glabrous. Leaves 2–3 dm. long; petioles 3–4 cm. long; leaflets 11–25, oblong, lance-oblong or ovate-oblong, 2–5 cm. long, 1–2 cm. wide, rounded at both ends, or rarely contracted at base or emarginate at apex, remote or at least not crowded on rachis, dark green, dull and glabrous or sparsely short-pilose above, paler and softly pilose beneath. Flowering racemes slender, 1–2 dm. long, usually two or three in cluster; calyx about 4 mm. long, sparingly pilose or nearly glabrous, except the margins of the very short lobes, the upper two of which are rounded or almost obsolete and the three lower short triangular and acutish; standard purple. Pod 6–7 mm. long, straight dorsally, glabrous and sparingly glandular-dotted.

Florida to Louisiana.—Type locality: near Chattahoochee River, Florida.

FLORIDA: near Chattahoochee River, *B. F. Bush*, no. 13 (isotype), Aug. 12, 1897 (A); Chattahoochee River, Gadsden County, *E. J. Palmer*, no. 35263, April 10, 1929 (A); Marianna, Jackson County, *E. J. Palmer*, no. 35302, April 12, 1929 (A); Florida, *A. W. Chapman* (without locality or date) (P).

LOUISIANA: Alexandria, *Josiah Hale* (P); Louisiana, *Wm. Carpenter* (without locality or date) (P); Mississippi delta, Panther basin, *Chas. Mohr*, May, 1894 (A).

19. **Amorpha occidentalis** Abrams in Bull. N. Y. Bot. Gard. VI. 394 (1910).—Fig. 19.

A shrub 2–3 m. high; branches and foliage more or less pubescent with short appressed hairs. Leaves 1–2 dm. long; petioles 2–3 cm. long; leaflets 11–27, oblong or elliptic, rounded or abruptly narrowed at base, rounded or rarely abruptly pointed at apex, 1.5–3 cm. long, 0.75–1.5 cm. wide, firm but thin at maturity, dark green and slightly reticulately veined above, paler and sparingly black dotted and more or less pilose, at least along veins beneath, not crowded on rachis. Flowering racemes usually single, slender, 1.5–2.5 dm. long, peduncled, sometimes with one or more additional shorter ones at base; calyx 3–4 mm. long, nearly glabrous or slightly pilose on tube; calyx-lobes all much shorter than the tube, the upper two broad and obtuse, the lower three triangular, acute, villous or ciliate along the margins; standard dark blue. Pod 6–7 mm. long, slightly curved dorsally, glabrous and conspicuously glandular-dotted.

Wyoming and western Texas to Arizona, California and northern Mexico.—Type locality: San Diego River, near Old Mission, California.

CALIFORNIA: Torrey Pines Park, San Diego County, *Philip A. Munz*, no. 1953, May 9, 1924 (G); Pipe Creek, Hemet Valley, San Jacinto Mts., *Mary F. Spencer*, no. 2191, Aug. 17, 1923 (G); San Diego County, *Edward Palmer*, no. 65, 1875 (G); San Diego River, near Old Mission, *LeRoy Abrams*, no. 3425 (isotype), May 6, 1903 (A, G, P); Wilson Creek, San Diego County, *LeRoy Abrams*, no. 4917, July 11, 1912 (A); San Diego, *C. S. Sargent*, Sept. 18, 1894 (A); San Bernardino, *S. B. & W. F. Parish*, no. 147, April 1881 (A); Waterman Cañon, San Bernardino Mts., *S. B. Parish*, no. 11379, June 14, 1917 (A); Cuyamaca, San Diego County, *Alice Eastwood*, no. 9139, June 25, 1919 (A); Coachella, Riverside County, *Philip A. Munz*, no. 10841, May 2, 1927 (A); San Jacinto Mts., *H. M. Hall*, no. 2121, June, 1901 (P).

WYOMING: Platte Cañon, Laramie County, *Aven Nelson*, no. 8651, Sept., 1901 (G).

TEXAS: Boerne, *S. H. Hastings*, 1911 (A); vicinity of El Paso, *Elmer Stearns*, no. 116, 1911 (A); New Braunfels, *H. A. Pilsbry*, April 17–19, 1903 (P); Tarrent Co., *Albert Ruth*, no. 21, May 5, 1919 (P).

New Mexico: Tierra Blanca, *Mrs. I. M. Beals*, 1904 (G); Kingston, *O. B. Metcalf*, no. 930, May 24, 1904 (A); Cliff, Grant County, *O. B. Metcalf*, no. 133, June 13, 1903 (G); Upper Gila River, *E. L. Greene*, no. 126, May 27, 1880 (G); Albuquerque, Bernalillo County, *E. J. Palmer*, no. 31129, June 20, 1926 (A).

Arizona: San Pedro Valley, *L. N. Gooding*, no. 53a, April, 1908 (G); Summit Ranch, Lectanes Plateau, *L. N. Gooding*, no. 705, July 28, 1910 (G); Willow Springs, *J. T. Rothrock*, no. 244, 1874 (G); Stephens Ranch, *Miss Bettina Stephens*, June 24, 1907 (G); Bonito Cañon, *J. S. Blummer*, no. 1292, Aug. 19, 1906 (G); Santa Catalina Mts., *Alfred Rehder*, no. 261, Aug. 1914 (A); Cave Creek Cañon, Chiricahua Mts., *J. W. Toomey*, July, 1894 (A); Santa Rita Mts., *C. G. Pringle*, May 5, 1881 (P); Arizona (without locality), *C. G. Pringle*, June 5, 1884 (P).

Mexico: Sonora, *Geo. Thurber*, no. 351, June 1851 (G).

19a. **Amorpha occidentalis** var. **emarginata,** var. nov.—Fig. 19a.
A typo recedit foliolis brevioribus apice truncatis vel retusis, glabratis vel subglabratis.

Arizona and southern California.—Type locality: Fish Creek, Apache Trail, Arizona.

California: Banning, San Diego County, *F. G. Woodcock*, no. 1628, April, 1922 (A); San Diego, *Mary F. Spencer*, no. 1442, April 25, 1926 (G).

Arizona: Fish Creek, Apache Trail (Cochise Co.?), *Alice Eastwood*, no. 8745, May 19, 1919 (type) (A); road to Pleasant Valley, Sierra Hucha, *Susan D. McKelvey*, no. 1183, May 30, 1929 (A).

19b. **Amorpha occidentalis** var. **arizonica,** comb. nov.—Fig. 19b.
Amorpha arizonica Rydberg in N. Am. Fl. xxiv. 33 (1919).

Differs from the type only in the looser and more copious pubescence of the branches, foliage and inflorescence.

Arizona and New Mexico.—Type locality of *Amorpha arizonica* Rydb.: Ramsey Cañon, Huachuca Mts., Arizona.

Arizona: Ramsey Cañon, Huachuca Mts., *L. N. Gooding*, no. 136 (isotype), June 10, 1909 (G).

20. **Amorpha fruticosa** Linnaeus, Spec. Pl. 713 (1753).—Fig. 20.
Amorpha perforata Schkuhr, Handb. ii. 333 (1796).
Amorpha nonperforata Schkuhr, l. c.
?*Amorpha arborea* Hort. ex Schkuhr, l. c.; nomen nudum.
Amorpha fruticosa α. *vulgaris* Pursh, Fl. Am. Sept. ii. 466 (1814).
?*Amorpha elata* Hayne, Dendr. Fl. 134 (1822).
Amorpha ornata Wenderoth, Ind. Sem. Hort. Marb. (1838); nomen nudum.

?*Amorpha herbacea* Schlechtendal, Ind. Sem. Hort. Hal. 8 (1848), nomen nudum.—Not *A. herbacea* Walt.
Amorpha pubescens Schlechtendal in Linnaea, XXIV. 691 (1851).—Not *A. pubescens* Willd.
Amorpha Ludvigii Hort. ex K. Koch, Dendr. I. 70 (1869), nomen nudum.
Amorpha fruticosa var. a *typica* C. Schneider, Ill. Handb. Laubholzk. II. 72 (1907).

A shrub 2–4 m. high, or rarely higher; branches striate, more or less strigose or pilose. Leaves 0.7–2 dm. long, usually ascending; petioles 1–2 cm. long; leaflets 9–25, oblong, elliptic or slightly ovate, rounded or abruptly pointed at both ends, or in forms sometimes cuneate at base, or emarginate at apex, usually finely pubescent above and more or less densely villous beneath when young, at maturity dull green and glabrous above, slightly paler and still pubescent, at least along the veins, beneath; petiolules 2–3 mm. long. Inflorescence usually of several clustered, erect, closely-flowered spikes 1–1.5 dm. long; calyx sparingly pilose, becoming glabrous in age except the ciliate margins of the lobes; calyx-lobes all much shorter than the tube, the two upper ones very blunt or rounded, the lower ones acute; standard purplish-blue, varying to pale blue or white in forms. Pod 7–8 mm. long, more or less curved dorsally, glabrous and marked by large resinous dots.

? Connecticut to Alabama and westward to Minnesota and Oklahoma.

Naturalized in the northeastern states and also in Europe and western Asia.

In cultivation since the eighteenth century and passing into several more or less distinct varieties and a number of forms, which have been distinguished in horticulture and in a wild state.

MASSACHUSETTS (introduced): vicinity of Woods Hole, *John M. Fogg, Jr.*, June 25, 1923 (P); Mystic Pond, Arlington, *C. K. Knowlton*, June 18, 1898 (G); Boston, Back Bay, *F. E. Williams*, Sept. 17, 1910 (G); Boston, Fenway, *Arthur Stanley Pease*, no. 9831, Oct. 9, 1906 (G).

NEW HAMPSHIRE (introduced): Lake Winnepesaukee, *Alfred Rehder*, no. 1081, Aug. 16, 1927 (A).

PENNSYLVANIA: Henderson Station, Montgomery County, *Jas. Crawford*, June 1, 1895 (P); Strafford, Chester County, *Edwin B. Bartram*, no. 1517, June 11, 1911 (A).

DISTRICT OF COLUMBIA: waste ground, *E. S. Steele*, May 28, 1898 (A).

NORTH CAROLINA: Salem, ex Schweinitz Herb. (P); Wilmington, *C. S. Williamson*, Aug. 1892 (P).

ALABAMA: ex Torrey Herb. (without locality or date) (G).

MISSISSIPPI: Yazoo City, *T. G. Harbison*, no. 25, May 1, 1915 (A).

OHIO: Cleveland, *L. D. Starr*, no. 6254, May 19, 1896 (G).

INDIANA: Shelby, Lake County, *C. C. Deam*, no. 20134, June 6, 1916 (G); Monroe, Knox County, *C. C. Deam*, no. 38676, June 4, 1923 (A); Decker, Knox County, *C. C. Deam*, no. 17050, July 8, 1915 (A); Cannelton, Perry County, *C. C. Deam*, no. 16616, June 29, 1915 (A); North, Ohio County, *C. C. Deam*, no. 48553, May 29, 1930 (A).

ILLINOIS: Port Byron, *E. T. & S. A. Harper*, June 1898 (A); Salem, *M. S. Bebb*, 1860 (G); Fountaindale, *M. S. Bebb*, 1870 (G); Davenport, La Salle County, *J. M. Greenman, O. E. Lansing, Jr. & R. A. Dixon*, no. 136, June 1–7, 1909 (G); Grand Tower, *Allen Gleason*, no. 1786, Aug. 17, 1900 (G); Starved Rock, La Salle County, *J. M. Greenman, O. E. Lansing, Jr. & R. A. Dixon*, no. 14, June 1–7, 1909 (G); *H. C. Skeels*, no. 628, May 30, 1905 (G); Aurora, *T. E. Boyce*, no. 572, June 1, 1884 (G); Peoria, *F. E. McDonald*, May 1904 (G); Cairo, Alexander County, *E. J. Palmer*, no. 23767, Sept. 17, 1923 (A); Aurora, *F. L. Bassett*, 1881 (P).

KENTUCKY: Brandenberg, *C. W. Short*, 1842 (P); Wickliffe, *Frank T. McFarland & W. A. Anderson, Jr.*, no. 189, Aug. 17, 1923 (A); Owensboro, Daviess County, *E. J. Palmer*, no. 17821, June 10, 1920 (A).

TENNESSEE: Memphis, *A. Fendler*, May 10, 1851, Aug. 28, 1853, 1855 (G); Reelfoot Lake, *Samuel L. Bain*, no. 402, June, 1903 (G).

MINNESOTA: St. Anthony, *J. H. Schuette*, June 2, 1888 (G); Swan Lake, Nickolet County, *C. A. Ballard*, June, 1892 (G); Lake City, *Warren H. Manning*, June 25, 1883 (G); St. Paul, ex Charles E. Smith Herb., June, 1872 (P).

IOWA: Ames, *C. R. Ball & Royal Meeker*, no. 525, June 21, 1897 (G); Carroll, *L. H. Pammel*, July 2, 1898 (G).

MISSOURI: Kennett, *C. S. Sargent & Wm. Trelease*, April 24, 1897 (A); Grain Valley, *B. F. Bush*, no. 10498, May 28, 1926 (A); Monteer, *B. F. Bush*, no. 9846, Aug. 5, 1922 (A); Dumas, *B. F. Bush*, no. 5922, Aug. 8, 1908 (A); Allenton, *Geo. W. Letterman*, 1897 (A, P); Creve Coeur Lake, St. Louis County, *Moses Craig*, June, 1909 (A); Galena, Stone County, *E. J. Palmer*, no. 5702, May 21, 1914; Novinger, Adair County, *E. J. Palmer*, no. 25545, June 16, 1924 (A); Monticello, Lewis County, *E. J. Palmer*, no. 35907, May 20, 1929 (A); Osceola, St. Clair County, *E. J. Palmer*, no. 35653, May 6, 1929 (A); Hickory County, *E. J. Palmer*, no. 35979, May 22, 1929 (A); Joplin, Jasper County, *E. J. Palmer*, no. 22891, May 28, 1923 (A); Alba, Jasper County, *E. J. Palmer*, nos. 4350, 30106, Sept. 16, 1913, May 15, 1926 (A); Forest Mill, Jasper County, *E. J. Palmer*, no. 25323, June 4, 1924 (A); Columbus, Johnson County, *E. J. Palmer*, no. 36646, June 21, 1930 (A).

ARKANSAS: Decatur, Benton County, *D. Demaree*, no. 4644, Oct. 15, 1927 (A); War Eagle, Benton County, *D. Demaree*, no. 5429, Sept. 16, 1928 (A); Avoca, Benton County, *D. Demaree*, no. 6664, May 17, 1929 (A); Greenland, Washington County, *D. Demaree*, no. 3025, May 12, 1927 (A); Fayetteville, Washington County, *E. J. Palmer*, no. 23262, June 13, 1923 (A); Midway, Sebastian County, *E. J. Palmer*, no. 33281, April 8, 1928 (A); Magazine Mountain, Logan County, *E. J. Palmer*, no. 23242, June 11, 1923 (A); Little Rock, Pulaski County, *E. J. Palmer*, no. 24443, April 21, 1924 (A); Mesa, Prairie County, *E. J. Palmer*, no. 25071, May 22, 1924 (A); Hot Springs, Garland County, *E. J. Palmer*, nos. 24907, 29136, May 14, 1924, Oct. 11, 1925 (A); Fulton, *B. F. Bush*, no. 2451, April 26, 1905 (A).

KANSAS: Augusta, *S. F. Poole*, no. 23, May, 1903 (G); Neodesha, Wilson County, *E. J. Palmer*, nos. 21163, 21396, May 5, 23, 1922 (A); Arkansas City, Cowley County, *E. J. Palmer*, no. 21233, May 11, 1922 (A); Downs, Osborn County, *E. J. Palmer*, no. 21336, May 20, 1922 (A); Ellsworth, Ellsworth County, *E. J. Palmer*, no. 21270, May 13, 1922 (A); Harper, Harper County, *E. J. Palmer*, no. 21199, May 8, 1922 (A).

MISSISSIPPI: Yazoo City, *T. G. Harbison*, no. 25, May 1, 1915 (A).

Plants that are assigned to this species and its varieties vary greatly in the size, shape, and number of the leaflets, and in the amount of pubescence, as well as to some extent in the shape and size of the fruit. Species based upon slight differences in these characters, such as *Amorpha fragrans* Sweet and *Amorpha tennesseensis* Shuttl., although appearing distinct in extreme forms, are often indistinguishable, as there is a complete gradation of intermediate forms, and it seems best therefore to treat them as varieties of one species. *Amorpha occidentalis* of the Pacific coast and the Southwest and *A. croceolanata* of the Gulf coastal plain are also closely related to *A. fruticosa*, the former not always easily distinguishable morphologically from *A. fruticosa* var. *angustifolia;* and while the latter is more outstanding from the character of its pubescence and the size and shape of the leaflets, it is a matter of opinion whether they should be regarded as distinct species, as they are treated in this paper, or as varieties of *A. fruticosa*, as has been done by some authors.

The following forms have been distinguished, mostly based on cultivated plants:

Amorpha fruticosa f. albiflora Sheldon in Bull. Geol. Surv. Minn. IX. 72 (1894).

Flowers white. This form is found also in cultivation.

Amorpha fruticosa f. pendula C. Schneider, Ill. Handb. Laubholzk. II. 73 (1907).

Amorpha pendula Carrière in Rev. Hort. 1869, 340.

Amorpha fruticosa b. *pendula* Dippel, Laubholzk. III. 691 (1893).

Distinguished by its slender recurved branches. Occasionally cultivated in American and European gardens.

Amorpha fruticosa f. crispa C. Schneider, Ill. Handb. Laubholzk. II. 72 (1897).

Amorpha fruticosa var. *crispa* Kirchner, Arb. Musc. 370 (1864).

Distinguished by the crisped margins of the leaves. In cultivation.

Amorpha fruticosa f. humilis, comb. nov.

Amorpha humilis Tausch in Flora, XXI. 750 (1838).

Amorpha fruticosa var. c. *humilis* C. Schneider, Ill. Handb. Laubholzk. II. 73 (1907).

A low form, often dying back to the ground each season. In cultivation.

Amorpha fruticosa f. coerulea, comb. nov.

Amorpha coerulea Lodd. Cat. (1830) ex Loudon, Arb. Brit. II. 607 (1838), nomen nudum.

Amorpha fruticosa var. 5. *coerulea* Loudon, Arb. Brit. II. 607 (1838).

A form in cultivation and sometimes found growing spontaneously with the type, from which it is distinguished by its pale blue flowers.

Amorpha fruticosa f. aureo-variegata Schwerin in Mitteil. Deutsch. Dendr. Ges. XVI. 255 (1907).

A form in cultivation, with variegated foliage.

20a. **Amorpha fruticosa** var. **angustifolia** Pursh, Fl. Am. Sept. 466 (1814).—Fig. 20a.

Amorpha nana Sims in Bot. Mag. XLVII. t. 2112 (1819).—Not Nuttall.

Amorpha fragrans Sweet, Brit. Fl. Gard. III. t. 241 (1828).

Amorpha Lewisii Lodd. Cat. (1830), ex Loudon, Arb. Brit. II. 607 (1838).

Amorpha fruticosa 4. *Lewisii* Loudon, Arb. Brit. II. 607 (1836).

Amorpha angustifolia Boynton in Biltmore Bot. Studies, I. 139 (1902).

Differs from the type in its usually narrower elliptic leaflets, narrowed or cuneate at the base, and in the more sparse, appressed, pubescence.

Wisconsin and Minnesota to Saskatchewan and southward to Kansas, Texas and northern Mexico. Occasionally escaped farther east.

MASSACHUSETTS (introduced): Boston, *Charles F. Batchelder*, June 8, 1918 (G).

WISCONSIN: St. Croix Falls, *C. F. Baker*, July 16, 1900 (G); Alma, Buffalo County, *E. J. Palmer*, no. 27833, June 10, 1925 (A); Fountain City, Buffalo County, *Huron H. Smith*, no. 7196, July 8, 1922 (A).

MINNESOTA: Cannon Falls, *J. H. Sandberg*, no. 357. July, 1891 (A).

NORTH DAKOTA: Bismarck, *Esther L. Larsen*, no. 171, Aug. 14, 1927 (G).

SOUTH DAKOTA: Missouri River Valley, Union County, *W. R. Wilcox*, Aug. 27 (A); Cottonwood Creek, Bad River, *T. A. Williams*, (G); Sioux Falls, *T. A. Williams*, June 5, 1896 (A); Big Stone, *T. A. Williams*, no. 161, Aug. 15, 1894 (A); Rapid City, Pennington County, *E. J. Palmer*, no. 37318, June 16, 1929 (A); Hot Springs, Fall River County, *E. J. Palmer*, no. 37440, June 21, 1929 (A); Pine Ridge Indian Reservation, Washabaugh County, *E. J. Palmer*, no. 37638, June 29, 1929 (A).

NEBRASKA: Thedford, Thomas County, *P. A. Rydberg*, no. 1314, Sept. 8, 1893 (G); Red Cloud, *J. M. Bates*, no. 2263, June 22, 1903 (G); Ponca, *Fred Clements*, no. 2538, June 14, 1893 (G); Butler County, opposite Columbus, *E. J. Palmer*, no. 36063, June 5, 1929 (A).

MISSOURI: Grain Valley, *B. F. Bush*, no. 6992, May 24, 1913 (A).

KANSAS: Osburn City, Osburn County, *C. L. Shear*, nos. 45, 168, May 26, July 20, 1894 (G); Riley County, *J. B. S. Norton*, nos. 89, 89a, 1895, 1896 (G).

COLORADO: Ft. Collins, *C. S. Crandall*, no. 1241, June 12, 1896 (G, P); no. 15, June 14, Oct. 3, 1893 (G); Wolhurst, Douglas County, *I. W. Clokey*, no. 3802, July 8, 1920 (G, P); Ft. Collins, *J. H. Cowan*, no. 127, June 13, 1895 (G).

ARKANSAS: Marion County, opposite Cotter, *E. J. Palmer*, no. 5935, June 12, 1914 (A).

OKLAHOMA: Fonts, Lincoln County, *Clara Nevins*, May 5, 1895 (G); Tulsa, Tulsa County, *G. W. Stevens*, no. 2993, Oct. 30, 1913 (A, G); Knowles, Beaver County, *G. W. Stevens*, no. 520, May 19, 1913 (A, G); Pawhoska, Osage County, *G. W. Stevens*, no. 1937, Aug. 8, 1913 (A, G); Page, Le Flore County, *G. W. Stevens*, nos. 1393, 2620, April 20, Sept. 6, 1913 (G); Canton, *D. M. Andrews*, Aug. 15, 1915 (A); along Little River, Pushtamaha County, *E. L. Little, Jr. & C. E. Olmstead*, no. 536, July 5, 1930 (A); Sapulpa, *B. F. Bush*, no. 1105, May 1, 1895 (A); Youkon, Canadian County, *E. J. Palmer*, no. 22134, Sept. 29, 1922 (A); Tishomingo, Johnston County, *E. J. Palmer*, no. 6441, Sept. 8, 1914 (A); Sapulpa, *C. B. Williams*, May 21, 1924 (P).

New Mexico: *A. Fendler*, no. 126, 1847 (G); Kingston, *O. B. Metcalf*, no. 930, May 24, 1904 (G).

Arizona: Willow Springs, *Edward Palmer*, no. 484, June 10–20, 1890 (G).

Texas: *F. Lindheimer* (without locality), nos. 595, 1847 (G, P); 742, 1850 (G, P); *V. Havard*, nos. 2, 3 (without locality), July, 1881 (G); Texas, *Charles Wright* (without locality or date) (G); Cibilo Creek, *V. Havard*, no. 1, May, 1881 (G); Burton, *Elihu Hall*, no. 127, May 26, 1872 (G, P); Kerrville, *A. A. Heller*, no. 1596, April 19–25, June 26–30 (A, G, P); Dallas, *J. Reverchon*, no. 223, June, Sept. 1880 (A); Dallas, *J. Reverchon*, no. 145, May, 1874 (G); Austin, *M. S. Young*, no. 38, April 15, 1918 (G); Kinney County, *V. L. Corey*, no. 377, April 17, 1929 (G); White's Ranch, Chambers County, *B. C. Tharp*, no. 3138, Sept. 3, 1924 (A); Dallas, *B. F. Bush*, no. 692, May 10, 1900 (A); Southeast Texas, *E. N. Plank* (A); *Lincecum* (without locality or date) (P); Kerrville, Kerr County, *E. J. Palmer*, no. 33827, May 7, 1929 (A); Tivoli, Refugio County, *E. J. Palmer*, no. 9253, March 22, 1916 (A); San Saba, San Saba County, *E. J. Palmer*, no. 11822, May 5, 1917 (A); Devil's River, Valverde County, *E. J. Palmer*, no. 11387, March 26, 1917 (A); Gamble's Ranch, Armstrong County, *E. J. Palmer*, no. 13967, June 6, 1918 (A); Brownwood, Brown County, *E. J. Palmer*, no. 26798, Oct. 31, 1924 (A); Sweetwater, Nolan County, *E. J. Palmer*, no. 33975, May 15, 1928 (A).

Manitoba: *John Macoun*, no. 12511, Aug. 7, 1896 (G).

Mexico: Casas Grandes, Chihuahua, *E. A. Goldman*, no. 405, May 12, 1899 (G); Paso del Norte, Chihuahua, *C. G. Pringle*, no. 1221, May 10, Aug. 12, 1887 (G, P).

Cultivated for many years in American and European gardens, often under the name *Amorpha Lewisii*.

Amorpha fruticosa var. **angustifolia** f. **glabrata,** forma nov.

A typo varietatis recedit ramulis foliisque glabris vel fere glabris.

Texas: Kurten, Brazos County, *E. J. Palmer*, no. 13479 (type), April 28, 1918 (A).

A plant that may be referred to this form which differs from typical var. *angustifolia* in the branches and foliage being nearly or entirely glabrous, is in cultivation at Highland Park, Rochester, N. Y. A specimen collected by E. H. Costich, July 17, 1915, bears the notation: "very late flowering." (A).

20b. **Amorpha fruticosa** var. **tennesseensis,** comb. nov.—Fig. 20b.

Amorpha tenesseensis Shuttleworth in Kunze, Delect. Sem. Hort. Lips. 1848, p. 1 adn. ex Walpers, Ann. Bot. Syst. II. 360 (1851); Linnaea, XXIV. 191 (1851).

Differs fron the type in the often more numerous, narrow-oblong leaflets, and in the slightly curved or nearly straight pod.

North Carolina to Florida and west to Kansas, Oklahoma and Texas.—Type locality: Dandridge, Tennessee.

NORTH CAROLINA: Swain County, *H. C. Beardsley & C. O. Kofoid*, July 17, 1891 (G); Falls of Yadkin River, Stanley County, *J. K. Small*, Aug. 18, 1892 (G).

TENNESSEE: Dandridge, *Rugel*, June–Sept., 1842 (isotype) (G); Ocoee River, Polk County, no. 1381a, ex Biltmore Herb., Oct. 5, 1897 (G); Cleveland, *E. E. Magee*, Oct. 1, 1897 (G).

ILLINOIS: Fall Creek, Adams County, *J. Davis*, no. 3226, Sept. 16, 1894 (A); Wady Petra, *Virginius H. Chase*, no. 737, Aug. 14, 1900 (P).

KENTUCKY: Eddyville, Lyons County, *E. J. Palmer*, no. 32712, Sept. 14, 1923 (A).

MISSOURI: Joplin, Jasper County, *E. J. Palmer*, nos. 21956, 21968, Sept. 14, 1922 (A); Noel, McDonald County, *E. J. Palmer*, no. 4156, Sept. 16, 1918 (A); Branson, Taney County, *E. J. Palmer*, no. 19232, Sept. 29, 1920 (A).

ARKANSAS: Van Buren, *G. M. Brown*, Aug. 8, 1909 (A); Baker Springs, Howard County, *J. H. Kellogg*, Oct. 5, 1909 (A); Blue Mountain, Logan County, *E. J. Palmer*, no. 24217, Oct. 18, 1923 (A); Hot Springs, Garland County, *E. J. Palmer*, no. 24251, Oct. 20, 1923 (A); Mesa, Prairie County, *E. J. Palmer*, no. 24333, Oct. 24, 1923 (A).

KANSAS: Galena, Cherokee County, *E. J. Palmer*, no. 21979, Sept. 15, 1922 (A); Neodesha, Wilson County, *E. J. Palmer*, no. 22033, Sept. 19, 1922 (A); Arkansas City, Cowley County, *E. J. Palmer*, no. 22073, Sept. 26, 1922 (A); Ellsworth, Ellsworth County, *E. J. Palmer*, no. 38163, Aug. 3, 1930 (A).

OKLAHOMA: Page, LeFlore County, *G. W. Stevens*, no. 2620, Sept. 6, 1913 (A); Page, LeFlore County, *E. J. Palmer*, nos. 20601, 22259, Sept. 23, 1921, Oct. 10, 1922 (A); Hugo, Choctaw County, *E. J. Palmer*, no. 24068, Oct. 7, 1923 (A).

ALABAMA: Cullman, *T. G. Harbison*, no. 3, Nov. 3, 1919 (A); Alabama, *Buckley* (without locality or date) (G).

CULTIVATED: Arnold Arboretum.

20c. **Amorpha fruticosa** var. **oblongifolia,** var. nov.—Fig. 20c. A typo recedit foliolis oblongis vel lineari-oblongis, 20–50 mm.

longis, 8–16 mm. latis, glabris vel infra minute scabro-pubescentibus.

An erect shrub 2–3 m. high. Leaves 1.5–2.5 dm. long; petioles 2–3 cm. long; leaflets 21–41, oblong or narrowly oblong, 2–5 cm. long, 0.5–1.5 cm. wide, rounded at both ends or slightly emarginate at mucronate apex, and rarely abruptly narrowed at base, thin but firm, dark green and glossy above, much paler or sometimes slightly glaucous, black-punctate and glabrous or sparsely scabrous-pubescent beneath; petiolules slender, 1.5–2 mm. long. Inflorescence of a few or several erect spikes 0.8–2 dm. long; calyx glabrous, its lobes much shorter than the tube, the two upper ones low and rounded, the lower broadly triangular. Pod 7–9 mm. long, 3 mm. wide, somewhat curved dorsally, with short erect beak, glandular dotted.

MISSOURI and ARKANSAS. Type locality: Helena, Phillips County, Arkansas.

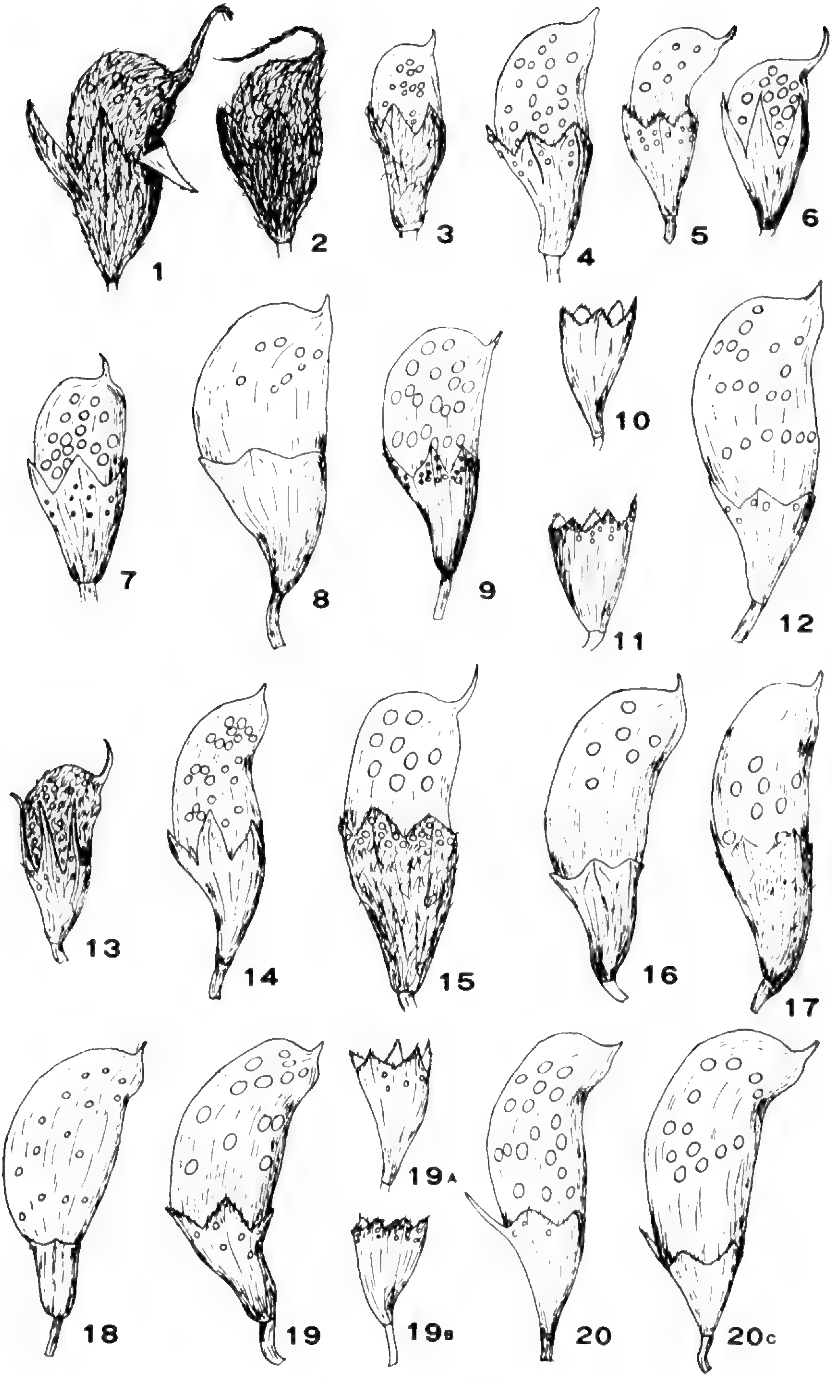
MISSOURI: Watson, Atchison County, *E. J. Palmer*, no. 19010, Sept. 4, 1920 (A); Purcell, Jasper County, *E. J. Palmer*, no. 22182, Oct. 3, 1922 (A).

ARKANSAS: Marion County, opposite Cotter, *E. J. Palmer*, no. 20659, Oct. 3, 1921 (A); Helena, Phillips County, *E. J. Palmer*, no. 26628 (type) Oct. 17, 1924 (A); Forrest City, St. Francis County, *E. J. Palmer*, no. 29278, Oct. 17, 1925 (A).

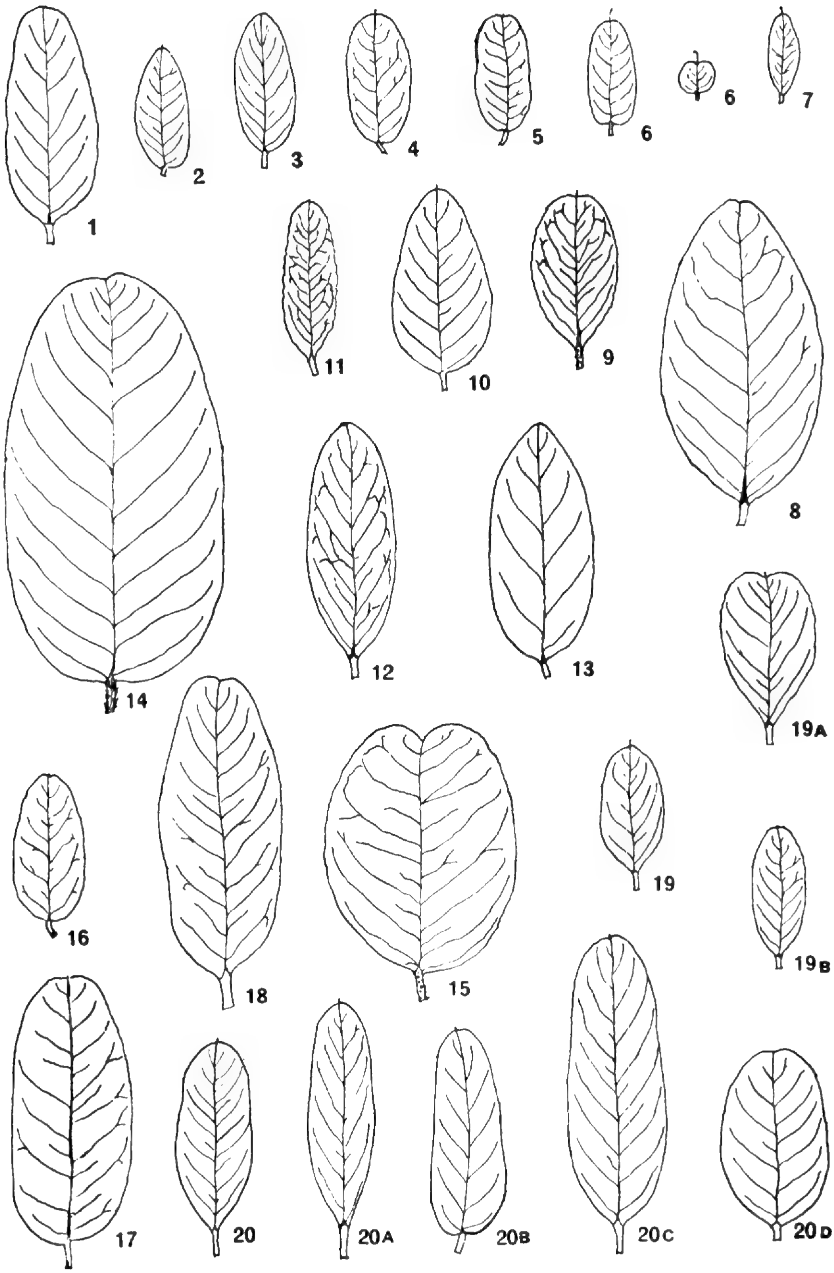
This is a very distinct looking variety, on account of its numerous, crowded, narrowly oblong leaflets. It may when better known prove to be a distinct species, but it seems safest at present to treat it as a variety of the polymorphous species *A. fruticosa*, since I have not seen the flowers and some of the specimens in which the leaf characters are best marked are without fruit, while certain specimens of *A. fruticosa* or the var. *tennesseensis* approach it. The leaflets in shape and number resemble most closely those of *A. fruticosa* var. *tennesseensis*, but they are usually much larger and differ in being glabrous or sparingly short-pilose or scabrate. The essentially glabrous branches and leaf rachises and the glabrous calyx also serve to distinguish it. The leaflets also resemble in size, shape, and texture those of *A. Bushii*, but they differ from those of the southeastern species in the absence of loose villous pubescence as well as in the shape of the fruit. The calyx in *Amorpha fruticosa* var. *oblongifolia* is entirely glabrous, at least in fruiting specimens, and the teeth are almost as short as in *A. glabra*. The fruit is slightly larger than in typical *A. fruticosa*, but is similarly curved on the back.

20d. **Amorpha fruticosa** var. **emarginata** Pursh, Fl. Am. Sept. II. 466 (1814).—Fig. 20d.

Amorpha emarginata Sweet, Hort. Brit. ed. 1, 121 (1827).



Fruits of Amorpha (× 5 ½–6)
(The figure numbers correspond with the numbers of the species in the text)



LEAFLETS OF AMORPHA (XI)
(The figure numbers correspond with the numbers of the species in the text)

Differs from the type in the usually larger, oval or ovate leaves, blunt or emarginate at the apex.

Mississippi to Arkansas and Illinois.

ILLINOIS: Crawford Bridge, Macon County, *I. W. Clokey*, no. 2382, May 31, 1915 (G); Decatur, *I. W. Clokey*, no. 2703, May 29, 1899 (G); Decatur, *Allan Gleason*, no. 825, May 21, 1899 (G); Mahomet, *Allan Gleason*, no. 2414, May, 1901 (G); Cairo, Alexander County, *E. J. Palmer*, no. 15082, May 8, 1919 (A).

MISSOURI: Webb City, *B. F. Bush*, no. 553, May 20, 1901 (A).

ARKANSAS: Newport, Jackson County, *E. J. Palmer*, no. 35528, April 26, 1929 (A).

TENNESSEE: cliffs of Cumberland River, Nashville, *A. Gattinger*, no. 130 (A); Shepards, Haywood County, *E. J. Palmer*, no. 17470, May 13, 1920 (A).

Cultivated in American and European gardens.

This variety is in some respects intermediate between typical *Amorpha fruticosa* and *A. croceolanata*, somewhat resembling the latter in the shape and size of the leaflets, but differing in its gray, less copious pubescence.

DOUBTFUL SPECIES AND VARIETIES, AND NAMES EXCLUDED FROM THE GENUS

Amorpha caroliniana Croom in Am. Jour. Sci. xxv. 74 (1834).

No specimens have been seen which agree with the original description. See remarks under 4. *A. cyanostachya* M. A. Curtis on p. 170.

Amorpha fruticosa var. *fragrans* Bean, Trees & Shrubs, I. 193 (1914).

From the brief description this is apparently not identical with *A. fruticosa* var. *angustifolia* (*A. fragrans* Sweet). Undeterminable.

Amorpha fruticosa β *pumila* Wenderoth in Schrift. Ges. Beförd. Naturw. Marburg, II. 259 (1831). This may possibly be the same as *A. humilis* Tausch (= *A. fruticosa* f. *humilis*), but description is too indefinite to show clearly to what form it refers.

Amorpha Gaertnerii Hort. ex K. Koch, Dendr. I. 70 (1869), nomen nudum.

Amorpha Gardnerii Hort. ex Kirchner, Arb. Musc. 370 (1864), nomen nudum.

Amorpha glandulosa Blanco, Fl. Philipp. ed. I. 553 (1837) = PAROSELA GLANDULOSA (Blanco) Merrill in Philipp. Jour. Sci. v. 68 (1910).

Amorpha lutea Rafinesque, Fl. Ludov. 105 (1817). Undeterminable and apparently does not belong to the genus.

Amorpha pedalis Blanco, Fl. Philipp. ed. I. 555 (1837) = SOLOMONIA CILIATA (L.) DC., fide Merrill, Spec. Blanc. 214 (1918).

Amorpha Rabiae Lexarza in Lexarza & La Llavé, Nov. Veg. Desc. fasc. I. 22 (1824).[1]

Amorpha tomentosa ? Rafinesque, Fl. Ludov. 105 (1817). Undeterminable and probably not an Amorpha.

Amorpha crocea, *A. dealbata*, *A. elatior*, *A. ludoviciana*, *A. marginata* Hort. ex Lavallée, Arb. Segrez. 60 (1877), nomina nuda.

ON THE OCCURRENCE OF CASUARINA NODIFLORA FORST. IN AUSTRALIA

C. G. G. van Steenis

Casuarina nodiflora Forster, Fl. Ins. Austr. Prodr. 64 (1716).

Northeast Queensland: Mt. Alexander, collected for the Arnold Arboretum by *S. F. Kajewski*, no. 1492 (Arnold Arb. Exped.), Feb. 17, 1929 (small tree up to 7 m. high, common in poor scrub on top of the mountain).

This species is somewhat variable in habit, the specimen being a mountain form with densely crowded short branchlets. It differs from most other specimens by the short ferrugineous pubescence remaining on the bracts as well as on the bracteoles of the fruiting cones. In other specimens this short tomentum is more scanty and soon disappears in the fruiting state.

I can find no sound differences between this and the East-Malaysian *C. Rumphiana* Miq. which in my eye ought to be referred to *C. nodiflora* Forst. as a synonym. If this is adopted the area of *C. nodiflora* adequately extends from the Fiji Islands, New Caledonia, Queensland and New Guinea to the Moluccas, Selebes (Celebes) and Philippines and overlaps the area of *C. sumatrana* Jungh.

The cones of the Malaysian specimens are usually described as much smaller but it should be borne in mind that also in immature cones the bracteoles spread when dried, except in the extremely young ones. In those opened immature cones the bracteoles are much less thickened than in the ripe ones and the unripe fruits are more or less wrinkled. I doubt whether the cones and fruits are fully developed in this specimen. Prof. L. Rutten collected the species in Central Séran (Ceram) at 1400 m. altitude and his specimen shows the same crowded mountainous habit as that collected by Kajewski.

Herbarium, Buitenzorg, Java

[1] A synopsis of the author's description of this species is as follows:

Herbaceous ?, 2 ft. high; stems terete, smooth; leaflets ovate, acute, tomentose; racemes axillary, fascicled; bracts short, acute; calyx cup-shaped, obscurely 6-lobed [!], tomentose without; calyx-lobes obtuse; standard obovate or cuneiform, white, slightly keeled; ovary covered with lanate or silky tomentum; style short, incurved; pod one-seeded, glandular; seed reniform.

The type specimen was collected on Mount Quinceo, in the state of Michoacan, southern Mexico, and apparently it has not been found or recognized since.

CHROMOSOME NUMBERS IN THE LIGNEOUS SAXIFRAGACEAE

KARL SAX

Plate 37

The ligneous Saxifragaceae include genera which differ considerably in morphological characters. These differences are so extreme that Hutchinson (1926) has divided this group of plants into three families; the Escalloniaceae, the Grossulariaceae and the Hydrangeaceae. Different genera also vary greatly in the number and distribution of species. Some of them, such as *Carpenteria* and *Whipplea*, are monotypic and endemic in western North America while others, such as *Ribes* and *Hydrangea*, contain numerous species and are widely distributed.

A study of chromosome number was made to determine whether the variability found in this family has a cytological basis and if the number of species in larger genera is associated with polyploidy.

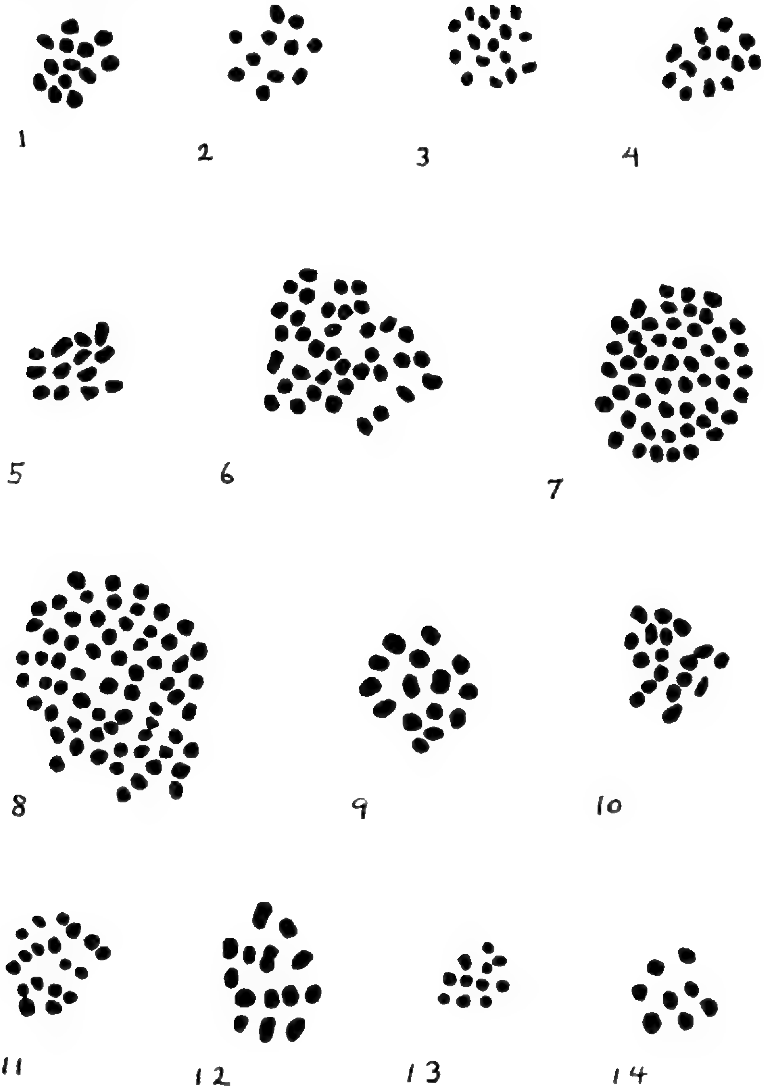
The Arnold Arboretum contains many species of the representative genera of the Saxifragaceae, both American and Asiatic. Most of the chromosome counts were obtained from aceto-carmine smears of pollen mother-cells. The taxonomic grouping is based on Rehder's (1926) Manual.

The following table shows the chromosome numbers, number of species and distribution of the genera studied.

Saxifragaceae

Genus	Chromosome number	Number of Species	Habitat
Philadelphus	13	40	N. America, Asia, Europe
Fendlera Wrightii	11	3	N. America
Jamesia	16	3	Western N. America
Deutzia	13–65	50	Asia, N. America
Decumaria	14	2	Asia, N. America
Hydrangea	18–36	35	Asia, N. & S. America
Schizophragma	14	3	Asia
Itea	11	11	Asia, N. America
Ribes	8	150	N. Hemisphere, S. America

The genus *Philadelphus* is well represented by both American and Asiatic forms. Bangham (1929) obtained chromosome counts of 9 American species, 12 Asiatic species and a number of hybrids and varieties. In all cases the haploid chromosome number was found to be 13. In the hybrids studies there was no indication of any chromosome irregularity. Two of the hybrids investigated were between species which are natives of different parts of the world. These species, or their ancestors, were probably separated



CHROMOSOME NUMBERS IN SAXIFRAGACEAE

long before the Glacial Period and yet their chromosomes are so similar that there is complete pairing of chromosomes. Species hybrids are very common in this genus wherever different species are brought together in gardens, and it is quite possible that all of the species of the genus can be inter-crossed freely.

The three species of *Fendlera* are found distributed from Colorado to New Mexico. *Fendlera Wrightii* is the only species represented in the Arboretum and it has 11 pairs of chromosomes.

Jamesia is found only in western North America and contains 3 closely related species, only one of which is described by Rehder. The haploid chromosome number of *J. americana* is 16.

Most of the 50 or more species of *Deutzia* are natives of Asia, but two species representing a distinct section (*Neodeutzia*) are found in Mexico. The chromosome numbers of representative species and hybrids are given in Table II. The basic chromosome number is 13 for this genus, but many species are polyploids. The chromosome numbers seem to be closely correlated with taxonomic grouping in some cases. *Deutzia Schneideriana* and *D. scabra* are morphologically similar and both species have 65 pairs of chromosomes. *D. discolor, reflexa* and *Vilmorinae* constitute another group of similar species, each with 52 pairs of chromosomes. *D. mollis* with about 39 pairs of chromosomes is a very distinct species, and other species with the basic chromosome number 13, may vary considerably in taxonomic characters. An interesting case of autopolyploidy is found in *D. parviflora* where the variety *ovatifolia* has 39 instead of 13 chromosomes. This hexaploid variety differs only slightly from the diploid form. The hexaploid variety is perhaps somewhat later in time of flowering, but the two forms are not growing under comparable conditions in the Arboretum. In general the species with the higher chromosome numbers are much later in time of flowering and have thicker stems and more fleshy receptacles than the diploid forms. The pollen grains of the polyploid species are somewhat larger than those of diploids but the difference is not proportional to the differences in chromosome number. All of the species studied produce good pollen with the exception of *D. mollis* where about 10 per cent of the pollen grains are obviously aborted. The chromosomes of the polyploid species usually form only bivalents at meiosis due presumably to the low frequency of chiasma formation between homologous chromosomes.

Among the species hybrids in the genus only one, *D. candelabrum*, was found to be fertile. The others listed in Table II are highly or completely sterile as indicated by the condition of the pollen.

In the unbalanced polyploid species there is of course considerable chromosome irregularity but in some of the sterile hybrids between 13 chromosome species the chromosomes usually pair and divide with little or no irregularity, but a large proportion of the pollen grains do not develop completely. In the two unbalanced polyploid hybrids there is a tendency for trivalents to be formed so that the total number of paired chromosomes is usually less than that of the parent with the larger number.

Table II.

Species of Deutzia	Chromosome number
Sect. I.	
1. D. gracilis	13[1]
2. D. scabra	65[1]
3. D. Schneideriana	65
4. D. Sieboldiana	13
5. D. purpurascens	13?
6. D. discolor	52
7. D. reflexa	52
8. D. Vilmorinae	52
Sect. II.	
9. D. mollis	39
10. D. parviflora	13
11. D. parviflora ovatifolia	39
12. D. hypoglauca	13
Hybrids.	
13. D. candelabrum (1 × 4)	13
14. D. rosea (1 × 5)	13
15. D. magnifica (2 × 8)	$52_{II} + 13_{I}$
16. D. Wilsonii (S) (6 × 9)	42 – 44
17. D. Lemoinei (10 × 1)	13
18. D. candida (17 × 4)	13
19. D. maliflora (17 × 5)	13
20. D. Kalmiaeflora (5 × 10)	13

Decumaria is a small genus with only two species, one in southeastern United States and the other in China. The chromosome number of the American form, *D. barbara*, is 14.

There are about 35 species of *Hydrangea* distributed in North and South America and in Asia. Few natural hybrids are found in this group. The haploid chromosome number is 18 for the American species, *H. cinerea*, *H. quercifolia*, *H. arborescens*, and *H. radiata*. Of the three Asiatic species studied two, *H. Xanthoneura* and *H. petiolaris*, are diploid forms with 18 pairs of chromosomes, while the other, *H. paniculata praecox*, is a tetraploid with 36 chromosomes. According to the recent work of Schoennagel, *H. arborescens*, *aspera*, and *radiata* all have 36 somatic chromosomes.

[1] Recently reported by Schoennagel (1931).

There are 3 species of *Schizophragma*, all of Asiatic origin. The chromosome number of *S. hydrangeoides* is 14, the same as that found in *Decumaria.*

Itea is the only genus of Escalloniaceae available for study in the Arboretum. This genus is represented by about 10 species in Asia and one in southeastern United States. The American species *I. virginiana* has 11 pairs of chromosomes as reported by Schoennagel (1931).

Ribes has been separated into a third family, the Grossulariaceae (Hutchinson). This genus contains about 150 species widely distributed in the northern hemisphere and in South America. Meurman (1928) has found only 8 pairs of chromosomes in this genus although about 20 species were studied. The same counts were also obtained by Tischler (1927) and by Darlington (1927). Mr. Dermen of this laboratory found 8 pairs of chromosomes in each of the following species: *R. Giraldii, R. Grossularia, R. missouriense, R. cynosbati,* and *R. fasciculatum.* In certain species hybrids Meurman finds more or less irregularity in pairing which would indicate that there may be a genetic differentiation of chromosome sets in certain species. In many species hybrids, however, there is normal chromosome pairing at meiosis.

DISCUSSION

The chromosome numbers found in the Saxifragaceae are not closely correlated with the taxonomic grouping. In the Hydrangeaceae, where the genera seem to constitute a natural group, the basic chromosome numbers are 11 in *Fendlera*, 13 in *Philadelphus* and *Deutzia*, 14 in *Decumaria* and *Schizophragma*, 16 in *Jamesia*, and 18 in *Hydrangea*. This variation in chromosome number does not necessarily mean, however, that these genera have not had a common origin because a single genus may include species with different chromosome numbers. In fact the species of the genus *Saxifraga* have 11, 14, 16 or 28 chromosomes (Schoennagel 1931).

Both the taxonomic and cytological evidence indicate that *Philadelphus* and *Deutzia* are closely related as are *Decumaria* and *Schizophragma*, but *Fendlera* and *Itea* with the same chromosome numbers differ considerably in morphological characters.

Pollen grain measurements do not show much difference for the various genera, with the exception of *Ribes*. The pollen grains of *Ribes* are more than twice as large as those of the other genera, which may be some indication that this genus forms a rather distinct group of plants. (Hutchinson 1926).

In this family there are two large genera which show no variation in chromosome number of the various species. There are about 40 species of *Philadelphus* and all of the species studied have 13 pairs of chromosomes. A considerable number of the 150 or more species of *Ribes* have been examined (Meurman, Tischler, and Darlington) and all have 8 pairs of chromosomes. In both genera species hybrids are numerous. In many of these species hybrids the chromosomes pair at meiosis and in some there is a high degree of fertility.

The species of *Philadelphus* are morphologically very similar, even though they are widely distributed. Of the species enumerated by Rehder 7 are found in China, 2 in Manchuria and Korea, 1 in Japan, 2 in the Himalayas, 1 in southeastern Europe, 5 along the west coast of North America, 6 in central and southeastern United States, and 3 in Colorado and New Mexico.

All of these species undoubtedly had a common origin. Species hybrids are numerous in this genus and it is probable that all species of *Philadelphus* will intercross freely. Hybrids have been obtained between such widely separated species as *P. pubescens*, a native of southern United States, and *P. tomentosus*, a native of the Himalayas; or between *P. pubescens* and the Pacific coast species *P. Gordonianus;* or between *P. laxus* of Georgia and *P. coronarius* of Europe. In certain species hybrids such as *P. penduli-folius*, which is supposed to be a cross between *P. pubescens* of Tennessee and Alabama and *P. laxus* of Georgia, the F_1 is highly fertile and the pollen grains are normal. In the hybrid *P. Lemoinei* a cross between American and European species, the chromosomes pair and the divisions are normal but most of the pollen grains do not mature. The female gametes must be functional, however, because this hybrid has produced numerous varieties when crossed with other species. In the hybrid, *P. maximus*, a cross between a Himalayan and an American species, the microspores disintegrate at an early stage and the plant is highly sterile.

Meurman (1923) finds a similar condition in *Ribes*. Closely related species from the same continent produce more or less fertile hybrids with normal chromosome pairing at meiosis. Hybrids between species from different continents were found to be highly sterile with various degrees of chromosome pairing.

Some of the species of *Philadelphus* and *Ribes* can apparently retain their identity only so long as they are isolated. In the course of species formation in these genera mutations must have occurred with geographic isolation. At the present time some of the species probably do not differ greatly in genetic constitution while others are so highly differentiated that fertile hybrids can no longer be obtained between certain species. In *Philadelphus*, at least, the species are not sufficiently different to prevent crossing between most or perhaps all species of the genus. In view of the genetic and cytological analysis of these genera it would seem that the same factors which have produced varietal differences are responsible for species and in certain cases even generic differentiation (i. e. *Philadelphus* and *Deutzia*). Mutation seems to have been the basic factor in causing variation in *Philadelphus* and *Ribes* although it is possible that changes have occurred in chromosome structure.

It has often been assumed that the individuals within a species can cross freely with a high degree of fertility, while crosses between species result in partially or completely sterile hybrids (Babcock 1931). The fact that two individuals are inter-sterile does not necessarily mean that they belong to different species. Genetic factors, changes in chromosome structure, or autopolyploidy may be responsible for a high degree of sterility in varietal hybrids. On the other hand plants, which would be classed by the most conservative taxonomists as distinct species, are often interfertile. According to the species concept based on cyto-genetics some polymorphic genera would be reduced to a single species, while the number of species in other genera would be greatly reduced. Such a concept of a species seems hardly justified from the point of view of the taxonomist. However, the taxonomic status of certain genera, such as *Crataegus*, would be greatly improved if the taxonomist were required to make the cyto-genetic tests before naming a new species!

Perhaps it would be more practical to apply the cyto-genetic test to fundamental or basic species. These "basic species" would include all individuals which have similar genoms and which produce fertile hybrids. Even the cyto-genetic tests cannot draw precise lines between basic species because of various degrees of chromosome pairing and sterility in species hybrids. It is of interest to note that there is complete chromosome pairing in many species hybrids in *Philadelphus* and in *Deutzia*, but there is a high degree of pollen sterility in these hybrids.

Deutzia and *Philadelphus* are closely related and both have the same basic chromosome number, but one genus is uniform in chromosome number while the other contains a series of polyploid species. Why should *Philadelphus* be so uniform and *Deutzia* so variable in the chromosome number of different species? Polyploidy may be induced by genetic factors, by environmental conditions, and is probably dependent to some extent on the number of chiasmata which unite the homologous chromosomes at meiosis.

In both *Philadelphus* and *Deutzia* there is apparently insufficient differentiation of chromosomes to prevent pairing of chromosomes in species hybrids. There is, however, a greater amount of morphological differentiation of the *Deutzia* species, even among those with the basic chromosome number. In certain species hybrids the chromosomes may fail to pair or are so loosely associated that environmental conditions would easily inhibit pairing. In such hybrids diploid gametes would be expected occasionally which would give rise to fertile intermediate polyploid species. Such types of new species have been produced in a number of genera (Clausen and Goodspeed 1925, Karpenchenko 1927, et al.) and recently Muntzing (1931) has been able to synthesize a widespread tetraploid Linnean species. It is possible that some of the polyploid *Deutzias* have been produced in this way.

Variations in temperature may also cause a semi-heterotypic division at meiosis and cause the production of tetraploid varieties. These tetraploids, since they are partially sterile when crossed with the diploid forms would serve as a basis for the development of new species by mutation even without geographic isolation. As Belling (1925) has suggested, the tropical or subtropical species might be more susceptible to the influence of low temperatures. In general, the species of *Deutzia* have a more southern range, are less hardy, and bloom earlier than the species of *Philadelphus*. The fact that the autopolyploid variety of *D. parviflora* is a hexaploid indicates that polyploidy has been due, in part at least, to the production of diploid gametes.

In both *Philadelphus* and *Deutzia*, and in the other genera of Saxifragaceae, the chromosomes at the first meiotic division are usually united by a single terminal or sub-terminal chiasma. There is apparently no difference in the chromosome pairing which would favor the production of diploid gametes in *Deutzia*.

Polyploidy in *Deutzia* may be due to greater differentiation of the chromosomes in different species and to the production of diploid gametes induced by low temperatures, facilitated perhaps by the low frequency of chiasma formation between homologous chromosomes at meiosis.

SUMMARY

The basic chromosome numbers of representative genera of the ligneous Saxifragaceae were found to be 13 in *Philadelphus* and *Deutzia*, 16 in *Jamesia*, 14 in *Decumaria* and *Schizophragma*, 18 in *Hydrangea*, 11 in *Fendlera* and *Itea*, and 8 in *Ribes*.

Deutzia contains many polyploid species, with numbers as high as 65 pairs of chromosomes, while the closely related genus *Philadelphus* contains only diploid species. The possible causes of these differences are discussed.

In both *Deutzia* and *Philadelphus* the chromosomes may pair in species hybrids and apparently normal microspores are produced, but the pollen is highly sterile in most of these hybrids.

Most, or perhaps all of the species of *Philadelphus* can be intercrossed freely and some of the hybrids are at least partially fertile. Species hybrids are also frequently found in *Deutzia* and in *Ribes.* Some of these species are apparently maintained as distinct units only by geographic isolation. The species concept is discussed in relation to the cyto-genetic analysis of certain genera.

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LITERATURE CITED

Babcock, E. B. (1931). Cyto-genetics and the species concept. (Amer. Nat. **65**: 5–18.)

Bangham, W. (1929). The chromosomes of some species of the genus Philadelphus. (Jour. Arnold Arb. **10**: 167–169.)

Belling, J. (1925). Production of triploid and tetraploid plants. (Jour. Heredity 16: 463–464.)

Clausen, R. E. & Goodspeed, T. H. (1925). Interspecific hybridization in Nicotiana 11. (Genetics, **10**: 278–284.)

Darlington, C. D. (1927). Reversion in black currants. (Jour. Pom. Hort. Sci. **6**: 242.)

Hutchinson, J. (1926). The families of flowering plants. MacMillan Co., London. 328 pp.

Karpechenko, G. D. (1928). Polyploid hybrids of Raphanus sativus L. Brassica oleracea L. (Zeit. Indukt. Abstamm. u. Vererb. **48**: 1–85.)

Meurman, O. (1928). Cytological studies in the genus Ribes L. (Hereditas, **11**: 289–356.)

Muntzing, A. (1931). Ueber Chromosomenvermehrung in Galeopsis-Kreuzungen und ihre phylogenetische Bedeutung. (Hereditas, **14**: 153–172.)

Schoennagel, E. (1931). Chromosomenzahl und Phylogenie der Saxifragaceen. (Bot. Jahrb. **64**: 266–288.)

Tischler, G. (1927). Chromosomenstudien bei Ribes Gordonianum und seinen Eltern. (Planta, **4**: 617–650.)

DESCRIPTION OF PLATE 37

Chromosome numbers in Saxifragaceae. Drawing from aceto-carmine smears of pollen mother cells. × 2100. (M. = metaphase).

Fig. 1. *Philadelphus Schrenkii* .... I M.
Fig. 2. *Fendlera Wrightii* .... I M.
Fig. 3. *Jamesia americana* .... 1st tel.
Fig. 4. *Deutzia Lemoinei* .... II M.
Fig. 5. *D. rosea campanulata* .... I M.
Fig. 6. *D. parviflora ovatifolia* .... I M.

POLYPLOIDY IN THE BETULACEAE

ROBERT H. WOODWORTH

The family Betulaceae contains six genera with more than one hundred species in the temperate and colder regions of the northern hemisphere. Hutchinson (1926) considers the Betulaceae to consist of but two genera, *Betula* and *Alnus*. He places the other four genera, *Carpinus*, *Ostrya*, *Ostryopsis*, and *Corylus* in a new family, the Corylaceae. Over sixty species of these six genera are growing in the Arnold Arboretum, each genus being well represented.

Betula is the best known and the largest genus containing some forty species which grow exclusively in the northern regions. From their circumpolar range they radiate out into Europe, Asia and North America in numbers of parallel forms which fall into somewhat definite geographic entities. They are baffling in their variability and accordingly very difficult to classify. Even though there were four times as many extinct species of *Betula* as there are existing species, the genus came through the glacial periods remarkably well as compared with most genera.

The species and varieties of *Betula* have interesting chromosome numbers. Many have fourteen pairs, four have twenty-eight pairs, two have thirty-five pairs, and three have forty-two pairs of chromosomes. About thirty of the forty known species are growing in the Arnold Arboretum. The specific names used are those found in Rehder's Manual (1927).

The existing species apparently form natural hybrids readily, since fifteen crosses have already been described by taxonomists. Four natural hybrids between species of different chromosome numbers have proved interesting from the cytological standpoint (Woodworth, 1929–1930). *Betula Jackii* is the result of a natural cross between *B. lenta* with fourteen gametic chromosomes and *B. pumila* with twenty-eight gametic chromosomes. Helms and Jorgensen (1925) report a similar European hybrid which is readily formed in nature from *B. verrucosa* with fourteen gametic chromosomes and *B. pubescens* with twenty-eight gametic chromosomes.

In both of the above hybrids there are fourteen pairs and fourteen univalent chromosomes at the metaphase of the reduction division.

B. Sandbergi was discovered in the tamarack swamps of southern Minnesota. Since then it has been found that true *B. pumila* does not occur west of New York State and that the plants which had been called *B. pumila* are really F_2 segregates of *B. Sandbergi* (Rosendahl, 1928). *B. papyrifera* with thirty-five gametic chromosomes and *B. pumila* var. *glandulifera* with twenty-eight gametic chromosomes are the parents of *B. Sandbergi* which has sixty-three chromosomes in the sporophytic tissue. The reduction division usually shows twenty-eight pairs and seven single chromosomes some of which may pair among themselves.

B. Purpusii from the taxonomic evidence is clearly a hybrid between *B. lutea* and *B. pumila* var. *glandulifera*. The former parent has forty-two pairs of chromosomes and the latter parent has twenty-eight. The cytology of the hybrid shows about twenty-eight pairs of chromosomes at the metaphase of the reduction division and about fourteen single chromosomes distributed all along the spindle. The metaphase plates of the sporophytic cells have seventy chromosomes. This plant also grows in the tamarack swamps of Minnesota.

The polymorphism of *B. papyrifera* and its varieties is well known to the systematist. *B. papyrifera* and its variety *kenaica* both have thirty-five pairs of chromosomes. *B. papyrifera* var. *cordifolia* and *B. papyrifera* var. *subcordata* both have twenty-eight pairs of chromosomes. *B. papyrifera* var. *occidentalis* has forty-two pairs of chromosomes.

B. japonica has fourteen pairs of chromosomes. *B. japonica* var. *mandshurica* has at the reduction division fourteen pairs and twenty-eight single chromosomes which behave abnormally. This variety appears to be a natural hybrid between *B. japonica* and some species with forty-two pairs of chromosomes. *B. grossa* grows in the same regions as *B. japonica* and its variety, and has forty-two pairs of chromosomes.

BETULA

Section	Species	Chromosome Number (pairs)	Native Habitat
Eubetula			
Subsection			
Costatae	B. nigra	14	E. U. S.
	B. utilis var. Prattii	14	W. China
	B. Schmidtii	14	N. E. Asia
	B. lenta	14	E. U. S.
	B. lutea	42	E. N. Am.
	B. grossa	42	Japan

Nanae	B. pumila	28	N. E. N. Am.
	B. pumila var. glandulifera	28	N. E. N. Am.
Albae	B. populifolia	14	E. N. Am.
	B. coerulea-grandis	14	N. E. N. Am.
	B. fontinalis var. Piperi	14	N. W. U. S.
	B. pendula	14	S. Eurasia
	B. japonica	14	N. E. Asia & Japan
	B. pubescens	28	N. Eurasia
	B. papyrifera var. cordifolia	28	N. E. N. Am.
	B. papyrifera var. subcordata	28	W. N. Am.
	B. papyrifera	35	N. N. Am.
	B. papyrifera var. kenaica	35	Alaska
	B. papyrifera var. occidentalis	42	W. N. Am.
	B. davurica	about 45	N. E. Asia & Japan
Betulaster Subsection Acuminatae	B. Maximowicziana	14	Japan

Natural Hybrids	Sporophytic & Parental Chromosome Numbers	Native Habitat
B. coerulea (coerulea-grandis × populifolia)	28 (14 + 14)	N. E. N. Am.
B. Jackii (lenta × pumila)	42 (14 + 28)	Mass.
B. verrucosa × pubescens	42 (14 + 28)	N. Europe
B. Sandbergi (pumila var. glandulifera × papyrifera)	63 (28 + 35)	N. U. S.
B. Purpusii (pumila var. glandulifera × lutea)	70 (28 + 42)	N. U. S.
B. japonica var. mandshurica (japonica ×?)	56 (14 + 42)	N. E. Asia

Alnus consists of about thirty species. It is the only member of the family that extends its range into the southern hemisphere and here only in the highlands of the Andes as far south as Peru. The Alders differ from the Birches mainly in their persistent and woody seed bearing cones. Some twelve species are growing in the Arnold Arboretum. The following species have fourteen pairs of chromosomes: *A. incana*, *A. crispa* var. *mollis*, *A. maritima;* while *A. japonica*, *A. Spaethii* and *A. glutinosa* all have twenty-eight pairs of chromosomes. The New England *A. rugosa* is something of a puzzle cytologically. Some of the plants have extremely irregular reduction divisions which strongly suggest a hybrid origin (Woodworth, 1929). Material from all the other species was collected at the same time and treated in exactly the same manner. That the abnormalities were not caused by the fixing fluid or any external agent is clearly shown by the presence of dwarf pollen grains and almost complete sterility of the contents of the anthers. When the divisions of the spore mother cells of *A. rugosa* are at all normal they have fourteen pairs of chromosomes. At other times it seems that some of the chromosomes have fragmented or that the other parent had about twenty-eight chromosomes. Although cytological material of *A. rugosa* from the southeastern United States has notyet been available for study, some of the mature catkins have been procured from Virginia and these have almost perfect pollen. This suggests that the polymorphism and cytological irregularities of the New England *A. rugosa* is probably due to the formation of natural hybrids between *A. incana* and *A. rugosa* where the two species grow together. Experiments are now being carried out along this line in an attempt to produce hybrid *A. rugosa.*

A. Spaethii has been reported as a hybrid between *A. subcordata* and *A. japonica*. *A. Spaethii* has regular meioses with twenty-eight pairs of chromosomes. *A. japonica* growing in the Arnold Arboretum also has twenty-eight pairs. Catkins of *A. subcordata* have not been available to me for study but Wetzel (1929) reports fourteen pairs of chromosomes for this species and also for *A. japonica*. If *A. Spaethii* is a hybrid its parents must have been either fourteen chromosome or twenty-eight chromosome individuals. If they had fourteen chromosomes there is no homology between any of the members of the chromosome sets, and if the parents had twenty-eight chromosomes there is complete homology between the chromosome sets. I believe that the hybrid nature of *A. Spaethii* is open to question.

There are fifteen species of *Corylus*. The Hazels are well known as ornamental trees and shrubs but perhaps better for their edible nuts (filberts and hazelnuts). The eleven species, five varieties and one hybrid growing in the Arnold Arboretum all have fourteen pairs of chromosomes. They are: *C. americana*, *C. americana* × *pontica*, *C. Avellana*, *C. Avellana* var. *pendula*, *C. Avellana* var. *pontica*, *C. colurna*, *C. cornuta*, *C. heterophylla*, *C. heterophylla* var. *sutchuenensis*, *C. maxima*, *C. maxima* var. *purpurea*, *C. Sieboldiana*, *C. Sieboldiana* var. *mandshurica*, *C. tibetica*, *C. spinescens*, *C. Vilmorinii*, *C. no. 9 of Vollertsen*. Wetzel (1929) reports the haploid number to be eleven in *C. Avellana*, *C. maxima* and *C. mandshurica*.

Species	Chromosome Number (pairs)	Native Habitat
Alnus incana	14	N. E. N. Am., Eur.
A. rugosa	14	E. N. Am.
A. crispa var. mollis	14	N. E. N. Am.

Species	Chromosome Number (pairs)	Native Habitat
A. maritima	14	E. N. Am.
A. japonica	14[1], 28	Japan, N. E. Asia
A. Spaethii	28	unknown
A. glutinosa	28	Eurasia, N. Afr.
A. subcordata	14[1]	Asia
Carpinus caroliniana	8	E. N. Am.
C. laxiflora	8	China
C. orientalis	8	S. E. Eur., Asia Minor
C. Turczaninovii	8	China, Korea
C. japonica	8	Japan
C. cordata	8	Asia
C. betulus	8	Eurasia
C. betulus var. fastigiata	32	
Ostrya virginiana	8	E. N. Am.
O. virginiana var. glandulosa	8	N. E. N. Am.
O. carpinifolia	8	S. Eur., Asia Minor
O. japonica	8	Asia
Ostryopsis Davidiana	8	China
Corylus (all species)	14	N. Am., Eur., Asia

[1] Wetzel, 1929.

There are about twenty species of *Carpinus*. The Hornbeams are known for their handsome foliage and their extremely hard and tough wood. It is noteworthy that the species have eight pairs of chromosomes which is in marked contrast to the species of the three genera treated above, which have fourteen as the fundamental number. *C. betulus* var. *fastigiata* deserves special mention since it has thirty-two pairs of chromosomes while *C. betulus*, *C. caroliniana*, *C. laxiflora*, *C. Turczaninovii*, *C. orientalis*, *C. japonica*, *C. cordata* all have eight pairs.

There are seven species of *Ostrya*, the Hop-hornbeam. Mature plants of *O. virginiana*, *O. virginiana* var. *glandulosa*, *O. carpinifolia*, *O. japonica* are growing in the arboretum. They all, like *Carpinus*, have eight pairs of chromosomes.

Ostryopsis has but two species. One, *O. Davidiana*, is growing in the Arnold Arboretum. It has eight pairs of chromosomes.

The chromosomes at the reduction division in the Betulaceae are almost spherical and small. The species of *Betula*, *Alnus*, *Carpinus*, *Ostrya*, and *Ostryopsis* have chromosomes which measure approximately one micron in diameter. The notable exceptions to this measurement are those species of *Betula* which have large numbers of chromosomes. The three plants with forty-two gametic chromosomes show these bodies to have a diameter of .6 of one micron, while those species with the intermediate chromosome numbers show, in general, an intermediate chromosome diameter. In the above genera the size of the pollen mother cells and the pollen grains increases as the chromosome number increases.

The chromosomes of the various species and varieties of *Corylus* are very small. They average approximately 0.5 of one micron in diameter. Compared with diploid species of the other genera they are half size. Nevertheless the pollen mother cells and the pollen grains are as large as those of any species in the family.

It has frequently been found that the species of certain subgenera or subsections will readily hybridize among themselves but not with the species of other subgenera or subsections, while in other groups there is free crossing between diverse species or even between genera. In recently suggested definitions of a species free intercrossing and high interfertility among the individuals of the group and absence of free intercrossing and low fertility or complete sterility in interspecific hybrids are considered important for the genetic bearing on the species concept (Muntzing, Tedin and Turesson, 1931; Babcock, 1931; Sax, 1931). In *Betula* the data above show that *B. pumila*, representing the dwarf Birches, readily hybridizes with species of both other subsections. Furthermore, it has recently been found that the plants from Michigan, Wisconsin, Minnesota, and Indiana which have long been called *B. pumila* are in reality F_2 segregates of × *B. Sandbergi* and that true *B. pumila* does not occur west of New York State (Rosendahl, 1928). Since *B. lenta* and *B. pumila* var. *glandulifera* are quite distinct species the hybrid *B. Sandbergi* is an exception to the genetic part of the specific concept noted just above. Experiments discussed below show the Betula species to hybridize readily.

EXPERIMENTAL HYBRIDS

The following experiments in crossing birch species have proved successful to the extent that embryos were formed. In each case twelve seeds were cut open and examined. The seeds of a great many more crosses than these have been planted but only in those listed here have embryos been seen. The gametophytic chromosome number of each parent is given.

B. pendula (14) produced seeds with embryos when crossed with: *B. coerulea-grandis* (14), *B. pumila* (28), *B. papyrifera* var. *cordifolia* (28), *B. grossa* (42).

B. Maximowicziana (14) crossed with *B. lutea* (42) and *B. davurica* (about 45).

B. pumila (28) crossed with *B. lenta* (14), *B. nigra* (14), *B. japonica* (14), *B. Maximowicziana* (14), and *B. papyrifera* var. *cordifolia* (28).

B. papyrifera var. *cordifolia* (28) crossed with *B. pendula* (14), *B. pumila* (28), *B. papyrifera* var. *kenaica* (35), *B. lutea* (42), and *B. papyrifera* var. *occidentalis* (42).

B. papyrifera var. *kenaica* (35) crossed with *B. papyrifera* var. *occidentalis* (42).

B. lutea (42) crossed with *B. lenta* (14), *B. coerulea-grandis* (14), *B. pumila* (28), *B. grossa* (42), and *B. papyrifera* var. *occidentalis* (42).

B. papyrifera var. *occidentalis* (42) crossed with *B. lenta* (14), *B. pendula* (14), *B. pumila* (28), *B. papyrifera* (35) and *B. papyrifera* var. *kenaica* (35).

B. davurica (about 45) crossed with *B. pendula* (14), *B. Maximowicziana* (14), *B. papyrifera* (35), *B. lutea* (42), and *B. japonica* var. *mandshurica* (42).

If all of these crosses which are known to have formed seeds with embryos should produce viable plants, hybrids with the following sporophytic chromosome numbers would be formed: one diploid (28), seven triploids (42), nine tetraploids (56), four pentaploids (70), one octoploid (84), and these dysploids; one 49, three 59's, one 63, one 77, one 80, and two 87's.

Since these seeds have not yet germinated it may be a little early to anticipate results, but it does seem as though the species of *Betula* are highly interfertile.

DISCUSSION

Species formation is probably due to changes in chromosome structure and chromosome number. Some genera consist of species all of which have the same chromosome number. Species formation in such groups might be attributed to gene mutations and other structural changes within the individual chromosomes aided perhaps by hybrids between varieties. Other genera consist of species which have different chromosome numbers. Species formation in these groups might be due not only to the causes mentioned above but also to the duplication of chromosomes or chromosome sets and to the combination of chromosome sets from different species.

Recent points of view hold that mutations are the basic cause of variation and evolution and that evolution is speeded up and aided by first varietal and later species hybridization (Wright, 1931 and others).

Many interesting polyploid series have been investigated. Considerable evidence supports the view that plants with the higher chromosome numbers have originated from those species with the smaller chromosome complement. A useful distinction has been made amongst polyploids (Kihara & Ono, 1926) according as their gametic complements are built up by the reduplication of similar series (autopolyploidy), that is, by the doubling of the chromosome number in a theoretically pure line, or by the combination of dissimilar series (allopolyploidy), that is, by doubling in a hybrid. There is not complete agreement as to which of these types of polyploid formation is the more frequent in nature. Jorgensen (1928) considers that hybridization has played a much greater role in the improvement of our cultivated plants than it has in species formation; that species hybridization occurs but rarely in nature; and that tetraploidy induced in the sparse species hybrids found in nature is very rare in comparison with the tetraploidy found in the huge numbers of pure species. Darlington (1927 and 1928) on the other hand concludes that polyploids have often arisen as the result of hybridization between diploid species and that most normally seed producing polyploids occurring in nature fall in the allopolyploid group.

Species of *Ostrya*, *Ostryopsis* and *Carpinus* all have eight as the basic chromosome number while species of *Betula*, *Alnus* and *Corylus* have the basic number of fourteen. Hutchinson (1926) has placed *Betula* and *Alnus* in the Betulaceae and has proposed another family, the Corylaceae, for *Corylus*, *Carpinus*, *Ostrya* and *Ostryopsis*. From the standpoint of chromosome number *Corylus* should go in with *Betula* and *Alnus*. Furthermore, *Corylus* species form their staminate catkins and mature their pollen in the fall as do the species of *Betula* and *Alnus* (except *A. maritima*) while the members of the other genera form and mature their pollen just previous to its shedding in the spring. If the family is to be split into two families a more natural grouping from the developmental and cytological evidence would place *Corylus* in with *Betula* and *Alnus*.

The basic chromosome number in this family is apparently seven, although no member has yet been found to have seven pairs of chromosomes. The eight chromosome genera may have originated from an original seven chromosome strain by the duplication of one chromosome. The fourteen chromosome genera would then have come about by a duplication of the original set of seven chromosomes. The meiotic conditions in *Corylus* may be of significance here. Wetzel (1929) reports eleven pairs of chromosomes in *C. Avellana*, *C. maxima* and *C. mandshurica*. During the reduction division in all species listed above there is an affinity between some of the gemini to the extent that usually two and sometimes three pairs of bivalents fuse to form tetrasomes, thus often causing the haploid number to be less than fourteen (Woodworth, 1929). If this be a normal process it may indicate an affinity of homologous chromosome pairs which in turn suggests a doubling, if not of a whole chromosome set, at least of certain chromosomes. However, Yarnell (1929) has shown that we can not be too dogmatic about the idea that only homologous chromosomes pair. In an artificially produced triploid *Fragaria* he has found unmistakable pairing between non-homologous chromosomes. This also happens in *Betula Sandbergi*.

Species formation in the genus *Corylus*, since all species have fourteen chromosome pairs, might be attributed to gene mutations and other structural changes within the individual chromosomes aided perhaps by hybrids between varieties, although it has recently been suggested that gene mutations have little influence in species formation (Anderson, 1928).

Species of *Alnus* seem to be well defined, with the exception of the New England material of *A. incana* and *A. rugosa*. The existence of much intergrading material makes for obscurity in specific lines. Much of the *A. rugosa* material has very abnormal meioses in both microgametophyte and macrogametophyte and the abundance of viable seed has been found to develop apogamously and to be polyembryonic (Woodworth, 1930). There is then here a correlation between polymorphism and reproductive irregularities. Some specimens of *A. japonica* have been reported as having fourteen pairs of chromosomes while others have twenty-eight pairs. Since the plants are taxonomically *A. japonica* there is no doubt that there has been a duplication of the chromosome set (autopolyploidy).

Carpinus betulus has eight pairs of chromosomes, while its variety *fastigiata* has thirty-two pairs. This variety obviously belongs to *C. betulus* because it differs only in its narrow pyramidal habit. The octoploid chromosome number probably originated in a four fold reduplication of the eight pairs of chromosomes (autopolyploid).

It has been mentioned above that *Betula* species are very difficult taxonomically. This is due to many intergrading forms. Fernald (1902) has shown that it is possible to trace by a series of specimens a direct connection between dwarf *B. nana*, through variants of many other species, to the tall *B. alba*. He notes that since it is obviously impracticable to regard all these forms as one species, it seems wise to recognize the more marked centers of variation as species which are admitted to pass by exceptional tendencies to other forms ordinarily distinguished by marked characteristics.

Evidence already discussed above and a careful study of hybrid birches of northern Europe support the thesis that some of this polymorphism at least is due to hybridization (Helms & Jorgensen, 1925). One of the well known authorities on the taxonomy of the Betulaceae has recently pointed out that hybridism in the genus *Betula* has played a very important rôle and is directly responsible for much of the variation so troublesome to specific concepts (Winkler, 1930).

Species of *Betula* show considerable polyploidy. The Betula list shows nine diploids, two triploids, four tetraploids, two pentaploids, three hexaploids. Here we have polymorphism and polyploidy occurring together. A mechanism for the origin of polyploidy is seen in × *B. Jackii*, × *B. Sandbergi*, × *B. Purpusii*, *B. japonica* var. *mandshurica*, *B. papyrifera* var. *cordifolia*, and *B. davurica*. In the anther sacs of these plants diads of diploid pollen grains are formed by the failure of one of the meiotic divisions (Woodworth, 1929–1930). Some even form tetraploid gametes. Most of these forms, and probably all of them, are definitely cases of allopolyploidy and they are now producing polyploid gametophytic tissue which, if it functions in fertilization, may be the basis for more polyploid or aneuploid forms.

The meioses of the tetraploid, pentaploid and hexaploid species, such as *B. pumila*, *B. papyrifera* and *B. lutea*, respectively, show a high percentage of chromosome pairing but frequently there are a few chromosomes which remain univalent. Slight irregularities lead to occasional formation of microcytes but I have never seen any diads of diploid pollen grains in any of the well marked diploid or polyploid species. Nor has an examination of thousands of mature pollen grains of these species disclosed any large grains which might be diploid in content. A high percentage of chromosome pairing would indicate duplication of similar sets of chromosomes or autopolyploidy. Experiments now being carried in crossing many of these birches may throw some light on their true origin.

B. papyrifera and its varieties constitute an interesting polyploid group. *B. papyrifera* var. *cordifolia* and *B. papyrifera* var. *subcordata* have twenty-eight gametophytic chromosomes, *B. papyrifera* and *B. papyrifera* var. *kenaica* have thirty-five, and *B. papyrifera* var. *occidentalis* has forty-two. The taxonomy of these plants is not yet well established. All of these varieties were previously considered to be distinct species. Recently Professor Rosendahl in correspondence has noted that var. *cordifolia* in northern Minnesota is quite distinct in many characteristics from *B. papyrifera*.

The chromosome numbers offer some support to this view although there are some fifty species of plants which are known to contain individuals with different chromosome numbers and complexes (Clausen, 1931). The formation of polyploid gametes is characteristic of hybrids. Since *B. papyrifera* var. *cordifolia* forms diads of diploid pollen grains it may have had a hybrid origin and if so it is allopolyploid. At the present time it is difficult to decide whether *B. papyrifera* and its varieties are to be considered autopolyploid or allopolyploid. In cases of this sort, taxonomy, cytology, genetics, and phytogeography must contribute in order that conclusions may be of value. Experiments in crossing individuals of this species and its varieties are being made with the hope that the interspecific hybrids will prove valuable toward clarifying the nature of the group.

The fact that none of the diploid species are now seen to be producing polyploid gametes does not of course preclude the possibility that they may have done so in the past. It is well known that certain groups of plants have passed through periods of great activity in individual variation and species building. The cause of this unusual behavior is not agreed upon by all investigators by any means. If it is internal it may be that polyploidy in *Betula* originated at a time when the group passed through a fluctuating state and it may have been due to cases of pure autopolyploidy.

SUMMARY

Species of *Betula* have the following numbers of chromosome pairs: 14, 28, 35 and 42. Six natural hybrids show significant correlative cytological data. *B. papyrifera* and its varieties have different polyploid chromosome numbers.

Species of *Alnus* have 14 and 28 pairs of chromosomes. The tetraploid species are probably autopolyploid.

Corylus species have 14 pairs of extremely small chromosomes.

Species of *Carpinus*, *Ostrya* and *Ostryopsis* have 8 pairs of chromosomes. *Carpinus betulus* var. *fastigiata* has 32 pairs and is autopolyploid.

Polyploid species have smaller chromosomes, in general, than diploid species (except in *Corylus*).

Thorough examination has disclosed no binucleate archesporial cells, no meioses producing diploid microspores and no unusually large pollen grains in the well marked diploid and polyploid species of the Betulaceae.

The only plants in the family which are known to produce diploid and sometimes tetraploid pollen grains are those which

are known to be or which are suspected of being of heterozygous origin. Polyploidy in *Betula* has been both allopolyploid and autopolyploid.

Experiments in crossing Betula species have proved about 50% effective in embryo formation.

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LITERATURE CITED

ANDERSON, E. (1928). The problem of species in the northern blue flags, Iris versicolor L. and Iris virginica L. (Ann. Missouri Bot. Garden, **15**: 241–332.)

BABCOCK, E. B. (1931). Cyto-genetics and the species-concept. (Am. Nat. **65**: 5–18.)

CLAUSEN, J. (1931). Viola canina L., a cytologically irregular species. (Hereditas, **15**: 67–88.)

DARLINGTON, C. D. (1927). "The Behavior of Polyploids." (Nature, **119**: 390.)

DARLINGTON, C. D. (1928). Studies in Prunus, I and II. (Jour. Gen. **19**: 213–256.)

FERNALD, M. L. (1902). Relationships of some American and old world birches. (Amer. Jour. Sci. **14**: 167–194.)

GAISER, L. O. (1930). Chromosome numbers in angiosperms, III. (Genetica, **12**: 161–261.)

HELMS, ANNA, & JORGENSEN, C. A. (1925). Birkene paa Maglemose. (Bot. Tidsskr. **39**: 57–133.)

HUTCHINSON, J. (1926). The families of flowering plants. Macmillan Co.

JORGENSEN, C. A. (1928). The experimental formation of heteroploid plants in the genus Solanum. (Jour. Gen. **19**: 133.)

KIHARA, H., & ONO, T. (1926). "Chromosomenzahlen und systematische Gruppierung der Rumex Arten." (Zeitschr. Zellforsch. u. Mik. An. **4**: 475–481.)

MUNTZING, A., TEDIN, O., & TURESSON, G. (1931). Field studies and experimental methods in taxonomy. (Hereditas, **15**: 1–12.)

REHDER, A. (1927). Manual of cultivated trees and shrubs. Macmillan Co.

ROSENDAHL, C. O. (1928). Evidence of the hybrid nature of Betula Sandbergi. (Rhodora **30**: 125–129.)

SAX, K. (1931). The origin and relationships of the Pomoideae. (Jour. Arnold Arb. **12**: 3–22.)

WETZEL, G. (1929). Chromosomenstudien bei den Fagales. (Bot. Arch. **25**: 258–84.)

WINKLER, H. (1930). Der gegenwärtige Stand der Betula-Systematik. (Mitteilungen der Deutschen Dendrologischen Gesellschaft, **42**: 36–40.)

WOODWORTH, R. H. (1929, 1930). Cytological studies in the Betulaceae. (Bot. Gaz. **87**: 331–363; **88**: 383–399; **89**: 402–409; **90**: 108–115.)

WRIGHT, S. (1931). Evolution in Mendelian Populations. (Genetics, **16**: 97–158.)

YARNELL, S. H. (1929). Meiosis in a triploid Fragaria. (Proc. Nat. Acad. Sci. **15**: 843.)

MILESINA RUSTS ON ASPIDIUM BRAUNII SPENNER

J. H. FAULL

THE white-spored rusts of Conifers are included in the two genera *Milesina* and *Uredinopsis*. All have their diploid stage on ferns, and for the few of which the complete life cycle is known, their haploid stage on *Abies*. Until quite recently only one white-spored rust was recognized on *Abies* in America, the so-called *Peridermium balsameum* Peck, but we now know that this name stood for a dozen or more species of *Milesina* and *Uredinopsis*. The same situation exists in Europe with regard to *Aecidium pseudocolumnare* J. Kuehn on *Abies*. Sydow remarks (Monographia Uredinearum, **4**: 13, 1915) "Aus Klebahn's Versuchen geht jedoch gleichzeitig hervor, dass das weisssporige *Aec. pseudocolumnare* insofern keine einheitliche Art darstellt, als es zu verschiedenen Farn-Uredineen gehört, nämlich zu *Uredinopsis Struthiopteridis* Störm. und *Milesina Blechni* Syd., wahrscheinlich auch noch zu anderen Arten." There now comes to hand a welcome paper by Kamei (Notes on *Milesina vogesiaca* Syd. on *Polystichum Braunii* and its Peridermial Stage on the Needles of *Abies Mayriana, A. firma* and *A. sachalinensis.* Trans. Sapporo Nat. His. Soc. **11**: 142–147. 1930) which records a new fern host of a known rust species and untangles a portion of the rust maze on *Abies*, and directly thereafter a new species on the same fern which calls for discrimination and further work on *Abies*.

Kamei's procedure was to culture from the teliospores of the fern rust onto the various species of *Abies* named above, and then from *Abies* back to the fern. He was completely successful with his experiments in both directions. A close morphological examination of the rust involved convinced him that it was *M. vogesiaca* Syd., a rust heretofore known in Europe only and on another, though related, fern host, *Aspidium lobatum*. Since the life history of *M. vogesiaca* in Europe has not yet been worked out and no cross-inoculations made as between *A. lobatum* and *A. Braunii*, Kamei's taxonomic determination, while probably correct, is of tentative status.

Additional interest now accrues to the subject from the discovery of a *Milesina* on *A. Braunii* quite distinct from *M. vogesiaca*. The material was communicated through the courtesy of Director A. Wróblewski of Kórnik, Poland. The description follows:

Milesina exigua, n. sp.

O and I. Spermogonia and aecia unknown.

II. Uredinia hypophyllous, subepidermal, scattered or loosely grouped on greenish to brownish areas of indefinite extent, pustular, 0.1 to 0.2 mm. in diameter, opening outwards through a centrally placed stomatic pore in the overlying brownish epidermis; peridium hemispheric, hyaline, delicate; peridial cells isodiametrically to irregularly polygonal, 8 to 15 μ across; walls of peridial cells hyaline, 0.5 to 1.0 μ thick; uredospores colorless, smooth, thin-walled (0.5–1 μ), short-stalked, obovate to elliptical or subspherical, 14–17 × 18–31 μ, averaging about 15 × 23 μ.

III. Unknown.

The type material of this species was collected on *Aspidium Braunii* Spenner by Antoine Wróblewski at Kniażdwór, District of Kolomea, Poland in August, 1913. I have also had the opportunity of studying further material on the same host from Olszanica, Lesko, Poland, collected October 18, 1917. It is to be expected that an abundance of telia develops on overwintered fronds in late spring or early summer; and it is almost equally certain that the peridermial stage occurs on *Abies*.

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NOTES

A Silvicultural Study of Abies pinsapo. Under the title "A travers les forêts de Pinsapo d'Andalousie" A. Barbey[1] has published a detailed study of *Abies pinsapo* considering it from a dendrological, silvicultural and entomological point of view. The author is a grandson of Edmond Boissier who in 1837 first recognized and described this Fir as a new species and whose portrait forms the frontispiece of the volume. A brief biography of Boissier is given and his description of *Abies pinsapo* is reprinted and also that part of his "Voyage botanique dans le midi d'Espagne"[2]) which refers to *Abies pinsapo* with reproductions of the two original plates of that Fir and one of *Quercus alpestris* Boiss. In 1929 the author visited the Sierra de Ronda and adjoining mountain ranges in Andalusia to study *Abies pinsapo* from a silvicultural point of view. In this region the forests of Pinsapo are found at an altitude of 1000–1800 m. and cover approximately an area of 1200 hectares. The tree has many enemies and if no protective measures are taken, it may disappear altogether from its native habitat. Natural re-

[1] Barbey, A. À travers les forêts de Pinsapo d'Andalousie; étude de dendrologie, de sylviculture et d'entomologie forestière. Préface de M. L. Pardé. 110 pp. 41 pl. O. Paris & Gembloux, 1931.

[2] A copy of this very rare work by Boissier with 181 (207) hand colored plates is to be found in the Library of the Arnold Arboretum.

generation is prevented or made difficult by grazing animals, such as goats, sheep and cattle; many insects prey on the trees, and drought during the summer is also often injurious. Besides, charcoal burners do much harm by cutting off the branches to a considerable height and formerly the "neveros," men who collected snow for refrigerating purposes, were careless with fire and burned old trees and destroyed young growth when working on the high plateaus, but since artificial ice has chiefly replaced the condensed snow brought from the mountains, the menace of the "neveros" has become negligible. Numerous photographs show stands of Pinsapo in various aspects, the young trees often mutilated and deformed by goats and sheep. There are also pictures of fine trees in cultivation in different countries of Europe where it has been planted as an ornamental tree and even has given rise to a number of interesting garden forms. There will perhaps soon be more and finer specimens of this tree in gardens and parks outside of Spain than in its original habitat, if immediate measures are not taken for its protection. To the insects preying on the Pinsapo the author who is an authority on forest entomology has paid special attention and enumerates a considerable number of species chiefly Coleoptera and describes and figures them and their ravages. There is also a brief chapter dealing with the insects of *Quercus alpestris* which is associated in the Sierra de Ronda with the Pinsapo and of which an ancient and interesting stand is described but which, since it has no chance of regeneration on account of unrestricted grazing, will probably disappear within the century. In his concluding remarks the author recommends protective measures for the Pinsapo whose great vitality is shown in the fact that it has been able to maintain itself in spite of its numerous enemies. With proper protection it would no doubt again form flourishing forests and might be used for the afforestation of other mountains in the Peninsula; this would be of great benefit to the population and to the development of agriculture.—A. R.

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CONTRIBUTION TO THE FLORA OF THE NEW HEBRIDES

PLANTS COLLECTED BY S. F. KAJEWSKI IN 1928 AND 1929

A. GUILLAUMIN

With three text figures

THE NEW HEBRIDES including the islands of the Banks and Torres groups which form their northern extension, represent, as I have had already occasion to state[1] one of the botanically least known regions of the world.

Indeed besides the plants which were collected by J. and G. Forster and W. Anderson[2] in 1774 during Cook's second voyage on Tanna and Malekula (Mallicolo), by W. Milne and J. MacGillivray[3] in 1859 on Aneityum (Annatom), Tanna, Erronan and Eromanga, during the voyage of the Herald, by the Rev. F. A. Campbell[4] in 1872–1873 on Aneityum, Tanna, Aniwa (Nioua), Eromanga, Efate and Espiritu Santo, and by D. Levat[5] in 1883 on Efate, we know only of few specimens collected by different travelers and occasionally cited.

Though the whole of the Phanerogames has been estimated at more than one thousand species, the list of the plants known from these islands which I published[6] and supplemented later[7] amounts only to 333; therefore it is very fortunate that from February 18, 1928 to March 20, 1929, Mr. S. F. Kajewski in this region with a very trying climate and peopled by still more or less anthropophagous natives collected for the Arnold Arboretum

[1] Bull. Soc. Bot. France, LXVI. 267 (1919)

[2] Preserved at the British Museum (Natural History) and cited by G. FORSTER, Florae insularum australium prodromus (1780).

[3] Preserved at the British Museum (Natural History) and cited by B. SEEMANN, Flora Vitiensis (1865–68).

[4] Preserved in the Botanic Garden of Melbourne and cited by F. VON MUELLER, Contributions to the phytography of the New Hebrides. (Appendix to F. A. CAMPBELL, A year in the New Hebrides, Loyalty Islands and New Caledonia, 1874.)

[5] Preserved at the Museum national d'histoire naturelle de Paris and at the Institut botanique de Montpellier, cited by A. GUILLAUMIN in Bull. Soc. Bot. France, LXVI. 267–277 (1919); LXXVI. 298–303 (1929).

[6] Bull. Soc. Bot. France, LXXIV. 693–712 (1927).

[7] l. c. LXXVI. 298–303 (1929).

and the California Botanic Garden about 900 numbers (including 180 numbers from Vanikoro Island of the Santa Cruz Group) of herbarium specimens which are preserved in the herbarium of the Arnold Arboretum (with duplicates to be distributed later) and the Gray Herbarium of Harvard University and in the herbarium of the Museum national d'histoire naturelle of Paris. The following localities have been explored by Kajewski: Aneityum: west coast, Aname, Anelgauhat Bay, Umage, Utgi, Inyeug; Tanna: Lenakel, Port Resolution, Ikiti, Mt. Tokosh Meru; Eromanga (Erromongo): Dillon Bay, centre of the Island; Efate (Vaté): Undine Bay, Port Vila; Banks Group: Vanua Lava.[1] As in most atlases the New Hebrides are represented on a small scale with the names of only a few of the more important islands a map of the whole group is given on the opposite page (Fig. 1).

The following enumeration will bring out once more[2] the particular interest of this flora, for the New Hebrides form the point of contact between the floras of Papua, Melanesia and Polynesia which are only special aspects of the Malayan flora, and the "flore canaque" which is so peculiar.

DILLENIACEAE

Dillenia biflora (A. Gray) Martelli in Beccari, Malesia, III. 163 (1887).

Tanna: Lenakel, alt. 150 m., rain-forest, common, no. **132**, March 8, 1928 (tree about 15 m. high).

It differs from the Fiji plant only in the longer petiole and in the more oval leaves rounded at the apex.

Dillenia neo-ebudica Guillaumin, sp. nov.

Arbor glaberrima, 10 m. alta, trunco 45 cm. diam., foliis nitentibus ovatis (usque ad 27 cm. x 6 cm.), basi subrotundatis et alarum reliquis usque ad 2 cm. productis, apice obtusis, margine laxe serratis rigidis, nervis circa 14-jugis, venis parallelis densis in nervis sub-perpendicularibus, petiolis 6–8 cm. longis margine alis 5 mm. latis basi recedentibus praeditis; inflorescentiae oppositiflorae, usque ad 5 cm. longae, 2-florae, pedicello usque ad 4 cm. longo, medio vel supra medium bracteolato, bracteolis?, floribus 2.5 cm. diam. albis vel luteis, sepalis 5 valde coriaceis late ovatis circa 2 cm. longis, petalis?, staminibus ∞, interioribus longioribus, carpellis 8, fructibus globosis 2.5 cm. latis.

Eromanga: Dillon Bay, alt. 400 m., rain-forest, common, no.

[1] For a brief account see S. F. KAJEWSKI, A plant collector's notes on the New Hebrides and Santa Cruz Islands (Jour. Arnold Arb. XI. 172–180. 1930).—The collections made on the Santa Cruz Islands are not included in the following enumeration.

[2] Compt. Rend. Soc. Biogéogr. VI. 26–28 (1929).

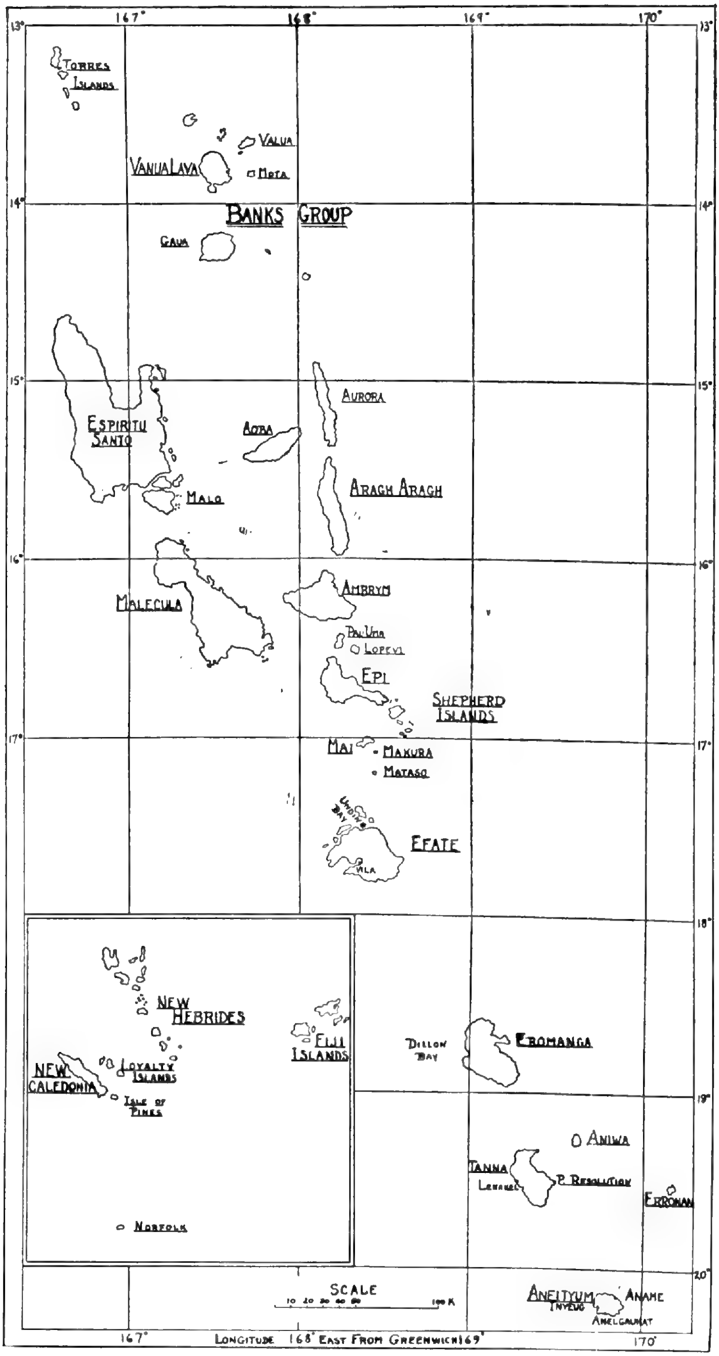

FIG. 1. Map of the New Hebrides.

323, May 29, 1928 (tree up to 10 m. high; flowers yellow; bark macerated with water used by natives as medicine for mother of new born child). Aneityum: west coast, alt. 300 m., rain-forest, common, no. **965** (coll. *J. P. Wilson*),[1] Sept. 1929 (low tree, about 40 cm. in diam.; leaves large, glossy; flowers large, white; fruit round, 2.5 cm. diam.)—Vernacular name "Net-hul" (under no. 323) or "Nejul" (under no. 965).

Related to *D. auriculata* Martelli.

ANNONACEAE

Oncodostigma Wilsonii Guillaumin, sp. nov.

Arbor parva, trunco 45 cm. diam., foliis lanceolatis (3–10 cm. x 1.5–3.5 cm.) papyraceis, basi fere aequali-rotundatis, apice longe attenuatis, nervis circa 10-jugis, tenuissimis, petiolo brevissimo 2 mm. longo; flores solitarii, e ramis foliatis orti, axillares, brunnei, pedicello 1 cm. longo glabro, basi bracteis minutis lanceolatis hirsutis praedito, sepalis 3 late triangularibus 1 mm. longis intus extraque brevissime brunneo-lanuginosis, petalis exterioribus 3 sat crassis anguste triangularibus 1 cm. longis acutis intus extraque brevissime brunneo-lanuginosis, interioribus 3 crassioribus anguste triangularibus, quam exteriora leviter brevioribus, intus basi verrucosa excavata genitaliaque arcte fovente excepta et extra brevissime brunneo-lanuginosis, staminibus ∞ connectivo incrassato sparsissime languinoso obtectis, carpellis 3–4 dense rufo-pilosis pluri-ovulatis, stigmate amplo glabro nigro caduco ovoideo-conico, carpidiis 3 subsessilibus ovoideis (2 cm. x 1.5 cm.) glaberrimis luteis, seminibus 3 transverse uniseriatis.

Aneityum: Anelgauhat Bay, lower hills in forest, alt. 500 m., common, no. **986** (coll. *J. P. Wilson*), Sept. 1929 (small tree to 45 cm. in diam.; leaves small; flowers medium, light brown; fruit three in a bunch, yellow, 1.5 cm. x 1.4 cm.).—Vernacular name "Nirasialau."

This genus was represented by only one species found only once in the northwest of New Guinea, very different in its leaves and in the subsessile flowers.

Polyalthia nitidissima Bentham, Fl. Austral. I. 51 (1863).

Efate: Undine Bay, alt. 50 m., rain-forest, common, no. **229,** April 28, 1928 (tree about 15 m. high; fruit yellow in bunches of five or six). Aneityum: Anelgauhat Bay, sea level, rain-forest, common, no. **721,** Feb. 11, 1929 (large tree up to 18 m. high; flowers with light yellow petals, sweetly scented; fruit red, borne usually in

[1] The numbers followed by "(coll. *J. P. Wilson*)" were collected in Aneityum after Mr. Kajewski had left the island, by natives under the supervision of Mr. J. P. Wilson, a resident of Aneityum.

a whorl of 3, others single; timber durable). E r o m a n g a: Dillon Bay, sea level, rain-forest, common, no. **268,** May 17, 1928 (tree up to 15 m. high with straight barrel, used by natives for house supports).—Also in Queensland.—Vernacular name "Nemarmis."

MENISPERMACEAE

Stephania Forsteri A. Gray, Bot. Wilkes U. S. Explor. Exped. I. 36 (1854).

E r o m a n g a: Dillon Bay, sea level, rain-forest, common, no. **337,** May 29, 1928 (vine growing up to the tops of trees; fruit red when ripe; stems used as ropes for house making).—Also Efate; New Caledonia, Lord Howe, Tonga, Samoa and Society Islands, New Guinea, North Australia, Admirality Islands to Java and the Philippine Islands.—Vernacular name "No-ses-sore-vol."

Hypserpa neo-caledonica Diels in Engler, Pflanzenr. IV–94, 209 (Menispermac.) (1910).

E r o m a n g a: Dillon Bay, alt. 300 m., rain-forest, common, no. **284,** May 23, 1928 (vine climbing on the small trees; flowers cream-colored).—Also Loyalty Islands, New Caledonia.—Vernacular name "Nosimpatuavu."

VIOLACEAE

Hybanthus ilicifolius Schinz & Guillaumin in Sarasin & Roux, Nova Caled. I. 183 (1921).

A n e i t y u m: Anelgauhat Bay, sea level, seashore, common, no. **921,** March 17, 1929 (small tree up to 9.5 m. high; flowers white). —Also Loyalty Islands, New Caledonia.

BIXACEAE

Bixa Orellana Linnaeus, Sp. Pl. 512 (1753).

T a n n a: Lenakel, alt. 200 m., rain-forest, common, no. **108,** March 6, 1928 (shrub about 5 m. high; fruit brown; seed bright pink).

American plant introduced in all the tropical countries.

PITTOSPORACEAE

Pittosporum aneityense Guillaumin, sp. nov.

Arbor parva, 5 m. alta, ramis modice validis teretibus rugose lenticellatis, primum appresse rufo-pilosis deinde glabris pallideque cinereis, foliis longiuscule (1.5–2 cm.) petiolatis lanceolatis (9–11 cm. x 2.5–3 cm.), apice obtusis rotundatisve, basi longe cuneatim attenuatis, supra atroviridibus infra appresse argenteo-pilosis, rigidis integerrimis, floribus roseis terminalibus dense fasciculatis, pedicello circa 2 mm. longo dense roseo-lanuginoso, bracteis lineari-lanceolatis pedicello longioribus extra dense roseo-lanuginosis intus apice lanuginosis basin versus glabris, calyce campanulato ad medium in lobos rotundatos diviso extra dense roseo-lanuginoso, petalis usque ad tertiam superiorem partem cohaerentibus obtusis glabris, antheris sessilibus lanceolatis, ovario 2-mero elongato dense roseo-lanuginoso, in stigma cylindricum glabrum attenuato; fructibus brunneo-flavis 3-nis fasciculatis, pedicello 0.5 cm. longo satis rigido appresse rufo-piloso, obovoideis (circa 2.5 cm. x 1.8 cm.) 2-meris 6-angulis, angulis ad commissurae utrumque latus 2-nis, rugose suberosis appresse rufo-pilosis.

Aneityum: Anelgauhat Bay, alt. 30 m., rain-forest, common, no. **723,** Feb. 11, 1929 (small tree up to 15 m. high; leaves dark green above, silvery underneath; fruit brownish yellow when ripe, 2.5 cm. long); west coast, lower ranges, alt. up to 500 m., common, no. **962** (coll. *J. P. Wilson*), Sept. 1929 (low tree up to 40 cm. in diam.; leaves medium; flowers small, pink; fruit pear-shaped, 2.5 cm. x 2 cm.).—Vernacular name "Nalas."

Pittosporum Campbellii F. v. Mueller, Contr. Phyt. New Hebrides, 5 (1874).

Aneityum: Anelgauhat Bay, sea level, rain-forest, common, no. **696,** Feb. 4, 1929 (a small tree 15 m. high; leaves dark green with prominent yellow-pink midrib; fruit orange when ripe, of strong nauseating smell). Tanna: Lenakel, alt. 100 m., rain-forest, not common, no. **32,** Feb. 21, 1928 (tree up to 10 m. high; flowers cream-colored; fruit brown, seeds red; has a repulsive odor when bark is broken).—Collected before on Tanna.

Pittosporum rhytidocarpum A. Gray, Bot. Wilkes U. S. Explor. Exped. I. 228, t. 18 (1854).

Eromanga: Dillon Bay, alt. 300 m., rain-forest, common, no. **378,** June 7, 1928 (small tree up to 10 m. high; fruit yellow inside, seeds black and numerous; seeds used by natives for a purple dye).—Also in the Fiji Islands.—Vernacular name "Nel-a-verti."

GUTTIFERAE

Garcinia Pancheri Pierre, Fl. For. Cochinch. II. 25, t. 89, fig. D (1887).

Banks Group: Vanua Lava, alt. 100 m., rain-forest, common, no. **414,** July 5, 1928 (tree up to 15 m. high; leaves very dark green; natives say one variety has red fruit and one has white); sea level, rain-forest, common, no. **415,** July 5, 1928 (small tree up to 7 m. high; fruit red, when ripe). Eromanga: Dillon Bay, alt. 400 m., rain-forest, common, no. **342,** June 1, 1928 (large tree up to 15 m. high; ripe fruit eaten by natives); alt. 300 m., rain-forest, common, no. **389,** June 8, 1928 (large tree up to 15 m. high; fruit red when ripe, eaten by the natives). Aneityum: Anelgauhat Bay, sea level, rain-forest, common, no. **831,** Feb. 28, 1929 (tree found growing in moist places as in depressions or on banks of creeks; fruit immature).—Also in New Caledonia.—Vernacular name "Ney-yah-heven" (under no. 389).

Garcinia vitiensis Seeman, Fl. Vit. 10 (1865).
Aneityum: Anelgauhat Bay, alt. 300 m., rain-forest, common, no. **840,** March 2, 1929 (large tree up to 12 m. high; fruit immature on specimens; wood durable).—Also in the Fiji Islands.

Calophyllum Inophyllum Linnaeus, Sp. Pl. 513 (1753).
Aneityum: Anelgauhat Bay, sea level, seashore, common, no. **783,** Feb. 19, 1929 (large tree up to 18 m. high; fruit yellow when ripe, only half grown on specimens; wood used for canoe-making). Tanna: Port Resolution, sea level, rain-forest, no. **69,** Feb. 27, 1929 (tree about 15 m. high, about 40 cm. in diam.; flower white with yellow stamens). Banks Group: Vanua Lava, sea level, seashore, common, no. 431, July 10, 1928 (large tree up to 8 m. high; flower white, sweetly scented; stamens yellow).—Also Efate; throughout the Pacific Islands except the New Zealand region, the Tonga, Wallis, Tubuai, Paumota and Gambier Islands; Australia (Queensland, N. Australia), Malaysia.

Calophyllum Inophyllum L.?
Aneityum: Anelgauhat Bay, alt. up to 300 m., rain-forest, common, no. **953** (coll. J. P. Wilson), Sept. 1929 (up to 18 m. high and 1 m. in diam.; leaves green, midrib yellow; flowers small, white; fruit round, brown, 2.5 cm. in diam., not edible; commercial timber much like mahogany but softer).—Vernacular name "Inpece" (Tamanu).

Calophyllum neo-ebudicum Guillaumin, sp. nov.
Arbor magna, usque ad 30 m. alta, trunco 1 m. diam., cortice nitido, ligno levi, gemmis exceptis glaberrima, ramis teretibus cortice brunneo vestitis, foliis elliptico-lanceolatis (6–7 cm. x 2.5–3 cm.) obtuse acuminatis basi acutis chartaceis utrinque nitidis atro-viridibus in sicco marginibus costaque brunneis, petiolo gracili circa 1.5 cm. longo, costa subtus prominente supra basin versus caniculata, nervis creberrimis prominulis. Racemi apicem versus axillares, numerosi, 5–7.5 cm. longi, 9–11-flori, rachi 2–3 cm. longo, pedicellis 1.5–2 cm. longis, floribus 1 cm. latis, sepalis 4 concavis 5 mm. longis margine ciliolatis, petalis 4 ovatis apice rotundatis

aequilongis albis, staminibus numerosis, antheris flavis, ovario ovato apice dilatato, stigmate peltato 2-lobo. Fructus globosus usque ad 2 cm. diam., pruinosus, apice stylo cuspidatus.

Aneityum: Anelgauhat Bay, alt. 25 m., rain-forest, common, no. **705,** Feb. 4, 1929 (large tree up to 20 m. high; leaves dark green; petals white; numerous yellow anthers; used for canoe-making). Eromanga: Dillon Bay, alt. 300 m., rain-forest, common, no. **288,** May 23, 1928 (one of the largest rain-forest trees in Eromanga, up to 25 m. high and 1 m. in diam.; used for canoes and fish spears because of its lightness); alt. 300 m., rain-forest, common, no **399,** June 8, 1928 (very large tree up to 30 m. high, bark light colored, wood used for spears on account of its lightness and strength).—Vernacular name "Pork-cull" or "Porkgud."

Its aspect recalls *C. pulcherrimum* Wall. distributed from Cambodia to Banca, but it differs in the longer petioles, the different color of the leaves when dry, in the longer inflorescence and particularly in the presence of petals.

MALVACEAE

Hibiscus tiliaceus Linnaeus, Sp. Pl. 694 (1753).
Hibiscus abutiloides Willdenow, Enum. Hort. Berol. 736 (1809).

Tanna: Lenakel, sea level, black sandy soil on beach, common, no. **2,** Feb. 20, 1928 (a beautiful spreading tree about 12 m. high, usually with two stems; leaves dark green; flowers creamy yellow, open in middle of day for only a short time). Banks Group: Vanua Lava, sea level, rain-forest along seashore, common, no. **443,** July 9, 1928 (a tree up to 12 m. high, common throughout the New Hebrides, used by settlers to form fences by the planting of straight branches which take root readily).—Also Efate and throughout the Pacific Islands except the New Zealand region, Wallis, Tubuai, Paumota, Union, Phenix and Gilbert Islands; in Queensland, N. Australia, New Guinea and Malaysia.—Vernacular name "Cottonwood."

Hibiscus tiliaceus L. f. **variegata** Guillaumin, form. nov.

Arbor 8 m. alta, foliis variegatis obovatis integris, basi non cordatis, 9-pli-nervis.

Tanna: Lenakel, alt. 150 m., native gardens, rain-forest, common, no. **85,** March 3, 1928 (an ornamental tree about 8 m. high; leaves variegated; flowers yellow).

Hibiscus diversifolius Jacquin, Coll. II. 307 (1788); Ic. Pl. Rar. III. t. 551 (1786–1793).

Aneityum: Anelgauhat Bay, sea level, swamp, common, no. **816,** Feb. 26, 1929 (up to 2 m. high, growing in swamps; petals cream-colored, dark velvety red inside at base; flowers open only in middle of day for a few hours).—Also New Caledonia, Loyalty and Fiji Islands, Norfolk Island, Queensland, New South Wales.

Thespesia populnea (L.) Solander apud Correa in Ann. Mus. Hist. Nat. Paris, IX. 290 (1807).

Aneityum: Anelgauhat Bay, sea level, seashore, common, no. **798,** Feb. 21, 1929 (tall rambling tree up to 12 m. high; petals cream-colored with pink inside at the base; fruit 3 cm. long, 2.5 cm. in diam.). Eromanga: Dillon Bay, sea level, rain-forest, common, no. **373,** June 7, 1928 (tree up to 15 m. high, growing close to the sea; flowers creamy-yellow); along seashore, sea level, rain-forest, common, no. **407,** June 8, 1928 (small tree up to 10 m. high; flowers cream-colored). Banks Group: Vanua Lava, seashore, sea level, rail-forest, common, no. **484,** July 16, 1928 (common tree along all the shores of the New Hebrides; flowers yellow).—Also Efate and throughout the Pacific Islands except the Tonga, Wallis, Tubuai, Paumota, Union, Phenix and Gilbert Islands; in Queensland, North Australia, New Guinea, Malaysia.—Vernacular names "Novo-mil" (under no. 407) and "No-vor-mil" (under no. 373); "Bois de rose d'Océanie" of the French colonists.

STERCULIACEAE

Sterculia banksiana Guillaumin, sp. nov.

Arbor 20 m. alta, ramis primum stellato-pilosis deinde glabris, foliis integris ovatis (usque ad 20 cm. x 11 cm.) apice obtusis basi cordatis supra glabris infra sparse stellato-pilosis, nervis 8–9-jugis tenuibus, petiolo gracili usque ad 5 cm. longo sparse stellato-piloso; inflorescentiae apicem versus axillares, paniculatae, usque ad 5 cm. longae, stellato-pilosae, graciles, floribus albis, pedicello capillari usque ad 8 mm. longo stellato-piloso, calyce ovato usque ad medium 4-laciniato, laciniis tenuibus lineari-lanceolatis 3 mm. longis acutis recurvis 3-nerviis, intus extraque dense hispido-pilosis; flores masculi androphoro brevissimo, staminibus circa 20 sessilibus, flores bisexuales carpellis 4–5 ovarium ovoideum 4–5-costatum dense hispido-pilosum in stylum glabrum attenuatum formantibus, stigmatibus 4–5 pendulis crassis roseis. Fructus brunnei, circa 8 mm. lati, 6 mm. longi.

Banks Group: Vanua Lava, sea level, rain-forest, common, no. **494,** July 18, 1928 (large tree up to 20 m. high; flowers white; fruit brown).

It seems to approach particularly *S. Forsteri* Seem. (*S. Balanghas* Forst., non L.)

Sterculia tannaensis Guillaumin, sp. nov.

Arbor 20 m. alta, ramis primum stellato-pilosis, foliis verticillatim 7–10-nis palmatim 9-foliolatis, foliolis ovato-lanceolatis (usque ad 30 cm. x 9 cm.), apice basique acutis, primum supra sparse infra densius stellato-pilosis deinde supra glabris infra sparse stellato-pilosis rigids 12 15-jugis, petiolo robusto ultra 5 cm. longo apicem versus hispido-piloso; inflorescentiae apicem versus axillares, anguste paniculatae, usque ad 20 cm. longae, stellato-pilosae, sat robustae, floribus intus roseis sessilibus, calyce campanulato extra dense stellato-piloso intus longe denseque hirsuto, pilis incurvis dentibus 5 crassis lanceolatis; flores bisexuales androphoro tubo calycino 2-plo breviore glabro, staminibus circa 20 sessilibus, carpellis 2–3, ovarium 2–3-lobum dense hispido-pilosum in stylum hispido-pilosum in ovario decumbens contractum formantibus, stigmate 2–3-lobo. Fructus rufi, 3.5 cm. lati, folliculis 2–3 1.5 cm. longis.

T a n n a: Lenakel, sea level, rich rain-forest soil, common, no. **14,** Feb. 21, 1928 (tall tree about 20 m. high; leaves arranged in whorls of seven to ten; flowers pink when open).

Heritiera littoralis Dryander in Aiton, Hort. Kew. III. 546 (1789).

A n e i t y u m : Anelgauhat Bay, sea level, rain-forest, common, no. **776**, Feb. 19, 1929 (large tree 12 m. high, with spreading habit; leaves dark green, light yellow midrib, silvery underneath; buds silvery, petals pink inside; fruit 8 cm. long, 5 cm. diam.)—Also New Caledonia, Australia (Queensland), Fiji, Tonga, Caroline and Mariana Islands, New Guinea, Malaysia.

Melochia odorata Linnaeus f., Suppl. 302 (1781).

A n e i t y u m : Anelgauhat Bay, sea level, rain-forest, common, no. **713**, Feb. 9, 1929 (small tree, 10 m. high; outer petals light pink, inner corolla dark pink)—Already found on Tanna and Efate; also New Caledonia, Loyalty, Fiji, Tonga, Samoa and Mariana Islands and Malaysia.

Commersonia echinata Forster, Char. Gen. p. 43, t. 22 (1776).

A n e i t y u m : sea shore and adjoining hills, alt. 7–70 m., no. **958** (coll. *J. P. Wilson*), Sept. 1929 (small tree, 8.15 cm. diam.; leaves silvery on back; flowers small, white; fruit covered with soft spines); Anelgauhat Bay, sea level, rain-forest, common, no. **715**, Feb. 9, 1929. E f a t e : Undine Bay, alt. 200 m., rain-forest, common, no. **238**, April 28, 1929 (tree up to 15 m. high; flowers white).—Also New Caledonia, Australia (Queensland, New South Wales), Fiji, Samoa, Society, Marquesas, Caroline and Bismarck Islands, New Guinea, Malaysia.—Vernacular name: "Nitchma" (under no. 958).

TILIACEAE

Grewia Malococca Linnaeus f., Suppl. 409 (1781).

Aneityum: Anelgauhat Bay, sea level, sea shore, common, no. **920,** March 17, 1929 (small tree, 12 m. high; flowers white). Tanna: Lenakel, alt. 100 m., rain-forest soil, common, no. **70,** March 1, 1928 (small tree, 7 m. high). Efate: Fila Island, Vila, alt. sea level, rain-forest, common, no. **178,** April 12, 1928 (small tree growing on sea coast; petals white).—Also New Caledonia, Loyalty, Fiji, Tonga, Samoa and Society Islands.

Grewia inmac Guillaumin, sp. nov.

Arbor alta, trunco ultra 60 cm. diam., ramis levibus in sicco castaneis glabris, foliis ovatis (usque ad 17 cm. x 8 cm.) basi rotundatis apice subito acute acuminatis supra nitidis margine apicem versus denticulatis in utraque pagina pilis lepidotis leviter scabris, nervis 6–7-jugis prominentibus, venis in nervis perpendicularibus prominulis, petiolo 1.5–2 cm. longo cito glaberrimo, stipulis lanceolatis 8 mm. longis glabris cito caducis. Inflorescentiae apicem versus axillares paniculatim cymosae, foliis breviores glaberrimae, floribus albis 1–3-nis, pedicello ad 7 mm. longo lepidoto, sepalis 5 ellipticis circa 1 cm. longis acutis extra dense lepidotis intus sparsius stellato-pilosis, petalis 5 spathulatis sepalis aequilongis apice obtuse rotundatis extra lepidotis intus basi pilis hirsutis nectarium cingentibus exceptis glabris, staminibus numerosis, filamentis glabris, antheris arcuatis peltate insertis et rima transversali dehiscentibus, ovario dense lepidoto 1-loculari, placentis 2 tantum oppositis septato, ovulis valde numerosis, stylo brevissimo, stigmatibus 4 reflexis marginibus crassis. Fructus 1 cm. diam.

Aneityum: Anelgauhat Bay, alt. up to 275 m., rain-forest, common, no. **967** (coll. *J. P. Wilson*), Sept. 1929 (tall tree up to 0.60 m. in diam.; leaves large; flowers medium, white; fruit 2 cm. long, 0.5 cm. in diam.).—Vernacular name "Inmac."

This species is remarkable on account of its ovary which is not two-loculed, but has two opposite placentas with numerous ovules.

Triumfetta sp. nov.?

Tanna: Lenakel, 200 m., rain-forest, common, no. **180,** March 7, 1928 (weed growing in native gardens).

ELAEOCARPACEAE

Elaeocarpus hortensis Guillaumin, sp. nov.

Arbor parva, 15 m. alta, trunco 60 cm. diam., ramis apice dense foliatis glabris, foliis atro-viridibus obovatis (usque ad 13 cm. x 5 cm.) apice rotundatis basi cuneatis glabris integris, nervis 6–8-jugis, immersis, petiolo circa 3 cm. longo. Inflorescentiae racemosae ad axillas foliorum delapsorum 1–2-nae, 3–5 cm. longae, pedicellis gracilibus 1.5 cm. longis glabris, sepalis anguste lanceolatis 14 mm. longis extra glabris intus brevissime albo-velutinis, petalis ellipticis (13 mm. x 6 mm.) apice irregulariter 4-fidis extra glabris margine ad basin pilosis, intus in costa supra basin dilatata elevataque pilosis, staminibus petalis 2-plo brevioribus minutissime puberulis, antheris linearibus apice apiculatis, filamentis sub-aequilongis, disco 4-squamo carnoso minute puberulo, ovario globoso 2-loculari glabro, loculis 6-ovulatis, stylo subulato glabro. Fructus ovoideus (3 cm. x 1.8 cm.), 1-locularis.

Tanna: Lenakel, alt. 200 m., rain-forest, not common, in native gardens, no. **127,** March 7, 1928 (a tree about 15 m. high and about 60 cm. diam.; leaves dark green).

It rather resembles *E. ovigerus* Brongn. & Gris of New Caledonia, but the leaves do not show the special reticulation and there are only 6, not 9–10 ovules in each locule. As the species has only three series of ovules in each locule and not 4, it must be placed in the section Fissipetalum.

Elaeocarpus Kajewskii Guillaumin, sp. nov.

Arbor parva, 5 m. alta, ramulis dense foliatis primum hispido-rufo-pilosis mox glabris, foliis ovatis (usque ad 8.5 cm. x 3–5 cm.) oppositis vel sub-oppositis apice acutis apiculatisque basi rotundatis vel leviter cordatis supra glaberrimis, infra primum in costa nervisque sparse hispidis deinde glabrescentibus rigidis margine irregulariter undulatis subserratisve, nervis 9–10-jugis, petiolo usque ad 4 mm. longo sparse hispido; flores erecti, sublutei, apice ramulorum corymbosi, hispido-tomentosi, circa 1 cm. longi, pedicellis gracilibus, sepalis 4–5 lanceolatis, 12 mm. longis acutis in utraque pagina sparse, marginibus dense brevissime pilosis, petalis 4–5 truncato-cuneatis 14 mm. longis apice obtuse 8–11-lobis extra puberulis intus ad basin rufo-lanuginosis, marginibus ad tertiam superiorem partem dense lanuginosis, staminibus 20–25, petalis 2-plo brevioribus, antheris linearibus breviter apice longe hispido-pilosis, filamentis brevioribus, disco 8–10-squamo carnoso breviter rufo-piloso, ovario ovoideo 4–5-loculari dense rufoque hispido-piloso, loculis 6-ovulatis, stylo subulato dimidio inferiore rufo-hispido-piloso. Fructus maturitate ruber.

Aneityum: Anelgauhat Bay, sea level, common, growing usually on banks of water courses, no. **710,** Feb. 9, 1928 (small tree up to 15 m. high; flowers cream-colored; fruit red when ripe).

It belongs probably to the section Papuanthus.

Elaeocarpus spec. affinis *E. persicaefolius* Brongn. & Gris.

Aneityum: Anelgauhat Bay, alt. 300 m., rain-forest, common, no. **917,** March 17, 1929 (small tree up to 9 m. high; fruit 2 cm. long, 2.5 cm. in diam.; wood used for comb-making). Tanna: Lenakel, alt. 200 m., rain-forest, common, no. **93,** March 5, 1928 (tree about 20 m. high, with straight trunk). Eromanga: Dillon Bay, alt. 400 m., rain-forest, common, no. **328,** May 29, 1928 (large tree up to 25 m. high; fruit blue, globular, flattened at each end, 1.5 cm. in diam.).—Vernacular name "Nay-yos."

MALPIGHIACEAE

Ryssopteris timorensis Blume ex Jussieu in Delessert, Icon. Sel. III. 21, t. 35 (1837).

Aneityum: Anelgauhat Bay, sea level, rain-forest, common, no. **803,** Feb. 21, 1929 (vine growing on rain-forest trees; flowers bright yellow). Efate: Undine Bay, sea level, rain-forest, common, no. **206,** April 25, 1928 (vine spreading over small trees; flowers yellow). Banks Group: Vanua Lava, sea level, rain-forest, seashore, common, no. **432,** July 10, 1928 (vine growing up to the tops of trees and small bushes; flowers yellow to orange; common throughout the Group).—Already found before on Efate; also in the Bismarck Islands, New Guinea, Malaysia.

Niedenzu considers the plants of New Caledonia as belonging to two distinct species: *R. austro-caledonica* Ndzu. and *R. discolor* Gandoger but to me it seems that they are only forms of the same species, for the plants of New Guinea have the leaves glabrous and the stamens pubescent, those of the New Hebrides have both the leaves and the stamens glabrous, and those of New Caledonia have the leaves pubescent and the stamens glabrous.

RUTACEAE

Evodia hortensis Forst. var. **typica** Lauterbach in Bot. Jahrb. LV. 231 (1918).

Aneityum: Anelgauhat Bay, sea level, rain-forest, common, no. **800,** Feb. 21, 1929 (small tree up to 6 m. high; leaves highly scented; flowers white; twigs used by natives to wear in armlets on account of their sweet scent). Tanna: Lenakel, alt. 150 m., rich rain-forest soil, common, no. **51,** Feb. 24, 1928 (small tree about 7 m. high; flowers white). Banks Group: Vanua Lava, sea level, rain-forest, common, no. **424,** July 6, 1928 (small tree about 6 m. high; leaves highly scented with a pleasing odor and crushed by natives to anoint their bodies for dancing; flowers white).

Evodia hortensis var. **sinuata** Lauterbach in Bot. Jahrb. LV. 232 (1918).

Aneityum: Anelgauhat Bay, sea level, rain-forest, common, no. **794,** Feb. 20, 1929 (small tree up to 6 m. high; flower white, sweetly scented; leaves fragrantly scented and rubbed by the natives on their bodies).

The type was already known from Tanna, Efate, Espiritu Santo, also from New Guinea, Bismarck, Samoa, Solomon, Wallis, Tongo and Fiji Islands.

Evodia Kajewskii Guillaumin, spec. nov.

Arbor mediocris, in silvis 10–15 alta, in terra rubra 5 m. tantum alta, ramis atro-rubris ad petiolos dilatatis, foliis atro-viridibus 3-foliatis, foliolis lanceolatis vel ovato-lanceolatis (usque ad 26 cm. x 6 cm.) asymmetricis, lateralibus vulgo falcatis, basi cuneatis apice longe caudato-acuminatis rigide membranaceis, nervis 10–17-jugis tenuibus, venis reticulatis, petiolulis 2–3 mm. longis, petiolis 2.5–5 cm. longis. Inflorescentiae axillares, paniculatae, petiolis paulo longiores, sordide puberulae, floribus albis, pedicello vix 1 mm. longo sordide puberulo, sepalis 4 extra puberulis obtuse triangularibus, petalis 4 glaberrimis 2 mm. longis ovatis apice inflexis, staminibus 4, filamentis glabris post anthesin antheris 2-plo longioribus, ovario dense piloso, carpellis 4, stylo staminum filamentis aequilongo apicem versus clavato. Fructus maturi lutei, subglabri, dense glandulosi, minimi, 1–2-cocci, seminibus atro-rubris.

E r o m a n g a: Dillon Bay, alt. 300 m., poor red soil, bracken country, common, no. **300,** May 24, 1928 (tree up to 15 m. high, in rain-forest, but in poor red soil only 5 m. high; flowers white; leaves heated and applied to abscesses or sores). A n e i t y u m: Anelgauhat Bay, sea level, rain-forest, common, no. **716,** Feb. 9, 1929 (medium-sized tree up to 15 m. high; leaves dark green; fruit light yellow when ripe).—Vernacular name "Neet-Nung" (under no. 300).

This species is to be placed near *E. cuspidata* K. Schum., but the inflorescence is much shorter.

Evodia Schullei Warb. var. **simplicifolia** Guillaumin, var. nov.

Foliis simplicibus linearibus usque ad 16 cm. x 3.5 cm. margine undulatis, petiolo 1.5–2.5 cm. longo.

T a n n a: Lenakel, alt. 200 m., rain-forest, common, no. **48,** Feb. 24, 1928 (shrub 6 m. high; leaves have a pleasant kind of sarsaparilla scent). E r o m a n g a: Dillon Bay, alt. 300 m., rain-forest, common, no. **387,** June 8, 1928 (small tree up to 10 m. high; leaves have an agreeable odor, slightly citrous, hard to describe).—Vernacular name "U layseye."

The type is found in the Bismarck Islands.

Evodia triphylla De Candolle, Prod. I. 724 (1824).

T a n n a: Lenakel, alt. 150 m., rich rain-forest soil, common, no.

52, Feb. 24, 1928 (specimen from small tree about 7 m. high; flowers white); alt. 250 m., rain-forest, common, no. **115,** March 6, 1928 (specimens from small tree about 7 m. high).

Also in the Solomon Islands, New Guinea?, Malaysia.

Evodia sp. aff. *E. latifolia* DC.

Aneityum: Anelgauhat Bay, alt. 300 m., rain-forest, common, no. **764,** Feb. 14, 1929 (medium-sized tree up to 12 m. high; fruit cream-colored when ripe, 5 mm. long, 3 mm. in diam.).

Bauerella australiana Borzi in R. Boll. Ort. Bot. Palermo, I. 153 (1897).

Aneityum: Anelgauhat Bay, alt. 300 m., rain-forest, common, no. **761,** Feb. 14, 1929 (large tree up to 21 m. high; fruit brown when ripe, 2 cm. long, 1.5 cm. in diam.).—Also New Caledonia and Australia (Queensland, New South Wales).

Halfordia kendack Guillaumin in Lecomte, Not. Syst. II. 98, (1911).

Aneityum: Anelgauhat Bay, sea level, poor sandy red soil, common, no. **698,** Feb. 4, 1929 (in poor soil; this is a shrub or in scrub small tree up to 5 m. high; flowers cream-colored; lower ranges, alt. up 200 m., no. **971** (coll. *J. P. Wilson*) Sept. 1929 (small tree, 23 cm. diam.; flowers small, white; fruit dark brown (1.3 cm. x 1 cm.); used for making combs, wood hard, white).—Vernacular name "Nugasop" (under no. 971).—Also in New Caledonia.

Micromelum pubescens Blume, Bijdr. Fl. Ned. Ind. 138 (1825).

Aneityum: Anelgauhat Bay, alt. 30 m., rain-forest, common, no. **739,** Feb. 13, 1929 (small tree up to 12 m. high; flowers white). Eromanga : Dillon Bay, sea level, rain-forest, common, no. **261,** May 15, 1928 (small tree up to 8 m. high; leaves dark green; flowers white; fruit red when ripe). Banks Group : Vanua Lava, sea level, rain-forest, common, no. **418,** July 6, 1928 (shrub about 3 m. high; fruit red when ripe; common throughout New Hebrides).—Already recorded from Efate; also Queensland, North Australia, Fiji, Tonga, Samoa and Bismarck Islands, New Guinea, Malaysia, etc.—Vernacular name "Nawghantivau" (under no. 261).

Murraya crenulata Oliver, in Jour. Linn. Soc. V. Suppl. II. 29 (1861).

Aneityum: Anelgauhat Bay, sea level, rain-forest, common, no. **789,** Feb. 20, 1929 (large tree up to 18 m. high; flowers have a scent like Eucalyptus; fruit cream when ripe, dotted with oil glands, 0.5 cm. long, 0.7 cm. in diam.). Eromanga: Dillon Bay, sea level, rain-forest, common, no. **374,** June 8, 1928 (large tree up to

20 m. high). Tanna: Lenakel, alt. 200 m., rich rain-forest soil, common, no. **46,** Feb. 24, 1928 (tree 12 m. high, 20 cm. in diam.; fruit cream-colored when ripe, eaten by the natives).—Already found on Tanna; also Queensland, New Caledonia, Loyalty Islands, Malaysia.—Vernacular name "Nepe-yessey" (under no. 374).

Murraya exotica Linnaeus apud Murray, Syst. Veg. ed. 13, 331 (1774).—De Candolle, Prodr. I. 537 (1824).

Murraea exotica Linnaeus, Mant. 563 (1771).

Tanna: Lenakel, sea level, heavy rain-forest soil, common, no. **4,** Feb. 20, 1928 (shrub about 2 m. high; leaves dark green; flower creamy white).

In the whole Archipelago; also in New Caledonia, Queensland, North Australia, New Guinea, Malaysia.

BURSERACEAE

Canarium nungi Guillaumin, sp. nov.—Fig. 2A.

Arbor 20 m. alta, trunco recto, 60 cm. diam., foliis usque ad 50 cm. longis?, foliolis 9–13 ovatis (6–19 cm. x 3.5–9 cm.) apice acuminatis basi rotundato-truncatis coriaceis, nervis 8–12-jugis, petiolulis 1.5–2.5 cm. longis, petiolo 5–6 cm. longo?, stipulis persistentibus maximis usque ad 3 cm. x 2 cm., margine profunde erosis leviter falcatis in utraque pagina minute pilosis. Fructus 20–30, ovati (5 cm. x 3.5 cm.), pedunculo dense sordide rufo-piloso, pedicello 3–4 cm. longo valde robusto ut pedunculus piloso, calyce fructifero late (2 cm.) cupulato intus extraque dense velutina, pericarpio primum purpureo deinde nigro, putamine rotundate 8-costato, loculis fertilibus 2.

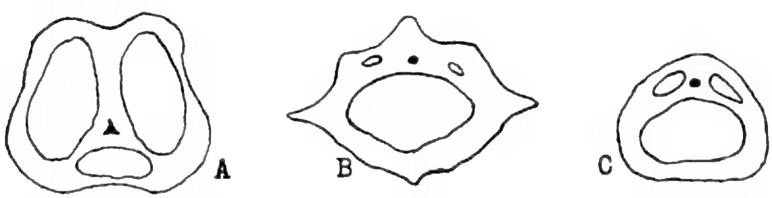

FIG. 2. Cross-sections of fruits of Canarium: A. CANARIUM NUNGI Guillaumin.—B. CANARIUM sp. nov.—C. CANARIUM sp. (R. C. Colomb). Nat. size.

Tanna: Lenakel, alt. 100 m., rain-forest, common, no. **122,** March 7, 1928 (tree about 20 m. high, straight barrel, about 60 cm. in diam.; fruit purple. outside skin black when ripe, in clusters of 20 and 30, 5 cm. long, 3.5 cm. in diam., kernel eaten by natives). Eromanga: Dillon Bay, sea level, rain-forest, common, no. **243,** May 14, 1928 (tree with straight trunk up to 20 m. high, fruit black when ripe; nuts eaten by natives who relish them).—Vernacular name "Nungi."

Canarium sp. nov.—Fig. 2B.

Arbor 20 m. alta, foliis 20 cm. longis?, foliolis 7 ?, asymmetricis leviter falcatis (8.5–12 cm. x 4–6 cm.) apice acutis basi obtusis rotundatisve leviter coriaceis, nervis circa 10-jugis, petiolulis 1–1.5 cm. longis, petiolo 4 cm. longo, stipulis deciduis ignotis. Fructus delumbato-obovatus (5 cm. x 3.5 cm. x 2 cm.), pericarpio viridi, putamine crasso acute 5-costato, loculo 1 fertili.

Banks Group: Vanua Lava, sea level, rain-forest, common, no. **408**, July 5, 1928 (large tree 20 m. high; fruit with green husk, large, edible kernel with carroty flavor, highly prized by both natives and Europeans and used in cooking in a number of ways).

The presence of the genus in the New Hebrides was known from a species represented in the collections of the "Laboratoire de Culture" of the Museum in Paris (R. P. Colomb) by a nut (Fig. 2c) rather similar to that of *C. commune* L., and from a note by Heim[1] on the "Nanai." The figures of the latter seem to agree well with the nut of this *C.* sp. nov.

MELIACEAE

Dysoxylum aneityense Guillaumin, sp. nov.

Arbor magna, 20 m. alta vel parva, ramis validis foliorum delapsorum cicatricibus valde notatis, primum brevissime rufo-puberulis deinde glabris, foliis 50 cm. longis, foliolis usque ad 10-jugis valde asymmetrice ovatis (10–14 cm. x 4–5,5 cm.) apice attenuatis basi truncatis et brevissime cuneatis circa 1.5 cm. graciliter petiolulatis, petiolo usque ad 17 cm. longo brevissime rufo-puberulo. Paniculae sat robustae, petiolo aequilongae, circa 2.5 cm. latae, breviter rufo-puberulae, floribus sub-luteis odoratis magnis (7 mm. longis), pedicello brevi (2 mm.) apice bracteolis 2 carinatis ovato-lanceolatis extra puberulis munito, sepalis 5 liberis circularibus margine erose fimbriatis 2.5–3 mm. longis extra dense rufo-puberulis, petalis ovatis (8 mm. x 4 mm. x 4 mm.) apice obtusis extra dense rufo-puberulis, tubo calycino glabro ⅔ petalorum aequante sub-integro omnino libero, disco glabro apice lobulis spherice incrassatis munito, ovario dense puberulo, stylo tubi calycini apicem attingente, stigma discoide valde incrassatum. Fructus ovati (3–3.5 cm. x 2 cm.), nigri.

Aneityum: Anelgauhat Bay, alt. 200 m., rain-forest, common, no. **754**, Feb. 13, 1929 (large tree up to 18 m. high; flower cream-colored, sweetly scented; used by natives for making canoe paddles);

[1] Notes et Études sur les productions et les cultures coloniales, p. 14–20.

sea level, beach land, common, no. **949** (coll. *J. P. Wilson*), Sept. 1929 (low tree up to 45 cm. in diam.; leaves large, glossy; flowers yellow; fruit 3 cm. long, 2.5. cm in diam.).—Vernacular name "Nimkove."

A species which seems to belong to the same group as *D. amooroides* Miq. from New Guinea and the Malayan Islands and as *D. rufum* Benth. from Australia.

Dysoxylum bijugum Seemann, Fl. Vit. 37 (1865). Without label. Also New Caledonia, New South Wales and Fiji Islands.

Dysoxylum Kunthianum Miquel in Ann. Mus. Bot. Lugd.-Bat. IV. 13 (1868).

Banks Group: Vanua Lava, sea level, rain-forest, common, no. **492,** July 18, 1928 (large tree up to 20 m. high; flowers white).—Also Bismarck Islands, New Guinea.

Aglaia elaeagnoides Bentham, Fl. Austral. I. 383 (1863).

Eromanga: Dillon Bay, sea level, rain-forest, common, no. **357,** June 3, 1928 (leaves light colored underneath; wood used for spear making). Aneityum : Aname, alt. 150 m. seashore, common, no. **987** (coll. *J. P. Wilson*), Sept. 1929 (small tree to 22.5 cm. in diam.; leaves medium; flowers very small, yellow, in clusters; fruit brown).—Also New Caledonia, Queensland, North Australia, New Guinea, Malaysia.—Vernacular name "Nitheow" (under no. 987) and "Ney-vey-varl" (under no. 357).

Aglaia sp. aff. *A. Diepenhorstii* Miq.

Banks Group: Vanua Lava, alt. 500 m., rain-forest, no. **482,** July 16, 1928 (tree up to 10 m. high; fruit brown when ripe).

Carapa obovata Blume, Bijdr. Fl. Ned. Ind. I. 179 (1825).

Efate: Undine Bay, sea level, over salt water creek only, common, no. **200,** April 24, 1928 (flowers white; fruit globular, about 7 cm. in diam.).—Also Queensland, North Australia, New Caledonia, Fiji, Tonga, Solomon and Bismarck Islands, Malaysia.

CELASTRACEAE

Elaeodendron artense Montrousier in Mém. Acad. Lyon, X. 194 (1860).

Aneityum: Anelgauhat Bay, alt. 60 m., rain-forest, common, no. **755,** Feb. 12, 1929 (small tree up to 9 m. high; petals cream-colored, stigma light green).—Also Art Island.[1]

RHAMNACEAE

Berchemia Fournieri Pancher & Sebert in Sebert, Not. Bois Nouv. Caléd. 236 (1874) ?

[1] A small island off the north coast of New Caledonia.

A n e i t y u m: Anelgauhat Bay, alt. 30 m., rain-forest, common, no. **738,** Feb. 12, 1929 (vine growing up to the tops of rain-forest trees; leaves dark glossy green; fruit purple when ripe, 0.7 cm. long, 0.4 cm. in diam.; wood used by natives for bows).—Also New Caledonia, Loyalty Islands.

Colubrina asiatica Brongniart in Ann. Sci. Nat. sér. 1, x. 369 (1827).

E r o m a n g a: Dillon Bay, sea level, rain-forest, common, no. **256,** May 15, 1928 (vine growing up to the tops of trees; fruit black when ripe). B a n k s G r o u p: Vanua Lava, sea level, rain-forest, common, no. **441,** July 9, 1928 (vine growing over small trees and bushes; flower yellowish green).—Already found on Aneityum, Eromanga and Efate; also New Caledonia, Fiji, Tonga, Samoa, Cook, Society, Marquesas, Mariana, Caroline, Solomon, Bismarck and Admiralty Islands, New Guinea, Malaysia.—Vernacular name "Nurse-ce-paporo" (under no. 256).

Alphitonia zizyphoides (Spreng.) A. Gray, Bot. Wilkes U. S. Explor. Exped. I. 278 (1854).

A n e i t y u m: Anelgauhat Bay, alt. 90 m., rain forest, common, no. **769,** Feb. 14, 1929 (large tree up to 15 m. high; leaves dark green above, silvery beneath; flowers white). E f a t e: Undine Bay, alt. 200 m., rain-forest, common, no. **217,** April 27, 1928 (spreading tree up to 15 m. high; common throughout the Islands). B a n k s G r o u p: Vanua Lava, sea level, rain-forest, common, no. **446,** July 9, 1928 (medium sized tree up to 15 m. high; common throughout the group).—Also Fiji, Samoa, Society and Cook Islands.

Gouania efatensis Guillaumin, sp. nov.

Scandens, ramosus, ramis ramulisque primum rufo-hirsutis deinde subglabrescentibus, foliis ovatis (usque ad 7 cm. x 5 cm.) apiculatis apice excepto integerrimis infra dense lanuginosis supra sparse in nervis densius tomentosis, petiolo hispidulo 1.5 cm. longo, cirrhis ad apicem oppositis; spicae terminales usque ad 10 cm. longae, dense hispidulae, floribus minimis fasciculatis vel solitaribus subsessilibus, calyce patelliformi extra tomentoso 2 mm. longo, lobis triangularibus acutis, petalis obovatis cucullatis lobis calycinis aequilongis apice emarginatis, staminibus in petalis absconditis aequilongisque glabris, antheris quam filamenta 3-plo brevioribus subglobosis utrinque excisis, disco lato glabro tubo calycino adnato et ovarium tegente, stylo brevi apice 2-fido glabro.

E f a t e : Fila Island, Vila, sea level, seashore, common, no. **186,** April 13, 1928 (vine growing over small trees overhanging the water).

This species is related to *G. Le Ratii* Schltr. from New Caledonia and the Loyalty Islands, but differs in its leaves.

AMPELIDACEAE

Cayratia carnosa (Lam.) Gagnepain in Lecomte, Not. Syst. I. 347 (1911).

E r o m a n g a: Dillon Bay, sea level, rain-forest, common, no. **246,** May 15, 1928 (vine growing over tops of bushes; fruit black when ripe).—Already found on Efate; also Queensland, North and South Australia, New Caledonia, Loyalty Islands, Malaysia.—Vernacular name "Noo-u-mindeh."

Cayratia saponacea (Seem.) Domin in Fedde, Rep. Spec. Nov. XI. 264 (1912).

B a n k s I s l a n d s: Vanua Lava, sea level, rain-forest, common, no. **501,** July 18, 1928 (vine growing on the tops of rain-forest trees).—Also Queensland and Fiji Islands.

SAPINDACEAE

Allophylus racemosus (Linn.) Radlkofer in Engler & Prantl, Nat. Pflanzenfam. III. 5, p. 313 (1895).

B a n k s I s l a n d s: Vanua Lava, sea level, seashore, common, no. **437,** July 9, 1928 (vine growing over small bushes).—Also New Guinea, Arou Island, Malaysia.

Allophylus ternatus (Forst.) Radlkofer in Engler & Prantl, Nat. Pflanzenfam. III. 5, p. 313 (1895).

T a n n a: Lenakel, alt. 200 m., rain-forest, common, no. **92,** March 5, 1928 (small tree about 8 m. high).—Also New Caledonia, Queensland, North Australia, Loyalty, Tonga, Wallis, Samoa, Society, Marshall and Bismarck Islands and New Guinea.

Allophylus timorensis (DC.) Blume, Rumphia, III. 130 (1847).

E r o m a n g a: Dillon Bay, alt. 300 m., rain-forest, common, no. **309,** May 26, 1928 (small tree up to 8 m. high; fruit red when ripe, about 8 mm. in diam., leaves baked in native oven by means of hot stones, and when steaming applied to swellings).—Also New Caledonia, Marshall, Solomon and Bismarck Islands, New Guinea, Malaysia.—Vernacular name "Nau-mon-pe-vat."

Aphania ? neo-ebudica Guillaumin, sp. nov.

Arbor magna, 18 m. alta, ramis teretibus primum rubiginosis deinde glabrescentibus; foliis paripinnatis 4-jugis, foliolis oppositis ovato-oblongis (2–12 cm. x 1.5–4.5 cm.) acute saepeque falciforme acuminatis basi rotundatis subsessilibus rigide chartaceis in utraque pagina glabris, nervis 6–12-jugis ad marginem anastomosantibus, ut venae reticulatis subtus tantum prominulis, petiolo communi 1.5–4.5 cm. longo et racheos basi breviter rufo-puberulis. Inflorescentia terminalis, thyrsoidea, ad 25 cm. longa, rubiginoso-puberula, cymulis 2–4-floris, floribus campanulatis, bracteis rubiginoso-puberulis linearibus, pedicellis basi articulatis, sepalis 5 anguste lanceolatis extra rubiginoso-puberulis, pedicellis aequilongis, petalis 4–5 transverse ovatis apiceque subtruncatis, sepalis brevioribus extra glabris intus basi glabra excepta breviter pilosis apicem versus puberulis, disco crasso glabro, staminibus 5–7 sepalis aequilongis, filamentis brevibus subulatis glabris, antheris cordiformibus basifixis papillosis, germine 2-loculari rubiginoso-piloso, stylo brevi apice sulco suturali stigmatoso utrinque notato, ovulis in quoque loculo singulis, fructibus . . .

Eromanga: Dillon Bay, sea level, rain-forest, common, no. **335,** May 29, 1928 (large tree up to 18 m. high; fruit eaten by natives who relish it).—Vernacular name "Tow."

Though this species resembles in its aspect much an *Erioglossum,* it will have to be referred to the genus *Aphania.*

Alectryon sp.

Aneityum: Anelgauhat Bay, sea level, rain-forest, common, no. **923,** March 19, 1929 (large tree up to 15 m. high). Eromanga: Dillon Bay, sea level, rain-forest, common, no. **364,** June 4, 1928 (large tree up to 25 m. high; pods brown).—Vernacular name "Novo metu."

Cupaniopsis neo-ebudensis Guillaumin, sp. nov.

Arbor 20 m. alta, ramis glabris; foliis breviter pinnatis 2–3-jugis breviter (1.5–2 cm.) petiolatis, foliolis oppositis ovato-lanceolatis (5–7 cm. x 2–3 cm.) apice obtusis basi cuneatis chartaceis, nervis lateralibus circa 10 tenuissimis, breviter (circa 5 mm.) petiolulatis; thyrsi terminales, folia superantes, brevissime pilosi, densiflori, alabastris globosis pedicello usque ad 3 mm. longo suffultis, bracteis minimis, sepalis 5 ovatis extra dense brevissime pilosis intus glabris, petalis albis cuneatis apice cuneatis intus medio dense pilosis sepalis vix longioribus, disco pentagono glabro, staminibus 8, filamentis geniculatis in parte discum superante sparse pilosis, petala duplo superantibus, antheris cordatis, germinis rudimento ovoideo apice attenuato dense appresse piloso 2-loculari.

Eromanga: Dillon Bay, alt. 300 m., rain-forest, common, no. **381,** June 8, 1928 (tree up to 20 m. high; flower small, petals white).—Vernacular name "Nar-vu-vat."

This belongs undoubtedly to the sect. *Macroplectrum* which is represented in Australia and New Guinea.

Cupaniopsis sp.

A n e i t y u m: Anelgauhat Bay, alt. 300 m. rain-forest, common, no. **842,** March 2, 1929 (large tree up to 12 m. high; flowers white; bark light colored; wood durable).

Cupaniopsis sp.

E r o m a n g a: Dillon Bay, alt. 300 m., rain-forest, common, no. **386,** June 8, 1928 (large tree up to 20 m. high).—Vernacular name "Nung arl."

Cupaniopsis sp.

E f a t e: Undine Bay, alt. 200 m., rain-forest, common, no. **219,** April 27, 1928 (tree up to 15 m. high).

Dodonaea viscosa Jacquin, Enum. Pl. Carib. 19 (1760).

E r o m a n g a: Dillon Bay, alt. 300 m., poor red soil, bracken country, common, no. **296,** May 24, 1928 (small tree about 6 m. high; leaves light green; flowers greenish yellow). T a n n a: Lenakel, alt. 150 m., rain-forest, common, no. **120,** March 6, 1928 (shrub about 2 m. high).—Also New Caledonia, Loyalty Islands, Australia, Tasmania, Norfolk Island, New Zealand, Fiji, Tonga, Samoa, Cook, Society, Gambier, Gilbert, Marshall, Caroline, Mariana and Bismarck Islands, New Guinea, Malaysia.—Vernacular name "Ney-in-temer" (under no. 296).

Harpullia arborea (Blanco) Radlkofer in Sitz. Kgl. Bayer. Akad. Wiss. XVI. 404 (1886).

T a n n a: Lenakel, alt. 100 m., rain-forest, no. **138,** March 8, 1928 (tree of many stems about 15 m. high).—Also Solomon Island, Malaysia.

ANACARDIACEAE

Dracontomelum vitiense Engler in De Candolle, Monog. Phaner. IV. 253 (1883).

A n e i t y u m: Anelgauhat Bay, sea level, rain-forest, common, no. **905,** March 11, 1929 (large tree up to 12 m. high; fruit yellow when ripe, 3 cm. long, 3.5 cm. in diam.).—Already found on Efate; also Fiji and Samoa Islands.

Rhus retusa Zollinger apud Teysmann & Binnendijk, Cat. Hort. Bogor. 230 (1866).

E f a t e: Undine Bay, alt. 200 m., rain-forest, common, no. **222,** April 27, 1928 (tree about 10 m. high, growing in gullies; flowers cream-colored).—Also Queensland, Malaysia and a special variety in New Guinea and on the Bismarck Islands.

Semecarpus tannaensis Guillaumin, sp. nov.

Arbor parva, ramis sat gracilibus teretibus, novellis sordide rubiginose puberulis, foliis lanceolatis (usque ad 32 cm. x 7 cm.) rectis apice acuminatis basi cuneatis petiolo 2 cm. longo suffultis chartaceis glaberrimis, nervis lateralibus 16–18-jugis obliquis subparellelis prope marginem sursum vergentibus et cum sequente arcte conjunctis, venis prominentibus inter lateralibus non recte perpendicularibus sed undulatis. Paniculae masculae terminales, validae, pyramidales, foliis 2-plo longiores, sordide rubiginoso-puberulae, ramis robustis, bracteis subulatis 1.5 mm. longis, alabastris globosis sessilibus 3 mm. longis, floribus albis, calycis lobis triangularibus 1 mm. longis extra dense rufo-velutinis, petalis 5 lanceolatis 3 mm. longis extra rufo-velutinis intus glabris, staminibus 5 petalis aequilongis, filamentis glabris subulatis, antheris subcordiformibus, ovario globoso dense rufo-setoso, stylo 1, stigmate 2-lobo.

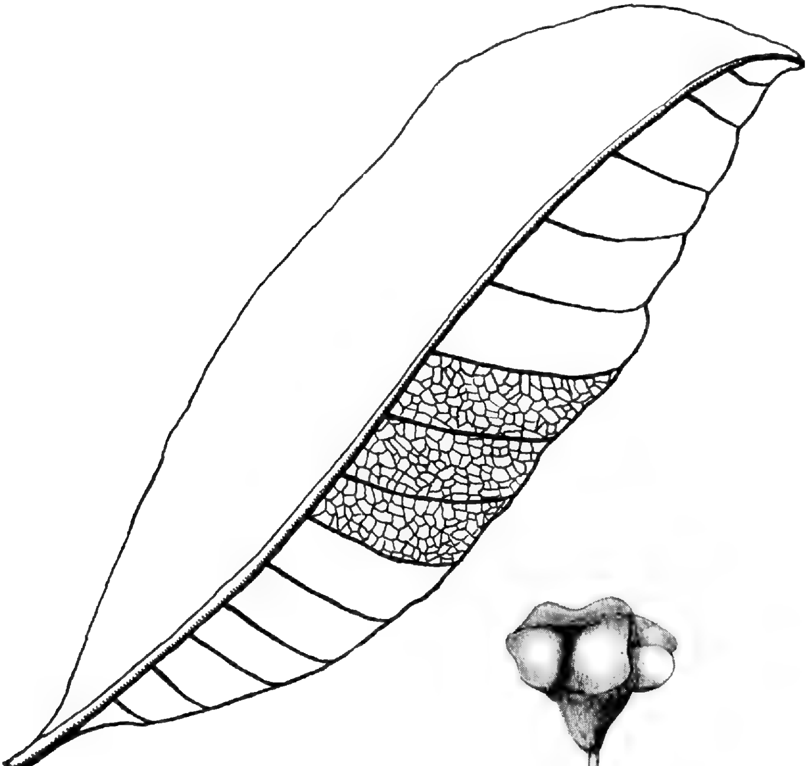

FIG. 3. Leaf and fruit of SEMECARPUS sp. nov? (nat. size).

T a n n a: Lenakel, alt. 100 m., rain-forest, common, no. **141**, March 8, 1928 (specimens gathered from small tree; flowers white; sap is very caustic).

This species is near *S. laxiflora* K. Schum. from New Guinea and the Bismarck Islands, but is distinguished by the much more compact staminate inflorescence with more robust branches and much thicker flowers.

Semecarpus sp. nov.?—Fig. 3.

E f a t e: Undine Bay, alt. 100 m., rain-forest, common, no. **193,** April 24, 1928 (specimens gathered on tree of 15 m.; sap of tree very caustic). A n e i t y u m: Umage, alt. 30 m., seashore, common, no. **997** (coll. *J. P. Wilson*), Sept. 1929 (small tree; leaves large; flower large, brown; fruit dark brown, 3 cm. long, 2.5 cm. in diam.).—Vernacular name "Neuclad."

LEGUMINOSAE

Indigofera Benthamiana Hance in Ann. Sci. Nat. sér. 4, XVIII. 219 (1862).

A n e i t y u m: Anelgauhat Bay, sea level, rain-forest, seashore, common, no. **785,** Feb. 20, 1929 (shrub up to 3 m. high; flowers pink); Anaunoe, alt. 15 m., seashore, common, no. **994** (coll. *J. P. Wilson*), Sept. 1929 (small tree to 15 cm. in diam.; leaves small; flowers small, pink; fruit in pods up to 4 cm. long, 0.4 cm. in diam.). B a n k s G r o u p: Vanua Lava, sea level, rain-forest, common, no. **500,** July 18, 1928 (small tree up to 6 m. high; flowers purple).—Already collected on Efate; also Malaysia.—Vernacular name "Niniow" (under no. 994).

Hanslia adherens Schindler in Fedde, Rep. Nov. Spec. xx. 276 (1924).

T a n n a: Lenakel, sea level, heavy rain-forest soil, common, no. **8,** Feb. 20, 1928 (shrub 2–3 m. high; leaves dark green; flowers white; the pods of the fruit are a great pest, adhering firmly to the clothing). E r o m a n g a : Dillon Bay, sea level, paths and cleared lands in rain-forest, common, no. **251,** May 15, 1928 (weed 1 m. high; flowers puce-colored; fruit sticks to clothing). B a n k s G r o u p : Vanua Lava, sea level, rain-forest, common, no. **491,** July 18, 1928 (shrub about 2 m. high with a troublesome fruit that sticks in the clothes; flowers white).—Already collected on Aneityum, Tanna and Efate, also Solomon and Bismarck Islands, New Guinea, Malaysia.—Vernacular names "Mompoyerrae" (under no. 251) and "Narse" (under no. 491).

Desmodium umbellatum De Candolle, Prodr. II. 325 (1825).

T a n n a: Lenakel, sea level, rain-forest soil, common, no. **77,** March 3, 1928 (shrub about 3 m. high; flowers white). A n e i t y u m: Anelgauhat Bay, alt. 30 m., seaside, common, no. **971**$^{\mathbf{A}}$ (coll.

J. P. Wilson), Sept. 1929 (small tree to 15 cm. in diam.; leaves small, oval; flowers small, white; fruit a bean-like pod). Banks Group: Vanua Lava, sea level, seashore, common, no. **430**, July 9, 1928 (shrub common on the beaches of all the islands; flowers white).—Already collected on Aneityum, Eronan, Tanna, Eromanga and Efate; also New Caledonia, Loyalty Islands, Queensland, Fiji, Tonga, Samoa, Society, Caroline, Mariana, Solomon, Bismarck and Admiralty Islands, New Guinea, Malaysia.—Vernacular name "Nalar" (under no. 971[A]).

Entada scandens Bentham in Hooker, Jour. Bot. IV. 332 (1842).
Aneityum: Anelgauhat Bay; alt. to 240 m., lower ranges, rain-forest, common, no. **966** (coll. *J. P. Wilson*), Sept. 1929 (vine similar to Luchards Bean; leaves medium; flowers yellow; fruit in long box-like pod). Eromanga: Dillon Bay, sea level, rain-forest soil, common, no. **336**, May 29, 1928 (vine growing on the tops of trees; flowers white to cream colored; fruit a large bean up to 1.5 m. long; seed roasted in native oven, kernel is put in baskets in running water for two weeks and then cooked a second time and eaten by the natives; see note on *Castanospermum australe*).—Already collected on Efate and Mallicolo; also New Caledonia, Queensland, Fiji, Tonga, Samoa, Cook, Mariana, Solomon and Bismarck Islands, New Guinea, Malaysia.—Vernacular name "Nardilinger" (under no. 966) and "Ou-vone-naw" (under no. 336).

Abrus precatorius Linnaeus, Syst. Nat. ed. 12, II. 472 (1767).
Eromanga: Dillon Bay, sea level, rain-forest, common, no. **254**, May 15, 1928 (common creeper on rain-forest brush; flowers purple; seeds made into necklaces and used as beads).—Also New Caledonia, Australia (Queensland, North Australia), Fiji, Tonga, Samoa, Cook, Society, Marquesas, Caroline, Mariana and Bismarck Islands, New Guinea, Malaysia.—Vernacular name "Tarmsee."

Strongylodon lucidus (Forst. f.) Seemann, Fl. Vit. 61 (1865).
Efate: Undine Bay, alt. 100 m., rain-forest, common, no. **192**, April 24, 1928 (vine growing over the tops of trees; flowers pink).—Already found on Efate; also Loyalty, Fiji, Society and Bismarck Islands, New Guinea, Hawaii, Malaysia.

Pueraria Thunbergiana (S. & Z.) Bentham in Jour. Linn. Soc. IX. 122 (1867).
Aneityum: Anelgauhat Bay, sea level, rain-forest, common, no. **895**, March 11, 1929 (vine on rain-forest trees mostly in scrub land which has been semi-cleared; flowers pink).—Also Tonga and ? Solomon Islands, Malaysia.

Canavalia obtusifolia De Candolle, Prodr. II. 404 (1825).

Eromanga: Dillon Bay, sea level, along seashore, common, no. **304,** May 24, 1928 (leguminous vine growing close to the shore; flowers purple; fruit pod when ripe 12 cm. long, 3 cm. in diam.; seeds brown; ripe seed boiled and eaten by the natives). Aneityum: Anelgauhat Bay, sea level, seashore, common, no. **780,** Feb. 19, 1929 (leguminous vine growing on the sand beaches above high water mark; flowers light blue). Already collected on Tanna, Efate and Aoba; also New Caledonia, Australia (Queensland, N. S. Wales, S. Australia, W. Australia) Fiji, Tonga, Society, Ellice and Bismarck Islands, New Guinea, Malaysia.—Vernacular name "No-sor-rae" (under no. 304).

Lablab vulgaris Savi, Diss. 19 (1821).

Eromanga: Dillon Bay, alt. 300 m., rain-forest, common, no. **272,** May 17, 1928 (bean growing over top of bushes; flowers white; seeds cooked and eaten by natives).—Already collected on Niua; also New Caledonia, Queensland, Fiji, Tonga, Samoa, Cook, Society, Caroline and Mariana Islands, New Guinea, Malaysia.—Vernacular name "Mertanye."

Dalbergia monosperma Dalzell in Hooker's Jour. Bot. & Kew Misc. II. 36 (1850).

Eromanga: Dillon Bay, sea level, rain-forest, common, no. **354,** June 1, 1928 (vine growing over the tops of rain-forest trees; flowers white).—Also New Caledonia, Fiji Islands, Malaysia.—Vernacular name "Nau-matt-au-matt."

Inocarpus edulis Forster, Char. Gen. 66 (1776).

Aneityum: Anelgauhat Bay, sea level, rain-forest, common, no. **778,** Feb. 19, 1929 (large tree up to 18 m. high; fruit green, 10 cm. long, 7.5 cm. in diam.; eaten largely by natives for food).—Already found on Eromanga and Efate; also Fiji, Tonga, Wallis, Society, Marquesas and Bismarck Islands, New Guinea, Malaysia.

Pongamia pinnata (L.) Merrill, Interpr. Rumph. Herb. Amboin. 271 (1917).

Pongamia glabra Ventenat, Jard. Malmaison, I. 28, t. 28 (1803).
Pongamia mitis (L.) Merrill in Philip. Jour. Sci. Bot. V. 101 (1910).

Eromanga: Dillon Bay, sea level, rain-forest, common, no. **353,** June 1, 1928 (large tree up to 20 m. high).—Already found on Eromanga; also New Caledonia, Queensland, North Australia, Bismarck and Caroline Islands, New Guinea, Malaysia.—Vernacular name "Fong-fate-nemett."

Sophora tomentosa Linnaeus, Sp. Pl. 373 (1753).

Aneityum: Inyig, alt. 30 m., seashore, common, no. **996,** (coll. *J. P. Wilson*), Sept. 1929 (small tree; leaves small; flowers small, yellow; fruit in long pods). Efate: Fila Island, Vila, sea level, sea beach, common, no. **182,** April 13, 1928 (shrub about 4 m. high; flowers bright yellow).—Already found on Efate; also New Caledonia, Queensland, New South Wales, Fiji, Tonga, Wallis, Cook, Society, Marquesas, Marshall, Mariana, Solomon, Bismarck and Admiralty Islands, New Guinea, Malaysia.—Vernacular name "Incispev" (under no. 996).

Sophora sp. nov.

Eromanga: Dillon Bay, alt. 300 m., rain-forest, common, no. **376,** June 7, 1928 (tree up to 10 m. high; seed black when ripe).

Castanospermum australe A. Cunningham & Fraser in Hook. Bot. Misc. I. 241, t. 51 (1830).

Eromanga: Dillon Bay, sea level, rain-forest, common, no. **401,** June 8, 1928 (tree up to 25 m. high).—Already found on Efate; also New Caledonia, Queensland, New South Wales.—Vernacular name "Oveeliungkill."

Caesalpinia nuga (L.) Aiton, Hort. Kew. ed. 2, III. 32 (1811).

Eromanga: Dillon Bay, sea level, rain-forest, common, no. **262,** May 15, 1928 (vine growing over the tops of brush; flowers yellow). Banks Group: Vanua Lava, sea level, rain-forest seashore, common, no. **419,** July 6, 1928 (vine with sharp, hooked thorns; flowers yellow).—Already found on Eromanga;[1] also New Caledonia, Loyalty Islands, Queensland, Santa Cruz, Caroline, Solomon and Bismarck Islands, New Guinea, Malaysia.—Vernacular name "Warliss warliss."

Cassia glauca Lamarck, Encycl. Méth. I. 647 (1783).

Eromanga: Dillon Bay, sea level, rain-forest, common, no. **365,** June 4, 1928 (small tree up to 7 m. high). Tanna: Lenakel, alt. 150 m., rain-forest, common, no. **121,** March 6, 1928 (shrub 2 m. high, growing in native gardens).—Also Australia ?, Fiji Islands, New Guinea, Malaysia.

Adenanthera pavonina Linnaeus, Sp. Pl. 384 (1753).

Eromanga: Dillon Bay, sea level, rain-forest, common, no. **403,** June 8, 1928 (tree up to 15 m. high; fruit with red seeds; wood used to make paddles).—Already found on Efate: also New Caledonia, Loyalty Islands, Queensland, Samoa, Mariana and Solomon Islands, New Guinea, Malaysia.—Vernacular name "Narn dup."

[1] Omitted from "Liste des plantes connues des Nouvelles Hebrides in Bull. Soc. Bot. France LXXIV. 696 (1927).

Mimosa pudica Linnaeus, Sp. Pl. 518 (1753).

Eromanga: Dillon Bay, alt. 200 m., open grass country, common, no. **370,** June 5, 1928 (creeping plant growing close to ground; flowers white; leaves are very sensitive, closing up when touched).—Also New Caledonia, Queensland, Fiji, Tonga, Samoa, Cook, Society and Marquesas Islands, Malaysia.—Vernacular name "Nemas une-map."

Leucaena Forsteri Bentham in Lond. Jour. Bot. v. 94 (1846).

Aneityum: Anelgauhat Bay, alt. 15 m., seashore, common, no. **993** (coll. *J. P. Wilson*), Sept. 1929 (small tree to 38 cm. in diam.; leaves fern-like; flowers small, pink; fruit with bean-shaped pod to 7.5 cm. long); sea level, seashore, common, no. **944,** March 19, 1929 (medium sized tree up to 12 m. high; pods about 6 cm. long, 2 cm. in diam.; it is not certain that this tree is indigenous). Banks Group: Vanua Lava, sea level, rain-forest along seashore, common, no. **438,** July 9, 1928 (small tree up to 7 m. high; flowers white). —Also New Caledonia, Loyalty, Fiji, Tonga, Cook and Society Islands.—Vernacular name "Niruman" (under no. 993).

Leucaena glauca Bentham in Hooker Jour. Bot. IV. 416 (1842).

Eromanga: Dillon Bay, sea level, rain-forest, common, no. **252,** May 15, 1928 (tree up to 10 m. high, but often smaller; a great pest throughout the whole group).—Also New Caledonia, Fiji, Samoa, Cook, Society, Marquesas, Caroline and Mariana Islands, Malaysia.—Vernacular name "Naemas."

Acacia simplicifolia (L. f.) Druce in Rep. Bot. Exch. Cl. Brit. Isles, 1916, p. 602 (1917).—Macbride in Contr. Gray Herb. LIX, 7 (1919).—Schinz & Guillaumin in Sarasin & Roux, Nova Caled. I. 152 (1920).

Aneityum: Anelgauhat Bay, sea level, seashore, common, no. **695,** Feb. 4, 1929 (medium sized tree up to 15 m. high with a crooked trunk; leaves dark green, pods light green when gathered). Eromanga: Dillon Bay, sea level, on beaches close to sea, common, no. **330,** May 29, 1928 (tree up to 12 m. high; common on sea beach). —Already collected on Efate, Tanna and Epi; also New Caledonia, Fiji, Tonga and Samoa Islands.—Vernacular name "Nem-elean-du" (under no. 330).

Acacia spirorbis Labillardiére, Sert. Austr.-Caled. 69, t. 69 (1824).

Eromanga: Dillon Bay, sea level, rain-forest and open country, common, no. **249,** May 15, 1928 (spreading wattle up to 12 m. high; flowers yellow; one of the few durable timbers in the New Hebrides). Eromanga: Dillon Bay, alt. 300 m., rain-forest, common, no. **285**, May 23, 1928 (a wattle different in type to other types gathered on Eromanga as it has a long straight barrel up to 20 m. high; one of the best wattles for timber purpose, natives use it for bows).—Also New Caledonia, Loyalty Islands.—Vernacular names "Morie" (under no. 249) and "Mouanger" (under no. 285).

Acacia sp. affinis *A. spirorbis* Labill.

Aneityum: Anelgauhat Bay, alt. 30 m., rain-forest, common, no. **727**, Feb. 11, 1929 (small tree up to 9 m. high, growing on poor red soil; leaves silvery green; flowers yellow; bark fissured).

Serianthes myriadenia Planchon apud Bentham in Lond. Jour. Bot. III. 225 (1844).

Tanna: Lenakel: on all levels, rich rain-forest soil, common, no. **41**, Feb. 22, 1928 (tree up to 20–25 m. high; about 80 cm. in diam., very handsome; flowers pink).—Also Society ! and Tonga ? Islands, but not in the Fiji Islands !

Serianthes vitiensis A. Gray, Bot. Wilkes U. S. Exped. I. 485 (1854).

Aneityum: Anelgauhat Bay, alt. 60 m., rain-forest, common, no. **743**, Feb. 13, 1929 (large tree up to 18 m. high; stamens with pink filaments and yellow anthers). Eromanga: Dillon Bay, alt. 300 m., rain-forest, common, no. **312**, May 28, 1928 (large tree up to 15 m. high; flower pink; fruit brown when ripe).—Also Fiji Islands.—Vernacular name "Ney-aroney" (under no. 312).

ROSACEAE

Rubus neo-ebudicus Guillaumin, sp. nov.

Repens, ramis glabris exaculeatis, foliis 3-foliatis, petiolo 2.5–3 cm. longo supra ad basin leviter villoso, stipulis persistentibus usque ad 1.4 cm. longis asymmetrice lanceolatis longe caudatis, foliolis ovatis (usque ad 8 cm. × 5 cm.) basi rotundatis apice acuminatis margine profunde serratis, dentibus caudatis, nervis 12–16-jugis subtus prominentibus, supra costa subtus costa nervisque exceptis glaberrimis, lateralibus basi leviter asymmetricis, petiolulis supra praecipue basin versus tomentosis, terminali 1.5–2 cm. longo, lateralibus 2–3 mm. longis. Inflorescentia usque ad 4 cm. longa apice tantum florifera, basi foliis 1-foliolatis (3.5 cm. × 2 cm.) munita, bracteis floriferis integris, stipulis simillimis vel 2–3 furcatis, pedicellis circa 1.5 longis ad apicem sparse hirsutis, floribus albis, sepalis anguste lanceolatis fere 1.5 cm. longis caudatis extra sparse hirsutis, intus basi excepta dense velutinis, petalis late ovatis sepalis fere aequilongis dorso praecipue costa sparse puberulis tenuibus, staminibus petalis brevioribus, carpellis ovatis trigonis, stylo glaberrimo brevioribus.

T a n n a : Mt. Tokosh Meru, common in rain-forest, **1000** m., no. **150**, March 15, 1928 (straggling plant growing on the crest of Mt. Tokosh Meru; flowers white).

Belongs apparently to section IV. *Anoplobatus* Focke.

SAXIFRAGACEAE

Dedea neo-ebudica Guillaumin, sp. nov.

Arbor parva, tortuosa, ramis nodosis apice dense foliatis resinosisque, foliis erecto-patentibus ovato-lanceolatis (usque ad 13 cm. x 3 cm.) apice rotundatis emarginatisve basi in petiolum 2 cm. longum longe attenuatis dense resinoso-punctulatis coriaceis, racemis axillaribus quam folia longioribus usque ad medium denudatis, floribus albis odoratis, calycis segmentis anguste triangularibus, petalis oblongis obtusis glabris 1.5 cm. longis, staminibus erectis petalis brevioribus, filamentis crassiusculis glaberrimis, antheris oblongis, ovario glaberrimo, stylis crassis columnam staminibus subaequilongam formantibus.

A n e i t y u m: Anelgauhat Bay, Saddle Rock, alt. **800** m., rainforest, no. **866,** March 5, 1929 (small twisted tree growing right on top of a high mountain; flowers white, sweetly scented).

Near *D. oreophila* Schltr. and *D. parviflora* Schltr. on account of its bisexual flowers, but quite distinct in its racemes much exceeding the leaves and naked from the base to about the middle.

Weinmannia Denhamii Seemann, Fl. Vit. 109 (1865) ?

E f a t e : Undine Bay, alt. 500 m., rain-forest, common, no. **236,** April 28, 1928 (small tree up to 10 m. high; seed vessels brown).

Differs from Seemann's description based on a plant from Aneityum solely in the subsessile terminal leaflets with the petiole not winged.

Weinmannia Kajewskii Guillaumin, sp. nov.

Arbor parva, ultra 8 m. alta, ramis gracilibus sparse pilosis, stipulis ovatis, foliis sub-erectis imparipinnatis 4–5-jugis usque ad 11 cm. longis, petiolo 1.5–2 cm. longo semiterete et apicem versus brevissime marginato supra breviter puberulo, rachi inter foliolorum jugas alata infra semiterete supra plana medio costata breviterque puberula, foliolis coriaceis glaberrimis infra nigro-punctulatis lanceolatis apice acutis margine serratis etiam terminali sessilibus, lateralibus 2.5–3 cm. longis 0.5–0.8 cm. latis basi inaequaliter cuneatis uno latere acute cuneato altero rotundato, terminali 2–4 cm. longo 0.4–0.8 cm. lato basi longe attenuato; racemi ad apicem ramulorum axillares, singuli vel 2-nis, 8–9 cm. longi, sparse pilosi, pedicellis 2 mm. longis sparse pilosis, capsula glabra 4 mm. longa.

E r o m a n g a: Dillon Bay, alt. 400 m., rain-forest, common, no. **317,** May 25, 1928 (small tree up to 8 m. high; common on altitudes on Tanna, Eromanga and Efate).—Vernacular name "Nari-yup."

Weinmannia Macgillivrayi Seemann, Fl. Vit. 109 (1865).

A n e i t y u m: Anelgauhat Bay, alt. 30 m., rain-forest, common, no. **735,** Feb. 11, 1929 (large tree up to 18 m. high; spikes of cream-colored flowers).—Already collected on the island.

Weinmannia tannaensis, Guillaumin, sp. nov.

Arbor ultra 15 m. alta, ramis gracilibus primum breviter puberulis mox glabris, stipulis ovatis margine ciliolatis mox glabris, foliis suberectis imparipinnatis 4–6-jugis, petiolo 0.5–0.7 cm. longo semiterete et apicem versus brevissime marginato primum sparse piloso cito glabro, rachi inter foliolorum jugas apicem versus breviter alata infra semiterete supra plana medioque costata primum sparse pilosa cito glabro, foliolis coriaceis ovatis rarius ovato-lanceolatis glaberrimis margine serratis infra punctulatis etiam terminali sessilibus, lateralibus 1–1.5 cm. longis 0.4–0.8 cm. latis apice obtusis rarius acutis basi inaequaliter obtusis uno latere acuto altero rotundato, terminali 1.5–2 cm. longo 0.4–0.8 cm. lato apice acuto basi longe attenuato; racemi ad apicem ramulorum axillares, vulgo singuli, circa 5 cm. longi, puberuli, pedicellis 1.5–2 mm. longis puberulis, bracteis lanceolatis aequilongis, floribus albis 1 mm. longis, calyce alte 4-partito, segmentis triangularibus vix 1 mm. longis, petalis 4 ovatis aequilongis, staminibus 8 erectis inaequalibus petalis leviter longioribus, filamentis subulatis glabris, antheris ovatis apiculatis, glandulis cylindricis filamentis antherarum breviorum dimidio brevioribus, ovario ovoideo glabro, staminibus longioribus subaequilongo, stylis 2 ovario leviter brevioribus.

T a n n a: Mt. Tokosh Meru, alt. 1000 m., rain-forest, common, no. **151,** March 15, 1928 (tree up to 15 m. high, right on crest of Mt. Tokush Meru; flowers white).

Near *W. Kajewskii* but the petiole two to three times shorter and the lateral leaflets much shorter and very generally obtuse.

Geissois Denhamii Seemann, Fl. Vit. 109 (1865).

A n e i t y u m: Anelgauhat Bay, alt. 60 m., rain-forest, common, no. **741,** Feb. 12, 1929 (large tree up to 18 m. high; spikes of scarlet flowers; fruit yellow when ripe). T a n n a: Lenakel, alt. 200 m., rain-forest, common, no. **106,** March 6, 1928 (tree about 20 m. high, 70 cm. in diam.). E f a t e: Undine Bay, alt. 300 m., rain-forest, common, no. **225,** April 27, 1928 (tree about 10 m. high; flower a bright scarlet, very pretty, growing out of branches).—Already found on Aneityum.[1]

RHIZOPHORACEAE

Rhizophora conjugata Linnaeus, Sp. Pl. 443 (1753).

Banks Group: Vanua Lava, sea level, seashore, common, no. **499,** July 18, 1928 (common mangrove throughout the New Hebrides).—Also Caroline Islands, Malaysia; a special variety in New Caledonia.

Rhizophora mucronata Lam. var. **stylosa** (Griff.) Schimper in Bot. Mitteil. Trop. Jena, III. 92 (1891).—Det. by F. M. Salvoza.

Efate: Fila Island, Vila, sea level, sea beach, common, no. **183,** April 13, 1928 (tree with many stilt roots).—Already recorded from the New Hebrides; also Australia (Queensland, North Australia), New Caledonia, Fiji, Tonga, Samoa, Ellice, Caroline, Mariana, Bismarck and Admiralty Islands, New Guinea, Malaysia.

Bruguiera eriopetala Wight & Arnott in Ann. Nat. Hist. I. 368 (1838).

Aneityum: Anelgauhat Bay, sea level, seashore, common, no. **782,** Feb. 19, 1929 (common mangrove up to 12 m. high). Eromanka: Dillon Bay, sea level, on salt water creek, common, no. **239,** May 29, 1928 (tree up to 15 m. high, leaning over salt water). Banks Group: Vanua Lava, sea level, seashore, common, no. **478,** July 12, 1928 (mangrove growing on sea beaches).—Also New Caledonia, Queensland, Tonga, Wallis, Samoa, Marshall, Caroline, Mariana, Solomon and Admiralty Islands, New Guinea, Malaysia. —Vernacular name "Net-ungou" (under no. 329).

Crossostylis banksiana Guillaumin, sp. nov.

Arbor 15 m. alta, ramis gracilibus glabris, stipulis truncatis 1 mm. longis, foliis vix coriaceis ovatis (usque ad 16 cm. x 7 cm.) glabris apice obtusis basi cuneatis, nervis 6–7-jugis, petiolo 1.5–2.5 cm. longo; floribus 1–2, 8 mm. latis, pedicello gracili 8 mm. longo, sepalis 5 triangularibus 3 mm. longis extra glabris intus breviter puberulis, petalis 5 albis cito deciduis spathulato-truncatis marginibus apicem versus inflexis dorso carinatis extra breviter puberulis intus apicem versus lanuginosis, sepalis aequilongis, staminibus circa 20 disco cupuliformi insertis, ovario 8-loculare, stigmatibus totidem.

Banks Group: Vanua Lava, alt. 700 m., rain-forest, common, no. **459,** July 10, 1928 (tree up to 15 m. high; petals white).

[1] Omitted from "Liste des plantes connues des Nouvelles Hebrides" in Bull. Soc. Bot. France, LXXIV. 697 (1927).

Related chiefly to *C. Cominsii* Hemsl. from the Santa Cruz Islands which, however, has 30 stamens, 10 carpels and glabrous petals; in the number of carpels it approaches *C. Harveyi* Benth. from the Fiji Islands, but that species has different leaves.

COMBRETACEAE

Terminalia Catappa Linnaeus, Mant. II. 519 (1771).

Eromanga: Dillon Bay, sea level, rain-forest soil, common, no. **244A**, May 14, 1928 (tall tree with spreading branches and prominent buttresses; leaves turn brownish red when they fall; flowers white; fruit red to black when ripe, eaten by the natives). Already collected on Tanna; also New Caledonia, Queensland, Fiji, Tonga, Samoa, Marshall, Caroline, Mariana, Solomon and Admiralty Islands, New Guinea, Malaysia.—Vernacular name "Dayle."

Lumnitzera littorea (Jack) Voigt, Hort. Suburb. Calcutt. 39 (1845).

Lumnitzera purpurea Presl, Rep. Bot. I. 155 (1834).
Lumnitzera coccinea Wight & Arnott, Prod. II. 316 (1834).

Banks Group: Vanua Lava, sea level, rain-forest, common, no. **427**, July 6, 1928 (mangrove growing along salt water creeks and foreshores; flowers red, very pretty).—Also New Caledonia, Queensland, Fiji, Tonga, Samoa, Ellice, Caroline, Mariana and Solomon Islands, New Guinea, Malaysia.

MYRTACEAE

Metrosideros villosa Smith in Trans. Linn. Soc. III. 268 (1797).

Aneityum: Anelgauhat Bay, alt. to 600 m., rain-forest, common, no. **982** (coll. *J. P. Wilson*), Sept. 1929 (large tree to 1 m. in diam.; leaves small; flowers yellow; fruit brown, 0.75 cm. in diam.). Tanna: Mt. Tokosh Meru, alt. 900 m., rain-forest, common, no. **157**, March 15, 1928 (tree up to 10 m. high; flower scarlet).—Also Fiji, Society, Marquesas and Gambier Islands, Lord Howe Island, Kermadec Islands (apparently incorrectly reported from New Caledonia by Jeanneney in his "Nouvelle Calédonie Agricole, p. 85").—Vernacular name "Nevug" (under no. 982).

Metrosideros villosa var. **glaberrima** Guillaumin, comb. nov.

Metrosideros collina var. *glaberrima* Bertero apud Guillemin in Ann. Sci. Nat. sér. 2. VII. 351 (Zephyr. Tait. 57) (1837).

Eromanga: Dillon Bay, alt. 300 m. poor red soil country (bracken), common, no. **294**, May 24, 1928 (tree up to 10 m. high but in rain-forest up to 30 m. high; a very remarkable growth; flowers red and yellow; one of the prettiest trees in the islands).—Also Society Islands.—Vernacular name "Nem-er-an."

Myrtus aneityensis Guillaumin, sp. nov.

Arbor parva, 10 m. alta, ramis teretibus brunneo-rubris, foliis vivo atro-viridibus lucidis ovatis vel ovato-lanceolatis (3–7 cm. x 2–3 cm.) apice attenuatis basi cuneatis obtusisve chartaceis minutissime pellucide punctulatis, petiolo brevi (2–4 mm. longo); floribus ad apicem axillaribus singulis vel 3–5-nis cymosis, pedunculis pedicellisve capillaribus 0.5 2 cm. longis apice minute 2-bracteolatis, bracteolis linearibus 0.5 mm. longis, calycis segmentis 4 ovatis 2 mm. longis, petalis 4, albis ovatis sepalis 2-plo longioribus apice minute ciliolatis, staminibus valde numerosis, stylo subulato petalis sub-aequilongo basin versus minute argenteo-puberulo, ovario 2-loculari. Fructus brunnei, 6 mm. longi.

A n e i t y u m: Anelgauhat Bay, alt. 120 m., rain-forest, common, no. **810,** Feb. 23, 1929 (small tree up to 9 m. high; leaves dark glossy green; petals white); alt. to 150 m., lower hills in rain-forest, common, no. **985** (coll. *J. P. Wilson*), Sept. 1929 (small tree to 30 cm. in diam.; leaves small; flowers small, white; fruit small, about 0.5 cm. long, brown).—Vernacular name "Nivic."

The genus ***Myrtus*** abundant in New Caledonia and on the east coast of Australia seems to be absent from New Guinea and Polynesia.

Decaspermum neo-ebudicum Guillaumin, sp. nov.

Arbor circa 10 m. alta, ramis primum argenteo-sericeis deinde glabris, foliis lanceolatis (usque ad 5 cm. x 1.5 cm.) rigidis apice longe acutis basi cuneatis vivo atro-viridibus sicco brunneis concoloribusque subtus abunde punctulatis, nervis inconspicuis primum costa marginibusque argenteo-sericeis mox glabris, petiolo brevi (2–4 mm. longo); floribus axillaribus solitaribus vel cymose 3-nis, pedunculo foliis breviore, bracteis foliaceis lineari-lanceolatis 4 mm. longis, bracteolis bracteis simillimis ad calycis basin singulis, cymarum flore centrali lateralibus brevius pedicellato et ebracteolato, calycis receptaculo extra dense argenteo-sericeo, dentibus 5 aequilongis margine argenteo-ciliolatis deinde glabrescentibus, petalis albis basi roseis ovatis calycis lobis 4-plo longioribus, staminum filamentis roseis, antheris subflavis, ovario 8-loculari, fructibus brunneis fere glabris globosis 4 mm. diam.

A n e i t y u m: Anelgauhat Bay, sea level, poor red soil country, common, no. **699,** Feb. 4, 1929 (small tree up to 7 m. high; leaves dark glossy green; petals white with pink bases; stamens pink with cream colored anthers). E f a t e: Undine Bay, alt. 100 m., rain-forest, common, no. **212,** April 26, 1928 (tree about 10 m. high; fruit brown when ripe).

In its general aspect this new species resembles **D. vitiense** Guillaumin, comb. nov. (*Nelitris vitiensis* A. Gray), known from the Wallis and Fiji Islands and from Aneityum, but that species has a paniculate inflorescence and a 5-celled ovary. In its 8-celled ovary *D. neo-ebudicum* approaches *D. humifusum* Diels, *D. nitidum* Lauterb. and *D. prunoides* Diels from New Guinea and *D. Raymondii* Diels from the Caroline Islands.

To this must probably also be referred the following specimen though it has much longer (up to 8 cm. x 2 cm.) and thinner leaves rounded at the base: Eromanga: Dillon Bay, alt. 300 m., rain-forest, common, no. **283,** May 23, 1928 (small tree up to 10 m. high; used by natives for enlarged spleen; used by macerating with cold water and white sedge).—Vernacular name "Nywass" (under no. 283).

Eugenia rariflora Bentham in Lond. Jour. Bot. II. 221 (1843).

Aneityum: Aname, sea level, alt. 15 m., no. **990** (coll. *J. P. Wilson*) Sept. 1929 (small tree to 22.5 cm. in diam.; leaves small, round; flowers white, small; fruit a red berry, 1.4 cm. in diam.).— Also Gambier, Society, Samoa, Tonga and Fiji Islands.—Vernacular name "Nupoin hudaig."

Eugenia sp.

Tanna: Lenakel, alt. 150 m., rich rain-forest soil, common, no. **53,** Feb. 24, 1928 (tree about 15 m. high; 40 cm. in diam.; fruit pink and growing out of trunk of tree).

Eugenia (§ *Jambosa*) **javanica** Lamarck, Encycl. Méth. III. 200 (1823).

Aneityum: Umage, alt. 450 m., rain-forest, common, no. **998** (coll. *J. P. Wilson*), Sept. 1929 (large tree to 1.30 m. in diam.; leaves medium; flower white tinged with pink; fruit black, 3 cm. long, 4 cm. in diam.).—Also New Guinea, Bismarck, Samoa and Caroline Islands, Malaysia.—Vernacular name "Indahau."

The specimen quite resembles in its rather long-petioled leaves neither rounded nor subcordate at the base some forms considered by Diels as a subspecies *timorensis.*

Eugenia (§ *Jambosa*) **Richii** A. Gray, Bot. Wilkes U. S. Explor. Exped. I. 510 (1854), var. vel spec. distincta?

Aneityum: Utgi, alt. to 150 m., seashore, common, no. **1003** (coll. *J. P. Wilson*) Sept. 1929 (large tree to 1 m. in diam.; leaves large, dark green; flowers crimson, in clusters; fruit red, 7.5 cm. long, 4 cm. in diam.; fruit eaten). Tanna: Lenakel, alt. 100 m., rain-forest soil, common, no. **36,** Feb. 21, 1928 (tree 10–12 m. high, 40–50 cm. in diam.; flower very pretty, puce-colored). Eromang a: Dillon Bay, alt. sea level, rain-forest, common, no. **255,** May 15, 1928 (splendid tree up to 25 m. high; bark brown; fruit pink when ripe, eaten largely by natives). B a n k s G r o u p: Vanua Lava, sea level, rain-forest, common, no. **472,** July 12, 1928 (large tree up to 20 m. high; flower red; common throughout the group).—Vernacular names "Inyheug" (under no. 1003) and "Wer-veh" (under no. 255).

The specimens differ from the quite polymorphous plant of the Fiji and Tonga Islands in the tips of the branches being flattened, not quadrangular with prominent lines, though certain parts of the older branches are distinctly quadrangular, in the generally obtuse leaves, but at the base sometimes rounded and slightly cordate, in the glands even pellucid on old leaves, and in the tube of the calyx not exceeding 1 cm. in length.

Eugenia (§ *Jambosa*) sp.

E r o m a n g a: centre of the island from Dillon Bay, no. **340,** June 1, 1928 (large tree up to 25 m. high; fruit red, 2.5 cm. long, 2 cm. in diam.).—Vernacular name "Nah-rom-ye-in."

Eugenia (§ *Jambosa*) sp.

A n e i t y u m: Anelgauhat Bay, alt. 150–450 m., rain-forest, common, no. **952** (coll. *J. P. Wilson*), Sept. 1929 (high tree up to 18 m. high, 0.60 m. in diam.; leaves medium, glossy; flowers small, yellow; fruit round, 2.5 cm. in diam., dark brown).—Vernacular name "Nomogheo."

Syzygium aneityense Guillaumin, sp. nov.

Arbor magna, ad 15 m. alta, foliis ovato-lanceolatis (usque ad 9 cm. x 3 cm.) longe (1–1.5 cm.) et oblique acuminatis basi cuneatis rigide membranaceis, nervis 9–11-jugis, in foliis junioribus bene, in adultioribus parum distinctis, petiolo gracili circa 5 mm. longo, inflorescentiis terminalibus circa 6 cm. longis laxis paucifloris, bracteis deciduis, pedicellis apice bracteolis minutissimis cito caducis instructis, floribus purpureis, receptaculo (tantum juniore) late obconico circa 1 cm. longo, lobis 4 brevissimis vix distinctis.

A n e i t y u m: Anelgauhat Bay, alt. 335 m., rain-forest, common, no. **846,** March 2, 1929 (large tree up to 12 m. high; flower buds only, and these purple in color).

On account of the lateral veins being more or less distinct from the intermediate ones and on account of the terminal inflorescences this species seems to take its place near *S. orthoneurum* and *S. modestum* Diels.

Syzygium Kajewskii Guillaumin, sp. nov.

Arbor alta, trunco ultra 60 cm. diam., foliis ovatis (usque ad

10 cm. x 5 cm.) apice breve et oblique acuminatis basi cuneatis chartaceis, nervis crebris tenuissimis, petiolo 1–1.5 cm. longo, inflorescentiis terminalibus usque ad 7 cm. longis paniculatis, bracteis deciduis, floribus parvis albis, receptaculo circa 1 cm. longo basi longissime attenuato et a pedicello capillari bractearum delapsorum cicatricibus tantum distincto, lobis 4 rotundatis vix 1 mm. longis, petalis plus minusve calyptratim deciduis vix 2 mm. longis, staminibus 7–8 mm. longis, fructibus baccatis 0.5 cm. diam. nigris.

Aneityum: Anelgauhat Bay, alt. 657 m., rain-forest, common, no. **970** (coll. *J. P. Wilson*), Sept. 1929 (large tree, trunk up to 0.60 m. in diam.; leaves medium; flowers small, white; fruit a berry, 0.7 cm. in diam., black when ripe).—Vernacular name "Nomo Thee."

Very remarkable on account of the elongated and slender receptacle which passes directly into the pedicel if there is one.

Syzygium neepau Guillaumin, sp. nov.

Arbor alta, trunco 1 m. diam., foliis fere discoideis (usque ad 12 cm. x 8 cm.) chartaceis apice rotundatis vel leviter retusis basi subito cuneatis, nervis crebris tenuibus a venis levissime distinctis, petiolo 1 cm. longo, inflorescentiis usque ad 20 cm. longis sat laxe paniculatis, ramis indistincte triangulis, bracteis deciduis, floribus albis, receptaculo obconico 5 mm. longo, lobis semi-circularibus vix 1 mm. longis, petalis calyptratim deciduis 2 mm. longis, staminibus 7 mm. longis, fructibus globosis 12 mm. diam.

Aneityum: Anelgauhat Bay, alt. 500 m., rain-forest, common, no. **973** (coll. *J. P. Wilson*), Sept. 1929 (large tree, trunk up to 1 m. in diam.; leaves green, nearly circular; flowers small, white; fruit black, round, about 1.4. cm. in diam.).—Vernacular name "Neepau."

Nearest to *S. clusiaefolium* A. Gray, but the leaves are less cuneate at the base, the inflorescence slenderer and the flowers smaller.

Syzygium nidie Guillaumin, sp. nov.

Arbor alta, trunco ultra 1.20 m. diam., glaberrima, foliis obovatis vel obovato-ellipticis (usque ad 7 cm. x 3 cm.) apice subito longeque (6 mm.) acuminatis basi cuneatis, punctis pellucidis minimis, nervis tenuibus crebris parallelis, petiolo ad 1.5 cm. longo; inflorescentia 5–7 cm. longa, terminalis, floribus albis trichotome paniculatim cymosis, pedicello 3–8 mm. longo apice articulato et vix infra apicem bracteolata (bracteolis deciduis non visis), receptaculo infero superum infundibuliformem aequante, tubo turbinato circa 1 cm. longo medio 5 mm. diam., segmentis 4 triangularibus 1.5 mm. longis, petalis calyptratim deciduis, exteriore tantum libero, staminibus 1.5 cm. longis, stylo 1.8 cm. longo.

A n e i t y u m: Anelgauhat Bay, alt. 500 m., rain-forest, common, no. **984** (coll. *J. P. Wilson*), Sept. 1929 (large tree to 1.30 m. in diam.; leaves medium; flowers white; fruit red, 1.2 cm. long, 0.5 cm. in diam.; wood used for building).—Vernacular name "Nidie."

Rather close to *S. corynocarpum* Diels from the Fiji, Samoa and Tonga Islands, but the flowers are much larger, and particularly to *S. heloanthum* Diels from New Guinea, but this has the tubular part of the receptacle much longer than the funnelform part.

Syzygium nomoa Guillaumin, sp. nov.

Arbor ad 20 m. alta, trunco ad 1.20 m. diam., foliis ovatis (usque ad 16 cm. x 6 cm.) sat coriaceis apice rotundatis basi cuneatim attenuatis, nervis crebris tenuibus parallelis, petiolo 1–1.5 cm. longo; inflorescentiis terminalibus ad 10 cm. longis corymboso-paniculatis, bracteis persistentibus minutis sed bene distinctis instructis, floribus sub-flavis, receptaculo obconico 5 mm. longo, lobis parum distinctis, ore tantum undulato, petalis plus minusve calyptratim cuneatis 3 mm. longis, staminibus 1 cm. longis, fructibus ovatis (10–12 mm. x 6–8 mm.) nigris.

A n e i t y u m: Anelgauhat Bay, alt. 180–325 m., rain-forest, common, no. **948** (coll. *J. P. Wilson*), Sept. 1929 (grows to large tree up to 1.30 m. in diam.; leaves thick, glossy; flowers cream-colored, tufted). T a n n a: Lenakel, alt. 200 m., rain-forest, common, no. **128,** March 7, 1928 (tree about 20 m. high, 70 cm. in diam.; fruit black when ripe).—Vernacular name "Nomoa" (under no. 948).

Resembles in certain characters *S. dictyoneurum* Diels from New Guinea, but is quite distinct in the shape of the leaves and in the nearly indistinct lobes of the calyx.

Syzygium sp. affine *S. scytophyllum* Diels.

A n e i t y u m: Anelgauhat Bay, alt. 800 m., rain-forest, common, no. **839,** Feb. 3, 1929 (large tree up to 12 m. high; fruit black when ripe, 3 cm. long, 0.5 cm. in diam. at base).

Syzygium?

E f a t e: Undine Bay, sea level, rain-forest, common, no. **197,** April 24, 1928 (tree up to 15 m. high; fruit cream-color when ripe).

LECYTHIDACEAE

Barringtonia excelsa Blume, Bijdr. Fl. Ned. Ind. 1097 (1825).

E r o m a n g a: Dillon Bay, sea level, rain-forest, common, no. **247,** May 15, 1928 (tree up to 20 m. high, with many branches; fruit 6 cm. long, 4.5 cm. in diam., skin green, nuts greatly prized and eaten by natives). T a n n a: Lenakel, alt. 100 m., rain-forest soil, common, no. **35,** Feb. 21, 1928 (tree 12–15 m. high, 30 cm. in diam.; it is a decidedly handsome tree, the leaves being of a bright green, and it gives a good shade; the fruits hang down in racemes having up to 8 fruits on a single raceme, so the trees are thus capable of bearing heavy crops; the fruit is about 7 cm. long, and about 3.5 cm. in diam. and slightly oval; when ripe it is a light green mottled with dark green irregular lines or dots; diameter of the husk about 1 cm.; the kernel is 3.5 cm. long, about 1.75 cm. in diam., has a brown skin and no outside covering except the husk mentioned; it is very pleasant to eat; there is a variety of this species which has exactly the same leaves and the fruit is of the same dimensions and shape, only the outside husk of the fruit is blue; the flavor of the two is identical).—Already found on Tanna and Efate; also Malaysia.—Vernacular names "Velingeh" (under no. 247) and "Nevingen" (under no. 35).

Barringtonia racemosa (L.) Roxburgh, Hort. Beng. 52 (1814), nomen nudum; Fl. Ind. 634 (1832).

A n e i t y u m: Anelgauhat Bay, sea level, rain-forest, common, no. **777,** Feb. 19, 1929 (tree up to 12 m. high; found growing only in swamps; leaves dark glossy green; fruit 9 cm. long, 5 cm. in diameter; the fruit of this species growing in swamps, not eaten; the fruit of another species is readily eaten). T a n n a: Lenakel, alt. 200 m., rain-forest, common, no. **126,** March 7, 1928 (tree similar to the Nevingen except the leaves are purple instead of green; fruit dark purple 9 cm. long, 5.5 cm. in diam., larger than the green Nevingen; the fruit of this tree instead of having a good edible nut, is poisonous).—Already found on Tanna; also New Caledonia, Queensland, Fiji, Samoa, Caroline, Mariana, Bismarck and Admiralty Islands, New Guinea, Malaysia.—Vernacular name "Nevingen (black)" (under no. 126).

MELASTOMACEAE

Melastoma denticulatum Labillardière, Sert. Austr.-Caled. I. 65, t. 64 (1824).

A n e i t y u m: Anelgauhat Bay, alt. up to 90 m., lower ranges, common, no. **972** (coll. ***J. P. Wilson***), Sept. 1929 (small tree about 20 cm. in diam.; leaves elongated, yellow-veined; flowers white; fruit brown, 1.4 cm. in diam.); sea level, poor red soil, common, no. **736,** Feb. 11, 1929 (shrub up to 2 m. high; petals white, tinged with cream). E f a t e: Undine Bay, alt. 400 m., rain-forest, common, no. **223,** April 27, 1928 (small shrub up to 2 m. high; flowers whitish pink).—Already found on Aneityum and Tanna; also New Caledonia, Fiji, Tonga, Samoa, Cook, and Society Islands.—Vernacular name "Aditi" (under no. 972).

Medinilla neo-ebudica Guillaumin, sp. nov.

Epiphytica, glaberrima, ramis crassis dense verrucoso-lenticellatis, foliis 3-nis carnosis, junioribus intense rubris, ovato-lanceolatis (usque ad 12 cm. x 5 cm.) 3-plinerviis apice acutis basi obtusis vel subrotundatis, petiolo 2–2.5 cm. longo; floribus rubris in axillis foliorum presentium vel delapsorum fasciculatis minimis pedicello 5–8 mm. longo subbrevioribus, calyce obconico apice truncate et brevissime 4-undulato 4 mm. longo, petalis 4 late ovatis 2.5 mm. longis, staminibus 8, antheris basi vix productis; fructibus rubris 5 mm. diam., pedunculo usque ad 2 cm. longo.

Aneityum: Anelgauhat Bay, alt. 700 m., rain-forest, common, no. **978** (coll. ***J. P. Wilson***) Aug. 1929 (parasite, grows on other trees; leaves elongated; flowers very small, red; fruit small, 0.5 cm. in diam., red). Banks Group: Vanua Lava, alt. 600 m., rain-forest, common, no. **486,** July 17, 1928 (parasite plant of the higher altitudes; fruit red).

Seems particularly near ***M. musofo*** Lauterb. & Schum. from New Guinea, but the leaves are more acute at the base and the flowers in denser fascicles.

Medinilla heteromorphophylla Guillaumin, sp. nov.

Scandens, ramis teretibus gracilibus primum dense rubiginoso-furfuraceis, cortice non verrucoso, nodis ebarbatis, foliis oppositis saepius heteromorphis, lamina una ovata (9–11 cm. x 4 cm.) apice acuminata basi rotundata 7-plinervia petiolo circa 1.5 cm. longo suffulta, altera cordata (3–4.5 cm. x 2–3.5 cm.) 5–7-plinervia sessili vel subsessili, omnibus primum rubiginose furfuraceis mox glaberrimis; inflorescentia axillaris, 4–5 cm. longa, primum rubiginose furfuracea, deinde glabrescens, umbellata, pedunculo basin versus minute 2-bracteolato, ramis bracteis ovatis vel elliptico-ovatis (8 mm. x 4–5 mm.) petaloideis roseis involucratis, umbellulis, si adsunt, similibus, bracteis floralibus late ovatis (1.5 cm. x 1.3 cm.), floribus roseis, tantum junioribus 1 cm. longis, sessilibus, calyce basi tantum stellato-piloso, apice truncato et 4-tuberculato, petalis 4, staminibus 8.

Banks Group: Vanua Lava, alt. 500 m., rain-forest, common, no. **481,** July 16, 1928 (shrub climbing up trees and hanging down in long stems; flowers pink, very pretty).

Seems rather close to ***M. rhodochlaena*** A. Gray from the Fiji Islands, but the leaves and particularly the inflorescences are very different.

Astronia aneityensis Guillaumin, sp. nov.

Arbor parva, 15 m. alta, glaberrima, trunco 20 cm. diam., ramis teretibus, foliis ovatis (10–13 cm. x 4–5 cm.) apice acute acuminatis basi cuneatis triplinervis, petiolo 3–5 cm. longo brunneo; inflorescentia circa 10 cm. longa, corymboso-paniculata, bracteis omnibus foliaceis apicem versus minoribus (1 cm. x 0.4 cm.), floribus rubris 1 cm. longis pedicello aequilongo suffultis, calyce in alabastro juniore calyptratim secedente deinde fere regulariter 4–6-lobato, petalis 6, ovario 4-loculari; fructibus brunneis globoso-depressis 1 cm. longis, calyce cylindrico fere aequilongo et margine 4-lobato superatis.

A n e i t y u m: Anelgauhat Bay, alt. 35–175 m., rain-forest, common, no. **957** (coll. *J. P. Wilson*), Sept. 1929 (small tree up to 20 cm. in diam.; leaves long, with three long veins; flowers small, red; fruit a small berry); alt. 450 m., rain-forest, common, no. **880,** March 5, 1929 (small tree up to 12 m. high; petioles of leaves brown; fruit brown when ripe, 1 cm. long, 0.75 cm. in diameter).—Vernacular name "Natge" (under no. 957).

It does not resemble any other species of the section *Naudinia.*

Astronia banksiana Guillaumin, sp. nov.

Arbor parva, ramis crassis teretibus dense rubiginoso-furfuraceis, foliis ovato-lanceolatis (circa 20 cm. x 6 cm.) apice longe (20 cm.) et graciliter falcato-acuminatis basi cuneatis supra glabris infra in nervis rubiginoso-furfuraceis, lamina lepidota vivaque brunnea, petiolo 3.5–4.5 cm. longo furfuraceo-rubiginoso; inflorescentia circa 9 cm. longa, corymboso-paniculata, dense rubiginoso-furfuracea, bracteis inferioribus foliis similibus (usque ad 6 cm. x 2 cm.) 1 cm. petiolatis, superioribus linearibus 3 mm. longis dense furfuraceis, bracteolis bracteis superioribus similibus sed minoribus, floribus (tantum junioribus) sessilibus obovatis, calyce dense furfuraceo apice breviter 6-dentato, dentibus triangularibus, ovario 6-loculari.

B a n k s G r o u p: Vanua Lava, on high mountains, alt. 200 m., rain-forest, common, no. **473,** July 12, 1928 (small tree growing on a high mountain; leaves brown underneath).

Seems rather near *A. tomentosa* Seem. from the Fiji Islands but the leaves are very different with a long slender and falcate acumen and cuneate at the base.

LYTHRACEAE

Pemphis acidula Forster, Char. Gen. 68, t. 34 (1776).

A n e i t y u m: Anelgauhat Bay, sea level, seashore, common, no. **779,** Feb. 19, 1929 (plant up to 1.30 m. high, growing on beaches; petals white). E f a t e: Fila Island, Vila, sea level, seashore, common, no. **189,** April 14, 1928 (small shrub about 2 m. high growing on rocks). Banks Group: Vanua Lava, sea level, seashore, common, no. **429,** July 9, 1928 (small plant growing on rocky foreshores).

Already found on Efate; also New Caledonia, Loyalty Islands, Australia (Queensland, North Australia), Tonga, Society, Paumota, Union, Ellice, Gilbert, Marshall, Mariana, Solomon and Bismarck Islands, New Guinea, Malaysia.

SONNERATIACEAE

Sonneratia acida Linnaeus f. Suppl. 252 (1781).

Banks Group: Vanua Lava, sea level, seashore, common, no. **442,** July 9, 1928 (common mangrove up to 10 m. high; flowers red).—Also Solomon Islands, Malaysia.

SAMYDACEAE

Homalium aneityense Guillaumin, sp. nov.

Arbor parva, 10 m. alta, foliis rigide membranaceis sub-discoideis (usque ad 8 cm. x 6.5 cm.) utrinque rotundatis, nervis 5–6-jugis infra in costa papillosis, petiolo sat gracili 1–1.5 cm. longo sparse papilloso; inflorescentia terminalis, ramoso-spicata, 16 cm. longa, dense flavo-fulvo-pilosa, floribus sub-sessilibus 6 mm. longis, calycis tubo 3 mm. longo dense piloso, segmentis 6 spathulatis (6 mm. x 1 mm.) extra dense pilosis intus sparsius lanuginosis margine dense lanuginosis, petalis 6 leviter longioribus similibus, glandulis oppositisepalis magnis glabris nigris, staminibus 3–5-nis fasciculatis alternantibus, filamentis basi sparse lanuginosis, disco lanuginoso, stylis 4–5 basi coalitis apice glabris basi lanuginosis.

Aneityum: Anelgauhat Bay, alt. 200 m., rain-forest, common, no. **914,** March 17, 1929 (small tree up to 9 m. high; flowers flannel-colored [tawny?]).

PASSIFLORACEAE

Passiflora aurantia Forster f., Fl. Ins. Austr. Prodr. 62 (1786).

Eromanga: Dillon Bay, alt. 300 m., rain-forest, common, no. **270,** May 17, 1928 (vine growing over the tops of brush; flowers cream-colored, with orange underneath petals).

Also New Caledonia, Loyalty Islands, Queensland, Norfolk Island, Samoa Islands, New Guinea.—Vernacular name "Ou-vli-nockie."

ARALIACEAE

Delarbrea collina Vieillard in Bull. Soc. Linn. Norm. IX. 342 (1865).

Eromanga: Dillon Bay, sea level, rain-forest, common, no.

269, May 17, 1928 (small tree up to 10 m. high). Banks Group: Vanua Lava, alt. 200 m., rain-forest, common, no. **412,** June 5, 1928 (small tree up to 12 m. high; natives say fruit is black when ripe).

Already found on Efate; also New Caledonia, Loyalty Islands.—Vernacular name "Nunginetum" (under no. 269).

Strobilopanax neo-ebudicus Guillaumin, sp. nov.

Arbor parva, trunco 45 cm. diam., foliis ovato-lanceolatis (usque ad 28 cm. x 18 cm.) apice obtusis basi attenuatis petiolo brevi (1–1.5 cm. longo) suffultis, lamina sat coriacea, nervis 12–16-jugis irregulariter dispositis, venis reticulatis, stipulis inter petiolum et caulem cupulam 3 mm. altam formantibus; inflorescentia robusta, capituloso-spicata, 12 cm. longa, capitulis 1–1.5 cm. diam., bracteis late triangularibus (8 mm. x 7 mm.) obtusis, floribus parvis albis, stylis 8–12. Fructus lutei, globosi, 4 cm. diam.

Aneityum: Anelgauhat Bay, alt. 325 m., lower hills, in forest, no. **980** (coll. *J. P. Wilson*), Sept. 1929 (small tree to 45 cm. in diam.; leaves long, large; flowers small, white, grows off the fruit; fruit 4 cm. long, yellow).—Vernacular name "Nabrouto."

The genus has been known so far only from New Caledonia and the Loyalty Islands.

Schefflera (sensu lato) sp.

Tanna: Lenakel, alt. 200 m., rain-forest, common, no. **114,** March 6, 1928 (small tree about 5 m. high).

Schefflera sp., praecedenti aff.

Aneityum: Anelgauhat Bay, alt. 300 m., rain-forest, common, no. **845,** March 2, 1929 (small tree up to 6 m. high; fruit cream-colored when rip , 0.5 cm. long, about 0.5 cm. in diameter).

Schefflera sp.

Tanna: Lenakel, alt. 200 m., rain-forest, common, no. **131,** March 7, 1928 (tree about 15 m. high, 50 cm. in diam.)

Schefflera sp.

Aneityum: Anelgauhat Bay, alt. 60 m., rain-forest, common, no. **758,** Feb. 13, 1929 (small tree up to 9 m. high; fruit black when ripe, those on specimen about half-grown when collected).

Tieghemopanax fruticosus (L.) R. Viguier in Ann. Sci. Nat. sér. 9, IV. 61 (1906).

Aneityum: Anelgauhat Bay, alt. 500 m., rain-forest, common, no. **931,** March 17, 1929 (small tree up to 8 m. high; petals white; leaves boiled and eaten by the natives). Tanna: Lenakel, alt. 150 m., rain-forest, native gardens, common, no. **63,** Feb. 24, 1928 (plant about 1 m. high; leaves yellowish green; very symmetrical plant after the style of *Kochia trichophylla*).

Already found on Efate; also Wallis, Fiji, Solomon and Bismarck Islands, New Guinea, Phillipines.

Tieghemopanax neo-ebudarum Guillaumin, sp. nov.

Arbor usque ad 40 m. alta, foliis usque ad 30 cm. longis imparipinnatis 4–6-jugis, foliolis petiolulatis (petiolulo circa 7 mm. longo) membranaceis ovatis (5 cm. x 3 cm.) valde asymmetricis falcatisque apice acute acuminatis basi cuneatis margine integris vel subintegris; inflorescentia paniculata, foliis fere aequilonga, floribus umbellatis parvis purpureo-brunneis pedicellatis (pedicello 2–3 mm. longo medio articulato), calycis dentibus minimis, petalis carnosis ovatis apice acutis intus carinatis uncinatisque, staminibus antheris ellipticis quam filamenta 2-plo longioribus, stylo 1 staminibus fere aequilongo. Fructus nigri, globoso-compressi, 3 mm. longi, stylo apice stigmatibus 2 divaricatis coronati.

Aneityum: Anelgauhat Bay, alt. 70 m., rain-forest, common, no. **749,** Feb. 12, 1929 (large tree up to 12 m. high; fruit black when ripe); alt. 600 m., rain-forest, common, no. **977** (coll. *J. P. Wilson*), Aug. 1929 (small tree up to 30 cm. in diam.; leaves medium; flower small, purplish brown; fruit a small berry). Eromanga: Dillon Bay, alt. 300 m., rain-forest, common, no. **291,** May 23, 1928 (medium-sized tree 8 m. high; leaves used as application for sore ears).—Vernacular names "Kirvano" (under no. 977) and "Narse" (under no. 291).

(To be continued)

MUSEUM NATIONAL D'HISTOIRE NATURELLE,
PARIS.

FOUR NEW PALMS COLLECTED IN THE TERRITORY OF PAPUA (BRITISH NEW GUINEA) BY L. J. BRASS

M. BURRET

Calamus nannostachys Burret, sp. nov.

Scandens, ut videtur, sat tenuis. Frondis vagina 5–7 mm. in diam., cirrhifera, pallide fusco-furfuracea, aculeis basi intumescentibus oblique insertis rectis 1–2 mm. longis sat tenuibus densiuscule praedita, ad apicem fere inermis. Ochrea destructa. Cirrhus tenuis, unguibus simplicibus raro 2, rarissime 3 confluentibus 2–3 mm. longis armatus. Frondes parvae, 40–58 cm. longae, cirrho carentes. Petiolus 12 cm. circ. longus, aculeis fere setiformibus parvis ad 2 mm. longis et unguibus parvis simplicibus magnitudinis in cirrho descriptae dispersis. Rhachis unguibus descriptis dispersis. Segmenta 12, quorum apicalia nonnihil 7 cm. alte connata, reliqua valde irregularia et aggregata, latiuscule lanceolata, inferne cuneata, apice sat subito contracta, frondis adultae usque ad 25 cm. circ. longa, 3.8 cm. lata, tenuia, subtus paulo pallidiora, margine setis plerisque 1 mm. usque ad 2 mm. longis ciliata, supra nervis aequivalidis 3 et ulterioribus tenuioribus dextra sinistra marginem versus 2, subtus nervis circ. 8 fere aequivalidis percursa. Nervi transversales praecipue supra optime conspicui, densi, serpentini. Spadix fusco-furfuraceus, 42 cm. longus, quorum pars ramosa circ. 8 cm., spathis primariis 2. Spathae angustae, superne modice dilatatae, fere inermes, inferne aculeis tuberculiformibus parvis, inferior oblique producta, in modo auris asini (germanice "Eselsohren," anglice "dog's ears"), secunda longius protracta. Inflorescentiae partiales 2, inermes, spiculis aggregatis nanis. Spathae secundariae breviores, infundibuliformes. Spicae breves, crassae, circ. 1–2 cm. longae, floribus in seriebus 2 secundis dense dispositis. Spathellae bracteiformes, late triangulares. Fructus ellipsoideus i. s. circ. 2.5 × 1.5 cm. Perianthium fructiferum 3 mm. altum. Calyx in lobos late ovatos incisus corolla petalis triangularibus quam sepala vix longioribus. Squamae flavidae, in seriebus verticalibus 15 dispositae, margine brevissime obscure fimbriatae, apice obtusae. Semen ambitu ovale, lateribus nonnihil compressis, 13 mm. longum, 11 mm. latum, 8 mm. crassum. Fovea chalazae profunda. Albumen aequabile. Embryo ad basin situs.

Kurandi, Eastern Division, no. **1379**, May 12, 1926 (large rambler, abundant in rain-forests).—Vernacular names: "Durado," "Lawyer vine."

This species resembles in its leaves *C. papuanus* Becc. known only from sterile material, but the pinnae are more elongated and toward the base gradually cuneate, also the leaves are much more robust in all parts and the pinnae aculeate at the margin. It is most closely related to *C. Lauterbachii* Becc. which it strongly resembles in its spadix, but the fruits are arranged in two distinct series and the pinnae have several almost equally strong nerves. In regard to some recently described species the much connate terminal pinnae present a difference.

Areca (Balanocarpus) **nannospadix** Burret, sp. nov.

Palma parva, gracilis, 1–3 m. circ. alta. Caudex tenuis, baculiformis, in parte spadicifera 11–15 mm. in diam., annulis 2.5–4.7 cm. dissitis, glaber, i. s. tenuiter longitudinem secus striatus. Frondes circ. 3 m. longae. Vagina 26 cm. longa, cylindrica, extus decidue fusco-leprosa, ceterum glabra, i. s. utrinque dense longitudinaliter costata. Petiolus fere nullus, ex vagina breviter lateque triangularis. Rhachis fusco-leprosa, plus minus glabrescens. Lamina segmentis paucis, nervis primariis multis percursis atque nonnullis unicostatis interjectis, prope rhachin inter nervos primarios praecipue versus frondis basin nonnihil reduplicato-plicata, sat tenuis. Segmenta apicalia apice destructa, reliqua visa in margine superiore 52–58 cm. longa, paulo falcata, apice sensim anguste acuminata, unicostata, a basi angustiore sensim sensim ad 1.3 cm. dilatata. Nervi primarii ad apicem et ad basin leviter curvati, ceterum fere recti, inter primarium secundariumque lamina utrinque valde dense longitudinaliter nervosa. Spadix nanus. Spatha primaria 15 cm. longa, tenuis, apice obtuse contracta, glabra, extus tenuiter striata. Bractea basi semiamplectens dimidio circ. pedunculo inserta, lanceolata, 1 cm. circ. longa. Spadix infra frondes evolutus 13.5 cm. circ. longus, florifer jam reflexus, pedunculus 1 cm. paulo superans. Rhachis florifera 3 cm., fructifera 4 cm. circ. longa, floribus ♀ ad 14 basi ima ramorum singulariter insidientibus omnino obtecta. Rami 5.5–9 cm. circ. longi, praeter florem ♀ basilarem flores ♂ tantum gerentes, ad illorum insertiones in seriebus 2 oppositis alternatim dispositas angulatim nonnihil flexuosi, et longitudinem secus angulosi, pertenues, glabri. Flores ♂ 2 juxtappositi, parvi, 4 mm. longi. Calyx 2 mm. vix in diam., sepalis perangustis acutis. Stamina 6. Antherae anguste lineares. Filamenta ad 0.75 mm. longa. Pistillodium subulatum. Flores ♀ oblongi, glabri, bracteae floriferae ovato-triangulares, acutae, calyx corollae subaequilongus. Fructus immaturi visi anguste oblongi, 2 cm. × 0.7 cm., utrinque angustati. Perianthium in statu viso 11 mm. longum, corolla quam calyx conspicue altior, sepala et petala acuta, forma fere aequalia, late ovata, petala potius paululo latiora, magis contracto-producta, apice brunescente, in sepalis viridi.

Ihu, Vailala River, rain-forest, no. **921**, Feb. 9, 1926 (handsome small palm, 4–8 ft. high; trunk slender, bright green; spathe yellow-white).

From the species better known to me this is well distinguished. In *A. Alicae* W. Hill ex F. v. Muell., which I have not before me, the staminate flowers are arranged in two unilaterally approximated series and said to have only three stamens; it produces several stems from one root-stock, while *A. nannospadix* apparently has solitary stems. Also *Areca torulo* Becc. and *A. niga-solu* Becc., which are based on incomplete fruiting material, might be compared, but both these species are tall palms the height of which is stated to be 16 to 20 meters, while this is a graceful dwarf palm.

Actinophloeus microcarpus Burret, sp. nov.

Palma gracilis, 2.5–3.5 m. alta. Frondes 1.20–1.55 m. circ. longae, longe petiolatae, petiolo longe vaginante fusco-furfuraceo. Vaginae fragmentum apicale visum pro rata tenue, extus longitudinaliter dense nervosum, decidue albo-tomentosum et fusco-leprosum, lobis 2 lanceolatis nonnihil auriculatum. Petioli fragmentum visun tomento albo fere omnino delapso, vestimento leproso sub lente punctulis minutissimis fuscis conspicuo, rotundato-triangulare, supra canaliculatum, marginibus subacutis. Segmenta inter tenuiora, omnia libera, nervo primario unico percursa, in rhacheos fragmentis inferioribus plura dense per greges nonnihil dissitos disposita, sed etiam haud procul apice 2 vel pauca approximata vel sequentia irregularia, omnia anguste linearia, basilaria oblique praemorsa et plus minus irregulariter denticulata, margine superiore nonnihil producto, infima circ. 15–16 cm. longa, 12 mm. lata, sequentia longitudine evidenter, latitudine paulo accrescentia, in rhachi probabiliter dimidia 2 cm. lata, 31 cm. longa, apice protracto-bifida, apicibus anguste acuminatis, 6 cm. circ. longis, subaequalibus, segmenta apicem versus sensim longitudine et latitudine diminuentia, apicalia 9–10 cm. longa, anguste linearia, apice breviter vel brevissime biloba, omnia subtus glabra, sub lente verruculosa. Spadicis fragmentum ramis 4, rami glabri, 20 cm. circ. longi, pro rata tenues, fructiferi sicci, in dimidio 2 mm. in diam., in internodiis fere teretes, longitudinem secus leviter rugulosi, apicem versus paulo attenuati, basi bractea late rotundata et breviter apiculata suffulti. Florum glomeruli in spira laxa dispositi, ad magnam ramorum partem flore ♀ cum ♂ 2 in dimidio latere appositis, ad apicem masculo unico femineo juxtapposito. Fructus parvi, 1.3 cm. longi, oblongi, modice rostrati. Perianthium dimidium fructum altitudine aequans. Calyx humilis, ⅓ corollam vix altus, sepalis latissime rotundatis, tiutnere striatis. Corolla petalis late rotundatis, apice perbreviter apiculatis, extus striato-nervosis. Semen anguste oblongum, fibris gracilibus velatum, 5 mm. fere in diam., sulcis 5 pro rata paulo insculptum, albumine aequabili.

Loloki River, in dumps on river bank, no. **1659**, June 17, 1926 (slender palm, 8–10 ft.; leaves 4–5 ft. long, with long sheathing petioles covered with brown mealy substance; inflorescence 3 panicles of various ages down below the leaves; fruits brownish, red when ripe).

Some species of this genus are known to me incompletely or only from the description; these show in comparison with the new species the following differences: in *Actinophloeus ambiguus* Becc. the fruits are considerably larger, the pinnae though also arranged in groups are much larger and broader, also the spadices are according to the description only simply branched; in *A. propinquus* Becc. the segments are oblanceolate; *A. furcatus* Becc. has regularly arranged pinnae which are much longer and broader; in *A. Sanderianus* the branches are thick, while in the new species they are remarkably thin.

Actinophloeus linearis Burret, sp. nov.

Palma amoena, gracilis, 4–5 m. alta. Petiolus 35 cm. longus, supra canaliculatus, subtus protracto-rotundatus, minute atro-fusco-leproso-punctatus. Segmenta inter robustiora, ex rhacheos fragmentis 2 visis circ. dimidiae 12.5 cm. longo atque apicalis 21.5 cm. longo, ut videtur, regulariter et in eadem planitie disposita, linearia, dimidiae rhacheos 50 cm. fere longa, in dimidia parte inferiore 2.7 cm. circ. lata, unde superne sensim paulo sed conspicue attenuata, apice oblique praemorsa, apicalia 2 sola nervis primariis 3 percursa, apice transverse praemorsa et brevissime obtuse lobulata, linearia, undique fere aequilata, 2.3 cm. et 3 cm. circ. lata, in margine superiore 20 cm. longa, inter nervos primarios nonnihil plicata, sequentia 6 visa quam apicalia nonnihil angustiora, inter se circ. aequilata, sed longitudine accrescentia, apice biloba, 1.5 cm. latitudine modice superantia, segmenta omnia supra glabra, laevia, nitentia, subtus opaca, sub lente trichomatibus minutis, fuscis dense verruculoso-punctata. Spadix multi-ramosus, visus prob. ramus primarius 40 cm. circ. longus, ramulis simplicibus 8, rhachis partialis ut rami minute denseque fusco-leproso-squamulosa, longitudinem secus conspicue acute angulosa, ramuli visi bractea triangulari suffulti, basin versus longitudinaliter angulosi, inter minus tenues, in dimidio, flores ♀ gerentes, sicci in internodiis 2 mm. in diam. vel vix superantes, 33–30 cm. circ. longi, apice breviter tenui. Florum glomeruli ad maximam ramorum partem 3-flori, intermedio ♀, ♂ in dimidio latere juxtappositis, apicem versus flos masculus juxta femineum. Flores ♂ 4 mm. longi, oblongi. Calyx 1.5 mm. altus, sepalis late rotundatis. Petala apice obtusiuscula. Stamina circ. 15. Antherae oblongo-lineares, in dimidio dorso affixae, basi sagittatae. Pistillodium stamina vix superans, superne fere filiforme, ad basin ventricosum. Flores ♀ sepalis late rotundatis, petalis late ovatis tegentibus apice valvatis. Fructus non visi.

Lower Mori River, Eastern Division, rain-forest, no. **1566**, May 28, 1926 (pretty, slender palm 12–15 ft.; several panicles down below the leaves; fruit black, fleshy).

Actinophloeus ambiguus Becc. is according to the description only 1.5–2 m. tall, the leaves are described as completely glabrous, while here the segments beneath are fairly densely covered with minute scales, also the spadix of *A. ambiguus* is according to the description glabrous and only simply branched. In *A. propinquus* Becc. the pinnae are oblanceolate. *Actinophloeus furcatus* Becc. has the branches of the spadix filiform, while those of *A. Sanderianus* are thick, which also does not agree with the new species. Of the other species I have a more exact knowledge.

Botanisches Museum
Berlin-Dahlem.

TWO PANDANACEAE FROM THE NEW HEBRIDES COLLECTED BY S. F. KAJEWSKI

U. Martelli

I am indebted to Mr. Alfred Rehder, Curator of the Herbarium of the Arnold Arboretum, for the opportunity of examining two interesting Pandanaceae collected by S. F. Kajewski in the New Hebrides. The flora of this island group is yet very little known.

Pandanus Cominsii Hemsley in Hooker's Icon. Pl. xxvii. t. 2654 (1900).

Banks group: Vanua Lava Island, common in rain-forest, alt. 100 m., no. **471**, July 12, 1928 (up to 4 m. high, much smaller than its coastal relative; fruit red when ripe, on a spike cylindrical in shape).

This species was originally described from the Solomon Islands.

Freycinetia tannaensis Martelli, sp. nov.

Caulis 7 mm. crassus ad apicem ramulorum ibique internodiis 5 mm. longis longitudinaliter rugulosis (in sicco). Folia ad apicem ramorum, rigidula, anguste linearia, sensim attenuato-acuminato-subulata, 8 mm. lata, planiuscula, utrinque longitudinaliter crebre et manifeste venosa, basi brevi tractu canaliculata et sensim dilatata, semiamplectentia, marginibus et costa media inermibus vel apicem versus remote breviterque et parce denticulatis, auriculis ad basim foliorum 3 cent. longis submembranaceis cito caducis basi 6 mm. latis lanceolato-acuminatis ambitu subconvexis apici adnatis. Inflorescentia triquetra, pedunculo crassiusculo 1 cm. diam. brevi 2.5 cm. longo, pedicellis subaequalibus 25–27 mm. longis et 3 mm. crassis levibus. Syncarpia oblonga, ellipsoidea, inaequalia, 2–4 cm. longa, 1–2 cm. crassa. Baccae circiter 8 mm. longae, parce cuneatae, in parte apicali brevi 3–4 mm. rotundata et a papilla brevissima stigmatifera 3–4-lobulata superata; stigmata 3–4, interdum 5, annulo lobulato levi cincta. Semina 1 mm. longa, lunata, linearia-subcymbiformia, longitudinaliter minutissime costulata, raphe angusta alba, strophiolo angustissimo.

Tanna Island: on Mt. Tokosh Meru, in rain-forest, alt. 800 m., very common, no. **163**, March 15, 1928 (climbing up the trunks of trees).

This is a very fine and characteristic species remarkable for its narrow acuminate-subulate leaves, but chiefly for its very small seeds looking like little worms; they are curved and sickle-shaped, with a narrow but evident white raphe, while the strophiole is extremely narrow and hardly visible. Under the lens the seeds are densely marked with very minute longitudinal lines.

FLORENCE, ITALY.

NOTES ON CHINESE PLANTS

FRANKLIN P. METCALF

Desmodium floribundum (D. Don) Sweet, Hort. Brit. ed. 2, 150 (1830); ed. 3, edited by G. Don, 180 (1839).—G. Don in Gen. Syst. II. 297 (1832).—Rehder & Wilson in Sargent, Pl. Wilson. II. 103 (1914).—Rehder, Man. Cult. Trees & Shrubs, 515 (1927).

Hedysarum floribundum D. Don, Prodr. Fl. Nep. 244 (1825).

The erroneous citation of G. Don as the author of this combination is apparently due to the fact that the 2nd edition of Sweet's Hort. Brit. was overlooked, in which the transfer to *Desmodium* was first made 2 years earlier than that of G. Don.

Desmodium Dunnii Merrill in Herb. Arnold Arboretum, nom. nov.

Lespedeza lanceolata Dunn in Jour. Linn. Soc. xxxv. 488 (1903).

Desmodium lanceolatum (Dunn) Schindler MSS. ex Gagnepain in Lecomte, Fl. Gen. Indo-Chine, II. 572 (1920).

There is already a *Desmodium lanceolatum* Walpers, Rep. I. 737 (1842), which was overlooked both by Schindler and by Gagnepain, hence this new name chosen by E. D. Merrill.

Spondias chinensis (Merrill) Metcalf, comb. nov.

Poupartia chinensis Merrill in Philip. Jour. Sci. xv. 245 (1919).

In describing this species as a *Poupartia* E. D. Merrill stated that it was very closely related to the only other Chinese species of this genus, *P. Fordii* Hemsley, which now has been referred as a synonym to *Spondias axillaris* Roxburgh (see Rehder & Wilson in Sargent, Pl. Wilson. II. 172 [1914]); the species that still remain in *Poupartia* according to Engler (in De Candolle, Monog. Phan. IV. 260) are from Madagascar and Mauritius. Moreover this species apparently has valvate or subvalvate petals and so should be placed in *Spondias*.

Known from Kwangtung, Fukien, Hainan and Tonkin.

Bredia amoena Diels in Notizbl. Bot. Gard. Mus. Berlin, IX. 197 (1924).

Bredia chinensis Merrill in Jour. Arn. Arb. VIII. 11 (1927); **synon. nov.**

Dr. E. D. Merrill evidently overlooked the description by Diels, published 3 years earlier. The type in both cases was Hu's no. 30, from Wenchow, Chekiang.

Schefflera Delavayi (Franchet) Harms in Bot. Jahrb. XXIX. 486 (1900).

Heptapleurum Delavayi Franchet in Jour. de Bot. X. 307 (1896).

Type from Yunnan (*Delavay*, no. 3865); also known from Hunan, (*Handel-Mazzetti*, no. 12251); Szechuan (*Wilson*, no. 4559; *Fang*, nos. 3241, 5713).

Schefflera Delavayi var. **ochrascens** Handel-Mazzetti in Anzeig. Akad. Wiss. Wien Math.-Nat. Kl. 1924, p. 120 (Pl. Nov. Sin. Forts. 27, p. 1) (1924).

Schefflera discolor Merrill in Lingnan Sci. Jour. VII. (1929) 318 [March 1931]; **synon. nov.**

Franchet in the original description of *Schefflera Delavayi* (l. c.) says "folia . . . subtus albo-tomentella" and the numbers listed under the species are typical. Handel-Mazzetti in describing the var. *ochrascens* only says "tomentum ochraceum." An isotype of Handel-Mazzetti's no. 4994 at the Arnold Arboretum matches very well with McClure's no. 13773 which is an isotype of Merrill's new species *S. discolor* from Kwangtung. Chun's no. 5672 and Tsiang's no. 1335, formerly identified and distributed as *S. Delavayi* (Fr.) Harms also agree perfectly with Merrill's type. Merrill states "that it is nearest to *S. Delavayi* Harms of Szechuan Prov., which has usually toothed leaves, closer and thinner pubescence and shorter racemes." This holds true for the species, except as to the racemes. On the other hand the species *S. discolor* does agree with the var. *ochrascens* Handel-Mazzetti, which was possibly overlooked by him.

There might be a question as to whether this should be of varietal or specific rank, but on account of the presence of intermediate forms it can hardly be maintained as a species. In both the variety and the species the leaves vary from entire to coarsely toothed and Schneider's no. 314 and Henry's no. 9214 from Yunnan have a tomentum intermediate between "albo-tomentella" of *S. Delavayi* and the "tomentum ochraceum" of the variety *ochrascens*.

DISTRIBUTION OF THE VARIETY: Yunnan: *Handel-Mazzetti*, no. 4994 (isotype of var.) and no. 9553. Kwangtung: *McClure*, no. 13773 (Arnold Arboretum; isotype of *S. discolor* Merrill); also *Chun*, no. 5672 and *Tsiang*, no. 1335. Schneider's no. 314 and

Henry's no. 9214 from Yunnan also approach this variety. (All in Herb. Arnold Arboretum.)

Xylosma congestum (Lour.) Merr.[1] var. **kwangtungensis** Metcalf, var. nov.

A typo differt foliis elongato-ellipticis vel oblanceolatis grosse serratis supra pallidioribus subtus plerumque castaneo-brunneis.

Kwangtung: Honan Island, *Levine*, nos. 172 and 177 (syntypes), 279 and 365, ex Herb. Canton Christian University; Canton and vicinity, *Levine*, nos. 18, 1809, 2084, 3261, all ex Herb. Canton Christian University; Peiyunchan, *Tsiang*, no. 1594, ex Herb. Sun Yatsen University; Lofaushan, *W. Y. Chun*, no. 1741 and *Tsiang*, no. 1680, both ex Herb. Sun Yatsen University.

This variety differs from the type in the elongate elliptical or oblanceolate coarsely serrate leaves, usually paler above and chestnut-brown beneath.

Vaccinium mandarinorum Diels in Bot. Jahrb. XXIX. 516 (1901).

Vaccinium Donianum Maximowicz in Mél. Biol. I. 608 (1872); in Bull. Acad. Sci. St. Pétersb. XVIII. 43 (1873); in part, in note under *V. bracteatum* Thbg.—Hemsley in Jour. Linn. Soc. XXVI. 15 (1889) in note under *V. bracteatum*.—Rehder & Wilson in Sargent, Pl. Wilson. I. 557 (1913), exclusive of synons. *V. affine* Wight, *Epigynium affine* Klotzsch and *E. Donianum* Klotzsch.—Non *V. Donnianum* Wight, nec *V. Donianum* Miquel).

Vaccinium parvibracteum Hayata in Ic. Pl. Formos. III. 128 (1913).

Vaccinium Donianum Wight var. *hangchouense* Matsuda in Bot. Mag. Tokyo XXVI. 319 (1912).

Vaccinium hangchouense (Matsuda) Komatsu in Ic. Pl. Koisikav. III. 95, t. 193 (1917); **synon. nov.**

All the Chinese material referred by most authors to the Himalayan *V. Donnianum* Wight (usually spelled *V. Donianum* Wight) is really not this species at all, but a distinct Chinese species with good characters which, however, have been mostly overlooked. This discovery was made while attempting to verify *V. parvibracteum* Hayata, which was described from Mt. Kosan, Fukien. This species was listed by Komatsu (l. c.) as a synonym of his *V. hangchouense* which he raised to a species from the variety originally described by Matsuda. In Matsuda's original description (l. c.) of this variety under *V. Donnianum* Wight, he said that the variety could be distinguished by having a glabrous non-ciliated calyx and

[1] The transfer of the specific epithet from *Apactis japonica* Thunberg (the oldest name, 1783) to *Xylosma* can not be made as there already exists a *Xylosma japonica* (Walpers) A. Gray. This is according to the International Rules, even if the second name is actually a synonym of the first as in this case. The specific epithet of the next oldest name therefore should be used which is *Croton congestum* Loureiro. Koidzumi (in Tokyo Bot. Mag. XXXIX. 316 [1925] and Nakai (Fl. Sylv. Kor. XVII. 51, t. 14 [1928]) use the combination *Xylosma Apactis* (Thunberg) Koidzumi for this plant, but I see no justification under the International Rules of abandoning the next oldest specific name and adopting this generic name for this species.

a corolla glabrous within and without, and stated that the species *V. Donnianum* had a ciliated calyx and a corolla glabrous without but villose within, as shown by Wight's Icones, t. 1191. When I examined the material named *V. Donnianum* I soon found that almost all had a glabrous non-ciliated calyx and a glabrous corolla within and without. We have therefore 2 distinct species, one *V. Donnianum* of Wight from the Himalayan region and another which is distinctly Chinese. To make sure of this, topotype material was critically examined in the Gray Herbarium. The only two sheets there from Khasia (type locality) and East Bengal, as well as two others at Arnold Arboretum had a distinctly ciliated calyx and a corolla villous within, agreeing perfectly with the original descriptions and plate of Wight.

The next question was what should the Chinese material be named. It is certainly of specific rank. The oldest name applied to this species is that of *V. mandarinorum* Diels. *Vaccinium parvibracteum* of Hayata is much later. Unfortunately Matsuda who actually first noticed the difference between the real *V. Donnianum* and the Chinese species separated the latter much later (1912) and only as a variety. Diels (l. c.) apparently did not get hold of the real distinguishing characters but distinguished it from the Himalayan *V. Donnianum* Wight by broader leaves and shorter pedicels. Rehder and Wilson reduced this rightly to the Chinese *V. Donnianum*, but did not separate it from the true Himalayan species.

A cotype of Diels *V. mandarinorum* was examined (Henry, no. 5807^{B}, at the Gray Herbarium) with which the Chinese material agrees. In making dissections of these two species additional characters were found which may also help in identification. A synopsis of the differences are given below:

Vaccinium Donnianum Wight

Calyx ciliate; corolla villose within, glabrous without; staminal appendages 1.2–1.4 mm. long and horns ⅓ to ½ the length of anther (minus the appendage).

Distribution: Wight (l. c.) lists Khasia by Griffith. Khasia: 3–5000 ft., *Hooker f. & Thomson*, Herb. Ind. Or. (Gray Herbarium); same locality 5000 ft., *Ruse*, no. 146, in 1923 (Arnold Arboretum). East Bengal: Herb. E. India Co., *Griffith*, no. 3457/1 (Gray Herbarium). Burma: Mergin, 1800 m., *Parker*, no. 3108 (Arnold Arboretum). Naga Hills: 4500 ft., *Prain*, May 10, 1886. (Arnold Arboretum).

Wilson's no. 1010 from Patung, W. China, approaches this, having a pubescent, not ciliate calyx and a corolla subglabrous to slightly pubescent within, or may not be this species. Henry's no. 11917 from Szemao Mts., 5000 ft., Yunnan, appears to be this species having a ciliate calyx and pubescent corolla within. It represents apparently the only specimen of this species from China proper. Other sheets collected from these same mountains are distinctly *V. mandarinorum* Diels.

Vaccinium mandarinorum Diels

Calyx not ciliate; corolla glabrous within and without; staminal appendages about 3 mm. long and horns about same length as anther (minus the appendage).

DISTRIBUTION: Diels (l. c.) lists only Henry's no. 5807^{B} from Hupeh (Berlin; cotype seen in Gray Herbarium). Many specimens examined from Fukien, Chekiang, Kiangsi, Anhwei, Kiangsu, Hunan, Hupeh, Szechuan, Yunnan and E. Tibet.

Vaccinium Donnianum Wight, Icon. IV^{1} 5, t. 1191 (1845–46); Calcutta Jour. Nat. Hist. VIII. 174 (1847).

Vaccinium affine Wight, Icon. t. 1190 (1845–46).
Vaccinium Donianum Wight apud Clarke in Hooker, Fl. Brit. Ind. III. 453 (1882).—Matsuda in Tokyo Bot. Mag. XXVI. 319 (1912) excl. var.—Non *V. Donianum* Maximowicz, nec *V. Donianum* Miquel.

The original spelling in Wight's Icones, in two places and in the Calcutta Journal was "Donnianum." Why "Donianum" was taken up by the Kew Index is a mystery. Others followed this error. Possibly it was on account of *V. Donianum* Miquel. The species was probably named after Donn and not Don.

There are a number of varieties grouped under *V. Donnianum* Wight by various authors. All this varietal material, however, is more closely allied to the Chinese species *V. mandarinorum* Diels, having a glabrous calyx and glabrous corolla. For that reason all these varieties should be transferred from *V. Donnianum* Wight to *V. mandarinorum* Diels. These combinations are made below:

Vaccinium mandarinorum Diels var. **laetum** (Diels) Metcalf, comb. nov.

Vaccinium laetum Diels in Bot. Jahrb. XXIX. 516 (1901).
Vaccinium Donianum Wight var. *laetum* (Diels) Rehder and Wilson in Sargent, Pl. Wilson. I. 558 (1913).

Szechuan only.

Vaccinium mandarinorum var. **austrosinense** (Hand.-Mazz.) Metcalf, comb. nov.

Vaccinium Donianum Wight var. *austrosinense* Handel-Mazzetti in Anzeig. Akad. Wiss. Wien Math.-Nat. Kl. 1921, p. 176 (Pl. Nov. Sin. Forts. 13, p. 1) (1921)

Type from Hunan, also known from Fukien, Kwangtung and Kiangsi.

The type of *V. Donianum* var. *brachybotrys* Franchet was not seen but I believe it is better here to follow Handel-Mazzetti (Anzeig. Akad. Wiss. Math.-Nat. Kl. 1925, p. 146 [Pl. Nov. Sin. Forts. 35, p. 4] [1925]) who has raised this to a species.

Xolisma ovalifolia (Wallich) Rehder var. **hebecarpa** (Franchet and Hemsley) Metcalf, comb. nov.

Pieris ovalifolia D. Don var. *hebecarpa* Franchet in litt. in Hemsley, Jour. Linn. Soc. xxvi. 17 (1889).

DISTRIBUTION: Chekiang: Meichi (*Poli* ex Franchet) in Hemsley, l. c.; Ningpo, *Macgregor*, in 1908 (Arnold Arboretum).

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NOTES ON THE LIGNEOUS PLANTS DESCRIBED BY H. LÉVEILLÉ FROM EASTERN ASIA[1]

ALFRED REHDER

SAXIFRAGACEAE

Philadelphus pekinensis Ruprecht in Bull. Phys. Math. Acad. Sci. St. Pétersb. xv. 365 (1857); in Mél. Biol. ii. 543 (1858).

Deutzia Chanetii Léveillé in Fedde, Rep. Spec. Nov. ix. 451 (1911); **synon. nov.**

CHINA. Chili: "Montagnes de Kou-ping," very rare, *L. Chanet*, no. 416, June, 1909 (holotype).

Philadelphus Henryi Koehne in Fedde, Rep. Spec. Nov. x. 126 (1911).

Deutzia mollis var. *erythrocalyx* Léveillé in herb.

CHINA. Yunnan: "rochers du mont à Pe-long-tsin, alt. 3280 m." *E. E. Maire*, June (holotype).

The leaves of Maire's specimen are more densely pubescent beneath than in typical *P. Henryi*. I have been unable to find the place of publication of Léveillé's name, probably it is only a manuscript name.

Philadelphus Magdalenae Koehne in Mitt. Deutsch. Dendr. Ges. xiii. 83 (1904).

Philadelphus coronarius var. *chinensis* Léveillé, Fl. Kouy-Tchéou, 389 (1916), nom. nudum; **synon. nov.**

CHINA. Kweichou: "Tou-chan," *J. Cavalerie* (herb. Bodinier, no. 2343), May 1898 (holotype).

Cavalerie's specimen represents apparently a glabrescent form of

[1] Continued from vol. x. 196 (1929).

P. Magdalenae Koehne. The leaves are rather densely setose-strigose above as in the type, but beneath they are glabrous except the setose-strigose veins.

Deutzia lancifolia Rehder in Sargent, Pl. Wilson. I. 147 (1912).—Léveillé, Fl. Kouy-Tchéou, 387 (1915).

Styrax Esquirolii Léveillé in Fedde, Rep. Spec. Nov. IX. 446 (1911); Fl. Kouy-Tchéou, 387 (1915), pro synon.
Deutzia Esquirolii Léveillé, Fl. Kouy-Tchéou, 387 (1915), pro synon.
Deutzia Chaffanjoni Léveillé, l. c. (1915), pro synon.

CHINA. Kweichou: "Lou-tsong-kouan, Kien-tin-chan," *J. Esquirol*, no. 22, May 2, 1904 (holotype of *Styrax Esquirolii* and *Deutzia Esquirolii*); "environs de Kouy-yang, monts du Collège," *J. Chaffanjon* in herb. Bodinier, no. 2223, April 1898 (holotype of *D. lancifolia* [in herb. Paris] and of *D. Chaffanjoni* [in herb. Léveillé]).

Apparently neither *D. Esquirolii* nor *D. Chaffanjoni* which is based on the same number as *D. lancifolia* were published before Léveillé cited them as synonyms of *D. lancifolia*.

Deutzia cyanocalyx Léveillé in Fedde, Rep. Spec. Nov. X. 438 (1912); Fl. Kouy-Tchéou, 386 (1915).

CHINA. Kweichou: Kouy-Yang, monts du Collège, *J. Cavalerie*, no. 1196, April 1903 (holotype).

This species is closely related to *D. lancifolia* Rehd., but differs chiefly in the much larger and broader leaves, up to 10.5 cm. long and 3 cm. broad, and in the larger flowers.

Deutzia coreana Léveillé in Fedde, Rep. Spec. Nov. VIII. 283 (1910).—Rehder in Sargent, Pl. Wilson. I. 22 (1911).—Nakai, Fl. Sylv. Kor. XV. 60, t. 16 (1926).

KOREA: in Monte des Diamants, *U. Faurie*, no. 364, June 1906 (holotype; isotype in herb. Arnold Arboretum).

This is a very distinct species constituting the subsect. *Coreanae* Rehd. of sect. *Eudeutzia* Engl.

Deutzia glabrata Komarov in Act. Hort. Petrop. XXII. 433 (1903).—Rehder in Sargent, Pl. Wilson. I. 24 (1911).—Nakai, Fl. Sylv. Kor. XV. 63 (1926).

Deutzia Fauriei Léveillé in Fedde, Rep. Spec. Nov. VIII. 283 (1910).
Crataegus Pomasae Léveillé in Fedde, Rep. Spec. Nov. XII. 189 (1913); **synon. nov.**

KOREA: "in rupibus Montis des Diamants" [Kogo-san], *U. Faurie*, no. 360, June 24, 1906 (holotype of *D. Fauriei*); Pomasa, *U. Faurie*, no. 362, May 21, 1906 (holotype of *Crataegus Pomasae*).

Hydrangea Davidii Franchet in Nouv. Arch. Mus. Paris, sér. 2, VIII. 227 (Pl. David. II. 44) (1885).

Hydrangea Arbostiana Léveillé in Bull. Acad. Intern. Geog. Bot. XII. 115 (1903).—Rehder in Sargent, Pl. Wilson. I. 41 (1911).

Hydrangea Davidi Franch. var. *Arbostiana* Léveillé, Fl. Kouy-Tchéou, 387 (1915).

CHINA. Kweichou: Kouy-Yang, Mont du Collège ça et la dans la montagne," *E. Bodinier*, no. 1694, June and July 21, 1897 (holotype of *H. Arbostiana*); Pin-fa, Yuin-ou-chan, *J. Cavalerie*, no. 39, July 15, 1902 (paratype of *H. Davidii* var. *Arbostiana*); Mei-ting-chan, *J. Cavalerie*, no. 49, July 1902 (ex Léveillé; paratype of *H. Davidi* var. *Arbostiana*).

Hydrangea Arbostiana does not seem to differ at all from *D. Davidi* and can not be maintained even as a variety.

Hydrangea paniculata Siebold in Nov. Act. Acad. Leop.-Carol. XIV. pt. II. 690 (Syn. Hydrang.) (1829).

Hydrangea Kamienskii Léveillé in Bull. Acad. Intern. Geog. Bot. XII. 115 (1903); Fl. Kouy-Tchéou, 388 (1915).—Rehder in Sargent, Pl. Wilson. I. 41 (1911).—**Synon. nov.**

Hydrangea sachalinensis Léveillé in Fedde, Rep. Spec. Nov. VIII. 282 (1910); **synon. nov.**

Saghalin: "in silvis Korsakof," *U. Faurie*, no. 439, Oct. 1908 (holotype of *H. sachalinensis*).

CHINA. Kweichou: "monts de Lou-tsong-koan," *E. Bodinier*, no. 1661, July 12, 1897 (syntype of *H. Kamienskii*); "Gan-pin, environs de Touchang," *L. Martin & E. Bodinier*, no. 1661bis, Aug. 1897 (ex Léveillé; syntype of *H. Kamienskii*).

Hydrangea strigosa Rehder in Sargent, Pl. Wilson. I. 31 (1911).

Premna Merinoi Léveillé, Sert. Yunnan. 3 (1916); Cat. Pl. Yunnan, 278 (1917); **synon. nov.**

Hydrangea villosa Rehd. var. *Mairei* Léveillé, Cat. Pl. Yunnan, 254 (1917); **synon. nov.**

CHINA. Yunnan: "brousses des montagnes a Siai-Ho, 2700 m.," *E. E. Maire*, May–July 1912 (holotype of *Premna Merinoi*); "brousses des monts Io-Chan et Kiao-Me-Ti, 3100–3300 m.," *E. E. Maire*, July–Oct. 1912 (holotype of *H. villosa* var. *Mairei*).

The specimen of *Premna Merinoi* bears only young inflorescences with the small lanceolate deciduous bracts still present and conspicuous, which probably induced Léveillé to refer the plant to *Premna*.

Hydrangea Rosthornii Diels in Bot. Jahrb. XXIX. 374 (1900).—Léveillé, Fl. Kouy-Tchéou, 388 (1915).

Hydrangea Maximowiczii Léveillé in Bull. Acad. Intern. Geog. Bot. XII. 114 (1903).

CHINA. Kweichou: "environs de Gan-pin, grand rocaille," *L. Martin & E. Bodinier*, July 11, 1897, July 1899 (ex Léveillé; syntypes of *H. Maximowiczii*); "environs de Tou-chan," *J. Cava-*

lerie, no. 22, July 1897 (syntype of *H. Maximowiczii*); Pin-fa, route de Tzai-kin, *J. Cavalerie*, no. 69, July 15, 1902.

I have not seen the specimen from Gan-pin, but Cavalerie's no. 22 and his 69 which is not cited in the original description, but in the Flore de Kouy-Tchéou, and bears on the original field label the name "*Hydrangea Maximowiczii* Lévl. ou sp. nov." and on another label the name "*Hydrangea Rosthornii* Diels," both in Léveillé's handwriting. Cavalerie's no. 22 resembles in its narrower oblong leaves (about 13 x 45 cm.) somewhat *H. strigosa*, but in the ciliate serration of the leaves and in the more villous pubescence it agrees with *H. Rosthornii.*

Hydrangea petiolaris Siebold & Zuccarini, Fl. Jap. I. 106, t. 54 (1835).—Rehder in Sargent, Pl. Wilson. I. 41 (1911).—Nakai, Fl. Sylv. Kor. XV. 71, t. 22 (1926).

Hydrangea tiliaefolia Léveillé in Fedde, Rep. Spec. Nov. VIII. 282 (1910).

KOREA. Quelpaert: "in dumosis," *U. Faurie*, no. 358, Oct. 1906; "in rupibus Yang-keuni," *U. Faurie*, no. 809, May 14, 1908; "in silvis," *U. Faurie*, no. 1654, July 1907; (all syntypes of *H. tiliaefolia*).

Of no. 809 I have seen the original specimen in the Edinburgh herbarium with the name in Léveillé's handwriting; of the other two numbers there are isotypes in the herbarium of the Arnold Arboretum.

Schizophragma hydrangeoides Siebold & Zuccarini, Fl. Jap. I. 58, t. 26 (1835).—Nakai, Fl. Sylv. Kor. XV. 73, t. 24 (1926).

Hydrangea Taquetii Léveillé in Fedde, Rep. Spec. Nov. VIII. 282 (1910).

KOREA. Quelpaert: "in muris agrorum Hogno," *E. Taquet*, no. 807, May 12, 1908 (syntype); "in silvis Yang-kami," *E. Taquet*, no. 808, May 10, 1908 (syntype).

Of both numbers there are isotypes in the herbarium of the Arnold Arboretum and of no. 807 I have also seen the original specimen now in the Edinburgh herbarium.

Dichroa febrifuga Loureiro, Fl. Cochinchin. 301 (1790).

Callicarpa Esquirolii Léveillé in Fedde, Rep. Spec. Nov. IX. 456 (1911); Fl. Kouy-Tchéou, 439 (1915); not Léveillé in Fedde Rep. Sp. Nov. IX. 325; **synon. nov.**

Dichroa Henryi Léveillé, Sert. Yunnan. 1 (1916); Cat. Pl. Yunnan, 254 (1917); **synon. nov.**

CHINA. Kweichou: "Ouang-mou," *J. Esquirol*, no. 72, June 1904 (holotype of *Callicarpa Esquirolii*). Yunnan: Szemao, eastern mts., 5000 ft., *A. Henry*, no. 11050 (holotype of *D. Henryi*).

Of Henry's no. 11050 I have seen an isotype in the herbarium of the Arnold Arboretum and I also saw no. 11050B; both are identical, but their leaves are denticulate and not "grosse dentata" as described by Léveillé. Nevertheless I consider *D. Henryi* identical with *D. febrifuga* which varies considerably in the shape, size, and serration of its leaves.

Itea yunnanensis Franchet in Jour. de Bot. x. 268 (1896).

Itea Bodinieri Léveillé in Fedde, Rep. Spec. Nov. IX. 457 (1911); Fl. Kouy-Tchéou, 388 (1917), pro synon. *I. Esquirolii* Lévl.; **synon. nov**

Itea Esquirolii Léveillé, Fl. Kouy-Tchéou, 388 (1917); **synon. nov.**

CHINA. Kweichou: Kiang-ti, *J. Esquirol*, no. 1501; "environs de Gan-Pin, dans la grande rocaille près de ville," *L. Martin & E. Bodinier*, no. 1625 (ex Léveillé; syntype); "environs de Kouy-Yang, mont du Collège, à la grande Cascade," *E. Bodinier* [no. 1645 ?], May 26, 1899 (ex Léveillé); Pin-fa, *J. Cavalerie*, no. 1082, June 23, 1903 (ex Léveillé; all syntypes of *I. Bodinieri*).

In his Flore de Kouy-Tchéou the author changes without apparent reason the name *Itea Bodinieri* to *I. Esquirolii* and cites the former name as a synonym; the syntypes cited are the same. Léveillé distingüishes his species chiefly by the pilose flowers from *I. yunnanensis* which typically has a glabrous calyx and pedicels, but a form with short-pilose calyx and pedicels, while differing in no other character from the typical form, seems not uncommon. In the Arnold Arboretum herbarium I find 19 Yunnan specimens with glabrous calyx collected by *G. Forrest, C. Schneider, J. F. Rock, E. E. Maire* and *H. Handel-Mazzetti*, and only the following specimens with pubescent calyx: *A. Henry*, no. 9297, *Siméon Ten*, no. 91, *H. Handel-Mazzetti*, no. 10197, *J. F. Rock*, no. 3095 and *G. Forrest*, no. 19240. Besides there is one specimen from western Szechuan (E. H. Wilson, no. 325) with pubescent calyx. *Itea ilicifolia* Oliv. which does not seem to occur in Yunnan and western Szechuan has its calyx always glabrous.

Ribes laurifolium Janczewski in Bull. Acad. Sci. Cracovie, sér. Sci. Nat. 1910, p. 79 (1910).

Cavaleriea enkianthoidea Léveillé in Fedde Rep. Spec. Nov. XI. 66 (1912); Fl. Kouy-Tchéou, 389 (1917), pro synon. Ribes pachysandroideae; **synon. nov.**

Ribes pachysandroidea Léveillé, Fl. Kouy-Tchéou, 389 (1917); non *R. pachysandroides* Oliver.

CHINA. Kweichou: Kin-Tchen-Hia, depression de terrain *J. Cavalerie*, no. 3183, April 8, 1907 (holotype of *Cavaleriea enkianthoidea*).

Léveillé in 1917 had reduced his *Cavaleriea enkianthoidea* originally published as a new genus of Hamamelidaceae to a synonym of *Ribes pachysandroides* Oliv. which in turn is a synonym of *R. Davidi* Franch., but Cavalerie's no. 3183 belongs to *R. laurifolium* Jancz. and not to *R. Davidi* Franch.

PITTOSPORACEAE

Pittosporum glabratum Lindley in Jour. Hort. Soc. London, I. 230 (1846).—Léveillé, Fl. Kouy-Tchéou, 315 (1915).

Pittosporum Cavaleriei Léveillé in Fedde, Rep. Spec. Nov. XI. 492 (1913); Fl. Kouy-Tchéou, 315 (1915), pro synon. *P. glabrati.*

Pittosporum trigonocarpum Léveillé in Fedde, Rep. Spec. Nov. XI. 492 (1913); **synon. nov.**

CHINA. Kweichou: "Pin-fa, près ruisseaux," *J. Cavalerie,* no. 1746, April 5, 1904 (ex Léveillé; holotype of *P. Cavaleriei*); bois à 100 kil. sud de Tin-fan, *J. Cavalerie,* no. 1857, Nov. 1904 (holotype of *P. trigonocarpum*).

Pittosporum truncatum E. Pritzel in Bot. Jahrb. XXIX. 378 (1900).

Euonymus provicarii Léveillé, Cat. Pl. Yunnan. 34 (1915); **synon. nov.**

CHINA. Yunnan: "collines rocheuses de Pi-ka-tong," 2550 m., *E. E. Maire,* May 1912 (holotype of *Euonymus provicarii*).

The leaves of Maire's specimen are not quite typical for *P. truncatum;* they are generally oblong-obovate and rather larger, but the flowers agree well with those of *P. truncatum.*

HAMAMELIDACEAE

Distylium chinense (Fr.) Diels in Bot. Jahrb. XXIX. 380 (1900).—Handel-Mazzetti, Symb. Sin. VII. 53 in nota (1929).

Distylium Dunnianum Léveillé in Fedde Rep. Spec. Nov. XI. 67 (1912); Fl. Kouy-Tchéou, 194 (1914); **synon. nov.**

Myrica Seguini Léveillé in Fedde, Rep. Spec. Nov. XII. 537 (1913).

CHINA. Kweichou: Lo-fou, *J. Cavalerie,* no. 3551, March 1909 (holotype of *D. Dunnianum*); without precise locality, *J. Cavalerie,* no. 3929 (holotype of *Myrica Seguini*).

In the shape of its leaves *D. chinense* shows considerable variation; in Hupeh the prevailing form has obovate to obovate-oblong leaves with one to three teeth near the apex on each side, while the form occurring in Kweichou here represented by the two specimens cited above and Handel-Mazzetti's nos. 10272, 10692 and 10810, has generally longer oblong to oblong-oblanceolate entire leaves up to 7.5 cm. long, but Wilson's 2961 and 3537 (partly) from near Ichang also have entire narrower leaves though shorter, and approach the Kweichou form, besides they are more or less pubescent on the under side of the leaves. Cavalerie's no. 3929 is intermediate between the two forms, while his no. 3551 represents an extreme long-leaved form.

Corylopsis alnifolia (Lévl.) Schneider in Fedde Rep. Spec. Nov. XII. 379 (1913).—Léveillé, Fl. Kouy-Tchéou, 193 (1914).

Berchemia alnifolia Léveillé in Fedde, Rep. Spec. Nov. X. 433 (1912).

CHINA. Kweichou: "route de Pin-fa à Kouy-Yang, montagnes," *J. Cavalerie*, no. 2712, April 1905 (holotype of *Berchemia alnifolia*).

Corylopsis Wilsonii Hemsley in Hooker, Ic. Pl. XXVII. t. 2819 (1906).

Corylopsis Cavaleriei Léveillé in Fedde, Rep. Spec. Nov. XI. 295 (1912); Fl. Kouy-Tchéou, 193 (1914); **synon. nov.**

CHINA. Kweichou: Pin-fa, *J. Cavalerie*, no. 1098, June 23, 1903, arbre (holotype of *C. Cavaleriei*).

(To be continued)

A STUDY OF CHROMOSOME NUMBER IN TWO GENERA OF BERBERIDACEAE: MAHONIA AND BERBERIS

HAIG DERMEN

THE STUDY of the chromosome situation in both *Mahonia* and *Berberis* was undertaken to determine the cytological relationships between these two genera and among species in each genus. There are supposed to be some 50 species of *Mahonia* and 175 species of *Berberis*. Rehder (1927) describes 6 *Mahonia* and 48 *Berberis* species hardy in temperate North America. He also gives some interspecies hybrid forms, and one intergeneric form which has never been known to bloom. In the Arnold Arboretum there are 2 species of *Mahonia*, some 50 species of *Berberis* and the intergeneric hybrid just mentioned.

THE GEOLOGICAL HISTORY AND THE PRESENT DISTRIBUTION OF MAHONIA AND BERBERIS. Some five fossil species have been described that were unearthed from tertiary formation in the south of France, northern Italy and Switzerland which showed considerable resemblance to present forms, especially to *M. Aquifolium* and to other species similar to it (Engler & Prantl, 1891). It is a curious fact, that at present not a single species of *Mahonia* and one only of *Berberis*, namely *B. vulgaris*, is found in Europe. *Mahonia* species are found in North and Central America and Eastern and Southern Asia, and *Berberis* species in Eastern and Central Asia, in South America, a few in North America and North Africa and one in Europe (Rehder, 1927).

CYTOLOGICAL STUDIES. Two species of *Mahonia* and 42 species of *Berberis* were studied. Young anthers were smeared on slides in aceto-carmine solution and the chromosomes of pollen mother cells were stained and counted. The time of development of buds for study began in the early part of April and lasted until the end of May. Buds from *B. aggregata* were not ready until June 19.

As the meiotic chromosomes in *Mahoberberis Neuberti*, the intergeneric hybrid, could not be studied, since this plant does not develop buds, it was necessary to make the study from somatic chromosomes. We tried to get root-tips from cuttings of this and of its parent species but were unsuccessful. Later roots were dug up from the arboretum specimens and root-tips were obtained and fixed in killing solution. Root-tips were fixed in a mixture of 1 part 0.5% chromic acid and 1 part 5% commercial formalin (as stock solutions these are kept separate) in small vials for 1 hour or longer depending on the size of the root-tips and were directly transferred into absolute alcohol for 1 hour or longer. This alcohol is replaced with fresh alcohol for the same length of time, then xylol for 1 hour, placed in the oven in equal parts of xylol and soft paraffin until the paraffin melts, put through two changes of melted hard paraffin, and is then embedded and sectioned. For staining, crystal violet-iodine was used. If the material is fixed in the morning, by evening it can be ready for study. This technique has given excellent results both for chromosome counts and for the study of chromosome structure without causing plasmolysis or shrinkage of cells.

CHROMOSOME COUNTS. In the 44 species studied all but one had 14 pairs of chromosomes; one had 28 pairs, namely *B. turcomanica integerrima*, this being a tetraploid varietal form. The following are the species studied by the author: 2 *Mahonia* species: *Aquifolium, repens;* 42 *Berberis* species: *aemulans, aggregata, amurensis, amurensis japonica, brachypoda, canadensis, candidula, chinensis, circumserrata, dasystachya, diaphana, dictyophylla, Dielsiana, Fendleri, Gagnepainii, Gilgiana, Henryana, heteropoda, Julianae, koreana, laxiflora oblanceolata, Mouillacana, notabilis, ottawensis, Poiretii, polyantha, provincialis* var., *Purdomii, Rehderiana, Sargentiana, Sieboldii, thibetica, Thunbergii, Thunbergii Maximowiczii, Thunbergii minor, Tischleri, turcomanica integerrima* (28 pairs), *Vernae, verruculosa, vulgaris, vulgaris atropurpurea, yunnanensis.*

The following 10 species were studied by Tischler (1931) all but one with 14 pairs of chromosomes. One was a tetraploid species: *Mahonia Aquifolium, M. japonica, M. repens, Berberis Darwinii, B. empetrifolia, B. integerrima, B. Thunbergii, B. Veitchii, B. vulgaris, B. buxifolia* (28 pairs).

No exact measurements were taken but microscopic observation showed all to have apparently the same size of chromosomes. This point was readily proven when the somatic chromosomes of *M. Aquifolium, B. vulgaris,* and *Mahoberberis Neubertii* (the generic hybrid between the two) were studied and drawn under the same magnification.

Size of Pollen Grain

The measurements of pollen grains of a group of plants (Table I) showed some differences but were not considered very striking. The shape of pollen grains of all species of both genera were the same and in no particular detail were they found different. There was no correlation between chromosome number and pollen grain size; therefore it is considered impractical to try to determine by pollen grain measurement which are tetraploid and which are diploid forms. Some plants showed high percentage of sterility. *B. notabilis*, a hybrid form from a cross between *B. vulgaris* and *B. heteropoda*, has practically no sterile pollen grains and its parent species show quite a high percentage of sterility. Pollen grains of *B. notabilis* measured 47.5 μ in diameter, while pollen grains of *B. vulgaris* measured 45.1 μ and *B. heteropoda* 50.6 μ, the hybrid having pollen grains intermediate in size.

TABLE I—POLLEN GRAIN MEASUREMENTS AND PERCENTAGE OF STERILITY

Name of species	Size	Sterility %
M. Aquifolium	52.8	65
M. repens	48.4	50
B. diaphana	52.8	4
B. turcomanica integerrima	52.8	10
B. circumserrata	55	nil
B. Gagnepainii	59.4	30
B. verruculosa	57.2	1
B. Vernae	41.8	5
B. brachypoda	50.6	5
B. laxiflora var.	48.4	40
B. vulgaris	45.1	20
B. heteropoda	50.6	12
B. notabilis	47.5	1
B. provincialis serrata	44	30
B. Tischleri (flowers in three)	55	20
" " (flowers in cluster)	46.2	15
B. Julianae	50.6	7
B. Sargentiana	48.4	7
B. Sieboldii	52.8	1
B. dasystachya	46.2	3
B. Fendleri	48.4	5

Species and Generic Hybrids

In the Arboretum there are two or three plants of *Mahoberberis Neubertii* that vary from each other somewhat and they all are considered to be hybrids between *M. Aquifolium* and *B. vulgaris.* These hybrids have never been known to develop flowers.

All the above evidence indicates convincingly that these two genera are very closely related. It would not be surprising that if some artificial intergeneric crosses were tried between *Mahonia* and species of *Berberis* other than *B. vulgaris*, it might result in some successful hybrids that would bloom. Some such crosses were made but only one developed fruits with seeds (Table IIa). The failure in others (Table IIb) may have been due to rain that followed pollination. Some of the crosses will be repeated next year with the hope of getting some successful intergeneric hybrids.

The genus *Berberis* has been divided into 15 groups (Rehder 1927) based on group characteristics. In Table III are listed some of the hybrid forms both of *Mahonia* and *Berberis*. The parent species are given with their climatic zone number, the name and region of countries of their native habitat, and the group number to which they belong according to their group characteristics.

This list indicates that in some cases quite divergent forms have been hybridized with apparent success. Mr. Rehder told me that most of these are chance hybrids. It is especially remarkable that some hybrids have been obtained from crosses between evergreen and deciduous species. Mr. Judd, Propagator at the Arnold Arboretum, informed me that *B. verruculosa* and *B. Gagnepainii* cross freely and give rise to many varied hybrids.

Table IIa gives the list of crosses made by the author that produced fruits; however, nothing further can be said about these till the seeds are germinated and plants grown to maturity. Table IIb contains the list of crosses that apparently were unsuccessful. As can be seen crosses were made between very divergent species, especially between evergreen and deciduous forms, as well as bebetween *Mahonia* and *Berberis* species.

Discussion

Although *Berberis* and *Mahonia* are very old genera they have the same chromosome number, and the numerous and widespread species of *Berberis* show no important differences in either chromosome number or chromosome size. The fact that the two genera can be crossed, and that species hybrids are frequently found in *Berberis*, shows that no fundamental change has occurred in the chromosomes of these genera and species. Even the species of *Berberis* from different parts of the world can often be crossed when brought together, even though they must have been separated for very long periods of time.

Since *Mahonia* and *Berberis* have the same number and size of chromosomes and can be crossed, there is some justification for including both of these forms in the same genus.

TABLE IIa—SUCCESSFUL CROSSES

Zone No.	Group No.	Habitat	Species Name ♀	Species Name ♂	Zone No.	Group No.	Habitat
VI ?	5	W. China	B. Tischleri	× B. Henryana	V	12	C. China
V	5	N. W. China	B. circumserrata	× B. notabilis			
V	12	Japan	B. Sieboldii	× B. diaphana	V	5	W. China
V	10	Turkest.	B. heteropoda	× M. Aquifolium	V		B. C. & Ore.
V	10	Turkest.	B. heteropoda	× B. Julianae	VI	4	C. China
			B. notabilis	× B. Thunbergii	V	12	Japan

TABLE IIb—UNSUCCESSFUL CROSSES

Zone No.	Group No.	Habitat	Species Name ♀	Species Name ♂	Zone No.	Group No.	Habitat
V		B. C. to Ore.	M. Aquifolium	× B. Sargentiana	VI ?	4	C. China
V		"	"	× B. Julianae	VI	4	C. China
VI ?	4	C. China	B. Sargentiana[1]	× M. Aquifolium	V		B. C. & Ore.
VI	4	C. China	B. Julianae	× "	"		"
V		B. C. to N. Mex. and Calif.	M. repens	× "	"		"
VI ?	5	W. China	B. Tischleri	× B. Julianae	VI	4	C. China
V	5	N. W. China	B. circumserrata	× B. Vernae	V	9	N. W. China
V	5	W. China	B. diaphana	× B. Sieboldii	V	12	Japan
V	5	W. China	B. Tischleri	× B. Vernae	V	9	N. W. China
"	"	"	"	× B. brachypoda	V	14	C. & N. W. China
V	5	N. W. China	B. circumserrata	× "	"	"	"

[1] *B. Sargentiana* started to form fruits but very soon after shed its fruit, both crossed and non-crossed.

TABLE III—THE LIST OF HYBRIDS (FROM REHDER 1927)

Zone No.	Group No.	Habitat	Parent species		Zone No.	Group No.	Habitat	Hybrid name
V	—	B. C. to Ore.	M. Aquifolium	× M. Fortunei	?	—	China	= M. heterophylla
V	—	B. C. to Ore.	M. Aquifolium	× B. vulgaris	III	15	Eu.	= Mahoberberis Neuberti
VII or VIII	—	Calif., New Mex. & Mex.	M. pinnata	× M. Aquifolium	V	—	B. C. to Ore.	= M. Wagneri
VIII ?	3	Chile	B. Darwinii	× B. empetrifolia	VI	1	S. Amer.	= B. stenophylla
VII ?	4	S. W. China	B. pruinosa	× B. diaphana	V	5	W. China	= B. Vilmorinii
VI to VII	4	C. China	B. Veitchii	× B. vulgaris	III	15	Eur.	= B. Vanfleetii
IV ?	5	Siberia	B. sibirica	× B. vulgaris	III	15	Eur.	= B. emarginata
VI	6	W. China	B. Wilsonae	× B. aggregata	V	6	W. China	= B. rubrostilla
V	7	N. W. Himal.	B. aristata	× B. vulgaris	III	15	Eur.	= B. macracantha
V	10	Turkest.	B. heteropoda	× B. vulgaris	III	15	Eur.	= B. notabilis
V	12	Japan	B. Thunbergii	× B. vulgaris	III	15	Eur.	= B. ottawensis
V	12	N. China, Amurl.	B. ? Poireti[1]	× B. canadensis	V	12	Va. to Ga. and Mo.	= B. durobrivensis
V	12	Caucas.	B. ? chinensis	× B. vulgaris	III	15	Eur.	= B. laxiflora
V	12	Caucas.	B. ? chinensis	× B. amurensis	II	15	N. E. Asia	= B. Meehanii
V	12	Va. to Ga. and Mo.	B. ? canadensis	× B. vulgaris	III	15	Eur.	= B. declinata
V	12	Va. to Ga. and Mo.	B. ? canadensis	× B. Fendleri	VI	12	Colo. to New Mex.	= B. Rehderiana

[1] Species with question mark are the species of which identity cannot be certain.

Species differentiation in *Berberis* is not due to changes in chromosome number or to any fundamental change in chromosome structure or genetic constitution. Most of the differences between species are those which might be attributed to mutation associated with geographic isolation. It is possible, of course, that hybridization between closely related forms has played an important part in causing variation in this genus, but the production of polyploid types or fundamental changes in the chromosome complex, produced by wide species hybridization, has evidently not played an important part in the formation of species in *Berberis*.

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BIBLIOGRAPHY

ENGLER & PRANTL, Natürliche Pflanzen-Familien, Teil III, Abt. 2, p. 70–77. Wilhelm Engelmann, Leipzig, 1891.

REHDER, A., Manual of cultivated trees and shrubs, p. 232–250. The Macmillan Company, New York, 1927.

TISCHLER, G., Pflanzliche Chromosomen-Zahlen, p. 133–134 (Tabulae Biologicae Periodicae, 1931).

CHROMOSOMES OF SOME HEVEA SPECIES

W. N. BANGHAM

IN THE SPRING of 1929 the writer, while a student at Bussey Institution, Forest Hills, Massachusetts, conducted an investigation of the cytology of some tropical plants. Thirty-four somatic chromosomes were found in the root tips of *Hevea brasiliensis* Muell. Arg. from the New York Botanic Garden. Heusser (1919) had reported 16 chromosomes in the vegetative and 8 in the generative cells.

It is possible that the tree which had furnished the above material was possibly abnormally polyploid in make-up. The investigation has been continued in Sumatra in the laboratory of the Plant Research Department of the Goodyear Rubber Plantations Co. and was extended to three other species of *Hevea* which were obtained from the Algemeen Proef Station der AVROS through the courtesy of Dr. Heusser. These other species, *H. Collina* Huber, *H. guianensis* Aubl., and *H. Spruceana* (Benth.) Muell. Arg. were budded on to *H. brasiliensis* stock with very good success. The only meristematic material available, therefore, was the growing point, which in every case gave good division figures. The species *H. guianensis* and *H. collina* were placed by Huber (2) under the subfamily *Euhevea* as they have only one ring of anthers in the staminate column, and the species *H. brasiliensis* and *H. Spruceana* he placed in the sub-family *Bisiphonia* which has two rings of anthers in the column. Root tips of *H. brasiliensis* and growing points of the other species were fixed in Flemming's strong solution. Buds of *H. brasiliensis* were fixed in a solution of two parts alcohol and one part acetic acid and were imbedded in paraffin. Smears were not satisfactory with such small anthers. The material was all stained with gentian violet by Newton's method.

The four species of *Hevea* studied had the same number of chromosomes—34—as the diploid count. This count was verified in the case of *Hevea brasiliensis* by counts made of chromosomes in the pollen mother cells. In these there were 17 chromosomes. Division was quite regular in every case observed, both in the homotypic and the heterotypic division.

The matter of whether or not hybridization takes place among the various species of *Hevea* has led to much discussion. T. F. C. (3) has stated that: "Experience has shown that cross-fertilization between *H. confusa* and *H. brasiliensis* readily takes place."

While the chromosome count adds no positive information as to whether hybridity has or has not taken place, the fact that all species investigated contain the same haploid number would suggest that fertile hybrids might be formed in some cases. It is evident that the haploid chromosome complement is quite stable.

I wish to express my indebtedness to Dr. Heusser of the Algemeen Proef Station der AVROS for material, and to Dr. J. R. Weir, Director of the Plant Research Department of the Goodyear Rubber Plantations Company for assistance.

SUMMARY

A study of the chromosomes of *Hevea brasiliensis* Muell. Arg., *H. collina* Huber, *H. guianensis* Aubl., and *H. Spruceana* (Benth.) Muell. Arg. has revealed a diploid count of 34 in every case, and a haploid number of 17 in *H. brasiliensis*.

While no direct evidence of hybridity between species is offered, the possibility of fertile hybrids is indicated.

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SUMATRA

LITERATURE CITED

HEUSSER, C. (1919). Over de voortplantings organen van *Hevea brasiliensis* Muell. Arg. (Archief voor de Rubbercultuur in Nederlandsch Indie).

HUBER, S. (1913). Novas contribuicoes para o conhecimento do genero Hevea. (Bol. Mus. Goeldi).

T. F. C. (1920). Notes on Hevea Confusa Hemsl. (Gard. Bull. Straits Settl. **2:** no. 6, p. 205.

THREE SPECIES OF BOTRYODIPLODIA (SACC.) ON ELM TREES IN THE UNITED STATES

Christine Buisman

Plates 38 and 39 and text figure

In connection with my work on the *Graphium* disease of elm trees in Europe, I studied some die-back diseases of Elms in the United States. Part of these investigations are related to three species of the genus *Botryodiplodia*. Two of these species were described as species of the genus *Sphaeropsis*, but were transferred by Petrak and Sydow to the genus *Botryodiplodia*. Since they are known in literature as *Sphaeropsis* species, however, I shall frequently use that name in the course of this paper, though I agree with Petrak and Sydow that their proper place is in the genus *Botryodiplodia*.

In 1920 Hubert and Humphrey described a serious die-back of American White Elm in Wisconsin. As a result of cankers extending from the twigs into the branches or into the stem, a large part of the tree or even the whole tree died. As Hubert and Humphrey always found *Sphaeropsis ulmicola* Ell. et Ev. on the cankers and always isolated this fungus from the wood of the diseased areas, they consider it the cause of the disease. Their publication, however, is only a preliminary account of the trouble, and inoculation experiments have not been made by them. They suppose that *Sphaeropsis ulmicola* Ell. et Ev. might be identical with *Sphaeropsis malorum* Peck, the well-known cause of blackrot of apples and of an apple tree canker. They pointed out the morphological similarity between the Elm Sphaeropsis and the Apple Sphaeropsis. Apples were attacked readily when inoculated with the Elm Sphaeropsis. Since the disease seems to have decreased, however, in the years following 1920, no further investigations have been carried out on the identity and the pathogenicity of *Sphaeropsis ulmicola* from a phytopathological point of view.

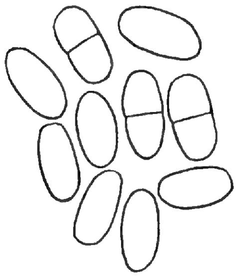
After I came to New England in the fall of 1929, I collected various diseased elm twigs on which a *Sphaeropsis* species was present. I decided, therefore, to continue the work of Hubert and Humphrey. During these investigations I came to the conclusion that three different species of *Sphaeropsis* may be found on elm twigs.

I. Hesler mentions the occurrence of *Sphaeropsis malorum* Peck (*Botryodiplodia malorum* [Peck] Petrak et Sydow) on twigs of *Ulmus americana*. As stated by Petrak and Sydow, the synonymy of this fungus is very complicated and not yet quite clear. It has been thoroughly described, however, by Hesler, including its cultural characteristics, and there is little trouble in identifying it. I found pycnidia of this fungus on diseased elm specimens from various places in New England, both on two year old twigs and on older ones. As an additional aid to diagnosis of the species, I inoculated apple fruits with cultural material from certain of these specimens; typical mummies as caused by *B. malorum* from apple resulted. The bark of the diseased area in young elm twigs is depressed, and separated by a rather sharp edge from the healthy tissue, thus forming a canker. The whole twig may be attacked, or the cankered area may extend along one side of the twig only. Older branches are sometimes flattened as a result of the attack. Below the diseased area twigs may grow somewhat after the manner of a witches'-broom. The diseased wood assumes a brown color, and brown streaks may extend for some distance into the healthy wood. These symptoms may be found both on nursery stock and on large trees. The twigs above a cankered area often lose their leaves and die. From the diseased wood *Sphaeropsis malorum* can be isolated. Sometimes pycnidia of *Phomopsis* sp. and *Cytospora* sp. are also found on these cankers.

When *Sphaeropsis malorum* is grown on sterilized elm twigs it often forms pycnidia with spores. It loses its spore-forming capacity, however, after it has been transferred a few times. I made various one-spore cultures of this fungus. As the spores are fairly large, it is easy to fish them with a thin glass needle from a drop of water and to deposit them on a clear agar medium in a petri dish. Under such circumstances germination of the spores can be quite readily observed. Hesler stated that the sizes of the spores and the relative numbers of two-celled spores are different in various isolations, and I found the same to be true. I measured 50 spores each from elm and apple twigs and from cultures (see figs. 1–5), and found the following sizes:

1. Elm twig: 21–24 μ x 10–12 μ;
2. Apple twig: 20–23 μ x 10½–13 μ;
3. Culture from elm twig: 23–26 μ x 10–12 μ;
4. Culture from apple twig: 22–25 μ x 9–11 μ.

Some inoculation experiments were carried out with *Sphaeropsis malorum*, isolated from elm twigs, on young trees about thirty inches high of *Ulmus americana* growing in the greenhouse. Cross inoculations were also made with the same fungus that had been isolated from an Elm and cultured on an Apple. The inoculations were performed by transferring some mycelium from a pure culture of *S. malorum* into a T-cut in the stems of elm saplings and into



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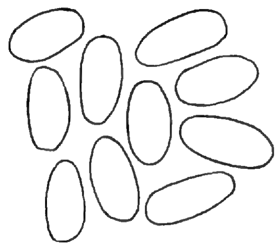

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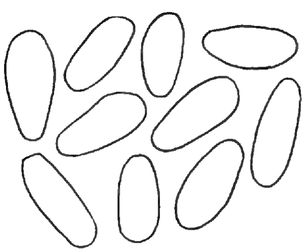

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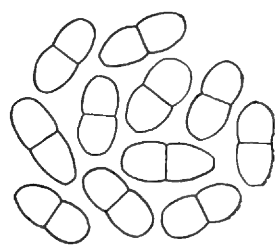

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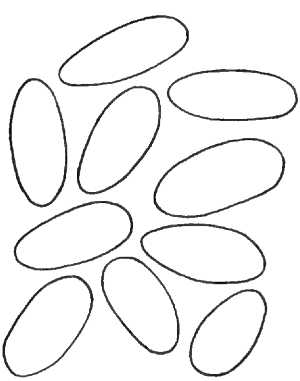

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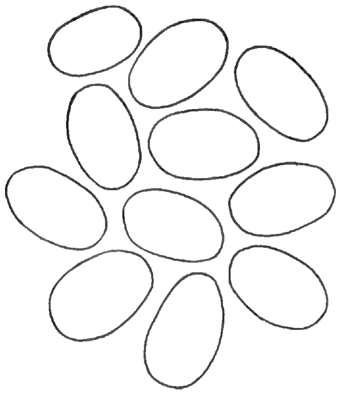
THREE SPECIES OF BOTRYDIPLODIA



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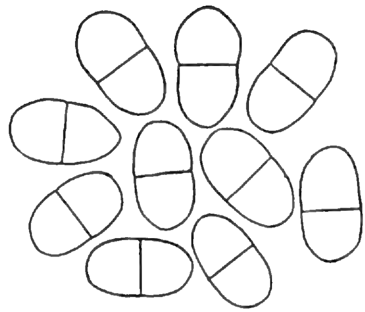

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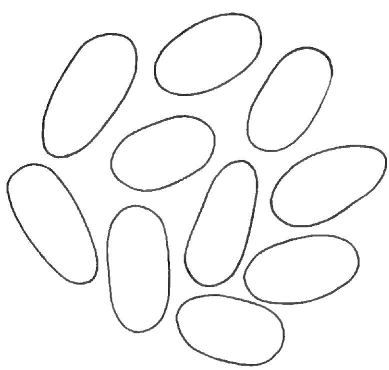

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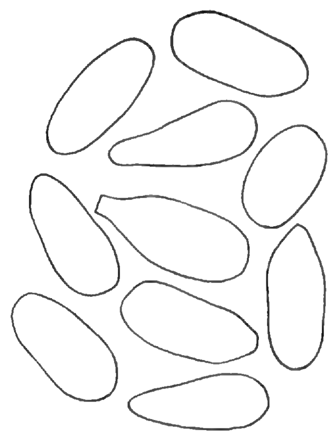

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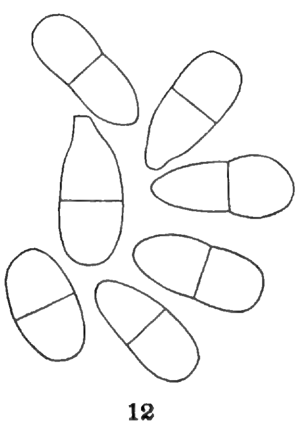

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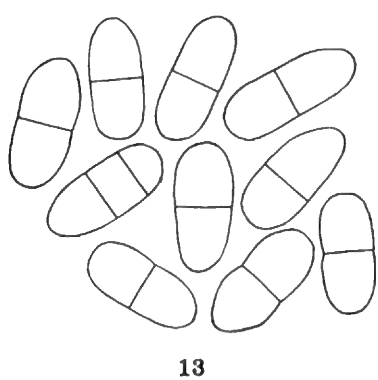

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THREE SPECIES OF BOTRYDIPLODIA

apple twigs. After each inoculation the wound was protected by raffia.

Though Hesler states that a canker formation resulted on apple bark after inoculation with *Sphaeropsis malorum*, originating from *U. americana*, my experiments were negative. On August 20, 1930, young trees, inoculated November and December 1929, and February 1930, were examined. There was neither a formation of cankers nor brown discoloration of the wood. Small pieces of some of these young trees were excised just where the inoculations had been made; the pieces removed were sterilized by leaving them in 0.1% corrosive sublimate for some minutes. After this the bark was peeled off and the pieces of wood were placed in a petri dish with agar. A fungus, always of the same type, grew out from these pieces of wood in six of the eight cases tested; this fungus must be assumed to be *S. malorum*, for while it did not at once form any pycnidia, its vegetative growth was similar to that of *S. malorum*. Three of these cultures that were transferred and taken to Holland have since produced typical spores of *S. malorum* when grown on sterilized maple twigs.

My inoculation experiments, therefore, do not prove the pathogenicity of *Sphaeropsis malorum* with regard to Elms. Since, however, the experiments were performed in a greenhouse, it may be that the conditions were not suitable for infection. In any case, *S. malorum* does not seem to be a virulent parasite for Elms. It is possible that it can establish itself in the twigs only after they have been weakened by some other cause.

II. I stated above that a canker on American White Elm, ascribed to *Sphaeropsis ulmicola* Ell. et Ev. on American Elm, has been reported by Hubert and Humphrey from Wisconsin. Some twigs, showing the typical symptoms of this disease, were sent to me from Wisconsin by Dr. Audrey Richards. Though no pycnidia were present on those twigs it was very easy to isolate *Sphaeropsis ulmicola* from them. Spores were produced in subsequent cultures on sterilized elm twigs. I found that in the same culture dark or white spore horns might be seen protruding from the pycnidia. The white spore horns consist of hyaline, continuous spores, the dark ones of dark brown, mostly two-celled spores. When one-spore cultures were made using either white or brown spores, the results were exactly the same. In the cultures, grown either from a white or from a brown spore, white and brown spore horns might develop regardless of the original color of the spores planted. It may be stated incidentally that agar media are not so suitable for the production of spores as sterilized elm twigs. The growth on elm twigs is dark, and only comparatively few pycnidia are formed.

I measured fifty white and fifty brown spores (see Figs. 6 and 7), and the results were

White spores: 27–30 μ x 14–15 μ;

Brown spores: 25–30 μ x 12–15 μ.

The spores are, therefore, decidedly larger and especially broader than those of *Sphaeropsis malorum.*

Petrak and Sydow include *Sphaeropsis ulmicola* under *Botryodiplodia hypodermia* (Sacc.) Petr. and Syd. In my opinion this should not be done. The fungus I isolated from the Wisconsin twigs agrees closely with the description Ellis and Everhart give of *Sphaeropsis ulmicola.* As the description of Petrak and Sydow of *Botryodiplodia hypodermia* agrees with the third species of *Sphaeropsis* that I found on elm twigs, I propose the removal of *Sphaeropsis ulmicola* Ell. et Ev. from *Botryodiplodia hypodermia* (Sacc.) Petr. et Syd., and prefer to call it **Botryodiplodia ulmicola** (Ell. et Ev.), nov. comb.

Some inoculation experiments were carried out with *S. ulmicola* on young elm trees, in the same way as with *S. malorum.* The inoculations were made in November and December 1929, and in January, February and April 1930, always in the greenhouse. On August 20, 1930, several inoculated saplings were examined, but only in two cases out of twenty-six was a slight discoloration of the wood visible. Six small pieces of these saplings, excised just at the region of inoculation, were sterilized, peeled and placed in a petri dish with agar, as has been described already. In all cases a fungus, similar in its vegetative growth to *S. ulmicola,* was isolated from the wood. Though no spores were immediately produced two of the transfers of these cultures that were taken back to Holland have since produced typical spores of S. *ulmicola.* In two instances small pieces of the saplings, taken just above the points of inoculation, were treated in the same way, but no fungus similar to *S. ulmicola* could be isolated. Therefore, while the fungus was apparently still alive in the wood, it did not make any progress in the suscept beyond the inoculation court.

III. A third species of *Botryodiplodia* I found only on dead twigs of *U. foliacea suberosa* in the Arnold Arboretum of Harvard University. A great many of the young twigs of this tree had died, but this apparently did not seriously interfere with the vigor of the tree, as immediately below the dead twigs new ones were formed, and the trouble did not spread to the thicker twigs. On the dead twigs pycnidia were present, filled with spores. It was easy to fish these spores from a drop of water with a glass needle and deposit them in a petri dish. They germinated readily and soon the mycelium could be transferred. Growth on prune agar was usually meager, but on sterilized elm twigs pycnidia with spores were formed in about 15 days.

This fungus agrees with *Botryodiplodia hypodermia* (Sacc.) Petr. et Syd. The occurrence of hyaline spores is more prevalent in this fungus than it is in *B. ulmicola.* Nearly all the spores are hyaline, in nature and in the cultures. When I first studied it I did not find any brown spores. It was only after some time that I detected them both on the twigs and in cultures initiated with single hyaline spores. The brown spores are nearly always two-celled. One-spore cultures from brown spores are identical with one-spore cultures from white spores; both yield white and brown spores again. I measured 50 spores each from twigs and from various one-spore cultures (see Figs. 8–13), and found the following sizes:

Hyaline spores from twig *a:* 29–34 μ x 15–18 μ;

Brown two-celled spores from twig *a:* 26–31 μ x 15–18 μ;

Monosporic culture from twig *a*, brown spores: 35–39 μ x 15½–17½ μ;

Monosporic culture from twig *a*, hyaline spores: 29–34 μ x 16–19 μ;

Hyaline spores from twig *b:* 26½–30 μ x 16½–20 μ;

Monosporic culture from twig *b*, brown two-celled spores: 32–37 μ x 15–17 μ;

Monosporic culture from twig *b*, hyaline spores: 34–37 μ x 16–17 μ;

Hyaline spores from twig *c:* 26–29 μ x 15½–18 μ;

Monosporic culture from twig *c*, brown two-celled spores: 27–32 μ x 15–18 μ;

Monosporic culture from twig *c*, hyaline spores: 32–37 μ x 16–19 μ.

Though the sizes are variable, they agree fairly well, at least in breadth, with those given by Petrak and Sydow for *Botryodiplodia hypodermia* (20–32 μ, mostly 25 μ x 15–18 μ, rarely to 21μ—Petrak and Sydow). According to Petrak and Sydow the spores remain continuous. It was my experience, however, that the brown spores are nearly always two-celled.

The abundance of the pycnidia in culture is a difference to be noted as between *Botryodiplodia hypodermia* and *B. ulmicola.* But the main difference is in the breadth of the spores, as the spores of *B. hypodermia* are considerably broader than those of *B. ulmicola.*

Inoculation experiments with this fungus on young elm trees in the greenhouse resulted with some success. Text figure 1 shows a small canker on young American Elm, caused by an inoculation with *B. hypodermia.* Another inoculation on the same tree resulted in an inconspicuous canker. When the saplings were examined on August 20, 1930, two out of eight other inoculations, made in April 1930, proved to have been partly successful. In one case a small canker was formed, in the other a white line of demarcation could be seen about half a centimeter from the inoculation wound that separated the diseased from the healthy tissue. Cultures were

Text figure 1. Canker on elm sapling resulting from inoculation with Botryodiplodia hypodermia. It carries pycnidia with spores. Inoculation made Nov. 13, 1929; picture taken Aug. 29, 1930.

made from the region of all these points of inoculation to investigate whether the fungus was still alive, even if no canker had been formed. In seven out of eight cases a fungus could be reisolated that was similar in its vegetative growth to *B. hypodermia.* A culture of some of these reisolations I took with me when I left the United States, and pycnidia with *Botryodiplodia* spores have appeared in them since.

An apple, inoculated with *B. hypodermia* did not show any symptoms of decay for a long time. But at last it rotted in a characteristic manner, as the tissues below the points of inoculation began to sink away. Deeply sunken spots eventually developed and continued to extend into the flesh of the apple. This fungus was, therefore, demonstrated to be pathogenic to the Elm, and to differ from *B. malorum* in its attack on fruits of the Apple.

This research was carried out while the writer was holder of a fellowship of Radcliffe College, Cambridge, Mass. She gratefully acknowledges her indebtedness to Professor J. H. Faull for encouragement during the progress of the investigation, to the Supervisor of the Arnold Arboretum for the provision of material, and to the Department of Botany of Harvard University for laboratory facilities.

SUMMARY

As an adjunct to my researches on the European Elm Disease I have made studies on "die-back" diseases of Elms in America.

From cankers of three such diseases, the first two from *Ulmus americana* and the third from *U. foliacea suberosa*, I isolated a different species of *Botryodiplodia* in each case, namely, *B. malorum*, *B. ulmicola*, and *B. hypodermia* respectively.

These fungi were studied in natural cankers and in cultures. Each was found to produce two types of spores, both in cankers and in monosporic cultures, namely, one-celled and two-celled spores. The latter are commonly brown in color.

Botryodiplodia ulmicola (Ellis and Ev.), n. comb., heretofore included under *B. hypodermia* by Petrak and Sydow, has been separated as a distinct species.

Elm saplings were inoculated in the greenhouse with spores from each of the three species of *Botryodiplodia*. The spores germinated and an infection resulted in each case. During the course of the experiment the mycelia of *B. malorum and B. ulmicola* persisted at the inoculation court in a living condition, but did not cause cankers. The mycelium of *B. hypodermia*, however, invaded tissues adjacent to the inoculation court and caused typical cankers.

LITERATURE CITED

Ellis, J. B. & Everhart, B. M. New species of fungi from various localities. (Proc. Acad. Nat. Sc. Philadelphia, 1891.)

Hesler, L. R. Black rot, leaf spot and canker of pomaceous fruit. (Cornell Univ. Agr. Exp. St. Bull. 379, Aug. 1916.)

Hubert, E. E. & Humphrey, C. J. A canker of the white elm in Wisconsin. (Bienn. Rep. Wisconsin State Dept. Agric. 1919–1920.)

Petrak, F. & Sydow, H. Die Gattungen der Pyrenomyceten, Sphaeropsideen und Melanconieen. 1927. Verlag des Repertoriums, Berlin-Dahlem.

Pathological Laboratory, Arnold Arboretum,
Harvard University.

EXPLANATION OF PLATES 38 AND 39

1. *Botryodiplodia malorum.* Spores from apple twig. × 533.
2. *B. malorum.* Spores from elm twig (Arnold Arboretum). × 533.
3. *B. malorum.* Spores from canker on elm twig (Lexington, Mass.). × 533.
4. *B. malorum.* Spores in culture. × 533.
5. *B. malorum.* Two-celled spores in culture. Taken from a monosporic culture in which there are many two-celled spores. × 533.
6. *B. ulmicola.* Hyaline spores taken from a monosporic culture.
7. *B. ulmicola.* Brown spores from culture. × 533.
8. *B. hypodermia.* Hyaline spores from elm twig. × 533.
9. *B. hypodermia.* Brown spores from elm twig. × 533.
10. *B. hypodermia.* Hyaline spores taken from a monosporic culture. × 533.
11. *B. hypodermia.* Hyaline spores taken from a monosporic culture. × 533.
12. *B. hypodermia.* Brown spores taken from a monosporic culture. × 533.
13. *B. hypodermia.* Brown spores taken from a monosporic culture. × 533.

NOTES

The Arnold Arboretum during the Fiscal year ended June 30, 1931.

The Arboretum.—The summer of 1930 was characterized by a serious drought. Artificial means of watering were attempted where the plantations were in obvious need of moisture, but it was impossible to meet the requirements of every plant or to do more than supply the minimum of relief to rare or unfavorably situated specimens of trees and shrubs, yet the injuries caused by the drought were not serious.

The winter was mild and proved favorable in that the ground was covered with snow for much of the time. The mildness of the winter was evident in the profusion of flowers produced by the Cherries and allied groups, and in the slight or negligible injury to the flower buds of the less hardy introduced trees and shrubs.

In the late spring the effects of the drought of the preceding summer became manifest in the abundance of dead wood that had to be removed from the trees and in the necessity for severe pruning among the shrubs. Copious rains in June, records for rainfall for the month being broken, were extraordinarily beneficial.

The "Bulletin of Popular Information" goes to 1,932 subscribers. It has proved to be a valuable medium for spreading information with regard to the behavior of woody plants that have proved hardy in the climate of Boston. Eighteen numbers were issued in 1930.

The "Journal of the Arnold Arboretum" is widely circulated, being issued to 300 subscribers and scientific institutions at home and abroad. It has proved to be a valuable medium of exchange with other libraries and we are indebted to it for many serial publications that are received by the Library of the Arnold Arboretum. Beginning with the twelfth volume (1931) the format and paper of the "Journal" were changed and the editorial work given to Alfred Rehder as editor and to Professors Faull and Sax as associate editors.

Between July 1, 1930, and June 30, 1931, to countries in all parts of the world 1,812 packets of seed were distributed and in the same period there were sent to institutions and individuals in the United States, Canada, Great Britain, Holland, Germany, Poland and Austria 1,097 cuttings. In the United States, Great Britain and Holland there were distributed 1,780 plants. In exchange there were received from New Zealand, the United States and countries in Europe, Asia, and South America 321 packets of seeds and 10,492 plants and cuttings.

At the end of this report there is appended a bibliography comprising the publications of the staff and students in the period covered between July 1, 1930, and June 30, 1931. This bibliography cogently shows the extent and nature of the investigations that are being undertaken by the Arnold Arboretum in the realm of botany and horticulture. It is worthy of note that several of the publications listed have been copied almost verbatim in foreign journals and have thrown new light on perplexing problems.

Visitors to the Administration Building numbered 1,178, representing Scotland, England, Ireland, New Zealand, Sweden, Germany, France, Russia, South Africa, India, Poland, Bulgaria and 35 of the United States.—O. A.

Pathological Laboratory.—Many requests for information on plant diseases were received by the Pathological Laboratory during the past year. These have pertained to a wide range of host species and diseases, and have referred to individual trees or shrubs, entire plantations and to forest areas covering tens of thousands of acres. To the exceptional inquirer interest centers in the disease itself, but generally the main concern is to learn how the disease may be eliminated, controlled or prevented. The Arboretum welcomes both types of inquiries, though sight is never lost of the fact that the ultimate ideal of its pathological division is the accumulation of data on the ways in which the conflicting factors that beset ornamental plants or forests, may be adjusted to permit normal development. (J. H. Faull, The Health of the Forest. *Forest and Outdoors*, **26**: 146–149. 1930.)

Another phase of our work has to do with aid given to students of pathological problems. During the year we have had seven of these, who have come to us from the United States, Canada and Europe.

The investigational activities for the year have been varied and substantial progress can be reported on several of the projects undertaken. Naturally the number of subjects under investigation at one time is limited, not by the number that call for research, but by man power and financial support. We have received heartiest co-operation from the Supervisor and some material aid from outside. A summary of the more important topics follows.

1. Diseases of Conifers. Several weeks were spent in the forest on a study of trunk diseases of Spruce, their causes, their relative frequency of occurrence, relation to age of the trees, the conditions that under-lie their spread, closer utilization and control. Investigations on these and certain other coniferous diseases have been continued in the laboratory.

2. Elm Diseases. Dr. Christine Buisman of Holland, who, as reported last year, first positively identified the occurrence of the Dutch Elm disease in America, studied various native diseases of Elms while at the Arboretum. Certain results of her work are recorded in this number of the Journal of the Arnold Arboretum.

3. Graft Blight of Lilacs. An important part of Dr. K. S. Chester's work on this disease was completed during the year. He was able to demonstrate the cause as involved in the common practice of propagation of Lilacs on privet stocks, a practice that has arisen, not through necessity but because of its somewhat lower cost. His work is bound to be a valuable aid to the lilac industry and to private growers. (K. S. Chester, Graft-Blight: A Disease of Lilac Related to the Employment of Certain Understocks in Propagation. *Jour. Arnold Arboretum*, XII. 79–146. 1931.

4. Studies on Ganoderma. The greatest confusion has prevailed with reference to the taxonomy of a group of wood-attacking fungi, on both hardwoods and softwoods, of the genus *Ganoderma*. An excellent piece of work by W. R. Haddow, based on a comparative study of distictive characters has revealed what appears to be the key to a correct understanding of the species concerned. (W. R. Haddow, Studies in Ganoderma. *Jour. Arnold Arboretum*, XII, 25–46. 1931.)

5. An Epidemic of Beech. The devastating epidemic on Beech in Nova Scotia has spread across the border into New Brunswick. Mr. John Ehrlich has begun his second year of study on this disease and finds that it results from a joint attack of a Coccus insect and

a Nectria fungus. The Coccus has been found by him in metropolitan Boston. His studies, not yet completed, afford interesting information as to cause and spread, and data on the matter of control.

6. THE NEEDLE CAST FUNGI OF CONIFERS. Dr. G. D. Darker has now assembled his work on the morphology and the biology of the needle cast fungi of conifers. The number of known species (about 50) is doubled and a good beginning made on a study of life histories. It is anticipated that the publication will be issued soon from the Arboretum in monographic form.— J. H. F.

Cytology Laboratory.—Cytological investigations of chromosome numbers in various families of plants have been continued during the year ended June 30, 1931. In certain groups, such as the Pomoideae, the chromosome numbers are closely correlated with the taxonomic grouping. In the Pomoideae cytological studies have given us considerable information concerning the origin and relationships of different genera and species. Chromosome numbers have also been obtained from representative genera and species of the Oleaceae, Berberidaceae, Cornaceae, Saxifragaceae, and from a number of isolated genera.

Considerable work has also been done on chromosome structure and behavior in relation to the mechanism of heredity. One paper has been completed on chromosome behavior in *Rhoeo*, based on material collected at the Harvard Botanic Garden, Soledad, Cuba. This paper has been sent to a Japanese journal for publication. Another long paper on chromosome structure is practically completed, also based on preparations made in Cuba in 1930. Mr. Dermen has published a paper on chromosome pairing in polyploids, and a paper on the mechanism of chromosome pairing by Mr. O'Mara has been sent to CYTOLOGIA for publication.

The breeding work was conducted on a large scale last spring and about 200 crosses were made between different species and varieties of ornamental shrubs and trees. Many of these crosses were successful. Earlier breeding work has produced a hybrid of unusual interest,—a cross between *Syringa pinnatifolia* and *S. oblata*. Similar hybrids of spontaneous origin have also been found in the nursery by Mr. Judd.—K. S.

The Herbarium.—The Herbarium contains 348, 603 specimens, 15,234 having been added between July 1, 1930 and June 30, 1931. Of accessions approximately 1,600 represent plants that are natives of the United States and Canada, 4100 that are natives of Central and South America, 2500 that are natives of China, 1250 that are natives of Southern Asia and Malaysia, 800 that are natives of Europe and Western and Central Asia, 1000 that are natives of Africa and 1500 that are natives of Australasia. About 1000 of the accessions represent cultivated plants.

Among the more important collections received during the year are the following: 1700 specimens collected by J. G. Jack in Cuba including cultivated plants from the Harvard Botanic Garden near Cienfuegos, 900 numbers with duplicates collected by Mrs. Susan Delano McKelvey, chiefly in Arizona, New Mexico and Texas; about 3000 numbers with duplicates collected in the northwestern and southeastern states by E. J. Palmer; about 700 specimens of Central and South American plants, chiefly collected by Ekman and Dusén (by exchange from the Botanical Museum at Stockholm); approximately 500 specimens from Haiti collected by Leonard; about 450 plants from British Honduras collected by Schipp; 150 plants from Venezuela collected by Pittier; about 200 Mexican plants collected by Purpus; about 650 Kwangtung plants received from the Sun Yatsen University; about 800 specimens of Kwangsi plants collected by Ching from the Metropolitan Museum in Nanking; about 800 numbers with many duplicates of Shantung plants collected by C. Y. Chiao from Nanking University; about 200 plants collected by Liu in Chili; about 175 plants collected by Rock in Szechuan; about 150 Japanese plants collected by T. Tanaka; about 250 Himalayan plants from the Forestry Institute at Dehra Dun; about 300 plants with many duplicates collected by Bornmueller in Asia Minor; about 150 plants of Central Asia from the University of Tashkent; about 700 plants from Madagascar and East Africa with duplicates collected by H. Humbert; about 200 Kamerun plants collected by Mildbraed; about 1200 specimens from New Caledonia collected by I. Franc, and a large collection made by Kajewski in the Solomon Islands.

To the fruit collection 214 specimens have been added bringing the number of fruit specimens to 7251.

The wood collection contains 2282 specimens, 106 having been added during the year.

To the collection of negatives of types and other herbarium specimens 540 negatives were added during the year 512 of these representing types of Chinese plants photographed by Alfred Rehder in European herbaria. The collection now contains 1766 plates and films.

Besides the constant use of the herbarium by the staff in the determination of plants sent in for identification and in the determination of some large collections chiefly from Eastern Asia and North America, the facilities of the herbarium have been used by members of other departments of the University and by representatives of other institutions. Dr. F. P. Metcalf of Lignan University, Canton, who is preparing a flora of Fukien and E. H. Walker of the National Herbarium in Washington, who is working on a revision of the Chinese Myrsinaceae have depended largely on our collections in the prosecution of their work.

For study outside the Arboretum 368 specimens were sent out on loan to 16 institutions and individuals.

There have been distributed 25,424 specimens to 46 institutions in the United States, Canada, Europe, Asia, Africa and Australia.

Botanical explorations by members of the staff or expeditions partly financed by the Arnold Arboretum have been carried on in different parts of the world. Since March 1930 Mr. S. F. Kajewski has been collecting in the Solomon Islands spending his time during 1930 on Bougainville Island, the largest of the group; he has been very productive and we have already received a large amount of material. Professor C. Y. Chiao returned in September 1930 from the expedition to Shantung mentioned in the report for 1929–30, and this year he expected to start, toward the end of June, with Professor A. N. Steward for the province of Kweichou. Mr. R. Goerz from the beginning of April to the beginning of August undertook a collecting tour into northern Asia Minor primarily for the study of the Willows of that region. From the beginning of April to the beginning of June Mrs. Susan Delano McKelvey collected chiefly in the southwestern United States, obtaining approximately 900 numbers with duplicates. She gave special attention to the species of *Yucca*, *Nolina* and *Agave* and visited most of their type localities; in addition to ample herbarium material representing these genera, she collected 84 numbers of flowers and fruits in formaldehyde and took about 100 excellent photographs. Professor J. G. Jack spent the month of July 1930 and the month of March 1931 in Cuba continuing his botanical explorations in the vicinity of the Harvard Botanic Garden near Cienfuegos. Mr. E. J. Palmer collected from the middle of June to the beginning of September 1930 in the northwestern United States and from the end of March to the middle of June in the southeastern United States as far west as Oklahoma, paying particular attention to the species of *Crataegus*. Mr. Alfred Rehder spent the summer from the end of June to the middle of September in Europe where he attended the International Congress of Horticulture in London as a member of the International Committee on Horticultural Nomenclature. He also attended the

International Botanical Congress in Cambridge. At the meeting in Cambridge he participated chiefly in the sessions of the Subsection on Botanical Nomenclature. Most of the proposals he had submitted for changes in the present rules were accepted and he was appointed a member of the Executive Committee of the Subsection on Botanical Nomenclature and of the Special Committee on Phanerogams and Pteridophytes. He also visited the herbaria of Kew, the British Museum, Paris, Berlin, Breslau and Vienna where he examined and took photographs of over 500 types of Chinese plants.—A. R.

The Library.—During the past year there have been added to the Library 688 volumes, 215 pamphlets and 965 photographs, the total number at the end of June being 39,770 bound volumes, 9,680 pamphlets and 16,465 photographs. Many of the photographs have been received by gift, about 100 by purchase, while the larger number were taken for the Arboretum, either in the Arboretum or in the Middle- or South-west. The remaining unidentified photographs taken by Mrs. Anita G. Curtis in Africa, have been named and placed in the files. A few portraits of well-known botanists and horticulturists have been received in exchange for those of botanists on the Arboretum staff.

Several new periodicals are received in exchange for the "Journal of the Arnold Arboretum" and the "Arnold Arboretum Bulletin of Popular Information," among which are:

HIROSHIMA UNIVERSITY. Journal of science. Series B, div. ii. Vol. i, art. 1 → Hiroshima. [1930] →

BRITTONIA. Vol. i, no. 1 → New York. 1931 →

LINGNAN UNIVERSITY, *Canton, China.* Science bulletin, no. 1 → Canton. 1930 →

ROSEN-ZEITUNG; zeitschrift des Vereins deutscher rosenfreunde. Jahrg. 46, no. 1 → Sangerhausen. 1930 →

SUNYATSENIA. Vol. i, no. 1 → Canton. 1930 →

LA TERRE ET LA VIE. No. 1 → Paris. 1931 →

TROPICAL HORTICULTURE. Vol. i, no. 1 → Taihoku. 1931 →

A new collection in the Library is that of lantern slides, of which 320 were made from Dr. E. H. Wilson's photographs taken in China and Japan, 844 were the gift of Prof. J. G. Jack and 244 were received from Mrs. George L. Slate, making a total of 1,408. These lantern slides have been catalogued.

More than 1,239 cards were filed in the catalogue of the Library and 1,600 slips were prepared for the supplement to the printed catalogue, which is now in the hands of the printer. To the catalogue of photographs 1,000 cards were added during the year and 4,889 cards were placed in the "Card-index of new genera, species and varieties published by the Gray Herbarium." To the manuscript "Index of illustrations and of new genera, species and varieties of ligneous plants published since 1915," prepared at the Arboretum, 4,040 cards have been added giving a total at the end of June of 88,912.

Four hundred and twenty-five books, including periodicals, have been bound.

Thirty-two shelves have been added to the periodical section, necessitating re-arrangement and the entire re-numbering of that section. Twelve steel filing units have been purchased to replace old stacks and pamphlets and nursery catalogues transferred to them and re-arranged.

For want of sufficient space many of the books of travel were moved and re-arranged, as were also the Japanese floras and periodicals. Approximately 1,000 of the more valuable old leather bindings, including many folios, have been lubricated and retouched, restoring their former beauty and protecting them against further injury.

Among the more important accessions of the year are:

CHAMBERS, William. A dissertation on oriental gardening. [With] an explanatory discourse by Tan Chet-qua. 2d ed. London. 1773.

HERBARUS [sic] zu teütsch und von aller hand kreüttern. Augspurg. 1502.—Woodcuts colored by a contemporary hand.

GREW, Nehemiah. Anatomie des plantes. Paris. 1675.

CHELLINI, Tommaso. Libro d'erbe dipinte al naturale. Scandicci. 1737.—Comprises 380 pages of colored drawings and 6 pages of text. Most of the drawings are of herbaceous plants.

SWEERT, Emanuel. Florilegium, tractans de variis floribus et aliis indicis plantis ad vivum delineatum in duabus partibus et quatuor linguis concinnatum. Francofurti. 1615, '14. 110 plates.—Title-page of pt. i bears also the date "1612."

CULLEN, William. A treatise of the materia medica. 2 vol. Edinburgh. 1789.

LINNÉ, Carl von. Berättelse om the inhemska wäxter, som i brist af sad kunna anwändas til bröd- och matredning. Stockholm. 1757.

This very rare brochure, in which Linnaeus enumerates the plants suitable for bread-making and food generally, was published in consequence of the failure of the crops in Sweden. Few copies are known to exist beyond those in the libraries of the British Museum and the Linnean Society, London, and the Library of Congress, Washington.

ANNALEN der forst-und jagd-wissenschaft. Tom. i–v; vi, heft 2. Darmstadt. 1811–21.

MURRAY, Johann Andreas. Prodromus designationis stirpium gottingensium. Gottingae. 1770.

CHATELAIN, Joan Jacob. Specimen inaugurale de Corallorhiza. [Basiliæ.] 1760.— Reproduced by Merrymount Press, Boston. 1919. Gift of Professor Oakes Ames.

STAPF, Otto. Index londinensis. Vol. iv, v. Oxford. 1930–31.

FERBER, Joh. Eberh. Hortus agerumensis. Holmiæ. 1739.

WICKES, Dean R. Flowers of Peitaiho. Peking. 1925.

NAKAI, Takenoshin. Florula of M't. Paik-tu-san. Seoul. 1918. —Gift of the author.

[RUIZ LOPEZ, Hipolito. Flora peruviana, et chilensis. Auctoribus Hippolyto Ruiz et Josepho Pavon. Twenty-eight unpublished plates of twenty-nine American species of Laurus.] N. P. [1802.] f°.—These unnumbered plates, cited as "Laurographia," were prepared for a 4th volume of "Flora peruviana, et chilensis" which was never issued. The Arnold Arboretum copy is the only known copy of the original plates in this country. On the inside of the cover is written in a fine hand "Laurographia devoué pour Monsieur le Respectable Palassou, par son passionné, M^{r}. J. Pavon. Offert à M. le Professeur De Candolle par son ami Léon Dufour."

An ACCURATE description of the cacao-tree. [London. 1673].

DUPPA, Richard. Illustrations of the lotus of the ancients, and tamara of India. London. 1816. f°.—12 hand-colored plates. "Only twenty-five copies printed."

The MARY ROBESON SARGENT FUND has made possible the purchase of some of the more expensive works.

Through the courtesy of the publishers, the Library has received Dr. E. H. Wilson's "If I were to Make a Garden."[1] Garden lovers everywhere will welcome this last book from the pen of Dr. Wilson. In more than 200 pages and 37 plates he gives a comprehensive picture of the garden of his dreams, loveable and satisfying. The claim of each plant to a place in the garden, its habit and requirements, are carefully noted, and the chapter on Boxwood adds a helpful bit of information for those interested in this historic shrub.

From the LIBRARY OF THE MASSACHUSETTS HORTICULTURAL SOCIETY have come nos. 1–4 of the rare vol. iii. of C. M. HOVEY'S "The fruits of America," [1858?], f°, 19 colored plates.

[1] If I were to make a garden. By Ernest H. Wilson. Boston, Stratford Company, 1931, 1. 8°. pp. xvi, 295. Port. and 37 plates.

Several gifts have been received from the Uniwersytet Jagiellonski w KRAKOWIE.

To MISS EMILY SARGENT and MRS. FRANCIS ORMOND the Library is indebted for six original pencil drawings by their brother, JOHN SINGER SARGENT. They are sketches of trees and vines and are interesting from a botanical point of view. Perhaps the most interesting one is that of the strangling fig.[1] The Library has received also three botanical drawings and a water color, the work of Mrs. Blanche Ames. They are a valuable addition to the growing group of artists' originals.

The constantly increasing demands upon the resources of the Library have been gratifying.—E. M. T.

Bibliography of the published writings of the staff and students July 1, 1930–June 30, 1931

AMES, Oakes.

A new species of Pleurothallis from Mexico. By Oakes Ames and Charles Schweinfurth. (In *Proceedings of the Biological society of Washington*, 1930, xliii, 195–196.)

Schedulae orchidianae. No. 10. Boston. 1930.

The Arnold Arboretum; [report 1929–30]. (*In* Report of the President of Harvard College, 1931, pp. 244–248.)

An addition to the flora of Honduras. (In *Proceedings of the Biological society of Washington*, 1931, xliv, 43–44.)

Botanical drawings by John Singer Sargent. (In *Arnold arboretum bulletin of popular information*, 1931, v, 37–40.)

Davidia involucrata. (In *Arnold arboretum bulletin of popular information*, 1931, v, 25–28.)

New or noteworthy Philippine orchids. i. By Oakes Ames and Eduardo Quisumbing. (In *Philippine journal of science*, 1931, xliv, 369–383.)

A new species of Pleurothallis from Central America. (In *Proceedings of the Biological society of Washington*, 1931, xliv, 41–42.)

An addition to the flora of Honduras. (In *Proceedings of the Biological society of Washington*, 1931, xliv, 43–44.)

Rhus verniciflua and Japanese damascene ware. (In *Journal of the Arnold arboretum*, 1931, xii, 1–3.)

CHESTER, Kenneth Starr.

The phytophthora disease of the calla in America. (In *Journal of the Arnold arboretum*, 1930, xi, 169–171.)

Graft-blight of lilac. (In *Journal of the Arnold arboretum*, 1930, xi, 232–233.)

Graft-blight: a disease of lilac related to the employment of certain understocks in propagation. (In *Journal of the Arnold arboretum*, 1931, xii, 79–146.)

Graft-blight of lilac. (In *Arnold arboretum bulletin of popular information*, 1931, v, 5–8.)

DERMEN, Haig.

Polyploidy in Petunia. (In *American journal of botany*, 1931, xviii, 250–261.)

FAULL, Joseph Horace.

Some general remarks regarding forest pathology in relation to forestry

[1] See Arnold Arboretum Bulletin of popular information, June 24, 1931.

and notes on forest diseases in Nova Scotia. (In *Report of the department of lands and forests, Nova Scotia*, 1930, pp. 33–40.)
The spread and the control of Phacidium blight in spruce plantations. (In *Journal of the Arnold arboretum*, 1930, xi, 136–147.)
Arnold arboretum Pathological laboratory; [report 1929–30]. (In *Journal of the Arnold arboretum*, 1930, xi, 235–237.)
The Dutch or European elm disease. (In *Country life*, 1931, lix, 106.)

HADDOW, William Robert.
Studies in Ganoderma. (In *Journal of the Arnold arboretum*, 1931, xii, 25–46.)

JACK, John George.
Planting trees in autumn. (In *Arnold arboretum bulletin of popular information*, 1930, iv, 65–68.)
Late persisting leaves on deciduous trees. (In *Arnold arboretum bulletin of popular information*, 1930, iv, 69–72.)
Effect of cold on flower buds of trees and shrubs. (In *Arnold arboretum bulletin of popular information*, 1931, v, 1–4.)
Forsythias. (In *Arnold arboretum bulletin of popular information*, 1931, v, 9–12.)
Flowering cherries. (In *Arnold arboretum bulletin of popular information*, 1931, v, 13–16.)
Various shrubs. (In *Arnold arboretum bulletin of popular information*, 1931, v, 21–24.)
American crabapples. (In *Arnold arboretum bulletin of popular information*, 1931, v, 29–32.)
Bush honeysuckles. (In *Arnold arboretum bulletin of popular information*, 1931, v, 33–36.)
Persimmons. (In *Arnold arboretum bulletin of popular information*, 1931, v, 41–44.)

JUDD, William Henry.
Lilacs which have proved their worth. (In *Horticulture*, 1930, viii, 379–380.)
Cultivation of the beauty-bush. (In *Horticulture*, 1930, viii, 404.)
Experience with Vitex macrophylla. (In *Horticulture*, 1931, ix, 13.)
A hardy holly from Japan. (In *Horticulture*, 1931, ix, 77.)
Kalmia latifolia. (In *Gardeners' chronicle*, 1930, lxxxviii, 297.)
Evonymus latifolia. (In *Gardeners' chronicle*, 1930, lxxxviii, 363.)
Ilex crenata var. bullata. (In *Gardeners' chronicle*, 1931, lxxxix, 90.)
Rhexia virginica. (In *Gardeners' chronicle*, 1931, lxxxix, 91.)

KOBUSKI, Clarence Emmeren.
A supplement to J. T. P. Byhouwer, "An enumeration of the roses of Yunnan." (In *Journal of the Arnold arboretum*, 1930, xi, 228–231.)

KRIBS, David Alson.
Chromosomes and phylogeny in Caprifoliaceae. By Karl Sax and D. A. Kribs. (In *Journal of the Arnold arboretum*, 1930, xi, 147–153.)

PALMER, Ernest Jesse. Additional notes on Texas ferns. (In *American fern journal*, 1930, xx, 138–142.)

REHDER, Alfred.
The azaleas and their allies. (*In* The species of Rhododendron, published by the Rhododendron Society, 1930, pp. 1–3, 42–123, 607–609.)
Zur nomenklatur der Magnolia kobus *D. C.* (In *Mitteilungen der Deutschen dendrologischen gesellschaft*, 1930, nr. 42, pp. 40–41.)
New species, varieties and combinations from the herbarium and collections of the Arnold arboretum. (In *Journal of the Arnold arboretum*, 1930, xi, 153–168; 1931, xii, 59–78.)
Ernest Henry Wilson. (In *Journal of the Arnold arboretum*, 1930, xi, 181–192.)—Reprinted in *Journal of the Kew guild*, 1931, v, 67–73.

Arnold arboretum Herbarium; [report 1929–30]. (In *Journal of the Arnold arboretum*, 1930, xi, 238–240.)
Species of Rhododendron; [book review]. (In *Journal of the Arnold arboretum*, 1931, xii, 146–147.)
Illustrations of Eucalyptus; [book review]. (In *Journal of the Arnold arboretum*, 1931, xii, 147–148.)

ROUSH, Eva Myrtelle Fling.
Monograph of the genus Sidalcea. (In *Annals of the Missouri botanical garden*, 1931, xviii, 117–244.)
A synopsis of Robinsonella. (In *Journal of the Arnold arboretum*, 1931, xii, 49–59.)

SAX, Hally Jolivette.
Chromosome numbers in Quercus. (In *Journal of the Arnold arboretum*, 1930, xi, 220–223.)

SAX, KARL.
Chromosomes and phylogeny in Caprifoliaceae. By Karl Sax and D. A. Kribs. (In *Journal of the Arnold arboretum*, 1930, xi, 147–153.)
Chromosome structure and the mechanism of crossing-over. (In *Journal of the Arnold arboretum*, 1930, xi, 193–220.)
Arnold arboretum Cytological laboratory; [report 1929–30]. (In *Journal of the Arnold arboretum*, 1930, xi, 237–238.)
The origin and relationships of the Pomoideae. (In *Journal of the Arnold arboretum*, 1931, xii, 3–22.)
Chromosome numbers in the ligneous Saxifragaceae. (In *Journal of the Arnold arboretum*, 1931, xii, 198–206.)
Plant hybrids. (In *Arnold arboretum bulletin of popular information*, 1931, v, 17–20.)

TUCKER, Ethelyn Maria.
Arnold arboretum Library; [report 1929–30]. (In *Journal of the Arnold arboretum*, 1930, xi, 240–244.)

WILSON, Ernest Henry.
Boxwood and the landscape scheme. (In *House and garden*, 1930, lvii, July.)
Forsythias to greet the spring sun. (In *House and garden*, 1930, lvii, Aug.)
Shrubs for banks and other steeply sloping places. (In *House and Garden*, 1930, lvii, Sept.)
Plants that climb the garden wall. (*In House and garden*, 1930, lvii, Oct.)
Shrubs to plant by the waterside. (In *House and garden*, 1930, lviii, Nov.)
Flowering bushes and small trees to fringe the border of the woodland. (In *House and garden*, 1930, lviii, Dec.)
Thuja orientalis and Juniperus chinensis. (In *Journal of the Arnold arboretum*, 1930, xi, 135–136.)
Arnold arboretum bulletin of popular information, 1930, iv, nos. 13–16.
Summer-flowering trees and shrubs. (In *Horticulture*, 1930, viii, 335–336.)
A new greenhouse Rhododendron. (In *Horticulture*, 1930, viii, 349–350.)
The purple-stamened Stewartia. (In *Horticulture*, 1930, viii, 380.)
The new Taxus cuspidata Thayerae. (In *Horticulture*, 1930, viii, 424.)
Viburnums for autumn color. (In *Horticulture*, 1930, viii, 447–448.)
Choosing shrubs for their fruits. (In *Horticulture*, 1930, viii, 483.)
In defense of goldenrod. (In *Horticulture*, 1930, viii, 484.)
The Arboretum; [report 1929–30]. (In *Journal of the Arnold Arboretum*, 1930, xi, 233–235.)
If I were to make a garden. Boston, Stratford Press. 1931.

ZIRKLE, Conway.
Nucleoli of the root tip and cambium of Pinus strobus. (In *Cytologia*, 1931, ii, 85–105.)—E. D. B.

Staff of the Arnold Arboretum, 1931–32

OAKES AMES, A.M., Professor of Botany, Supervisor.
JOHN GEORGE JACK, Assistant Professor of Dendrology.
ALFRED REHDER, A. M., Curator of the Herbarium.
JOSEPH H. FAULL, Ph.D., Professor of Forest Pathology.
KARL SAX, Ph.D., Associate Professor of Cytology.
EDGAR ANDERSON, Sc.D., Arborist.
IVAN MURRAY JOHNSTON, Ph.D., Research Associate.
CLARENCE E. KOBUSKI, Ph.D., Assistant Curator, Herbarium.
SUSAN DELANO MCKELVEY, Research Assistant.
K. S. CHESTER, Ph.D., Research Assistant.
ERNEST J. PALMER, Research Assistant.
EVA M. FLING ROUSH, Ph.D., Assistant in the Herbarium.
ETHELYN MARIA TUCKER, Librarian.
KATHARINE ELEANOR KELLEY, Assistant in the Library.
ETHEL ANTOINETTE ANDERSON, Business Secretary.
LOUIS VICTOR SCHMITT, Superintendent.
WILLIAM HENRY JUDD, Propagator.

ERRATA AND ADDENDA

Page 42, line 4 *for* Qebec *read* Quebec
" 59, line 10 from below *after* Bayard *insert* Thayer
" 73, line 5 from below *for* **Ilex crenata** f. **bullata,** f. nov. *read*: **Ilex crenata** f. **convexa** Makino in Jour. Jap. Bot. v. 27 (1928).
Ilex crenata f. *bullata* Rehder in Jour. Arnold Arb. XII. 73 (1931).
" 76, line 23 for *Thunbergii* read *fragrans*
" 165, line 15 *for* Forsythe County *read* Macon County
" 169, line 16 *for* Fig. 3. *read* Fig. 4.
" 176, after line 26 under 9. **Amorpha laevigata** insert:

Since the publication in the July issue of this Journal of a Conspectus of the Genus *Amorpha*, we have received through the courtesy of the authorities of the British Museum a photograph and fragments of a flowering raceme of the type specimen of *Amorpha laevigata* from the Nuttall Herbarium. The type specimen consists of a flowering branch showing leaves and several much-elongated spikes of the inflorescence, just coming into flower. It is gratifying to find that the evidence of the type specimen quite confirms the view taken of this species from the original description and the study of other collections, and that the Texas specimens enumerated seem to be clearly referable to it.—E. J. P.

" 195, line 1 from below *for* (XI) *read* (× 1)
" 196, line 7 and 2 from below *for* Philipp. *read* Filip.

INDEX

Synonyms are printed in *italics;* new names in **bold-face type**